San Juan Basin Action Plan

PROJECT DESCRIPTION TECHNICAL REPORT

for the
Environmental Impact Statement on Public Service Company of New Mexico's Proposed New Mexico Generating Station and Possible New Town

United States
Department
of the Interior

Bureau of Land Management
New Mexico State Office
Santa Fe, New Mexico

October 1982

Report 2 of 22

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
NEW MEXICO STATE OFFICE
P.O. BOX 1449
SANTA FE, NEW MEXICO 87501

IN REPLY REFER TO
NM30840EIS
1792.73(934A)

October 1982

Dear Interested Citizen:

Attached is one of twenty-two technical reports developed as a basis for writing the Environmental Impact Statement on Public Service Company of New Mexico's Proposed New Mexico Generating Station and Possible New Town (NMGS EIS). (A list of the technical reports is attached.)

These technical reports provide detailed information on the existing environment, methods used for the impact analysis, and related data supportive of the analysis and conclusions presented in the EIS. These reports should be retained for use with the Draft and Final EIS and other documents related to BLM's San Juan Basin Action Plan (SJBAP).

The Draft NMGS EIS will be filed with the Environmental Protection Agency and released for public review on November 30, 1982. Comments on the Draft EIS will be due by close of business February 7, 1983, at the BLM New Mexico State Office. Because of the large volume of material presented in the technical reports, the BLM is distributing these reports in advance of the Draft EIS to provide sufficient time for public review. The technical reports will be available for public review at the places indicated on the attached list. Copies will also be available from the BLM New Mexico State Office, U.S. Post Office and Federal Building, Santa Fe, for a copy fee.

Informational public meetings are scheduled for December 1982 to provide a public forum to clarify questions and concerns about the SJBAP proposals and the related environmental documents, which will all have been issued by that time. The meetings are scheduled as follows:

- December 14, Civic Center, Farmington, 3 to 9 PM
- December 14, Convention Center, Albuquerque, 3 to 9 PM
- December 15, Chapter House, Crownpoint, 3 to 9 PM
- December 16, Holiday Inn, Gallup, 3 to 9 PM
- December 16, Kachina Lodge, Taos, 3 to 9 PM

In addition, formal public hearings will be held in January 1983 to solicit public comments on the SJBAP Proposals. These meetings are scheduled as follows:

- January 10, Chapter House, Crownpoint, beginning at 1:00 PM
- January 12, Civic Center, Farmington, beginning at 9:00 AM
- January 14 (and 15th if necessary because of the number of registrants), Four Seasons Motor Lodge, Albuquerque, I-40 and Carlisle Blvd., beginning at 9:00 AM (each day)

Questions on the public meetings, hearings, and the technical reports themselves should be directed to:

Leslie M. Cone
NMGS Project Manager
BLM, New Mexico State Office
P.O. Box 1449
Santa Fe, NM 87501
(505) 988-6184 FTS 476-6184

Sincerely yours,

Charles W. Luscher
State Director, New Mexico

List of Technical Reports

1. Purpose and Need
2. Project Description
3. Alternatives to the Project
4. Site Alternatives
5. Permit Reconnaissance
6. Air Quality
7. Geologic Setting
8. Mineral Resources
9. Paleontology
10. Soils, Prime and Unique Farmlands
11. Hydrology
12. Water Quality
13. Vegetation
14. Wildlife and Aquatic Biology
15. Threatened and Endangered Species
16. Cultural Resources
17. Visual Resources
18. Recreation Resources
19. Wilderness Values
20. Transportation
21. Social and Economic Conditions
22. Land Use Controls and Constraints

Availability of Technical Reports for Public Review

Individual copies of the technical reports can be obtained for a copy fee. Inquiries should be directed to:

Bureau of Land Management, New Mexico State Office
Title Records and Public Assistance Section (943B)
U.S. Post Office and Federal Building
P.O. Box 1449
Santa Fe, NM 87501
(505) 988-6107 FTS 476-6107

Copies of the reports are available for public review at the locations listed below. [Formal and informal cooperating agencies are denoted by an asterisk (*).]

BUREAU OF LAND MANAGEMENT OFFICES

New Mexico State Office

NMGS Project Staff (934A)
Room 122, Federal Building
Cathedral Place
P.O. Box 1449
Santa Fe, NM 87501
(505) 988-6184 FTS 476-6184

San Juan Energy Projects Staff (911)
Room 129, Federal Building
Cathedral Place
P.O. Box 1449
Santa Fe, NM 87501
(505) 988-6226 FTS 476-6226

Public Affairs Staff (912)
Room 2016
U.S. Post Office and Federal Building
P.O. Box 1449
Santa Fe, NM 87501
(505) 988-6316 FTS 476-6316

Division of Resources (930)
509 Camino de los Marquez, Suite 3
P.O. Box 1449
Santa Fe, NM 87501
(505) 988-6212 FTS 476-6212

Albuquerque District Office
3550 Pan American Freeway NE
P.O. Box 6770
Albuquerque, NM 87107
(505) 766-2455 FTS 474-2455

Farmington Resource Area Headquarters
900 La Plata Road
P.O. Box 568
Farmington, NM 87401
(505) 325-3581

Taos Resource Area Office
Montevideo Plaza
P.O. Box 1045
Taos, NM 87571
(505) 758-8851

Socorro District Office
198 Neel Avenue
P.O. Box 1219
Socorro, NM 87801
(505) 835-0412 FTS 476-6280

Las Cruces District Office
1705 N. Valley Drive
P.O. Box 1420
Las Cruces, NM 88001
(505) 524-8551 FTS 571-8312

Roswell District Office
1717 W. Second Street
P.O. Box 1397
Roswell, NM 88201
(505) 622-7670 FTS 476-9251

Carlsbad Resource Area Headquarters
114 S. Halagueno Street
P.O. Box 506
Carlsbad, NM 88220
(505) 887-6544

USDI, Bureau of Land Management
Division of Rights-of-Way (330)
18th and C Streets, NW
Washington, D.C. 20240
(202) 343-5441 FTS 343-5441

USDI, Bureau of Land Management
Denver Service Center (D-460)
Technical Publications Library
Denver Federal Center, Bldg. 50
Denver, CO 80225
(303) 234-2368 FTS 234-2368

NEW MEXICO STATE AGENCIES

New Mexico State Environmental Improvement Division*
725 St. Michaels Drive
P.O. Box 968
Santa Fe, NM 87503
(505) 827-5217, ext. 2416

New Mexico Energy and Minerals Department*
525 Camino de los Marquez
P.O. Box 2770
Santa Fe, NM 87503
(505) 827-3326

New Mexico Historic Preservation Bureau*
State Historic Preservation Officer
505 Don Gasper Avenue
Santa Fe, NM 87503
(505) 827-2108

New Mexico Natural Resource Department*
Villagra Building
Santa Fe, NM 87503
(505) 827-5531

New Mexico Public Service Commission*
Bataan Memorial Building
Santa Fe, NM 827-3361
(505) 827-3361

New Mexico State Engineer's Office*
Bataan Memorial Building
Santa Fe, NM 87503
(505) 827-2423

New Mexico State Planning Office*
505 Don Gaspar Avenue
Santa Fe, NM 87503
(505) 827-5191

OTHER ORGANIZATIONS

Public Service Company of New Mexico
Alvarado Square
P.O. Box 2268
Albuquerque, NM 87158
(505) 848-2700

Woodward-Clyde Consultants, Inc.
3 Embarcadero Center, Suite 700
San Francisco, California 94111
(415) 956-7070

PUBLIC AND UNIVERSITY LIBRARIES

Reading copies of the NMGS EIS and associated technical reports will be available at the following public and university libraries:

State and Public Libraries

Albuquerque Public Library
501 Copper Avenue NW
Albuquerque, NM 87102

Aztec Public Library
201 W. Chaco
Aztec, NM 87401

Crownpoint Community Library
c/o Lioness Club, P.O. Box 731
Crownpoint, NM 87313

Cuba Public Library
Box 5, La Jara
Cuba, NM 87027

Farmington Public Library
302 N. Orchard
Farmington, NM 87401

Gallup Public Library
115 W. Hill Avenue
Gallup, NM 87301

Mother Whiteside Memorial Library (Public)
525 W. High Street
P.O. Box 96
Grants, NM 87020

New Mexico State Library
325 Don Gaspar Avenue
Santa Fe, NM 87503

OTHER DEPARTMENT OF THE INTERIOR AGENCIES

Bureau of Indian Affairs*
Albuquerque Area Office
123 4th Street
P.O. Box 2088
Albuquerque, NM 87198
(505) 766-3374 FTS 474-3374

Bureau of Indian Affairs*
Eastern Navajo Agency
P.O. Box 328
Crownpoint, NM 87313
(505) 786-5228

Bureau of Indian Affairs*
Navajo Area Office
Box M - Mail Code 305
Window Rock, AZ 86515
(602) 871-5151 FTS 479-5314

Bureau of Reclamation*
Upper Colorado Regional Office
125 S. State Street
P.O. Box 11568
Salt Lake City, UT 84147
(801) 524-5463 FTS 588-5463

Minerals Management Service*
South Central Region
505 Marquette Avenue NW, Suite 815
Albuquerque, NM 87102
(505) 766-1173 FTS 474-1173

Minerals Management Service*
Resource Evaluation Office
411 N. Auburn
Farmington, NM 87401
(505) 327-7397 FTS 572-6254

National Park Service*
Southwest Regional Office
1100 Old Santa Fe Trail
Santa Fe, NM 87501
(505) 988-6375 FTS 476-6375

National Park Service*
Environmental Coordination Office
Pinon Building, 1220 St. Francis Drive
P.O. Box 728
Santa Fe, NM 87501
(505) 988-6681 FTS 476-6681

U.S. Fish and Wildlife Service*
Field Supervisor, Ecological Services
3530 Pan American Highway, Suite C
Albuquerque, NM 87107
(505) 766-3966 FTS 479-3966

U.S. Geological Survey (WRD)*
505 Marquette Avenue, Room 720
Albuquerque, NM 87101
(505) 766-2810 FTS 474-2817

OTHER FEDERAL AGENCIES AND ORGANIZATIONS

Environmental Protection Agency*
Region VI
1201 Elm Street
Dallas, TX 75270
(214) 767-2716 FTS 729-2716

Navajo Tribe*
c/o Division of Resources
P.O. Box 308
Window Rock, AZ 86515
(602) 871-6592

Pueblo of Zia*
General Delivery
San Ysidro, NM 87053
(505) 867-3304

Soil Conservation Service*
424 N. Mesa Verde
Aztec, NM 87410
(505) 334-9437

U.S. Corps of Engineers*
P.O. Box 1580
Albuquerque, NM 87103
(505) 766-2657 FTS 474-2657

USDA, Forest Service*
717 Gold Avenue
Albuquerque, NM 87102
(505) 474-1676 FTS 474-1676

USDA, Forest Service*
District Ranger
Mt. Taylor Ranger District
201 Roosevelt Avenue
Grants, NM 87020
(505) 287-8833

Harwood Foundation Library
(Public)
25 LeDoux
P.O. Box 766
Taos, NM 87571

University/College Libraries

University of New Mexico
General Library
Albuquerque, NM 87131

Navajo Community College Library
Shiprock Branch
P.O. Box 580
Shiprock, AZ 87420

Northern New Mexico Community College
P.O. Box 250
Espanola, NM 87532

New Mexico State University
San Juan Campus
4601 College Blvd.
Farmington, NM 87401

University of New Mexico, Gallup Campus
Learning Resources Center
200 College Road
Gallup, NM 87301

New Mexico State University/Grants
1500 Third Street
Grants, NM 87020

New Mexico Highlands University
Donnelly Library
National Avenue
Las Vegas, NM 87701

College of Santa Fe
Fogelson Memorial Library
St. Michaels Drive
Santa Fe, NM 87501

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for the

Environmental Impact Statement on Public Service Company of New Mexico's Proposed New Mexico Generating Station and Possible New Town

Prepared by

Woodward-Clyde Consultants

for the

**U.S. Department of the Interior
Bureau of Land Management**

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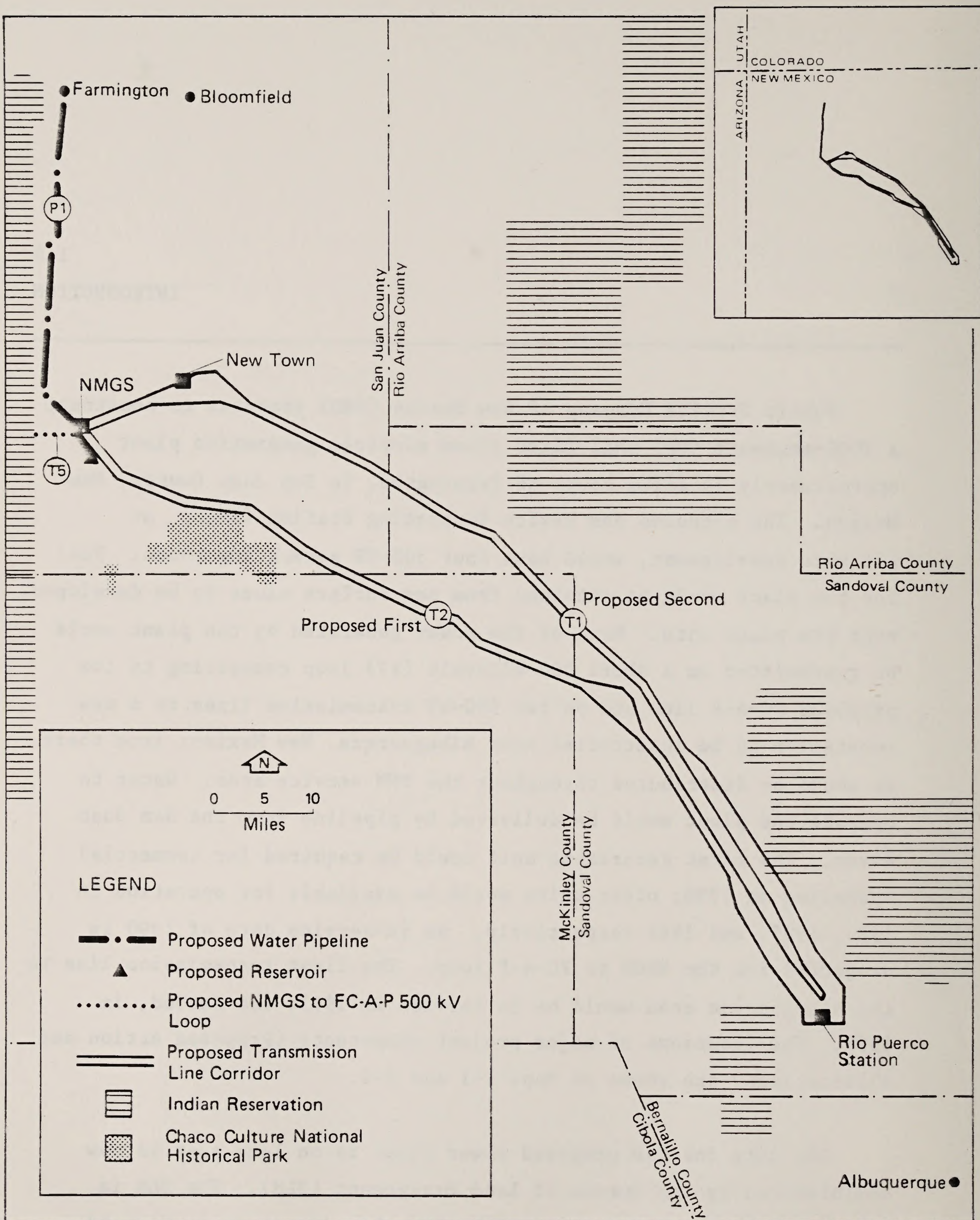
MAPS AND FIGURES

TABLES

1.0 INTRODUCTION

Public Service Company of New Mexico (PNM) proposes to construct a 2000-megawatt (MW) coal-fired steam electric generation plant approximately 35 miles south of Farmington, in San Juan County, New Mexico. The proposed New Mexico Generating Station (NMGS), at ultimate development, would have four 500-MW generating units. Fuel for the plant would be obtained from new surface mines to be developed near the plant site. Most of the power generated by the plant would be transmitted on a short 500-kilovolt (kV) loop connecting to the proposed FC-A-P line and on two 500-kV transmission lines to a new substation to be constructed near Albuquerque, New Mexico; from there, it would be distributed throughout the PNM service area. Water to operate the plant would be delivered by pipeline from the San Juan River. The first generating unit could be required for commercial operation in 1990; other units would be available for operation in 1993, 1995, and 1998 respectively. An in-service date of 1990 is projected for the NMGS to FC-A-P loop. The first transmission line to the Albuquerque area would be in service in 1993; the second, in 1998. The locations of major project components (Proposed Action and alternatives) are shown on Maps 1-1 and 1-2.

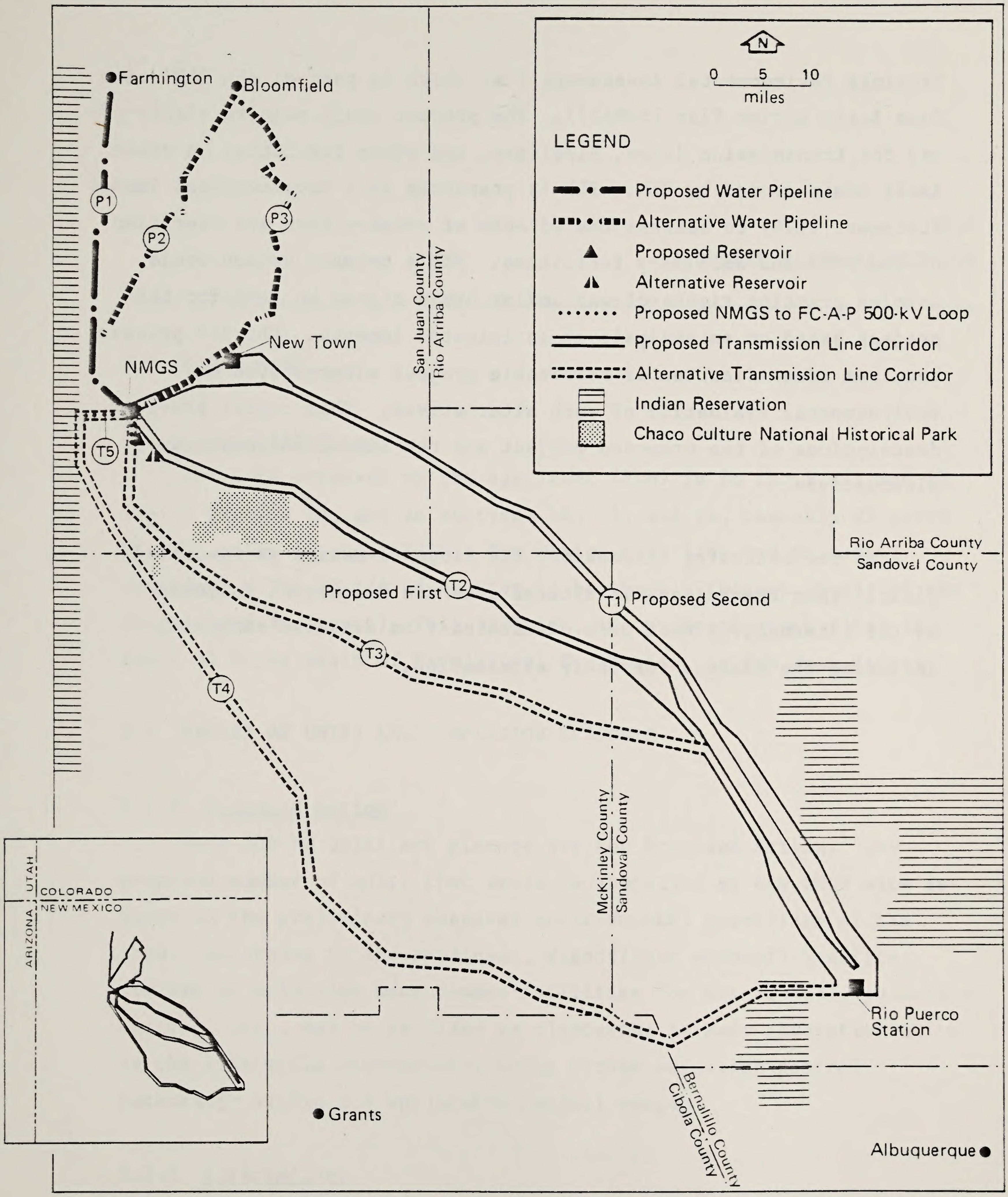
The site for the proposed power plant is on land that is now administered by the Bureau of Land Management (BLM). The BLM is considering an exchange proposed by PNM that if consummated would place the plant site in private ownership (refer to Ute Mountain Land



Note: For more information, see the location maps in Appendix G of the EIS.

Source: BLM 1982.

Map 1-1. GENERAL LOCATION OF PROPOSED ACTION



Note: For more information, see the location maps in Appendix G of the EIS.

Source: BLM 1982.

Map 1-2. GENERAL LOCATION OF ALTERNATIVES INCLUDING THE PROPOSED ACTION

Exchange Environmental Assessment [EA] which is part of the BLM's San Juan Basin Action Plan [SJBAP]). The project would require rights-of-way for transmission lines, pipelines, and other facilities on other lands administered by BLM. BLM is preparing this Environmental Impact Statement (EIS) to address the effects of construction and operation of the NMGS and ancillary facilities. BLM's primary action would involve granting rights-of-way and/or other rights to land for the project based on an analysis of anticipated impacts. The EIS process requires identification of reasonable project alternatives and environmental evaluation of such alternatives. This report provides descriptions of the proposed project and the identified reasonable alternatives.

In the following discussion, the Proposed Action is described first. Then the reasonable alternatives are discussed, followed by the alternatives that were eliminated from detailed analysis, including the reasons for their elimination.

2.0

PROPOSED PLANT FACILITIES

2.1 PLANT SITE

2.1.1 Proposed Site

The site proposed by the applicant (PNM) is in the S 1/2 and NW 1/4 of section 13, and in sections 14, 23, and 24, township 23 north (T23N), range 13 west (R13W), New Mexico base line and principal meridian. (The SE 1/4 of section 13 has been withdrawn in aid of the Navajo Land Exchange.) This location, the proposed plant site, is about 35 miles south of Farmington, New Mexico, in San Juan County.

2.2 NUMBER OF UNITS AND COMPLETION SCHEDULE

2.2.1 Proposed Action

Four 500-MW units are planned for the Proposed Action. The proposed number of units that would be installed at the NMGS site is based on the preliminary assessed environmental capability of the site. According to the applicant, significant economic benefits, derived by utilizing many common facilities for water, fuel, pollution control, etc., may be realized by clustering as many generation units as the site would accommodate, using proven emissions control technology within its applicable control range.

2.2.2 Alternatives

Alternatives to the proposed number of units and completion schedules include site development limited to two or three units and development schedules based on longer time intervals between unit completions. It is expected that the major differences in impacts associated with variations in the construction schedule would be the socioeconomic effects in the project area. A reduction in the total number of units at ultimate development would reduce other environmental impacts.

2.3 POWER PLANT CONSTRUCTION SEQUENCE

The general sequence for constructing NMGS would be as indicated in the following list.

- Access road construction
- Worker living accommodations (if required)
- Site clearing, construction warehouse and shops
- Site grading, fencing, and security
- Unit excavation
- Unit foundation construction and underground work
- Rail spur (if possible)
- Structural framing
- Heavy equipment installation--boilers, turbines, generators, condensors, pumps, fans, cooling towers, switching station
- Coal handling system--receiving station, crushers, conveyors, stackers, weighers, silos, pulverizers
- Handling and disposal facilities for ash and other wastes

- Finishing--ductwork, piping, wiring, controls, instruments, and recorder

- Transmission connection

There would be no clear demarcation in the sequence between one group of activities and another. It is expected that about 60 months would elapse from the time site clearing started until the first generating unit would be ready for commercial operation. The tabulation above considers only plant site activities; off-site activities such as constructing the project water supply, coal supply, transmission, and reservoir would progress simultaneously.

2.4 STATION LAYOUT AND SITE PREPARATION

2.4.1 Station Layout

The proposed arrangement of power plant facilities is shown on Figure 2-1. Most of the structures would be enclosed by corrugated metal panels, painted rawhide color with buckskin-colored trim. Exposed structural steel surrounding the boiler structure, particulate removal system, and sulfur dioxide (SO_2) removal system would be painted the same rawhide color. Rawhide and buckskin-colored finishes were chosen for compatibility with the existing visual environment. Exposed paint-receptive surfaces of storage tanks, coal-handling conveyors, cooling towers, and plant support structures would be finished to match the main power block.

The main power block would consist of four units, each arranged in a series of rectangular buildings varying in height from approximately 100 feet at the turbine generator area to approximately 240 feet in the boiler area. The chimney stacks may be as high as 575 feet. From south to north, each generating unit would include the turbine generator area, coal pulverizer area, boiler area, particulate removal system, SO_2 removal system, and chimney stack.

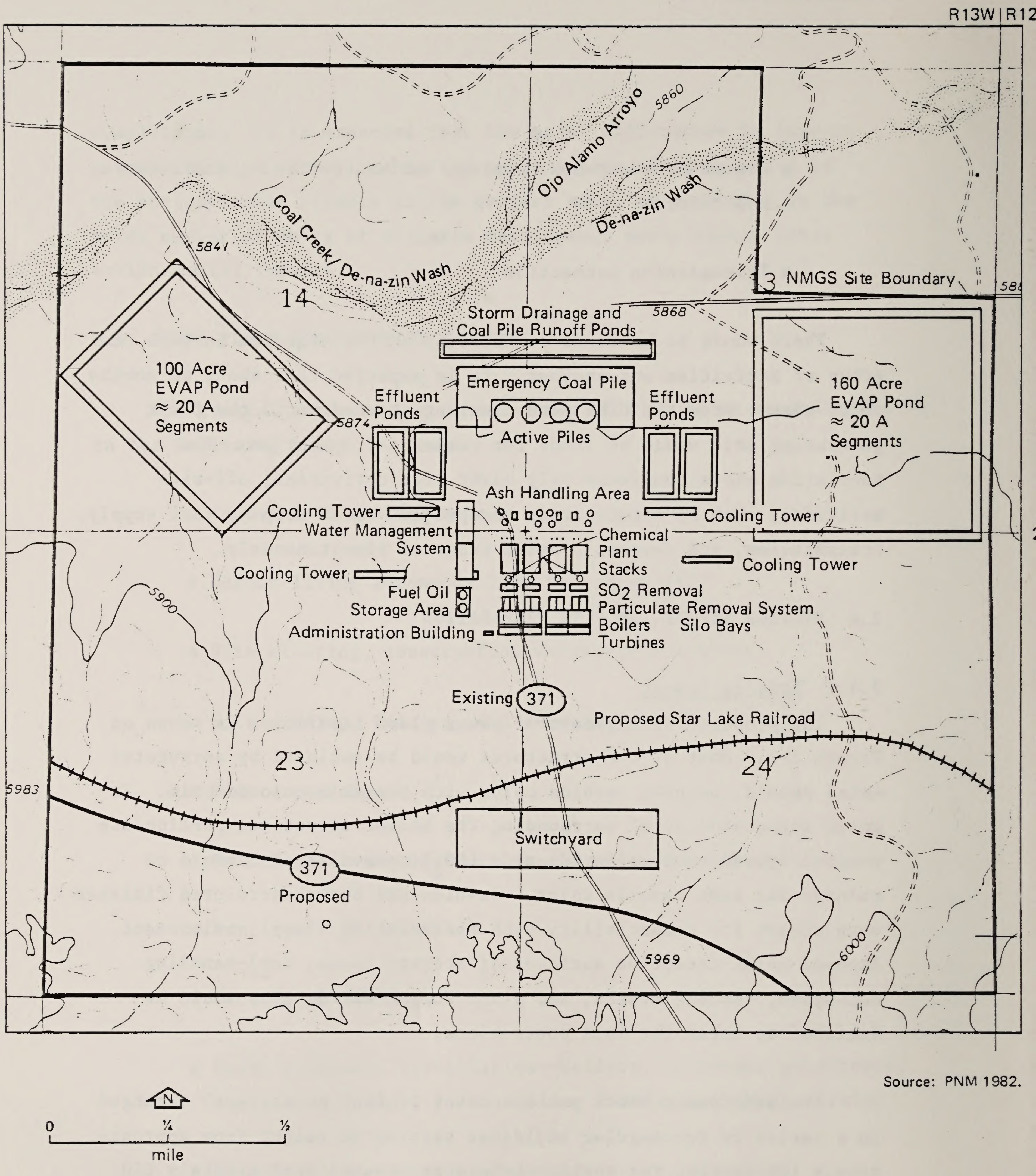


Figure 2-1. STATION LAYOUT

2.4.2 Site Preparation and Grading

Existing topography at the site has slopes ranging from 2 to 10 percent. The power block site is in an area having about 4 percent average cross slope. Preliminary plans would be to step-grade the plant area and preserve existing contours to the maximum practical extent to avoid excessive cut-and-fill operations.

Preliminary site preparation and grading would be done on the entire plant area. Final finish-grading and backfilling would be done on a unit basis as required by detailed design.

Erosion Control. During construction, erosion control would consist of drainage ditches across disturbed areas that would tie into the existing surface drainage features. Siltation control measures would include sedimentation ponds, sediment traps, and controlled drainage slopes.

Upstream Diversions of De-Na-Zin Wash. At this time, no diversion of the De-na-zin wash is anticipated. Should diversion be required, however, proper erosion control in those areas requiring it would be provided. Only those areas of the plant which may protrude into the wash would have riprap-protected embankments.

Size and Location of Sedimentation Ponds for Siltation Control. The size and location of sedimentation ponds would be based upon detailed earthwork and general arrangement drawings prepared during the final design of the NMGS units. U.S. Soil Conservation Service (SCS) methods would be used in sizing and designing the sedimentation ponds. The SCS method is based on the area of land disturbed and specification of the maximum precipitation to be considered.

Laydown Areas. Laydown areas (storage areas for plant construction materials) would be located within a 1-mile radius of the plant.

These areas are to be designated later when construction laydown requirements are more clearly identified and located.

Rehabilitation of Disturbed Areas. All spoil (material unacceptable for structural fill) would be hauled to on-site areas not required for the plant, spread to blend with the natural topography, and shaped to control erosion from drainage.

