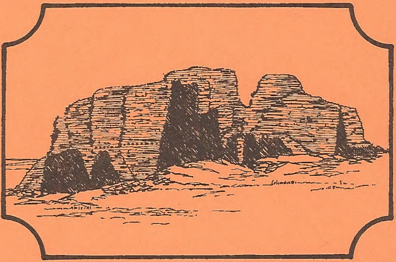
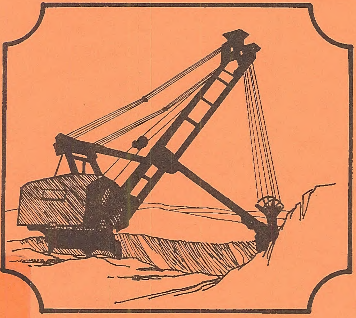
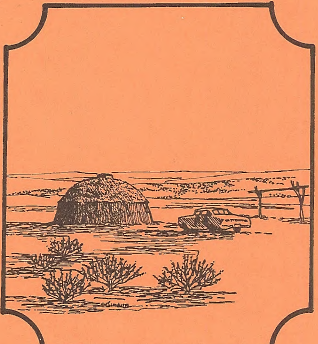
Volume 2 **Site-Specific Analyses**
Appendices

FINAL
Environmental Statement
STAR LAKE · BISTI
REGIONAL COAL







U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VOLUME II

SITE SPECIFIC ANALYSES

STAR LAKE RAILROAD
FRUITLAND COAL LOAD TRANSMISSION LINE

APPENDICES

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SITE SPECIFIC ANALYSIS

STAR LAKE RAILROAD

STAR LAKE RAILROAD

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CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

THIS CHAPTER IS A DETAILED DESCRIPTION OF A FEDERAL PROPOSAL TO CONSIDER THE APPROVAL OF A RIGHT-OF-WAY APPLICATION BY THE STAR LAKE RAILROAD CO. TO BUILD A RAILROAD IN MCKINLEY AND SAN JUAN COUNTIES, NEW MEXICO. OTHER DEVELOPMENTS IN THE AREA ARE DESCRIBED TO THE EXTENT THAT THEY MAY COMPLEMENT OR CONFLICT WITH THE PROPOSED ACTION.

CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

INTRODUCTION

This site specific analysis considers the environmental impacts of construction and operation of the railroad proposed in the applications to the Interstate Commerce Commission (ICC) assigned to dockets FD 28272 and FD 28448, and right-of-way application to the Bureau of Land Management (BLM) NM 29324. Modifications to the alignment made after the filing of these applications have been incorporated into the assessment. This analysis was done as part of the Star Lake-Bisti Regional Coal Environmental Statement, which also includes the site specific analysis of the proposed Fruitland Coal Load Transmission Line and generic analysis of potential coal development in the Star Lake-Bisti coal region.

The Star Lake Railroad Company (SLR), a Delaware Corporation and a wholly owned subsidiary of the Atchison, Topeka and Santa Fe Railway Company (Santa Fe), a wholly owned subsidiary of Santa Fe Industries, Inc., proposes to construct a railroad from Santa Fe's main line near Prewitt to the area of potential coal-mine activity in the Star Lake-Bisti area of the San Juan Basin. This would involve the construction of 114 miles of new rail line in San Juan and McKinley Counties, New Mexico.

The existing Santa Fe main line is a major east-west transportation route, connecting Santa Fe's California and Arizona operations with its operations in the Midwest and Texas. Traffic generated along the proposed railroad would have access through the Santa Fe system to the national rail system.

Construction of the proposed railroad would provide direct rail access to the Star Lake-Bisti area, enabling the mining and shipping of large quantities of low sulfur, subbituminous coal. Most of the potential coal mines in the area would not be developed without the railroad. Table SLR I-1 lists potential quantities of coal to be produced by mines that would be served by the proposed railroad and the destinations for the coal. At this time it is expected that the dominant use for this coal would be in coal-fired electric generating plants in Arizona and Texas.

The proposed rail line would serve no existing population centers or resource producing areas, and coal is the principal anticipated freight over the line. The SLR has no plans to build any team tracks or other public loading facilities on the line. However, if business develops, team tracks or other public loading facilities can be constructed on the railroad right-of-way. Access to rail services would be by way of private sidings or spurs.

Related Reviews and Approvals

The Star Lake Railroad (SLR) would require a certificate of public convenience and necessity from the Interstate Commerce Commission prior to construction and operation of the proposed line. Possible future additions of spur, industrial, team, switching, or side tracks located wholly within New Mexico may be exempt from ICC authority.

In addition to this general authority covering the entire line, the SLR must obtain rights-of-way approval from the following agencies prior to construction on lands under their jurisdiction:

(1.) The Bureau of Land Management must approve rights-of-way across 289.6 acres of public lands.

(2.) The Bureau of Indian Affairs must approve rights-of-way across 906.2 acres of PLO 2198, Navajo Tribal Trust and Indian allotment lands.

(3.) The New Mexico Commissioner of Public Lands must approve rights-of-way across 286.6 acres of State lands.

Chapter I of the Regional Analysis gives additional information on authorizing actions and interrelationships.

Setting

The route proposed by the SLR is shown on Map SLR I-1. From its connection with the existing Santa Fe main line at Prewitt (designated Baca by the Santa Fe), the railroad would run approximately 61 miles in a generally north-northeasterly direction to the vicinity of Pueblo Pintado (designated Star Lake Junction by the Santa Fe). At this point, the line would fork, with the right fork extending in a southeasterly direction for approximately 10 miles to the Star Lake area, and the left fork extending approximately 43 miles in a generally northwesterly direction to the eastern boundary

Table SLR I-1

COAL TRAFFIC OVER THE PROPOSED LINE BY
1990 FOR THE MID-LEVEL OF COAL PRODUCTION

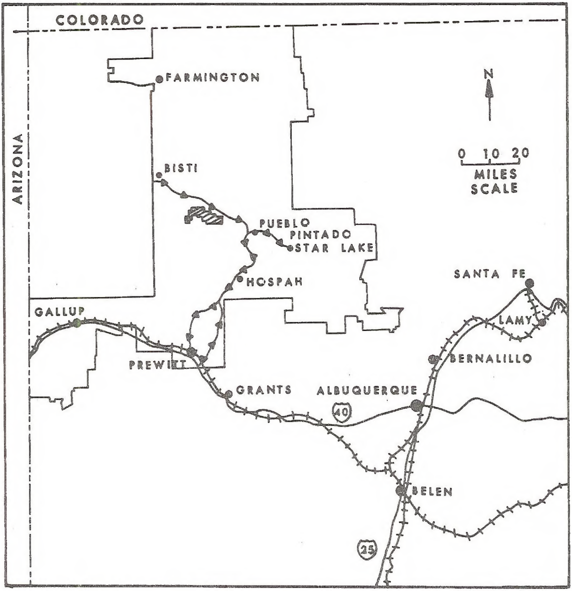
Mine	Annual Tonnage (Thousand Tons)	Equivalent Unit Trains Per Year	Destination
South Hospah	3,500	350	Colorado City, Grandbury and Monahans, TX
Star Lake	7,000	700	
Alamito	6,000	600	Springerville, AZ

Table SLR I-2

RIGHT-OF-WAY REQUIREMENTS BY CATEGORY
OF PRESENT LANDOWNER

Present Owner or Administrator	Right-of-Way Requirements (acres)
Bureau of Land Management	289.6
Bureau of Indian Affairs (PLO 2198)	231.3
State of New Mexico	286.6
Indian allotment lands	616.7
Navajo Tribal fee lands	378.0
Navajo Tribal trust lands	58.2
Private ownership	993.6
	2,854.0

Source: Star Lake Railroad Company, 1978.



LEGEND

CHACO CANYON NATIONAL MONUMENT

BORDER OF ENVIRONMENTAL STATEMENT REGION

AT & SF MAIN LINE RAILROAD

PROPOSED RAILROAD LINE

ALTERNATE RAILROAD LINE

MAP SLR I-1. LOCATION OF PROPOSED STAR LAKE RAILROAD of the Navajo Reservation at De-na-zin Wash south of Bisti.

An alternative route (discussed in Chapter VIII) would extend northward from Prewitt to Borrego Pass. There it would turn eastward to join the proposed route near mile post 27.

History

On September 3, 1976, the SLR filed an application before the ICC pursuant to Section I (18) of the Interstate Commerce Act to construct a line of railroad extending 72 miles from the existing Santa Fe main line at Prewitt to the Star Lake area, in McKinley County. This application identified Texas Utilities Services, Inc., as the major consignee for coal from the mines to be served by this line.

The application was amended on November 9, 1976 to include a 10-mile branch of this line from Pueblo Pintado to Gallo Wash. The amended application was for a total of 82 miles of track in McKinley and San Juan Counties. At the time of this submittal, no specific destinations for the coal were given.

On December 1, 1976 the SLR applied for a right-of-way permit across public lands administered by the BLM pursuant to the Federal Land Policy and Management Act of 1976. This application (NM 29324) was for 301.7 acres of rights-of-way required for the railroad described above plus an extension of the west branch to the eastern boundary of the Navajo Indian Reservation to serve other potential coal mining areas.

The SLR filed an additional application with the ICC on April 5, 1977, for authority to construct a railroad from its previously proposed terminus at Gallo Wash to the eastern boundary of the Navajo Reservation at De-na-zin Wash in San Juan County, a distance of 33 miles. This application was assigned Finance Docket No. 28448. The two applications before the ICC describe the same line as proposed in the application to the BLM. As with the previously amended application, there was no definite destination given for the coal to be hauled over the proposed line.

Since the filing of these applications, final engineering of the proposed railroad has resulted in some minor route changes. The final alignment would be 114 miles long, excluding 1.89 miles of line used as wye connections. The right-of-way would encompass 2,854 acres, 289.6 of which are public lands.

The SLR has said that the Santa Fe will file an application with the ICC for authority to acquire trackage rights over the line and/or operation as a common carrier pursuant to a lease, at some future date.

PROPOSED ACTION

The proposed action is the construction of a railroad by SLR. The Federal Government action is the review and consideration for approval of right-of-way application NM 29324 to cross public land administered by BLM.

Approval of the proposed action would result in the construction of approximately 114 miles of new rail line plus attendant passing tracks. Loading loops would be constructed by users of the rail service. The right-of-way would vary generally between 100 feet and 200 feet in width; slopes associated with cuts and fills would require greater widths. Approximately 2,854 acres would be required for permanent use as right-of-way. Table SLR I-2 lists the needed rights-of-way. The entire right-of-way would be fenced. This fence would be barbed wire except in areas of sheep grazing, where a 'sheep-tight' fence of wire fabric topped with three strands of barbed wire would be used. Fences would be supplemented by cattleguards at the grade crossings.

The railroad would be single-track, standard-gauge (4'8-1/2"), built to Santa Fe main-line standards. Sidings or passing tracks, each 7,900 feet long, would be placed every 10 to 15 miles. Although these sidings would be placed at the same intervals required for rail lines operating with a Traffic Control System (TCS), this system is not planned for initial use on the proposed line. The later installation of TCS, when the traffic demand warrants, would be facilitated by this placement. (TCS enables the remote control of train speeds and switching to minimize slowdowns or stopping as trains pass. Installation of TCS can double or triple the theoretical capacity of a rail line.) The capacity of the rail line, as proposed, would be approximately 15 to 20 trains per day. The SLR estimates that it could accommodate 40 to 60 trains per day on the proposed line when operating with TCS.

Many public and private roads cross the proposed railroad alignment. Crossings of the rail line would be either by grade separation (bridges or large culverts) or by standard grade crossings. At several places, two or more local roads would be rerouted to a single grade crossing. Table SLR I-3 lists the location and type of rail-line crossings proposed for this project.

The rail alignment also crosses approximately 284 streams or drainage channels. Culverts or bridges would be used to pass natural and storm flows beneath the roadbed. The size of these drainage structures would depend on the flow to be carried and the height of fill over them. In some areas, drainage ditches would be placed along the

Table SLR I-3

ROAD CROSSINGS

Milepost	Type of Road	Type of Crossing	Type of Structure
	Prewitt to Pueblo Pintado		
1.8	Private	Grade	
1.9	Private	Underpass	Bridge
6.7	County	Underpass	Bridge
7.2	Private	Underpass	CMP
9.2	County	Grade	
12.0	Private	Grade	
12.6	Private	Underpass	Bridge
13.0	Private	Underpass	CMP
14.2	Private	Grade	
15.6	Private	Grade	
18.4	Private	Grade	
18.6	Proposed Private	Overpass	Bridge
20.5	Private	Grade	
25.5	Private	Grade	
26.5	Private	Grade	
27.1	Private	Grade	
29.9	County	Underpass	Bridge
35.3	Private	Grade	
36.6	Private	Grade	
40.3	County	Underpass	Bridge
41.8	Private	Grade	
45.3	Private	Grade	
46.6	Public	Grade	
47.8	Public	Grade	
48.6	Private	Grade	
50.3	Private	Grade	
51.9	Private	Grade	
52.9	Private	Grade	
55.5	Private	Grade	
57.1	Private	Grade	
60.5	BIA	Underpass	Bridge
61.0	Public	Underpass	CMP
61.6	Public	Underpass	CMP
62.1	Public	Underpass	Bridge
63.9	Private	Grade	
64.7	Public	Grade	
66.3	Public	Underpass	Bridge
67.2	Private	Grade	
67.8	Private	Grade	

Table SLR I-3 (continued)

Milepost	Type of Road	Type of Crossing	Type of Structure
		Pueblo Pintado to Navajo Reservation	
0.5	Public	Underpass	CMP
1.8	Private	Grade	
2.8	Private	Grade	
7.5	Private	Grade	
8.5	Private	Grade	
9.9	Private	Underpass	CMP
11.5	Private	Grade	
12.9	Public	Underpass	CMP
16.8	Public	Underpass	Bridge
20.8	State	Underpass	Bridge
22.1	Private	Underpass	CMP
23.1	Private	Grade	
24.1	Private	Grade	
25.3	Private	Underpass	CMP
26.0	Private	Grade	
27.0	Private	Underpass	CMP
30.6	Private	Grade	
32.9	Public	Underpass	Bridge
34.0	Private	Grade	
35.4	Public	Underpass	CMP
38.0	Public	Underpass	Bridge
42.1	Private	Grade	
42.8	Private	Grade	

Source: Star Lake Railroad Company, 1978.

Key: CMP = Corrugated Metal Pipe

toe of the roadbed slope to collect and transport runoff to these drainage structures.

Detailed route maps are available for public inspection at the BLM Albuquerque District Office (Albuquerque, New Mexico), the BLM State Office (Santa Fe, New Mexico), and the Bureau of Indian Affairs at Crownpoint, New Mexico.

Additional Facilities

SERVICE AND REPAIR YARD

The SLR plans include a locomotive and rolling stock repair and service facility adjacent to the first 2.25 miles of rail line near Prewitt. The yard would be about 12,000 feet long, have a maximum width of 350 feet, and involve an estimated 96 acres. The facility would provide water, fuel, and sand, as well as inspection and minor repair service for the cars and locomotives.

The following improvements would be built at this facility:

(1) 1 spot - 1 track building (35 ft x 180 ft) (equipment from one spot)

(2) Diesel engine house (45 ft x 180 ft)

(3) Diesel service facility (5 spot - 375 ft)

(4) Diesel fuel storage tank and pumping station (a million-gallon steel tank)

(5) Compressor building (40 ft x 60 ft) (2 compressors and 1 boiler)

(6) Material unloading, track, sand, and fuel storage (1,500 ft)

(7) 2 Water wells

(8) Sanitary disposal (septic tank and leach field)

(9) Industrial waste (oil separator and evaporation pond)

(10) Electric substation

Communications

Four communications facilities (at Pueblo Pintado, Chaco Mesa, Mesa Amada, and Haystack Mountain) are planned to provide telephone service for railway personnel and UHF radio communication to trains and other mobile units, and to serve as relays between other stations. Each of these facilities would consist of an 8 x 12 x 9 foot molded fiberglass building and a 46-inch triangular galvanized steel tower 40 to 120 feet high. Three of the four facilities would be powered by photovoltaic solar-power systems which would include solar panels 7.3 feet wide and from 5.8 to 16.7 feet in length. The fourth would use power provided from local utility service. Each site would require approximately one acre and would be enclosed by a chain-link fence.

WATER SUPPLY

A reliable water supply would be necessary for the operation of these facilities and the rail-line in general. Water needs would vary during construction; operation of the railroad would require about 45,000 gallons a day. This supply would be obtained from three existing Santa Fe Industries' wells, one BLM well, and eleven deep wells that would be developed for construction purposes. Three of the new wells would be retained for supply during operations. Information on these wells is given in Table SLR I-4A. (Storage reservoirs have been considered by the SLR as a possible alternative to continual pumping of wells during construction. This possibility, which would require fewer wells and different pumping schedules for the wells, is shown in Table SLR I-4B.)

PROJECT DEVELOPMENT

Design

DESIGN CRITERIA

Santa Fe staff engineers are designing the Star Lake Railroad to contemporary Santa Fe main-line standards and the specifications of the American Railroad Engineers Association. Applicable standards include:

(1) maximum grades for loaded trains of 1.5 percent ascending and 1.8 percent descending,

(2) maximum main-line curvature of 4 degrees,

(3) subgrade widths of 22 to 24 feet on fill and 44 feet in cuts,

(4) minimum cut slopes ranging from 1:1 to 1:4, depending on the material through which the cut is made,

(5) fill slopes of 1.5:1.

Track materials used in construction would be the same as new main-line construction by the Santa Fe, including 136-pound continuously welded rail and pressure-treated wood ties. (Rail is designated by its weight per yard.)

DESIGN DEVELOPMENT

Most preconstruction planning and design for the proposed railroad has been completed. Final design engineering, however, is an ongoing process that would continue during most of the construction. The Santa Fe has made extensive contacts with local persons and has attempted to incorporate their suggestions into the design of the project.

Route Survey

The Santa Fe has surveyed the proposed route. Prior to construction, subsurface investigations would be made along the route to determine what type of grading, filling, and foundation preparation would be required for specific sites. This would involve the use of a truck-mounted drilling rig, which generally would not require access road preparation.

Table SLR I-4A

WELLS TO BE DEVELOPED DURING RAIL-LINE CONSTRUCTION

Route Milepost	Twp.	Rge.	Sec.	Qtr.	Aquifer	Estimated Daily Pumpage (12 hr. day)
3.xxx	13	11	26	SE	Psa, Pg	62,640 gallons for 408 days
3.5 xxx	13	11	26	NW	Psa, Pg	62,640 gallons for 326 days
11	14	10	21	SE	Jmw	54,000 gallons for 644 days
19	15	10	13	SW	Jmw	144,000 gallons for 400 days
28 x	16	10	2	NE	Jmw, Kcda, Kg	324,000 gallons for 144 days
38	17	9	3	NE	Kcda, Kg	144,000 gallons for 208 days
47	18	8	13	NW	Kg	108,000 gallons for 274 days
55 xxx	19	8	4	NE	Kg	108,000 gallons for 458 days
70 x	20	6	32	NE	Jmw, Je	180,000 gallons for 234 days
Pueblo Pintado to Navajo Reservation						
10 x (3 wells)	21	9	16	NE	Jmw, Je	900,000 gallons for 26 days
20	22	10	30	NE	Qal	72,000 gallons for 734 days
31	22	12	10	NW	Kg	108,000 gallons for 478 days
42 xx	23	13	9	NW	Jmw	360,000 gallons for 84 days

Source: Star Lake Railroad Company, 1978.

Aquifers: Je, Entrada Sandstone; Jmw, Westwater Canyon Member of the Morrison Formation; Kcda, Dalton Sandstone Member of the Crevasse Canyon Formation; Kg, Gallup Sandstone; Pg, Glorietta Sandstone; Psa, San Andres Limestone; Qal, Alluvium.

Note: The table above consists of four existing wells (one belonging to BLM and three belonging to Santa Fe Industries), and eleven new deep wells, three of which would be retained to serve facilities at Baca and Star Lake Junction. Water would have to be pumped from several wells simultaneously during construction. (See Table SLR I-4B.)

Key:
x = existing Santa Fe Industries well
xx = existing BLM well
xxx = new well to be retained to serve facilities

Table SLR I-4B

ALTERNATE WATER SUPPLY FOR RAIL LINE CONSTRUCTION

Route Milepost	Twp.	Rge.	Sec.	Qtr.	Aquifer	Would Pump From Wells at MP	Estimated Daily Pumpage (gal/24 hr.)	No. Days	Reservoir Location, Mile Post	Advance Reservoir Supply (Acre Feet)	Number of Days Advance Pumping
3 xxx	13	11	26	SE	Psa, Pg	3,3.5,11,19	646,560	21	1.9	37	19
3.5 xxx	13	11	26	NW	Psa, Pg	3,3.5,11,19	646,560	17	7.39	15	15
13	14	10	21	SE	Jmw	11,19,28	1,044,000	29	12.54, 13.41	5	5
21	15	10	13	SW	Jmw	11,19,28	1,044,000	48	15.3	23	8
28 x	16	10	2	NE	Jmw, Kcda, Kg	19,28	936,000	39	22.35, 23.79, 31.0	31	11
						19,28	936,000	25	25.3 & 31.0 (Orphan Annie)	21	7
						19,28	936,000	25	46.31, 47.95	20	7
55 xxx	19	8	4	NE	Kg	55,10	1,200,000	42	57.16, 61.33	0	0
70 x	20	6	32	NE	Jmw, Je	70,10	1,200,000	13	61.33, 70.0	0	0
					Pueblo Pintado to Navajo Reservation						
						10	1,200,000	23	0.28 (Same as 70)	0	0
10 x (3 wells)	21	9	16	NE	Jmw, Je	10	1,200,000	19	9.85, 11.36	0	0
						10	1,200,000	44	19.89	0	0
						10	1,200,000	43	28.88 (Black Lake)	0	0
42 xx	23	13	9	NW	Jmw	42	720,000	25	36.93 (Tanner Lake)	37	17

Source: Star Lake Railroad Company, 1978.

Notes: The above list consists of four existing wells (three belong to Santa Fe Industries and one to BLM) and seven new deep wells, of which three would be retained to serve facilities at Baca and Star Lake Jct.

It is considered that pumping on weekends would replace evaporation losses. If work is on 7-day-a-week basis, advance storage would have to be increased by 1,785 gallons per acre of surface for each day the reservoir would be used.

Key:

x = existing Santa Fe Industries wells
xx = existing BLM well
xxx = new wells to be retained to serve facilities

Rail Line Construction

Standard railroad construction methods would be employed (Figure SLR I-1). Table SLR I-5 summarizes the necessary earthwork and Table SLR I-6 gives the location of proposed borrow pits.

Materials, equipment and personnel involved in construction of the rail line would use existing roads to reach the work sites. Roads that would receive most of this traffic are State Highways 57, 197 and 371, and county roads. Access roads would be cut from these roads onto the right-of-way, parallel to the alignment. They would be exceedingly primitive, merely a route cut with a grader and devoid of obstacles. Later, portions of these access roads would be connected and graded smooth to provide a permanent, continuous work road adjacent to the railroad.

Temporary material storage yards may be built at strategic locations along the line. These would consist of an acre or so of the right-of-way graded and fenced for security. Materials and equipment needed for construction would be shipped by rail and truck for temporary storage and staging at these yards.

The SLR anticipates that contractors would construct most of the fencing after the railroad has acquired the right-of-way and other necessary permits.

A general contractor's work camp for the south end would be established at the existing trailer camp at Prewitt. Self-supporting camps would be located at Hospah, Gallo Wash and possibly at Pueblo Alto. The fencing contractor would probably move his trailers in 10-mile increments along the right-of-way.

Santa Fe rail-crew camps would be railroad bunk cars. Initially the cars would be placed on a siding at Bluewater. As trackage is completed, the bunk cars would be moved to a new main-line siding at Prewitt and then to sidings at milepost (MP) 23, MP 42 and MP 55. The camp then would be moved to the north leg of the Y at Pueblo Pintado. The camp would be on spurs at MP 10 and MP 30 on the western extension. Engineering camps would be located close to the general contractor's camps.

All camps would have mess and dormitory facilities. Food, catering service, fuel, work clothing, and miscellaneous supplies would be obtained from the local economy. It is possible that local suppliers of quantity materials such as fencing, pipe, etc. could be successful bidders.

Construction Employment and Cost Estimates

The SLR estimates that construction for the entire line should take approximately 30 months. Operations over the line as far as Star Lake would start approximately 20 to 24 months after construction begins.

The total estimated cost for this line is approximately 88 million dollars. Table SLR I-7 gives the number of railroad and contractor employees involved in construction, together with the construction expenditures on a month-by-month basis.

RAIL OPERATIONS AND MAINTENANCE

Most operations over the proposed rail line would be unit coal trains. A unit train is dedicated to the sole purpose of frequent round trips from a specific point of supply to a specific point of consumption. The typical unit train generally consists of 100 gondolas, of 100 tons capacity each (Figure SLR I-2), and hauls 10,000 tons of coal on the outward journey and returns empty. Thus, loading one unit train per day would require over 3.5 million tons of coal per year (Figure SLR I-3). To haul the estimated 16 million tons of coal that would be mined yearly as a result of the proposed action (Chapter I of the Regional Analysis) would require 4.5 unit trains a day. As designed, the proposed line could accommodate up to 10 round trips per day.

As many as eight 3,000 horsepower locomotives would be part of a typical unit train operating over the proposed line. The Santa Fe expects that it would use General Motors SD 40 locomotives, although any similar locomotive in the Santa Fe fleet could operate over the line.

The proposed rail line would be maintained by crews headquartered at Santa Fe's offices in Gallup. The track would be inspected and maintained in accordance with Federal regulations and Santa Fe main-line standards. Right-of-way maintenance would consist mainly of weed control by chemical and mechanical means similar to maintenance on the existing Santa Fe main line. Santa Fe presently uses Bromocyl No. 5 at a rate of 180 gallons per mile per application on its main line between Albuquerque and Gallup.

For the first four or five years, the section crew responsible for maintaining and repairing damage to the track and right-of-way would consist of eight persons. Thereafter, the section crew would have to be supplemented by some unknown figure as more maintenance is required on an older line.

Train maintenance, including inspection and minor repairs of the rolling stock, would be done at the service and repair facility near Prewitt. Continuous operations at this facility would ensure the inspection of every train entering the branch line. Major repairs to locomotives, however, would be done at existing Santa Fe repair facilities.

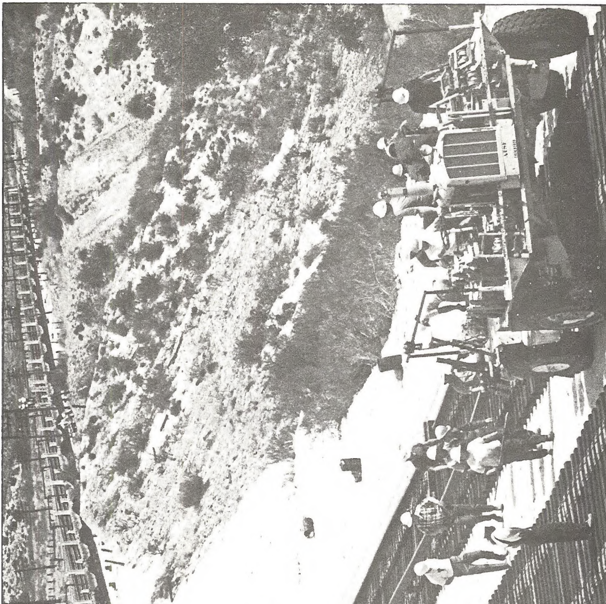


Figure SLR I-1.--A "straddle buggy" pulling continuous welded rail into position. (Photo courtesy of Santa Fe Railway.)

Table SLR I-5

EARTHWORK ESTIMATE FOR THE STAR LAKE RAILROAD

Grading	
Excavation (Includes 745,000 cu. yds. for balast and rip rap)	9,546,000 cu. yds.
Borrow	408,000 cu. yds.
Embankment (fill)	8,222,000 cu. yds.
Maximum height of fill	53 feet
Total distance of fills greater than 40 feet	2,100 feet
Maximum depth of cut	59 feet
Total distance of cuts greater than 40 feet	5,740 feet

Source: Star Lake Railroad Company, 1978.

Table SLR I-6

LOCATION OF BORROW PITS

Township	Range	Section	Present Owner	Size	MP Location
			Prewitt to Pueblo Pintado		
13 N	10 W	17	Tietjen	983' x 200'	7+1440'
13 N	10 W	5	Zuni Mountain Ranches	1270' x 325'	9+1480'
14 N	10 W	21	Navarre	900' x 250'	12+3840'
18 N	9 W	35	Phillips Petroleum	1300' x 125'	39+2280'
			Pueblo Pintado to Navajo Reservation		
21 N	8 W	32	Navajo Tribal Fee	2000' x 300'	4+1880'

Source: Star Lake Railroad Company, 1978.

TABLE SLR I-7

SCHEDULE OF ESTIMATED LABOR, SALARIES AND EXPENSES DURING CONSTRUCTION

	January 3/	February	March	April	May	June	July	August	September	October	November	December
1979												
Personnel 1/ (Number)	91	122	302	302	302	302	302	292	310	272	163	163
Salaries & Expenses 1/ (Dollars)	210,175	245,590	531,642	510,073	531,642	524,406	517,307	516,642	530,072	479,439	349,850	349,850
Purchases, Rentals, Supplies, Etc. 2/ (Dollars)	215,825	764,615	2,092,694	2,032,180	2,141,834	2,092,694	2,056,750	2,107,521	2,140,671	1,457,890	361,350	361,350
SUBTOTALS (DOLLARS)	426,000	1,010,565	2,624,336	2,542,253	2,673,476	2,617,100	2,574,057	2,624,163	2,670,743	1,937,329	711,200	711,200
1980												
Personnel 1/ (Number)	91	122	300	300	300	127	18	10	0	0	0	0
Salaries & Expenses 1/ (Dollars)	210,175	245,950	527,472	505,973	527,472	173,689	44,100	27,000	0	0	0	0
Purchases, Rentals, Supplies, Etc. 2/ (Dollars)	215,825	764,615	2,074,694	2,014,180	2,123,834	1,107,340	10,800	7,300	0	0	0	0
SUBTOTALS (DOLLARS)	426,000	1,010,565	2,602,166	2,520,153	2,651,306	1,281,029	54,900	34,300	0	0	0	0

Source: VTN Consolidated, Inc., 1976a.

1/ Includes Santa Fe and contractor's supervisory force.
2/ Includes Santa Fe and contractor's expenditures for local, regional and out-of-state transactions. (Does not include Federal or State Sales Tax, contractors' profit, payroll-associated costs, etc.)
3/ Years and months show only the sequence of the construction schedule and are not binding to either the SLR or the U.S. Government.

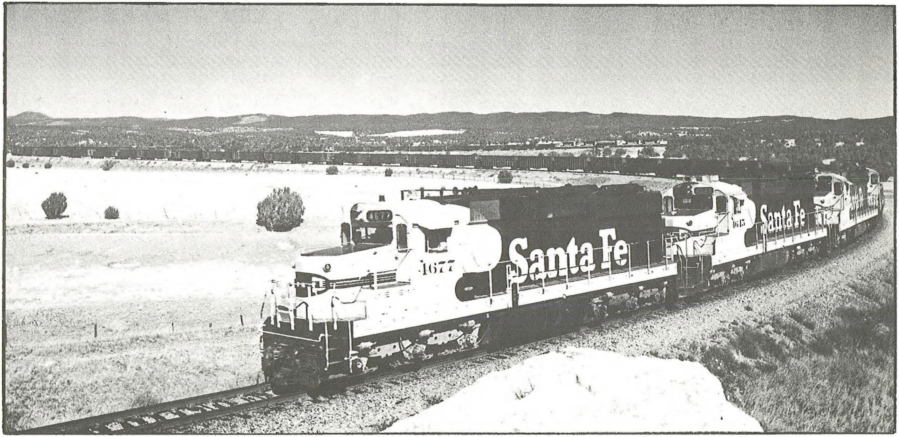


Figure SLR I-2.--Two-thirds of a unit coal train is visible on this S-curve.
(Photo courtesy of Santa Fe Railway.)

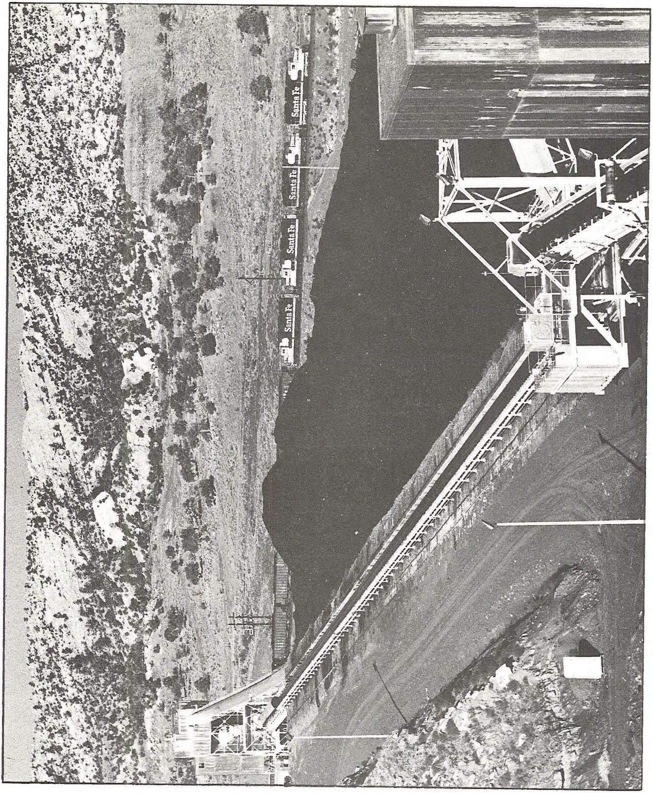


Figure SLR I-3.--Coal loading operation at McKinley Mine near Gallup.
(Photo courtesy of Santa Fe Railway.)

Employment

The Santa Fe Railway has indicated that the operation and maintenance of the proposed rail line would require the expansion of its existing work force. Table SLR I-8 lists new permanent positions that would be created by this project and estimates of the annual payroll for these persons.

To provide personnel to fill these positions, Santa Fe has stated that it intends to train and employ local people for every possible assignment. This will require special training in some cases.

Abandonment

Because of the large volume of coal projected for export from the region, it is not possible to predict when the line would be abandoned. Based on projected coal traffic, the SLR estimates the useful life of the railroad to be at least 35 years. During the time that coal traffic exists, non-coal traffic may develop to the point that the line would be viable without coal traffic.

On the other hand, after considering its common carrier obligations, existing and projected levels of traffic, and the overall profitability of the line, the railroad may seek to abandon the line.

If abandonment is approved, salvageable track materials and other improvements made for the railroad would be removed by salvage contractors. Fills, cuts, and culverts would be left intact. The surface rights of those parts of the right-of-way owned by the railroad would be sold or otherwise transferred. The parts of the right-of-way held as an easement for the railroad would revert to the owners of the property. Bridges desired by the new owner would be left in place; the remainder would be salvaged. The parties to whom surface rights are transferred would assume the responsibility to maintain the structures left in the right-of-way.

The Santa Fe and its subsidiary, the SLR, have prepared extensive reports regarding the planning, surveying, construction, operation, maintenance, and abandonment of the proposed rail line. These reports are available for public inspection at the ICC in Washington, D.C., the BLM, Albuquerque District Office in Albuquerque, New Mexico, and the BLM, New Mexico State Office in Santa Fe, New Mexico.

Table SLR I-8

NUMBER OF PERMANENT POSITIONS AND ESTIMATED PAYROLL 1/

Operation	Number of Employees	Annual Payroll
Unit train operations	20	$360,000
Maintenance of rolling stock	8	100,000
Maintenance of right-of-way	8-10	100,000
TOTAL	36-38	$560,000

Source: VTN Consolidated, Inc., 1978.

1/ This is an estimate based on the best available information. Actual figures depend on final destination of the coal.

CHAPTER II

DESCRIPTION OF THE ENVIRONMENT

THIS CHAPTER DESCRIBES THE PHYSICAL, BIOLOGICAL, AND CULTURAL RESOURCE VALUES THAT CONSTITUTE THE ENVIRONMENT IN WHICH THE STAR LAKE RAILROAD WOULD BE BUILT. THE DESCRIPTION FOCUSES ON ENVIRONMENTAL ASPECTS MOST LIKELY TO BE AFFECTED BY THE RAILROAD AND OTHER RELATED DEVELOPMENTS.

CHAPTER II

DESCRIPTION OF THE ENVIRONMENT

EXISTING ENVIRONMENT

Geologic Setting

Topography

The junction of the Star Lake Railroad and the main line of the Atchinson, Topeka and Santa Fe Railroad is in a broad valley at Prewitt (Map C). The SLR extends about 5 miles southeast from this junction, then turns northward up and out of the valley. The railroad climbs from an altitude of 6,740 feet at the junction to 7,394 feet at its highest point, about 17 miles from the junction. The topography is generally one of broad, gently rolling areas of alluvium and shale spotted with sandstone-capped mesas (Map II-1). About 26 miles from the junction, the railroad climbs to the Continental Divide and follows it for almost 25 miles. The topography here is generally low relief with no large drainages. The route crosses Chaco Mesa through Pueblo Pintado Canyon, the site of a pipeline (Shell Oil Co.), telephone line, and paved road (Navajo Route 9). The canyon walls are steep, but the canyon floor is about 1,000 feet wide throughout its length. North of Pueblo Pintado Canyon the route splits, one branch going eastward toward Star Lake, the other westward toward Bisti. The east branch goes through gently rolling shale and alluvium that is dissected slightly by the upper part of Chaco Wash. The climb over the 10-mile route is only about 150 feet. The west branch follows Chaco Wash for about 3 miles, then trends northwest away from it. The entire west branch crosses broad areas of low relief. Shale, the predominant rock type, is crossed by broad, shallow stream courses. The largest of these ephemeral streams are Escavada and De-na-zin Washes. These generally west- or southwest-draining streams are tributary to Chaco Wash. The lowest altitude of the railroad is 5,806 feet at De-na-zin Wash, about four miles east of where the railroad would end at the Navajo Indian Reservation boundary.

Stratigraphy

The strata exposed along the route of the proposed railroad are chiefly Mesozoic age sandstone and shale (Map SLR II-2). These units are shown on the San Juan Basin time-stratigraphic nomenclature chart (Figure II-1) of the Regional Analysis section of this report. The oldest rocks are of Jurassic age and consist of 1,000 to 1,500 feet of sandstone, siltstone, mudstone, and claystone with minor limestone and gypsum. Jurassic units include the Entrada Sandstone, the Todilto Limestone, the Summerville Formation, the Bluff Sandstone, and the Morrison Formation.

The thick sequence of Cretaceous strata, totaling about 6,000 feet, that overlies the Jurassic strata is mainly composed of sandstone and shale, with abundant coal in the upper part. The basal Cretaceous unit is the Dakota Sandstone. Overlying the Dakota are the Mancos Shale, the Gallup Sandstone, Crevasse Canyon Formation, the Menefee Formation, the Cliff House Sandstone, the Lewis Shale, the Pictured Cliffs Sandstone, and the Fruitland Formation.

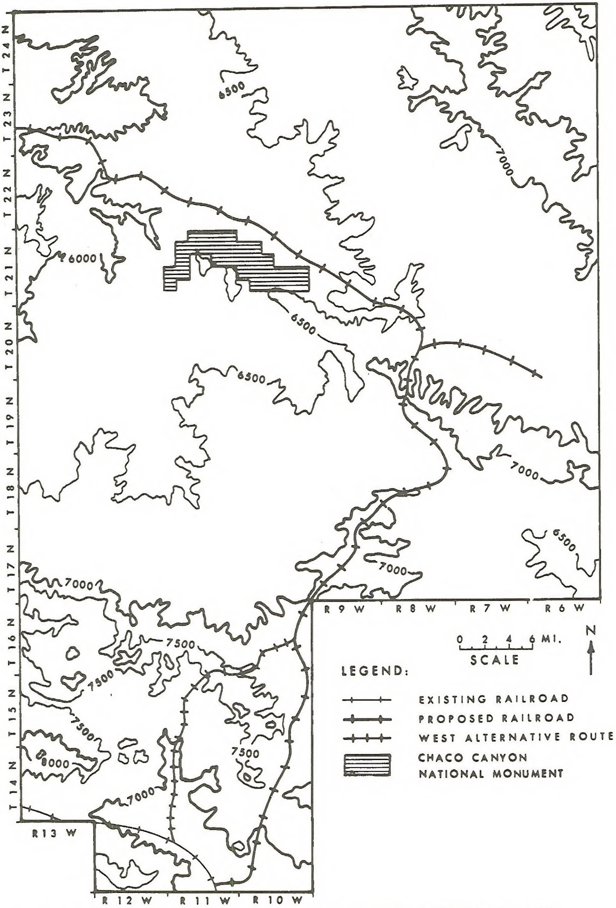
Quaternary deposits overlying the Mesozoic rocks include lava flows (as much as 120 feet of black scoriaceous and prophyritic basalt), alluvium (30 or more feet of sand and silt with clasts of sandstone from local bedrock or of rocks from distant sources let down from high gravel sheets now eroded away), sand dune deposits, landslide deposits, and deeply weathered shale and mudstone. A brief description of these formations is given on the back of Map D.

Structure

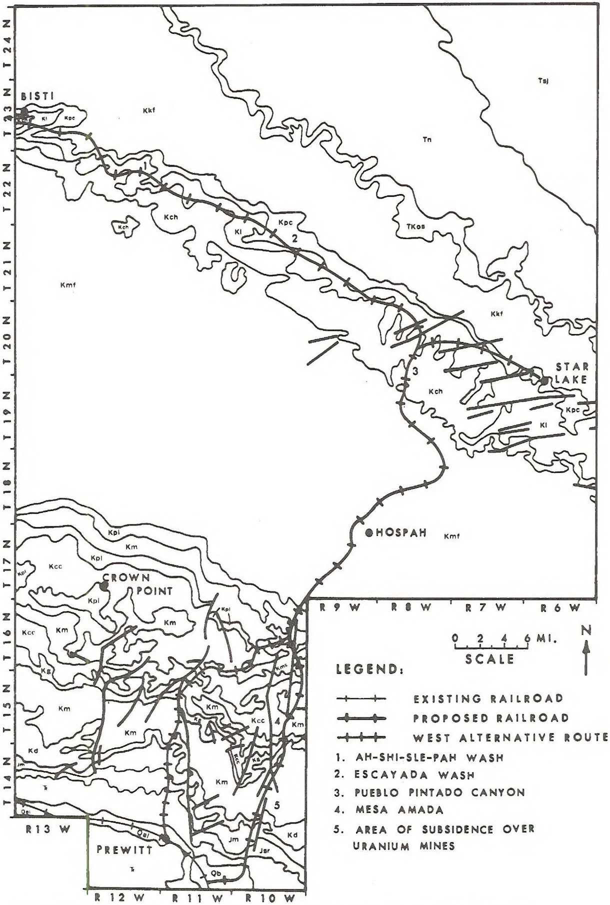
Bedding in the Mesozoic rocks dips 1° to 5° to the northeast toward the center of the San Juan Basin. Local variations in direction are believed to be caused by different rates of compaction, and to drag along faults. Normal faults striking north to east intersect the proposed route between 10 and 28.5 miles north of the Santa Fe main line (Map SLR II-2). The faults rarely have displacements larger than 100 feet. They are as much as 3 miles long and cut all rocks older than the Menefee Formation. These faults are Cretaceous age or younger, but are older than Quaternary (inactive over the last million years). Steep joints in the Mesozoic rocks strike north, northeast and east.

Geologic Hazards

Swelling clays, which could cause foundation problems, occur in most of the shaly formations,



MAP SLR II-1. TOPOGRAPHY ALONG THE PROPOSED STAR LAKE RAILROAD.



MAP SLR II-2. GENERALIZED GEOLOGY ALONG THE PROPOSED STAR LAKE RAILROAD.

Table SLR II-1

FLOOD-FREQUENCY DISCHARGE ESTIMATES

Route Stationing	Stream Name	Drainage area (mi^2)	Flood-Frequency Discharge (cubic feet per second) 2-year	5-year	10-year	25-year	50-year	100-year
		Prewitt to Pueblo Pintado						
807+00	Martin Draw	9.9	583	1,400	2,200	3,400	4,330	5,270
1205+00	Canada Milpitas	18.1	497	1,220	2,040	3,320	4,450	5,610
1338+00	Canada Marcelina	14.0	263	812	1,320	2,240	3,050	3,960
3228+00	Pueblo Pintado Wash	8.2	89	393	628	1,100	1,500	1,970
3316+00	Unnamed tributary	8.2	312	746	1,200	1,930	2,520	3,120
3401+00	Burning Bridge Wash	9.8	352	881	1,480	2,420	3,260	4,140
3566+00	Unnamed tributary	11.8	359	867	1,430	2,320	3,090	3,870
		Pueblo Pintado to Navajo Reservation						
57+00	Chaco Wash	32.7	386	1,740	2,770	4,850	6,620	8,700
215+00	Canada Alemita	38.4	590	2,280	3,670	6,350	8,650	11,310
526+00	Gallo Wash	15.5	308	1,020	1,660	2,830	3,860	5,020
901+00	Escavada Wash	31.7	146	1,410	2,370	4,050	5,640	7,390
988+00	Betonnie Tsosie Wash	21.3	0	425	991	1,740	2,420	3,290
1047+00	Kimbeto Wash	28.0	353	1,460	2,350	4,080	5,570	7,300
1339+00	Ah-shi-sle-pah Wash	26.8	0	662	1,300	2,150	3,100	4,150
1549+00	Tsaya Canyon	24.1	0	286	764	1,400	1,910	2,620
2174+00	De-na-zin Wash	177.9	2,610	6,940	10,200	14,600	17,800	21,100

Source: Route stationing and frequency data from Star Lake Railroad Company.

and rockfalls are possible where thick sandstones overlie shale in cliff faces, as in Pueblo Pintado Canyon.

In the Ambrosia Lake uranium-mining district, subsidence has occurred over some mined-out areas. The proposed route is 2,300 feet northwest of mining operations in sec. 22, T. 14 N., R. 10 W.; 2,000 feet west of operations in sec. 15; and 800 feet west of the suspended operations in sec. 10. The closest subsidence area is about a mile east of the proposed line (Map SLR II-2).

Paleontology

The railroad would be located in areas of minor local relief. There are few fossil-bearing rock exposures within the proposed right-of-way; consequently, an effort was made to obtain the best possible data on fossil materials by surveying the areas bordering the right-of-way. Two surveys, one by the University of New Mexico (Kues, et al., 1977), and one by the Museum of Northern Arizona under the direction of Mr. William Breed (in SLR's submittal to the BLM), found 34 localities near or within the proposed right-of-way. These localities consist primarily of Cretaceous fossil wood, leaves, marine and freshwater invertebrates, scattered vertebrate remains, and scattered Jurassic leaves and vertebrate remains.

Mineral Resources

Mineral industry activities are an important part of the economy of the ES Region, although the amount of land involved is minor. Several mineral industries are located along the proposed route of the SLR.

Coal

The railroad would cross the coal-bearing units in the Dakota and Gallup Sandstone and the Crevasse Canyon, Menefee, and Fruitland Formations. However, only the upper part of the Crevasse Canyon Formation and the Menefee and Fruitland Formations contain significant quantities of coal in the area of the proposed railroad. The railroad would cross the upper part of the Crevasse Canyon Formation (Gibson Member) between mileposts 23 and 26. No interest has been shown so far in mining coal in this area. Coal in the Menefee Formation would be crossed between mileposts 30 and 33, at the site of the potential South Hospah Mine. The railroad would run parallel to and just south of most of the commercial coal in the Fruitland Formation between Star Lake and Bisti (Map SLR II-2).

Oil and Gas

The railroad would cross the Walker Dome oil field, an abandoned two-well field, five miles north of Ambrosia Lake. At Hospah the railroad would pass about a mile from the active Hospah Oilfield. The railroad also would cross various undeveloped oil and gas leases and several pipelines.

