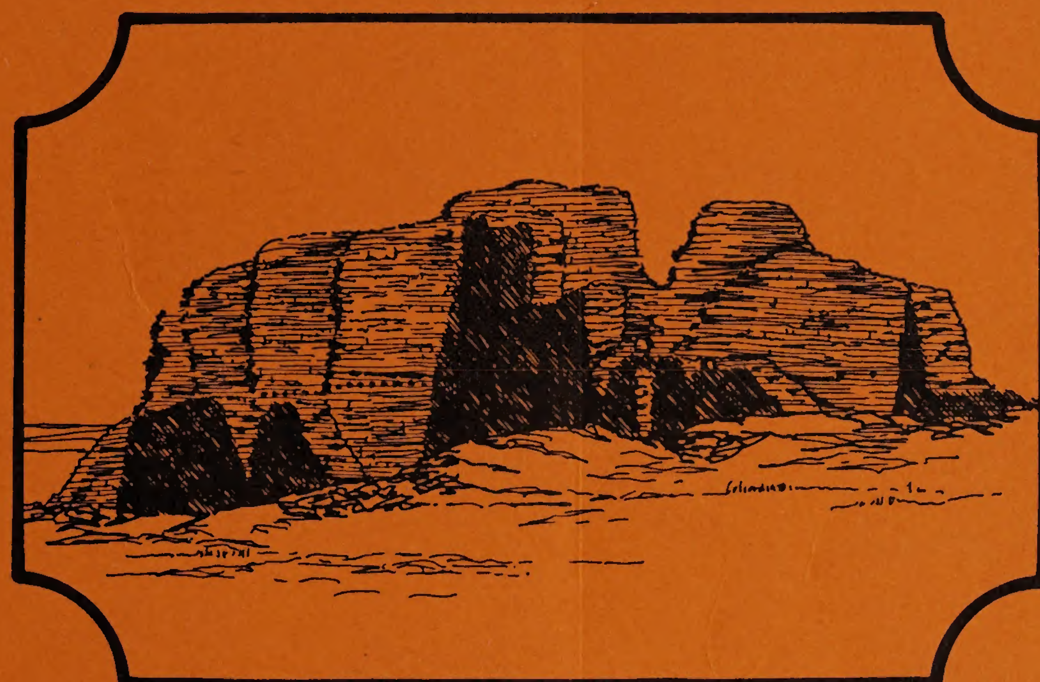
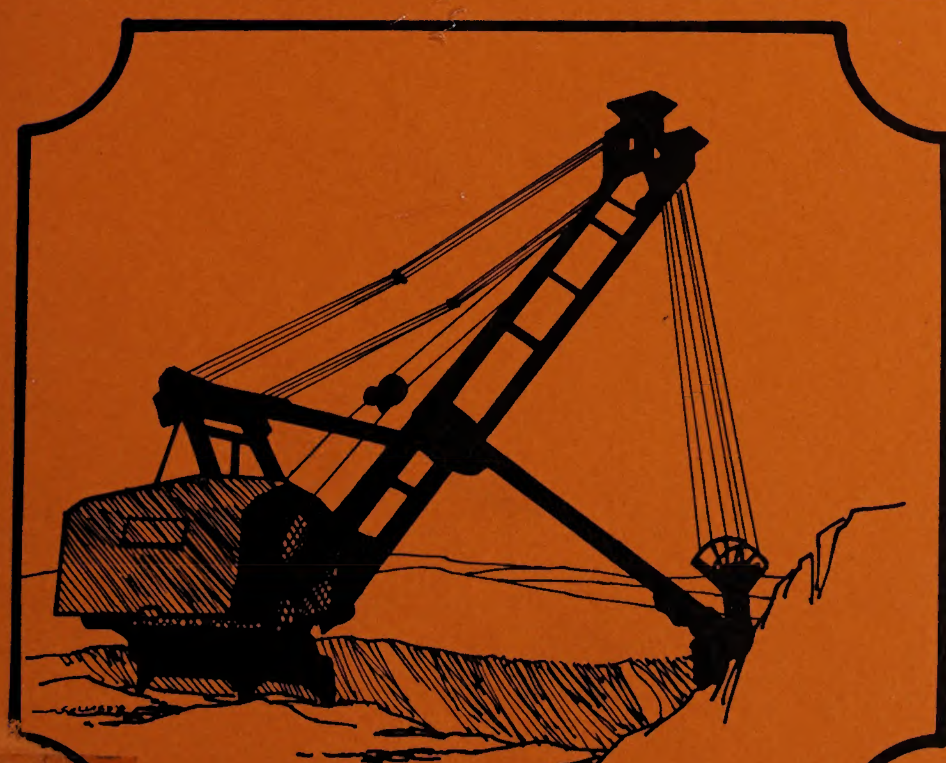
Appendices B,C,D

DRAFT

Environmental Statement STAR LAKE · BISTI REGIONAL COAL





S. DEPARTMENT OF THE INTERIOR
REAU OF LAND MANAGEMENT

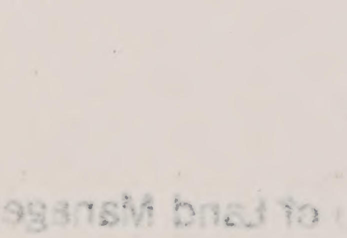
STAR LAKE-BISTI REGIONAL

COAL ENVIRONMENTAL STATEMENT

APPENDIX A

MAPS

(See separate envelope.)



APPENDIX A

Maps

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D. Geology

E. General soils distribution

F. Vegetation distribution

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STAR LAKE-BISTI REGIONAL

COAL ENVIRONMENTAL STATEMENT

APPENDIX B

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PALEONTOLOGY

PALEONTOLOGY

GENERAL SUMMARY OF PALEONTOLOGICAL RESOURCES IN THE ES REGION

Most of the formations exposed within the ES Region are fossiliferous, but little systematic paleontologic study of them has been done, with the exception of Late Cretaceous and early Tertiary vertebrates. Much of the paleontological record of these units is in literature dealing primarily with their stratigraphy, in which lists of fossils are presented, with little additional information. For some formations, fossil collections are limited or absent from sites within the region, though the formations are known to be fossiliferous elsewhere. The following faunal and floral lists were compiled by Kues, Froelich, Schiebout, and Lucas (1977).

In the summary of the paleontology of the ES Region below, all published and some unpublished information about the distribution of fossils in each formation exposed within the region is assembled. Coverage is limited to the San Juan Basin of New Mexico; thus references to some fossils from sites near but not in the ES Region are included, but mention of some large collections from areas in neighboring states and from areas in New Mexico outside the San Juan Basin are omitted. Fossils reported from sites within the region are designated by asterisks in the lists, or otherwise distinguished in the commentary. With the exception of Late Cretaceous and early Tertiary vertebrates, only a minimal attempt has been made to change taxonomic names to modern usage or to resolve synonymies. For clarity of expression in the taxonomic lists, generic or specific names are not underlined.

Also included in the paleontological summary for each formation are general comments about geology, surface expression, and distribution of the formations.

San Andres (Permian) Limestone

The San Andres Limestone is exposed only slightly in the southern part of the ES Region. It is predominantly a gray, highly weathered, thickbedded, dolomitic limestone, with quartz vugs and occasional stringers of sandstone and red siltstone. Fossils are relatively abundant, though poorly preserved, and consist of several taxa of marine invertebrates. The fossils of the San Andres Formation in northern New Mexico have never been studied.

The following taxa were identified at sites close to the ES Region near Fort Wingate by Baars (1961) and Ash (1969).

Brachiopoda
- Avonia subhorrida
- Chonetes kaibabensis
- Derbyia regularis
- D. sp.
- Productus ivesi
- "scattered productoids"

Bivalvia
- Leda? sp.
- Schizodus sp.

Gastropoda
- Euomphalus sp.

Other
- crinoids
- cephalopods
- conodonts

Chinle (Upper Triassic) Formation

The Chinle is exposed relatively widely in the southern part of the region compared with other pre-Cretaceous formations. Four of five Chinle members are recognized here by Ash (1969), but only the "Lower Red Member" contains well-preserved fossils. This unit consists primarily of red, lenticular, slope-forming claystones and silty sandstones cut in places by channel sandstones. The Chinle, as a whole, represents deposition under a variety of continental conditions, including freshwater lakes and streams, moist lowlands, and somewhat arid highlands. Stewart, Poole, and Wilson (1972) have summarized the stratigraphy and paleontology of the Chinle in the Southwest, including parts within the ES Region.

The following list includes Chinle fossils found within a few miles of Fort Wingate. Although Fort Wingate is not in the ES Region, there are good exposures of Chinle around the fort that are in the region. Therefore, many of the fossils noted below are expected to occur within the region. Chinle exposures in neighboring states and in the Ghost Ranch area of north-central New Mexico have yielded impressively diverse and abundant fossil biotas, particularly Triassic reptiles; these are not included in this summary. Only bone scrap and plants have been reported from exposures near or in the region.

This list was compiled from information in Ash (1967, 1969), and Stewart, Poole, and Wilson (1972).

Plants
- Neocalamites sp.
- Todites fragilis
- Clathropteris walkeri
- Cynepteris lasiophora
- Phlebopteris smithii
- Wingatea plumosa
- Cladophlebis daughertyi
- C. "reticulata"
- Otozamites powelli
- Nilssoniopteris n. sp.
- Williamsonia n. sp.
- unidentified Gingko
- Pelurodea poleonensis?
- Araucarioxylon arizonicum
- Petrified wood

Invertebrates
- Bivalvia
- Unio arizonensis

Vertebrates
- Reptilia
  - Acompsosaurus wingatensi
  - Eupelor frasii
  - Rutiodon? sp.
  - Machaeroprosopus sp.

San Rafael (Middle Jurassic) Group

The San Rafael Group is exposed only in a very small area in the southern part of the ES Region. Different formations are included in this group in Arizona and Utah. Moving up-section, the three formations defined in and near the region are the Entrada Sandstone, Todilto Limestone, and Summerville Formation.

The Entrada Sandstone in northwest New Mexico consists of two units; a prominent, cross-bedded, cliff-forming, red-orange to white, clean sandstone up to 250 feet thick, and an underlying red siltstone unit about 50 feet thick. The formation represents sediments that were probably deposited subaqueously with gradation into eolian deposits. No fossils have been reported from the Entrada within the region; however, in Utah, the partially equivalent Carmel Formation contains marine limestones with a sizeable invertebrate fauna (Gilluly and Reeside, 1924).

The Todilto Limestone consists of a lower, highly laminated, organic-rich, gray limestone that grades upward into gypsiferous limestone, which in places becomes a thick layer of gypsum of economic importance. Deposition occurred in a saline lake that was nearly isolated from the sea to the north, and received relatively little freshwater influx (Anderson and Kirkland, 1960). A few fossils are known from the Todilto, some from within the region. Deposition of the Todilto was partially contemporaneous with that of the Curtis Formation in Utah, which contains a rather sparse marine fauna.

The Summerville Formation is a red-brown, fine grained, sparsely cross-bedded sandstone that represents a shoreline deposit. No fossils have been reported from the Summerville in northwestern New Mexico.

The Bluff sandstone intertongues with and overlies the Summerville in this area. It is not well defined within the region and is unfossiliferous, so is not considered further.

The paleontological resources of the San Rafael Group are as follows:

<u>Entrada Sandstone and Summerville Formation</u>

No fossils reported from within or near the ES Region.

Todilto Limestone

Invertebrates
*Metacypris todiltensis (ostracod)

Vertebrates
Leptolepis schowei
Pholidophorus americanus

Morrison (Upper Jurassic) Formation

The Morrison Formation is exposed in a thin band in the southern part of the region, roughly parallel to and a little north of Interstate 40 from about Grants to Gallup. The stratigraphic division and facies relationships of units within the Morrison of northwestern New Mexico is still a matter for debate, but most workers agree that the formation represents primarily a braided fluviatile environment, with variations in lithology due mainly to changes in stream depositional characteristics resulting from varying tectonic and sediment source conditions.

Three members are recognized in the region: the basal Recapture, medial Westwater Canyon, and upper Brushy Basin (Saucier, 1967). The Recapture is composed of alternating red-brown to gray-green, lenticular, slope-forming sandstones and shaley mudstones with some thin conglomerate layers; the Westwater Canyon of resistant cliff-forming, yellow/green/tan coarse-grained sandstones; and the Brushy Basin of white/green/purple/reddish-brown sandy shales with occasional massive sandstones that generally weather into low rounded hills. Near Fort Wingate the entire Morrison is about 425 feet thick.

Fossils of vertebrates (mainly dinosaurs), invertebrates, and plants are abundant and diverse in some parts of the Morrison in the western United States, but only scattered pieces of petrified wood and a few dinosaur bone fragments come from the formation (mainly from the Brushy Basin Member) within the region. Smith (1967) reported bones of the dinosaurs Brontosaurus, Allosaurus, and Stegosaurus in Morrison exposures in Valencia County, N.M., to the south of the region, but the formation remains largely unexplored and unstudied paleontologically in northwestern New Mexico.

The list of taxa represented here (from Mook, 1916) includes all species reported from the Morrison of the western United States. Subsequent work has reduced some of the species on this list to synonyms of others.

Plants
- Cycadella reedii
- C. beecheriana
- C. wyomingensis
- C. knowltoniana
- C. compressa
- C. jurassica
- C. nodosa
- C. cirrata
- C. exogena
- C. ramentosa
- C. ferruginea
- C. contracta
- C. gravis
- C. verrucosa
- C. jejuna
- C. concinna
- C. crepidaria
- C. gedida
- C. carbonensis
- C. knightii
- C. utopiensis
- Araucarioxylon ? obscurum
- Pinoxylon dacotense

Invertebrates
- Bivalvia
  - Unio felchii
  - U. toxonotus
  - U. iridoides
  - U. macropisthus
  - U. lapilloides
  - U. stewardi
  - U. nucellus
  - U. willistoni
  - U. knight
  - U. baileyi
- Gastropoda
  - Limnaea altivuncula
  - L. accelerata
  - L. consortis
  - Planorbis veternus
  - Vorticifax stearnsii
  - Valvata scabrida
  - V. leei
  - Viviparus gilli
  - Lioplacodes veternus
  - Neritina nebrascensis
- Ostracoda
  - Darwinula leguminella
  - Cypris purbeckensis?
  - Metacypris forbesii
  - M. ? sp.

Vertebrata
- Reptilia
  - Sauropoda
    - Astrodon johnstoni
    - Dystrophaeus viaemalae
    - Atlantosaurus immanis
    - A. montanus
    - Camarasaurus supremus
    - C. leptodirus
    - Caulodon diversidens
    - C. leptoganus
    - Apatosaurus ajax
    - A. laticollis
    - A. louisiae
    - Morosaurus grandis
    - M. agilis
    - M. impar
    - M. robustus
    - M. lentus
    - Amphicoelus altus
    - A. latus
    - A. fragillimus
    - Symphyrophus muscolosus
    - Epantherias amplexus

Diplodocus longus
D. lacustris
D. carnegii
Brontosaurus excelsus
B. amplus
Pleurococlus nanus
P. altus
P. montanus
Barosaurus lentus
B. affinis
Elosaurus parvus
Haplocanthosaurus priscus
H. utterbacki
Brachiosaurus altithorax

Theropoda
Dryoptosaurus trihedrodon
Hypsirophus discurus
Allosaurus fragilis
A. medius
Creosaurus atrox
C. potens
Antrodesmus lucaris
A. valens
Coelurus agilis
C. fragilis
C. gracilis
Tichosteus lucasanus
T. aequifaces
Ceratosaurus nasicornis
Ornitholestes hermanni

Ornithischia
Stegosaurus armatus
S. discurus
S. seeleyanus
S. ungulatus
S. affinis
S. stenops
S. sulcatus
S. duplex
S. longispinus
Diracodon laticeps
Hoplitosaurus marshi
Camptosaurus dispar
C. amplus
C. medius
C. nanus
C. depressus
C. browni
Laosaurus celer
L. gracilis
L. consors
Dryosaurus altus
Macelognathus vagans

Apatodon mirus
Brachyrophus altarkansanus

Rhyncocephalia
Opisthias rarus

Crocodilia
Goniopholis lucasii
G. felix
G. gilmorei

Chelonia
Compsemys plicatulus

Pterosauris
Dermodactylus montanus

Mammalia
Allodon fortis
A. laticeps
Asthenodon segnis
Dryolesthes priscus
D. arcuatus
D. gracilis
D. obtusus
D. vorax
Ctenacodon serratus
C. nanus
C. potens
Dicrocynodon victor
Docodon striatus
Ennadon crassus
E. affinis
Paurodon valens
Stylacodon gracilis
S. S. validus
Laodon venustus
Priacodon ferox
Menacodon rarus
Tinodon bellus
T. lepidus
T. robustus
Triconodon bisulcus

Osteichthyes
Ceratodus guntheri
C. robustus
C. americanus

Aves
Laopteryx priscus

Dakota Sandstone (Upper Cretaceous)

Fossils in the Dakota Sandstone are uncommon and have yet to be listed in their entirety, particularly for exposures in New Mexico. Many of the sandy beds lack body fossils but have high concentrations of trace fossils, especially Thalassinoides and the crustacean burrow Ophiomorpha. Dane, Landis and Cobban (1971) and Landis, Cobban and Dane (1973) (A) summarized Dakota stratigraphy and paleontology in the San Juan Basin of New Mexico, Cobban (1977) (B) listed most additional fossils.

A complete list of plants from Dakota equivalents in New Mexico and neighboring states is given by Young (1960); the plants listed here are from the Chuska Mountains of Arizona and New Mexico, west of the ES Region (Gregory, 1917; in Young, 1960) and from north of Shiprock (Ash and Read, 1976, C). No plants have been described from the Dakota within the region.

Plants
- Ilex sp.
- Andromeda pfaffiana
- Salix sp.
- Juglans cf. J. crassipes
- Ficus inaequalis
- F. sp.
- Phyllocladus subintegrifolius
- Tempskya sp. (C)

Invertebrates
- Bivalvia
  - *Acanthocardia tritis (A)
  - Aphrodina
  - Camptonectes symmetricus (B)
  - C. of C. cavanus (A)
  - Cymbophera aff. c. securis (A)
  - Exogyra columbella (A)(B)
  - E. laeris (A)
  - E. qwuillana (B)
  - E. trigeri (B)
  - E. sp. (A)

E. n. sp. (A)
Granocardium white (B)
*"Gryphae" newberryi (A)
Idonearca depressa (B)
Inoceramus eulessianus (A)(B)
I. ginterensis (B)
I. prefragilis (B)
I. rutherfordi (A)
I. cf. I. macconelli (B)
Limetula (B)
Lopha staufferi (B)
*L. sp. (A)
Nuculana (B)
Ostrea beloiti (A)
Parmicorbula (B)
Pholadomya sp. (A)
Pinna petrina (A)(B)
P. sp. (A)
Plicatula arenaris (A)(B)
P. goldenana (A)
P. cf. P. ferryi (B)
Psilomya aff. P. concentrica (A)(B)
Pycnolonte cf. P. icellumi (B)
Tellira sp. (A)

Gastropoda
Actaeon (B)
Anchura sp. (B)
Arrhoges modesta (A)(B)
Cerithiopsis (A)(B)
Cerithium (B)
Gracilata (B)
Gyrodes (B)
Turritella (B)

Ammonoidea
Burissiakoceras compressum (B)
Calycoceras canitaurium (B)
C.? of C.? canitaurinum (B)
C. obrieni (B)
C. tarrantense (B)
Desmoceras sp. (B)
Johnsonites suleatus (B)
*"Mantelliceras" sp. (A)
Metiococeras sp. (A)
*M. defordi (A)
Turrilites acutus (A)(B)

Mancos Shale (Upper Cretaceous)

The Mancos is a thick, predominantly shale unit that has been divided several different ways in New Mexico. In earlier works, various units within the formation were assigned to ages based on nomenclature used in the Midwest, especially Kansas and South Dakota. More recently, various units exposed in the New Mexico part of the San Juan Basin have been named. Much work remains to be done in determining the faunal succession through the New Mexican Mancos section.

The following list is compiled from Lee (1917), Reeside (1924), Renick (1931), Pike (1947), Cobban and Reeside (1952), Dane, Bachman and Reeside (1957), Young (1960), Dane, Cobban and Kauffman (1968), Dane, Kauffman and Cobban (1968), Lamb (1968), Dane, Landis and Cobban (1971), O'Sullivan et al (1972), Cobban (1973), Lamb (1973), Landis, Dane and Cobban (1973), Cobban (1977), and Peterson and Kirk (1977).

Invertebrates
- Bivalvia
  - Anatina n. sp. aff. A. lineata
  - Anomia sp.
  - Anomia n. sp.
  - Area sp.
  - Anicula gastodes
  - A. linguiformis
  - A. sp.
  - Camptonectes platessa
  - C. symmetricus
  - C. sp.
  - Cardium pauperculum
  - C. speciosum
  - C. trite
  - C. sp.
  - C. sp. aff. cipuperculum
  - Corbula sp.
  - Crassatellites ? sp.
  - Culullaea sp.
  - Cymbophora ? emmonsi
  - Cyprimeria ? sp.
  - "Lyrena" securis
  - "C" n. sp.
  - Exogyra columbella
  - E. levis
  - E. olisiphorensis

E. trigeri
E. cf. E. oxyntas
E. sp.
Granocardium enstromi
G. trite
G. sp.
Gryphaea newberryi
G. sp.
Idonearca depressa
Inoceramus arvanus
I. barabini
I. capulus
I. deformis
I. aff. I deformis
I. dimidius
I. n. sp. aff. I. dimidius
I. cf. erectus
I. fragilis
I. howelli
I. involutus
I. labiatus
I. cf. I. lobatus
I. lundbreckensis
I. cf. nahwisi
I. perplexus
I. prefragilis
I. rutherfordi
I. sagensis
I. cf. I. Stanfoni
I. subquadratus
I. umbonatus
I. undabundus
I. (large, thick-shelled)
I. sp.
Isocardia sp.
Laternula sp.
Liopistha undata
Lopha belliplicata
L. lugubris
Lucina sp. of L. maltiformis
L. subundata
L. sp.
L. n. sp.
Lunatia sp.
Mactra arenia
M. cf. formosa
Mytilus sp.
Nemodon sp.
Nucilana sp.
Ostrea beloiti
O. congesta
O. elegantula
O. aff. O. elegantula newberryi
O. larva
O. lugubris

O. malachitensis
O. soleniscus
O. cf. O. soleniscus
O. n. sp.
O. sp.
"Ostrea" sannionis
"O" sp. aff. "O" congesta
Pachychiloides cf. P. chrysalloides
Pecten sp.
Pholadomya sp.
Pinna petrina
P. cf. P. petrina
P. sp.
Plicatula hydrotheca
P. cf. P. ferryi
P. sp.
Psilomya sp.
Pteria gastrodes
P. nebrascana
P. sp.
Pycnodonte cf. P. kellumi
Sauvagesia cf. s. austinensis
Sinonia n. sp. aff. s. levia
Tellina aquilateralis
T. sp.
T. ? n. sp.
Trigonarca sp. aff. T. oblique
Xenophora simpsoni
Yoldia aff. Y. subelliptica

Gastropoda
Acteon sp.
Ampullina ? sp.
Anchura fusiformis
A. sp.
Anisonyon apicalus
Aporrhais bianulata
Crommium sp.
Fasciolaria ? sp.
Gyrodes depressa
G. n. sp. aff. G. conradi
G. sp.
Liopeplum sp.
Pseudomelania ? sp.
Pyrifusus ? sp.
Pyropsis coloradensis
P. sp.
Syncyclonema sp.
Turitella sp.
T. n. sp.
Volutoderma sp.
Volutomorpha sp.

Ammonoidea
Acanthoceras alvaradoense

A. amphibolum
A. sp.
Allocrioceras annulatum
Baculites anceps var. obtusus
B. cf. B. anceps
B. aquilensis
B. asper
B. cf. B. besairei
B. codyensis
B. gracilis
B. cf. B. gracilis
B. ovatus
B. sp.
Calycoceras obrieni
C. ? canitourinum
C. sp.
Coilopuceras colleti
C. springeri
Desmoscaphites bassleri
Dunueganoceras sp.
Euonphaloceras aff. E. cunningtoni
Hamites ? n. sp.
Kanibiceras septemseriatum
Metoicaceras defordi
M. praecox
M. whitei
M. sp.
Placenticeras guadalupe
P. sacarlosense
P. sp.
Plesiacanthoceras amphibulum
Prionocyclus hyatti
P. macombi P. wyomingensis
P. wyomingensis var. wyomingensis
P. wyomingensis var. elegans
P. sp.
Priontropis hyatti
P. cf. P. hyatti
P. woolgari
P. sp.
Puzosia (Latidorsella) mancosensis
Romaniceras sp.
Scaphites aquilaensis
S. bassleri
S. ferronensis
S. hippocrepis
S. leei
S. stantoni
S. ventricosus
S. v. var. interjectus
S. vermiformis
S. warreni
S. W. var. ubiquitosus
S. whitfieldi
S. sp.

Sciponoceras gracile
Spathites sp.
Stantonoceras pseudocostatum ?
Stomabamites sp.
Tarrantoceras rotatile
T. ? sp.
Thomasites sp.
Turrilites sp.

Vertebrates
Echidnocephalus ? sp.
Holcolepis ? sp.
Hypsodon radiatulus
H. sp.
Ichthyodectes sp.
Isurus
Lamna
Leuchichthyops vagans
Ptychodus sp.
Scapanorhynchus
Fish teeth, bone, scales, operculum

Other
Lingula nitida ?
L. sp.
Epiaster ? sp.
Hemiaster sp.
Uintacrinus socialis
Solitary coral
Plant fragments

Mesa Verde Group (Upper Cretaceous)

The Mesa Verde Group consists of three formations through much of the San Juan Basin: the Point Lookout Sandstone and Cliff House Sandstone on the bottom and top, and the Menefee Formation in the middle. In the western part of the basin several other Mesa Verde formations, representing units that intertongue with the Mancos Shale, are present. The two most important are the Gallup Sandstone and Crevasse Canyon Formation. Faunal and floral information is available for some but not all formations within the Mesa Verde Group.

Mesa Verde Group (Undifferentiated)(Data from Lee, 1917.)

Plants
- Abietetes dubius
- Brachyphyllum macrocarpum
- B. cf. B. macrocarpum
- Cunninghamites pulchellus
- Diospyros sp.
- Dombeyopsis ? sp.
- Dryopteris n. sp.
- Eucalyptus sp.
- Ficus aff. F. lanceolata
- F. praetrinervis
- F. speciosissima
- F. wardii
- F. n. sp.
- Myrica n. sp. ?
- Sequoia reichenbachii

Bivalvia
- Cyprimeria sp.
- Inoceramus sp.
- Leopistha undata
- Nucula sp.
- Ostrea sp.

Gastropoda
- Acteon sp.
- Gyrodes sp.
- Liopeplum sp.
- Pyrifusus sp.
- Pyropsis sp.
- Volutoderma sp.
- Volutomorpha sp.

Ammonoidea
- Heteroceras sp.
- Placenticeras sarcarlosense
- P. sp.

Gallup Sandstone

(Data from Dane, Bachman and Reeside, 1957 (no notation); 1947 (A); Molenaar, 1977 (B).)

Bivalvia
- *Alectryonia saunionis
- *"Callista" orbiculata
- *Cardium curtum
- *C. pauperculum (A)
- *Corbula nematophora

*C. sp.
*Inoceramus dimidius
I. erectus (B)
*I. aff. I. deformis
*I. fragilis (A)
*I. aff. I. fragilis
I. umbonatus ? (A)
I. (large thick-shelled variety) (A)
*Laternaula sp.
*Leguman sp.
*Lucina juvenis
*Mactra utahensis
*Ostrea lugubris (A)
O. congesta (A)
*Tapes cyprimeriformis
*Tellina sp.
*T.? sp.

Gastropoda
*Actaeon ? sp.
*Gyrodes depressa
*Mesostoma ? occidentalis
*Polynices ? sp.
*Pyropsis ? sp.
*Turritella whitei
*Volutoderma sp. (A)

Ammonoidea
*Baculites cf B. besaireii
*B. sp.
*Prionocyclus wyomingensis
*P. w. var. robusta
*P. sp.
*Scaphites whitfieldi

Vertebrata
*shark teeth

Crevasse Canyon Formation

The only published references to fossils within the Crevasse Canyon Formation are in Molenaar (1973), and Kirk and Zech (1977).

Plants
Carbonaceous material
Petrified wood
Leaf imprints

Bivalvia
    Inoceramus sp.
    Oyster beds

Ammonoidea
    Stantonoceras

Vertebrata
    Shark teeth

Trace Fossil
    Ophiomorpha

Point Lookout Sandstone

The Point Lookout Sandstone (including the Hosta Tongue) is known to contain a shallow marine fauna, but the fauna of New Mexico exposures has never been identified or listed except for the species below (from Peterson and Kirk, 1977; and Cobban, 1973).

Bivalvia
    Inoceramus texanus

Ammonoidea
    Baculites aquilensis
    Texanites texanus

Menefee Formation

The Menefee has few fossils in the San Juan Basin. Data here are from O'Sullivan et al, (1972) (no notation), for localities on the Navajo Reservation, the Mannhard (1976) (A) for exposures just within and to the east of the region.

Plants
    Anemia hesperia
    Ficus planicostata
    Sabalites montanus
    Sequoia reichenbachii

Bivalvia
    Corbicula chacoensis
    C. sp.
    C. cf. C. perundata
    Unio sp.

Gastropoda
- Goniobasis? sp.
- Neritina cf N. baueri
- N.? n. sp.

Trace Fossils
- *Planolites (A)
- *Teredolithus (A)

Cliff House Sandstone

Sources for this list are Reeside (1924) (no notation); Siemers and King (1974) (A) for exposures in and around Chaco Canyon; and Mannhard (1976) (B) for exposures of the La Ventana Tongue in and near the region.

Bivalvia
- *Anadara? sp. (A)
- *Anomia n. sp.
- *Arcopagella n. sp. (A)
- *Astarte n. sp.
- *Callista deweyi
- *C. n. sp.
- *Corbula n. sp.
- *Crassostrea subtrigonalis (A)
- *Cymbophora aff C. alta (A, B)
- ?C. simpsonensis (A)
- *Cyprimeria n. sp.
- *Donax n. sp.
- *Exogyra aff E. ponderosa (A)
- *Granocardium whitei (A, B)
- *Hercodon sp. (A, B)
- *Idonearca sp. (A)
- *Inoceramus barabini (A)
- *I. pertenuis (A)
- *I. sagensis (A)
- *I. tenuilineatus (A)
- *I cf I. simpsoni (A)
- *I vanuxemi (A)
- *I. sp.
- *Liopistha undata
- *Lunatia occidentalis
- *Mactra formosa
- *M. warrenana
- *M. sp.
- *Micrabacia americana
- Nucula? sp. (B)
- Nucualna? sp. (B)
- *Ostrea plumosa (A)
- *O. sp.

*Oxytoma sp. (A, B)
*Parmicorbula? sp. (A, B)
*Parvilucina? aff P.? linearia (A)
*P.? sp. (B)
*Protodonax chlorpagus (A)
*P. exaquilius (A)
P. sp. (B)
*P. n. sp. A (A)
*P. n. sp. B (A)
*Pteria nebrascana
*Pycnodonte cf P. vesicularis (A)
*Tancredia americana
*Tellina aquilateralis
*Tellinimera sp. (A, B)
*Venericardiella sp. (B)
*Yoldia evansi
*Y. sp. (A, B)

Gastropoda
*Actaeon attenuatus
*Anchura nebrascensis
*Anisomyon borealis
A. cf. A. sexsulcatus
*A. cf A. schumardi
*Banis cf B. siniformis (A, B)
*Chemnitzia cerithiformis?
*C. sp.
*Euspira obliquata (A, B)
*Fusus cf. F. newberryi
*F.? sp.
*Gyrodes aff G. petrosa
*Haminea subcylindrica
*Holospira sp. (A)
*Lunatia concinna?
*L. occidentalis
*L. subcrassa?
*Morea? sp.
Oreohelix? sp.
*Pachymelania? sp.
*Parafusus sp. (A)
*Pseudomelania sp.
*Solarium n. sp.
*Spironema cf S. perryi
S. sp. (B)
*Trachytriton? sp. (A)
*Velatella? sp. (A)
*Volutoderma sp.
*Volutomorpha retifera (A)
V. sp. (A)

Ammonoidea
*Baculites anceps var. obtusus (B)
*B. perplexus (A)
B. sp. (B)
*Placenticeras intercalare (A, B)

Other
*Hardouinia taylori (echinoid) (A)
*shark teeth and bone (B)

Trace Fossils
Ophiomorpha (B)
Thalassinoides (B)
Skolithos (B)

Lewis Shale (Upper Cretaceous)

Sources for the fossils listed are: Reeside (1924) (no notation); Lee (1917, p. 190) (A); Renick (1931) (B); Dane (1936) (C); Mannhard (1976) (D); Cobban, Landis and Dane (1974) (E).

Bivalvia
Anomia argentaria (E)
A. tellinoides (E)
*A. sp. (A)
*Cardium speciosum (A)
Crassostrea subtrigonalis (D)
Granocardium whitei (C, D)
*Inoceramus barabini (D)
I. oblongus (A)
I. aff I. proximus (E)
I. aff I. pertenuis (E)
I. sagensis (A, B, C, D, E)
I. subcompressus (E)
I. tenuilineatus (E)
I. aff I. turgidus (E)
I vanuxemi (D, E)
*Leda sp.
Legumen planulatum (B)
Lucina occidentalis (A)
*L. sp.
*Lunatia sp. (A, B)
*Liopistha undata (A, B)
Liopistha montanensis (C)
Mactra? sp. (A)
Modiola sp. (A)
Nucula? sp. (D)
*Ostrea gilluyi (C)
*O. inornata
O. pellucida (A)
O. plumosa (D, E)
O. russelli (E)
O. aff O tecticosta (A)
O. sp. (A)
Pinna lakesi (A)
P. sp. (D)
Pteria linguaeformis (B)

Tellina equilateralis (B)
T. sp. (A)
*Teredo sp.
Thetis circularis (A, C)
Trigonarca exigua (A)
Veneridae (indet.) (D)
Yoldia evansi (B)

Gastropoda
Actaeon sp. (A)
Anisomyon borealis (C, D)
A. patelliformis (A)
Aporrhias meeki (C)
A. sp. (D)
Banis cf. B. siniformis (D)
Eoactaeon? sp. (D)
Fusus sp. (A, B)
*Gyrodes depressus (C)
Haninea sp. (A)
Pyrifusus newberryi (C)
P. sp. (A)
Pyropsis sp. (C)
Spironema sp. (C)
Syncyclonema rigida (A, B)
*S. sp. (A)
Volutoderma? sp. (C)

Ammonoidea
Anapachydiscus sp. (E)
Anacycloceras sp. (A)
Baculites cf. B. asperiformis (E)
B. compressus (A, B)
B. gregoryensis (E)
B. maclearni (E)
B. ovatus (A, C)
B. obtusus (E)
B. perplexus (D, E)
B. pseudovatus (E)
B. rugosus (E)
B. aff B. rugosus (E)
B. scotti (E)
B. aff B. scotti (E)
*B. sp. (E)
Didymoceras cheyennense (E)
D. nebrascense (E)
D. n. sp. (E)
D. sp. (E)
Exiteloceras jenneyi (E)
Hoploscaphites nodosus (A, E)
Oxybeloceras n. sp (E)
*Placenticeras intercalare (A, C, D)
P. meeki (B, E)
P. whitfieldi (A)
*P. sp. (E)
Scaphites gilli (E)

Vertebrata
- Lamna sp. (C)
- Fish scales (A)

Other
- Serpulid (worm) tubes (D)
- Gyrochorte (D)

Pictured Cliffs Sandstone (Upper Cretaceous)

The invertebrate list is from Reeside (1924); the vertebrates, from Fassett and Hinds (1971). All invertebrates have been found within the region; vertebrates are from a site about 10 miles east of the region but they are presumed to appear within the region also. Additional taxa from Dane (1936) (A).

Bivalvia
- Baroda sp.
- Cardium cf C. speciosum
- C. whitei (A)
- Corbula sp. (A)
- Inoceramus barabini
- I. sp.
- Leptosolen n. sp.
- Lunatia occidentalis
- Mactra gracilis
- M. warrenana?
- Modiola cf M. meeki
- Ostrea sp.
- Tellina scitula (A)

Gastropoda
- Acteon sp.
- Anchura sp.
- Buccinum? sp. (A)
- Chemnitzia cerithiformis
- Cirulia sp.
- Haminea subcylindrica
- H. sp.
- Odontobasis sp.
- Turris? sp.
- Turritella? sp.

Vertebrata
- Enchodus sp.
- Ischyrhiza mira
- Lamna appendiculata
- Oxyrhiza angustidens
- Scapanorhynchus raphiodon

Squalicorax pristodontus
Indeterminate turtle

Other
Serpula sp. (worm)
Ophiomorpha major (A)

Fruitland Formation and Kirtland Shale (Upper Cretaceous)

The following list is from Knowlton (1916), reprinted in Reeside (1924). Taxa from near Dulce, N. M., about 20 miles east of the ES Region (Lee, 1917) (A); plants from Sheep Springs, N. M., on the Navajo Reservation, from O'Sullivan et al (1972) (B).