Topsoil would be removed and stockpiled by construction equipment prior to required excavations. The piles would be shaped and graded for drainage and erosion control. Topsoil would be reused in revegetating spoil disposal and disturbed areas.

Dust Control for Disturbed Areas. Water sprayed from tank trucks would be used as a dust suppressant on unpaved roads during construction. Some roads would not be paved until near the end of major construction phases in order to prevent unnecessary damage to pavement from the construction operations. All disturbed nonroad areas not covered with asphalt, concrete, or gravel would be reseeded with native grasses or shrubs as required for erosion and dust control.

Fencing. The entire site would be fenced at the beginning of construction to provide adequate security for contractors' equipment, plant materials and equipment, and overall station security requirements.

2.5 STEAM ELECTRIC SYSTEM

In the vapor power cycle, water is pumped by feed pumps to the boiler. Water entering the boiler flows up the sides in the water wall section exiting to the boiler steam drum. Water that is not driven off as steam (in the steam drum) is recirculated to the water wall tubes. The water leaves the steam drum, enters the boiler at the bottom, and flows up the sides of the boiler in tubes lining the boiler walls. Heat from fuel combustion is transferred to the water, converting it to steam and finally to superheated steam. The superheated steam leaves the boiler and enters the high-pressure (HP) portion of the turbine. Expansion of the steam against the turbine blades causes rotation of the generator shaft. From the HP turbine, the steam is returned to the boiler for further reheating before entering the intermediate (IP) and low pressure (LP) turbine sections. Reheating improves the thermal efficiency of the cycle. After expanding in the LP turbine, the steam is discharged to the condenser, where its latent heat of vaporization is transferred to the circulating water. The condensed vapor, known as condensate, enters a series of heaters that progressively raise the temperature of the condensate. Steam is extracted from various points of the turbines to heat the condensate in the heaters. Finally, the condensate returns to the boiler feed pump and the process is repeated.

2.5.1 Proposed Action

The Proposed Action is to purchase and install conventional boilers and turbine generators as produced by any of several manufacturers. Each unit would have a gross output of about 550 MW with an expected net output of 500 MW. About 50 MW would be required for plant operations.

2.5.2 Alternative Designs Not Selected for Detailed Analysis

Fluidized-Bed Combustion. A steam generation system based on fluidized-bed combustion (FBC) might be substituted for conventional boilers in NMGS if the technology were sufficiently developed and the relative economics were favorable. At present, FBC is in the pilot plant stage for utility-type applications, and extensive additional research and development will be required before the process becomes commercially competitive for large power plants. The process, when developed, is expected to provide significant improvements and economies with respect to air emissions control compared with present state-of-the-art boilers and emission control systems. PNM has estimated that atmospheric FBC may be commercially available for placing boiler orders by about 1992 (PNM January 1981). Consequently, overall coal-to-electricity conversion efficiencies should be nominally improved in plants using FBC.

For the NMGS EIS it is not considered necessary to separately evaluate fluidized-bed boilers as an alternative plant component because it is believed that large units of this type, with proven reliability and economy, would not be available when orders were placed for the plant steam generation units. Also, if such units were available at that time they could be substituted for conventional boilers without requiring significant new environmental analysis because the environmental effects associated with their use would be generally equal to or less than the impacts associated with the proposed units.

Magnetohydrodynamics. Magnetohydrodynamics (MHD) is a potential generation technology that would couple an unconventional MHD topping cycle to an essentially conventional steam electric bottoming cycle. Extensive analysis and research have been done to explore the potentials for producing electricity by MHD systems because of thereoretical fuel-to-electricity efficiencies approaching 60 percent. Much additional research and development work must be done to develop system components that would perform reliably and for extended periods under the conditions required for efficient MHD performance, as would be required for utility applications. The Electric Power Research Institute has estimated (EPRI Journal, April 1980) that MHD systems would not be available for utility service before 2000, and at this time there is not sufficient information available to determine whether such systems would be economic at the efficiencies that would be possible at that stage of development.

MHD systems should incorporate air emissions controls that would perform essentially as well as current state-of-the-art commercial systems. Environmental effects of MHD systems should therefore not be significantly more severe than conventional steam electric systems, and because they should consume less coal for equivalent energy outputs, they should be more favorable in that regard. However, because MHD systems are not expected to be commercially available as an alternative for NMGS, it is not considered necessary to evaluate them in the NMGS EIS. If they should become available, it should not be necessary to perform significant new environmental analyses to substitute them for the proposed units.

2.6 FUEL SUPPLY SYSTEMS

2.6.1 Identification of Primary and Secondary Fuels

The NMGS would require two types of fuel for efficient, reliable operation: the proposed primary fuel would be San Juan Basin subbituminous coal; residual fuel oil produced in New Mexico is the expected secondary fuel. The choice of a secondary fuel would be based on economics (including costs for environmental compliance) and availability. Subbituminous coal would be used in the steam generation system supplying steam to the turbine generator and plant ancillary systems. Table 2-1 gives an analysis of the expected quality of the coal, and Table 2-2 gives an analysis of the expected concentrations of trace elements in the coal.

Residual fuel oil would be used to produce steam for the plant auxiliary steam system during plant startup and maintenance intervals. Typical residual fuel oil (No. 6) composition is shown in Table 2-3. Diesel fuel oil (No. 2) is expected to be used only as a fuel for the emergency diesel generators. Typical diesel fuel oil composition is also shown in Table 2-3. Auxiliary steam would supply thermal energy for station heating, deaerator pegging steam, steam coil air heater requirements, main steam generator ignitor oil supply, and condenser air ejectors.

Table 2-1. BISTI MINE COAL ANALYSIS

Proximate Analysis	As Received (raw) Typical	Range
Moisture (%)	16.7	11.0 to 23.03
Ash (%)	19.6	8.33 to 30.35
Volatile (%)	29.6	23.85 to 39.81
Fixed Carbon (%)	34.1	26.26 to 41.80
Total	100.0	
Btu per Pound (as received)	8,300	6870 to 10,546
Btu per Pound (dry)	10,400	8185 to 12,406
Sulfur (%)	0.54	0.30 to 0.74
Sulfur Forms		
Pyritic Sulfur (%)	0.15	0.05 to 0.69
Sulfate Sulfur (%)	0.01	0.00 to 0.02
Organic Sulfur (%)	0.38	0.25 to 0.53
Water-Soluble Alkalis		
Water-Soluble Na_2O	0.6	0.34 to 1.40
Equilibrium Moisture	16.3	
Hardgrove Gindability Index	47.8	43.5 to 58.7
Ultimate Analysis		
Carbon (%)	48.96	39.62 to 57.52
Hydrogen (%)	3.62	3.18 to 3.80
Nitrogen (%)	0.88	0.67 to 1.14
Chlorine (%)	0.00	0.00 to 0.01
Sulfur (%)	0.53	0.30 to 0.71
Ash (%)	19.03	8.24 to 30.44
Oxygen (%)	9.66	8.27 to 10.71
Moisture (%)	17.32	12.95 to 25.28
Moisture Analysis (Ash)		
Phosphorus Pentoxide (P_2O_5)	0.1%	0.03 to 0.35%
Silica (SiO_2)	56.8%	46.66 to 63.92%
Ferric Oxide (Fe_2O_3)	3.7%	2.43 to 5.91%
Alumina (Al_2O_3)	27.4%	19.68 to 36.30%
Titania (TiO_2)	0.8%	0.69 to 1.04%
Calcium Oxide (CaO)	3.8%	1.54 to 4.83%
Magnesium Oxide (MgO)	0.9%	0.64 to 1.82%
Sulfur Trioxide (SO_3)	1.9%	0.32 to 7.35%
Potassium Oxide (K_2O)	0.8%	0.34 to 1.84%
Sodium Oxide (Na_2O)	2.1%	1.15 to 3.15%
Undetermined	1.7%	
Total	100.0%	

Fusions	Reducing
Initial Deformation	2260 to +2700°F
Softening (H = W)	2325 to +2700°F
Hemispherical (H = 1/2W)	2460 to +2700°F
Fluid	2585 to +2700°F

Source: Western Coal Company 1978, unpublished data

Table 2-2. TRACE ELEMENT CONCENTRATION--RAW COAL FROM BISTI MINE

Element	Range in Concentration (in ppm by weight)	Element	Range in Concentration (in ppm by weight)
Antimony	0.1 - 1	Neodymium	3 - 21
Arsenic	0.2 - 10	Nickel	1 - 16
Barium	41 -1500	Niobium	4 - 24
Beryllium	0.1 - 6	Praseodymium	1 - 10
Boron	3 - 68	Rhenium	tr
Bromine	0.1 - 4	Rubidium	2 - 940
Cadmium	0.3 - 1	Samarium	2 - 6
Cerium	9 - 250	Scandium	0.9 - 7
Cesium	0.4 - 6	Selenium	0.3 - 2
Chromium	2 - 18	Silver	tr - 0.4
Cobalt	0.4 - 8	Strontium	30 - 390
Copper	4 - 270	Tantalum	tr
Dysprosium	1 - 4	Tellurium	0.1 - 0.6
Erbium	0.3 - 2	Terbium	0.1 - 0.8
Europium	0.1 - 1	Thallium	tr - 0.9
Fluorine	24 - 220	Thorium	7 - 20
Gadolinium	0.2 - 2	Thulium	tr - 0.2
Gallium	4 - 36	Tin	tr - 6
Germanium	0.1 - 3	Tungsten	tr - 2
Hafnium	tr - 3	Uranium	2 - 9
Holmium	0.4 - 2	Ytterbium	tr - 2
Iodine	tr - 0.3	Yttrium	5 - 36
Lanthanum	8 - 87	Zinc	1 - 18
Lead	1 - 20	Zirconium	35 - 160
Lithium	4 - 660		
Lutetium	tr - 0.4		
Manganese	1 - 120		
Mercury	0.03- 0.22		
Molybdenum	2 - 9		

Source: Western Coal Company 1978, unpublished data.

Methods of analysis: atomic absorption, flameless atomic absorption (mercury only), specific ion electrode (fluorine only).

Table 2-3. ANALYSIS OF SECONDARY FUEL

	No. 6 Fuel Oil[a]	No. 2 Fuel Oil[b]
Specific Gravity at 60°F	0.95	0.85
Flash Point (°F)	150	178 (closed-cup
Pour Point (°F)	110	15 (summer)
Viscosity (SSU)	5000 at 110°F	32 at 140°F
Carbon (percent)	85.9	86.3
Hydrogen (percent)	10.1	12.9
Oxygen (percent)	0.5	0.43
Nitrogen (percent)	0.5	0.03
Sulfur (percent) (max)	3.0	0.5
Vanadium (ppm)	800	Not Available
Ash (percent)	0.10	0.001
Heating Value (Btu/lb)	18,200	19,500

[a]Source: PNM unpublished data, 1978.

[b]Source: Union Oil of California.

2.6.2 Fuel Consumption and Supply

NMGS coal consumption for four 500-MW units (assuming coal heat content of 8300 Btu/lb) would average about 7.5 million tons per year and 300 million tons over a 40-year plant life, based on project estimates for station heat rate, gross output, and average unit capacity factors (65 percent) over the life of the station. Annual and total fuel oil consumption would be a function of number of units on-line and boiler design. Average annual fuel consumption with four units on-line would be approximately 180,000 barrels of oil. Total fuel oil consumption over the life of the plant would be approximately 7.2 million barrels. Fuel oil supplies have not yet been contracted; delivery would probably be by truck or tank car.

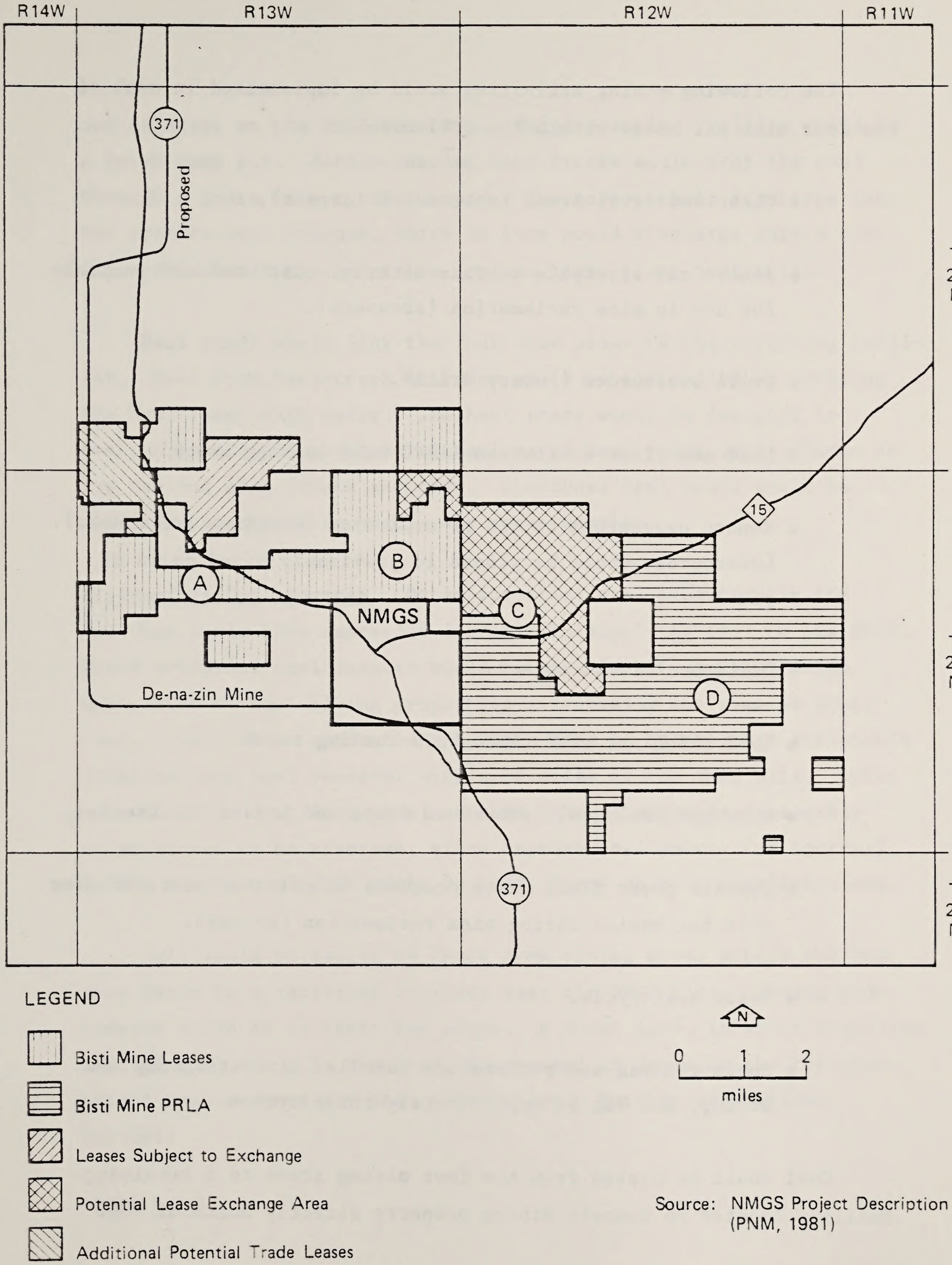
Proposed Action. Coal for NMGS would be acquired through negotiated purchase contracts, based on the available coal supply in the region. A number of potential suppliers have expressed interest in negotiating supply contracts. Sunbelt Mining Company, a wholly owned subsidiary of PNM, owns and has started production at the De-na-zin Mine, which is near the site of the proposed NMGS. Further, the Sunbelt Mining Company is negotiating with Arch Minerals Company for additional coal reserves, located adjacent to Sunbelt Mining Company's Bisti coal leases. The Proposed Action would be to supply coal necessary for the operation of NMGS from a joint venture of Sunbelt and Arch Minerals Company. In this document the joint venture is referred to as the Bisti coal mine.

In order to provide background information for the NMGS EIS, a summary of the probable operation of a mine which could supply coal to NMGS is provided below. In addition, a generic evaluation of San Juan Basin coal sources is presented in the Star Lake-Bisti Regional Coal EIS (BLM 1978). A detailed description of mining operations and site-specific impacts due to coal mining are not addressed in this EIS. These issues would be addressed on a site-specific basis in an EA or

EIS that the Office of Surface Mining would prepare for individual mining plans. No mining would occur until this analysis and decision process were completed.

To describe the general operation of the coal mine, a scenario in which 9 million tons per year is supplied is assumed. This coal volume is slightly larger than the maximum anticipated NMGS coal consumption (80 present capacity factor), and 20 percent larger than the estimated average annual consumption of 7.5 million tons (65 percent capacity factor). The 9 million tons per year maximum mining rate would accommodate replenishment of the emergency stockpiles after a prolonged period of operations using stockpiled coal. This mining description is based on a proposed joint venture between Sunbelt Mining Company and Arch Minerals. The land area included in this joint venture is indicated in Map 2-1. In the areas outlined on the map there is sufficient surface-minable coal to supply NMGS for its anticipated economic life of 40 years according to information supplied by the applicant.

In a given year of full production, four separate mine pits may be needed to supply the necessary coal. Typical mine pit areas for the early years of full (four units) NMGS consumption are shown on the map, lettered A, B, C, and D. The areas on the map to the northwest of NMGS are subject to exchange. These areas are part of Sunbelt Mining's lease and may subsequently be deleted. The Secretary of the Interior has been directed by Public Law 96-475 (HR 6816) to exchange these lands, which are within the Bisti Wilderness Study Area, for currently unleased coal in the area designated "Potential Lease Exchange Area" on the map. Public Law 96-475 states that all or portions of federal coal leases NM-0186612 and NM-0186613 be exchanged. BLM is currently proposing that 18 acres of NM-0186612 and all of NM-0186613 (1261 acres) be exchanged.



Source: NMGS Project Description (PNM, 1981)

Map 2-1. NMGS PROBABLE COAL SOURCE, BISTI COAL MINE

The following mining activities would be implemented in each of the four mine pit areas within the coal mine:

- Clear and level areas to be mined (dozers).
- Remove and stockpile surface material that would be suitable for use in mine reclamation (scrapers).
- Drill overburden (rotary drill).
- Load and blast overburden (ANFO bulk loading truck).
- Remove overburden to top of coal seam (dragline and trucks). (Overburden would be placed in previously mined parts of pit.)
- Drill coal (coal auger).
- Load and blast coal (ANFO bulk loading truck).
- Mine and haul coal (shovel or front-end loader and trucks).
- Deposit power plant waste products in selected parts of mine pits for burial during mine reclamation (trucks).
- Begin next cycle.
- Spoil grading and reclamation parallel coal stripping and mining, and lag by approximately three cycles.

Coal would be hauled from the four mining areas to a receiving facility located on Sunbelt Mining property directly north of NMGS and adjacent to the NMGS boundary. This receiving facility would be a truck dump pit. Bottom-dumping coal trucks would drop the coal through a grate into a coal hopper. The hopper would discharge into the primary coal crusher, which in turn would discharge onto a conveyor that would transport the coal to power plant facilities.

Haul roads would link the four mine areas to the receiving facility. Dust from haul-truck activity would be controlled by spraying the haul roads with water. The haul roads would be designed to control runoff and erosion. Locations of haul roads would change as the various mine fronts advanced. Abandoned haul roads would be reclaimed according to regulatory requirements.

Alternative Coal Sources. Other potential coal producers in the San Juan Basin have expressed interest in supplying coal to the NMGS. These potential coal sources would be capable of supplying large quantities of coal having properties essentially the same as Bisti coal. There is an estimated 4 billion tons of uncommitted strippable subbituminous coal reserves within 30 miles of the NMGS site. Other potential San Juan Basin coal sources were selected as reasonable alternatives to be assessed, since another coal source (or sources) in the vicinity of NMGS might be used, based on cost considerations.

Coal would be hauled by truck from mining areas within the San Juan Basin to a receiving facility near the NMGS site. Mining procedures would be as described above. A worst case, in which 9 million tons of coal would be required, is assumed to describe the transportation requirements for this alternative. Further assumptions include:

- o One-way haulage of 30 miles (worst case)
- o 120-ton trucks
- o 250 haul days per year

Based on these assumptions, approximately 300 round trips per haul day would be required. Total mileage per haul day would be approximately 18,000 miles. Design and maintenance of haul roads would be similar to that described for the Proposed Action.

Alternative Coal Sources Not Selected for Detailed Analysis. Sources of coal outside the San Juan Basin are not considered reasonable alternatives for supplying a power plant at the Bisti site because: (1) they would generally have significantly different physical and chemical properties from San Juan Basin coals, and (2) they would have a delivered cost substantially above the delivered cost of San Juan Basin coal. Large utility boilers are designed to burn coal having properties within relatively narrow ranges. Coals having properties outside the design ranges generally would not perform satisfactorily, and major differences could cause boiler failure.

It is proposed that NMGS would be a mine-mouth plant, thereby avoiding coal transportation costs except those incident to the mining operations. San Juan Basin coals, because they are present at relatively shallow depths and in substantial deposits, could be mined at unit costs that would be near the lower limits for the industry. Therefore it is expected that San Juan Basin coals could be delivered to the NMGS at substantially lower cost per Btu than coals from other, more remote sources. Examples of cost for coal sources outside the San Juan Basin range from $1.15 to $1.58 per million Btu based on first of the year 1980 dollars. Coal from the San Juan Basin would average $1.00 per million Btu based on first of the year 1980 dollars. If inflation is factored into these estimates, delivered costs of coal from the San Juan Basin would have an even greater economic advantage over coal from outside the San Juan Basin.

2.6.3 Fuel-Handling Systems

Coal

Because final design of the coal-handling system cannot be specified until the coal supply selection is completed, only the general configuration of the probable system is discussed here. Although the NMGS coal-handling system cannot be detailed, assumptions concerning the system will allow the evaluation of expected environmental impacts. These assumptions have been used in the Air Quality Impact Analysis (Air Quality Technical Report).

Proposed Action. Within the power plant area, coal transfer and handling would be accomplished by a covered conveyor system. Primary crushed coal, approximately 4 x 0 size (4-inch diameter and smaller), would be received directly north of NMGS and adjacent to the site boundary. Coal would be transferred via conveyor belt from the receiving station to enclosed secondary crushers and then to four open, active storage piles (Figure 2-1). Active storage piles, sufficient for 3 days of full plant operation, would be formed by dropping the crushed coal from a conveyor through a lowering well. All coal handling and processing after active storage would be enclosed, for dust control. Coal from active storage piles would be conveyed to the plant coal silos (above the pulverizers). It would be fed from storage silos into the pulverizers upon demand, and the pulverized coal would be air forced to burners in the boilers.

Primary crushed and screened coal would be used to develop emergency storage piles, sufficient for operation of on-line units at

80 percent of capacity for 90 days. The emergency piles would be formed and compacted with conventional mining/road construction equipment. The surfaces of these piles would be treated with a surface stabilizer and would not be trafficked after formation. Should the emergency piles be tapped, coal would be transferred by self-loading scrapers or other conventional bulk materials handling equipment to the secondary crushers and from there to the active storage piles and reclaim feeders, and then through the fuel cycle. All storage piles and coal-processing areas would be designed so that runoff from precipitation would be diverted either to clay-lined runoff evaporation basins or to the plant water treatment systems, or would be discharged into local streams/arroyos as appropriate and allowed under NPDES standards. Discussion of possible discharges past the plant boundaries under precipitation events exceeding a ten-year, 24-hour storm is presented in the Water Quality Technical Report.

Coal spills from any plant conveyor would be rare. Spills would be removed promptly by front-end loader and truck, or manually. This coal would be returned to the proper area for subsequent reclaiming.

The foundation beneath on-site coal stockpiles would be prepared to control percolation. A clay liner may be used to collect precipitation from the coal piles and to deliver it to a clay-lined coal-pile runoff pond. The pond would be sized to impound runoff from the coal piles which could originate from a 10-year, 24-hour storm. The physical dimensions of the pond cannot be specified until detailed site studies are completed. The clay liner would have an estimated minimum thickness of 9 inches in order to achieve a maximum allowable permeability of 10^{-7} cm/s. This 10^{-7} cm/s permeability represents an estimate of the permeability allowable under existing regulations. The actual maximum allowable permeability would be determined by the New Mexico EID based on the quality of water that would be impounded in the basin. The use of a synthetic liner is not excluded, should future studies determine that a synthetic liner is most feasible. This system would be designed within the NMGS zero-discharge philosophy but would include the option for NPDES permit application, as discussed in "Disposal of Plant-Generated Wastes" (Section 2.8).

Coal blending would not be required to achieve environmental acceptance. Random blending would result from concurrent working of four mine areas and from the routine in-plant operations associated with handling and stockpiling the coal. Plant fuel and emission control systems would be designed to use unblended run-of-mine San Juan Basin coals.

Alternatives. Primary crushed coal could be delivered from the mine to the receiving station by conveyor. If conveyors were used, unloading hoppers would be eliminated at the station and coal would be transferred directly to the plant conveyor and storage piles.

An alternative to on-site storage of primary crushed emergency coal would be storage of compacted run-of-mine coal on Sunbelt Mining Company property north of the NMGS site. Reclaim of this coal would be by earthmoving equipment to the mine truck dump pit/primary crusher.

Fugitive Dust Control.

Proposed Action. Fugitive dust emissions from conveyors, crushers, and other coal processing areas would be controlled using proven techniques. The estimated fugitive emissions and emission control effectiveness for the various coal-handling and processing steps are summarized in the Air Quality Technical Background Report. To prepare these fugitive dust estimates, the applicant has assumed certain control techniques for fugitive dust sources. Fugitive dust controls assumed for the Proposed Action are listed below:

- Enclosed conveyors, transfer points, crushers, and other processing areas
- Additional control at secondary crushers, such as baghouse or water spray
- Lowering wells for active storage piles
- Surface stabilizer on emergency coal pile surface
- Compaction of emergency coal piles
- Emergency pile would act as a partial windbreak for active storage piles
- Dust control at the coal silos (such as a dustless loader and enclosure)

Storage in silos as an alternative method of fugitive dust control for the emergency pile was eliminated from detailed analysis because the low level of activity for the pile and its large size determined that the increased cost of storage silos was not reasonable.

Secondary Fuel (Oil)

Secondary fuel would be stored in tanks at the site and would be loaded from truck or train unloading stations. Unloading stations would be designed to collect any inadvertent oil spills in sumps. Spilled oil would be transferred to holding tanks for oily wastes, which would be included in the water management system. These wastes would be trucked off-site to a contracted disposal firm for final disposition.

The fuel oil storage area would be lined with impervious material and sloped to drainage collection areas. The oil storage area would be surrounded by dikes high enough to contain and withstand the hydraulic pressures resulting from the spill of a full tank; spills or overflows would be disposed of as described above.

Tanks would be designed with approved and reliable safety and venting devices. Tank roofs would be internally supported and designed for expected wind and snow loads. Tank venting devices would include flame-arresting vents, free vents with manually controlled flame snuffers, and emergency pressure/vacuum venting devices, in accordance with American Petroleum Institute (API) Standard 2000. Efforts would be made to contain and recycle the volatile hydrocarbon off-gases from the tanks through tank design.

Diesel Fuel and Gasoline

Diesel fuel would be used during station construction for on-site equipment and transportation at the rate of approximately 250,000 gallons per year (gal/yr). It would not be used as a boiler startup fuel. Gasoline would be consumed in normal vehicle use during station construction at the rate of approximately 25,000 gal/yr.

All diesel fuel and gasoline for construction equipment would be stored on the site in elevated or buried storage tanks. Earthen berms would surround elevated tanks to protect adjacent areas from possible spills. Tanks would comply with all applicable fire safety regulations. Construction contractors would be responsible for supplying equipment, diesel fuel, gasoline, and storage tanks. Off-site fuel use would be dependent on sources and methods of transportation to the site and is currently undetermined.

2.7 EMISSION CONTROL SYSTEMS

2.7.1 Particulate Removal System

Two particulate control systems were evaluated for use at the proposed NMGS. These two systems were selected for detailed analysis because they would be capable of removing particulate matter at high efficiencies and would meet applicable federal and state regulations for particulates. These requirements include the following:

- The particulate control system should be capable of removing flue gas particulates so that the emissions would meet the federal EPA emission limitation of 0.03 pound per million Btu of heat input ($lb/10^6$ Btu), as well as a New Mexico fine-particulate limit of 0.02 $lb/10^6$ Btu for particles less than 2 microns and 0.05 $lb/10^6$ Btu total.

- The operating reliability of the particulate control system must be such that the generating capability of the unit would not be limited by the particulate control system.

Fly ash would be collected in hoppers with a design storage capacity that would prevent ash from reducing the efficiency of the particulate removal system, regardless of the system chosen.

Proposed Action

Fabric Filters. For years, fabric filters have been used extensively in small industrial applications, but until recently they have not been widely used in utility boiler applications.

This was primarily because of short bag life and high operating costs rather than the inability of this type of device to collect particulates. Recently, fabric filter manufacturers, electric utilities, and textile manufacturers have reduced the most common causes of bag failure and have developed more durable fabrics and finishes.

Fabric filter collection efficiencies are not affected by the resistivity of the fly ash, as are those for electrostatic precipitators. Fabric filters are sized on the basis of the flue gas flow rate and the design air-to-cloth ratio. The selection of the air-to-cloth ratio for a woven glass bag is a function of the desired bag life, residual pressure drop, method of cleaning, and required cleaning cycle. An air-to-cloth ratio of 2:1 is typical for a reverse-air-type fabric filter used in large-sized utility applications. Design parameters were established with the aid of an air quality system design and cost model and were based on recent technical specifications issued for fabric filter applications on large generation units designed to fire low-sulfur western fuel.

The fabric filter would have a lower capital and total annual cost than a precipitator system designed for the NMGS using the Bisti coal. It also would offer the greatest flexibility in fuel supply variability. The estimated total annual costs for the fabric filter were based on a three-year bag life, which is consistent with the guarantees currently being offered. The selection of a fabric filter would be closely coupled to the SO_2 control system and other plant environmental systems. If these systems are redefined at some later date, such changes should not increase plant emissions.

Alternatives

Electrostatic Precipitators. Electrostatic precipitators of the size and efficiencies required for the NMGS have been proven in operation on similar-sized utility power plants firing coal similar to that under consideration for this station. This particulate removal process is the most widely used technique for large utility units at the present time.

Electrostatic precipitators (ESP) are generally categorized as hot-side or cold-side, depending on their location in the flue-gas stream.