Uranium

Near its junction with the Santa Fe main-line, the railroad would cross the Grants mineral belt, which produces most of the uranium in the U.S. The proposed route skirts mines at the west end of the Ambrosia Lake district, passing about 800 feet west of the nearest mine. The railroad also would cross many undeveloped mining claims.

Climate

The semi-arid nature and the large elevation differential of the area through which the SLR would run cause temperatures to vary considerably. Average annual temperatures range from about 45°F to about 49°F, with extremes ranging from -15°F to the mid-90's.

The growing season varies with altitude and is approximately 150 days in the valleys and 160 days on the plateaus. The first fall freeze occurs in early October and the last spring freeze occurs by mid-May.

Annual average precipitation in the area ranges from 8.7 inches to 10.5 inches and average annual snowfall ranges from 20 inches to 34 inches.

Evaporation is greatest during the dry, windy spring months and least during the winter months. Average annual pan evaporation ranges from about 67 inches to about 71 inches.

Mixing depths and ventilation are quite variable on a diurnal basis as well as on a seasonal basis. Morning mixing depths and ventilation values are low throughout the year, increasing noticeably during the afternoon, particularly during the spring and summer. In general, the lowest mixing depths and ventilation values occur during the winter.

Surface winds in the area result from a mixture of synoptic-scale and terrain-induced effects. The prevailing surface wind direction is west-southwesterly, with the strongest winds occurring during the spring, and the lightest winds occurring during the winter. Sustained winds of 84 mph can be expected once every 100 years, and winds of 81 mph can be expected every 50 years.

The upper winds, which may occasionally transport pollutants for long distances, are stronger than surface winds because of the absence of friction. Normally, the upper air winds are westerly.

A combination of low mixing heights and light transport winds occasionally persists over the region for an extended period of time, causing periods of poor dispersion most frequently during the winter, but also occur during the summer and fall. Poor dispersion conditions are infrequent during the spring because of strong transport winds and frequent air mass changes.

The area seldom experiences severe storms. Duststorms and thunderstorms with strong, gusty winds and/or hail occasionally occur during the late spring and summer. A more detailed discussion of the climate is in the Regional Analysis.

Air Quality

No ambient air quality data are available for the vicinity of the railroad. The total suspended particulate (TSP) concentrations measured at Star Lake are assumed to be representative of the air quality in the area through which the railroad would run. The annual mean concentration of 27 micrograms per cubic meter ($\mu g/m^3$) is less than half the Federal secondary and State air-quality standards. The maximum 24-hour concentration observed at Star Lake is 214 $\mu g/m^3$; however, the second highest 24-hour concentration is 67 $\mu g/m^3$, which is well below the Federal secondary and State air quality standards.

The TSP background concentrations for the annual and 24-hour averages is assumed to be 27 $\mu g/m^3$. Other pollutant concentrations in the central sub-area of the ES Region are discussed in the Regional Analysis. These include sulfur dioxide, carbon monoxide, nitrogen dioxide, non-methane hydrocarbons, photochemical oxidants, sulfate and nitrate particulates, and trace elements. Concentrations of regulated pollutants are low in comparison to State or Federal standards.

Visibility in the area is good, with an annual average of at least 35 miles. Greatest visibility occurs during the summer and least during the winter.

Water Resources

GROUND WATER

Nearly all the geologic formations that would be crossed by the railroad (Map SLR II-2) yield water to wells, as discussed in the Regional Analysis, although the amounts generally are small (less than 20 gallons per minute (gal/min)). Most of the wells along the proposed route obtain water from one of the bedrock aquifers and are several hundred feet deep. Only where it crosses Chaco Wash and its major tributaries does the route approach areas where shallow wells obtain water from the alluvium. These wells generally are less than 20 feet deep, and the water level is within 10 feet of the land surface.

Heaviest withdrawals of ground water along the route are in the Ambrosia Lake area, where many of the uranium mines in the Westwater Canyon Member of the Morrison Formation have to be dewatered. As much as 3,000 gal/min are pumped from some of the shafts. Some of this water is used during the milling process; the rest is discharged into nearby washes.

The only public supply wells along the route are at Pueblo Pintado, where five wells pump water from either the Cliff House Sandstone, the Menefee Formation, or both. The rest of the wells along the route are used for domestic and stock water. Table SLR I-4A summarizes the proposed sources of water for construction and operation of the SLR.

SURFACE WATER

The proposed railroad starts on the eastern side of the Continental Divide, follows the Divide for about 25 miles and terminates on the western side. The eastern drainage is in the Rio San Jose basin, which is tributary to the Rio Puerco and thence tributary to the Rio Grande. The western drainage is in the Chaco River basin, which is tributary to the San Juan River and thence tributary to the Colorado River. The drainage pattern (Map C) and downstream order along the proposed route is as follows:

- Rio Puerco basin
  - Arroyo Chico basin
    - Canada Marcelica
      - Canada Milpitas
  - Rio San Jose basin
    - San Mateo Creek basin
      - Arroyo del Puerto basin
        - Martin Draw
- San Juan River basin
  - Chaco River
    - Chaco Wash
      - Unnamed tributary no. 1
      - Burning Bridge Wash
      - Canada Alamita
      - Fajada Wash
      - Gallo Wash
      - Escavada Wash
      - Betonnie Tsosie Wash
      - Kimbeto Wash
    - Ah-shi-sle-pah Wash
    - Tsaya Canyon
    - De-na-zin Wash

Mitchell Draw, in the Rio San Jose basin, would not be crossed by the SLR, but the service facility at Prewitt would be built in its flood plain.

All streams crossing the proposed railroad are ephemeral, streamflow usually occurring in response to short-duration, high-intensity storms. Limited streamflow data are available in the vicinity of the railroad. Several gaging stations have recently been established on nearby streams but sufficient data are not yet available to determine the streamflow characteristics. Estimates of the flood frequency for all stream crossings of the railroad have been made by the SLR (written commun., 1977). Selected values are shown in Table SLR II-1.

Table SLR II-2 lists the number of stream crossings by size of drainage area for various segments

Table SLR II-2

NUMBER OF STREAM CROSSINGS OF THE STAR LAKE RAILROAD
LISTED BY SIZE OF DRAINAGE AREA

Route Stationing	Number of Crossings 0.01 - 0.1 square mile	0.1 - 1.0 square mile	1.0 - 10.0 square miles	10 square miles
	Prewitt to Pueblo Pintado			
0+00-600+00	2	8	6	0
600+00-1200+00	16	15	2	0
1200+00-1800+00	6	16	1	2
1800+00-2400+00	27	10	0	0
2400+00-3000+00	26	14	4	0
3000+00-End	10	18	8	1
	Pueblo Pintado to Navajo Reservation			
0+00-600+00	16	7	4	3
600+00-1200+00	6	10	1	3
1200+00-1800+00	2	16	2	2
1800+00-End	2	13	2	1
Total	113	127	32	12

of the route. Of 284 crossings, 12 are major (drainage area greater than 10 square miles) and will require large structures. There will be an average of one drainage structure every 0.4 mile of railroad.

The 12 major streams that cross the railroad route have channels that range from the sharp-sided, narrow and deep to wide and shallow. All these channels have beds composed of sand and gravel. The medium-sized streams generally have the sharp-sided erosion channels. Most of the small streams do not have a defined channel, and are merely lower areas.

There are three small stock ponds within or immediately adjacent to the proposed right-of-way and another six to eight within 2,000 feet. All these ponds are manmade and are less than five acres in size. Because of sedimentation, the expected life of these ponds is less than 15 years.

WATER QUALITY

No analyses of the chemical quality of the surface water are available for the area that would be crossed by the railroad. However, the few analyses available for northwest New Mexico indicate that the surface water along the route would contain 300 to 7,000 milligrams per liter (mg/L) of total dissolved solids. The specific conductance would range from 500 to 10,000 micromhos per centimeter. The predominant ions would be sodium (100 to 3,000 mg/L), bicarbonate (200 to 1,200 mg/L) and sulfate (50 to 400 mg/L).

The quality of the water in the bedrock aquifers is generally good near their areas of outcrop, and deteriorates with distance from the outcrop, becoming fair for stock and marginally suitable for domestic use. The quality of water in the alluvium generally is better than that in the bedrock and is similar to that of the surface water.

SEDIMENT

No data on sediment discharges are available for the railroad route. From other studies it is estimated that the annual sediment discharge for the route should average between 0.1 and 0.8 acre-feet per square mile per year.

The proposed route crosses many areas highly susceptible to accelerated erosion. About 22 miles (27 percent) of the main route and all of the extension from Pueblo Pintado to the Navajo Reservation involve such areas.

Soils

A general soil map was prepared for San Juan County (Maker, Keetch and Anderson, 1973) and for McKinley County (Maker, Bullock and Anderson, 1974) by the New Mexico Agricultural Experiment Station in cooperation with the Water Resources Research Institute and the Soil Conservation Service. The soil associations were mapped at a level designed to provide information for general planning and potential limitations for use. Additional soils information was submitted by the Santa Fe in support of their proposal for the SLR, as shown in Map SLR II-3. Table B-18, in Appendix B, provides descriptive information for the major soils in each of the mapping units. Supplemental information is on file at the Albuquerque District Office of the BLM.

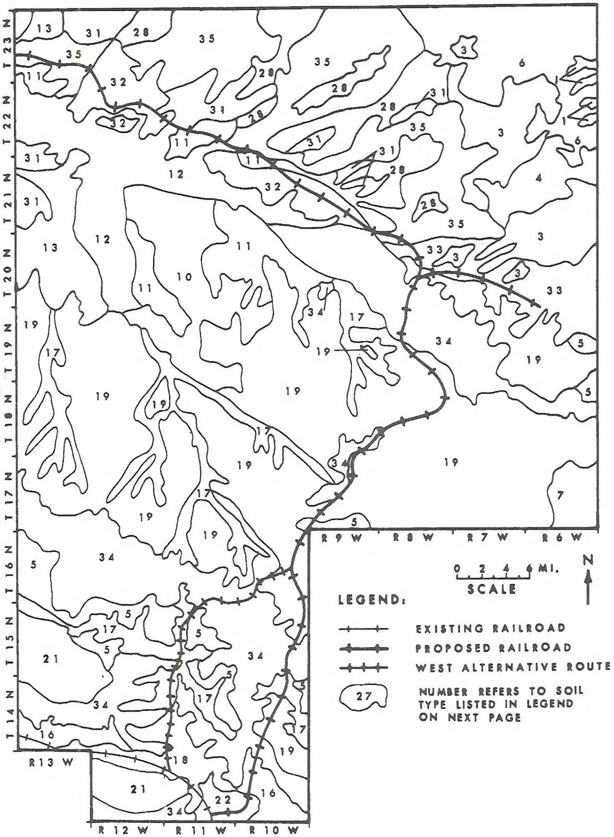
The soils range in texture from fine sand to clay, and the depth to bedrock ranges from zero to greater than sixty inches. The permeability is slow to moderately rapid and the soils are moderately to highly susceptible to erosion if vegetation is removed and topsoil disturbed. Badland, Farb, Persayo, Rockland, Sheppard, and Travessilla soils have high erosion hazards when disturbed. Badland, Chipita, Doak, Lohmiller, Moriarity, Persayo, Prewitt, and Thunderbird soils are fine textured, having high clay contents and high shrink-swell potentials. Other limitations of soils of the area include high sodic and soluble salt conditions of Badland, Farb and Fluvent soils. Billings, Chipita, Lohmiller, Palma, Penistaja, and Prewitt soils are of low strength, and embankments are subject to piping. Table B-19, in Appendix B, provides interpretation for selected uses of the major soils occurring within the area.

Lohmiller-San Mateo soil associations occur in stream valleys and floodplains and are moderately to highly susceptible to erosion, as shown by numerous deep cuts and gullies. The presence of recent sand dunes in the northern part of the area indicates that wind erosion is a hazard along Chaco Wash and some of its tributaries. Collapsible soils are evident along tributary drainages susceptible to deposition by sheet flow or flooding. Hagerman-Travessilla and Persayo-Lohmiller soils appear to be the least suitable as a source of fill material due to the presence of low-strength plastic clays. Preliminary investigations by the SLR have shown that the proposed borrow pits contain suitable material for fill.

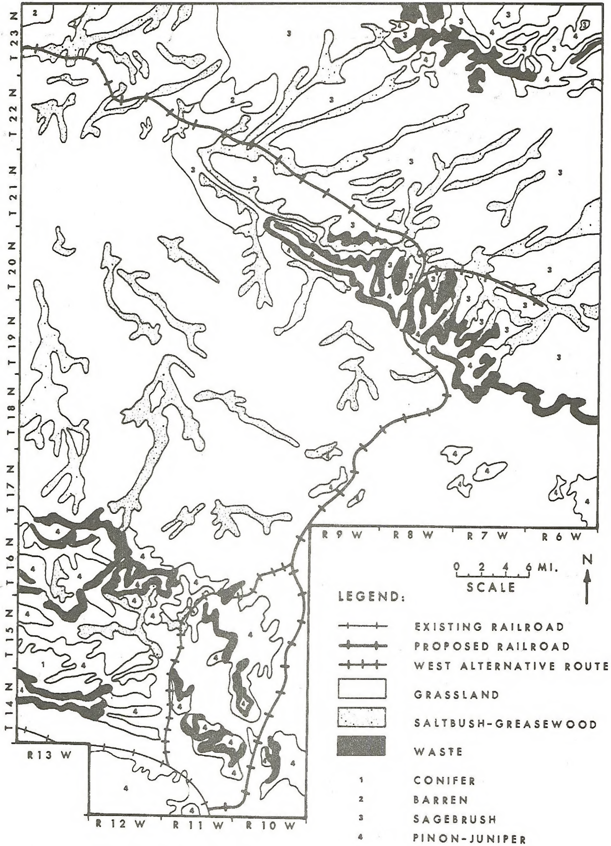
Vegetation

The proposed railroad would traverse five types of vegetation: grassland, sagebrush, barren, pinyon-juniper, and saltbush greasewood. The types in the vicinity of the proposed route are illustrated in Map SLR II-4. For a detailed discussion of these vegetation types see Chapter II of the Regional Analysis.

The vegetation along the southern part of the proposed route consists of grasslands on the lower and more gently sloping sites, with pinyon-juniper occupying most mesa tops and hillsides. There are



MAP SLR II-3. SOIL ASSOCIATIONS ALONG THE PROPOSED STAR LAKE RAILROAD.



MAP SLR II-4. VEGETATION TYPES ALONG THE PROPOSED STAR LAKE RAILROAD.

some very steep slopes (30-60 percent) on which the waste vegetation type occurs. Scattered junipers occur in grasslands adjacent to hills, and there are many small intrusions of dominant pinyon-juniper into grassland sites having shallow soils and moderate slopes.

The grasslands resemble the shortgrass plains vegetation because of the dominance of galleta and blue grama throughout the major part. In low areas adjacent to drainageways, rubber rabbitbrush is growing in association with the grasses and is the dominant plant species on small areas. Past disturbances of the grassland such as overgrazing have resulted in increased density of shrubs, mainly Greenes rabbitbrush.

The pinyon-juniper type is dominated by pinyon pine and one-seed juniper. The primary understory species are blue grama and Greenes rabbitbrush with some galleta and threeawn.

North of Chaco Mesa the proposed route runs through an area of broad expanses of the sagebrush type. Areas along drainageways and depressions in this area are occupied by a saltbush-greasewood complex. Small areas of grassland occur within the sagebrush type. These grassland sites are generally associated with finer textured soils.

Big sagebrush is the dominant shrub throughout most of the sagebrush type, but Greenes rabbitbrush is present in some localities. Understory grasses most frequently encountered in this type include galleta, blue grama and alkali sacaton. The dominant plant species in the saltbush-greasewood complex are fourwing saltbush and black greasewood. In many areas big sagebrush and Greenes rabbitbrush are intermingled with the dominant shrub species. The predominant understory grass species include western wheatgrass, blue grama, and galleta. The annual forb, Russian thistle, becomes a major component of this vegetative type during its season of growth. Grassland sites within the sagebrush type are occupied by the clay upland-grass complex. On these sites, alkali sacaton, blue grama, and galleta are the dominant species.

The western part of the proposed route extends beyond the sagebrush type into a predominantly grassland area. This grassland differs from those at the southern part of the proposed route because of the inclusion of alkali sacaton, sand dropseed, and Indian ricegrass as codominants with the galleta and blue grama. Also, there is a greater content of scattered fourwing saltbush shrubs in the grassland.

The areas along drainageways within the grassland are occupied by a saltbush-greasewood complex similar to those described above. The major differences are the absence of sagebrush in the shrub component and very low density of perennial grasses as understory species where this type occurs.

There are small areas in the grasslands along and near the western part of the proposed route of the barren vegetation type. The vegetation in this type consists of scattered shadscale shrubs on the hills and slopes and thin stands of grasses and forbs along the drainageways.

ENDANGERED OR THREATENED PLANTS

Surveys (Spellenberg, 1976; Martin, et al., 1978) of the area through which the railroad would run found no plants proposed for endangered and threatened status in the Federal Register (vol. 40, no. 117, July 1, 1975; vol. 41, no. 127, June 16, 1976) or listed as endangered and threatened by the State of New Mexico.

Wildlife

The following discussion of the wildlife along the proposed railroad route is based upon records from approximately 300 sightings, plus published literature on animal species known to occur within the proposed rail corridor (Findley, et al., 1975; Peterson, 1961; Robbins, et al., 1966; Stebbins, 1966); personal communications with the U.S. Fish and Wildlife Service and the New Mexico Department of Game and Fish; reports or investigations of other projects within the same ES Region (National Park Service, 1975a; Bureau of Reclamation, 1976a, d, e, and f); information obtained from Chaco Canyon National Monument; and VTN field observations and reports (VTN, 1976a).

MAMMALS

Habitat/species relationships for the 40 species of mammals known to occur within and adjacent to the proposed rail corridor are contained in Table SLR II-3. Of these, 17 mammals were observed, tracked or trapped in the study area. The blacktail jackrabbit, desert cottontail, Colorado chipmunk, and whitetail antelope squirrel were observed most frequently throughout the proposed rail corridor. The jackrabbit was found in all habitat types, the cottontail was observed in all habitats but the grama-galleta, the antelope squirrel was observed in the grama-galleta and saltbush habitats, and the Colorado chipmunk appeared primarily in the pinyon-juniper habitat. Two established prairie dog colonies have been reported along the right-of-way corridor in grama-galleta and saltbush habitats.

Results of a small-mammal trapping study were too low to be of value in estimating population sizes. Trapping success ranged from five percent in the grama-galleta community to 10 percent in big sagebrush, with an overall success of seven percent (22 animals caught in 315 trap-nights).

Table SLR II-3

SPECIES/HABITAT RELATIONSHIPS FOR MAMMALS IN THE PROPOSED RAIL CORRIDOR[1/]

Scientific Name	Common Name	Habitat Type[2/] PJ	GG	S	BS
Order Chiroptera	Bats				
Family Vespertilionidae					
Myotis leibii	Small-footed Myotis	x	x		
Pipistrellus hesperus	Western Pipistrelle	x			
Eptesicus fuscus	Big Brown Bat	x			
Antrozous pallidus	Pallid Bat		x		
Order Lagomorpha	Rabbits and Hares				
Family Leporidae					
* Sylvilagus auduboni	Desert Cottontail	x	x	x	
* Lepus californicus	Black-Tailed Jackrabbit	x	x	x	x
Order Rodentia	Squirrels, Mice & Rats				
Family Sciuridae					
Eutamias dorsalis	Cliff Chipmunk	x			
* Eutamias quadrivittatus	Colorado Chipmunk	x			
* Ammospermophilus leucurus	White-tail Antelope Squirrel		x	x	
Spermophilus spilosoma	Spotted Ground Squirrel		x		
* Spermophilus variegatus	Rock Squirrel	x	x		
* Cynomys gunnisoni	Gunnison's Prairie Dog			x	
Family Geomyidae	Botta's Pocket Gopher	x	x		x
* Thomomys bottae					
Family Heteromyidae					
* Perognathus flavus	Silty Pocket Mouse		x		x
Perognathus flavescens	Plains Pocket Mouse		x		
Dipodomys ordii	Ord's Kangaroo Rat	x	x	x	x
* Dipodomys spectabilis	Banner-tailed Kangaroo Rat	x	x		x
Family Cricetidae					
Reithrodontomys megalotis	Western Harvest Mouse	x	x	x	x
Peromyscus crinitus	Canyon Mouse	x			
* Peromyscus maniculatus	Deer Mouse	x	x		x
Peromyscus boylii	Brush Mouse	x			x
Peromyscus truei	Pinyon Mouse	x			
* Onychomys leucogaster	No. Grasshopper Mouse				x
Neotoma albigula	White-Throated Woodrat	x	x	x	x
Neotoma stephensi	Stephen's Woodrat	x			
Neotoma mexicana	Mexican Woodrat	x			
Neotoma cinerea	Bushy-tailed Woodrat	x			
* Neotoma sp.	Woodrat	x			
Microtus mexicanus	Mexican Vole	x			

Table SLR II-3 (continued)

Scientific Name	Common Name	Habitat Type PJ	GG	S	BS
Family Erethizontidae					
* Erethizon dorsatum	Porcupine	x			
Order Carnivora	Carnivores				
Family Canidae					
* Canis latrons	Coyote	x			x
Vulpes macrotis	Kit Fox		x		
* Urocyon cinereoargenteus	Gray Fox	x	x	x	
Family Procyonidae					
Bassariscus astutus	Ringtail Cat	x	x		
Family Mustelidae					
Mustela nigripes	Black-footed Ferret		x		x
Taxidea taxus	Badger		x		x
Spilogale gracilis	W. Spotted Skunk	x	x		
* Mephitis mephitis	Striped Skunk		x		
Family Felidae					
Lynx rufus	Bobcat	x	x	x	x
Order Felidae	Deer and Elk				
Family Cervidae					
* Odocoileus hemionus	Mule Deer	x			
Family Antilocapridae					
Antilocapra americana	Pronghorn		x	x	x

Source: VTN Consolidated, Inc., 1976a.

Footnotes:

1/ Records of mammals were compiled from direct observation, trapping, tracking and other signs. * Species noted with an asterisk were recorded during a series of five field studies from July to October, 1975.

2/ Key to Habitat Types:

PJ = Pinyon-Juniper
GG = Grama-Galleta
S = Saltbush-Greasewood
BS = Big Sage

Carnivore tracks were observed in several areas along the proposed railroad route. The number of such carnivores as bobcat, coyote, and grey fox in northwestern New Mexico is unknown. Low carnivore populations are expected because of the sparse vegetation, generally low rodent densities, and the absence of rocky areas and rough terrain preferred by these species.

Two important game mammals, mule deer and pronghorn antelope, have been reported in the study area. However, only two signs of mule deer were found in the corridor, a relatively fresh skull north of Haystack Mountain and an old jaw bone in Pueblo Pintado Canyon. Tracks or scat could not be relied upon, owing to the large number of sheep grazed throughout the study area. Local residents report that deer occur in the pinyon-juniper habitat on higher mesas (e.g. San Mateo and Chaco), but hunting success is poor. Residents note that the development of uranium mines around Ambrosia Lake has led to an increase of hunters and a decrease of deer. This, coupled with overgrazing and a lack of adequate water sources, makes the study area poor deer habitat (BLM, 1974). Approximately 30 pronghorn antelope were transplanted 10 years ago to an area southeast of Chaco Canyon National Monument (BLM, 1974). No antelope were observed in the proposed rail corridor (Larsen, 1967), probably due to the adverse influences of off-season hunting and competition with sheep and other livestock (BLM, 1974).

BIRDS

A total of 52 species of birds were observed during the 1975 field investigations (Table SLR II-4). Approximately 25 of these bird species are year-round residents.

Resident birds occurring in the proposed railroad corridor are typical of species in open, dry, grassland habitat common to northwest New Mexico. They include the horned lark, mourning dove, western meadowlark, common raven, rock wren, loggerhead shrike, and house finch. The most frequently observed bird throughout the study area was the horned lark. No pattern of occurrence was detected for the avifauna species observed at numerous localities and in different vegetative habitats within the proposed railroad corridor. Although no areas were devoid of bird life, a flushing transect showed that densities vary spatially and seasonally. John Hubbard (personal communication, 1976-77) of the New Mexico Department of Game and Fish made a bird count in the northern part of the study area in June, the peak of the breeding season. His census of birds per unit observation was more than three times greater than a July census in the study corridor.

Direct evidence of breeding activity was noted for seven species of birds: prairie falcon, scaled quail, white-throated swift, violet-green swallow, cliff swallow, western bluebird and loggerhead shrike. The prairie falcon, the swift, both species of swallow, and the western bluebird all nested within a relatively small area of a single mesa north of Ambrosia Lake (Mile Point 16: NW1/4 sec. 35, T. 15 N., R. 10 W.). Colonies of swallows were found beneath many cliff overhangs in the study area. Solitary white-throated swifts were also found at several sites nesting in narrow cracks near swallow colonies.

The most frequently encountered raptor is the American kestrel (unpublished Public Service Company of New Mexico raptor survey). The three raptors next in abundance are the red-tailed hawk, golden eagle and prairie falcon. Golden eagles were observed hunting south of Haystack Mountain, in Canada Milpitas and near Mesa Alta (Mile Points 0, 21, and 42, respectively). A pair of golden eagles was seen perched on power line poles near Ah-shi-sle-pah Wash, within 1/4 mile of the proposed railroad route.

AMPHIBIANS AND REPTILES

The number of expected amphibian species is low, because of the absence of riparian habitat and permanent streams or springs. Table SLR II-5 lists the species of amphibians and reptiles which might be affected by the proposed rail extension.

Only the western spadefoot toad, the plains spadefoot toad and the tiger salamander have been reported near Chaco Canyon National Monument (National Park Service, 1975a), a location that includes virtually all habitat types found along the proposed corridor.

Because of their general independence from water, there are more snakes and lizards than amphibians in the area of the proposed rail line. Eight species of lizards and eight species of snakes have been reported from Chaco Canyon National Monument (National Park Service, 1975a). Based on habitat requirements and known distribution limits, all but two species, the sagebrush lizard and the northern tree lizard, are likely to be found on or near the proposed project (Stebbins, 1966). Three additional species not reported near Chaco Canyon, the leopard lizard, the desert spiny lizard and the many-lined skink, may occur within the proposed route. All eight of the snake species found in the monument are possible-to-likely residents of the proposed rail corridor.

ARTHROPODS

A detailed survey of arthropods was not made during field studies conducted by VTN in 1975. The arthropod species typically inhabiting the

Table SLR II-4

SPECIES/HABITAT RELATIONSHIPS FOR BIRDS OBSERVED WITHIN THE PROPOSED RAIL CORRIDOR

Scientific Name	Common Name	Habitat Type[1/]				
		PJ	GG	S	BS	A
ANATIDAE	Waterfowl					
Anas platyrhynchos	Mallard					x
Anas acuta	Pintail					x
CATHARTIDAE	American Vultures					
Cathartes aura	Turkey Vulture	x	x	x	x	
ACCIPITRIDAE	Hawks and Eagles					
Accipiter cooperi	Coopers Hawk	x	x			
Buteo jamaicensis	Red-Tailed Hawk		x	x		
Aquila chrysaetos	Golden Eagle	x	x	x		
FALCONIDAE	Falcons					
Falco mexicanus	Prairie Falcon			x		
Falco sparverius	American Kestrel	x	x	x	x	
PHASIANIDAE	Quail and Pheasants					
Callipepla squamata	Scaled Quail				x	
CHARADRIIDAE	Plovers					
Charadrius vociferus	Killdeer					x
PHALAROPODIDAE	Phalaropes					
Steganopus tricolor	Wilson's Phalarope					x
COLUMBIDAE	Pigeons and Doves					
Zenaidura macruoura	Mourning Dove	x	x	x	x	
STRIGIDAE	Owls					
Bubo virginianus	Great Horned Owl	x	x	x		
Speotyto cunicularia	Burrowing Owl		x			
CAPRIMULGIDAE	Goatsuckers					
Chordeiles minor	Common Nighthawk	x	x	x		
APODIDAE	Swifts					
Aeronautes saxatalis	White-Throated Swift		x	x		
TROCHILIDAE	Hummingbirds					
Selasphorus platycercus	Broad-Tailed Hummingbird			x		
PICIDAE	Woodpeckers					
Colaptes cafer	Common Flicker	x				

Table SLR II-4 (continued)

Scientific Name	Common Name	Habitat Type[1/]				
		PJ	GG	S	BS	A
TYRANNIDAE	Tyrant Flycathers					
Tyrannus verticalis	Western Kingbird	x				
Tyrannus vociferans	Cassin's Kingbird		x	x		
Myiarchus cinerascens	Ash-Throated Flycatcher	x	x	x		
ALAUDIDAE	Larks					
Eremophila alpestris	Horned Lark	x	x	x	x	
HIRUNDINIDAE	Swallows					
Tachycineta thalassina	Violet Green Swallow			x		
Petrochelidon pyrrhonota	Cliff Swallow		x	x		
CORVIDAE	Jays and Crows					
Aphelocoma coerulescens	Scrub Jay	x				
Corvus corax	Common Raven			x	x	
Gymnorhinus cyanocephalus	Pinyon Jay	x	x	x		
PARIDAE	Titmice and Bushtits					
Parus gambeli	Mountain Chickadee	x				
Parus inornatus	Plain Titmouse	x				
Psaltriparus minimus	Common Bushtit	x				
SITTIDAE	Nuthatches					
Sitta carolinensis	White-Breasted Nuthatch	x				
TROGLODYTIDAE	Wrens					
Salpinetes obsoletus	Rock Wren	x	x			
MIMIDAE	Mockingbirds and Thrashers					
Mimus polyglottos	Mockingbird	x	x	x		
Toxostoma bendirei	Bendires Thrasher	x	x	x	x	
Oreoscoptes montanus	Sage Thrasher				x	
TURDIDAE	Thrushes and Bluebirds					
Sialia mexicana	Western Bluebird			x		
Sialia currucoides	Mountain Bluebird	x	x	x		
LANIIDAE	Shrikes					
Lanius ludovicianus	Loggerhead Shrike		x	x	x	
VIREONIDAE	Vireos					
Vireo vicinior	Gray Viero	x	x			
ICTERIDAE	Blackbirds and Orioles					
Sturnella neglecta	Western Meadowlark		x	x	x	
Agelaius phoeniceus	Red-Winged Blackbird					x
Icterus parisorum	Scott's Oriole	x	x			
Euphagus cyanocephalus	Brewer's Blackbird					x
Molothrus ater	Brown-Header Cowbird	x			x	

Table SLR II-4 (continued)

Scientific Name	Common Name	Habitat Type[1/]				
		PJ	GG	S	BS	A
FRINGILLIDAE	Finches, Sparrows, etc.					
Carpodacus mexicanus	House Finch	x		x		
Pipilo fuscus	Brown Towhee			x		
Pooecetes gramineus	Vesper Sparrow			x		
Chondestes grammacus	Lark Sparrow			x		
Aimophila ruficeps	Rufous-Crowned Sparrow	x				
Amphispiza belli	Sage Sparrow				x	
Spizella passerina	Chipping Sparrow		x			
Spizella breweri	Brewers Sparrow		x		x	

Source: VTN Consolidated, Inc., 1976a.

1/ Key to Habitat Types
PJ = Pinyon-Juniper
GG = Grama-Galleta
S = Saltbrush-Greasewood
BS = Big Sage
A = Aquatic

Table SLR II-5

REPRESENTATIVE REPTILE AND AMPHIBIAN SPECIES WITHIN THE PROPOSED RAIL CORRIDOR

Order Urodela	Salamanders and Newts
Family Ambystomatidae	
Ambystoma tigrinum	Tiger Salamander
Order Anura	Frogs and Toads
Family Pelobatidae	
Scaphiopus bimbifrons	Plains Spadefoot Toad
Scaphiopus hammondi	Western Spadefoot Toad
Family Bufonidae	
Bufo punctatus	Red-Spotted Toad
Order Squamata	Lizards and Snakes
Family Iguanidae	
Holbrookia maculata	Lesser Earless Lizard
Crotaphytus wislizenii	Leopard Lizard
Crotaphytus collaris	Collared Lizard
Sceloporus magister	Desert Spiney Lizard
Sceloporus undulatus	Eastern Fence Lizard
Uta stansburiana	Side-Blotched Lizard
Phrynosoma douglassi	Short-Horned Lizard
Family Scincidae	
Eumeces multivirgatus	Many-Lined Skink
Family Teiidea	
Cnemidophorus tigris	Western Whiptail
Cnemidophorus velox	Plateau Whiptail
Family Colubridae	
Masticophus taeniatus	Striped Whipsnake
Arizona elegans	Glossy Snake
Pituophis melanoleucus	Gopher Snake
Thamnophis elegans	Western Terrestrial Garter Snake
Hypsiglena torguata	Night Snake
Family Viperidae	
Crotalus viridus	Western Rattlesnake

Source: VTN Consolidated, Inc., 1976a.

known vegetative habitats are summarized in Appendix Table B-23.

AQUATICS

There are only three small livestock impoundments within the proposed right-of-way. There are no fish because of the ephemeral nature of these impoundments. The impoundments do, however, provide habitat for aquatic invertebrates, such as water striders, backswimmers, predacious diving beetles, water boatmen, and numerous other benthic organisms (refer to Appendix Table B-23 for a detailed inventory of aquatic invertebrates).

ENDANGERED AND THREATENED SPECIES

The status of the species discussed in this section is based on the national list, 'Endangered and Threatened Wildlife and Plants' (Federal Register, October 27, 1976), and the New Mexico State Game Commission Regulation No. 563, 'Endangered Species and Subspecies of New Mexico' (adopted January 24, 1975, amended March 7, 1975, December 5, 1975 and May 21, 1976).

The black-footed ferret is the only mammal classified as endangered on both the Federal and State lists that might occur within the inventory area. As stated in the Regional Analysis of this ES, there have been no recent confirmed sightings of the ferret in northwestern New Mexico. The presence of ferrets in the area cannot be discounted, however, since they are nocturnal and are seldom observed even when known to exist.

The peregrine falcon is listed as endangered on both Federal and New Mexico lists. Hubbard (1970) cites the species as being a year-round resident and breeder in the San Juan Valley. Recent confirmed sightings of the falcon in the San Juan and Chaco regions indicate the apparent suitability of these areas to sustain resident populations.

The bald eagle also is listed as endangered on the Federal and New Mexico lists. Hubbard (1970) indicates that bald eagles winter in San Juan County, and have been sighted during mid-summer near Navajo Lake. There are no known bald eagle nests within the inventory area.

No other endangered or threatened animals occur in the region of the proposed rail line.

Aesthetics

NOISE

Ambient sound-level measurements were taken at 30 points from August 25 through August 29, 1975. Noise sensitive points considered in these measurements were schools, churches, homes, communities, trading posts, and chapter houses. Monitoring points at which ambient sound-level measurements were taken are shown in Map SLR II-5. Typical noise readings from those monitoring points are shown in Table SLR II-6.

Ambient noise levels at most receptor points distant from busy roadways ranged from 20 to 40 adjusted decibel level (dBA). Random peak noise levels of 40 to 70 dBA were caused typically by airplane overflights and motor vehicle traffic.

Typical ambient sound levels of various environments are in Regional Table II-13. Noise levels along the proposed route are low compared with most urban and suburban areas.

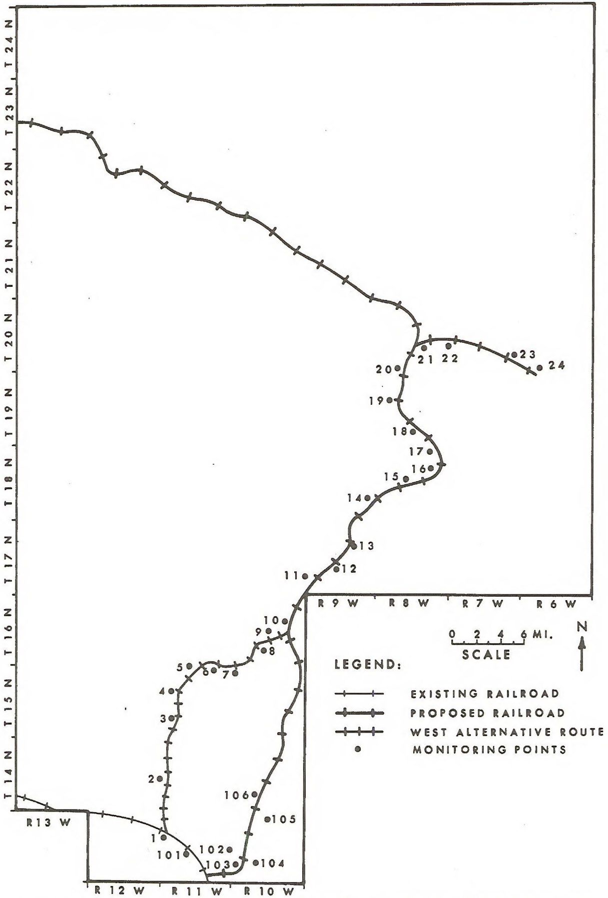
The Environmental Protection Agency has identified that virtually all the population would be protected against lifetime hearing loss when annual exposure to noise averaged on a 24-hour daily level is less than or equal to 70 dBA. The equivalent level (L_{eq}) for 24 hours, weighted for night time noise exposure, is denoted as day-night level (L_{dn}). Noise levels found requisite to residential outdoor enjoyment and to indoor activities are L_{dn} of 55 dBA and L_{dn} of 45 dBA, respectively. Most hearing losses occur with repeated exposures over long periods.

VISUAL RESOURCES

The general landscape characteristics along the SLR consist of broad upland valleys, rolling terrain, mesas, sharp canyons, badlands, and broad dry water courses. The major part of the proposed railroad corridor would be routed across flat or gently sloping terrain, with the undulating surfaces separated by rocky cliffs of flat-lying strata. The route crosses these cliffs through erosional openings.

The intensity of colors along the proposed corridor varies with the lighting, seasons and climatic conditions. Colors of red, brown, tan and gray from the soils and rocks, moderate variations of green, gray and tan from vegetative sources, and blue from the sky reflected in stock ponds and washes exist along the proposed railroad. Within the grassland and sagebrush areas, colors are more muted and less spectacular. The prominent color displays in this region are expressed in the soils and rocks of the badlands, canyons and bluffs.

The semiarid climate results in rather sparse vegetation characterized by little variation in vegetative patterns. Vegetative types occurring along the proposed corridor are grassland, pinyon-juniper, saltbush, greasewood, barren, and waste. A major part of the railroad would be associated with the grassland type. Texture within the region is found in canyons and broken lands with scattered pinyon-juniper vegetation. The rolling flat grassland and sagebrush country represents a smoother texture, but it can appear coarser as the viewer comes closer



MAP SLR II-5. AMBIENT SOUND-LEVEL MEASURING POINTS ALONG THE PROPOSED STAR LAKE RAILROAD.

Table SLR II-6

AMBIENT SOUND-LEVEL MEASUREMENTS
PREWITT TO STAR LAKE, NEW MEXICO

Site No.	Location	Time	dBA Background Range 1/	dBA Random Range and Source 2/		Remarks
1	20' west of C_L gravel road, 50' north of C_L of two Santa Fe tracks (mainline); Baca siding	1706 to 1723	29-32	33-70+	Train whistle, train passby, vehicles, vehicles on local highway, trucks on freeway	Meter span set to read ambient without train peak+
2	Trail on eastside of Andrews Ranch house at narrows, west of RR route	1432 to 1453	20-23	24-46	Insects, horses, wind gusts	
3	Eastside of dirt road to Borrego Pass, at tee road intersection, at "BM 704"	1533 to 1540	20-23	24-60	Vehicle passby, wind gusts	
4	Parking lot, east side of building; Casamero Lake Chapter House, south of Borrego Pass	1032 to 1055	15-18	19-57	Airplane, vehicles to east on road	
5	Eastside Continental Divide dirt road, opposite entrance drive to Borrego Pass Indian School	1150 to 1207	18-21	22-60	Vehicle passby, airplane, archaeology crew yelling	
6	Northside Continental Divide dirt road at tee road to Indian home, northside of RR route; east of Borrego Pass	1340 to 1357	18-21	22-59	Vehicle passby, wind gusts	
7	Southside of Continental Divide dirt road, at RR route xing; northeast of "BM 7644"	1425 to 1442	17-20	21-44	Surveyors in distance stake pounding, vehicle, airplane	
8	Eastside Continental Divide dirt road, at fence (Section 20-29) westside of RR route; southwest of Albers Ranch house	1506 to 1523	19-22	23-60	Vehicle passby, pounding at well drilling to northeast, wind gusts	
9	South side of Continental Divide dirt road, on C_L of power transmission; west of Albers Ranch house	1531 to 1611	31-34	35-79	Vehicles, insects, transmission audible sound	The sound level in environs of elec. transmission varies with weather/humidity.
10	South side of Continental Divide dirt road, at east "Y" of dirt tee road to south; west of Albers Ranch house	0931 to 0948	25-28	29-55	Cattle, insects	
11	East side of Continental Divide dirt road, at RR route xing; east of Albers Ranch house	1028 to 1045	18-21	22-53	Cattle, insects	

Table SLR II-6 (continued)

Site No.	Location	Time	dBA Background Range 1/	dBA Random Range and Source 2/		Remarks
12	South side of Continental Divide dirt road, opposite entrance drive to Escondido Ranch house	1118 to 1128	20-23	24-54	Cattle, insects	
13	Center of trail, at RR route xing; east of Continental Divide; southwest of Hospah	1232 to 1249	16-19	20-44	Airplane, insects, car door, paper rattled	
14	West side of Continental Divide dirt road, at RR route xing; northwest of Hospah	1450 to 1507	34-40	41-79	Airplane, vehicles, insects, survey crew	
15	Trail tee intersection, at RR route xing; northside of Alta Mesa	1609 to 1626	18-21	22-56	Airplane, car door, insects	
16	By "Y" of trail, at RR route xing; north of Prairie Dog Trading Post (closed)	1706 to 1723	18-21	22-57	Rain, wind gusts, insects	
17	Between "tank" and RR route, east of Continental Divide; at Baptist Mission	1000 to 1017	14-17	18-49	Airplane, insects, airplanes in distance, car door	Military jet dog-fight overhead just before measurement started
18	At "Y" of trail, at RR route xing; northeast of Tucker Windmill	1058 to 1115	15-18	19-37	Airplane in distance, dog in distance, grasshoppers	
19	North side of old highway, at fence (Section 8-17), west of RR route, east of new highway; at mouth of Tucker Gap	1904 to 1930	16-19	20-50	Crickets, vehicles on new highway	
20	East side of new highway, southside of service off ramp, at R/W fence, opposite cliff dwellings; in Pueblo Pintado Canyon	1825 to 1842	20-23	24-58	Vehicles on new highway, airplane, wind gusts	
21	North side of new highway, southside of service off ramp, at R/W fence; opposite Pueblo Pintado School	1757 to 1814	30-33	34-60	Vehicle passby, vehicles on highway, wind gusts, yelling/pounding/voices on school ground	
22	South side of old highway, at wash bridge, on RR route; east of Pueblo Pintado School	1710 to 1727	18-21	22-58	Vehicles, airplane, wind gusts	
23	Trail junction, at RR route xing; south of Pueblo Pintado Trading Post	1630 to 1647				

Table SLR II-6 (continued)

Site	Location	Time	dBA Background Range 1/	dBA Random Range and Source 2/		Remarks
24	End of trail, between two tanks; northwest of Star Lake Trading Posts	1313 to 1330	20-23	24-44	Insects, horses, airplane	
101	At dirtroad underpass, 100' north of C_L tracks, 50' west of C_L road (ATSF .2+872 on sign); at Mitchell Draw	1748 to 1812	30-33	34-70	Trains, vehicles on road and freeway	2 trains passed. Meter below and in accoustical shadow from trains.
102	Fence corner, southside of dirt road, southeast of church; south of Haystack Mountain	0942 to 0959	35-38	39-67	Airplane, train in distance, well driller, insects	There was a drilling rig operating in church-yard in the 35-44 range.
103	Pasture fence at Indian farm; southeast of Haystack Mountain	1021 to 1038	16-19	20-50	Insects, grasshoppers, crickets	Quiet
104	East side of road on prolongation of fence to east; Redondo Community	1110 to 1127	16-19	20-59	Airplanes, vehicles, child on bicycle, motorcycle, insects	Quiet punctuated by man
105	West side of dirt road, at tee trail to west	1158 to 1210	20-23	24-45	Indian on horse, grasshoppers, crickets	Quiet
106	North side of dirt road, parallel to Albers Ranch south fence, in terrain saddle, on RR route: Loma de la Gloria	1352 to 1409	20-23	24-52	Airplane, insects	

Source: VTN Consolidated, Inc., 1976a.

1/ Background - the level of sound that is steady within an area.

2/ Random - the sound characterized by not being subject to precise prediction.

Uniqueness gives a measure of added importance to the scenic features within a region. Often it may be a number of commonplace elements in the proper combination that produces the most interesting scenery. The uniqueness factor can be used to recognize this type of area and give it the added emphasis it needs. The badlands within this region are an example.

Land, vegetation, structures, and other man-made improvements that are generally out of context with the characteristic landscape are considered intrusions. Usually, these intrusions are modifications to the natural landscape resulting from the activities of man. Past and present use and occupation in the area has resulted in numerous encroachments on and sensitivities for the natural landscape. These uses and occupations include an interstate highway, rural roads, transmission corridors, pipelines, coal and uranium mining operations, oil and gas wells, housing and community developments, range management improvements and livestock grazing.

Map SLR II-6 shows the proposed railroad alignment as it relates to the four Visual Resource Management (VRM) Classes identified in the area. These classes are part of a procedure in which the visual resources on lands administered by the BLM are identified, mapped, evaluated, and managed (BLM Manual 6310, Visual Resource Inventory and Evaluation). The criteria used in determining VRM classes are scenic quality, sensitivity levels, and distance zones. These are described in more detail in Chapter II of the Regional Analysis.

Land Use

RECREATION

The land in and along the proposed railroad route generally has limited recreational use. Relatively low population, poor roads, diversity in land ownership, few publicized recreational attractions, and a general lack of tourist services have discouraged development of the area's recreation potential. Dispersed recreation activities, such as hunting, off-road vehicle use, and sightseeing, occur within the area.

Chaco Canyon National Monument, the only developed recreation site, is approximately one mile from the proposed railroad at the closest point. This National Monument contains the ruins of 12 major pueblos and several hundred smaller archeological sites. Facilities at the monument include visitor center, campground, and picnic areas.

The Unit Resource Analysis of the Chaco Planning Unit recognized several areas of recreational special interests that would be crossed by the proposed railroad. Areas having a moderate to high capability for recreation experience are shown in Map SLR II-7.

A proposed national trail, referred to as the Continental Divide Trail, could cross the route of the proposed railroad. The trail was proposed under Public Law 70-543, which establishes legislative authority for a national system of hiking trails.

TRANSPORTATION

The transportation system in the vicinity of the proposed rail line is an integral part of the transportation system of the ES Region. How these specific elements function in the regional context is discussed in greater detail in Chapter II of the Regional Analysis.

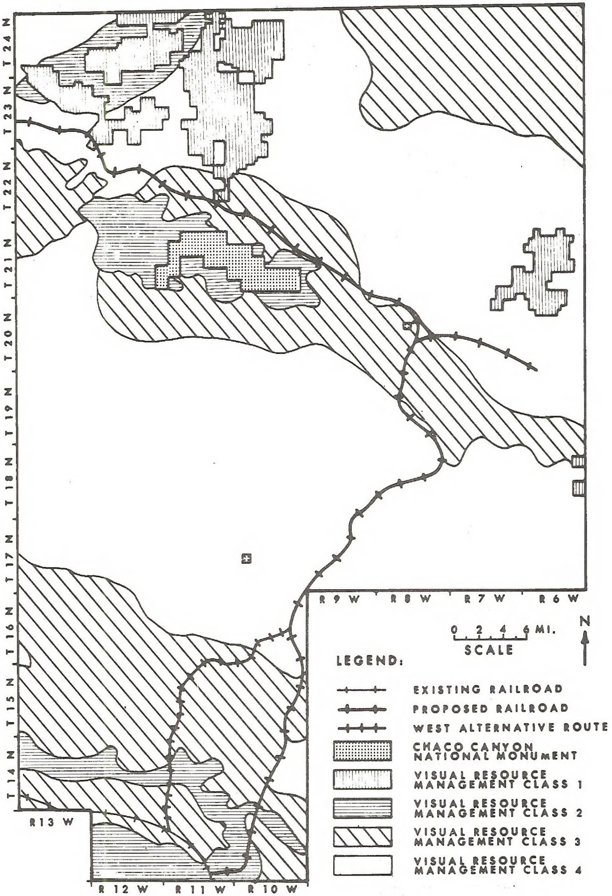
Highways

The only highway of interstate or interregional importance in the vicinity of the proposed rail line is Interstate (I) 40, which passes immediately south of the existing Santa Fe main line. This highway, together with a north-south route comprised of parts of State Highways 57 and 371 and the north-west-southeast aligned State Highway 44, form the framework for the road network in the ES Region (Map A). The proposed rail line would cross Highway 57 north of Chaco Canyon National Monument and Highway 371 south of Bisti.

