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Final Environmental Impact Statement



Great Plains Gasification Project

**Mercer County
North Dakota**

U.S. Department of Energy

August 1980

Cover Sheet
Final Environmental Impact Statement
Great Plains Gasification Project
Mercer County, North Dakota
DOE/EIS - 0072 F

- (a) Lead Agency: U.S. Department of Energy
Cooperating Agencies: U.S. Department of the Interior Bureau of Reclamation, Federal Energy Regulatory Commission, U.S. Department of the Interior Bureau of Land Management and the State of North Dakota
- (b) Proposed Action: The Department of Energy plans to issue a loan guarantee for the construction costs associated with the Great Plains Gasification Project. The project will result in a 125 million cubic feet per day coal gasification facility to be located in Mercer County, North Dakota. The Department of Energy is adopting three NEPA documents prepared by other Federal Agencies. They are:
- ANG Coal Gasification Company, North Dakota Project.
Final Environmental Impact Statement. Bureau of Reclamation, U.S. Department of the Interior, FES 78-1, January 20, 1978.
 - ANG Coal Gasification Company, North Dakota Project.
Supplement to the Department of the Interior's Final Environmental Impact Statement. Federal Energy Regulatory Commission, FERC/EIS-0001, April 1978.
 - Final West-Central North Dakota Regional Environmental Impact Study on Energy Development. United States Department of the Interior, Bureau of Land Management and State of North Dakota, October 1978.

Public comments were received in the process of completing the above cited documents and those comments were incorporated in the final documents.

(c) For Further Information Contact: (1) Mr. Phillip Gallo, High-Btu Gas Resource Manager, U.S. Department of Energy, Room 3443, Federal Building, 12th and Pennsylvania Avenue, N.W., Washington, D.C. 20461, Ph: (202) 633-9176; (2) Dr. Robert J. Stern, Acting Director, NEPA Affairs Division, Office of the Assistant Secretary for Environment, Room 4G-064, Forrestal Building, Washington, D.C., 20585, Ph: (202) 252-4600; or (3) Mr. Stephen H. Greenleigh, Esq., General Counsel for Environment, Room 6D-033, Forrestal Building, Washington, D.C. 20585, Ph: (202) 252-6947.

For Copies of the EIS Contact: Mr. Phillip Gallo at the address noted above.

(d) Designation: Final EIS

(e) Abstract: The statement assesses the potential environmental impacts associated with the construction and operation of a 250 million cubic feet per day coal gasification facility (although the present action will be a half-sized facility) and an associated 365 mile product pipeline. This project will demonstrate the technical operability, economic viability, and environmental acceptability of a high-Btu gas facility. Impacts addressed include potential impacts on terrestrial and aquatic ecology, including State and Federally-declared threatened or endangered species; expected impacts on land use; potential changes to the quality of surface water and groundwater; compliance with State and Federal ambient air quality standards; and changes to the existing economic and social characteristics of nearby areas. Additionally, the statement presents an identification of potential hazards associated with the operation of the proposed facility and plans for monitoring and controlling such hazards. Additionally, DOE has prepared an updated environmental analysis.

(f) Comments on this final EIS should be addressed to Mr. Phillip Gallo at the above-noted address. Comments are due by September 15, 1980. No additional public hearing is scheduled.

Final Environmental Impact Statement



Great Plains Gasification Project

**Mercer County
North Dakota**

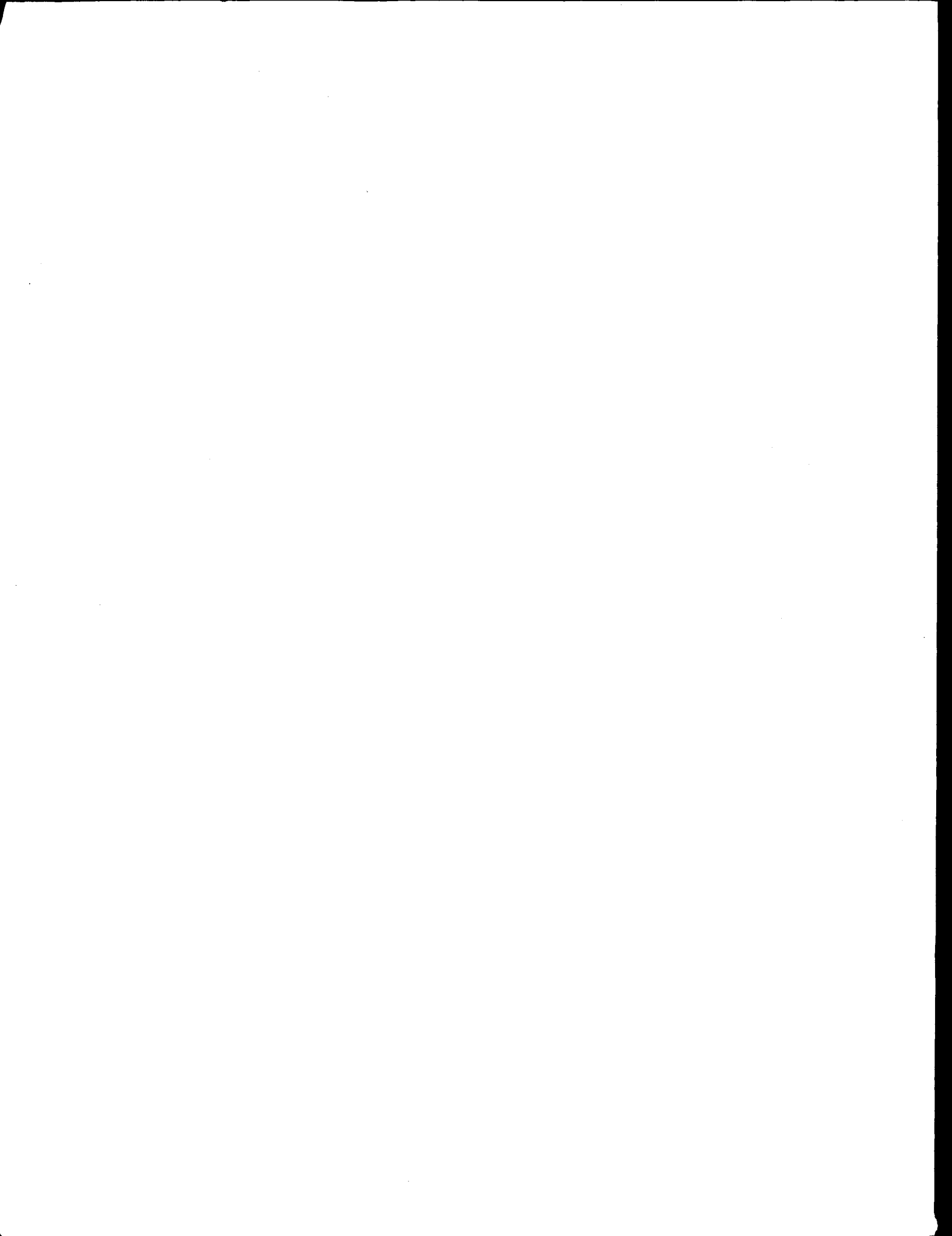
Responsible Official

U.S. Department of Energy

Ruth C. Clusen

Assistant Secretary for Environment

August 1980



Environmental Analysis: DOE Proposal to Issue Loan
Guarantee to Great Plains Gasification Associates

Introduction/Background

Great Plains Gasification Associates (GPGA, previously referred to as ANG) has applied to the Department of Energy (DOE) for a loan guarantee, pursuant to the DOE's authority under Public Law 96-126, for the first-year construction costs of a 125 million-cubic-feet-per-day coal gasification facility, to be located in Mercer County, North Dakota. GPGA also plans to construct a 365-mile pipeline to transport the synthetic gas to Thief River Falls, Minnesota, for further distribution to gas utility customers.

Based on a review of the available documentation, DOE has determined that the issuance of a loan guarantee (or a commitment thereto), thereby enabling the project to proceed, would be a "major Federal action significantly affecting the quality of the human environment", within the meaning of the National Environmental Policy Act (NEPA). Therefore, an environmental impact statement (EIS) is required for the proposed DOE action.

The proposed facility, including the pipeline, has been discussed in three NEPA documents prepared by other Federal agencies:

- ANG Coal Gasification Company, North Dakota Project.
Final Environmental Impact Statement. Bureau of Reclamation, U.S. Department of the Interior, FES 78-1, January 20, 1978.
- ANG Coal Gasification Company, North Dakota Project.
Supplement to the Department of the Interior's Final Environmental Impact Statement. Federal Energy Regulatory Commission, FERC/EIS-0001, April 1978.
- Final West-Central North Dakota Regional Environmental Impact Study on Energy Development. United States Department of the Interior, Bureau of Land Management and State of North Dakota, October 1978.

The two documents prepared by the Department of the Interior received public review and comment, and the reviews are reflected in the final documents. The Federal Energy Regulatory Commission (FERC) document also was circulated for public review as a supplement to the Department of the Interior EIS.

During the period since publication of the above documents, new environmental regulations have been enacted, some of which are applicable to the facility. In addition, the nature and pace of energy development in western and central North Dakota have changed so that the analysis in the Bureau of Land Management (BLM) document probably overstates cumulative impacts. The changes in regulations and in the development in the project area, and their implications for the project, are described below.

New Environmental Requirements

1. Since the publication of the final EIS by the Bureau of Reclamation, the Theodore Roosevelt National Memorial Park has been designated a Class I area for purposes of the regulations governing Prevention of Significant Deterioration (PSD) of air quality, under the Clean Air Act. The park is approximately 70 miles west and southwest of the GPGA facility. The North Dakota Department of Health used the EPA-recognized RAM and CRSTR models to analyze the impacts on the park of four facilities which use coal, including GPGA. The Department concluded that three of the facilities (the GPGA plant and the Coal Creek and Coyote powerplants) would consume 74% of the Class I 24-hour increment for SO_2 . Operation of the Antelope Valley powerplant could have caused the increment to be exceeded. Therefore, before receiving its PSD permit, the Antelope Valley plant was required to reduce its SO_2 emissions by 67.5%. Therefore, the increment should not be exceeded by the four plants either singly or collectively. No other PSD increment is expected to be exceeded by these plants.

2. On May 19, 1980, the U.S. Environmental Protection Agency (EPA) promulgated regulations implementing the hazardous waste provisions of the Resource Conservation and Recovery Act (45 FR 33066 ff). GPGA is taking steps to ensure compliance with the control and accounting of all potentially hazardous materials that may be generated at the site, in accordance with RCRA permitting requirements. Gasifier ash is a major

solid waste to be produced by the facility. This material has been taken to high temperature in the presence of oxygen. It is similar to bottom ash from coal stoker boilers, which is currently excluded from the RCRA definition of a "hazardous waste." Preliminary tests on ash generated in pilot gasification runs indicate that this material will not have the characteristics of a "hazardous waste" in accordance with RCRA protocols. Additional RCRA specific characterization of this and other solid wastes generated by the gasification facility are to be performed once the facility becomes operational, to ensure adequate control of all "hazardous" materials.

3. EPA has promulgated regulations which implement the Toxic Substances Control Act (TSCA) (40 CFR Part 710 et seq.). The regulations apply to any commercial substance which poses an unreasonable risk to man or the environment. The synthetic gas to be produced by this facility, and by-products, are potentially subject to TSCA. There are as yet no TSCA standards relating to high-Btu gas. It is expected that to comply with TSCA, in the future, premanufacture notice for high-BTU gas will have to be provided to EPA. In addition, reports may be required. No problems are anticipated in complying with TSCA.

4. Under the regulations implementing the Safe Drinking Water Act, EPA has issued interim primary (health-related) and secondary standards for drinking water supplies. As no process water from the project will be discharged to surface waters, there will be no violation of the standards in any surface supply of drinking water. Only inorganic ash will be disposed of as solid wastes. A brine solution from the secondary water treatment will be disposed of in a deep saline aquifer that is not a potential source of drinking water. In addition, the disposal system for the brine solution will be designed in accordance with applicable EPA regulations for Underground Injection Control, which are designed to permit compliance with the Safe Drinking Water Act and the Clean Water Act. *groundwater?*

Floodplains/Wetlands

The Water Resources Council (WRC) has issued guidelines for development in floodplains and wetlands since the date of issuance of the EIS on the GPGA facility. The WRC guidelines and DOE implementing regulations (10 CFR Part 1022) require each agency to determine whether an action which it proposes to take will occur in a floodplain/wetlands. If so, the agency must assess the impacts of the action on the floodplain/wetlands, discuss whether there are practicable alternatives

to locating in the floodplain or wetland, and discuss measures that can be taken to prevent or minimize harm resulting from an action in a floodplain. If there is no practicable alternative to construction in a floodplain, a finding to that effect must be made and circulated.

No wetlands or floodplains will be affected by construction or operation of the gasification plant itself. Because of its length and linear nature, however, the pipeline built to transport product gas to market would cross both wetland areas and floodplains. It is estimated that there will be approximately 85 river or stream crossings, in four major drainage basins, and many marshes, potholes, and other wetland areas will be crossed. The pipeline would be constructed in its entirety on an existing embankment in a railroad right-of-way.

Impacts, mitigation, and alternative routings are fully described in FERC's supplement. Because the pipeline will be buried, impacts should be only those related to construction, and should be temporary. These impacts could include sedimentation and erosion, changes in drainage patterns, damage to or destruction of vegetation by equipment, and injury to waterfowl and animals from human intrusion and ingestion of spilled materials. Many of these impacts can be mitigated by construction during winter (where possible) and by careful construction practices. Operational impacts, if any, would be caused by leaks or ruptures in the pipeline.

Any alternative routes in the same general area also would traverse wetlands and floodplains. Because of the length of the pipeline and the location of the market, it would be impossible to move this pipeline to an area where there would be no construction in wetlands or floodplains. Thus, there are no practicable alternatives to the proposed construction.

Changed Circumstances

The environmental impact study published by BLM and the State of North Dakota analyzed cumulative impacts of three levels of energy development in western and central North Dakota. The first level included the GPGA gasification facility; steam-electric powerplants to be constructed by Basin Electric Power Cooperative on a site north of, and adjacent to, the GPGA site (Antelope Valley plant, two units), and by Montana-Dakota Utilities on a

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site approximately 20 miles south of the ANG site (Coyote, one unit); a coal gasification facility with approximately the same capacity as the GPGA facility, to be located in Dunn County, west of the GPGA site; and several mining operations. The second level included unit 2 at Coyote and five new coal mines. Level three included several coal mine developments, which were not specifically defined.

Since the 1978 date of publication of the final environmental impact study, unit 1 at Coyote has been nearly completed; operation is scheduled to begin in the spring of 1981. Antelope Valley unit 1 is approximately 50 percent completed; construction of the second unit has been significantly deferred. The proposal to construct a coal gasification plant in Dunn County has been dropped. In addition, the proposed size of the GPGA plant has been reduced to half of that analyzed in the original EIS.

Therefore, there are no longer potential emissions, effluents, and other wastes from the Dunn County gasification facility and its powerplant which might interact with those from GPGA and the Coyote, Antelope, and (existing) Coal Creek powerplants. In addition, coal mining activity which would have taken place in connection with the Dunn County plant will not occur. Because the Dunn County facility will not be constructed, and because of the advanced state of construction of the two new coal-fired powerplants, the significant overlap of construction workers, which was discussed in the BLM document, apparently will not occur. Consequently, the substantial impacts on the economies, social services, and other facilities of the affected towns and areas that were analyzed in that document will be considerably diminished.

Conclusions

In light of the above, DOE believes that, although certain new requirements and circumstances have arisen since publication of the EIS, its supplement, and the regional environmental study in 1978, these requirements and circumstances are not significant enough to warrant preparation of an EIS supplement by DOE. Consequently, DOE finds that the existing NEPA documents present a currently valid assessment of the environmental impacts of construction and operation of the proposed facility, and hereby adopts these documents to meet its NEPA obligations with respect to the project, as provided in section 1506.3 of the Council on Environmental Quality's regulations.

SUMMARY

() Draft (X) Final Environmental Statement

Department of the Interior, Bureau of Reclamation, Upper Missouri Region

1. Type of action: (X) Administrative () Legislative

2. Brief description of action:

The Bureau of Reclamation proposes to make available to ANG Coal Gasification Company (ANGCGC) 17,000 acre-feet of water annually for coal gasification needs from Garrison Reservoir through a 40-year water service contract. The gasification complex, to be located in southwestern (Mercer County) North Dakota, would produce 250 million cubic feet per day of synthetic natural gas for use in the Michigan and Wisconsin market areas. The water intake, coal and ash handling, and plant access systems would be shared with an adjacent 880 MW coal-fired powerplant proposed by Basin Electric Power Cooperative.

3. Summary of environmental impact and adverse environmental effects:

Starting in 1988, the combined ANGCGC and Basin Electric projects would emit 14,665 pounds of sulfur dioxide, 6,143 pounds of nitrogen oxides, and 693 pounds of particulates each hour. These emissions would adversely affect existing ambient air quality and visibility. Surface waters would be temporarily degraded from mining and construction of a 365-mile product gas pipeline which would traverse 86 water areas. Ground water quantity and quality could be altered by aquifer disturbance and leachates from ash and other solid wastes buried in the mined area. The gasification plant and associated facilities would occupy about 600 acres of land; mining activity would disturb about 12,500 acres over the 25-year life of the plant. Land disturbance would temporarily destroy wildlife habitat and agricultural land and even with successful reclamation the wildlife habitat would be permanently altered. The proposed ANGCGC and Basin Electric projects would cause a peak influx of about 6,200 persons during construction and about 4,800 persons during operations into a presently rural area. This population influx would cause significant effects on existing social systems and infra-structures.

4. Alternatives considered;

Alternatives considered include: No project; alternate sources of natural gas; alternate locations; alternate processes and process units; alternate use of resources; and alternate sources of energy.

5. Statements are being distributed to the following:

List of agencies from whom comments have been requested is attached.

6. Date of draft statement made available to CEQ and the public:

Draft Statement: March 17, 1977

Final Statement:

LIST OF ENTITIES FROM WHOM COMMENTS HAVE BEEN REQUESTED
OR RECEIVED WITH RESPONDENTS INDICATED BY "*"

A. Statements distributed by the Commissioner of Reclamation for
review and comment:

Department of the Interior:

Director, U.S. Fish and Wildlife Service
*Director, Bureau of Outdoor Recreation
*Director, National Park Service
Commissioner, Bureau of Indian Affairs
*Director, Geological Survey
*Director, Bureau of Mines
*Director, Bureau of Land Management

Department of Agriculture

*Advisory Council on Historic Preservation

Secretary, Department of Defense

*Secretary, Department of Health, Education, and Welfare

*Secretary, Department of State

Secretary, Department of Transportation

Regional Director, Department of Housing and Urban Development,
Denver, Colorado

*Regional Director, Environmental Protection Agency, Denver,
Colorado

*Chairman, Federal Power Commission

*Administrator, Energy Research and Development Administration

Administrator, Federal Energy Administration

B. Statements distributed by the Regional Director for information
only:

Department of the Interior:

Field Representative, Missouri Basin Region, Denver, Colorado
Missouri River Basin Planning Officer, Omaha, Nebraska
*Area Director, Bureau of Indian Affairs, Aberdeen,
South Dakota
State Director, Bureau of Land Management, Billings, Montana
Chief, Intermountain Field Operation Center, Bureau of
Mines, Denver, Colorado
Regional Director, U.S. Fish and Wildlife Service, Denver,
Colorado

Department of the Interior (continued):

- *Area Manager, U.S. Fish and Wildlife Service, Bismarck,
North Dakota
- Regional Hydrologist, Water Resources Division, Geological Survey
Denver, Colorado
- Regional Director, National Park Service, Denver, Colorado
- North Central Reservoir Investigations, U.S. Fish and Wildlife
Service, Pierre, South Dakota

Department of Agriculture:

- Farmers Home Administration, Bismarck, North Dakota
- State Conservationist, Soil Conservation Service, Bismarck,
North Dakota
- *Rural Electrification Administration, Washington, D.C.
- *Forest Service, Missoula, Montana

Department of the Army:

- *District Engineer, U.S. Army Engineer District, Corps of
Engineers, Omaha, Nebraska

Department of Health, Education, and Welfare:

- Regional Director, U.S. Public Health Service, Denver, Colorado

Department of Transportation:

- Division Engineer, Federal Highway Administration, Bismarck,
North Dakota

Federal Power Commission:

- Regional Engineer, Federal Power Commission, Chicago, Illinois

Energy Research and Development Administration:

- Manager, Field Office, Chicago, Illinois

Chairman, Missouri River Basin Commission, Omaha, Nebraska

C. Statements distributed by the Regional Director inviting comments:

State of North Dakota:

- Governor of North Dakota, Bismarck
- *North Dakota State Planning Agency, Bismarck^{1/} (For distribution
to State agencies.)
- Superintendent, State Historical Society, Bismarck
- *North Dakota Game and Fish Department, Bismarck
- *State Attorney General, Bismarck
- *North Dakota Regional EIS, Bismarck
- *North Dakota Geological Survey, Grand Forks
- *North Dakota Park Service, Mandan
- *State Health Department, Bismarck
- *North Dakota Highway Department, Bismarck
- *Regional Environmental Assessment Program, Bismarck

^{1/} State Clearinghouse

County Commissioners:

Mercer County
Oliver County
Dunn County

City Governments:

Bismarck	Center
Beulah	Dodge
Hazen	Halliday
Golden Valley	Riverdale
Stanton	Killdeer

State of Minnesota:

Governor of Minnesota, St. Paul^{1/}
State Planning Agency, St. Paul^{1/}
*Minnesota Historical Society, St. Paul

Others:

Three Affiliated Tribes Business Council, New Town, North Dakota
Regional Governor, Izaak Walton League, Minot, North Dakota
Environmental Defense Fund, East Setauket, New York
Director, Midwest Region, Nature Conservancy, Minneapolis, Minnesota
Central Environmental Council, NDSU, Fargo, North Dakota
*North Dakota Natural Science Society, Jamestown, North Dakota
Institute of Ecological Studies, UND, Grand Forks, North Dakota
North Dakota Wildlife Federation, Bismarck, North Dakota
Northern Environmental Council, Duluth, Minnesota
North Dakota Chapter, The Wildlife Society, Jamestown, North Dakota
Field Representative, National Audubon Society, Jamestown,
North Dakota
Field Representative, Wildlife Management Institute, Firth,
Nebraska
United Plainsmen, Bismarck, North Dakota
Lewis and Clark Environmental Association, Bismarck, North Dakota
North Dakota Section, Sierra Club, Minot, North Dakota
North Dakota Farmers Union, Jamestown, North Dakota
*Otter Tail Power Company, Fergus Falls, Minnesota
*American Natural Gas Service Company, Detroit, Michigan
*Iowa Confederation of Environmental Organizations, Ames, Iowa
*Mercer County Landowners, Beulah, North Dakota

^{1/} State Clearinghouse

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CHAPTER 1

DESCRIPTION OF PROPOSED PROJECT

1. Description of Proposed Project

1.1 Brief Description of Project and of Companies Involved

The ANG Coal Gasification Company (ANGCGC) proposes to construct and operate a coal gasification plant and the necessary support facilities in southwestern North Dakota. The plant, which would use the Lurgi gasification process, would produce an average 250 million cubic feet (MMcf) per day of synthetic natural gas (SNG). The U.S. Bureau of Reclamation proposes to enter into a water service agreement with ANGCGC for up to 17,000 acre-feet of water annually for gasifying the coal, cooling needs, and mine operations. The water would be provided from Garrison Reservoir (Lake Sakakawea) through a 40-year water service contract.

ANGCGC is a subsidiary of American Natural Resources Company (ANR), a holding company which holds all of the common stock in ANGCGC, Michigan Wisconsin Pipe Line Company, ANG Production Company, Michigan Consolidated Gas Company, and one-half of the common stock in Great Lakes Gas Transmission Company. Together these companies make up what is known as the "American Natural Resources System" (Figure 1-1).

Michigan Wisconsin Pipe Line Company (Michigan-Wisconsin) owns and operates an extensive natural gas pipeline system which spans the United States from the Gulf Coast to the Canadian border and supplies gas to 54 gas distributing utilities. The area served has a total population of over 8 million people in Michigan, Wisconsin, Iowa, Illinois, Indiana, Kansas, Ohio, and Tennessee.

Michigan-Wisconsin, in response to its need for additional gas to serve its customers, initiated a program to determine the feasibility of, and to select a site for, a coal gasification complex. Parameters considered were size of coal reserves, mining costs, environmental concerns, production costs, water availability, and gas transportation costs (Section 8.2). North Dakota coal reserves were selected and Michigan-Wisconsin entered into an agreement with the North American Coal Corporation (NACCO) through its subsidiary Coteau Properties Company (Coteau Properties) for options on 1.5 billion tons of low sulfur coal in and around Mercer County for future gasification needs.

As the coal gasification program developed, ANGCGC was organized to construct and operate the proposed facilities. A contract to mine the coal for ANGCGC would be executed with Coteau Properties.

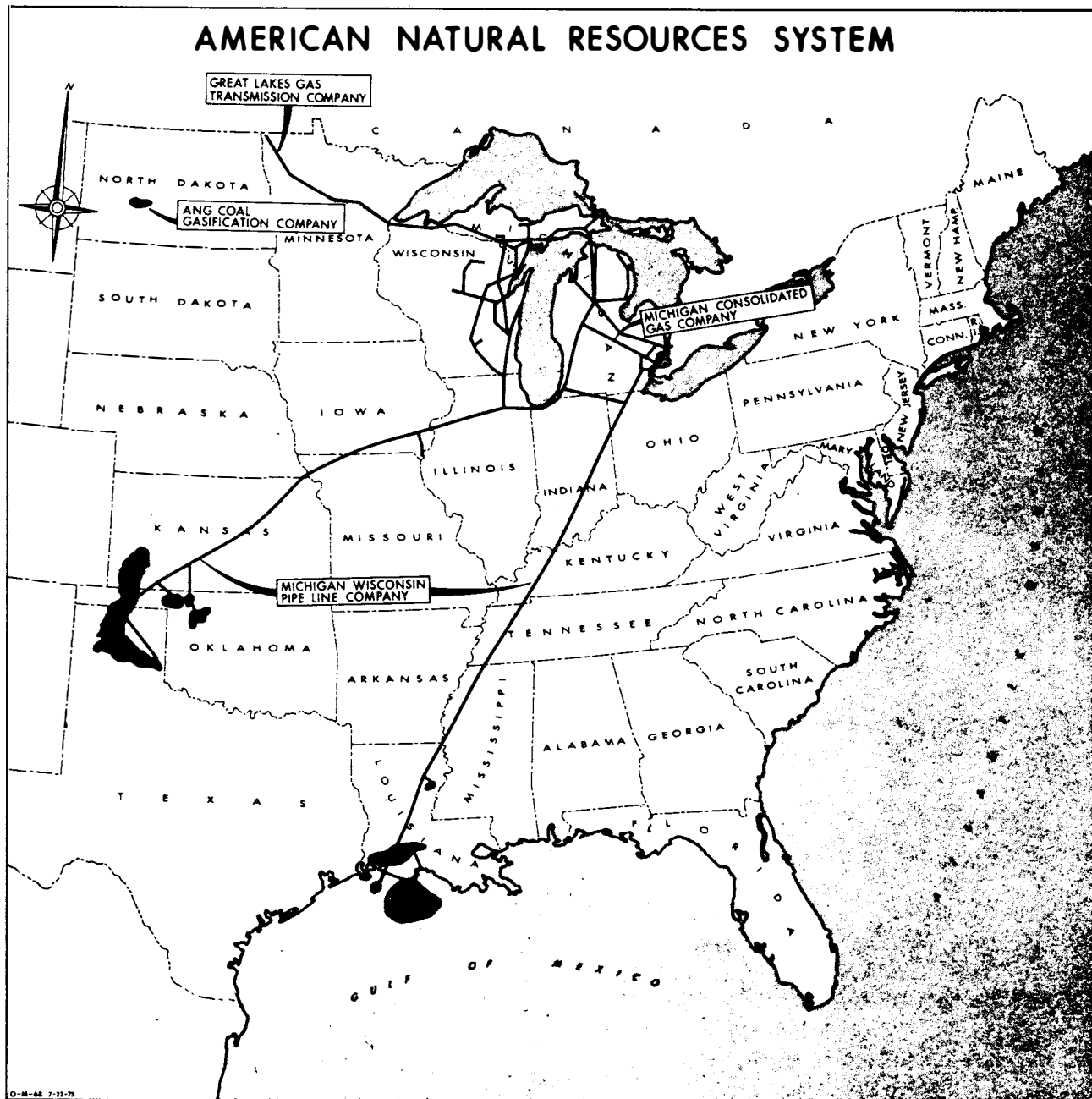


Figure 1-1 American Natural Resources System

To transport the SNG produced, Great Lakes Gas Transmission Company (Great Lakes) would extend its existing gas transmission system from Minnesota into North Dakota. The proposed 20-inch product gas pipeline (product pipeline) would extend 365 miles from Great Lakes' existing Thief River Falls Compressor Station to Mercer County. Burlington Northern Railroad (Burlington Northern) would extend a 9.0-mile railroad spur from its existing lines in Mercer County to provide materials to the gasification facilities and to transport byproducts for sale. Wastes (i.e., ash and sludge) from operation of the plant would be buried in the mines.

After release of the Draft Statement, Natural Gas Pipeline Company of America (NGPC) joined ANGCGC as a coowner of the proposed project. ANGCGC would remain as project administrator and be responsible for all phases of construction and operation of the project. However, half of the cost of the project would be paid by NGPC and half the SNG produced would be conveyed to NGPC's market area (Chicago).

Construction of the plant would occur in two phases beginning in 1978. Each phase would include all facilities necessary to produce an average 125 MMcf/day. Phase I would be placed into operation (in 1981) before construction begins on Phase II so that operating data and experience can be used to incorporate design improvements into the second phase. Phased construction would also result in lower socioeconomic impacts in the local area compared to unphased construction of the full plant capacity. Construction of the second phase of the plant is tentative but would begin about 1983 and be completed by about 1987. This statement will be concerned with the construction, operation, and impact of a full 250 MMcf/day plant.