Hot-Side ESP. The precipitator would be located downstream of the economizer. It would receive flue gases at approximately 720°F. The gases would pass through the precipitator and discharge to the air preheater. The precipitator would separate the particulate matter from the flue gas by exposing the stream to a high-voltage electric field, imparting an electric charge to the solid particles in the stream. The charged particles would migrate to an oppositely charged collecting surface, where they would cling until removed. The electric field would be formed by radiation from electrodes--usually steel wires or rigid steel strips--spaced equidistant from each other and the collecting surfaces. Particles clinging to the collector plates would be removed by periodically rapping the plates, causing the collected dust to drop into the hoppers below. The collected ash would be conveyed to the the ash-handling system.

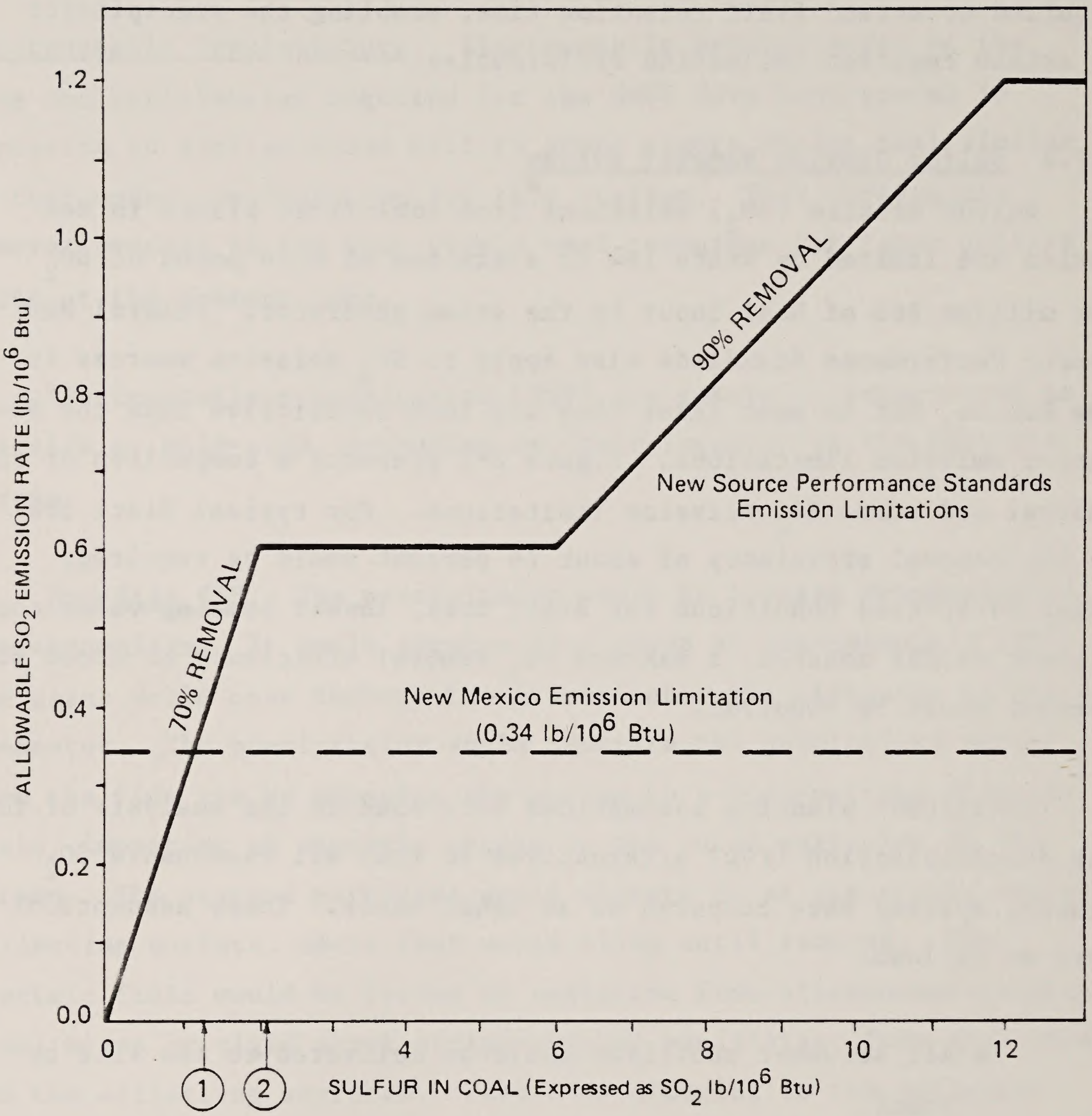
Cold-Side ESP. If a cold-side ESP were used, it would be located downstream of the air preheater and would treat flue gases at approximately 250°F. Operation of the cold-side ESP would be the same as described for the hot-side precipitator. Because of the low migration velocity, a large specific collection area (SCA) would be required to extend field retention time, enabling the precipitator to attain required collection efficiencies.

2.7.2 Sulfur Dioxide Removal System

Sulfur dioxide (SO_2) emissions from coal-fired plants in New Mexico are limited by state law to a maximum of 0.34 pound of SO_2 per million Btu of heat input to the steam generator. Federal New Source Performance Standards also apply to SO_2 emission sources in New Mexico, but in most cases they are less restrictive than the New Mexico emission limitations. Figure 2-2 presents a comparison of the federal and state SO_2 emission limitations. For typical Bisti coal an SO_2 removal efficiency of about 74 percent would be required. Under worst-case conditions for Bisti coal, lowest heating value and highest sulfur content, a maximum SO_2 removal efficiency of about 85 percent would be required.

Consistent planning assumptions were used in the analysis of flue gas desulfurization (FGD) alternatives so that all reasonable SO_2 control systems were compared on an equal basis. These assumptions were as follows:

- All scrubber additives would be delivered to the site by truck.
- Additive preparation would be accomplished during one shift per day on the basis of average operating conditions.
- Units 1 and 2, and Units 3 and 4 would share common two-unit additive preparation buildings.



(1) Typical Sulfur Bisti Coal, 1.3 lb SO_2 /10^6 Btu (74% Removal Required)

(2) Maximum Sulfur Bisti Coal, 2.04 lb SO_2/10^6 Btu (85% Removal Required)

Figure 2-2. CURRENT SO_2 EMISSION LIMITATIONS FOR STATE OF NEW MEXICO

- A common limestone or lime receiving and reclaim facility and storage area would be shared by all four units.

- Operation with different particulate control, solid-waste disposal, and water management systems was considered for each SO_2 control system evaluated.

- Each SO_2 control system would provide the same level of performance.

Two alternative SO_2 removed systems have been selected for detailed analysis. The proposed action for an SO_2 system would be identified as part of the bid process.

Alternative 1: Wet Limestone Scrubbing. Wet limestone scrubbing is currently the most common method of SO_2 control for treatment of utility boiler combustion gases. In this system, limestone ($CaCO_3$) additive is crushed, slurried with water, and used as an alkaline spray to absorb SO_2 from the flue gas. The estimated quantities of reagent and water that would be required for each 500-MW unit are:

- 25,500 tons of limestone per year (65% capacity factor)
- 33,346 tons of limestone per year (85% capacity factor)
- 390 gallons of water per minute (65% capacity factor)
- 510 gallons of water per minute (85% capacity factor)

The utility industry has considerable operating experience with limestone scrubbers, and many recently installed operational systems have exhibited high reliability. Limestone additive is inexpensive and readily available. The disadvantages of the limestone scrubber include high maintenance requirements for the additive grinding equipment and for the piping and pumping systems because of the abrasiveness of the slurry and the potential for plugging and scaling.

Alternative 2: Alkali Spray Drying. The spray absorber process is a relatively recent development in combustion gas cleaning technology. It is a two-stage SO_2 and particulate removal process that uses a spray absorber/dryer for SO_2 removal, followed by a particulate removal device to collect the solid scrubber reaction products and the fly ash in the flue gas stream. In the first stage, boiler flue gas would be passed through a chamber where it would react with a mist of a dilute sodium carbonate solution or calcium hydroxide slurry. A large fraction of the SO_2 would be absorbed by the additive solution or slurry. A total of 21,600 tons of lime per year would be required for each 500-MW plant at 65 percent capacity factor. A total of 28,246 tons of lime per year would be required for each 500-MW unit at 85 percent capacity factor. The key to efficient SO_2 absorption is to atomize the sorbent solution, or slurry, throughout the flue gas stream to promote rapid and mass transfer of the SO_2 from the gas into the sorbent droplets. The heat of the flue gas evaporates the water contained in the spray, leaving a dry powder mixture of sulfite and sulfate with some residual unreacted alkali. The water requirements would be less than for a wet limestone process (310 gallons per minute for each 500-MW unit at 65 percent capacity factor and 405 gallons per minute at 85 percent capacity), and some of the operational problems associated with wet scrubbers would not occur.

Increased SO_2 Removal Efficiency (Initial Design and Post-operational Changes). The SO_2 control system selected would be designed to achieve a peak SO_2 removal efficiency of 85 percent, based on the worst-case Bisti coal analysis (0.74 percent sulfur and 6870 Btu/lb) (Table 2-1). All storage facilities such as tanks, bins, and silos would be designed based on an expected average removal efficiency of 74 percent for the typical Bisti coal (0.54 percent sulfur and 8300 Btu/lb). The SO_2 control system would be capable of consistently attaining an average SO_2 removal efficiency of 80 percent, if required to meet New Mexico state emission limits. The retention time of storage equipment such as tanks, silos, and bins would be less under such conditions, but this could normally be accommodated by changing operating approaches, such as increasing the number of shifts that the additive system was operated.

2.7.3 Nitrogen Oxides Control System

Total NO_x from the proposed power plant would be generated from two mechanisms, fuel NO_x and thermal NO_x. The approximate level of fuel-derived NO_x for the typical Bisti coal would be 0.34 $lb/10^6$ Btu. This estimate is based on 15 percent conversion of the fuel-bound nitrogen to NO_x. The thermal NO_x emission was calculated to be approximately 0.18 $lb/10^6$ Btu, assuming a combustion flame temperature of 3100°F. Therefore the total NO_x emission for the Bisti coal would be approximately 0.52 $lb/10^6$ Btu when fired in a conventional steam generator without NO_x control provisions.

The current federal New Source Performance Standard for NO_x emissions is 0.60 $lb/10^6$ Btu for bituminous coal and 0.50 $lb/10^6$ Btu for subbituminous coal. New Mexico restrictions on NO_x emissions for either kind of coal are more stringent, at 0.45 $lb/10^6$ Btu.

Regardless of the source of nitrogen, fuel or air, NO_x control methods are based on reducing peak temperature in the combustion chamber, reducing the time at high temperatures, or reducing the excess oxygen in the high-temperature regions of the furnace. Descriptions of alternative control techniques that are capable of meeting the current New Mexico NO_x standards are presented below. The final NO_x control system would be selected during the bid process. Total NO_x emissions would be 35,000 tons per year with any of the alternative systems, assuming that minimum New Mexico NO_x standards are met.

Alternative 1: Dual-Register Burner. A dual-register burner is used to reduce NO_x emissions to the present regulation level. The burner design incorporates an inner and outer burner register that controls the mixing of fuel and air. This design allows combustion of fuel to be initiated at the burner throat in a fuel-rich atmosphere. Additional air is introduced through the outer register to complete combustion. The delayed combustion reduces the combustion intensity and the flame temperature of the fuel, which minimizes the formation of thermal NO_x from the nitrogen in the combustion air.
Also, because of the controlled fuel and air mixing, the availability of oxygen is minimized during initial stages of the combustion, limiting the formation of fuel-derived NO_x.

Alternative 2: Tangentially Fired Steam Generator. A tangentially fired steam generator is designed so that the entire furnace area acts as a single burner, allowing fuel-rich and air-rich streams to be blended for complete combustion of the fuel. This design is inherently low in NO_x formation because of the large amount of internal recirculation of the gas generated in the flame vortex and the long diffusion flames which allow slower mixing of the fuel and the air.

Overfire air is used where further reduction in NO_x emissions is required. Since a portion of the secondary air flow is diverted to the overfire air registers, the total oxygen supply to the primary flame zone is reduced.

Alternative 3: Controlled-Flow/Split-Flame Burner. This system uses a series register arrangement that divides the secondary air into two concentric streams. The two registers control the mixing rate between the primary and secondary air streams and the rate of entrainment of the furnace gases. The inner register is designed to regulate the degree of swirl around the coal nozzle. The split-flame fuel nozzle is designed to divide the coal into concentrated streams to form individual flames.

In addition to the NO_x control technologies described above, two options exist to meet future, possibly stricter, emission standards. These options were not considered for detailed analysis because they are in the early development stage and are unproven. The two options are:

- New equipment designs, including low-NO_x burner and furnace designs that may reduce NO_x emissions to 0.2 $lb/10^6$ Btu.
- Flue gas treatment: removal of NO_x from flue gas by a wet or dry process.

2.7.4 Stacks

Stack height for each NMGS unit has not been established. Therefore, worst case conditions were assumed for assessing air quality, visibility, and visual impacts. Stack heights assumed for worst case conditions include 400 feet for air quality and visibility modeling and 575 feet for assessing visual impacts (Air Quality and Visual Resources Technical Reports). The stack heights used for impact analysis were based on revisions to 40 CFR, Part 51 to implement Section 123 of the 1977 Clean Air Act Amendments published in the February 8, 1982 Federal Register. This regulation establishes that stack heights, for dispersion modeling purposes, are limited to what is termed "good engineering practice" (GEP) as determined by the following empirical formula:

$$H_g = H + 1.5L$$

where:

H_g = GEP stack height

H = height of the structure or nearby structures

L = lesser dimension (height or width) of the structure or nearby structures

(nearby structures must be within 0.5 mile of the stack)

The structure containing the boiler and turbine would be about 230 feet high. Since the width of this structure is about 300 feet, the GEP formula yields:

$$H_g = 230 \text{ feet} + (1.5)(230 \text{ feet}) = \text{approximately } 575 \text{ feet}$$

The nearly level topography in the plant vicinity would not cause downwash problems. The stack exit diameter would be approximately 30 feet. Construction materials would probably be concrete with brick lining. One stack would be required for each of the four units. The planned distance between stacks is about 400 feet. The stack lighting system would conform to FAA requirements.

2.7.5 Other Emissions

Auxiliary Boilers. The primary function of the auxiliary boiler would be to provide steam during plant startup operations. The required capacity of the auxiliary boiler has not been determined. The boiler would probably be used twice a year for 2- to 4-week periods during maintenance. For the rest of the year, auxiliary steam would be supplied from the main unit boilers.

The auxiliary boiler would comply with federal and state emission limitations for auxiliary boilers fired with No. 6 fuel oil, and would consume approximately 675 gal/hr. Preliminary estimates of fuel oil consumption after startup total approximately 1.9 million gal/yr for each 500-MW unit.

According to EPA's AP-42 document on emission factors, emissions at maximum load would be approximately (lb/hr):

SO_2	Particulate	NO_x	CO	Hydrocarbons
535	16.4	42.8	2.9	2.1

The estimates are based on the fuel analyses presented in Table 2-3.

Diesel Generators. A diesel generator would be required to supply electric power in an emergency. The unit size would probably be between 800 and 1000 kW. The unit would run on diesel oil supplied from the unit's day tank.

2.8 DISPOSAL OF PLANT-GENERATED WASTES

Construction and operation of the NMGS would result in the production of several kinds of solid and liquid wastes. The wastes and their characteristics can be only broadly categorized at this time; detailed descriptions must await final project design. An important objective in the design of the NMGS is that there would be no transport of wastewater beyond the boundaries of the waste disposal facilities (zero discharge). The zero-discharge design philosophy would include applications for NPDES permits, should upset or off-design operation cause discharge of effluents beyond the plant boundary. All solid and liquid waste disposal facilities would be in the general vicinity of the plant. Mined-out pits from the coal mining operation would be used for solid waste disposal to the maximum practical extent.

2.8.1 Water Management and Water Treatment

Water Management. The water management system for NMGS would include all of the on-site facilities associated with the control, use, and disposal of water. The design features of a water management system for the power plant would be determined by the four major categories of systems that use water:

- Steam cycle and plant services
- Heat rejection
- Flue gas treatment
- Ash disposal

A conceptual flow diagram showing the major water sources and water uses within the plant, and basic flow paths between them, is shown in Figure 2-3. This diagram would be generally applicable for any combination of feasible water supply and treatment options available, and is therefore considered representative of the Proposed Action. Table 2-4 identifies and describes the process blocks and flow nodes in Figure 2-3. Numerical values given for water flows in Figure 2-3 are based on a 65 percent long-term annual average capacity factor, a wet limestone scrubber, and 100 percent wet-cooling towers. Flows at a 100 percent capacity factor would be as indicated in the parentheses in the diagram.

Proposed Action. The system would have to accommodate all water delivered to the plant site through the project water supply system plus any on-site precipitation or overland flows that could be affected by NMGS. Overland flows and precipitation runoff from the

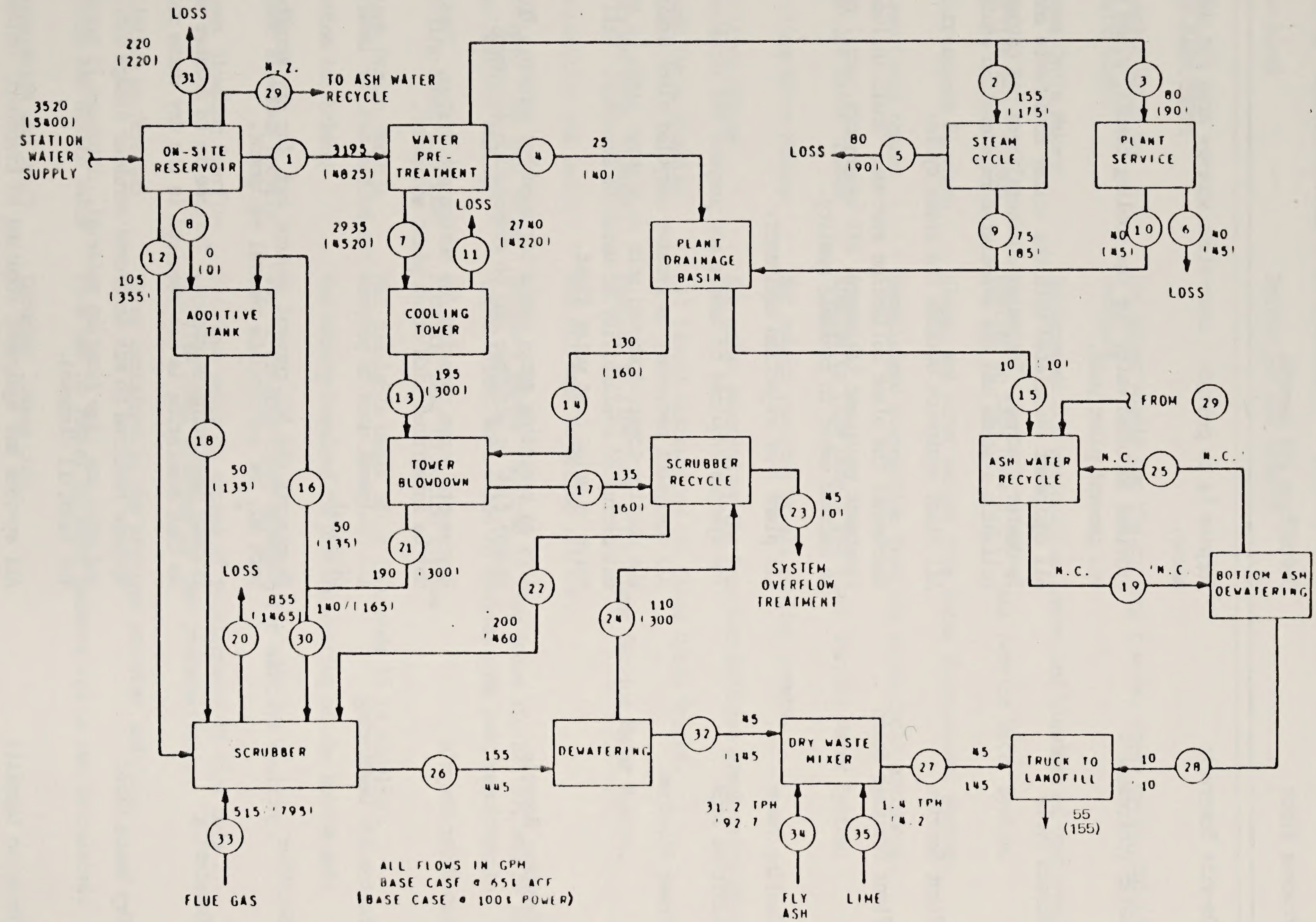


Figure 2-3. PROCESS FLOW DIAGRAM FOR THE BASE CASE WATER MANAGEMENT SYSTEM PER UNIT

Table 2-4. DEFINITION OF PROCESS BLOCKS AND FLOW NODES SHOWN ON FIGURE 2-3

Process Block	Definition and Remarks
On-site Reservoir	Purpose is to provide a near-plant storage area for make-up water.
Water Pretreatment	Provides softened water for the cooling towers, steam cycle, and general plant uses.
Stream Cycle	All equipment associated with the boiler condensate and feedwater systems. Including demineralizers and condensate polishing systems and the associated regeneration equipment.
Plant Service	All plant equipment outside the steam cycle.
Plant Drainage Basin	Represents the plant collection systems. Would include any treatment equipment (skimmers, oil separators, etc.) required to upgrade water to reusable quality.
Cooling Tower	All plant heat rejection equipment.
Additive Tank	The systems required to handle and prepare the scrubber additive.
Tower Blowdown	All equipment necessary to receive recycled plant drainage and the cooling-tower blowdown; acts as a surge basin to ensure uninterrupted availability of water to scrubber. Will cascade water by using best water first.
Scrubber Recycle	Acts as cascading surge basin for scrubber makeup. Ensures steady flow to scrubber and to evaporation equipment.
Ash Water Recycle	Represents surge capacity for bottom ash system. Physically may be integrated with other plant equipment.
Bottom Ash Dewatering	All equipment used to prepare the bottom ash for landfill disposal.
Scrubber	Represents the SO_2 removal systems and, for dry scrubber case, both SO_2 and particulate removal equipment.
Dewatering	Primary dewatering equipment. Purpose is to dewater sufficiently so that dewatering is not required in the dry waste mixer.
Dry Waste Mixer	Systems required to mix dewatered scrubber sludge with fly ash and with any lime fixation material. Produces 75 percent solids for landfill disposal.
Truck to Landfill	All systems and equipment required to transport, unload, compact, and cover plant solid wastes.

Table 2-4. DEFINITION OF PROCESS BLOCKS AND FLOW NODES SHOWN ON FIGURE 2-3 (concluded)

Process Block	Definition and Remarks
Process Flow Nodes	
1. Settled Water to Pretreatment	Net water supply for the cooling towers, steam cycle, and plant services.
2. Steam Cycle Makeup	Replacement for evaporation losses and blowdown of waste water.
3. Service Water Makeup	Similar to flow node 2 for Plant Service Water System.
4. Pretreatment Blowdown	Sludge and other wastes from Water Pretreatment System.
5. Steam Cycle Losses	Unreclaimed evaporation from the steam cycle equipment.
6. Service Water Losses	Similar to flow node 5 for Plant Service Water System.
7. Cooling-Tower Makeup	Net makeup required by all cooling towers.
8. Additive Makeup	Net water required by the Scrubber Additive Preparation System.
9. Steam Cycle Blowdown	All liquid wastes from the Steam Cycle System.
10. Service Water Blowdown	Similar to flow node 9 for Plant Service Water System.
11. Evaporation and Drift	For all heat rejection systems.
12. Scrubber Pump Seal Water and Scrubber Makeup	Scrubber makeup required if flow nodes 18, 22, 30, and 33 are insufficient when added to minimum pump seal requirements.
13. Cooling-Tower Blowdown	From all heat rejection systems.
14. Plant Drains Recycle	Net available water after flow node 15 is supplied.
15. Bottom Ash Makeup	Net makeup required to provide wetting of the bottom ash.
16. Tower Blowdown Recycle	Use of cooling-tower blowdown for additive sluicing.
17. Tower Blowdown Overflow	Blowdown water in excess of requirements of flow node 21. Recycled plant drainage is used preferentially.
18. Additive to Scrubber	Water contained in the prepared scrubber additive.
19. Bottom Ash Sluice Water	Flow has no impact on water balance and is not calculated.
20. Evaporation and Drift	Scrubber losses only.
21. Tower Blowdown to Scrubber	Dedicated uses of plant drainage and cooling-tower blowdown waters.

plant site not contaminated by plant site drainage or discharges would not be diverted to the water system or impounded.

PNM plans that the water management system would operate, under nonupset conditions, without discharge to any off-site channel or receiving water body, and without significant percolation or seepage to ground water. Therefore evaporation would be the only available means for disposing of unusable water. Because water is a scarce and valuable commodity in the area, and in order to limit the quantity of water to be disposed of, the NMGS water management system would be designed and operated to reuse, reclaim, and recycle water to the maximum practical extent, including reuse in progressively less demanding parts of the system. Several water treatment systems and processes would be incorporated in the water management system to provide water of acceptable quality for the various in-plant needs. Used water, degraded to the extent that it could not be economically treated for further in-plant use, would be used for transport and disposal of plant-generated wastes or would be discharged to evaporation ponds.

Plant Site Drainage. Several minor intermittent drainage channels presently cross the area where the power plant would be constructed. All of these channels ultimately discharge into De-na-zin Wash. The Proposed Action would be to perform area grading so that flow in those channels would be diverted around the plant area and into De-na-zin Wash; thus the runoff would not be affected by plant activities or emissions. The diversion channels would be designed and constructed with sufficient capacity to divert the maximum runoff that would result from storms having a probability of occurring once in 100 years without causing flooding of the plant site. Channel gradients would limit flow velocities sufficiently to control scour and erosion, or critical reaches of the channels would be lined to prevent erosion.

The plant site area would be graded, shaped, and surfaced to facilitate control and collection of contaminated runoff from on-site precipitation (from a ten-year 24-hour storm) and possible liquid spills. Surfacing may include covering areas with impervious materials, such as compacted clay, to control percolation. Plant site contaminated runoff and spills would be collected in drainage basins. From the basins the collected liquids could be transferred to water treatment facilities for reclamation and use; used without treatment in the ash disposal system, if appropriate; or sent to evaporation ponds for disposal. On-site drainage that would not be contaminated by the NMGS facility would not be collected.

Water Treatment

Proposed Action. The Proposed Action for water treatment would be essentially the same regardless of the water supply source(s). Therefore any differences in the Proposed Action would be related to the degree of treatment required to provide water of acceptable quality for each plant water use.

The major plant water use would be in the heat rejection system, which would discharge large volumes of water into the atmosphere by evaporation from the cooling towers. Makeup water for this system, from either the San Juan River source or ground water, would be treated by lime or lime-soda softening and pH adjustment to control scaling and corrosion before introduction into the system. In addition, the water in the system probably would be chlorinated or ozonated as required to control biological fouling of the tower and algae growths in the basins beneath the towers. Blowdown from the system would be used in the plant flue gas desulfurization system and for ash transport or wetting.

The most sophisticated water treatment system required for the plant would process makeup water for the steam cycle. Prevention of scaling and corrosion would be required for water used in the steam cycle, both for system protection and sustaining system efficiency. NMGS would use demineralizers that would produce water of acceptable quality for boiler water make-up. The details of the water treatment system to be provided for the steam cycle would not be selected until final project design. The final process selection would be based on economic considerations and the expected system performance with the specific water supplied to the system from the water softening plant.

Plant service water would probably require only treatment in the water softening plant. It is expected that this supply would be similar to drinking water and that the chlorination system provided with the softening system would yield a satisfactory water for human consumption.

Chlorine for the plant water treatment system would be delivered in liquid form, in cylindrical steel containers of 1-ton capacity. Containers for the purpose have been standardized by the industry, and experience has shown that the containers are exceedingly durable. The technology for producing, handling, and shipping chlorine is well established, and accidents that result in releases of chlorine to the environment are rare. At the plant, the cylinders would be stored under cover, but in an otherwise open and well-ventilated area. Gas masks would be provided in accessible areas in case leaks occur in the process of connecting or disconnecting the cylinders to the service manifold.

Other chemicals for the plant water treatment system would be delivered in liquid, granular, or powdered form and would present no major risks with respect to storage and handling, although they would be considered corrosive or reactive, particularly if wet. The techniques and procedures for handling, mixing, and feeding all chemicals likely to be used in the water treatment processes are well established by the industry. Ordinary care in their use, according to the accepted practices, would protect the workers and the environment.

The water treatment processes would yield several waste products, including sludges and concentrated solutions. These wastes would be either discharged to the plant wastewater evaporation ponds or used for wetting fly ash and then disposed of in the mine. Liquid wastes unsuitable for placement in the mine with the ash would be disposed of in on-site evaporation ponds.

Disposal of Wastewater and Water Treatment Sludges

The Proposed Action would be to construct evaporation ponds for the disposal of unusable waters and water treatment sludges that are unsuitable for disposal in the mine. The areas proposed for pond construction are indicated in Figure 2-1. The details of pond construction would be established in the project final design. Several ponds would be available to provide flexibility in system operation. The ponds would be lined with impervious material to limit and control seepage losses and would conform with applicable state and federal regulations. Water might be recovered by decanting from ponds receiving settleable sludges. Sufficient pond surface area would be provided to evaporate the water received in the ponds, on an annual basis, and sufficient depth would be provided in the ponds to accommodate surges resulting from storm runoff or accumulations during periods of low evaporation.

2.8.2 Solid Waste Disposal

Four types of wastes would be derived from coal used in NMGS:

- Bottom ash
- Fly ash (including economizer ash)
- Coal pulverizer rejects
- Flue gas desulfurization by-product

Bottom ash and pulverizer rejects would be combined when removed from the system. The flue gas desulfurization (FGD) by-product could be either dry particulate matter or a water-based slurry, depending on the selected desulfurization process. If the FGD by-product were in particulate form, it would be removed from the flue gas in combination with the fly ash; in slurry form, it would be removed separately from the fly ash.