Plants
Asplenium neomexicanum
Onoclea neomexicana
Anemia hesperia (B)
*A. sp.
*Sequoia reichenbachii (A, B)
*S. obovata?
Geinitzia formosa
Sabal montana (A)
S.? sp.
*Myrica torreyi
M.? neomexicana
Salix baueri
S. sp.
*Quercus baueri
*Ficus baueri
F. curta?
F. praetrinervis (A)
F. leei
*F. praelatifolia
*F. sp.
F. rhamnoides
*F. squarrosa
F. eucalyptofolia?
Laurus baueri
L. coloradensis
*Nelumbo sp.
*Heteranthera cretacea
Pistia corrugata
Leguminosites? neomexicana
*Pterospermites undulatus
*P. neomexicanus
P. sp.
Ribes neomexicana
*Carpites baueri
*Phyllites petiolus

*P. neomexicanus
unassigned plant, a
*unassigned plant, b
Brahcyphyllum macrocarpum (A)
Cunninghamites pulchellus (A)
Ficus planicostata? (A, B)
F. type of F. lanceolata (A)
Zizyphus n. sp. (A)
Metasequoia cuneata (B)
Rhamnus cleburni (B)
Dombeyopsis obtusa (B)

Vertebrata (Kirtland Formation)

Reptiles listed below are from Powell (1972) and Gilmore (1916); and fish are from Gilmore (1916).

Chondrichthyes
Myledaphus sp.

Osteichthyes
Lepisosteus sp.

Reptilia
Testudines
Adocus bossi Gilmore
A. kirtlandis Gilmore
Asperidites ovatus Gilmore
A. vorax Gilmore
Baena nodosa Gilmore
B. ornata Gilmore
Basilemys nobilis Hay
Boremys grandis Gilmore
Thescelus hemisphaera Gilmore
T. rapiens Hay?

Crocodilia
Brachychampsa sp.?
Crocodylus sp.

Saurischia
Deinodon? sp.
Gorgosaurus liberatus Lambe

Ornithischia
Kritosaurus navajovius Brown
Parasourolophus tubicen Wiman
Monoclonius sp.
Pentaceratops sternbergii Osborn
P. fenestratus Wiman
Chasmosaurus sp.

Ceratops? sp.
gen. et sp. indet.

Vertebrata (Fruitland Formation)

Reptiles in the following list are from Gilmore (1916) and Powell (1972); fish are from Gilmore (1916); and mammals are from Fassett and Hinds (1971).

Osteichthyes
Lepisosteus sp.

Reptilia
Testudines
Neurankylus baueri Gilmore
Baena nodosa Gilmore
Adocus bossi Gilmore
Asperidites sp.

Crocodilia
Brachychampsa? sp.
Crocodylus

Saurischia
Deinodon? sp.

Ornithischia
Parasaurolophus crytocristatus Ostrom
Monoclonius? sp.
Pentaceratops sterbergii Osborn
Nodosauridae, gen, et sp. indet.

Mammalia
Multituberculata
Mesodma cf M. formosa
Cimolodon sp. 1
C. aff C. imitidus
Eucosmodon? sp.
new gen. & sp.

Marsupialia
Alphadon cf A. marshi
A. n. sp.
Pediomys sp.

Eutheria
Gypsonictops sp.
Cimolestes sp.

The following list from Stanton (1916) was reprinted in Reeside (1924) and Henderson (1935). The taxa, from near Sheep Springs on the Navajo Reservation, are from O'Sullivan et al. (1972) (A)

Invertebrates
Bivalvia
*Anonia gryphorhynchus
*A. grypheiformis
Corbula chacoensis (A)
C. cf C. chacoensis (A)
Corbicula cytheriformis
*Ostrea glabra
*Modiola laticostata
Panopoaea simulatrix
Sphaerium sp. (A)
Teredina neomexicana
Unio amarillensis (A)
U. holmesiana
U. pyramidatoides
U. gardneri
U. reesidei
U. aff U. reesidei
U. brachypisthus
U. aff U. brachypisthus (A)
U. baueri
U. neomexicanus
U. brimhallensis
U. aff U. brimhallensis (A)
U. cf U. primevus
U. n. sp.? (A)

Gastropoda
Neritina baueri
N. (Velatella) sp.
Tulotomops n. sp. (A)
Campeloma amarillensis (A)
C.? sp. (A)
Tulotoma thompsani
Melania insculpta
Goniobasis? subtortuosa (A)
G.? sp. (A)
Physa reesidei
P. sp. (A)
Planorbis chacoensis
Viviparus sp. (A)

Vertebrata (Kirtland Formation - Naashoibito Fauna)

The source for this list is the same as for the previous one.

Osteichthyes
    Lepisosteus sp.

Reptilia
  Testudines
    Adocus bossi Gilmore?
    Asperidites vorax Hay
    Baena nodosa Gilmore
    Compsemys sp.
    Thescelus rapiens Hay

  Crocodilia
    Brachychampsa? sp.
    Crocodylus sp.

  Saurischia
    Alamosaurus sanjuanensis Gilmore
    Deinodon? sp.

  Ornithischia
    Kritosaurus navajovius Brown
    Monoclonius sp.
    Chasmosaurus sp.
    Ceratops? sp.
    Scelidosauridae ? gen. et sp. indet.

Ojo Alamo Sandstone (Restricted; Cretaceous/Paleocene)

The Ojo Alamo Sandstone is a well indurated, gray to brown, medium to coarse-grained sandstone that crops out in an undulating band from near Bisti to Torreon Arroyo and is present also near Farmington and southward along Gallegos Canyon. Early paleontologists described dinosaur bones from the Ojo Alamo, but recent stratigraphic studies (Baltz, Ash and Anderson, 1966) have restricted the formation entirely to the Paleocene. The definition of the Ojo Alamo is still a subject of vigorous debate (see Powell, 1973; Fasett, 1973). In the ES Region, fossils from the Ojo Alamo are largely restricted to silicified logs and plants, although Paleocene mammals have been found at the top of the formation during this study (see Rigby and Lucas, 1977). Dinosaur bones, probably reworked, are known from the base of the restricted formation, which is characterized by conglomeratic layers.

The plant list below is compiled from Bauer (1916) and Reeside (1924). Anderson (1960) and Baltz, Ash, and Anderson (1966) listed many genera of spores and pollen from the Ojo Alamo, but these are not considered here.

Plants
- Anemia-like fern
- Aralia cf A. notata
- Ficus sp.
- Pteris-like fern
- Sapindus cf S. angustifolia
- S. cf S. affinis
- Platanus? or Aralia?
- Palm leaf
- Willow-like leaf
- numerous types of petrified wood

Vertebrata
- Testudines
- Archosauria

Mammalia
- Anisonchus gillianus
- A. sp.
- Conacodon ectoconus
- C. entoconus
- Ectoconus ditrigonus
- Hemithlaeus kowalevskianus
- Oxyclaenus simplex
- Pantodonta?
- Tetraclaenodon sp.
- Wortmania otariidens

NACIMIENTO FORMATION

(Paleocene)

The Nacimiento Formation, exposed over a wide area in the northern half of the region, is composed mainly of a series of shales, siltstones and soft sandstones. Exposure as dissected badlands and on the slopes of mesas capped by resistant sandstones is typical. Two mammal faunas, the Puercan and Torrejonian, have received much study in the region for almost one hundred years, and the Nacimiento of northwest New Mexico contains one of the best records of Paleocene vertebrates in the world. A more detailed summary of the history of this study follows this faunal listing.

The following list was compiled from Reeside (1924) for plants, White (1880) and Cockerell (1915) (A) for invertebrates, Matthew (1937) for reptiles, and Russell (1968) for mammals. Compared to the vertebrate faunas, the plants and invertebrates of the Nacimiento are less abundant and almost completely unstudied. Every taxon listed under Puercan and Torrejonian is found in the ES Region. Over 90 percent of the vertebrate species were originally described from sites within the region.

Plants (Puercan)
- Artocarpus sp. indet.
- Ficus occidentalis
- Paliurus zizyphoides
- Platanus cf P. haydenii
- Populus cf. P. cuneata
- Viburnum lakesii?
- V. sp.

Plants (Torrejonian)
- Artocarpus pungens
- Dombeyopsis obtusa?
- Liquidamber cucharas?
- Paliurus zizyphoides?
- Platanus aceroides
- Quercus sp.
- Rhamnus goldianus?
- fragments of several kinds of dicotyledons

Invertebrates
- Goniobasis tenuicarinata (A)
- Helix adapis
- H. nacimientensis
- Pupa leidyi

Unio rectoides
Viviparus trochiformis

Vertebrata (Puercan)
Reptilia
Testudines
Adocus hesperius Gilmore
Amyda eloisae Gilmore
Asperidites sagatus Gilmore
A. puercensis Hay
A. reesidei Gilmore
A. vegetus Gilmore
A. quadratus Gilmore
A. perplexus Gilmore
Baena sp.
Compsemys parva Hay
C. puercensis Gilmore
C. vafer Hay
Conchochelys admirabilis Hay
Hoplochelys crassa (Cope)
H. bicarinata Hay
H. laqueata Gilmore
Plastomenus sp.

Crocodilia
Allognathosuchus mooki Simpson

Lepidosauria
Champsosaurus puercensis Cope
C. saponensis Cope?
Helagras prisciformis Cope?

Mammalia
Multituberculata
Ptilodontidae
Eucosmodon americanus (Cope
Americanus primus Granger and Simpson

Taeniolabidae
Catopsalis foliatus Cope
Taeniolabis attenuatus (Cope)
T. sulcatus Cope
T. taoensis Cope
T. triserialis Granger and Simpson

Marsupialia
Thylacodon pussilus Matthew and Granger

Insectivora
Puercolestes simpsoni Reynolds

Taeniodonta
Onychodentes rarus Osborn and Earle
O. tisonensis Cope
Wortmania otariidens (Cope)

"Conylarthra"
Periptychidae
Anisonchus gillianus Cope
Carsioptychus coarctatus (Cope
C. matthewi (Simpson)
Conacodon cophator (Cope)
C. entoconus (Cope)
Ectoconus ditrigonus (Cope)
E. majusculus Matthew
Hemithlaeus kowalevskianus Cope

Hyopsodontidae
Oxyacodon agapetillus (Cope)
O. apiculatus Osborn and Earle
O. priscilla Matthew
Tiznatzinia priscus (Matthew)
T. turgidunculus (Cope)
T. vanderhoofi Simpson

Carnivora
Arctocyonidae
Carcinodon filholianus (Cope)
Eoconodon gaudrianus (Cope)
E. heilprinnianus (Cope)
Escatepos campi Reynolds
Oxyclaenus cuspidatus Cope
O. simplex (Cope)
Loxolophus attenuatus (Osborn and Earle)
L. hyattianus (Cope)
L. interruptus (Cope)
L. priscus (Cope)
Paradoxodon ruetimeyerianus (Cope)
Protogonodon kimbetovius Matthew
P. pentacus (Cope)
P. protogonoides (Cope)
P. stenognathus Matthew
Ictidopappus sp. of MacIntyre

Vertebrata (Torrejonian)
Reptilia
Testudines
Adocus substrictus (Hay)
A. onerosus Gilmore
A. annexus (Hay)
Aspideretes singularis
A. sp.
Baena escavada Hay
B. sp.
Compsemys torrejonensis Gilmore
C. parva? Hay
Hoplochelys saliens Hay
H. paludosa Hay
H. elongonta Gilmore
Plastomenus acupictus Hay
P. n. sp.?

P. sp. indet.
P. torrejonensis Gilmore
Platypeltis antiqua Hay

Crocodilia
Crocodylus sp.
Leidyosuchus multidentatus Mook

Lepidosauria
Champsosaurus australis Cope
C. puercensis Cope
C. saponensis Cope
Machaerosaurus torrejonensis Gilmore
Helagras prisciformis Cope

Osteichthyes
Lepisosteus sp.

Mammalia
Multituberculata
Ectypodontidae
Parectypodus trouessartianus
P. cf P. trouessartianus
Ectypodus? sp.
Neoplagiaulax macrotomeus

Cimolodintidae
Anconodon? sp.

Ptilodontidae
Ptilodus mediaevus
gen et sp. indet.

Eucosmodontidae
Eucosmodon? sp.
Stygimys teilhardi

Taeniolabidae
Catopsalis fissidens

Insectivora
Leptictidae
Prodiacodon puercensis
P. n. sp.?

Mixodectidae
Mixodectes pungens
M. crassiusculus
M. malaris
M. cf M. malaris

Pentacodontidae
Pentacodon inversus
P. occultus
P. n. sp.

Coriphagus arcinensis

Creodonta
Palaeoryctidae
Acmeodon secans
A. cf A. secans
Palaeoryctes puercensis
P. cf P. puercensis
gen et sp. indet.

Carnivora
Miacidae
Protictis vanvaleni
P. haydenianus
P. n. sp. a
P. n. sp. b

Primates
Paromomyidae
Palaechthon nacimienti
Paromomys maturus
n. gen. et n. sp.

Pantodonta
Pantolambdidae
Pantolambda bathmodon
P. cavirictus

"Condylarthra"
Arctocyonidae
Arctocyon (=? Claenodon) ferox
"Neoclaenodon" procyonoides
Chriacus pelvidens
C. baldwini
Tricentes crassicollidens
Mimotricentes subtrigonus
M. sp.
Deltatherium fundaminis
Deutergonodon n. sp.
Triisodon crassicuspis
T. sp.
Goniacodon levisanus
Pantinomia ambiqua

Mesonychidae
Dissacus navajovius
D. saurognathus
Microclaenodon assurgens
gen. et sp. indet.

Phenacodontidae
Tetraclaenodon puercensis
T. pliciferus
n. gen. et n. sp.

Hyopsodontidae
- Mioclaenus turgidus
- M. lydekkerianus
- M.? n. sp.
- Promioclaenus lemuroides
- P. acolytus
- P. aeguidens
- Ellipsodon inaeguidens
- E. grangeri
- Protoselene opisthacus

Periptychidae
- Anisonchus sectorius
- Haploconus angustus
- H. corniculata
- Periptychus carinidens
- P. sp.

Taeniodonta
- Psittacotherium multifragum
- P. aspasiae
- Conoryctes comma
- n. gen et n. sp.

SAN JOSE FORMATION

(Eocene)

The San Jose Formation is exposed over a wide area in the northeastern part of the ES Region. It consists of four members; they are, in ascending order, Cuba Mesa, Regina, Llaves, and Tapicitos. The Cuba Mesa Member consists of tan to yellow, conglomeratic, massive sandstones; the Regina Member of light gray, tan or olive, but especially purple and maroon shales and siltstones; the Llaves Member of massive tan to red conglomeratic sandstones and sandy shales; and the Tapicitos Member of red shales and interbedded red, tan and white sandstone.

The San Jose Formation in northwest New Mexico contains a very diverse Wasatchian (early Eocene) vertebrate fauna that has been studied for almost one hundred years, but all the localities from which these fossils have come are immediately east of the region.

Those exposures of the San Jose within the region are largely unexplored. Survey of some of these exposures during this study revealed that some of the species listed here are indeed present in the region. The first species on the list is from Cockerell (1915); the vertebrata are from Lucas (1977a).

Gastropoda
- Campeloma calamodontis

Vertebrata
- Chondrichthyes
  - Isurus sp.
  - Lamna texana
  - L. sp.
  - ?L. sp.
  - Squalicorax pristodontus
  - Galeocerdo sp.
  - ?G. aduncus
- Osteichthyes
  - Lepisosteus aganus
  - L. integer
  - L. sp.

Reptilia
- Testudines
  - Baena arenosa
  - Kallistira costilata
  - Echmatemys cibollensis
  - E. lativertebralis
  - Testudo sp.
  - Trionyx cariosus
  - T. catenatus
  - T. communis
  - T. corrugatus
  - T. fractus
  - T. guttatus
  - T. lachrymalis
  - T. leptomitus
  - T. radulus
  - T. serialis
  - T. thomasii
  - T. ventricosus
  - T. sp.
- Crocodilia
  - Crocodylus chamensis
  - C. gryphus
  - C. wheelerii
  - C. sp.

C.? elliotii
C.? liodon
Orthosaurus sphenops

Lepidosauria
Placosaurus obtusidens
Anguidae, gen. et sp. indet.

Aves
Diatryma giganteum

Mammalia
Marsupicarnivora
?Peratherium sp.

Insectivora
Diacodon alticuspa
D. bicuspis
Leptictidae, gen. et sp. indet.
Palaeosinopa didelphoides
Apatemys bellus
Leptacodon sp.
cf Entomolestes nitens
Nyctitherium celatum

Deltatheridia
Didelphoides absarokae
Provivera multicupia
P. secundaria
P. strenua
P. viverrina
Tritemnodon hians
Prolmnocyon atavus
P. sp.
Oxyaena forcipata
O. lupina
O. simpsoni
O. sp.
cf O. n. sp.
Ambloctonus hyaenoides
A. sinuosus

Primates
Phenacolemur jepsoni
Unitanius vespertinus
Omomys sp.
?O. sp.
Microsyops angustidens
M. latidens
M. wilsoni
M. sp.
Navajovius? mckennai
Pelycodus frugivorus
P. jarrovii
P. tutus

P. sp.
Notharctus nunienus

Taeniodontia
Ectoganus gliriformis
E. simplex
E. sp.

Edentata
?Paleanodon sp.

Rodentia
Paramys copei copei
P. copei bicuspis
P. copei ssp.
P. cf P. copei
P. excavatus taurus
P. excavatus ssp.
Leptotomus sp.
aff Leptotomys costilloi
Thisbemys nini
Franimys buccatus
Sciuravus? sp.
Sciuravinae, gen. et sp. indet.

Carnivora
Didymictis protenus protenus
D. cf D. protenus
Unitacyon massetericus massetericus
Vulpavus australis
Miacis sp.
?M. sp.
cf M. sp.

Condylarthra
Chriacus gallinae
Anacodon ursidens
A. sp.
Phenacodus brachypternus
P. primaevus
P. wortmani
Hyopsodus miticulus
H. wortmani
Meniscotherium chamense
M. tapiacitis
Apheliscus insidiosus
Pachyaena ossifraga

Tillodontia
Esthonyx bisulcatus

Pantodonta
Coryphodon armatus
C. cuspidatus
C. elephantopus

C. latidens
C. lobatus
C. radians
C. testis
C. sp.

Perissodactyla
Hyracotherium angustidens angustidens
H. angustidens etsagicum
H. craspedotum
H. vasacciense vasacciense
H. vasacciense ssp.
H. sp.
cf Homogalax sp.

Artiodactyla
Bunophorus dorseyana
B. grangeri
Diacodexis chacensis
D. sp.

CHRONOLOGY OF RESEARCH

Most of the formations within the region have been studied intermittently; paleontological studies have been few, with the exception of those on the Fruitland Formation/Kirtland Shale and Nacimiento Formation, which have received attention because of their vertebrate faunas. Detailed histories of these studies are presented in Tables B-1 and B-2.

Table B-1

CHRONOLOGY OF THE STUDY OF THE FRUITLAND FORMATION AND THE KIRTLAND SHALE IN THE ES REGION

Name	Institution & Project Name	Investigators	Publications	Location of Collections
1880-1888	E. D. Cope	David Baldwin, Prof. collector	Cope, 1885d Osborn, 1898b	American Museum, U.S. National Museum
1904	American Museum Expedition	Barnum Brown	Brown, 1910, 1914	American Museum
1908	U.S. Geol. Survey Field Party	James Gardner	--	U.S. National Museum
1909	U.S. Geol. Survey & U.S. National Museum, Field Parties	James Gardner J. W. Gidley	--	U.S. National Museum
1912	American Museum Expedition	W. J. Sinclair Walter Granger	--	American Museum
1915	U.S. Geol. Survey, Field Party	C. M. Bauer J. B. Reeside, Jr.	Bauer, 1916 Gilmore, 1916 Knowlton, 1916 Stanton, 1916	U.S. National Museum
1917	U.S. Geol. Survey, Field Party	J. B. Reeside, Jr. F. R. Clark	Gilmore, 1919	U.S. National Museum
1921	U.S. Geol. Survey, Field Party	J. B. Reeside, Jr.	Gilmore, 1921, 1922 Reeside, 1922, 1924	U.S. National Museum

Table B-1 (continued)

Name	Institution & Project Name	Investigators	Publications	Location of Collections
1923	U.S. National Museum, Field Party	C. W. Sternberg	Gilmore, 1935 Osborn, 1923 Ostrom, 1961, 1963 Wiman, 1930, 1931, 1932, 1933 Sternberg, 1932	U.S. National Museum American Museum Field Museum, Chicago University, Uppsala Sweden
1929	U.S. National Museum, Field Party	C. W. Gilmore	Gilmore, 1930, 1935	U.S. National Museum
1961-1966	Univ. of Kansas, Field Party	W. Clemens	Clemens, 1973	Univ. of Kansas U. C. Berkeley
1966	U.S. Geol. Survey Univ. of New Mexico, Field Party	E. Baltz S. Ash R. Y. Anderson	Baltz, Ash, & Anderson, 1966	U.S. National Museum
1977	Univ. of Arizona, Field Party	E. H. Lindsay J. S. Powell	Powell, 1969, 1972, 1973	Univ. of Arizona

Source: Kues, Froelich, Schiebout, and Lucas, 1977.

Table B-2

CHRONOLOGY OF THE STUDY OF THE NACIMIENTO FORMATION IN THE ES REGION

Date	Institution & Project Name	Investigators	Publications	Location of Collections
1879	O.C. Marsh, Yale University	David Baldwin professional coll.	Simons, 1963	Yale Peabody Museum
1880-1888	E.D. Cope	David Baldwin	Cope, 1881a,b,c,d,e,f,g ---- 1882a,b,c,d,e,f,g,h, i,j,k,l ---- 1883a,b,c,d,e,f,g,h ---- 1884a,b,c,d,e,f,g,h ---- 1885a,b,c,d,e ---- 1886 ---- 1887a,b,c ---- 1888a,b,c,d,e 1897	American Museum U.S. National Museum
1892	American Museum Expedition	J.L. Wortman H.F. Osborn	Earle, 1895, Osborn & Earle, 1895	American Museum
1896	American Museum Expedition	J.L.Wortman	Matthew, 1897, 1898a,b. 1890, 1909, 1913, 1914, 1917a,b Osborn, 1909, 1914 Wortman, 1896b	American Museum
1907	U.S. Geol. Survey, Reconnaissance Paties	J.H. Gardner	Gardner, 1910 Gidley, 1909	U.S. National Museum
1913(a)	U.S. Geol. Survey, Field Party	C.M. Bauer J.B. Reeside, Jr.	Bauer, 1916	U.S. National Museum

Table B-2 (continued)

Date	Institution & Project Name	Investigators	Publications	Location of Collections
1913(b)	American Museum Expedition	W. Granger W.J. Sinclair G. Olsen	Granger, 1914 Sinclair, 1914 Sinclair & Granger, 1974	American Museum
1916	American Museum, Expedition	W. Granger	Granger, 1917 Matthew & Granger, 1921	American Museum
1928	Univ. of Calif., Berkeley, Field Party	C. L. Camp	Simpson, 1936b	Univ. of Calif. Museum of Paleontology
1929	American Museum, Expedition	G. G. Simpson	Mook, 1930 Simpson, 1930, 1936b	American Museum
1930	Univ. of Calif., Berkeley, Field Party	C. L. Camp	Simpson, 1936b	Univ. of Calif. Museum of Paleontology
1935	St. Louis Univ., Field Party	T. E. Reynolds	Reynolds, 1931, 1935, 1936, 1948	American Museum
1936	U.S. National Mus. Field Party	C. L. Gazin	Gazin, 1936, 1937	U.S. National Museum
1948	Univ. of Kansas Field Party	R. W. Wilson	Wilson, 1949, 1950	Univ. of Kansas

Table B-2 (continued)

Date	Institution & Project Name	Investigators	Publications	Locations of Collections
1949	American Museum Field Party	G. G. Simpson G. O. Whitaker	Simpson, 1959	American Museum
1950	Univ. of Kansas Field Party	R. W. Wilson	Kay & Cartmill, 1977 Wilson, 1951 Wilson & Szalay, 1972	Univ. of Kansas
1956	Univ. of Kansas Field Party	R. W. Wilson R. R. Camp	Wilson, 1956a,b,c	Univ. of Kansas
1958	American Museum, Expedition	G. G. Simpson G. O. Whitaker	Whitaker, 1958a,b	American Museum
1974-1977	Univ. of Arizona Field Party	E. H. Lindsay	--------	Univ. of Arizona
1976-1977	Univ. of New Mex. Field Party	S. G. Lucas J. W. Froelich	--------	Univ. of New Mex.

Source: Kues, Froelich, Schiebout, and Lucas, 1977.

AIR QUALITY

Table B-3

FEDERAL AND NEW MEXICO AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	Federal Primary Standards[1/]		Federal Secondary Standards[1/]		New Mexico State Standards [2/]	
		ug/m3	ppm	ug/m3	ppm	ug/m3	ppm
SO_2	Annual	80	.03			43	.02
	24-hour	365	.14			216	.10
	3-hour			1,300	.5		
Suspended Particulate (TSP)	Annual[3/]	75		60		60	
	24-hour	260		150		150	
	30-day					90	
	7-day					110	
CO	8-hour	10,000	9	10,000	9		8.70
	1-hour	40,000	35	40,000	35		13.10
Photochemical Oxidant	1-hour	160	.08	160	.08		.06
Non-Methane HC 6-9 am	3-hour	160	.24	160	.24		.19
NO_2	Annual	100	.05	100	.05	78	.05
	24-hour					156	.10

Source: 40 CFR 50, National Primary and Secondary Ambient Air Quality Standards. New Mexico Air Quality Control Regulation 201, Ambient Air Quality Standards.

Footnotes:

1/ Standards other than those based on annual averages or annual geometric means, are not to be exceeded more than once per year

2/ These are maximum standards which must not be equaled nor exceeded in actual air quality.

3/ Geometric mean.

Table B-4

ALLOWABLE AIR QUALITY INCREMENTS FOR SULFUR DIOXIDE AND
TOTAL SUSPENDED PARTICULATES FOR SIGNIFICANT DETERIORATION REGULATIONS

Pollutant	Averaging Time	Allowable Air Quality Increments (ug/m^3)		
		Class I	Class II	Class III
Sulfur Dioxide (SO_2)	Annaual Mean	2	20	40
	24-hour	8	91	182
	3-hour	25	512	700
Total Suspended Particulates (TSP)	Annual Mean	5	19	37
	24-hour	10	37	75

Source: 40 CFR 52.2, Prevention of Significant Air Quality Deterioration.

Table B-5

SPECIAL NEW MEXICO AMBIENT AIR QUALITY STANDARDS

Pollutant	Special Conditions	Averaging Time	New Mexico State Standards ug/m^3	ppm
Hydrogen Sulfide (H_2S)	Statewide	1-hour		.003
	Pecos-Permian Basin	½-hour		.100
	Municipalities within Pecos-Permian Basin	½-hour[1]		.030
	Within 5 miles of Minicipalities in Pecos-Permian Basin	½-hour[2]		.030
Total Reduced Sulfur	State	1-hour		.003
	Pecos-Permian Basin	1-hour		.010
	Municipalities within Pecos-Permian Basin	½-hour[1]		.003
	Within 5 miles of Municipalities in Pecos-Permian Basin	½-hour[2]		.003
Suspended Particulate Trace Elements	Beryllium	30-day	.01	
	Asbestos	30-day	.01	
	Heavy Metals (Combined total)	30-day	10	

Source: New Mexico Air Quality Control Regulation 201, Ambient Air Quality Standards (not to be equaled or exceeded).

Footnotes:

1/Effective January 1, 1976.

2/Effective January 1, 1978.

Table B-6

AMBIENT AIR QUALITY CONCENTRATIONS MEASURED IN THE STAR LAKE-BISTI ES REGION[1/]

Site	Total Suspended Particulates (TSP) ug/m³		Sulfur Dioxide (SO_2) ppm		Nitrogen Dioxide (NO_2) ppm		Carbon Monoxide (CO) ppm	
	24 Hour Maximum	Annual Mean	24 Hour Maximum	Annual Mean	24 Hour Maximum	Annual Mean	1 Hour Maximum	Annual Mean
Central Rural								
Star Lake[2/]								
1975-76 (one year)	214.3	26.8	--	--	--	--	--	--
South Rural								
Zuni								
1975	80.1	24.4	--	--	--	--	--	--
1976	94.1	39.8	--	--	--	--	--	--
North Rural								
Aztec								
1975	153.0	47.4	.006	.000	.0300	.0102	--	--
1976	158.6	61.2	.024	.007	.0255	.0106	--	--
EPNG Plant								
1975	83.8	37.3	--	--	--	--	--	--
1976	275.3	68.8	--	--	--	--	--	--
Kirtland								
1975	136.4	31.7	--	--	--	--	--	--
1976	219.0	80.9	.039	.012	.0363	.0129	--	--
Shiprock								
1975	105.0	43.7	.003	.000	.0210	.0118	--	--
	79.2	30.3	.007	.000	.0520	.0140	--	--
1976	303.9	76.4	.025	.009	.0347	.0134	--	--
	356.4	68.4	.014	.007	.0209	.0080	--	--
	134.5	48.4	--	--	--	--	--	--
Urban								
Farmington								
1975	154.8	85.0	.035	.001	.0300	.0121	20.00	4.98 (Jan, Feb, 1975)
	179.7	41.5	--	--	--	--	--	--
1976	357.0	160.4	.019	.008	.0668	.0242	17.00	2.81 (Oct-Dec, 1976)
	357.7	98.7	--	--	--	--	--	--
Gallup								
1975	671.2	125.2	--	--	--	--	--	--
1976	252.8	162.0	--	--	--	--	--	--

Footnotes:

1/ Ambient Air Quality Monitoring Data, 1975 and 1976, State of New Mexico Environmental Improvement Agency, Air Quality Division.

2/ Ambient Air Quality Monitoring Data from the Star Lake Project, McKinley Co., New Mexico., New Mexico; Peabody Coal Co.

Note: Dashes indicate that no measurements were taken or reported.

Table B-7

BACKGROUND CONCENTRATIONS FOR THE RURAL SUBAREAS OF THE STAR LAKE-BISTI ES REGION

	Total Suspended Particulate (TSP) ug/m^3	Sulfur Dioxide (SO_2) ppm	Carbon Monoxide (CO) ppm	Nitrogen Dioxide (NO_2) ppm	Non-Methane Hydrocarbons (NMHC) ug/m^3	Ozone (O_3) ppm
North Rural	53	$\leq$ 0.012	< 1.	$\leq$ 0.0102	~ 200-700	0.05
Central Rural	27	$\leq$ 0.012	< 1.	$\leq$ 0.0102	50	0.05
South Rural	32	$\leq$ 0.012	< 1.	$\leq$ 0.0102	50	0.05

Source: Ambient Air Quality Monitoring Data, 1975 and 1976, State of New Mexico Environmental Improvement Agency, Air Quality Division.

Table B-8

ATMOSPHERIC TRACE METALS CONCENTRATIONS 1/

Metal	Average Maximum Observation of 149 Urban Stations (1968) ug/m3	Average Maximum Observation of 2 Urban NGPRP 2/ Stations (1968) ug/m3	Average Maximum Observation of 28 Non-Urban Stations 3/ (1968) ug/m3	Maximum Observation of 1 Non-Urban Black Hills Station (1968) ug/m3
Beryllium	.005	.0004	.0002	< .0001
Cadmium	.016	x 4/	.002	.007
Chromium	.065	.031	.010	< .002
Cobalt	.005	x 4/	.001	.002
Copper	.50	.11	0.40	.450
Iron	8.03	4.60	1.07	< .03
Lead	3.39	1.36	0.20	.024
Manganese	.50	x 4/	.03	< .01
Nickel	.11	.01	.01	< .002
Tin	.02	x 4/	.005	< .0003
Titanium	.23	.05	.05	< .003
Vanadium	.21	x 4/	.02	< .001

1/ Final Environmental Statement, Northwest Colorado Coal, United States Department of Interior, Bureau of Land Management, June 2, 1976.

2/ Northern Great Plains Resource Program.

3/ Located at several representative sites over the United States, including Yellowstone, Mesa Verde, and Grand Canyon National Parks.

4/ Observations less than minimum detectable concentrations.

Table B-9

EMISSIONS FOR SAN JUAN COUNTY
(Tons per year)

Source	Total Suspended Particulates (TSP)	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NO_x)	Hydrocarbons (HC)	Carbon Monoxide (CO)
Major Point Sources					
Arizona Pub. Serv. Co. Four Corners Plant	20,285.	107,374.	90,361.	1,212.	4,035.
Asphalt Paving Co. Inc. B135 Farmington	868.	0	0	0	0
El Paso Natural Gas Co. Blanco Station	1.	1.	672.	1,586.	0
El Paso Natural Gas Co. Chaco Station	21.	1.	958.	2,048.	0
El Paso Natural Gas Co. San Juan River Station	0	5,296.	111.	157.	0
El Paso Natural Gas Co. Blanco Station	28.	0	961.	820.	30.
El Paso Natural Gas Co. Chaco Station	29.	0	1,073.	873.	30.
El Paso Natural Gas Co. Four Corners Tank Bats	0	0	0	733.	0
Pub. Service of N.M. San Juan Plant	1,195.	18,975.	8,627.	187.	624.
Other Point Sources	506.	281.	1,847.	2,045.	28.
Total Point Sources	22,933.	131,928.	104,610.	9,661.	4,747
Area Sources	783.2	421.5	5,285.2	4,233.9	18,998.3
TOTAL EMISSIONS	23,716.2	132,349.5	109,895.2	13,894.9	23,745.3

Source: 1972 National Emissions Data System Emissions Inventory for San Juan Co. with updates through 1975.

Table B-10

EMISSIONS FOR SANDOVAL COUNTY
(Tons per year)

Source	Total Suspended Particulates (TSP)	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NO_x)	Hydrocarbons (HC)	Carbon Monoxide (CO)
Major Point Sources					
Duke City Lumber, Cuba	84.	36.	12.	132.	1,560.
N.M. State Highway Dept.	1,975.	0.	0.	0.	0.
Other Point Sources	5.	31.	240.	1.	7.
Total Point Sources	2,064.	67.	252.	133.	1,567.
Area Sources	767.7	554.8	5,423.8	5,997.8	33,639.3
TOTAL EMISSIONS	2,831.7	621.8	5,675.8	6,130.8	35,206.3

Source: 1972 National Emissions Data System Emissions Inventory for Sandoval Co. with updates through 1975.

Table B-11

EMISSIONS FOR MCKINLEY COUNTY
(Tons per year)

Source	Total Suspended Particulates (TSP)	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NO_x)	Hydrocarbons (HC)	Carbon Monoxide (CO)
Major Point Sources					
Broce Construction Co.	2,017.	0	0	0	0
El Paso Natural Gas Plant, Bluewater Station	9.	0	368.	572.	9.
El Paso Natural Gas Plant, Gallup Station	12.	0	448.	544.	12.
El Paso Natural Gas Plant, Wingate	9.	1.	220.	2,178.	15.
Kerr-McGee Ambrosia Lake	0	2,008.	0	0	0
Shell Oil Co., Wingate Star Rt.	96.	252.	530.	2,519.	2.
Hamilton Bros. Construction B.H.H. Gallup	976.	0	0	0	0
Other Point Sources	705.	2.	374.	501.	10.
Total Point Sources	3,824	2,263	1,940.	6,314.	48.
Area Sources	535.5	231.6	3,811.7	4,413.6	20,286.7
TOTAL EMISSIONS	4,359.5	2,494.6	5,751.7	10,727.6	20.334.7

Source: 1972 National Emission Data System Emissions Inventory for McKinley Co. with updates through 1975.

WATER RESOURCES

WATER RESOURCES

COMPUTATION OF FLOOD FREQUENCY

The magnitude of flood frequency has been defined regionally for New Mexico (Scott, 1971). Using multiple regression techniques, the analysis relates flood peaks of 2-, 5-, 10-, 25-, and 50-year recurrence intervals (50-, 20-, 10-, 4-, and 2- percent chance of occurrence respectively) to selected physical and climatic basin characteristics. The equations developed in that study can be used to compute the peak discharges of floods of given recurrence intervals.

Six basin characteristics were used to develop the equations applicable for the ES Region. The characteristics and their description are as follows:

Drainage area (A), in square miles, is determined by use of a planimeter from the best available topographic maps.

Mean basin altitude (Em), in 1,000's of feet above mean sea level, is the average of the altitudes at points 10 percent and 85 percent of the distance along the main channel from the station to the basin divide, as determined from the best available maps.

Area of lakes and ponds (St), within the drainage basin, is expressed as a percentage of the total basin drainage area and increased by 1.0. The area of lakes and ponds is determined from the best available topographic maps using a transparent grid divided into 0.01 or 0.04 square-mile areas. The grid is placed over a lake on the map and a count made of squares or partial squares covering the lake area.

Normal May through September precipitation (Ps), in inches minus 3.00, is the basin average determined from a 1:500,000 scale isohyetal map prepared by the U.S. Weather Bureau and available from the office of the New Mexico State Engineer (U.S. Weather Bureau, no date).

Maximum 24-hour 2-year rainfall (I), in inches, is the basin average of the maximum 24-hour rainfall with a recurrence interval of 2 years. These values are determined from rainfall-frequency maps for New Mexico (U.S. Weather Bureau, 1967).

Mean minimum January temperature (T), in degrees F., is the basin average determined from a map published in von Eschen (1959).