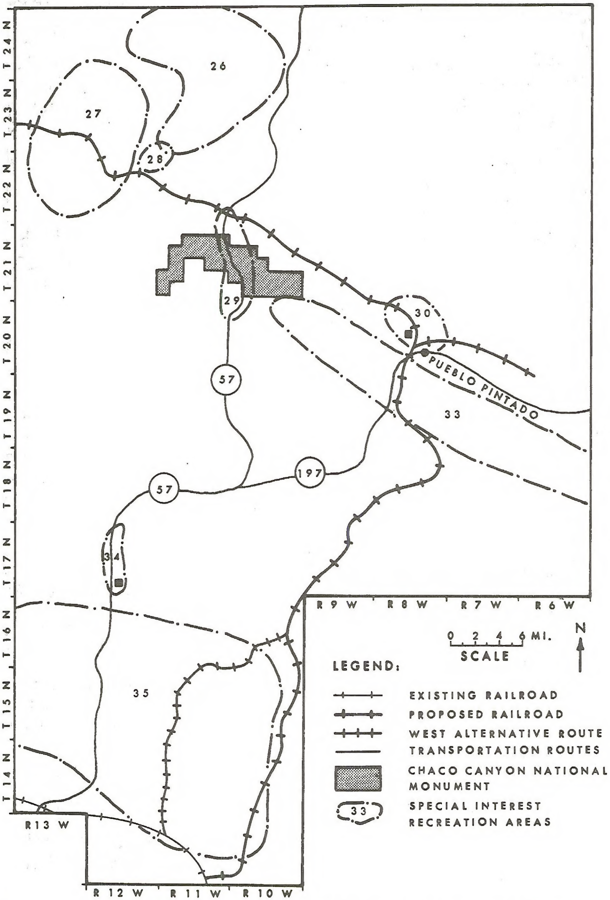
The rest of the road network in the vicinity of the proposed rail line serves primarily to connect small, isolated population centers to the three major routes. The major elements in this part of the road network consist of BIA-maintained roads and some limited segments of the State highway system. Additionally, there are numerous barely improved public and private roads or trails which serve primarily as shortcuts between major elements of the road network. None of these roads are paved except Navajo Route 9 and State Highway 197, which provide a connection between Highway 371 at Crownpoint and Highway 44 at Cuba. All these roads have light traffic volumes. The proposed SLR would cross Route 9 in Pueblo Pintado Canyon and many of the minor roads throughout its entire length.

Railroads

The main line of the Atchison, Topeka and Santa Fe Railway (Santa Fe) is the only existing rail line in the vicinity of the proposed action. In this area, the line is generally aligned in an east-west direction parallel to I-40. A double-track structure with automatic block signals, it is a major east-west link in the Santa Fe system, carrying between 25 and 30 trains per day.



MAP SLR II-6. TENTATIVE VISUAL RESOURCE MANAGEMENT CLASSES ALONG THE PROPOSED STAR LAKE RAILROAD.



MAP SLR II-7 SPECIAL INTEREST RECREATION AREAS ALONG THE PROPOSED STAR LAKE RAILROAD.

Airports

Airport facilities in the vicinity of the proposed action are limited to dirt landing strips at Ambrosia Lake, Borrego Day School, Whitehorse, Pueblo Pintado, Tanner, and Chaco Trading Post. Except for Whitehorse and Tanner, these airports are restricted to private use. Operations at the airports in this area are limited to occasional flights by light planes; the nearest commercial service is at Gallup.

GRAZING

Livestock grazing is the primary agricultural activity in the area. Grazing land use is discussed fully in Chapter II of the Regional Analysis. Agricultural land devoted to field crops is minimal; the agriculture that exists is essentially a subsistence type, limited to dry farming of small corn patches near homes. The entire proposed route can be classified as rangeland.

Sheep and goats constitute about 62 percent, horses 24 percent, and cattle 14 percent of livestock grazing in the area. The 20 grazing allotments affected by the proposal are shown in Map SLR II-8. Except for Allotment 12 along the northwest part of the rail line, allotments are grazed year-round without seasonal pasture rotation. Allotment 12 is under an allotment management plan discussed more fully in Chapter II of the Regional Analysis. Forage productivity varies greatly from year to year depending on precipitation, class of livestock grazed, and different management practices. Stocking rates on public lands in allotments affected by the proposal range from 3.5 to 14 acres per AUM. In the southern part of the right-of-way, public lands are scattered and grazing leases are smaller, generally about 700 acres per lease. Currently, permits on these leases are stocked at a rate of 9 acres per AUM.

Range condition estimates for all lands are not available, but 77 percent of the public lands in the region are classified as being in satisfactory condition. Only 32 percent of this land, however, is classified as being in an upward trend; 53 percent is classified as static, and 15 percent as declining. Factors contributing to the decline include continual use around dependable water and housing concentrations, traditional patterns of diurnal sheepherding to and from hogans, minimal trespass control since 1966, poor water distribution, concentration of use in treated areas, some areas overrated, and low forage production during periods of prolonged drought.

Livestock watering places, consisting of deep wells, hand-pumped shallow wells, and earthen tanks, are scattered throughout the area.

WILDERNESS

At present, there are no national wilderness areas within the ES Region in which the proposed SLR is located. However, pursuant to the FLPMA wilderness review process, 24 wilderness inventory units within the ES Region have been identified. The wilderness inventory units and the status of these units is discussed in more detail in Chapter II of the Regional Analysis. Two of these areas, NM-010-09 and NM-010-58, would be within the proposed right-of-way. Map II-9 shows the relationship of these units to the SLR right-of-way and their recommended status pursuant to the wilderness inventory procedures.

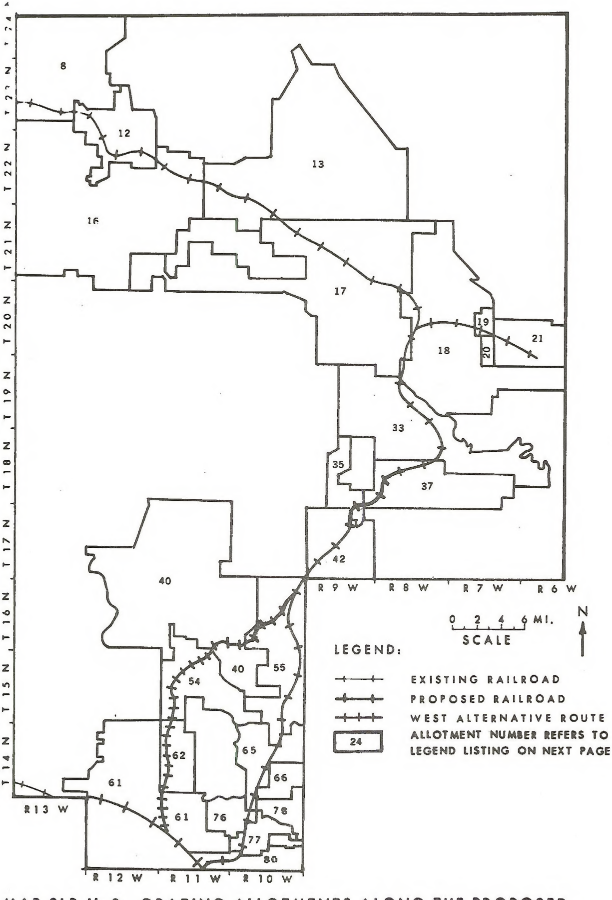
Cultural Resources

Consultation on the cultural resources in the proposed right-of-way has been initiated with the State Historic Preservation Officer. The right-of-way was inventoried for cultural resources by New Mexico State University (NMSU) (Bussey, et al., 1976, Rorex, et al., 1976, Bussey, 1977, Brethauer, 1977, and Hoyt et al., 1978), and by work directed by William M. Harrison (1975) (Table SLR II-7). These surveys covered only the land surface to be disturbed by the rail line and the service and repair yard; sites for communications facilities, wells, water lines, and construction facilities have not been inventoried.

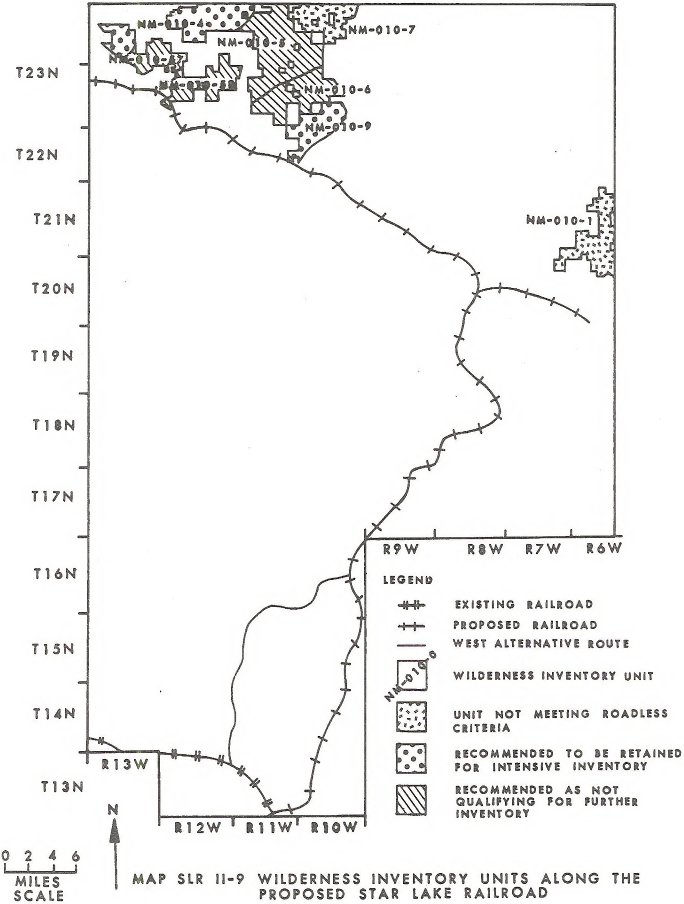
Although the surveys have not yet been accepted or rejected by BLM, parts of the proposed right-of-way were field-checked in May 1978 and several deviations from the previous surveys were found. The check reinventoried approximately 5 percent of the 114-mile right-of-way. The reinventory located 13 sites as compared with 6 sites listed in the previous inventories. Three of these (two lithic scatters and a hearth) are within the right-of-way and on federal land. Information from the existing inventories is summarized below and on Table SLR II-7. The estimated site totals in Table SLR II-8 compensate for some of the differences in the existing inventories.

Cultural resources in the immediate vicinity of the right-of-way reflect most of the cultural manifestations common to the San Juan Basin. Least abundant are indications of earliest occupations--PaleoIndian and Archaic hunters and gatherers. The two lithic sites (Lithic 1 and 2) may represent one or both of these occupations although no diagnostic materials were reported. Evidence of these occupations is generally sparse, and the failure of the survey to find them does not necessarily indicate their absence. The one lithic site located in the BLM field check suggests that additional lithic remains will be discovered.

Agriculturally-based social organizations in the San Juan Basin developed, reached their climax,



MAP SLR II-8. GRAZING ALLOTMENTS ALONG THE PROPOSED STAR LAKE RAILROAD.



MAP SLR II-9 WILDERNESS INVENTORY UNITS ALONG THE PROPOSED STAR LAKE RAILROAD

Table SLR II- 7

CULTURAL RESOURCES SUMMARY

Site#	Site Type	Site Characteristics	Sig. Est.	Impact	Land Status	Location Comment
1	Anasazi	Eight-to twelve-room pueblo, kiva, sherd and lithic scatter	5	I	PVT	Pueblo II-III; 20 feet outside right-of-way
2	Anasazi	Pithouse village of eight depressions containing sherd and	5	I	PVT	Basketmaker III Pueblo I, 15 feet outside right-of-way
3	Anasazi	One-room structure on small mound, sherd scatter, mano fragment	4	I	IA	Pueblo II-III, 395 feet outside right-of-way
4	Navajo	Hogan, Corral, two trash piles	3	I	IA	Historic, 225 feet outside right-of-way
5	Navajo	Rock hogan, sherds and lithics washed from pueblo on ridge above	3	I	PVT	Historic, 365 feet outside right-of-way
6	Anasazi	Several stone rooms, trash mound, sherd and lithic scatter	5	I	PVT	Pueblo II-III, 95 feet outside right-of-way
7	Anasazi	Wall remnant, dense sherd and lithic scatter	4	I	IA	Pueblo II-III, 120 feet outside right-of-way
8	Anasazi	Thirteen-room (?) pueblo, refuse pile, ceramics, pile and line of rocks	5	I	IA	Pueblo II, 75 feet outside right-of-way
9	Anasazi	Sherd Scatter	3	D	PVT	On centerline, recommended re-examination & testing
10	Anasazi	One-room masonry structure, dense sherd and lithic scatter	4	I	PVT	Pueblo II-III, 100 feet outside right-of-way
11	Anasazi	Sherd scatter	3	D	PVT	Pueblo II, 20 feet outside right-of-way
12	Anasazi	Sherd scatter	3	D	PVT	Inside right-of-way, recommended re-examination and testing
13.	Navajo	Ceremonial (?) hogan	4	I	PVT	Historic, 40 feet outside right-of-way
14.	Navajo	Sand-filled storage cist built around undercut boulder	2	I	PVT	Age unknown, 470 feet outside right-of-way
15	Navajo	Hogan remains, firepit, trash	3	I	IA	Historic, 680 feet outside right-of-way
16	Navajo	Cribbed-log hogan, brush corral	3	I	PVT	Recent, 60 feet outside right-of-way
17	Navajo	Fork-stick sweat lodge or hogan	3	I	PVT	Prehistoric (?), 95 feet outside right-of-way
18	Anasazi	Rockshelter with hearth and sherd scatter	3	I	ST	Basketmaker III Pueblo II, 25 feet outside right-of-way
19	Navajo	Corral of juniper branches	2	I	ST	Modern, 60 feet outside right-of-way
20	Euro-american	Butchering corral of upright logs	2	I	PVT	Escondito Ranch, 35 feet outside right-of-way
21	Unclassified	Log dam	2	I	PVT	Navajo (?), 60 feet outside right-of-way
22	Unclassified	Log and brush corral	2	I	PVT	Navajo (?), 80 feet outside right-of-way
23	Euro-american	Lean-to frame of brush and sandstone slabs	2	I	PVT	Early 1900's, 65 feet outside right-of-way
24	Unclassified	Stone pillar	2	I	PVT	Pueblo or Navajo, 155 feet outside right-of-way
25	Navajo	Log and brush corral	2	I	PVT	Historic, 100 feet outside right-of-way
26	Unclassified	Corral of upright posts	2	I	PVT	110 feet outside right-of-way
27	Navajo	Stone hogan with cribbed-log roof against a cliff	3	I	PVT	Pre-reservation (?), 60 feet outside right-of-way

Table SLR II-7(Continued)

Site#	Site Type	Site Characteristics	Sig. Est.	Impact	Land Status	Location Comment
28	Navajo	Forked-stick sweathouse	2	I	PVT	465 feet outside right-of-way
29	Navajo	Two posts set in ground to form triangle with juniper tree	2	I	PVT	20th century, 260 feet outside right-of-way
30	Navajo	Sandstone slab shrine	3	I	PVT	195 feet outside right-of-way
31	Navajo	Log and sandstone dam	3	I	PVT	20th century, 10 feet outside right-of-way
32	Navajo	Stone firepit, ashpit	2	I	PVT	20th century, 5 feet outside right-of-way
33	Navajo	Semi-circular stone firepit, ashpit	2	I	PVT	20th century, 80 feet outside right-of-way
34	Navajo	Log and brush hogan, surface trash	3	I	PVT	20th century, 205 feet outside right-of-way
35	Navajo	Forked-stick sweathouse, two piles of burnt sandstone chips	2	I	PVT	140 feet outside right-of-way
36	Navajo	Forked-stick sweathouse, corral	3	I	PVT	Recent, 185 feet outside right-of-way
37	Navajo	Square corral of upright posts	2	I	PVT	20th century, 230 feet outside right-of-way
38	Navajo	Small sandstone hogan	4	I	PVT	Special use (?), 35 feet outside right-of-way
39	Navajo	Forked-stick sweat-	3	I	ST	70 feet outside right-of-way
40	Lithic	Lithic scatter	3	D	PVT	On centerline, no remaining surface evidence
41	Navajo	Stone masonry hogan, trash area	3	I	PVT	Historic, 260 feet outside right-of-way
42	Navajo	Two stone hogans	3	I	IA	Historic, 290 feet outside right-of-way
43	Navajo	Hogan with modern foundation with firepit	3	I	IA	Mid-1900's, 10 feet outside right-of-way
44	Navajo	Hogan, oven, stone corral, rock-shelter, trash area	5	I	IA	Early 1900's, 95 feet outside right-of-way
45	Anasazi	Heavily eroded pithouse, ten dwelling depressions, artifact scatter	5	I	IA	Pueblo II-III, 35 feet outside right-of-way
45	Anasazi	Heavily eroded pithouse, ten dwelling depressions, artifact scatter	5	I	IA	Pueblo II-III, 35 feet outside right-of-way
46	Anasazi	Sherd scatter	3	I	ST	35 feet outside right-of-way
47	Anasazi	Pithouses (?), sherd scatter	4	I	ST	Pueblo II-III, 265 feet outside right-of-way
48	Anasazi	Six or more badly eroded pithouses, sherd and lithic scatter	5	I	BIA	Pueblo II-III, 20 feet outside right-of-way
49	Anasazi	Five pithouses (?), light sherd scatter	5	I	IA	Pueblo II-III, 95 feet outside right-of-way
50	Anasazi	Five-room stone building, kiva (?), ceramic and lithic scatter	5	I	BIA	Pueblo II-III, 275 feet outside right-of-way
51	Anasazi	Two pithouse depressions (?), petroglyphs, dense artifact scatter	5	D	IA	Pueblo III, NE portion of site crossed by right-of-way fencing
52	Navajo	Sweathouse	3	I	NTFL	Historic, 175 feet outside right-of-way
53	Anasazi	Two or three pithouse depressions, artifacts	4	I	NTFL	Pueblo II, 5 feet outside right-of-way
54	Anasazi	Two stone masonry-lined pithouses	4	I	NTFL	Pueblo II-III, 60 feet outside right-of-way
55	Anasazi	Collapsed rock shelter three sherd scatters, burnt corn	4	I	NTFL	Pueblo II-III, 60 feet outside right-of-way

Table SLR II-7 (continued)

Site#	Site Type	Site Characteristics	Sig. Est.	Impact	Land Status	Location Comment
56a	Anasazi component	Pithouse (?), rectangular pit with masonry walls, light lithic scatter	4	I	NTFL	Pueblo II, 15 feet outside right-of-way
56b	Navajo	Stone hogan, rock and mortar oven, stone masonry oven	3	I	NTFL	Modern, 15 feet outside right-of-way
57	Navajo	Stone oven	2	I	NTFL	Modern, 35 feet outside right-of-way
58a	Anasazi component	Rock art, petroglyphs, a few sherds	4	I	NTFL	Basketmaker III, 175 feet outside right-of-way
58b	Navajo component	Stone hogan, two ovens	3	I	NTFL	Historic, 175 feet outside right-of-way
59	Navajo	Stone hogan, corral	3	I	NTFL	Modern, separate locations, hogan 160 feet outside right-of-way, corral 70 feet outside right-of-way
60	Navajo	Sweathouse, two stone oven rings	3	D	NTFL	Modern, site intruded by RR fence
61	Navajo	Two stone hogans, rectangular depressions, corral, car, two trash piles	3	I	BIA	Historic, 180 feet outside right-of-way
62a	Anasazi component	Stone wall, sherds	4	I	BIA	Pueblo II, 535 feet outside right-of-way
62b	Navajo component	Hogan, trash	3	I	BIA	Historic, 535 feet outside right-of-way
63	Navajo	Four hogans, sweathouse, ovens, firepile, rock pile, two trash areas	4	I	BIA	Mid-1900's, 570 feet outside right-of-way
64	Anasazi	Rock shelter, artifacts	3	I	BIA	Pueblo II-III, 230 feet outside right-of-way
65a	Anasazi component	Rock art, ceramic scatter	4	I	GT/NT	25 feet outside right-of-way
65b	Navajo component	Rock art, modern trash	4	I	GT/NT	25 feet outside right-of-way
66	Anasazi	Masonry pithouse, two depressions (pithouses?), sherd and light lithic scatter	4	I	GT/NT	Pueblo II-III, 25 feet outside right-of-way
67	Unclassified	Smoke-stained rock shelter with two stone walls	3	I	GT/NT	Navajo shelter or pen (?), 385 feet outside right-of-way
68	Navajo	Two sandstone enclosures, slab and brush shelter, three firepits (CCC camp site?) (cf. Bailey & Bailey, 1978: 46-50)	4	D	GT/NT	1930's-50's, inside right-of-way, recommended excavation to coordinate archaeological and ethnographic data
69	Navajo	Sandstone hogan ring, historic trash	3	I	BIA	Modern use, 320 feet outside right-of-way
70a	Anasazi component	Masonry wall, sherd scatter	4	I	BIA	Pueblo III, 340 feet outside right-of-way
70b	Navajo component	Lambing pens, fireplaces	3	I	BIA	Modern, 340 feet outside right-of-way
71a	Anasazi component	Three-room structure with kiva (?)	5	I	IA	Pueblo II-III, 330 feet outside right-of-way
71b	Navajo component	Two stone hogans, three ovens, water check dam, room (?)	5	I	IA	Historic, 330 feet outside right-of-way
72a	Anasazi component	Prehistoric trash mound, sherds	4	I	BIA	Pueblo II-III, 545 feet outside right-of-way
72b	Navajo component	Historic trash	4	I	BIA	Historic, 545 feet outside right-of-way
73	Navajo	Stone and adobe structure with hearth, light ceramic scatter	4	I	BIA	Historic, 125 feet outside right-of-way
74	Anasazi	Stone structure (three rooms ?), pithouse (?), trash scatter	5	I	BIA	Pueblo I (?), 135 feet outside right-of-way
75	Navajo	Remains of large stone structure, hogan, trash heap, pottery scatter, eight rock circles averaging two meters in diameter	5	I	BIA	Early 18th century, 45 feet outside right-of-way
76	Navajo	Metate, sherds, worked flakes	3	I	NTFL	19th century (?), 350 feet outside right-of-way

Table SLR II- 7 (continued)

Site#	Site Type	Site Characteristics	Sig. Est.	Impact	Land Status	Location Comment
77a	Anasazi component	Pottery scatter in small mound	4	I	BLM	Pueblo, 40 feet outside right-of-way
77b	Navajo component	Wooden hogan, two small stone structures, historic trash	4	I	BLM	Historic, 40 feet outside right-of-way
78	Anasazi	Sherd and lithic scatter	3	I	IA	Pueblo I-II, 5 feet outside right-of-way
79a	Anasazi component	Prehistoric artifact scatter	3	I	IA	Pueblo I-II, 40 feet outside right-of-way
79b	Navajo component	Modern structure (hogan?)	3	I	IA	Historic, 40 feet outside right-of-way
80	Anasazi	Firepit, sherd scatter	3	I	IA	Pueblo I-II, 15 feet outside right-of-way,
81	Navajo	Hogan, prehistoric refuse	3	D	NTFL	Historic, partially within right-of-way
82	Anasazi	Fire-cracked sandstone light lithic scatter, one black-on-white Chacoan sherd	3	I	NTFL	Pueblo III, 5 feet outside right-of-way
83	Anasazi	One hearth (?), eight sherds, two groundstone fragments (?)	2	I	NTFL	20 feet outside right-of-way
84	Lithic	Lithic and ceramic scatter	3	D	NTFL	On centerline, re-examine and collect or test
85	Anasazi	Ceramic scatter	3	I	ST	Pueblo II, 10 feet outside right-of-way
86a	Anasazi component	Several small room-blocks of sandstone, light sherd scatter	4	I	ST	110 feet outside right-of-way
86b	Navajo component	Two stone cairns, two cans	2	I	ST	Historic, 110 feet outside right-of-way
Pre-his-roads	Anasazi	Three road segments (?) crosscut by the rail-line	3	D	BLM & IA	Recommend testing to determine road surface and collection of associated artifacts
87	Unclas-sified	Base of one point	3	I	BLM	100 feet outside right-of-way
88	Anasazi	Three concentrations plus scatters of lithics and ceramics	3	I	BLM	80 feet outside right-of-way
89	Navajo	Recent tent site and historic trash presently used as sheep camp (related to VIN5-9?) (cf. Bailey & Bailey 1978:51-53)	4	D	IA	Inside right-of-way, presently used, recommended excavation to coordinate archaeological and ethnographic data
90a	Anasazi component	Ceramic scatter	3	D	IA	Pueblo II, on right-of-way line
90b	Navajo component	Historic trash and oven (Navajo sheep camp?) (cf. Bailey & Bailey 1978:51-53)	4	D	IA	Same recommendation as for 89, some testing already completed (Hoyt et al, 1978:39-42), on right-of-way line
LA	Anasazi	Pueblo Pintado-multi-room, multi-story Chacoan site	6	I	NPS	Pueblo III, an outlying portion of Chaco Canyon National Monument

Sources: Bussey, et al., 1976; Rorex, et al, 1976; Bussey, 1977; Brethauer, 1977; Hoyt, et al., 1978; Harrison, 1975.

Note: Significance estimates (Sig. Est.) range from 1 through 6. Estimates of 4 or greater may be eligible for National Register nomination. Ascending numerical rankings indicate increasing importance of cultural materials. A complete explanation of the ranking system is included in Appendix B. Impact is either direct (D) or indirect (I).

Key to land status:

BIA	=	Bureau of Indian Affairs
BLM	=	Bureau of Land Management
GT/NT	=	Government Trust/Navajo Tribe (BIA)
IA	=	Indian Allotment (BIA)
NPS	=	National Park Service
NTFL	=	Navajo Tribal Fee Land
PVT	=	Private
ST	=	State of New Mexico

Table SLR II-8

NUMBER OF SITES IN VICINITY OF PROPOSED
SLR RIGHT-OF-WAY BY CULTURAL AFFILIATION

Cultural Affiliation	Within Right-of-Way		Vicinity of Right-of-Way		Total Present	
	Observed	Estimated	Observed	Estimated	Observed	Estimated
Lithic	2	2–7	0	0–10	2	2–17
Anasazi	5	5–9	37	37–46	42	42–58
Navajo	5	5–10	45	45–55	50	50–65
Euroamerican	0	0–5	2	2–12	2	2–17
Unclassified	0	0–5	6	6–16	6	6–21

Sources: Bussey, et al., 1976; Rorex, et al., 1976; Bussey, 1977; Brethauer, 1977; Hoyt, et al., 1978; Harrison, 1975.

and collapsed during the Anasazi period. Anasazi sites are numerous near the proposed right-of-way; 42 to 58 sites ranging from Basketmaker through Pueblo III should be expected. These represent occupation from approximately 600 AD to 1300 AD. Remains include Basketmaker pit-house villages, multiple-room pueblos with kivas and associated trash mounds, rock shelters, shrines, segments of prehistoric Chacoan roads, and ceramic scatters. Summary descriptions are available in Table SLR II-7. Potentially these sites are valuable for understanding processes of social and economic change. Minimally, sites with significance estimates of four or greater should be considered eligible for nomination to the National Register of Historical Places (see Appendix B for a discussion of significance estimates). Presently, twenty-seven Anasazi sites appear to meet these criteria (Table SLR II-7). The largest single site in the vicinity of the right-of-way is Pueblo Pintado. This impressive Pueblo III structure is listed in the National Register and administered by the National Park Service.

Sites in this area also represent the rise of the Navajo pastoral economy and its changes through time. The surveys located 50 Navajo sites near the right-of-way. Most sites are historic hogans, sweat lodges, corrals, and associated trash. Various types of cultural occurrences, including rock art, were also found (Table SLR II-7). The highest significance ratings have been given to sites that are unique or appear to have the greatest research value. On this basis, perhaps 13 sites appear to be eligible for inclusion in the National Register. The number may change as more information becomes available.

The remaining sites contain Euroamerican and unclassified materials. The two Euroamerican sites (20 and 23 in Table SLR II-7) have materials associated with historic ranches in the region. The unclassified sites are probably Navajo, but lack diagnostic material suitable for definitive classification.

Socioeconomic Conditions

The proposed line would run across sparsely populated areas and serve as a primary means of coal (and equipment, materials, supplies) transport in the ES Region. The railhead site near Prewitt would be located near an area already experiencing rapid growth due to uranium development.

The proposed line would be near only small settlements with few available housing facilities or other social support systems. The transportation previously discussed would be used for access between available housing and service areas and the work areas of the railroad.

The primary assessment region has been defined to encompass McKinley County and the northern part of Valencia County, particularly Grants and Milan, although the eastern portion of the line would spur into western Sandoval County. The line would traverse much of the sparsely settled lands of the Eastern Navajo Agency. Persons whose primary language is Navajo comprised over 38 percent of the estimated 107,900 persons in McKinley and Valencia Counties in 1970. Persons speaking Spanish comprised over 26 percent, and those speaking English comprised over 34 percent (Bureau of the Census, 1972b). The rapidly growing Grants/Milan area in Valencia County with a 1977 estimated population of 12,900 (Harbridge House, Inc., 1978) is 12 miles southeast of the terminus of the Star Lake Railroad with the Santa Fe main line. The region is one where subsistence ranching by Navajos predominates, but this lifestyle has undergone recent change as uranium exploration and mining activity has increased. Steep increases in oil, natural gas and coal exploration and production activity have also recently occurred.

As the price for uranium has soared, the Grants/Milan area is again experiencing the boom conditions of the 1950's. Crownpoint, about 40 miles from the southern terminus of the Star Lake Railroad, is also experiencing recent rapid growth as a result of nearby uranium activity. Shortages in housing, educational and health facilities, and safety personnel, and increased crime are becoming more common in the Grants/Milan area. The ability of governments at all levels to provide adequate services is being tested. Public authorities are being forced to borrow up to statutory debt limits and to appeal to the state for aid (New Mexico Department of Finance and Administration, 1977a, b, c).

The economic sectors employing the most people are, in order, government, mining, education, and trade. Mining of coal and uranium is the largest basic, or export, sector, and the relative importance of this sector to the economy of the two counties is expected to increase. Per capita income in McKinley and Valencia counties is $4,491, and has been rising at a rate of 10.8 percent per year since 1970. Hispanos and Indians still lag behind Anglos in income by as much as 85 percent (Harbridge House, 1978). The unemployment rate in the two counties in 1977 was 7.1 percent, but wide disparities exist, with unemployment rates among the Navajo of the Eastern Navajo Agency reported to be about 40 percent (Bureau of Indian Affairs, 1976).

Chapter II of the Regional Analysis contains a more detailed discussion of the socioeconomic conditions.

FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

General

If the Star Lake Railroad is not built, the coal mines dependent on it for transportation would not be developed. However, other mines would continue to operate as described in the Regional Analysis. These and other economic developments, such as uranium mining and milling, would continue to have slight, but unknown effects on such resources as air quality, soils, vegetation, wildlife, noise, and grazing. Exploration, development, and production of mineral resources, principally coal, oil and gas and uranium would continue.

In the absence of the railroad, natural erosional processes would continue to cover some geological exposures and excavate others.

Archaeological, historical and paleontological resources would be subject to gradual depletion through unauthorized collection, vandalism, and natural processes of erosion. The rate of loss, however, would be significantly lower than that resulting from construction of the railroad.

Water Resources

Most of the proposed railroad would run through grazing land. Wells generally are few and far between, with yields of only a few gallons per minute. A few more stock or domestic wells may be drilled to replace existing wells or provide a more convenient water source, but withdrawal of ground water from wells will not increase noticeably.

There may be a significant change in groundwater pumping arond Ambrosia Lake. Many of the uranium mines in the Westwater Canyon Member of the Morrison Formation have to be dewatered. At the present time (1978), it is not certain what trend this pumping will take. However, it seems likely that pumping from the Westwater Canyon Member will increase as old mines go deeper and new mines are started.

The existing coal and existing and proposed uranium mining in the area may affect flow and sediment characteristics of streams in the immediate vicinity of the activity. Otherwise, streamflows and sediment discharges will remain about the same as at present.

Visual Resources

The landscape character along the railroad will not change from its characteristic rolling terrain, broad upland valleys, mesas, canyons, badlands, and dry water courses. Visual intrusions into the characteristic landscape can be expected through developments that are not related to the railroad. Continuing oil and gas exploration, mining operations and other possible developments of alternate energy sources will result in changes in form, line, color, and texture, primarily through disturbance to the soil and vegetation. Other deviations in color and line will result from construction of surface facilities.

Visual resources along the proposed route would generally remain as described in the existing environment. However, some visual intrusions into the characteristic landscape would occur from the implementation of the proposed grazing systems. Addition of range improvements will cause some changes. The contrast created by some of these disturbances will be short term. Over a period of years, these developments will blend in. However, areas of livestock overuse, livestock concentration, and improper placement of range structures will create visual intrusions.

With the continual increase in population, housing developments in the principal communities and surrounding areas within the ES Region will continue to create a variety of contrasts.

Some programs, such as watershed improvements to help reduce erosion, rehabilitation of disturbed areas, and enhancement projects that borrow dominant elements from the landscape, may improve the aesthetic attractiveness of the region.

Land Use

TRANSPORTATION

Highways

Development of energy resources, with its concomitant population growth, is already increasing the amount of highway use in northwestern New Mexico. This includes, to some degree, the highways in the vicinity of the proposed rail line. It is expected that this trend would continue if the proposed rail line is not built. To accommodate increases in highway use, State Highway 371 is being reconstructed as a two-lane paved highway from the Crownpoint area to Farmington. Although parts of the local road network would need to be upgraded, none of these improvements would be in the immediate vicinity of the proposed action. Aside from Highway 371, the highways that would be crossed by the proposed rail lines are situated so that planned development would not significantly increase their level of utilization.

Railroads

The Santa Fe has indicated that it has no formal plans for rail-related improvements in the vicinity of the proposed rail line. It is presently considering the installation of TCS on the main-line; however, elimination of the Star Lake Railroad may delay the need for this improvement. Consolidation Coal Company and El Paso Natural Gas Company (ConPaso) have made a joint right-of-way application to the Navajo tribe to construct a rail line from their coal lease near Burnham southward to the Santa Fe's Defiance branch and northward to the San Juan Power Plant. Development of this line would be independent of the proposed action in this ES (see Chapter VIII of the Regional Analysis).

Airports

There are no known plans to improve the airports in the vicinity of the proposed rail line. Increased population and economic activity will probably increase the frequency of operations at those airports open to the general public.

WILDERNESS

The lands along the proposed right-of-way identified as meeting the roadless and wilderness characteristics criteria presented in FLPMA will be managed in accordance with the law to prevent the impairment of their suitability for designation as wilderness. Restrictions imposed by Section 603 of FLPMA during the wilderness review process will no longer apply to those inventory lands that clearly and obviously did not meet the wilderness study area criteria. Those lands no longer being carried through the wilderness review procedures will be returned to ongoing multiple-use management.

Socioeconomic Conditions

Increases in basic and secondary employment will occur in and adjacent to the ES Region as a result of the expansion of oil and natural gas operations; uranium exploration, mining, and milling; Federal and non-Federal coal mining, and the related construction and expansion of coal-fired electric generation facilities; and the Navajo Indian Irrigation Project. The resulting increased population will display different social characteristics from those exhibited today, including ethnic affiliation, life-style, age, and marital status. Gross earnings and per capita income will also rise, primarily as a result of expansion in the mining, utility, and construction sectors. The increased population will place greater demands on the local infrastructure, particularly in the areas of transportation, health care, education and housing. Refer to the analysis in Chapter II, and to the tables in Chapter VIII of the Regional Analysis for greater detail.

CHAPTER III

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

THIS CHAPTER ANALYZES THE ENVIRONMENTAL IMPACTS OF THE STAR LAKE RAILROAD. IN ADDITION, IMPACTS ARE CONSIDERED FROM THE DEVELOPMENT OF THE ALAMITO, SOUTH HOSPAH, AND STAR LAKE MINES, WHICH WOULD USE THE RAILROAD TO HAUL COAL. WHERE DATA ARE AVAILABLE IMPACTS ARE LINKED TO SPECIFIC ACTIONS AND ARE QUANTIFIED AS TO MAGNITUDE, INTENSITY, AND DURATION.

CHAPTER III

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

GEOLOGIC SETTING

Topography

Changes in topography caused by the construction of the railroad would be small and limited to a long narrow band. Although the route would avoid rapid changes in elevation, many cuts and fills would be necessary (see Table SLR I-5). The two largest cuts would be located southwest of Mesa Amada (about 17 miles from the junction with the mainline), and just south of where the west branch of the railroad would cross Escavada Wash (about 16 miles west of Pueblo Pintado). A section along the entire length of the railroad showing all cuts and fills is on file with the Interstate Commerce Commission.

Additional impacts that would take place as a result of building the railroad would be the disturbance by the year 1990 of 7,295 acres from coal mining and development of communities in which the workers would live. Locally these disturbances would be significant, but over the region as a whole the changes would be negligible.

Stratigraphy and Structure

Estimates of the relative impacts of railroad construction and maintenance on each of the geologic units along the proposed rail line are based on the number of miles of rail line that cross each unit (see Table SLR III-1). Impacts on a given unit may be more extensive per mile of rail line when sidings and service facilities occur along the rail line, such as impacts on the basalt rocks from planned facilities on the first 2-1/4 miles of rail line near Prewitt.

Railroad construction and maintenance and the related development would have a negligible effect on the stratigraphy and structure of the area. About 745,000 cubic yards of basalt would be used for ballast and rip-rap. Fresh exposures of some units during construction may provide additional stratigraphic information.

Geologic Hazards

Slope stability and rockfalls are possible problems in construction of the railroad. Slopes in shale or alluvium, which would constitute a major portion of the roadbed, could become unstable from steep cuts made during construction. Steepening of shale slopes overlaid by sandstone could create conditions favorable for rockfalls. Examples of places where this could be a problem are Pueblo Pintado Canyon, where the massive Cliff House Sandstone is underlain by the weaker shale of the Menefee Formation, and the Mesa Amada area, where the Point Lookout Sandstone overlies the Mancos Shale (see Map SLR II-2). No recent faulting is known along the proposed route and any older faults are not perceived to be problems.

Paleontology

The railroad right-of-way is located in areas of minimal relief, typically valley fills or pediment surfaces that do not contain substantial amounts of geological exposure. Negative impacts from construction are not anticipated for paleontological resources in covered areas. However, there may be substantial impacts where construction involves bedrock disturbance.

There is limited concern for most of the 34 fossil localities identified by paleontological survey along the right-of-way, but 14 localities would be disturbed or destroyed during construction. Nine localities are in the Mesa Verde Group along the Prewitt to Pueblo Pintado section of the railroad. Little is known about fossil resources from this stratigraphic section. The Bisti to Pueblo Pintado section would directly impact five localities with fossilized Cretaceous invertebrate, vertebrate and plant materials. The University of New Mexico under contract to the BLM has located additional deposits of vertebrate, invertebrate, and plant materials near the proposed construction site. Bedrock disturbances in this part of the right-of-way may have the greatest potential for significant impact.

Development associated with the proposed railroad construction, including signal facilities, wells, construction camps, and access routes, would have similar impacts from disturbance of the bedrock. The surveys did not locate any fossil materials in areas proposed for these facilities.

Chapter IV of the Regional Analysis has a discussion of major negative secondary impacts from several large strip mines associated with coal development contingent on railroad construction (refer to Table SLR III-2). Some minor indirect impacts of unknown magnitude also are anticipated from

Table SLR III-1

IMPACT OF PROPOSED STAR LAKE RAILROAD ON STRATIGRAPHY

Era	System	Stratigraphy Unit	Thickness (feet)	Amount of Rail Line on Unit (miles)	Minimum Acreage Disturbed Per Unit Assuming 150 Feet of Right-of-Way
Cenozoic	Quaternary	Sand dune Deposits	No Data	0 1/	0
		Talus	No Data	0 1/	0
		Landslide Deposits	No Data	0 1/	0
		Clay	No Data	2.36	42.85
		Alluvium	30-50	21.42	389.56
		Lava Flows	120	5.56	197.25 2/
Mesozoic	Cretaceous	Kirtland Shale	300	0 1/	0
		Fruitland Formation	300	7.42	134.66
		Pictured Cliffs Sandstone	60	23.00	417.27
		Lewis Shale	350	17.52	317.85
		Cliff House Sandstone	250	1.22	22.12
		Menefee Formation	1,000	26.95	488.95
		Point Lookout Sandstone	250	2.95	53.51
		Crevasse Canyon Formation	600	2.09	37.94
		Gallup Sandstone	0-120	.18	3.27
		Mancos Shale	600	5.30	95.88
		Dakota Sandstone	5-125	.06	1.09
	Jurassic	Morrison Formation	600	0 1/	0
		Bluff Sandstone	150-400	0 1/	0
		Summerville Formation	90-220	0 1/	0
		Todilto Limestone	0-85	0 1/	0
		Entrada Sandstone	150-250	.05	.90
			Totals	116.08 3/	2,203.10 4/

1/ Formation or deposit occurs near the proposed railroad, but is not traversed by it or is covered by alluvium.

2/ Includes a stock repair and service facility of approximately 96.4 acres.

3/ Includes connecting track.

4/ Total acreage disturbed estimated at 2,854. Discrepancy of 650.90 acres due to greater widths of right-of-way, and slopes associated with cuts and fills that would require greater widths. Also, acreage for and locations of attendant passing tracks, sidings and loading loops are not known.

Table SLR III-2

ESTIMATED SECONDARY IMPACTS ON FOSSIL RESOURCES

	Number of Localities		
	1980	1985	1990
Mining[1]	45-55	160-180	325-350
Community Development	3-5	3-5	4-6
TOTAL	48-60	163-185	329-356

1/ South Hospah, Star Lake, and Alamito Mines

Table SLR III-3

AIR POLLUTION EMISSIONS RESULTING FROM RAIL OPERATIONS

Pollutant	Emission in Tons Per Year
Carbon Monoxide	257
Hydrocarbons	187
Nitrogen Oxides	730
Sulfur Oxides	113
Particulates	49

railroad construction. Impacts would occur from increased accessibility of previously remote areas resulting in unauthorized collection and vandalism. Some benefit may be realized from increased fossil resource discoveries resulting from surveys and construction, thereby making them available for scientific use.

Mineral Resources

The Star Lake Railroad could have substantial beneficial impact on the minerals industry by providing an efficient and economical way to move coal to markets. As a common carrier, the railroad also would have a potential beneficial impact on any other mineral industry activity that would use railroad transportation to or from the central ES Region.

Approximately 745,000 cubic yards of basalt would be excavated near the south end of the railroad and used as ballast and rip-rap for the roadbed.

The 2,854 acres within the right-of-way would be removed from mineral exploration and development during the life of the railroad.

AIR QUALITY

The primary source of emissions from the proposed action can be divided into those resulting from construction and those from operations. During construction (1979-1981), emissions would be intermittent and localized, and would have little impact on air quality and visibility beyond the railroad right-of-way.

Air pollutant emissions resulting from rail operations would be due to dust blowing off open hopper cars and emissions from diesel locomotives. The dust would be small in magnitude, settle quickly, and its effect limited to the area immediately adjacent to the rail line. Emissions from diesel locomotives are presented in Table SLR III-3. They were estimated using emission factors developed by the U.S. Environmental Protection Agency (1976) and the fuel consumption estimate in Table SLR III-8.

Emissions of these pollutants would be relatively low, intermittent at any one location, and distributed over a large area. Therefore, levels of pollutants resulting from rail operations along the proposed line would be insignificant, and visibility would be little affected.

The coal mines dependent on the SLR also would be sources of emissions and dust, but their impacts will be small and local.

WATER RESOURCES

Ground Water

The proposed railroad is not anticipated to have any significant impacts on the ground water of the San Juan Basin. No wells are known to exist within the right-of-way, although fences along the railroad may partially block access to a few existing wells. Construction at the washes could affect the quality of water in wells pumping from the alluvium downstream, but proper control of potential pollutants can prevent this.

The greatest use of ground water by the railroad probably would occur during construction, when water would be needed to help in compaction of fill and for dust suppression. Except for a well in the alluvium of Kimbeto Wash, none of the wells proposed for construction water is within a mile of any existing well that taps the same aquifer. The wells would be pumped 12 hours a day at rates ranging from 75 to 500 gal/min for up to 734 days (see Table SLR I-4A). Because water levels would return to near their original positions during the nonpumping periods, effects of this pumping would not be noticeable beyond two miles from a pumping well, and generally would not be noticed more than about 0.5 mile away. No data are available to evaluate the possible effects of the well in the alluvium along Kimbeto Wash. Any impact would be of short duration because the aquifer would be replenished by natural recharge once pumping stopped.

During operation of the railroad, withdrawal from wells at the maintenance yard and Pueblo Pintado is expected to be minimal. Although pumping would continue intermittently for many years, it is not anticipated to have any noticeable effect on the ground-water supply of the area.

It is possible that some of the railroad cuts may encounter shallow zones of perched ground water. These small zones or lenses have very limited capability to yield water. No wells are known to obtain water from them. Therefore, the only impact from draining one of these zones would be to vegetation depending on it for water.

The mines that would be developed if the SLR is built would use about 4,700 acre-feet of water a year. Pumping this amount of water would lower water levels near the mines; however, there is little ground-water development in the vicinity, so impacts would be small.

Surface Water

No large impact on the surface water of the region is anticipated from the proposed railroad. The most important impacts would be some ponding against the upstream side of the railroad embankment and a reduction in the peak discharge because of the storage effect of this ponding. The effect of most floods should be minimal because the bridges and culverts would be designed for the 100-year flood. However, the effect could be quite large for very major floods. There is about a 20-percent chance for the 200-year flood to occur during the 35-year life of the railroad (see the Regional Analysis for other probabilities). The total volume of surface-water flow should not be affected by the proposed drainage structures. The three stock ponds within the proposed right-of-way could be destroyed or damaged during construction.

Water Quality

Pollution could result from accidental spillage of diesel fuel or coal along the route and from other wastes and lubricants from normal train traffic. Activities at service and repair facilities would greatly increase the potential for pollution from fuel, oil and coal spills, from yard trash and wastes, and from human trash and wastes. Locating the service and repair facilities on the flood plain for Mitchell Draw near Prewitt would increase the opportunity for impact on water quality by accidental spillage. Herbicides used for control of weeds along the right-of-way could cause minor pollution in the streams or the alluvial aquifers by accidental spillage.

Sediment

The major impacts on water resources by the proposed Star Lake Railroad would be increased sediment from cuts and fills along the route, disturbance of stream channels during construction of drainage structures, and change in hydraulic characteristics of channels caused by these structures.

The sediment discharge from such structures as cuts and fills, and service and construction roads, would depend on erodibility of the soils. Using the maps of erosion susceptibility furnished to the Atchison, Topeka and Santa Fe Railway by VTN Consolidated, Inc., and figures for the areas of disturbed ground, it is estimated that an additional 177,000 tons of sediment would be discharged during construction (Table SLR III-4). Assuming an average disturbed channel area of 25 x 100 feet for each culvert, with a loss of 0.1 foot from the channel bottom, an additional 2,300 tons of sediment would be added during culvert construction. The total increased sediment discharge would be about 179,000 tons during the 2.5-year construction period; the amount of sediment produced each year would depend on the construction schedule.