As currently proposed, the cost of the product gas would be distributed among all of the ANR gas system customers (i.e., rolled-in). Cost estimates based on noninflated late 1975 dollars per MMBtu (.97 thousand cubic feet) would be:

	<u>Plant</u> <u>Synthesis</u>	<u>Pipeline</u> <u>Transport</u>	<u>Distribution</u>	<u>Total</u>
<u>Michigan</u>				
Incremental	\$3.63	\$0.69	\$0.55	\$4.87
Rolled-In	-	-	-	1.54
<u>Wisconsin</u>				
Incremental	3.63	0.69	0.92	5.24
Rolled-In	-	-	-	1.94

The above incremental cost totals are used only to develop rolled-in costs; the gas would be sold only on a rolled-in basis.

1.2 Purpose and Need

1.2.1 Domestic Energy Supply and Demand

Natural gas, electricity, fuel oil, and low sulfur coal are in short supply today in many areas of the United States. Current

demands for natural gas exceed the present and future supply. Figure 1-2 (from Federal Energy Administration's 1976 National Energy Outlook) depicts energy consumption in the United States from 1950 to the present and projected into the year 1990. Beginning in 1950, the United States changed from a net exporter of energy to a net importer. Since 1958, energy imports have increased at rates of 7 to 10 percent per year (1).

Total energy use in the United States 1950, increasing at a rate of 4.25 percent per year (2). During the same period, domestic energy production has increased at an annual rate of only 3 percent; and, during recent years, production increase has slowed to less than 1 percent.

Figure 1-3 shows domestic gas reserves and annual consumption from 1947 to present. It is evident that there will soon be a large unsatisfied demand for natural gas even if all available sources are developed to the greatest possible extent. Moreover, the gas supply will continue to decline unless new sources of natural gas are discovered, significant volumes of SNG are produced from coal, or other means of producing natural gas are found.

National Energy Consumption

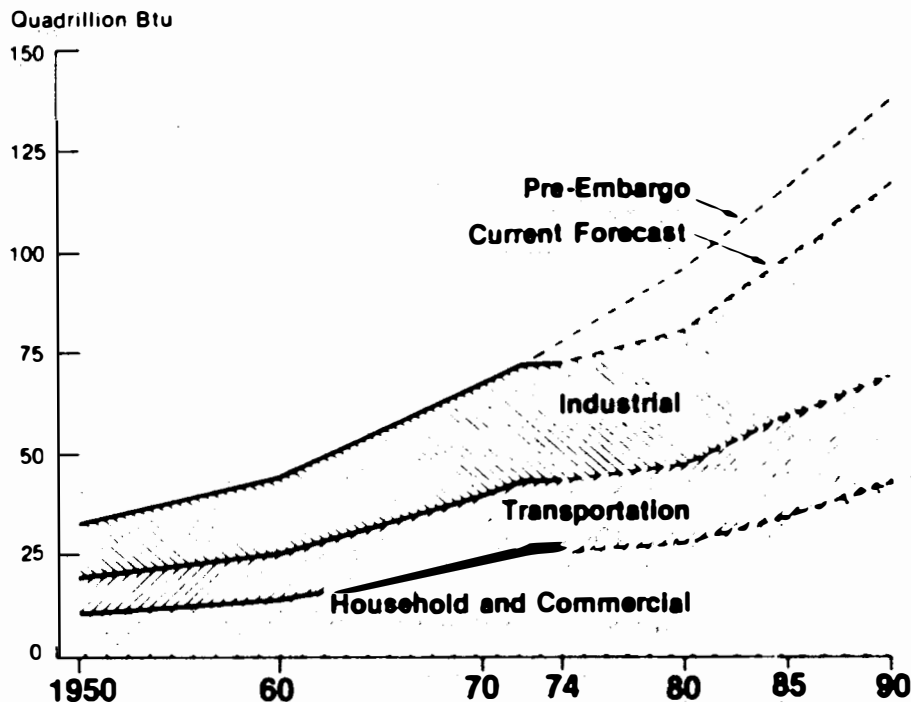
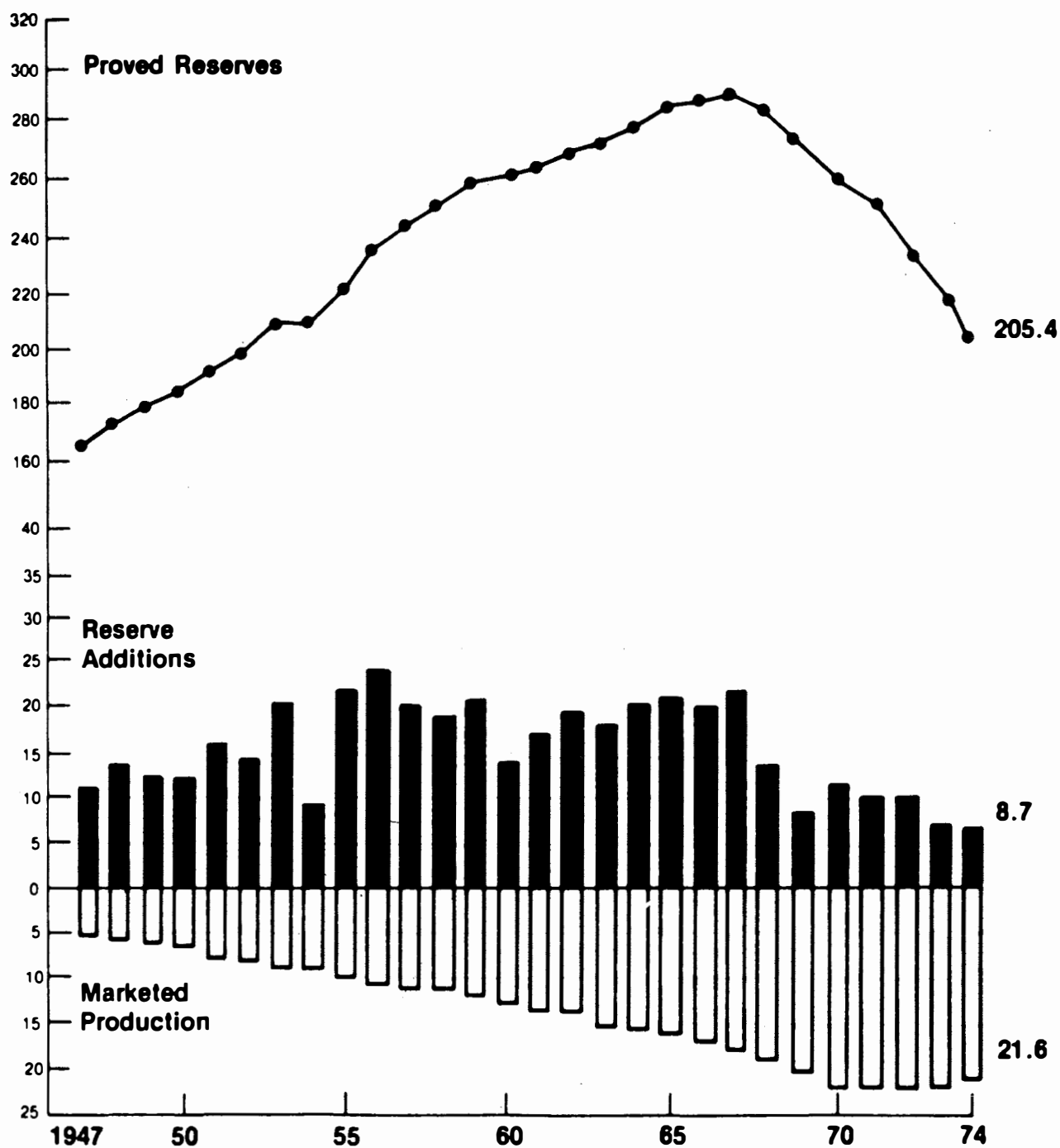


Figure 1-2

U.S. Natural Gas Reserves (Excluding Alaska)

Trillion Cubic Feet



Source: American Gas Association.

Figure 1-3

There were several reasons for the demand for natural gas. Pipelines were built after World War II forming a transport network which made gas available throughout much of the country. A large number of homes and industries became dependent on natural gas due to its low price, clean burning characteristics, and availability. Industries on "interruptible" gas contracts could enjoy a relatively continuous supply of energy at a very low price. Since 1967, however, industrial interruptions have become common, and in some areas new industrial customers are being turned away entirely.

Total proven reserves of natural gas in the U.S. reached a peak of 293 trillion cubic feet (Tcf) in 1967. Until that time, natural gas reserve additions exceeded production each year. Since 1968, production has exceeded reserve additions except for 1970 when Alaska's Prudhoe Bay reserves were added to the proved reserves (75). During the past 8 years, reserve additions in the lower 48 states have averaged 9.3 Tcf annually compared to an average production of 21.4 Tcf. In 1975 proven reserves with and without Alaska were 237 and 205 Tcf, respectively.

Deregulation of natural gas wellhead prices has been proposed as the most immediately available method of stimulating natural gas production. Proponents of deregulation cite that increased prices would stimulate exploration and development, and the higher prices would lower the demand for natural gas through the increased use of less costly fuels and increased conservation. The opponents of deregulation counter that such deregulation would place hardships on the residential customer, cause increased inflation, produce a drop in the gross national product, deplete reserves, and provide windfall profits to the gas companies.

In July 1976, the Federal Power Commission in Opinion No. 770 authorized an increase in the price of natural gas sold in interstate commerce. This rate increase is expected to increase natural gas supplies for the short-term; however, recoverable reserves are limited and for the long-term the U.S. will need to find alternative means of producing energy (See Section 8.3 for alternatives).

1.2.2 Need for Project

The need for the proposed project is based on Michigan-Wisconsin's need for additional gas supplies to fulfill its customer's requirements. About 5 years ago, a long-range forecast was made comparing Michigan-Wisconsin system requirements with natural gas supplies from traditional sources through the year 1995. The major conclusion of the forecast was that Michigan-Wisconsin, like most natural gas transmission companies, will not have sufficient gas supplies from its traditional sources to meet its long-range requirements.

Table 1-1 summarizes Michigan-Wisconsin's projected natural gas supply requirements by priority, supplies, and proportion of priorities served. These projections do not include any new additions of domestic reserves that might occur (86).

Customers are allocated gas on a priority basis. Priority 1 customers have gas allocated to them before any of the other priorities are considered. This scheme continues through all 9 priorities with priority 9 being allocated gas only after the previous 8 priorities have been fully served. The priorities are defined as follows:

1. Residential, small commercial (< 50 Mcf (thousand cubic feet) on a peak day).
2. Large commercial (50 Mcf or more on a peak day), firm industrial requirements for plant protection, feedstock, and process needs, and pipeline customer storage injection requirements.
3. All industrial requirements not specified in 2, 4, 5, 6, 7, 8, and 9.
4. Firm industrial requirements for boiler fuel use at less than 3,000 Mcf/day but more than 1,500 Mcf/day where alternate fuel capabilities can meet such requirements.
5. Firm industrial requirements for boiler fuel (more than 3,000 Mcf/day) where alternate fuel capabilities can meet such requirements.
6. Interruptible requirements of more than 300 Mcf/day and less than 1,500 Mcf/day, where alternate fuel capabilities can meet such requirements.
7. Interruptible requirements between 1,500 Mcf/day and 3,000 Mcf/day, where alternate fuel capabilities can meet such requirements.
8. Interruptible requirements between 3,000 Mcf/day and 10,000 Mcf/day, where alternate fuel capabilities can meet such requirements.
9. Interruptible requirements more than 10,000 Mcf/day, where alternate fuel capabilities can meet such requirements.

As of September 1, 1975, gas service to priorities 6 through 9 was curtailed by Michigan-Wisconsin. As can be seen from Table 1-1, Michigan-Wisconsin will need new natural gas supplies by 1982 to continue serving residential and small commercial customers.

Table 1-1

MICHIGAN WISCONSIN PIPE LINE COMPANYRequirements, Gas Supplies and Priorities Served
(Volumes in MMcf @ 14.73 Psia)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
<u>Requirements by F.P.C. Priorities</u>										
Priority 1	492,461	516,677	535,793	555,665	573,834	591,986	610,188	628,411	646,630	664,509
Priority 2	212,304	233,252	245,006	265,965	286,469	302,647	314,527	332,019	347,274	364,208
Priority 3	78,771	82,246	85,448	89,143	92,210	95,322	98,419	101,504	104,610	107,652
Priority 4	12,977	13,130	13,580	14,104	14,561	15,026	15,494	15,972	16,456	16,946
Priority 5	29,587	28,442	29,363	30,648	31,635	32,667	33,749	34,884	36,076	37,325
Priority 6	19,373	21,151	21,668	22,087	22,505	22,924	23,343	23,761	24,180	24,564
Priority 7	5,999	8,147	8,185	8,224	8,262	8,301	8,340	8,378	8,417	8,456
Priority 8	23,336	26,102	26,400	26,658	26,996	27,295	27,593	27,891	28,189	28,438
Priority 9	21,967	18,366	16,366	16,366	16,366	16,366	16,366	16,366	16,366	16,366
Total Requirements	896,775	947,513	981,809	1,028,900	1,072,838	1,112,534	1,148,019	1,189,186	1,228,198	1,268,464
<u>Supplies</u>										
Producers-Owned and Contracted	703,782	666,315	667,361	586,573	518,323	456,458	391,861	332,406	276,792	234,709
Pipeline Supplier Purchases	165,018	163,685	162,639	162,639	162,639	162,639	162,639	161,236	159,903	158,637
Arctic Gas	-	-	-	-	-	34,960	69,350	69,350	69,350	69,350
Substitute Natural Gas	-	-	-	-	-	-	-	22,812	22,812	22,812
Total Supplies	868,800	830,000	830,000	749,212	680,962	654,057	623,850	585,604	528,857	485,508
<u>Proportion of Priorities Served</u>										
Priority 1	100%	100%	100%	100%	100%	100%	100%	100%	92%	83%
Priority 2	100%	100%	100%	73%	37%	21%	20%	8%	-	-
Priority 3	100%	97%	58%	-	-	-	-	-	-	-
Priority 4	100%	-	-	-	-	-	-	-	-	-
Priority 5	100%	-	-	-	-	-	-	-	-	-
Priority 6	100%	-	-	-	-	-	-	-	-	-
Priority 7	100%	-	-	-	-	-	-	-	-	-
Priority 8	74%	-	-	-	-	-	-	-	-	-
Priority 9	-	-	-	-	-	-	-	-	-	-

Source: Michigan-Wisconsin Pipeline Company

The proposed gasification plant would supply an average 250 MMcf/day of SNG or over 91 billion cubic feet (Bcf) annually. This would amount to 23.7 percent of the 1975 gas requirements of Michigan Consolidated's 1 million customers.

1.3 Permits, Approvals, and Certifications Required

The following major permits and approvals must be obtained by ANGCGC before construction and operation of the coal gasification facility can begin:

Federal Agencies

Permit and/or Approval

U.S. Army Corps of Engineers

Easement for Water Intake, Pipeline, and Access Road; Section 10 Permits for Water Intake and Pipeline Crossings of Major Streams; Section 404 Permits for Wetland Disturbance

Environmental Protection Agency

New Source Performance and Air Quality Significant Deterioration Review, Deep Well Disposal Review

Federal Power Commission

Certificate of Public Convenience and Necessity

Federal Aeronautical Administration

Application for and Notice of Proposed Construction for Structures over Regulated Heights

U.S. Bureau of Reclamation

Water Service Contract, Environmental Impact Statement

State Agencies

North Dakota Public Service
Commission

Plant Certificate of Site Compatibility, Water Pipeline Certificate of Site Compatibility, Water Pipeline Transmission Facility Route Permit, Mining Plan

North Dakota Department of Health -
Environmental Engineering Division

Permit to Construct
(Air Pollution Control Permit)
Permit to Operate
(Air Pollution Control Permit)

Water Supply and Pollution
Control Division

NPDES Permit for Deep Well Disposal,
NPDES Permit for Mine Drainage
Disposal,
Solid Waste Disposal Permit

North Dakota Department of Health

License for Radioactive
Measuring Device Operations,
Hazardous Waste Control Plan,
Wells for Temporary Water
Supply,
Sewage Treatment Plant

North Dakota State Highway
Department

Rail Siding Crossing,
Pipeline Construction on Highway ROW

North Dakota State Water
Commission and State Engineer

Appropriation of Underground
Water,
North Dakota State Water
Permit (conditional permit
obtained)

North Dakota Secretary of State

Certificate of Authority for
Foreign Corporation to Transact
Business

North Dakota Unemployment Compensation
Division of Employment
Security Bureau

Application for Coverage
by ANGCGC

North Dakota Workman's Compensation
Bureau

Coverage by ANGCGC

Mercer County

Board of Commissioners

Petition for Access to
County Roads,
Petition for Vacating County
Road and Closing Section Lines,
Certificate of Zoning Compliance,
Plantsite Rezoning,
Conditional Use Permit

Soil Conservation District

Erosion and Sediment Control
Plan

1.4 Relationship to Other Projects

1.4.1 Industrial

a. Basin Electric Coal-Fired Powerplant

Basin Electric has proposed the construction of two 440-megawatt (MW) coal-fired electric generating units adjacent to the ANGCGC gasification complex. The generating complex would be on the north side of the proposed gasification site and the two companies would share the water intake system, plant access road, and railroad spur (Figure 1-6). The Basin Electric plant would use the excess coal fines (coal particles too small for gasification) from ANGCGC's operation for the generation of electricity thus eliminating the need to transport the fines for sale elsewhere. The mining operations, coal handling and storage facilities, as well as ash handling and disposal, would also be shared, resulting in a more economical coal production system for both.

Basin Electric's environmental report was not scheduled for completion until September 1977; thus, it was decided to proceed with this environmental statement for the ANGCGC proposal and for the Rural Electrification Administration (REA) to prepare the environmental statement for the powerplant. This suggestion was approved at a meeting between the Council on Environmental Quality (CEQ), Environmental Protection Agency (EPA), REA, and Department of the Interior in Washington, D.C., because other statements are being prepared that would cover the cumulative impacts of these and other projects. These statements are detailed in Section 1.4.2. However, Sections 3.1.1.3, 3.3, and 3.6 of this statement consider the cumulative air quality and socioeconomic impacts of the two facilities; other impacts associated with the Basin Electric project, such as transmission lines, switchyards, wastewater discharges, etc., will be addressed in REA's environmental statement.

The construction of both facilities is phased. Construction on the first phase of the gasification plant is scheduled to begin in the spring of 1978. Basin Electric would also begin construction on the first 440-MW unit in the spring of 1978. The construction of the second electric generating unit would begin about 2 years later (1980), and construction on the second phase of the gasification facilities would commence 2 to 3 years after that (1982 or 1983).

The annual coal requirement for both facilities would be 14.6 million tons, or an increase of 20 percent (about 100 acres annually) over that required by the gasification plant alone. The increase is

relatively small because about one-third of Basin Electric's coal needs would be met by ANGCGC's excess fines. The water permit applications of both ANGCGC and Basin Electric have been approved by the North Dakota State Water Commission; Basin Electric had requested 19,000 acre-feet annually for powerplant needs.

b. Coyote Station - Coal-Fired Powerplant

A consortium of five utility companies has proposed the construction of a powerplant 3.5 miles south of Beulah. Montana-Dakota Utilities (MDU) would operate the plant which would consist of two 440-MW units to be completed in 1985. Coal consumption would be 4.4 million tons/year from the Knife River Coal Company's existing mines at the proposed site. An 11,000 acre-feet/year water application for Missouri River water for one 440-MW unit (taken from below Garrison Dam) has been approved by the North Dakota State Water Commission; the second unit would require an additional 10,000 acre-feet/year.

Because the proposed Coyote plantsite is only about 10 miles south of the ANGCGC and Basin Electric project sites, it is probable that some overlap would occur in the air quality impacts of the proposed projects. Also, the influx of workers associated with the Coyote powerplant would be superimposed on that resulting from the ANGCGC and Basin Electric projects. The cumulative impacts of these projects are covered briefly in Section 3.6 and will also be covered in the Bureau of Land Management (BLM) and State of North Dakota's West-Central North Dakota Energy Development Environmental Statement (EIS) (see next Section). The site-specific EIS for the Coyote powerplant is being prepared by REA.

c. Natural Gas Pipeline Company of America (NGPC)

The NGPC has proposed the construction of a coal gasification complex near Dunn Center in Dunn County. The complex would be composed of one 250 MMcf/day gasification plant and ancillary facilities. The plant would require about 13.9 million tons of coal and 17,500 acre-feet of water annually. A permit application to take water from Lake Sakakawea has been denied by the North Dakota State Water Commission.

d. Minnkota Power Cooperative (MPC)

MPC is currently constructing a 440-MW coal-fired power generating unit near Center, Oliver County, adjacent to an existing 235-MW unit completed in 1970. The new unit is scheduled for completion by June 1977. This unit will use about 2.8 million tons of coal and 5,700 acre-feet of water annually.

e. Possible Future Developments

The original water permit applications of both ANGCGC and NGPC to the State of North Dakota each requested 68,000 acre-feet of water annually for four 250 MMcf/day coal gasification plants. Action on seven of the eight proposed plants has been deferred by the State of North Dakota, but they represent possible future developments in the area. In addition, Consolidation Coal Company is considering opening up two new strip mines in Mercer County (Renner's Cove and Dakota Star) if a market is found, and expanding their existing Glenharold mine near Stanton if Basin Electric builds a third coal-fired generating unit at its existing Leland Olds plant.

f. Use of Natural Resources

The five actually proposed industrial developments would use coal, water, and land resources. The ANGCGC and Basin Electric plants would be supplied coal from leases held by Coteau Properties with possible future supplements from nearby Federal coal reserves. The Coyote plant would be provided coal from Knife River Coal Company leases and the NGPC plant would obtain coal from American Metals Climax leases just east of Dunn Center. MPC will obtain coal from the existing Baukol-Noonan mine near Center. ANGCGC, Basin Electric, and NGPC would obtain water from Lake Sakakawea; MDU (Coyote) and MPC propose to pump water from the Missouri River below Stanton. Table 1-2 summarizes the cumulative use of major resources by these projects.

1.4.2 Governmental

a. Bureau of Land Management (BLM) -
North Dakota Regional EIS

BLM has been designated the lead Federal agency for preparing a West-Central North Dakota Energy Development EIS with the State of North Dakota. This EIS will address the cumulative environmental impacts resulting from coal-mining and related industrial development in the western North Dakota counties of Oliver, Mercer, Dunn, McLean, Stark, Morton, and Burleigh. The EIS will cover the cumulative impacts of the ANGCGC, Basin Electric, NGPC, Consolidation Coal Company, and Coyote proposals and associated facilities. The draft statement is scheduled for release about October 26, 1977.

b. Bureau of Reclamation

The Bureau of Reclamation has recently completed a draft environmental statement entitled "Water for Energy - Missouri River Reservoirs" (102) on the impacts in the Upper Missouri River coal region resulting

TABLE 1-2

Summary of Resource Use by Proposed Projects

<u>Project</u>	<u>Maximum Water Use (ac.ft./yr)</u>	<u>Coal (tons/year)</u>	<u>Total Land Disturbance (acres)</u>
ANGCGC	17,000	9.4×10^6	14,000
Basin Electric	19,000	5.2×10^6	500 ^{1/}
MDU (Coyote)	21,000	4.4×10^6	2,500 ^{2/}
NGPC	17,500	13.9×10^6	11,000
MPC	<u>5,700</u>	<u>2.8×10^6</u>	<u>1,600</u>
Totals	80,200	35.3×10^6	29,600

^{1/} Acreage disturbed by mining is included in the ANGCGC figure.

^{2/} Estimate based on acres disturbed/million tons of coal of other projects.

from the use of up to 1 million acre-feet of water from the Missouri main-stem reservoirs for coal related industrial development. The ANGCGC, Basin Electric, and NGPC facilities were included in the hypothetical industrial development scenario.

c. Other Studies

The Yellowstone Level B Study, under Missouri River Basin Commission lead, and the Regional Environmental Assessment Program (REAP) are Federal and State sponsored studies currently underway which will also look at cumulative impacts of coal related industrial development within their areas of concern. Portions of data gathered in these studies would be applicable to western North Dakota.

1.5 Detailed Project Description

1.5.1 Location

The site selected for the coal gasification complex is approximately 65 miles northwest of Bismarck, North Dakota. The site lies in a multistate region generally known as the Northern Great Plains (Figure 1-4). Within North Dakota, the site lies south of Lake Sakakawea, a large reservoir formed by Garrison Dam on the Missouri River (Figure 1-5). Straight line distances to North Dakota cities are: 65 miles SE to Bismarck, 65 miles NNE to Minot, 58 miles SW to Dickinson, and 100 miles NW to Williston. Local municipalities nearby include: Beulah, 7 miles SSE; Hazen, 11 miles SE; and Zap, 7 miles SSW.

The plant and mine would lie entirely within Mercer County (Figure 1-6), 7 miles south of Lake Sakakawea, and 4.5 miles north of State Route 200. The Fort Berthold Indian Reservation is located 9 miles to the northwest.

1.5.2 Land Requirements

The site for the coal gasification complex includes both the plantsite and the minesite (Figure 1-6). Land to be acquired for the ANGCGC and Basin Electric plantsites would consist of 1,575 acres (1,127 acres for ANGCGC and 448 for Basin Electric). Of the total acreage, about 535 acres would be occupied by ANGCGC's buildings, process equipment, and coal storage. The remainder of ANGCGC's property (about 592 acres) would be used for construction laydown, areas to deposit overburden from the initial mining cuts, or remain unused.

In addition to the plantsite proper, a railroad spur would be extended from an existing Burlington Northern railroad spur (near Hazen) 9.0 miles to the plant. Also, about 6.2 miles of new roads would be built near the plant and mine. An underground water pipeline, 7.6 miles in length, would be constructed from Lake Sakakawea southward to the plantsite. The product pipeline, about 365 miles long, would carry the SNG to Thief River Falls, Minnesota, where it would be comingled with natural gas for transmission to the Michigan-Wisconsin market area. These associated facilities would be constructed at full capacity during Phase I construction.