Fly ash may have resource values that could be economically recovered. The market value of the ash resources would probably vary over time, and conceivably during some or all of the operating life of the power plant it would not be economic to recover the resource values. The potential values would probably be less if the fly ash were mixed with other materials (i.e., FGD by-product). The least-cost resource recovery procedure would probably be based on receiving ash directly from the point where it was discharged as waste from the power plant operations, because this would minimize handling and rehandling requirements. Therefore, for the following description of alternatives, it is assumed that the only configurations for which concurrent resource recovery from ash would be considered would be systems that discharged only fly ash directly to receiving facilities of the resource recovery system. The ash could be directed to those facilities, either in whole or in part, continuously or intermittently, throughout the operating life of the plant. It is further assumed that any ash not sent directly to resource recovery would be disposed of by the most economic, environmentally acceptable means available, and that blending or mixing of the fly ash with other wastes would be acceptable if this were economically desirable for the disposal.

On a quantitative basis, the most significant waste streams associated with NMGS would result from the coal burning process, including coal preparation (pulverizing) and desulfurization of the combustion gases. Other project-related wastes would be derived from the various water treatment processes required for operations; sanitary wastes derived from support of the project construction, operating, and maintenance staffs; and plant construction wastes.

Quantities of Coal-Derived Wastes. Estimates are presented in Table 2-5 for the annual quantities of bottom ash and pulverizer rejects, fly ash, and scrubber sludge that would be produced from the operation of one generating unit at a 65 percent capacity factor and also an 85 percent capacity factor (worst case), using Bisti coal with typical properties. The Table 2-5 data include estimates for both wet limestone and lime spray drying FGD systems, since no final decision has been made at this time concerning the applicant's proposed FGD process.

On a volumetric basis, the estimated average production of coal-derived wastes would be about 1475 acre-feet per year with four units operating, or 59,000 acre-feet over a 40-year plant life. The estimated unit weight upon which the volumetric estimates were based were as follows:

• Bottom ash and pulverizer rejects, combined	45 pounds per cubic foot
• Fly ash and scrubber sludge	70 pounds per cubic foot

Table 2-5. ESTIMATED QUANTITIES OF COAL-DERIVED WASTES
(tons per year per 500-MW unit)

Waste	Quantity at 65% Capacity Factor		Quantity at 85% Capacity Factor	
	Solids	Water	Solids	Water
Wet Limestone FGD System				
Bottom ash and pulverizer rejects, combined	82,000	14,500	107,400	19,000
Fly ash, including economizer ash	272,000	0	356,300	0
Scrubber (FGD) sludge	37,000	333,000	48,500	436,200
Fly ash and dewatered scrubber sludge, combined	309,000	103,000	404,800	135,000
Alkali Spray Drying FGD System				
Bottom ash and pulverizer rejects, combined	82,000	14,500	107,400	19,000
Fly ash and SO_2 scrubber by-products, combined and wetted for disposal	313,300	104,400	410,400	136,800

Source: Black and Veatch, Consulting Engineers.

Ash Composition. It is expected that the mineralogical composition of the ash produced at NMGS would be similar to that of ash from the existing Four Corners Power Plant, since the NMGS would use coal from the San Juan Basin, which is also the source of coal for the Four Corners Power Plant. Table 2-6 presents the representative results of mineralogical analyses of ash from the Four Corners Power Plant, together with the range of results from several analyses of ash from Bisti coal and the typical values that would be expected from NMGS ash.

Table 2-7 presents the results of elemental analyses of fly ash and bottom ash from the Four Corners Power Plant; these ashes are expected to be similar to ashes from NMGS.

Under existing laws and regulations, power plant wastes derived from coal and coal combustion, including by-products from emissions controls, are not considered hazardous.

Dry fly ash, as collected in the particulate emissions control system, would be a fine, light, powdery material that would be subject to dispersion in air if exposed to the atmosphere and wind. Accordingly, any fly ash that would be disposed of as waste from the plant operations would first be wetted to control dusting.

2.8.3 Ash Disposal

Proposed Action.

Fly Ash and Scrubber By-Product. The proposed action includes combining fly ash with FGD by-product prior to disposal. If a wet limestone FGD process were selected, the slurry from the FGD system would be dewatered before being mechanically mixed with fly ash. If an alkali spray drying FGD process were selected, fly ash and FGD

Table 2-6. MINERALOGICAL ANALYSIS OF FOUR CORNERS ASH AND BISTI COAL ASH (percent)

Mineral	Representative Values, Four Corners Ash[a]	Bisti Coal Ash[b]	
		Range	Typical
Phosphorus Pentoxide (P_2O_5)	NA[c]	0.03 to 0.35	0.1
Silica (SiO_2)	56.7	46.66 to 63.92	56.8
Ferric Oxide (Fe_2O_3)	3.4	2.43 to 5.91	3.7
Alumina (Al_2O_3)	26.5	19.68 to 36.30	27.4
Titania (TiO_2)	0.7	0.69 to 1.04	0.8
Calcium Oxide (CaO)	5.6	1.54 to 4.83	3.8
Magnesium Oxide (MgO)	0.7	0.64 to 1.82	0.9
Sulfur Trioxide (SO_3)	NA	0.32 to 7.35	1.9
Potassium Oxide (K_2O)	1.8	0.34 to 1.84	0.8
Sodium Oxide (Na_2O)	1.5	1.15 to 3.15	2.1
Undetermined	3.10		1.7
Total	100.0		100.0

[a]Source: Paul Weir 1976.

[b]Source: PNM (D.J. Groves et al. 1981).

[c]NA - Data not available.

Table 2-7. ELEMENTAL COMPOSITION OF FOUR CORNERS ASH

Element	Micrograms/gram (unless % indicated)	
	Fly Ash	Bottom Ash
Aluminum	14.3%	13.2%
Arsenic	12	1
Boron	233	117
Barium	0.30%	0.3%
Beryllium	3.7	3
Calcium	2.74%	3.1%
Cerium	--	--
Cadmium	<0.50	>0.5
Cobalt	--	7
Chromium	20	15
Copper	54	37
Europium	13	15
Fluorine	140	>50
Iron	2.66%	2.78%
Gallium	50	20
Mercury	0.06	>0.01
Potassium	0.75%	0.03%
Lanthanum	70	70
Lithium	79	78
Magnesium	0.59%	0.54%
Manganese	267	367
Molybdenum	7	>7
Sodium	1.4%	1.31%
Niobium	17	>20
Nickel	8	>10
Phosphorus	0.06%	0.03%
Lead	70	27
Sulfur	0.11	0.06
Antimony	1.34	0.23
Scandium	13	10
Selenium	6.87	0.18
Silicon	27.6%	27.1%
Strontium	367	300
Tellurium	0.18	>0.02
Titanium	0.57%	0.37%
Thallium	1.40	0.30
Uranium	9.80	9.77
Vanadium	90	70
Yttrium	30	30
Zinc	63	24
Zirconium	267	167

References for fly ash data: Wangen and Wienke (1976) and Swanson (1972). Samples were collected from electrostatic precipitator at Four Corners Power Plant.

by-products would be collected simultaneously in the particulate control system, and the combined material would be wetted in a mechanical mixer.

Ash wetting and mixing with FGD by-products would have several beneficial effects. The wetting would control dust releases to the atmosphere. The mixed material would have a lower permeability than the FGD sludge by itself, increased shear strength, and lower combined volume. The mixed material would have relatively low permeability and therefore a low release rate for leachates.

The wet material would be hauled by end-dump truck to previously mined portions of the coal mine. Disposal areas would be selected on the basis of (1) providing substantial vertical separation between the disposed ash and ground water, to limit the potentials for ground water degradation by ash leachates, and (2) proximity to the power plant, to control haulage costs.

Disposal areas would be prepared for receiving ash by first backfilling with mine overburden material to a depth of 20 to 60 feet, depending on the volume of overburden requiring disposal. The surface of the overburden would be leveled and nominally compacted by the equipment used for the leveling operation. Ash would be dumped and spread in the maximum thickness layers feasible for the trucks being used. Present expectations are that several layers of ash would be placed, to an ultimate thickness of 40 to 60 feet. The wetted ash and sludge mixture would be self-cementing as it dried, and there would be little tendency for dusting or airborne emissions from exposed ash surfaces. However, for dust control, the area being used for ash disposal would be as small as practically possible for efficient operation.

After the ash was placed and spread to the final disposal depth, it would be covered with random overburden from the mining operations to a depth of 4 to 8 feet. The overburden would in turn be covered with approximately 4 inches of select overburden (top dressing). The area would then be disced to yield a transition zone of mixed overburden and top dressing. An additional 8 inches of top dressing would then be spread and disced and the area seeded. The final surface of the disposal area would be shaped and gently sloped to permit drainage without erosion. Also, it may be furrowed to retard runoff.

Final reclamation of disposal areas would consist of establishing a vegetative cover in accordance with reclamation requirements that would be specified by the Office of Surface Mining for individual mining plans. In general, revegetation would be accomplished by seeding, with selected native species, at the appropriate season and irrigating or reseeding as required until a satisfactory ground cover was established. Details regarding areas to be revegetated and techniques to be used would be specified by the Office of Surface Mining. Although the quantity of water to be used for irrigation cannot be specified at this time, it could be substantial.

The Proposed Action would result in the fly ash being concentrated within relatively small areas and uncontaminated with materials other than the FGD by-product, waste waters from the water management system, or water treatment sludges. Therefore future recovery of the material might be feasible if economic conditions made it worthwhile for resource recovery, or if for any reason environmental effects of the disposal were no longer satisfactory.

Bottom Ash and Pulverizer Rejects. Combined bottom ash and pulverizer rejects would be collected for disposal in dewatering bins where they had deposited as a dilute waterborne slurry. The dewatered slurry would be discharged into end-dump trucks for hauling to the disposal area. Disposal would be into previously mined portions of the coal mine, probably contiguous to the fly ash disposal areas. The procedures for disposal would be the same as described above for fly ash, in case at some time it was necessary or desirable to have access to the materials.

Alternatives Not Selected for Detailed Analysis

Fly Ash - Alternative 1. If a wet limestone FGD process were selected for the project, then the fly ash would be collected from the boiler as a separate material. As such it would have the maximum potential market value. If an economic market developed for any or all of the fly ash, it would be exploited. At this time it is not known whether such a market might develop, where it might be located, or how the fly ash would be transported to the market. Therefore, although such disposal might be available and desirable, it cannot be analyzed in the NMGS EIS.

Fly Ash and Scrubber By-Products - Alternative 2. Fly ash and FGD by-products would be wetted and mixed as described for the proposed action. The mixed products would be hauled by end-dump trucks to the mine, where it would be randomly dumped over the mine highwall and dispersed throughout the overburden during burial instead of systematically kept separate from the overburden. Although this procedure would be less costly to implement, it is considered not available because the randomly dispersed fly ash and FGD by-product mixture would be left inaccessible either for resource recovery or for remedying environmental effects that might be declared unacceptable.

Fly Ash and Scrubber By-Products - Alternative 3. Instead of returning the mixed and wetted fly ash and FGD by-products to the mine, a separate disposal facility might be developed. The disposal area would be prepared by stripping and excavating topsoil, leveling and compacting the exposed surface, and possibly lining it with clay or synthetic liner material. The fly ash would be placed in layers as described for the proposed action, and final reclamation of the disposal area also would be as described for the proposed action. This alternative is considered not available because, in addition to being the most costly to implement, it would be physically impractical to implement. There is not sufficient suitable area available for the purpose within the plant site, and other lands outside the potential coal mine areas are not available to the applicant.

Bottom Ash and Pulverizer Rejects - Alternative 1. Bottom ash and pulverizer rejects could be randomly placed within previously mined portions of the mine, as described above for fly ash alternative 2. This alternative is considered not available for the same reasons as noted for fly ash.

Bottom Ash and Pulverizer Rejects - Alternative 2. Bottom ash and pulverizer rejects could be disposed of in a separate disposal facility, as described for fly ash alternative 3. This alternative is considered not available for the same reasons as those noted for fly ash.

2.8.4 Sanitary Waste

The sanitary sewage treatment system would consist of two treatment plants capable of handling the waste of an aggregate population of 1000 individuals. One sewage treatment plant would be constructed for Units 1 and 2, and a second plant would be installed when Units 3 and 4 are constructed. Each sewage plant would be sized to handle an estimated 30,000 gallons per day.

Each sewage treatment unit would be a package plant involving four primary treatment steps: a screening section, an aeration unit (sized for 24-hour retention), a settling section with sludge return to the aeration section, and an effluent chlorinator tank. Sewage sludge disposed would be contracted to a local firm or disposed of in acceptable landfill or reclamation operations. The effluent from sewage treatment would be delivered to the water management system for reuse within the generating complex.

During the construction period, portable chemical toilets would provide sanitary facilities for the construction labor force. Supply and maintenance of these facilities, including treatment and waste disposal, would be contracted to a local chemical toilet supply firm.

Sewage treatment facilities would be located to optimize the following considerations:

- Maintenance
- Operations
- Gravity flows to the various components (i.e., reduce dependence on pumping equipment wherever possible)

The final location and layout of the sewage treatment facilities would not be decided until a detailed plant layout is adopted.

2.9 HEAT REJECTION SYSTEM

Spent steam discharged from turbine generators must be condensed before it can be returned to the boilers for recycling. A large quantity of heat is released in the condensation process. The heat of condensation is transferred to the condenser circulating water and from there to the atmosphere. In areas where water supplies are limited, such as New Mexico, it is necessary to cool and recycle the circulating water. Evaporative cooling is the usual method for transferring heat from the circulating water to the atmosphere. However, it may be necessary to transfer all or a portion of the waste heat to the atmosphere by convective processes. In that case, the circulating water is passed through closed heat exchangers having large surface areas exposed to the atmosphere. These two heat transfer methods are commonly referred to as wet and dry systems, respectively.

2.9.1 Proposed Action

Wet-Type Cooling Towers. At this time, potential water supplies available for the NMGS are believed to be sufficient to permit design of a complete evaporative cooling system for a four-unit plant. The proposed action, therefore, would be to construct a heat rejection system based only on evaporative cooling and to use forced-draft cooling towers. This system would consist of cooling towers coupled via circulating-water piping and pumps to the steam cycle condensers. The system would be designed to operate satisfactorily during all normal and foreseeable emergency conditions.

Cooling-tower makeup water would be drawn from the nearby raw water storage reservoir. This water may require pretreatment prior to cooling-system use. The makeup water would replace the tower losses from evaporation, drift, and blowdown. Preliminary cooling-tower information is listed below (based on San Juan No. 4 wet-cooling tower design):

Circulating-water flow rate	250,000 gpm/unit
Evaporative consumption (average)	4510 gpm/unit

Evaporation	1.8 %/circulating-water flow rate
Drift	0.01 %/circulating-water flow rate
Blowdown	100 to 300 gpm/unit
System makeup	4635-4835 gpm/unit

Source: PNM 1980, unpublished data.

Blowdown System. As water evaporates from a closed-cycle cooling system, dissolved and suspended substances become increasingly concentrated in the remaining recirculating water. To limit concentrations to acceptable levels, a portion of the recirculating water would be withdrawn continuously. The discharged cooling water, termed "blowdown," would be replenished by makeup water to maintain a constant quantity of water in the system.

The ratio of the concentration of dissolved and suspended substances in circulating cooling water to original concentrations in makeup water is generally referred to as the number of cycles of concentration. As concentration ratios increase, dissolved materials precipitate from solution and cause fouling or scaling of the system; and ultimately, extensive water treatment is required.

Historically, treatment of closed-cycle cooling water (evaporative systems) generally has been limited to acid or base addition for pH control, and chlorination for control of biological fouling. Scale inhibitors have been used to prevent dissolved solids from precipitating on heat transfer surfaces. Generally, as the availability of makeup water supplies becomes more limited (or more costly) and as more stringent limitations are placed on blowdown, more extensive water treatment may be needed.

Operating recirculating systems at a high number of cycles of concentration would be desirable at the NMGS, if the ultimate objective were to operate with makeup water requirements and/or blowdown rates as low as possible. Reduction of the makeup requirement would be an objective where water was scarce; reduction of blowdown would be an objective where strict limits were imposed on the discharge or where no discharge to a receiving stream was allowed. In the latter case, a reduction of blowdown would be important in reducing the size and cost of blowdown treatment. Typical blowdown ranges for a 500-MW unit wet tower would be 100 to 300 gallons per minute. Cooling-tower blowdown probably would be evaporated, treated and/or recycled as necessary to achieve zero discharge.

2.9.2 Alternatives

Wet/Dry Towers. If sufficient water could not be secured for a totally evaporative system (see water supply section), a water-cooling system employing both dry and conventional wet towers might be required. A combination of wet- and dry-cooling towers would require approximately 2.5 times the land area (less than 25 acres total) and substantial increases in hardware items over what wet-cooling towers alone would require. The wet towers would be designed to operate mainly during the summer and the dry towers to operate mainly during cold weather. Capabilities of these two cooling systems would be combined to condense the turbine exhaust steam in a dual-service condenser. The net result would be a power plant that could use conventional low-back-pressure turbines and still meet reduced makeup-water requirements.

2.9.3 Alternatives Not Considered for Detailed Analysis

Once-Through Cooling. Once-through cooling with San Juan River water would not be feasible because flow in the river would not be adequate to provide the large amounts of water required for this system compared to the Proposed Action. Also, such a system would require pumping water in a loop between NMGS and the river. Pipelines and pumping stations would be much larger than required for a recirculating, nonreturn system. Capital and operating costs for necessary facilities with this configuration would be economically unjustifiable compared with other potential heat dissipation systems.

Cooling Ponds. Artificial ponds, or lakes, could be used as a thermal energy dissipation system. However, cooling ponds would require large land areas and would be subject to larger water losses than those for cooling towers. Ponds could affect surface and subsurface hydrology because of seepage. Suitable geologic formations for impounding necessary quantities of water for pond cooling are unavailable at or near the NMGS site. Costs associated with this option would be substantially greater than for other available cooling systems.

Natural Draft Cooling Towers. Natural draft cooling-tower systems are generally used in relatively cool climates, where the density of the influent ambient air is sufficiently greater than that of the heated and moistened effluent air to create the necessary natural draft effect. Such a system would not be feasible at NMGS because of persistent high dry-bulb temperatures and low humidities during the summer. Natural draft towers are massive structures, with some towers attaining a height of 600 feet. Such towers may be considered aesthetically unacceptable because they would be visually prominent many miles from the site. For these reasons, plus high capital costs, natural draft cooling towers are not considered a reasonable alternative for NMGS.

Dry Mechanical Draft Cooling Towers. In dry-cooling-tower systems, cooling water is circulated through closed heat exchangers with large surface areas exposed to the air. Heat is dissipated by conduction and convection. Such towers avoid problems of fogging and icing and thus do not have great visual impacts other than their large physical size. Also, water consumption is substantially less than that of wet-cooling towers. However, overall plant efficiency is reduced because the turbines must operate against higher condenser back pressure. Dry cooling requires a larger land area, and installed costs may be as much as 20 times the cost of mechanical draft wet-cooling systems. These drawbacks would substantially reduce the desirability of a dry-cooling system at NMGS. Dry-cooling towers, and turbine designs to operate with them, have been developed but have not been used on any power plant whose generating capacity exceeds 330 MW.

3.0

WATER SUPPLY SYSTEM

The estimated water requirement for NMGS, with four units operating at rated capacity, would be about 35,000 acre-feet per year. This requirement is based on a plant heat rejection system equipped with wet-cooling towers. If an adequate water supply could not be obtained for a fully wet cooling system, it would be technically feasible, with substantial economic penalties, to design and operate the NMGS with a combination wet/dry heat rejection system. PNM anticipates that it will be able to conclude water supply agreements that would provide sufficient water for a fully wet heat rejection system, or 35,000 acre-feet per year. PNM has almost completed arrangements to ensure that at least 20,000 acre-feet per year would be available. Systems using 20,000 and 35,000 acre-feet per year are described below for the Proposed Action and alternatives.

The Proposed Action would involve acquiring contractual rights to 35,000 acre-feet of water per year from Navajo Reservoir (San Juan River). The water would be stored in Navajo Reservoir for release on demand. The natural channel of the San Juan River would be used for delivery of the water to a river diversion facility to be constructed near Farmington. Pumps at the diversion facility would discharge the water into pipelines that would deliver the water to NMGS. Booster pumping stations would be required along the pipelines. In general, water would be delivered to NMGS at rates corresponding to current use. A staged program of construction of pumps, pumping stations, and pipelines would be implemented, coordinated with the times when new generating units would go in service at NMGS. A storage reservoir near the plant would compensate for minor differences between supply and demand and would provide a backup supply during periods of service interruption on the proposed supply system.

3.1 WATER SUPPLY SOURCE

3.1.1 Proposed Action

PNM proposes to obtain water from Navajo Reservoir (San Juan River) for NMGS by negotiating for use of existing water allocations and acquiring an allocation of contract water. The rights of New Mexico to water from the San Juan River (a tributary of the Colorado River) are governed by the terms of two compacts between the various states in the Colorado River Basin and by a treaty between the United States and Mexico. New Mexico's water rights for the San Juan River are administered by the State Engineer. The New Mexico Interstate Stream Commission works with other states and the federal government to administer the interstate compacts and to help develop New Mexico's water resources. Almost all of the water available to New Mexico under the terms of the compacts has been allocated to various applicants. This water includes the supply available from Navajo Reservoir, which was constructed and is administered by the U.S. Bureau of Reclamation, and for which rights were granted by the state of New Mexico to the federal government.

It is anticipated that PNM can obtain water for NMGS from Navajo Reservoir (San Juan River) by negotiating for use of existing water allocations and acquiring an allocation of contract water. PNM is currently negotiating to lease 20,000 acre-feet of water per year for beneficial consumptive use from an existing industrial contract holder from Navajo Reservoir, subject to required state and federal provisions. These contractual rights are good until 2005. PNM expects that these contractual rights could be extended to include the life of the proposed project.

PNM has applied to the New Mexico Interstate stream Commission for additional water from Navajo Reservoir, and if the water is available, would use an additional 15,000 acre-feet per year for NMGS. The maximum consumptive use of water from Navajo Reservoir for NMGS would be 35,000 acre-feet per year.

Water quality analyses for San Juan River water are presented in Table 3-1.

3.1.2 <u>Alternatives</u>

<u>Alternative 1: 20,000 ac-ft/yr from San Juan River and 15,000 ac-ft/yr from Well Field</u>. If the rights to more than 20,000 acre-feet per year of San Juan River water cannot be acquired, PNM would develop a well field in the vicinity of NMGS. Water from this well field would be used to make up the balance of the water required (i.e., 15,000 acre-feet per year for a wet-cooling system).

Ground water in certain areas of New Mexico is subject to regulation by the State Engineer. The authority of the State Engineer exists only in "declared underground water basins," which are basins declared by the State Engineer to have reasonably ascertainable boundaries, and for which he determines that management controls are necessary. The State Engineer declared the San Juan Basin in 1976 and will review applications for water rights therein, most likely on the basis of priority of application.

A subsidiary of PNM has applied to the state of New Mexico, through the State Engineer's office, for rights to 40,000 acre-feet

Table 3-1. RAW WATER ANALYSIS FOR THE SAN JUAN RIVER

Parameter	Measure
Calcium as Ca^{++}	62 mg/l
Magnesium as Mg^{++}	9 mg/l
Alkalinity as HCO_3	120 mg/l
Sulfates as SO_4^{--}	140 mg/l
Chlorides as Cl^{-}	9 mg/l
Iron as Fe	20 mg/l
Silica as SiO_2	9 mg/l
pH	8.2
Conductivity	535 μmhos/cm
Total Dissolved Solids	349 mg/l
Total Suspended solids	400 mg/l (avg)

Source: PNM 1981.

per year of ground water to be developed from wells in the vicinity of NMGS. Four applications having priority to PNM's most likely will be reviewed first. Water users in the San Juan underground water basin prior to 1976 (date of declaration) probably will be granted water rights permits in the amount of their historical beneficial use. Present plans are that PNM will continue to pursue the rights application and do sufficient exploratory drilling and testing to provide information required for consideration of this application.

The proposed wells would extract water from the Westwater Canyon Member of the Morrison Formation. The Westwater Canyon aquifer is projected to lie between 4000 and 6000 feet below the ground surface in the project vicinity. Unsubstantiated estimates indicate that potential well yields from the Westwater Canyon Member would be in the range of 100 to 1000 gallons per minute. Water quality analyses are presented in Table 3-2. Because of drilling, well development, and pumping costs, water recovered from the Westwater Canyon Member would have high unit costs.

PNM's application for rights to ground water specifies 16 locations for wells in the vicinity of NMGS. The wells would be widely spaced, so collecting pipeline systems and new access roads would be necessary to develop a water supply from this source. Variations to the well locations would probably be required after the status of the Arch Minerals coal preference right lease application (PRLA) is determined. Also, relocation of the pipeline collection system would be required if part of the well-field area were mined for coal.

Alternative 2: 20,000 ac-ft/yr from San Juan River and Combination Wet/Dry-Cooling System. This alternative water supply system is based on a total supply of 20,000 acre-feet per year, all from the San Juan River, and a combination of wet- and dry-cooling towers designed

Table 3-2. RAW WATER ANALYSES FOR WESTWATER CANYON WELLS

Parameter	Measure
Calcium as Ca^{++}	141 mg/l
Magnesium as Mg^{++}	4 mg/l
Alkalinity as $CaCO_3$	264 mg/l
Sulfates as SO_4^{--}	2074 mg/l
Chlorides as Cl^-	639 mg/l
Iron as Fe	1.0 mg/l
Silica as SiO_2	17.9 mg/l
pH	8.0
Conductivity	6060 μmhos/cm
Total Dissolved Solids	4458 mg/l
Total Suspended Solids	--

Source: Shomaker 1974.

to perform satisfactorily within the supply constraint. The wet/dry alternative would be substantially more costly than other cooling systems, would require additional land on which to erect cooling towers, and minor changes in plant appearance would be necessary. Less water would be discharged to evaporation ponds for disposal.

3.1.3 Alternatives Not Selected for Detailed Analysis

Mine Dewatering. A water supply possibility that did not pass the criterion of availability was a system based in whole or in part on water produced from uranium mine dewatering. Reasons for rejecting this potential source included:

- Levels of activity in the uranium mining industry are uncertain because of current low prices for uranium fuel.
- Production would not be within the control of PNM.
- Policies with respect to rights and uses for such water are in an emergent stage.

3.2 LOCATION OF SURFACE-WATER DIVERSION ON THE SAN JUAN RIVER

PNM has investigated the technical and administrative feasibility of diverting water from the San Juan River. Two locations appear most favorable; the Proposed Action is listed first:

3.2.1 Proposed Action

- A location in the vicinity of Farmington (Map 1-1)

3.2.2 Alternative

- A location near the State Highway 44 bridge crossing near Bloomfield (Map 1-2)

3.3 SURFACE WATER DIVERSION

3.3.1 Proposed Action

The proposed action would include the construction of a diversion facility (Figure 3-1) similar in design and operation to the existing diversion facility serving the San Juan Generating Station. Pumps would be used to lift water from the river without requiring construction of a diversion weir in the San Juan River. For flood protection, the site for the intake works and pumping plant would be surrounded by a dike, or the entire plant area would be filled to above flood level, i.e., above the 100-year floodplain. Site dewatering pumps would be required if a dike were built. Final designs may vary from the details shown on Figure 3-1, but the resulting environmental effects would not be substantially different. Approximately 35 acres of land would be required for the entire facility.

An intake structure with headgates would be installed on the southern bank of the San Juan River. The intake would be designed to divert, during the lowest river stages, the flows required for full development of NMGS. Diverted water would be conveyed through settling chambers, where suspended sand would be removed by sedimentation. Sediments in the settling channel may be removed by sluicing or pumping on a continuous or intermittent basis. An increase in turbidity would not be expected downstream because the coarse sand particles would settle out rapidly. If local sedimentation and back eddies result in deposition of sandbars, two options would be considered: (1) movable sections of pipe could be connected to the settling chamber pump system in order to disperse sand particles; (2) sands could be pumped out of the settling chambers and transported immediately downstream on the floodplain. Depending on peak flow rates in the San Juan River, it is likely that deposits on the floodplain or local buildup of sandbars would be washed

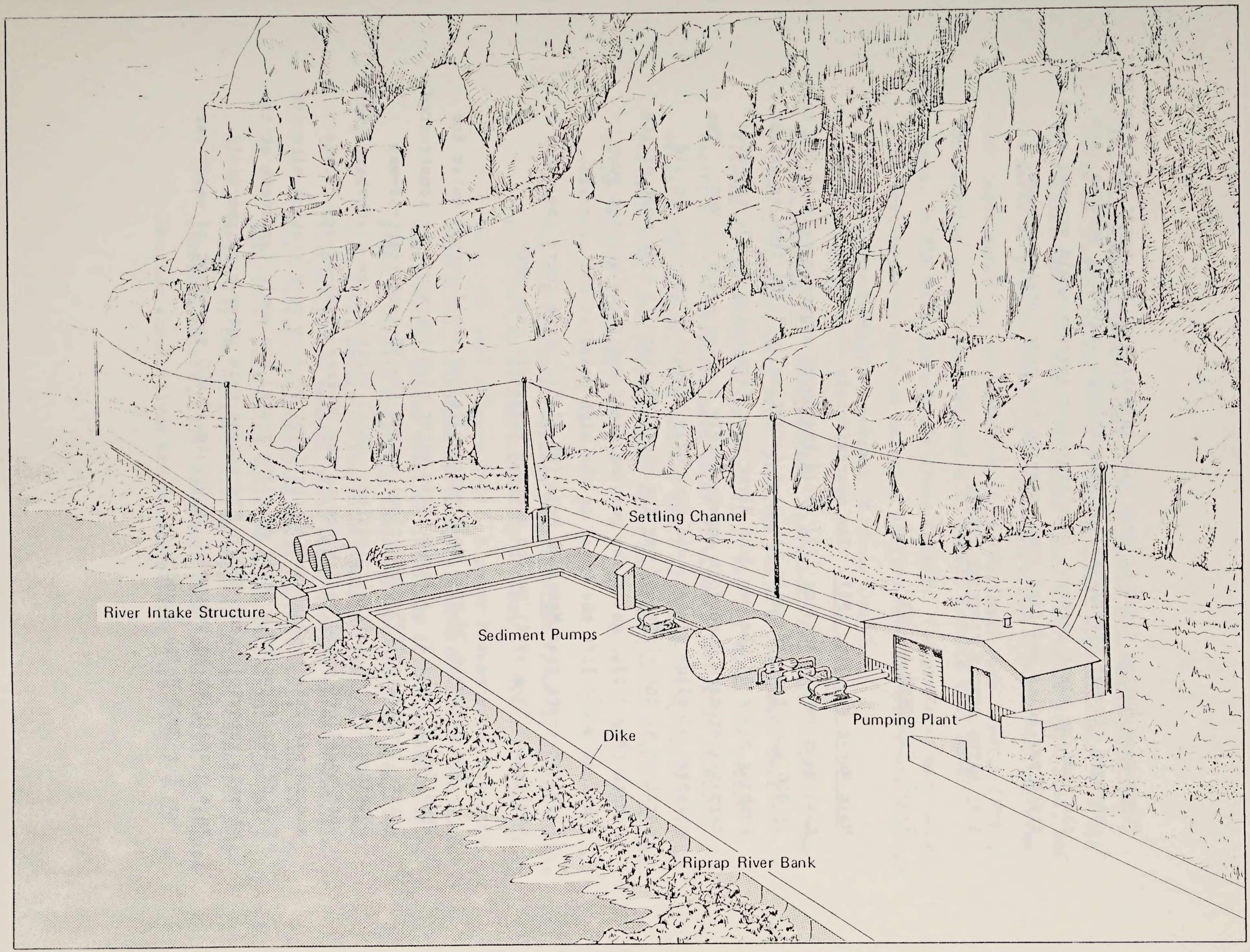


Figure 3-1. RIVER INTAKE PUMPING PLANT

downstream during flood or peak flow conditions. The water would be conveyed through trashracks and then through traveling screens into the pumping plant forebay. The traveling screens would prevent small trash particles and fish from entering the pump intake chamber.