There probably would be increased sediment discharge from construction disturbances until channel stability is achieved, and from increased flow velocities caused by the bridges and culverts. The sediment discharges caused by these factors cannot be adequately estimated.

Some increase in sediment could be expected from the service road along the track. Stock ponds within 1/2 mile downstream could be filled with sediment from the construction.

Secondary Impacts

Development of the three coal mines depending on construction of the railroad would impact the water resources more severely than the railroad would. The major impacts would be lowering of water levels over a large area as a result of pumping about 4,700 acre-feet of ground water a year, destruction of several stream channels, increased opportunities for pollution of ground water, and an average increase in sediment discharge of 13,700 tons per year per mine. These impacts are discussed in Chapter IV of the Regional Analysis.

SOILS

Impacts on soils would result from varied disturbance of approximately 2,854 acres within the right-of-way during development of the Star Lake Railroad. About 1,272 acres of soil surface (45 percent of the right-of-way) would be removed from productivity through being covered by ballast, service roads and fill material, or by excavation for cuts and borrow material. Table SLR III-5 shows acreages by soil associations within the right-of-way that would be disturbed and lost to productivity. Secondary impacts would result from coal development dependent upon the railroad as a source of transportation, disturbing an estimated 7,295 acres by 1990.

Removal of vegetation and topsoil during stripping and grubbing phases of construction would expose subsoils to wind and water action. Compaction of the subsoil would result in long-term reduction of permeability and infiltration rates. Compaction would also change soil structure, thereby increasing potential for runoff, soil erosion, and sedimentation. Cut-and-fill operation would involve the mixing and moving of approximately 9,954,000 cubic yards of material to develop fill structure and adjust for undesirable subgrade materials. Cut and fill operations and subsequent mining development would result in loss of soil structure and compaction and mixing of various-textured soils and horizons, thereby increasing bulk density and creating different soils. An estimated 408,000 cubic yards of material from borrow pits would involve about 37 acres of the right-of-way. During the excavation phase of construction, less fertile subsoils or toxic materials may be exposed that could be detrimental to reclamation efforts. Accidental spillage of toxic materials, such as gasoline, oils and chemicals, and

Table SLR III-4

SEDIMENT DISCHARGE FROM EROSION DURING CONSTRUCTION

Route Stationing	Sediment Discharge (tons) Cut, Fill, Roads	Widening of Cuts	Service Yard, Sidings	Borrow Pits
	Prewitt to Star Lake			
0+00-600+00	15,102	403	958	1,530
600+00-1200+00	14,906	883	0	688
1200+00-1800+00	19,908	304	0	0
1800+00-2400+00	15,695	106	0	452
2400+00-3000+00	15,563	1,288	0	1,677
3000+00-End	14,219	1,182	0	885
Sub Total	95,393	4,166	958	5,232
	Pueblo Pintado to Bisti			
0+00-600+00	14,500	994	0	1,680
600+00-1200+00	18,585	993	0	0
1200+00-1800+00	16,806	1,117	0	3,851
1800+00-End	13,485	451	0	902
Sub Total	63,376	3,555	0	6,434
Grand Total	158,769	7,721	958	11,666

Note: See section on sediment computation in Appendix B for methodology.

Table SLR III-5

ACREAGE OF SOIL ASSOCIATIONS DISTURBED AND REMOVED FROM PRODUCTIVITY BY RAILROAD CONSTRUCTION WITHIN THE RIGHT-OF-WAY

Association 1/	Acres Disturbed	Acres Removed From Productivity
11 Persayo-Billings	170	60
16 Penistaja-Sheppard-Palma	75	49
17 Lohmiller-San Mateo	98	51
19 Hagerman-Travesilla	898	404
22 Prieta-Thunderbird	177	104
28 Doak-Shiprock	190	59
31 Badland-Rockland	90	60
32 Cumborthids-Farb	230	114
33 Persayo-Lohmiller	355	118
34 Rockland-Travessilla	278	92
35 Billings-Badland	293	161
TOTAL	2,854	1,272

1/ Numbers accompanying soil associations refer to Table B-7 in Appendix B of the Regional Analysis.

waste material from concrete batch plants, could pollute the soils, affecting micro-organism activity and reducing vegetative cover. Cut slopes, lacking vegetative cover, would be exposed to wind and water action. Productivity levels would be lowered until the soil has had time to reestablish its structural and micro-organism relationships, which in the semi-arid Southwest may take decades to occur.

The most intense soil erosion problem would be encountered when the proposed route crosses through the Lohmiller-San Mateo, Persayo-Billings, Persayo-Lohmiller, Camborthids-Farb, and Badland-Rockland Associations. These soils are alluvial deposits, occurring primarily in stream valleys and floodplains. They are highly susceptible to erosion when disturbed, as demonstrated by steep-sided, deeply entrenched gullies. Recent sand dunes indicate that wind erosion is a locally active process along Chaco Wash and some of its tributaries. The combined extent of these associations within the right-of-way is about 940 acres.

Other soil characteristics subject to impact are as follows: Lohmiller-San Mateo, Prieta-Thunderbird, and Persayo-Lohmiller Associations have high clay content and shrink-swell potential, which would create uplift or slumping and affect foundation stability. Maintenance roads would be slick and difficult to travel during periods of wet weather due to the plastic nature of the clay. These soils occur on approximately 630 acres of the right-of-way.

Hagerman-Travessilla, and Persayo-Billings Associations contain low strength soils. When wetted, these soils have a tendency to collapse while supporting a load. Consequently, collapsible soils would provide poor subgrade support for roadbeds during wet seasons where surface drainage is poor or artifically restricted. Collapsible soils comprise about 1,068 acres of the right-of-way.

Lohmiller-San Mateo, Persayo-Lohmiller, Persayo-Billings and Badland-Rockland Associations contain soils with physical-chemical characteristics that may induce accelerated corrosion of uncoated steel and concrete. These soils occur on approximately 713 acres of the right-of-way.

Hagerman-Travessilla, Persayo-Billings, Persayo-Lohmiller, and Badland-Rockland Associations contain soils with poor load-bearing capabilities that could lead to detrimental deformation of the supported structures. These soils comprise about 1,513 acres of the right-of-way.

In summary, an estimated 2,854 acres would be disturbed by construction of the SLR, resulting in major alteration of soil characteristics, creating different soils, and removing 1,272 acres of soil surface from productivity. The long-term loss of productivity of the 1,272 acres (45 percent of the right-of-way) would be a significant impact to the soil resource within the right-of-way. However, 1,272 acres would involve less than 0.03 percent of the region. Impacts of coal development dependent upon the railroad would change soils and reduce soil productivity of an estimated 6,762 acres (less than 0.2 percent) of the region by 1990. Reclamation experience in the region has not been of sufficient duration for studies to determine the long-range effects on soil productivity.

VEGETATION

Impacts on vegetation in the right-of-way would range from slight disturbance to total destruction. Coal mining that could occur, using the railroad for transportation, would result in destruction of vegetation on other areas. The approximate acreages of the various vegetation types that would be impacted by development of the railroad are shown in Table SLR III-6.

Initial disturbance of vegetation would result from vehicles and machinery driving through during fence construction and from access by heavy earth-moving equipment. Destruction of vegetation also would occur during stripping and clearing operations prior to moving cut and fill material for roadbed preparation, and during grading of the service road.

Secondary impacts would result from altered environments and from invasion by annual weedy species. The altered environments would result from land-shaping operations which change moisture accumulation, aspect and steepness of exposures, and surface materials available as plant-growth medium. Very little, if any, vegetation would be expected to become established on the steep slopes of cuts and fills and on areas left with a dense compact surface. A saltbush-greasewood type would probably replace grasslands along drainageways where runoff from roadbeds and slopes would accumulate. On sites where moisture available for plant growth is reduced by development of the railroad, vegetation communities tolerant of drier conditions would develop. Grassland or annual weed communities would probably develop on the downhill side of the roadbed and on sloping surfaces.

In addition to the vegetation destroyed directly through construction of the railroad, the vegetation on 6,762 acres would be destroyed by coal mining that would occur through 1990 at mines using the railroad for transportation. Table SLR III-6 shows the acreages of the various vegetation types that would be affected by this mining.

Neither construction of the railroad nor the associated mining would affect locations where endangered or threatened plants are growing.

Table SLR III-6

APPROXIMATE ACREAGES OF VEGETATION TYPES THAT WOULD BE IMPACTED

Vegetation Type	Impacted by Construction of the Railroad		Destroyed by Mining 1/
	Disturbed	Destroyed	
Grassland	1,850	821	2,978
Sagebrush	340	152	3,491
Sarren	14	6	152
Pinyon-Juniper	280	130	98
Saltbush-Greasewood	370	163	43
TOTAL	2,854	1,272	6,762

1/ Estimates of areas that would be mined through 1990.

WILDLIFE

It is estimated that 1,272 acres of wildlife vegetative habitat would be impacted by construction and operation of the proposed railroad. Major vegetative communities were ranked sequentially according to their value as wildlife habitat as follows: saltbush and greasewood, big sagebrush, pinyon-juniper, and gramma-galleta. Gramma-galleta, which comprises the greatest percentage of vegetative cover on the subject lands, would receive the greatest disturbance. Changes in plant communities caused by environmental alterations would result in minor impacts to wildlife habitat. Depending on the revegetation success along the right-of-way, much of the wildlife habitat could be improved by establishing ecotone areas to attract various wildlife species into the revegetated areas. Many small mammals (mainly rodents), reptiles, some amphibians, and numerous arthropods would benefit from utilizing these revegetated areas along the right-of-way.

The major impacts on wildlife would be noise, human harassment, and train-animal collisions. Noise, vibration, increased traffic, and human activity would displace various species, particularly larger mammals and numerous birds. Displacement into other occupied habitats would result in competition and possible mortalities. Small or less mobile animal species occupying limited territories, would be unable to escape heavy construction equipment. Blasting would kill small rodents, some birds, reptiles, amphibians, and various arthropods, as well as destroy dens and nesting habitat. Two established prairie dog colonies also would be impacted by construction and operation of the railroad.

Impacts from fencing the right-of-way would depend largely on type and location of the fencing. Fencing, for the most part, would impair movement patterns of large- to medium-sized mammals. Such impairment could prevent some species from utilizing habitat traditionally used for calving and/or wintering grounds. Fences along the proposed route could restrict escape inside the right-of-way for animals alarmed by approaching trains. Some mortalities from train collisions would be expected along the right-of-way.

The existence and operation of the proposed rail line is not expected to have an adverse impact on reproduction of raptors since cliffs, trees and other nesting habitat do not occur within the immediate area. In addition, there are no crucial or sensitive wildlife areas expected to be impacted as a result of the proposed action.

Development of the coal mines dependent on the SLR would destroy an additional 6,762 acres of wildlife habitat.

Endangered and Threatened Species

There are no indications that prairie dog colonies along the right-of-way support black-footed ferrets. While the potential exists, based on the ferrets' geographical distribution, it is not expected that black-footed ferrets would be directly impacted.

No peregrine falcons have been sighted within the proposed railroad right-of-way, but in recent years they have been observed in the San Juan and Chaco Regions. This indicates the apparent suitability of the region to sustain a resident population. Increased coal transporting activity and human intrusions would cause these unique falcons to shy from the area. Human activity also could result in illegal shooting of the peregrine falcon.

Although the bald eagle would occur only as an uncommon migrant, increased human activity would prevent any habitat and feeding utilization of the area.

Official Section 7 consultation required by the Endangered Species Act of 1973 has been completed with the U.S. Fish and Wildlife Service.

AESTHETICS

Noise

The impact of noise would come in two stages: 1) during construction of the railroad and 2) during operation of trains over the line. The project area is sparsely populated, ranging between primitive and rural. Development of the three coal mines dependent on the SLR would create local noise sources.

CONSTRUCTION

In general, shifts would be 60 or more hours per week. Construction of the railroad would require the use of powered equipment that would generate temporary noises between 70 and 105 dBA. The impact from pile driving would have the most far-reaching effect on local residents. Noise from the project would be temporary because the noise sources would change locations as the work progresses.

OPERATIONS

The exterior noise level of 55 dBA on a day-night basis (55 L_{dn}) has been set by EPA as a long term exterior noise-level goal for the protection of public health and welfare from all adverse effects of noise based on present knowledge (USEPA, 1977d). At the probable level of traffic over the SLR, the 55 L_{dn} contour would be between 670 and 780 feet from the center line of the railroad. No critical noise sensitive points such as national monuments, schools, churches, trading posts or community meeting buildings would be within this area. The noise levels at these points may, at times, interfere with some outdoor activities, however they will not reach 70 L_{dn}, the threshold level at which prolonged exposure is thought to result in hearing loss. The 70 L_{dn} contour would be between 120 and 140 feet from the center-line of railroad. Most of the area subjected to these levels would be within the right-of-way.

The noise levels discussed above would be the result of locomotive and car noise. In addition to this, locomotive horns would also be part of rail operations. This source can be expected to emit a peak sound level of 94 decibels, at a 90° angle 300 feet from the rail line. This noise would be of short duration and is considered necessary as a safety warning device.

Visual Resources

Four Visual Resource Management (VRM) classes, as described in Chapter II, would be affected by inharmonious contrasts in form, line, color and texture resulting from the proposed action. These contrasts would be caused by the removal of vegetation, disturbance of the soil, construction of roads and the roadbed of the railroad, and the placement of work camps, material storage yards, and other structures on the landscape. The more evident these activities are, the less acceptable they would be to the VRM classes. The proposed action would create contrasts in excess of acceptable limits for Class I and Class II areas.

Approximately 1 percent of the 114 miles of the SLR would be within Class I lands; Class II lands make up about 6 percent of the total length; Class III and IV lands make up 40 percent and 53 percent, respectively. The 114 miles of railroad would mean that 1,272 acres would be altered from its existing condition. This acreage would contain contrasts resulting from such things as the roadbed, service roads, fill material and cut slopes.

Vegetation removal would be required for construction of the railroad, communication sites and other related development. Removal of vegetation would cause an interruption of existing patterns, creating modifications in form, line, color, and texture. The type of vegetation, method of clearing, and location and timing of reclamation would determine the magnitude of these visual impacts. Modifications to the visual aspect of vegetation would be less apparent in the grassland areas than through the woodlands of the ES Region.

Construction of the roadbed for the railroad would create strong contrasts in form, line, and color as it winds through the ES Region. To conform to grade limits, considerable cut and fill slopes would be necessary in the steep and broken terrain. A total of 2,100 feet of fills higher than 40 feet in height and 5,740 feet of cuts deeper than 40 feet would be expected from construction of the railroad. As designed, the maximum height for fills would be 53 feet and the maximum depth of cuts would be 59 feet. These cuts and fills would create crescent-shaped forms of light-colored soils. Other activities associated with the roadbed that would affect visual resources inside and outside the right-of-way include borrow pits, drainage structures, and access roads.

Communication sites and service facilities would introduce additional form, line, color and texture changes in the landscape. The exterior-finish color and form of the structures would determine the magnitude of impacts upon the visual resources. It has been proposed that temperature stabilization of the fiberglass buildings used at communication sites be achieved by burying 80 percent of the building and covering the remaining 20 percent of the building exposed above ground level with excavated soil. This would help reduce the visual impacts. However, a strong vertical contrast would still be present in the form of a triangular galvanized steel tower ranging between 40 and 120 feet in height at each site. The solar panels on these towers would create a visual impact through form and color contrasts.

Contrasts created by the construction of the railroad would be most evident from four critical areas where the largest number of people would have the greatest opportunity to view the railroad. These areas would be where the proposed railroad would join the mainline near Interstate 40; where the railroad would cross over and parallel Navajo Route 9 near Pueblo Pintado; where the railroad would cross State Highway 57, the road that leads into Chaco Canyon National Monument; and where the railroad would cross State Highway 371. The railroad would pass at the closest within 2 miles of Chaco Canyon National Monument but should not be visible from within the canyon, where the main visitor facilities are located.

If the railroad were built, additional disturbances to the characteristic landscape would occur from mining activities and community development. In 1980, 1,323 acres would be disturbed, by 1985, 3,935 acres, and by 1990, 7,295 acres. Mining activities from the secondary development would be within VRM Class III and IV areas.

LAND USE

Recreation

Recreation activities would not be appreciably affected by the proposed action because those occurring within the corridor are primarily a dispersed type. The recreationist participating in these activities is not dependent on the 289.6 acres of public lands within the 2,854 acres of committed land in the right-of-way. Any resultant loss or gain of recreation visits resulting from the proposed action cannot be quantified.

The quality of outdoor recreation experiences in and adjacent to the railroad right-of-way would be reduced by disturbance of soil, vegetation, and wildlife during construction. The rail alignment would cross numerous public and private roads used by recreationists. The railroad right-of-way, when fenced, would also restrict cross-country off-road recreation travel.

Chaco Canyon National Monument would be indirectly impacted by the proposed railroad. Secondary impacts may result from the noise of mining operations and the interruption of vehicular traffic during the construction of the grade separation crossing on State Highway 57 north of the monument boundary.

The Continental Divide Trail could be in direct conflict with the railroad if both are built as proposed. The Continental Divide would be crossed several times in the 114-mile length of the railroad.

Mining and community development relating to the SLR would remove land from recreation use. The disturbance and development in previously undisturbed recreation use areas would also result in a lower quality of recreation experiences.

Transportation

CONSTRUCTION

The movement of materials, equipment, and workers during construction of the proposed rail line would create a short-term increase in transportation demands in the vicinity of the proposed route. Access to the site would require the use of several existing and proposed roadways. Specific impacts on these routes are delineated in Table SLR III-7. Increased highway use by workers and by trucks hauling materials would increase the potential for highway accidents. Due to the comparatively small number of workers involved in this project at any one time, the magnitude of this increase should be small. The impacts associated with construction would terminate when construction is complete.

OPERATION

It is anticipated that the proposed rail line would serve at least three coal mines, requiring the operation of approximately 9 unit trains per day, including empties. This is well within the capacity of the rail line. The impact of this additional traffic on the Santa Fe main line and related down-line impacts are discussed in Chapter IV of the Regional Analysis.

Rail operations would have minimal impact on the existing transportation system. The 4 public roads and 34 private roads that would cross the line at grade have very low traffic levels. The frequency of rail-highway grade crossing accidents that would result from train operations is unknown and, in effect, would be random occurrences.

Rail operations over the proposed line would almost exclusively be limited to unit trains, which have been demonstrated to be one of the most fuel-efficient means of moving bulk freight. Operations over the proposed line were simulated to obtain an estimate of diesel fuel consumption, by station, for the anticipated operations. The results of these simulations for 1990 are summarized in Table SLR III-8. The approximately 4 million gallons of fuel consumed is about 4 percent of the highway consumption of diesel fuel in New Mexico in 1975.

Grazing

The proposal would affect 20 grazing allotments in varying degrees, depending on the acreage required for the railroad right-of-way. (Indian grazing practices on these allotments are discussed fully in Chapter II of the Regional Analysis.) The entire length of the right-of-way would be fenced by the time construction is complete; thus, 2,854 acres of right-of-way would be removed from livestock grazing until the economic life of the railroad is completed and the land is returned to grazing. Table SLR III-9 shows the acreage removed from grazing in each allotment and the attendant loss of production expressed in Animal Unit Months (AUMs). A low adverse impact would be realized by most livestock operators affected by the proposal due to the relatively low number of AUMs lost. The highest loss would occur in allotment 55, where 64 AUMs, or approximately 5 animal units yearlong, would be lost.

A major adverse impact could be realized by Indian operators whose sole grazing unit is their 160-acre Individual Indian Allotment which would be crossed by the proposed railroad. These operations are so small that even though the acreage lost to the railroad is relatively low, a combination of the loss of forage, grazing distribution restrictions, and a day-long sheep herding requirement, could cause the operator to choose to abandon the traditional livestock-based way of life and depend entirely on other sources for subsistence. It is estimated that 5 to 10 such operations would be affected by the proposal. Allotment 12, presently operating under an allotment management plan, would require a complete change in the grazing system. A fenced railroad right-of-way would necessitate a new pasturing system, additional fencing, and additional water development.

All livestock operations would be adversely affected by a change in livestock distribution patterns and possible isolation of watering areas. Beneficial impacts could result from new watering places in

Table SLR III-7

IMPACT ON HIGHWAYS FROM CONSTRUCTION OF THE STAR LAKE RAILROAD

Road Designation	Average Rating[1]	Description of Impact	Estimated Costs
S.R. 371	15.8 miles: 62 40.0 miles: Under construction or proposed	Acceleration of required improvements due to increased truck traffic on access roads.	None
S.R. 57	27 miles: 30	Grading to improve surface; decreased road life due to increased truck traffic on access roads.	Unknown
N 9	Not rated	Acceleration of required improvements due to increased truck traffic on access roads.	None
Various local area roads	Not rated	Connecting and grading existing local roads to provide a permanent access route to the proposed rail line.	None
N 46	Not rated	Grading, draining and surfacing to provide access to area.	$2.5 million[2]

Sources: New Mexico Highway Department, 1977a; U.S. Department of the Interior, Bureau of Indian Affairs, 1977b; Harbridge House Inc., 1978.

1/ Under the New Mexico State Department of Highways Condition Rating for appropriate roads and portions thereof affected by action, a rating of 74 or less indicates a deficient condition.

2/ One-half of estimated total cost.

Table SLR III-8

SIMULATED SLR FUEL CONSUMPTION IN 1990 1/

Station	Level of Production (million tons/year)	Fuel Consumption Per Trip (gallons)	Number of Trips	Total Fuel Consumption (gallons)
Star Lake	7.0	2,689	700	1,882,300
Alamito	6.0	2,783	600	1,669,800
South Hospah	3.5	1,132	350	396,200
TOTAL				3,948,300

1/ Train Performance Simulator, TPS 3 - U.S. DOT Transportation Systems Center, Cambridge, Mass. derived from a simulator developed by Missouri Pacific Railroad.

Table SLR III-9

ACREAGE REQUIRED AND AUMS LOST BY GRAZING ALLOTMENT

Grazing Allotment by Number	Right-of-Way Acreage Required	AUMs Lost
80	275.4	41
77	68.6	9
76	19.6	2
65	72.9	9
78	12.0	3
66	43.8	6
55	430.3	64
42	194.9	56
35	78.6	9
37	143.8	33
33	226.6	21
18	305.6	28
17	290.5	38
19	3.3	1
20	19.3	3
21	66.0	15
13	168.3	20
16	114.1	11
12	235.1	27
8	85.3	6
	2,854.0	402

borrow pits, water storage pits, and new permanent wells.

Secondary impacts due to mine development as a result of the railroad construction would be negligible. Losses in forage production that would have occurred have been eliminated by company and surface owner negotiations resulting in the purchase of the surface, exchange of use areas, or relocation of livestock.

Wilderness

No national wilderness would be directly impacted by the proposed railroad. The proposed route would not directly impact any of the wilderness inventory units recommended for more intensive inventory pursuant to the Wilderness Inventory Handbook, dated September 27, 1978.

Inventory Unit NM-010-58, of which approximately 6 acres of right-of-way are involved (Map SLR III-1), has been recommended as an area that was clearly and obviously unsuitable for further wilderness consideration. The southern part of Unit NM-010-009, of which 17 acres of right-of-way are involved (Map SLR III-2), was also recommended as unsuitable for further wilderness consideration.

These recommendations have been proposed to the public for their comment and review for a period of 90 days, commencing on January 10, 1979 and terminating April 10, 1979. The New Mexico State Director, BLM, will publish his final decision on those initial inventory decisions on or before April 20, 1979. Should the final decision concur with the present recommendations, no wilderness study areas or inventory units under intensive inventory for wilderness characteristics would be impaired by the proposed action.

Noise levels and visibility of activities that would occur during construction and operation of the railroad could degrade existing wilderness values, making these lands unsuitable for wilderness designation.

No direct impacts to roadless areas would occur as a result of mine development associated with the railroad.

CULTURAL RESOURCES

Construction of the railroad would cause both direct and indirect impacts to cultural resources. Consultation with the State Historic Preservation Officer concerning these impacts has begun and will continue through such time as the railroad proposal is rejected or construction begins. Direct impacts, in most cases, would result in irretrievable loss of the physical site and the context for cultural materials. Indirect impacts would affect surface materials primarily, but these impacts should not be discounted since sites are identified and dated largely from surface remains.

Fencing of the right-of-way and construction of track and associated railway facilities would directly impact sites 9, 12, 40, 51, 60, 68, 81, 84, 89, 90a, 90b, and prehistoric roads in Table II-9. Since additional sites probably were overlooked in existing inventories (see Chapter II), direct impacts to perhaps as many as 33 additional sites must be anticipated. Impacts to presently known sites include two non-diagnostic lithic scatters (Sites 40 and 84 on Table SLR II-7). Impacted Anasazi sites would be more substantial (Sites 9, 12, 51, 90a, and prehistoric roads). Navajo sites include a dwelling site (Site 81), a sweat lodge (Site 60), and camp areas (Sites 68, 89, 90b).

The proposed action could indirectly impact 91 to 142 sites. These sites are described on Table SLR II-7. Most are Anasazi and Navajo remains. Damage to these sites would be less severe than to those located directly in the right-of-way. Nevertheless, sites near the proposed alignment likely would receive some vandalism and incidental construction damage. Pueblo Pintado, a National Register site, would be easily visible from the right-of-way. Its standing walls may be a particularly attractive target for vandalism.

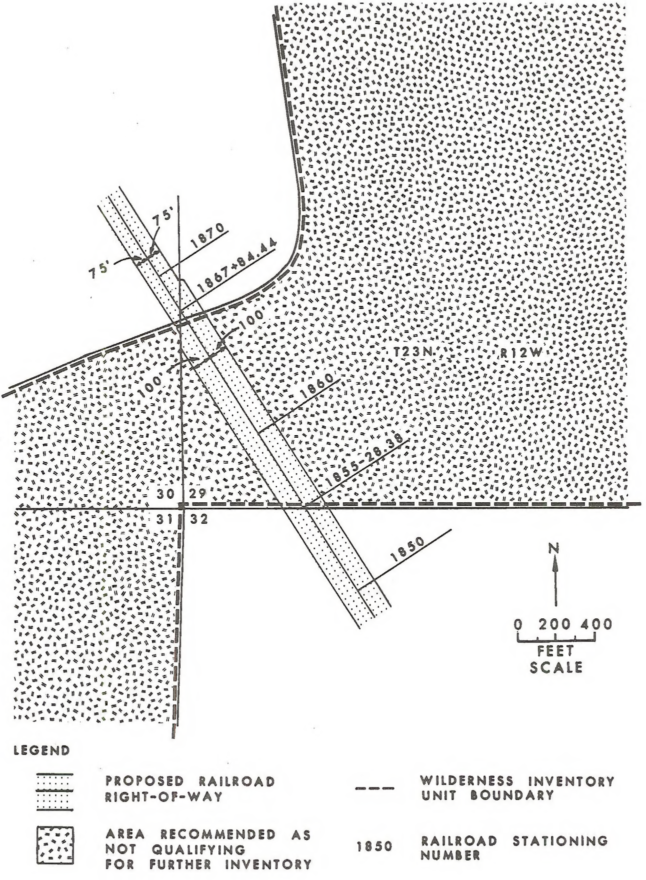
Additional direct and indirect damage to sites may result from construction of wells and communication sites, and from construction facilities. Potential impacts are unknown because data on the location of ancillary structures are not available at present. Development of the coal mines dependent on the SLR would impact 107 to 165 additional sites.

Impacts on cultural resources can be minimized through careful supervision. Past experience, however, indicates that this is difficult to accomplish. As a result, an undetermined loss of surface materials should be expected if the railroad is constructed.

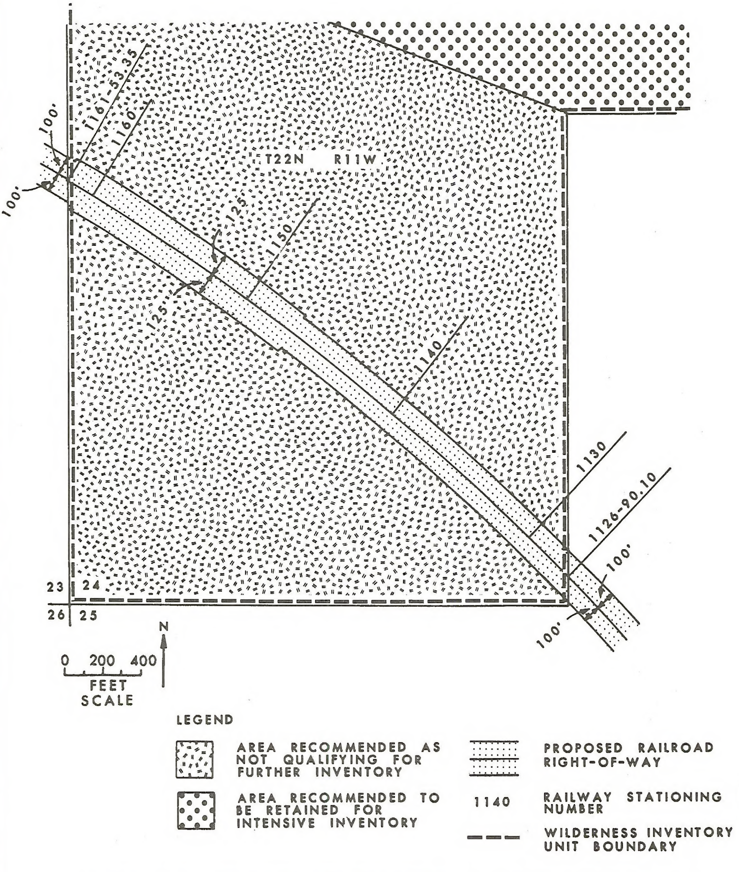
One Anasazi and three Navajo sites that would be directly impacted have been given significance ratings of four or higher. These sites appear to meet research criteria for nomination to the National Register of Historic Places. At least 37 sites (those rated 4 or above in Table II-7) subject to indirect impact also appear to be eligible for nomination to the National Register.

SOCIOECONOMIC CONDITIONS

Specific social and economic impacts of the Star Lake Railroad would be minimal. The cumulative effects of construction and operation of the railroad and the coal mines it would serve are discussed in the sections below.



MAP SLR III-1 RELATION OF PROPOSED RAILROAD RIGHT-OF-WAY TO WILDERNESS INVENTORY UNIT NM-010-58



MAP SLR III-2 RELATION OF PROPOSED RAILROAD RIGHT-OF-WAY WILDERNESS INVENTORY UNIT NM-010-09

Demographic Features

Construction of the Star Lake Railroad would involve a labor force of 310 men at the peak of building activity, in 1980. Up to 200 of these workers are expected to be residents of the ES Region. A large portion of this work force would consist of present employees of the Santa Fe Railroad, including 100 Navajo Indians of the Santa Fe Railroad's permanent track crew.

Approximately 200 employees of contractors would be engaged in some or all elements of grading, bridge and culvert construction, and fencing. The source of these workers cannot be predicted since no contracts have been awarded. The Star Lake Railroad intends to use local residents whenever possible. However, it has been assumed that 60-percent of these laborers would not be local.

Temporary work camps, as described in Chapter I, would be used by both Santa Fe and the contractors. The use of these camps would be the primary reason for the minimal socioeconomic impacts during construction.

Several aspects of the population impacts of the proposed railroad construction are unique. First, all significant increases in population would occur during the construction phase, and would occur very rapidly. In 1978, there would be no impact. Construction would peak in 1980 leading to an increase in population of 921 persons due to the railroad. By 1985, construction would be completed and the railroad in operation, with no long-term population effect. In 1985 the operational employment would stabilize at 103 persons and remain at that level through 1990. In 1980 the railroad would account for 12.4 percent of the coal-related regional population increase, or 0.5 percent of the total population projected for the region. For 1985 and 1990, these figures would drop to 1.3 and 1.0 percent of the ES Region's coal-related increase. Of the 103 permanent residents created by operation of the railroad, it is estimated that 52 would live in McKinley County and 51 in Valencia County. In 1985 and 1990 this would account for 1.6 and 1.1 percent of McKinley County's, and 6.3 and 4.6 percent of Valencia County's coal-related population increases, respectively.

The railroad would make possible the future development of additional coal mines in the region which otherwise would not exist. Construction of related mines would account for a 79.2 percent increase in the regional coal-related population in 1980, 17.0 percent in 1985, and 19.1 percent in 1990 above levels projected without the proposed railroad.

Economic Conditions

One-third of the jobs involved in the construction of the Star Lake Railroad would be taken by the Santa Fe Railroad's permanent Navajo line workers. The Star Lake Railroad would add to employment and income in the five-county (McKinley, Rio Arriba, Sandoval, San Juan and Valencia counties) area, as shown in Tables SLR III-10 and SLR III-11, but these incremental gains would be slight. Construction of the proposed railway would involve a peak labor force of 310 persons (including the permanent track layers). The total construction payroll would peak in 1980 at $5.86 million. The building of the Star Lake Railroad would be highly seasonal in its labor requirements and tempo of activity. Whereas employment in the summer of 1980 is anticipated to reach 310, at the end of that year it would have dropped to about 200.

Operation of the Star Lake Railroad would begin in 1980 with a permanent work force of 38 persons. While the projected number of construction-phase workers would be significant if it represented a long-term addition to area payrolls, it would not be important given the shortness of the phase as planned. The operation-phase work force is so small as to be insignificant in the context of the projected growth and development of the economies of northwest New Mexico. Operation-phase payrolls are projected at a constant $661,000 a year beginning in 1982. The Santa Fe Railroad would expect to hire local residents for these jobs.

Until contracts for materials have been let, no estimate of impacts from capital expenditure can be projected. Primary sources for steel and other items would likely be CF&I Steel in Pueblo, Colorado, and United States Steel in Gary, Indiana. Through June 30, 1978, Santa Fe had spent $2.1 million on pre-construction activities.

Community Infrastructure

HOUSING

Construction phase population would require concentrated increases in temporary housing (trailers) in the vicinity of the proposed site, as described in Chapters I and II. Santa Fe has no plans for permanent housing of their employees. The track crew and fence crew would be housed by Santa Fe in bunk cars and trailers within the proposed right-of-way. The remaining population would create a peak demand for 270 additional mobile home units in the area in 1980, to be distributed between Prewitt, Hospah, Gallo Wash, and Pueblo Alto. This would be an increase of 2.1 percent in the ES Region's mobile home stock in 1980. In 1985 and 1990, there would be a permanent demand for an estimated 38 units to house the local residents who have been trained to maintain and operate the railroad. Because the construction headquarters would be in Gallup, the demand for

Table SLR III-10

DIRECT AND INDIRECT EMPLOYMENT CREATED, 1980-1990

Type Employment	1980 Number of Jobs	Percent Increase With Proposed Action 1/	1985 Number of Jobs	Percent Increase With Proposed Action	1990 Number of Jobs	Percent Increase With Proposed Action
Direct	310	0.4	38	—	38	—
Indirect	432	0.6	42	—	42	—
Total	742	1.0	80	0.1	80	0.1

Source: Harbridge House, Inc., 1978; Adcock and Associates, 1978.

1/ Increase in total employment in five-county area.

Table SLR III-11

ESTIMATED ANNUAL PERSONAL INCOME, 1980-1990
(in thousands of 1977 dollars)

Year	Annual Total Personal Income1/	Percent Increase With Proposed Action2/
1980	10,696.6	1.6
1985	1,128.6	0.1
1990	1,128.6	0.1
Total	37,225.6	1.5

1/ Adcock and Associates, 1978.

2/ Increase in total personal income in five-county area.

housing would be felt most there. Housing demand would increase insignificantly compared to the demand already existing in western Valencia County due to increased uranium activity.

TAX REVENUES

Tax revenues to be generated by the Star Lake Railroad would primarily benefit McKinley County. While the tax base would be expanded in the county with an increase in residents, an estimated 40 to 50 percent of the workers would not pay local taxes because they would commute from other areas. Because the projected increases in population and housing units are negligible, compared to the coal and uranium related increases, indirect impacts on local taxes would be minimal.

EDUCATION

There would be negligible impact upon educational systems in the ES Region. However, schools would be temporarily impacted with an additional 30 to 40 students (an approximate 30-percent increase) during construction. Two additional teachers would also be required in the area during this period. Facilities expansion of 10 to 15 percent (in the form of temporary modular classrooms) would be required for an estimated long-term increase in student enrollment due to the railroad.

HEALTH SERVICES

Impact on health care would be less than one percent in McKinley and Valencia Counties in terms of facilities and personnel. At least one additional physician and registered nurse, with two additional hospital beds would be needed in the immediate vicinity of Prewitt to maintain national standards. This health care plus most emergency treatment could be provided by services in Grants.

PUBLIC SAFETY

An additional police officer would be required in the Prewitt area by 1980 to maintain recommended standards of protection. Police protection in other parts of McKinley County near the route would be adequate between 1980 and 1990. There would be no impact on fire protection during this period. The volunteer department in Prewitt would be sufficient to handle projected new residents. The railroad crossings by dirt roads in the area would add an additional hazard to motorists, and might require additional patrol personnel.

PUBLIC SERVICES

Waste disposal and wastewater systems would be strained as a result of the population influx into the Prewitt area. Due to the extremely temporary nature of resident increases, however, a full-scale expansion of these systems would not be necessary. Projected work camps would be equipped with required short-term facilities by Santa Fe Railroad, which would absorb much of the demand placed on local systems. Water supply and other utilities would be adequate in both the Prewitt and Grants/Milan areas.

SOCIAL AND CULTURAL CHARACTERISTICS

Insofar as the Star Lake Railroad would open the Star Lake-Bisti Region to coal development, both positive and negative impacts would occur to the values, beliefs and lifestyles of the area's residents. As mentioned in Chapter IV of the Regional Analysis, any impacts on such areas of subjective quality of life are difficult to project. However, given Anglo and Hispanic values which dominantly favor increased business opportunities and economic growth, the developments would have a positive impact. Negative impacts could be expected, particularly, in the areas of community infrastructure.

Positive impacts for the Indian population would also be defined in economic terms, with negative impacts relating to such factors as overcrowding, environmental damage, and the erosion of traditional cultural values. Since Indians view their land with great reverence, primary negative impacts could revolve around potential impacts on that land and its water resources. It is impossible to evaluate the extent to which spiritual values would be lost, and it is difficult to predict the number of people who would migrate to and from Indian (primarily Navajo) communities in response to the proposed developments. Migration could induce competition between Indians and other newcomers over jobs, and could lessen family bonds, the basic unit of traditional Indian culture. Similar social dislocation could occur with those Indians forced from their homes by any development.

Chapter IV of the Regional Analysis has a fuller discussion of the sociocultural impacts expected from the proposed developments.

CHAPTER IV

MITIGATING MEASURES

THIS CHAPTER PRESENTS MEASURES THAT WOULD LESSEN OR ELIMINATE ADVERSE IMPACTS RESULTING FROM CONSTRUCTION OF THE STAR LAKE RAILROAD. THESE MEASURES ARE DISCUSSED IN TWO CATEGORIES: THOSE REQUIRED BY LAW OR REGULATION, AND OTHER MEASURES.

CHAPTER IV

MITIGATING MEASURES

MITIGATION REQUIRED BY LAW OR REGULATION

Paleontology

The BLM is developing technical guidelines to define the resource, provide evaluatory criteria, and develop measures for protection. The provisions of these documents will serve as a basis for Federal management and protection of paleontological resources. (Refer to Chapter III of the Regional ES for complete mitigation requirements.) In addition, a report has been submitted by the New Mexico Paleontology Task Force to the Legislative Finance Committee on October 4, 1978, detailing options for State management and use of paleontological resources. This task force is currently studying possible protective measures. Recommendations will be made and some action on these recommendations is anticipated by the Legislature in the 1979 session.

Air Quality

The specific regulations pertaining to the control of smoke from diesel-powered locomotives are limited to permissible opacity levels cited under Regulation 401 by the New Mexico Environmental Improvement Agency as follows:

"401. Regulation to Control Smoke

E. No person shall permit, cause, suffer or allow the emission into the open air of any smoke having a density of shade greater than #1 on the Ringelmann s alg for any period greater than ten seconds from any diesel-powered locomotive operating below 8,000 feet (mean sea level).

F. No person shall permit, cause, suffer or allow the emission into the open air of any smoke having a density of shade greater than #2 on the Ringelmann scale for any period greater than ten seconds from any diesel-powered locomotive:

1. Operating above 8,000 feet (mean sea level); or

2. Involved in switching and railroad yard use.

G. This regulation does not apply to emissions from diesel-powered locomotives if the emissions are a direct result of a cold engine start-up."

The emissions for particulates, sulfur dioxide, and nitrogen dioxide are limited for oil combustion sources with heat inputs greater than 10^{12} Btu per year by New Mexico regulations number 501, 605, and 606.

"501. Oil Burning Equipment--Particulate Matter

No person owning or operating oil burning equipment having a heat input of greater than 1,000,000 million British Thermal Units per year per unit shall permit, cause, suffer or allow particulate matter emissions to the atmosphere in excess of .005 pounds per million British Thermal Units of heat input."

"605. Oil Burning Equipment--Sulfur Dioxide

No person owning or operating oil burning equipment having a heat input of greater than 1,000,000 million British Thermal Units per year per unit shall permit, cause, suffer or allow sulfur dioxide emissions to the atmosphere in excess of .34 pounds per million British Thernmal Units of heat input."

"606. Oil Burning Equipment--Nitrogen Dioxide

No person owning or operating oil burning equipment having a heat input of greater than 1,000,000 million British Thermal Units per year per unit shall permit, cause, suffer or allow nitrogen dioxide emissions to the atmosphere in excess of .3 pounds per million British Thermal Units of heat input."

Water Resources

In accordance with 43 CFR 2801.1-5(h), precautions, such as settling ponds in affected drainages, would reduce the sediment discharges due to construction activities.

Proper design and operation of waste-disposal systems, as covered by the Water Quality Control Commission for the State of New Mexico, would prevent pollution of ground water in the shallow aquifers.

Soils, Vegetation, and Wildlife

In 43 CFR 2801.1-5, terms and conditions are set forth that would be used as the basis for mitigation and stipulations to lessen impacts. By accepting a right-of-way across Federal lands, the applicant agrees and consents to comply with the following conditions:

"To comply with State and Federal laws applicable to the project for which the right-of-way is approved, and to the lands which are included in the right-of-way, and lawful existing regulations thereunder." and,

"To take such soil and resource (wildlife species and habitat) conservation and protection measures including weed control, on the land covered by the right-of-way as the superintendent in charge of such lands may request."

To comply with these regulations, the following mitigating measures would be required:

(1.) Unnecessary off-road vehicle use would be restricted to minimize disturbance, particularly areas outside the right-of-way.

(2.) All temporary construction of access roads, equipment storage sites, and construction sites would be restricted to the smallest compatible area where least soil disturbance and destruction of vegetative cover occurs. Clearing and grubbing would be done only where required.

(3.) Contingency plans would include measures to clean up accidental spillage of detrimental or toxic materials such as gasoline, oils and chemicals, and to restore damaged vegetation to near-natural condition.

(4.) Toxic materials exposed in borrow operations would be buried to avoid detrimental affects to reclamation efforts.

(5.) Waste water from concrete batch plants or from trucks carrying concrete would be discharged to settlement basins for impoundment and evaporation.

(6.) Areas disturbed during construction would be restored to their natural state insofar as practicable and in a timely manner according to an approved reclamation plan.

(7.) Temporary roads would be scarified or bermed to discourage future use.

(8.) Edges or sides of excavated material sites and borrow pits would be sloped to a ratio of not less than 3:1 horizontal to vertical and the bottom or floor of the pit graded to minimize sloughing and enhance revegetation efforts.

(9.) Waste piles would be leveled to conform with the general contours of the area, eliminating mounds of high relief.

(10.) If any information came to light indicating that endangered or threatened species inhabit the proposed railroad route, notification and Section 7 consultation would be undertaken with the U.S. Fish and Wildlife Service.

On areas where seeding is necessary to reestablish vegetation and stabilize the soils, a diverse mixture of native or adapted introduced perennial grass and shrub seeds would be drilled into a prepared seedbed. The timing of this operation would coincide with the season of most reliable rainfall.

After seeding, mulch at a minimum rate of 3,000 pounds per acre would be applied to stabilize the soil surface and reduce the evaporation rate.

If seeding efforts fail to produce a stand adequate to stabilize the soil, these efforts would be repeated in subsequent years until such a stand is established.

Implementation of these mitigating measures would reduce areas disturbed by construction activities, reduce sediment yield and fugitive dust, reduce the time frame for reestablishment of ground cover, and reduce wind and water erosion.

Visual Resources

The Federal Land Policy and Management Act of 1976 (P.L. 94-579) (FLPMA) specifies that the public lands be managed in a manner that will protect the quality of scenic values.

Land Use

RECREATION

On-site impacts on recreational capabilities that result from right-of-way construction would be mitigated under provisions of 43 CFR, Subparts 2801.1-5(a) and 2801.0-5(h)--Rights-of-Way; Terms and Conditions. These regulations require compliance with Federal and State laws applicable to the project for which the right-of-way would be approved and with other regulations necessary to render such approval compatible with the public interest.

WILDERNESS

Under provisions of Section 603 of FLPMA, the Secretary of the Interior may grant access across public land under review for wilderness designation only when it would not impair the suitability of the area for preservation. The right-of-way would have to be amended to avoid these lands if impairment were to occur.

Cultural Resources

Federal and State legislations have promulgated Acts and Laws to protect and preserve significant cultural resources. These Acts and Laws are cited in Chapter III of the Regional Statement. The mitigating measures required to protect significant cultural resources affected by Federally licensed projects are:

(1.) All terrain subject to proposed actions must be inventoried for cultural resources by professionals affiliated with qualified educational or scientific institutions.

(2.) No sites on the National Register may be damaged without comment of the Advisory Council and without prior professional investigation of the affected sites.

(3.) No sites eligible for nomination to the National Register may be transferred or damaged without prior comment y the Advisory Council.

(4.) Steps must be taken to recover cultural data from significant archaeological sites subject to damage from projects with Federal involvement.

The following protective measures are provided for State lands:

(1.) Cultural resources on State lands may not be damaged without prior permission and investigation by qualified professionals working under permit granted by the Cultural Properties Review Committee.

(2.) Cultural resources on private lands may not be destroyed by mechanical means for artifact collection, except by the owner, without prior permission by the Review Committee.

Legislation, then, assures that significant cultural resources on land of any ownership must not be damaged by Federal or Federally-licensed projects without prior scientific recovery of data.

OTHER MITIGATING MEASURES

Geologic Setting

TOPOGRAPHY

The Star Lake Railroad plans to fence the right-of-way and contractural requirements would be established that would restrict contractors from excessive disturbance of the terrain outside the right-of-way, and would mandate returning the disturbed areas to the condition prior to disturbance.

Topographic changes at borrow pits would be made less evident by smoothing as they are abandoned to enhance the potential for natural revegetation. Drainage of surface water would be provided if the landowner does not want water-storage ponds. Haul roads to and from the borrow pits would be obliterated.

GEOLOGIC HAZARDS

The application of sound engineering practices would be followed, fills would be compacted, slopes dressed and deep cuts benched to minimize erosion by water and wind and to retard the generation of excessive sediment that could be washed to streams. Techniques to be employed are compacting of earth materials to form stable slopes, dressing of slopes to increase the potential for natural revegetation, and intercept ditches in cut areas to direct surface water to the nearest natural drainage areas or drainage structures.

PALEONTOLOGY

Areas where the bedrock would be disturbed during railroad construction require the following mitigation measures to reduce loss of scientific material and information:

(1.) After the final alignment has been surveyed and staked, but in advance of construction, disturbed areas would be surveyed for fossil materials, and, where possible, fossils would be salvaged prior to disturbance.

(2.) During construction, periodic inspections would be made by a qualified paleontologist and samples collected from surface and subsurface disturbed fossil-bearing horizons. At least one on-site inspection per bedrock disturbance area would be made. Large areas of disturbance may require several inspections. Where possible, sample collections would be made from excavated areas after earth moving operations are complete to avoid operational interference.