The proposed minesite consists of four areas within close proximity of the plant (Figure 1-6). Three areas are located adjacent to the plantsite and one is located about 5 miles northeast. Approximately 500 acres per year would be mined, involving about 12,500 acres

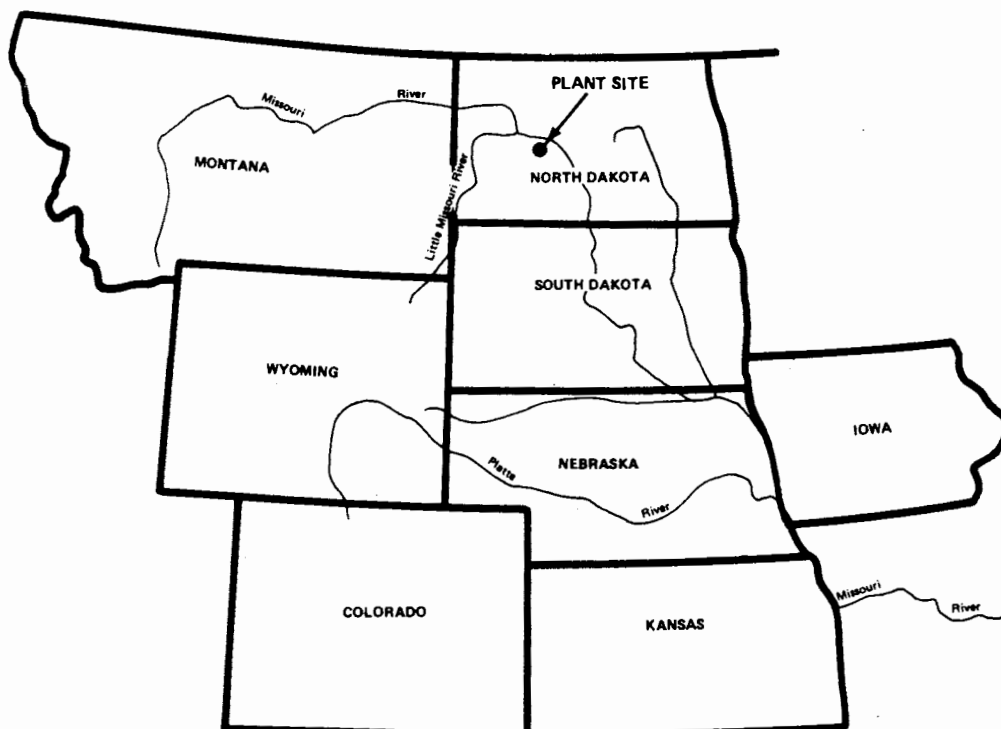


Figure 1-4 LOCATION OF PLANT SITE WITHIN THE NORTHERN GREAT PLAINS

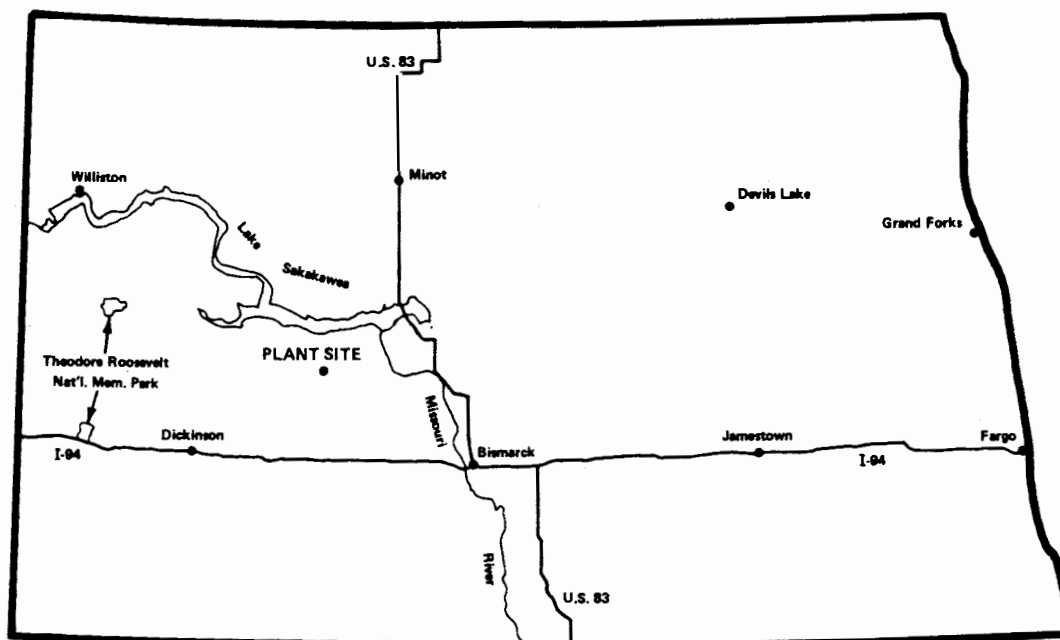
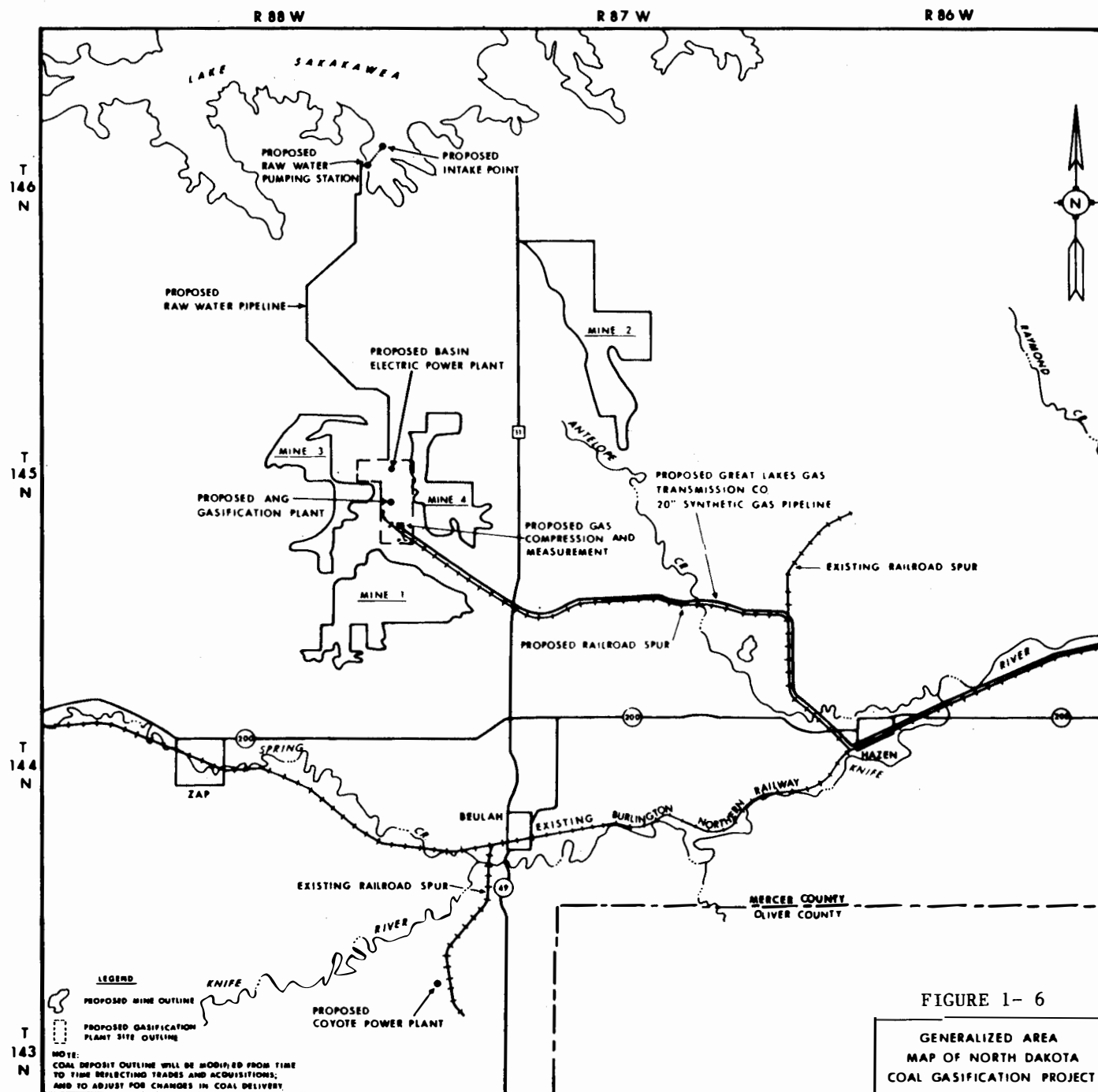


Figure 1-5 MERCER COUNTY COMPLEX - LOCATION IN NORTH DAKOTA



during the first 25 years of mine operation. The mining plan would allow the majority of land within the mine area to remain in its current use until mining reaches each segment. Reclamation would commence as soon as mining of each segment was completed.

Total land disturbed by the proposed project and associated facilities would be as follows:

<u>Function</u>	<u>Acreage</u>
Plantsite	535
Mining	12,500
Water Intake & Pipeline	138
Railroad Spur	219
Roads	83
Product Pipeline & Compressor Stations	<u>2,222</u>
Total	15,697

The land requirements of the plantsite, water intake and pipeline, railroad spur, and product pipeline (including two 10-acre compressor station sites) are relatively firmly established; the acreage disturbed by mining could vary somewhat (as much as 10 percent) as the depth and thickness of the coal seams are more accurately established. In addition to the 365-mile SNG pipeline, 217 miles of 36-inch pipeline may be required parallel to the Great Lakes pipeline system in Minnesota, Wisconsin, and Michigan, and 28 miles of 30-inch pipeline and 20,000 horsepower of compression facilities may be needed parallel to the Michigan-Wisconsin pipeline system in Michigan and Wisconsin. These facilities would carry regular natural gas comingled with SNG and the impacts of these additional facilities are beyond the scope of this EIS.

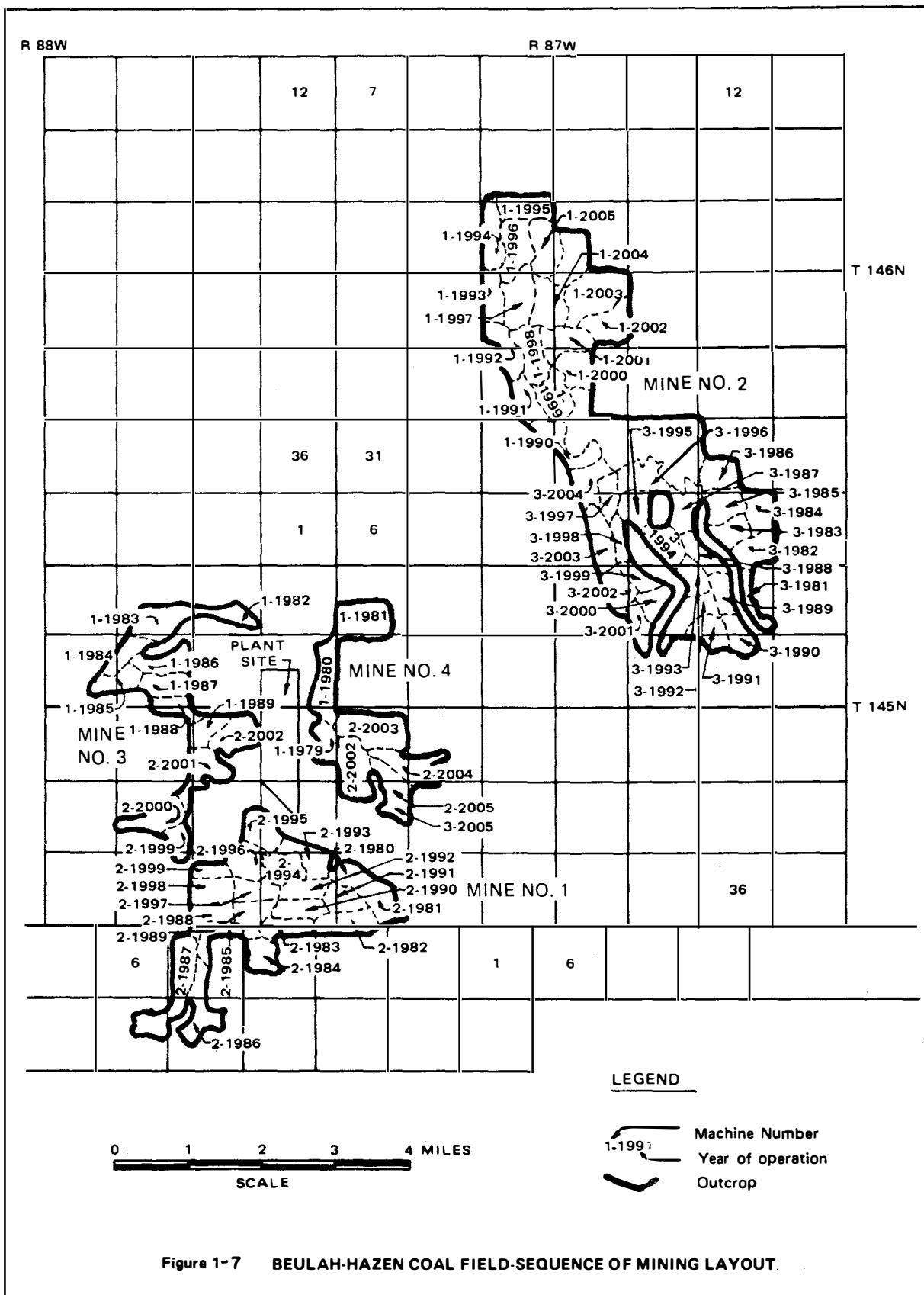
1.5.3 Coal Mining

1.5.3.1 General

a. Project Requirements

The coal gasification plant requires approximately 31,500 tons of lignite per annual average day.^{1/} To satisfy this requirement and that of Basin Electric, mining operations are designed to produce about 56,000 tons/day (14.6 million tons/year) of lignite on a 5 day/week basis. Coal would be surface mined at the four locations within the Beulah-Hazen coalfield and would be conveyed from the mine to the coal preparation plant by 150-ton bottom dump trucks operating over a network of private haul roads. A tentative mining plan is shown in Figure 1-7.

^{1/} Annual average day refers to 365 24-hour days and averages in down-time. Stream day refers to 332 24-hour days; thus, stream day values are about 10 percent higher than average values but it would be the actual operating day.



b. Coal Resources

The estimated size of the coal reserves near the plant-mine site is about 1.5 billion tons (947 million currently recoverable tons). All of the coal to be mined for the proposed project could come from private coal leases held by Coteau Properties. However, the Federal Government has retained extensive coal-rights in the area and at some future date some of these rights could be obtained by Coteau Properties for use by ANGCGC. (See Section 8.1.3.6 for a discussion of the Federal coal alternative.)

c. Coal Characteristics

The proximate analysis of the run-of-mine lignite (107 samples) is as follows:

<u>Constituent</u>	<u>Percent by Weight</u>
Moisture	35.98
Ash	7.42
Fixed Carbon	23.39
Volatiles	27.21

Heat content of the lignite is about 7,230 Btu/lb.

The ultimate analysis of the run-of-mine lignite on a dry, ash-free basis (DAF) is:

<u>Element</u>	<u>Percent by Weight</u>
Carbon	71.45
Hydrogen	4.81
Oxygen	21.01
Nitrogen	1.44
Sulfur	1.26
Chloride	.02

Except for being crushed and screened, the run-of-mine lignite would not be changed in any way prior to gasification. Since the lignite would not be washed, its composition prior to gasification would remain the same as the run-of-mine coal. The results of three trace element analysis of coal from the Beulah-Zap bed are shown in Table 1-3.

d. Equipment Used in Mining

Equipment which would be used in mining is listed in Table 1-4. All of the heavy equipment, exclusive of the electrically powered

TABLE 1-3

Comparison of Trace Element Analyses
Performed on the Beulah-Zap Coal Seam
(Parts per Million by Weight)

Element	Bureau of Mines ¹	Commercial Testing & ² Engineering Co.	Sasol ³
Ag	-	.07	0.1
As	0	2.3	30
B	12	130	300
Ba	60	100	2500
Bc	.12	.42	2.0
Br	-	1.5	-
Cd	-	.63	<0.1
Co	6.0	.84	2.0
Cr	6.0	1.4	6.0
Cu	1.2	6.4	5.
F	-	83.	24.
Ga	1.2	.46	-
Ge	1.2	.03	-
Hg	-	.09	.05
La	0	1.1	-
Li	12.	4.3	20
Mn	12.	50	-
Mo	1.2	1.5	0.5
Nb	0	1.4	-
Nd	0	3.4	-
Ni	1.2	5.9	3.0
Pb	1.2	.67	20
Rb	12.	.4	-
Ru	-	.4	-
Sb	-	.12	.1
Sc	6.	<0.1	-
Se	-	1.3	1.0
Sn	0.6	.25	4
Sr	600	570	-
Th	-	.56	1.
Ti	440	-	-
U	-	.27	1.
V	12	2.7	10
Y	6.	4.	-
Zn	12.	2.1	.6
Zr	60	68	-

1. Calculated by Zubovic, USGS, 1961 from the data of Abernathy et al., US Bureau of Mines, 1969.
2. Trace element analysis performed for The North American Coal Corporation on December 5, 1973. Based on one sample.
3. Analysis performed under contract to ANG Coal Gasification Company on October 28, 1974 by South African Coal, Oil, and Gas Corporation Limited. Based on 48 subsamples of one sample.

TABLE 1-4**Vehicular Equipment to be Used in Mining**

<u>Item</u>	<u>Number of Units</u>	<u>Estimate Hours Per Day Per Unit</u>	<u>Total Equipment Hours Per Year (Estimate)</u>
STRIPPING EQUIPMENT			
1. Bulldozers	4	12	17472
LOADING EQUIPMENT			
1. Front-end loader (20 cu. yd.)	2	6	2700
2. Explosives trucks	4	12	10800
3. Bulldozers	4	12	10800
COAL AND ASH HANDLING			
1. Bottom dump coal haulers (150 ton)	16	21	75600
2. End dump ash trucks (50 ton)	4	21	30576
ROAD CONSTRUCTION AND MAINTENANCE			
1. Compactor	1	12	2700
2. Road graders	3	21	14175
3. Water trucks (5,000 gal.)	8	21	37800
4. Dump trucks (15 ton)	4	10	9000
5. Front-end loader (10 cu. yd.)	2	10	4500
6. Hydraulic backhoe (2 cu. yd.)	1	8	1800
7. Hydraulic crane (15 ton)	1	6	1350
8. Bulldozers	3	12	8100
9. Scrapers (32 cu. yd.)	3	12	8100
SUPPLY AND MAINTENANCE			
1. Supply trucks (flat bed)	4	10	9000
2. Fuel trucks	4	18	16200
3. Welding trucks	4	8	7200
4. Service and lube trucks	4	12	10800
5. Field maintenance trucks	2	8	3600
PERSONNEL TRANSPORT			
1. Station wagons, pickups, crew cabs	36	12	97200
RECLAMATION EQUIPMENT			
1. Scrapers (32 cu. yd.)	9	18	38880
2. Bulldozers	9	18	38880
ELECTRICALLY POWERED EQUIPMENT			
1. Draglines (100 cu. yd.)	4	24	35040
2. Coal loaders	4	21	90576

draglines and coal loaders, would be diesel powered. The supply and maintenance and personnel transport vehicles would be gasoline powered. Major equipment, such as draglines, would be shipped to the project site unassembled. The equipment would then be assembled at the mine shop complex near the plantsite.

e. Power and Water Supply

Power would be distributed to the mines from an Oliver-Mercer Electric Coop. substation adjacent to the Basin Electric substation. Power would be run underground about one-half mile north of the substation and from that point would be distributed overhead to the various mine areas. The power requirements for the mine would be approximately 25 to 30 MW.

The mines would require about 140 million gallons of water/year for dust abatement purposes. This water would be obtained from an environmentally acceptable waste stream from the gasification plant or excess water in the mine pits. About 19 million gallons of potable water would also be required; this water would either come from existing wells or from the potable water supply at the gasification plant.

1.5.3.2 Mining Operations and Reclamation

The lignite seam in the Beulah-Hazen coalfield (Beulah-Zap bed) is almost horizontal, has good continuity and quality, and averages 14 feet thick. The mining plan is based upon balancing the overburden (which averages 70-80 feet thick) to coal ratio among four large (100 cubic yard class) draglines for the entire life of the mine. The sequence of mining operations would be as follows:

a. Topsoil would first be removed from an initial mining area and stockpiled by wheeled tractor-scrapers. Since the initial stockpile could be in place for up to several years, it would be protected from wind erosion by seeding. Initial mining would begin where the overburden is about 20 feet thick. A "box" cut would be made by the dragline with the resulting spoil (excavated overburden) piled in a windrow on the surface outside of the minable coal reserve limit. A pit, about 5,000 feet long by 120 feet wide, would be excavated down to the coal surface, with provisions for truck ramps established on the spoil side of the cut.

b. Behind the dragline, the lignite would be bladed off and cleaned with a rotary broom. Drilling and blasting, using an ammonium nitrate-fuel oil mixture to fracture the lignite, follow. On the average, blasting would occur one time per workday

pit; usually during the evening shift. A crawler-mounted electric loading shovel of 18- to 20-cubic-yard capacity would then dig and load the fractured coal into 150-ton diesel-powered bottom dump trucks. These trucks transport the coal over haul roads to the dump station where they would arrive at the rate of 20/hour.

c. The dragline would reverse its direction at the planned pit end and move to its starting point on the highwall side of the cut. Once repositioned, the dragline would dig into the highwall, establishing a new digging face. Spoil from this new highwall inset cut would be placed in the old pit, now cleared of all coal by the loading shovel which advances away from the dragline. The sequence described continues, resulting in long parallel spoil windrows (Figure 1-8).

d. The second or third spoil windrow back from the pit (depending on timing and stability factors) would be leveled by bulldozers to a rolling or flat topography, depending upon the prescribed reclamation plan (Section 4.2.4). Finally, up to 5 feet of topsoil would be distributed by wheeled tractor-scrappers. The topsoil may be brought either from stockpiles or the highwall side of the cut as needs dictate. Final grading of topsoil and seeding would be done just prior to the growing season.

All operations in mining are closely interrelated. The burial of processed ash with overburden illustrates the point. Ash haul trucks (50-ton, rear-end dump diesel trucks with special bodies) would traverse haul roads partly in conjunction with coal trucks. Ash would be dumped in the mining area and covered with the overburden that the dragline would deposit in a previously mined pit. The ash would generally be buried about 80 to 100 feet below the surface.

Typical plan views of the mining system are shown in Figures 1-9 and 1-10. These sketches do not detail the treatment of final highwalls which would be trimmed down to conform with the rehabilitation plan. In general, however, the dragline would make a final pass, filling the final pit with overburden which had been stockpiled above the highwall in the previous pass, and also sloping the highwall itself.

Final shaping and grading would be done by bulldozer to attain the prescribed slopes approved by the North Dakota Public Service Commission. Topsoil from the highwall stockpile would then be placed by a scraper followed by seeding. A more detailed reclamation plan is included in Section 4.2.4.

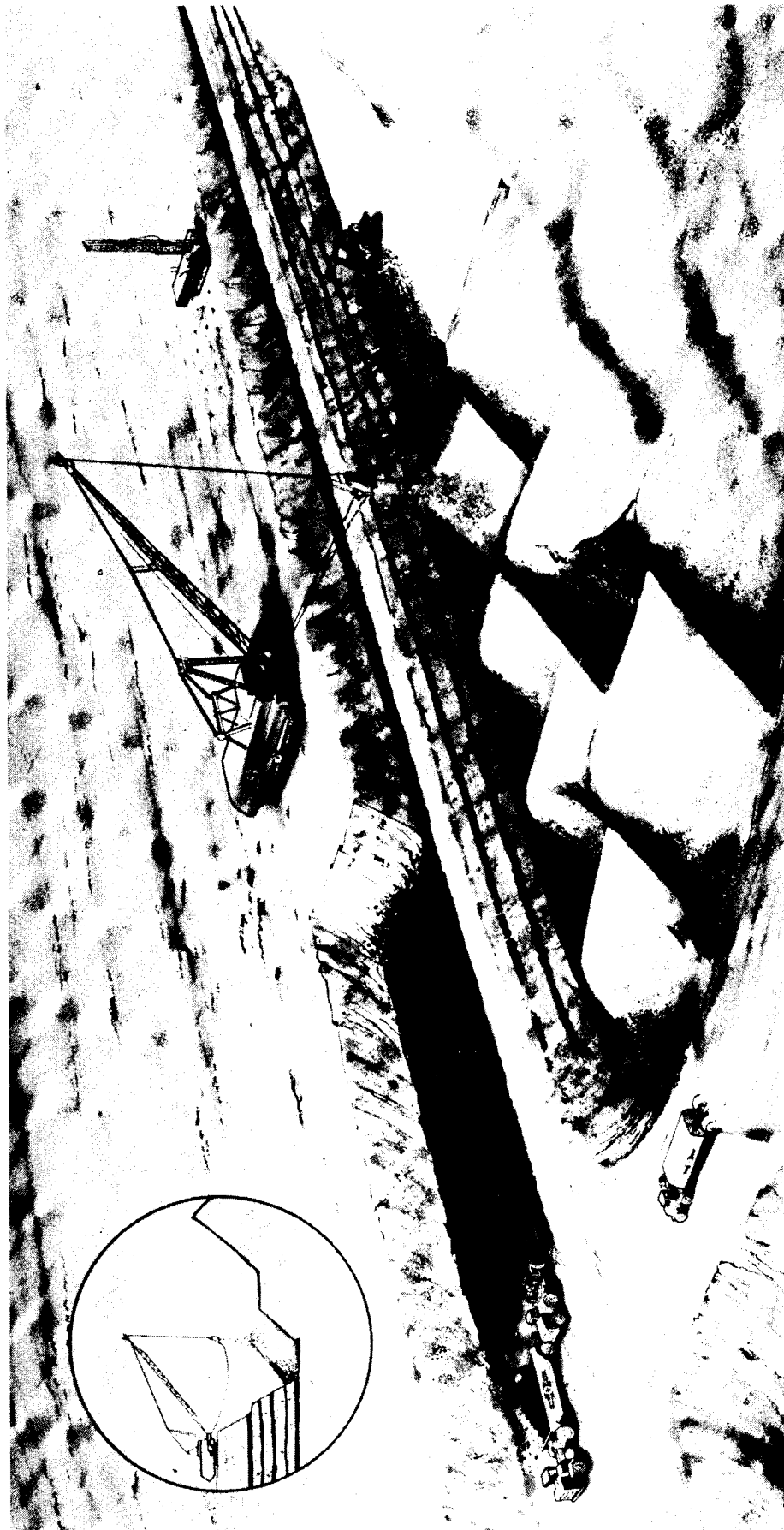


FIGURE 1-8. Typical Strip-Mining Operation

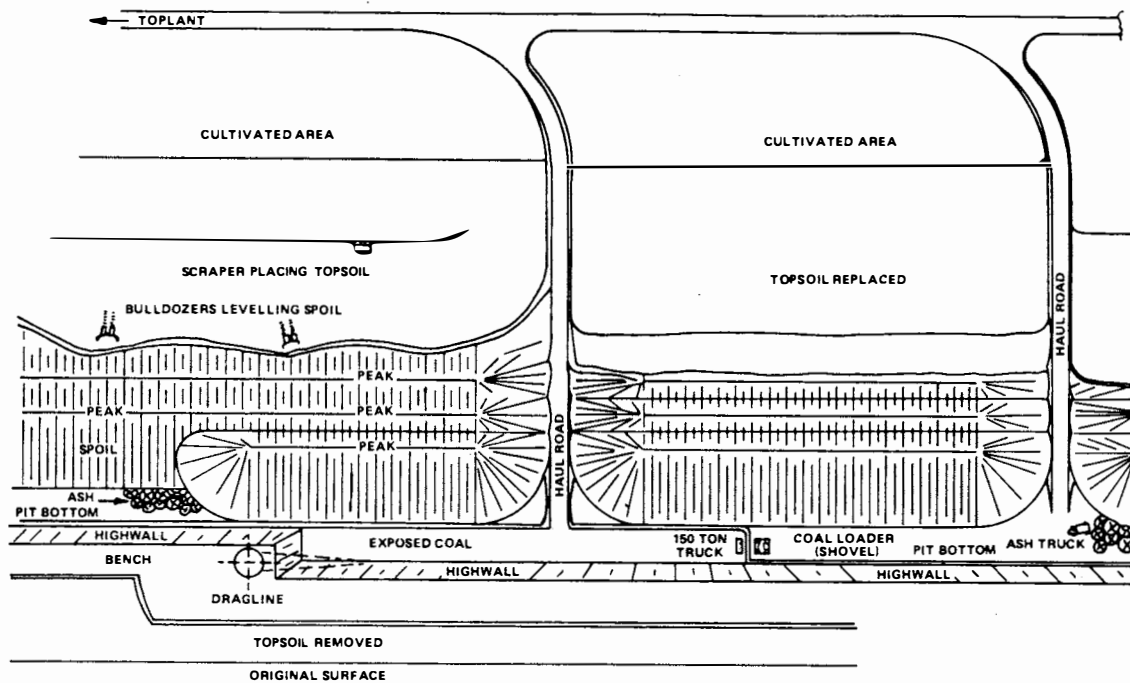


Figure 1-9 NORTH DAKOTA MINING WITH TOPSOIL REPLACED BY TRACTOR-SCRAPER

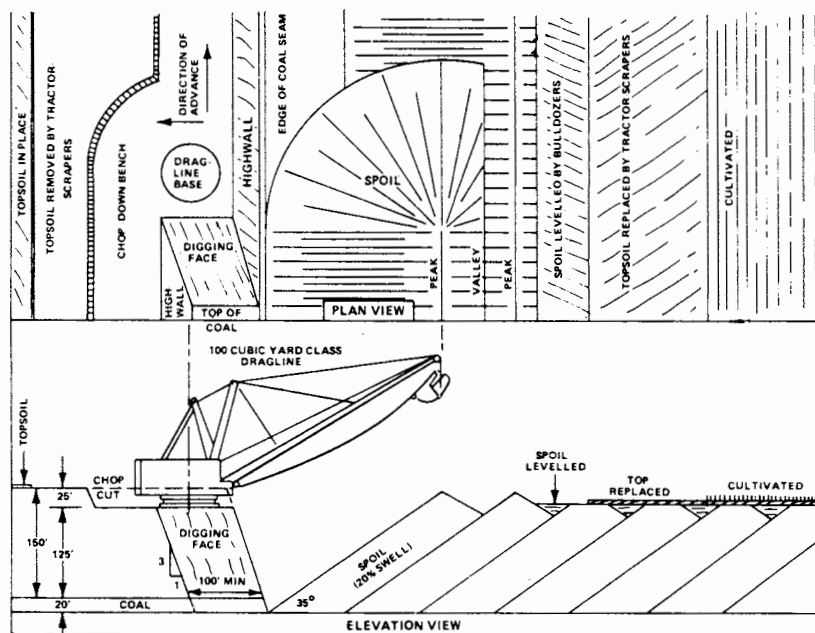


Figure 1-10 PLAN AND ELEVATION VIEWS OF TYPICAL DRAGLINE MINING

1.5.4 Coal Gasification Plant

1.5.4.1 General

(1) Access

One major access road would be constructed for the plant connecting the plantsite with County Road 11 along the proposed product pipeline and railroad access (Figure 1-6). It would be a paved two-lane primary road. Other access would be available from the west and north by existing unpaved county roads.

The water pipeline would be maintained via existing county roads. Construction access would be supplied by temporary dirt roads in the plantsite. As noted in Section 1.5.6.3, a railroad would also afford access to the plantsite, especially for heavy construction material and removal of byproducts.

(2) Construction

Construction of the first phase of the proposed gasification plant would start in 1978. The first phase would be fully operational by 1981. Construction of the second phase would start in 1983 and be completed in 1987. The ultimate production capacity of 250 MMcf/day would be reached by 1988. An artist's representation of the completed facility is shown in Figure 1-11.

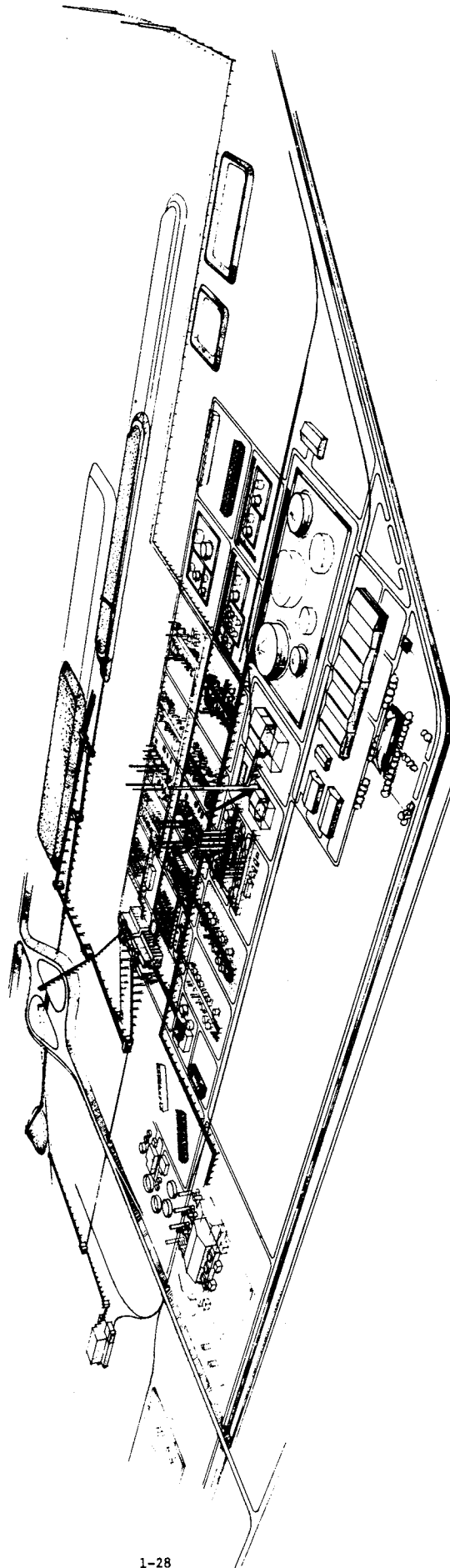
(3) Personnel Requirements

The estimated number of construction and operations workers needed for the plant and mine by year would be as follows:

Average Manpower Requirements

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988-2015</u>
Construction											
Plant	312	1077	1796	812	300	267	808	1121	1136	313	0
Mine	130	320	250	240	30	200	200	200	0	0	0
Operation											
Plant	0	0	0	414	414	414	414	414	414	640	640
Mine	<u>47</u>	<u>81</u>	<u>147</u>	<u>278</u>	<u>278</u>	<u>278</u>	<u>278</u>	<u>278</u>	<u>310</u>	<u>360</u>	<u>360</u>
Total	489	1478	2193	1744	1022	1159	1700	2013	1860	1313	1000

The peak labor force requirements would occur in 1980 and 1985.