These basin characteristics are used with the following equations:

$$Q_2=2860\ A^{0.56}Em^{-1.76}St^{-0.86}$$

$$Q_5 = 261\ A^{0.49}$$

$$Q_{10} = 411\ A^{0.47}$$

$$Q_{25} = 716\ A^{0.49}Ps^{-1.18}I^{2.57}T^{.23}$$

$$Q_{50} = 915\ A^{0.49}Ps^{-.23}I^{2.74}T^{.25}$$

The standard error of estimate in the use of these 5 equations is 86, 83, 82, 72, and 74 percent, respectively.

After the 5 flood peaks have been determined, the data are plotted on log probability paper and a smooth curve drawn through the 5 values. The curve is then used as the flood-frequency

Table B-12

STREAMFLOW CHARACTERISTICS FOR SELECTED STREAMS

Station Number	Station Name	Drainage Area (sq mi)	Records Used (years)	Mean Annual Discharge (cfs)	Range of Annual Minimum Daily Discharge (cfs)	Peak Flow: Average recurrent interval (years) 2	5	10	25	50	100	Maximum Observed: Date	Discharge (cfs)	Unit Discharge (cfs/sq mi)	Remarks
08270500	Rio Grande at Embudo, New Mexico	10,400	1889-75	999	130 -496	-	-	-	-	-	-	June 19, 1903	16,200	1.6	Diversions above station for irrigation of about 620,000 acres in Colorado and 40,000 acres in New Mexico.
08284200	Willow Creek above Heron Reservoir, near Parkview, New Mexico	112	1963-76	-	0.0 - 0.24	990	1,340	1,570	-	-	-	Aug. 11, 1967	1,600	14.3	Since Nov. 1970 includes San Juan River water imported through Azotea tunnel.
08289000	Rio Ojo Caliente at La Madera, New Mexico	419	1932-75	67.1	0.6 - 6.2	1,070	1,750	2,200	2,760	3,150	3,540	Apr. 21, 1958	3,140	7.5	Diversions above station for irrigation of about 3,500 acres.
08290000	Rio Chama near Chamita, New Mexico	3,144	1912-70	541	0.0 - 94	5,360	8,140	10,300	13,300	-	-	May 22, 1920	15,000	4.8	Diversions above station for irrigation of about 27,600 acres above and several hundred acres below. Flow partly regulated by El Vado Reservoir and Abiquiu Reservoir.
08316000	Santa Fe River near Santa Fe, New Mexico	18.2	1913-75	8.0	0.10- 2.7	77	180	280	-	-	-	Aug. 14, 1921	1,500	82.4	Flow regulated by McClure Reservoir.
08318000	Galisteo Creek at Domingo, New Mexico	640	1943-67	13.2	0.0 - 0.0	6,400	11,200	15,000	20,400	24,800	-	Aug. 20, 1935	24,300	38.0	Diversions above station for irrigation of about 50 acres.
08321500	Jemez River below East Fork, near Jemez Springs, New Mexico	173	1959-75	28.4	3.3 - 10.0	640	1,040	1,440	2,170	-	-	Apr. 21, 1958	2,520	14.6	
08321900	Rio de las Vacas near Senorita, New Mexico	26.8	1957-75	-	-	250	410	520	680	-	-	May 23, 1958	800	29.8	Partial record station.
08323000	Rio Guadalupe at Box Canyon near Jemez, New Mexico	235	1939-42 1950-75	36.3	3.4 - 10.0	350	790	1,340	2,600	4,500	-	Apr. 21, 1958	1,440	6.1	Transmountain diversion for irrigation of about 300 acres. Flow partly regulated by San Guesorio Reservoir.
08329000	Jemez River below Jemez Canyon Dam, New Mexico	1,038	1936-37 1943-75	54.8	0.0 - 1.1	4,400	10,000	14,500	20,500	-	-	Aug. 29, 1943	16,300	15.7	Diversions above station for irrigation of about 3,000 acres. Flow partly regulated by Jemez Canyon Reservoir.
08334000	Rio Puerco above Arroyo Chico near Guadalupe, New Mexico	420	1952-75	13.8	0.0 - 0.0	2,840	4,010	4,780	5,740	6,440	-	July 29, 1967	6,940	16.5	Diversions above station for irrigation of about 3,700 acres in past years.
08340500	Arroyo Chico near Guadalupe, New Mexico	1,390	1944-75	22.6	0.0 - 0.0	5,480	8,500	10,200	14,000	17,200	20,500	Sep. 12, 1972	15,200	10.9	Diversions above station for irrigation of about 100 acres.

Table B-12 (continued)

Station Number	Station Name	Drainage Area (sq mi)	Records Used (years)	Mean Annual Discharge (cfs)	Range of Annual Minimum Daily Discharge (cfs)	Peak Flows: Average recurrent interval (years) 2	5	10	25	50	100	Maximum Observed: Date	Discharge (cfs)	Unit Discharge (cfs/sq mi)	Remarks
08341300	Bluewater Creek above Bluewater Dam, near Bluewater, New Mexico	75	1953-71 1974-75	-	-	160	270	340	390	-	-	July, 1953	3,570	47.6	Partial record station.
08343100	Grants Canyon at Grants, New Mexico	13.0	1962-75	0.190	0.0-0.0	360	770	1,080	1,800	-	-	Aug. 26, 1963	1,550	119.	
08343500	Rio San Jose near Grants, New Mexico	2,300	1936-75	6.50	2.7-4.6	-	-	-	-	-	-	Sep. 20, 1963	1,400	0.6	Diversions and ground-water withdrawal for irrigation of about 5,100 acres above station. Flow partly regulated by Bluewater Lake.
08348500	Encinal Creek near Casa Blanca, New Mexico	6.19	1961-75	-	-	190	380	600	1,090	-	-	Sep. 9, 1967	4,330	699.	Partial record station.
08351500	Rio San Jose at Correo, New Mexico	3,660	1944-75	12.1	0.0-0.0	1,920	3,690	5,420	7,690	9,890	12,400	Aug. 11, 1955	7,150	2.0	Flow regulated to some extent by Bluewater Lake. 1,130 sq. mi. of area does not contribute to runoff.
08353000	Rio Puerco near Bernardo, New Mexico	7,350	1940-75	50.2	0.0-0.0	4,540	8,000	10,600	14,000	16,700	19,500	Sep. 23, 1941	18,800	2.6	Diversions and ground-water withdrawal for irrigation of about 11,500 acres above station. 1,130 sq. mi. of area does not contribute to runoff.
09350500	San Juan River at Posa, New Mexico	1,990	1911-65	1,193	39 -225	6,600	10,600	13,800	18,700	23,000	28,000	Jun. 29, 1927	25,000	12.6	Diversions above station for irrigation of about 14,000 acres.
09355700	Gobernador Canyon near Gobernador, New Mexico	19.8	1956-75	-	-	650	1,120	1,580	2,290	-	-	Aug. 6, 1963	3,450	174.	Partial record station.
09356400	Mancanares Canyon near Turley, New Mexico	3.1	1956-75	-	-	390	800	1,240	2,050	-	-	Aug. 3, 1969	2,210	713.	Partial record station.
09357200	Gallegos Canyon tributary near Nageezi, New Mexico	0.2	1952-75	-	-	110	220	350	570	840	-	July 12, 1964	580	2,900.	Partial record station.
09364500	Animas River at Farmington New Mexico	1,360	1921-75	924	2.4-288	6,110	9,190	11,400	14,300	16,500	18,900	June 29, 1927	26,000	18.4	Diversions above station for irrigation of about 30,000 acres.
09365000	San Juan River at Farmington, New Mexico	7,240	1912-75	2,406	27 -918	13,100	22,500	30,900	44,500	57,100	72,100	June 29, 1927	68,000	9.4	Diversions above station for irrigation of about 86,000 acres. Flow partly regulated by Navajo Reservoir.
09367500	La Plata River near Farmington, New Mexico	583	1938-75	26.0	0.0- 1.9	-	-	-	-	-	-	Sep. 10, 1939	-	-	Diversions above station for irrigation of about 24,000 acres.

Table B-12 (continued)

Station Number	Station Name	Drainage Area (sq mi)	Records Used (years)	Mean Annual Discharge (cfs)	Range of Annual Minimum Daily Discharge (cfs)	Peak Flows: Average recurrent interval (years) 2	5	10	25	50	100	Maximum Observed: Date	Discharge (cfs)	Unit Discharge (cfs/sq mi)	Remarks
09367530	Locke Arroyo near Kirtland, New Mexico	2.96	1951-75	-	-	120	270	420	710	1,010	-	Aug. 29, 1957	812	274.	Partial record station.
09367640	Yazzie Wash near Mexican Springs, New Mexico	2.1	1937-42 1953-54 1956-75	-	-	390	730	1,030	1,520	1,970	-	, 1941	1,390	662.	Partial record station.
09367860	Chusca Wash near Mexican Springs, New Mexico	8.7	1937-42 1953-75	-	-	1,110	2,510	3,950	6,100	8,000	-	Oct. 15, 1967	6,400	736.	Partial record station.
09367880	Catron Wash near Mexican Springs, New Mexico	26.9	1937-40 1956-75	-	-	1,710	3,420	4,650	6,220	7,600	-	Oct. 15, 1967	4,750	177.	Partial record station.
09367900	Black Springs Wash near Mexican Springs, New Mexico	7.05	1954-75	-	-	428	1,030	1,520	2,700	3,750	-	Aug. 18, 1955	2,200	312.	Partial record station.
09367950	Chaco River near Waterflow, New Mexico	4,350	1959-69	-	-	3,900	7,100	8,000	-	-	-	Sep. 20, 1969	7,300	1.7	Partial record station.
09368000	San Juan River at Shiprock, New Mexico	12,900	1926-75	2,216	8 -1,150	14,300	25,300	35,100	51,000	65,700	83,400	Aug. 11, 1929	80,000	6.2	Diversions above station for irrigation of about 118,000 acres. Flow partly regulated by Navajo Reservoir.
09386900	Rio Nutria near Ramah, New Mexico	71.4	1970-75	4.63	0.01- 0.05	240	590	900	-	-	-	Apr. 14, 1973	782	11.0	
09386950	Zuni River above Black Rock Reservoir, New Mexico	810	1970-75	10.2	0.0 - 0.0	1,140	3,600	6,500	-	-	-	Aug. 4, 1974	5,200	6.4	
09387050	Galestena Canyon tributary near Black Rock, New Mexico	19	1957-75	-	-	150	350	500	750	-	-	Sep. 5, 1970	660	34.7	Partial record station.
09395400	Milk Ranch Canyon near Fort Wingate, New Mexico	14.0	1953-75	-	-	65	170	260	410	-	-	, 1949	1,360	97.1	Partial record station.
09395500	Puerco River at Gallup, New Mexico	558	1940-45 1956-75	-	-	3,280	6,140	8,130	10,600	12,300	-	July 17, 1972	12,000	21.5	Partial record station.
09395600	Wagon Trail Wash near Gamerco, New Mexico	0.38	1951-74	-	-	75	180	270	400	510	-	Aug. 17, 1958	437	1,150.	Partial record station.
09395850	Black Creek tributary near Window Rock, Arizona	0.28	1963-75	-	-	130	145	165	180	-	-	Aug. , 1968	171	611.	Partial record station.
09396400	Dead Wash tributary near Holbrook, Arizona	1.0	1963-75	-	-	200	420	600	900	-	-	Aug. , 1967	743	743.	Partial record station.

Source:

Table B- 13
BASIN CHARACTERISTICS FOR FLOOD FREQUENCIES

Name	Drainage Area (A)	Mean Basin Altitude (Em)	Main Channel Slope (S)	Storage Factor (St)	Mean Oct - Apr. Precip. (Pa)	Mean May - Sep. Precip. (Ps)	Rainfall Inten. 2 yr. - 24 hr. (I)	Mean Minimum Jan. Temp (T)	Lat. of Center of Basin (LA)	Shape Factor (Sh)
	sq. mi.	1000 ft.	Ft/Mi.	Percent + 1	in.	in.-3.00	in.	Deg.	Deg.-30	
Arroyo Chiguilla	66.4	6.93	35.1	1.34	5.8	5.0	1.2	9.	6.02	4.15
Sandoval Arroyo	26.5	6.83	38.5	1.07	3.2	2.5	1.05	12.	5.72	2.70
Papers Wash	69.1	6.82	41.4	1.25	3.8	3.5	1.1	11.	5.87	4.90
Arroyo Piedra Lumbre	78.0	6.47	38.8	1.31	5.2	4.7	1.3	11.	5.78	4.68
Arroyo del Puerto	93.8	7.06	35.8	1.31	3.8	4.5	1.2	14.	5.42	3.49
La Fragua Canyon	46.4	6.67	99.1	1.04	7.0	3.0	1.25	4.	6.80	4.04
Little Pump Canyon	15.2	6.23	108.	1.00	6.2	2.3	1.25	10.	6.88	3.25
Palluche Wash	40.5	6.41	57.1	1.03	5.8	2.5	1.15	11.	6.40	3.80
Kutz Canyon	51.0	5.77	58.2	1.01	4.8	2.1	1.1	14.	6.60	2.87
West Fork Gallegos Canyon	76.5	6.00	38.7	1.09	4.4	2.1	1.05	15.	6.47	3.13
Hutch Canyon	8.08	5.37	60.6	1.13	4.5	0.8	1.05	17.	6.80	7.15
Arroyo Pueble Alto	2.54	6.65	48.0	1.00	4.2	3.1	1.2	11.	5.97	2.96
Pueblo Pintado Canyon	7.06	6.66	65.1	1.00	4.1	2.5	1.2	12.	5.92	6.90
Escavada Wash	89.2	6.50	27.3	1.03	4.6	2.7	1.1	12.	6.13	8.66
Ah-shi-pah Wash	43.1	6.11	25.3	1.05	4.4	2.1	1.1	15.	6.15	5.58
Kim-me-ni-oli Wash tributary	34.2	6.37	41.0	1.07	3.0	2.1	1.0	15.	5.92	7.41
Coal Creek	51.4	6.29	45.9	1.10	4.5	2.3	1.1	15.	6.23	7.62
Puerco River	277.	6.99	23.7	1.13	6.0	4.6	1.3	18.	5.62	5.42
South Fork Puerco River tributary	11.2	6.88	73.5	1.03	6.0	3.8	1.2	16.	5.48	5.66
Burned Death Wash	53.3	6.61	34.0	1.07	5.9	3.4	1.25	16.	5.62	4.81

Note: The letters at the head of each column are the same as the symbols in the appropriate flood frequency equations.

curve.

A sample computation is shown for Arroyo Pueblo Alto (NW 1/4, NE 1/4, sec. 13, T. 20 N., R. 7 W.) near Star Lake. The basin characteristics are:

Drainage area, A = 2.54 square miles

Mean basin altitude, Em = 6.65 1000's of feet

Area of lakes and ponds, St = 1.00 percent

Normal May through September precipitation, Ps = 3.1 inches

Maximum 24-hour 2-year rainfall, I = 1.2 inches

Mean minimum January temperature, T = 11°F

These values are substituted in the 5 equations where applicable, which are used in their logarithmic form for ease in computation:

$Q_2 = 3.4558 + 0.405 \times 0.56 - 0.823 \times 1.76 - 0.00 \times 0.86$

$Q_5 = 2.4159 + 0.405 \times 0.49$

$Q_{10} = 2.6138 + 0.405 \times 0.47$

$Q_{25} = 2.8549 + 0.405 \times 0.49 - 0.491 \times 1.18 + 0.079 \times 2.57 +$
1.041×0.23

$Q_{50} = 2.9614 + 0.405 \times 0.49 - 0.491 \times 1.23 + 0.079 \times 2.74$
1.041×0.25

Taking anti-logarithms of the computed flood peaks gives:

Q_2 = 172 cubic feet per second (cfs)

Q_5 = 411 cfs

Q_{10} = 637 cfs

Q_{25} = 825 cfs

Q_{50} = 1,077 cfs

Figure B-1 is a plot of this data. This smooth curve is the final flood-frequency curve for the basin.

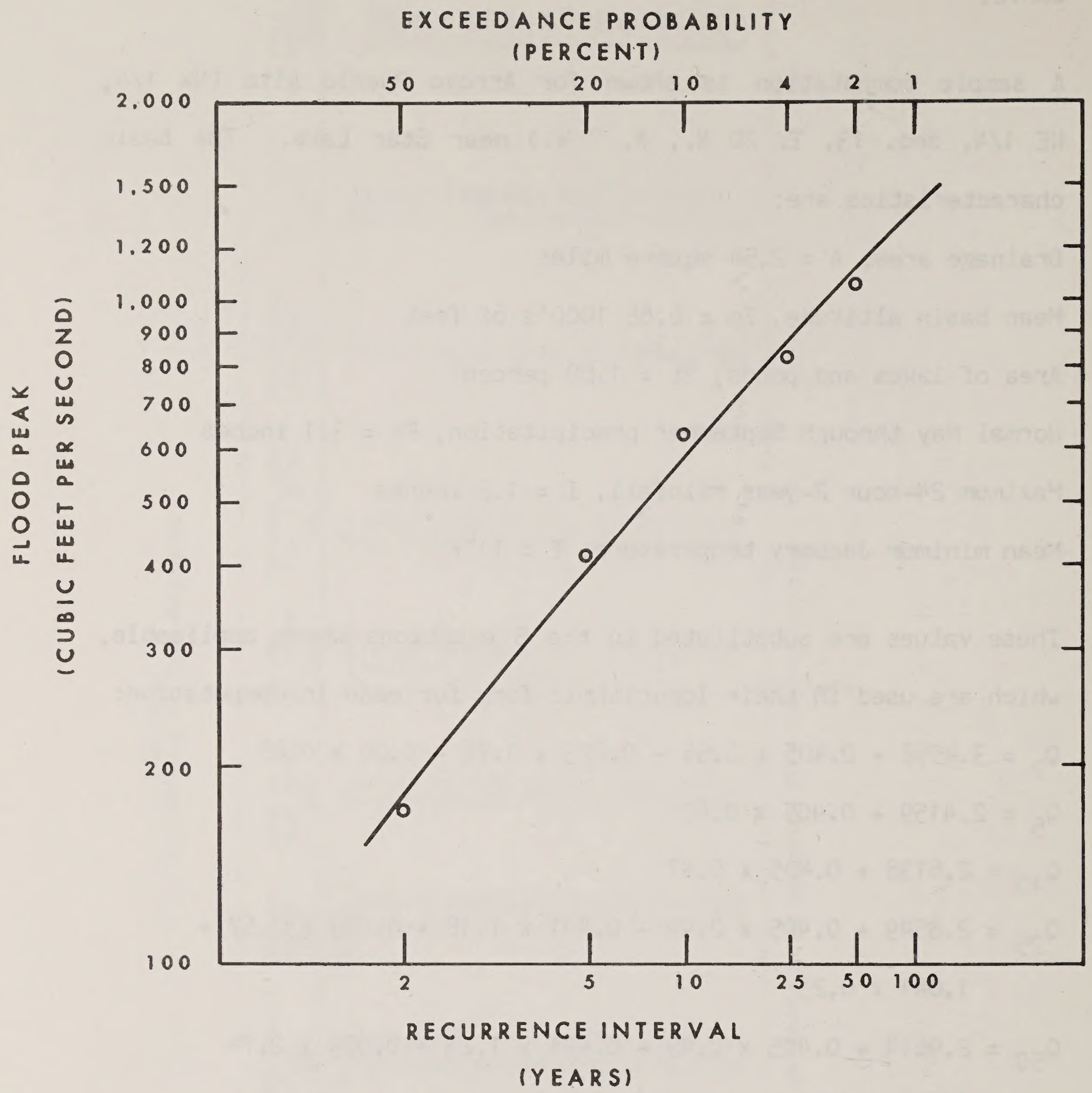

FIGURE B-1: FLOOD-FREQUENCY CURVE FOR ARROYO PUEBLO ALTO.

WATER QUALITY

Table B-14

PHYSICAL PROPERTIES AND CHEMICAL QUALITY OF GROUND WATER

Aquifer	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium & Potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids	Total Hardness (Units)	pH	Temperature (°C)
Alluvium	4.1-63	0-6.6	4-2,870	0.8-2,040	5.5-12,000	34-1,000	2.5-8,890	2-27,500	0-11	0-439	143-47,100	18-15,500	7.3-8.3	4-21
San Jose Formation	7.6-28	0.02-14	1.6-365	0-67	29-745	120-814	71-1,430	3.2-87	0.2-4.0	0-25	323-2,520	4-1,960	6.5-9.2	9-14
Nacimiento Formation	14-22	0.02-0.58	0-385	0-50	3-2,415	0-478	6.2-5,455	1-145	0-4	0.2-5.7	56-14,150	30-966	6.9	12
Ojo Alamo Sandstone	9.6-39	0-2.1	1.6-548	0-126	23-788	0-888	0.4-2,440	0.8-923	0.3-1.8	0-70	275-4,010	4-1,860	6.5-8.9	2-14
Pictured Cliffs Sandstone	11-20	0-0.24	1.9-425	1-217	50-16,600	209-2,400	7.3-4,400	19-26,600	1.2-5.5	0-8.6	383-44,200	11-1,950	7.4-9.1	3-19
Cliff House Sandstone	2.7-19	0-0.01	2.2-280	0.7-170	26-6,140	0-1,250	350-8,230	7-4,210	0-8.1	0.1-2.5	849-3,120	8-1,600	4.3-8.9	13-18
Menefee Formation	5.1-21	0-1.1	1-168	0-34	8-2,620	92-1,890	1.8-3,930	1.5-956	0-12	0-19	129-7,780	4-534	7.4-9.1	12-21
Point Lookout Sandstone	0.05-39	0-0.31	0-684	0.4-267	13-833	116-826	3.8-3,410	2.2-113	0.2-3.7	0.1-14	149-5,080	5-2,800	7.4-10.0	13-21
Crevasse Canyon Formation	5.5-24	0-3.6	1.3-630	0-245	0.9-1,002	122-1,030	9.2-2,980	1.4-94	0-2.0	0-427	243-4,470	4-3,100	6.8-9.1	12-20
Gallup Sandstone	10-38	0.02-15	1-456	0-268	16-1,690	85-763	17-2,854	4-1,940	0-6.8	0-40	285-4,400	4-2,240	7.2-8.8	9-42
Dakota Sandstone	6.5-42	0-7.8	1.5-330	0.9-103	5.8-1,430	130-1,600	7.8-3,540	6-500	0.1-10	0.1-10	165-5,560	9-1,080	7.2-8.4	13-23
Westwater Canyon Member Morrison Formation	6.2-29	0-4	1.2-373	0.2-188	9.2-1,430	60-1,200	11-3,540	0.8-374	0.1-4	0-200	168-5,560	4-1,700	7.2-9.2	14-52
Bluff Sandstone	7.4-18	0-0.39	7.5-221	2.2-106	24-949	168-898	17-2,380	12-118	0.2-5.1	0.1-18	264-3,760	20-988	7.5-8.3	11-24
Entrada Sandstone	9.1-27	0.09	1.2-262	0.2-64	15-543	83-539	5.8-1,930	5-2,230	0.2-1.6	0-33	196-2,870	4-916	9.2	17
Chinle Formation	3.9-45	0-1.2	0.4-304	0.5-587	1.2-5,740	34-1,150	16-4,110	5-9,590	0.1-5.9	0-129	171-6,410	3-3,170	6.8-9.1	12-20
San Andres Limestone	6.7-23	0-1.2	60-266	14-128	1.2-426	161-702	11-1,030	4-254	0-0.8	0-105	272-2,370	72-1,040	6.7-8.2	11-46
Glorieta Sandstone	8.2-13	3.4-4.1	100-183	15-87	9.2-1,330	184-265	230-637	5-1,980	0.1-0.8	0-1.7	567-4,330	412-779	7.2	13-26

Table B-15

CHEMICAL ANALYSES OF SURFACE WATER

PART I

Water Year	Total Number of Samples	Temperature (DegC) Min	Temperature (DegC) Max	Turbidity (JTU) Min	Turbidity (JTU) Max	Color (Platinum-Cobalt Units) Min	Color (Platinum-Cobalt Units) Max	Specific Conductance (Mmhos) Min	Specific Conductance (Mmhos) Max	Dissolved Oxygen (mg/l) Min	Dissolved Oxygen (mg/l) Max	Biochemical Oxygen Demand 5-day (mg/l) Min	Biochemical Oxygen Demand 5-day (mg/l) Max	Chemical Oxygen Demand (mg/l) Min	Chemical Oxygen Demand (mg/l) Max	pH (units) Min	pH (units) Max	Alkalinity as $CaCO_3$ (mg/l) Min	Alkalinity as $CaCO_3$ (mg/l) Max	Bicarbonate (mg/l) Min	Bicarbonate (mg/l) Max	Carbonate (mg/l) Min	Carbonate (mg/l) Max	Hardness (mg/l) Min	Hardness (mg/l) Max	Dissolved Solids (time/day) Min	Dissolved Solids (time/day) Max
08290000 Rio Chama near Chamita, New Mexico																											
1961	12	2.2	26.7																								
1963	24	7.8	25.0					214	697							7.2	8.4			80	222	0	4	84	254		
1964	32							206	1,000							7.1	8.5			90	256	0	5	86	391	1,747[2]	
1965	22							182	779							7.1	7.8			82	228	0	0	78	370	65.7	595
1966	29	1.7	25.6					207	980							7.1	7.9			97	232	0	0	89	376		
1967	44	.0	29.4					284	924							7.0	8.0			106	264	0	0	111	344		
1968	35	1.0	26.0					211	856							6.9	7.6	82	185	100	226	0	0	92	310	44.6	1,130
1969	32	.0	23.0					132	810	8.2	11.4	0.5	2.3			7.1	7.7	63	190	77	232	0	0	72	322	59.1	1,060
1970	18	1.0	24.5					176	895							7.3	8.3	67	165	82	201	0	1	76	304	110	829
1971	20	.0	25.0	2	120	0	80	206	946							7.2	8.1	79	222	96	271	0	0	86	390	1.81	611
1972	36	.0	24.5	3	300	0	100	225	701							7.0	8.2	88	195	107	238	0	0	110	230	21.5	481
1973	38	1.0	21.5	0	380	5	50	210	757							6.9	8.2	69	138	83	168	0	0	84	250	102	869
1974	19	1.0	25.6					277	790							7.9	8.3	80	181	97	221	0	0	110	300	57.0	530
1975 (May)	9	.0	23.9					289	740							7.9	8.3	171	196	209	239	0	0	220	250	72.3	89.3
08313000 Rio Grande at Otowi Bridge, New Mexico																											
1960	365							211	613							7.5	8.5			89	179	0	2	83	276		
1961	365	5.6	24.4					237	749							7.3	8.7			96	211	0	8	100	336	178	2,180
1962	365							229	565							7.5	8.9			96	188	0	13	93	208		
1963	365	1.7	27.8					231	1,310							7.1	8.4			94	264	0	8	90	702	110	1,590
1964	365							243	1,010							7.5	8.2			114	360			100	332	132	1,440
1965	365							255	528							7.6	8.1			101	182	0	0	100	222	166	3,390
1966	365	4.4	26.7					261	594							7.6	8.0	83	148	101	180	0	0	104	224	200	1,800
1967	365	5.0	23.3					272	835							7.4	8.1	92	166	112	202	0	0	103	342	215	2,490
1968	365	3.0	25.0					225	565							6.8	8.4	67	153	88	186	0	0	83	228	211	2,600
1969	365	3.0	26.0					200	939	6.9	11.4	0.8	2.4	28[2]		7.5	8.5	76	185	93	226	0	0	87	440	283	3,680
1970	365	.0	26.0	10	200	5	45	200	778	7.0	11.4	.9	4.9	3	37	7.6	8.6	73	148	85	181	0	4	83	316	281	1,670
1971	365	.5	26.0	7	110	3	80	254	582	6.7	12.0	.7	4.2	3	14	7.5	8.6	81	153	99	186	0	8	92	220	195	1,120
1972	365	.0	27.0	20	325	3	40	274	802	7.6	11.8	.7	2.6	4	10	7.5	8.6	86	202	105	246	0	0	95	330	200	2,180
1973	365	.0	23.0	9	140	5	50	217	502	7.4	11.2					7.0	8.9	68	141	83	172	0	7	86	190	174	3,190
1974	365	.0	20.5	8	200			295	628	6.5	11.3			8	14	7.4	8.9	45	135	45	164	0	5	110	290	188	1,450
1975	365	.0	25.0	7	200			209	493	7.4	12.0			4	39	7.9	8.7	70	168	87	180	0	3	83	180	273	2,370
1976	365	.5	22.0	30	250			217	450	7.7	12.3			3	59	7.7	8.6	65	121	79	141	0	0	79	170	312	1,170
1977 (Mar)	182	1.0	14.0	8	25			340	450	9.8	12.8			3	55	7.5	8.2	110	143	140	174	0	0	130	160	234	402

Table B-15 (continued)

Water Year	Total Number of Samples	Temperature (DegC) Min	Temperature (DegC) Max	Turbidity (JTU) Min	Turbidity (JTU) Max	Color (Platinum-Cobalt Units) Min	Color (Platinum-Cobalt Units) Max	Specific Conductance (Mmhos) Min	Specific Conductance (Mmhos) Max	Dissolved Oxygen (mg/l) Min	Dissolved Oxygen (mg/l) Max	Biochemical Oxygen Demand 5-day (mg/l) Min	Biochemical Oxygen Demand 5-day (mg/l) Max	Chemical Oxygen Demand (mg/l) Min	Chemical Oxygen Demand (mg/l) Max	pH (units) Min	pH (units) Max	Alkalinity as $CaCO_3$ (mg/l) Min	Alkalinity as $CaCO_3$ (mg/l) Max	Bicarbonate (mg/l) Min	Bicarbonate (mg/l) Max	Carbonate (mg/l) Min	Carbonate (mg/l) Max	Hardness (mg/l) Min	Hardness (mg/l) Max	Dissolved Solids (time/day) Min	Dissolved Solids (time/day) Max
08329000 Jemez River below Jemez Canyon Dam, New Mexico																											
1966	5							630	1,720							7.4	7.7			195	330	0	0	134	236		
1967	13	0.0	24.4					1,080	3,540							7.2	8.2			232	582	0	0	168	1,220		
1968	12	0.0	31.0					456	2,630							7.3	7.9	98	266	119	324	0	0	115	664	17.3	3,430
1969	12	5.0	21.0					457	2,830							7.5	8.1	101	264	123	322	0	0	128	810	3.0	244
1970	6	8.0	25.0					1,010	3,030							7.6	8.2	84	234	103	344	0	0	162	985	5.22	1,200
1972	10	.0	13.0					612	1,545							7.9	8.4	152	251	185	306	0	8	160	280	4.68	61.4
1973	23	.5	29.5	200	1,900	8	10	305	1,390							7.4	8.2	84	254	104	310	0	0	85	300	15.9	5,390
1974	38	.0	24.5	84	210			564	3,090							7.7	8.4	131	294	160	361	0	0	130	410	2.74	331
1975	23	.0	24.0					339	2,320							7.7	8.3	96	417	117	509	0	0	89	400	13.5	360
1976	9	5.0	17.0					840	4,700							7.6	8.4	171	272	207	332	0	4	130	890	3.39	92.9
1977 (Jan)	4	.0	8.5					2,320	2,700							7.7	8.0	240	386	287	470	0	0	270	390	23.7	107
08353000 Rio Puerco near Bernardo, New Mexico																											
1961	15	12.8	23.9					1,730	3,050							7.2	7.8			171	201			410	672	40.1	4,340
1963	18	5.6	26.1					1,610	4,980							7.1	7.6			150	275			452	1,570	37.0	4,320
1964	7							1,020	3,440							6.9	7.7			225	324	0	0	260	1,100	43.6	2,877
1966	20[3]	13.9	25.6					1,000	3,880							7.0	7.6			120	343	0	0	425	1,580		
1967	--[3]	15.5	26.6					435	4,920							7.2	7.7			144	446	0	0	170	1,330		
1968	--[3]	14.0	25.0					964	11,400							7.3	7.8	131	239	160	292	0	0	250	2,000	6.74	6,560
1969	--[3]	8.0	30.0					503	3,740							7.3	8.2	108	302	132	368	0	0	118	1,100	41.6	2,420
1970	31	16.0	29.5					722	4,490							7.2	8.2	100	290	122	354	0	0	150	1,360	16.5	11,100
1971	20	5.0	25.0					1,250	4,240							7.4	7.9	146	353	178	430	0	0	390	1,500	20.4	1,230
1972	33[3]	.0	25.5					823	3,400							7.4	8.2	124	282	151	344	0	0	220	1,200	48.9	11,500
1973	--[3]	8.0	24.0					541	3,210							6.8	8.2	94	215	104	262	0	0	130	850	16.7	1,920
1974	17[3]	15.0	20.0					437	3,200							6.9	8.3	79	214	96	261	0	0	97	1,100	6.19	7,700
1975	--[3]	9.0	26.5					754	3,730							6.7	8.3	95	209	116	255	0	0	170	1,100	3.50	3,280
1976	10	23.0	27.0					492	2,960							7.0	8.4	102	285	124	347	0	0	160	1,200	1.71[2]	

Table B-15 (continued)

Water Year	Total Number of Samples	Temperature (DegC)		Turbidity (JTU)		Color (Platinum-Cobalt Units)		Specific Conductance (Mmhos)		Dissolved Oxygen (mg/l)		Biochemical Oxygen Demand 5-day (mg/l)		Chemical Oxygen Demand (mg/l)		pH (units)		Alkalinity as $CaCO_3$ (mg/l) [3]		Bicarbonate (mg/l)		Carbonate (mg/l)		Hardness (mg/l)		Dissolved Solids (time/day)	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
09364500 Animas River at Farmington, New Mexico																											
1960	365	1.1	15.6					220	1,090							7.0	8.3			65	223	0	2	89	420	83.4	2,910
1961	365	1.1	26.1					222	1,340							7.1	8.0			71	209			92	608	118	1,3[illegible]0
1962	365							216	1,150							7.2	8.2			60	216			88	418	156	1,340
1963	365	5.6	24.4					239	1,160							7.0	8.4			72	228	0	6	102	425	115	1,170
1964	365							220	959							7.3	8.1			68	240			93	400	184	1,340
1965	365							219	944							7.6	8.0			74	208	0	0	94	378	209	3,231
1966	365	5.6	27.8					266	921							7.4	8.1	74	166	90	202	0	0	104	326	235	1,340
1967	365	6.7	23.3					292	898							7.3	8.2	74	220	90	238	0	0	124	380	161	1,530
1968	365	4.0	22.0			0	15	214	871							7.0	8.0	54	180	76	220	0	0	90	362	192	1,930
1969	365	5.0	25.0			3	5	227	931							7.5	8.4	66	187	80	228	0	6	99	360	229	1,180
1970	--[3]	.0	20.0	17	225	0	25	273	765	7.4	12.4	0.8	2.5	0	16	7.6	8.6	75	171	91	208	0	0	117	320	286	3,820
1971	18	1.5	26.5	14	35	5	15	231	920	8.3	12.5	.8	1.4	5	9	7.4	8.7	64	177	78	216	0	3	98	350	108	1,170
1972	18	1.0	27.5	15	320	3	10	364	912	8.0	12.2	.6	2.8	3	8	7.6	8.6	83	196	101	239	0	0	140	370	278	810
1973	21	.0	20.5	10	150	3[2]		255	676	7.6	11.7					7.3	8.8	79	169	96	206	0	0	110	280	273	1,930
1974	16	.5	25.0					354	1,030	6.0	12.8					7.7	8.9	79	186	96	227	0	0	160	410	41.5	1,800
1975	22	.5	21.0	3	3,400			205	833	7.1	12.4			2	210	7.9	8.9	53	175	65	213	0	0	82	350	347	1,700
1976	13	2.5	24.0	0	1,800			260	895	9.1	13.0			1	110	7.8	8.6	69	189	82	230	0	0	100	370	291	1,320
1977 (Feb)	5	.0	10.5	6	15			750	950	11.2	12.6			0	110	7.9	8.3	135	191	164	233	0	0	290	370	259	362
09365000 San Juan River at Farmington, New Mexico																											
1962	--[3]							164	950							7.5	8.0			63	184			65	260	291	2,450
1963	365							340	1,540							7.4	8.0			82	334			124	404	302	4,090
1964	365							266	1,140							7.4	8.0			84	276			108	376	400	18,970
1965	365							207	1,020							7.4	8.0			72	208	0	0	84	264	495	6,430
1966	365							266	1,840							7.5	7.9	66	277	80	338	0	0	96	464	439	3,580
1967	365							335	1,850							7.3	8.0	79	236	98	288	0	0	118	400	432	16,630
1968	365							252	1,580							6.9	7.8	61	239	74	292	0	0	104	820	416	10,600
1969	365	.0	24.0					259	1,220	5.4	11.7	0.4	2.0	10	22	7.1	8.6	75	185	92	226	0	16	104	300	467	5,440
1970	365	2.0	22.5	29	300	3	20	279	2,290	6.8	12.0	.6	4.9	6	21	7.0	8.7	68	220	83	268	0	12	111	565	458	10,400
1971	365	3.5	27.0	12	85	3	55	265	930	6.6	12.1	.4	2.6	1	22	6.9	8.6	71	208	87	254	0	0	90	370	400	2,460
1972	365	7.5	26.0	20	850	3	10	360	1,580	7.9	12.2	.5	3.2	2	8	6.9	8.5	84	274	102	334	0	0	130	390	345	3,240
1973	365	3.0	18.0	10	2,000	3	60	263	946	8.2	10.8					7.4	8.4	75	226	92	276	0	0	100	290	537	10,800
1974	365	2.5	23.0					318	2,050	6.9	11.6					7.6	8.6	77	302	94	368	0	2	110	490	441	4,370
1975	365	.0	19.0		46,000[2]			255	1,050	7.2	12.5				340[2]	7.2	8.4	63	203	77	247	0	0	100	240	825	4,020
1976	365	7.5	34.0		25[2]			307	1,000	6.4	11.0				2[2]	7.5	8.6	80	158	92	193	0	4	110	320	0.12	4,200
1977 (Feb)	--[3]	.0	14.0		85[2]			400	911	10.4	11.4				16[2]	7.5	8.3	92	110	113	134	0	0	140	210	682	2,150