(3.) Collected fossil materials would be curated, identified, and reposited in an appropriate manner to insure their protection and future scientific utility. Data on contextual relationships of sampled fossil materials would be obtained as completely as possible to preserve scientific value.

(4.) To reduce the negative impacts from increased accessibility, the right-of-way would be fenced and posted to prohibit unauthorized persons from using the right-of-way.

(5.) During construction, all Santa Fe Railroad employees, contractors, subcontractors, and their employees would be advised that removal of fossil materials is not permitted. In the event that fossil materials are discovered by construction workers, the BLM is to be notified, and appropriate action will be taken by the Bureau.

With the implementation of these measures, it is anticipated that nearly all the direct negative impacts would be neutralized. If properly implemented, some benefits would occur through collection of materials and data that would not be otherwise available.

Air Quality

Fugitive dust emissions along the line during construction of the railroad would best be controlled by the application of water from suitable spray systems, either with or without commercially available wetting agents. Major haul roads would be surface graded and wetted to control traffic-generated dust.

Areas within the right-of-way other than those required for fills, cuts, and service roads that are disturbed would be prepared for natural revegetation to reduce erosion and fugitive dust emissions.

Gaseous pollutants and smoke emissions from the diesel locomotives would be an insignificant source of air pollution along the rail line. The emission control program undertaken by the Electromotive Division of General Motors (Kotlin and Williams, 1975) is indicative of the recent trend of locomotive suppliers to include smoke emission ratings in their performance specifications. Locomotives intended for service on the proposed unit trains would meet these specifications. Existing engines have been tested to determine their exhaust smoke characteristics and, if necessary, retrofitted to reduce emissions to an acceptable level.

Water Resources

Measures to mitigate the impacts on the water resources include:

(1.) Disturbing or clearing of vegetation or disruption of the soil surface would be minimized.

(2.) Work roads would be water-barred to reduce erosion.

(3.) Culverts would be placed in the roadbed in such a way that discharged flows would not accelerate erosion.

(4.) Prevention and control of soil erosion within the right-of-way and adjacent lands would be of prime importance. The following would help control erosion:

-- Work roads would be prepared for natural revegetation as soon as practicable.

-- Material excavated for culvert installations would not be placed below the culvert outlet.

-- Outlets of culverts would be aligned with the natural stream course and some means of protection would be placed where needed to minimize drainage course erosion from scour.

-- In areas of cut, interceptor ditches would direct water into the nearest natural drainage or drainage structure.

-- All erosion damage would be reapired as soon as possible to prevent further loss of material into existing drainage.

-- All temporary roads and other areas of soil disturbance would be reworked to aid in natural revegetation.

(5.) Excavated material which requires temporary stacking would be placed where it would be subject to minimal erosion and will not damage vegetated areas.

(6.) Cuts and fills would be the minimum required, consistent with sound engineering practices. These areas would be smoothed to blend with the natural terrain, and erosion control methods would be applied immediately following construction to reduce sediment yield and increase the potential for natural revegetation.

(7.) Herbicide for control of weeds in the ballast section would be applied by qualified individuals as is done on the rest of Santa Fe Railroad which is consistent with State and Federal regulations.

(8.) To provide an early warning of developing problems, a system for monitoring sediment discharges and water quality along the railroad and in the vicinity of the railyard would be installed. This would allow corrective action to be taken before the problem spreads.

(9.) The alignment would be located so as to avoid destroying existing stock ponds.

In addition, the company would dress all cut slopes and compact all fills.

The above mitigating measures should reduce the sediment yield from cuts and fills by about 69 percent or about 123,000 tons after construction. Sediment discharges during construction would be virtually unmitigated.

Soils

Standard engineering practices would be applied to stabilize fill slopes, involving state of the art techniques to avoid use of soils having high shrink-swell potential, tendency to collapse, low load-bearing capacity and potential to corrode. This would minimize slope failure and subsidence, minimize the effects of weathering and erosion by water and wind, and retard the generation of excessive sediment washed to streams. Such techniques would involve the proper compaction of soil and geologic materials to form stable slopes. Cut and fill areas would be watered by tank truck for dust control during operation. Abandoned borrow pits, temporary roads, and camp sites would be graded to blend with the adjacent topography to increase the potential for natural revegetation and to minimize erosion. Permanent maintenance roads would be graded.

Solid wastes from work camps would be buried within the work area. Debris from drainage structures, maintenance yards and right-of-way would be disposed of to minimize detrimental effects on the environment.

Vegetation

The SLR has no plan for revegetation following construction of the proposed railroad, and would depend on natural revegetation of disturbed areas. Therefore, any active revegetation program would depend on stipulations of granting the right-of-way. Since the right-of-way would be fenced to exclude livestock, there is no need, at this time, for a revegetation program to restore the grazing potential of this land. However, prior to abandonment of the railroad, the SLR would conduct a study to determine the measures necessary to return the land to the same grazing use as prior to building the railroad. These measures would then be implemented by the SLR.

Wildlife

Guidelines and specific policies dealing with mitigation of wildlife resources are limited. However, there are many indirect methods of mitigating impacts on wildlife species and related habitats:

(1.) The method of clearing within the right-of-way would minimize destruction of natural vegetation, and avoid disturbance of adjacent wildlife habitat.

(2.) Only federally approved herbicides would be used for weed control on the track ballast area and shoulder. Application of such herbicides would conform to all standards to insure the protection and survival of various animal species.

(3.) Wildlife movement patterns would be protected by constructing bridges, culverts, road crossings, and livestock underpasses.

Visual Resources

After completion of construction activities, excess service or construction roads would be graded to conform to the adjacent topography. Discarded equipment and any debris or rubbish would be removed from the route along with any facilities not to be retained during operation of the railroad.

Land Use

Recreation

Revegetation of the proposed right-of-way and other disturbed areas following abandonment and removal of the railroad would minimize loss of site for future activities.

Transportation

In the areas where several roads cross the rail line within a short distance, the merging of the road system to create one crossing would minimize crossing hazards while maintaining access within the area. The danger of collisions between vehicular traffic and moving trains would be mitigated by the installation of signs, signals, or other warning devices at grade crossings.

The SLR would construct 24 grade-separated crossings or underpasses to minimize interference with local traffic.

Grazing

Because of the right-of-way would be fenced to keep livestock out, the treatment of distrubed areas following construction would be designed to prevent erosion. A more extensive plan of improving the grass lands for grazing would be followed when the railroad is abandoned and the land is returned to grazing. To minimize the effect of the livestock distrubution barrier caused by the fencing, the company would place livestock underpasses at various locations after constultation with the ranchers affected. All surface owners would be compensated for the grazing areas lost due to the proposed action.

Cultural Resources

Consultation with the State Historic Preservation Officer (and through him the Advisory Council for Historic Preservation) has commenced, and official review by the SHPO is integral to this document. Star Lake Railroad is committed to mitigation measures for sites that would be directly impacted by construction of the proposed alignment (Table SLR IV-1).

The mitigating measures listed in Table SLR IV-1 have been or will be voluntarily taken by the railroad company to prevent the loss of information from 5 of 11 sites and prehistoric roads subject to direct impact. Before terrain is disturbed, the appropriate land-managing agency has or will approve a mitigation plan which specifies the types and degrees of information recovery and site avoidance to be accomplished.

The company's mitigation plan has been found acceptable for sites on Tribal Trust and Allottment lands. The Bureau of Land Management has not yet considered acceptability of survey reports or clearance. The Navajo Nation and the State of New Mexico have not yet granted clearance for sites on fee lands or state property, but they probably will do so without further changes in mitigation plans (Andrew Jackson, personal communication, 1978).

Table SLR IV-1

COMMITMENTS OF STAR LAKE RAILROAD
FOR ARCHAEOLOGICAL MITIGATION

Site Number	Significance	Site Type	Commitment
51	5	Anasazi Pithouses and Artifacts	Avoid by narrowing right-of-way
68	4	Navajo Enclosures	Ethnohistoric investigation completed
81	3	Navajo Hogan and Refuse	Testing
89	4	Navajo Tent Site	Ethnohistoric investigation completed
90a	3	Ceramic Scatter	Some testing completed; no further commitment
90b	4	Navajo Camp	Ethnohistoric investigation completed

CHAPTER V

UNAVOIDABLE ADVERSE IMPACTS

THIS CHAPTER DISCUSSES THE ADVERSE IMPACTS FROM CONSTRUCTION OF THE STAR LAKE RAILROAD THAT WOULD REMAIN AFTER THE APPLICATION OF MITIGATING MEASURES.

CHAPTER V

UNAVOIDABLE ADVERSE IMPACTS

Resources in this chapter are arranged according to the order of magnitude of the adverse impacts. Resources that would be subjected to the greatest impact are listed first.

CULTURAL RESOURCES

Unavoidable adverse impacts to cultural resources include direct destruction or damage to sites from the SLR construction, and indirect damages from unauthorized collecting and vandalism due to increased human activity in the area. Twelve to 33 sites would be lost or damaged during construction. Mitigation measures would retain some of the information value of these sites; however, they are limited to research objectives current at the time of excavation and, in most cases, to partial testing. If mitigation is not accomplished according to a problem-oriented research design relevant to major archeological concerns in the San Juan region, the information gained would be greatly lessened in its value to the archeological community. It would, in that case, be more descriptive than explanatory of cultural processes. Because the sites would be destroyed after mitigation, they cannot later be re-examined for information guided by different questions or procedures, nor can the previous data be reconfirmed. As a result, losses of information and of the physical site must be considered unavoidable impacts of the proposed action.

Up to 165 sites could be lost by 1990 from the related coal development.

SOCIOECONOMIC CONDITIONS

Local traffic would be temporarily disrupted during construction and traffic on local roads would be increased. While the placement of warning and protective devices would reduce the incidence of vehicle-train collisions, a slight increase in incidence of collisions at grade crossings would be unavoidable. Occupational injuries would occur to about 6 railroad workers per year after 1982 (U.S. Department of Labor, Bureau of Labor Statistics, 1977). The development dependent on the SLR would place additional burdens on the already strained community infrastructure.

GRAZING

The removal of 2,854 acres of grazing land would result in an unavoidable loss of 402 AUMs for the life of the railroad. Despite mitigation, some of the 5 to 10 Indian operators could chose to abandon their livestock-based way of life and depend entirely on other sources of subsistence. A rotational grazing system being implemented in one grazing allotment would be disrupted by the railroad and a new Allotment Management Plan would have to be designed, with additional costs incurred for additional range improvements. An additional 400 AUMs will be lost from the coal mines related to the SLR. While a variety of impacts exist, the total impact is minor relative to the size of the livestock grazing industry in the region.

GEOLOGIC SETTING

Topography

Impacts on the region's topography that cannot be avoided would be small and consist of cuts, fills, and borrow pits along the route. Volumes are estimated as 9,546,000 cubic yards of excavation, 8,222,000 cubic yards of fill, and 408,000 cubic yards for borrow pits. (See Table SLR I-5 for more details on grading.) In a regional context, this would be a very insignificant impact. Locally, however, the change will be very apparent. Disturbance of 6,762 additional acres by the year 1990 would occur on land being mined for coal and in communities where workers would live.

Paleontology

Unavoidable impacts would result from: 1) inadvertant destruction of fossil materials during construction; 2) intrusion of construction, maintenance and operational personnel and the resulting increased population, increasing vandalism and unauthorized collecting; and 3) coal development resulting from the SLR inadvertantly destroying fossils and increasing vandalism and unauthorized collecting. Mitigation would reduce the magnitude of these impacts, but some impact would remain.

It is highly improbable that all fossil material would be located, sampled, and identified through mitigation procedures. The magnitude of these unavoidable impacts is difficult to quantify, but it may be estimated that at least 50-percent of the disturbed materials would go unsampled. This magnitude is insignificant for fossil invertebrates and plants because only 1 or 2 percent of these resources are needed. The magnitude of impact would be greater on the vertebrate fossils because 20 to 100 percent of the resource is needed.

Unavoidable impacts due to increased population resulting from the railroad are expected to be small and of short-term duration. However, resulting coal development and associated population increases are expected to have substantial unavoidable impacts.

Mineral Resources

The overall adverse impact of the proposed Star Lake Railroad on the minerals industry in the ES Region would be small. About 2,854 acres of land within the right-of-way for the railroad and 6,762 acres of the related coal development would be unavailable for mineral exploration and possible future production for as long as the railroad exists. Owners of mineral rights within the right-of-way would be unable to develop their holdings except at the South Hospah Mine, where plans have been made to permit mining under the right-of-way.

AIR QUALITY

Although controlled to the extent possible, there would be a minimal amount of unavoidable exhaust emitted from diesel locomotives, cars, trucks and mining equipment. This would increase the particulates (49 tons/yr), sulfur dioxide (113 tons/yr), nitrogen oxides (730 tons/yr), and hydrocarbons (187 tons/yr), and slightly lessen visibility. Some fugitive dust would be released from construction and operation of the railroad and the related coal development despite control procedures including land reclamation and revegetation.

WATER RESOURCES

It would not be possible to avoid lowering water levels within a 0.5- to 2-mile radius of most of the supply wells during construction. However, once construction is finished and the wells are no longer pumped, the water levels should return to their pre-pumping positions through natural recharge. About 2,000 acre-feet per year of water would be required by the related coal development. Nearly all the water used would be lost to the atmosphere through evaporation and transpiration. There would not be any discharges to the streams of the area.

Approximately 179,000 tons of sediment produced during construction would be unmitigated. This would be reduced after construction to about 55,800 tons per year as a result of the mitigating measures and the natural stabilization of the cuts, fills, and stream channels. The average annual sediment discharge of 13,700 tons per mine from the related coal mines and community development would be unavoidable. These sediment discharges amount to about 7 percent or less of the natural sediment discharge of the Chaco Wash and Rio Puerco basins, and would not cause a significant change in the total sediment yield of the region.

SOILS

Disturbance of soil on 2,854 acres during construction of the railroad cannot be avoided. An estimated 1,272 acres of soil surface would either be covered by ballast, service road, or fill material, or would be disturbed by excavation for cuts, resulting in the loss of productivity. The long-term loss of productivity of the 1,272 acres (45 percent of the right-of-way) would be a significant impact to the soil resource within the right-of-way. However, 1,272 acres would involve less than 0.03 percent of the region. Productivity of the remaining 1,582 acres within the right-of-way would be lowered by compaction, mixing of native soils, and accelerated erosion. Impacts of coal development dependent on the railroad would change soils and reduce productivity of an estimated 6,762 acres (less than 0.2 percent) of the region by 1990. Reclamation experience in the region has not been of sufficient duration for studies to determine the long-range effects on soil productivity.

Accelerated soil loss during construction and mining operations and prior to re-establishment of vegetative cover cannot be avoided. However, as ground cover is re-established or as readily detachable soil and geologic material is removed, the quantity of eroded material would diminish and soil loss would decline. Alteration of soil horizons, parent material, and soil characteristics that have developed over long periods of geologic time cannot be avoided. Consequently, new soils would form with characteristics unlike those existing prior to disturbance.

VEGETATION

The destruction or disturbance of vegetation on 2,854 acres would be unavoidable. A revegetation program would mitigate this impact to some degree, but approximately 1,272 acres (45 percent of the right-of-way) occupied by the roadbed and service road would remain free of vegetation through the life of the railroad. The destruction of the existing vegetation on an additional 6,762 acres that would be mined for coal by 1990 would also be unavoidable. This is about 0.14 percent of the area of the region.

WILDLIFE

Construction of the railroad would unavoidably destroy 1,272 acres and the related coal development 6,762 acres of wildlife habitat. Escape cover, food availability, dens, and nesting sites lost directly from the construction and operation of the proposed railroad would affect small mammals (mainly rodents), various reptiles, amphibians, and arthropods. The extent of displacement of various animal densities is not known; however, it is expected to be negligible considering the widespread distribution of these animal species in northwest New Mexico. No crucial or sensitive habitat is expected to be displaced as a result of the proposed action.

Noise associated with railroad construction and operation would present short-term unavoidable adverse impacts to various terrestrial fauna inhabiting the area. Some animal species, however, would adjust to non-destructive human activity.

AESTHETICS

Noise

The project would create unavoidable adverse noise impacts by increasing noise levels above the ambient rural sound levels. However, most of the noise would be of a transitory nature, caused by moving sources that would not pollute for an intolerable exposure time span. The service facility and the related coal mines would be fixed sources of intermittent low-level noise pollution.

Single source equipment noise levels during construction would vary from 105 dBA (pile driver) to 70 dBA (vehicles) at 50 feet from the noise generator. The pile driver would only be used in a few places. Therefore, the major noise generators would be various types of vehicles.

The operating train would cause a new noise impact upon an area unaccustomed to receiving train noises. In general, with a minimum of 10 trains per day traveling at 20 mph, the 55 dBA level would be exceeded within a distance of 785 feet from the source. Trains traveling at 45 mph would impact an area within a 680 foot distance. The operating trains would cause a temporary impact on a stationary receiver from increased noise levels for a duration of approximately four minutes.

Visual Resources

Visual evidence of the railroad would remain after reclamation. Though the contrasts may be lessened by mitigation, the dominant form, line and color contrasts of the roadbed would still remain. These contrasts would be less evident in the gently rolling terrain, where disturbance to land form and vegetation would be minimal. If the railroad is abandoned, fills, cuts and drainage structures would be left intact. All other salvageable material and improvements would be removed. The modification that had occurred on the landscape would remain.

The communication facilities would create unavoidable impacts. Placement of structures on the landscape would modify the existing form, line, color, and texture. The strong vertical line created by the steel towers would be the most dominant visual impact from the communication facilities. The related coal development also would modify the natural landforms.

LAND USE

Recreation

Unavoidable adverse impacts resulting from the proposed railroad would be removal of 289.6 acres of public lands from potential recreation use and disruption of recreation activities in the vicinity of the railroad. The roadbed through open lands would restrict cross-country travel and recreational use of numerous unimproved roads. Interruption of recreation traffic at grade crossings by trains would be an unavoidable impact. The presence of the railroad and construction activities and the related coal mines would reduce the quality of recreation near these disruptive activities.

Transportation

Unavoidable impacts include an increase in the number of highway-railroad crossing accidents and increased disruption and delay of vehicular traffic in communities through which the trains would pass. These impacts will predominantly be felt on the Santa Fe mainline, because the SLR would not pass through any communities.

Initially, a limited amount of fuel would be consumed in constructing the line. Afterward there would be a continuing commitment of energy and resources to haul freight generated by the line. The extent of this continuing consumption may vary as coal production levels change or as rail operations are made more fuel efficient.

Wilderness

Should the State Director's final decision on the initial inventory concur with the present recommendations, the implementation of the proposed action would not result in any unavoidable loss of wilderness values. All areas under intensive survey to determine suitability for wilderness consideration would be avoided.

CHAPTER VI

THE RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

THIS CHAPTER DISCUSSES THE LONG-TERM IMPAIRMENT OR ENHANCEMENT OF RESOURCE VALUES THAT WOULD OCCUR AS A RESULT OF THE SHORT-TERM USES OF THE ENVIRONMENT PROPOSED BY THE STAR LAKE RAILROAD CO.

CHAPTER VI

RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

Construction of the proposed rail line would provide access and transport to market for the extensive coal reserves (5.1 billion tons) of the Fruitland Formation (Shomaker, 1971), enabling development of the coal along this 250-mile outcrop. The coal would be available to meet future national energy demands. Construction and operation of the railroad would be a long-term land-use commitment of the 2,854-acre right-of-way in a 114-mile-long corridor. This use would effectively preclude other land uses such as development of other minerals than coal, grazing, and some casual recreation in the right-of-way.

Both archaeological and paleontological sites directly impacted during construction of the right-of-way would be permanently lost. Some of the information in these sites would be salvaged through mitigation excavations prior to site destruction. This data could be retained for long-term use, but the actual site localities would not be available for long-term research or improved interpretive methods. Indirect impacts due to vandalism and unauthorized collection would also affect sites in the vicinity of the right-of-way, further impairing long-term productivity.

Construction and operation of the railroad, with anticipated related development, would contribute a small increment to the large workforce and population increases projected for the area (see Chapter IV of the Regional Analysis). Direct and indirect employment would rise by 742 jobs, with a projected population increment of 921 persons during peak construction.

Fugitive dust and other particles would enter the atmosphere during railroad transport of the coal. These fugitive emissions and the aerosol formed in the atmosphere from sulfur dioxide, nitrogen oxide, and hydrocarbons would reduce visibility during railroad operation; however, they are not expected to have a long-term affect.

The short-term use of the water resources of the region due to construction and operation of the SLR would not impair the long-term productivity of the environment. Water that is pumped out would gradually be replaced by natural recharge.

Construction of the railroad would result in the long-term commitment of and loss of productivity on approximately 1,272 acres of soil surface that would be covered by roadbed or service road, or exposed by excavation for cuts and fills. Productivity of the remaining 1,582 acres within the right-of-way would also decline due to the construction-related activities. Coal development dependent upon the railroad would reduce the productivity of the soils of an estimated 7,295 acres (less than 0.2 percent of the region).

In the short term, a loss of vegetation on about 1,684 acres would occur, and disturbance on about 1,866 additional acres. In the long term, vegetative productivity would be reduced on about 1,272 acres. All terrestrial wildlife species identified as inhabiting the right-of-way would experience displacement and resulting decline in animal densities, according to the amount of disturbance to various vegetative types and the variety and numbers of wildlife.

After construction, long-term disturbance to the area's visual resources would remain, though they would be less significant than short-term impacts. Elevation of noise levels would be greatest during construction and would lessen during operation, with a probable return to preconstruction levels over the long term.

Short-term recreation use of the 1,272 acres within the right-of-way (sightseeing, hunting) would be reduced due to exclusive use of the railroad. No long-term reduction in wilderness values is expected as a result of short-term impacts from development of the SLR.

After abandonment of the railroad, reclamation of the acreage disturbed is expected to return several resources to near preconstruction productivity; these resources include air quality, vegetation, wildlife, recreation, and livestock grazing. This process could take decades or centuries due to semiarid climatic conditions and, in the case of vegetation, species diversity and stability may never equal that of preconstruction communities. Pollutant dispersion patterns may also be permanently altered if reclamation and revegetation does not restore surface contours and vegetation to conditions similar to those present before construction.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

THIS CHAPTER IDENTIFIES THOSE RESOURCES THAT WOULD BE CONSUMED AND PERMANENTLY LOST AS A RESULT OF CONSTRUCTION AND OPERATION OF THE STAR LAKE RAILROAD.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The railroad would require approximately 33,100 tons of steel for rails, additional steel for spikes, tie plates and anchors, 450,000 wood ties, and 745,000 cubic yards of basalt excavated on site for ballast. (There is an abundant supply of basalt in the area.) Some materials used in manufacturing mining equipment and buildings would be committed for the life of the project, but much of this would be salvageable.

Construction and operation of the rail line would require the consumption of energy, in the form of diesel fuel and, to a much lesser degree, gasoline. The diesel fuel would be used both on the SLR and on the mainline to deliver the coal to its destination.

Approximately 142 million tons of coal would be produced and consumed from the coal mines dependent on the proposed action, and an estimated 28 million tons would be lost due to current mining methods out of the strippable reserves of 6.3 billion tons.

An estimated 329 to 356 fossil localities and about 119 to 177 archaeological and historic sites would be unstudied, or only partially studied, and destroyed by 1990 as a result of construction of the SLR and related development. This is a small part of the total number of sites in the area; however, any one of those could be uniquely important.

The sediment discharge would be 179,000 tons per year from the SLR and 40,000 tons per year from the related development, compared to the natural discharge of 2.5 to 3.0 million tons per year. Water requirements for the SLR would be about 100 acre-feet per year and for related developments would be about 4,700 acre-feet per year.

Approximately 1,272 acres within the right-of-way would be committed to use as a transportation corridor; roadbed, cuts, fills, and drainage structures would remain intact after abandonment. An additional 6,762 acres would be disturbed by the related coal development. Soils, existing native vegetation, and wildlife habitat would be lost on the 8,034 acres, as would the soil profile characteristics of the cut and fill areas. These losses compare to the 4.8 million acres in the ES Region. Following abandonment and reclamation, much of the right-of-way would revert to grazing land.

The construction of a railroad would impair the suitability for preservation as wilderness of any designated wilderness study area, since, by definition, a railroad meets the BLM criterion of a road. However, should the State Director's final decision on the initial inventory concur with present recommendations, no wilderness values or potential wilderness areas would be irreversibly or irretrievably lost.

Increased population for construction of the Star Lake Railroad and the related coal mines would add to the deterioration of small-town atmospheres and some distinctive aspects of Hispanic and Indian cultures.

CHAPTER VIII

ALTERNATIVES TO THE PROPOSED ACTION

THIS CHAPTER PRESENTS THE ENVIRONMENTAL IMPACTS OF REASONABLE ALTERNATIVES TO THE PROPOSED RAILROAD, INCLUDING THE NO-ACTION ALTERNATIVE.

CHAPTER VIII

ALTERNATIVES TO THE PROPOSED ACTION

Alternatives to the SLR considered by the ES team include no action on the proposal, an alternate route for the first 27 miles of the proposed route, alternative rail corridors, and phased development of the Pueblo Pintado to Bisti segment. This last alternative was developed during the public review process and is discussed in Chapter VIII of the Regional Analysis. Time pressures precluded its inclusion in this volume. Resources not impacted by these alternatives are omitted from this chapter.

NO-ACTION ALTERNATIVE

Under the no-action alternative, the SLR would not be built. A slurry line and trucks, were considered as possible alternatives to the railroad. Slurry was found not to be feasible due to the lack of available water. The truck alternative would have construction impacts similar in magnitude to the railroad. No highways in the area could handle the required volume of traffic and new ones would have to be built. Operationally, trucks would consume more energy, generate more air pollution and noise, and result in a greater number of accidents.

Also considered was a scenario in which no new high bulk transportation access was provided in the Star Lake-Bisti area. As a result, the Star Lake, South Hospah and Alamito Mines would not be developed and coal production from the region would amount to 14.5 million tons in 1990, approximately 16.5 million less than if the railroad were built. Population growth and related impacts would be correspondingly less.

These alternatives are presented in more detail in Chapter VIII of the Regional Analysis.

WEST ROUTE ALTERNATIVE

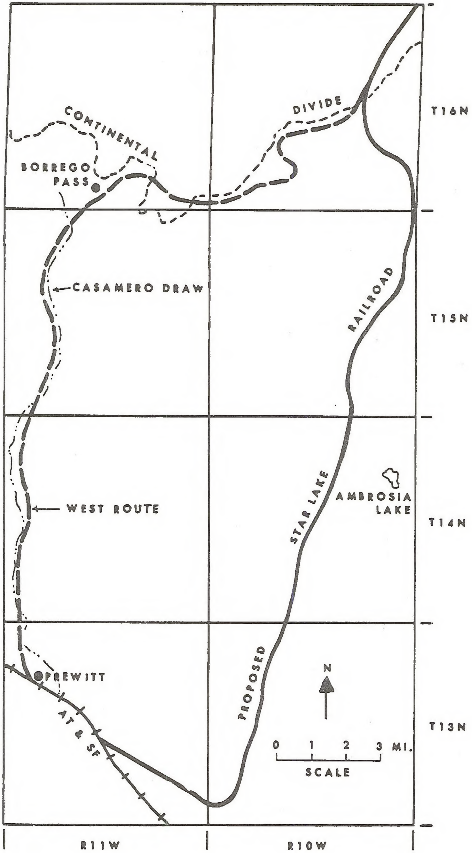
The Star Lake Railroad was proposed by the applicant primarily to provide direct rail service to private coal resources located near Star Lake, near Hospah, and near Gallo Wash. While the SLR also desires to provide rail service to nearby potential operations that would mine as yet unleased Federal coal, it has indicated that the rail operation would be viable serving just the private coal resources. Alternative routes were considered by the applicant to provide efficient rail service to the private coal resources and the applicant selected the most desirable route based on its own evaluation of these alternatives. This route was then presented as the proposed route to the ICC and BLM in the applications to these agencies and is discussed in Chapters I through VII. The applicant also documented an alternate to the first 27 miles of the proposed route, which it considered and rejected. This 'West Route' is discussed in the following sections.

The topography and natural environment of northwestern New Mexico and the constraints of modern, high capacity rail construction limit meaningful alternatives that can be developed within a general corridor. North and roughly paralleling the existing main-line is a line of mesas and other terrain features. The extensive earthwork required to cross such features yet maintain acceptable grades limits practical routes to gaps between the terrain features. In the Prewitt area, there are two such gaps. The proposed route is located in the gap between Mesa Montanos and Haystack Mountain. The west route, after leaving the main-line near Prewitt, follows Casamero Draw. Approximately 14 miles north of the main-line, the route curves to the east. At Borrego Pass it climbs to the Continental Divide, which it crosses twice then parallels in a northeasterly direction until it intercepts the primary route near the southeast corner of Sec. 11, T. 16N., R. 10W. From that point, the west route is the same as the primary route (Map SLR VIII-1).

Between Prewitt and its interception with the primary route, the west route would require almost the same amount of right-of-way. The ownership of this right-of-way differs from the primary route as shown in Table SLR VIII-1.

The west route would require significantly more earthwork than the primary route as shown in Table SLR VIII-2. In addition to this earthwork, bridges would be needed over the steep canyons north of the Borrego Pass Trading Post. Approximately the same amount of ballast would be required. Because of these more complex construction requirements, this alternative would be more expensive than the primary route.

Faults have been found only along the segment of the west route between mile posts 15 and 27. These are normal, steeply dipping faults with less



MAP SLR VIII-1. LOCATION OF WEST ROUTE.

Table SLR VIII-1

RIGHT-OF-WAY OWNERSHIP TO MILEPOST 27
(acres)

Owner		West Route		Primary Route
Public (BLM)		32		65
State		31		20
Private		388		462
Indian Allotment	184		111	
Indian Withdrawal	15		2	
Indian Trust	9		0	
Total Indian		208		113
Total		659		660

Source: VTN Consolidated, Inc. 1976a; 1976b.

Table SLR VIII-2

EARTHWORK REQUIREMENTS TO MILEPOST 27
(cubic yards)

	West Route	Primary Route
Unclassified Excavation	1,600,000	1,600,000
Borrow	750,000	450,000
Fill	2,150,000	1,750,000

Source: VTN Consolidated, Inc. 1976a; 1976b.

than 100 feet displacement. They trend northerly to northeasterly, and probably have not been active for at least several thousand years.

Impacts

GEOLOGIC SETTING - PALEONTOLOGY

Much of the net impact identified in the site specific analysis of the proposed action would remain the same. The alternative route would cross similar geologic strata, and fossil localities are anticipated to contain the same or similar fossil materials; however, four more localities were identified than in the proposed route.

AIR QUALITY

The west route is essentially the same length as the primary route. However, the somewhat steeper grades would increase the rate of fuel consumption about 223 gallons per trip (Santa Fe estimate). This would result in a total annual fuel consumption for the west route of 4,316,250 gallons, approximately 9 percent more than would be consumed by operations over the primary route.

Air pollutant emissions from rail operations are directly related to the rate of fuel consumption, so emissions would be greater if this alternative is constructed. This could result in a slight reduction in visibility along the route. Table SLR VIII-3 presents the estimated annual level of pollutant emissions.

WATER RESOURCES

Impacts on water resources for the west route would be approximately the same as for the proposed route. This route crosses approximately 14 miles more of areas that have a high susceptibility to erosion, which would produce a greater sediment discharge. This increase in sediment is alleviated somewhat by shorter service road requirements, with a lesser sediment discharge. Overall there probably would be an increase in sediment discharge. The number of stream crossings is essentially the same for the west route as for the proposed route. The water-quality impacts would be the same. The west route would,pass close to several wells, particularly in the Prewitt area, but not close enough to cause any problems.

SOILS

Impacts on soils for the west route would be similar to those described for the proposed route. The west route would cross an estimated 14 more miles of soil having high erosion susceptibility, 12 more miles of soil having shrink-swell tendencies, and 17 more miles of highly corrosive soil than the proposed route. However, the west route would cross an estimated 8 fewer miles of soil having a high tendency to collapse, 9 fewer miles of soil having poor load-bearing capacity, and 3 fewer miles of soil having poor suitability for use as fill material.

VEGETATION

The more broken topography of the west route provides environments more conducive to the development of varied vegetation types. Thus, the west route would traverse about 18 percent more pinyon-juniper, 2 percent more saltbush-greasewood, and 20 percent less grassland than the proposed route.

The greater amount of borrow and fill material needed for the west route would result in destruction of about 15 percent more vegetation than the proposed route. Nearly all of this increased vegetation destruction would occur in the pinyon-juniper type. The more shallow soils and steeper slopes in these areas would make re-establishment of vegetation more difficult. Therefore, in addition tc more vegetation destruction along the west route, the average time these areas remain free of vegetation would be longer. Secondary succession to pinyon-juniper climax would be slow, and would require more time than succession to grassland in areas where grassland is the climax vegetation type.

WILDLIFE

Impacts on wildlife species under the west route alternative would be considerably greater due to the diversity and composition of habitat. Construction activities along the west route would tend to disrupt wildlife species inhabiting steep rocky slopes. Particularly affected would be raptors (hawks, eagles and owls) that nest in these areas. Migratory patterns of carnivores and wild ungulates would also be disrupted during construction and operation of the west route. Approximately 18 percent more pinyon-juniper habitat would be traversed in the alternative route.

AESTHETICS

Noise

The west route would require more earthwork and steeper grades would be required. With increased earthwork, construction equipment would be present in certain localities for longer-duration than would be required from construction of the primary route.

Visual Resources

The anticipated visual impacts resulting from construction of the railroad along this route would be greater than along the proposed route. Due to the terrain traversed by this route, more earthwork would be required, which would create more con-

Table SLR VIII-3

AIR POLLUTANT EMISSIONS

Pollutant	Emissions tons/year West route	Emissions tons/year Proposed route
Carbon monoxide	281	257
Hydrocarbons	203	187
Nitrogen Oxides	798	730
Sulfur Oxides	123	113
Particulates	54	49

Table SLR VIII-4

GRAZING ALLOTMENTS ALONG THE WEST ROUTE

Grazing Allotment	Right-of-Way Acreage Required	AUM's Lost
61	251.9	38
62	145.2	20
54	170.1	10
40	145.7	16
55	209.7	31
42	194.9	56
35	78.6	9
37	143.8	33
33	226.6	21
18	305.6	28
17	290.5	38
19	3.3	1
20	19.3	3
21	66.0	15
13	168.3	20
16	114.1	11
12	235.1	27
8	85.3	6
Total	2,854.0	383

trasts with the existing landscape. These contrasts would be more evident to the viewer as the railroad would cross the Prewitt to Navajo 9 road at several places.

LAND USE

Recreation

The west route crosses the Prewitt-Pueblo Pintado road five times, and crosses approximately the same density of the area primitive road network as the proposed route. There would be no direct impact on any national wilderness or potential wilderness area.

Grazing

Land along the west route is used primarily for grazing; approximately 2,854 acres with a carrying capacity of 383 AUMs would be removed from use. Table SLR VIII-4 shows the grazing allotments that would be affected by the west route. Six grazing allotments along the proposed route would not be affected by the west route. However, four new grazing allotments would be involved that would not be affected under the proposed route. Total number of AUMs lost in the west route is 383 compared to 402 for the proposed route. The number of small (160-acre) range units that would be impacted by the alternative is less than half of those in the proposed route. The west route is near more homes than the proposed route, possibly affording a higher impact on the diurnal sheep-herding practices normally associated with the homes. All other impacts on livestock grazing would be similar on both routes.

CULTURAL RESOURCES

The west route was inventoried for cultural resources in 1975 (Harrison, 1975). The results have not been field-checked for accuracy, and it has been assumed that the Harrison survey adequately reflects the nature of cultural resources along the route. The data are summarized in Table SLR VIII-5.

If the west route is selected, cultural resource impacts will change only on the southern part of the proposed route. Sites 1 through 14 on Table SLR II-9 would be avoided. In their place, the 23 sites summarized on Table SLR VIII-5 would be affected. The site count near the west route is somewhat higher than the comparable section of the proposed route (23 to 15), but the cultural range of sites along the west route is roughly similar to that of the proposed route. Anasazi and Navajo remains dominate the material. Anasazi materials include two possible Pueblo III communities (Sites 91 and 92), and an isolated great kiva (Site 110). The community sites are heavily alluviated, and the full extent of the deposits has not been determined, but their research value is judged to be high. The kiva has exposed walls, which increase the sites' vulnerability to vandalism. Kivas of this size are relatively rare in the area; as a consequence, it may also be considered a highly significant archaeological resource. These Navajo sites include sandstone and cribbed-log hogans, corrals, sweat lodges, ovens, and trash. Collectively, they offer significant research potential for dealing with such problems as Navajo habitation and use patterns in the area. The single Euroamerican Site (Site 109) appears to be a homestead building from the Alber's Ranch.

The west route would increase both direct and indirect impacts to cultural resources. Table SLR VIII-6 compares numbers of sites impacted by both routes. The results of the impacts are the same for both routes. Sites directly impacted will be subject to extensive or total damage. The indirect impact of vandalism will accelerate the loss of cultural materials in the vicinity of the right-of-way.

Conclusion

The West Route would require approximately the same amount of right-of-way as the proposed route, although the pattern of land ownership would be different. The acreage required from Indian Allotment, withdrawal, or Trust land would increase, while the acreage of BLM and private lands acquired would decrease. The West Route would require approximately the same amount of excavation; however, the borrow and fill requirements would be 67 percent and 23 percent greater, respectively. In addition to this earthwork, bridges not required by the proposed route would be required to cross the steep canyons north of Borrego pass Trading Post. Construction of the west route, therefore, would be more expensive.

Impacts on palentological resources, water resources and soils would be similar in magnitude to those resulting from the proposed route, although impacts on vegetation and wildlife would be somewhat greater.

The steeper grades of this route would increase fuel comsumption by approximately 9 percent, as well as resulting in air pollution and noise. Since the west route passes closer to inhabited areas, the latter two impacts as well as the frequency of accidents would have a greater impact on residents of the area.

ALTERNATIVE CORRIDORS

General alternative corridors to provide rail service to the area of potential coal development between Bisti and Star Lake were also considered. These analyses are presented in Chapter VIII - Transportation Alternatives, of the Regional Analysis. To summarize briefly, three possible corridors are discussed, two corridors from the Santa Fe main-line and a corridor from the Denver and Rio Grande Western Railroad. The SLR route proved to be environmentally superior to these alternative corridors. Operationally, the proposed SLR route was superior in hauling the traffic generated by the probable level of coal development in the region, as well as most other scenarios of coal development in the region and on the Navajo Indian Reservation.

Table SLR VIII-5

CULTURAL RESOURCES IMPACTED BY WEST ROUTE

Site No.	Site Type	Site Characteristics	Sig. Est.	Impact	Miscellaneous
91	Anasazi	Shaped limestone blocks, sherds, cultural materials and a human skull eroding from an arroyo bank.	5	D	Pueblo III-Remains poss. indicate more extensive site
92	Anasazi	Surface trash of a pueblo community and a 40 ft. circular depression (poss. Great Kiva)	5	I	Pueblo III heavily alluviated
93	Navajo	Storage cist of limestone and a peach can	2	I	Historic
94	Navajo	Cribbed-log hogan and two extensive trash mounds	4	I	Historic
95	Navajo	Hogan remains	3	I	Poss. Historic
96	Navajo	Stone hogan, oven, firepit and wood scatter	3	I	Historic
97	Navajo	Large sandstone hogan, corral and trash	4	I	Historic
98	Navajo	Oval sandstone hogan, forked stick sweathouse and a stone quarry	4	D	Historic poss. early
99	Navajo	Burnt log hogan and trash	3	I	Historic
100	Navajo	Forked-stick sweathouse, charcoal and burned sandstone	2	D	Historic
101	Navajo	Cribbed-log hogan, storage cist and a forked-stick sweatlodge	4	I	Historic
102	Navajo	Five sided wooden storage cist	3	I	Historical; BP-4-BP-7 may be a single complex
103	Navajo	Brush corral	2	D	Historic
104	Navajo	Brush corral	2	D	Historic

Table SLR VIII-5 (continued)

Site No.	Site Type	Site Characteristics	Sig. Est.	Impact	Miscellaneous
105	Unclass.	Petroglyphs of names, dates, and horse	4	I	1848-1947
106	Navajo	Forked-stick sweathouse	3	D	
107a	Navajo Compon.	Brush corral	2	I	Historic
b	Anasazi Compon.	Ground stone artifacts	3	I	Pueblo
108	Navajo	Oval sandstone hogan, burned, and a firehearth	4	UK	Historic, early
109	Euroamer.	Stone, one room structure and cellar	4	I	Poss. assoc. with the Albert ranch homestead
110	Anasazi	Isolated Great Kiva with visible masonry	6	I	Pueblo III
111	Navajo	Cribbed-log and sandstone hogan	3	UK	Historic
112	Anasazi	Six-ceramic scatters were located in the vicinity of the route	2	D&I	
113	Lithic	One lithic scatter was located near the right-of-way	2	I	

Source: Harrison, 1975.

Impacts: D - Direct
I - Indirect
UK- Unknown

Table SLR VIII-6

COMPARISON OF IMPACTS ON CULTURAL RESOURCES

Route Number of Sites Impacted	Proposed Route South Portion	 Total	West Route South Portion	 Total
Direct Impact	3 - 10	14 - 39	6 - 7	18
Indirect Impact	12 - 30	89 - 139	14 - 15	91
Unknown Impact	-	-	2	2
TOTAL	15 - 40	103 - 178	23	111
Direct Impact to Sites with potential National Register eligibility (tentative)	1 - 3	5 - 10	2 - 3	6 - 7

Source: Bussey, et al., 1976; Rorex, et al., 1976; Bussey, 1977; Brethauer, 1977; Hoyt, et al., 1978; Harrison, 1975. On file at BLM, Albuquerque District Office.

SITE SPECIFIC ANALYSIS

FRUITLAND COAL LOAD TRANSMISSION LINE

FRUITLAND COAL LOAD TRANSMISSION LINE

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The Regional Environmental Statement describes the consultation and coordination efforts involved in the preparation of this site specific analysis.

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CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

THIS CHAPTER IS A DETAILED DESCRIPTION OF A FEDERAL PROPOSAL TO CONSIDER THE APPROVAL OF A JOINT APPLICATION BY PUBLIC SERVICE CO. OF NEW MEXICO AND PLAINS ELECTRIC GENERATION AND TRANSMISSION COOPERATIVE, INC. FOR A RIGHT-OF-WAY TO CONSTRUCT A POWER TRANSMISSION LINE IN MCKINLEY AND SAN JUAN COUNTIES, NEW MEXICO. OTHER DEVELOPMENTS IN THE AREA RELATING TO THE PROPOSED ACTION ALSO ARE DESCRIBED.

CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

BACKGROUND

This site-specific analysis discusses the environmental impacts of the proposed Fruitland Coal Load Transmission Line (FCL), including the secondary impacts resulting from the development of coal mines and a generating station that are facilitated by the FCL. The development analyzed is part of the proposed action described in Chapter I of the Regional Analysis. Impacts are assessed through 1990, with the years 1980, 1985, and 1990 as reference years, and are compared to the environment in 1977.

The Public Service Company of New Mexico (PNM) and Plains Electric Generation and Transmission Cooperative, Inc. (PG&T) have proposed the construction of a 230-kilovolt (kv) transmission system between Star Lake and Bisti in the San Juan Basin. The system would provide electricity to power mine equipment and for office and support building complexes at various potential coal mines along the Fruitland Formation.

The system would start near Bisti at a new substation on PNM's existing Four Corners to Ambrosia 230-kv line (Map F I-1). It would run to a switching station immediately east of the tap, follow an east-southeasterly direction to Star Lake, and then south-southwesterly to close at the existing Ambrosia station. Also, a 115-kv line would be constructed from a substation on the FCL to provide power for the projected Bisti mine and start-up power for the New Mexico Generating Station, both near Bisti. As planned by PNM and PG&T, the system would be built in three stages. Stage I, to be completed in 1979, would consist of the substation and switching station at the Four Corners to Ambrosia line, the substation to serve Western Coal's Bisti mine, the first six miles of 230-kv line between the Bisti switching station and the Western Coal substation, and the eight miles of 115-kv line to Western Coal's point of service and the New Mexico Generating Station's switchyard. Stage II, to be completed in 1980, would consist of 47 miles of 230-kv line between Western Coal's substation and a combination switching and substation at Star Lake. Stage III, to be completed in 1983, would consist of the final 47 miles of 230-kv line between the Star Lake station and the Ambrosia station.

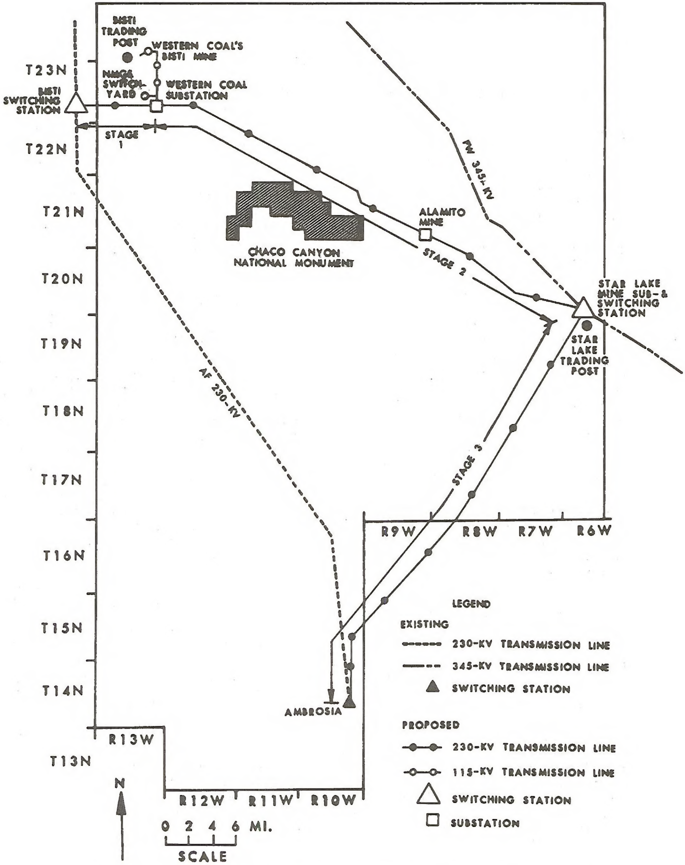
A total of about 100 miles of 230-kv line and eight miles of 115-kv line would be constructed. Additional substations and 115-kv lines would be required for the mines to be served by Stage II. Whether these would be constructed by the power company or the mining companies is being negotiated at this time. They are not part of the proposed action.

AUTHORIZING ACTIONS, INTERRELATIONSHIPS, AND ASSUMPTIONS

The Bureau of Land Management (BLM) is responsible for granting rights-of-way across public land. The Bureau of Indian Affairs (BIA) exercises the Secretary of the Interior's trust responsibility in review and approval of agreements between the Navajo Nation and private companies concerning rights-of-way across Indian Trust land. The New Mexico Commissioner of Public Lands is responsible for granting rights-of-way across State land. The New Mexico Public Service Commission reviews proposals for issuance of a Certificate of Public Convenience and Necessity. Because the line is wholly within the State of New Mexico, no other Federal approvals are needed.

The Star Lake Railroad Company has proposed a railroad from the main line of the Atchison, Topeka and Santa Fe Railroad at Prewitt to Pueblo Pintado and then branching southeasterly to Star Lake and northwesterly to the Navajo Reservation near Bisti. This route roughly parallels the FCL and for certain sections might share the right-of-way. Other developments within the ES Region that might interrelate with the FCL include coal gasification, carbon dioxide extraction, oil and gas development, uranium mining and milling, transportation corridors, and the Navajo Indian Irrigation Project.

It has been assumed in analyzing the impacts that the right-of-way for the 115-kv section would be 50 feet wide, the 230-kv would be 100 ft; and that reclamation would not occur without supplemental irrigation.



MAP F 1-1 LOCATION OF THE FRUITLAND COAL LOAD TRANSMISSION LINE

Chapter I of the Regional Analysis discusses in more detail the authorizing actions, interrelationships, and assumptions.