3.4 WATER SUPPLY PIPELINE SYSTEM

3.4.1 Proposed Action

Main Water Pipeline (P1). The approximately 40-mile proposed initial main water pipeline (P1) would transport approximately 16,000 to 18,000 acre-feet of water per year (starting in 1990) from an intake pumping plant on the San Juan River near Farmington to the proposed terminal storage reservoir approximately 2 miles south of NMGS. The proposed pipeline route would generally be within the new and old portions of the rights-of-way for State Highway 371 over most of its length (Map 1-1). An intake pumping plant and three booster pump stations would lift the water to the high point of the proposed pipeline route near Moncisco Mesa (MP 17.0). From there the water would flow by gravity to the storage reservoir near NMGS.

The proposed initial main water pipeline would supply water for NMGS Units 1 and 2. A second main water pipeline would be constructed later (tentative 1995 completion) within the 90-foot right-of-way obtained for the initial pipeline. Total width of the disturbance for both pipelines would be limited to the 90-foot-right-of-way. This second pipeline would start at the first booster pump station site (MP 0.8 of the first main water pipeline route) and would terminate at the storage reservoir near NMGS. The second main water pipeline would have a capacity to transport 16,000 to 18,000 acre-feet of water per year for NMGS Units 3 and 4.

Initial Siting Considerations. The proposed main water pipelines would be located on and would directly affect approximately 94 acres of federal land, 318 acres of Indian land, 4 acres of state land, and 14 acres of private land. The buried pipeline(s) would not traverse any lands under the jurisdiction of the National Park Service (NPS), or existing or proposed NPS and U.S. Forest Service (FS) RARE II areas, or BLM Wilderness Study Areas (WSAs). The proposed main water pipelines would be near an existing utility (new and old State Highway 371) for approximately 75 percent of their length.

Project Components. Construction, operation, and maintenance of the following proposed main water pipeline project components were considered in the environmental analysis. Map 1-1 shows the general location of the proposed main water pipelines. Specific location details (topography, land status, etc.) are shown in Appendix G of the NMGS EIS. The proposed main water pipelines would consist of the following six elements:

1. One electric-motor-driven pumping plant (manned) at the intake site with an ultimate capacity of about 35,000 acre-feet of water per year (Figure 3-1). A power transmission line and substation, telephone service, telemetering lines, and microwave control system would be installed at the intake pumping plant. Details regarding these systems would be specified when final design of the intake pumping plant is completed. Initially, the pumping plant would contain three pump units (one backup) for supplying water to NMGS Units 1 and 2. Two additional pump units would be added to the intake pumping plant for the ultimate system supply. Direct-connected synchronous motors, 1250 horsepower each, would drive the pumps. Nonslam check valves and motor-operated gate valves would be

installed on the pump discharge lines. The discharge lines from each pump would feed into the common pump discharge manifold. Two surge suppressors, connected to the discharge manifold of the pumps, would be installed to discharge water back into the pump intake chamber in the event of excessive pressure during hydraulic transients in the main water pipelines. Initially, the intake pumping plant dimensions would be approximately 48 feet by 90 feet, and ultimately would be about 48 feet by 130 feet. The intake plant would include a control room, office, kitchen, toilet, and storeroom building. The plant would be constructed of reinforced concrete, steel, concrete block, or combinations thereof. The plant site would be surrounded by a dike, or the entire site area would be filled and raised above the 100-year flood level. If a dike were used, site dewatering pumps would be required. The entire plant site would be enclosed by a chain-link fence. The plant would have battery power and battery-charging equipment to provide electricity for the automatic control system devices, telemetering, telephones, and emergency lighting.

2. Approximately 1 mile of 48-inch outside diameter (OD) main water pipeline (steel) from the intake pumping plant to the first booster pump station. This pipeline segment would include a 6- to 7-foot-diameter adit (tunnel) into the base of the adjacent cliff, and a 6- to 7-foot-diameter vertical shaft connecting the adit to the ground surface on the mesa above. The purpose of the adit/shaft would be to get the pipeline on top of the mesa without scarring the sandstone escarpment directly south of the proposed intake pumping plant on the San Juan River. The space between the pipe and the

adit/shaft walls would be filled with concrete to secure the pipe in place.

3. Initially, approximately 39 miles of 40-inch outside diameter (OD) main water pipeline, between the first booster pump station and the terminal storage reservoir near NMGS. This pipe would be reinforced-concrete pressure pipe or mortar-lined and coated steel pipe. A second identical main water pipeline would be constructed at a later date to serve additional NMGS units (e.g., Units 3 and 4). The second line would be located parallel and within the 90-foot ROW that would be requested for the first line.

4. Three automatic electric-motor-driven pump stations (unmanned) would be needed between the intake pumping plant and the pipeline high point near Moncisco Mesa. Approximate locations for these booster pump stations and the intake pumping plant are listed in Table 3-3. Figure 3-2 illustrates a typical booster pump station. To provide electric power to intermediate pump stations, a power system would consist of a power transmission line (115 kV) and substation, telephone line, and telemetering lines. Details regarding the power system would be specified when final design of booster pumping station is completed. Initially, each booster pump station would contain three pump units (one backup) for servicing NMGS Units 1 and 2. The second main water pipeline would use the same intermediate pump stations, but two additional pump units would be required at each booster pump station. Two vertical surge tanks (one on each pipeline), with water-level sensors for emergency starting and stopping of pump motors and auxiliary

Table 3-3. LOCATIONS OF PUMP STATIONS

Name	Land Ownership	Township	Range	Section	Milepost	Elevation (feet)
Farmington Intake Pumping Plant		29N	13W	21	0.0	5245
Intermediate #1	Public Lands (BLM Admin.)	29N	13W	28	0.8	5820
Intermediate #2	Indian Lands or Reservation	27N	13W	21	10.4	6045
Intermediate #3	Indian Lands or Reservation	26N	13W	9	14.7	6298

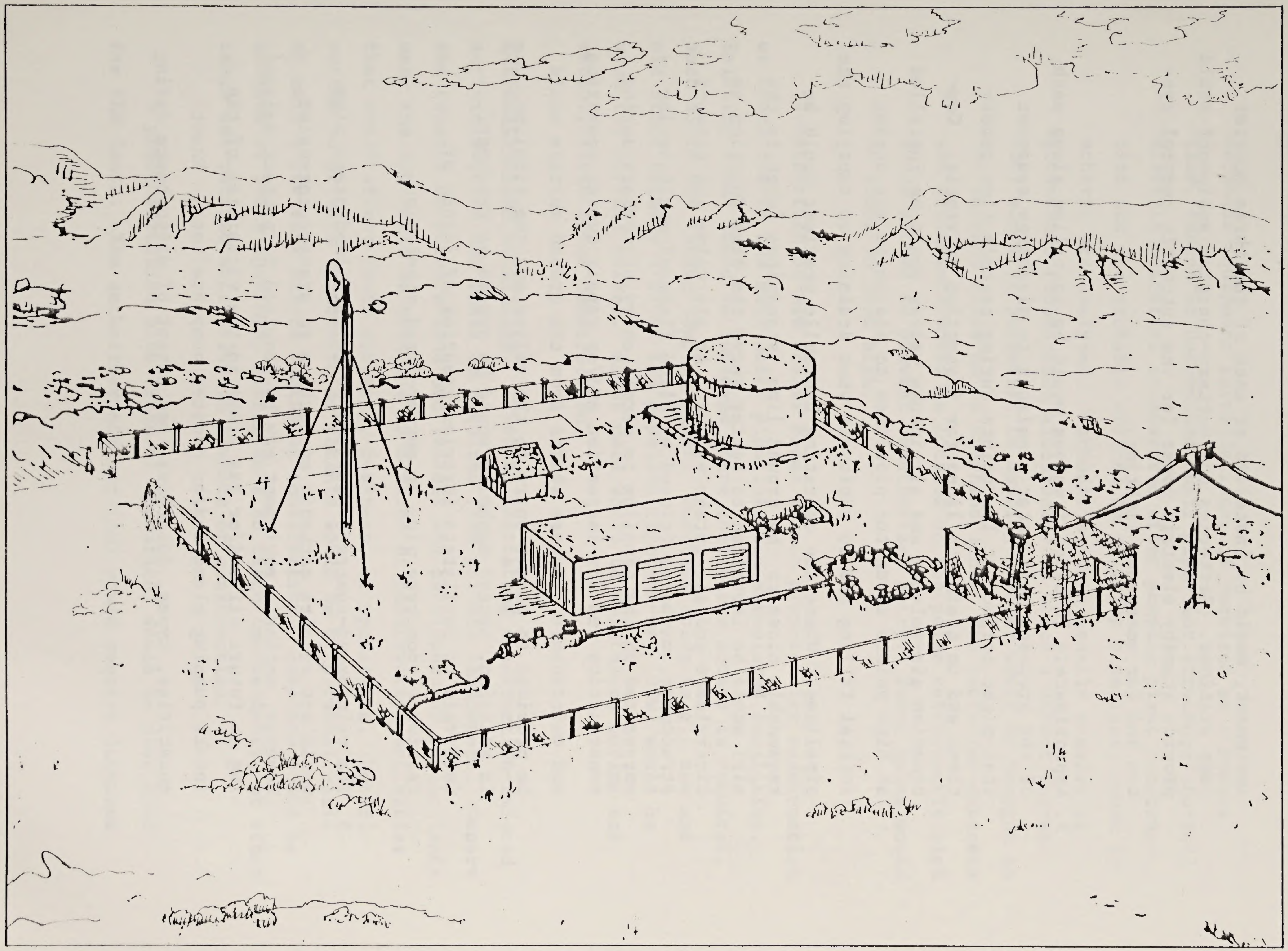


Figure 3-2. INTERMEDIATE PUMP STATION

equipment, would be installed at each of the three booster pump stations. Batteries and battery-charging equipment would provide standby electric power for the automatic control system and for emergency lighting.

5. Approximately 20 blowoff valves would be installed along each of the proposed main water pipelines to discharge sediment that might collect at low points during certain flow conditions and to drain the lines for inspection or repair. Combination air-release and air-intake valves would be installed at high points along the pipelines to discharge air during initial filling and to admit air when draining or emptying the pipelines. Where the operating hydraulic gradient would be reasonably close to the ground line, standpipes (open to the air) would be installed to better serve the same function as air-release and air-intake valves. At air valve and blowoff structures, manholes (closed by blind flanges) would be incorporated in the pipeline to permit entry of workers during construction and for inspection and/or repair during operation and maintenance. Access shafts from the ground surface would be provided to permit entry to the valves and the pipeline. In addition, access manholes would be spaced at frequent intervals to facilitate interior grouting of joints of reinforced-concrete pipe or mortar-lined steel pipe.

6. The reinforced-concrete pipeline or mortar-lined steel pipe would not require cathodic protection to prevent corrosion. However, cathodic equipment may be required to protect existing or future oil and/or gas lines in the vicinities of the intake pumping plant and/or booster pump stations. Exact quantities, types, locations, and extent of disturbance during

cathodic equipment installations, if required at a future time, cannot be determined until pipe- (or structure) to-soil electric potential is measured after pumping plant construction and the probable effects on existing pipelines, owned by others, are analyzed. Cathodic systems usually consist of groundbeds (subsurface electrodes) to which a direct current (DC) electric potential is applied. Power would be brought to the cathode sites on an overhead line. The rectifier cabinets and rectifiers would be located on the poles sufficiently high above ground to prevent unauthorized entry. Power poles would be about 35 feet high.

Construction of new access roads is not proposed for construction or operation of the main water pipelines and associated facilities. Existing roads would be improved where continuous access is required, such as to the intake pumping plant. Existing roads (e.g., new and old State Highway 371) or the pipeline right-of-way (ROW) would be used for surface travel. Roads used would be maintained during and rehabilitated after construction.

Preconstruction Activities. Prior to initiating construction-related activities, the ROW would be acquired from private landowners. Owners and tenants of private land and leasees and developers of public lands near the ROW would be notified in advance of construction activities that could affect their property, business, or operations. Notification to private landowners or tenants would be by personal visit or mail a few days before beginning construction. Ranchers would be advised of fence openings, disturbance to range improvements, or other range use-related activities in advance of construction.

A preconstruction plan (Plan of Operation) would be developed for BLM lands. The authorized officer (AO) would require detailed plans for construction, operation, maintenance, and termination of the pipeline system. At a minimum, the plans would include:

- Schedules for construction of the pipeline and all related facilities and estimated construction costs

- Plans for the protection of the environment during construction, operation, maintenance, and termination of the pipeline

- Plans for emergency repair of any rupture during operation, containment of spilled water, and restoration of areas which may have been damaged

Construction Methods. Construction of the intake pumping plant would require excavation to as much as 20 feet below the existing ground level. Ground water encountered during subsurface construction activities would be pumped into the San Juan River. A backhoe would be used for excavation. Excavated materials would probably be hauled by truck to a convenient on-site stockpile area or be used for construction of a protective dike. Some of the excavated material would be stockpiled for later use as backfill around intake pumping plant structures. The first intake pumping plant structure to be constructed would be the pump room. Other rooms would be attached to the pump room with their foundations near ground level, and would be considerably lower in height than the pump room. Following pump room construction, a bridge crane would be installed for setting equipment in place. A crane would be required to handle forms and to place concrete in the superstructure. Alternatively, a concrete pump could be used for lifting concrete into the forms. Concrete probably would be hauled to the site in transit-mix trucks from local commercial concrete batching and mixing plants. Air compressors and tampers, or possibly gasoline-powered tampers, would be used to compact backfill adjacent to the completed structures. Power rollers would be used to compact backfill in the larger areas around the structures and possibly for construction of a protective dike embankment. The intake pumping plant superstructure would be constructed of reinforced concrete, steel, concrete blocks, or combinations thereof. The completed intake pumping plant superstructure would extend at least 20 feet above the pump room floor, and the dimensions would be about 48 feet by 90 feet initially (i.e., with three pump units for NMGS Units 1 and 2). After two more pump units were added for NMGS Units 3 and 4, the dimensions would be 48 feet by 130 feet.

The plant site would be surrounded by a dike, or the entire site area would be filled and raised above the 100-year flood level, prior to construction of the intake pumping plant. The protective dike would be constructed on suitable foundation near the riverbank, using suitable excess materials from required excavations and from borrow materials. The dike would have 3:1 slopes both on the river side and on the landward side. The riverside slopes would be protected with riprap, or a reinforced-concrete surfacing if suitable rock for riprap were not economically available. Riprap or the concrete slab would extend well below the riverbed to prevent undermining. The dike would have a 10-foot top width to serve as a road for inspecting and maintaining the dike and for equipment access to the headgate area.

If the site were filled to provide a level surface above flood level, slope protection along the river would be constructed as described above.

Under either plan, construction would require removal of unsuitable materials from the dike and/or yard area; the foundation would be compacted and embankment placed thereon in shallow, level lifts. After processing to proper moisture content, the lifts of earth would be compacted to adequate densities by vibrating power rollers and by hand-operated compacting equipment in areas unaccessible to power equipment. The yard area would be graded and surfaced with gravel. Frequently traveled roadways and parking areas would be paved with asphaltic concrete.

To determine that adverse effects on river flow would not result from constructing these protective works, hydraulic conditions would be carefully analyzed during final designs and, if required, PNM would take corrective action to protect property abutting the river.

The applicant proposes to acquire approximately 35 acres on the floodplain of the San Juan River for siting of the intake pumping plant and river diversion facilities.

Installation of the 48-inch main water pipeline in the adit and vertical shaft would require tunneling equipment and a raise boring machine. Because of the short length of tunnel work required, only a small plant would be justified and the work would be done largely by hand. Excavation of the vertical shaft would probably be done by a specialty contractor using a raise boring machine. Raise boring would be undertaken after completion of the adit. The operation would consist of drilling a 10- or 12-inch pilot hole from the ground surface to the end of the adit, using water or air circulation to raise the drill cuttings to the surface. A 6- or 7-foot reaming cutter then would be attached to the drill stem at the end of the adit and the shaft enlarged by raising the cutter to the ground surface. During reaming, cuttings would fall to the adit level and would be continuously removed through the adit. Temporary support would probably be required in all or part of the shaft to stabilize the ground and to provide safe working conditions for installing and embedding the pipeline. The support would be installed following reaming of the shaft to full dimensions and would proceed from the top down. Pipe would then be installed concurrently in the shaft and in the adit, embedding it in concrete after pipe welding was completed and the welds were tested and accepted.

Pipeline construction activities would normally be confined to a 90-foot ROW (Figures 3-3 and 3-4). Only that portion of the ROW needed for construction would be cleared. Typical construction activities require clearing above-ground vegetation and obstacles from an average 30-foot width of the ROW to allow safe and efficient operation of the construction equipment. Blading of the ROW would not be done unless necessary for the movement of machinery and equipment or for the ditching required for the installation of pipe (for instance, it is sometimes necessary to blade in areas with steep side slopes). In some areas of rough terrain, a 60-foot ROW clearance would be the minimum necessary for safe and efficient construction. Due to terrain or proximity of existing utilities, there would be some areas for which more than 90 feet would be needed, but in no instance would temporary use of more than 120 feet be required. In these cases, it is possible that a temporary use permit would be needed for as much as a 120-foot construction ROW.

To permit safe vehicle operation, it may be necessary to construct temporary bridges or culverts across washes and arroyos on the working side of the ROW. Where this was necessary, road materials would be obtained either from: (1) the ROW, (2) commercial sources, or (3) adjacent lands by permission from surface management agencies or private landowner. Grading and cut-and-fill excavation would be

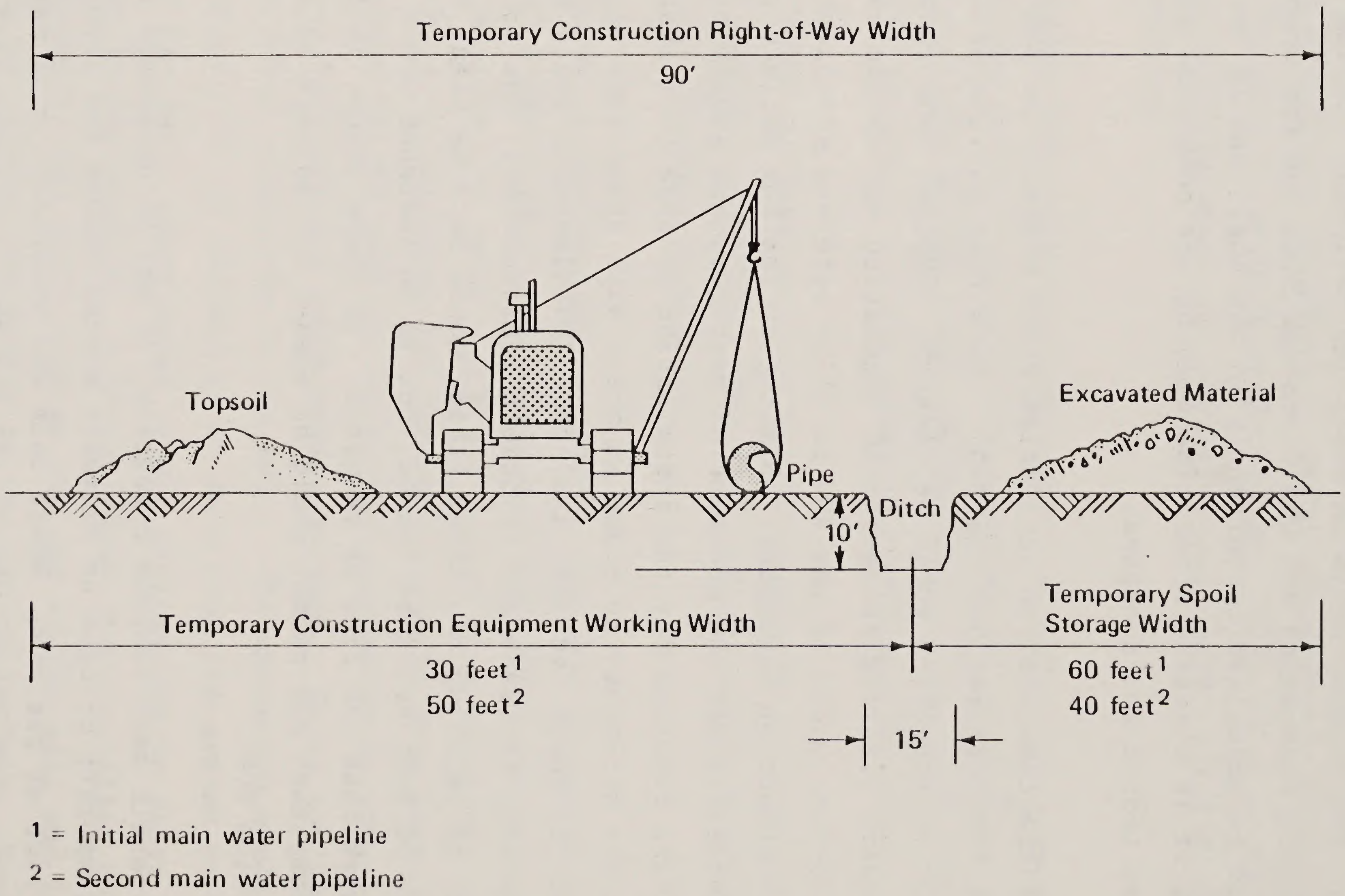
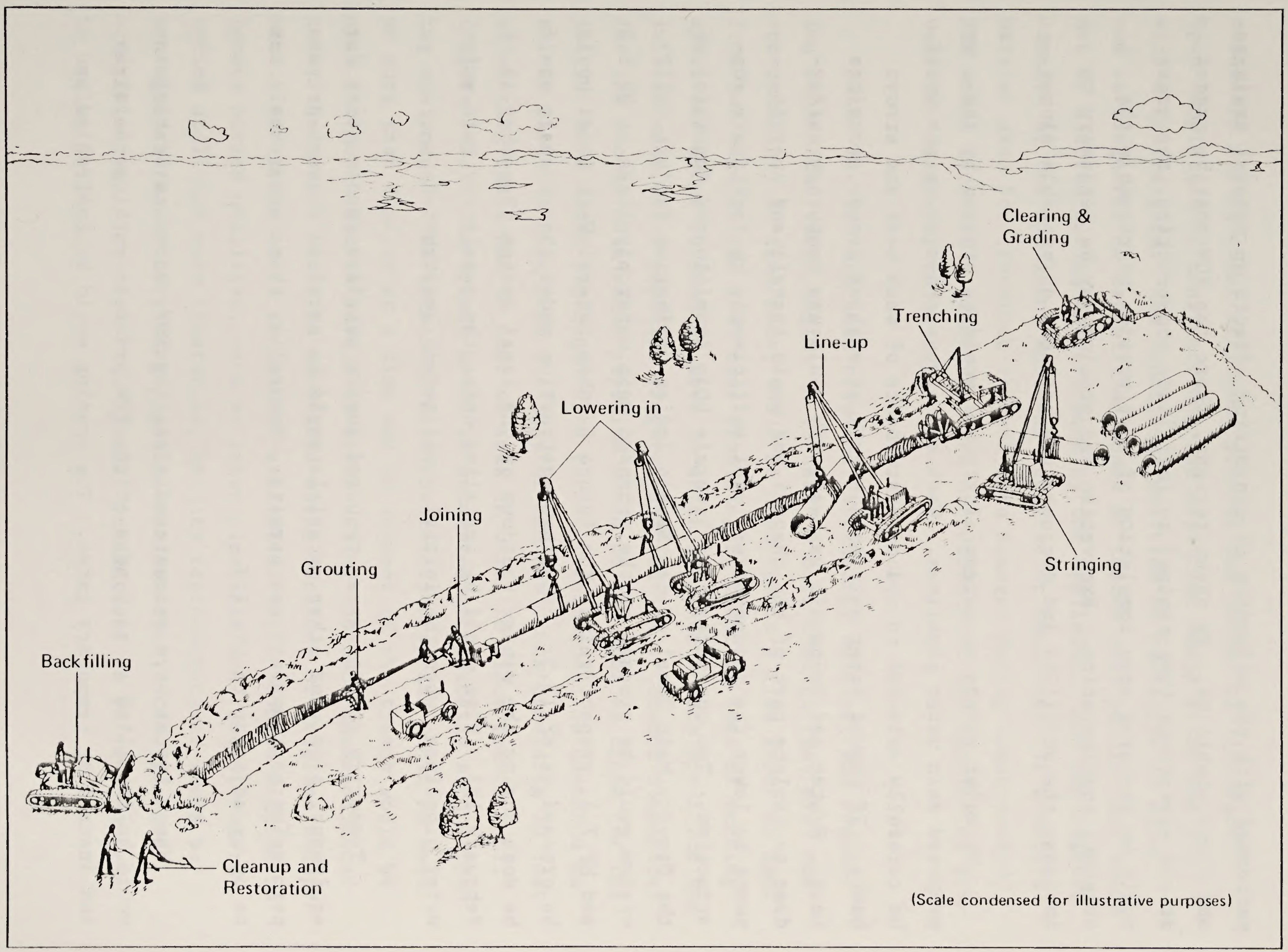


Figure 3-3. CONSTRUCTION RIGHT-OF-WAY USE FOR MAIN WATER PIPELINES



(Scale condensed for illustrative purposes)

Figure 3-4. TYPICAL CONSTRUCTION ACTIVITIES performed with the objective of minimizing effects on natural drainage and slope stability. On steep terrain, where the ROW must be graded at two elevations (two-toning) to facilitate construction, the areas would be restored upon completion of construction to resemble the original configuration. Excavation and grading may be necessary to increase the stability and decrease the gradient of unstable slopes.

No major rivers or perennial streams would be crossed by the proposed main water pipelines. Wash and arroyo crossing points would be carefully selected to reduce disturbance of wash beds and arroyo banks. If ground water were encountered at wash or arroyo crossings (e.g., Hunter and De-na-zin washes), PNM would use temporary coffer-dams to isolate part of the channel and would install and operate pumps to lower the ground-water level sufficiently to facilitate construction. Two concrete-lined laterals (Ojo Amarillo and Amarillo) of the Gravity Main Canal of the Navajo Indian Irrigation Project (NIIP) system would be crossed by the proposed main water pipelines at MP 6.5 and MP 7.4, respectively. The future Burnham Lateral West Canal would be crossed at MP 13.5. Pipeline construction under these canals would be done during the winter shutdown of the canal system (December 15 to February 15). Pipe would be installed under the canals for both main water pipelines, when the initial pipeline was constructed.

Temporary storage areas required during pipeline construction for equipment, pipe, and other materials would be acquired through private permission or temporary use permits. Generally, these areas would not be on or adjacent to the ROW.

Where fences were encountered along the ROW, adequate bracing would be installed at each edge of the ROW prior to cutting the wires and installing temporary gates. The opening would be controlled as necessary during construction to prevent the escape of livestock. Upon completion of construction, the applicant would close the gap with a locked gate. The functional position or operation of gates and cattleguards on established roads or tracks over public land would not be altered during construction by the applicant. Any cattleguard damaged by the applicant would be repaired or replaced. If a natural barrier used for livestock control were damaged during construction, PNM would adequately fence the area or reconstruct the barrier to prevent the escape of livestock.

Once the ROW had been prepared, stringing, welding, and trenching operations would begin. A trench, no more than 15 feet wide and approximately 10 feet deep, would be centered on a line about 60 feet from one edge of the ROW, thus providing at least 30 feet of working space and about 50 feet of area in which to place trench spoil for the initial main water pipeline (Figures 3-3 and 3-4). Trench dimensions for the second main water pipeline would be the same as those for the initial main water pipeline. The second trench would be centered on a line about 40 feet from the edge of the ROW, thus providing 50 feet of working space and 40 feet of area in which to place trench spoil (Figure 3-3). The trench would be excavated mechanically with ditching equipment. The trench of each construction spread would be open no more than 2 miles at a time and no segment of the trench would be open for more than 14 days. In areas having loose or unconsolidated rock, the trench would be excavated using backhoes or dragline equipment. An exception to mechanical excavation would be hand digging to locate buried utilities, such as other pipelines and cables. Where buried utilities were identified, utility representatives would be consulted before undertaking pipeline construction. Construction activities would proceed with special precautions to prevent damage to buried utilities.

The depth of the trench would vary with the conditions encountered. The cover from the top of the pipe to the ground level would be a minimum of 3 feet. Occasionally, the trench would be excavated to depths greater than the stated minimums. For instance, in places for which there are definite plans to level the land for irrigation or other purposes, the pipe would be buried at a depth that would accommodate these plans. When crossing canals or irrigation ditches, the pipeline would be constructed under them at safe depths. Care would be taken to restore such structures to their original serviceability. At road crossings, the depth of the trench would conform to appropriate regulations and to the design requirements established for the pipelines.

Generally, trenching operations would employ backhoes or draglines; however, subsurface conditions may require different types of excavating equipment. In areas of loose or unconsolidated rock, the trench line may be ripped mechanically. If the material encountered could not be ripped, it would be blasted. In preparation for blasting, unconsolidated material would be removed from the trench line and a series of holes would be drilled.