Table B-15 (continued)

Water Year	Total Number of Samples	Temperature (DegC) Min	Temperature (DegC) Max	Turbidity (JTU) Min	Turbidity (JTU) Max	Color (Platinum-Cobalt Units) Min	Color (Platinum-Cobalt Units) Max	Specific Conductance (Mmhos) Min	Specific Conductance (Mmhos) Max	Dissolved Oxygen (mg/l) Min	Dissolved Oxygen (mg/l) Max	Biochemical Oxygen Demand 5-day (mg/l) Min	Biochemical Oxygen Demand 5-day (mg/l) Max	Chemical Oxygen Demand (mg/l) Min	Chemical Oxygen Demand (mg/l) Max	pH (units) Min	pH (units) Max	Alkalinity as $CaCO_3$ (mg/l) Min	Alkalinity as $CaCO_3$ (mg/l) Max	Bicarbonate (mg/l) Min	Bicarbonate (mg/l) Max	Carbonate (mg/l) Min	Carbonate (mg/l) Max	Hardness (mg/l) Min	Hardness (mg/l) Max	Dissolved Solids (time/day) Min	Dissolved Solids (time/day) Max
09367561 Shumway Arroyo near Water Flow, New Mexico																											
1974	5	15.0	24.0					2,190	11,900							7.9	10.4	44	142	54	173	0	0	650	4,400	31.6[2]	
1975	52	.0	33.0	8	130			3,330	12,200	6.3	11.2			25	49	2.4	10.4	0	260	0	317	0	42	250	3,600	0.67	12.9
1976	16	.0	30.5	2	200			3,500	12,200	7.0	12.1			24	68	6.6	9.2	8	332	10	405	0	12	620	3,600	.0	24.5
1977 (Mar)	6	3.0	15.0	10	40			655	6,800	9.0	11.0			26	60	7.1	8.6	26	273	32	333	0	11	840	2,800	3.60	37.3
09367930 Hunter Wash at Bisti Trading Post, New Mexico																											
1974	4	14.5[2]																									
1975	37	14.0	31.0					482	1,780							7.5	9.8	92	166	65	202	0	23	18	120	.0	280,000
1976	22	30.0[2]		310	550			435	2,500							6.9	8.4	0	275	0	335	0	0	27	300	0.33	14.7
09368000 San Juan River at Shiprock, New Mexico																											
1960	365	.0	22.2					201	1,870							7.1	8.5			66	240	0	11	76	570	271	10,680
1961	365							231	1,330							7.2	8.4			74	304	0	6	87	580	363	11,450
1962	365							244	2,340							6.9	9.1			20	229	0	16	86	695	364	6,450
1963	365	2.8	28.9					403	2,490							7.0	8.2			92	322			164	780	148	11,840
1964	365							358	1,690							7.2	8.2			70	308			136	718	362	18,000
1965	365							253	1,360							7.4	8.1			78	220	0	0	96	540	775	23,440
1966	365	6.1	25.6					372	1,710							7.4	8.1	80	218	98	266	0	0	134	490	620	4,380
1967	365							493	1,750							7.2	8.2	46	235	56	286	0	0	178	560	377	18,630
1968	365	3.0	29.0					304	1,430							6.8	8.2	66	233	80	284	0	0	118	364	605	13,700
1969	365	.0	25.0					303	1,220	5.0[2]		1.4	2.3			7.1	8.3	48	231	58	282	0	6	120	386	967	7,540
1970	365	3.0	28.5	60	530	3	10	307	1,890	6.0	11.5	1.2	6.6	1	20	7.3	8.4	67	230	82	280	0	4	124	600	489	20,000
1971	365	4.5	30.0	14	90	3	35	350	1,700	7.5	10.8	.6	1.4	2	14	7.3	8.7	21	199	25	243	0	0	140	610	513	5,950
1972	365	.0	21.5	20	2,000	5	15	343	2,660	7.7	12.1	.8	2.1	4	11	7.2	8.7	32	238	39	290	0	0	120	800	272	8,510
1973	365	.5	19.5	1	2,600	4	25	278	1,190	7.7	12.0					7.4	8.6	78	223	94	272	0	7	110	330	816	12,300
1974	365	1.0	25.0					418	1,550	7.7	11.1			11[2]		7.5	9.0	48	236	48	288	0	5	120	420	357	4,490
1975	365	.0	28.0	20	7,200			280	1,030	7.9	12.8			6	400	7.5	8.9	62	215	76	262	0	11	110	340	1,090	10,300
1976	365	3.0	18.0	14	13,000			315	6,860	7.8	12.2			1	200	7.5	9.0	49	220	48	220	0	7	120	400	598	5,730
1977 (Feb)	212	1.5	7.5	20	150			552	990	10.8	14.5			17	100	7.2	8.2	109	139	125	171	0	0	190	320	852	1,620
09395500 Puerco River at Gallup, New Mexico																											
1975	30	3.0	29.5					493	1,030							7.6[2]		101	277	123	338	0		45	250		3.66[2]
1976	365	21.5[2]						587	1,030							7.5	8.9	141	290	141	353	0	15	52	170		
1977 (Mar)	243	11.0[2]						652	962							7.7	8.2	193	258	235	315	0	0	71	140		

Table B-15 (continued)

Part II

Water Year	Dissolved Calcium (mg/l) Min	Max	Dissolved Magnesium (mg/l) Min	Max	Dissolved Sodium (mg/l) Min	Max	Dissolved Potassium (mg/l) Min	Max	Dissolved Chloride (mg/l) Min	Max	Dissolved Sulfate (mg/l) Min	Max	Dissolved Fluoride (mg/l) Min	Max	Dissolved Silica (mg/l) Min	Max	Dissolved Iron (mg/l) Min	Max	Total Nitrogen (mg/l) Min	Max	Total Phosphorus (mg/l) Min	Max	Fecal Coliform Col./100 ml Min	Max	Streptococci Col./100 ml Min	Max
08290000 Rio Chama near Chamita, New Mexico																										
1961																										
1963									3.0	19																
1964	128[2]				11	73	5.0[2]		2.2	35	25	182	0.2	0.5	16[2]		150[2]									
1965	26	81	3.2	20	7.2	58	1.6	4.6	1.8	21	22	196	.1	.4	10	19	10	60								
1966	30	106	3.4	27	7.6	74	1.8	4.4	1.8	24	22	314	.1	.5	11	20	0	20								
1967	36	98	4.4	24	9.2	85	1.8	3.8	2.6	24	34	265	.2	.5	13	22	0	10								
1968	31	94	3.5	22	7.4	19	2.2	3.3	1.8	20	20	273	.2	.4	14	21	0[2]									
1969	24	90	2.4	24	15	25	2.4	3.0	1.9	16	23	230	.0	.5	13	21	70[2]						<1	200	<1	300
1970	25	95	3.3	18	39	46	3.0	3.4	1.2	14	18	252	.2	.5	12	20	10	80								
1971	28	130	4.5	16	10	59	1.7	5.3	2.8	20	31	360	.1	.5	15	24	60[2]									
1972	33	71	5.7	14	10	65	1.6	4.2	3.0	18	24	160	.1	.5	13	23	10	180								
1973	26	72	4.7	18	8.8	65	1.8	3.7	2.1	11	36	240	.1	.5	12	20	9	50								
1974	35	81	5.7	23	11	53	2.0	3.8	2.5	21	49	220	.0	.9	14	18	5	40								
1975 (May)	69	73	12	17	50	58	3.5	4.6	14	24	120	180	.3	.5	18	23	10[2]									
08313000 Rio Grande at Otowi Bridge, New Mexico																										
1960	28	78	3.0	13	9.7	37	3.2[2]		3.2	12	25	171	0.8[2]		19	36	10[2]									
1961	36	113	2.4	13	9.8	54			2.6	14	27	230			2.7	60										
1962	32	71	3.2	11	9.5	49	5.1[2]		2.6	15	26	129			18	32										
1963	30	258	2.2	15	11	50			3.0	14	2.2/602				17	34										
1964	9.8/159		3.6	16	11	63	2.8[2]		3.0	10	4.0/366		.5[2]		16	44										
1965	34	75	2.2	10	10	32	2.3	3.4	3.2	9.9	36	119			17	30										
1966	35	64	3.4	16	13	41	4.2[2]		4.0	12	36	159	.8[2]		19	27	30[2]									
1967	33	114	5.0	16	17	52	3.9[2]		5.0	13	38	282	.5[2]		17	28	10[2]									
1968	27	77	3.8	9.6	10	25	3.2[2]		2.3	12	28	126	.4[2]		18	29	120[2]									
1969	30	150	2.9	23	30[2]		3.4[2]		1.3	14	27	374	.5[2]		16	27	110[2]						<1	15,000	<1	70
1970	26	105	2.2	14	11	35	1.8	4.2	.0	36	32	249	.3	.8	15	30	0	30	.57[2]		.06[2]		<10	3,880	<10	150
1971	27	60	5.3	12	11	44	2.5	4.9	3.5	44	33	130	.3	.9	18	31	180[2]		.55[2]		.40[2]		10	540	10	320
1972	29	110	5.6	14	14	49	2.3	5.0	3.7	33	3.7/260		.3	.7	17	32	10	170	.38	.81	.18	.49	0	2,300	0	70
1973	27	61	3.7	10	9.7	36	2.3	4.0	3.4	9.2	29	120	.2	.7	11	26	20	60	.20	1.2	.08	.52	3	8,200		
1974	34	98	5.6	11	14	31	2.3	3.9	3.8	10	43	230	.2	1.1	12	28	0	890	.39	1.1	.07	.32	20	6,400	15	420
1975	26	56	4.4	11	9.7	34	1.7	4.5	2.6	11	28	120	.2	.7	15	27	10	830	.10	1.6	.04	.23	60	2,300	48	2,500
1976	22	51	4.6	10	12	27	1.8	3.5	2.7	9.8	31	110	.2	.5	12	23	0	530	.36	1.5	.10	.52	270	12,000	100	1,450
1977 (Mar)	39	49	7.4	8.6	23	28	3.0	3.7	7.2	13	49	72	.4	.7	20	27	10	20	.36	.81	.06	.12	223[2]		55	8,128

Table B-15 (continued)

Part II

Water Year	Dissolved Calcium (mg/l) Min	Max	Dissolved Magnesium (mg/l) Min	Max	Dissolved Sodium (mg/l) Min	Max	Dissolved Potassium (mg/l) Min	Max	Dissolved Chloride (mg/l) Min	Max	Dissolved Sulfate (mg/l) Min	Max	Dissolved Fluoride (mg/l) Min	Max	Dissolved Silica (mg/l) Min	Max	Dissolved Iron (mg/l) Min	Max	Total Nitrogen (mg/l) Min	Max	Total Phosphorus (mg/l) Min	Max	Fecal Coliform Col./100 ml Min	Max	Streptococci Col./100 ml Min	Max
08329000 Jemez River below Jemez Canyon Dam, New Mexico																										
1966	46	79	4.6	9.5	81	278	15[2]		77	228	40	266	1.5[2]		25	39	10[2]									
1967	56	423	6.9	40	165	438	1.9	18	102	306	84	1,500	.7	2.0	17	43	0	100								
1968	40	232	3.6	22	49	164	5.0	11	35	308	38	712	.6	1.4	20	43	0	50								
1969	41	284	5.4	25	55	344	5.7	17	42	270	44	1,020	.5	1.8	8.3	40	20	60								
1970	57	335	4.9	36	146[2]		2.9[2]		134	236	96	1,200	1.2[2]		21	35	10[2]									
1972	34	94	4.5	11	82	230	9.1	14	71	210	59	240	.8	1.5	27	38	0	20								
1973	29	100	3.0	15	26	270	4.0	16	19	230	32	360	.2	1.2	20	35	9	20								
1974	43	140	5.7	15	98	[illegible]	8.8	18	66	486	66	640	.9	2.3	28	44	20[2]									
1975	31	130	2.7	18	31	370	4.3	22	26	340	31	480	.3	1.6	16	52	0	20								
1976	42	300	6.5	33	130	770	11	25	110	610	99	1,500	.9	1.5	20	36	0[2]									
1977 (Jan)	87	11[illegible]	13	27	320	400	16	21	310	370	340	410	1.0	1.7	29	37	0[2]									
08353000 Rio Puerco near Bernardo, New Mexico																										
1961	124	199	17	43	210	473	6.8	15	33	298	730	1,050	0.7	1.0	7.1	17	0	20								
1963	142	512	24	71	163	720	7.4	17	41	398	667	2,340	.6	1.2	11	16	10	30								
1964	196	299			275	417	4.5	12	30	108	178	1,660	.6	.8	14	16	20	40								
1966	74	472	10	98	81	1,230	7.6	9.0	31	975	651	2,630	.7[2]		11	18	10[2]									
1967	53	444	9.2	90	33	712	8.6[2]		17	572	22	1,690	.8	1.2	11	22	0	30								
1968	73	612	17	115	213	319	4.4	11	43	1,800	283	4,100	.7	1.0	12	20	50	130								
1969	37	302	6.2	98	256	381	6.2[2]		40	202	77	1,600	.7[2]		13	23	90	300								
1970	42	390	9.7	94	171	427	7.5[2]		32	145	186	2,270	.8[2]		11	19	20[2]									
1971	120	430	21	94	130	500	8.4	11	37	350	460	2,200	.3	.9	11	19	10[2]									
1972	70	370	12	72	93	390	5.6	12	39	260	2[illegible]0	1,500	.6	1.2	6.3	18	40[2]									
1973	130	240	6.3	80	59	440	4.8	11	29	290	140	1,300	.5	1.3	7.7	15	40[2]									
1974	32	330	4.2	64	45	400	5.4	16	20	170	86	1,500	.5	1.0	8.8	24										
1975	54	280	8.5	87	74	520	6.4	13	33	260	210	1,700	.5	1.1	7.0	15	20[2]									
1976	51	340	6.7	76	41	320	5.6	11	23	130	86	1,500	.5	1.2	7.8	16	210[2]									

Table B-15 (continued)

Part II

Water Year	Dissolved Calcium (mg/l) Min	Max	Dissolved Magnesium (mg/l) Min	Max	Dissolved Sodium (mg/l) Min	Max	Dissolved Potassium (mg/l) Min	Max	Dissolved Chloride (mg/l) Min	Max	Dissolved Sulfate (mg/l) Min	Max	Dissolved Fluoride (mg/l) Min	Max	Dissolved Silica (mg/l) Min	Max	Dissolved Iron (mg/l) Min	Max	Total Nitrogen (mg/l) Min	Max	Total Phosphorus (mg/l) Min	Max	Fecal Coliform Col./100 ml Min	Max	Streptococci Col./100 ml Min	Max
09364500 Animas River at Farmington, New Mexico																										
1960	28	136	4.6	20	8.3	81	1.7	5.9	6.4	42	61	264	0.3	0.6	7.9	11	0	60								
1961	34	211	1.7	20	1.1	98	1.6	5.2	6.0	42	41	324	.3	.6	6.0	10	10	40								
1962	30	131	3.2	22	5.7	98	1.7	4.2	7.6	41	52	226	.2	.7	7.3	12	0	10								
1963	36	138	2.9	20	6.3	92	1.1	6.2	4.4	42	49	368	.4	.6	6.0	13	0	20								
1964	38	133	3.2	17	5.7	64	1.2	4.6	3.4	41	43	274	.3	.5	5.8	15	0	110								
1965	31	118	3.0	20	4.1	59	1.4	4.3	2.7	34	49	281	.2	.7	6.9	11	0	120								
1966	24	105	3.9	21	6.2	76	1.8	6.4	8.4	31	83	228	.3	.5	6.4	9.4	0	10								
1967	42	124	4.6	21	2.3	61	2.0	3.4	7.5	31	71	226	.3	.4	7.0	11	0	20								
1968	29	120	3.8	20	5.8	53	2.1	4.0	2.7	32	90	224	.3	.5	8.2	12	0	60								
1969	35	119	2.8	55	6.6	47	1.3	4.3	1.8	28	37	258	.3	.6	4.9	15	0	40								
1970	38	105	3.9	19	6.9	339	.9	3.4	2.7	22	53	225	.3	.7	5.0	17	0	50			0.0	0.04	10	1,520	<10	90
1971	32	110	4.3	18	7.9	53	1.1	3.7	4.0	24	54	260	.1	.6	5.5	9.0	10	120	0,33[2]		.02	.08	40[2]		50[2]	
1972	52	120	6.7	18	14	52	1.8	4.4	7.7	30	84	250	.3	.5	6.4	9.6	10	600	.13	..72	.06	.16				
1973	36	990	5.1	16	6.4	36	1.0	3.2	3.7	21	47	170	.2	.6	5.6	8.8	0	60	.17	4.4	.05	.51				
1974	48	130	6.3	21	12	64	1.7	4.7	7.6	33	78	320	.3	.6	6.1	10	10	80	.32	16	.01	1.9				
1975	26	110	4.2	18	5.0	50	1.0	4.7	2.8	29	36	240	.2	.6	4.9	9.2	10	50	.28	7.4	.03	2.8				
1976	37	120	4.4	17	5.8	73	1.3	3.8	3.8	28	44	300	.3	.7	5.5	8.8	0	130	.05	5.1	.0	.87				
1977 (Feb)	92	120	15	18	39	49	3.2	4.1	22	31	220	250	.4	.5	6.3	8.9	0	160	.11	.90	.01	.07				
09365000 San Juan River at Farmington, New Mexico																										
1962	21	88	2.7	11	7.6	113	2.4[2]		2.0	26	25	318	.3[2]		7.8	15	10[2]									
1963	42	136	1.6	22	10	210	2.3	4.2	5.6	48	61	537	.4[2]		5.4	22										
1964	39	124	1.9	16	10	186	2.4	4.1	3.5	31	55	532			6.4	23										
1965	29	90	2.8	13	8.1	134			2.1	17	39	342			5.9	15										
1966	30	148	3.6	23	15	269	2.6	4.2	3.1	18	50	691			6.1	24										
1967	5.1	168	.3	19	5.0	290			2.6	22	77	810			6.0	19										
1968	34	276	4.5	32	8.4	209			2.8	28	46	706			6.0	23										
1969	36	108	2.2	12	11	150	1.8	3.8	1.3	17	48	406	.5[2]		6.7	15	110[2]						<1	120,000	< 10	14,100
1970	34	192	3.9	23	9.8	332	1.6	3.4	2.6	17	54	1,000	0.2	0.7	5.9	27	0	1,700			0.03	0.23	20	98,800	<10	4,000
1971	27	130	4.5	13	10	100	1.2	5.3	2.4	20	49	270	.0	.8	6.0	16	20	60			.18	.49	10	50,000	10	1,500
1972	40	130	5.6	17	19	200	1.8	5.2	3.6	50	83	550	.1	.7	4.5	17	10	60	0.09	0.76	.05	.44	<10	110,000	<10	24,000
1973	32	100	4.9	13	11	96	1.3	4.3	2.9	17	48	270	.2	3.0	3.5	12	20	50	.32	4.0	.06	2.0	27	29,000		
1974	34	160	5.6	21	20	300	1.7	4.9	2.5	19	56	330	.1	.5	4.5	33	10	500	.38	4.9	.03	1.8	10	31,000		
1975	33	77	4.9	12	10	140	.2	4.9	2.7	17	49	280	.1	1.2	4.7	23	0	30		4.2[2]		4.0[2]				
1976	34	110	5.6	10	12	140	1.4	5.3	2.7	16	56	430	.2	.6	5.9	11	0	80		.35[2]		.03[2]				
1977 (Feb)	45	68	7.2	11	25	120	1.9	2.7	5.0	160	96	190	.2	.3	8.0	10	0	20		.92[2]		.09[2]				

Table B-15 (continued)

Part II

Water Year	Dissolved Calcium (mg/l) Min	Max	Dissolved Magnesium (mg/l) Min	Max	Dissolved Sodium (mg/l) Min	Max	Dissolved Potassium (mg/l) Min	Max	Dissolved Chloride (mg/l) Min	Max	Dissolved Sulfate (mg/l) Min	Max	Dissolved Fluoride (mg/l) Min	Max	Dissolved Silica (mg/l) Min	Max	Dissolved Iron (mg/l) Min	Max	Total Nitrogen (mg/l) Min	Max	Total Phosphorus (mg/l) Min	Max	Fecal Coliform Col./100 ml Min	Max	Streptococci Col./100 ml Min	Max
09367561 Shumway Arroyo near Waterflow, New Mexico																										
1974	140	470	74	810	270	1,900	6.1	23	99	620	940	7,200	.7	1.1	0.6	12	0²									
1975	72	680	16	620	160	2,200	6.8	29	28	830	390	6,400	.6	2.0	.0	37	0	16,000	5.8	26	0.17	1.5	0	410	0	1,000
1976	180	510	42	580	400	3,400	10	22	160	1,900	1,700	6,200	.6	1.3	3.5	11	0	3,400	3.9	29	.06	.78	0	300	5	4,700
1977 (Mar)	200	420	82	440	520	1,700	7.0	21	140	550	1,400	5,100	.4	1.2	5.6	25	0	70	3.5	21	.29	1.1	0	700	200	525
09367930 Hunter Wash at Bisti Trading Post, New Mexico																										
1974																										
1975	4.7	41	0.9	4.2	98	340	2.9	6.3	6.2	21	92	710	0.7	1.5	12	21										
1976	8.1	100	0.5	12	91	270	3.9	13	6.3	18	52	460	.3	2.2	12	27	20	16,000								
09368000 San Juan River at Shiprock, New Mexico																										
1960	32	147	2.7	51	9.3	218			2.8	74	38	729			9.0	20										
1961	27	208	1.1	30	12	200			3.8	61	46	720			9.2	21										
1962	28	171	4.6	65	11	293	1.7	5.3	3.8	196	41	944			5.0	16	78,000²									
1963	49	202	4.1	77	23	325	4.1	6.9	8.7	112	111	1,080			3.0	23										
1964	53	238	3.9	37	18	207	3.3	3.8	5.7	46	83	762			4.0	25										
1965	25	196	3.9	21	13	162			3.2	28	52	542			7.9	20										
1966	41	167	5.8	21	21	260	2.4²		5.2	25	92	642	0.2	0.7	6.1	19	0	10								
1967	52	160	5.1	43	39	291	2.9	4.5	9.8	44	135	702	..2	.9	3.3	18	0	10								
1968	38	118	4.4	24	15	68	2.1	4.5	3.4	34	62	494	.3	.7	1.9	19	0	10								
1969	1	124	6.3	23	20	86	1.7	4.6	1.6	25	64	412	.2	.7	8.3	20	10	20						<10²	<10²	
1970	36	202	5.8	23	3.5	66	.8	3.3	2.8	86	62	702	.1	.7	3.6	19	0	40			0.07²		<10	51,000	<10	780
1971	42	200	4.8	28	17	250	1.4	6.0	5.9	49	86	690	.1	1.0	.9	16	50²		0.68²		.23²		100	3,000	10	180
1972	33	240	6.9	49	24	310	1.7	9.7	7.4	72	110	1,200	.1	1.8	.4	23	0	40	0.26	4.1	0.11	0.96	90	16,000	<10	530
1973	34	99	5.6	20	11	160	1.4	6.3	3.4	24	56	370	.2	.7	2.9	15	9	90	.48	4.8	.10	33	220	6,200		
1974	31	140	7.9	23	23	190	1.8	6.6	7.6	27	110	520	.2	1.3	2.2	15	0	40	.61	6.0	.04	2.5	180	13,000		
1975	33	110	5.7	18	12	140	1.5	5.1	3.6	23	58	330	.2	1.3	3.9	37	0	40	.30	15	.08	6.4	63	19,000	110	8,200
1976	24	120	6.0	36	15	180	1.6	6.8	4.4	44	65	550	.2	.7	.2	11	0	80	.40	6.8	.07	1.2	34	7,900	5	2,700
1977 (Mar)	59	99	11	19	38	67	2.3	3.2	12	22	140	300	.3	.6	6.8	12	0	150	.92	1.6	.05	.20	10	750	0	320
09395500 Puerco River at Gallup, New Mexico																										
1975	14	80	2.5	13	78	210	1.8	6.3	14	31	100	260	0.6	1.0	4.7	14	0	10								
1976	12	61	5.3	10	100	200	2.0	6.6	12	51	120	260	.4	.9	2.5	15	0	90								
1977 (Mar)	21	40	4.5	9.1	120	170	2.7	4.2	22	42	100	190	.5	.7	11	15	0	130								

Table B-16

TRACE ELEMENT ANALYSIS OF SURFACE WATER

Water Year	Total Number of Samples Analyzed	Average for Year (all in Mg/l) Aluminum	Arsenic	Barium	Boron	Cadium	Chromium	Copper	Lead	Lithium	Manganese	Nickel	Strontium	Zinc
08290000 Rio Chama near Chamita, New Mexico														
1964	1				140									
1965	5				71									
1966	5				74									
1967	2				45									
1968	2				15									
1969	2				65									
1970	3				60									
1971	3		0		53									
1972	4	38	< 1	102	52	1	< 10	3	< 5	30	7	< 5	525	< 425
1973	4	80	2	72	41	< 1	< 5	3	< 5	33	6	9	382	< 245
1974	3	31	2	77	35	< 3	< 2	2	< 4	17	4	< 2	337	4
1975 (May)					37									
08313000 Rio Grande at Otowi Bridge, New Mexico														
1960	1				80									
1961	0													
1962	0													
1963	0													
1964	1										1040			
1965	0													
1966	2				90									
1967	1				100									
1968	2				35									
1969	2				75									
1970	4				77									
1971	2		3		15			< 4	< 4					5
1972	5				56									
1973	11				49			5						10
1974	3		2		54	< 1	0	2	0	20	12			15
1975	4		1		55	< 1	< 5	3	< 1		2			4
1976	4		2		42	< 1	< 1	2	3		7			2
1977 (Mar)	2		2		50	1	0	< 1	2		20			10

Table B-16 (continued)

		Al	Ar	Ba	B	Cd	Cr	Cu	Pb	Li	Mn	Ni	St	Zn
08329000 Jemez River below Jemez Canyon Dam, New Mexico														
1966	1				2900									
1967	3				1267									
1968	2				365									
1969	2				660									
1970	0													
1972	2				785									
1973	3				657									
1974	7		40		1173					1117	0[2]			
1975	11		22		1337					877				
1976	1		30		1500									
1977 (Jan)	1		50		1600									
08353000 Rio Puerco near Bernardo, New Mexico														
1961	4				312									
1963	7				377									
1964	3				263									
1966	2				235									
1967	2				430									
1968	2				310									
1969	2				320									
1970	1				220									
1971	2				410									
1972	1				200									
1973	1				570									
1974	0													
1975	1				510									
1976	1				260									

Table B-16 (continued)

	Al	Ar	Ba	B	Cd	Cr	Cu	Pb	Li	Mn	Ni	St	Zn
09364500 Animas River at Farmington, New Mexico													
1960	4			82									
1961	5			66									
1962	5			72									
1963	4			85									
1964	4			95									
1965	4			50									
1966	4			225									
1967	4			118									
1968	4			125									
1969	4			100									
1970	10			106									
1971	9			78									
1972	12	< 1	50	67	1	< 5	4	< 5		15	< 5	460	150
1973	9	3	200	60	0		6	74		20			20
1974	11	1	0	134	0		3	< 100		45			17
1975	12	1		54	0	10	4	< 1		0			15
1976	13	1		139	0	0	2	< 1		90			7
1977 (Feb)	5	0		84	0	0	5	3		0			10
09365000 San Juan River at Farmington, New Mexico													
1962	1			60									
1963	0												
1964	0												
1965	0												
1966	0												
1967	0												
1968	0												
1969	0												
1970	5			90									
1971	1			20									
1972	32			59									
1973	46			45									
1974	36	1	0	52	0		2	100		12			10
1975	37	1		40	0	0	4	0		0			30
1976	23	2		38	0	0	1	1		10			0
1977 (Feb)	11	2		38	1	0	2	2		20			30

Table B-16 (continued)

		Al	Ar	Ba	B	Cd	Cr	Cu	Pb	Li	Mn	Ni	St	Zn
09367561 Shumway Arroyo near Waterflow, New Mexico														
1974	3		2		603									
1975	25		5		792	0	15	31	2	260	430			62
1976	16		8		626	1	18	11	<1		90			23
1977 (Mar)	6		3		617	<1	0	8	2		150			35
09367930 Hunter Wash at Bisti Trading Post, New Mexico														
1974	0													
1975	8				151									
1976	11			300	147					33	930		1400	
09368000 San Juan River at Shiprock, New Mexico														
1960	60				77									
1961	60				92									
1962	56				86								24400	
1963	69				105									
1964	56				119									
1965	44				74									
1966	2				90									
1967	2				110									
1968	5				108									
1969	3				63									
1970	4		< 100		75	3		< 10	< 40		< 20	< 20		10
1971	1				40									
1972	36				202									
1973	47	28		72	68	< 110	< 8	6	< 6	10	< 5	< 8	780	< 490
1974	39		2		100	0	0	2	0		2100			
1975	42		< 1		78	0	< 10	6	0		2			12
1976	39		1		134	0	2	2	< 1		15			2
1977 (Mar)	18		< 1		188	0	0	4	2		15			
09395500 Puerco River at Gallup, New Mexico														
1975	6				143									
1976	16				124						5			
1977 (Mar)	9				112									

COMPUTATION OF SEDIMENT DISCHARGE

The Universal Soil Loss Equation (USLE) was used to compute the sediment discharges caused by the development for this ES. This method does not allow for gully or channel erosion, and thus covers only part of the total sedimentation process. However, considering such unknowns in the mining process as acres mined and acres reclaimed, and the totally unknown process of sediment transport in an arid climate, the method should produce adequate results.

The USLE is an empirically developed formula used to estimate soil loss on agricultural lands, and is used here to estimate sheet and rill erosion for all land uses.

The equation is: $A = R\ K\ L\ S\ C\ P$

where:

A is the predicted average annual soil loss expressed in tons per acre per year.

R, the rainfall factor, is the number of erosion-index units in a normal year's rain. The erosion-index is a measure of the erosive force of a specific rainfall. When other factors are constant, storm losses from rainfall are directly proportional to the product of the total kinetic energy of the storm times its maximum 30- minute intensity.

K, the soil-erodibility factor, is a measure of the erodibility of a specific soil. It is the erosion rate per unit of erosion index for a specific soil in cultivated, continuous fallow on a

9-percent slope, 72.6 feet long. Soil properties that influence erodibility by water are: (1) those that affect the infiltration rate, permeability and total water capacity, and (2) those that resist the dispersion, splashing, abrasion, and transporting forces of the rainfall and runoff.

L, the slope length factor, is the ratio of soil loss from the field slope length to that from a 72.6 foot length on the same soil type and gradient. Slope length is the distance from the point of origin of overland flow to: (1) the point where the slope decreases to the extent that deposition begins, or (2) the point where runoff enters a defined channel.

S, the slope-gradient factor, is the ratio of soil loss from the field gradient to that from a 9-percent slope. The relation of soil loss to gradient is influenced by density of vegetal cover and by soil particle size.

C, the cropping-management or plant cover factor, is the ratio of soil loss from a field with a specified cropping and management system or plant cover to that from the fallow condition on which the factor K is evaluated. This factor reflects the combined effect of all the interrelated cover and management variables plus the growth stage and vegetal cover at the time of the rain.

P, the erosion control practice factor, is the ratio of soil loss with contouring, stripcropping, or cross-slope farming to that with straight row farming up-and-down the slope.

These factors can be determined with the assistance of the publication, Guide for Water Erosion Control (Soil Conservation Service, 1975) and Map E, General Soil Distribution, in Appendix A of this ES.

The following computation is for the Star Lake area.

Factors for this area are:

R = 24

K = .33

LS = 4.0

C = .2

P = 1.0

Thus:

A = 24 x 0.33 x 4.0 x 0.2 x 1.0

= 6.34 tons per acre per year.