ANG COAL GASIFICATION PROJECT
NORTH DAKOTA

FIGURE 1-11

Project Name	ANG COAL GASIFICATION PROJECT
Project Number	54E-702-901-1
Revision	
Scale	
Author	
Checker	
Engineer	

(4) Construction Camp

A construction camp to house about 20 percent of the annual work force plus seasonal peaks would be built by ANGCGC in the vicinity of the plantsite but outside the main perimeter. The complex would be laid out similar to a motel; housing units would house one or two workers to a room. Appropriate dining, laundry, parking, and recreation facilities would also be provided.

Water for the camp would be provided from onsite wells until the water pipeline from Lake Sakakawea is operational. Sanitary sewage would be gathered and treated in a package plant of activated sludge extended aeration design that would provide primary and secondary treatment. Discharge from the sewage treatment plant would be further polished in an oxidation pond before release. Solid wastes would be collected by a private refuse service.

Power for the camp would be provided from the plant substation (Section 1.5.4.7); a step-down transformer would be located at the construction camp to obtain necessary voltage levels. Telephone communications would be provided from cables installed to serve permanent plant facilities.

(5) General Plant Makeup and Layout

The coal gasification plant is essentially a self-sufficient facility designed to produce 250 MMcf of SNG/annual average day or about 275 MMcf/stream day. The plant would consist of the following process areas:

- a. Coal preparation, handling, and storage;
- b. Storage reclaim system;
- c. Screening system;
- d. Gasifier feed system;
- e. Gasification units; and
- f. Utilities.

Each area is described in detail below; general plant layout is shown in Figure 1-12.

1.5.4.2 Coal Preparation, Storage, and Handling

The proposed coal storage and handling system is shown schematically in Figure 1-13. The system is designed to receive and crush up to 4,000 tons of lignite from the mine per hour on an 18-hour day, 5-day-per-week basis. After crushing, weighing, and sampling, the

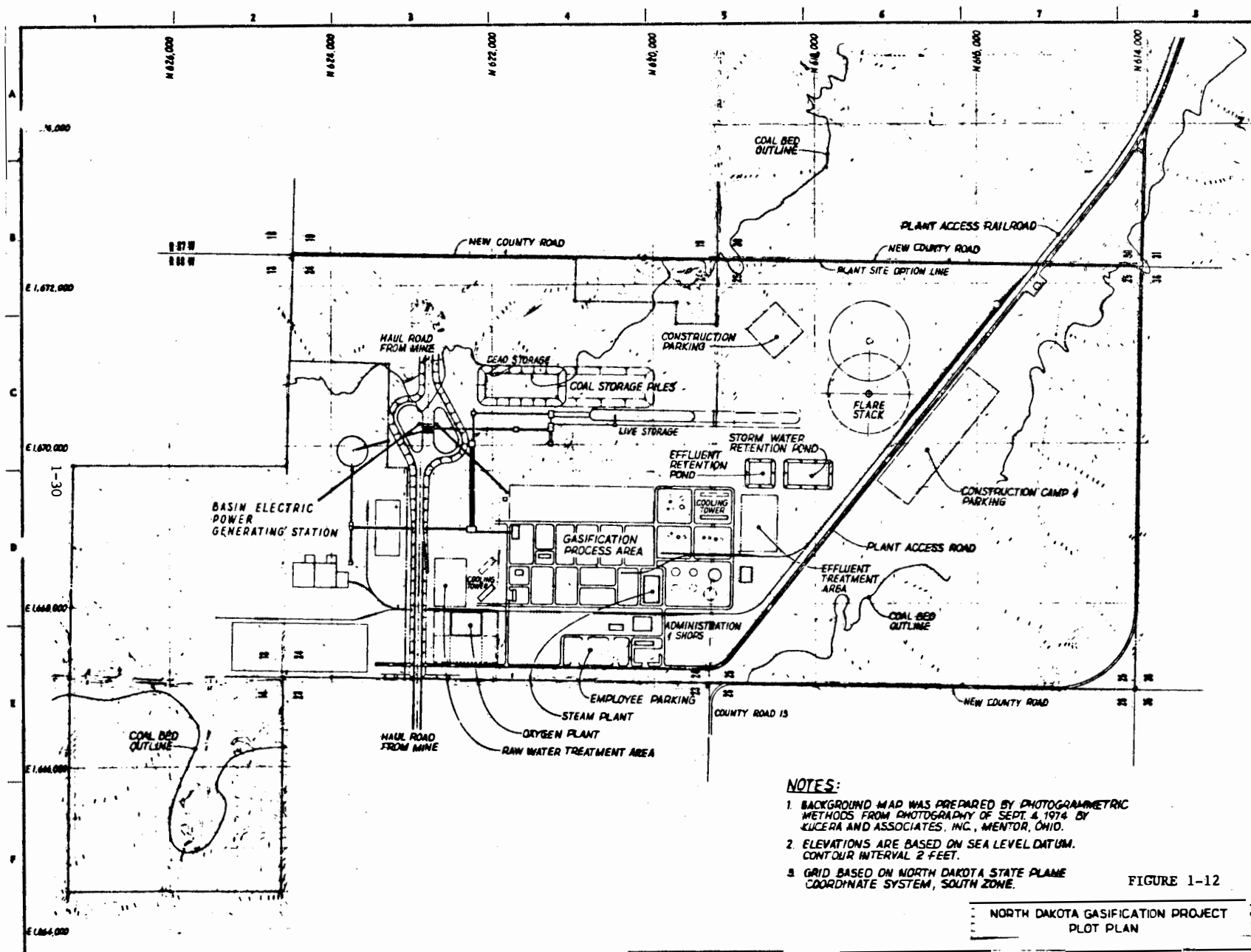


FIGURE 1-12

coal would be conveyed to either an active or inactive storage pile for future use. The reclaim rate from storage would be approximately 1,780 tons per hour (tph), 24 hours/day, for sizing and delivery to the gasifiers. The gasifiers would require approximately 1,140 tph of the crushed and sized lignite. The remaining coal fines, approximately 640 tph, would be transported to Basin Electric by a conveyor for use in their powerplant. Figure 1-13 shows the tonnage required for feeding the gasifiers and the powerplant.

Raw lignite coal would be delivered to the truck dump station in 150-ton bottom dump trucks. The station can accommodate up to four trucks simultaneously. The coal would drop into a bin and be fed into one of the four primary crushers.

The crushers are designed to reduce the coal size from 36 inches in diameter to 8 inches while generating a minimum of coal fines. Any of three crusher-feeder systems would handle the normal daily tonnage requirements. The product of the primary crushers would drop onto a belt conveyor system to be weighed and conveyed to the first transfer point. At this point, the coal would be transferred to the screening and secondary crushing station.

All screening would take place on four 8- x 20-foot single deck screens for proper sizing. The undersize product of the screen would fall into a 4,000 tph collecting conveyor. The oversize screen product would be discharged from the screen into the secondary crushers. The crushers would reduce and discharge the product onto the same collecting conveyor as the undersize product. The screening and crushing area would be enclosed and equipped with bag-type filters to reduce fugitive coal dust.

The crushed product would be conveyed to a transfer station, where it would be sampled and analyzed to determine moisture and ash content and heating value to insure proper operation of the gasifiers. The lignite may be diverted to (1) active (live) storage piles, (2) inactive (dead) storage piles, or (3) the live storage reclaim belts. The normal route would be to live storage.

The live storage would consist of one 300,000-ton pile, part of which would be above and part below grade. The pile would be fed from a traveling boom stacker receiving coal from the 4,000 tph conveyor, which originated at the secondary crushing station. Actual live storage would be sufficient for about 7 days of gasifier plant production.

The dead storage would consist of a 1,200,000-ton pile sufficient to feed the plant for 30 days. Half this pile would be established during Phase I construction and the balance built up during Phase II construction.

The dead storage would be laid down and compacted in 1-foot layers to prevent fires by spontaneous combustion. Bulldozers and tractor-scrappers would be used to build up and spread the pile from the feed point. The pile would be approximately 1,200 feet square and about 30 feet high. To reduce wind caused fugitive dust, the slopes around the perimeters of the pile would be kept to a maximum of 20 percent grade and a latex coating applied. When the stacker or conveyor to live storage or reclaiming system is out of operation, the crushed lignite can either be compacted there and become part of dead storage or can be fed to the live storage reclaim conveyors.

1.5.4.3 Storage Reclaim System

Normally, the live storage feeds the plant on a day-to-day basis. The dead storage would be used only during extended shutdowns or strikes in the mine.

Reclaim from live storage at the rate of 1,780 tph would be accomplished with rotary plow feeders located in two tunnels beneath the live storage pile. The rotary plows would traverse the full length of the tunnel beneath the live storage and unload onto conveyors supplying the secondary screening bin.

The traveling boom with the rotary plow reclaim system would not produce a homogeneous feed to the gasifiers; however, a certain amount of mixing would be accomplished by the differential motion between stacking and reclaiming. Reclamation from dead storage would be accomplished by front-end loaders and trucks transferring material to the live storage pile. The reclaim conveyor would transfer the lignite to the screen surge at the hoppers in the secondary screening building.

1.5.4.4 Screening System

Lignite reclaimed from live storage via the reclaim belt would be transferred to the secondary screening building for final sizing of the gasifier feed. These conveyors would enter the building and evenly distribute coal over the screen feed hopper. The 1,800-ton capacity hopper would feed all the sizers through variable vibrating feeders. The sizing would separate the fines from the properly sized coal and deposit each on separate conveyors.

The properly sized coal would be sampled and delivered to the gasifier feed belt. The undersize fines product would be sampled, weighed, and delivered to one of two 5,000-ton storage silos which provide surge capacity between the ANGCGC and Basin Electric plants.

1.5.4.5 Gasifier Feed System

The gasifier feed system would consist of two sets of conveyors which would be used alternately and independently. Each system would consist of a feed conveyor, diverting chute, transfer belt, and a reversing shuttle conveyor over each line of gasifiers.

The presized coal would fall onto one of the two gasifier feed belts. The gasifier feed conveyor would leave the coal screening building and enter the gasifier building perpendicular to, and in the middle of, the gasifier feed bins. At the top of the first line of gasifiers, the feed belt would discharge through a diverting chute to either the shuttle conveyor on top of the first line of gasifiers or the transfer belt to the second line of gasifiers.

If one part of the conveyor system is not working, the entire system from the screening building to the bins would be switched to the standby system.

1.5.4.6 Gasification Units

The gasification plant proper would include all process units necessary to produce pipeline quality gas from presized lignite. The main process area would consist of the two following major systems:

- a. A gasification system composed of six process units:
 - (1) Gasification;
 - (2) Shift conversion;
 - (3) Gas cooling;
 - (4) Rectisol unit;
 - (5) Methanation; and
 - (6) Gas compression and drying.
- b. A byproduct recovery system composed of three process units:
 - (1) Gas liquor separation;
 - (2) Phenosolvan unit; and
 - (3) Ammonia recovery.

Most of the process units would be open-air outdoor structures located as shown in Figure 1-11.

a. Gasification System

(1) Gasification

The plant would contain 26 gasifiers; approximately 23 of these would be required to be in operation to produce 250 MMcf/day of SNG. The coal received from the mine, after preparation and classification, would be transported by a coal belt conveyor to storage bins on top of the gasifiers. The coal would be brought to gasifier pressure in a coal lock. About 98 percent of the gas escaping during the operation of the coal lock would be collected and fed into the process; the remaining 2 percent would be exhausted by air ejectors. Rotating coal distributors would feed the coal evenly across the gasifier vessel where the coal would be converted into gas under pressure (Figure 1-14). While the coal travels from top to bottom of the gasifier, it is dried, devolatilized, and gasified.

A mixture of oxygen and superheated steam is required for gasification. Part of the steam necessary for the process would be generated in the water jacket surrounding the gasifier. The oxygen-steam mixture would be introduced through a bottom rotating grate into the ash bed. At a moderately high pressure, the partial combustion of the coal with oxygen would supply the heat necessary for the gasification reactions. The temperature of the gas leaving the gasifier would be about 523° F; its pressure about 427 psig.

The composition of raw gas leaving the gasifiers would be as follows:

<u>Components</u>	<u>Percent by Weight</u>
Dry Gas	51.7378
Water	45.4125
Hydrogen Cyanide	.0002
Chlorides	.0016
Tar	1.6125
Oil	.3669
Naphtha	.1834
Phenols	.3125
Fatty Acids	.0881
Dust	.2845

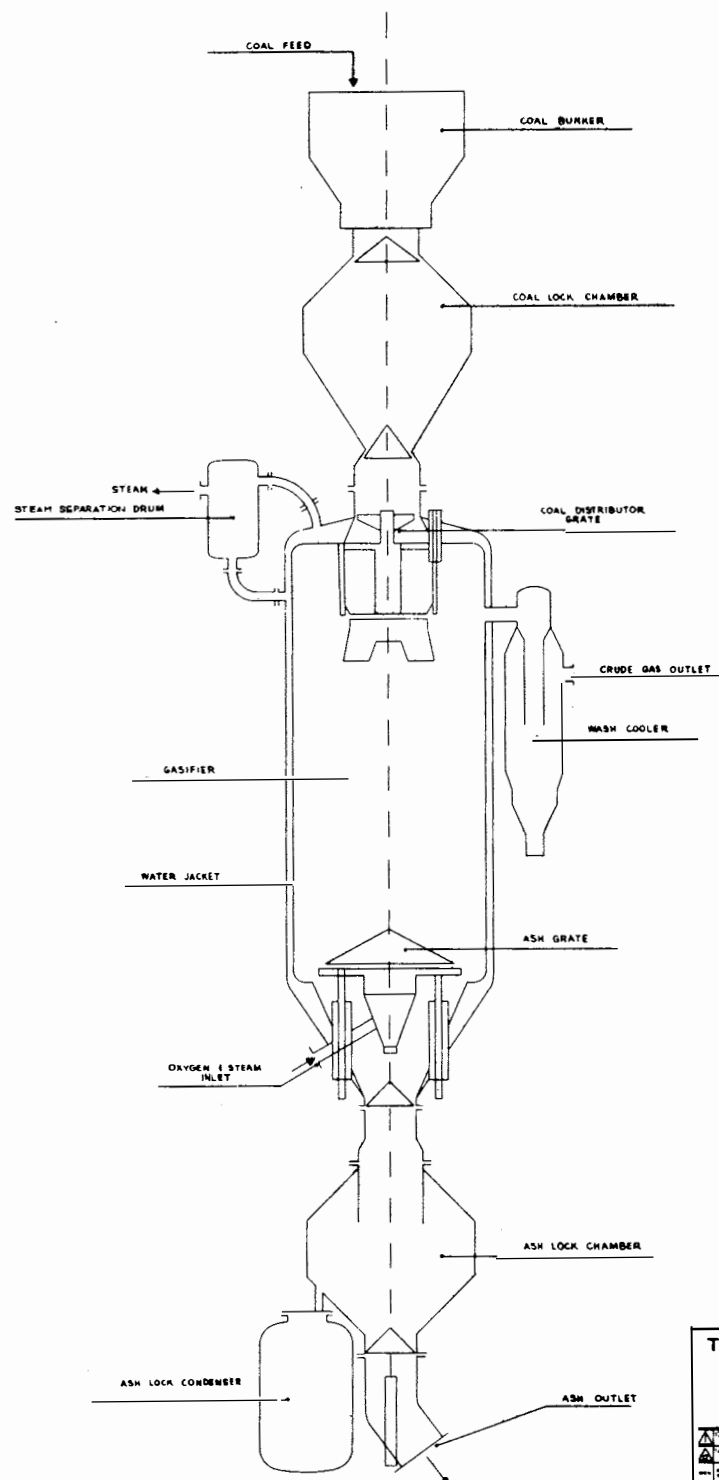


Figure 1-14 LURGI PRESSURE GASIFIER

THE COAL GASIFICATION COMPANY NORTH DAKOTA GASIFICATION PROJECT									
THIS DRAWING IS THE PROPERTY OF THE LUMBER COMPANY. IT IS TO BE USED ONLY FOR THE PROJECT AND NOT FOR ANY OTHER PURPOSE. IT IS TO BE KEPT IN THE OFFICE OF THE LUMBER COMPANY. IT IS TO BE KEPT IN THE OFFICE OF THE LUMBER COMPANY. IT IS TO BE KEPT IN THE OFFICE OF THE LUMBER COMPANY.									
THE LUMBER COMPANY BLANDFORD, NEW HAMPSHIRE A DIVISION OF CONSTRUCTION ENGINEERING, INC. BLANDFORD DIVISION									
LURGI PRESSURE GASIFIER SCALE									
NO. SK D-702-201A-1									

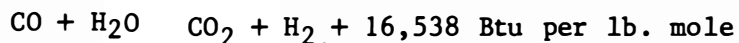
The composition of the dry gas would be (see Appendix A for definitions):

<u>Compound</u>	<u>Molecular Percent</u>
H ₂	38.77
CO	15.63
CO ₂	32.52
CH ₄	10.805
C ₂ H ₆	.495
C ₂ H ₄	.07
C ₃ H ₈	.08
C ₃ H ₆	.07
C ₄ H ₁₀	.04
C ₄ H ₈	.07
N ₂	.07
Ar	.05
H ₂ S	.35
COS	.01
Organic Sulf.	.01
NH ₃	.96

The hot product gas would be conveyed from the vessels to the shift conversion and crude gas cooling units. The ash would be removed by a rotating grate at the bottom of the gasifier and discharged semiautomatically through an ash-lock. As the ash is discharged, a water quench would be applied. About one-third of the water would be evaporated; the rest would remain with the ash. Excess water would be separated from the ash, prior to its disposal in the mines. A block flow diagram of the entire process is shown in Figure 1-15.

(2) Shift Conversion

The amount of methane (the principal component of natural gas) in the crude gas from the gasification unit would be quite low and further chemical conversion of the crude gas to increase the methane content is necessary. This conversion would be performed in the Crude Gas Shift and Methanation Units. The shift conversion unit is designed to produce the hydrogen (H₂) required to adjust the H₂:CO ratio for the methanation unit. This would be accomplished through the "water gas shift" reaction carried out over a catalyst in the presence of steam as follows:



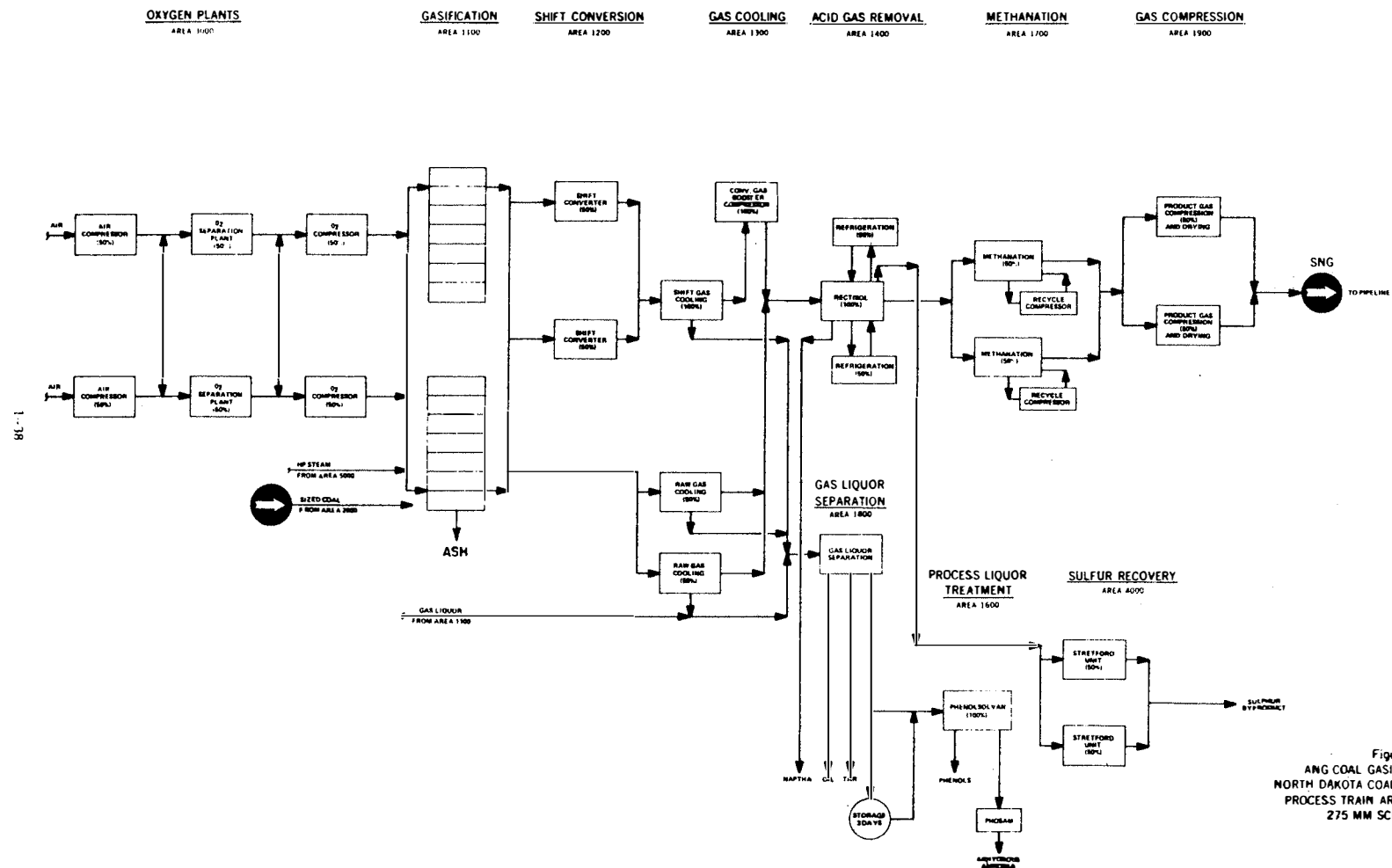


Figure 1-15
ANG COAL GASIFICATION COMPANY
NORTH DAKOTA COAL GASIFICATION PROJECT
PROCESS TRAIN ARRANGEMENT DIAGRAM
275 MM SCF/SD CAPACITY

Approximately 33 percent of the total crude gas would be subject to shift conversion with the balance bypassed directly to the gas cooling unit. The proportions of the two gas streams would be adjusted to achieve the desired $H_2:CO$ ratio for methanation.

(3) Gas Cooling

The gas cooling unit is designed to cool the raw gas from gasification and shift conversion and to remove the heavier hydrocarbons and unreacted steam before low temperature purification. The cooling scheme is arranged to recover and utilize as much of the process heat as practical; further cooling would be accomplished in water coolers.

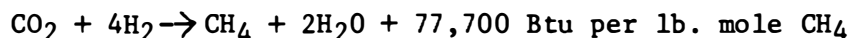
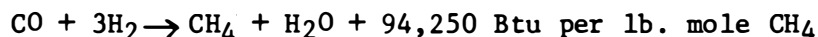
The gas cooling for each phase of the gasification plant would be accomplished in three parallel trains. Two trains would be used for cooling the crude gas bypassing the shift conversion area and the other train for cooling the converted gas. Converted gas would be compressed and combined with the crude gas stream. The mixed gas stream, having a predetermined $H_2:CO$ ratio, would be conveyed to the gas purification unit. The condensate from gas cooling would go to the gas liquor separation unit for recovery of tar and oil.

(4) Rectisol

The gas purification unit would utilize the Rectisol process to remove carbon dioxide (CO_2), sulfur compounds, and other impurities from the raw gas. A flow diagram of the process is shown in Appendix B. Sulfur compounds (H_2S and COS) would be removed to a level of less than 0.1 ppm (by volume) and the sulfur free gas then passed to methanation.

(5) Methanation

The methanation unit would convert the low Btu synthetic gas to methane-rich high Btu gas by the following exothermic reactions:



Other minor reactions which would take place are the hydrogenation of ethylene to ethane and hydrocracking of ethane to methane. About 60 percent of the methane in the final product would be produced here.

Feed gas entering the unit from each gas purification unit (Rectisol) would be heated and then mixed with recycled methanated effluent gas before being methanated in parallel catalytic reactors. Diluting the feed gas with methanated effluent would limit the temperature rise across the reactors. The reactors are designed as fixed bed downflow units employing a pelleted reduced nickel-type catalyst.

The reaction heat would be removed by generation of 1300 psig steam in waste heat exchangers at the outlet from each reactor.

Gas leaving the synthesis loop would be passed through a cleanup reactor (final methanation reactor) to accomplish essentially complete conversion of carbon monoxide (CO), and then cooled by successive heat exchange with fresh feed gas, air, and cooling water. Water condensed from the gas would be separated and forwarded for recovery as boiler feed water. The net product would be sent to the gas compression unit.

(6) Gas Compression and Drying

This section is designed to deliver the SNG to the pipeline at a pressure of 1,440 pounds per square inch (psig). The product gas compression system would consist of four parallel systems of centrifugal compressors, driven by condensing steam turbines. The product would be dry, in addition to having the CO₂ content reduced to below 0.4 percent. Final product gas would now be ready for metering and discharge to the pipeline for distribution. Final drying of the product gas to pipeline gas specifications would be accomplished by a glycol dehydration unit.

The specification of the SNG product is given below:

<u>Constituent</u>	<u>Percent by Volume</u>
CH ₄	95.95
H ₂	3.00
CO	0.05
CO ₂	0.40
N ₂	0.60
Heating Value	970 Btu/Standard Cubic Foot (Minimum)

b. Byproduct Recovery

(1) Gas Liquor Separation

The gas liquor would contain tar, tar oil, naphtha, and dissolved compounds such as phenols, ammonia, CO₂, and hydrogen sulfide

(H₂S). Tar is defined as a heavier-than-water organic liquid phase, while tar oil is the lighter-than-water organic liquid phase.

The gas liquor separation is designed to clean up tarry and oily gas liquors by separating the incoming streams into tar, tar oil, recycled gas liquor, and clarified aqueous liquor streams. Flash gases released from the gas liquor by pressure reduction would be scrubbed to remove ammonia.

The gas liquor streams originating from the gasification, shift conversion, and gas cooling units would be cooled, combined, and reduced in pressure. The entrained gases, consisting primarily of CO₂ but with traces of CH₄, CO, NH₃, and H₂S, would be released and passed through a water scrubber for recovery of ammonia and then to a low pressure flare for incineration. A flow diagram of the process is shown in Appendix B.

(2) Phenosolvan

The process water from the Gas Liquor Separation Unit, which would be contaminated with phenols, ammonia, H₂S, and CO₂, would be treated in the Phenosolvan Unit for removal of phenols prior to being transferred to the ammonia recovery area.

The incoming process water would be passed through extractors where an organic solvent is used to extract phenols. The organic solvent would be distilled and separated from the phenol and recycled to the extractors for reuse. The crude phenol byproduct would be recovered and transferred to storage for subsequent use as part of the byproducts feed to the boilers.

(3) Ammonia Recovery

The Ammonia Recovery unit would use the Phosam-W Process which involves the selective absorption of ammonia from the gas liquor leaving the Phenosolvan Unit by a water solution of ammonium phosphates (Appendix B). The Phosam-W Process would also remove the CO₂ and H₂S from the process water which would then be used in the process cooling water tower.

A materials balance for the gasification plant, a trace element mass balance, a plant energy balance, and pollutant emission and abatement parameters are also presented in Appendix B. The thermal efficiency of the gasification process is about 84.6 percent; that is, 84.6 percent of the heating value of the coal used in the process would be recovered in the product gas and byproducts.

however because a large portion of the byproduct production would be used to generate steam (see next Section), the overall efficiency of the entire operation would be about 66.7 percent.

1.5.4.7 Utilities

In addition to facilities physically involved in the coal preparation and gasification phase, a group of supporting utilities are required for plant operation. These include such items as:

- a. Steam generation and distribution;
- b. Power distribution;
- c. Oxygen production;
- d. Raw water supply and water treatment;
- e. Fire protection; and
- f. Plant communications.

Although these utilities serve a supporting role in the gasification process, their dependability would be necessary to maintain safe and efficient plant operation at all times.

a. Steam Generation and Distribution

The normal steam requirements of the gasification plant would be supplied from two sources; in-plant boilers which would be fired by certain of the plant liquid byproducts and waste heat recovery from plant processes. High pressure steam (1300 and 550 psig) would be used primarily to drive compressors and large pumps, and as process steam for coal gasification. The plant boilers would generate only 1300 psig steam. Lower level steam, mostly from waste heat exchangers, would be used for smaller turbine drives, and process and heating applications.

The following amounts of byproducts would be burned per stream day for the generation of steam:

Tar	192,330 gal
Oil	70,758 gal
Naphtha	39,804 gal
Phenols	35,752 gal

In case of a plant upset which results in the loss of high pressure steam generation, emergency steam would be purchased from Basin Electric.

b. Power Distribution

The electrical power for the gasification plant would be provided on overhead transmission lines from the Basin Electric substation.