Blasting would be used only when necessary. Normally, the effects of the blasting would be confined to the ROW. Where blasting was necessary, the following safety precautions would be taken:

- In areas of human use, blasting would be blanketed (matted).

- Landowners or tenants in close proximity to the blasting would be notified in advance so that livestock and other property could be adequately protected.

- Before blasting took place, the affected area would be checked to ensure that construction personnel and equipment and local residents were out of danger.

- Blasting would be controlled or limited where damage to rock mass may create slope instability.

- In areas where blasting would not be feasible because of proximity to other pipelines or utilities, the trench would be dug by hand.

Generally, intermittent watercourses (washes/arroyos) would not be crossed during periods of periodic high flow (e.g., late summer). Construction of crossings would generally be accomplished within 14 days. The trench would be excavated to the depth that minimizes the effect of scour action to the pipeline during periods of high flow. In these areas, the pipeline would be constructed well below the maximum scour depth. Streambed reconstruction would be consistent with Corps of Engineers (COE) requirements for 404 permits (33 USC 1344). During construction at stream crossings, drainage or storm runoff from staging areas would be controlled via detention basins, evaporation pits, or straw bale filters to ensure that levels of suspended solids and grease or oil would not exceed ambient receiving-water standards.

Normally, the trench would be graded on each approach to the stream, wash, or arroyo to fit the profiles of the pipelines and to avoid potential exposure of the pipe at the banks due to erosion. Every effort would be made to minimize the potential effects of construction on water flow. The stream gradient would be restored upon completion of construction, stream banks would be restored to resemble their original grade, and breakers or riprap would be placed over the pipeline along banks where necessary for erosion control.

Crossings of Highway 371 would be done by open trench methods, unless final design studies show that tunneling under the highway by jacking casing pipe is feasible. If pipeline construction was by open trench, both the initial and second main water pipelines would be installed under the highway during initial construction. Unimproved roads would be trenched and restored.

Stringing, trenching, lowering, joining, grouting, backfilling, and cleanup are the main steps that would follow ROW preparation. The pipe would be strung along the ROW prior to or during trenching operations. A temporary pipeline laid on the surface near the ROW boundary would be used to convey about 5 acre-feet of water along the work site for construction use. Water would be pumped from the San Juan River, one of the irrigation canals crossed, and/or nearby wells as appropriate. Existing livestock water ponds would be used for storing water from the construction water line through arrangements made with the owners for such use. The water would be used for purposes such as dust suppression on roads, conditioning materials for compacted or consolidated backfill, and hydrostatic testing of the pipeline.

Reinforced-concrete or mortar-coated steel pipe would be brought by truck to the trench site in lengths of 16 or 20 feet (or more). The pipe segments would have a steel ring on the bell end and a formed steel spigot on the other end. The segments would be joined in the trench, using a rubber ring gasket for the water seal. The trench bottom would be shaped to fit the contour of the pipe, by hand if necessary, to ensure complete and uniform support of the pipe. The segments, with rubber gaskets installed in an annular groove on the spigot end, would then be lowered and the spigot carefully forced into the bell end of the previously laid pipe. The pipe would be inspected to ensure that the gasket was in place and undamaged and that proper space was maintained for grouting the insides and outsides of the joints. Pipe bedding would be checked for accuracy of alignment and adequacy of pipe support.

Sufficient backfill would be placed and compacted to hold the pipe in position while the next section was being joined. The outside pipe joints would then be grouted by placing a band of tar paper or steel around the pipe to serve as a form and then working sand-cement mortar completely around the joint between pipe segments.

After the grout had attained sufficient strength, backfill would be carefully placed and compacted to the horizontal centerline of the pipe. Backfill compaction would be by mechanical tampers or by settling the backfill with water and consolidating it with concrete vibrators. Backfilling would then proceed to the top of the trench. After backfilling was completed, the joints on the interior surface of the pipeline would be grouted, using a trowel to force mortar into the annular space and to finish the joint to form a smooth, continous pipe surface.

The pipeline would then be sectionalized with airbags for low-pressure runs and with bulkheads of hand-placed brick in mortar for high-pressure runs. Then water would be injected into the pipe, pressure applied and held for a specified time, during which the amount of water supplied to maintain the pressure would be carefully measured. This process would continue until the input rate of water stabilized. If specified loss rates were not exceeded, the test would be considered satisfactory. If specified loss rates were exceeded, pressure would be maintained until a leak became evident by the surrounding backfill becoming wet. The leak would then be stopped by whatever means were necessary.

The three proposed intermediate pump stations would be essentially identical (except for power ratings, etc.). Figure 3-3 shows typical intermediate pump station details. The main water pipeline and ROW would be shifted away from the highway on each end of the intermediate pump station sites to enable these sites to abut the highway. During construction, 2 additional acres of land outside of the permanent ROW would be temporarily required for office, tool, and equipment storage areas. Backhoes would be used to excavate building footings, pumping unit foundations, and the trenches forming the floor support girder slabs. Excavations would be finished by hand tools prior to pouring of the concrete. Ground surfaces would be leveled to form support for the concrete floor slab. Footings for the intermediate pump station buildings would be set 4 to 5 feet below the floor grade. Foundations for the horizontal pumps and motors would be equally deep and would extend to a few inches above floor level. Floor level would be slightly above ground level. The concrete floors would be supported by reinforced-concrete girders and would be structurally separated from the pump foundations. The floor of the pump room would be about 28 feet by 90 feet; it would include sufficient space for working on equipment and for a tractor-trailer to enter for unloading heavy equipment. A bridge crane would be installed to handle all heavy equipment. An annex to the pump room would contain a battery room, a storage room, and a toilet. A crane would be used to handle concrete forms above ground level, for setting pipe and manifolds connecting to the main water pipeline(s), for erecting the surge tanks, and for installing the permanent bridge crane. A dozer would be used for rough-grading the site and backfilling around the structure. The area around the pump stations would be graded following construction and surfaced with gravel. Roadways and parking areas would be stabilized and surfaced with gravel.

Materials from trench excavation, particularly the dune sand, between MP 3.5 and 30.5 of the proposed main water pipeline, would be suitable for all backfill requirements of pipeline construction. Materials for backfill around structures and for embankment work at the intake works and pumping plant would come from excavation required for the structures and from a proposed borrow area downstream of and adjacent to the proposed intake plant site. Materials for use in concrete manufacture would come from commercial sources in the Farmington area. These sources also would be used for special filters, asphaltic concrete and coarse materials for road foundations, and gravel for yard cover. Soils in which the proposed main water pipeline trench would be excavated, from MP 30.5 to the end of the pipeline at the terminal reservoir, would be silty clay or clayey silt, except probably at crossings of Hunter and De-na-zin washes. The clayey materials probably would be undesirable for backfill for the underquadrants of the pipeline but would be satisfactory for backfill over the pipe. Tests of the materials during the design phase would provide data for determining acceptability. The beds and adjacent areas of the two washes would be explored for suitable sandy materials for use as pipe support backfill if materials in the trenches were determined to be unsuitable. The applicant would undertake construction and restoration measures, as appopriate, to minimize damage to the land at borrow areas.

Completed construction areas (including the ROW) and access roads no longer required would be returned as nearly as practicable to original condition or to that agreed upon by the applicant and the landowners or the authorized officer. Restoration of areas disturbed by intake pumping plant, pipeline, and intermediate pump station construction would be accomplished by whatever means is most suitable for the soils, terrain, climatic conditions, and surrounding vegetation. Preparation of seedbed and reseeding where desirable would be accomplished by the applicant, and the seed mix or plant species would be planted in accordance with techniques customarily used for the area and in accordance with agreements made with owners of private property.

A series of sand dunes occupy much of the mesa lands along the proposed main water pipeline route from about MP 3.5, some 6 miles south of Farmington, to about MP 30.5, north of Bisti Trading Post. These dunes, the sands for which appear to have local origin, are for the most part currently stabilized by native vegetation. Some dunes show evidence of slow migration, the result of overgrazing, physical disturbance, and, in some instances, direct wind action. Nevertheless, even where cut by road construction the dunes appear to slowly revegetate naturally and the cut surface becomes stable. Where these dunes were disturbed by the proposed pipeline construction, their original contours would be restored and the surface seeded and mulched to provide protection until vegetation became reestablished. If some critical dune areas required additional remedial action, techniques such as jute fabric laid over the ground to assist in reestablishment of vegetation would be considered.

In other areas where rehabilitation problems are common, e.g., alkaline/salty soils, rock outcrop, etc., revegetation would also be considered a special management problem to be resolved in coordination with the surface management agency or landowner. It would be necessary to solicit advice for such problem areas from other agencies, such as the Soil Conservation Service (SCS).

In some cases, original topsoils would be saved and later placed on top of the excavated ditch to hasten recovery of cultivated or grazing lands. In other cases, terraces would be built to enhance retention of the seeds.

Erosion control, as necessary, would be employed on sloping areas (>4 percent slope) along the main water pipeline ROW and along any cuts made through unconsolidated materials. All reasonable means would be undertaken to control erosion and soil damage resulting from construction, rehabilitation, or maintenance and operations, including (but not limited to) construction of terraces, water bars, or other structures.

At intermediate pump station sites, work areas outside the permanent ROW fence would be restored as nearly as possible to natural preconstruction condition. Topsoil removed from all areas during site preparation would be used to restore construction and work areas. Care would be exercised during regrading to avoid forming channels where none existed before and in adding channels where appropriate to spread runoff onto undisturbed sod. The areas would be mulched and seeded to restore vegetation as rapidly as possible. The applicant would work closely with the SCS and/or local agricultural specialists to develop suitable restoration plans. The permanent intermediate pump station areas would be graded according to a prepared plan. Traveled areas would be gravel-surfaced. Areas not needed for travel would be restored as outlined above. Care would be exercised to ensure adequate drainage and avoid concentrating flows, except under controlled conditions.

During routine aerial reconnaissance, the applicant would monitor the success of erosion control and revegetation in accordance with the BLM monitoring plan, as stipulated in the ROW grant. Among other things, this monitoring program should identify problem areas, so that mitigating measures could be employed. Monitoring would also include, but not be limited to, requirements for studies to determine the success of erosion control and revegetation.

Environmental Considerations. The applicant would undertake a number of construction and restoration practices in addition to those already mentioned. The resource considerations outlined below are intended to reduce environmental impacts. These practices would be incorporated as stipulations to a ROW grant.

Air and Water Quality. The applicant would conduct all activities associated with the project in a manner that would avoid or minimize degradation of air, land, and water quality. During construction, operation, maintenance, and termination of the project, the applicant would perform all activities in accordance with applicable air and water quality standards, related facility siting standards, and related plans for implementation, including (but not limited to) standards adopted pursuant to the Clean Air Act, as amended (42 USC 7401 et seq.), and the Federal Water Pollution Control Act, as amended (33 USC 1251 et seq.).

Pesticide and Herbicide Use. Pesticides would not be used during construction or operation of these pipelines. An EPA-approved herbicide would be used within the fences at the pump stations to prevent weed fires, and around safety signs within the ROW so they remain visible.

Traffic Safety. Adequate warning signs would be positioned far enough ahead of construction zones so that drivers would have sufficient warning to decelerate safely. Signs would be positioned in accordance with relevant regulations.

Recreation Resources. Construction of the proposed main water pipeline may occur during months when recreation use is high. The work force would not use public campgrounds or forests for temporary housing; however, recreational use of these facilities would not be denied to workers.

Cultural Resources. Prior to initiating any ground disturbance, the applicant would take actions to protect cultural resources in accordance with agreements currently being developed between the Bureau of Land Management, the Advisory Council on Historic Preservation, and the State Historic Preservation Officer in New Mexico.

Visual Resources. The applicant would make a concerted effort to protect the scenic values in the area of construction and the adjacent land. For example, all aboveground improvements and barricades would be nonreflective. When a safety color is not required, the color used would be chosen to blend with the natural background for that location.

Wilderness Values. The proposed main water pipelines would not be located within a Wilderness Study Area (or RARE II Area) boundary and would not come closer to a boundary than an already existing road or trail.

Public Monuments and Markers. Where the ROW includes public lands on which cadastral survey monuments and markers are located, the applicant would avoid disturbance or removal of such monuments and markers. If the removal of monuments or markers becomes necessary during specific construction activities, the applicant would advise the appropriate agency of that need. Removal and/or relocation would then be done in accordance with detailed instructions set forth by the appropriate agency.

Compliance Check and Monitoring. Preconstruction conference(s) would be held with contractor(s), the applicant, and authorized officer to clarify procedures and expectations to enable efficient implementation of all requirements. Compliance checks would be made throughout construction by a representative of the authorized officer. When all developments and rehabilitation had been completed, a final joint compliance check of the ROW would be made by a representative of the applicant and the authorized officer. The purpose of this check would be to determine compliance with the terms and conditions of the ROW grant. The applicant would perform, at its own expense, any required monitoring, modifications, or additional reclamation work needed to comply with the terms and conditions of the ROW grant.

Operation and Maintenance. The applicant would conduct aerial patrols to inspect the ROW at least every 2 weeks to determine the integrity of the pipeline and the success of surface-disturbance mitigation measures. Surface traffic would be limited to periodic valve inspections, ROW maintenance, and emergency pipeline repairs. Pipeline patrols for checking functioning of valves and staff for performing routine maintenance and special repair work would be handled as part of the duties of the maintenance crew at NMGS. Pipeline operation and maintenance would not require assignment of a fulltime staff. The intermediate pump stations would be inspected daily by a two-person crew from NMGS. This crew would perform minor servicing and adjustments and would check control, recording, and telemetering equipment. The pipeline pressures, pump performances, and status information of the system would be telecommunicated from the booster plants to the intake plant and would be monitored and recorded by instruments and supervisory personnel 24 hours per day.

Ruptures. Concrete pipeline ruptures usually occur because of outside forces and not from internal pipeline pressure or corrosion. Vandalism, particularly at blowoff and air-valve structures, is the principal cause. Washouts from floods rarely occur. The pipeline would be constructed to avoid these incidents. Structures would be as vandal-proof as reasonably possible. The pipeline location along a principal highway for much of its length should deter vandalism.

Emergency Procedures. Identification and control of emergency conditions along the main water pipeline route would be the responsibility of the intake plant operator. The control center at the intake plant would be attended 24 hours a day, 7 days a week. Instruments would continously monitor pipeline pressures and pump status at each intermediate pump station. Instruments would sound alarms any time a deviation occurred in pressure or flow, indicative of an outage or unusual condition in the pipeline system. Indications of an outage could come from any of several sources--a telephone call from a member of the public, a radio alert from an aerial patrol pilot, or an alarm from the instruments. Upon receiving a report from any of these sources, the operator would immediately implement emergency procedures--the first priority is to secure the area to reduce the possibility of damage to persons or property. The sequence of response actions would be as follows:

1. Confirm the probable location of the leak, using all the information available, including pressure and flow conditions from indicator instruments.

2. Shut down upstream pumping facilities and close appropriate valves on the line.

3. People would be dispatched by road (assisted by the aerial patrol pilot if needed) to the scene of the leak; establish roadblocks; evaluate hazards; warn people; and generally prevent personal injuries and minimize damage to property.

4. A PNM employee in charge at the leak site would determine the proper way of controlling the spill to minimize damage to people or property and the procedures necessary for repairing or replacing the pipeline.

5. The pipeline maintenance crew would be immediately dispatched from NMGS to the leak site with the necessary repair and safety equipment.

6. The supervisor in charge during the repair would demand strict adherence to all safety rules.

7. A PNM official would notify the appropriate federal, state, and local regulatory agencies as required by law and/or organizations, or private landowners if involved.

8. After repairs had been completed, the control center operator would be notified, the valves opened, and the pumps started to refill the line and put it back in service. While the line was being refilled, the leak location would be observed to ensure that satisfactory repairs had been made.

9. A complete report would be made showing all data obtained and actions taken, from time of notification or suspicion of a leak to final repair and return to operations. The report would include the conditions at the leak site, damage to the area or people, repair procedures employed, and final cleanup of the area.

3.4.2 Alternatives

Route Alternatives. Two main water pipeline route alternatives were selected for detailed analysis (Map 1-2). They are described below.

<u>Main Water Pipeline Route Alternative P2</u>. This approximately 43-mile alternative main water pipeline route would initiate from an intake pumping plant on the San Juan River near Bloomfield, and would terminate at the proposed terminal storage reservoir near NMGS. Alternative route P2 would be located in and would directly affect approximately 159 acres of federal lands, 270 acres of Indian lands, 4 acres of state lands and 29 acres of private lands. This alternative pipeline route would follow a southerly course for about a half-mile through a suburban residential area and then join an existing pipeline ROW (El Paso Natural Gas). The alternative pipeline route would cross and then generally parallel this ROW on the southern side to the crossing of old State Highway 371 (north of Bisti Trading Post) where it would join the proposed main water pipeline route at MP P1-29.5. Alternative route P2 would parallel an existing ROW for approximately 85% of its total length. The last 10 miles of this alternative route is the same as the proposed main water pipeline route (P1). Approximately 19 miles of NIIP lands would be traversed by this alternative route, and the Main Irrigation Conveyance System Canal and the future Burnham Pump Lateral would be crossed at MP P2-11 and MP P2-25, respectively. No new access roads would be required for construction of the four intermediate pump stations associated with this alternative. An intake pumping plant and four intermediate pump stations would be required to transport the approximately 16,000 to 18,000 acre-feet of water per year (starting in 1990) required for NMGS Units 1 and 2. As with the proposed main water pipeline, a second main water pipeline (running parallel and adjacent to the initial pipeline) would be constructed at a later date (tentative 1995 completion date) for NMGS Units 3 and 4. Incremental increases in the amount of water to be transported by the second pipeline for NMGS Units 3 and 4 (and the associated dates) would be the same as for the proposed main water pipeline.

Main Water Pipeline Route Alternative P3. This approximately 49-mile alternative would also start from an intake pumping plant on the San Juan River near Bloomfield, and would also terminate at the proposed terminal storage reservoir near NMGS. Alternative route P3 would be located on and would directly affect approximately 395 acres of federal lands, 3 acres of Indian lands, 78 acres of state lands, and 23 acres of private lands. This alternative pipeline route is in common with main water pipeline alternative P2 for the first mile or so, and then it crosses over to the east side of Highway 44. At approximately MP P3-20 this route alternative crosses back over Highway 44 and then runs almost due south for approximately 8 miles, at which point it turns southwest and continues to the proposed terminal storage reservoir near NMGS. P3 would parallel existing ROW for approximately 46 percent of its total length. This route alternative would avoid crossing the NIIP system, although it would cross over the Main Irrigation Conveyance System Tunnel 4. This alternative would traverse the Kutz Canyon Badlands between MP 9 and 16, the Angel Peak Recreation Area between MP 14 and 18.

An intake pumping plant and four intermediate pump stations would be required to transport the approximately 16,000 to 18,000 acre-feet of water per year (starting in 1990) required for NMGS Units 1 and 2. This pipeline would operate by gravity from the summit at about MP 32.0 to the terminal storage reservoir. As with the proposed main water pipeline, a second main water pipeline (running parallel and adjacent to the initial pipeline) would be constructed at a later date (tentative 1995 completion date) for NMGS Units 3 and 4. Incremental increases in the amount of water to be transported by the second pipeline for NMGS Units 3 and 4 (and the associated dates) would be the same as for the proposed main water pipeline.

Specific location details (topography, land status, etc.) for these route alternatives are shown in Appendix G of the NMGS EIS.

Pump station(s) details for each alternative are listed in Table 3-4.

Special Construction Practices for Alternative Routes. If one of the main water pipeline alternative routes is ultimately selected, the applicant would undertake construction and reclamation/mitigation using the same general practices and procedures as specified for the proposed main water pipeline (P1). As with the proposed main water pipeline, special arrangements might have to be made for obtaining padding and backfill material from borrow areas for some pipeline areas.

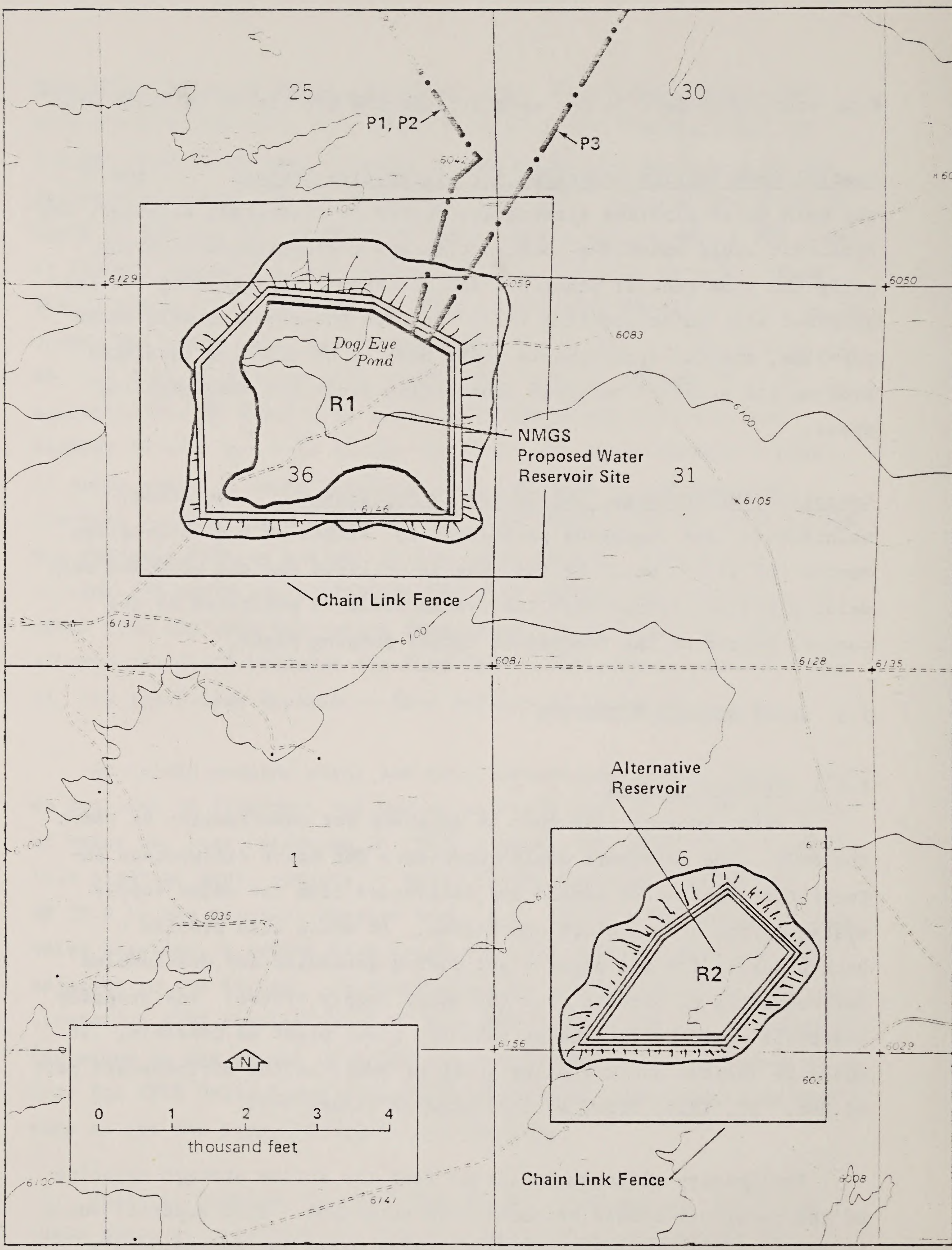
Operation, Maintenance, and Emergency Procedures. Operation, maintenance, and emergency procedures for either of the alternative routes (P2 or P3) would be the same as outlined for the proposed main water pipeline, except that the system would be monitored by the control center at the Bloomfield intake pumping plant.

3.5 WATER STORAGE RESERVOIR

3.5.1 Proposed Action

A water storage reservoir is proposed for construction to serve the NMGS. The reservoir would compensate for minor differences between the plant water demand and deliveries from the water supply system during normal plant operations. It would also provide a backup supply for the power plant during scheduled and unscheduled interruptions of service from the water supply system. The proposed reservoir would be located as near the power plant as feasible. It would be located about 2 miles south of NMGS, in the northeastern part of Sec. 36, T23N, R13W, as indicated on Figure 3-5.

Preliminary planning indicates that the active storage capacity of the reservoir should be about 4000 acre-feet. This quantity would be adequate for supplying the power plant needs for approximately



Source: BLM 1982.

Figure 3-5. PROPOSED TERMINAL STORAGE RESERVOIR

Table 3-4. LOCATION OF ALTERNATIVE MAIN WATER PIPELINE PUMP STATIONS

Name	Land Ownership	Township	Range	Section	Milepost	Elevation (Feet)
Main Water Pipeline Alt. P2						
Bloomfield Intake Pumping Plant		29N	11W	27	0.0	5385
Intermediate #1	Public Lands (BLM Admin.)	28N	11W	16	2.8	5595
Intermediate #2	Public Lands (BLM Admin.)	28N	11W	29	5.1	5810
Intermediate #3	Indian Lands or Reservation	26N	12W	3	14.6	6041
Intermediate #4	Public Lands (BLM Admin.)	25N	13W	1	21.8	6208
Main Water Pipeline Alt. P3						
Bloomfield Intake Pumping Plant					0.0	5385
Intermediate #1	Public Lands (BLM Admin.)	28N	11W	13	3.8	5800
Intermediate #2	Public Lands (BLM Admin.)	27N	10W	20	12.9	6180
Intermediate #3	Public Lands (BLM Admin.)	27N	10W	28	14.9	6390
Intermediate #4	State Lands	25N	10W	32	28.5	6680

5 weeks at ultimate development (four 500-MW units). A gross capacity of about 5000 acre-feet would be provided to allow for sediment deposition in the reservoir and dead storage below the minimum reservoir operating level. The full reservoir water level would be approximately elevation 6135 feet; the minimum operating level would be about elevation 6100 feet. The reservoir would be sufficiently higher in elevation than the power plant so that the power plant could be supplied by gravity flow throughout the full range of reservoir operating conditions. The water surface area of the reservoir, when full, would be approximately 145 acres. The total area (fenced) for the reservoir would be approximately 640 acres.

The reservoir design and operation would be essentially the same whether the project water supply was obtained from the San Juan River, or a well field located in the power plant vicinity, or a combination of those sources. Because there may be suspended solids in the supply, particularly if the supply is from the San Juan River, present plans are to provide separate pipelines to deliver water to the reservoir and to transfer water from the reservoir to the power plant. The reservoir inlet and outlet structures would be separated from each other to the maximum practical extent, to facilitate sediment deposition in the reservoir.

The reservoir would be contained by a dike, or embankment, extending about 70 percent around the reservoir perimeter. Maximum height of the dike would be about 70 feet. Its length would be about 5000 feet. For preliminary planning purposes, it is expected that the slopes of the embankment would be about 2.5 horizontal to 1.0 vertical, and that the embankment would have a crest width of about 12 feet. About 1.5 million cubic yards of material would be required to construct the embankment.

To the maximum practical extent, the embankment would be constructed using materials available within the reservoir area. Soils investigations and testing, to be performed for final design of the embankment and reservoir, would establish appropriate details for construction, including the development of a suitably impervious section in the embankment, a cutoff for preventing seepage under the embankment, and the possible need for lining the reservoir bottom to limit seepage to an acceptable extent.

A program would be implemented to establish a vegetative cover on the exterior slope of the embankment. The program would include seeding and covering the slope with straw or other mulch, held in place with jute fabric or similar material, and anchored in place with stakes driven in the embankment. If necessary, the slope would be sprinkler-irrigated to promote growth and establish the cover.

A fence would be erected around the entire perimeter of the reservoir. Access to the reservoir would be provided from the new State Highway 371, which will cross the extreme northeastern corner of the section in which the reservoir would be constructed (Figure 3-5).

Special materials that may be needed in constructing the embankment would come from outside sources. The types of special materials and their potential sources would be determined during design of the project.

Borrow area(s) outside the reservoir, if required, would be prepared by first removing and stockpiling topsoil. After materials for construction were removed, these borrow area(s) would be graded to satisfactory, stable slopes, with proper drainage. Topsoil would be replaced over the area, and the area would be planted with appropriate seeds. The surfaces would be mulched where added protection is needed to reestablish vegetation. Such maintenance work as necessary would be done until vegetation was reestablished.

The BLM and local agencies would be consulted to formulate restoration plans.

3.5.2 Alternative

An alternative reservoir site is located in Sec. 6, T22N, R12W, as shown on Figure 3-5. This location is considered a reasonable alternative if the proposed site is found unsatisfactory after detailed investigations required for design and evaluation.

Construction and design details would be essentially the same for the alternative reservoir site as those detailed for the proposed action, except that the total area (fenced) required would be about 320 acres.

4.0
TRANSMISSION SYSTEM

The NMGS is designed to provide bulk energy to the PNM system. In order to deliver power from NMGS to the various load centers, it would be essential to integrate the plant into the existing bulk transmission systems of PNM and neighboring utilities. Expansion and reinforcement of the existing bulk transmission system would be necessary to achieve this goal in a reliable and economic manner. Two major requirements that would be satisfied include the following:

1. Adequate bulk transfer capability to transport the generated power to the load centers

2. Adequate plant outlet capacity to maintain reliability and acceptable stability margins

At present, PNM operates an extra-high voltage (EHV) system consisting of 230-kV and 345-kV transmission lines to accommodate bulk power transfers from the Four Corners area to central New Mexico, where it is then distributed to PNM's customers (Figure 4-1). Also shown in Figure 4-1 are EHV facilities that will be added to the northwestern New Mexico system prior to development of NMGS. These additional facilities consist of several new 345-kV line segments in the Albuquerque and northern New Mexico areas, and the FC-A-P 500-kV line from Four Corners to Ambrosia Lake and on to the Albuquerque area.

A 115-kV tap from PNM's proposed Fruitland 230-kV transmission line has been proposed to supply necessary power to local coal mining operations. The tap would originate at a new substation (proposed as part of the Fruitland 230-kV project) that would be located about 1 mile south of the southeastern corner of the station site. Because of the availability of this tap, it would be proposed to also use the tap to provide electric power for construction of the power plant (Figure 4-1).