Table B-17

SEDIMENT DISCHARGES

Water Year	Annual Discharge Thousands of ac.ft./yr.	Daily or Observed Concentration min (mg/L)	max (mg/L)	Suspended Sediment Discharge Daily min (T/day)	max (T/day)	Thousands of tons per year	Tons per square mile per year
08290000 Rio Chama near Chamita, New Mexico							
1948	359	0	25000	0	83700	2165	689
1949	428	0	27100	0	65900	1650	525
1950	304	0	40900	0	46400	1085	345
1951	144	0	31400	0	43500	580	184
1952	567	0	31000	0	139000	3391	1079
1953	167	0	31100	0	36300	611	194
1954	177	12	36700	0.5	46600	1062	338
1955	142	0	57700	0	150000	1663	529
1956	146	9	11500	0.5	12800	538	171
1957	523	10	39600	0.5	209000	3344	1064
1958	561	8	21700	0.5	167000	5468	1739
1959	237	18	39000	2	68900	1021	325
1960	364	19	16800	0.5	38000	1466	466
1961	245	12	54900	0.5	143000	1635	520
1962	412	20	26200	0.5	62100	2018	642
1963	270	20	26500	0.5	36000	613	195
1964	147	20	34700	0.5	90000	703	224
1965	422	170	34700	4	110000	2283	726
1966	386	20	34600	0.5	39000	2227	708
1967	209	20	61400	0.5	340000	3017	960
1968	279	30	17500	0.28	60700	2013	640
1969	417	10	19700	0.10	43400	984	313
1970	265	20	33000	1.8	34700	678	216
1971	188	25	62800	0.16	59800	488	155
1972	170	20	29700	1.1	25000	319	101
1973	438	30	10000	7.1	46400	653	208
1974	338	10	6950	3.5	15300	213	68

Table B-17 (continued)

Water Year	Annual Discharge Thousands of ac.ft./yr.	Daily or Observed Concentration min (mg/L)	max (mg/L)	Suspended Sediment Discharge Daily min (T/day)	max (T/day)	Thousands of tons per year	Tons per square mile per year
	08313000 Rio Grande at Otowi Bridge near San Ildefonso, New Mexico						
1948	1362	100	5620	65	86000	4306	301
1949	1304	0	20500	0	176400	3681	257
1950	663	81	32800	57	184000	1733	121
1951	395	82	47400	57	55400	901	63
1952	1378	111	20900	108	132000	4473	313
1953	549	18	20600	9	37200	732	51.2
1954	451	14	35100	11	73700	1329	92.9
1955	432	74	43500	769	239000	2431	170
1956	377	34	9530	13	17000	714	49.9
1957	1297	40	17300	16	158000	4557	319
1958	1526	42	26700	29	362000	7562	529
1959	510	37	36700	16	140000	1424	99.6
1960	821	14	9760	8	42700	2074	145
1961	676	24	30700	16	366000	1972	138
1962	1040	40	11500	24	83600	3253	227
1963	560	11	9290	3	28000	862	60.3
1964	384	22	40200	8	130000	947	66.2
1965	1178	78	23200	49	140000	3378	236
1966	945	90	12100	55	42000	2256	158
1967	581	55	26500	36	290000	2651	185
1968	856	130	15400	99	120000	2574	180
1969	1038	102	9450	124	52700	1824	128
1970	906	310	19900	259	77400	1939	136
1971	579	50	32500	61	164000	1106	77.3
1972	514	105	17200	60	58200	1464	102
1973	1394	35	6320	61	126000	3881	271
1974	687	11	12100	18	26400	654	45.7
1975	1066	29	12500	20	52200	1526	107

Table B-17 (Continued)

Water Year	Annual Discharge Thousands of ac.ft./yr.	Daily or Observed Concentration min (mg/L)	max (mg/L)	Suspended Sediment Discharge Daily min (T/day)	max (T/day)	Thousands of tons per year	Tons per square mile per year
08329000 Jemez River below Jemez Canyon Dam, New Mexico							
1949	54.9	0	57200	0	48600	503	485
1950	10.2	0	69400	0	98100	256	247
1951	13.8	0	147000	0	167000	790	761
1952	33.0	0	69400	0	48100	515	496
1953	7.64	0		0		61.7	59.4
1954	20.2	0	53000	0	150000	691	666
1955	19.7	0	127000	0	90600	768	740
1956	13.3	0	70200	0	94400	228	220
1957	35.0	0	68100	0	46600	319	307
1958	111	0	101000	0	78800	688	663
08340500 Arroyo Chico near Guadalupe, New Mexico							
1948	4.95	0	97200	0	121000		
1949	17.5	0	121000	0	473000	2088	1502
1950	10.4	0	113000	0	744000	1573	1132
1951	12.6	0	138000	0	245000	1439	1035
1952	8.83	0	216000	0	142000	1187	854
1953	21.1	0	198000	0	1220000	3157	2271
1954	37.3	0	92800	0	480000	4562	3282
1955	37.0	0	113000	0	679000	1367	983
1956	10.2	0	49100	0	5570	13.7	9.86

Table B-17 (continued)

Water Year	Annual Discharge Thousands of ac.ft./yr.	Daily or Observed Concentration min (mg/L)	max (mg/L)	Suspended Sediment Discharge Daily min (T/day)	max (T/day)	Thousands of tons per year	Tons per square mile per year
	08353000 Rio Puerco near Bernardo, New Mexico						
1948	10.5	0	174000	0	195000	1634	222
1949	28.3	0	245000	0	985000	5760	784
1950	12.0	0	209000	0	895000	2753	375
1951	23.1	0	293000	0	814000	4613	628
1952	13.4	0	354000	0	313000	2953	402
1953	31.2	0	277000	0	1160000	6953	946
1954	78.3	0	193000	0	1740000	14780	2011
1955	85.3	0	233000	0	2120000	18320	2493
1956	12.3	0	228000	0	1320000	3424	466
1957	86.0	0	267000	0	2240000	18050	2456
1958	44.2	0	168000	0	1510000	8070	1098
1959	21.5	0	243000	0	977000	5039	686
1960	17.6	0	246000	0	1000000	4157	566
1961	28.3	0	222000	0	716000	4548	618
1962	10.2	0	176000	0	138000	1449	197
1963	19.9	0	178000	0	330000	3026	412
1964	18.6	0	190000	0	580000	2917	397
1965	30.4	0	214000	0	519000	3808	518
1966	19.3	0	245000	0	406000	3529	480
1967	77.6	0	230000	0	970000	12260	1668
1968	27.6	0	192000	0	713000	4941	672
1969	26.2	0	215000	0	1000000	4919	669
1970	26.7	0	188000	0	744000	2822	384
1971	9.13	0	218000	0	1320000	1889	257
1972	61.5	0	217000	0	1220000	9490	1291
1973	60.3	0	216000	0	229000	5913	804
1974	6.10	0	175000	0	594000	2820	384
1975	39.2	0	246000	0	728000	6829	929

Table B-17 (continued)

Water Year	Annual Discharge Thousands of ac.ft./yr.	Daily or Observed Concentration min (mg/L)	max (mg/L)	Suspended Sediment Discharge Daily min (T/day)	max (T/day)	Thousands of tons per year	Tons per square mile per year
	09364500 Animas River at Farmington, New Mexico						
1952	935	16	7180	6	64000	1036	762
1953	374	9	194000	1	40500	370	272
1954	376	14	36800	2	337000	1274	937
1955	413	13	22800	.5	50200	827	608
1956	365	1	4400	.5	22000	504	371
1957	970	3	18200	.5	121000	1876	1379
1958	913	1	13600	.5	46900	1440	1059
1959	278	2	12000	.5	32900	236	174
1960	609	2	14700	.5	37200	1129	830
1961	489	9	19500	3	37400	496	365
1962	578	5	19200	1	40000	571	420
1963	376	5	9790	.5	22000	291	232
1964	306	11	22100	4	66000	454	334
1965	851	15	20200	4	82000	1109	815
1966	540	4		2	20000	411	302
1967	315	5	12100	3	59000	426	313
1968	546	13	17200	4.5	59900	518	381
1969	611	8	13400	5.1	31900	504	371
1970	608	11	20200	8.9	125000	830	610
1971	477	14	17200	8.6	24600	272	200
1972	391	13	14300	.21	293000	513	377
1973	1176	8	6400	6.4	55000	1499	1102
1974	308	1	13800	.02	84100	400	294
1975	877	15	13300	4.8	112000	1710	1257

Table B-17 (continued)

Water Year	Annual Discharge Thousands of ac.ft./yr.	Daily or Observed Concentration min (mg/L)	max (mg/L)	Suspended Sediment Discharge Daily min (T/day)	max (T/day)	Thousands of tons per year	Tons per square mile per year
	09368000 San Juan River at Shiprock, New Mexico						
1952	2482	20	33900	31	369000	11190	867
1953	873	14	51400	16	317000	2235	173
1954	943	28	101000	36	1330000	11630	902
1955	956	75	91200	46	1200000	12030	933
1956	860	25	86200	2	490000	5094	395
1957	2500	101	49400	13	1700000	21790	1689
1958	2363	43	43300	44	571000	16750	1298
1959	624	6	61600	1	528000	2300	178
1960	1697	30	64800	11	1290000	14780	1146
1961	1183	14	85600	5	1360000	7261	563
1962	1442	7	48300	1	286000	3873	300
1963	508	2	61400	1	1000000	4440	344
1964	694	39	77700	23	1400000	9549	740
1965	1934	90	39800	98	1110000	8444	655
1966	1751	54	63800	160	346000	3956	307
1967	810	38	114000	15	2000000	14790	1146
1968	888	90	65400	146	890000	6397	496
1969	1534	350	44100	657	473000	13260	1028
1970	1366	78	52200	62	1730000	8849	686
1971	1021	74	82600	92	888000	4617	358
1972	879	19	59600	7.3	1020000	3798	294
1973	2480	35	27200	207	187000	7344	569
1974	1019	13	66100	7.8	870000	3642	282
1975	1745	71	59500	66	87000	10350	802

Source:

SOILS

Table B-18

ESTIMATED PHYSICAL AND CHEMICAL CHARACTERISTICS OF SOILS

Soil, Soil Association or Land Type	Percent of Association	Slope Percent	Depth to Bedrock (In.)	Texture: Surface	Texture: Underlying Layer	Texture: Substratum	Reaction (pH)	Permeability (In./Hr.)	Water-holding Capacity (In./In.)	Salinity (MMHOS/CM)
1. Lohmiller-Navajo		0 - 3								
Lohmiller	40		60	clay loam	silty clay	clay loam	7.4 - 9.0	0.06 - 0.6	0.13 - 0.18	4 - 16
Navajo	23		72	clay	clay	clay, silty clay	7.9 - 8.4	< 0.02	0.14 - 0.16	2 - 8
Gullied Land	15		-	-	-	-	-	-	-	-
Other soils, land types	22		-	-	-	-	-	-	-	-
2. Sheppard-Rough Broken Land										
Sheppard	70	3 - 9	60	loamy sand	loamy fine sand	sand, loamy sand	7.9 - 9.0	6.0 - 20.0	0.05 - 0.08	0 - 2
Rough broken land	25	9 - 30	-	-	-	-	-	-	-	-
Other soils, land types	5	-	-	-	-	-	-	-	-	-
3. Penistaja-Sheppard-Rockland										
Penistaja	45	3 - 5	60	fine sandy loam	sandy clay loam	sandy loam	6.6 - 8.4	0.6 - 6.0	0.09 - 0.16	-
Sheppard	25	3 - 9	60	loamy sand	loamy fine sand	sand, loamy sand	7.9 - 9.0	6.0 - 20.0	0.05 - 0.08	0 - 2
Rockland	15	9 - 60	-	-	-	-	-	-	-	-
Other soils, land types	15	3 - 15	-	-	-	-	-	-	-	-
4. Persayo-Billings-Badland										
Persayo	35	5 - 25	10 - 20	silty clay loam	silty clay loam	shale	7.9 - 8.4	0.2 - 0.6	0.15 - 0.19	2 - 8
Billings	35	0 - 5	72	silty clay loam	clay loam	silty clay loam	7.4 - 9.0	0.06 - 2.0	0.14 - 0.19	2 - 4
Badland	15	9 - 75	-	-	-	-	-	-	-	-
Other soils, land types	15	-	-	-	-	-	-	-	-	-
5. Las Lucas-Litle-Persayo										
Las Lucas	30	3 - 5	40 - 60	loam	clay loam	shale	7.9 - 9.0	0.06 - 2.0	0.15 - 0.20	< 2
Litle	25	3 - 5	20 - 40	clay loam	clay	shale	7.4 - 8.4	0.06 - 0.6	0.12 - 0.21	2 - 8
Persayo	25	1 - 9	10 - 20	silty clay loam	silty clay loam	shale	7.9 - 8.4	0.2 - 0.6	0.15 - 0.19	2 - 8
Other soils, land types	20	-	-	-	-	-	-	-	-	-
6. Travessilla-Rockland										
Travessilla	40	3 - 25	6 - 20	fine sandy loam	fine sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.06 - 0.17	< 2
Rockland	25	30 - 75	-	-	-	-	-	-	-	-
Other soils, land types	35	-	-	-	-	-	-	-	-	-
7. Travessilla-Persayo-Rockland										
Travessilla	30	3 - 25	6 - 20	fine sandy loam	fine sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.06 - 0.17	< 2
Persayo	25	3 - 25	10 - 20	silty clay loam	silty clay loam	shale	7.9 - 8.4	0.2 - 0.6	0.15 - 0.19	2 - 8
Rockland	25	25 - 75	-	-	-	-	-	-	-	-
Other soils, land types	20	-	-	-	-	-	-	-	-	-
8. Basalt Rockland-Cabezon-Torreon										
Basalt Rockland	40	25 - 75	-	-	-	-	-	-	-	-
Cabezon	32	1 - 15	10 - 20	stony loam	cobbly clay	basalt	6.1 - 7.3	0.06 - 2.0	0.11 - 0.15	< 2
Torreon	23	1 - 15	40 - 60	loam	silty clay loam	silty clay loam	6.6 - 8.4	0.06 - 2.0	0.14 - 0.21	< 2
Other soils, land types	5	1 - 15	-	-	-	-	-	-	-	-
9. Rockland										
Rockland	75	25 - 75+	-	-	-	-	-	-	-	-
Other soils, land types	25	-	-	-	-	-	-	-	-	-
10. Persayo-Camborthids										
Persayo	40	1 - 15	10 - 20	silty clay loam	silty clay loam	shale	7.9 - 8.4	0.2 - 0.6	0.15 - 0.19	2 - 8
Camborthids	20	1 - 9	20 - 40	fine sandy loam	fine sandy loam	sandstone	7.9 - 8.4	0.6 - 2.0	0.08 - 0.17	< 2
Rockland	20	30 - 75+	-	-	-	-	-	-	-	-
Other soils, land types	20	-	-	-	-	-	-	-	-	-
11. Persayo-Billings										
Persayo	60	0 - 15	10 - 20	silty clay loam	silty clay loam	shale	7.9 - 8.4	0.2 - 0.6	0.15 - 0.19	2 - 8
Billings	25	0 - 5	72	silty clay loam	clay loam	silty clay loam	7.4 - 9.0	0.06 - 0.2	0.14 - 0.19	2 - 4
Lohmiller	15	0 - 3	60	clay loam	silty clay	clay loam	7.4 - 9.0	0.06 - 0.6	0.13 - 0.18	4 - 16

Table B-18 (continued)

Soil, Soil Association or Land Type	Percent of Association	Slope Percent	Depth to Bedrock (In.)	Texture: Surface	Texture: Underlying Layer	Texture: Substratum	Reaction (pH)	Permeability (In./Hr.)	Water-holding Capacity (In./In.)	Salinity (MMHOS/CM)
12. Rockland-Billings										
Rockland	55	30 - 75	-	-	-	-	-	-	-	-
Billings	15	0 - 5	72	silty clay loam	clay loam	silty clay loam	7.4 - 9.0	0.06 - 0.2	0.14 - 0.19	2 - 4
Lohmiller	10	0 - 3	60	clay loam	silty clay	clay loam	7.4 - 9.0	0.06 - 0.6	0.13 - 0.18	4 - 16
Farb	10	3 - 30	10 - 20	sandy loam	sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.05 - 0.10	2 - 4
Other soils, land types	10	3 - 30	-	-	-	-	-	-	-	-
13. Chipeta-Sheppard-Shiprock										
Chipeta	58	0 - 15	10 - 20	silty clay loam	clay, clay loam	shale	7.4 - 8.4	0.06 - 0.2	0.15 - 0.17	8 - 16
Sheppard	17	1 - 9	60	fine sand	loamy fine sand	loamy fine sand	7.9 - 9.0	6.0 - 20.0	0.05 - 0.08	< 2
Shiprock	10	0 - 5	60	fine sandy loam	sandy clay loam	sandy loam	7.4 - 8.4	2.0 - 6.0	0.06 - 0.12	0 - 4
Other soils, land types	15	-	-	-	-	-	-	-	-	-
14. Del Rio-Silver										
Del Rio	45	1 - 9	60	loam	clay loam	loam, clay loam	7.4 - 8.4	0.2 - 2.0	0.12 - 0.17	< 2
Silver	30	0 - 5	60	clay loam	clay loam	loam, clay loam	7.3 - 8.4	0.06 - 2.0	0.16 - 0.20	< 2
Travessilla	10	3 - 30	6 - 20	fine sandy loam	fine sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.06 - 0.17	< 2
Other soils, land types	15	-	-	-	-	-	-	-	-	-
15. Penistaja-Lohmiller-Travessilla										
Penistaja	35	3 - 5	60	fine sandy loam	sandy clay loam	sandy loam	6.6 - 8.4	0.6 - 6.0	0.09 - 0.16	2
Lohmiller	30	0 - 3	60	clay loam	silty clay	clay loam	7.4 - 9.0	0.06 - 0.6	0.13 - 0.18	4 - 16
Travessilla	25	3 - 15	6 - 20	fine sandy loam	fine sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.06 - 0.17	< 2
Other soils, land types	10	-	-	-	-	-	-	-	-	-
16. Penistaja-Sheppard-Palma										
Penistaja	35	1 - 5	60	fine sandy loam	sandy clay loam	sandy loam	6.6 - 8.4	0.6 - 6.0	0.09 - 0.16	< 2
Sheppard	20	1 - 9	60	fine sand	loamy fine sand	loamy fine sand	7.9 - 9.0	6.0 - 20.0	0.05 - 0.08	< 2
Palma	20	1 - 9	60	fine sandy loam	fine sandy loam	fine sandy loam	6.6 - 8.4	2.0 - 6.0+	0.08 - 0.14	< 2
Other soils, land types	25	-	-	-	-	-	-	-	-	-
17. Lohmiller-San Mateo										
Lohmiller	65	0 - 3	60	clay loam	silty clay	clay loam	7.4 - 9.0	0.06 - 0.6	0.13 - 0.18	4 - 16
San Mateo	25	0 - 3	60	sandy clay loam	fine sandy loam	fine sandy loam silty clay loam	7.9 - 8.4	0.2 - 2.0	0.13 - 0.19	< 2
Other soils, land types	10	-	-	-	-		-	-	-	-
18. Moriarty-Prewitt										
Moriarty	60	0 - 3	60	clay	clay	silty clay	7.9 - 8.4	< 0.06	0.12 - 0.14	1 - 4
Prewitt	20	0 - 3	60	loam	clay	fine sandy loam & clay loam	7.9 - 9.0	0.06 - 2.0	0.14 - 0.21	1 - 4
Other soils, land types	20	-	-	-	-	-	-	-	-	-
19. Hagerman-Travessilla										
Hagerman	35	1 - 5	20 - 40	sandy clay loam	sandy clay loam	sandstone	6.6 - 8.4	0.6 - 2.0	0.14 - 0.16	< 2
Travessilla	20	3 - 25	6 - 20	fine sandy loam	fine sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.06 - 0.17	< 2
Rockland	20	25 - 75+	-	-	-	-	-	-	-	-
Other soils, land types	25	-	-	-	-	-	-	-	-	-
20. Vermejo-Galisteo										
Vermejo	40	0 - 3	60	silty clay loam	silty clay	silty clay	7.9 - 9.0	0.06 - 0.6	0.15 - 0.21	2 - 4
Galisteo	20	0 - 3	60	clay loam	silty clay	clay	7.9 - 9.0	0.06 - 2.0	0.15 - 0.21	< 2
Manzano	10	0 - 5	60	loam	clay loam	loam	7.4 - 8.4	0.2 - 2.0	0.16 - 0.19	2 - 4
Gullied Land	10	-	-	-	-	-	-	-	-	-
Other soils, land types	20	-	-	-	-	-	-	-	-	-
21. Rockland-Bond										
Rockland	40	5 - 75+	-	-	-	-	-	-	-	-
Bond	35	1 - 5	12 - 20	fine sandy loam	sandy clay loam	sandstone	6.6 - 8.4	0.2 - 2.0	0.11 - 0.16	< 2
Travessilla	15	5 - 25	6 - 20	fine sandy loam	fine sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.06 - 0.17	< 2
Other soils, land types	10	-	-	-	-	-	-	-	-	-

Table B-18 (continued)

Soil, Soil Association or Land Type	Percent of Association	Slope Percent	Depth to Bedrock (In.)	Texture: Surface	Texture: Underlying Layer	Texture: Substratum	Reaction (pH)	Permeability (In./Hr.)	Water-holding Capacity (In./In.)	Salinity (MMHOS/CM)
22. Prieta-Thunderbird										
Prieta	30	0 - 10	10 - 20	stony loam	stony clay loam	basalt	6.6 - 8.4	0.06 - 2.0	0.08 - 0.11	<2
Thunderbird	20	0 - 10	20 - 40	stony clay loam	clay	basalt	6.6 - 8.4	0.02 - 0.6	0.09 - 0.16	<2
Rockland	30	-	-	-	-	-	-	-	-	-
Other soils, land types	20	-	-	-	-	-	-	-	-	-
23. Thurloni-Savoia-Concho										
Thurloni	30	5 - 25	20 - 40	clay	silty clay	shale	7.4 - 9.0	0.06 - 0.6	0.13 - 0.17	2 - 4
Savoia	20	2 - 20	60	fine sandy loam	sandy clay loam	fine sandy loam	6.1 - 8.4	0.6 - 6.0	0.08 - 0.17	<2
Concho	12	1 - 9	60	clay loam	sandy clay loam	sandy clay loam	7.4 - 8.4	0.2 - 2.0	0.10 - 0.19	2 - 4
Rockland	10	15 - 75+	-	-	-	-	-	-	-	-
Other soils, land types	28	-	-	-	-	-	-	-	-	-
24. Argiborolls										
Aridic Argiborolls (fine)	55	20 - 40	30 - 50	cobbly clay loam	clay	shale	6.6 - 8.4	0.2 - 2.0	0.14 - 0.20	2 - 4
Aridic Argiborolls (fine-loamy)	20	20 - 40	30 - 50	cobbly clay loam	sandy clay loam	sandstone	6.6 - 8.4	0.6 - 2.0	0.13 - 0.19	<2
Rockland	10	20 - 65+	-	-	-	-	-	-	-	-
Other soils, land types	15	-	-	-	-	-	-	-	-	-
25. Argiborolls-Rockland										
Aridic Argiborolls (fine)	45	20 - 75+	30 - 50	cobbly clay loam	clay	shale	6.6 - 8.4	0.2 - 2.0	0.14 - 0.20	2 - 4
Rockland	40	30 - 75+	-	-	-	-	-	-	-	-
Other soils, land types	15	-	-	-	-	-	-	-	-	-
26. Persayo-Farb										
Persayo	35	5 - 30	10 - 20	silty clay loam	silty clay loam	shale	7.9 - 8.4	0.2 - 0.6	0.15 - 0.19	2 - 8
Farb	35	5 - 30	10 - 20	sandy loam	sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.05 - 0.11	<2
Sundown	10	1 - 9	60	loamy sand	loamy sand	loamy sand	7.4 - 8.4	6.0 - 20.0	0.03 - 0.10	2 - 4
Shiprock	5	0 - 5	60	fine sandy loam	sandy loam	sandy loam	7.4 - 8.4	0.6 - 6.0	0.09 - 0.12	2 - 4
Badland	10	10 - 75+	-	-	-	-	-	-	-	-
Rockland	5	30 - 75+	-	-	-	-	-	-	-	-
27. Werlow-Fruitland-Billings										
Werlow	25	0 - 3	60	loam	sandy clay loam	fine sandy loam	7.4 - 8.4	0.6 - 2.0	0.10 - 0.15	<4
Fruitland	10	1 - 9	60	sandy loam	sandy clay loam	sandy loam	7.4 - 8.4	0.6 - 6.0	0.08 - 0.17	<4
Billings	15	0 - 5	72	silty clay loam	clay loam	silty clay loam	7.4 - 9.0	0.06 - 0.2	0.14 - 0.19	2 - 4
Azfield	15	1 - 5	60	fine sandy loam	sandy clay loam	sandy loam	7.4 - 8.4	0.6 - 6.0	0.11 - 0.17	<4
Sundown	5	1 - 9	60	loamy sand	loamy sand	loamy sand	7.4 - 8.4	6.0 - 20.0	0.03 - 0.10	2 - 4
Other soils, land types	30	-	-	-	-	-	-	-	-	-
28. Doak-Shiprock										
Doak	55	0 - 5	60	fine sandy loam	clay loam	loam	7.4 - 9.0	0.2 - 2.0	0.13 - 0.19	1 - 4
Shiprock	30	0 - 5	60	fine sandy loam	sandy loam	sandy loam	7.4 - 8.4	0.6 - 6.0	0.09 - 0.12	2 - 4
Other soils, land types	15	-	-	-	-	-	-	-	-	-
29. Shiprock-Sheppard										
Shiprock	35	0 - 5	60	fine sandy loam	sandy loam	sandy loam	7.4 - 8.4	0.6 - 6.0	0.09 - 0.12	2 - 4
Sheppard	20	1 - 9	60	fine sand	loamy fine sand	loamy fine sand	7.9 - 9.0	6.0 - 20.0	0.05 - 0.08	<2
Nageezi	10	0 - 5	10 - 20	sandy loam	sandy loam	sandy loam	7.9 - 8.4	2.0 - 6.0	0.10 - 0.13	<4
Kinnear	12	1 - 9	60	fine sandy loam	sandy clay loam	sandy loam	7.4 - 8.4	0.6 - 2.0	0.11 - 0.15	<4
Camborthids	10	1 - 9	60	fine sandy loam	sandy clay loam	sandy loam	6.6 - 7.4	0.6 - 6.0	0.11 - 0.14	<4
Other soils, land types	13	-	-	-	-	-	-	-	-	-
30. Hilly Gravelly Land										
Hilly Gravelly Land	75	5 - 75	-	-	-	-	-	-	-	-
Doak	5	0 - 5	60	loam	clay loam	loam	7.4 - 9.0	0.2 - 2.0	0.13 - 0.19	1 - 4
Grandview	5	0 - 5	60	loam	clay loam	loam	7.9 - 9.0	0.2 - 2.0	0.15 - 0.19	1 - 4
Other soils, land types	15	-	-	-	-	-	-	-	-	-

Table B-18 (continued)

Soil, Soil Association or Land Type	Percent of Association	Slope Percent	Depth to Bedrock (In.)	Texture: Surface	Texture: Underlying Layer	Texture: Substratum	Reaction (pH)	Permeability (In./Hr.)	Water-holding Capacity (In./In.)	Salinity (MMHOS/CM)
31. Badland-Rockland										
Badland	50	0 - 75+	-	-	-	-	-	-	-	-
Rockland	20	-	-	-	-	-	-	-	-	-
Alluvial Land	10	1 - 9	-	-	-	-	-	-	-	-
Persayo	5	5 - 30	10 - 20	silty clay loam	silty clay loam	shale	7.9 - 8.4	0.2 - 0.6	0.15 - 0.19	2 - 8
Other soils, land types	15	-	-	-	-	-	-	-	-	-
32. Camborthids-Farb										
Camborthids	50	1 - 9	20 - 40	fine sandy loam	fine sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.08 - 0.13	<2
Farb	30	3 - 30	10 - 20	sandy loam	sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.05 - 0.11	<2
Other soils, land types	20	-	-	-	-	-	-	-	-	-
33. Persayo-Lohmiller										
Persayo	35	5 - 25	10 - 20	silty clay loam	silty clay loam	shale	7.9 - 8.4	0.2 - 0.6	0.15 - 0.19	2 - 8
Lohmiller	30	0 - 3	60	clay loam	silty clay	clay loam	7.4 - 9.0	0.06 - 0.6	0.13 - 0.18	4 - 16
Badland	15	-	-	-	-	-	-	-	-	-
Other soils, land types	20	10 - 75+	-	-	-	-	-	-	-	-
34. Rockland-Travessilla										
Rockland	45	5 - 75+	-	-	-	-	-	-	-	-
Travessilla	35	5 - 30	6 - 20	fine sandy loam	fine sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.06 - 0.17	<2
Other soils, land types	20	-	-	-	-	-	-	-	-	-
35. Billings-Badland										
Billings	35	0 - 5	72	silty clay loam	clay loam	silty clay loam	7.4 - 9.0	0.06 - 0.2	0.14 - 0.19	2 - 4
Badland	20	30 - 75+	-	-	-	-	-	-	-	-
Farb	20	5 - 30	10 - 20	sandy loam	sandy loam	sandstone	7.4 - 8.4	2.0 - 6.0	0.05 - 0.11	<2
Azfield	10	0 - 5	60	fine sandy loam	sandy clay loam	sandy loam	7.4 - 8.4	0.6 - 6.0	0.11 - 0.17	1 - 4
Other soils, land types	15	-	-	-	-	-	-	-	-	-

Source: Available Soils Conservation Service Soils Interpretations (Soils 5, by series); New Mexico State University, Agricultural Experiment Station Research Reports, Nos. 188, 254, 257 and 262.

Table B-19

INTERPRETATIONS FOR SELECTED USES OF MAJOR SOILS

Soil or Land Type	Erosion Hazard	Shrink-swell	Limitation For Use: Septic Tank Filter Fields	Sewage Lagoons Settling Ponds	Sanitary Landfills[1]	Shallow Excavations	Embankments	Suitability as a Source: Topsoil	Roadfill	Sand/Gravel
Argiborolls, Fine	moderate	high	severe--depth, permeability	severe--steep slopes, stones	severe--depth, too stony	severe--depth, steep slopes, stones	shrink-swell, stones	poor--clayey, stones, slope	poor--too clayey	unsuited
Argiborolls, Fine loamy	moderate	moderate	severe--depth, steep slopes	severe--steep slopes, stones	severe--depth, too stony	severe--depth, steep slopes, stones	steep slopes, stones	poor--stones, steep slopes	poor--shrink-swell, stones	unsuited
Azfield	moderate	moderate	slight	severe--seepage	moderate--seepage	severe--cutbanks cave	piping, easily eroded	fair--thin layer	fair-excess fines	unsuited
Badland	high	no interpretations made								
Basalt Rockland	low	no interpretations made								
Beebe	moderate	low	slight	severe--seepage	moderate--seepage	severe--cutbanks cave	piping, erodes easily	poor--too sandy	good	poor--excess fines
Billings	moderate	moderate	severe--permeability	moderate--piping	moderate--too clayey	moderate--clayey	low strength, piping	fair--too clayey	poor--low strength shrink-swell	unsuited
Blancot	moderate	moderate	slight	severe--seepage	moderate--seepage	moderate--cutbanks cave	piping, erodes easily	poor--thin layer	poor--excess fines	unsuited
Bond	moderate	moderate	severe--depth	severe--depth	severe--depth	severe--depth	thin layer	poor--thin layer	poor--thin layer	unsuited
Cabezon	low	high	severe--depth, slope	severe--depth, slope	severe--depth	severe--depth	thin layer, shrink-swell	poor--thin layer, large stones	poor--thin layer, shrink-swell	unsuited
Camborthids	moderate	low	severe--depth	severe--depth, seepage	severe--depth	severe--depth	thin layer, piping	fair--thin layer	poor--thin layer, depth	unsuited
Chipeta	moderate	high	severe--depth	severe--depth, permeability	severe--depth	severe--depth	low strength, piping	poor--thin layer, too clayey	poor--low strength, shrink-swell	unsuited
Concho	moderate	moderate	moderate--permeability	1-7% moderate--seepage 7%+ severe--slope, seepage	moderate--too clayey	moderate--clayey	shrink-swell	fair--clayey	fair--clayey, shrink-swell	unsuited
Del Rio	moderate	high	severe--permeability	moderate--slope	moderate--too clayey	slight	compressibility	fair--thin layer	poor--shrink-swell	unsuited
Doak	moderate	moderate	severe--permeability	0-2% slight 2%+ moderate--slope	slight	slight	shrink-swell, low strength	fair--too clayey	poor--low strength	unsuited
Farb	high	low	severe--depth	severe--depth, seepage	severe--depth	severe--depth	piping, erodes easily	poor--thin layer	poor--thin layer	unsuited
Fluvents	high	no interpretations made								
Fruitland	moderate	low	slight	severe--seepage	slight	slight	piping, seepage, erodes easily	good	fair--low strength	poor--excess fines
Galisteo	low	high	severe--permeability	severe--floods	severe--floods	severe--floods	low strength, compressible	poor--thin layer	poor--shrink-swell low strength	unsuited

Table B-19 (continued)

Soil or Land Type	Erosion Hazard	Shrink-swell	Limitations for Use: Septic Tank Filter Fields	Sewage Lagoons Settling Ponds	Sanitary Landfills[1/]	Shallow Excavations	Embankments	Suitability as a Source: Topsoil	Roadfill	Sand/Gravel
Gullied Land	high	no interpretations made								
Hagerman	moderate	moderate	severe--depth	severe--depth	severe--depth	severe--depth	thin layer, low strength	poor--thin layer	poor--thin layer, low strength	unsuited
Hilly Gravelly Land	moderate	no interpretations made								
Huerfano	moderate	high	severe--depth, permeability	severe--depth	severe--depth	severe--depth	low strength, shrink-swell	poor--too clayey, thin layer	poor--low strength shrink-swell	unsuited
Las Lucas	moderate	moderate	severe--permeability	moderate--depth	moderate--depth	slight	piping, low strength	fair--too clayey	poor--low strength	unsuited
Litle	moderate	high	severe--depth, permeability	severe--depth	severe--depth	severe--too clayey	compressible, low strength	poor--thin layer, too clayey	poor--shrink-swell low strength	unsuited
Lohmiller	moderate	high	severe--permeability	severe--floods	severe--too clayey	moderate--too clayey, floods	low strength, shrink-swell	fair--too clayey	poor--low strength shrink-swell	unsuited
Moriarty	low	high	severe--permeability	severe--floods	moderate--floods, too clayey	moderate--floods, too clayey	low strength, compressible	poor--too clayey	poor--low strength shrink-swell	unsuited
Navajo	low	high	severe--permeability, floods	severe--floods	severe--too clayey, floods	severe--too clayey, floods	shrink-swell, low strength	poor--too clayey	poor--shrink-swell low strength	unsuited
Notal	moderate	high	severe--permeability	slight	severe--too clayey	severe--too clayey	shrink-swell, compressible	poor--thin layer, too clayey	poor--shrink-swell low strength	unsuited
Otero	high	low	slight	severe--seepage	severe--seepage	moderate--small stones	seepage, erodes easily	poor--thin layer, small stones	fair--excess fines	fair--excess fines
Palma	moderate	low	slight	moderate--seepage	moderate--seepage	slight	piping, seepage, low strength	good	fair--low strength	poor--unsuited
Penistaja	moderate	moderate	slight	moderate--seepage	slight	slight	low strength, piping	fair	fair--low strength	unsuited
Persayo	high	high	severe--depth	severe--depth	severe--depth	moderate--depth	thin-layer, compressible	poor--thin layer, too clayey	poor--thin layer, shrink-swell	unsuited
Prewitt	moderate	high	severe--floods	severe--floods	moderate--floods	moderate--floods	piping, low strength	fair--too clayey	fair--low strength shrink-swell	unsuited
Prieta	low	high	severe--depth	severe--depth	severe--depth	severe--depth	thin layer, piping, large stones	poor--stones	poor--thin layer, low strength	unsuited
Riverwash	high	no interpretations made								
Rockland	low	no interpretations made								
Rock Outcrop	low	no interpretations made								
Rough Broken Land	moderate	no interpretations made								

Table B-19 (continued)

Soil or Land Type	Erosion Hazard	Shrink-swell	Limitation for Use: Septic Tank Filter Fields	Limitation for Use: Sewage Lagoons Settling Ponds	Limitation for Use: Sanitary Landfills 1/	Limitation for Use: Shallow Excavations	Limitation for Use: Embankments	Suitability as a Source: Topsoil	Suitability as a Source: Roadfill	Suitability as a Source: Sand/Gravel
San Mateo	moderate	moderate	severe--floods	severe--floods	severe--floods	severe--floods	low strength, piping	fair	poor--low strength	unsuited
Savoia	moderate	moderate	moderate--slope	severe--seepage	severe--seepage	moderate--slope	favorable	fair	fair--low strength	unsuited
Sheppard	high	low	slight	severe--seepage	moderate--seepage	severe--cutbanks cave	seepage, piping	poor--too sandy	good	poor--unsuited
Shiprock	moderate	low	slight	severe--seepage	moderate--seepage	slight	piping, seepage	fair	fair--low strength	poor--unsuited
Silver	low	moderate	severe--permeability	moderate--slope	moderate--too clayey	moderate--too clayey	low strength, compressible	poor--too clayey	poor--low strength	unsuited
Stumble	moderate	low	slight	severe--seepage	severe--seepage	severe--cutbanks cave	erodes easily, piping	poor--too sandy	good	fair/poor--excess fines
Thunderbird	low	high	severe--depth, permeability	severe--depth	severe--depth	severe--depth, too clayey	shrink-swell, thin layer	poor--too clayey, stones	poor--thin layer, shrink-swell	unsuited
Thurloni	moderate	high	severe--depth	severe--depth	severe--depth	severe--depth	shrink-swell, low strength	poor--too clayey, thin layer	poor--low strength shrink-swell	unsuited
Torreon	low	high	severe--permeability	moderate--slope	severe--too clayey	severe--too clayey	low strength, compressible	fair--thin layer, too clayey	poor--low strength shrink-swell	unsuited
Travessilla	high	low	severe--depth	severe--depth	severe--depth	severe--depth	piping, thin layer, erodes easily	poor--thin layer	poor--thin layer	unsuited
Uffens	moderate	high	severe--permeability	slight	severe--too clayey	moderate--too clayey	moderate--shrink-swell	poor--thin layer, too clayey	poor--shrink-swell low strength	unsuited
Vermejo	high	high	severe--permeability	severe--floods	moderate--floods	severe--too clayey	piping, erodes easily	poor--too clayey, excess salt	poor--shrink-swell low strength	unsuited
Werlow	moderate	moderate	moderate--permeability	severe--seepage	moderate--seepage	moderate--cutbanks cave	piping, low strength	fair--thin layer	fair--shrink-swell	poor--excess fines

Source: USDA, SCS, "Guide for Interpreting Engineering Uses of Soils," November, 1971.

Footnote:
1/ Trench type.