PROPOSED ACTION

The proposed action is the construction and operation of the FCL. The action of Federal Government addressed in this ES is to review and consider for approval an application for right-of-way across public land when it is submitted. A preliminary application (NM 30724) was submitted on May 6, 1977 for a 5-mile wide corridor about 108-miles long crossing an unknown mixture of private, State, Indian, and Federal lands. A centerline has not been determined at this time, so the number of miles of right-of-way across public land is not known.

The purpose of this proposed action is to allow the construction of the transmission line across public and Indian Trust lands. The objective is to supply the necessary electric power to the projected coal mines along the Fruitland Formation. Table F I-1 lists the expected loads and initial service dates.

The standard expected life of a transmission system is 30 years. However, the FCL would continue to be operated as long as there is a demand for electrical power along the line.

The information described herein and used for the impact analysis was that supplied to BLM as of June, 1978, and will be updated when a specific right-of-way application is received.

DESCRIPTION OF TRANSMISSION SYSTEM

Because of present uncertainties regarding the number of mines to be served by the transmission system, the location of their substations and the extent of their needs, and the lack of a centerline location, the precise configuration of the FCL has not been determined. Therefore, the following description is general.

Transmission Line

DESIGN FEATURES

The proposed 230-kv transmission line would be constructed with three conductors strung overhead on wooden 'K' frame structures or towers within a 100-foot right-of-way. The height of the towers would vary between 60 and 90 feet, with an average span between towers of 750 feet. The towers would be set in the ground using the direct burial method, with two feet plus ten percent of the total height buried. Clearance between the conductors and the ground at final sag would be no less than 29 feet at 60°F. The conductors would be 20 feet apart, suspended from the towers by 13-insulator strings, and protected from lightning by 2 overhead shield wires.

Figure F I-1 shows the standard design that would be used for approximately 90 percent of the towers. Towers used for special conditions such as small angles, abrupt changes in topography, transpositions, and deadend structures would have a variety of designs.

Dampers would be used to protect conductors from wind-induced vibrations. The dampers would be located at deadend towers, towers adjacent to deadends, and on all spans greater than 1,000 feet.

Conductor splices would be applied approximately every 17,000 feet, at deadends, or when a reel of wire runs out. Extreme caution would be used to prevent nicking of the conductor during splicing and to have a smooth surface on the splice to avoid excessive corona loss along the transmission line.

Fences crossed by the line would be grounded 30 feet from the outside conductors, gates within 150 feet of the centerline would be grounded on the hinge side, and fences parallel to the line and closer than 75 feet to the center line would be grounded every 750 feet. The grounding would consist of a 10-foot long ground rod welded to a ground wire and crimped to each fence wire. The grounding would dissipate the electrostatic buildup that can occur on fences under a high voltage transmission line.

The proposed 115-kv transmission line would be constructed similarly, except that wooden 'H' frame structures with an average span of 800 feet would be used. For this the clearance at final sag would be not less than 27 feet, 7-insulator strings would be used, and the distance between conductors would be 14.5 feet. Fences under the line would not be grounded.

CONSTRUCTION

Construction of a transmission line generally consists of a route survey; construction of access roads and staging areas; tower assembly and erection; conductor and static wire stringing, sagging and clipping; grounding; restoration; and cleanup.

To complete the final design and determine the exact centerline location, a field survey of the approximate centerline would be run to establish necessary ground information for aerial photography. Photogrammetric and/or field survey methods would then be used to provide the plan and profile maps needed to determine tower location and design, and exact centerline location. No roads would be constructed during this survey.

A road, up to fourteen-feet wide, would be constructed along the entire right-of-way to provide access to each tower site. Existing roads would be

Table F I-1

EXPECTED LOADS AND INITIAL DATES SERVICE IS REQUIRED
(Mid-level of Production)

Mine	Megawatts	Year
Alamito	18	Unknown
Bisti	30	1979
Chaco-Star Lake	17	1980

Note: PNM anticipates other loads if other potential mines are developed.

Table F I-2

ACRES DISTURBED BY CONSTRUCTION

	Disturbed Acres		
Component	Stage I	Stage II	Stage III
Access road	19	66	66
Towers and pulling sites	14	47	47
Stations	21	27	0
TOTAL	54	140	113

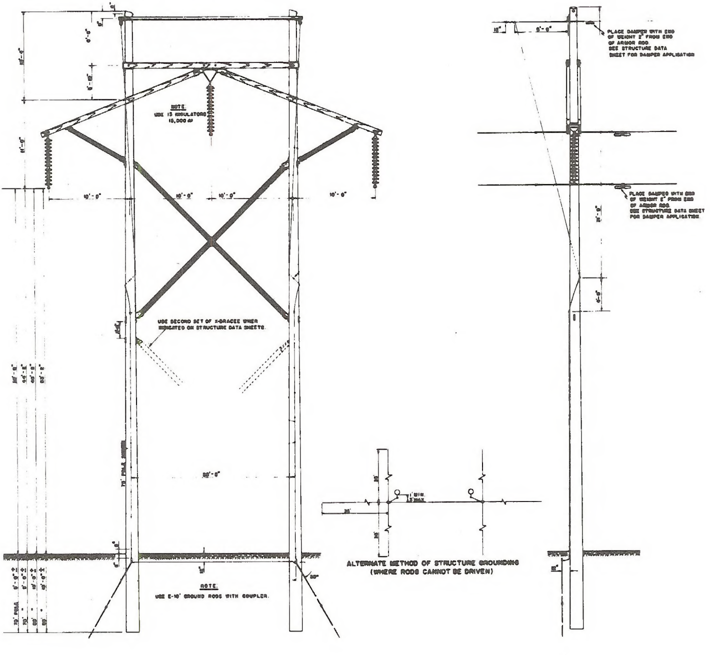


FIGURE F I-1. TYPICAL-230KILOVOLT TOWER STRUCTURE.

used wherever possible. Spur roads to towers would be built only where required. Only minimum grading appropriate for the construction vehicles using the roads would be done for the cuts and fills. On the average, about 6,000 feet of new and existing access road would be required per mile of transmission line.

In general, assembly and erection of the towers takes place as follows. A crawler-tractor-mounted auger drills a small-diameter hole to test for rock where the pole will be set; if found, the rock would be fractured by explosives. Then the holes are drilled for the poles and anchors (Figure F I-2A). Flatbed trucks and pole trailers haul materials to the right-of-way. Once materials are at the site, the area for tower assembly and setting is cleared and graded to provide work space for the framing and setting crews. After the tower is framed, the setting crew uses a crawler-tractor-mounted setting rig or a truck-mounted crane, a winch truck, and a compressor truck to raise, set and adjust the tower (Figure F I-2B, 2C). The holes are back-filled and tamped to set the structure. Each 230-kv tower would require an area approximately 100 feet by 125 feet for assembly and setting, and each 115-kv tower approximately 100 feet by 50 feet.

The conductor is strung in sections about three miles long. A tensioner is used at one end to feed the conductor under tension from supply reels. A puller winds a light-weight leader cable at the other end of the section being strung, thus pulling the conductors over the towers and into place. By proper adjustment of the tensioner, the conductors can be kept off the ground where they might be scratched or accumulate dirt and foreign material. This care in handling the conductors minimizes corona and its associated electro-magnetic radiation effects.

Copperweld ground rods would normally be used to ground the towers. As an alternative, a counterpoise, consisting of a grounding mat of copperweld wire, might be used.

Completion of all unfinished construction and cleanup would be the last step. This could include replacing defective or missing structural parts, changing broken insulators, and sanding damaged conductors. At this time, the right-of-way would be dressed and the soil around the towers would be graded and seeded. The final step would be regrading, harrowing and seeding of the roads.

MAINTENANCE

Monthly line patrols would be made by helicopter to spot check lines for areas that may require maintenance. When maintenance is required, access usually would be from existing roads, but would be overland if necessary, to allow maintenance equipment into the area. The area would be restored as needed when maintenance is completed.

Stations

Two types of stations would be required for the transmission system. A switching station would be needed near the substation on the Four Corners to Ambrosia 230-kv line. A 50-megawatt substation would be needed on the FCL at the tap point to Western Coal's Bisti coal mine and a 30-megawatt substation would be needed for limited start-up and for construction power at the New Mexico Generating Station. A substation, sized for the load requirements, would be needed at the tap point for each additional mine. A substation with switching capability would be used at Star Lake where the 230-kv line would meet the 345-kv line running from Four Corners to Albuquerque.

The final design of the stations has not been determined at this time. A typical switching station occupies an area about 800 feet by 800 feet. The towers and supports, buswork and control systems, circuit breakers and relay protection devices, and other electrical apparatus are enclosed by protective fencing. A typical substation occupies an area about 500 feet by 500 feet. In addition to the equipment listed above, a substation contains the necessary power transformers.

Construction of a station typically consists of site grading and preparation, construction of foundations, installation of towers and electrical equipment, and building of protective fencing. Access roads would be needed for the heavy construction equipment and materials; however, these might be the same roads used for construction of the transmission line.

Communication Facilities

Communications are necessary to provide channels for telephone service, supervisory control, and protective relaying. The communication facilities to be used are not known at this time; however, they typically include telephone service, microwave radio and powerline carrier. The communications equipment usually is installed in the switching and substations.

Disturbed Ground

Table F I-2 lists the acres disturbed by the various components of the transmission line.

Employment

It is estimated that 35 employees would be required during construction of the transmission system, with a lesser unknown number required for operation and maintenance.

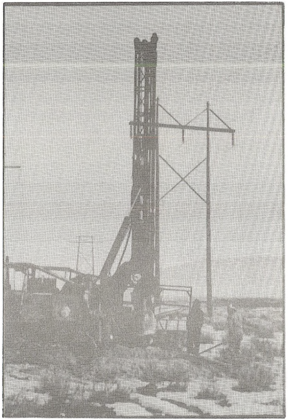


Figure F I-2A.--Track-mounted auger digging postholes (115-kv structure in foreground, 345-kv structure in background).

Figure F I-2B.--Wooden K-frame structure for 230-kv line.

Figure F I-2C.--Tire-mounted, 60-ton crane erecting a slightly larger version of the structure used in a 230 kv-line.

(Photos courtesy of Public Service Company of New Mexico.)

Abandonment

The normal life of a transmission system is about 30 years. However, the FCL will probably continue to operate as long as there is a demand for electrical power. The line will also become a part of the regional power distribution network.

Removal procedures after the transmission line is abandoned would be somewhat similar to construction methods. Heavy equipment, trucks and cranes would be required to disassemble the towers. An access road would be required, but clearing and grading would be held to a minimum. Following removal, all useful material would be salvaged and the right-of-way would be reconditioned.

CHAPTER II

DESCRIPTION OF THE ENVIRONMENT

THIS CHAPTER DESCRIBES THE PHYSICAL, BIOLOGICAL, AND CULTURAL SETTING THAT CONSTITUTES THE ENVIRONMENT IN WHICH THE FRUITLAND COAL LOAD TRANSMISSION LINE WOULD BE BUILT. THE DESCRIPTION FOCUSES ON ENVIRONMENTAL ASPECTS MOST LIKELY TO BE AFFECTED BY THE TRANSMISSION LINE, AND ON OTHER DEVELOPMENTS THAT WOULD BE FACILITATED BY IT.

CHAPTER II

DESCRIPTION OF THE EXISTING ENVIRONMENT

EXISTING ENVIRONMENT

Geologic Setting

Topography

The general topography along the proposed FCL corridor is one of broad, gently rolling hills with shale outcrops, dissected by wide and shallow, although occasionally sharply entrenched, dry streambeds and spotted with slightly higher sandstone-capped mesas. The section from Bisti to Star Lake would be in subdued lowlands or gently rolling flatlands and the section from Star Lake to Ambrosia would be rougher because of the resistant sandstones standing higher than the softer interbedded shales. The terrain is not considered rugged. The altitude of the FCL would range from about 5,800 feet above sea level at the northwestern end to about 7,600 feet near the south end.

Stratigraphy and Structure

The geology along the route of the FCL is shown in Map F II-1. Most of the rock traversed is shale, with lesser amounts of sandstone and some coal, all of Cretaceous age. The rocks generally dip about 1 or 2 degrees to the north or northeast. The faults in the area are generally normal and are of Cretaceous or younger age but older than Quaternary. The geology of the area is described in greater detail in Chapter II of the Regional Analysis.

Paleontology

Most of the disturbance associated with the transmission line would affect soil, alluvial deposits or other Quaternary sediments which have not produced significant fossils in the area of the FCL. For the estimated 4-percent of the area where bedrock would be disturbed, the strata of the Mesa Verde Group and the Fruitland Formation have the greatest potential for significant fossil materials. Important fossil localities in or near the FCL corridor were located during surveys by the University of New Mexico under contract to the Bureau of Land Management and to Western Coal Company, and in a survey by the Museum of Northern Arizona under contract to VTN, environmental consultants for the Santa Fe Railroad. The most significant of these localities is in the Fruitland Formation near the proposed New Mexico Generating Station and the Bisti mine. Fossil summaries of geologic formations that would be crossed by the line are in Appendix B.

Mineral Resources

Exploration for mineral resources, including coal, uranium, petroleum, and natural gas, is the predominant mineral industry activity along the FCL corridor. Except for coal, mineral industry facilities and operations are a minor component of land use along the corridor.

The Fruitland Formation is the principal coal-bearing formation in the region and the locale of several potential mines that would be served by the FCL. About half of the corridor is along the Fruitland Formation, whose coalbeds might lie within the final right-of-way for the line. Mining claims and mineral leases, plus several oil or gas pipelines and dry-holes are within the corridor.

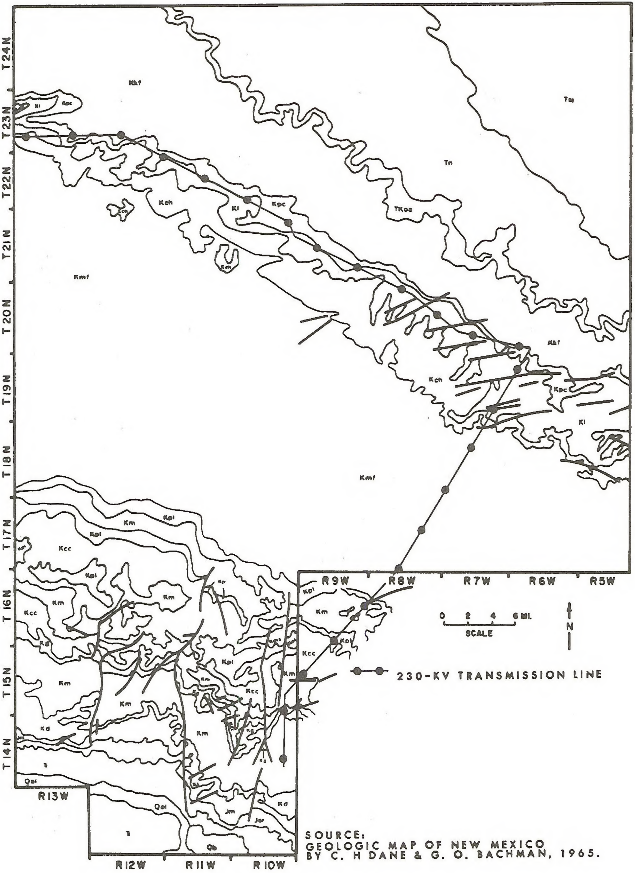
At the southern end, the corridor would be within the Ambrosia Lake uranium mining district.

Climate

The area along the FCL is semi-arid with temperatures that vary considerably. Average annual temperatures range from about 45°F at the higher elevations to about 49°F at the lower elevations, with extremes ranging from about -15°F to about 95°F. The average annual precipitation ranges from about 9 inches to about 11 inches with average annual snowfall ranging from 20 inches to 34 inches. The average annual pan evaporation ranges from about 67 inches to about 71 inches and the average annual humidity ranges from about 49-percent to 55-percent.

Heavy, persistent fogs occasionally occur along the route during the winter. The route may experience as many as 20 to 30 foggy days in the valleys and 15 foggy days on the plateaus during a typical year.

West-southwesterly winds prevail, with winds from the northwest and southeast being fairly uncommon. Severe storms are rare, however, duststorms and thunderstorms do occur during the spring and summer months. Hail occurs with the thunderstorms on the average about 6 times a year, but the hailstones are usually so small that little



MAP F II-1. GENERALIZED GEOLOGY ALONG THE FRUITLAND COAL LOAD CORRIDOR.

damage results. Winds associated with these storms are expected to reach about 81 miles per hour once every 50 years and 84 miles per hour once every 100 years.

Air Quality

No ambient air quality data exist for the proposed FCL corridor. Concentrations of total suspended particulates (TSP) measured for one year at Star Lake are assumed to be representative of the area along the corridor. The mean TSP concentration for the year of 27 micrograms per cubic meter ($\mu g/m^3$) is less than half the Federal secondary and State air quality standards. The maximum observed 24-hour TSP concentration of 214 $\mu g/m^3$ exceeds the Federal secondary and State standards of 150 $\mu g/m^3$, but not the Federal primary standard of 260 $\mu g/m^3$. The second highest observed 24-hour TSP concentration of 67 $\mu g/m^3$ is well below the Federal secondary and State air quality standards. The higher TSP concentrations are associated with spring and summer duststorms.

Concentrations of other regulated pollutants along the corridor are expected to be similar to those described for the central sub-area of the ES Region in Chapter II of the Regional Analysis. These concentrations are below Federal and State standards. Visibility in the area is good, averaging at least 35 miles.

Water Resources

Most of the various members of the Mesaverde Group and the Fruitland Formation contain some groundwater. However, most yields are low and the quality of the water generally is fair to poor, ranging from 200 to more than 5,000 mg/L in dissolved solids.

The FCL would cross many stream channels, the larger being Tsaya Canyon, Ah-shi-sle-pah Wash, Kimbeto Wash, Betonnie Tsosie Wash, Escavada Wash, Chaco Wash and the North Fork Arroyo Chico. These streams are shown on Map C. The streams in the area are all ephemeral and are usually dry, but may experience severe flooding during the more intense summer thunderstorms.

Chapter II of the Regional Analysis and Appendix B contain a more detailed description of the water resources of the area.

Soils

The soil associations in the area are shown on Map F II-2 at a level designed to provide information for general planning and potential limitations for use. Appendix Table B-18 provides descriptive information for the major soils in each of the associations.

The soils range in texture from fine sands to clays, and range in depth to bedrock from zero to greater than sixty inches. The permeability is slow to moderately rapid and the soils are moderately to highly susceptible to erosion if vegetation is removed and topsoil disturbed. Badland, Farb, Persayo, Sheppard, and Travessilla soils have high erosion hazards when disturbed. Badland, Chipeta, Litle, Lohmiller, and Persayo soils are fine- textured, having high clay contents and high shrink-swell potentials. High sodic and soluble salt conditions are prevalent among Badland and Farb soils. Appendix Table B-19 provides interpretations for selected uses of the major soils occurring within the area.

Vegetation

The FCL corridor crosses six vegetation types: grassland, sagebrush, waste, barren, pinyon-juniper, and saltbush-greasewood (Map F II-3). These are discussed in detail in Chapter II of the Regional Analysis.

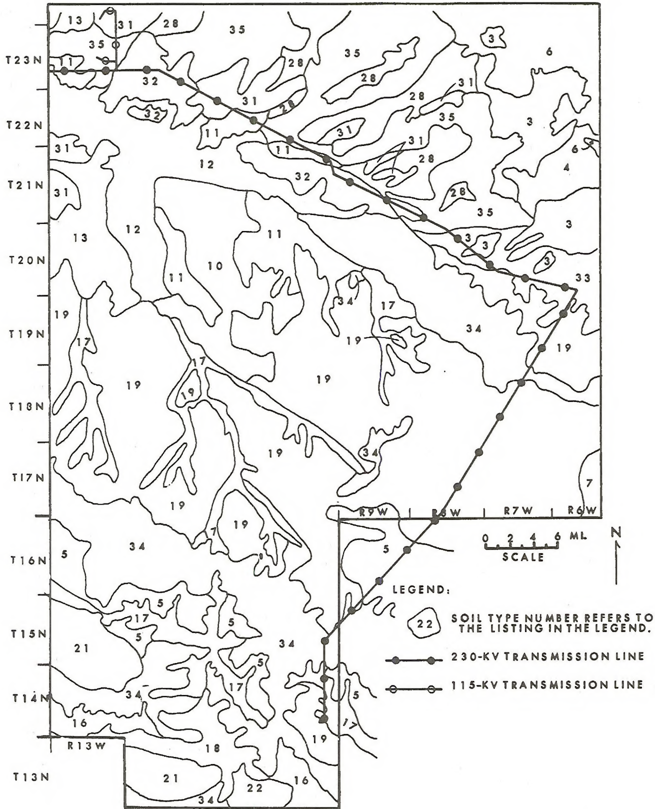
The northwestern part of the corridor is through an area that is predominantly grassland, with saltbush-greasewood along drainageways. There are also some small barren areas (badlands). The mid-part of the corridor is through an area that contains extensive sagebrush stands interspersed with areas of saltbush-greasewood. The corridor crosses a small strip of waste after turning southwesterly, and then to its southern terminus it would cross grasslands containing small areas of pinyon-juniper and saltbush-greasewood.

ENDANGERED AND THREATENED PLANTS

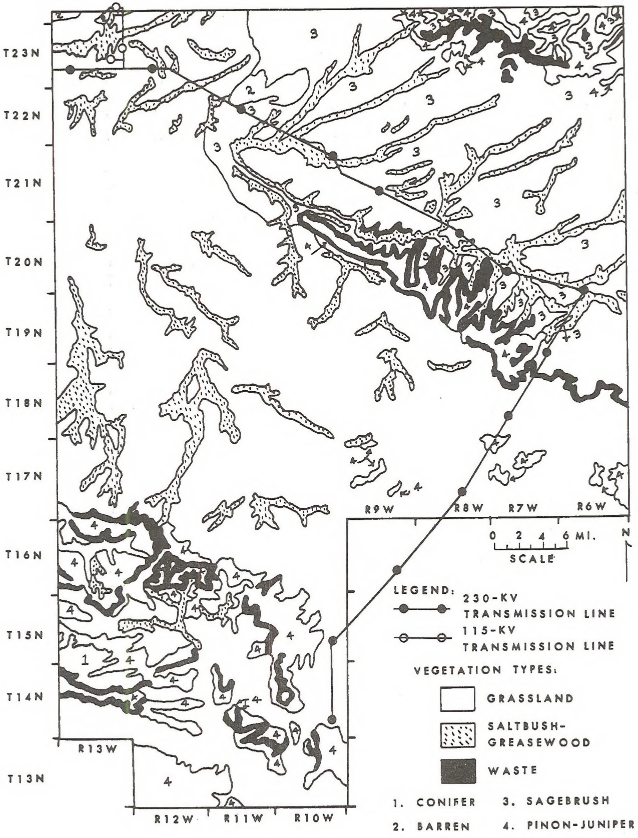
Surveys of the area through which the transmission line would run and of areas with developments dependent on it revealed no plants proposed for endangered and threatened status (Spellenberg, 1976; Martin, et al., 1978), as listed in the Federal Register (vol. 40, no. 117, July 1, 1975; vol 41, no. 127, June 16, 1976) or by the State of New Mexico.

Wildlife

The FCL corridor crosses two distinct wildlife habitat types, neither of which are considered critical, grassland/desert-shrub/barren and pinyon-juniper woodland. Most of the corridor is dominated by grassland/desert-shrub/barren habitat. The corridor crosses the pinyon-juniper woodland habitat where it traverses Chaco Mesa southwest of Star Lake and Mesa de los Torros north of Ambrosia Lake (Map C). Chaco Mesa is important in that the area supports numerous canyons covered by various grasses, forbs, shrubs and trees, which account for the diversity of terrestrial fauna inhabiting the area. Species/habitat relationships for animals observed or expected to occur in the region are discussed in Chapter II of the Regional Analysis.



MAP F II-2. SOIL ASSOCIATIONS ALONG FRUITLAND COAL LOAD CORRIDOR.



MAP FII-3. VEGETATION TYPES, FRUITLAND COAL LOAD CORRIDOR.

MAMMALS

Most of the FCL corridor supports a variety of desert rodents, such as pocket mice, kangaroo rats, and desert ground squirrels in the grassland/desert-shrub/barren habitat. These plus white-footed mice, wood rats, and chipmunks commonly inhabit the rock piles at the foot of cliff faces and accumulations of large rocks and boulders in the pinyon-juniper woodland habitat.

The coyote is, by far, the most abundant carnivore within the region. Also present are the bobcat, badger, kit fox, red fox, striped skunk, and spotted skunk. The long-tailed weasel is almost always found in pinyon-juniper woodland habitat. Recently a mountain lion was observed in Chaco Canyon National Monument (personal commun., Park Ranger, Chaco Canyon National Monument, 1976).

Mule deer and pronghorn antelope range through the area but their densities are low because of indiscriminate shooting and competition with livestock for forage.

BIRDS

The grassland/desert-shrub/barren habitat supports a total of 79 bird species, 22 of which are dependent on it for survival and reproduction. The horned lark, a year-round resident and the most abundant and widespread bird in the grassland/desert-shrub/barren habitat, is capable of surviving adverse climatic conditions with short food supplies. The sage sparrow, vesper sparrow, mourning dove, American kestrel, western kingbird, loggerhead shrike, barn swallow, and cliff swallow also commonly occur throughout this habitat.

The pinyon-juniper woodland habitat supports a greater diversity of birds, 108 species, 14 of which are entirely dependent on it. Many species that occupy the pinyon-juniper woodland habitat are summer and winter migrants, and generally appear in these areas in large flocks. For example, the pinyon jay, cedar waxwing, shrub jay, and white-crowned sparrow are often observed in greater densities during migration.

Other transient inhabitants of the region include the turkey vulture, red-tailed hawk, ferruginous hawk, golden eagle, prairie falcon, common raven, common bushtit, and the bluebird. A detailed survey of raptors in the region was made by Rodney, (PNM, 1976). A detailed breakdown on relative densities, seasonal occurrences, and species/habitat relationships of the birds is given in Chapter II of the Regional Analysis.

REPTILES AND AMPHIBIANS

The reptiles and amphibians known or expected to occur in the region are typical inhabitants of the Lower and Upper Sonoran Life Zones. The region approaches the northern limits of the home range for some amphibians and reptiles, such as the many-lined skink and the western diamondback rattlesnake.

The tiger salamander is the most widespread amphibian in the region. The spadefoot toad, short-horned lizard, plateau whiptail, collard lizard, and eastern fence lizard are also found throughout the region (Harris, 1963; Gelhbach, 1965). The side-blotched lizard, on the other hand, is found only at altitudes below pinyon-juniper woodland.

The gopher snake, western rattlesnake, and the western terrestrial garter snake are widespread throughout the area.

OTHER ANIMALS

The distribution, abundance, and species composition of terrestrial and aquatic invertebrates in the corridor have not been intensively surveyed, and data are notably lacking on these populations. Common aquatic invertebrates, but no fish, would most likely occur in ephemeral ponds. Terrestrial and aquatic invertebrates of the region are described in Chapter II of the Regional Analysis.

ENDANGERED AND THREATENED SPECIES

The black-footed ferret is the only mammal on Federal and New Mexico endangered species lists that conceivably could occur within the proposed transmission corridor (Findley, et al., 1975).

The peregrine falcon and the bald eagle also are on Federal and State lists of endangered species. Recent confirmed sightings of the falcon have been made in the San Juan and Chaco Region (Fish & Wildlife Service, 1977; Rodney, 1976). Although the habitat range of the bald eagle includes all of the proposed transmission route, it is likely that this bird would occur only as a casual migrant.

No other animals on the Federal or State lists of endangered and threatened species are known to occur on or near the corridor.

Aesthetics

NOISE

Ambient noise levels in the rural areas through which the FCL corridor would pass are generally low. Recent studies in the area have indicated the noise level generally ranges from 20 to 40 decibels (dBA).

Increased noise levels can be found near communities. Random peak noise levels of 40 to 70 dBA result from vehicular traffic and airplane overflights.

VISUAL RESOURCES

Four Visual Resource Management (VRM) Classes have been identified through procedures of

BLM Manual 6310 in and adjacent to the transmission line corridor (Map F II-4). These VRM Classes have been discussed in detail in Chapter II of the Regional Analysis. (This system gives greater emphasis to undisturbed lands than to lands disturbed by agriculture or other activity.)

The majority of the corridor is in VRM Class IV areas. These areas are characterized by low-growing vegetation, broken terrain, some man-made intrusions, and low to moderate visual sensitivity. Class III lands have greater variation in vegetation and landform and are located closer to more heavily used areas. Class II lands have higher scenic quality and are located near areas of high visual sensitivity, such as Interstate 40 and Chaco Canyon National Monument. Class I, with the most restrictive management objectives, has been tentatively assigned to the roadless areas identified pursuant to FLPMA until the final status of these areas has been established.

The corridor would cross three State Highways and several secondary roads. With the exception of existing highway and utility rights-of-way, the proposed corridor is generally free of any dominant man-made landscape intrusions.

Land Use

RECREATION

The land in and along the FCL corridor generally receives a low amount of dispersed recreation, attributable to low population, poor roads, diversity in land ownership, few publicized recreational attractions, and a general lack of tourist services in a largely uninhabited, semi-arid region.

BLM, through its inventory and analysis process, has identified several areas of recreational special interest. The primary activities occurring within these areas are hunting, sightseeing, and off-road vehicle use. Map F II-5 shows and Table F II-1 lists special interest areas with high to moderate capability for quality recreation experiences in and along the corridor.

Chaco Canyon National Monument is the only developed recreation area near the proposed corridor. This monument preserves the ruins of 13 major pueblos and hundreds of smaller archaeological sites. Facilities provided at the monument include a visitor center, a campground, and picnic areas.

TRANSPORTATION

Automobiles and trucks constitute the primary means of transportation in the vicinity of the FCL. State Highways (SH) 371, 197, 57, and 44, and Navajo Highways (N) 9 and 48 are the basic framework of the local highway system (Map A). They provide access to population centers as well as connections to interregional and interstate highways. Within this basic framework, numerous marginally improved roads and trails provide direct access to isolated residences and points of potential mineral extraction.

The primary limitations of this highway network are that only SH 44 and 197, portions of SH 57 and 371, and N 9 are paved. This results in safety problems and low traffic capacity. Existing traffic on highways in the area, however, is fairly low, with only SH 44 and the section of SH 57 between Thoreau and Crownpoint averaging more than 1,000 vehicles per day.

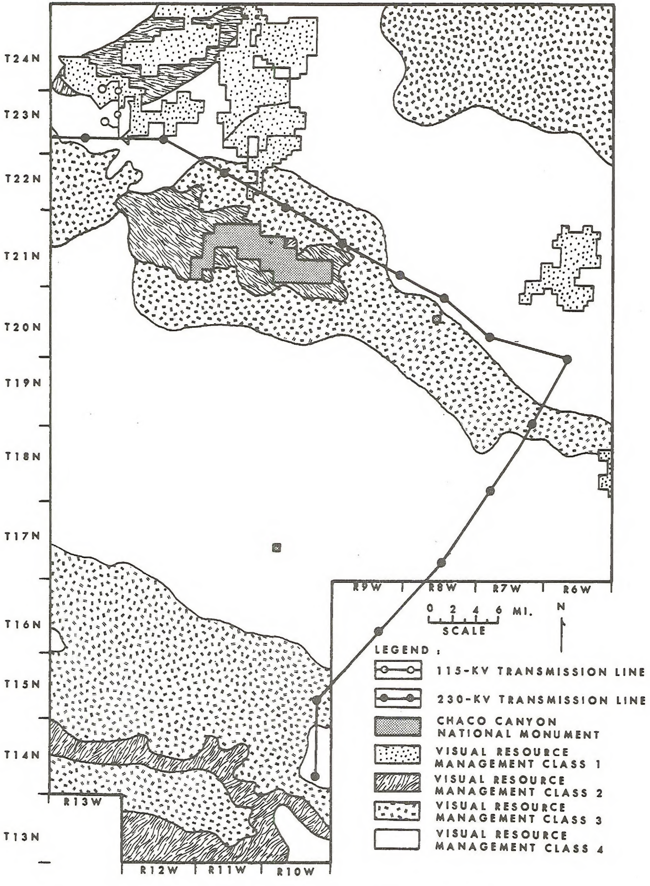
GRAZING

Livestock grazing is the primary land use and the major economic activity in the area of the FCL corridor. With the exception of small corn patches near the predominantly Navajo homes, the entire corridor is rangeland.

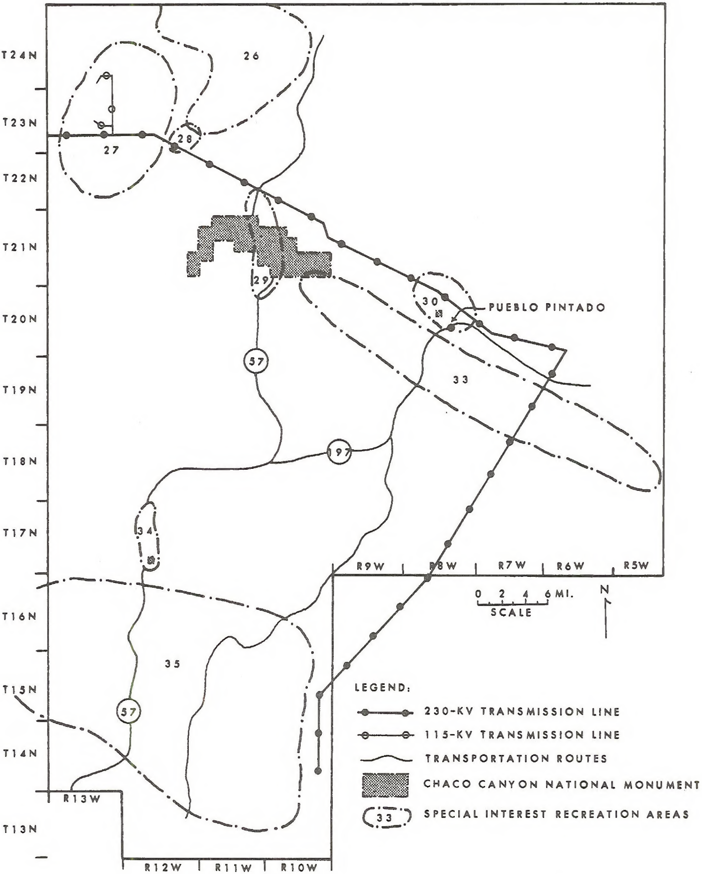
Sheep and goats constitute about 62 percent, horses 24 percent, and cattle 14 percent of the livestock in the area. Allotments are grazed year-round, except for Allotment 12 in the northwest part of the corridor. This is under an existing allotment-management plan utilizing a seasonal pasture-rotation grazing system. The 18 grazing allotments that would be affected by the proposal are shown in Map F II-6. Forage productivity varies greatly with annual precipitation, class of livestock grazed, and different management practices between allotments. Stocking rates on public lands in allotments affected by the FCL corridor range from 4 to 11 acres per AUM. In the southern part of the corridor, public lands are scattered and grazing leases are smaller, generally about 700 acres per lease. Currently, permits on these leases are stocked at a rate of 9 acres per AUM.

Current range condition estimates for all lands are not available, but 77 percent of the public lands are classified as being in satisfactory condition. Only 32 percent of this land, however, is classified as being in an uptrend, whereas 53 percent is static, and 15 percent is in declining range conditions. Factors contributing to the decline include continual use around dependable sources of water and housing concentrations, traditional diurnal sheep herding to and from hogans, minimal trespass control, poor water distribution, and low forage production during periods of prolonged drought.

Livestock watering places consisting of deep wells, hand-pumped shallow wells, and earthen tanks, are scattered throughout the area. Livestock trespass between allotments is restricted by fencing or natural barriers.



MAP F II-4. VISUAL RESOURCE MANAGEMENT CLASSES ALONG THE FRUITLAND COAL LOAD CORRIDOR.



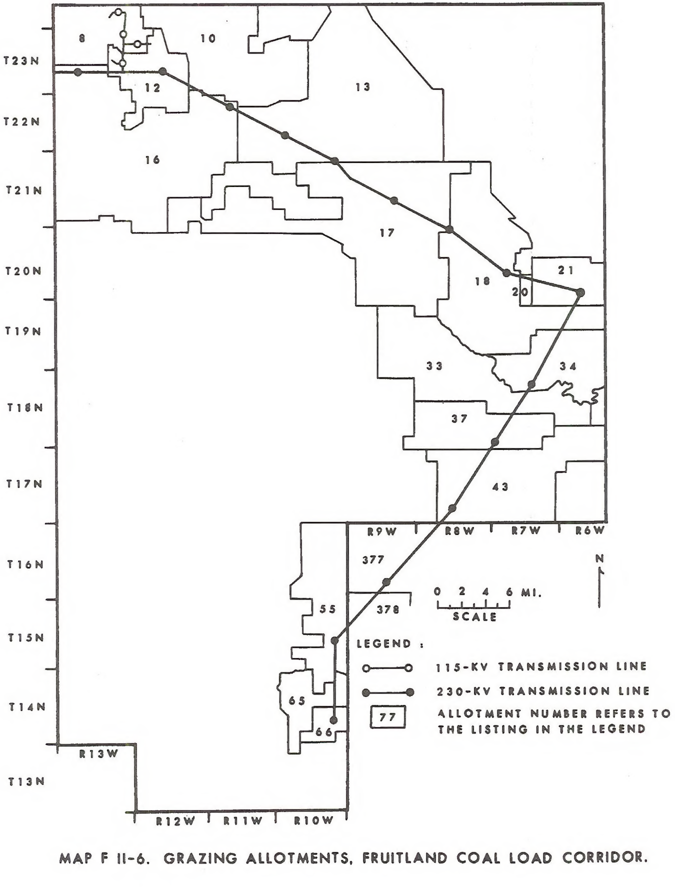
MAP F II-5. SPECIAL INTEREST RECREATION AREAS ALONG THE FRUITLAND COAL LOAD CORRIDOR.

Table F II-1

RECREATION AREAS

Area No. 1/	Recreation Activities
26	Off-road vehicles
27	Sightseeing, geological; collecting, vegetation
28	Sightseeing, geological
29	Sightseeing, other (Chaco Canyon National Monument)
30	Sightseeing, historical; sightseeing, scenery
33	Sightseeing, scenery; sightseeing, archaeological sightseeing, other (Scenic Road - Pueblo Pintado Canyon Highway); hunting, big game; primitive, back country
34	Sightseeing, other (Outliers of Chaco Canyon National Monument)
35	Sightseeing, scenery; sightseeing, geological sightseeing, other (Scenic Road - Crownpoint Highway); hunting, small game

1/ See Map F II-1 for the location of these special interest recreation areas.



MAP F II-6. GRAZING ALLOTMENTS, FRUITLAND COAL LOAD CORRIDOR.

WILDERNESS

At present, there are no national wilderness areas within the ES Region. However, 24 wilderness inventory units have been identified pursuant to FLPMA. The wilderness inventory units and the status of these units is discussed in more detail in Chapter II of the Regional Analysis. Wilderness inventory units near the transmission corridor and their recommended status pursuant to the wilderness inventory procedures are shown on Map F II-7.

Cultural Resources

Consultation with the State Historic Preservation Officer has begun concerning the presence of National and State Register sites in the vicinity of the corridor. Cultural resources have not yet been inventoried, and will not be until a centerline has been established. The following information is only a general description of the cultural resources likely to be encountered, drawn from previous inventories in the vicinity of the corridor. The nature and density of archaeological remains vary in response to such highly localized factors as terrain, vegetation, and soil. Consequently, actual cultural resources in the corridor may vary from the description presented here.

The corridor is likely to transect the entire range of cultural resources common to the San Juan Basin. Stages I and II of the FCL would cross primarily sage flats and low mesas. Previous surveys indicate an abundance of Navajo and lithic materials (Bussey et al., 1976; Rorex et al., 1976; Bussey, 1977; Brethauer, 1977; Hoyt et al., 1978; Huse et al., 1978). Presumably, the lack of terrain features suitable for water control made the area less favorable for the agriculturally-based Anasazi. Table F II-2 gives a cultural breakdown of the 814 sites and isolated occurrences located by these surveys.

Stage III of the FCL would cross more varied terrain and vegetation. This is reflected by variation in the cultural distribution of sites, notably between lithic and Anasazi. Previous surveys (Harrison 1975; Beal and Whitmore 1976; Bussey et al., 1976; Rorex et al., 1976; Beal 1977; Brethauer 1977; Bussey 1977; and Hoyt et al., 1978) have been made in the general area, though further removed tnan those noted above. Table F II-3 indicates the cultural breakdown of 443 sites and isolated occurrences located in these surveys.

Distributions similar to these may be projected for the corridor. Projections of cultural affiliation are likely to be more accurate for sites impacted by Stages I and II than for Stage III because of the closer proximity and larger area covered by the surveys. It should be noted that the figures above do not reflect the size or the complexity of archaeological sites. While low in relative frequency, Anasazi sites may be quite extensive. For example, Pierre's site complex, about two miles from the proposed corridor, is a major site of National Register quality. The relative absence of Paleoindian sites in the surveys does not necessarily indicate their absence along the corridor. These sites are associated with hunters of large Pleistocene mammals (mammoth and bison) and are fragile and difficult to distinguish. Only a few such sites in the corridor would represent significant archaeological finds.

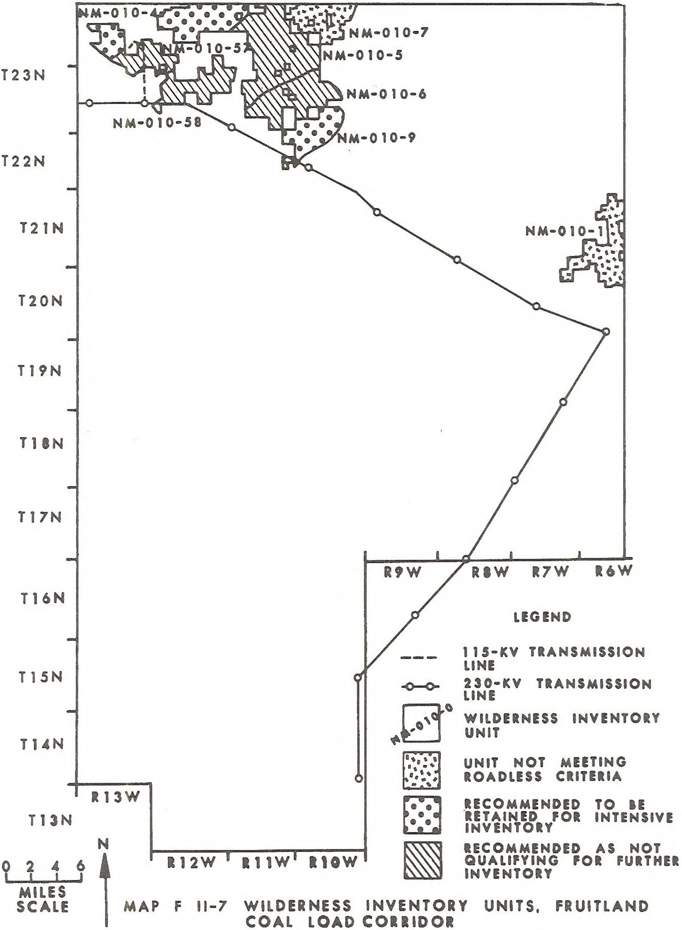
Socioeconomic Conditions

The areas of southern San Juan and northeastern McKinley Counties that would be crossed by the FCL, are sparsely populated land containing much of the Eastern Navajo Agency (Navajo land outside the Navajo Reservation). Persons whose primary language is Navajo comprised over 48 percent of the estimated 126,700 persons in the two counties in 1977. Persons speaking Spanish comprised nearly 9 percent, and those speaking English comprised over 42 percent of the population (Bureau of the Census, 1970, 1973). The urbanizing Farmington-Aztec-Bloomfield area, with a 1977 estimated population of 36,600, is 40 to 70 miles north of the area. Crownpoint, with an estimated 1977 population of 3,500, is 35 miles to the south. The area is one where subsistence ranching by Navajos predominates. However, in recent years, oil, natural gas, coal, and uranium exploration and production have increased steeply.

The Farmington-Aztec-Bloomfield area in San Juan County is again experiencing the boom conditions of the 1950's from oil and gas activity, and of the 1960's from coal mine and power plant construction. Crownpoint, the headquarters of the Eastern Navajo Agency, is the trade center for 12,000 Navajos living in the area and has experienced recent rapid growth as a result of nearby uranium activity.

Shortages in housing, educational and health facilities, and safety personnel, and increased crimes and traffic congestion are becoming more common in the larger communities of Farmington and Gallup. The ability of all levels of government to maintain facilities and provide services is being strained. Public authorities in the study area are being forced to borrow up to statutory debt limits and to appeal to the state for assistance (New Mexico Department of Finance and Administration, 1977a & b).

The economic sectors employing the most people are, in order, all government, public education, wholesale and retail trade, mining, and commercial and professional services. The single most important sector in the economy of the study area



MAP F II-7 WILDERNESS INVENTORY UNITS, FRUITLAND COAL LOAD CORRIDOR

Table F II - 2

ARCHAEOLOGICAL SITES IN THE VICINITY OF

STAGES I AND II OF THE FCL

Culture	Percent of Total Sites
Paleoindian	0
Archaic and/or Lithic	7
Anasazi	21
Navajo	52
Euro-American	10
Unclassified	10

Sources: Bussey et al. (1976), Rorex et al. (1976), Bussey (1977), Brethauer (1977), Hoyt et al. (1978), Huse et al. (1978).

Table F II - 3

ARCHAEOLOGICAL SITES IN THE VICINITY OF

STAGE III OF THE FCL

Culture	Percent of Total Sites
Paleoindian	0.4
Archaic and/or Lithic	37
Anasazi	11
Navajo	50
Euro-American	.4
Apache	.2
Unclassified	1

Sources: Harrison (1975), Beal and Whitmore (1976), Bussey et al. (1976), Rorex et al. (1976), Beal (1977), Brethauer (1977), Bussey (1977), Hoyt et al. (1978).

is government, accounting for 21.2 percent of all jobs and 24.3 percent of all income. Mining and power generation are the largest basic, or export, sectors, and the relative importance of these industries to the area's economy is expected to increase. Per capita income in McKinley and San Juan Counties in 1977 was $4,772 and has been rising at a rate of 10.5 percent per year since 1970. Hispanos and Indians still lag behind Anglos in income by as much as 85 percent (Harbridge House, 1978). The unemployment rate in the two counties was 7.1 percent in 1977, but wide disparities again exist, with unemployment rates among Navajos of the Eastern Navajo Agency reported to be about 40 percent (Bureau of Indian Affairs, 1976).

Chapter II of the Regional Analysis contains a more detailed discussion of the socioeconomic conditions.

FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

If the FCL is not built, the coal mines and generating station dependent on it would not be developed, and the characteristics of many resources of the area along the corridor and around these secondary developments would remain essentially as described for the existing environment. These include air quality, vegetation, soils, recreation, and topography. Other economic developments, such as coal mines not dependent on the FCL for power, oil and gas production, and uranium mining and milling, would continue to have slight, but unknown effects on such resources as noise, visibility, wildlife, grazing, and mineral resources.

Archaeological, historical, and paleontological resources would be subject to gradual depletion through unauthorized collection, vandalism and natural processes of erosion. The rate of loss, however, would be lower than that resulting from construction of the FCL.

There may be a significant change in groundwater pumping around Ambrosia Lake. Many of the uranium mines in the Westwater Canyon Member of the Morrison Formation have to be dewatered. At the present time (1977), it is not certain what trend this pumping will take. However, it seems likely that pumping from the Westwater Canyon Member will increase as old mines go deeper and new mines are started.

The existing coal and existing and proposed uranium mining in the area may affect flow and sediment characteristics of streams in the immediate vicinity of the activity. Otherwise, streamflows and sediment discharges will remain about the same as at present.

The continued growth in the area, including projects such as the Navajo Indian Irrigation Project, will place additional water requirements on the area.

Development of energy resources, with its concomitant population growth, is already increasing the highway use in northwestern New Mexico. It is expected that this trend will continue even if the FCL is not built. State Highway 371 is being reconstructed as a two-lane paved highway from the Crownpoint area to Farmington. Although other parts of the road network need to be upgraded, none of these improvements would be in the immediate vicinity of the corridor.