The power distribution system would operate at 13.8 kv to supply all local plant substations where the power would be transformed to the appropriate voltage. The wattage requirements for the plant would be about 135 MW. Total requirements, including mining operations would be about 160 MW.

Power to the pump station (water intake) would be provided over two separate circuits. One circuit would run underground from the plant to the pump station along the water pipeline route. The second, back-up, circuit would be extended from the Oliver-Mercer Electric Coop. area distribution system overhead to the pumphouse except for the final 3,000 feet which would be underground.

Power for construction would be provided by Oliver-Mercer Electric Coop., the REA cooperative serving local areas in Oliver and Mercer Counties. Power would be provided from a 13.8-kv substation located on the construction site; this substation would also provide power to the construction camp. A peak construction requirement of 15 MW is estimated for the period 1978-79 for both the ANGCGC and Basin Electric projects.

At the end of the plant life (about 25 years), the overhead powerline and its support towers to the plant would be removed. The pump station and its feeder circuits and the mine distribution system would be turned over to Basin Electric for the continued operation of their powerplant.

c. Oxygen Production

The oxygen facilities are designed to provide 6,000 tpd of gaseous oxygen to the process plant with an oxygen purity of 99.5 percent. Four parallel process trains would be utilized consisting of both turbine-driven and electric motor-driven axial/centrifugal air compressors, air separation units (cold box), and turbine-driven and electric motor-driven centrifugal oxygen compressors. The air separation units would use low temperature liquefaction and fractionation to separate and purify the major constituents of air (oxygen, nitrogen, and noble gases).

d. Raw Water Supply and Water Treatment

The raw water would be piped from Lake Sakakawea (Garrison Reservoir) through a submerged intake in Renner Bay (Figure 1-6). Pump capacity would be installed to meet the peak operating requirements of both the gasification plant and Basin Electric's powerplant of approximately 22,500 gpm or about 36,000 acre-feet/year. The sequence of water treating steps (with flow rates), water balance, and the interrelation with waste treatment are shown in Figure 1-16.

Incoming raw water would be preheated prior to treatment to insure efficient operation of the clarifier during the winter. Upon entering the plant, the raw water would be processed in a suspended-solids contact softener-clarifier. Alum, lime, and poly-electrolytes would be added to reduce the silt content and calcium hardness of the raw water. The clarifier underflow (silt and CaCO_3) would be processed in a thickener and then sent to ash handling where it would be buried in the mine with the ash. The thickener overflow would be returned to the clarifier. Clarified water would then be provided to both the Basin Electric powerplant and the gasification facilities.

A portion of the clarified water, about 820 gpm, would be used as cooling tower makeup for the oxygen plant. This water would be pH adjusted with sulfuric acid and treated with chlorine to control algal growth. One of two corrosion inhibitor systems would be used, either chromate with a subsequent removal system, or an organo-phosphate.

The remainder of the clarified water would be filtered through anthracite pressure filters to further lower the turbidity. A portion of this water would be sent to the potable water system after pH adjustment, chlorine addition, and activated carbon treatment. The potable water distribution system would be buried 6-1/2 feet deep to protect against freezing and would consist of a looped piping system serving use points, as required. In addition to supplying potable water to the major plant buildings, the system would also supply the plant safety showers and eye baths.

Zeolite softeners would remove calcium and magnesium from the low and medium pressure boiler feed water. The softeners would be regenerated with sodium chloride with the spent regenerant and rinse stream routed to the deep well for disposal. The softened water would be stored in a 1.44 million gallon surge tank from which it would be pumped to the low and medium pressure steam deaerators and then to the boilers.

e. Fire Protection System

The fire protection system would be a common system shared between the gasification plant and the Basin Electric powerplant. It would consist of a fire water loop with two water sources; one would be the powerplant cooling tower basin, and the other source would be the gasification plant clear well. Chemical and foam fire suppression equipment and mobile equipment would also be used where appropriate.

The fire water loop would consist of a piped network around the operating and tankage areas and would be provided with isolation valves so that portions of the system may be isolated for repair or maintenance. Fire hydrants would be provided in all areas of the gasification plant and powerplant.

f. Plant Communications

The gasification plant would be provided with two communication systems: telephone and radio. An in-plant dial telephone system would be installed. This system would be automatically monitored against failure to the degree that it is acceptable for fire reporting and thereby negates the need for a separate fire alarm system. The system would allow outside communication from designated telephones.

Communications to the water intake pump house would be remote controlled from the plant via an underground telephone cable. Level controls in the water storage sump at the plant would keep operating personnel aware of water consumption and supply. By resetting the controls and therefore altering the number of pumps operating (or their output), the water supply could be constantly regulated from the plant.

1.5.5 Pollution Control and Abatement

1.5.5.1 General

Pollution control and abatement facilities for the coal gasification plant are designed to limit the discharge of potential pollutants. Most byproducts arising from the gasification processes, rather than being disposed of, would either be recovered for sale or used in the plant. Five sources of potential pollutants require special treatment:

- a. Wastewater
- b. Gaseous effluent
- c. Cooling facilities
- d. Solid wastes
- e. Liquid byproducts

Abatement methods and facilities for each of these sources are discussed in detail below.

1.5.5.2 Wastewater Treatment

No waste streams would be discharged to surface waters from the coal gasification plant. Water would be recovered to the maximum

possible extent for reuse. The portion that is not recovered would be either disposed of with the waste solids, lost as vapor from cooling processes or disposed of in the deep well (Figure 1-16).

a. Treatment Facilities for General Service Water and Surface Runoff

All process areas, including areas around pumps and other sources of contaminated liquids, would be paved with concrete. Water drainage from these areas would be collected in contaminated water sewers and transported to a 570,000 ft³ (6-acre) retention pond.

Water that is not evaporated would first be treated in a gravity oil separator followed by flocculation and clarification. The oil recovered would be incinerated. The sludge from the clarifier would be sent to the raw water thickener and then to the ash handling system for burial in the mine. The clarifier overflow would be sent to the process water cooling tower.

Stormwater runoff from clean areas on the plantsite and natural drainage from surrounding areas would be collected in open ditches and culverts and routed into a 3.75 million ft³ retention pond. Since inflow would be intermittent and only during storms, there would not be any outflow from this pond unless a storm exceeded the 25-year flood event.

Mining and reclamation will require impoundments to intercept runoff and mine-pit water. These impoundments would be designed to withstand a 25-year flood event as required by the North Dakota State Engineer's Office, State Water Commission and MESA laws.

b. Domestic Sewage Treatment Facilities

About 50,000 gpd of domestic sewage would be biologically treated in a package-type sanitary waste treatment unit. This unit includes facilities for biological oxidation, clarification, and chlorination. Solids accumulating in this unit would be used as a soil conditioner in the reclamation program. The effluent from the sanitary waste treatment unit would be reused in the ash handling facilities or other process areas. Additional capacity would be installed to handle the larger sewage treatment load during the construction period.

c. Multieffect Evaporator

The blowdown stream from the process water cooling tower would be purified in a multieffect evaporator. The evaporated water would be condensed and used as low pressure steam boiler feed water and a portion would be sent to the Phosam-W ammonia recovery plant. Sludge from the evaporators consisting of 92 percent water, 6 percent acetate, 1 percent phenols, and 1 percent inorganic salts would be buried in the mine at a rate of 70 gallons/minute. This would result in 1,950 lbs of acetate salts, 325 lbs of phenolic salts, and 325 lbs of inorganic salts being buried in the mine each hour.

d. Other Wastewater Treatment Facilities

Due to buildup of impurities in the liquid phase of the Stretford sulfur recovery unit, a small purge would be required. The purge stream would be sent to a recovery system to reuse the chemicals.

e. Deep Well Disposal

The regeneration wastes for the softened and demineralized water streams would be combined with low pressure steam blowdown; these streams are not amenable to further reuse and would be disposed via a deep well. The estimated chemical composition of the total stream (234 gpm average; Phase I) for deep well disposal is shown in Table 5. Details of a study by Woodward-Clyde Consultants as to the feasibility of the deep well are presented in Section 2.1.3, 1c.

TABLE 1-5

WASTE STREAM TO DEEP WELL DISPOSAL

<u>PARAMETER</u>	<u>CONCENTRATION (mg/l)</u>
CaSO ₄	540
MgSO ₄	460
Na ₂ SO ₄	6460
NaCl	2770
NaHCO ₃	110
CaCl ₂	860
MgCl ₂	730

Source: The Lummus Company, July 1975

1.5.5.3 Gaseous Effluent Systems

Sources of gaseous emissions from this plant would be the steam boiler and superheater, flares (from both the gasifiers and emergency systems), start-up incinerator, air flows from the cooling towers, oxygen plants (N₂), byproduct and chemical storage, refuse incinerator, and coal and ash handling area. Effluent from

all sources except the incinerators and flares would be passed into the atmosphere through a common 400-foot stack.

The refuse incinerator would have a load of 1 to 2 tons per day (tpd). (Federal New Source Performance standards only apply if loads are more than 50 tpd.) According to preliminary calculations, the incinerator flue gas would be 60,000 standard cubic feet (scf) per hour with a particulate concentration of 0.2 grains per scf.

All lignite handling and preparation facilities, including crushers, screens, conveyors, and transfer points, would be enclosed to prevent nuisance dust emissions. At potential particulate matter emission sites, hoods operating under suction would be installed to capture the dust. The ventilation air streams would convey the captured dust pneumatically via ducting to the respective baghouses. Baghouse dust collectors are designed to reduce the particulate concentration of 257 m³/sec of the air stream to about 0.02 grains per scf. Thus, emissions related to these sources would total about 93.3 lbs/hr of TSP.

The steam boiler and superheater, the flares, the start-up incinerator, and byproduct and chemical storage are discussed in the following sections on the control of specific air pollutants. Properties of the fuels to be utilized in the plant are shown in Table 1-6. Pollutant emissions and abatement efficiencies are presented in Appendix B; air quality regulations are discussed in Section 4.1.2.1.

a. Sulfur

The gas purification unit would utilize the Rectisol process to remove sulfur compounds, CO₂, and other contaminants from the raw gas. The design of the sulfur recovery system is based on coal containing an average 1.3 percent sulfur on dry ash free (DAF) basis. Sulfur compounds would be removed to a level of less than 0.1 ppm (by volume). H₂S and CO₂ would be recovered in the Ammonia Recovery unit. These two acid gas streams would be sent to the Stretford sulfur recovery plant for sulfur recovery.

The Stretford process would operate on a continuous regenerative basis using a dilute aqueous solution containing sodium carbonate, sodium bicarbonate, sodium metavanadate, and anthraquinone disulfonic acid (ADA).

The H₂S in the entering gas stream would be absorbed by the alkaline carbonate solution countercurrently in an open grid absorption tower, forming bisulfide ions. The sulfide would then be oxidized to free sulfur by the metavanadate,

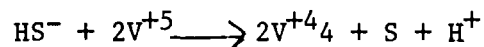


TABLE 1-6

PROPERTIES AND QUANTITIES OF COAL AND LIQUID BYPRODUCT FUELS

<u>Area</u>	<u>Fuel Type</u>	<u>Rate</u>	<u>Lbs/hr</u>	<u>SCFM</u>	<u>MMBtu/hr (HHV)</u>
Coal Gasification	Coal (DAF)		1,343,900	-	16,200
Steam Boilers	Tar		70,120	-	1,140
	Tar Oil		9,390	-	160
Superheater	Tar Oil		14,000	-	240
	Naphtha		11,520	-	215
	Phenol		13,750	-	190
	Stretford Tail Gas		-	277,280	680
	Coal Lock Ejector Gas			520	10

Ash and Sulfur Analysis:

Percent Sulfur

<u>Fuel Type</u>	<u>Ash Wt. %</u>	<u>Weight</u>	<u>Volume</u>
Coal	6.13 ^{1/}	1.3 ^{2/}	-
Tar	0.45	0.65	-
Tar Oil	-	0.52	-
Naphtha	-	1.60	-
Phenol	-	0	-
Stretford Tail Gas	-	-	0.029
Coal Lock Ejector Gas	-		0.32

^{1/} On as received basis (34.3%M)^{2/} On DAF Basis

This reaction would proceed during the absorption step and would be completed in a holding vessel. The solution would be regenerated by reoxidation of V^{+5} to V^{+4} . This would be accomplished by sparging with air in a separate vessel with ADA as a catalyst for the reaction. The sulfur formed would be separated as a froth from the solution and processed to produce a salable liquid sulfur byproduct. The excess air from the sparging step would be released to the atmosphere. This air would contain only CO_2 and water vapor.

The Stretford process would convert H_2S to elemental sulfur. Other sulfur compounds, such as COS and CS_2 , are unaffected by the process. The tail gas, therefore, would be combusted in the superheater furnaces, described below.

A small degree of oxidation of sulfides to thiosulfate and sulfate would occur. These salts are nonregenerable and require a liquid purge. Sulfuric acid would be added to this purge stream to reduce the pH to around 2. The stream would then be flash-stripped. The stripper bottoms would be centrifuged to remove sulfur and sent to a vacuum crystallizer. The $Na_2SO_4 \cdot 10H_2O$ would be crystallized, centrifuged, and sent to a Na_2SO_4 dryer. After addition of Na_2CO_3 the liquor would be returned to the Stretford process.

The Na_2SO_4 dryer would be fired with either a light fuel oil or sulfur-free gas (about 7 MMBtu per hour). The flue gas from the dryer would pass through cyclones to remove any residual Na_2SO_4 dust and would be mixed with the steam boiler flue gases. The Na_2SO_4 product would be sold.

Some of the sulfur in the coal feed would end up in the byproduct tar, tar oil, and naphtha. The steam boilers would be fired with the tar and tar oil. The superheater furnaces would be fired with the rest of the tar oil and the naphtha and phenol, simultaneously combusting the Stretford tail gas. The combined tar and tar oil would have an SO_2 emission rate of 0.78 lb. SO_2 /MMBtu and the combined tar oil, naphtha, and phenol would have a SO_2 emission rate of 0.80 lb. SO_2 /MMBtu. Including the Stretford tail gas, the superheater emission rate would be 0.96 lb. SO_2 /MMBtu. (See Section 4.1.2.1 for discussion of air quality standards.) A sulfur disposition diagram for the entire process is shown in Appendix B.

b. Nitrogen Oxides

There would be two sources of nitrogen oxides (NO_x) during combustion: fixation of nitrogen from the combustion air and the nitrogen content of the fuel itself.

The formation of NO_x due to the nitrogen in the air depends on the size, type, and arrangement of burners, the heat flux in the fired equipment involved, and the adiabatic flame temperature. The size, type, and arrangement of the liquid fuel burners in the steam boilers and superheater furnaces would be such that the NO_x formation would be low. The combustion of the waste gas in the superheater furnace would not produce NO_x and would have some quenching effects on NO_x production from the tar.

Because the tar and tar oil would be derived from lignite, which is high in nitrogen and oxygen, the tar and tar oil would also be high in nitrogen and oxygen. Therefore, more NO_x would be produced during the combustion of the tar and tar oil than during combustion of a commercial liquid fossil-fuel.

Preliminary estimates of NO_x emissions indicate that the emission from the steam boilers would be 0.6 lb. NO_x /MMBtu and from the superheater furnaces would be 0.5 lb. NO_x /MMBtu. (For the liquid fuels only; based on the combined liquid and gas fuel streams, the emission from the superheater furnace would be 0.24 lb. NO_x per MMBtu.) See Section 4.1.2.1 for a discussion of air quality standards.

c. Particulates

The flue gas from the steam boilers would be passed through electrostatic precipitators (fly ash removal efficiency of about 80 percent) to reduce the ash concentration to about 0.03 grains/scf. This corresponds to an emission rate of 0.1 lb. TSP/MMBtu.

The superheater furnace flue gas would not need particulate emission control. The ash concentration in the superheater flue gas would be about 0.02 grains/scf with a corresponding emission rate of 0.06 lb. TSP/MMBtu (based only on the heat input from the liquid fuels).

d. Hydrocarbons

Hydrocarbon vapors and gases containing traces of hydrocarbons would be collected and combusted. The Stretford tail gas (previously discussed in the section on sulfur) would be combusted in the superheater.

During start-up and shut-down, the raw gas from the gasifiers would be incinerated in a separate start-up incinerator. This incinerator would have a separate stack, approximately 120 feet tall.

Two elevated flare stacks would be used to incinerate emergency hydrocarbon vapors emanating from safety valves and overriding pressure controllers. Each flare would be capable of flaring 25 percent of the total plant gas production.

Steam injection into the flared gas stream would be used to obtain smokeless conditions for normal flaring. In the event of a plant-wide emergency, however, the quantity of gas relieved may exceed the smokeless burning capacity of the flare. These occurrences are unpredictable and would be of short duration (1 hour).

The flare stacks (including the gas liquor low pressure flare) would be self-supporting and include ignitors, flame front generators, molecular seal, and continuous pilots. Ladders and access platforms would be provided on the flare stack to facilitate maintenance. The two main flare stacks would be 200 feet above grade and have a tip diameter of 36 inches. The low pressure flare stack would be 120 feet above grade with a 10-inch diameter. The flare stack locations are shown in Figure 1-12; estimated emissions from the flare stacks are presented in Appendix B.

The estimated characteristics of each of the gaseous streams and the combined stream are listed in Table 1-7. The gaseous effluent treatment system is shown schematically in Figure 1-17.

1.5.5.4 Cooling Facilities

a. Air Cooling

Air cooling would be used within the plant to reduce water consumption. High-level cooling surfaces would be cooled with air or a combination of air and water cooling, depending on initial temperature and the required heat transfer rate.

b. Cooling Towers

Two cooling towers would be provided to handle additional plant heat rejection:

- a cooling tower using gas liquor process water from the Phenosolvan and Gas Liquor Separation units.
- a cooling tower for the oxygen plant, using clarified fresh water. (A separate tower is required for the oxygen plant to eliminate the hazard associated with the presence of any hydrocarbons entering the oxygen plant system.)

Cooling water from the process gas liquor and the fresh water cooling towers would be utilized to the maximum possible extent.

TABLE 1-7

ESTIMATED OPERATING CONDITIONS DUE TO FUEL COMBUSTION

	<u>Steam Boilers</u>	<u>Superheater Furnaces</u>	<u>Rotary Dryers</u>	<u>From Stack Tip</u>
Flow Rate, SCFM	260,460	550,150	Negligible	810,610
Pressure, in WG	2	1		1
Temperature, °F	400	500		410
Dew Point, °F	148	108		140
Fired Duty, MMBTU/Hr (HHV)	1,300 (liquid)	645 (liquid) 700 (gas)	7 (fuel gas)	2,652
Emissions, lbs/hr				
SO ₂	1,010	1,596 (417 liquid) (1,179 gas)		2,606
NO _x	780	320		1,100
Particulates	130	40		170
Stack Heights	400 ft.			
Stack Diameter	24 ft.			

NOTE: Above figures are for maximum sulfur coal.

Both of these cooling systems are designed for two-stage use of the circulating cooling water by first passing the cooling water through a service requiring a low process temperature followed by a high temperature service. For example, cooling water would be used first in the compressor intercoolers and then in the turbine surface condensers of a steam turbine-driven compressor.

The estimated rates of water loss due to evaporation and drift from each tower are listed in Table 1-8. The process gas liquor cooling tower would be designed to minimize drift loss.

TABLE 1-8
COOLING TOWER CHARACTERISTICS

<u>Characteristic</u>	<u>Process Gas-Liquor Cooling Tower</u>	<u>Oxygen Plant Cooling Tower</u>
Duty, MMBtu/hr ^{1/}	3,906	350
Circulation, gpm	200,520	40,000
Temperature, °F		
a. Supply	82	82
b. Return	118	100
Make-Up Water, gpm ^{2/}	7,020	820
Number of Circulating Pumps		
a. Operating	6	4
b. Spare	1	1
Estimated Water Loss		
a. Evaporation, gpm	6,340	700
b. Drift, gpm	100	20
c. Blowdown, gpm	580	100
d. Total	<u>7,020</u>	<u>820</u>

1/ At temperature 190° F (Duty included in tower rating)

2/ Total make-up requirements, including recovered gas-liquor. About 25 percent is nonprocess water during the summer; during winter no fresh water is required.

c. Other Evaporative Losses

Besides drift and evaporative losses of water from the cooling towers, water from other processes would also be lost to the atmosphere by evaporation. A summary of these estimated losses is presented below:

<u>Source</u>	<u>Evaporated Water Loss, gpm</u>
Multieffect Evaporators	400
Stretford Unit	67
Ash Handling	92
Water Clarifiers, Thickeners, and Pond	Negligible

The total amount of water discharged to the atmosphere from the above processes and cooling towers during summer would be about 7,720 gpm; discharges during winter would total about 5,790 gpm.

1.5.5.5 Solid Wastes

Four types of solid wastes requiring disposal would be generated at the plant:

1. Ash from the gasifiers, evaporator residue, and fly ash from steam boilers;
2. Inorganic sludge and silt from raw water treatment;
3. Sludge from the package-type biological treatment unit for sanitary sewage; and
4. Refuse (i.e. paper, cartons, rags, wood scraps, etc.)

The ash would be dewatered in the ash handling facilities and then returned to the mine. Residue from the multiple-effect evaporators and the inorganic sludge and silt from raw water treatment would also be disposed of at the mine with the ash. Sludge from the biological wastewater treatment plant would be returned to the mine for use as a soil conditioner. The refuse would be burned in an incinerator.

The ash discharged from each of two lines of gasifiers would be quenched and sluiced down a sloping sluiceway to 1/2-inch vibrating screens. The plus 1/2-inch material would be discharged onto a conveyor belt; the water and minus 1/2-inch ash would be discharged to four rake classifiers. The classifiers would remove the plus 1/2-mm material and deposit it on the same conveyor with the screen oversize. The combined screen and classifier discharge would be about 75 tph of 15 percent moisture ash.

The excess water along with the minus 1/2-mm fraction, estimated to constitute 15 percent of the total ash, would overflow the classifier to the classifier sump. During normal operations, the ash slurry entering the sump would be about 1.0 percent solids by weight and would amount to approximately 15 tph.

From the classifier sump, the water and fine ash would be pumped to two 60-foot-diameter thickeners for settling. The clarified overflow (7800 gpm) from the thickener, plus 200 gpm of make-up water would be reused in the hydraulic ash sluicing system. The underflow from the thickener would be fed to top feed belt type vacuum filters. The minus 1/2-mm material collected by the filters would be discharged to the ash removal conveyor.

The total ash production (approximately 90 tph) would be conveyed to a covered ash bin which would be emptied periodically into a 50-ton truck (making 1.5 trips/hr) for disposal in the mine. The ash bin would be heated and insulated to prevent the ash and condensate from freezing during the winter.

The fly ash, collected by the electrostatic precipitators on the byproducts fired boilers, would be separately hauled to mine for disposal. Ash burial was described in Section 1.5.3.2.

1.5.5.6 Byproducts

During the processing of coal to SNG, several liquid byproducts would be produced. Onsite storage facilities for these byproducts would be provided, with a minimum 15-day storage capacity, except for the anhydrous ammonia. The anhydrous ammonia would be stored as a liquid at atmospheric pressure in a single-wall, insulated tank having a vapor recovery refrigeration system and providing 30 days' storage capacity. Tar, tar oil, naphtha, and phenol byproducts would be utilized as fuel within the plant.

All storage tanks would be located in diked areas and fire protection provided (Section 1.5.4.7). Each diked area would be capable of holding the entire contents of each storage tank. The interior surfaces of the diked areas would be coated with an impervious material; any excess buildup of water would be pumped to the retention pond.

The elemental sulfur produced by the sulfur recovery unit would be stored in molten state in a below grade storage pit equipped with steam heating coils. The pit, located within the battery limits of the sulfur recovery unit would be fully enclosed, sealed, and made of concrete. It would be provided with submerged loading pumps and rail loading facilities.

North Dakota and Federal EPA regulations concerning emission of hydrocarbons from storage tanks have been followed to determine which storage tanks require either a floating roof or a vapor recovery system. (The regulations provide: If the true vapor pressure of the petroleum liquid is equal to or greater than 1.5 psia, but less than or equal to 11.1 psia, a floating roof or vapor recovery system is necessary. If the true vapor pressure is greater than 11.1 psia, vapor recovery is needed.)

A summary of the storage tank characteristics is presented in Table 1-9.

1.5.6 Associated Systems

1.5.6.1 Product Gas Pipeline

Product gas from the plant would be transported by a 20-inch pipeline system owned and operated by Great Lakes, about 365 miles to their Thief River Falls Compressor Station in Minnesota. With a few minor exceptions, the proposed pipeline would use existing Burlington Northern and Soo Line Railroad rights-of-way almost the entire route (Figure 1-18). Because of the constraints of the existing rights-of-ways, special construction procedures would be used which allow construction in a width of less than 50 feet. The average distance of the pipeline from the centerline of the railroad would be about 40 feet. The total land disturbed by pipeline construction would be 2,190 acres of which new right-of-way (ROW) requirements would amount to 79 acres. After construction the new ROW would be maintained, and existing ROW would revert to its previous condition.

The proposed facilities include a 20-inch buried steel pipeline, five communication towers, a series of main-line valves spaced 15 to 20 miles apart, two gas compression facilities, and a district headquarters in Devils Lake, North Dakota. These facilities would require an additional 32 acres of land.

Construction would be continuous over the 365-mile length of the pipeline using four main-line construction crews (spreads) and special spreads for construction through towns, the Missouri River crossing, and the dry land crossing of the Snake Creek Embankment between Lake Sakakawea and Lake Audubon. The main-line spreads would vary from 87 to 98 miles in length.