With the initial development of NMGS in 1990, it is planned to loop the then-existing 500-kV line between Four Corners and Ambrosia through the NMGS switching station. This interconnection would provide power for checkout and testing of the major electrical equipment at the plant. This loop is also expected to provide adequate transfer capability in New Mexico and to the Four Corners area to accommodate the initial unit at NMGS.

With the addition of the second unit at NMGS in 1993, outlet capacity from the power plant would be marginal, when considering transient stability performance, indicating the need for additional transmission capacity. In addition, potential participation by other utilities indicates the possible need for additional transfer capability from NMGS to the Albuquerque area, where the power would be transferred to the existing bulk transmission network for further distribution to the participants' load centers.

Assuming that the need for additional plant outlet and transfer capability would be satisfied for the addition of the second unit at NMGS, technical performance is expected to remain adequate until installation of the fourth unit. With the addition of the fourth unit, stability considerations again would indicate the need for additional outlet capacity from the plant. Also, ultimate expected

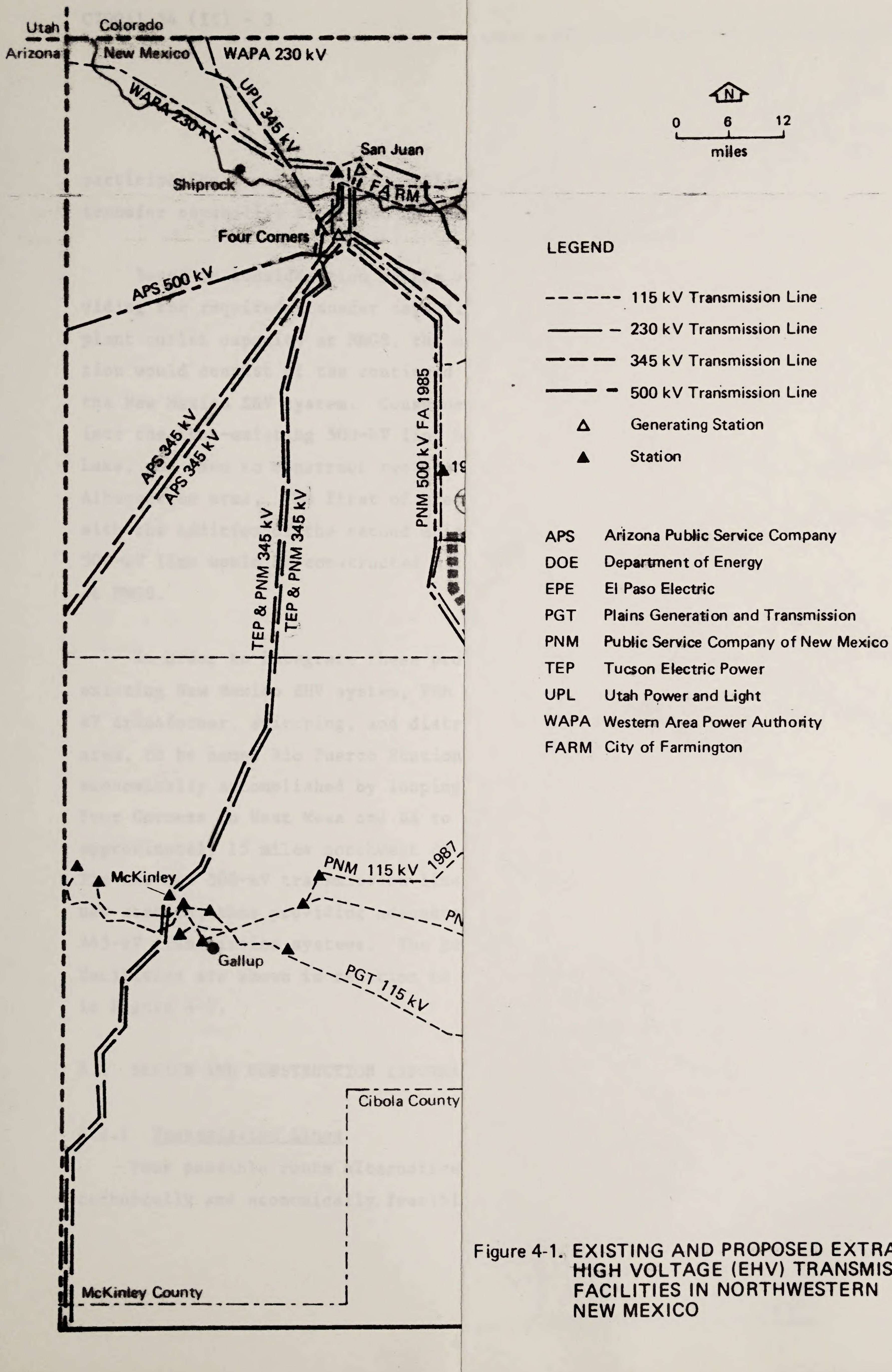


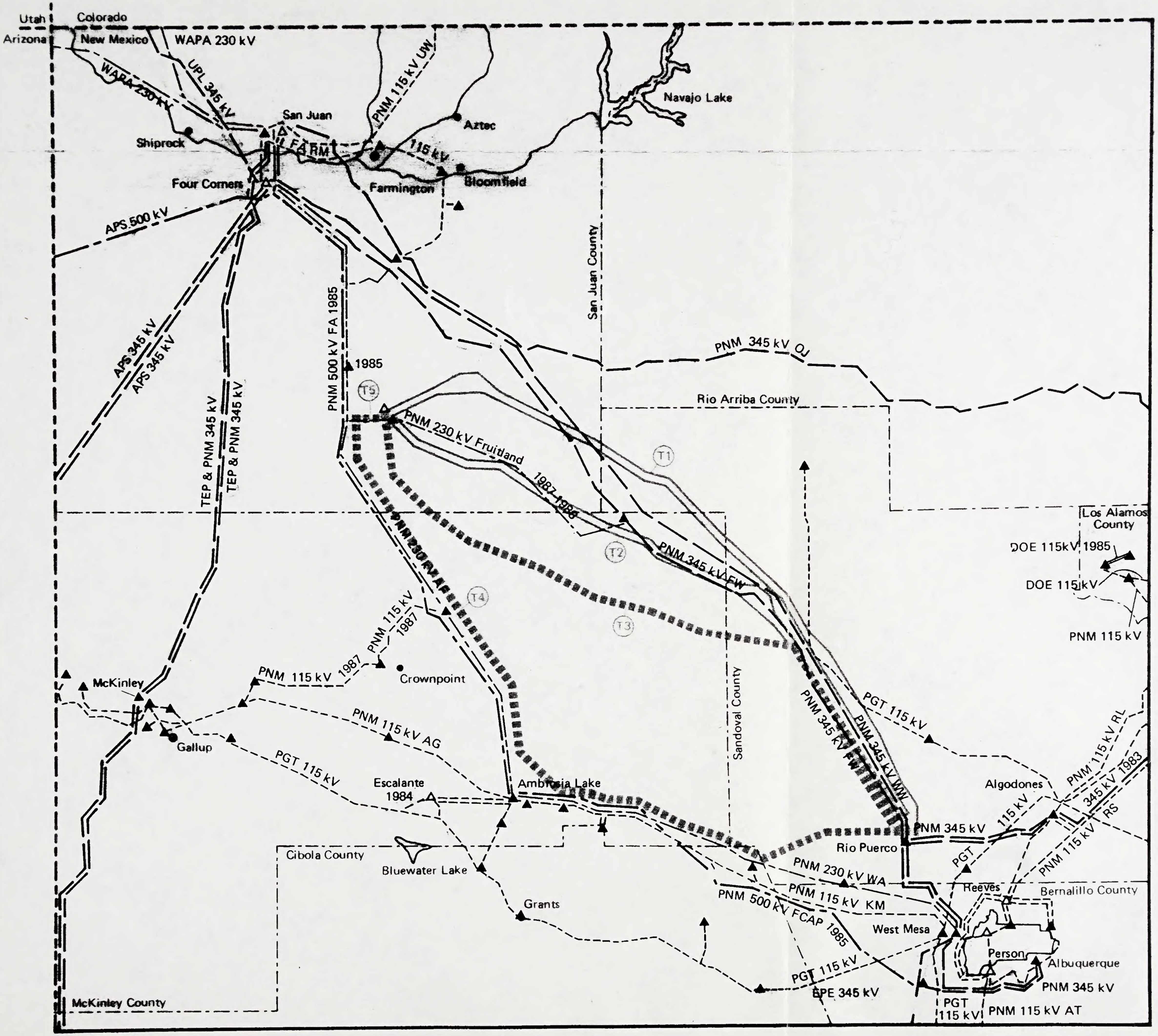
Figure 4-1. EXISTING AND PROPOSED EXTRA-HIGH VOLTAGE (EHV) TRANSMISSION FACILITIES IN NORTHWESTERN NEW MEXICO

A 115-kV tap from PNM's proposed Fruitland 230-kV transmission line has been proposed to supply necessary power to local coal mining operations. The tap would originate at a new substation (proposed as part of the Fruitland 230-kV project) that would be located about 1 mile south of the southeastern corner of the station site. Because of the availability of this tap, it would be proposed to also use the tap to provide electric power for construction of the power plant (Figure 4-1).

With the initial development of NMGS in 1990, it is planned to loop the then-existing 500-kV line between Four Corners and Ambrosia through the NMGS switching station. This interconnection would provide power for checkout and testing of the major electrical equipment at the plant. This loop is also expected to provide adequate transfer capability in New Mexico and to the Four Corners area to accommodate the initial unit at NMGS.

With the addition of the second unit at NMGS in 1993, outlet capacity from the power plant would be marginal, when considering transient stability performance, indicating the need for additional transmission capacity. In addition, potential participation by other utilities indicates the possible need for additional transfer capability from NMGS to the Albuquerque area, where the power would be transferred to the existing bulk transmission network for further distribution to the participants' load centers.

Assuming that the need for additional plant outlet and transfer capability would be satisfied for the addition of the second unit at NMGS, technical performance is expected to remain adequate until installation of the fourth unit. With the addition of the fourth unit, stability considerations again would indicate the need for additional outlet capacity from the plant. Also, ultimate expected



LEGEND

- 115 kV Transmission Line
- 230 kV Transmission Line
- 345 kV Transmission Line
- 500 kV Transmission Line
- △ Generating Station
- ▲ Station

APS	Arizona Public Service Company
DOE	Department of Energy
EPE	El Paso Electric
PGT	Plains Generation and Transmission
PNM	Public Service Company of New Mexico
TEP	Tucson Electric Power
UPL	Utah Power and Light
WAPA	Western Area Power Authority
FARM	City of Farmington

Figure 4-1. EXISTING AND PROPOSED EXTRA-HIGH VOLTAGE (EHV) TRANSMISSION FACILITIES IN NORTHWESTERN NEW MEXICO

participation levels of other utilities would require additional transfer capability from NMGS to the Albuquerque area.

Based on consideration of the various alternative means of providing the required transfer capability in New Mexico and adequate plant outlet capacity at NMGS, the most favorable network configuration would consist of the continued development of a 500-kV overlay on the New Mexico EHV system. Consequently, PNM proposes to tie NMGS into the then-existing 500-kV line between Four Corners and Ambrosia Lake, and then to construct two new 500-kV lines from NMGS to the Albuquerque area. The first of these new lines would be constructed with the addition of the second unit at NMGS, while the second new 500-kV line would be constructed with the addition of the fourth unit at NMGS.

In order to integrate these proposed transmission lines into the existing New Mexico EHV system, PNM proposes to develop a new 500/345-kV transformer, switching, and distribution station in the Albuquerque area, to be named Rio Puerco Station. This can be effectively and economically accomplished by looping the existing 345-kV circuits from Four Corners to West Mesa and BA to West Mesa into a new site located approximately 15 miles northwest of the West Mesa 345-kV station. The two new 500-kV transmission lines also would terminate at the new station, thus providing adequate integration of the 500-kV and 345-kV transmission systems. The general locations of these proposed facilities are shown in relation to the then-existing EHV facilities in Figure 4-1.

4.1 DESIGN AND CONSTRUCTION INFORMATION

4.1.1 Transmission Lines

Four possible route alternatives (Figure 4-1) are considered technically and economically feasible for construction of the 500-kV transmission system. These routes have been selected to avoid areas of known land use conflicts and to consider all reasonable routes of access between NMGS and the proposed Rio Puerco station. Route T2 is proposed for construction of the first 500-kV transmission line. Route T1 is proposed for the second line from NMGS to Rio Puerco station. Brief descriptions of the four alternative routes are provided below.

Proposed Action - First 500-kV Line, NMGS to Rio Puerco Station: Route T2. This route would be 101 miles long, the shortest of all the alternatives; it would provide the greatest degree (91 percent) of corridorization with existing and future transmission lines, railways, and highways.

Proposed Action - Second 500-kV Line, NMGS to Rio Puerco Station: Route T1. This route would be 107 miles long and traverse generally open, rolling terrain. This alternative route would traverse the greatest amount of shale badland topography, which is the least amenable to recovery after disturbance by access roads and leveling.

Land use along this route consists of grazing and mining. Mining could increase in the future. The route passes near Pierre's Ruin (a Chacoan outlier) and the De-na-zin and Ojito wilderness study areas. This alternative would open the greatest length of new transmission right-of-way, with only 32 percent of its length following existing rights-of-way.

Alternative Route T3. Alternative route T3 would be 105 miles long. The use of this route would require opening a substantial new length of right-of-way, since only 36 percent of the route would parallel existing rights-of-way.

Alternative Route T4. This 126-mile route would parallel the existing PNM 230-kV transmission line and a proposed 500-kV line (Four Corners-Ambrosia-Pajarito) through most of its length, and an additional 115-kV line in the Mount Taylor/Mesa Chivato region. From the perspective of system reliability, the concentration of four major transmission lines in one corridor is not desirable. This would make a major portion of the energy supply for this region vulnerable to a single natural or human-caused disaster.

500-kV Loop. The alignment for the proposed 500-kV loop from the NMGS location to the Four Corners-Ambrosia transmission line is shown in Figure 4-1. The two proposed 500-kV lines comprising the loop would be constructed in parallel within a half-mile corridor. This corridor would be approximately 5 miles long and would be corridorized with the then-existing State Highway 371.

Right-of-Way. The right-of-way width for the 500-kV transmission lines would be 200 feet, which would allow the use of long-span construction and provide some flexibility for structure alignment. This width would ensure that midspan conductor blowout from high winds would not exceed the right-of-way. Clearances to any existing buildings or structures would be provided in accordance with the National Electric Safety Code (1977 edition).

<u>Structures and Towers</u>. Three general types of tower structures would be used for the proposed 500-kV transmission lines: tangent, angle, and dead end. Applications requiring additional strength, such as angles or dead ends, would employ proportionately stronger structures designed to meet additional loads and stresses. These general types of structures are illustrated in Figure 4-2.

The proposed tangent structure design is a guyed vee tower, 80 to 150 feet high, shown in the upper portion of Figure 4-2. Tangent structures would be used in straight-line applications requiring normal strength and design. This tower design may be constructed of two different types of material; the advantages of each are now being evaluated. One material option is galvanized lattice steel, the other employs tubular, weathering steel (Corten), which is the only tubular material economically competitive with lattice steel. Specific comments regarding color, texture, and scale are presented in the Visual Resources Technical Background Report.

Self-supporting lattice steel structures would be used for angle and dead-end structures, or where topography or land use constraints make guy cable extensions unfeasible. Since these self-supporting lattice-steel structures would be constructed of whatever material proves most feasible for tangent structures, all structures would have the same appearance or surface finish.

The number of structures required per mile would be approximately as follows: 0.15 dead-end angle structure (angles greater than 30°), 0.30 running angle structure (angles less than 30°), and 3.55 tangent structures. Towers would be located to avoid archaeological sites and other environmentally sensitive areas; span lengths would be adjusted to avoid these areas where practical.

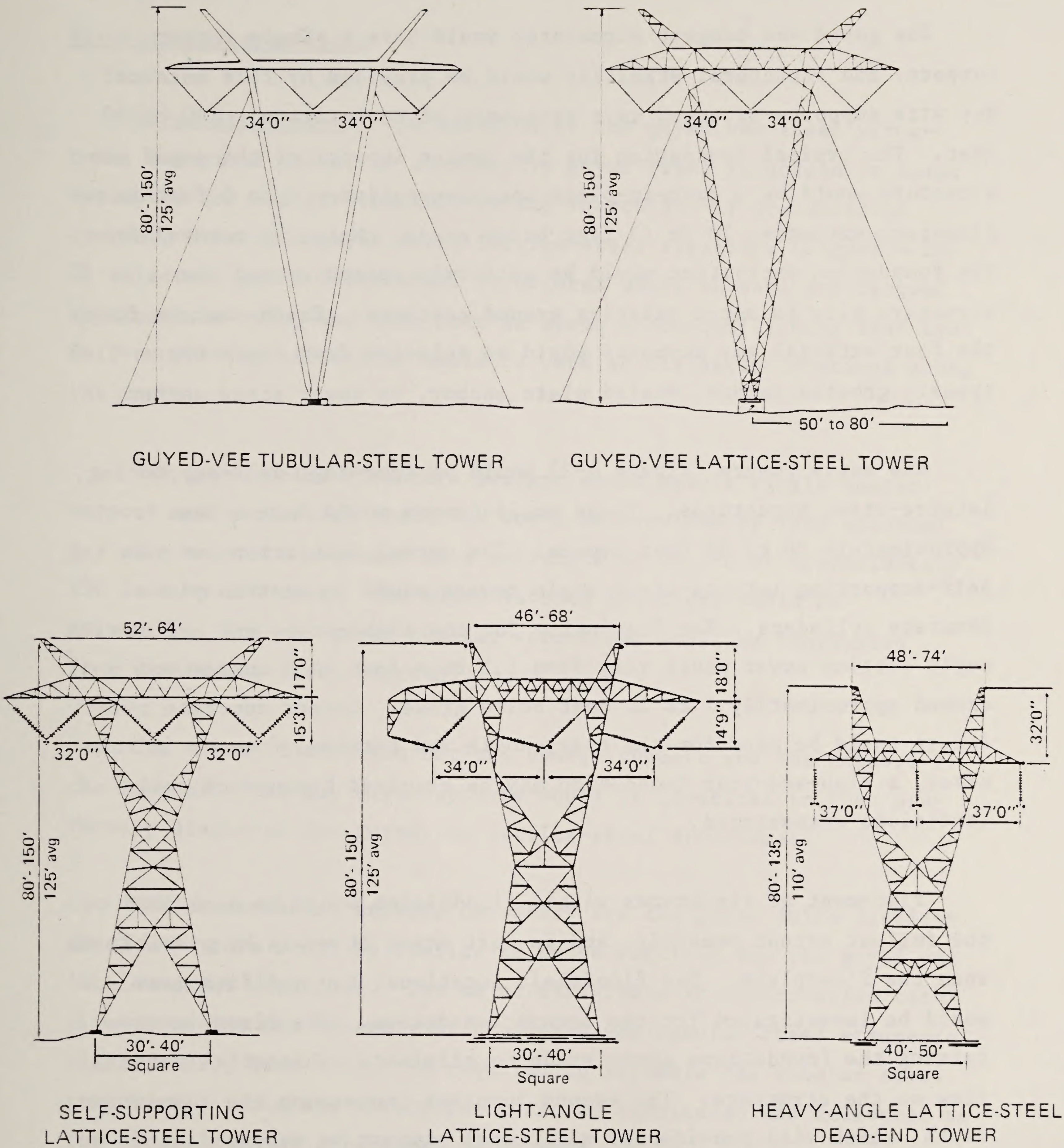


Figure 4-2. 500-kV STRUCTURE TYPES

The guyed vee tangent structures would have a single center support, and structural stability would be provided by four external guy wire supports arranged in a rectangle of approximately 140 by 80 feet. The typical foundation for the center support of the guyed vee structure would be a cast-in-place concrete cylinder 4 to 5 feet in diameter, extending 10 to 15 feet below grade. Material removed from the foundation excavation would be uniformly spread around the structure site to match existing ground contours. Earth anchors for the four external guy supports would be selected from these three types: grouted anchor, buried plate anchor, or power screw anchor.

The angle towers (Figure 4-2) would be four-leg, self-supporting, lattice-steel structures. These angle towers would have a base approximately 30 to 50 feet square. The normal foundation for the self-supporting lattice-steel angle towers would be cast-in-place concrete cylinders. The foundation for the light-angle and medium-angle lattice tower would vary from 2.5 to 4 feet in diameter and extend approximately 7 to 20 feet below grade. Larger concrete cylinders would be used for the heavy-angle and terminal towers; in some cases, a slab-and-pier foundation may be required because of soil conditions encountered.

Placement of structures within floodplains would be minimized to the fullest extent possible, and in most areas it would be possible to span the floodplain. For floodplain locations, two modifications would be investigated for the foundation design. The first involves raising the foundations above grade to eliminate substantial water flow on the structure. The second involves increasing the foundation depth, which will provide for additional support to accommodate substantial stream flow pressure on the exposed foundation and the additional unsupported foundation length in the event of flood-induced scouring.

Structure Alternatives.

Guyed Structures. In addition to the guyed vee steel structures described above, an alternative guyed steel structure is being evaluated for use for the NMGS-to-Rio Puerco 500-kV transmission system. This is a guyed delta lattice-steel structure (Figure 4-3). If selected, guyed delta steel structures would be used for tangent applications only, and then only in areas of nonconflicting land use. Self-supporting structures would be used at all angle locations along the route.

All guyed delta structure designs would have a single center support and structural stability would be provided by four external guy wire supports arranged in a rectangle or square of approximately 130 feet by 160 feet. The guyed lattice structure would be galvanized, and the guyed tubular structures would be fabricated from weathering steel (Corten).

The normal foundation for the center support and the anchors for the four external guy wire supports would be identical to that previously discussed for guyed vee lattice-steel structures.

The construction methods necessary for the guyed delta lattice-steel structure would be similar to those required for the guyed vee lattice-steel structure. The major difference in construction technique concerns the assembly of the guyed vee tubular steel structure. Significantly less effort is required to assemble the tubular steel structures, since the structures would be fabricated and delivered to the sites in major structural components.

Self-Supporting Structures. Other structure alternatives to be evaluated are self-supporting lattice steel, tubular-steel H-frame,

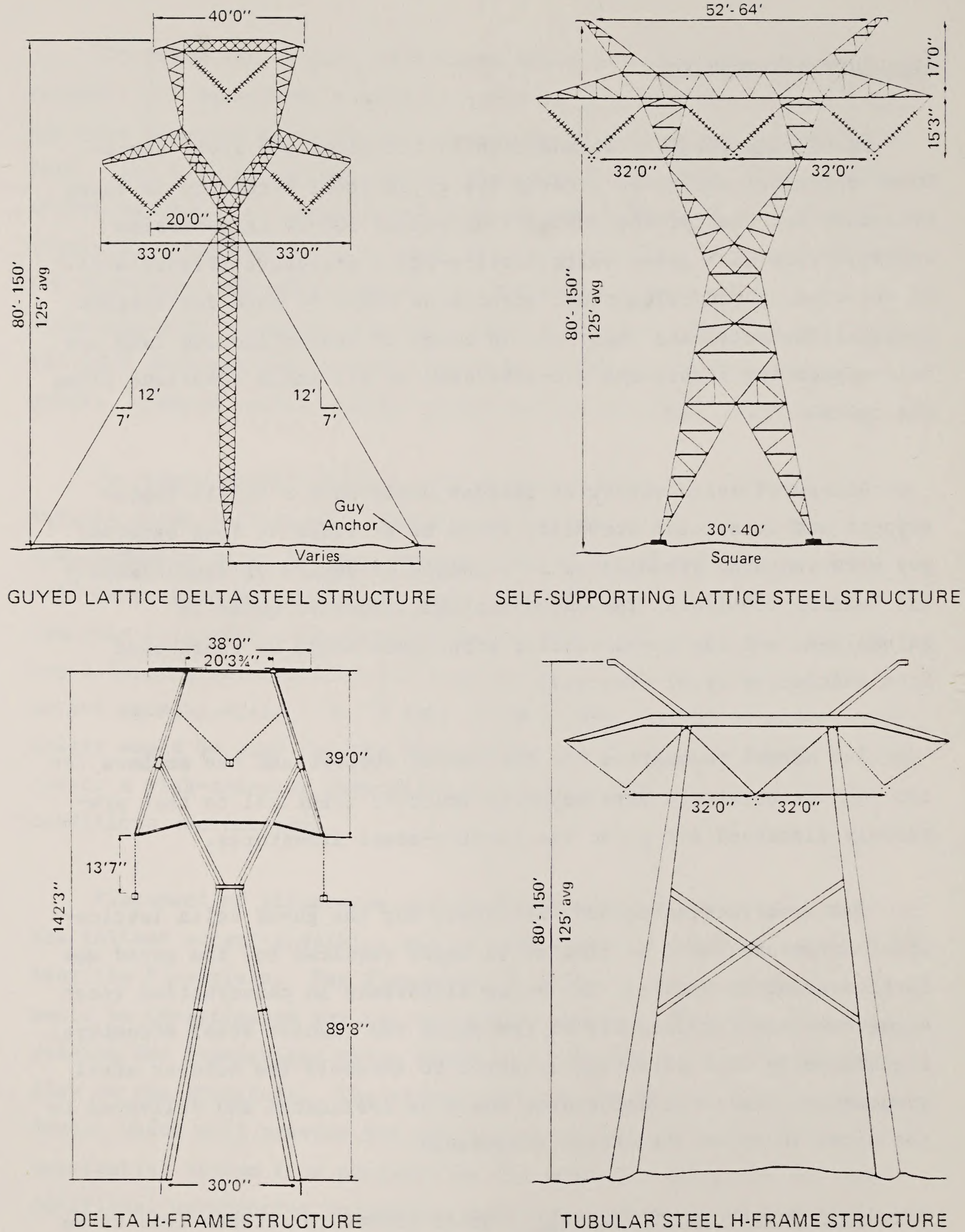


Figure 4-3. ALTERNATIVE 500-kV STRUCTURE TYPES

and tubular-steel delta H-frame (Figure 4-3). The tubular-steel types would be used for tangent and small-angle applications only, with major angles and dead ends being self-supporting lattice structures.

The lattice-steel structure has four legs and the tubular-steel types have two legs. These structures are designed for the same loading criteria as the guyed vee lattice-steel structure and would have similar span capability. The lattice-steel members would be galvanized. Tubular-steel types would be fabricated from weathering steel (Corten).

The normal foundations for these structures are cast-in-place concrete cylinders 2.5 to 5 feet in diameter and extending 12 to 20 feet below grade. Although the lattice structures require four foundations and the tubular structures require only two, the total amount of concrete required for the two structure types is about equal. Self-supporting structures require about four times as much concrete as guyed structures.

The construction methods necessary for self-supporting structures would be very similar to those required for guyed vee lattice-steel structures. Clearing and access requirements for both types of construction are identical. The foundation installation methods are very similar to the previously mentioned difference of the number of foundations required per structure. There is also more spoil material to be leveled at the site associated with self-supporting structures than with guyed structures.

The assembly of self-supporting lattice structures is very similar to the assembly of guyed lattice structures. The assembly of tubular steel structures requires significantly less effort, since the structures are fabricated and delivered to the sites in major structural components.

Grounding, Conductors, Insulators, and Shield Wires. The potential of induced voltages from structures to earth would be maintained at a low value by the installation of a grounding system. Each structure would be connected to a driven ground rod or series of ground rods to obtain the specified ground resistance. In areas where the underlying strata would prohibit the driving of ground rods, a counterpoise system would be installed to obtain the specified ground resistance.

Metal fences, gates, metal buildings, and roofs (on or directly adjacent to the right-of-way) would be grounded to eliminate possible shock hazard caused by induced voltages.

The conductor type and size would be determined from a study that compares the economic and performance characteristics of aluminum cable, steel-reinforced (ACSR), electrical-grade aluminum strands over a stranded steel core; aluminum cable, aluminum-reinforced (ACAR), electrical-grade aluminum strands over a high-strength aluminum alloy core; and self-damping conductor (SDC), trapezoidally shaped electrical-grade aluminum strands over a stranded steel core.

Each phase would probably consist of three subconductors, each approximately 1.3 inches in diameter. Dampers would be used to control wind-induced vibration. A minimum ground clearance of 36 feet would be maintained at the maximum conductor operating temperature, which exceeds the requirements of the National Electric Safety Code. Greater clearances would be provided over highways, railroads, and specific cultivated areas as conditions dictate. The electrical performance of this line would be similar to that of existing 345-kV lines currently operating in New Mexico.

Vee-string insulator assemblies with 24 to 26 units in each leg would be used to support the conductor at the tangent towers.

Parallel insulator strings of similar quantities would be yoked together in an assembly to dead-end the conductors as required. Insulator units would be approximately 5.75 inches long by 10 inches in diameter and constructed of glazed porcelain, tempered glass, or polymer materials.

Two shield wires would be installed above the three-phase conductor bundles for lightning protection and would be positioned to provide a shielding angle of approximately 10 degrees with respect to the outside phases.

The shield wire would be galvanized or aluminum-coated stranded steel of a size compatible with the current-carrying conductors. A typical size is 3/8-inch seven-strand extra-high-strength (EHS) galvanized steel with a diameter of 0.360 inch, a weight of 0.273 pound per foot, and an ultimate breaking strength of 15,400 pounds.

4.1.2 NMGS Switching Station

The northern terminus of the 500-kV line from NMGS to Rio Puerco station would be provided by the proposed 500-kV switching station located about a quarter-mile south of NMGS (Figure 4-1). The switching station would be developed in four phases.

The switching station would initially consist of a four-breaker 500-kV ring connected directly to the plant step-up and startup transformers. Connected to the bus would be two 500-kV lines, one startup transformer, and one generating unit. The station would be constructed of structural steel, with a maximum tower height of 120 feet. Most of the station would be less than 45 feet in height. To provide for terminations of the second, third, and fourth generating units and the two 500-kV lines to Rio Puerco station, the switching station would be expanded in three additional phases. The site would be a rectangle approximately 800 by 2200 feet (40.3 acres), and would be surrounded by an 8-foot chain-link fence topped by three strands of barbed wire. Access to the switching station would be from either State Road 371 or the Star Lake railroad.

A new microwave station would be established at the NMGS switching station. Channels would be used for telephone service, supervisory control, data acquisition, and protective relaying. Facilities would consist of a self-supporting, open lattice framework, steel tower with a parabolic antenna directed north toward PNM's existing Moncisco Mesa microwave repeater near Farmington.