The lands within the corridor identified as meeting the roadless and wilderness characteristics criteria presented in FLPMA will be managed in accordance with the law, to prevent the impairment of their suitability for designation as wilderness. Restrictions imposed by Section 603 of FLPMA during the review process will no longer apply to those inventory lands that clearly and obviously did not meet the wilderness study area criteria. Those lands no longer being carried through the wilderness review procedures will be returned to on-going multiple use management.

Patterns of growth are described in Chapter II of the Regional Analysis. New investments in mineral resources, with resulting increases in population, employment, and income will yield consequences for all components of community infrastructure and for the values, lifestyles and relationships of the ES Region's three cultures. Chapter II and the tables in Chapter VIII of the Regional Analysis describe this in greater detail.

Even without the transmission line, increases in basic and secondary employment will occur in and adjacent to the ES Region as a result of the expansion of oil, natural gas, uranium, and coal development, the related construction and expansion of coal-fired electric generation facilities, and the Navajo Indian Irrigation Project. The increased population will display different social characteristics from those exhibited today, including ethnic affiliation, lifestyle, age, and marital status. Gross earnings and per capita income will also rise, primarily as a result of expansion in the mining, utility, and construction sectors. The growing population will place greater demands on the local infrastructure, particularly in the areas of transportation, governmental financing, health care, education, housing, and water supply.

CHAPTER III

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

THIS CHAPTER ANALYZES IMPACTS OF THE FRUITLAND COAL LOAD TRANSMISSION LINE ON THE ENVIRONMENT. IN ADDITION, IMPACTS ARE CONSIDERED THAT WOULD RESULT FROM DEVELOPMENT OF COAL MINES AND A GENERATING STATION, WHICH WOULD BE FACILITATED BY THE TRANSMISSION LINE. WHERE DATA ARE AVAILABLE, IMPACTS ARE LINKED TO SPECIFIC ACTIONS AND ARE QUANTIFIED AS TO MAGNITUDE, INTENSITY, AND DURATION.

CHAPTER III

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

GEOLOGIC SETTING

The direct impact of the proposed FCL line itself on the topography, stratigraphy, and structure of the region would be negligible as only 307 acres would be disturbed.

Secondary impacts on these resources would include the disturbance by the year 1990 of 12,663 acres due to the related coal mining and generating station and the associated community development. These disturbances would be noticeable locally, but over the region as a whole, they would also be negligible.

Most of the corridor has not been surveyed for fossil localities, but available data indicate that there is a strong potential that fossils would be destroyed where the bedrock is disturbed by construction (estimated to be about 4-percent of the total disturbance) resulting in the minor impact of destruction of 2 to 5 fossil localities.

Secondary impacts caused by the related development will be substantial (Table F III-1). Indirect impacts including vandalism and unauthorized removal of fossil materials are anticipated to be small. Some benefit may be realized from increased fossil resource discovery and availability for scientific use through surveys and construction.

The impact on the minerals industry would be to provide an efficient power source to develop the region's coal resources. The line also would have a beneficial impact on any other mineral industries that could use the power, such as the uranium industry at the southern end of the line. Adverse impacts on the mineral industry are expected to be minor or insignificant, about 199 acres occupied by towers, service road, switching stations, or substations would not be available for mineral exploration and development while the line exists.

AIR QUALITY

Impacts of the FCL on air quality would mainly result from construction activities. Fugitive dust would be the major pollutant resulting from these activities. Road dust created by vehicular traffic and construction equipment, and wind erosion from bare soil surfaces would be the main sources of fugitive dust. Occasionally, blasting and drilling of holes for placing poles and anchors for the towers would generate some fugitive dust. During cleanup activities following construction of the transmission lines, small amounts of fugitive dust would be generated during the grading, harrowing, and seeding of the soil surface for reclamation. It is estimated that from 90 to 250 tons of fugutive dust would result from these sources. These emissions would be spread out over the three years for construction, and along the total length of the line. The individual particles would have relatively large diameters and would settle rapidly. Thus, the impacts would be intermittent with no widespread effect.

In addition, a small amount of gaseous emissions would be generated by combustion sources such as passenger and construction vehicles, generators, and compressors. These emissions would be small, intermittent, and localized and would have no noticeable impact on the local or regional air quality.

Negligible emissions of pollutants would be expected after the transmission lines begin operation. The lines would be patrolled by helicopter and pollutant emissions would be small and intermittent. The movement of equipment into the area to perform occasional maintenance would generate small amounts of fugitive dust.

Secondary impacts on air quality would come from coal mines and the generating station. Emission of particulates, sulfur dioxide (SO_2) and nitrogen oxides (NO_2) would total about 9,678, 17,223 and 25,800 tons per year by 1990. The effects of emissions from the mines on particulate concentrations would drop to less than 1 $\mu g/m^3$ beyond 6 miles from the mining activities. Emissions from the generating station would result in increased concentrations of SO_2 and NO_2 above the background level over an area of approximately 360 and 750 square miles (4.8 and 10 percent respectively, of the region).

Population growth associated with the proposed action and associated development would result in increased concentrations of SO_2 and NO_2 in the towns, but this increase would not be noticable in areas outside the towns.

WATER RESOURCES

As a result of construction of the FCL and the related development, the FCL would use 5 acre-

Table F III-1

ESTIMATED SECONDARY IMPACTS ON FOSSIL RESOURCES

	Localities		
	1980	1985	1990
Mines[1/]	70-80	230-250	480-510
Other[2/]	25-35	27-37	32-42
Total	95-115	257-287	512-552

1/ South Hospah, Alamito and Star Lake mines.
2/ New Mexico Generating Station, community development, transmission lines and water pipeline.

feet per year, the coal mines would use about 4,750 acre-feet per year of ground water, and the generating station would require 30,000 to 40,000 acre-feet. An additional 1,350 acre-feet a year would be needed to meet increased demands for domestic water supplies. Several stream channels would be destroyed during coal mining, and the possibility for pollution of ground water would be increased. Table F III-2 lists the estimated sediment discharges. These impacts are discussed in Chapter IV of the Regional Analysis.

SOILS

Varied degrees of surface disturbance would impact the soil on an estimated 307 acres (23 percent of the right-of-way) within the corridor during construction of the transmission line. About 48 acres of soil surface (less than 4 percent of the right-of-way) would be removed from productivity for the life of the project through being covered by switching stations, substations and poles. Temporary surface disturbance would occur on an estimated 259 acres (20 percent of the right-of-way) due to access roads, marshalling and storage of materials, structure landings, drilling operations, setting of poles, and pulling of conductors. Table F III-3 shows estimated acreages, by soil association, that would be removed from productivity for the life of the project or that would be temporarily disturbed during construction activities.

Secondary impacts would result from coal development facilitated by the transmission line as a source of power, disturbing about 8,731 acres by 1990. An estimated 2,785 acres would be disturbed during construction of the New Mexico Generating Station and ancillary facilities. About 1,147 acres would be disturbed due to population increases associated with the transmission line and subsequent development.

Removal of vegetative cover and topsoil during stripping and grubbing phases of construction and subsequent mining development would expose subsoils to wind and water action. Less fertile subsoils or toxic materials may be exposed, which could be detrimental to reclamation efforts. However, previous reclamation attempts on transmission rights-of-way in the vicinity of the FCL have not been studied to determine the effects of less fertile subsoils or toxic material on reclamation efforts. Compaction of the subsoil would result in long-term reduction of permeability and infiltration rates, as well as a change in soil structure, thus increasing the potential for runoff, erosion, and sedimentation. Mining operations would mix various textured soils, thereby increasing bulk density and creating different soils. Accidental spillage of such materials as gasoline, oil, wastewater, or excess concrete would pollute soils, affecting microorganism activity, sealing the surface, and reducing vegetative cover. Productivity levels would be lowered until the soil has had time to reestablish its structural and microorganism relationships, which in the semi-arid southwest may take decades to occur.

VEGETATION

Construction of the FCL would cause the destruction or disturbance of vegetation on about 307 acres where grading is required for tower assembly pads, switching stations, substations, and roads. Grading may not be required on areas of relatively smooth terrain, but disturbance of vegetation would result from vehicles and machinery running over plants and from the compaction of soils, which may affect the growth characteristics of nearby plants.

The relative proportions between destruction and disturbance of vegetation would vary depending on the exact location of the FCL centerline. The worst case would be destruction of vegetation on the entire 307 acres. If the line were built along the middle of the proposed corridor, the estimated percentages of affected vegetation types would be: grassland, 45 percent; sagebrush, 27 percent; saltbush-greasewood, 23 percent; pinyon-juniper, 5 percent; and waste and barren less than 1 percent.

The greatest impact would occur on areas where grading would completely remove the vegetation (up to 23 percent of the right-of-way). On these areas, plants would have to become reestablished from seeds. The probability of successful seed germination and seedling survival until a permanent vegetative cover is established cannot be predicted with accuracy. The low amount and intermittent nature of precipitation along the corridor is the greatest obstacle to successful seedling establishment.

On portions of the right-of-way where the vegetation is disturbed but not destroyed, growth characteristics of disturbed plants could be affected. On areas where only the larger woody plants (such as trees) were removed, the growth and productivity of understory herbaceous species may increase. On areas where soils were compacted by vehicles and machinery, vegetative productivity would probably decrease. Annual weeds would invade areas where the existing vegetation is disturbed or destroyed. Invasion of annual weeds onto disturbed areas where perennial plants are already established would be less detrimental than on graded areas where perennial plants must become established from seed. In time, alternate freezing and thawing would cause compacted soils in disturbed areas to loosen, and plant growth should return to normal.

Table F III-2

ESTIMATED SEDIMENT DISCHARGE(tons)

	1980			1985			1990		
	Gross			Gross			Gross		
Name	Working Mine[1/]	Total[2/]	Net[3/]	Working Mine[1/]	Total[2/]	Net[3/]	Working Mine[1/]	Total[2/]	Net[3/]
Alamito				13,600	13,600	8,150	15,400	18,700	4,960
Star Lake	14,000	15,900	10,800	13,300	21,700	10,400	14,600	26,800	7,730
Bisti	9,410	9,710	9,010	10,100	11,200	8,790	19,200	21,400	15,900
New Mexico Generating		6,660	3,700		6,660	3,700		6,660	3,700
Fruitland Coal Load		680	190		1,070	310		1,070	310
Community Development		2,070	300		2,330	410		2,580	450

Note: Sediment discharges are not cumulative and therefore not totaled.
For methodology see section on sediment computation in Appendix B.
* Not applicable.

1/ Includes discharge from open pit, spoil, pile, vegetated areas and revegetated areas not fully recovered.
2/ Includes above plus rehabilitated areas and other disturbed areas (buildings, storage, roads, etc.)
3/ Above adjusted for the sediment discharge that would have occurred naturally.

Table F III-3

ESTIMATED ACRES OF SOIL ASSOCIATIONS DISTURBED AND REMOVED FROM PRODUCTION

Association[1/]		Acres Disturbed	Acres Removed From Productivity For Life of Project	Total Acres Disturbed
3	Penistaja-Sheppard-Rockland	2	0	2
5	Las Lucas - Litle - Persayo	14	0	14
11	Persayo - Billings	22	0	22
12	Rockland - Billings	2	0	2
13	Chipeta - Sheppard - Shiprock	0	15	15
17	Lohmiller - San Mateo	10	0	10
19	Hagerman - Travessilla	72	0	72
28	Doak - Shiprock	10	0	10
31	Badland - Rockland	17	0	17
32	Camborthids - Farb	31	6	37
33	Persayo - Lohmiller	26	21	47
34	Rockland - Travessilla	19	0	19
35	Billings - Badland	34	6	40
	TOTAL	259	48	307

1/ Numbers accompanying soil associations refer to Map F II-2 and Table B-17 in Appendix B.

Vegetation would also be impacted by other activities facilitated by the FCL as a source of power. The area on which vegetation would be affected by these activities would total about 12,663 acres by 1990; and is 47 percent grassland, 28 percent sagebrush, 12 percent barren, 4 percent saltbush-greasewood, less than one percent pinyon-juniper, and 9 percent undeterminable.

WILDLIFE

Construction of the FCL would result in the alteration of 307 acres of wildlife habitat with a number of impacts on wildlife. An additional 12,663 acres would be altered from the related development.

Changes in species diversity and density would result from destruction of escape cover, dens, and nesting sites. Impacts would be particularly evident among small mammals (rodents), reptiles, amphibians, and arthropods that are less mobile and inhabit limited home ranges. Bird species that nest on the ground or in desert shrubs would be forced to migrate into adjacent lands.

Increased accessibility may increase shooting of birds resting on transmission lines. For example, a loss of 30 raptors occurred along a 12-mile segment of power transmission line in Utah (Ellis, Smith and Murphy, 1969). In addition, there would be disruption of daily and seasonal short-term movement as mule deer, antelope, and various carnivores shy away from the construction area.

Some impacts from the FCL would be beneficial. The tower would add new roosting and hunting perches for raptorial birds, increasing preying activities on subject lands. The New Mexico Environmental Institute (1974) found that, although transmission lines do change predator-prey relationships, such activities are not detrimental to densities of prey species. Changes in vegetal cover and the creation of 'edge effect' often increases rodent activity, thus improving predator-prey relationships.

Destruction of surface water impoundments by coal mining facilitated by construction of the FCL would cause moderate impacts to aquatic invertebrates. Disturbances in ephemeral drainages could increase the destruction of habitats associated with washes, although this impact is expected to be negligible.

Endangered and Threatened Species

The black-footed ferret is closely associated with prairie dog colonies, which are known to exist within the proposed corridor. There is currently no evidence that the area supports ferrets; however, accidental destruction of prairie dog colonies would reduce available habitat for this associated species.

In recent years the peregrine falcon has been observed in the San Juan and Chaco Regions, indicating the apparent suitability of the region to sustain a resident population. Increased human activity would cause falcons to shy away and may result in illegal shooting of them.

Although the bald eagle is an uncommon migrant, increased human activity would hinder any habitat and feeding utilization of the area. Accidental electrocution from high-voltage transmission structures, though unlikely, conceivably could occur under certain circumstances if these birds migrate through the area.

Official Section 7 consultation required by the Endangered Species Act of 1973 has been completed with the U.S. Fish and Wildlife Service.

AESTHETICS

Visibility

Visibility would not be significantly affected by the FCL. Emissions and particles generated by equipment and construction activites would be the primary sources of any localized or intermittent reduction in visibility. Maintenance activities on the line would cause negligible amounts of emissions at infrequent intervals. Emissions and particulates generated by the related generating station would reduce visibility in its immediate vicinity.

Noise

Impacts of noise from vehicles and equipment would be greatest during the construction of the line. The increased noise levels of 70 to 100 dBA at 50 feet, would be intermittent, and they would move as work progressed along the corridor. The development facilitated by the FCL would also cause the noise level to increase in the vicinity of this development.

Under foul weather conditions, such as fog and rainfall, transmission lines crackle and make other audible noises. A 115-kv or 230-kv line, if properly designed and maintained, should not create any significant noise problems.

Visual Resources

Construction and operation of the line would reduce visual quality through the introduction of contrasts generated by towers, conductors, switching stations, substations, and construction activities on 307 acres of the existing landscape of the area. Even where areas of relatively low scenic values (VRM Class IV areas) are involved, intrusions would still disrupt the landscape character.

The transmission line would not directly impact Chaco Canyon National Monument, but would be visible to people traveling State Highway 57, which provides access to the Monument. The principal ruins, visitor center, and campground are enclosed by the canyon walls, but the transmission line may be visible in the middleground distance zone from some vantage points at the higher elevations within the Monument.

The presence of the line and the disturbance would be most evident at road crossings and other heavily used areas. Perception of the degree of impact upon the visual resource would vary according to how much the viewer notes the presence of the line. For many local people, the line would become less intrusive after they became accustomed to viewing it during their daily activities.

The most prominent visual impact on the landscape would occur on the rolling sagebrush lands within VRM Class IV, as a result of the contrast generated by the physical presence of the line, structures, substations, and switching stations. Wooden K-frame structures varying from 60 to 90 feet in height, and spaced 750 feet apart, would intrude on the landscape. A strong vertical element would be introduced by these structures and electrical equipment within the station, and a strong linear element by the line itself progressing across country.

In general, topographic and vegetative conditions would determine the degree of disturbance and the severity of visual impacts; disturbance would be more evident in grassland and sagebrush than in pinyon-juniper. Additionally, due to the length of time required for restoration in this region, some scars from construction would be visible for an indefinite period. Of the 307 total acres disturbed, 259 would temporarily be placed into the lowest VRM class (Class V) until successful reclamation efforts return the acreage to a higher class.

The remaining 48 acres disturbed would continue to be visually altered to the extent that they could not be returned to their previous VRM classification for the life of the project. Of these, 15 acres devoted to a switching station and 18 acres devoted to three substations would drop to Class V after a previous designation as Class IV; the other 15 acres occupied by a second switching station would obtain Class V status instead of their present Class III status.

Less than one acre of the total located on Class I, II, and III lands, would be disturbed by pole structures. However, about 3 miles of the 115-kv segment would cross approximately 4 acres of Class I lands assigned to roadless area NM-010-57.

By 1990, an estimated 12,663 total acres would be affected by the activities whose growth would be enabled by the FCL, causing some permanent reduction of the visual quality of the area as a whole.

LAND USE

Recreation

The dispersed recreation activities occurring in or near the corridor (e.g., hunting, off-road vehicle use, and sightseeing) would not be appreciably affected by the line. A total of 307 acres would be disturbed, with only 48 of those acres (less than 1 percent of the total ES Region) committed to the FCL for the life of the project. Any loss or gain to recreation visits as a result of the line cannot be quantified, but past trends in the area indicate that a general increase in recreation visits is occuring.

Adverse impacts on the vegetation, wildlife, soils, and visual resources during construction of the transmission line would reduce the quality of the recreation experience near the right-of-way. After construction, the presence of the poles, conductors, and switching station would continue to result in a reduction of quality experience to varying degrees.

Secondary impacts to recreation activities and experiences would occur from the related development. These activities would reduce the quality of the recreation experience on an additional 12,663 acres by 1990.

Transportation

Trucks hauling construction materials and workers commuting to their work would cause highway congestion and related impacts to increase. Since construction of the line would precede much of the other development in the area, it should have little impact on the transportation needs of these developments.

Grazing

The FCL would require about 307 acres affecting 18 grazing allotments, and resulting in a total loss of 46 AUMs of forage production. Table III-4 indicates the acreage disturbed and AUMs lost in each allotment. Other minor adverse impacts of construction include possible livestock harassment, downed fences, and damage to gates and cattleguards. With the exception of the area occupied by the structures, all impacts would be of short duration because disturbed areas would be revegetated after construction. The proposed transmission line would have a low adverse impact on grazing, with the highest loss being six AUMs in allotment 377. Impacts due to maintenance would be negligible.

Developments associated with the FCL transmission line would result in a minor impact on the grazing resource. The acreage required for the proposed New Mexico Generating Station would ac-

Table F III-4

ACRES DISTURBED AND AUMS LOST

Grazing Allotment	Source of Impact	Acres Disturbed	AUMS Lost
16	switching station	15.0	1
16	230-kv line	19.5	2
8	115-kv line	12.0	2
12	substation	6.0	1
12	115-kv line	4.0	0
12	230-kv line	19.5	2
10	230-kv line	3.9	0
13	230-kv line	25.1	3
17	substation	6.0	1
17	230-kv line	28.0	4
18	230-kv line	25.1	2
20	230-kv line	2.9	0
21	switching station	15.0	3
21	substation	6.0	1
21	230-kv line	15.6	3
34	230-kv line	15.6	3
33	230-kv line	6.8	1
37	230-kv line	9.2	2
43	230-kv line	18.3	3
377	230-kv line	24.3	6
378	230-kv line	6.6	2
55	230-kv line	13.1	2
65	230-kv line	5.4	1
66	230-kv line	4.1	1
TOTAL		307.0	46

count for a loss of 108 AUMs for the life of the project, affecting 3 grazing allotments. A loss of 25 AUMs would result from the construction of transmission lines from the generating station, and 59 AUMs would be lost due to the construction of a water pipeline to the station. The routes of these developments are not known; therefore the ranchers that would be affected cannot be determined. Impacts due to mine developments would be negligible because losses in forage production would be avoided by company and owner negotiations resulting in the purchase of the surface, exchange of use areas, or relocation of livestock.

Wilderness

Intrusion from construction activities, erection of poles and development of service roads, and the presence of the FCL in any of the wilderness inventory units recommended for intensive inventory would impair their suitability for designation as wilderness. However, the final centerline within the 5-mile-wide corridor has not been determined. As shown in Map F III-1, varying amounts of 5 wilderness inventory units fall within the 5-mile corridor. It is possible that no inventory units, with the exception of the 115 kv segment of Stage I within Unit NM-010-57, would be affected if the line was located in the southern portion of the corridor below all the inventory units. The area within NM-010-57 crossed by the 115 kv segment of Stage I was identified for public comment as clearly and obviously not qualifying as a wilderness study area, with recommendation that those lands are unsuitable for further wilderness consideration.

Intrusions from construction activities, erection of poles and development of service roads for the line and the development related to the FCL could cause a permanent loss of roadless area values. Furthermore, if the corridor divided a roadless area into parcels of less than 5,000 acres, they would probably be deleted from the roadless area program.

The related coal development on 12,660 acres would remove them from consideration as a wilderness area.

CULTURAL RESOURCES

Direct impacts on archaeological and historical resources involving site destruction could result from construction of the line and access roads. Based on data submitted by the Star Lake Railroad and adjusted for possible variations in terrain, at least 20 to 30 sites would be encountered. The size and cultural affiliation of involved sites cannot be determined from the available data.

Unauthorized artifact collection and vandalism could damage surface materials as the area is opened by the access roads. This type of indirect impact would peak during construction and decline upon completion of the line. Again, the number and nature of sites likely to be affected by vandalism cannot be determined from the available data.

An additional 136 to 211 sites would be destroyed by the development facilitated by the FCL.

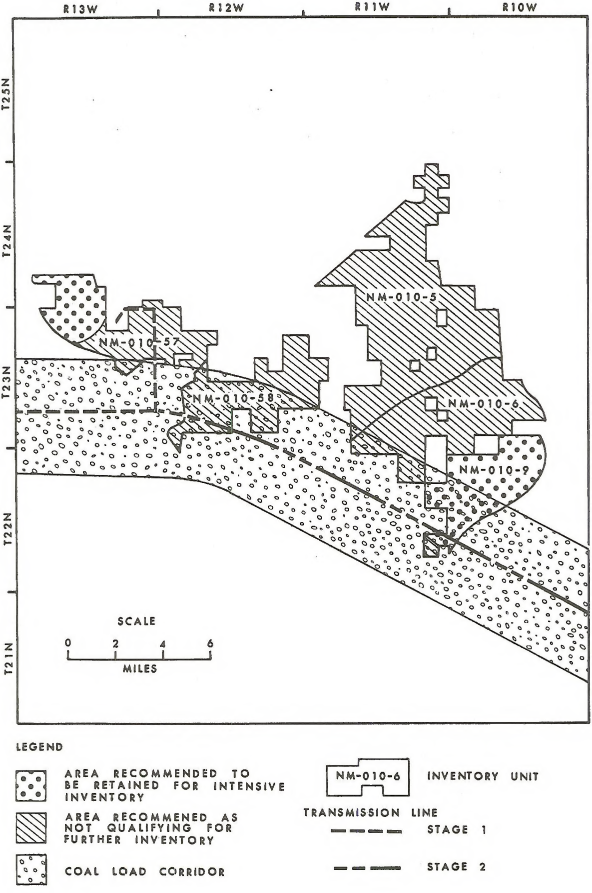
SOCIOECONOMIC CONDITIONS

The FCL would cause only minor socioeconomic impacts within the ES Region. The phased construction of the line would require no more than 35 workers at any given time from 1979 through 1984. Most of these workers would be highly skilled union members already employed in the region. The tenure of any other employees brought into the region during construction would be brief and their presence would be unlikely to cause any impact. Materials used in construction probably would be supplied from outside the region. Operation and maintenance of the line would require no additional regular employees.

Construction of the FCL would facilitate the development of at least three coal mines and a generating station. These developments would employ 1,630 workers with another 1,594 workers employed elsewhere to provide support.

All homes would be avoided, making it unnecessary to relocate any residents. There could be some slight disruption of local secondary road traffic as construction materials are delivered to erection sites.

Insofar as the FCL would facilitate the development of mines and other activities in the region, it would contribute to the socioeconomic impacts outlined in Chapter IV of the Regional Analysis.



MAP F III-1 RELATION OF THE FRUITLAND COAL LOAD CORRIDOR TO WILDERNESS UNITS

CHAPTER IV

MITIGATING MEASURES

THIS CHAPTER PRESENTS MITIGATING MEASURES REQUIRED BY LAW OR REGULATION AND OTHER MITIGATING MEASURES THAT WOULD LESSEN OR ELIMINATE ADVERSE IMPACTS RESULTING FROM CONSTRUCTION OF THE FRUITLAND COAL LOAD TRANSMISSION LINE.

CHAPTER IV

MITIGATING MEASURES

MITIGATION REQUIRED BY LAW OR REGULATION

Paleontology

TThe BLM is developing technical guidelines to define the resource, provide evaluatory criteria, and develop measures for protection. The provisions of these documents will serve as a basis for Federal management and protection. (Refer to Chapter III of the Regional ES for complete mitigation requirements.) In addition, a report has been submitted by the New Mexico Paleontology Task Force to the Legislative Finance Committee on October 4, 1978, detailing options for State management and use of paleontological resources. This task force is currently studying possible protective measures. Recommendations will be made and some action on these recommendations is anticipated by the Legislature in the 1979 session.

Air Quality, Water Resources, Soils, Vegetation, and Wildlife

In 43 CFR 2801.1-.5, terms and conditions are set forth that would lessen impacts. By accepting a right-of-way across Federal lands, the applicant agrees and consents to comply with the following conditions:

"To comply with State and Federal laws applicable to the project for which the right-of-way is approved, and to the lands which are included in the right-of-way, and lawful existing regulations thereunder." and,

"To take such soil and resource (wildlife species and habitat) conservation and protection measures including weed control, on the land covered by the right-of-way as the superintendent in charge of such lands may request."

To comply with these regulations, the following mitigating measures would be required:

(1.) Unnecessary off-road vehicle use would be restricted to minimize disturbance, particularly in areas having a high erosion hazard or that are outside the right-of-way.

(2.) All temporary construction of access roads, equipment storage sites, and construction sites would be restricted to the smallest compatible area where least soil disturbance and destruction of vegetative cover occurs. Clearing and grubbing would be done only where required.

(3.) Contingency plans would include measures to clean up accidental spillage of detrimental or toxic materials such as gasoline, oils and chemicals, and to restore damaged vegetation to pre-construction condition.

(4.) Waste water from concrete batch plants or from trucks carrying concrete would be discharged to settlement basins for impoundment and evaporation.

(5.) Areas disturbed during construction would be restored to their natural state insofar as practicable and in a timely manner according to an approved reclamation plan.

(6.) Temporary roads would be scarified or blocked to discourage future use.

(7.) Excess soil excavated during construction would be leveled to conform with the general contours of the area, eliminating mounds of high relief.

(8.) If it is determined that any endangered or threatened species inhabit the FCL corridor, notification and consultation will be undertaken with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act of 1973.

A mixture, consisting of grass and shrub seeds of species native to the area, or of adapted introduced species, would be seeded into a prepared seedbed wherever the existing vegetation is destroyed. Seeding operations would be carried out in a manner that would place the seeds in contact with the soil at optimum depth for germination and establishment, and would be timed to coincide with the season when climatic conditions and weather patterns offer the highest probability of receiving sufficient moisture for successful seed germination and seedling establishment. Mulch would be applied to seeded areas in sufficient quantity to stabilize the soil surface until plants become established.

In the event of failure, seeding efforts would be repeated in subsequent years until a plant cover is reestablished on areas where vegetation was destroyed.

Implementation of the mitigating measures would reduce the size of areas disturbed by construction activities, the amount of sediment and fugitive dust, the time frame for reestablishment of ground cover, and the amount of wind and water erosion.

Visual Resources

The FLPMA specifies that the public lands be managed in a manner that will protect the quality of scenic values.

Land Use

RECREATION

On-site impacts on recreational capabilities that result from right-of-way construction would be mitigated under provisions of 43 CFR, Subparts 2801.1-5(a) and 2801.0-5(h)--Rights-of-Way; Terms and Conditions. These regulations require compliance with Federal and State laws applicable to the project for which the right-of-way would be approved and with other regulations necessary to render such approval compatible with the public interest.

WILDERNESS

Under provisions of Section 603 of FLPMA, the Secretary of the Interior may grant access across public land under review for wilderness designation only when it would not impair the suitability of the area for preservation as wilderness. The right-of-way would have to be amended to avoid these lands if impairment was to occur.

Cultural Resources

Under provisions of the Antiquities Act of 1906 (P.L. 59-209; 34 Stat. 225), no cultural resources on Federally controlled lands (including Indian Trust Lands) may be excavated or damaged without permission of the Secretary of the department holding jurisdiction over involved lands.

The Historic Sites Act of 1935 establishes a National Register of Historic Places. The National Historic Preservation Act of 1966 (P.L. 89-665; 80 Stat. 915) extends the National Register and establishes the President's Advisory Council on Historic Preservation. These are intended to insure that cultural resources of significance to U.S. national heritage are not damaged by Federal or Federally licensed undertakings. The National Environmental Policy Act of 1969 (NEPA)(P.L. 91-190; 31 Stat. 852) also stresses the national objective to preserve important historic and cultural aspects of our national heritage. Executive Order 11593 further extends the acts to protect both Federally and non-Federally controlled cultural properties from damage by Federally initiated programs. In cases where sites potentially eligible for, but not currently included on the National Register would be damaged, it requires that such actions be withheld until the Advisory Council has an opportunity to comment on the proposal. In New Mexico, comment is made through the State Historic Preservation Officer (SHPO) for the Advisory Council.

The Historical and Archaeological Data Preservation Act of 1974 (P.L. 93-291; 88 Stat. 174) provides for the preservation of all significant cultural resources subject to damage by Federal or Federally licensed projects. The Secretary of the involved department may take steps deemed necessary to protect or recover information from involved sites.

These acts plus other measures that largely reiterate their provisions require that the following measures be taken to protect cultural resources affected by Federal action or Federally licensed projects:

(1.) All terrain subject to the proposed action must be inventoried for cultural resources by professionals affiliated with qualified educational or scientific institutions.

(2.) No sites on or eligible for nomination to the Federal Register may be damaged without approval of the Advisory Council and without prior professional investigation of the affected sites.

(3.) Steps must be taken to recover cultural data from significant archaeological sites subject to damage from projects with Federal involvement.

New Mexico State laws (NM Stat. Ann.; Sections 4-27-4 through 4-27-16--1969 and 1977) provide for a cultural properties review committee and permit system for the protection and excavation of sites on State lands.

State legislation requires the following protective measures be taken:

(1.) Cultural resources on State lands may not be damaged without prior permission and investigation under permit granted by the Cultural Properties Review Committee.

(2.) Cultural resources on private lands may not be destroyed by mechanical means for artifact collection, except by the owner of the land, without prior permission of the Review Committee.

OTHER MITIGATING MEASURES

Geologic Setting

The final route of the line would be located to avoid, as much as possible, recoverable coal resources, and towers and stations would be placed to avoid conflict with oil or gas pipelines that cross the right-of-way, making the impacts on the mineral industry insignificant.

Paleontology

In areas of high relief and a high percentage of geologic exposure, anticipated disturbance would be small and would require little or no salvage of fossil materials or data. The following mitigation methods would be imposed in areas of significant bedrock disturbance (i.e., road construction cuts and fills):

(1.) In advance of actual disturbance of bedrock areas, after the final corridor has been surveyed and staked, disturbance areas would be surveyed for fossil materials, and, where possible, fossils would be salvaged prior to disturbance.

(2.) During actual excavation, periodic inspections would be made and, if available, samples collected from disturbed fossil-bearing horizons. An additional sample would be taken of unweathered materials and additional data would be gathered for preservation of contextual relationships.

(3.) Collected fossil materials would be curated, identified and reposited in an appropriate manner to insure their protection and future scientific utility.

(4.) To reduce the negative impacts due to increased accessibility, the routes of major access would be posted (sufficiently removed from areas of exposure) to discourage unauthorized removal of fossil materials.

(5.) During construction, all employees, contractors, subcontractors and their employees would be advised that removal of fossil materials is not permitted. In the event that fossil materials are discovered by construction workers, the Bureau of Land Management is to be notified and appropriate action would be taken by the Bureau.

With the implementation of these measures, it is anticipated that nearly all the direct negative impacts would be mitigated, and some benefits would occur through the collection of materials and data that would not be available otherwise.

Water Resources, Soils, and Vegetation

Existing access roads would be used whenever possible for construction and maintenance of transmission lines. Temporary spur roads would be developed only when required for inaccessible locations and other areas where it is impractical to build a continuous road; the use of bulldozers to cut roads would be avoided unless required by terrain. Construction personnel would use only authorized access roads, which would be kept to a minimum. Unauthorized use of access roads would be discouraged as much as possible by gates or other similar measures. Areas that are sufficiently smooth and stable to support construction vehicles and activities would not be graded.

Clearing and grading during construction would be confined to structure sites, staging areas, pulling sites, and necessary access roads. Contractors would be required to remove as little vegetation as possible. Standard construction techniques would be used to suppress dust created by movement of heavy vehicles. Erosion-prone, unstable soils would be avoided whenever possible. Erosion-control devices, such as water bars, would be constructed where appropriate, and side drainage and culverts would be used where necessary. Erosion and sedimentation would be monitored and corrective action would be taken if necessary.

After construction is completed, new access roads would be closed. Disturbed areas of the right-of-way would be dressed up and the soil around the structure bases would be graded to improve appearance and drainage. Excessive rutting and any equipment unloading ramps would be smoothed out to the approximate original contour. Helicopters would be used wherever possible for maintenance patrols to reduce further disturbance to the area, eliminating the need for a continuous permanent service road. If maintenance is required, the lands involved would be reclaimed.

Wildlife

The following measures would mitigate impacts on wildlife species and related habitats:

(1.) The method of clearing the right-of-way would be designed to avoid soils of low stability, minimize destruction of natural vegetation, and avoid disturbance of adjacent wildlife habitat.

(2.) Natural vegetation would be removed or cleared only when necessary to provide electrical clearance, line reliability, or suitable access for construction, operation, and maintenance.

(3.) In general, mitigation methods for soils, which have an indirect effect on wildlife, concern (a) avoidance of erosion-prone soils where possible, (b) use of erosion-control devices to enhance vegetative recovery and reduce or eliminate sedimentation loading to arroyos where appropriate, (c) closure of access roads after construction, and patrolling of the facility by helicopter for maintenance reconnaissance, and (d) use of existing access roads whenever possible.

(4.) Burning cleared debris would not be allowed.

(5.) Herbicides would not be used on the right-of-way.

(6.) The 230-kv transmission line components would be sufficiently spaced from conductors that the potential for electrocution of raptors is practically nonexistent.

Visual Resources

Mitigation measures taken to minimize the visual effects of the line are:

(1.) Erosion control devices would be constructed where appropriate.

(2.) Existing access roads would be utilized when available.

(3.) Following construction, new access roads would be closed, harrowed and reseeded where appropriate.

(4.) The contractor would be directed to remove as little vegetation as possible.

(5.) Changes in landform characteristics would be held to a minimum.

(6.) Construction techniques would be used to suppress dust created by the movement of heavy vehicles.

(7.) Route for the line would cross areas of low population.

(8.) Towers that blend with the landscape would be used.

Land Use

RECREATION

Recreation impacts would be minimized by using techniques that would cause the least possible impact on the areas. Construction activities requiring traffic interruption would be done as quickly as possible and safety procedures would be utilized to insure safe traffic flow.

GRAZING

The acres disturbed would be reclaimed as soon as possible after construction. A loss of 123 AUMs of forage production would be mitigated by revegetation within five years after the end of construction. Wire gates would be placed at allotment boundary fences that the transmission line crosses. After construction, the gates would be left or replaced according to the rancher's desires. In most cases, all gates would be replaced to discourage vehicle travel within the right-of-way. Any damage to cattle guards or other range improvements would be repaired.

Cultural Resources

Wherever possible, sites would be avoided by relocation of access roads, construction areas, and facilities. Sites which could not be avoided would be mitigated as required by the land managing agency. Protection of sites subject to indirect impact would also be considered.

Socioeconomic Conditions

PNM's contractor would hire locally, to the extent feasible.

CHAPTER V

UNAVOIDABLE ADVERSE IMPACTS

THIS CHAPTER DISCUSSES THE ADVERSE IMPACTS FROM CONSTRUCTION OF THE FRUITLAND COAL LOAD TRANSMISSION LINE THAT WOULD REMAIN AFTER MITIGATING MEASURES HAVE BEEN APPLIED.

CHAPTER V

UNAVOIDABLE ADVERSE IMPACTS

CULTURAL RESOURCES

Unavoidable adverse impacts to archaeological and historic resources include direct destruction or damage to sites during construction of the transmission line, and indirect damage from unauthorized collection and vandalism. It has been tentatively projected that 20 to 30 sites would be encountered. Those avoided would be free of direct impact. Scientific excavation would preserve some information from these sites, but such information would be limited by research techniques and orientations current at the time of excavation and, in most cases, by incomplete excavation. Because site destruction would follow the mitigation procedures, affected sites could not be re-examined for further information as different questions arise or new procedures are developed. As a result, both information loss and physical site loss must be considered unavoidable impacts of the proposed action. Indirect impacts from unauthorized artifact collection and vandalism would result in an undetermined loss of surface and subsurface material. These impacts would peak during construction and decline thereafter. An additional 136 to 211 sites would be affected by development of coal mines and the powerplant facilitated by the FCL.

PALEONTOLOGY

Unavoidable impacts on paleontology have three potential sources: 1) inadvertent destruction of fossil materials during construction, 2) intrusion of construction, maintenance, and operational personnel into the area, and 3) subsequent industrial development as a result of the transmission line. Quantification of the impact remaining after mitigation is difficult because of incomplete survey data, however, it is estimated that 2 to 5 fossil localities would be disturbed during construction of the FCL. An estimated 50 percent of the fossils in disturbed materials would probably go unnoticed and unsampled. This would be insignificant for invertebrate and plant fossils, where only 1 or 2 percent are needed for sampling, but the effect on vertebrate fossils would be much greater, because 20 to 100 percent of them is needed for adequate sampling.

Impacts caused by related developments would be substantial, with over 500 localities estimated to be impacted by 1990. Increased population would also result in increased vandalism and unauthorized removal of fossil materials. (A general treatment of the extent and sensitivity of fossil materials is presented in the Regional Analysis, Chapter II.)

AIR QUALITY

Construction of the FCL would have only temporary and insignificant effects on air quality. The increase in emission of particulates, SO_2, and NO_2 from the generating station would be unavoidable, even with pollution control measures. Although stringent fugitive dust control measures would be applied to the mines, Federal and State ambient standards would be violated at points very near specific dust sources in the mines. Even though ambient pollutant levels resulting from emissions from the generating stations would be relatively low, atmospheric pollutant levels would increase. The degradation of air quality caused by emissions related to growth of towns would cause an unavoidable increase in pollutant levels in the towns. Overall, it is estimated that emission of particulates, SO_2 and NO_2 would total 9,678, 17,223, and 25,800 tons per year, respectively, by 1990.

GEOLOGIC SETTING

About 199 acres occupied by structures, service road, and stations would be unavailable for mineral exploration and possible future development for as long as the line exists. This impact should be insignificant to the mineral industry. Disturbance of 12,663 acres by 1990 due to related development of coal mines, the generating station, and nearby communities would be very noticeable locally, but would be negligible in the region as a whole.

WATER RESOURCES

A sediment discharge of 1,070 tons per year during construction of the FCL would be unavoidable. Development facilitated by the FCL would cause an average of 30,000 tons of sediment per year. These sediment discharges are small when compared to the estimated total natural sediment discharge from the Chaco River basin of over 2.5 million tons per year. The 35,000 to 45,000 acre-feet per year of water requirements from the development facilitated by the FCL would also be unavoidable.

SOILS

Disturbance of soil on an estimated 307 acres during construction of the transmission line could not be avoided. About 48 acres of soil surface (less than 4 percent of the right-of-way) would be removed from productivity for the life of the project through being covered by switching stations, substations and poles. Productivity of the 259 acres temporarily disturbed during construction would be lowered by compaction, mixing of native soils, and accelerated erosion. Impacts of coal development, the New Mexico Generating Station, and ancillary facilities facilitated by the transmission line as a source of power during some phases of development would change soils and reduce soil productivity of an estimated 12,663 acres (less than 0.3 percent) of the region by 1990. Reclamation experience in the region has not been of sufficient duration to determine the long-range effects on soil productivity.

Accelerated soil loss during construction and mining operations, and prior to re-establishment of vegetative cover could not be avoided. However, as ground cover is re-established or as readily detachable soil and geologic material is removed, the quantity of eroded material would diminish and soil loss would decline. Alteration of soil horizons, parent material, and soil characteristics that have developed over long periods of geologic time cannot be avoided. Consequently new soils would form with characteristics unlike those existing prior to disturbance.

VEGETATION

About 307 acres of vegetation would be impacted during construction of the transmission line, of which about 199 acres would be disturbed to accommodate switching stations, substations, service roads, and towers. Productivity and stability of the plant communities would be reduced on areas where disturbance occurred. This reduction would persist until plant community development progressed to equilibrium with the environment (including land-use activities). Stable plant communities should develop within ten years on areas where minor disturbance occurred. However, on graded areas, decades would probably pass before stable plant communities develop because plants would have to start from seed and would be slow to develop in the arid climate along the route. Related developments would impact vegetation on an additional 12,663 acres by 1990.

WILDLIFE

Loss of escape cover, shelter, food sources, and dens and nesting sites on 307 acres, and associated animal mortalities, would result from construction and use of access roads, structure assembly, and stringing of wires associated with the transmission line. Related development would alter 12,663 acres. Overall, the less mobile species of small mammals, some reptiles, amphibians, and various arthropods would be impacted the most.

Disturbance of watersheds during construction activities could affect animals inhabiting lowland washes or arroyos that traverse the corridor. Human activity during construction could disturb daily and, possibly, seasonal movement of such large mammals as coyotes, bobcats, deer, and antelope.

AESTHETICS

Dust and emissions from construction and operation of the generating station and coal mines facilitated by the FCL that cannot be controlled through mitigation would result in an unavoidable but insignificant reduction in visibility.

Increased noise levels would be created temporarily by all the construction activities. These noise levels would change as construction progresses on the line. In addition, unavoidable crackling noises may be created in the line during foul weather. There would also be a local increase in noise near the related mines.

The transmission line would create an intrusion on the visual resource, and prominent contrasts in color and line from soil and vegetation disturbances would remain for an indefinite period of time. The physical presence of the line would be a source of horizontal and vertical linear intrusions on the skyline. These contrasts with the existing visual resource are beyond the acceptable limits for VRM Class I areas. Impacts on the area's aesthetic resources also would occur as the result of the disturbance of over 12,000 acres during development of activities facilitated by the FCL.

LAND USE

Recreation

Loss of the area's characteristic remoteness and open spaces would impact some existing recreational activities. Related developments would also contribute to disturbance of recreation activities.

GRAZING

There would be an unavoidable loss of range livestock forage. Rehabilitation measures would limit the temporary loss to about a five-year period. A permanent loss of 115 AUMs of forage production would occur from the areas occupied by substations, pole footings, and the proposed generating station. Normal grazing patterns could be disrupted for short periods during construction. Related developments would cause a loss of 192 AUMs.

Wilderness

In April 1979, the New Mexico State Director will hand down an initial decision on the wilderness inventory. If this decision concurs with present recommendations, it would be possible, by routing the FCL along the southern boundary of the right-of-way corridor, to avoid all the wilderness inventory units that have been recommended to be retained for intensive inventory to identify wilderness study areas. The segment of NM-010-57 crossed by the 115-kv segment of the FCL has been recommended as clearly and obviously unsuitable for further wilderness consideration. Therefore, it is possible that no unavoidable impairment to wilderness values would occur. No final statement concerning unavoidable adverse impacts to the wilderness inventory units affected by the proposed action can be made until the 90-day period of public comments terminates and the State Director issues his initial inventory decision. This decision will be final 30 days after its publication in the Federal Register.

SOCIOECONOMIC CONDITIONS

Unavoidable impacts due to increased population are expected to be small. Construction-related population increases would introduce some small, unavoidable impacts of short-term duration. Unavoidable socioeconomic impacts from coal development facilitated by the transmission line are addressed in Chapter V of the Regional Analysis.

CHAPTER VI

THE RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

THIS CHAPTER DISCUSSES THE LONG-TERM IMPAIRMENT OR ENHANCEMENT OF RESOURCE VALUES THAT WOULD OCCUR AS A RESULT OF THE SHORT-TERM USES OF THE ENVIRONMENT PROPOSED BY PUBLIC SERVICE CO. OF NEW MEXICO AND THE PLAINS ELECTRIC GENERATION AND TRANSMISSION COOPERATIVE, INC.

CHAPTER VI

THE RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

Construction of the proposed FCL would provide electricity for various potential coal mines along the Fruitland Formation, making more coal available to meet future national energy demands. Construction and operation of the FCL would be a long-term land-use commitment of the 453-acre right-of-way in a 108-mile-long corridor. This use would effectively preclude other land uses such as development of minerals other than coal, grazing, and some casual recreation on the right-of-way.

Short-term uses of archaeological, historic, paleontological resources would impair their long-term productivity. Some of the information value of these areas would be salvaged, but the actual site localities would not be available for long-term research or improved interpretive methods. Indirect impacts would continue to affect sites in the vicinity of the right-of-way over the long term. While vandalism and/unauthorized collection would be greatest during the short term, the materials lost cannot be regained. The cumulative effect would be the permanent loss of surface and some subsurface cultural and paleontological materials in the vicinity of the right-of-way.

The short-term commitments of the water resources near the FCL would not affect the long-term productivity of the area.

Fugitive dust, particulates, sulfur dioxide and nitrogen oxides from the FCL and related developments would constitute disturbance of the air quality of the region. In the long-term, these disturbances, along with increased urbanization from population growth associated with these and other regional activities, would impair air quality. If the labor force remains after the activities have ceased, the projected urban air pollutant concentrations would persist, and may increase if new industrial sources of air quality disturbance arise.

Construction of the transmission line would result in the loss of productivity on an estimated 43 acres of soil surface that would be covered by the switching stations, substations, and poles for the life of the project. Productivity of the remaining 259 acres disturbed within the right-of-way would also decline due to the construction-related activities. Coal development, construction of the New Mexico Generating Station and ancillary facilities facilitated by the transmission line as a source of power would reduce the productivity of the soils on an estimated 12,663 acres (less than 0.3 percent) of the region by 1990. Development of soils and re-establishment of productivity would be a slow process due to the semiarid conditions. Reclamation experience in the region has not been of sufficient duration for studies to determine the long-range effects on soil productivity.

In the long term, the vegetation disturbed on 307 acres would return to approximately its present level of productivity. The time required for this progression would range from less than ten years on disturbed areas to decades on areas where the vegetation was totally destroyed and would have to be re-established from seed.

The long-term productivity of native terrestrial fauna and associated habitat would ultimately depend on the proper implementation of mitigation programs. Terrestrial fauna inhabiting the right-of-way would experience a decline in animal densities until the areas are revegetated and brought back into full production. Because the company plans to close off access roads upon completion of construction, excessive human activity and off-road vehicular use of the subject lands would be limited.

Intermittent and localized reductions in visibility would occur during the short term, but not over the long term. Short duration increases in noise levels would occur in limited areas from construction activities and equipment used to construct the line, but noise levels should return to their previous range over the long term. The most intense impacts to visual resources would be during construction, implementation of rehabilitative measures, and placement of the transmission line into operation. A long-term reduction in visual quality would result from the physical presence of the transmission line and the evidence of construction that would remain for an indefinite period of time.

In the long term, only a small amount of acreage would be restricted from recreational use by fenced switching stations and pole locations. Some wilderness values would also be lost for the long term through the presence of structures and the length of time required for successful reclamation.