Construction procedures of a typical main-line spread are illustrated in Figure 1-19. Within each spread there is an activity zone of continuous operation, consisting of all procedures between starting on the untouched ROW to cleanup and restoration. Clearing and grading would start with the removal of obstacles such as trees,

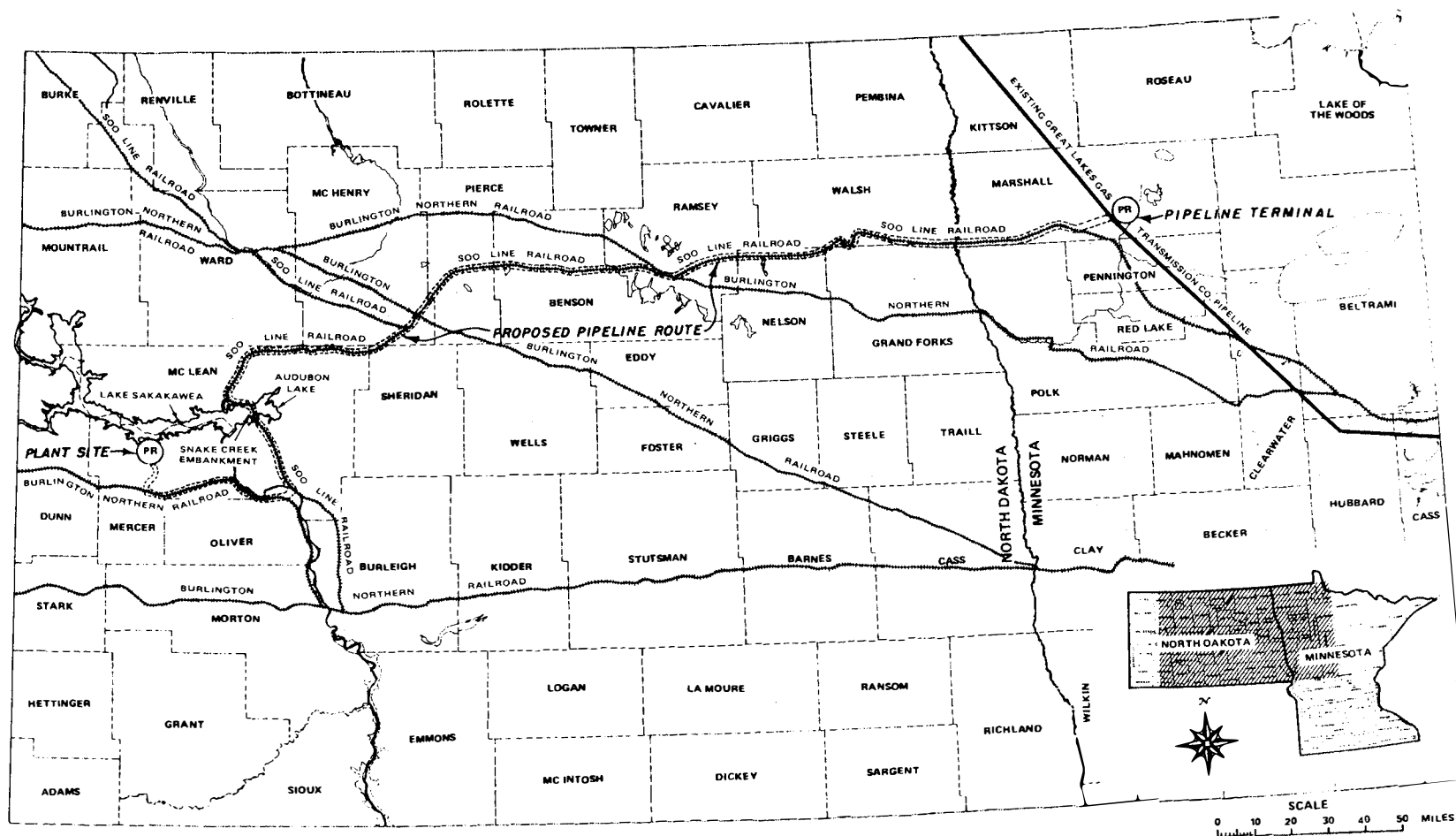
TABLE 1-9

BYPRODUCT AND CHEMICAL STORAGE TANK CHARACTERISTICS

	<u>Chemical</u>	<u>Amount Produced</u>	<u>Storage Capacity</u>		<u>Tank Diameter, ft.</u>	<u>Tank Height, ft.</u>	<u>Total Emissions, Bbl/yr</u>	<u>Type</u>
			<u>Number</u>	<u>Capacity per Tank</u>				
	Tar	192,300 gal/day	2	35,810 Bbl	80.0	40.0	20	B
	Tar Oil	70,800 gal/day	2	13,600 Bbl	45.0	48.0	14	B
	Naphtha	39,800 gal/day	2	7,160 Bbl	40.0	32.0	108	A
	Crude Phenol	35,800 gal/day	2	7,160 Bbl	40.0	32.0	6	B
1-60	Anhydrous Ammonia	215 tons/day	2	3,000 tons			0	C
	Slop Oil		1	1,010 Bbl	21.4	16.0	0.06	(insulated) B
	Fuel Oil #2		1	5,020 Bbl	33.5	32.0	0.07	B
	Sulfur	160 tons/day					0	Pit
	Methanol (100%)		1	2,020 Bbl	21.4	32.0	0	C
	Phenosolvan (100% Di-isopropyl ether) solvent		1	5,000 Bbl			0	D

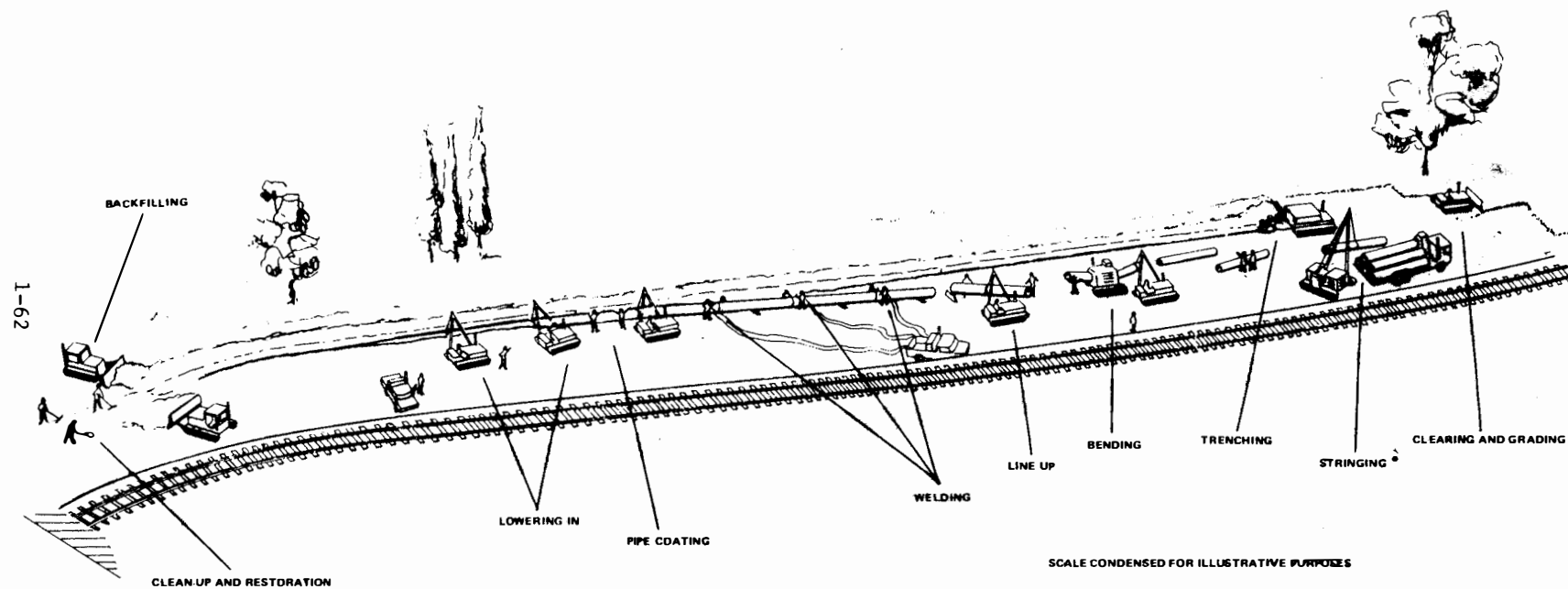
- A: API Type Floating Roof
 B: API Type Cone Roof, with Steam Coil
 C: API Type Cone Roof with Vapor Recovery
 D: Horizontal Tank with Vapor Recovery

1) Preliminary estimate (based on equations in API-2518: "Evaporation Loss From Fixed-Roof Tanks," API-2523: "Petrochemical Evaporation Loss From Storage Tanks and API-2517: Evaporation From Floating-Roof Tanks")



PROPOSED ROUTE OF THE PRODUCT GAS PIPELINE

FIGURE 1-18



TYPICAL PIPELINE CONSTRUCTION SPREAD

• STRINGING WILL BE FROM RAIL CARS WHERE POSSIBLE

Figure 1-19

rocks, brush, and logs. Topsoil, to a typical depth of 8 inches, would be segregated where required by an agency or landowner. The topsoil would be stored on the outermost edge of the railroad ROW. Partial leveling and smoothing of abrupt contours would also be performed at this time.

During the stringing operation, pipe would be brought to the construction zone on railroad cars and unloaded by crane along the ROW in a continuous line. The pipe required for stream and road crossings would be stockpiled near each crossing. The trenching operation would involve excavating the ditch by means of a trenching machine or mechanical backhoe. The typical trench depth would be about 6½ feet. Rock-laden areas may require some drilling and blasting.

If necessary, the pipe would be bent to compensate for minor variations in alignment, and then lined up and welded. The pipe would be laid on supports in a continuous line along the side of the trench, and the welding and subsequent inspection performed according to Department of Transportation Regulations (Title 49, CFR, DOT, Part 192 - Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards).

In the pipe coating operation the pipe would be cleaned and primed prior to coating using sideboom tractors with cradles and a traveling cleaning and priming machine. After priming, the pipe would be coated and wrapped. Sideboom tractors would again be used to apply coal tar, asphalt, or other material while asbestos felt and heavy kraft paper are simultaneously wound around the pipe. Following wrapping, an electronic Holiday detector would be used to inspect the coated surface for defects.

After the pipe has been coated and inspected, it would be lowered into the trench by sideboom crawler tractors with special belt slings for handling the coated pipe. The trench would then be backfilled with the previously excavated material. Then the topsoil would be bulldozed back over the pipeline area and normal contours and drainage restored. Revegetation would be consistent with the existing vegetation, except that trees and large bushes would not be established.

Special construction methods required during main-line spread construction would include: (1) tunneling under existing roads, highways, and railroads; (2) construction of temporary drains where existing drains are disturbed; (3) excavation of streambeds during low water and timed to avoid fish migration and spawning periods; (4) use of floating excavation equipment to cross the Missouri River; (5) construction around existing structures; and

(6) relocation of the existing telephone cable and drain system at the Snake Creek embankment crossing.

With the exception of the Missouri River crossing, perennial streams would be crossed by excavating from the bank using backhoes or draglines. Some blasting may be required. Crossings would be timed to avoid known periods of flood potential and of fish migration and spawning. The excavated material would be deposited on either the streambed or adjacent banks. The pipe would be buried beneath the scour depth of the stream to prevent subsequent exposure. Streambanks would be restored to their original elevation and grade, erosion control structures installed where necessary, and shrubbery planted.

For the Missouri River crossing, the trench would be opened with either a clam shell or dragline mounted on a barge. To ensure pipeline integrity during flood periods, the pipe would be concrete-coated and buried 2 to 5 feet below scour depth. The pipe would be installed by a set of pulling cables strung across the river and the pipe pulled by winch from a prefabrication area on the other side. About 50 days would be required for construction which would be done during late summer; this is normally the low flow period.

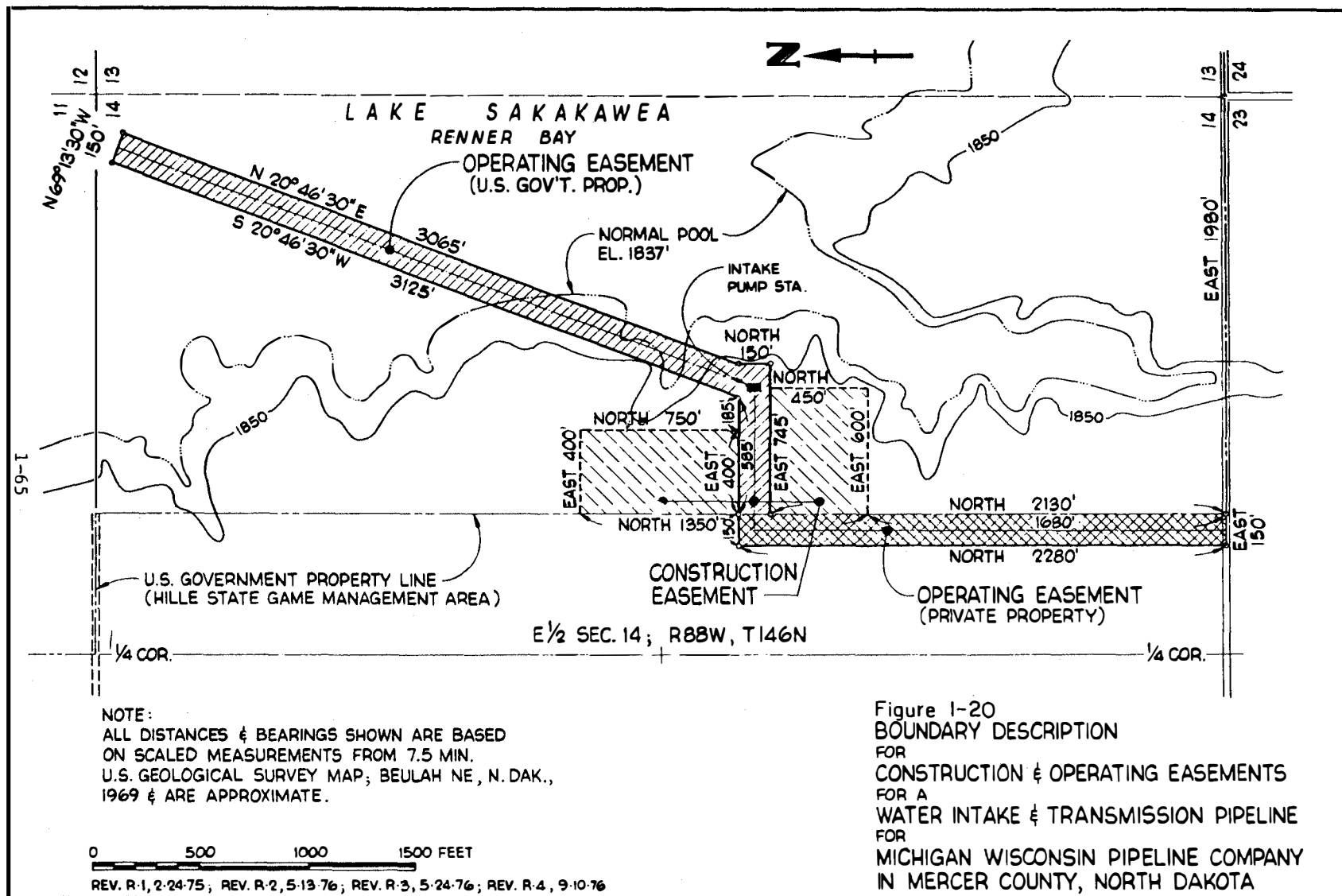
After construction, hydrostatic testing of the pipeline will be performed. Sources of hydrostatic test water have not yet been determined, but a study will be done prior to construction to locate the several suitable water sources required. Once a section of the pipeline has been tested, the test water would be discharged into natural drainages.

The SNG output from Phase I of the gasification plant would not require compression, so the two compressor stations would not be built until Phase II construction. Each compressor station site is planned to enclose 10 acres. These sites have not been specifically identified but would be in the vicinity of Mile 120 in McLean County and Mile 240 in Ramsey County, both in North Dakota.

Each compressor station would consist of a small, combination office-warehouse and a separate compressor building enclosing a SNG operated gas-turbine compressor.

1.5.6.2 Water Intake and Pipeline

The raw water intake structure would be located in Lake Sakakawea at the west arm of Renner Bay (Figure 1-20). The intake would be located 67 feet below normal pool elevation (Figure 1-21). The submerged intake would insure the necessary supply of water at minimum probable pool elevation. Medium-sized ($\frac{1}{4}$ inch) fish screens would be provided on the intake; maximum intake velocity would be about 0.5 ft/sec.



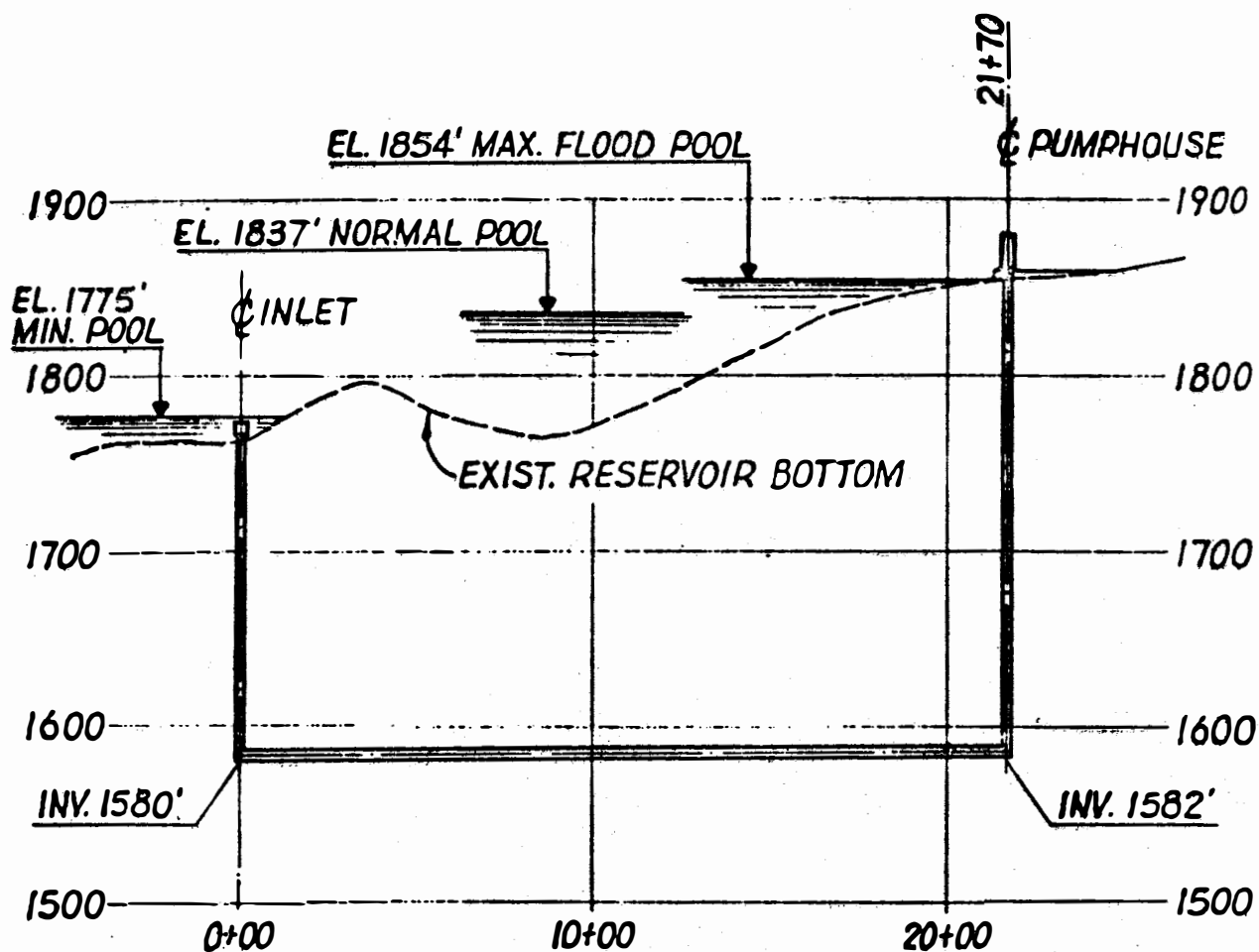


Figure 1-21
 ANG COAL GASIFICATION COMPANY
 PROFILE
 RAW WATER INTAKE
 SCALE: 1" = 500'

Water would be conveyed by gravity from the offshore intake to an onshore pumping station. Pumps would be provided to deliver water at varying rates depending on plant requirements. Standby pumps would be installed to insure the delivery of water at all times. The water would be pumped to the plant via a 42-inch underground pipeline, as shown in Figure 1-22, extending 7.6 miles to the plant.

For construction, a precast intake structure would be set in place and a tunnel extended to it from the pumping facility. Tunnel excavation material would be deposited on shore, contoured, and seeded with native grasses in accordance with the Corps of Engineers' permit stipulations. The pipeline would be constructed using the basic procedure described for the product gas pipeline.

1.5.6.3 Railroad Spur

A railroad spur would be constructed generally eastward about 9.0 miles to an existing Truax Traer spur which would require upgrading 3.1 miles southward to the existing Burlington Northern mainline (Figure 1-6). (The existing spur is not currently in use.) It would be used to bring building materials and equipment into the plantsite and export byproducts for sale. A rail-mounted track layer would be used to construct the spur after the initial grading by bulldozers. After construction, the 150-foot ROW would grow back to the seminatural weedy vegetation characteristic of railroad ROW's in the area.

During plant construction, rail traffic on the spur is estimated at an average of 63 cars/week. During operations, rail traffic for the gasification plant and mine is estimated to average 39 cars/week, plus 10 cars/week of limestone for the powerplant, for a total of 49 cars/week.

Total construction materials, commodities, consumables, and plant equipment required for construction of the gasification plant, powerplant, and mine is estimated at 675,000 tons. About 10 percent of this (67,500 tons) would be delivered by truck; the remaining 90 percent (609,500 tons) would be brought in via the rail spur.

1.5.7 Maintenance Procedures

To assure reliability and to meet all Federal and State safety requirements, periodic maintenance is scheduled for all operating equipment. This includes inspection of all high pressure piping systems, major equipment, rotating equipment, and all critical operational areas for any abnormalities. Corrosion control would

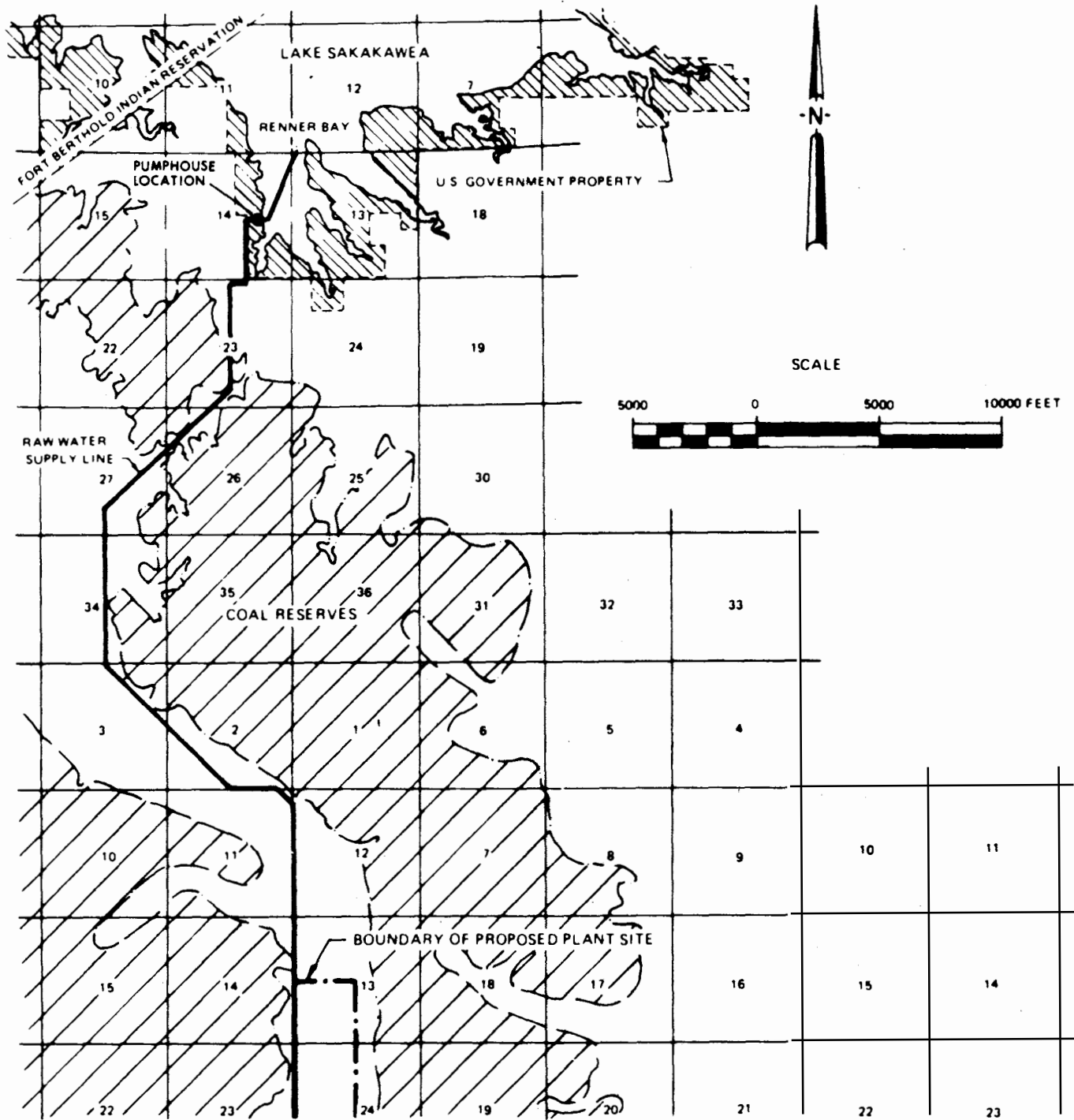


Figure 1-22 NORTH DAKOTA COAL GASIFICATION PROJECT - RAW WATER SUPPLY LINE

be carried out to insure that no piece of operating equipment is subject to unanticipated excessive corrosion rates. Maintenance procedures are also provided to respond to abnormal occurrences.

The design of each major unit of operating equipment includes complete instrumentation and interlocking systems to notify plant personnel in the event of equipment malfunction and, where necessary, to shut down the plant. In general, rectifying the problem would involve isolating the equipment, venting to the flare system, inspecting the equipment, and making any necessary repairs.

During operation of the plant, certain equipment would require regular internal inspection. These units are isolated, as described above, vented to the flare system, purged, and blanked off and inspected to determine and report condition of equipment.

Scheduled maintenance should have no effect on plant output since certain major operating equipment is duplicated (spared) to prevent reduction in gas production. The conservative sparing of major key pieces of equipment in the design of the facility assures the reliability of the plant being on-stream for 91 percent of the year. However, some equipment that is out-of-service would reduce gas output during the required period of maintenance. Presently no assumptions can be made as to how much down time would occur.

Associated with maintenance and on-stream reliability are the safety aspects of the specific chemicals and equipment required for production. Defending against human and/or mechanical error is of prime importance in the design and operation of this facility. All equipment will be designed for safety and reliability. Adequate provision for movement of personnel and equipment in case of emergency is incorporated in the conceptual layout of the facility. Equipment (pumps, absorbent material, etc.) would be on hand for rapid cleanup of accidental spills of oil and other hazardous materials.

The process areas would have detecting devices to forewarn of any impending danger in operation. Various temperature, pressure and level alarms, and shutdown circuits, known as interlocks, would be incorporated to minimize potential hazards. All required vessels would have safety relief valves to protect personnel and equipment from dangerous buildup of pressure. Any emission from the safety valves is piped into an emergency relief system which includes emergency venting lines. The products are piped to a smokeless flare stack to burn the hydrocarbons to CO_2 and water. All equipment containing flammable and potentially hazardous materials would be electrically grounded.

The activities associated with coal handling have been designed to maximize safety aspects. To prevent spontaneous combustion of the coal, the dormant or "dead storage" piles are laid down and compacted in 1-foot layers. The pile slopes would be at maximum to the angle of the repose to reduce coal dusting and thereby decrease hazards associated with coal dust. All coal handling equipment would have sufficient ventilation and properly grounded collection equipment to reduce coal dust explosion; this equipment would be designed and installed in accordance with the Federal Health and Safety Act of 1969.

Pipelines would be inspected and maintained in accordance with standards set forth in 49 CFR 192 by the Office of Pipeline Safety. This includes continuous surveillance of facilities, investigation of all possible failures, and immediate correction when necessary. In addition, pipeline patrols would conduct surface inspections to set schedules.

CHAPTER 2
DESCRIPTION OF EXISTING
ENVIRONMENT

2. Description of Existing Environment

The following discussion describes the project area in general and the plant-mine site and product pipeline route in detail. The water pipeline and railroad spur are closely adjacent to the plant-mine site, so the description of the existing environment of the plant-mine site would include them also. To avoid duplication, only aspects of the product pipeline differing from the plant-mine site are covered in detail.

ANGCGC commissioned Woodward-Clyde Consultants, and Great Lakes commissioned Ecology and Environment, Inc., to study the existing environment at and near the plant-mine site and product pipeline route, respectively. Much of the following description is based on data from their reports (4, 14). Appendix C summarizes the environmental studies which have been undertaken to assess the environmental impacts of the proposed gasification plant and its associated systems. More detailed data on some aspects of the proposed systems and existing environment are available in the reports of these studies.

2.1 Physical Environment

2.1.1 Climate

The climate in the area of the proposed project is semiarid. It is a region of climatic extremes; summers are hot and winters are cold and long. Averages are misleading, for seldom does "average" weather actually occur. Instead, weather tends to fluctuate widely around the annual averages. Blizzards and cold waves occur every winter. However, most of the annual precipitation occurs in the spring and summer associated with thunderstorm activity which can occasionally deposit large amounts of rain in a relatively short time. Normal and extreme precipitation and temperature data at Bismarck, North Dakota, are shown in Table 2-1.

Precipitation in the area is light, averaging 16.16 inches annually at Bismarck, and 17.20 inches annually at Beulah. Snowfall is moderate (38.4 inches annually), but has occurred in every month except July and August. Extreme snowfall for 1 month was about 31 inches (March 1975 and November 1896). The maximum daily temperature is greater than 100° F about once a year and below 0° F about 7 days a year. Minimum temperatures are below 0° F about 51 days per year.

The prevailing wind direction at the plant-mine site is from the northwest. Easterly winds occur with the greatest frequency from

TABLE 2-1

PRECIPITATION AND TEMPERATURE DATA FOR BISMARCK, NORTH DAKOTA (3)

	<u>Jan.</u>	<u>Feb.</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Annual</u>
Average Precipitation (Inches)	0.44	0.43	0.78	1.22	1.97	3.40	2.19	1.73	1.19	0.85	0.59	0.36	15.15
<u>Temperature (F)</u>													
2-1 Average Max.	19.1	24.5	35.4	54.8	67.1	75.8	84.3	83.5	71.3	60.3	39.4	26.0	53.0
Average Min.	-2.8	2.4	14.7	31.1	41.7	51.8	57.3	54.0	43.7	33.2	18.3	5.2	29.3
Mean	8.2	13.5	25.1	43.0	54.4	63.8	70.8	69.2	57.5	46.8	28.9	15.6	41.4
Highest (Year)	60 1908	68 1958	81 1946	92 1952	102 1934	107 1921	114 1936	109 1941	105 1876	95 1953	75 1975	66 1939	114
Lowest (Year)	-45 1916	-45 1936	-36 1897	-12 1975	13 1907	30 1969	32 1884	32 1911	10 1876	-10 1919	-29 1964	-43 1967	-45

May to August. The average annual wind speed is 11.6 mph. Winds are strongest in April, averaging 14.4 mph and weakest in July (10.8 mph). Tornadoes are rare in the area; the probability that one would strike the plant is 0.00034 and the mean recurrence interval is 2,950 years (4, 5).

2.1.2 Air

2.1.2.1 Meteorology

Meteorological parameters were continuously recorded by an instrument package installed near the plant-mine site (Figure 2-1). Hourly averages of wind speed and direction were documented from sensors 33-feet and 133-feet above-ground. Average annual wind flows for 2 years data are shown in Figure 2-2. Comparative data for Williston and Bismarck are presented in Appendix D. Wind flow at all three locations was primarily from either the north-west or the south-east quadrants. The absence of calms at the Beulah site can be partly explained by its better exposure.

Temperature inversions considerably reduce the ability of the atmosphere to disperse pollutants. Data from 1955 through 1964 show that inversion conditions exist 24 percent of the time at Bismarck. During these times, wind speed is usually from the east averaging 5.7 mph. Inversions are most prevalent during summer and least prevalent during the spring. In 35 years of record, no stagnation lasting more than 4 days has been noted for North Dakota (6).

For air quality purposes, the stability of the air is related to stability classes. The frequency of occurrence of the three main stability classes at the meteorological station is summarized below:

<u>Vertical Temperature Gradient (°C/100m)</u>	<u>Stability Category</u>	<u>Pasquill Stability Class</u>	<u>% Frequency of Occurrence</u> ^{1/}
-1.9 to -1.5	Unstable	A, B, C	24.5
-1.5 to 0.5	Neutral	D	28.5
0.5 to 4.0	Stable	E, F, G	47.0

^{1/} Based on 7,477 hours of observations from February through December 1974.