WILDLIFE

WILDLIFE

Table B-20

MAMMALS KNOWN TO OCCUR IN THE ES REGION

Common Name	Scientific Name	Habitat Type R	SG/DS	P/J	P
Insectivora: (shrew)					
Vagrant shrew	Sorex vagrans				x
Desert shrew	Notiosorex crawfordi		x	x	
Chiroptera: (bats)					
Yuma myotis	Myotis yumanensis	x	x	x	
Little brown myotis	Myotis lucifugus	x	x	x	x
Long-eared myotis	Myotis evotis				x
Fringed myotis	Myotis thysanodes	x	x	x	x
Long-legged myotis	Myotis volans	x	x	x	xx
California myotis	Myotis californicus	x	x	x	x
Small-footed myotis	Myotis leibii	x	x	x	xx
Silver-haired bat	Lasionycteris noctivagans	x	x	x	xx
Western pipistrelle	Pipistrelles herperus	x	xx	x	x
Big brown bat	Eptericus fuscus	x		x	xx
Hoary bat	Lasiurus cinereus	x		x	x
Spotted bat	Euderma maculatum			x	x
Townsend's big-eared bat	Plecotus townsendii	x	x	x	x
Pallid bat	Antrozous pallidus	x	xx	x	x
Brazilian free-tailed bat	Tadarida brasiliensis	x	x	x	
Big free-tailed bat	Tadarida macrotis	x	x	x	
Lagomorpha: (rabbits)					
Desert cottontail rabbit	Sylvilagus audubonii	x	x	x	
Eastern cottontail rabbit	Sylvilagus floridanus			x	xx
Nuttal's cottontail rabbit	Sylvilagus nuttalli	x			
Blacktail jackrabbit	Lepus californicus	x	xx	x	x
Rodentia: (rodents, mice, squirrels, etc.)					
Cliff chipmunk	Eutamias dorsalis			xx	x
Colorado chipmunk	Eutamias quadrivattatus			x	xx
White-tailed antelope ground squirrel	Ammospernophilus leucurus		xx	x	
Spotted ground squirrel	Spermophilus spilosoma		x		
Rock squirrel	Spermophilus variegatus	x	x	x	x
Gunnison's prairie dog	Cynomys gunnisoni	x	xx	x	x
Abert's squirrel	Sciurus aberti				x
Red squirrel	Tamiasciurus hudsonicus				x

Table B-20 (continued)

Common Name	Scientific Name	R	Habitat Type SG/DS	P/J	P
Botta's pocket gopher	Thomomys bottae	x	x	x	x
Northern pocket gopher	Thomomys talpoides				x
Silky pocket mouse	Perognathus flavus		xx	x	
Plains pocket mouse	Perognathus flavescens		xx	x	
Ord's kangaroo rat	Dipodomys ordii		xx	x	
Banner-tailed kangaroo rat	Dipodomys spectabilis		x		
Beaver[2]	Castor canadensis	x			
Western harvest mouse	Reithrodontomys megalotis	x	x	x	x
Canyon mouse	Peromyscus crinitus			x	
Deer mouse	Peromyscus maniculatus	x	x	x	x
Brush mouse	Peromyscus boylii			x	
Pinyon mouse	Peromyscus truei		x	xx	
Rock mouse	Peromyscus difficilis			x	
Northern grasshopper mouse	Onychomys leucogaster		xx	x	
White-throated woodrat	Neotoma alloigula		x	x	x
Stephen's woodrat	Neotoma stephensi			x	
Mexican woodrat	Neotoma mexicana			x	xx
Bushy-tailed woodrat	Neotoma cinerea			x	xx
Meadow vole	Microtus pennsylvanicus	x			
Montane vole	Microtus montanus				x
Mexican vole	Microtus mexicanus			x	xx
Long-tailed vole	Microtus longicaudus				x
Muskrat	Ondatra zibethicus	x			
House mouse[3]	Mus musculus	x	x		
Porcupine	Erethizon dorsatum	x	x	x	xx
Carnivora: (bear, foxes, etc.)					
Coyote	Canis latrans	x	xx	x	x
Red fox	Vulpes vulpes	x	x	x	
Kit fox	Vulpes macrotis		x		
Gray fox	Urocyon cinereoargenteus	x	x	xx	x
Black bear	Ursus americanus	x		x	xx
Ring-tailed cat[4]	Bassariscus astutus		x	x	
Raccoon	Procyon lotor	xx	x	x	x
Long-tailed weasel	Mustela frenata	x	x	x	x
Black-footed ferret[5]	Mustela nigripes	x	x	x	x
Mink	Mustela vison	x			
Badger	Taxidea taxus	x	x	x	x
Western spotted skunk	Spilogale gracilis	x	x	x	x
Striped skunk	Mephitis mephitis	x	x	x	x
Mountain lion	Felis concolor	x		x	x
Bobcat	Lynx rufus	x	x	x	x

Table B-20 (continued)

Common Name	Scientific Name	R	SG/DS	P/J	P
		Habitat Type			
Artiodactyla: (even-toed ungulates)					
Elk	Cervus elaphus			x	x
Mule deer	Odocoileus hemionus	x	x	x	x
Pronghorn antelope	Antilocapra americana		x		
Barbary sheep[3]	Ammotragus lervia			x	

Source: Fish and Wildlife Service, 1977

Footnotes:

1 Habitat Type

R = riparian
SG/DS = shortgrass/desert shrub
P/J = pinyon-juniper
P = Ponderosa pine forest
x = found in habitat
xx = preferred in habitat

2 Re-introduced

3 Introduced

4 Possible

5 Possibly extinct

Table B-21

BIRDS RECORDED IN THE ES REGION

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Gaviformes						
Common loon	Gavia immer	R	WR,M	R	C-O	
Order Podicipediformes						
Horned grebe	Podiceps auritus	R	WR,M	R-U	C-O	
Eared grebe	Podiceps caspicus	R	YR,SR	R-C	C-O	Breeds
Western grebe	Aechmophorus occidentalis	R	WR	R-F	O	
Pied-billed grebe	Podilymbus podiceps	R	SR,WR,M	R-F	C-O	Breeds
Order Pelicaniformes						
White pelican	Pelecanus erythrorhynchos	R	M	R-U	C	
Double-crested cormorant	Phalacrocorax auritus	R	M	R-U	C	
Order Ciconiiformes						
Great blue heron	Ardea herodias	R	YR,SR	U-F	C-O	Breeds
Green heron	Butorides striatus	R	YR,WR	R-U	C-O	May breed
Great egret	Casmerodius albus	R	M	R-F	C	
Snowy egret	Leucophoyx thula	R	M	R-F	C	
Black-crowned night heron	Nycticorax nycticorax	R	SR,M	R-U	C-I	May breed
Least bittern	Ixobrychus exilis	R	SR	R-U	C	May breed
American bittern	Botaurus lentiginosus	R	SR,WR,M	R-U	C-O	Breeds
White-faced ibis	Plegadis chihi	R	SR,M	R-F	C	
Order Anseriformes						
Whistling swan	Olor columbianus	R	WR,M	R-U	C	
Canada goose	Branta canadensis	R	YR,M	R-F	C-I	Breeds
White-fronted goose	Anser albifrons	R	WR,M	R-U	C-O	
Snow goose	Chen hyperborea	R	WR	R	C-O	
Mallard	Anas platyrhynchos	R	YR	R-A	I-R	Breeds
Gadwall	Anas strepera	R	YR,SR, WR,M	U-F	C-O	
Pintail	Anas acuta	R	YR,SR,M	R-F	C-O	Breeds
Green-winged teal	Anas carolinensis	R	WR,M	R-A	C	
Blue-winged teal	Anas discors	R	YR,SR,M	R-C	O	May breed
Cinnamon teal	Anas cyanoptera	R	SR,WR	U-C	C-I	Breeds
American wigeon	Mareca americana	R	WR,M	R-U	C-O	
Northern shoveler	Spatula clypeata	R	YR,WR,M	R-C	R	May breed
Wood duck	Aix sponsa	R	WR,M	R-U	C	
Redhead	Aythya americana	R	SR,WR,M	R-F	C-O	May breed
Ring-necked duck	Aythya collaris	R	WR,M	R-F	C	
Canvasback	Aythya valisineria	R	WR,M	R-F	O	
Lesser scaup	Aythya affinis	R	WR,M	R-U	C-O	
Common goldeneye	Bucephala clangula	R	SR,WR,M	R-F	C	
Barrow goldeneye	Bucephala islandica	R	WR	R	X	

Table B-21 (continued)

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Anseriformes con't						
Bufflehead	Bucephala albeola	R	WR,M	R-F	C	
Surf scoter	Melanitta perspicillata	R	M	R	X	
Ruddy duck	Oxyura jamaicensis	R	SR,WR,M	R-C	O	Breeds
Hooded Merganser	Lophodytes cucullatus	R	WR	R	C-I	
Common Merganser	Mergus merganser	R	YR	R-U	O	Breeds
Red-breasted Merganser	Mergus serrator	R	M	R-U	C-O	
Order Falconiformes						
Turkey vulture	Cathartes aura	G/S, PJ,PP	SR	U-C	C-I	Breeds
Mississippi kite	Ictinia mississippiensis	R	M	R	X	Endangered
Goshawk	Accipiter gentilis	PJ,PP	SR,WR,M	R-U	I	
Sharp-shinned hawk	Accipiter striatus	G/S,R PJ,PP	YR	R-F	I	Breeds
Cooper's hawk	Accipiter cooperii	PJ,PP R	YR,SR	R-U	O	Breeds
Red-tailed hawk	Buteo jamaicensis	G/S, PJ,PP	YR	R-U	O-I	Breeds
Swainson's hawk	Buteo swainsoni	G/S,R	SR	U-F	C-O	Breeds
Rough-legged hawk	Buteo lagopus	G/S	WR,M	R-C	I	
Ferruginous hawk	Buteo regalis	G/S,PJ	WR,M	R-F	C-O	May breed
Golden eagle	Aguila chrysaetos	G/S,PJ	YR	R-U	I	Breeds
Bald eagle	Haliaeetus leucocephalus	R	WR,M	R	C	Endangered
Marsh hawk	Circus cyaneus	G/S,R	SR,WR,M	R-F	O	Breeds
Osprey	Pandion haliaetus	R	M	R	O	Endangered
Prairie falcon	Falco mexicanus	G/S,R, PJ	YR	R-U	C-O	Breeds
Peregrine falcon	Falco peregrinus	G/S, R,PJ	YR	R	C-O	Breeds, Endangered
Merlin	Falco columbarius	PJ	WR,M	R	C	
American kestrel	Falco sparverius	G/S,R, PJ,PP	YR	P	O-R	Breeds
Order Galliformes						
Blue grouse	Dendragapus obscurus	PP				Transplanted to area but not established
Sage grouse	Centrocercus urophasianus	G/S				Historically in area but not there now
Scaled quail	Callipepla squamata	G/S,R	YR	U-C	O-R	Breeds
Gambel's quail	Lophortyx gambelii	G/S,R, PJ	YR	R-C	I-R	Breeds

Table B-21 (continued)

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Galliformes con't						
Ring-necked pheasant	Phasianus colchicus	G/S,R	YR	R-F	O-R	Breeds-Introduced
Chukar	Alectoris graeca	G/S	YR	R-U	C	Breeds-Introduced
Turkey	Meleagris gallopavo	PJ,R, PP	YR	R-C	O-R	Breeds
Order Gruiformes						
Virginia rail	Rallus limicola	R	SR	R-U	C-I	Breeds
Sora	Porzana carolina	R	SR	R-F	C-I	Breeds
Common gallinule	Gallinula chloropus	R	SR,M	R-C	O-I	Breeds
American coot	Fulica americana	R	YR	F-C	C-R	Breeds
Order Charadriiformes						
Semi-palmated plover	Charadrius semipalmatus	R	M	R	I	
Snowy plover	Charadrius alexandrinus	R	M	R-F	C	
Killdeer	Charadrius vociferus	R	YR,SR	R-C	I-R	Breeds
Mountain plover	Eupoda montana	G/S,R	SR,M	R-F	C-O	Breeds
Black-bellied plover	Squatarola squatarola	G/S,R	M	R-U	C	
Common snipe	Capella gallinago	R	WR,M	R-F	C-O	
Long-billed curlew	Numenius americanus	R	M	R-F	C	
Upland plover	Bartramia longicauda	G/S,R	M	R-F	C	
Spotted sandpiper	Actitus macularia	PP,R	SR,UR,M	R-P	C-I	Breeds
Solitary sandpiper	Tringa solitaria	R	M	R-F	C	
Willet	Catoptrophorus semipalmatus	R	M	R-F	C	
Greater yellowlegs	Totanus melanoleucus	R	M	R	C	
Lesser yellowlegs	Totanus flavipes	R	M	R	C-O	
Pectoral sandpiper	Erolia melanotos	G/S,R	M	R-U	C-O	
Baird's sandpiper	Erolia bairdii	R	M	R-F	O-R	
Least sandpiper	Erolia minutilla	R	M	R-U	C-O	
Long-billed dowitcher	Limnodromus scolopaceus	R	M	R-F	C	
Western sandpiper	Ereunetes mauri	R	M	R-U	C	
Marbled godwit	Limosa fedoa	R	M	R-U	C-O	
Sanderling	Crocethia alba	R	M	R-U	C	
American avocet	Recurvirostra americana	R	M,SR	R-F	C-O	
Black-necked stilt	Himantopus mexicanus	R	M	R-F	O	
Wilson's phalarope	Steganopus tricolor	R	M	R-C	O	
Northern phalarope	Lopipes lobatus	R	M	R-F	C-I	
Herring gull	Larus argentatus	R	M	R-U	C	
California gull	Larus californicus	R	M	R	X	
Laughing gull	Larus atricilla	R	M	R	X	
Ring-billed gull	Larus delawarensis	R	M,WR	R-U	C-O	

Table B-21 (continued)

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Charadriiformes con't						
Franklin's gull	Larus pipixcan	R	M	R-U	C-I	
Bonaparte's gull	Larus philadelphia	R	M	R-U	C-I	
Sabine's gull	Xema sabini	R	M	R	X	
Forester's tern	Sterna forsteri	R	M	R-F	C-O	
Common tern	Sterna hirundo	R	M	R	X	
Caspian tern	Sterna caspia	R	M	R	X	
Black tern	Chlidonias niger	R	M,SR	R-C	C-O	
Order Columbiformes						
Band-tailed pigeon	Columba fasciata	PJ,PP, R	SR	R-C	I	Breeds
Rock dove	Columba livia	G/S,R	YR	R-U	O-R	Breeds
Mourning dove	Zenaidura macroura	G/S,R, PJ	YR,SR	F-A	I-R	Breeds
Inca dove	Scardafella inca	R	WR,M	R	X	
Order Cuculiformes						
Yellow-billed cuckoo	Coccyzus americanus	R	SR	R-U	I	Breeds
Roadrunner	Geococcyx californianus	G/S, PJ,R	YR	R	C	
Order Strigiformes						
Barn owl	Tyto alba	G/S,R	SR,WR	R	C	
Screech owl	Otus asio	PJ,R PP	YR,SR,WR	R	C	Breeds
Flammulated owl	Otus flammeolus	PP	SR	R-U	C	Breeds
Great horned owl	Bubo virginianus	PJ,PP, R	YR,SR	R-F	C-I	
Pygmy owl	Glaucidium gnoma	PJ,PP	M	R	C	
Burrowing owl	Athene cunicularia	G/S	SR	R-F	C-I	Breeds
Spotted owl	Strix occidentalis	PJ,PP	SR,M	R-F	C-I	Breeds
Long-eared owl	Asio otus	PJ,R	SR	R-U	C	Breeds
Short-eared owl	Asio flammeus	G/S	WR,M	R-F	C	
Saw-whet owl	Aegolius acadicus	PP	SR	R	C	Breeds
Order Caprimulgiformes						
Poor-will	Phalaenoptilus nuttallii	G/S, PJ,PP	SR,M	R-F	C-O	Breeds
Common nighthawk	Chordeiles minor	G/S,R, PJ,PP	SR	F-C	I-R	Breeds
Order Apodiformes						
Black swift	Cypseloides niger	R	SR,M	R	C-O	
White-throated swift	Aeronautes saxatalis	PJ,PP	SR,M	R-F	C-I	Breeds

Table B-21 (continued)

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Apodiformes con't						
Broad-tailed hummingbird	Selasphorus platycercus	PJ,PP, R	SR,M	U-C	O	May breed
Black-chinned hummingbird	Archilochus alexandri	G/S,R, PJ	SR	R-F	C-O	Breeds
Rufous hummingbird	Selasphorus rufus	G/S,R, PJ,PP	M	R-C	C-O	
Calliope hummingbird	Stellula calliope	PP	M	R	X	
Order Coraciiformes						
Belted kingfisher	Megaceryle alcyon	R	SR,WR	U-F	O-R	Breeds
Order Piciformes						
Common flicker	Colaptes cafer	PP,R	YR	F-C	I-R	Breeds
Red headed woodpecker	Melanerpes erythrocephalus	R	SR	R-U	O	Endangered Breeds
Acorn woodpecker	Melanerpes formicivorus	PP	YR,SR, WR,M	R-C	C-O	
Lewis' woodpecker	Melanerpes lewis	PJ,PP, R	YR,SR	R-C	O-I	Breeds
Yellow-bellied sapsucker	Sphyrapicus varius	PJ,R, PP	SR,M	R-F	O-I	Breeds
Williamson's sapsucker	Sphyrapicus thyroideus	PJ,PP	YR,SR, WR	R-F	O-I	
Hairy woodpecker	Picoides villosus	PJ,R, PP	YR	R-C	C-O	Breeds
Downy woodpecker	Picoides pubescens	PJ,R, PP	YR,SR	R-F	C-O	May breed
Northern three-toed woodpecker	Picoides tridactylus	PP	SR	R-U	C-O	Breeds
Order Passeriformes						
Eastern kingbird	Tyrannus tyrannus	R	SR	U-F	O-I	Breeds
Western kingbird	Tyrannus verticalis	G/S,PJ	SR	U-F	C-R	Breeds
Cassin's kingbird	Tyrannus vociferans	PJ,PP, R	SR	U-C	O-R	Breeds
Ash-throated flycatcher	Myiarchus cinerascens	PJ,PP, G/S	SR	F	O-R	Breeds

Table B-21 (continued)

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Passeriformes con't						
Eastern phoebe	Sayornis phoebe	R	M	R	C	
Black phoebe	Sayornis nigricans	R	SR	R	C	
Say's phoebe	Sayornis saya	G/S	YR,SR	F	O	Breeds
Willow flycatcher	Empidonax traillii	PP,R	SR,M	R-F	C-O	
Hammond's flycatcher	Empidonax hammondii	PP	SR,M	R	C-O	
Dusky flycatcher	Empidonax oberholseri	PP	SR,M	R-U	C	
Gray flycatcher	Empidonax wrightii	G/S,PJ	SR	R-F	C-O	Breeds
Western flycatcher	Empidonax difficilis	PJ,PP,R	SR,M	U-F	C	
Coues' flycatcher	Contopus pertinax	PJ,PP	SR	R	C	
Western wood pewee	Contopus sordidulus	PJ,R,PP	SR,M	U-F	C-R	Breeds
Olive-sided flycatcher	Nuttallornis borealis	PP,R	SR,M	R-F	O-I	
Horned lark	Eremophila alpestris	G/S	YR	C-A	R	Breeds
Violet green swallow	Trachycineta thalassina	PJ,R,PP	SR	U-C	C-R	
Tree swallow	Iridoprocne bicolor	PP,R,PJ	SR,M	R-U	I	
Bank swallow	Riparia riparia	G/S,R	SR,M	R-F	C-O	
Rough-winged swallow	Stelgidopteryx ruficollis	R	SR	C	I-R	Breeds
Barn swallow	Hirundo rustica	G/S	SR	C-A	O-R	Breeds
Cliff swallow	Petrochelidon pyrrhonata	G/S	SR	C-A	O-R	Breeds
Purple martin	Progne subis	PP	SR,M	R-U	C	Breeds
Gray jay	Perisoreus canadensis	PP	YR	R	C	
Blue jay	Cyanocitta cristata	PJ,R	M,WR	R-U	X	
Steller's jay	Cyanocitta stelleri	PJ,PP	SR,WR	U-C	I	May breed
Scrub jay	Aphelocoma coerulescens	G/S,PJ	YR	U-F	C-I	Breeds
Black-billed magpie	Pica pica	G/S,R,PJ,PP	YR	R-C	I-R	
Common raven	Corvus corax	PJ,PP	YR,SR	U-F	C-R	Breeds
Common crow	Corvus brachyrhynchos	G/S,R,PJ,PP	YR,WR	R-F	C-I	
Pinyon jay	Gymnorhinus cyanocephalus	PJ	YR,WR	R-F	C-I	Breeds
Clark's nutcracker	Nucifraga columbiana	PP	YR,WR,M	R-C	I-R	Breeds
Black-capped chickadee	Parus atricapillus	PP	YR,WR	F	C-I	Breeds
Mountain chickadee	Parus gambeli	PJ,R,PP	YR,WR	U-C	I-R	Breeds
Plain titmouse	Parus inornatus	PJ	YR,SR,WR	U-F	C-I	Breeds

Table B-21 (continued)

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Passeriformes con't						
Common bushtit	Psaltriparus minimus	PJ,R, PP	YR,M	U	I	Breeds
White-breasted nuthatch	Sitta carolinensis	PJ,R, PP	YR,SR	U	C-O	Breeds
Red-breasted nuthatch	Sitta canadensis	PJ,R,	YR,WR,M	R-U	C-O	Breeds
Pygmy nuthatch	Sitta pygmaea	PJ,R, PP	YR,WR	U-C	C-I	Breeds
Brown creeper	Certhia familiaris	PJ,PP	WR,SR,YR	R-F	O-I	Breeds
Dipper	Cinclus mexicanus	PJ,R, PP	YR,WR	R-F	O-I	
House wren	Troglodytes aedon	PJ,R, PP	SR	U-C	I-R	Breeds
Bewick's wren	Thryomanes bewickii	PJ,R, PP	YR,SR	R-U	O-I	Breeds
Long-billed marsh wren	Cistothorus palustris	R	SR,WR,M	R-F	I-R	Breeds
Canon wren	Catherpes mexicanus	G/S, PJ,PP	YR,SR,M	U-C	O-R	Breeds
Rock wren	Salpinctes obsoletus	G/S, PP,PJ	YR,SR	U-C	O-R	Breeds
Mockingbird	Mimus polyglottus	G/S, PJ,PP	YR,SR,WR	U-C	C-R	Breeds
Gray catbird	Dumetella carolinensis	G/S,R	M	R-U	C-I	May breed
Brown thrasher	Toxostoma rufum	G/S	WR,M	R	C-I	
Bendire's thrasher	Toxostoma bendirei	G/S,PJ	SR	R-U	C-I	Breeds
Sage thrasher	Oreoscoptes montanus	G/S	YR,SR,WR	U-F	C-O	Breeds
American robin	Turdus migratorius	PJ,R, PP	YR	C	O-R	Breeds
Hermit thrush	Hylocichla guttata	PP,R	YR,SR,WR	R-U	C-I	Breeds
Swainson's thrush	Hylocichla ustulata	PJ,PP, R	SR	R-U	C-O	
Eastern bluebird	Sialia sialis	PJ	WR,M	R-U	C-O	
Western bluebird	Sialia mexicana	PJ,R, PP	YR,SR	U-C	I-R	Breeds
Mountain bluebird	Sialia currocoides	PJ,PP	YR	R-C	I-R	Breeds
Townsend's solitaire	Myadestes townsendi	PJ,PP	YR,SR,WR	R-F	I-R	Breeds
Blue-gray gnatcatcher	Polioptila caerulea	G/S,PJ	SR,M	R-C	O-I	Breeds
Golden-crowned kinglet	Regulus satrapa	PP	WR,M	R-U	C-I	

Table B-21 (continued)

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Passeriformes con't						
Ruby-crowned kinglet	Regulus calendula	PJ,PP	WR,M	R-F	C-I	
Water pipit	Anthus spinoletta	PJ,R, PP	WR,M	R-U	C-O	
Bohemian waxwing	Bombycilla garrula	PJ	WR,M	R-C	C-O	
Cedar waxwing	Bombycilla cedrorum	PJ	WR,M	U-C	O-I	
Northern shrike	Lanius excubitor	G/S	WR,M	R	C-O	
Loggerhead shrike	Lanius ludovicianus	G/S,PJ	YR,SR	U-C	I-R	Breeds
Starling	Sturnus vulgaris	PJ,R	YR	F-C-A	O-R	Breeds, Introduced
Gray vireo	Vireo vicinior	PJ	SR,M	U-F	C-I	Breeds
Solitary vireo	Vireo solitarius	PJ,R, PP	SR	U-C	C-I	Breeds
Red-eyed vireo	Vireo olivaceus	PJ	M	R	X	
Warbling vireo	Vireo gilvus	PJ,R,	SR	R-C	C-O	Breeds
Black and white orange warbler	Mniotilta varia	PJ	M	R	C-O	
Crowned warbler	Vermivora celata	PP	SR,M	R-U	C-O	
Nashville warbler	Vermivora ruficapilla	PJ	M	R	X	
Virginia's warbler	Vermivora virginae	R,PJ, PP	SR,M	U-F	O	Breeds
Lucy's warbler	Vermivora luciae	R,G/S	M	R	C	
Yellow warbler	Dendroica petechia	R,PJ, PP	SR,M	R-C	O-I	Breeds
Magnolia warbler	Dendroica magnolia	PP	M	R	X	
Black-throated blue warbler	Dendroica caerulescens	PJ	M	R	X	
Yellow-rumped warbler	Dendroica auduboni	PJ,PP	YR,SR	U-C	O-R	Breeds
Black-throated gray warbler	Dendroica nigrescens	PJ	SR,M	U	O	Breeds
Townsend's warbler	Dendroica townsendi	R,PJ, PP	M	R-U	C-O	
Black-throated green warbler	Dendroica virens	PP	M	R	X	
Hermit warbler	Dendroica occidentalis	PJ,PP	M	R-U	C	
Grace's warbler	Dendroica graciae	PJ,PP	SR,M	R-F	C-I	Breeds
Palm warbler	Dendroica palmarum	PJ	M	R	X	
Ovenbird	Seiurus aurocapillus	PJ	M	R	X	
Northern water-thrush	Seiurus noveboracensis	R	M	R	C-O	
MacGillivray's warbler	Oporonis tolmiei	R,PP	M,SR	R-F	C-I	
Common yellow-throat	Geothlypis trichas	R	SR,M	R-C	I	Breeds

Table B-21 (continued)

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Passeriformes con't						
Yellow-breasted chat	Icteria virens	R,G/S	SR	U-C	O-R	Breeds
Wilson's warbler	Wilsonia pusilla	R,G/S	M	R-F	I-R	
American redstart	Setophaga ruticilla	PJ	M	R-U	C-I	
House sparrow	Passer domesticus	G/S,PJ	YR	U-C	R	Breeds, Introduced
Eastern meadowlark	Sturnella magna	G/S,R	SR	R-U	C-I	
Western meadowlark	Sturnella neglecta	G/S,R	SR	U-C	O-R	Breeds
Yellow-headed blackbird	Xanthocephalus xanthocephalus	R	SR,WR	F-C-A	C-R	Breeds
Red-winged blackbird	Agelaius phoeniceus	R,PJ, PP	YR,SR	C-A	R	Breeds
Scott's oriole	Icterus parisorum	G/S,PJ	SR	U-F	O-I	Breeds
Northern oriole	Icterus galbula	R	SR	U-C	O-R	Breeds
Brewer's blackbird	Euphagus cyanocephalus	G/S,R	SR	U-F	C-R	Breeds
Boat-tailed grackle	Quiscalus mexicanus	R	SR,WR	U-C	C-O	Breeds
Common grackle	Quiscalus guiscula	R	SR	R	C-O	Breeds
Brown-headed cowbird	Molothrus ater	R,PJ, PP	SR,WR	F-C	O-R	Breeds
Western tanager	Piranga ludoviciana	R,PJ, PP	SR,M	R-F	C-O	Breeds
Scarlet tanager	Piranga olivacea	R,PP	M	R	X	
Hepatic tanager	Piranga flava	PP	M	R-U	C-O	
Rose-breasted grosbeak	Pheuticus ludovicianus	PJ	M	R-U	C-I	
Black-headed grosbeak	Pheuticus melanocephalus	R,PJ, PP	SR	U-F	O-R	Breeds
Blue grosbeak	Guiraca caerulea	G/S,R	SR	U-F	O-R	Breeds
Indigo bunting	Passerina cyanea	R,G/S	SR	R-F	C-O	Breeds
Lazuli bunting	Passerina amoena	R,G/S	SR	R-F	O-I	Breeds
Dickcissel	Spiza americana	G/S	M	R	X	
Evening grosbeak	Hesperiphona vespertina	PJ,PP	YR,WR,SR	R-F	C-R	
Cassin's finch	Carpodacus cassinii	PJ,PP	YR,WR,M	R-U	C-I	
House finch	Carpodacus mexicanus	G/S,R, PJ	YR,SR	U-C	I-R	Breeds
Gray-crowned rosy finch	Leucosticte tephrocotis	PJ,R, PP	M	R-C	O-I	
Black rosy finch	Leucosticte atrata	PJ,R, PP	M	R-U	C-O	
Brown-capped rosy finch	Leucosticte australis	R	M	R-U	C-O	

Table B-21 (continued)

Common Name	Scientific Name	Habitat[1]	Season[2]	Abundance[3]	Frequency[4]	Remarks
Order Passeriformes con't						
Pine siskin	Cardeulis pinus	R,PP	SR,WR	R-U	C-I	Breeds
American goldfinch	Carduelis tristis	R,PJ, G/S	SR,WR	R	C-O	Breeds
Lesser goldfinch	Carduelis psaltria	R	SR,WR	R-F	C-I	Breeds
Lawrence's goldfinch	Carduelis lawrencei	R	SR,WR	R	X	
Red crossbill	Loxia curvirostra	PP	M	R-C	I	
Green-tailed towhee	Pipilo chlorurus	G/S,R	SR,M	R-C	I-R	
Rufous-sided towhee	Pipilo erythrophthalmus	PJ,R, G/S	SR,WR	R-C	I-R	Breeds
Brown towhee	Pipilo fuscus	G/S,PJ	SR,WR	U	O-I	Breeds
Lark bunting	Calamospiza melanocorys	G/S	M	R	C	
Savannah sparrow	Passerculus sandwichensis	G/S	M	R-U	C	
Vesper sparrow	Pooecetes gramineus	G/S	SR,M	R-C	I-R	Breeds
Lark sparrow	Chondestes grammacus	G/S,PJ	SR,M	U-C	C-R	Breeds
Cassin's sparrow	Aimophila cassinii	G/S	M,SR	R	C	
Black-throated sparrow	Amphispiza bilineata	G/S	SR	C	I-R	Breeds
Sage sparrow	Amphispiza belli	G/S	SR,WR	R-F	C-O	Breeds
Dark-eyed junco	Junco oreganus	R,PP, PJ	WR	U-A	I-R	
Gray-headed junco	Junco caniceps	PJ,PP	YR	U-C	O-R	Breeds
Tree sparrow	Spizella arborea	G/S,R	WR	R-E	O-I	
Chipping sparrow	Spizella passerina	PJ,R, PP	SR	F-C	C-R	Breeds
Brewer's sparrow	Spizella breweri	G/S	SR	U-C	I-R	Breeds
Harris' sparrow	Zonotrichia guerula	G/S	WR,M	R-U	C-I	
White-crowned sparrow	Zonotrichia leucophrys	G/S,R, PJ	WR	U-C-A	I-R	
White-throated sparrow	Zonotrichia albicollis	G/S	M	R-U	C-I	
Fox sparrow	Passerella iliaca	G/S,R	M	R	X	
Lincoln's sparrow	Melospiza lincolnii	G/S,R	W	R-F	C	
Swamp sparrow	Melospiza melodia	R	WR	R-U	C-I	
Lapland longspur	Calcarius lapponicus	G/S	M	R	X	

Source: Fish and Wildlife Service, 1977

Footnotes:

[1] Habitat Preference
- R - Riparian, Agricultural Areas
- G/S - Short Grassland/Shrubland
- PJ - Pinyon-Juniper Woodland
- PP - Ponderosa Pine Forest

[2] Season of Occurrence
- YR - Yearlong Resident
- SR - Summer Resident
- WR - Winter Resident
- M - Migrant

[3] Abundance (Hubbard, 1970)
- R - Rare
- U - Uncommon
- F - Fairly Common
- C - Common
- A - Abundant

[4] Frequency of Occurrence (Hubbard, 1970)
- X - Accidental (recorded but unexpected)
- C - Casual
- O - Occassional
- I - Irregular
- R - Regular

Table B- 22

AMPHIBIANS AND REPTILES OCCURRING WITHIN THE ES REGION

COMMON NAME	SCIENTIFIC NAME	HABITAT TYPES 1/ R	SG/DS	P-J	P
Tiger salamander	*Ambystoma tigrinum* 2/	X	X	X	X
Western spadefoot	*Scaphiopus hammondi* 2/	X	XX	X	
Plains spadefoot	*Scaphiopus bombifrons* 2/	X	XX		
Red-spotted toad	*Bufo punctatus*	X	X		
Woodhouse's toad	*Bufo woodhousei* 2/	X	X	X	X
Chorus frog	*Pseudaeris triseriata*	X	X	X	X
Canyon treefrog	*Hyla arenicolor*			X	X
Bullfrog	*Rana catesbeiana*	X			
Leopard frog	*Rana pipiem*	X			
Painted turtle	*Chrysemys picta*	X			
Western box turtle	*Terrapere ornata* 2/				
Lesser earless lizard	*Holbrookia maculeta* 2/		X		
Collared lizard	*Crotophytus collaris* 2/		X	X	
Eastern fence lizard	*Sceloporus undulctus* 2/	X	X	X	X
Sagebrush lizard	*Sceloporus graciosus* 2/		X	X	
Side-blotched lizard	*Uta stansburiana* 2/		X		
Tree lizard	*Urosamus ornatus*		X	X	X
Short horned lizard	*Phrynosoma douglassi* 2/		XX	XX	X
Great plains skink	*Eumeces obsoletus*			XX	X
Many-lined skink	*Eumeces multivirgatus*	XX		X	X
Western whiptail	*Cnemidophorus tigris*	X	X	X	
Plateau whiptail	*Cnemidophorus velox* 2/	X	X	X	
Little striped whiptail	*Cnemidophorus inornatus*		X		
Ringneck snake	*Diadophis punctatus*			X	X
Coachwhip	*Masticophis flagellum*			X	
Striped whipsnake	*Masticophis taeniatur*		X	X	
Gopher snake	*Pituophis melanoleucus* 2/	X	X	X	X
Glossy snake	*Arizona elegans*		X		
Black-necked garter snake	*Thamnophis cyrtopsis*	X			
Western Terrestrial garter snake	*Thamnophis elegans* 2/	X	X	X	X
Night snake	*Hypsiglena torquata*			X	
Black-tailed rattlesnake	*Crotalus molossus*			X	X
Western rattlesnake	*Crotalus viridis*		X	X	X
Western diamondback rattlesnake	*Crotalus atrox*			X	
Possibly occurring in vicinity:					
Great Plains spadefoot	*Scaphiopus intermontanus*		X	X	
Western toad	*Bufo boreas*	X			
Smooth green snake	*Opheodrys vernalis*	X			
Mountain patch-nosed snake	*Salvadora grahamiae*			X	
Milk snake	*Lanypropeltis triangulum*				X
Leopard lizard	*Crolophytus wislizenii*		X		
Desert spring lizard	*Sceloporus magistee*	X	X	X	

Source: Fish and Wildlife Service, 1977

1/ Key
- R — riparian
- SG/DS — short grass/desert shrub
- P/J — pinyon/juniper
- P — Ponderosa pine forest

2/ common and widespread

Table B-23

ARTHROPODS OCCURRING IN THE ES REGION

Order	Family	Common Name
Terrestrial		
Odonata	Coenagrionidae	Dragonflies, Damselflies
Orthoptera	Acrididae Tettigoniidae	Grasshoppers
Thysanoptera	Phloeothripidae	Thrips
Hemiptera	Miridae Phymatidae Navidae Tingidae Lygaeidae Coreidae Scutelleridae Pentatomidae	True Bugs
Homoptera	Cicadidae Membracidae Cicadellidae Fulgoridae Delphacidae Dictyopharidae Cixiidae Psyllidae Aphididae	Cicadas, Hoppers, Aphids
Coleoptera	Cicindelidae Carabidae Malachiidae Meloidae Mordellidae Tenebrionidae Anobiidae Cerambycidae Chrysomelidae Curculionidae	Beetles
Neuroptera	Chrysopidae	Lacewings
Lepidoptera	Pieridae Nymphalidae Sphingidae Noctuidae	Butterflies, Moths

Table B-23 (continued)

Order	Family	Common Name
Aquatic		
Ephemeroptera	Ephemerelidae Baetidae Heptogeniidae	Mayflies
Odonata	Gomphidae Aestinidae Coenagionidae	Dragonflies
Plecoptera	Perlodidae	Stoneflies
Hemiptera	Valiidae Corixidae Naucoridae Notonectidae Gerridae	True aquatic bugs
Coleoptera	Gyrinidae Dytisicidae Hydrophilidae	Aquatic beetles
Trichoptera	Hydrophilidae Brochycentridae Hydrophilidae	Caddis flies
Diptera	Tendipedidae Simulidae Empididae Rhagionidae Ceratopoinidae Chironomidae	True aquatic flies
Thysanoptera		Thrips
Gastropoda	Lymnaeidae Physidae Planorbidae Ancylidae	Snails
Annelid	Hirundinea	Aquatic worms
Amphipoda		Scuds and sideswimmers
Decapoda		Crayfish

Source: Data from studies by Graves, 1967 and Sublette, 1977.

Table B-23 (continued)

Order	Family	Common Name
Diptera	Culicidae Chironomidae Anisopodidae Stratiomyidae Tabanidae Acroceridae Asilidae Bombyliidae Dolichopodidae Syrphidae Otitidae Tephritidae Sepsidae Drosophilidae Chloropidae Trioxscelidae Anthomyiidae Muscidae Gasterophilidae Calliphoridae Tachinidae	Flies
Hymenoptera	Braconidae Icheumonidae Chalcididae Cynipidae Chrysididae Mutillidae Formicidae Vespidae Colletidae Andrenidae Halictidae Megachilidae Apidae	Bees, Wasps, Ants
Araneida	Thomisidae Salticidae Tetragnathidae	Spiders

Source: Battele-Columbus Laboratories, unpublished study for WESCO, 1974.

Table B-24

FISH OCCURRING IN THE ES REGION

Common Name	Location: Navajo Reservoir	Cutter Lake	Beeline Reservoir (Farmington Lake)	Farmington City Lake	Jackson Lake	Bluewater Lake	San Juan River	Animas River	Los Pinos River	LaPlata River
Non-game species										
Black bullhead	X	X		X	X		X		X	
Bluehead sucker	X						X	X	X	X
Bonytail chub*							X			
Carp	X				X		X	X	X	
Central Plains killifish						X	X			
Colorado River squawfish	X						X			
Fathead minnow	X			X	X	X	X	X	X	
Flannelmouth sucker	X		X	X	X		X	X	X	X
Freshwater mottled sculpin	X						X	X		X
Green sunfish	X						X			
Mosquitofish				X	X		X		X	
Razorback sucker							X	X	X	
Red shiner							X			
Rio Grande chub						X				
Rio Grande killifish							X			
Rio Grande mountain sucker						X				
Roundtail chub	X						X		X	
Speckled dace	X						X	X	X	X
White sucker	X		X	X		X	X	X	X	
Game species										
Bluegill	X	X	X	X	X		X	X		
Brook trout								X		X
Brown trout	X					X	X	X	X	X
Channel catfish	X		X	X	X	X	X	X		
Cutthroat trout								X		X
Kokanee salmon	X						X	X	X	
Largemouth bass			X	X	X	X	X	X		
Northern pike							X	X		
Rainbow trout	X	X	X		X	X	X	X	X	X
White crappie			X		X					
Yellow perch								X		

Sources: Patrick H. Davies, 1965; Ralph G. Little, 1968; Warren McNall, 1969; Harold F. Olson, 1962c; Charlie Sanchez, 1975 (field observation); and Norwin F. Smith, 1976; U.S. Fish and Wildlife Service, 1977.