The removal of 1,968 acres from range production would result in a long-term annual loss of 115 AUMs of forage. The short-term loss of 123 AUMs would be recovered after vegetation has been reestablished on the acreage disturbed during construction. Recovery of range productivity is expected to be completed within a 10-year period after construction is completed.

As a result of short-term impacts from development of the FCL, no long-term reduction in wilderness values is expected, provided that the final decision of the State Director concurs with present communications.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

THIS CHAPTER IDENTIFIES THOSE RESOURCES THAT WOULD BE CONSUMED AND PERMANENTLY LOST AS A RESULT OF CONSTRUCTION OF THE PROPOSED POWER TRANSMISSION LINE.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

About 2 to 5 fossil localities and 20 to 30 archaeological and historic sites would be unstudied, or partially studied, and destroyed by the construction of the FCL, and 512 to 552 fossil localities and 136 to 211 archaeological sites would be destroyed from the related development. This is a small portion of the total number of sites in the area; however, anyone of these sites could be uniquely important.

Materials used to construct the line, including steel used in the switching, sub, and generating stations and copper and aluminum for conductors and at the stations, and in the manufacturing of the mining machinery and buildings, would be committed for the life of the project, but much of it would be salvageable upon abandonment. Energy would be consumed during both construction and operation.

Approximately 133 million tons of coal would be produced and consumed from the coal mines dependent on the proposed action, and an estimated additional 27 million tons would be lost due to current mining methods, out of the estimated reserve of 6.3 billion tons of strippable coal.

Energy in the form of petroleum products and electricity would be expended by the proposed action and related developments.

The sediment discharge of 1,070 tons per year from the FCL and 30,000 tons per year from the related development is compared to a natural discharge of 2.5 to 3.0 million tons per year. Water requirements for the FCL and related developments would be about 35,000 to 45,000 acre-feet per year.

Soil productivity would be lost on an estimated 199 acres occupied by the switching stations, substations, service road, and towers and on 12,660 acres from the related development. Vegetation and wildlife productivity on the 12,860 acres would be lost until reclamation returns productivity to that of the existing community. These losses compare to the 4.8 million acres in the ES Region.

Forage production of 212 AUMs would be lost out of a total of 328,000 AUMs for the area.

No wilderness inventory units with the potential for wilderness would be lost should the final decision of the State Director concur with present recommendations. Roadless area lands crossed by the 115-kv line in Stage I development are those identified under wilderness review procedures as clearly and obviously unsuitable for further wilderness consideration and would be returned to multiple-use management.

CHAPTER VIII

ALTERNATIVES TO THE PROPOSED ACTION

THIS CHAPTER PRESENTS THE ENVIRONMENTAL IMPACTS OF REASONABLE ALTERNATIVES TO THE PROPOSED POWER TRANSMISSION LINE, INCLUDING THE NO-ACTION ALTERNATIVE.

CHAPTER VIII

ALTERNATIVES TO THE PROPOSED ACTION

Alternatives to the proposed FCL are no action, partial action, use of the same right-of-way corridor as the SLR, and an alternate corridor. Only the significant impacts from these alternatives are discussed in this chapter.

NO-ACTION ALTERNATIVE

Under the no-action alternative, the FCL would not be built and the environment in the vicinity of the transmission line would change as described in Chapters IIB of this analysis and of the Regional Analysis.

If the line is not built, the Bisti, Alamito and Star Lake coal mines, that would be dependent on its power to operate, probably would not be developed. Without a need to deliver coal from these mines, the Star Lake Railroad probably would not be built. Thus, the no-action alternative would become essentially the same as the regional no-action alternative, with basically the same impacts. (See Chapter VIII of the Regional Analysis for a discussion of the impacts for the no-action alternative.) The beneficial and adverse impacts discussed in preceeding sections of this site-specific analysis would not occur. The land within the proposed corridor would continue in its present condition, or be modified by the owners to meet their needs. Paleontological, archaeological and historical materials would continue to be depleted, although at a slower rate, through erosion, continuing unauthorized collection and vandalism, and non-coal-related development. The expansion of the regional economy in the ES Region would continue, producing the consequences described in Chapters IIB and VIII of the Regional Analysis.

PARTIAL-ACTION ALTERNATIVE

Under the partial-action alternative, only Stage I of the FCL would be built. Stage I consists of the substation on the existing Four Corners to Ambrosia 230-kv line, the switching station, the Western Coal 50-Mw substation, the temporary 30 Mw substation for the New Mexico Generating Station, six miles of 230-kv line, and eight miles of 115-kv line (see Map FI-1). With this alternative, electrical power service would be provided only to the Bisti Mine and the New Mexico Generating Station switchyard. The impacts under this alternative for most resources would be small, and there would be no impact for the resources not discussed below.

Direct impacts upon paleontological resources would be small, because no disturbance of major fossil-producing horizons is anticipated.

The direct impacts on air quality would be emissions of 15 to 45 tons of fugitive dust. Related impacts would consist of particulate emissions from the Bisti Mine and the generating station and gaseous emissions from the generating station. About 2,976 tons of particulates would be emitted from the Bisti Mine by 1990. Annual average particulate concentrations would drop to less than 1 $\mu g/m^3$ beyond 6 miles from the mining activities. Emissions from the generating station would result in increased concentrations of SO_2 and NO_2 over an area of approximately 360 and 750 square miles respectively.

Particulates and gaseous emissions from construction equipment, vehicular traffic and the related coal development would produce a small to negligible reduction in the visibility. The related generating station would probably reduce visibility in its immediate vicinity.

The only direct impact on the water resources would be a slight increase in sediment discharge of 190 tons per year. The related development would produce about 30,000 tons per year of sediment and require about 35,000 to 45,000 acre-feet per year of water.

Varied degrees of disturbance and mixing of existing soils would occur on an estimated 5,000 acres by 1990. The impacts would be similar to those described for the proposed action, but the magnitude would be less because fewer acres would be involved.

Impacts on vegetation and wildlife would be similar to those described for the proposed action, but would involve about 5,000 acres by 1990, and mostly grassland and saltbush-greasewood would be impacted. About 60 percent of the area impacted by this alternative would be grassland. The vegetation destroyed would result in a loss of 192 AUMs, a negligible impact on the grazing resource.

The impacts from increased noise levels would be similar to those discussed in Chapter III, except the degree of impacts would be less and they would be concentrated within a much smaller area away from populated districts.

The impacts on visual resources and recreation would be similar but smaller than those discussed in Chapter III, because fewer acres and miles of line would be involved.

Impacts from surface disturbance and the placement of structures as a result of this alternative would be within the area of NM-010-57 that was recommended through the initial inventory as clearly and obviously not qualifying as a wilderness study area and to be reverted back to multiple-use management.

Two archaeological surveys have been made in the vicinity (Rorex and Connors, 1977a and 1977b). Neither survey was concerned directly with the line, nor can either be considered an exhaustive inventory. Nonetheless, they provide a general indication of the types of cultural resources that would be impacted by Stage I construction. Table F VIII-1 shows the cultural breakdown reported for the 45 sites located by the surveys.

There would be no direct, significant socioeconomic impacts to Indian, Hispanic, and Anglo residents, particularly impacts involving relocation of any persons. However, construction of the transmission line would facilitate the construction and operation of the Bisti Mine and New Mexico Generating Station, and the impacts detailed in the Partial Action Alternative of Chapter VIII of the Regional Analysis would occur.

SHARED CORRIDOR

PNM plans to construct the FCL within the same right-of-way corridor as is being used by the Star Lake Railroad, except for a 35-mile section in T.15N., R.10W. to T.20N., R.6W., about 3 miles west of Star Lake.

Because of the many bends and turns in the railroad in this section, it would not be economically feasible to follow the railroad right-of-way. PNM estimates that following the right-of-way here would add as much as four times the basic construction cost to this 35-mile stretch of line.

The physical, biological, and cultural features within the 35-mile railroad corridor are, to all indications, the same as those of the 35-mile proposed FCL corridor. Thus, the impacts on all resources would be nearly the same if the FCL were to follow the SLR corridor, except for acreages disturbed; the disturbed acreages would be greater under this alternative because of the increased number of towers and pulling sites needed to construct the FCL to follow the rail line.

ALTERNATE CORRIDOR

Because of the location of the loads along the Fruitland Formation, only two corridors are feasible, one south of the Fruitland and one north. The south corridor is the proposed action and the north is the alternate corridor. The physical, biological and cultural features within the north corridor are, for all practical purposes, the same as those of the south corridor. Thus the impacts on all resources would be nearly the same. The north corridor has the disadvantage of being on the opposite side of the coal seams from the proposed locations of the mine support facilities and would have to cross the coal several times, with the problem of moving the line as mining progressed.

Table F VIII - 1

ARCHAEOLOGICAL SITES IN THE VICINITY OF

STAGE I OF THE FCL

Culture	Percent of Total Sites
Paleoindian	0
Archaic	13.3
Anasazi	8.9
Navajo	57.8
Euro-American	2.2
Unclassified	17.8

Source: Rorex and Conners (1977a, 1977b).

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APPENDIX B: SUPPORTING DATA

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APPENDIX A

MAPS (See separate envelope)

A. AREAS OF COAL INTEREST, POPULATION CENTERS, AND TRANSPORTATION NETWORK

B. RELATED NON-COAL DEVELOPMENT

C. TOPOGRAPHY OF STAR LAKE-BISTI ENVIRONMENTAL STATEMENT REGION

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PALEONTOLOGY

GENERAL SUMMARY OF PALEONTOLOGICAL RESOURCES IN THE ES REGION

INTRODUCTION

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, 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.

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

FAUNAL AND FLORAL LISTS

San Andres Limestone (Permian)

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 (1962) and Ash (1969).

Invertebrates

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 Formation (Upper Triassic)

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
Reptiles
Acompsosaurus wingatensi
Eupelor frasii
Rutiodon? sp.
Machaeroprosopus sp.

San Rafael Group (Middle Jurassic)

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:

Entrada Sandstone and Summerville Formation

No fossils reported from within or near the ES Region.

Todilto Limestone

Invertebrates
- *Metacypris todiltensis (ostracod)

Vertebrates
- Fish
  - Leptolepis schowei
  - Pholidophorus americanus

Morrison Formation (Upper Jurassic)

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.

Vertebrates
Reptiles
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

Antrodemus 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

Pterosauria
Dermodactylus montanus

Mammals
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. validus
Laodon venustus
Priacodon ferox
Menacodon rarus
Tinodon bellus
T. lepidus
T. robustus
Triconodon bisulcus

Fish

Osteichthyes

Ceratodus guntheri
C. robustus
C. americanus

Birds

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. cf. C. cavanus (A)
Cymbophera cff. C. securis (A)
Exogyra columbella (A)(B)
E. laeris (A)
E. qwuillana (B)
E. trigeri (B)
E. sp. (A)
E. n. sp. (A)
Granocardium (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 cff. 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.? cf. 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 (1966), 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. cff. cipuperculum
Corbula sp.
Crassatellites ? sp.
Cutullaea sp.
Cymbophora ? emmonsi
Cyprimeria ? sp.
"C" n. sp.
"Lyrena" securis
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. cff. I. deformis
I. dimidius
I. n. sp. cff. 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. cf. L. maltiformis
L. subundata
L. sp.
L. n. sp.
Lunatia sp.
Mactra arenia
M. cf. M. formosa
Mytilus sp.
Nemodon sp.
Nucilana sp.
Ostrea beloiti
O. congesta
O. elegantula
O. cff. O. elegantula newberryi
O. larva
O. lugubris

O. malachitensis
O. soleniscus
O. cf. O. soleniscus
O. n. sp.
O. sp.
"Ostrea" sannionis
"O." sp. cff. "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. cff. S. levia
Tellina aquilateralis
T. sp.
T. ? n. sp.
Trigonarca sp. cff. T. oblique
Xenophora simpsoni
Yoldia cff. Y. subelliptica

Gastropoda
Acteon sp.
Ampullina ? sp.
Anchura fusiformis
A. sp.
Anisonyon apicalus
Aporrhais bianulata
Crommium sp.
Fasciolaria ? sp.
Gyrodes depressa
G. n. sp. cff. 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 cff. 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
Fish
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 cff. F. lanceolata
F. praetrinervis
F. speciosissima
F. wardii
F. n. sp.
Myrica n. sp. ?
Sequoia reichenbachii

Invertebrates
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); Pike, 1947 (A); Molenaar, 1977b (B).)

Invertebrate
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. cff. 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

Vertebrates
Fish
*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

Invertebrates
Bivalvia
Inoceramus sp.
Oyster beds

Ammonoidea
Stantonoceras

Vertebrates
Shark teeth

Trace Fossils
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).

Invertebrates
    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, and Mannhard (1976) (A) for exposures just within and to the east of the region.

Plants
        Anemia hesperia
        Ficus planicostata
        Sabalites montanus
        Sequoia reichenbachii

Invertebrates
    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.

Invertebrates
    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 cff. C. alta (A, B)
?C. simpsonensis (A)
*Cyprimeria n. sp.
*Donax n. sp.
*Exogyra cff. 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? cff. 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 cff. 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).

Invertebrates
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. cff. I. proximus (E)
I. cff. I. pertenuis (E)
I. sagensis (A, B, C, D, E)
I. subcompressus (E)
I. tenuilineatus (E)
I. cff. 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. cff. 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. cff. B. rugosus (E)
- B. scotti (E)
- B. cff. 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)

Vertebrates

Fish
- 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).

Invertebrates

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.

Vertebrates
Fish
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)

Vertebrates (Kirtland Formation)

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

Vertabrates
- Fish
  - Chondrichthyes
    - Myledaphus sp.
  - Osteichthyes
    - Lepisosteus sp.
- Reptiles
  - Testudines
    - Adocus bossi
    - A. kirtlandise)
    - Asperidites ovatus
    - A. vorax
    - Baena nodosa
    - B. ornata
    - Basilemys nobilis

Boremys grandis
Thescelus hemisphaera
T. rapiens

Crocodilia
Brachychampsa sp.?
Crocodylus sp.

Saurischia
Deinodon? sp.
Gorgosaurus liberatus

Ornithischia
Kritosaurus navajovius
Parasaurolophus tubicen
Monoclonius sp.
Pentaceratops sternbergii
P. fenestratus
Chasmosaurus sp.
Ceratops? sp.
gen. et sp. indet.

Vertebrates (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), Armstrong-Ziegler (1978), and Clemens (1973).

Vertebrates
Fish
Osteichthyes
Lepisosteus sp.

Reptiles
Testudines
Neurankylus baueri
Baena nodosa
Adocus bossi
Asperidites sp.

Crocodilia
Brachychampsa? sp.
Crocodylus

Saurischia
Deinodon? sp.

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

Mammals
- Multituberculata
  - Mesodma cf. M. formosa
  - Mesodma? sp.
  - new gen. & sp.
  - Cimexomys, cf. C. judithae
  - cf. Kimbetohia campi
  - Cimolodon sp. 1
  - C. cff. C. imitidus
  - Eucosmodon? sp.
  - new gen. & sp.
  - Essonodon? sp.
- Marsupialia
  - Alphadon cf. A. marshi
  - A. n. sp.
  - cf. Paradectes 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. cff. U. reesidei
  - U. brachypisthus
  - U. cff. U. brachypisthus (A)
  - U. baueri
  - U. neomexicanus
  - U. brimhallensis
  - U. cff. 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 thompsoni
- Melania insculpta
- Goniobasis? subtortuosa (A)
- G.? sp. (A)
- Physa reesidei
- P. sp. (A)
- Planorbis chacoensis
- Viviparus sp. (A)

Vertebrates (Kirtland Formation - Naashoibito Fauna)

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

Fish
- Osteichthyes
  - Lepisosteus sp.

Reptiles
- Testudines
  - Adocus bossi
  - Asperidites vorax
  - Baena nodosa
  - Compsemys sp.
  - Thescelus rapiens
- Crocodilia
  - Brachychampsa? sp.
  - Crocodylus sp.
- Saurischia
  - Alamosaurus sanjuanensis
  - Deinodon? sp.
- Ornithischia
  - Kritosaurus navajovius
  - 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; Fassett, 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

Vertebrates

- Reptiles
  - Testudines
  - Archosauria
- Mammals
  - _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 (1886) and Cockerell (1915) (A) for invertebrates, Matthew (1937) for reptiles, and Russell (1967) 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.

(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

Vertebrates (Puercan)

Reptiles

Testudines

Adocus hesperius
Amyda eloisae
Asperidites sagatus
A. puercensis
A. reesidei
A. vegetus
A. quadratus
A. perplexus
Baena sp.
Compsemys parva
C. puercensis
C. vafer
Conchochelys admirabilis

Hoplochelys crassa
H. bicarinata
H. laqueata
Plastomenus sp.

Crocodilia
Allognathosuchus mooki

Lepidosauria
Champsosaurus puercensis
C. saponensis
Helagras prisciformis

Mammals
Multituberculata
Eucosmodon americanus
Americanus primus
Catopsalis foliatus
Taeniolabis attenuatus
T. sulcatus
T. taoensis
T. triserialis

Marsupialia
Thylacodon pussilus

Insectivora
Puercolestes simpsoni

Taeniodonta
Onychodentes rarus
O. tisonensis
Wortmania otariidens

"Condylarthra"
Anisonchus gillianus
Carsioptychus coarctatus
C. matthewi
Conacodon cophator
C. entoconus
Ectoconus ditrigonus
E. majusculus
Hemithlaeus kowalevskianus
Oxyacodon agapetillus
O. apiculatus
O. priscilla
Tiznatzinia priscus
T. turgidunculus
T. vanderhoofi

Carnivora
Carcinodon filholianus
Eoconodon gaudrianus
E. heilprinnianus
Escatepos campi

Oxyclaenus cuspidatus
O. simplex
Loxolophus attenuatus
L. hyattianus
L. interruptus
L. priscus
Paradoxodon ruetimeyerianus
Protogonodon kimbetovius
P. pentacus
P. protogonoides
P. stenognathus
Ictidopappus sp.

(Torrejonian)
Reptiles
Testudines
Adocus substrictus
A. onerosus
A. annexus
Aspideretes singularis
A. sp.
Baena escavada
B. sp.
Compsemys torrejonensis
C. parva?
Hoplochelys saliens
H. paludosa
H. elongonta
Plastomenus acupictus
P. n. sp.?
P. sp. indet.
P. torrejonensis
Platypeltis antiqua

Crocodilia
Crocodylus sp.
Leidyosuchus multidentatus

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

Fish
Osteichthyes
Lepisosteus sp.

Mammals
Multituberculata
Parectypodus trouessartianus
P. cf. *P. trouessartianus*
Ectypodus? sp.
Neoplagiaulax macrotomeus

Anconodon? sp.
Ptilodus mediaevus
gen. et. sp. indet.
Eucosmodon? sp.
Stygimys teilhardi
Catopsalis fissidens

Insectivora
Prodiacodon puercensis
P. n. sp.?
Mixodectes pungens
M. crassiusculus
M. malaris
M. cf. M. malaris
Pentacodon inversus
P. occultus
P. n. sp.
Coriphagus arcinensis

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

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

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

Pantodonta
Pantolambda bathmodon
P. cavirictus

"Condylarthra"
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

Dissacus navajovius
D. saurognathus
Microclaenodon assurgens
gen. et sp. indet.
Tetraclaenodon puercensis
T. pliciferus
n. gen. et n. sp.
Mioclaenus turgidus
M. lydekkerianus
M.? n. sp.
Promioclaenus lemuroides
P. acolytus
P. aeguidens
Ellipsodon inaeguidens
E. grangeri
Protoselene opisthacus
Anisonchus sectorius
Haploconus angustus
H. corniculata
Periptychus carinidens
P. sp.
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. 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 vertebrates are from Lucas (1977a).

Invertebrates
    Gastropoda
        Campeloma calamodontis

Vertebrates

Fish

Chondrichthyes

Isurus sp.
Lamna texana
L. sp.
?*L.* sp.
Squalicorax pristodontus
Galeocerdo sp.
?*G. aduncus*

Osteichthyes

Lepisosteus aganus
L. integer
L. sp.

Reptiles

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.

Birds

Diatryma giganteum

Mammals

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.
cff. 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.

PALEONTOLOGY

CONSULTATION AND COORDINATION FOR PALEONTOLOGICAL RESOURCES

PALEONTOLOGICAL RESOURCE MANAGEMENT PROGRAM

The BLM is developing a bureau-wide program for paleontological resource management. The preparation of the Star Lake-Bisti Regional Coal ES has played an integral part in the development of this program. The following federal agencies, institutions, and special interest groups were consulted in the development of this ES and the paleontological resource management program.

CONSULTATION AND COORDINATION

Government Agencies

New Mexico State, Governor's Commission on Wilderness
New Mexico State, Governor's Task Force on Paleontology
New Mexico State Bureau of Mines and Mineral Resources
New Mexico State Geologist
U.S. Geological Survey

Universities

Arizona, University of
Brigham Young University
Brown University
California, University of, Berkeley
Chicago, University of
Colorado, University of
Harvard University
Johns Hopkins University
Kansas, University of
Louisiana State University
Nebraska, University of
New Mexico, University of
Princeton University
Providence College
Texas, University of, Austin
Wyoming, University of
Yale University

Museums

Alberta, Provincial Museum of
American Museum of Natural History
Arizona, Northern, Museum of
Carnegie Museum of Natural History
Chicago Natural History Museum
Los Angeles County Museum
Michigan, University of, Museum of Paleontology
Smithsonian Institute

Special Interest Groups

Albuquerque Gem and Mineral Club
Four Corners Wilderness Workshop
Natural History Resource Management, Inc.
Paleontological Society
Pan American Roundtable
Plateau Sciences Society
Rio Rancho Rockhound Club
San Juan Archeological Society
Senior Citizens' Rockhound Club
Sierra Club
Society of Vertebrate Paleontology

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/] ug/m3	Federal Primary Standards[1/] ppm	Federal Secondary Standards[1/] ug/m3	Federal Secondary Standards[1/] ppm	New Mexico State Standards [2/] ug/m3	New Mexico State Standards [2/] 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)	Annual Mean	2	20	40
	24-hour	5	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 24 Hour Maximum	Total Suspended Particulates (TSP) ug/m3 Annual Mean	Sulfur Dioxide (SO_2) ppm 24 Hour Maximum	Sulfur Dioxide (SO_2) ppm Annual Mean	Nitrogen Dioxide (NO_2) ppm 24 Hour Maximum	Nitrogen Dioxide (NO_2) ppm Annual Mean	Carbon Monoxide (CO) ppm 1 Hour Maximum	Carbon Monoxide (CO) ppm 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	$\sim$ 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: Radian Corp. (1977b).

Table B-8

ATMOSPHERIC TRACE METALS CONCENTRATIONS[1]

Metal	Average Maximum Observation of 149 Urban Stations (1968) ug/m^3	Average Maximum Observation of 2 Urban NGPRP[2] Stations (1968) ug/m^3	Average Maximum Observation of 28 Non-Urban Stations[3] (1968) ug/m^3	Maximum Observation of 1 Non-Urban Black Hills Station (1968) ug/m^3
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/ U. S. Department of the Interior, Bureau of Land Management (1976a).

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

$Q_2 = 2860\ A^{0.56} Em^{-1.76} St^{-0.86}$
$Q_5 = 261\ A^{0.49}$
$Q_{10} = 411\ A^{0.47}$
$Q_{25} = 716\ A^{0.49} Ps^{-1.18} I^{2.57} T^{.23}$
$Q_{50} = 915\ A^{0.49} Ps^{-.23} I^{2.74} T^{.25}$

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 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 which are used in their logarithmic form for ease in computation, are substituted where applicable in the following 5 equations.
$Q_2 = 3.4558 + 0.405 \times 0.56 - 0.823 \times 1.76 - 0.00 \times 0.86$
$Q_5 = 2.4159 + 0.405 \times 0.49$
$Q_{10} = 2.6138 + 0.405 \times 0.47$
$Q_{25} = 2.8549 + 0.405 \times 0.49 - 0.491 \times 1.18 + 0.079 \times 2.57 + 1.041 \times 0.23$
$Q_{50} = 2.9614 + 0.405 \times 0.49 - 0.491 \times 1.23 + 0.079 \times 2.74\ 1.041 \times 0.25$

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.

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 115,000 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.

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.

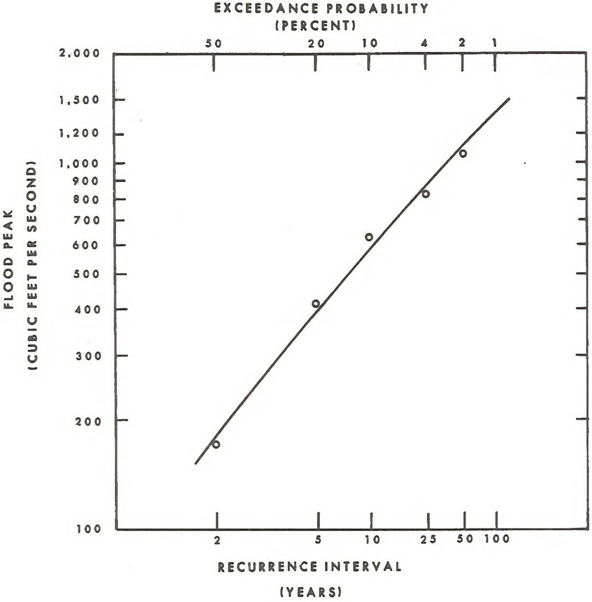

FIGURE B-1: FLOOD-FREQUENCY CURVE FOR ARROYO PUEBLO ALTO.

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.[illegible]	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-[illegible],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)	Bicarbonate (mg/l)	Carbonate (mg/l) Min	Carbonate (mg/l) Max	Hardness (mg/l) Min	Hardness (mg/l) Max	Dissolved Solids (tons/day) Min	Dissolved Solids (tons/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	
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	86	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	369
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	146	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	136	0	2	83	228	211	2,600
1969	365	3.0	26.0					200	939	6.9	11.4	0.8	2.4	28		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)		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)		Bicarbonate (mg/l)		Carbonate (mg/l)		Hardness (mg/l)		Dissolved Solids (tons/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
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	13.9	25.6					1,000	3,880							7.0	7.6			120	343	0	0	425	1,580		
1967	--	15.5	26.6					435	4,920							7.2	7.7			144	446	0	0	170	1,330		
1968	--	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	--	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	.0	25.5					823	3,400							7.4	8.2	124	282	151	344	0	0	220	1,200	48.9	11,500
1973	--	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	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	--	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	

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)		Carbonate (mg/l) Min	Carbonate (mg/l) Max	Hardness (mg/l) Min	Hardness (mg/l) Max	Dissolved Solids (tons/day) Min	Dissolved Solids (tons/day) 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	1,360
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	--	.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		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	150	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	--							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	0.0	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		4,600			255	1,050	7.2	12.5			340		7.2	8.4	63	203	77	247	0	0	100	240	825	4,020
1976	365	7.5	34.0		25			307	1,000	6.4	11.0			2		7.5	8.6	80	158	92	193	0	4	110	320	0.12	4,200
1977 (Feb)	--	.0	14.0		85			400	911	10.4	11.4			16		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/1) Min	Dissolved Oxygen (mg/1) Max	Biochemical Oxygen Demand 5-day (mg/1) Min	Biochemical Oxygen Demand 5-day (mg/1) Max	Chemical Oxygen Demand (mg/1) Min	Chemical Oxygen Demand (mg/1) Max	pH (units) Min	pH (units) Max	Alkalinity as $CaCO_3$ (mg/1) Min	Alkalinity as $CaCO_3$ (mg/1) Max	Bicarbonate (mg/1) Min	Bicarbonate (mg/1) Max	Carbonate (mg/1) Min	Carbonate (mg/1) Max	Hardness (mg/1) Min	Hardness (mg/1) Max	Dissolved Solids (tons/day) Min	Dissolved Solids (tons/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	21.[illegible]	
1975	52	.0	33.0	8	130			3,330	12,200	6.3	11.2			25	49	7.4	10.4	0	760	0	317	0	42	750	3,600	0.07	12.9
1976	16	.0	30.5	2	200			3,500	12,200	7.0	12.1			24	68	6.6	9.2	[illegible]	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	640	2,800	3.60	37.3
09367930 Hunter Wash at Bisti Trading Post, New Mexico																											
1974	4	14.5																									
1975	37	14.0	31.0					482	1,780							7.5	9.8	92	166	65	202	0	[illegible]	14	120	.0	280,000
1976	22	30.0		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	1,670							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	[illegible]	87	580	363	11,450
1962	365							244	2,340							6.9	9.1			20	229	0	16	86	695	364	[illegible],460
1963	365	2.8	28.9					403	2,490							7.0	8.2			92	322			164	730	14[illegible]	11,840
1964	365							358	1,690							7.2	8.2			70	30[illegible]			136	718	362	1[illegible],000
1965	365							253	1,360							7.4	8.1			78	220	0	0	96	540	775	3,440
1966	365	6.1	25.6					372	1,710							7.4	8.1	80	218	98	266	0	0	134	490	620	4,3[illegible]0
1967	365							493	1,750							7.2	8.2	46	235	96	286	0	0	178	560	377	1[illegible],[illegible]30
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		1.4	2.3			7.1	8.3	48	231	58	232	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	900	272	[illegible],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		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	175	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		101	277	123	334	0		45	250	3.[illegible]	
1976	365	21.5						587	1,030							7.5	8.9	141	190	141	353	0	15	58	170		
1977 (Mar)	243	11.0						652	962							7.7	8.2	193	[illegible]	139	315	0	0	71	140		

Table B-15 (continued)

Part II

Water Year	Dissolved Calcium (mg/1)		Dissolved Magnesium (mg/1)		Dissolved Sodium (mg/1)		Dissolved Potassium (mg/1)		Dissolved Chloride (mg/1)		Dissolved Sulfate (mg/1)		Dissolved Fluoride (mg/1)		Dissolved Silica (mg/1)		Dissolved Iron (ug/1)		Total Nitrogen (mg/1)		Total Phosphorus (mg/1)		Fecal Coliform Col./100 ml		Streptococci Col./100 ml	
	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
08290000 Rio Chama near Chamita, New Mexico																										
1961	26																									
1963									3.0	19																
1964	128				11	73	5.0		2.2	35	25	182	0.2	0.5	16		150									
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									
1969	24	90	2.4	24	15	25	2.4	3.0	1.9	16	23	230	.0	.5	13	21	70						<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									
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	150	.3	.5	18	23	10									
08313000 Rio Grande at Otowi Bridge, New Mexico																										
1960	28	78	3.0	13	9.7	37	3.2		3.2	12	25	171	0.8		19	36	10									
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		2.6	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		3.0	10	4.0/366		.5		16	44										
1965	34	75	2.2	10	10	32	2.3	[2]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		19	27	30									
1967	33	114	5.0	16	17	52	3.9[2]		5.0	13	38	282	.5		17	28	10									
1968	27	77	3.8	9.6	10	25	3.2[2]		2.3	12	28	126	.4		18	29	120									
1969	30	150	2.9	23	30		3.4[2]		1.3	14	27	374	.5		16	27	110						<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		.06		<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		.55		.40		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	45	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		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 (ug/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		77	228	40	266	1.5		25	39	10									
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		2.9		134	236	96	1,200	1.2		21	35	10									
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	600	8.8	18	66	486	66	640	.9	2.3	28	44	20									
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									
1977 (Jan)	87	118	13	27	320	400	16	21	310	370	340	410	1.0	1.7	29	37	0									
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		11	18	10									
1967	53	444	9.2	90	33	712	8.6		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		40	202	77	1,600	.7		13	23	90	300								
1970	42	390	9.7	94	171	427	7.5		32	145	186	2,270	.8		11	19	20									
1971	120	430	21	94	130	500	8.4	11	37	350	460	2,200	.3	.9	11	19	10									
1972	70	370	12	72	93	390	5.6	12	39	260	200	1,500	.6	1.2	6.3	18	40									
1973	130	240	6.3	80	59	440	4.8	11	29	290	140	1,300	.5	1.3	7.7	15	40									
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									
1976	51	340	6.7	76	41	320	5.6	11	23	130	86	1,500	.5	1.2	7.8	16	210									

Table B-15 (continued)

Part II

Water Year	Dissolved Calcium (mg/l)		Dissolved Magnesium (mg/l)		Dissolved Sodium (mg/l)		Dissolved Potassium (mg/l)		Dissolved Chloride (mg/l)		Dissolved Sulfate (mg/l)		Dissolved Fluoride (mg/l)		Dissolved Silica (mg/l)		Dissolved Iron (ug/l)		Total Nitrogen (mg/l)		Total Phosphorus (mg/l)		Fecal Coliform Col./100 ml		Streptococci Col./100 ml	
	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	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	39	.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		.02	.08	40		50	
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	5.8	0	130	.05	5.1	.0	.87				
1977 (Feb)	92	120	15	18	39	49	3.2	4.1	22	31	210	250	.4	.5	6.3	5.9	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		2.0	26	25	318	.3		7.8	15	10									
1963	42	136	1.6	22	10	210	2.3	4.2	5.6	48	61	537	.4		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	5.1	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		6.7	15	110						<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		4.0					
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		.03					
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		.09					

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 (ug/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	0.7	1.1	0.6	12	0									
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	78,000									
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	2.4		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						<10	<10	
1970	36	202	5.8	23	3.5	66	.8	3.3	2.8	86	62	702	.1	.7	3.6	19	0	40			0.07		<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	50		0.68		.23		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	Aluminum	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Lead	Lithium	Manganese	Nickel	Strontium	Zinc
		Average for Year (all in Mg/1)												
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)

TRACE ELEMENT ANALYSIS OF SURFACE WATER

Water Year	Total Number of Samples Analyzed	Average for Year (all in Mg/l) Aluminum	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Lead	Lithium	Manganese	Nickel	Strontium	Zinc
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)

TRACE ELEMENT ANALYSIS OF SURFACE WATER

Average for Year (all in Mg/l)

09364500 Animas River at Farmington, New Mexico

Water Year	Total Number of Samples Analyzed	Aluminum	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Lead	Lithium	Manganese	Nickel	Strontium	Zinc
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

Water Year	Total Number of Samples Analyzed	Aluminum	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Lead	Lithium	Manganese	Nickel	Strontium	Zinc
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)

TRACE ELEMENT ANALYSIS OF SURFACE WATER

Water Year	Total Number of Samples Analyzed	Aluminum	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Lead	Lithium	Manganese	Nickel	Strontium	Zinc
		Average for Year (all in Mg/l)												
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									

WATER RESOURCES

COMPUTATION OF SEDIMENT DISCHARGE

The Universal Soil Loss Equation (USLE) was used to compute the sediment discharges caused by the development. 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 a publication, Guide for Water Erosion Control by the Soil Conservation Service (U.S. Department of Agriculture, (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

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	0.06 - 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	0.0[illegible] - 0.11	[illegible]
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 - [illegible].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 - [illegible].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 - [illegible]
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	[illegible] - 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	0.0[illegible] - 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 - [illegible].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(1971, 1973a,b, 1974).

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 strengtb 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--deptb, permeability	severe--depth	severe--depth	low strength, piping	poor--thin layer, too clayey	poor--low strength, sbrink-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	sligbt	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, permeablity	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	Sewage Lagoons Settling Ponds	Sanitary Landfills [1]	Shallow Excavations	Embankments	Suitability as a Source: Topsoil	Roadfill	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--exeess 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: U.S. Department of Agriculture, Soil Conservation Service (1971).

Footnote:
[1] Trench type.

WILDLIFE

Table B-20

MAMMALS KNOWN TO OCCUR IN THE ES REGION

Common Name	Scientific Name	Habitat Type 1/ 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	Ammospermophilus 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	Habitat Type [1/] R	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	Habitat Type 1/ R	SG/DS	P/J	P
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: U. S. Department of the Interior, 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: U. S. Department of the Interior, 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

HIGHER INVERTEBRATES OCCURRING IN THE ES REGION

Phylum/Class/Order	Family	Common Name
Terrestrial[1/]		
Arthropoda		
Insecta		
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 Curculionidae	Beetles
Neuroptera	Chrysopidae	Lacewings
Lepidoptera	Pieridae Nymphalidae Sphingidae Noctuidae	Butterflies, Moths

Table B-23 (continued)

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

Table B-23 (continued)

Phylum/Class/Order	Family	Common Name
Aquatic[2]		
Arthropoda		
Insecta		
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
Crustacea		
Amphipoda		Scuds and sideswimmers
Decapoda		Crayfish
Mollusca		
Gastropoda		
Pulmonata	Lymnaeidae Physidae Planorbidae Ancylidae	Snails
Annelida		
Hirudinea		
Gnathobdellida	Hirundidae	Aquatic worms

[1] Battele - Columbus Laboratories (1974).
[2] Graves (1967), Sublette (1977).

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 1/							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 1/							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: Davies, (1965); Little, (1968); McNall, (1969); Olson, (1962c); Charlie Sanchez, field observation, 1975; Smith, (1976); U.S. Department of the Interior, Fish and Wildlife Service, (1977).

1/ 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
		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
		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
			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) (continued)			
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

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.					

Source: Kinsky (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: New Mexico State Planning Office (1976b).

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

SIX-POINT SCALE FOR DETERMINING SIGNIFICANCE ESTIMATES OF 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

ES REGION ARCHEOLOGICAL SITES ON THE REGISTERS OF HISTORIC PLACES

McKinley County

National Register: Manuelito Complex,[1] Fort Wingate, Historic District
Nominated to National Register: McKinley Mine Archeological District
State Register: Casamero Pueblo, Gamerco Mine Smokestack

Rio Arriba County

National Register: Frances Canyon Ruin, Tapacito Ruin, Split Rock Ruin Crow Canyon Site
Nominated to National Register: Cerrito Recreation Site Archeological District
State Register: Three Corn Ruin/Old Fort Ruin, Hooded Fireplace Ruin, Largo Schoolhouse Ruin

Sandoval County

National Register: Big Bead Mesa[1]
State Register: Ko-ah-sai-ya

San Juan County

National Register: Aztec Ruins National Monument, Christmas Tree Ruin, Simon Canyon Ruin, Salmon Ruins, Gallegos Wash Archeological District, Chaco Canyon National Monument
Nominated for National Register: Chacoan Anasazi Sites within Chacoan Interaction Sphere
State Register: Pictured Cliffs Site, Bloomfield Irrigation Ditch System, Old Indian Racetrack

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Source: State Historic Preservation Office Files as of January, 1979.

Footnote

[1] National Historic Landmark

STATE OF NEW MEXICO
EDUCATIONAL FINANCE AND CULTURAL AFFAIRS DEPARTMENT
HISTORIC PRESERVATION PROGRAM
SANTA FE
87503

PO BOX 1629

October 11, 1978

Mr. L. Paul Applegate, District Manager
Bureau of Land Management
Albuquerque District
P.O. Box 6770
Albuquerque, New Mexico 87107

Attn: Ms. Cheryl Ferguson

Dear Mr. Applegate:

On October 10, 1978, I met with Ms. Cheryl Ferguson, Mr. C. Randall Morrison and Mr. Don Broussard of your office to determine the eligibility or ineligibility to the National Register of Historic Places of certain archeological and historical sites in the Star Lake - Bisti region of northwestern New Mexico. We were assisted by Mr. Steve Hallisy of the National Park Service (Santa Fe).

The seventy-seven sites reviewed were among over four hundred sites recorded by a contract archaeological sample survey in 1977. These seventy-seven sites were reviewed with the understanding that they were most likely to be affected by BLM - authorized mining in this area in 1980-81. You are no doubt aware that determinations of the significance of all sites that may be affected by mining operations will be required.

The following determinations were agreed on:

Archaic sites BS-30, BS-104, BS-203, BS-192, BS-197, BS-330 and BS-200 were found eligible to the Register under criterion d (likely to yield significant information).

Site BS-400 was found ineligible.

Navajo sites BS-328, BS-330, BS-332, BS-400, BS-406, BS-401, BS-405, BS-100, BS-103, BS-26, BS-27, BS-28, BS-106, BS-107, BS-114, BS-115, BS-116, BS-117, BS-120, BS-187, BS-201, BS-209, BS-211, BS-213, BS-191, BS-193 and BS-261 were found eligible to the Register under criterion d.

Studies of the factors determining distribution of historic Navajo sites were particularly recommended for the above sites. It was our agreement in regard to all the sites discussed at this meeting, that samples could and would be drawn for their study, and that not all the sites listed would necessarily be examined or included in a sample. Ethno-historic studies were recommended for Navajo sites; standard archeological techniques were considered less important.

Sites BS-402, BS-404, BS-22, BS-23, BS-24, BS-109, BS-110, BS-111, BS-113, BS-119, BS-200, BS-208, BS-210, BS-262, BS-198, BS-199, BS-192, BS-194, BS-195, BS-196 and BS-202 were found to be ineligible to the Register.

Sites BS-106 and BS-261 were found to have heritage values apart from their scientific potential. Sites BS-107 and BS-114 were observed to have architectural significance (criterion c). Site 209 may be a burial, and will require special measures in mitigation.

The following lithic sites were found eligible under criterion d: BS-121, BS-101, BS-102, BS-29, BS-204, BS-207, BS-212, BS-214, BS-216, BS-263, BS-329, BS-403.

The following lithic sites were found ineligible: BS-122, BS-124, BS-25, BS-26, BS-31, BS-205, BS-206, BS-262.

The following Pueblo sites were found eligible under criterion d: BS-123, BS-104, BS-105, BS-107, BS-109, BS-115, BS-215.

Sites BS-106, BS-108, BS-112 and BS-119 were found to be ineligible.

Site BS-118 was found to have architectural significance (criterion c).

Site BS-331 (Euro-American) was found to be significant under criterion d.

You will note that the different components of the same site are dealt with separately.

These determinations are subject to review by the Keeper of the National Register (36 CFR 63). I will expect to be informed if the meeting notes kept by your agency representatives differ in any way from the above.

Sincerely,

Thomas W. Merlan
State Historic
Preservation Officer

TWM:dg

cc: Steve Hallisy

Figure B-2.--Letter from the New Mexico State Historic Preservation Officer listing sites in the ES Region eligible for the National Register of Historic Places.

SOCIOECONOMIC CONDITIONS

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., 1973).

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 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.

Table B-28

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.

SOCIOECONOMIC CONDITIONS

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 Albuquerque Standard Metropolitan Statistical Area (SMSA), its inclusion could have affected the results of the input-output model significantly. Sandoval County also 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

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 within the area 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 Employment 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 <u>Table of Direct, Indirect, and Induced Effects</u> 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 x .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.

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

(\$238,109 ÷ \$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 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.

Table B-29

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
POWERPLANT 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
POWERPLANT 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: Adcock and Associates (1978).

Table B-30

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
POWERLINE 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
POWERPLANT 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
POWERPLANT 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: Adcock and Associates (1978).

Table B-31

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
POWERLINE 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
POWERPLANT 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
POWERPLANT 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
POWERLINE 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
POWERPLANT 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
POWERPLANT 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: Adcock and Associates (1978).

Table B-32

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
POWERLINE 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
POWERPLANT 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
POWERPLANT 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

Source: Adcock and Associates (1978).

Table B-33

ESTIMATEO ANNUAL PERSONAL INCOME GENERATEO FROM COAL ANO RELATEO DEVELOPMENT
ES REGION, WITH PROPOSED ACTIONS (by source)1/

Year	Private Sector			Government Sector	Oividends, Interest and Rents	Annual Total Personal Income
	Oirect	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

Source: Adcock and Associates (1977).

1/ Constant 1977 dollars.

SOCIOECONOMIC CONDITIONS

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-34

PLANT SPECIES NOTED IN THE ES REGION [1]/

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-34 (Continued)

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

Table B-34 (Continued)

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

Sources: U. S. Department of the Interior, Bureau of Land Management (1965); Kearney and Peebles (1960); Kelsey and Dayton (1974).

Footnote:

1/ This list is not meant to be comprehensive.

APPENDIX C

REFERENCES

GLOSSARY

SOURCES CITED IN THE TEXT

ABBREVIATIONS

AMP	allotment management plan
AO	area of operation (of a coal mine)
AUM	animal unit month
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BR	Bureau of Reclamation
BTU	British Thermal Unit
CFR	Code of Federal Regulations
dBA	decibel (on the A-scale)
DOE	Department of Energy
D&RGW	Denver and Rio Grande Western Railroad
EAR	Environmental Assessment Record
EID	Environmental Improvement Division (State of New Mexico
EMRIA	Energy Mineral Rehabilitation Inventory and Analysis
EO	Executive Order
EPA	Environmental Protection Agency (Federal)
EPNG	El Paso Natural Gas Company
ES	Environmental Statement
FCL	Fruitland Coal Load Transmission Line
FCLAA	Federal Coal Leasing Amendments Act
FHA	Farmers Home Administration
FLPMA	Federal Land Policy and Management Act
gal/min	gallons per minute
HUD	Department of Housing and Urban Development
ICC	Interstate Commerce Commission
IHS	Indian Health Service
kv	kilovolt
Ldn	decibles weighted on a day-night basis
Leq	equivalent level
MFP	management framework plan
Mgal/d	million gallons per day
ug/m^3	micrograms per cubic meter
MNM	Museum of New Mexico
MP	milepost
MW	megawatt
N	Navajo (highways)
NA	nonattainment
NAAQS	National Ambient Air Quality Standards
NEDS	National Emission Data System
NEPA	National Environmental Policy Act
NIIP	Navajo Indian Irrigation Project
NO_2	nitrogen dioxide
NSPS	New Source Performance Standards
OSM	Office of Surface Mining Reclamation and Enforcement
PL	Public Law
PNM	Public Service Company of New Mexico
ppm	parts per million
PRLA	Preference Right Lease Application
PSD	prevention of significant deterioration

SH	State highway
SHPO	State Historic Preservation Officer
SLR	Star Lake Railroad
SMCRA	Surface Mining Control and Reclamation Act
SO_2	sulfur dioxide
Stat.	statute
TCS	Traffic Control System
TSP	total suspended particulates
URA	Unit Resource Analysis
USBM	United States Bureau of Mines
USC	United States Code
USF&WS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VRM	Visual Resource Management

GLOSSARY

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 elongated trench or opening in a surface mine from which coal is actually being extracted.

ALLUVIAL VALLEY FLOOR. An area of valley fill composed of unconsolidated stream-laid silt, sand and clay, and having subirrigation or the capacity for being irrigated for farming.

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, c. AD 500-1300.

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

ANDESITIC. Like andesite, which is 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 or to satisfy a research question. Excavation is a destructive activity, that removes the physical site context.

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. The reconnaissance should be adequate to estimate time and cost of a survey.

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. Sometimes surface artifacts are collected and test excavations are made. Published reports should interpret data, indicate endangered sites, and state recommendations for management and research.

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 difficult, 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 reservations and which serve as commercial centers for on-reservation Indians.

BOTTOM ASH. Coarse, solid particles of noncombustible ash that 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 (British Thermal Unit) or heat content.

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

CALCAREOUS. Said of a substance that contains calcium carbonate. When applied to a rock name, the term implies that a considerable percentage (up to 50 percent) 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 mining coal and the subsequent chemical conversion of the coal 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 to that component 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. Water under pressure significantly greater than atmospheric. 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.

COMPASO. A name used for a joint venture of the Consolidated Coal Company and the El Paso Natural Gas Company.

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. 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.

DRAWDOWN. The distance water is lowered in a well during pumping.

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. Finc, 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 an instrument and scattered back from a rock formation to a detector shielded from the source. The amount of scattering is proportional to electron density and thus proportional to mass concentration. Therefore, the measurement, after certain corrections, yields a density log of the formation penetrated.

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.

INSOLATION. The rate of delivery of all direct solar energy per unit of horizontal surface.

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

IONS. An atom or a group of atoms 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. 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). A Land-use plan for public lands which provides a set of goals, objectives, and constraints for a specific planning area. These goals 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 vertically downward from the timberline 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 a shoreline.

PHOTOCHEMICAL. Relating to or produced by the chemical action of radiant energy and especially 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 containing interstices or voids. Porosity may be expressed as the ratio 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. Land whose value derives from its 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.

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

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 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 the 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.

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 with 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 far enough to hold standing water.

XERIC. An arid system almost totally lacking water.

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