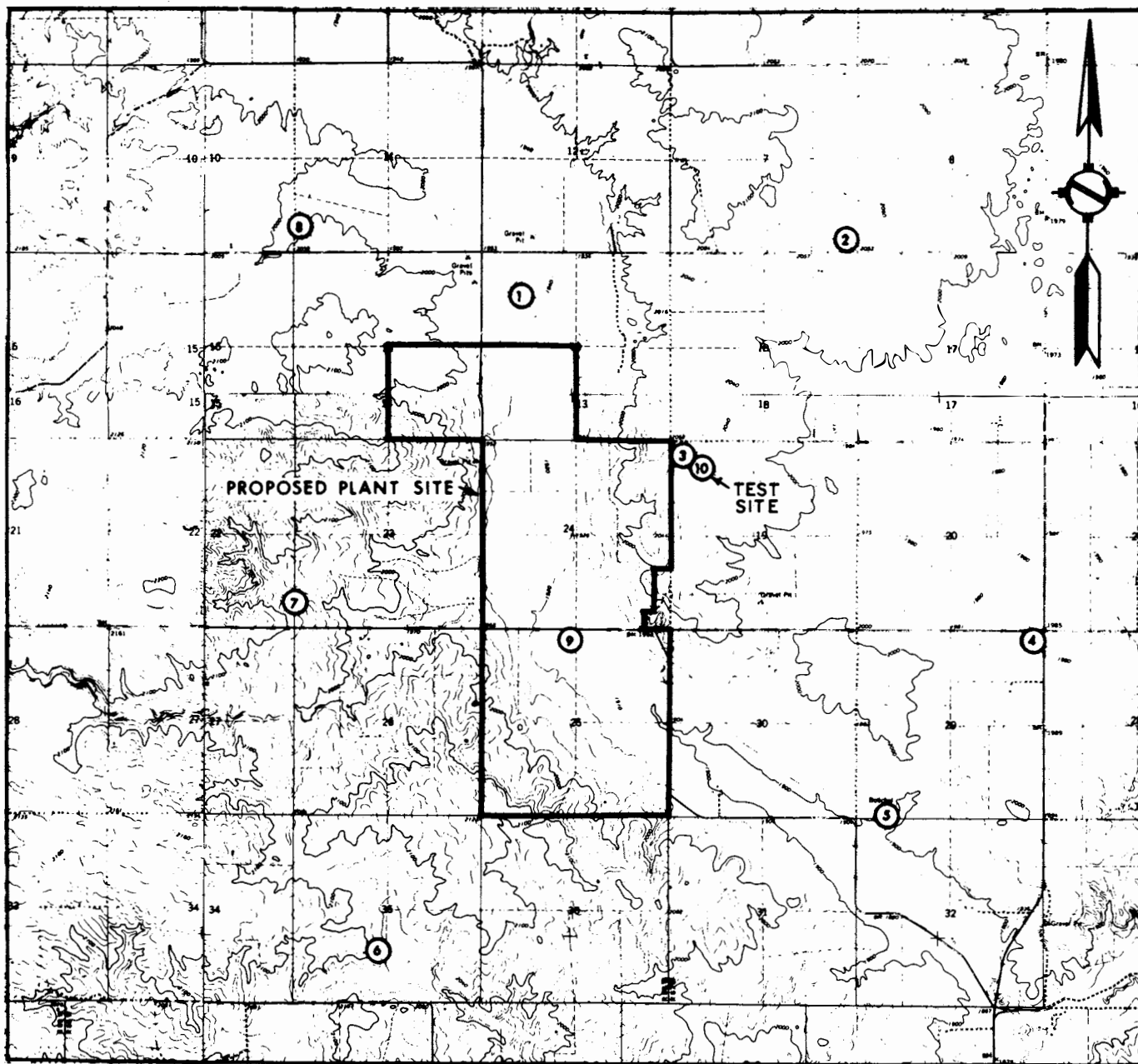


FIGURE 2-1 SULFATION PLATE AND DUSTFALL SAMPLING NETWORK:
METEOROLOGICAL TEST SITE

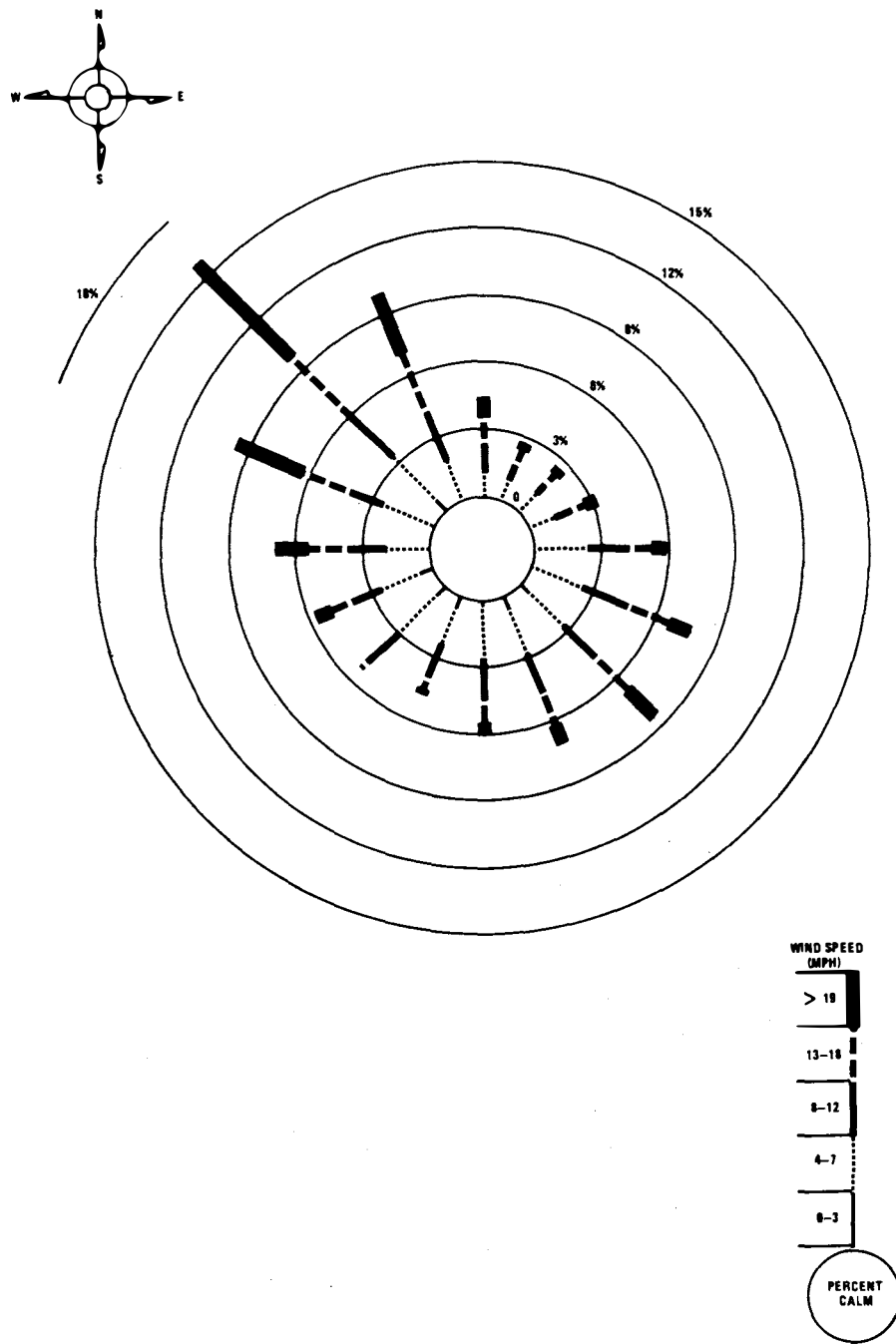


Figure 2-2
ANNUAL PERCENTAGE FREQUENCY OF WIND SPEED AND DIRECTION
METEOROLOGICAL TEST SITE, 1974 THROUGH 1975

2.1.2.2 Quality

a. Plant-Mine Site

To obtain data on present ambient air quality, a baseline study was conducted from June 15 to July 31, 1974, at the meteorological test site. Measurements were made of all air contaminants for which standards have been established by the North Dakota State Department of Health. Tests were also made of suspended nitrates, fluorides, and trace metals (mercury, arsenic, molybdenum, selenium, lead, beryllium, antimony, and cadmium); radionuclides were identified by gross alpha and beta radiation. A summary of air quality data from other North Dakota stations is presented in Appendix D.

Sulfur Dioxide (SO₂): Measurements of SO₂ concentrations were made using the coulometric automated continuous sampler. The percent frequency of concentration levels are shown in Appendix D while Figure 2-3 details levels by date. An additional monitoring period was conducted (Figure 2-4) because of a coal fire at a coal mine 12 miles east of the study area which may have caused unusually high SO₂ levels during the June 15 to July 31 test period. The highest 24-hour concentration recorded was 156 ug/m³ (0.06 ppm), which is 60 percent of the State standard (see Section 4.1.2.1 for Federal and State air standards). The highest 1-hour concentration was 260 ug/m³ (0.10 ppm); 36 percent of the State standard. Concentrations decreased during August-September indicating that the June-July readings may have been abnormally high and nonrepresentative of the usual ambient background level.

Sulfation Rate: Sulfation rates were obtained using lead dioxide plates exposed to the air for 30 days. Figure 2-1 shows the plant-mine area sampling network. The maximum 1-month value was about 0.20 mg/100 cm²/day; the minimum sample value was less than 0.13 mg/100 cm²/day (Appendix D). None of the stations exceeded the State reactive sulfation rate standard of 0.50 mg/100 cm²/day. Data from three State monitoring stations are included in Appendix D for comparison.

Suspended Particulates (tape): Co-efficient of haze (COH), sulfuric acid mist (H₂SO₄), and hydrogen sulfide (H₂S) were measured by tape samplers. The 1-month geometric means for COH calculated from data obtained during June and July were 0.030 and 0.018 COH/1000 linear feet, respectively. The State standard is 0.4 COH/1000 linear feet. The average H₂SO₄ concentration (3-hour samples composited for a 7-day single analysis) was 9.81 ug/m³, which is less than the State standard of 12 ug/m³ and 30 ug/m³,

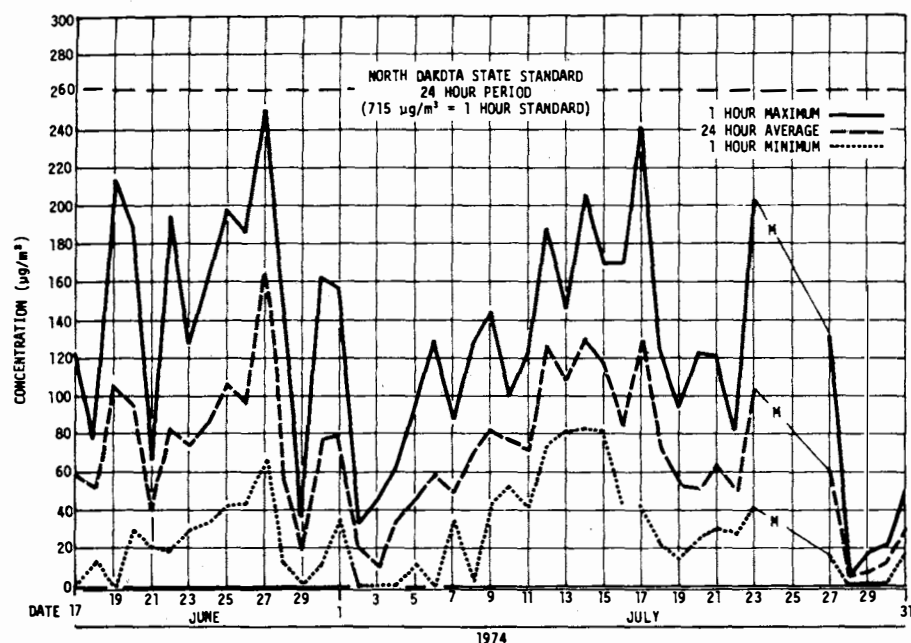


Figure 2-3 OBSERVED SULFUR DIOXIDE CONCENTRATIONS: 24 HOUR AVERAGE, 1 HOUR MAXIMUM, AND 1 HOUR MINIMUM AVERAGES AT METEOROLOGICAL TEST SITE FROM 17 JUNE THROUGH 31 JULY, 1974

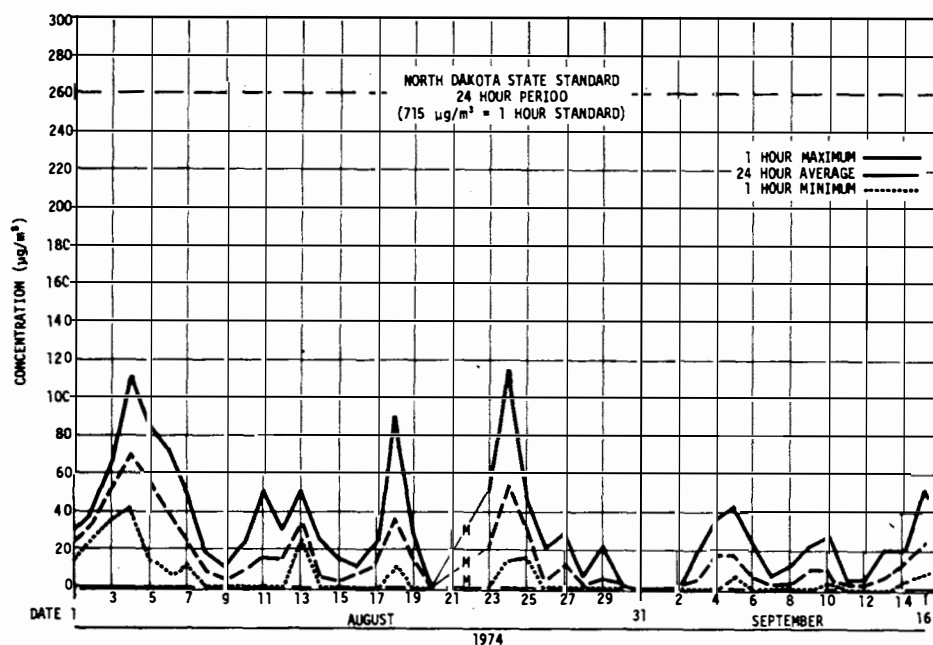


Figure 2-4 OBSERVED SULFUR DIOXIDE CONCENTRATIONS: 24 HOUR AVERAGE, 1 HOUR MAXIMUM, AND 1 HOUR MINIMUM AVERAGES AT METEOROLOGICAL TEST SITE FROM 1 AUGUST THROUGH 15 SEPTEMBER, 1974

maximum 24- and 1-hour concentrations not to be exceeded over 1 percent of the time. Of 2,042 half-hour samples of H₂S, only 13 samples showed any concentrations at all. The maximum half-hour H₂S concentration was 2.11 ug/m³ (0.0015 ppm) as compared to the State standard of 45.0 ug/m³.

Suspended Particulates (Hi-Vol): A Weather Measure APS-24 high-volume sampler system was used to measure total suspended particulates (TSP), suspended sulfates, nitrates, fluorides, pH, trace metals, and radionuclides. All samples of TSP were below the State standard (150 ug/m³ of air, maximum 24-hour concentration not to be exceeded more than once per year) except one sample on July 6 (Figure 2-5). Comparable data for three State stations for 1972-1974 are shown in Figure 2-6.

None of four groups of 24 1-hour samples (corrected to be one 24-hour sample each) for suspended sulfates exceeded the State standard of 12 ug/m³ (maximum 24-hour concentration not to be exceeded over 1 percent of the time). A comparison of site readings with State data is found in Appendix D. Nitrate concentrations for four 24-hour samples varied from 0.33 to 0.44 ug/m³. There are no State standards for nitrates or fluorine. Fluorine samples at the site ranged from .003 to .022 ug/m³ for four 24-hour samples. Results of the pH, trace metals, and radionuclide analyses are also shown in Appendix D. The pH of suspended particulates varied from 9.2 to 9.6. Iron (1.50 ug/m³) and copper (0.114 ug/m³) were the major trace metals. Alpha and beta activity was normal for the area.

Dustfall: The site network for sampling dustfall was shown in Figure 2-1. Data from the site was similar to that for Bismarck, 1972-1974 (Appendix D). None of the stations exceeded the State standard of 15 tons/mi²/mo, maximum 3-month average.

Photochemical Oxidants-Ozone (O₃): Ozone concentrations were higher than expected (Figure 2-7). The average of all measurements was 124 ug/m³ (0.062 ppm), or 77.5 percent of the State standard (160 ug/m³). Nearly 23 percent of the 1-hour concentrations exceeded the standard with a daily 1-hour maximum average of 172 ug/m³ (0.086 ppm). There is no obvious explanation as to why these concentrations were high.

Carbon Monoxide (CO): Measurements at the test site showed the maximum 1-hour concentration of CO to be 0.11 mg/m³ (0.1 ppm), which is only 0.3 percent of the State standard. The maximum 8-hour concentration was 0.90 mg/m³ (0.08 ppm), or 0.9 percent of the State standard.

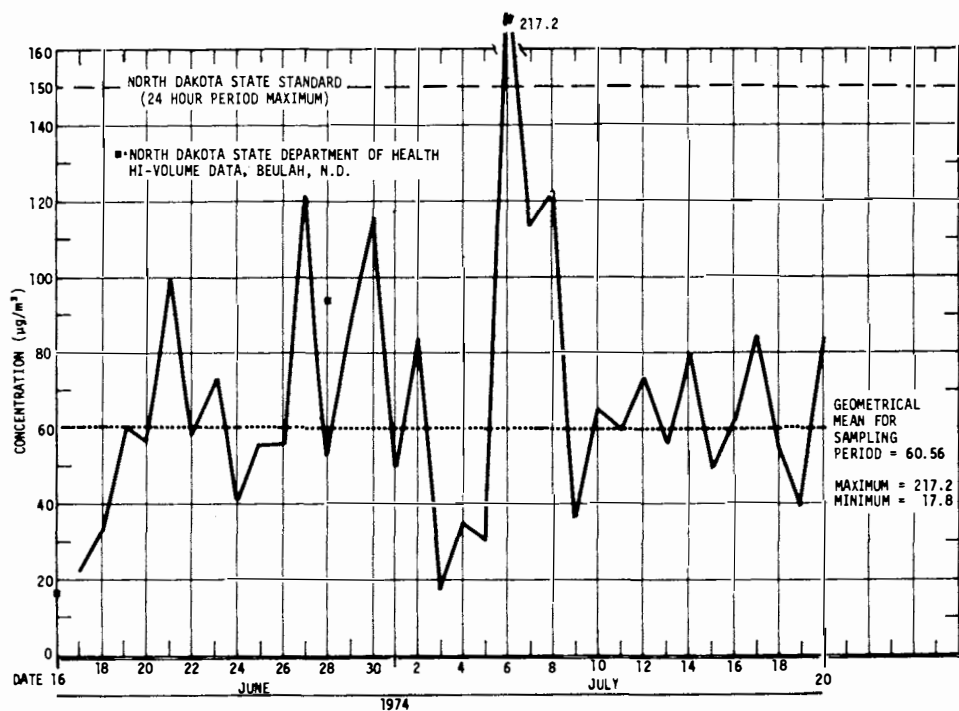


Figure 2-5 DAILY DISTRIBUTION OF SUSPENDED PARTICULATE MATTER: HI-VOLUME SAMPLER AT METEOROLOGICAL TEST SITE FROM 17 JUNE THROUGH 20 JULY, 1974

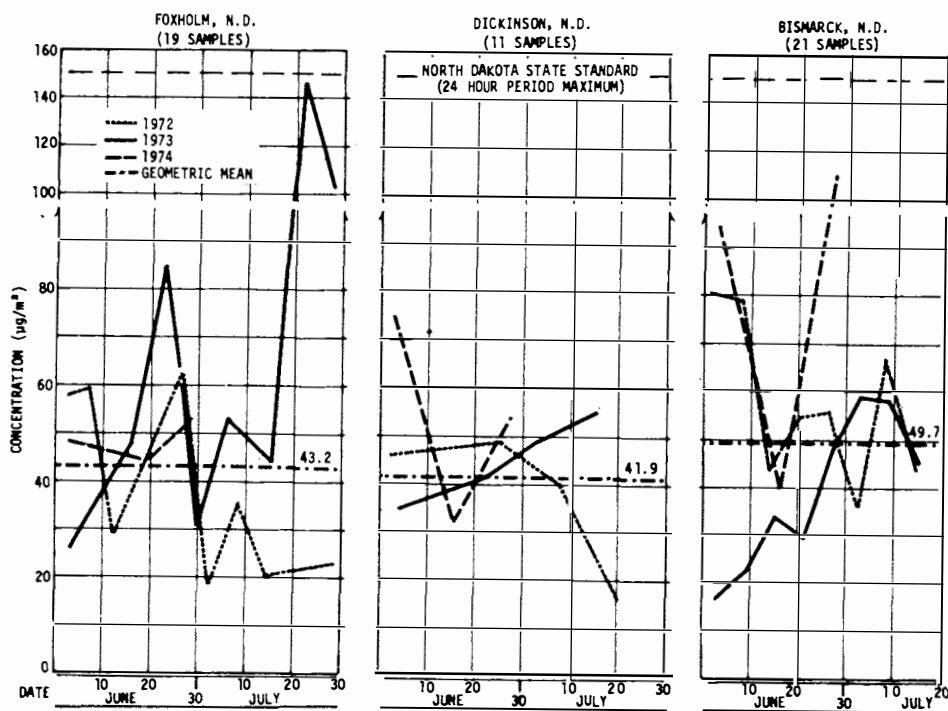


Figure 2-6 CONCENTRATION OF TOTAL SUSPENDED PARTICULATES AT INDICATED NORTH DAKOTA STATE STATIONS FOR MONTHS JUNE AND JULY

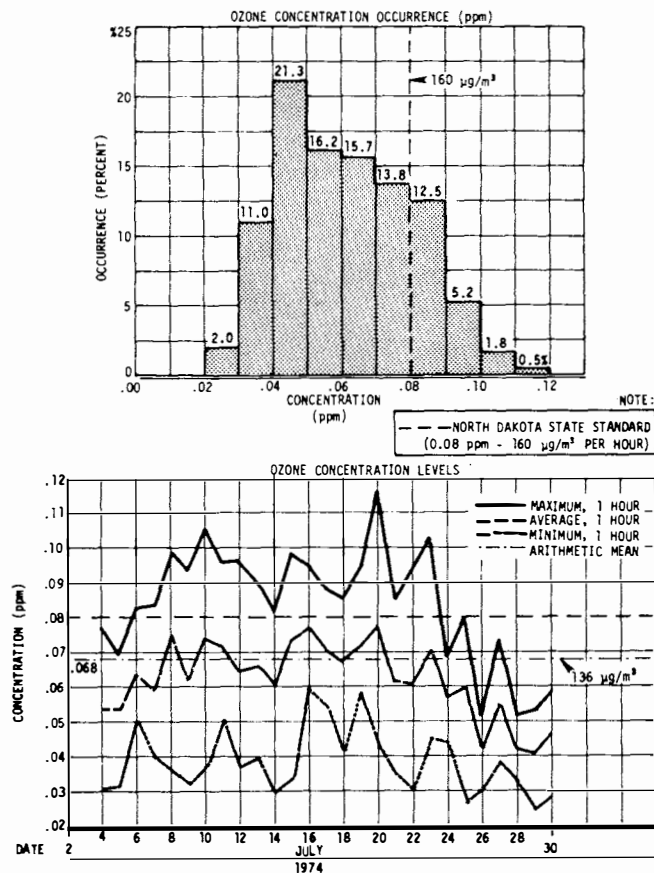


Figure 2-7

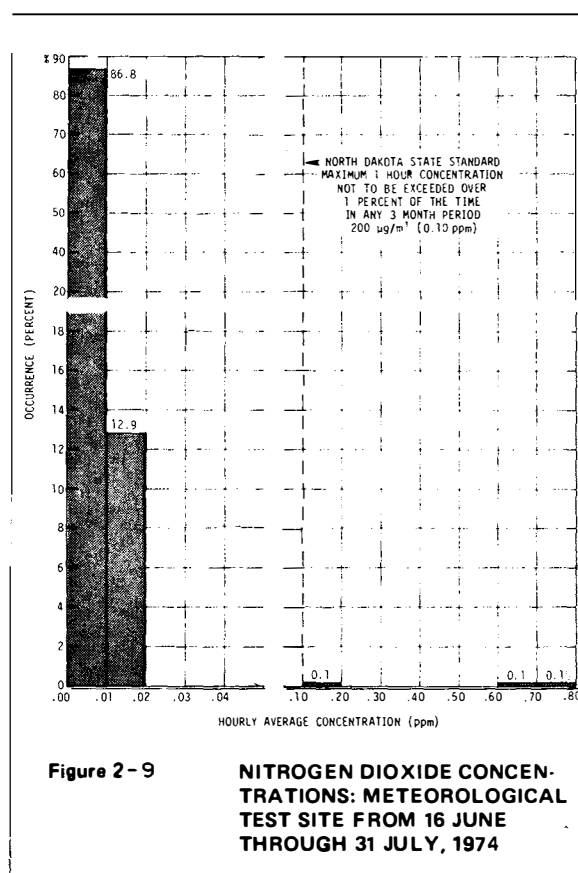
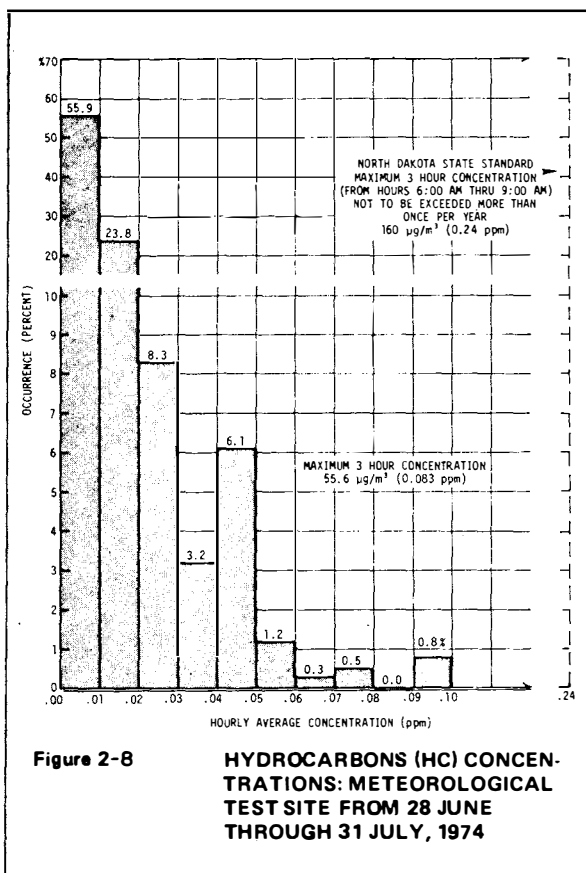
PHOTOCHEMICAL OXIDANTS HOURLY CONCENTRATIONS: METEOROLOGICAL TEST SITE FROM 2 JULY THROUGH 30 JULY, 1974

Hydrocarbons (HC): The maximum 3-hour average concentration of hydrocarbons was $55.6 \mu\text{g}/\text{m}^3$ (0.08 ppm) (Figure 2-8), or 34.8 percent of the State standard of $160 \mu\text{g}/\text{m}^3$ (0.24 ppm). Except for one other 3-hour maximum of $53.3 \mu\text{g}/\text{m}^3$ (0.08 ppm), no other 3-hour value exceeded $33.4 \mu\text{g}/\text{m}^3$ (0.05 ppm).

Nitrogen Dioxide (NO_2): Of the 1,067 1-hour averaged observations of NO_2 concentrations, 99.7 percent was equal to or less than 20 percent of the State standard of $200 \mu\text{g}/\text{m}^3$ 1-hour concentration not to be exceeded over 1 percent of the time (Figure 2-9). Only 3 hours (0.3 percent) exceeded concentrations of $40 \mu\text{g}/\text{m}^3$ (0.02 ppm).

b. Product Pipeline

The general climate and existing air quality along the proposed product pipeline route are essentially the same as that described for the plant-mine site. Exceptions to this are localized, minor deteriorations in air quality near small population centers and locally high concentrations of particulates, SO_2 , and NO_2 near the two steam-electric powerplants between Stanton and Washburn, North Dakota.



2.1.2.3 Noise

To define existing noise levels, an ambient noise survey was conducted around the proposed plant-mine site June 28 through July 2, 1974. Points on the site boundary and at the nearest residences were monitored throughout the day and night for 2 weekdays and 2 weekend days to determine existing sound levels (Figure 2-10). There were no significant differences in noise levels between the four points monitored. The primary reason for this homogeneity of noise levels is an almost complete lack of human influence. Though differences in noise levels between the weekend and weekdays did exist, observations of the noise survey members indicated the changes were due to varying meteorological conditions rather than human activity. The most significant meteorological parameter in terms of noise levels at the site was wind speed (Figure 2-11).