*Presence unconfirmed

Table B-25

ENDANGERED AND THREATENED ANIMALS IN THE ES REGION

TYPE OF OBSERVATION	LOCATION	DATE	COLLECTOR	SOURCE	COMMENTS
		BLACK-FOOTED FERRET (Mustela nigripes)			
Visual	Near old Fort Wingate, McKinley Co., New Mexico	1916,1917	Joseph Crick	Bailey (1971)	Crick reports that the ferrets are frequently seen in this area.
Specimen Collected (USNM)	Near San Mateo, 10 miles NE of Mt. Taylor, McKinley Co., New Mexico	1918	J.S. Ligon	Bailey (1971)	Specimen re-examined recently, Findley, et al. (1975)
Specimen Collected (USNM)	2 miles N of Bluewater, McKinley Co., New Mexico	Oct.15, 1918	M.E. Musgrave	Bailey (1971)	Specimen re-examined recently, Findley, et al. (1975)
Specimen Collected	Near Mexican Springs, McKinley Co., New Mexico	1940	---------	Halloran (1964)	Specimen examined by William E. Fair

Table B-25 (continued)

TYPE OF OBSERVATION	LOCATION	DATE	COLLECTOR	SOURCE	COMMENTS
		COLORADO RIVER SQUAWFISH (*Ptychocheilus lucius*)			
--------	San Juan River below Rosa, San Juan Co., NM	July & August 12, 1959	Milton Seibel	NM State Heritage Program (1976)	--------
Specimen Collected (UNM)	San Juan River between Navajo Dam & Colorado border, San Juan Co., NM	August 25, 1961	W. Koster	NM State Heritage Program (1976) and Olson (1962)	--------
Specimen Collected (NMGF)	San Juan River near Bloomfield, San Juan Co., NM	July 1966	Harold Olson	C. Sanchez, personal communication (Jan 3, 1977)	Fish creeled by angler and confirmed by H. Olson.

BONYTAIL CHUB (*Gila elegans*)

No confirmed records of the bonytail chub have been reported in New Mexico. However, historical range of this species includes the San Juan River and major tributary streams.

RAZORBACK SUCKER (*Xyrauchen texanus*)

No confirmed records of the razorback sucker have been reported in New Mexico. However, this species has been recently collected in the San Juan River, Utah.

Table B-25 (continued)

TYPE OF OBSERVATION	LOCATION	DATE	COLLECTOR	SOURCE	COMMENTS
		MISSISSIPPI KITE (Ictinia mississippiensis)			
Visual	Kirtland, San Juan Co., New Mexico	June 2, 1972	G. Schmitt	Schmitt (1976)	Casual sighting.
		RED-HEADED WOODPECKER (Melanerpes erythrocephalus caurinus)			
Visual	Near Blanco, San Juan Co., New Mexico	August 16, 1971; June 22 & July 6, 1972	G. Schmitt	Schmitt (1976)	Possibly same bird.
Specimen Collected (DMNH)	Near Blanco, San Juan Co., New Mexico	July 21, 1976	G. Schmitt	Schmitt (1976)	Adult male w/brood patch, probably breeding
		OSPREY (Pandion haliaetus)			
Visual	Navajo Dam, San Juan Co., New Mexico	June 18, 1971	G. Schmitt	Schmitt (1976)	Casual sighting, probably only a migrant.
Visual	San Juan River at Blanco, San Juan Co., NM	July 21, 1972	G. Schmitt	Schmitt (1976)	Casual sighting, probably only a migrant.

Table B-25 (continued)

TYPE OF OBSERVATION	LOCATION	DATE	COLLECTOR	SOURCE	COMMENTS
MINK (*Mustela vison energumenos*)					
Specimen Collected (AMNH)	T31N,R13W, Sec. 3, La Plata, San Juan Co., New Mexico	-------	--------	Findley, et al. (1975)	------------------
Specimen Collected (USNM)	T29N, R13W, Farmington, San Juan Co., New Mexico	-------	--------	Findley, et al. (1975)	------------------
Visual	T29N,R15W, Sec. 10&14, San Juan Co., NM	Around 1900	Birdseye & Rowley	Bailey (1971)	Frequently seen along the Animas and San Juan Rivers, and around Fruitland, New Mexico

Table B-25 (continued)

TYPE OF OBSERVATION	LOCATION	DATE	COLLECTOR	SOURCE	COMMENTS
PEREGRINE FALCON (Falco peregrinus)					
Visual	Near Navajo Damsite, San Juan Co., New Mexico	July 21, 1960	White & Behle	White, et al. (1961)	--------
Specimen Collected (MSWB #3064)	T30N, R7W, Sec. 18, San Juan Co., New Mexico	Summer 1966	N. Segal	NM State Heritage Program (1976)	--------
Visual	Navajo Damsite, San Juan Co., New Mexico	June 22, 1967	A.P. Nelson	Schmitt (1976)	2 birds sighted
Visual	Sandstone cliff near Archuleta, San Juan Co., New Mexico	June 29, 1972	Greg Schmitt	Schmitt (1976)	This bird was classified as a breeder by Hubbard, 1970.
Visual	T27N, R15W, Sec. 33, San Juan Co., New Mexico	December 1972	Al Rodney	Bird, personal communication (Jan 3, 1977)	2 birds sighted in December, 1972. May be same bird.
Visual	T26N, R14W, Sec. 30, San Juan Co., New Mexico	September 1973	Al Rodney	Bird, personal communication (Jan 3, 1977)	--------
Visual	San Juan Co., New Mexico	February 1977	C. Sanchez, Jr. & Art Kinsky		1 bird sighted on rock ledge and observed in flight.

Table B-25 (continued)

TYPE OF OBSERVATION	LOCATION	DATE	COLLECTOR	SOURCE	COMMENTS
			BALD EAGLE (*Haliaeetus leucocephalus*)		
Visual	Navajo Damsite San Juan Co., New Mexico	July 21, 1960	White & Behle	White, et al. (1961)	
Visual	T29N,R15-16W, San Juan Co., New Mexico	Winter 1968 & Spring 1969	Alan P. Nelson	NM State Heritage Program (1976)	--------
Visual	S of Chaco Canyon Natl. Monument	November 15, 1974	C. Sanchez	Sanchez, personal communication (1976)	Field sighting during fishery investigations in NW New Mexico - 1 bird in flight.
Visual	Animas River, San Juan Co., New Mexico	January 5, 1976	Schmitt & Cole	Schmitt, personal communication (1976)	Field sightings during survey conducted for Endangered Species Program, NM State Game and Fish Dept. - 12 birds seen; 7 adults and 5 immatures.
Visual	Miller Mesa, NM State Game & Fish Dept. Refuge, Rio Arriba Co., NM	January 7, 1976	G. Schmitt	Schmitt, personal communication (1976)	Field sightings during survey conducted for Endangered Species Program, NM State Game & Fish Dept. - 29 birds seen; both adults & immatures.
Visual	Miller Mesa, NM State Game & Fish Dept. Refuge, Rio Arriba Co., NM	December 13, 1976	Schmitt & Sawyer	Schmitt, personal communication (1976)	Field sightings during survey conducted for Endangered Species Program, NM State Game & Fish Dept. - 6 birds seen; both adults and immatures.

Table B-25 (continued)

TYPE OF OBSERVATION	LOCATION	DATE	COLLECTOR	SOURCE	COMMENTS
		BALD EAGLE (*Haliaeetus leucocephalus*)			
Visual	Animas River, San Juan Co., New Mexico	December 18-19, 1976	Cole, Dziadulewicz, Schmitt & Weeks		Field sighting during coal EIS survey, USFWS - 2 birds seen.
		ROUNDTAIL CHUB (*Gila robusta robusta*)			
Specimen Collected	San Juan River	1961-1967	H. Olson	Olson, 1962 & 1967	Specimens collected during fishery investigation sponsored by Section F, Colorado River Storage Project
Specimen Collected (NFWD)	San Juan River	1974	C. Sanchez	C. Sanchez personal Communication (1976)	Specimen collected below Shiprock, NM during fishery investigation

Source: Arthur M. Kinsky (U.S. Fish and Wildlife Service), 1977

RECREATION

Table B-26

RECREATION FACILITIES IN NORTHWESTERN NEW MEXICO

			County	
	McKinley (District I)	San Juan (District I)	Rio Arriba (District II)	Sandoval (District III)[1/]
1974 Population [2/]	49,500	61,700	27,300	22,800
Acres Devoted to Recreation	6,258	90,685	1,029,958	52,914
Recreation Acres Publicly Owned[3/]	1,223	44,454	60,033	37,083
Camping Facilities				
Developed Camping Sites	67	95	174	96
Acres for Primitive Camping	452	3	2,028	1,586
Outdoor Sports Facilities				
Baseball/Softball Diamonds	11	41	11	23
Basketball Goals	38	59	15	27
Football Fields	3	5	2	4
Multipurpose Courts	14	15	1	16
Tennis Courts	6	18	4	8
9-Hole Golf Courses	0	3	0	0
18-Hole Golf Courses	1	2	0	0
Snowskiing Slopes	0	0	0	0
Designated Hunting Areas (Acres)				
Waterfowl	450	175	1,707	25
Upland Game	0	8,511	41,979	391
Big Game	0	21,251	41,979	391
Designated Trails (Miles)				
Hiking	18	0	7	31
Bicycling	9	0	0	15
Horseback Riding	0	100	0	60
Motorcycles	14	0	0	4
Nature Study	2	1	1	17
Water-Related Areas				
Boating (surface acres)	1,050	16,959	6,427	1,234
Lake Swimming (surface square feet)	0	0	0	1
Pool Swimming (surface square feet)	625	11,775	0	3,150
Miles of Stream (Fishing)	6	4	76	6
Lake Fishing (surface acres)	631	17,778	7,228	1,253

Source: 1976 State Comprehensive Outdoor Recreation Plan for New Mexico (State Planning Office).

Footnotes:

1/ State planning and development districts.

2/ Estimated by L. M. Wombald and L. D. Adcock, 1975.

3/ Federal, State, county, or municipal ownership.

CULTURAL RESOURCES

CULTURAL RESOURCES

Estimates of cultural resource significances in this ES are based on a six-point scale intended to provide a means for initial discrimination when site records are the only data available. Three factors have been used to determine site significance: a) uniqueness within a limited area or cultural/temporal framework; b) relative absence of site erosion; and c) relative degree of research or heritage value. It can be effectively argued that all sites are important to anthropological and archaeological research. However, if forced to discriminate between sites, focusing on those with the highest rating would provide a sample of the most intact sites representative of the entire temporal/cultural range in the San Juan Basin. It is felt that such an approach preserves useful data for a broad range of research interests.

Following are the criteria for the six-point scale used in determining significance estimates:

1. A rating given any site for which little or no additional data can be generated once original survey data are recorded. Examples include past site localities that have been completely lost, arroyo dams, and isolated boundary markers.

2. This rating refers to heavily vandalized, eroded, or highly abundant sites for which little new data can be generated by further investigation. Examples include sites largely destroyed by arroyo cutting, isolated Navajo ovens or corrals, and isolated trash scatter.

3. This rating includes sites with moderate erosion or sites

that are relatively abundant in the region. For such sites, the probability of additional data is low due to site erosion or to redundant information. Sites with this rating warrant re-examination for final evaluation. Examples include recent Navajo hogans (when abundant) and some lithic scatters in blowouts.

4. This rating includes sites that are relatively intact and present possibilities for data acquisition warranting re-examination and archaeological testing. The category includes eroded sites that are relatively unique cultural manifestations for a given area. Examples include high density lithic scatters without diagnostic artifacts or such datable features as hearths.

5. This rating distinguishes sites that appear to: a) provide a high probability for data acquisition pertinent to cultural/temporal distinctions, resource utilization, and environmental characteristics, or b) are examples of a limited number of cultural manifestations of their type, or c) contain other indicators of particularly high research value. Such sites warrant high priorities for preservation or research. Examples include Archaic sites containing both diagnostic artifacts and datable features, pithouses, small pueblo structures, clustered Navajo habitations, and Paleo-Indian sites. Such sites should be nominated to the National Register of Historic Places.

6. This category is reserved for sites of outstanding research value that display additional historical or heritage significance. Examples include larger pueblos and pithouse villages.

It must be recognized that ranking systems, such as this, are highly subjective and rely on data of varying quality. In addition, varying research interests may lead to quite different classifications. Disagreements with the estimates are to be expected. To minimize unwarranted destruction of cultural resources, it is suggested that all sites be re-examined wherever possible. Minimally, those sites with a significance estimate of three or higher should be re-examined and mitigation measures established before terrain-disturbing activities are permitted. At present, all sites with an estimate of four or greater should be considered eligible for nomination to the National Register. The Advisory Council, through the New Mexico State Historic Preservation Officer, must be consulted prior to excavation or disturbance.

Table B-27

NEW MEXICO STATE HISTORIC REGISTER OF SITES IN THE SAN JUAN BASIN

McKinley County

Casamero Ruin
Gamerco Mine Smoke Stack
Fort Wingate Buildings #44, #46 & Cemetery
Heshotautha Ruin
Kechipawan
Kuakina
Kyakima
Matsaki
Soldado Ruin
Tchatchi Village
Village of the Great Kivas
Yellow House Ruin
Zuni-Cibola Complex (NHL)

Rio Arriba County

Hooded Fireplace Ruin
Large School Ruin
La Jara Site (Jicarilla Reservation)
Old Fort Ruin
Split Rock
Tapacito Ruin
Three Corn Ruin
Turkey Spring Archaeological Site

Sandoval County

Canon de Juan Tafoya (Marquez)
Masonry Dam on the Rio Puerco

San Juan County

Brigham Young Jr. House (Farmington)
Christmas Tree Ruin
Coal Gasification Project CGP 56
Coal Gasification Project CGP 54-1
Coal Gasification Project CGP 605-49
Crumbled House Ruin
Hogback Ruins
Mitten Rock Archaeological District
Old Indian Racetrack
Original Farmington Schoolhouse built in 1893
Pictured Cliffs Archaeological District
Simon Canyon Ruin
Skunk Springs Archaeological District
Two Grey Hills Archaeological District
Yellow Adobe Site

Valencia County

Colbilita Ruin
Cienega Ruins
Dittert Site
Gigantes Ruin
Los Portales Cave (Cebolleta)
Old Fort Wingate-Zuni Wagon Road
Pueblo de los Muertos
TG&E Route Archaeological Sites (extends into Catron Co.)

Table B-28

SAN JUAN BASIN SITES IN THE NATIONAL REGISTER OF HISTORIC PLACES

McKinley County

Manuelito vicinity: Manuelito Complex
Thoreau vicinity: Chaco Canyon National Monument
Gallup vicinity: C.N. Cotton House; Halona Pueblo (Zuni); Church of Nuestra Senora de Quadalupe de Alona (Zuni)

Nominated as eligible for inclusion in the register

Zuni Pueblo watershed: Oak Wash Sites
Fort Wingate: Fort Wingate Historic District

Rio Arriba County

Blanco vicinity: Frances Canyon Ruin
Farmington vicinity: Crow Canyon Archaeological Site (extends into San Juan County)

Nominated as eligible for inclusion in the register

Cerrito Recreation Site Archaeological District

Sandoval County

Casa Salazar vicinity: Big Bead Mesa (NHL)
Jemez Springs vicinity: San Juan Mesa Ruin; Jemez State Monument (San Jose de los Jemez Mission and Giusewa Pueblo)

Big Bead Mesa (NHL)

Nominated as eligible for inclusion in the register

Tetilla Peak area: Tetilla Peak Recreation Area

San Juan County

Aztec vicinity: Aztec Ruins National Monument
Farmington vicinity: Salmon Ruins; Gallegos Wash Archaeological District

Valencia County

Acoma: San Estevan del Rey Mission Church (NHL, HABS)
Casa Blanca vicinity: Acoma
Albuquerque vicinity: Laguna Pueblo
El Morro vicinity: El Morro National Monument
Laguna Pueblo: San Jose de la Laguna Mission and Convento
Grants vicinity: Dittert Site (LA 11723)
Zuni vicinity: Hawikun (NHL); Zuni-Cibola Complex (NHL); Zuni Salt Lakes

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Source: Magers, et al., 1978.

KEY:

NHL - National Historic Landmark
HABS - Historic American Building Survey
G - recipient of National Park Service grant-in-aid for historic preservation.

SOCIOECONOMIC CONDITIONS

METHOD OF POPULATION ESTIMATES AND PROJECTIONS

Definition of Commuting Distance

Willingness to commute to a particular site is dependent on driving distance--the greater the mileage to be driven, the fewer the workers who would be willing to commute to that site. While some workers may be willing to drive 300 miles round-trip, most would not drive more than 75 miles each way, or 150 miles round-trip. Therefore, a daily commuting distance of 75 miles each way has been taken as the acceptable limit for most workers in northwestern New Mexico. This figure is corroborated by a recent study of labor force mobility in north-central New Mexico (Carruthers, et al., 1975).

Population Estimates

Baseline population figures for the five-county area and the ES Region were derived from several sources. Primary among these sources was the Bureau of Business and Economic Research at the University of New Mexico, which serves as the official state depository for the U.S. Bureau of the Census. Additional data were gathered from area reports produced by the McKinley Area Council of Governments, the San Juan Council of Governments, the Middle Rio Grande Council of Governments, and the New Mexico

Energy Resources Board.

Population Projections

A population-migration rate was projected to compute the change that would result from coal development and related activities in the five-county area and the ES Region. This projection was based on the new direct and indirect jobs that would be created and the expected non-availability of certain occupational and/or labor skills in northwestern New Mexico. Using data contained in the Construction Worker's Profile, it was determined that the overall size of migrating households would be 2.28. (The Construction Worker's Profile, produced by Mountain West Research, Inc., was used extensively to determine characteristics of in-migration.) The family size would vary depending on the year in which migration would take place. Table B-29 lists expected family sizes for newcomers to northwestern New Mexico by year. This list was calculated from Bureau of the Census information and takes into account the composition of households within the Southwest, from which many of the construction workers or miners would migrate.

Because of the large number of developments anticipated in northwestern New Mexico and the shortage of skilled labor, it is expected that about two of three workers needed during the construction phase of the various projects would be newcomers. Approximately 50 percent of the jobs indirectly created by the coal construction phase would be filled by newcomers.

It is also assumed that approximately 60 percent of the workers

Table B-29

AVERAGE HOUSEHOLD SIZE FOR NON-CONSTRUCTION WORKER NEWCOMER

Year	Household Size
1977	2.89
1978	2.86
1979	2.85
1980	2.83
1981	2.83
1982	2.82
1983	2.82
1984	2.81
1985	2.80
1986	2.80
1987	2.80
1989	2.80
1990	2.80
1991	2.80
1992	2.80
1993	2.80
1994	2.80
1995	2.80
1996	2.80
1997	2.80
1998	2.80
1999	2.80
2000	2.80

Source: Derived from 1970 Census data, New Mexico and United States. Trended by Household Series C and Projection Series I, P-25, Current Population Reports #606.

for the operational phase of the development would be newcomers. It is assumed that only one out of three employees in the indirect jobs created during the operational phase of each development would be newcomers; contributing factors include lower wages, the indirect jobs require lower skill levels, and many coal-related jobs already exist within the ES Region.

For every 100 households relocating into a new area associated with coal and coal-related construction and development, an additional 19 to 20 workers would be available for jobs in secondary and tertiary sectors (Construction Worker's Profile). Therefore, the creation of 100 new jobs as an indirect result of the coal and related development (assuming that all of these jobs are filled by outside people) would mean that an average of only 77 new households would be needed to supply workers for the 100 positions.

THE INPUT-OUTPUT MODEL

Input-Output Model

A regional input-output model was constructed for the study area. For this model, Valencia County was divided into two portions. Because the eastern portion of Valencia County is impacted heavily by the Albuqueque Standard Metropolitan Statistical Area (SMSA), its inclusion could have affected the results of the input-output model significantly. Sandoval County is impacted by the Albuquerque SMSA. Corrales, Rio Rancho Estates, and Taylor Ranch serve as "bedroom" communities for the Albuquerque SMSA. However, few primary and secondary industries exist in the county, so it was decided that all of Sandoval County would be included in the model. The 75-mile driving limit also includes a small portion of southern Rio Arriba County, but was excluded from the model because its impacts would be negligible. Therefore, the area that was modelled includes San Juan, McKinley, Sandoval, and Valencia Counties.

The original derivation of input-output modeling is described in the published proceedings of the 1975 Conference of the Association of University Business and Economic Research. This paper is on file at the Albuquerque District Office of the BLM. The procedure described was followed in general detail in constructing this model.

Subsequent to publication of the proceedings, information on the agricultural sector for northwestern New Mexico was improved. The credibility of this information is believed to be such that the variation experienced in the original model has been decreased. Regardless of the extent of the accuracy of the agricultural information, the effect of the construction and operation of all coal-related developments in northwest New Mexico on the agricultural sector is believed to be less than one percent in terms of employment and income. Therefore, the accuracy of the agricultural sector in terms of indirect consequences is negligible to the overall modeling process.

Base Model

The regional modeling process adjusts a national model by means of location quotients and aggregating techniques. The national, or base model used in this process contains 407 economic categories or subsectors of the economy, 389 of which represent the private economy, and 18 of which represent activities primarily involved with the public sector. The 389 identified subsectors were used in the modeling process; the government impact was computed after the private sector analysis.

The national base model used in this model represented an updated version of the 1967 National Input-Output Model constructed by the Department of Commerce, Bureau of Economic Analysis. Two important changes to the 1967 version have been made: the mining sectors have been expanded to 44 subsectors in the latest version, and Lawrence Berkeley Laboratories has mathematically updated the 1967 version to a 1972 version using a process called RAS. In simple terms, the technical coefficients are updated based upon data collected through the U.S. Bureau of the Census in the 1972 Census of Business.

Several important aspects of this particular model for northwestern New Mexico should be noted. First, detailed information on employment, by category, was determined from the files of the New Mexico Employment Security Commission under special permission obtained from the Energy Resources Board, State of New Mexico, through the Employment Security Commission's Director. Using this information, detailed location quotients for manufacturing were determined at the four-digit Standard Industrial Classification (SIC) code level, which added considerable credibility and accuracy to the modeling process.

Second, because of the makeup of the retail and wholesale sectors within the area, a detailed analysis was made of the types of outlets located within the area. Basic information from the 1972 Census of Business was used with updated information from the employment files for this analysis.

Finally, once the location quotients had been determined, 1972 census data were used to identify output per employee for those subsectors with location quotients computed through employment statistics. A total output figure was derived for these sectors. In turn, the total output figures were used to aggregate the 389 subsectors in the base model into the 44 private subsectors for the regional model.

Seven additional private subsectors were established for each of the seven types of operations in coal development. The coefficients for each of these were based on data supplied by the companies involved and specially modified national technical production process coefficients.

Household Compensation for Labor and Personal Consumption Within the Area

The figures for labor percentages, or coefficients, were determined through material produced in the 1967 National Input-Output Model. These figures represent the average percentage of cost going to labor from the technical production process (direct coefficients). Personal consumption figures were adjusted by weighing the location quotients of each of the 44 identified private subsectors in the regional model.

The final determination of the location quotients and the results of the aggregation process are in the files of the BLM's Albuquerque District Office, as are the results of the matrix inversion, or the aggregated direct, indirect, and induced effects of the modeling.

Output Multiplier

The volume of activity generated in the private sector due to a $1 exogenous increase in a subsector can be determined through the input-output process. Consider powerplant construction, for example. By subtracting from 1.45042 (the sum of the coefficients of the direct, indirect, and induced effects) the amount of money flowing both directly and indirectly through households (.23459), the residual is 1.21583, or approximately $1.22 in total activity due to $1 exogenous increase in powerplant activity. Thus, an additional $.22 of indirect activity will be generated throughout the area modeled.

It should be noted at this point that the output multiplier is not of primary concern in determining overall impact of new developments within the area. The employment and income multipliers are believed to be of greater importance. And these multipliers may vary significantly from the 1.22 multiplier noted for dollar output change due to an increase in activity in the powerplant construction subsector of the economy.

Employment Multipliers

To determine the employment multipliers for coal, powerplant activity, and other related development, three basic procedures must be undertaken. First, wage information for the area or region under consideration must be determined in constant dollars -- in this case 1977 dollars. Second, total output on an annual basis for any reference year using constant 1977 dollars must be determined. And finally, the actual number of dollars from the technical process going for labor costs must be determined.

Once having determined by subsector the number of dollars for labor costs flowing on an annual basis, the average labor unit cost is divided into each gross amount to determine the actual number of jobs supported in that specific subsector due to an exogenous increase in the specific activity being investigated.

Wages

First, the level of wages must be determined. The average annual wages and labor cost figures for each of the 44 identified economic subsectors are on file at the Albquerque District Office of the BLM.

Average employee costs for each of the 44 identified sectors in the input-output model were computed from available Employment Security Commission information. The 1976 average wage for the area was derived from Second Quarter 1976 Covered Employeemnt and Wages, Quarterly Report. An additional 7 percent was added to the 1976 average wages to arrive at the 1977 estimated average wages.

Interviews with New Mexico Employment Security Commission staff members indicated that second quarter data would be reasonably representative of averages for the whole year. Averages for 1977 could not be obtained because all of the 1977 information has not yet been released.

Wages for each sector were computed at the four-county level unless the identified sector was non-existent or the wages were not available for that sector because of disclosure regulations in one of the four counties modelled. In a few cases, single-county information was used when that information was obviously more representative of the wage in the area, e.g., coal mining wages were computed from San Juan County averages.

Expected fringe benefits added to these sector wages were computed in several ways. First, several companies were contacted concerning additional costs for labor due to fringe benefits. These companies were principally in the construction and mining categories. For other areas, where large companies were not predominant, averages were used that reflected minimum fringe benefits at various salary levels. Thus, the labor cost per employee is the estimated annual wage paid in 1977 plus the expected fringe benefit percentage.

Calculating Indirect Job Impact

Detailed calculations for the derivation of all indirect jobs created by coal and related development in the northwest part of the state are too extensive to list here. However, a sample calculation illustrating the procedure used to determine the estimated number of new indirect jobs created by development of coal and other related activities follows:

The first step is to determine the annual flow of dollars going through the economy due to the increase in activity in a specific economic subsector. The example used in this case is powerplant construction in the year 1990. It is estimated that 163 million new dollars would be brought to the area by powerplant construction in 1990. This direct impact is then multiplied by the coefficients listed in the input-output table, inverted version, i.e., the direct, indirect and induced effects for that specific column in which an activity is taking place.

The process is illustrated in the following equations.

$$I_{ij} x PPC_{1990} = \$IMP_{ij}$$

$$(.00436 \times \$162,793,000 = \$707,777)$$

where: I_{ij} = coefficient from input/output Table of Direct, Indirect, and Induced Effects for row i and column entry j; i=1, ..., 51 and j=1, ..., 51. Example uses i=31 and j=45, i.e., $I_{31,45}$

PPC_{1990} = powerplant construction impact for 1990, i.e., \$162,793,000.

$\$IMP_{ij}$ = dollar indirect impact in subsector i due to exogenous increase in subsector j; i.e., impact on communications subsector due to an increase in powerplant construction activity.

From this calculation, it is apparent that the model estimates the increase in the communications sector during 1990 to be almost $708,000.

The next calculation is to determine the amount of money in the communications sector that will be expended for labor, i.e., labor costs.

$$\$IMP_{ij} x LC_{52j} = \$LC_{ij}$$

$$(\$707,777 \times .33547 = \$238,109)$$

where: LC_{52j} = coefficient for labor costs in subsector j, Direct Coefficients Table; j-1, ..., 51 (i.e., $LC_{52,31}$=.33547).

$\$LC_{ij}$= dollars flowing to labor cost in subsector j due to an increase in activity in subsector i (i.e., total labor cost in communications (j=31) as an indirect result of an increase in powerplant construction activity (i=45) of $162,793,000 in 1990).

After determining that a little more than $238,000 will flow into labor costs during 1990 through the communications sector from increased powerplant construction activity, the remaining step is to determine how many jobs this $238,000 will support during 1990.

$$\$LC_{ij} \div \text{Annual } ULC_j = \text{Indirect } Job_{ij}$$

$$(\$238,109 \div \$14,098 = 16.9)$$

Where: Annual ULC_j = annual average per unit labor cost in subsector j (i.e., in subsector j=31. Communications annual ULC_j = $14,098).

Indirect Job_{ij} = Number of new jobs in subsector j supported by new activity in subsector (i.e., i=45, powerplant construction,

$163,793,000 supports 16.9 jobs in j=31 communications).

This example shows that the resulting impact on the communications subsector will be 16.9 jobs for 1990. Obviously, the impact from the number of jobs supported indirectly by the various powerplant activities and related projects varies yearly. However, as an example of the number and type of indirect jobs supported in selected years, 31 tables were prepared which list powerplant construction, powerplant operation, coal mine construction, surface coal operation, underground coal operation, railroad construction, railroad operation, and total activity for the four levels of coal development. These tables list the number of jobs directly created in each of the major subsectors for the years 1980, 1985 and 1990. (The 44 subsector model results were aggregated into the standard 7 major subsectors plus government.) It should be noted that the process described above is for the private sector only. The government sector is computed separately. These 31 tables are on file at the Albuquerque District Office of the BLM.

The impact associated with the public sector could be determined by the input-output modeling process, but because of widespread variations in the demand for and provision of public services and the jobs connected therewith, the input-output modeling process could yield unusable results.

In an area such as northwestern New Mexico, many Federal jobs are connected with or supply services to the Indian population; some of these activities in other areas of the country might be associated with the private sector or with state and local government. Therefore, for this project, the number of new jobs created in the government sector was determined from the marginal relationship between new non-agricultural jobs and government jobs as shown by the Bureau of Economic Analysis regional information for the four counties in the model area. This relationship indicated that in the area, approximately 7.9 percent of all new non-agricultural jobs within the area were government jobs. This factor was used to determine the number of new jobs supported on an annual basis by coal, powerplant activity, and other related developments within the area.

Total Job Impact

Tables B-30 to B-33 list the total number of jobs in the area covered by the study created by coal mining, powerplant activity, and related development for the period 1978-1990. The four levels of coal development discussed in Chapters I and VIII of the Regional Analysis were used to determine the level of impact. Thus, careful attention to the specific level of development should be exercised in reviewing the tables.

Personal Income

Table B-34 lists the personal income generated directly and indirectly by the coal and related development for the years 1977 through 1990. The direct impact is calculated by payments directly to individuals associated with coal and related developments. The calculated number of personal income dollars

Table B-30

NO-ACTION ALTERNATIVE

JOBS CREATED AND SUPPORTED BY COAL MINING AND RELATED DEVELOPMENT
(Includes power plant construction and operation)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
POWER PLANT CONSTRUCTION													
Direct Jobs	826	851	545	177	0	0	0	0	0	0	0	0	0
Private, Indirect Jobs	602	620	397	129	0	0	0	0	0	0	0	0	0
Government Jobs	113	116	74	24	0	0	0	0	0	0	0	0	0
Total Jobs	1,541	1,587	1,016	330	0	0	0	0	0	0	0	0	0
Annual New Jobs	1,541	46	-571	-686	-330	0	0	0	0	0	0	0	0
POWER PLANT OPERATION													
Direct Jobs	220	220	330	330	439	439	439	439	439	439	439	439	439
Private, Indirect Jobs	279	279	418	556	556	556	556	556	556	556	556	556	556
Government Jobs	39	39	59	79	79	79	79	79	79	79	79	79	79
Total Jobs	538	538	807	807	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074
Annual New Jobs	538	0	269	0	264	0	0	0	0	0	0	0	0
COAL MINE DEVELOPMENT													
Direct Jobs	462	485	25	0	0	0	0	0	0	0	0	0	0
Private, Indirect Jobs	534	561	29	0	0	0	0	0	0	0	0	0	0
Government Jobs	79	82	4	0	0	0	0	0	0	0	0	0	0
Total Jobs	1,075	1,128	58	0	0	0	0	0	0	0	0	0	0
Annual New Jobs	1,075	53	-1,070	-58	0	0	0	0	0	0	0	0	0
SURFACE COAL OPERATION													
Direct Jobs	47	185	580	605	605	605	605	605	580	555	555	535	535
Private, Indirect Jobs	35	137	429	447	447	447	447	447	429	410	410	396	396
Government Jobs	6	25	80	83	83	83	83	83	80	76	76	73	73
Total Jobs	88	347	1,089	1,135	1,135	1,135	1,135	1,135	1,089	1,089	1,041	1,004	1,004
Annual New Jobs	88	259	742	46	0	0	0	0	-46	-48	0	-37	0
UNDERGROUND COAL OPERATION													
Direct Jobs	0	0	110	130	220	270	300	300	300	300	300	300	300
Private, Indirect Jobs	0	0	75	88	149	183	204	204	204	204	204	204	204
Government Jobs	0	0	15	17	29	36	40	40	40	40	40	40	40
Total Jobs	0	0	200	235	398	489	544	544	544	544	544	544	544
Annual New Jobs	0	0	200	35	163	91	45	0	0	0	0	0	0
TOTAL													
Direct Jobs	1,555	1,741	1,590	1,242	1,264	1,314	1,344	1,344	1,319	1,294	1,294	1,274	1,274
Private, Indirects Jobs	1,450	1,597	1,348	1,082	1,152	1,186	1,207	1,207	1,189	1,170	1,170	1,156	1,156
Government Jobs	237	262	232	183	191	198	202	202	199	195	195	192	192
Total Jobs	3,242	3,600	3,170	2,507	2,607	2,698	2,753	2,753	2,707	2,659	2,659	2,622	2,622
Annual New Jobs	3,242	358	-430	-663	100	91	55	0	-46	-48	0	-37	0

Source: Larry Adcock and Associates, 1978.

Table B-31

PARTIAL-ACTION ALTERNATIVE

JOBS CREATED AND SUPPORTED BY COAL MINING AND RELATED DEVELOPMENT
(Includes power line construction and power plant construction and operation)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
POWER LINE CONSTRUCTION													
Direct Jobs	0	35	35	35	0	0	0	0	0	0	0	0	0
Private, Indirect Jobs	0	43	43	43	0	0	0	0	0	0	0	0	0
Government Jobs	0	6	6	6	0	0	0	0	0	0	0	0	0
Total Jobs	0	84	84	84	0	0	0	0	0	0	0	0	0
Annual New Jobs	0	84	0	0	-84	0	0	0	0	0	0	0	0
POWER PLANT CONSTRUCTION													
Direct Jobs	826	1,041	1,320	1,582	925	0	90	775	1,489	1,910	1,495	1,950	1,399
Private, Indirect Jobs	602	759	963	1,154	675	0	66	565	1,086	1,393	1,090	1,422	1,020
Government Jobs	113	142	180	216	126	0	12	106	203	261	204	266	191
Total Jobs	1,541	1,942	2,463	2,952	1,726	0	168	1,446	2,778	3,564	2,789	3,638	2,610
Annual New Jobs	1,541	401	521	489	-1,226	-1,726	168	1,278	1,332	786	-775	849	-1,028
POWER PLANT OPERATION													
Direct Jobs	220	220	330	330	689	689	689	689	689	689	889	889	1,139
Private, Indirect Jobs	279	279	418	418	873	873	873	873	873	873	1,127	1,127	1,443
Government Jobs	39	39	59	59	123	123	123	123	123	123	159	159	204
Total Jobs	538	538	807	807	1,685	1,685	1,685	1,685	1,685	1,685	2,175	2,175	2,786
Annual New Jobs	538	0	269	0	878	0	0	0	0	0	490	0	611
COAL MINE DEVELOPMENT													
Direct Jobs	462	635	225	195	0	0	0	0	0	0	0	0	95
Private, Indirect Jobs	534	735	260	226	0	0	0	0	0	0	0	0	110
Government Jobs	79	108	38	33	0	0	0	0	0	0	0	0	16
Total Jobs	1,075	1,478	523	454	0	0	0	0	0	0	0	0	221
Annual New Jobs	1,075	403	-955	-69	-454	0	0	0	0	0	0	0	221
SURFACE COAL OPERATION													
Direct Jobs	47	185	589	605	800	800	800	800	775	750	834	825	825
Private, Indirect Jobs	35	137	429	447	592	592	592	592	573	555	625	610	610
Government Jobs	6	25	80	83	110	110	110	110	106	103	116	113	113
Total Jobs	88	347	1,089	1,135	1,502	1,502	1,502	1,502	1,454	1,408	1,586	1,548	1,548
Annual New Jobs	88	259	742	46	367	0	0	0	-48	-46	178	-38	0
UNDERGROUND COAL OPERATION													
Direct Jobs	0	0	110	130	220	270	300	300	300	300	300	300	300
Private, Indirect Jobs	0	0	75	88	149	183	204	204	204	204	204	204	204
Government Jobs	0	0	15	17	29	36	40	40	40	40	40	40	40
Total Jobs	0	0	200	235	398	489	544	544	544	544	544	544	544
Annual New Jobs	0	0	200	35	163	91	55	0	0	0	0	0	0
TOTAL													
Direct Jobs	1,555	2,116	2,600	2,877	2,634	1,759	1,879	2,564	3,253	3,649	3,529	3,964	3,758
Private, Indirect Jobs	1,450	1,953	2,188	2,376	2,289	1,648	1,735	2,234	2,736	3,025	3,046	3,363	3,387
Government Jobs	237	320	378	414	388	269	285	379	472	527	519	578	564
Total Jobs	3,242	4,389	5,166	5,667	5,311	3,676	3,899	5,177	6,461	7,201	7,094	7,905	7,709
Annual New Jobs	3,242	1,147	777	501	-356	-1,635	223	1,278	1,284	740	-107	811	-196

Source: Larry Adcock and Associates, 1978.