Rio Puerco Station. The proposed Rio Puerco station would provide the southeastern terminus of the proposed 500-kV lines. The proposed station (approximately 10 miles northwest of Rio Rancho, New Mexico) would be situated directly northwest of the WW-BA 345-kV tap (Figure 4-1).

Initially, the station would consist of a transformer-terminated 500 kV line and a three-breaker 345-kV ring. The 1500-MVA 500/345-kV transformer would feed bulk power to the 345-kV ring, which would tap into the 345-kV line from West Mesa to BA for outlet capacity for the 500-kV line. Both 500-kV and 345-kV transmission termination structures within the station would be of structural steel. The maximum tower height would be 120 feet, but most of the station would be less than 45 feet in height. Details of color, scale, and texture have not been finalized. Phase II of Rio Puerco would involve additional terminations for the 500-kV lines and 500/345-kV transformers.

The site would be a rectangle 2045 by 2325 feet (109.2 acres) (Figure 4-4), with 45.7 acres enclosed by an 8-foot chain-link fence and topped by three strands of barbed wire. Access would be from Rio Rancho, over approximately 10 miles of existing road (20 feet wide), which would be improved by grading.

A new microwave station would also be constructed at the Rio Puerco station. Channels derived would be used for telephone service, supervisory control, data acquisition, and protective relaying. Facilities would consist of a self-supporting, open lattice framework, steel tower with a parabolic antenna directed toward PNM's Person Station in Albuquerque.

Proposed Site (Sec. 29, T13N, R1E). The proposed site is located at the WW-BA 345-kV tap along the western edge of the Rio Rancho development. The site is characterized by terrain with a slope of 2 to 3 percent. There are no rock outcroppings or drainage problems associated with the site, and the soil consists of eolian sand over alluvial gravels.

Access to the site is excellent. The graded roads of the Rio Rancho development would require only slight improvements. This site is located adjacent to all of the 345-kV lines that would be connected to the station. Hence, no 345-kV construction would be required. Incremental 500-kV transmission line length would be 8.4 miles. These 500-kV lines would probably be within existing corridors.

4.2 CONSTRUCTION PROCEDURES

Construction of transmission lines would generally follow a sequence of right-of-way clearing, road construction, tower foundation construction, tower assembly and erection, conductor and shield wire stringing and tensioning, and finally, site restoration. However, prior to the actual start of construction procedures, extensive aerial photography and on-the-ground survey work would be completed. The survey work and those operations involved in the typical construction sequence are discussed below. It should be noted that, within the limits set by PNM, the final choice of exact procedures would be that of the contractor selected by PNM to construct the transmission line, though PNM would meet all landowner/manager restrictions and stipulations.

Large and bulky materials would most likely be delivered by rail. Two or three marshalling yards near the railheads would be required during construction of the project. Staging areas for temporary material and equipment storage would be located about every 30 miles along the transmission line route. Materials would probably be delivered to the construction site by truck.

Construction activities at stream crossings would be planned and supervised by the construction contractor and the PNM engineering staff on a site-by-site basis, to ensure minimal modification of channel hydraulics and minimal introduction of sediment and contaminants to stream channels.

Various types of equipment would be used during construction of the line. The types and functions of this equipment are shown in Table 4-1.

4.2.1 Survey Procedure

The line survey would be accomplished by a combination of ground survey and aerial photography.

The ground survey team would establish a basic control network by locating photo-identifiable points on the ground at selected points along the route. This activity would use existing roads, trails,

Table 4-1. TYPES AND FUNCTIONS OF LINE CONSTRUCTION EQUIPMENT USED FOR TRANSMISSION LINE CONSTRUCTION

Vehicle	Area of Operation	Where Vehicle Travels
Utility vehicle (4-wheel drive)	Down the centerline	Centerline
Pick-up trucks	Soil test sites, tower sites, pulling tensioning sites, and throughout the ROW for cleanup	ROW
Bulldozer with clearing blade	Any location that requires clearing or grading, including roads, tower sites, dense vegetation, and timbered areas	ROW
Bulldozer with clearing blade up	Down the centerline to pull in the sock line	Centerline
Flat-bed trucks	At all tower sites and along the ROW when hauling material or removing cleared waste	ROW
Truck with boring equipment	Predetermined sites along the centerline	ROW
Digger-cat or truck-mounted auger	Tower sites	ROW
Boom truck	Tower sites and staging areas	ROW
Ready-mix truck	At and between temporary batch plants and tower sites	ROW
Wagon drill (mounted on crawler tractor)	Tower sites	ROW
Truck with rock coring equipment	Tower sites where rock anchors are required	ROW
Air compressor and jackhammer (truck-mounted)	Tower sites where rock anchors are required	ROW
Air compressor and tamps (truck-mounted)	Tower sites where grillage anchors are required	ROW
Air compressor and driver (truck-mounted)	Tower sites	ROW
Crawler tractor with ripper blade or cable plow	Tower sites	ROW
Mobile crane (15-20 ton)	Tower sites	ROW
Mobile crane (50-ton)	Tower sites	ROW
Pulling machine	At pulling sites, which are located on the centerline	ROW
Tensioning machine	At tensioning sites, which are located on the centerline	ROW
Reel trailer	At and between pulling/tensioning sites and staging/material storage areas	ROW

railroad rights-of-way, or other established access wherever possible. Horizontal and vertical control would be provided to control the scale of photogrammetric mapping. The elevation of each reference point would be determined from benchmarks established by the National Geodetic Survey and the U.S. Geological Survey (USGS). The ground survey data would be coordinated with aerial photogrammetry to provide topographic maps and plan-profile drawings.

Points of intersection (PI), coordinate locations, and the corridor centerline would be determined by the ground survey team. No roads would be required for the initial survey; however, a minor amount of trimming may be required at a limited number of locations to provide unobstructed visibility along the survey line.

Boundary and easement identities would be determined from a combination of ground survey and aerial photographs. After the route is firmly established, the survey team would stake the PI locations, as well as structure center hubs, longitudinal reference stakes, and transverse reference stakes. Final data for determining span lengths, preparatory to issuing conductor sag-tension charts, and as-built completion drawings would be derived from the field survey.

4.2.2 Soil Borings

Soil borings would be made at approximately half-mile intervals, or where there are significant changes in the geology, to determine the engineering properties of the soil. Truck-mounted equipment would be used; the boring holes would be approximately 4 inches in diameter and would average 30 feet in depth. Boring holes would be backfilled with the excavated material upon completion.

4.2.3 Clearing

The clearing of some natural vegetation would be required; however, selective clearing would be done only when necessary to provide electrical clearance, line reliability, and construction and maintenance operations.

Clearing crews would make a minimal number of passes through the right-of-way, making use of existing access roads as much as possible. The amount and type of clearing or grading required for electrical clearance cannot be accurately estimated prior to a survey of the right-of-way, since these activities are very specific to certain locations. In general, the extent of clearing or grading would be minimal.

Preconstruction conferences would be held to review the procedures for clearing and the precautions to be taken to prevent range and forest fires. Applicable laws and regulations would be reviewed to ensure that they are strictly enforced.

Existing cleared areas would be used whenever possible for construction areas, storage areas, etc. Grading and removal of grass cover or low growth would be prohibited unless considered necessary. The height of saw-cut tree stumps, disposition of tree trunks, and the method of handling cleared waste (i.e., remove, conceal, shred, stack, or scatter about the site) would be in accordance with requirements of the land management agency or landowner. Along the transmission right-of-way, the application of herbicides (defoliants) would be prohibited and the burning of cleared waste would be controlled.

Large trees encountered under or near conductors would be topped or removed. This would be done to provide adequate electrical clearance under the lines according to National Electric Safety Code (NESC) standards, and to improve line reliability by removal of trees that could possibly fall on the line (whether they were in or outside the right-of-way). Trees that could affect the lines during wind-induced line swing (blowout) would also be removed. The normal clearing procedure is to fell large trees with saws and to cut down or bulldoze smaller trees. In critical areas such as forest lands, any determination of a hazard to the power line (with respect to the NESC and state or other electric safety and reliability requirements), would be jointly reviewed by the utility company and the landowner/manager.

4.2.4 Access Road Construction

The construction of access roads would be required to allow the movement of the various sizes and types of vehicles required for construction of the line. Access roads would be temporary, unpaved construction roads along the right-of-way, permitting access for workers, materials, and equipment to the right-of-way (sometimes with approved deviations away from the right-of-way). New access roads would generally be bladed with a Caterpillar tractor in order to facilitate relatively direct, smooth, and efficient movement of workers, materials and equipment along the construction route. All vegetation would generally be removed and the roadway leveled to provide a smooth driving surface. Without bladed access, variable terrain conditions would generally require very roundabout overland access into and along the right-of-way.

Access roads would be closed to public travel and restoration measures applied once construction is completed. The use and control of access roads would comply with the specifications of the land management agency or landowner. The width of these roads is normally 14 feet; the average length is approximately 6000 feet for each mile of construction.

Roads with a maximum grade of 7 to 10 percent are desired for safe and efficient construction. Existing roads would be used for construction access when possible. When new access roads are required, they are laid out according to construction needs, tempered by previously identified environmental concerns, and approved by the land management agency or private landowner. Access roads are generally located beyond the outside phase of the line in order to provide a safe distance from which to work during conductor stringing operations.

Where necessary, roadside drainage ditches and water bars would be installed to control erosion. Where fences are encountered crossing the route of a temporary road, a temporary gate would be installed, which can be removed at the completion of the project and the fence permanently closed.

The total amount of new access roads required for construction of the proposed facilities is very dependent on the right-of-way surveys. Only after the surveys are completed and exact line alignment and structure sites are located can the number and extent of new access roads be precisely determined. As a result, a worst-case analysis for new access (Table 4-2) was used for impact analysis in the EIS.

4.2.5 Tower Construction, Assembly, and Erection

It is expected that circular cast-in-place concrete foundations would be the predominant type for the tower center support; however, other types may be used in certain cases. The excavation for the circular concrete foundation would be made with a track- or truck-mounted auger. The diameter would usually be 2.5 to 5 feet, and the depth would vary from 10 to 15 feet, depending upon soil quality. The socket extension, vertical reinforcing bars, and circular ties would be positioned in the excavation, which would then be filled with concrete. Normally, the concrete foundation would extend about 6 inches above grade, except where additional projection would be required to compensate for uneven terrain. The portion extending above grade would be formed and the top surface crowned and smoothed. Excavated material would be spread at the structure site to match existing ground contours, unless otherwise requested by the landowner.

At locations where the circular concrete foundations could not be installed because of underlying rock formations, rock bolts or rock anchors would be considered. Rock bolts would be inserted into holes cored in the rock formation and expanded or grouted into place to provide an anchorage for the tower leg. A rock anchor would require a hole in the rock strata into which the socket extension is installed and concreted. The hole may be obtained by coring, drilling, jackhammering, or blasting; each method requires truck-mounted equipment.

Depending upon anchor type, earth anchors for the four external guy supports would be constructed as follows:

- Grouted Anchor--The grouted anchor is a 9-inch-diameter cylinder augered at a 45 degree angle and extending 20 to 30 feet into the ground. Spoil material is minimal and is spread at the site.

- Buried Plate Anchor--The plate anchor is installed by excavating (with a backhoe or auger) a hole 10 to 15 feet deep with a tapering trench for the anchor rod. The plate anchor is then placed in the hole and the excavated material replaced and tamped to its original density.

- Power Screw Anchor--Power screw anchors are installed by a truck- or track-mounted hydraulic rotary drive which screws the anchor directly into the soil. The depth of the installation varies with the density of the soil, but typically ranges from 10 to 40 feet. This anchor has distinct limitations in its application. It cannot be used in areas of shallow bedrock, cobbly soils, or soils of extremely low density.

Construction of the foundations for the self-supporting angle structures would be very similar to the construction of the foundation for the center support of the guyed vee structure. The equipment used and construction methods would be the same. The difference is that four drilled pier foundations would be required for each self-supporting structure.

An area approximately 150 by 200 feet would be required at each tower site to provide space for the actual tower installation as well as an assembly and construction area for foundations, anchors, and tower components.

The area immediately surrounding the tower site must be relatively clear and level to permit safe and efficient construction. Within this 150- by 200-foot level area, a perfectly flat area about 20 by 20 feet is required to safely operate the crane. The amount of clearing and leveling required at a specific site is a function of terrain, soil, and vegetation. For example, a flat grassy tower site would require no leveling or clearing, but a tower site in rough, uneven terrain with heavy vegetation would require much clearing and leveling.

Concrete from existing commercial plants would be delivered in transit-mix trucks to the tower site when possible and economically desirable. In remote areas, the concrete would be supplied from temporary batch plants located at approximately 20-mile intervals, i.e., five batch plants for the proposed and alternative routes. An area of about 2 acres would be required to store cement, gravel, sand, and water and to operate the portable plant. The contractor would determine the site best suited for the batch plant. The batch plant would not always be located adjacent to the right-of-way.

Ten- to 30-acre marshalling yards for receiving and disbursing materials would be secured adjacent to railroad and major transportation facilities in the Albuquerque area. Smaller staging areas, approximately 5 to 10 acres, would be located on private lands about every 30 miles, i.e., three marshalling yards per line, along the right-of-way to store material and equipment as construction progresses.

The lattice tower members would be bundled by tower units at the marshalling yard and transported by truck to the tower sites. The members would be assembled into two or three sections at the vacant areas located adjacent to the tower foundation installation. A small mobile crane or "cherry picker" may be used to handle the heavier members in the assembly. A larger rubber-tire-mounted crane (70-90 tons) would be used to erect the preassembled sections progressively. The suspension insulator assemblies and stringing sheaves may be attached to the top section before lifting and installation.

4.2.6 Grounding

The steel structure would be grounded by means of a grounding wire attached to the stub angle, routed below grade, and connected to a grounding rod adjacent to the foundation. A grounding plate buried at the bottom of the foundation excavation may be used as an alternative to the ground rod.

In areas where ground rods or plates cannot be installed, a counterpoise would be considered. This system requires the burial of a ground wire; ground rods may be attached at the ends. The ground wire would be buried along the centerline of the transmission line in each direction from the tower. The ground wire would be installed by a crawler tractor with a ripper blade or cable plow.

The application of magnesium sulfate, copper sulfate, sodium chloride, or other chemicals to decrease soil resistivity would be considered only when other grounding methods prove ineffective.

4.2.7 Conductor Installation

The reels of conductor and shield wire would be transported from the marshalling yard to the tower site by truck. The shield wire would be installed by the pay-out method or by tension stringing; the conductors would be installed by tension stringing. Tension stringing would be accomplished by maintaining a predetermined tension and maintaining clearance above roads, trees, and other obstructions. This method protects the conductor surface from nicks and scratches that contribute to corona and radio interference, as well as strand failure.

A pilot or sock line, made from nylon or flexible steel, would be threaded through the stringing sheaves from one tower to another. A crawler tractor, which traverses the center of the right-of-way, would be used to install the sock line. A larger, higher-strength, flexible steel pulling line would be threaded through the sheaves by the pilot line and used to pull the conductor into position. Some contractors use the sock line as a pulling line.

Individual lengths of conductor or shield wire would be strung in opposite directions and compression-spliced together to provide approximate 3-mile lengths, which can be tensioned simultaneously. At one end of the line section being installed, the conductor and shield wire reels would be positioned behind a tensioning machine. At the other end of the section, a pulling machine would reel in the pulling line, attached to the conductor or shield wire. Pulling and tensioning machines may be self-propelled, truck- or trailer-mounted, and pulled from one location to another by a crawler tractor. Each pulling and tensioning machine would require two horizontal areas approximately 20 by 40 feet for the pulling/tensioning machine and for the truck holding the reels of conductor. The total disturbed area at a pulling/tensioning site would be about 200 by 50 feet, although no clearing or leveling would be required outside the 20- by 40-foot areas unless vegetation and terrain make it necessary for safety and efficiency.

After the conductors and shield wires were strung in a section, tension would be adjusted to provide the specified sag. The stringing sheaves would be removed from the end of the insulator string, and the conductor and shield wire would be installed in their respective clamping devices and attached to the insulator assembly.

4.2.8 Cleanup and Site Restoration

Normal cleanup at each site during construction would eliminate most cleanup efforts during the final phase. All waste and scrap materials would be removed from the right-of-way and deposited in local land fills in compliance with local regulations and in accordance with land management agency or landowner agreements.

Lands disturbed by heavy equipment or trucks would be restored; deep ruts and holes would be eliminated by filling or grading. Disturbed areas around structure foundations would be graded to approximate the original grade. Any damage to existing bridges, culverts, driveways, or roadways during construction would be repaired by the contractor. Temporary bridges and culverts would be removed from temporary access roads, and the roads would be restored to their natural state by grading original slopes and planting natural cover. Temporary construction roads would be harrowed and reseeded as required, or allowed to return to an original state as specified by the land management agency or landowner. Soil removed during construction would be replaced, graded, and reseeded to approximate the original conditions.

4.2.9 Maintenance

PNM would keep the transmission line right-of-way closed and would patrol the transmission line by helicopter each month. Should it become necessary to reach a structure for maintenance (such as tightening loose hardware, replacing damaged members, or replacing broken insulators), that structure would be reached either by helicopter or overland from existing access roads. Depending on the maintenance requirements, it may be necessary to use a high-reach line truck and several pickup trucks. If any maintenance required access to a structure on public lands, the appropriate agency would be notified in advance, except for emergencies requiring immediate repair. In all cases, PNM would restore lands and fences as necessary.

4.2.10 Land Requirements

The land requirements for construction and operation of the proposed and alternative 500-kV lines and associated stations are shown in Table 4-2. Land status for the proposed and alternative 500-kV lines is detailed in Appendix G of the NMGS EIS.

Proposed Action.

First 500-kV Transmission Line. During operation of route T2, a total of 2595 acres would be required for the line and associated stations. The right-of-way would cover a distance of approximately 101 miles and would have an average right-of-way width of 200 feet, resulting in about 2440 acres being classified as right-of-way corridor land use. With the exception of the tower sites, totaling 1.6 acres, the right-of-way corridor would be usable for other land uses

Table 4-2. LAND REQUIREMENTS FOR THE TRANSMISSION SYSTEM

Area/Facilities	Size	Number/ Distance	Area Temporarily Disturbed (cleared & graded) (acres)	Area Permanently Disturbed (acres)	Land Required for Operation (acres)
Rio Puerco Station	109.2 acres	1	7.1	45.7	109.2
NMGS Switching Station	37.9 acres	1	7.0	40.3	40.3
Alternative T1					
Right-of-Way	200 ft	107 mi			2593.7[d]
Access Road[a]	14 ft	107 mi	206.4		
Construction Route Storage Areas	10 acres	3	30.0		
Pulling and Tensioning Areas[b]	50x200 ft	36	8.3		
Framing and Tower Erection Sites[b]	150x200 ft	428	295.3		
Tower Area[b,c]	177.7 ft^2	428		1.7	
Batch Plants	2 acres	5	10.0		
Total Land Requirements			550.0	1.7	2593.7
Alternative T2					
Right-of-Way	200 ft	101 mi			2448.24[d]
Access Road[a]	14 ft	101 mi	200.2		
Construction Route Storage Areas	10 acres	3	30.0		
Pulling and Tensioning Areas[b]	50x200 ft	34	7.8		
Framing and Tower Erection Sites[b]	150x200 ft	404	278.8		
Tower Area[b,c]	177.7 ft^2	404		1.6	
Batch Plants	2 acres	5	10.0		
Total Land Requirements			526.8	1.6	2448.24

Table 4-2. LAND REQUIREMENTS FOR THE TRANSMISSION SYSTEM (concluded)

Area/Facilities	Size	Number/ Distance	Area Temporarily Disturbed (cleared & graded) (acres)	Area Permanently Disturbed (acres)	Land Required for Operation (acres)
Alternative T3					
Right-of-Way	200 ft	105 mi			2545.2[d]
Access Road[a]	14 ft	105 mi	202.5		
Construction Route Storage Areas	10 acres	3	30.0		
Pulling and Tensioning Areas[b]	50x200 ft	35	8.0		
Framing and Tower Erection Sites[b]	150x200 ft	420	289.8		
Tower Area[b,c]	177.7 ft^2	420		1.68	
Batch Plants	2 acres	5	10.0		
Total Land Requirements			540.3	1.68	2545.2
Alternative T2					
Right-of-Way	200 ft	126 mi			3054.2
Access Road[a]	14 ft	126 mi	243.0		
Construction Route Storage Areas	10 acres	3	30.0		
Pulling and Tensioning Areas[b]	50x200 ft	42	9.7		
Framing and Tower Erection Sites[b]	150x200 ft	504	348.0		
Tower Area[b,c]	177.7 ft^2	504		2.0	
Batch Plants	2 acres	5	10.0		
Total Land Requirements			640.7	2.0	3054.2

[a]Access road along ROW estimated at 6000 ft/mi (access roads would probably be located within the ROW).

[b]Area or facility located within ROW.

[c]Because of existing land use, primarily grazing, the land area that would be occupied by the guyed towers is based on a 2-foot-diameter circle around each guy and a 5-foot-diameter circle around the center support. The tower area of the estimated 55 self-supporting structures is assumed to be 35 feet x 35 feet.

[d]ROW acreage does not preclude other land uses.

such as grazing. Land committed to the Rio Puerco station and the NMGS switching station would total about 149.5 acres (40.3 acres at NMGS and 109.2 acres at Rio Puerco). Of this 149.5 acres, 86 acres would not be available for other land uses (40.3 acres at NMGS and 45.7 acres at Rio Puerco). Land not available for other land uses is classified as "permanently disturbed" in Table 4-2.

During construction of the project, a number of activities, occurring both within and outside the right-of-way, would temporarily disturb land through clearing and grading. These activities include access road construction, construction route storage areas, pulling and tensioning areas, framing and tower erection sites, and batch plants. These activities are classified as areas of temporary disturbance and would total about 541 acres for route T2 and stations. Areas of temporary disturbance would be restored as discussed above.

Second 500-kV Transmission Line. As shown in Table 4-2, the 500-kV line from NMGS to Rio Puerco station would require a total of 2594 acres. The right-of-way would cover a distance of approximately 107 miles and would have a right-of-way width of 200 feet, resulting in about 2594 acres being classified as right-of way corridor land use. With the exception of the tower sites, totaling 1.7 acres, the right-of-way corridor may be used for other land uses, such as grazing. Area of temporary disturbance for this portion of the project is about 540 acres.

The land requirements for the 5-mile 500-kV loop to the Four Corners-Ambrosia 500-kV line would be less. Approximately 242 acres would be required for right-of-way. Tower sites would occupy about 0.2 acre, which would not be available for other land use. The area of temporary disturbance for the loop totals about 51.5 acres.

4.3 TRANSMISSION SYSTEM COST

The total cost of the proposed 500-kV transmission line can only be estimated at this time. Surveying and engineering studies are required to determine the exact centerline and tower locations. Once this is accomplished, accurate costs can be identified.

For the purposes of this study, preliminary construction and right-of-way cost estimates are available and have been used. The total estimated cost of the transmission project is $256,618,458 (nominal dollars). This estimate includes the following components: first transmission line, $78,775,216; second transmission line, $104,684,401; NMGS switching station, $43,178,965; Rio Puerco station, $23,338,537; and NMGS-FC-A 500-kV loop, $6,641,339. All of these estimated costs reflect a projected inflation rate of 7 percent calculated through the year of expected completion of each project component.

5.0
WORK FORCE AND SCHEDULE

5.1 STATION FACILITIES

Construction and operation labor requirements for the station facilities are shown in Table 5-1. The applicant is expecting 20 to 60 percent of all construction workers at the station site to be in-migrants, depending on local availability of qualified craftsmen during the 14-year construction period. Construction employment for station facilities would reach peaks of 1515 employees in 1987 and 1530 employees in 1992.

Operations employment at station facilities would increase steadily from 30 employees in 1989 to 900 employees in 1999 when all four units are expected to be on-line. The percentage of operations employees that are expected to be in-migrants is not currently available. Operations employees would reside in the project area for the life of the project (estimated 40-year project life).

5.2 TRANSMISSION SYSTEM

5.2.1 Schedule

PNM estimates that a 12-month period would be required for construction of the first proposed 500-kV transmission line and stations. The estimated project schedule is shown in Table 5-2.

Table 5-1. NMGS CONSTRUCTION AND OPERATION EMPLOYMENT

Year	Pipeline and Reservoir	500-kV Transmission Line	NMGS Construction Unit 1	Unit 2	Unit 3	Unit 4	Total	NMGS Operation Unit 1	Unit 2	Unit 3	Unit 4	Total	Total Employment	Annual Change
1985	—	—	85	—	—	—	85	—	—	—	—	—	85	+85
1986	—	—	800	—	—	—	800	—	—	—	—	—	800	+715
1987	115	—	1515	—	—	—	1630	—	—	—	—	—	1630	+830
1988	295	104	1180	30	—	—	1505	—	—	—	—	—	1505	-125
1989	—	—	360	450	—	—	914	30	—	—	—	30	944	-560
1990	—	—	100	940	40	—	1080	200	—	—	—	200	1280	+336
1991	—	—	—	750	570	—	1320	250	—	—	—	250	1570	+290
1992	—	—	—	270	1260	—	1530	250	24	—	—	274	1804	+234
1993	—	—	—	105	955	30	1090	250	160	—	—	410	1500	-304
1994	—	78	—	—	325	435	838	250	200	30	—	480	1318	-182
1995	—	—	—	—	90	940	1030	250	200	200	—	650	1680	+362
1996	—	—	—	—	—	775	775	250	200	250	—	700	1475	-205
1997	—	—	—	—	—	255	255	250	200	250	24	724	979	-496
1998	—	—	—	—	—	95	95	250	200	250	160	860	955	-24
1999	—	—	—	—	—	—	0	250	200	250	200	900	900	-55

Source: PNM 1980, unpublished data.

About 13 months would be required for construction of the second 500-kV transmission line between NMGS and Rio Puerco Station. It is estimated that approximately 4 months would be required to construct the 5-mile 500-kV loop to the FC-A-P 500-kV line.

5.2.2 Labor Force Requirements

Construction of the proposed 500-kV transmission lines and associated stations would be contracted. Peak employment for the first transmission line construction is estimated at 145 persons, and would occur during the seventh month (Table 5-2).

In addition, about 26 persons would be required for construction of stations during this peak period in the construction schedule. It is not known whether the contractor would use employees exclusively from the local labor force or import some of the workers from elsewhere. The number of workers enlisted from the local labor force depends on the availability of qualified craftsmen at the time of construction.

Labor force requirements for the second 500-kV line between NMGS and Rio Puerco Station would be very similar to the requirements for the first line. Peak employment would be about 150 people in the seventh or eight month of construction.

Construction of the 5-mile loops between NMGS and the 500-kV line from Four Corners to Ambrosia would have a peak employment estimated at 35 people.

5.3 WATER SUPPLY SYSTEM

5.3.1 Schedule

Pipeline. All the underground work for the adit and vertical shaft is specialized and could involve more than one contractor. Because

Table 5-2. CONSTRUCTION SCHEDULE FOR PROPOSED NMGS-RIO PUERCO STATION 500-kV TRANSMISSION PROJECT

Construction Activity	Month												
	1	2	3	4	5	6	7	8	9	10	11	12	13
ROW Clearing and Access	x	x	x	x	x	x							
Foundation Installation	x	x	x	x	x	x	x	x					
Structure Assembly			x	x	x	x	x	x	x	x			
Structure Erection					x	x	x	x	x	x	x		
Conductor Stringing						x	x	x	x	x	x	x	
Grounding						x	x	x	x	x	x		
Cleanup and Restoration							x	x	x	x	x	x	x
Administration	x	x	x	x	x	x	x	x	x	x	x	x	x
Material Control	x	x	x	x	x	x	x	x	x				

of the uncertainties at this time (i.e., ground stability), 15 months should be allowed for the underground work. Pipeline work from the top of the shaft to Booster Pumping Plant 1 cannot be connected until underground work is completed.

Pipeline constructed in trench would be straightforward work and the rate of progress would depend largely upon the rate at which the pipe manufacturers can deliver pipe to the job. More than one pipe-laying crew could be engaged.

Two or more manufacturers in the region are capable of large production rates on the classes of pipe proposed. Based on a production rate of 500 feet per day in each of the two plants, the total requirement of the initial pipeline project could be delivered in about one year. Four pipeline crews could easily install the pipeline and appurtenances and accomplish the leakage tests in about 18 months' time from start of pipe manufacture.

Intake Structure and Primary Pumping Plant. Construction of intake works, settling channels, and primary pumping plants would be accomplished in 2 years or less. Duration is somewhat dependent upon the time of year the work is started. For example, protective dike construction work cannot be carried out economically in winter months and this work should be well advanced before excavation for the structures is attempted.

Booster Plants. Each booster plant structure could be constructed and all machinery installed and tested in one year. If construction of all three plants was awarded to a single contractor, they could be completed easily in 2 years' time with a single crew. Large valves, pipe and special pipe fittings, the station crane, pumps and pump motors would be purchased in ample time to ensure delivery by the time each plant is readied for equipment installation.

5.3.2 Labor Force Requirements

Pipeline. Construction of the initial pipeline would require the services of the contract work force shown in Table 5-3. The contract work force shown in Table 5-3 is that required for each pipe-laying crew. Depending on the production rate for pipe, up to four pipe-laying crews would be used.

Intake Structure and Primary Pumping Plant. Construction of the intake works, including headgate structure, settling channels, protective dike works and site grading plus the pumping plant structure, including installation of piping, pumping units, and all auxiliary equipment would require the services of the contract work force shown in Table 5-3. Workers would not be employed continuously throughout the job.

Booster Plants. Construction of each booster plant would require the services of the contract work force shown in Table 5-3.

Use of the work force would be intermittent at each plant. For this reason, a single contractor could construct all three booster plants and effectively utilize manpower on a continuous basis thereby gaining some efficiency.

More efficient use of construction machinery also would result from using a single contractor.

Reservoir. The work force required for reservoir construction is listed in Table 5-3.

Table 5-3. APPROXIMATE WORK FORCE REQUIREMENTS FOR THE WATER SUPPLY SYSTEM

Component	Supervisory/ Adminstrative Personnel	Laborers
Pipelaying and Tunnel Crew	10	59
Intake Structure and Pumping Plant	9	57
Booster Pumping Plant	9	49
Reservoir Construction	9	19