Table B-32

PROPOSED ACTION

JOBS CREATED AND SUPPORTED BY COAL MINE AND RELATED DEVELOPMENT
(Includes power line construction; power plant and railroad construction and operation)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
POWER LINE CONSTRUCTION													
Direct Jobs	0	35	35	35	0	35	35	0	0	0	0	0	0
Private, Indirect Jobs	0	43	43	43	0	43	43	0	0	0	0	0	0
Government Jobs	0	6	6	6	0	6	6	0	0	0	0	0	0
Total Jobs	0	84	84	84	0	84	84	0	0	0	0	0	0
Annual New Jobs	0	84	0	0	-84	84	0	-84	0	0	0	0	0
POWER PLANT CONSTRUCTION													
Direct Jobs	826	1,041	1,320	1,582	925	0	90	775	1,489	1,910	1,495	1,950	1,399
Private, Indirect Jobs	602	759	963	1,154	675	0	66	565	1,086	1,393	1,090	1,422	1,020
Government Jobs	113	142	180	216	126	0	12	106	203	261	204	266	191
Total Jobs	1,541	1,942	2,463	2,952	1,726	0	168	1,446	2,778	3,564	2,789	3,638	2,610
Annual New Jobs	1,541	401	521	489	-1,226	-1,726	168	1,278	1,332	786	-775	849	-1,028
POWER PLANT OPERATION													
Direct Jobs	220	220	330	330	689	689	689	689	689	689	889	889	1,139
Private, Indirect Jobs	279	279	418	418	873	873	873	873	873	873	1,127	1,127	1,443
Government Jobs	39	39	59	59	123	123	123	123	123	123	159	159	204
Total Jobs	538	538	807	807	1,685	1,685	1,685	1,685	1,685	1,685	2,175	2,175	2,786
Annual New Jobs	538	0	269	0	878	0	0	0	0	0	490	0	611
COAL MINE DEVELOPMENT													
Direct Jobs	462	749	541	592	265	367	0	0	0	0	101	0	95
Private, Indirect Jobs	534	866	626	685	307	425	0	0	0	0	117	0	110
Government Jobs	79	128	92	101	45	63	0	0	0	0	17	0	16
Total Jobs	1,075	1,743	1,259	1,378	617	855	0	0	0	0	235	0	221
Annual New Jobs	1,075	668	-484	119	-761	238	-855	0	0	0	235	-235	221
POWER LINE CONSTRUCTION													
Direct Jobs	0	35	35	35	0	35	35	0	0	0	0	0	0
Private, Indirect Jobs	0	43	43	43	0	43	43	0	0	0	0	0	0
Government Jobs	0	6	6	6	0	6	6	0	0	0	0	0	0
Total Jobs	0	84	84	84	0	84	84	0	0	0	0	0	0
Annual New Jobs	0	84	0	0	-84	84	0	-84	0	0	0	0	0
POWER PLANT CONSTRUCTION													
Direct Jobs	826	1,041	1,320	1,582	925	0	90	775	1,489	1,910	1,495	1,950	1,399
Private, Indirect Jobs	602	759	963	1,154	675	0	66	565	1,086	1,393	1,090	1,422	1,020
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Total Jobs	1,541	1,942	2,463	2,952	1,726	0	168	1,446	2,778	3,564	2,789	3,638	2,610
Annual New Jobs	1,541	401	521	489	-1,226	-1,726	168	1,278	1,332	786	-775	849	-1,028
PLANT PLANT OPERATION													
Direct Jobs	220	220	330	330	689	689	689	689	689	689	889	889	1,139
Private, Indirect Jobs	279	279	418	418	873	873	873	873	873	873	1,127	1,127	1,443
Government Jobs	39	39	59	59	123	123	123	123	123	123	159	159	159
Total Jobs	538	538	807	1,685	1,685	1,685	1,685	1,685	1,685	1,685	2,175	2,175	2,786
Annual New Jobs	538	0	269	0	878	0	0	0	0	0	490	0	,611
COAL MINE DEVELOPMENT													
Direct Jobs	462	749	541	592	265	367	0	0	0	0	101	0	95
Private, Indirect Jobs	534	866	626	685	307	425	0	0	0	0	117	0	110
Government Jobs	79	128	92	101	45	63	0	0	0	0	17	0	16
Total Jobs	1,075	1,743	1,259	1,378	617	855	0	0	0	0	235	0	221
Annual New Jobs	1,075	668	-484	119	-761	238	-855	0	0	0	235	-235	221

Source: Larry Adcock and Associates, 1978

Table B-33

FULL-DEVELOPMENT SCENARIO

JOBS CREATED AND SUPPORTED BY COAL MINING AND RELATED DEVELOPMENT
(Includes power line construction; power plant and railroad construction and operation)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
POWER LINE CONSTRUCTION													
Direct Jobs	0	35	35	35	0	35	35	0	0	0	0	0	0
Private, Indirect Jobs	0	43	43	43	0	43	43	0	0	0	0	0	0
Government Jobs	0	6	6	6	0	6	6	0	0	0	0	0	0
Total Jobs	0	84	84	84	0	84	84	0	0	0	0	0	0
Annual New Jobs	0	84	0	0	-84	84	0	-84	0	0	0	0	0
POWER PLANT CONSTRUCTION													
Direct Jobs	826	1,041	1,320	1,582	925	0	90	775	1,489	1,910	1,495	1,950	1,399
Private, Indirect Jobs	602	749	963	1,154	674	0	66	565	1,086	1,393	1,090	1,422	1,020
Government Jobs	113	142	180	215	126	0	12	106	203	261	204	266	191
Total Jobs	1,541	1,942	2,463	2,952	1,725	0	168	1,446	2,778	3,564	2,789	3,638	2,610
Annual New Jobs	1,541	401	521	489	-1,227	-1,725	168	1,278	1,332	786	-775	849	-1,028
POWER PLANT OPERATION													
Direct Jobs	220	220	330	330	689	689	689	689	689	689	889	889	1,139
Private, Indirect Jobs	279	279	418	418	873	873	873	873	873	873	1,127	1,127	1,443
Government Jobs	39	39	59	59	123	123	123	123	123	123	159	159	204
Total Jobs	538	538	807	807	1,685	1,685	1,685	1,685	1,685	1,685	2,175	2,175	2,786
Annual New Jobs	538	0	269	0	878	0	0	0	0	0	490	0	611
COAL MINE DEVELOPMENT													
Direct Jobs	537	945	992	1,262	1,260	1,172	601	737	63	0	101	0	95
Private, Indirect Jobs	621	1,093	1,148	1,460	1,458	1,356	695	853	73	0	117	0	110
Government Jobs	91	161	169	215	215	200	102	126	11	0	17	0	16
Total Jobs	1,249	2,199	2,309	2,937	2,933	2,728	1,398	1,716	147	0	235	0	221
Annual New Jobs	1,249	950	110	628	-4	-205	-1,330	318	-1,569	-147	235	-235	221
SURFACE COAL OPERATION													
Direct Jobs	47	185	580	886	1,214	1,378	2,128	2,228	2,481	2,516	2,611	2,591	3,341
Private, Indirect Jobs	35	137	429	655	889	1,019	1,574	1,648	1,835	1,861	1,931	1,916	2,470
Government Jobs	6	25	80	122	167	189	292	306	341	346	359	356	459
Total Jobs	88	347	1,089	1,663	2,270	2,586	3,994	4,182	4,657	4,723	4,901	4,863	6,270
Annual New Jobs	88	259	742	574	607	316	1,408	188	475	66	178	-38	1,407
UNDERGROUND COAL OPERATION													
Direct Jobs	0	0	110	130	220	730	760	760	1,410	1,760	1,760	1,760	2,060
Private, Indirect Jobs	0	0	75	88	149	495	515	515	956	1,194	1,194	1,194	1,397
Government Jobs	0	0	15	17	29	97	101	101	187	233	233	233	273
Total Jobs	0	0	200	235	398	1,322	1,376	1,376	2,553	3,187	3,187	3,187	3,730
Annual New Jobs	0	0	200	35	163	924	54	0	1,177	634	0	0	543
RAILROAD CONSTRUCTION													
Direct Jobs	25	155	310	262	0	0	0	0	0	0	0	0	0
Private, Indirect Jobs	30	189	378	319	0	0	0	0	0	0	0	0	0
Government Jobs	4	27	54	46	0	0	0	0	0	0	0	0	0
Total Jobs	59	371	742	627	0	0	0	0	0	0	0	0	0
Annual New Jobs	59	312	371	-115	-627	0	0	0	0	0	0	0	0
RAILROAD OPERATION													
Direct Jobs	0	0	0	38	38	38	38	38	38	38	38	38	38
Private, Indirect Jobs	0	0	0	36	36	36	36	36	36	36	36	36	36
Government Jobs	0	0	0	6	6	6	6	6	6	6	6	6	6
Total Jobs	0	0	0	80	80	80	80	80	80	80	80	80	80
Annual New Jobs	0	0	0	80	0	0	0	0	0	0	0	0	0
TOTAL													
Direct Jobs	1,655	2,581	3,677	4,525	4,346	4,042	4,341	5,227	6,170	6,913	6,894	7,228	8,072
Private, Indirect Jobs	1,567	2,500	3,454	4,173	4,079	3,822	3,802	4,490	4,859	5,357	5,495	5,695	6,476
Government Jobs	253	400	563	687	666	621	642	768	871	969	978	1,020	1,149
Total Jobs	3,475	5,481	7,694	9,385	9,091	8,485	8,785	10,485	11,900	13,239	13,367	13,943	15,697
Annual New Jobs	3,475	2,006	2,213	1,691	-294	-606	300	1,700	1,415	1,339	128	576	1,754

Table B-34

ESTIMATED ANNUAL PERSONAL INCOME GENERATED FROM COAL AND RELATED DEVELOPMENT
ES REGION, WITH PROPOSED ACTIONS (By Source)*

Year	Private Sector			Government Sector	Dividends, Interest and Rents	Annual Total Personal Income
	Direct	Indirect	Total			
1978	29,700.5	13,430.9	43,131.4	2,276.2	4,041.3	49,448.9
1979	44,776.9	20,506.0	65,282.9	3,466.3	6,118.7	74,867.9
1980	60,572.2	26,505.8	87,078.0	4,590.3	8,158.5	99,826.8
1981	72,283.9	30,583.4	102,867.3	5,412.0	9,636.9	117,916.2
1982	60,311.7	26,298.5	86,610.2	4,514.7	8,110.1	99,235.0
1983	46,307.9	22,237.0	68,544.9	3,617.4	6,422.4	78,584.7
1984	48,622.2	21,598.4	70,220.6	3,655.2	6,574.9	80,450.7
1985	62,768.2	26,160.2	88,928.4	4,609.2	8,324.8	101,862.4
1986	76,731.2	30,804.0	107,535.2	5,563.1	10,065.7	123,164.0
1987	84,783.6	33,467.3	118,250.9	6,120.4	11,069.0	135,440.3
1988	84,358.5	35,168.2	119,526.7	6,205.4	11,190.2	136,922.3
1989	90,713.7	36,834.3	127,548.0	6,602.1	11,939.4	146,089.5
1990	86,787.2	37,628.4	124,415.6	6,469.8	11,648.8	142,534.2
Totals	848,717.7	361,222.4	1,209,940.1	63,102.1	113,300.7	1,386,342.9

* Constant 1977 dollars.

Source: Larry Adcock and Associates, 1977.

associated with the indirect impact comes from jobs associated with that impact. The private sector calculations are exclusive of the government sector and are based upon results of the input-output modeling. The government sector calculations are based upon the marginal effect on jobs determined through Bureau of Economic Analysis information. The actual dollar calculations take into account the average government wage paid in 1977. Finally, interest, rents and dividends are calculated as a percentage of other personal income generated in the area based, again, on Bureau of Economic Analysis data for the period 1970-1975 and estimated for 1977. Thus, all figures are for 1977 constant dollars.

KEY INFORMANT INTERVIEWS

In June, July and August of 1977, Harbridge House, Inc. interviewed 110 residents of northwestern New Mexico to obtain data for the Star Lake-Bisti Regional Coal Environmental Statement. Interviews were designed to supply information for analysis of social and cultural characteristics and to obtain the range of values, norms, and beliefs that characterize the communities. Interviewees afforded an indication of those issues and feelings that are most central to the lives of individuals and groups in the ES Region, as well as suggested how residents perceive themselves as individuals and as members of the community.

The selection of key informants in the ES Region centered upon the compilation of a list of potential interviewees from various sources within the community. These sources were contacted by telephone and in person. One initial approach was to ascertain the formal, political, and social organization in the locality and to contact key officials. These persons then suggested other potential key informants, as well as outlined the informal organizations and interest groups within the community in which some of these individuals are prominent. Representatives of informal leaders and decision-makers in the area were included, such as prominent landholders, ranchers, businessmen, and civic leaders, who are often highly integrated into the patterns of information flow in the community, and are articulate spokespeople of local values and concerns. As each individual was contacted, he/she was asked to suggest names of additional key informants. As the process of contacting community leaders continued, a "snowballing" effect occurred and an extensive list of prospective interviewees was developed. This process continued until no new names or issues were suggested. This procedure of contacting community leaders and asking for the names of credible and respected group leaders and members, and for a listing of significant social issues is called "judgemental sampling" and its external validity on both professional and academic is discussed by Norman K. Denzin, (1970).

From the list of potential key informants thus obtained, a cross-section was then taken of those contacts who were representative of the diverse groups and interests within the community, and who were anticipated to yield the most valid and detailed responses. These individuals were then interviewed as key informants in the Harbridge House survey. Harbridge House orally implemented a memorized instrument. There were no written questionnaires and no note-taking during interviews. Additionally, open-ended questions encouraged personal monologues about communities and developments in the region. However, interviews also included more limited kinds of questioning that focused upon selection from a range of responses, e.g., negative, neutral, positive. Following the interviews, researchers privately recorded the types of responses received.

Some questions used semantic differential design (also called complimentary opposition of adjective pairs), a technique that includes asking the subject to rate a given concept on a series of 7-point, bipolar rating scales. Any concept, whether it is a political issue, a person, an institution, or a work of art, can be rated on a 7-point scale (as shown, this unilineal paradigm is assigned numbers):

VERY	QUITE	SLIGHTLY	NEUTRAL	SLIGHTLY	QUITE	VERY
1	2	3	4	5	6	7

This particular technique has certain advantages. First, it deals primarily with individual attitudes, particularly if administered in a closed situation (no other informants present). Second, the interviewer is able to code the informant's words (the interviewer can memorize a numerical rating and later record a number, which has all the obvious advantages that are inherent with such symbols). Next, this design acts as an appropriate supplement to other possible designs, permitting great flexibility in programming material. Finally, a critical advantage is the ease of response by informants.

A catalogue of all responses is on file at the Albuquerque District Office of the BLM.

VEGETATION

Table B-35

PLANT SPECIES NOTED IN THE ES REGION*

Scientific Name	Common Name
Anacardiaceae	
Rhus trilobota	squawbush
Asteraceae	
Antennaria parviflora	pussytoes
Artemisia bigelovii	Bigelow sagebrush
A. corruthii	carruth sagebrush
A. filifolia	sand sagebrush
A. frigida	fringed sagebrush
A. nova	black sagebrush
A. tridentata	big sagebrush
Aster hirtifolius	
A. tanacetifolius	tansyleaf aster
Chrysopsis villosa	hairy goldenaster
Chrysothamnus greenei	Greene's rabbitbrush
C. nauseosus	rubber rabbitbrush
C. viscidiflorus	douglas rabbitbrush
Erigeron superbus	fleabane
Gutierrezia sarothrae	broom snakeweed
Haplopappus spinulosus	ironplant goldenweed (spring goldenweed)
Helianthus sp.	sunflower
Hymenoxys richardsonii	pinque
Hymenoxys sp.	hymenoxys
Leucelene ericoides	leucelene
Senecio longilobus	threadleaf groundsel
Solidago petradoria	rock goldenrod
Solidago sp.	goldenrod
Boraginaceae	
Hackelia floribunda	stickseed
Cactaceae	
Opuntia sp.	pricklypear
Capparidaceae	
Cleome serrulata	Rocky Mountain beeplant
Chenopodiaceae	
Atriplex canescens	fourwing saltbush
A. confertifolia	shadscale
A. jonesii	
A. obovata	
Chenopodium fremontii	fremont goosefoot

Table B-35 (Continued)

<u>Chenopodium sp.</u>	goosefoot
<u>Eurotia lanata</u>	winterfat
<u>Kochia scoparia</u>	summer-cypress
<u>Salsola kali</u>	Common Russianthistle
<u>Sarcobatus vermiculatus</u>	black greasewood
Cruciferae (Brassicaceae)	
<u>Lepidium sp.</u>	mustard
<u>Lesquerella sp.</u>	bladderpod
Cupressaceae	
<u>Juniperus deppeana</u>	alligator juniper
<u>J. monosperma</u>	oneseed juniper
<u>J. osteosperma</u>	Utah juniper
<u>J. scopulorum</u>	Rocky Mountain juniper
Cyperaceae	
<u>Carex sp.</u>	sedge
Ephedraceae	
<u>Ephedra torreyana</u>	Torrey jointfir
<u>E. viridis</u>	green jointfir
Fabaceae	
<u>Astragalus sp.</u>	loco
<u>Lupinus kingii</u>	
<u>Lupinus sp.</u>	lupine
Fagaceae	
<u>Quercus gambelii</u>	Gambel oak
Liniaceae	
<u>Allium cernuum</u>	nodding onion
<u>Lilium sp.</u>	lily
Pinaceae	
<u>Pinus edulis</u>	pinyon pine
<u>P. ponderosa</u>	ponderosa pine
<u>Psuedotsuga menziesii</u>	Douglas-fir
Plantaginaceae	
<u>Plantago purshii</u>	wooly Indianwheat
<u>Plantago sp.</u>	plantain
Poaceae	
<u>Agropyron cristatum</u>	crested wheatgrass
<u>A. smithii</u>	western wheatgrass
<u>Aristida divaricata</u>	poverty threeawn
<u>A. longiseta</u>	red threeawn
<u>A. purpurea</u>	purple threeawn
<u>Aristida sp.</u>	threeawn
<u>Blepharoneuron tricholepis</u>	hairy dropseed

Table B-35 (Continued)

Bouteloua curtipendula	sideoats grama
B. eriopoda	black grama
B. gracilis	blue grama
Bromus ciliatus	fringed brome
Distichlis stricta	desert saltgrass
Festuca arizonica	Arizona fescue
Hilaria jamesii	galleta
Koeleria cristata	junegrass
Muhlenbergia montana	mountain muhly
M. pungens	sandhill muhly
M. thurberi	thurber muhly
M. torreyi	ring muhly
M. wrightii	spike muhly
Oryzopsis hymenoides	Indian ricegrass
Poa fendleriana	muttongrass
Schizachyrium scoparius	little bluestem
Sitanion hystrix	squirreltail
Sporobolus airoides	alkali sacaton
S. cryptandrus	sand dropseed
S. flaxuosus	mesa dropseed
S. contractus	spike dropseed
Stipa comata	needle-and-thread
Polemoniaceae	
Gilia longiflora	
G. subnuda	
Polygonaceae	
Eriogonum sp.	eriogonum
Rosaceae	
Amelanchier utahensis	Utah serviceberry
Cercocarpus montanus	true mountain-mahogany
Purshia tridentata	antelope bitterbrush
Salicaceae	
Populus tremuloides	quaking aspen
Saxifragaceae	
Fendlera rupicola	cliff fendlerbush
Ribes inebrians	squaw currant
Scophulariaceae	
Castilleja integra	wholeleaf paintedcup (Indian paintbrush)
Pensteman barbatus	beardlip penstemon
P. jamesii	james penstemon

* This list is not meant to be comprehensive.

Sources: Bureau of Land Management, 1965; Kearney, T. H. and Peebles, R. H. 1960; Kelsey, H. P. and Dayton, W. T., 1974.

APPENDIX C
GLOSSARY

ABBREVIATIONS

A.M.P.:	allotment management plan
A.U.M.:	animal unit month
B.I.A.:	Bureau of Indian Affairs
B.L.M.:	Bureau of Land Management
B.R.:	Bureau of Reclamation
B.T.U.:	British Thermal Unit
C.E.T.A.:	Comprehensive Education and Training Act
C.F.R.:	Code of Federal Regulations
C.T.C.:	centralized traffic control
d.B.A.:	decibel (on the A-scale)
D.O.E.:	Department of Energy
D.&R.G.W.:	Denver and Rio Grande Western Railroad
E.A.R.:	Environmental Anlaysis Record
E.I.A.	Environmental Improvement Agency (State of New Mexico)
E.M.R.I.A.:	Energy Mineral Rehabilitation Inventory and Analysis
E.O.:	Executive Order
E.P.A.:	Environmental Protection Agency (Federal)
E.S.:	Environmental Statement
F.C.L.:	Fruitland Coal Load Transmission Line
F.H.A.:	Farmers Home Administration
F.L.P.M.A.:	Federal Land Policy and Management Act
F.W.P.C.A.:	Federal Water Pollution Control Act
H.U.D.:	Department of Housing and Urban Development
I.C.C.:	Interstate Commerce Commission
KV:	kilovolt
M.F.P.:	management framework plan

ug/m^3:	micrograms per cubic meter
M.N.M.:	Museum of New Mexico
MW:	Megawatt
N:	refers to Navajo highways
NA:	nonattainment
N.A.A.Q.S.:	National Ambient Air Quality Standards
N.E.D.S.:	National Emission Data System
N.E.P.A.:	National Environmental Policy Act
N.I.I.P.:	Navajo Indian Irrigation Project
N.M.D.G.F.:	New Mexico Department of Game and Fish
N.S.P.S.:	New Source Performance Standards
O.S.H.A.:	Occupational Safety and Health Administration
O.S.M.R.E.:	Office of Surface Mining Reclamation and Enforcement
P.G.&T.:	Plains Electric Generation and Transmission Cooperative
P.L.:	Public Law
P.N.M.:	Public Service Company of New Mexico
PPM:	parts per million
P.R.L.A.:	Preference Right Lease Application
P.S.D.:	prevention of significant deterioration
S.H.:	State Highway
S.H.P.O.:	State Historic Preservation Officer
S.L.R.:	Star Lake Railroad
S.M.C.R.A.:	Surface Mining Control and Reclamation Act
Stat.:	statute
T.S.P.:	total suspended particulates
U.S.B.M.:	United States Bureau of Mines
U.S.C.:	United States Code

U.S.F.&W.S.: United States Fish and Wildlife Service

U.S.G.S.: United States Geological Survey

V.R.M.: Visual Resource Management

ACRE-FOOT. A term used in measuring the volume of water, equal to the quantity required to cover 1 acre 1 foot in depth, or 43,560 cubic feet.

ACTIVE PIT. The elongate trench on opening in a surface mine from which coal is actually being extracted.

ALLUVIUM. Clay silt, sand, gravel, or other materials transported by flowing water and deposited in comparatively recent geologic time as sorted or semisorted sediments in riverbeds, estuaries, and flood plains, on lakes, shores, and in fans at the base of mountain slopes.

ANASAZI. Prehistoric Indians who inhabited the Four Corners area, ca A.D. 700-1300.

ANCILLARY FACILITIES. Mine, power plant, or railroad support facilities, such as offices, maintenance shops, storage areas, motor pools, settling ponds, switchyards.

ANDESITIC. Like andesite, a dark-colored, fine-grained extrusive igneous rock.

ANION. A negatively charged ion.

AQUIFER. A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

ARCHAEOLOGICAL EXCAVATION. The scientific recovery of subsurface materials and information from a portion or totality of a prehistoric or historic site. May be undertaken if destruction is imminent (salvage) or to satisfy a research question. Excavation is a destructive activity, for it removes the physical site context.

ARCHAEOLOGICAL SITE. Any place associated with an event, important person, or cultural activity of the past.

ARCHAEOLOGICAL SURVEY (INTENSIVE). A comprehensive physical examination of a study area to locate every site within a region or right-of-way. Environmental data are recorded and sites are described, mapped, photographed, and assigned to a cultural type and period. Surface artifacts are sometimes collected and test excavations are sometimes done. Published reports should interpret data, indicate endangered sites, and state recommendations for management and research.

ARCHAEOLOGICAL RECONNAISSANCE. A cursory examination of representative portions of a project area to define general categories of cultural and related environmental resources in an area. Should be adequate to estimate time and cost of a survey.

ARENACEOUS. Said of a sediment or sedimentary rock consisting wholly or in part of sand-size fragments or having a sandy texture or the appearance of sand.

ARGILLACEOUS. Pertaining to, largely composed of, or containing clay-size particles or clay minerals.

ARKOSIC SANDSTONE. A sandstone with considerable feldspar.

ARTESIAN. Refers to ground water under sufficient hydrostatic head to rise above the aquifer containing it.

ARTIFACT. A material object made or modified in whole or in part by man. The most common artifacts at archaeological sites are stone chips, tools, projectile points, and similar lithic debris.

AVIFAUNA. Collectively, the birds of an area or region.

BACKGROUND LEVEL. In air pollution studies, the concentration of a pollutant that would exist in the absence of the particular source under study; a "standard" against which the contribution of the particular source can be compared.

BADLANDS. A region nearly devoid of vegetation where erosion, instead of carving hills and valleys of the ordinary type, has cut the land into an intricate maze of narrow ravines and sharp crests and pinnacles. (Traveling across such a region is almost impossible, hence the name.)

BENTHIC. Living at the bottom of a body of water.

BIOTA. The animal and plant life of a region.

BORDER TOWNS. Communities such as Farmington and Gallup, New Mexico or Winslow, Arizona which are adjacent to the Navajo (or other) Indian Reservation and which serve as a commercial center for on Reservation Indians.

BOTTOM ASH. Coarse, solid particles of noncombustible ash which settle out of a bed of solid fuel, such as coal.

BUSWORK. Conductor-connecting breakers, switches, etc. in a substation or switchyard, allowing switching and distribution of power to different transmission or distribution lines.

BTU ANALYSIS. In the case of coal, the determination by prescribed methods of the Btu (heat) content.

CALCARENITE. A limestone consisting predominantly (more than 50%) of detrital calcite particles of sand size.

CALCAREOUS. Said of a substance that contains calcium carbonate. When applied to a rock name it implies that a considerable percentage (up to 50%) of the rock is calcium carbonate.

CARBONACEOUS. Said of a sediment containing organic matter.

CATION. An ion having a positive charge.

CLASTIC. Consisting of fragments of rocks or of organic structures that have been moved individually from their places of origin.

COAL GASIFICATION. The process of coal mining and the subsequent chemical conversion to a high-Btu, clean-burning, sulfur-free, substitute natural gas (SNG).

COAL RESERVE. That portion of the identified coal resource that can be economically mined at the time of determination. The reserve is derived by applying a recovery factor so that components of the identified coal resource designated as the reserve base.

COAL RESOURCE. Concentrations of coal in such forms that economic extraction is currently or may become feasible.

COLLUVIUM. Loose, unconsolidated clay, silt, sand, and gravel at the foot of a slope, brought there chiefly by gravity.

CONDUCTANCE (OR SPECIFIC CONDUCTANCE). A measure of the ability of water to conduct an electrical current, expressed in micromhos per centimeter at 25° C. Conductance serves as an index to the concentration of dissolved solids in water.

CONFINED GROUND WATER. Is under pressure significantly greater than atmospheric, and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the material in which the confined water occurs.

CONFINING BED. A body of "impermeable" material stratigraphically adjacent to one or more aquifers.

CONSUMPTIVE USE. The quantity of water discharged to the atmosphere or consumed in connection with domestic use, vegetative growth, food processing, or an industrial process.

CORONA LOSS. Loss of energy at the surface of a transmission line conductor.

COUNTERPOISE. An alternate method of grounding a structure in rocky terrain.

CULTURAL RESOURCES. All evidences (structures, fields, skeletal materials, artifacts, environmental data) which can be used to reconstruct prehistoric and historic lifeways, interpret human behavior, and predict future courses of cultural and biological evolution. Also, districts, structures, objects, etc. important to a culture or community for traditional, religious, educational, or interpretive reasons.

dBA. Decibels; measured on the A-scale, on which the readings generally correspond to the response of the human ear. Threshold limit values for noise are based on a single overall decibel measurement on the A-scale.

DENSITY (GAMMA-GAMMA). The density of a material in grams per cubic centimeter as determined through measurement of gamma ray concentration.

DEW POINT. The temperature at which air becomes saturated, resulting in formation of water droplets.

DILIGENCE REQUIREMENTS. The Coal Leasing Amendment Act of 1976 stipulates that an approved mining plan must require all logical mining unit reserves be mined within 40 years; also, advance royalties may be accepted in lieu of continuous operation for no more than 10 years.

DIURNAL. Pertaining to or occurring during the course of a day.

ECOSYSTEM. A natural unit of living and non-living components which interact to form a stable system.

ECOTONE. A transition zone, as that between two biomes; oftentimes creating "edge effect".

EFFLUENT. A liquid, solid, or gaseous product, frequently waste, discharged or emerging from a process.

EOLIAN. Of, relating to, formed by, or deposited from the wind or currents of air.

EPEIRIC. Applied to shallow seas that cover or have covered large parts of continents without being disconnected from the ocean.

EPHEMERAL. A stream or pond that contains water only in direct response to precipitation.

FACIES. The aspect belonging to a geologic unit of sedimentation, including mineral composition, type of bedding, fossil content, etc.; also, a stratigraphic body as distinguished from other bodies of differing appearance or composition.

FEE COAL. Privately owned coal rights.

FISHERMAN USE. A quantitative measurement of fishing in a given body of water.

FLUVIAL. Of or pertaining to a river or rivers. Produced by the action of a stream or river.

FLY ASH. Fine, solid particles of noncumbustible ash carried out of a bed of solid fuel, such as coal.

FRIABLE. A rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder.

FUGITIVE DUST. A type of particulate emission made airborne by forces of wind, man's activities, or both, such as unpaved roads, construction sites, tilled land, or windstorms.

GAMMA-RAY LOG. A bore-hole measurement of gamma rays originating in a gamma ray source in the instrument and scattered back from the rock formation to a detector shielded from the source. The amount of scattering is proportional to electron density and thus proportional to mass concentration so that the measurement, after certain corrections, yields a density log of the formation penetrated.

GILLETTE SYNDROME. The social and mental problems produced by rapid growth as typified by the experiences of Gillette, Wyoming.

HYDRAULIC CONDUCTIVITY. The volume of water that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

HYDRAULIC GRADIENT. The change in static head per unit of distance in a given direction.

INVERSION. A state in which the air temperature increases with increasing altitude, holding surface air down along with its pollutants.

IONS. An atom or a group of atoms when combined in a radical or molecule that carries a positive or negative electric charge as a result of having lost or gained one or more electrons.

LACUSTRINE. Pertaining to, produced by, or formed in a lake or lakes.

LANGLEY. A unit of illumination equal to one gram calorie per square centimeter of irradiated surface.

LENTIC - LENTICULAR. Pertaining to standing, inland waters, as lakes, ponds and swamps.

LITTORAL BEACH DEPOSIT. The gravel, sand, and other material dropped on a shoreline between the high- and low-water lines.

MANAGEMENT FRAMEWORK PLAN. (MFP) - Land use plan for public lands which provides a set of goals, objectives, and constraints for a specific planning area to guide the development of detailed plans for the management of each resource.

MESIC. Characterized by moderately moist conditions; neither too moist nor too dry.

MESOTHERMIC. Pertaining to middle temperature range.

MINERAL RESERVE. That portion of the identified resource from which a usable mineral or energy commodity can be economically and legally extracted at the time of determination.

MINERAL RESOURCE. A concentration of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust in such form that economic extraction of a commodity is currently or potentially feasible.

MONOCLINE. A geologic structure (series of strata) dipping only in one direction.

MONTANE. In mountainous regions, a zone extending downward from the timberline, a vertical distance of about 1,500 feet.

MORPHOLOGY. The features comprised in the form and structure of an organism or any of its parts.

NUTRIENTS. Chemicals essential to the growth and reproduction of plants, algae, or bacteria.

OROGRAPHIC. Of or relating to mountains especially with respect to their location, distribution and accompanying phenomena.

PALEOBOTANICAL. Referring to the plant life of the geologic past.

PALUDAL. Pertaining to a marsh.

PARTICULATES. Any liquid or solid particles suspended in or falling through the atmosphere.

PARTING. A small joint in coal or rock, or a layer of rock in a coal seam.

PATHOGEN. A specific cause of disease (as a bacterium or virus).

PELAGIC. Open water beyond the shoreline.

PHOTOCHEMICAL. Relating to or produced by the chemical action of radiant energy and esp. of light.

PHOTOGRAMMETRY. The process of making maps or scale drawings by aerial or other photography.

PLANKTON. Passively floating or weakly motile microscopic aquatic plants and animals.

PLANT COMMUNITY. An assemblage of plant populations living in a prescribed area or physical habitat.

PLANT SUCCESSION. The process of vegetational development whereby an area becomes successively occupied by different plant communities of higher ecological order.

POROSITY. The property of a rock or soil of containing interstices or voids and may be expressed as the ratio of the volume of its interstices to its total volume.

POTENTIOMETRIC SURFACE. The surface which represents the static head of water. The levels to which water will rise in tightly cased wells. Water table is a particular potentiometric surface.

PREFERENCE RIGHT LEASE. Lease issued to the holder of a prospecting permit who has demonstrated that, during the period of the permit, commercial quantities of coal were discovered.

PRIME FARMLAND. The Council on Environmental Quality defines prime farmland as "those whose value derives from their general advantage as cropland due to soil and water conditions".

PRIMITIVE AREAS. Natural, wild, and undeveloped areas essentially removed from the effects of civilization.

PROXIMATE ANALYSIS. In the case of coal, the determination by prescribed methods, of moisture, volatile matter, fixed carbon (by difference) and ash.

PUBLIC LAND. Any land owned by the United States and administered by the Secretary of the Interior through the Bureau of Land Management.

RAPTOR. Birds of prey with sharp talons and strong notched beaks; hawks, owls, vultures.

REGRESSIVE. Pertaining to a retreat or contraction of the sea from land areas.

RESEARCH DESIGN. A detailed research plan formulated prior to archaeological study. It includes a statement of the problem and assumptions, strategies, and methods required for problem solution and hypothesis testing. It specifies relevant data to collect and plans for their manipulation.

RESERVE. That portion of the identified coal resource that can be economically mined at the time of determination.

RESISTIVITY. That factor of the resistance of a conductor (depending on the material and its physical condition) to an electrical current traversing it longitudinally.

RIPARIAN. Of, on, or pertaining to the bank of a river or stream, or a pond or lake.

SATURATED ZONE. That part of the earth's crust beneath the deepest water table in which all voids, large and small, are filled with water.

SEISMICITY. Measure of frequency of earthquakes.

SEMI-ARID. Characterized by light rainfall and high evaporation: having from about 10 to 20 inches of annual precipitation.

SHORT-TERM COAL LEASE. Competitive coal lease issued for 8 years' worth of coal at present or contracted rates of production, based on criteria of hardship, bypass of coal, or employment; qualification requires an existing, operating mine or valid contracts for delivery of coal.

SOIL ASSOCIATION. A group of defined and named taxonomic soil units occurring together in individual and characteristic patterns over a geographic region.

SOIL PRODUCTIVITY. The capacity of a soil in its normal environment for producing a specified plant or sequence of plants under a specified system of management.

SOLAR ELEVATION. Refers to the magnitude of the angle of the sun above the southern horizon at mid-day.

SPECIFIC CAPACITY. The rate of discharge of a well divided by the drawdown of water level within the well.

SPECIFIC YIELD. The volume of water which a rock or soil, after being saturated, will yield by gravity divided by the volume of the rock or soil. The definition implies that gravity drainage is complete.

STORAGE COEFFICIENT. The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

SUBBITUMINOUS COAL. Coal having between 8,300 and 13,000 Btu per pound (moist, mineral-matter-free).

SUMMER SOLSTICE. The time at which the sun is directly over the Tropic of Cancer. Vertical rays from sun are at the most northerly latitude.

SYNOPTIC SCALE. Relating to or displaying atmospheric and weather conditions as they exist simultaneously over a broad area.

TAP POINT. A point off an existing transmission line where a lateral line or lines intersect to supply power to a new load source.

TAXONOMIC ORDER. Classification made up of families and forming a subdivision of a class or subclass.

TRANSGRESSIVE. Pertaining to a spread or extension of the sea over land areas.

TRANSMISSIVITY. The rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

TRANSPOSITION. A structure used for shifting conductors from one phase position to another in order to balance the impedence between phases and/or to achieve the proper phasing for transmission line termination into a substation, tap site, or switching station.

TURBIDITY. Measure of the clarity in a naturally clear liquid.

UNCONFINED GROUND WATER. Water in an aquifer that has a water table.

UNIQUE FARMLAND. The Council on Environmental Quality defines unique farmlands as "those whose value derives from their particular advantages for growing specialty crops".

UNSATURATED ZONE. That part of the earth's crust between the land surface and the deepest water table.

VUGGY. Applied to rocks or mineral deposits abounding in cavities (sometimes lined with mineral deposits of different composition than those surrounding the vug).

WATER TABLE. That surface in a ground-water body at which the water pressure is atmospheric. It is defined by the levels at which water stands in wells that penetrate the water body just for enough to hold standing water.

XERIC. An arid system almost totally lacking water.

APPENDIX D

REFERENCES

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