The quality of the present sound environment was determined by comparing the 24-hour L_{90} , L_{50} , and L_{10} decile values (see Glossary) with limits proposed by HUD for potential housing development sites. The comparison (Figure 2-12) showed all levels to be

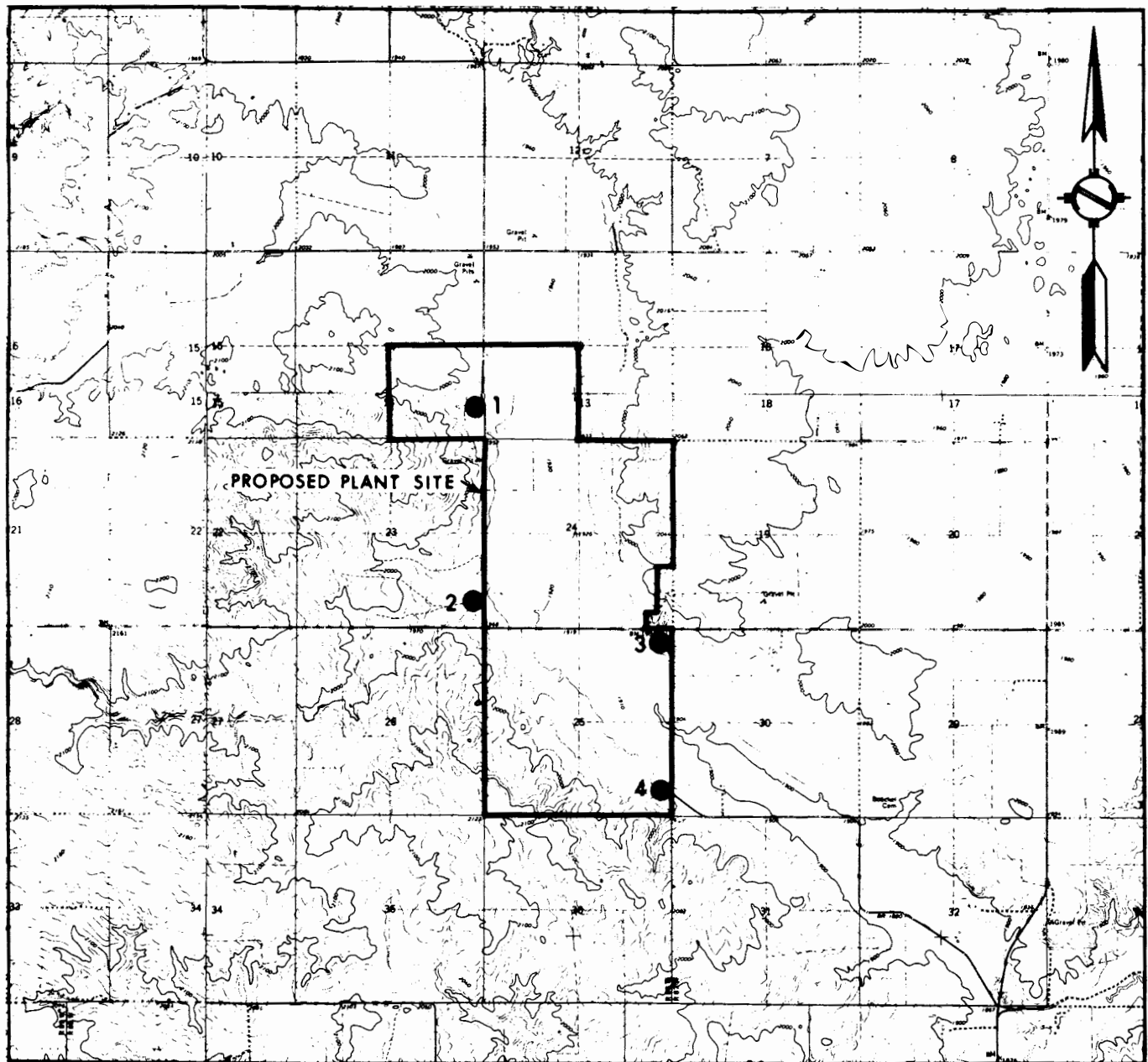


**FIGURE 2-10 NOISE MONITORING POINT LOCATIONS: BEULAH QUADRANGLE,
MERCER COUNTY, NORTH DAKOTA**

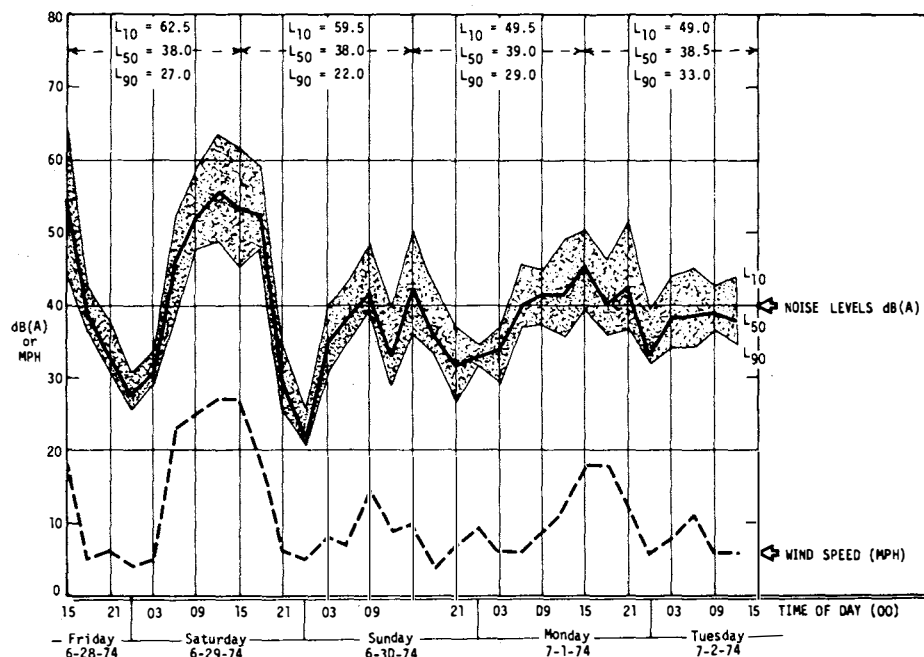


Figure 2-11 MEAN dB (A) NOISE LEVEL OF ALL MONITORING POINTS AND WIND SPEED VERSUS TIME, PROPOSED COAL GASIFICATION PLANT NEAR BEULAH, NORTH DAKOTA

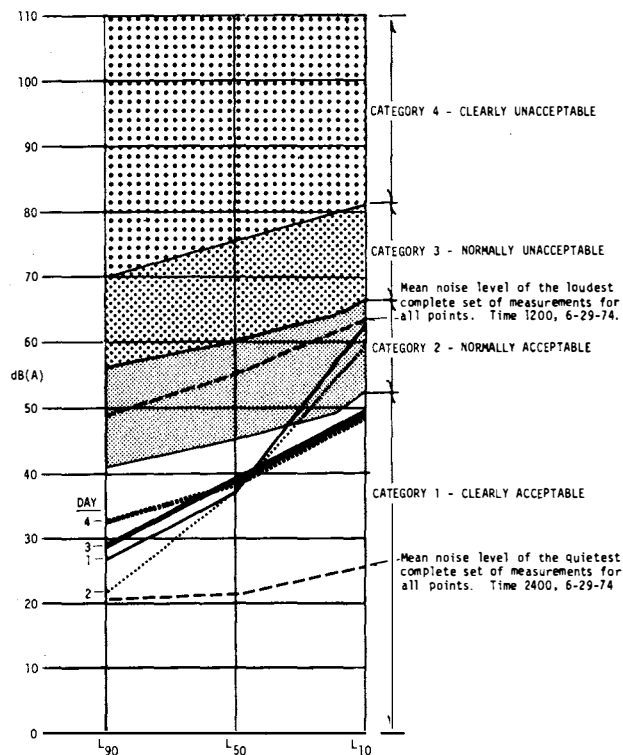


Figure 2-12 MEAN dB(A) NOISE LEVEL OF ALL MONITORING POINTS VERSUS HUD'S COMMUNITY ACCEPTABILITY CRITERIA AT THE PROPOSED COAL GASIFICATION PLANT - BEULAH, NORTH DAKOTA

"clearly acceptable" except the L_{10} level for the first 2 days when wind speed was highest. At these times the L_{10} level was in the "normally acceptable" category.

Existing noise levels along the proposed product pipeline route are typical of rural areas where natural background levels are produced by wind and animals, and man-made noise is generally daytime, nonpersistent noise. The proposed route is mostly along existing railroad right-of-way (ROW) so that ambient noise levels will be fairly high when a train passes. Several highways also parallel the route so occasional high ambient levels occur associated with combined railroad and highway traffic (as high as 90 dBA) (14).

2.1.2.4 Odor

The odor survey program at the plant-mine site was conducted by nine persons selected without regard to training or sensitivity to duplicate the average response of the general public. Three of the nine members performed each odor measurement on a semirotational basis depending on availability.

The survey, conducted over a 10-week period, consisted of 30 sets of measurements with each set containing 1 measurement upwind and 1 downwind of the site. Monitoring locations were selected to permit this as much as possible while still encircling the site (Figure 2-13). The results indicate no odor was detectable at a dilution to threshold ratio (D/T) greater than 1.5 during the survey period. The few odors which were detected were all at low concentrations with D/T ratios of 1 or 1.5, and were typical of odors present in a clean, nonpolluted farming environment. The odors were not detected in any particular location but were scattered and closely associated with their source. The smell of dust was evident near the unpaved roads, hay near freshly cut hay fields, and cow manure near a small pond where cattle drank. The typically moderate to high winds tend to disperse odors and prevent any degree of concentration.

2.1.3 Water

2.1.3.1 Hydrology

The plant-mine hydrologic impact area includes the proposed plant-mine site and those adjacent areas in which water occurrences may be altered in any way by the intended action (Figure 2-14). The southern portion of the impact area is encompassed by the

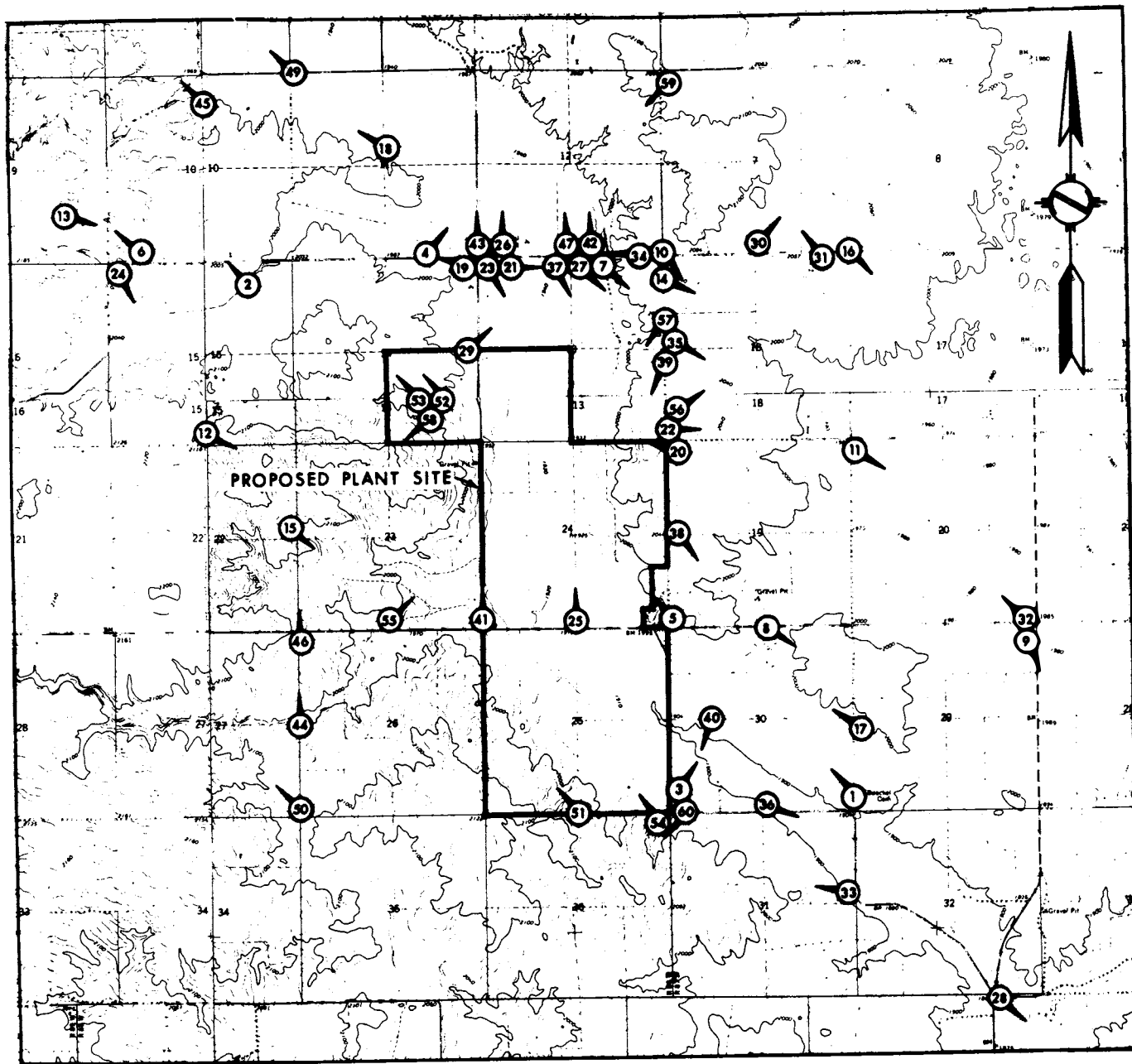
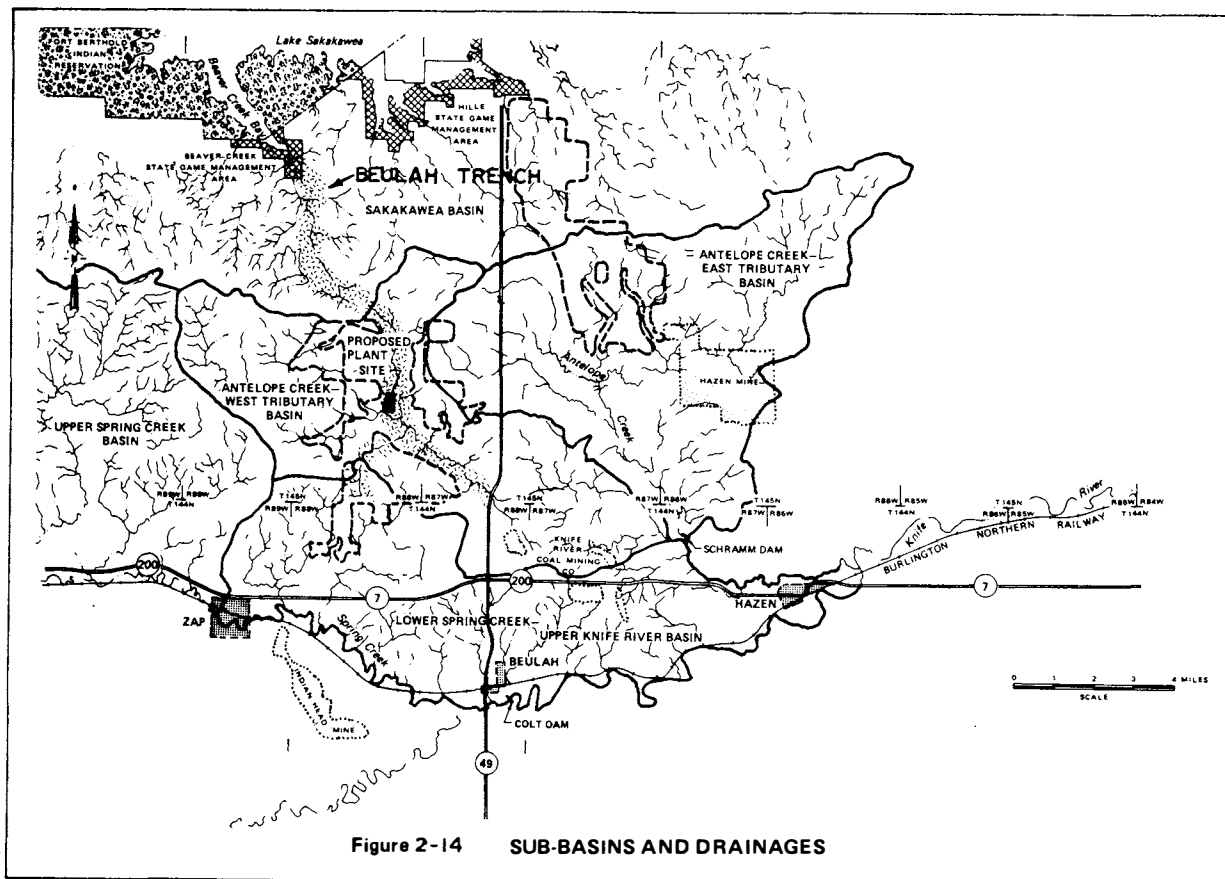


FIGURE 2-13 ODOR MONITORING POINTS WITH WIND DIRECTION INDICATION

Lower Spring Creek-Upper Knife River drainage basin while the northern portion is part of the basin directly contributing runoff to Lake Sakakawea. Some interior drainage also takes place through localized topographic depressions. The most imposing physiographic feature of the study area is the Beulah Trench, a typical glacially carved valley which winds its way from Beaver Creek Bay, through the proposed plant site, to a point about 4 miles north of Beulah where it divides and continues eastward toward Hazen and westward toward Zap (Figure 2-14). Because the trench actually divides the plant-mine site, it plays a significant role in this report. In the vicinity of Section 11, T. 145 N., R. 88 W., Beulah Trench is intersected by the Krem Moraine and an eastward trending surface water drainage divide follows the peak of the deposit and coincides with its strike. North of the divide, runoff flows northward toward Lake Sakakawea; south of the divide, runoff flows southward toward Spring Creek and the Knife River.



a. Watershed Divisions

Antelope Creek Basin - West Tributary: The west tributary of Antelope Creek drains a narrow, elongated basin 44.5 mi² in area including large portions of the proposed mine. The main channel is 19.8 miles long and is fed by numerous small tributaries. The stream is intermittent and retains standing or ponded water much of the year. The channel is winding to convoluted and its average slope is 25 ft/mile. Maximum channel width is about 50 feet. Sediments characteristic of the channel include alluvium varying from clay size particles to boulders, organic matter, and debris. Fine-grained alluvium is predominant and bank and bottom vegetation is common.

Antelope Creek Basin - East Tributary: The east tributary of Antelope Creek drains a broad area covering parts of the proposed eastern mine site. Total area of the basin is 51.3 mi². The main channel is 20.3 miles long and is fed by four major tributaries. Like the west tributary of Antelope Creek, the east tributary is intermittent, winding to convoluted, and its average slope is about 12.5 ft/mile. The east tributary of Antelope Creek is impounded by Schramm Dam near Hazen which is primarily a recreation dam, but also provides for some flood control. Channel sediment characteristics of Antelope Creek east tributary are similar to those of the west tributary.

Upper Spring Creek Basin: Spring Creek is a major stream in the study area. Upper Spring Creek Basin is that portion of the Spring Creek Basin upstream of the mine area into which no drainage from the mine site flows. The downstream limit of this basin has been placed at the U.S. Geological Survey (USGS) gage near Zap. The drainage area at this point is 549 mi². The maximum discharge at the gage (Table 2-2) for the period of record (March to September 1924, October 1945 to current year) was 6,130 cfs, while, at times, there has been no flow. Flow from this point is mixed with runoff from the proposed mine area into Spring Creek and the Knife River.

Lower Spring Creek - Upper Knife River Basin: The Knife River is also a major stream in the study area. Spring Creek joins the Knife River in Section 35, T. 144 N., R. 88 W. The Lower Spring Creek - Upper Knife River Basin is the area between the USGS gage on Spring Creek near Zap, and Antelope Creek. A USGS gage is located just upstream from the confluence of Antelope Creek and the Knife River near Hazen. The drainage area at this point is approximately 2,240 mi². Maximum discharge during the period of record (Table 2-2) was 35,300 cfs, while no flow was recorded at times.

TABLE 2-2
PEAK DISCHARGE HISTORY NEAR PROPOSED MINE

<u>Gaging Station</u>	<u>Period of Record</u>	<u>Date</u>	<u>Maximum Flood</u>		
			<u>Gage Height (feet)</u>	<u>Discharge CFS</u>	<u>Recurrence Interval (years)</u>
Knife River Near Golden Valley	1903-Present	Mar. 26,27, 1943	26.7	11,500	21.0
Spring Creek at Zap	1924, 1947-Present	Apr. 2, 1952	20.03	6,130	16
Knife River at Hazen	1928-33,1937-Present	June 24, 1966	26.3	35,300	50

Sources: USGS Water Supply Paper #1679, 1966.

Personal Communication with USGS Office, Bismarck, N.D., 1974

A portion of the Lower Spring Creek - Upper Knife River Basin north of Spring Creek and the Knife River is of importance because it includes a portion of the proposed mine site. This part of the mine site would drain directly to Spring Creek and eventually to the Knife River.

Lake Sakakawea Basin: North of the Antelope Creek Basin, runoff drains to Lake Sakakawea. About half of the eastern mine area currently drains to the Lake. Dendritic drainage systems in these areas flow into Beaver Creek Bay near the Hille State Game Management Area. Channels are well developed, though flow is intermittent, and they retain standing or ponded water much of the year. The convoluted channels are characterized by alluvium and grass.

b. Surface Water

Current Use: Table 2-3 lists the quantities of surface water used in Mercer County between 1969 and 1973. The greatest quantity of water was withdrawn from the Missouri River for industrial use.

Only 1,650 acre-feet of the 244,650 withdrawn for industrial use was for consumptive use; most was used for once through cooling systems at coal-fired powerplants near Stanton. The only surface water withdrawn for municipal use was at Pick City just west of the Garrison Dam. Substantial quantities of water were withdrawn for irrigation purposes.

TABLE 2-3
SURFACE WATER USE (IN ACRE-FEET PER YEAR) IN MERCER COUNTY

Use Category	1969	1970	1971	1972	1973	Average
Industrial	244,650	244,650	244,650	244,650	244,650	244,650
Municipal	5.9	6.2	7.3	6.0	8.0	6.7
Irrigation	2,996	2,495	2,372	1,563	2,393	2,364
Stock	781	825	887	943	1,015	890
TOTALS	248,432.9	247,976.2	247,916.3	247,162	248,066	247,910

Compiled by: Woodward-Envicon, Inc. 1974.

Runoff: To evaluate the potential effects of drainage from the plant-mine site, surface water stations were established on tributaries within the study area (Figure 2-15). Anticipated mean monthly runoff values are shown in Table 2-4. Total calculated runoff from the tributaries draining the plant-mine site averages 7,892 acre-feet/year (or about 1 inch of precipitation over the entire area). Most (77 percent) of the annual runoff occurs during the March, April, and May snow melt. The June, July, and August storm runoff (15 percent) is sporadic flow occurring during and shortly after heavy rains. Flood magnitudes for various recurrence intervals were estimated, using regional flood frequency curves, for ungaged surface water sites in the impact area (Table 2-5).

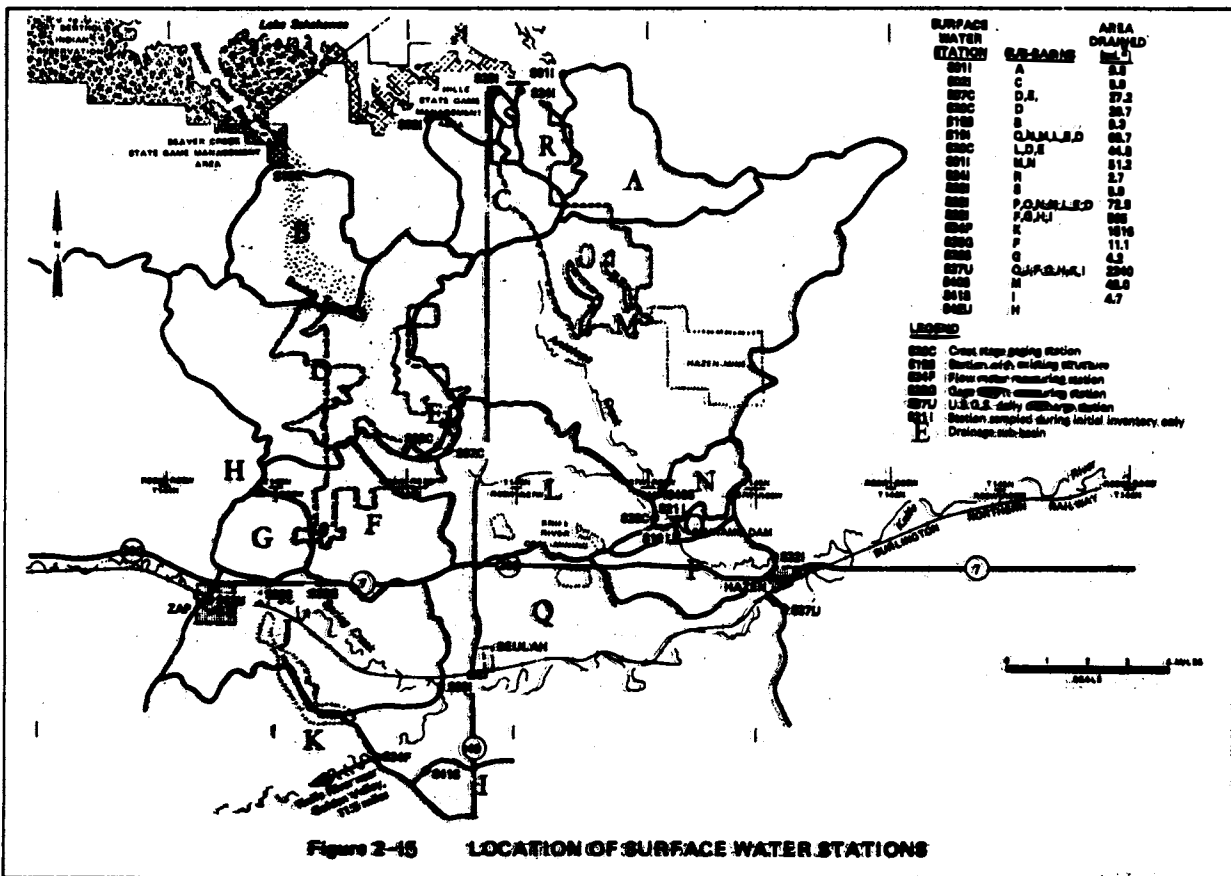


TABLE 2-4
ANTICIPATED MONTHLY DISCHARGE AT SURFACE WATER STATIONS IN THE STUDY AREA (CFS-DAYS)

Surface Water Station	Station Number	Area (sq. mi.)	Ant. Monthly Discharge (cfs-days)	Ant. Annual Discharge (cfs-days)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0011	0.0	0.0	207.0	2.0	0.0	150.0	62.3	60.5	37.0	12.3	4.9	2.0	6.0	1.0	2.7	
0021	5.0	0.3	171.3	1.7	4.1	60.0	37.3	34.3	14.1	7.4	2.9	1.7	3.4	1.1	1.0	
0030	27.2	2.2	704.0	0.0	20.1	324.0	173.0	113.0	74.0	34.3	13.3	0.0	13.1	9.9	7.0	
0032	24.7	2.1	701.0	7.0	10.7	32.0	170.0	110.0	73.0	33.0	13.3	7.0	10.0	0.4	7.3	
0100	0.3	0.7	274.0	1.7	0.0	111.0	90.7	30.0	20.0	15.0	0.7	2.7	3.0	1.2	2.0	
0101	00.7	5.2	1,000.0	10.2	00.0	700.0	410.0	270.0	100.0	00.0	22.0	10.2	00.0	23.0	17.0	
0102	04.3	3.0	1,200.0	13.0	21.2	520.0	003.0	105.0	122.0	00.0	22.1	13.0	10.7	10.0	12.1	
0111	00.3	0.1	1,000.0	10.0	04.0	000.0	220.0	211.0	141.0	00.2	20.4	10.0	20.0	17.0	13.0	
0141	2.7	0.22	70.0	0.0	1.0	22.1	17.1	11.1	7.4	3.4	1.3	0.0	1.1	0.0	0.7	
0201	0.0	0.00	23.7	0.2	0.0	0.4	5.1	3.3	2.3	1.0	0.4	0.2	0.3	0.2	0.2	
0211	00.0	0.0	1,125.0	21.1	01.2	000.0	000.0	301.0	300.0	01.7	30.7	21.1	00.0	20.0	10.0	
0212	00.0	0.0	1,000.0	10.0	00.0	0,710.0	1,007.0	1,120.0	1,001.0	700.0	200.0	100.0	211.0	100.0	100.0	
0307	1,700.0	121.0	04,207.0	043.0	1,000.0	10,017.0	9,000.0	6,242.0	4,101.0	1,021.0	701.0	041.0	000.0	011.0	022.0	
0308	11.3	0.0	300.0	1.2	7.0	112.0	70.0	00.0	30.0	14.0	0.0	2.3	4.0	3.0	3.0	
0309	0.2	0.2	124.0	1.2	3.0	30.0	37.0	17.0	11.7	0.3	2.1	1.3	1.7	0.0	1.1	
0370	2,200.0	170.0	00,000.0	00.0	1,070.0	10,001.0	14,200.0	9,222.0	0,100.0	3,012.0	1,112.0	000.0	010.0	000.0	000.0	
0400	00.0	1.0	1,000.0	10.0	23.0	071.0	300.0	100.0	110.0	00.0	22.0	10.0	10.0	10.0	13.0	
0410	0.7	0.4	130.0	1.4	2.3	00.0	30.3	10.0	13.1	0.0	2.4	1.4	1.0	1.7	1.3	
0410	000.0	00.0	10,071.0	100.0	000.0	0,020.0	1,000.0	2,200.0	1,507.0	000.0	272.0	100.0	234.0	102.0	100.0	
Snake River																
Snake Valley	1,220.0	00.4	10,000.0	200.0	000.0	14,010.0	7,010.0	5,004.0	3,770.0	1,540.0	011.0	200.0	002.0	031.0	234.0	

Source: Westward-Geograph, Inc. 1970.

TABLE 2-5
ESTIMATES OF FLOOD MAGNITUDES IN THE STUDY AREA BASED ON
U.S. GEOLOGICAL SURVEY FLOOD-FREQUENCY CURVES

Surface Water Site ¹	Mean Annual Flood (cfs) ²	Flood Intensity (in cfs) for Selected Recurrence Intervals				
		1.1 Years Discharge (cfs)	2 Years Discharge (cfs)	5 Years Discharge (cfs)	10 Years Discharge (cfs)	25 Years Discharge (cfs)
S19I	500	60	425	960	1,375	2,065
S20C	400	48	340	768	1,100	1,625
S21I	450	54	383	864	1,238	1,859
S32I	550	66	467	1,056	1,375	2,271
S35G	180	22	153	346	495	743
S08C	290	35	247	557	797	1,198
S07C	300	36	255	576	855	1,239
S40S	430	52	366	826	1,183	1,776
S33I	1,900	228	1,615	3,648	5,225	7,847
S34F	3,400	408	2,890	6,528	9,350	14,042
S37U	4,400 ³	528	3,740	8,448	12,100	18,172
S42U	1,800 ⁴	216	1,530	3,456	4,950	7,434

¹ Stations with drainage basins less than 10 mi² have been excluded.

² Defined as a flood having a recurrence interval of 2.33 years in the annual flood series.

³ Calculated value = 4,300 cfs.

⁴ Calculated value = 1,850 cfs.

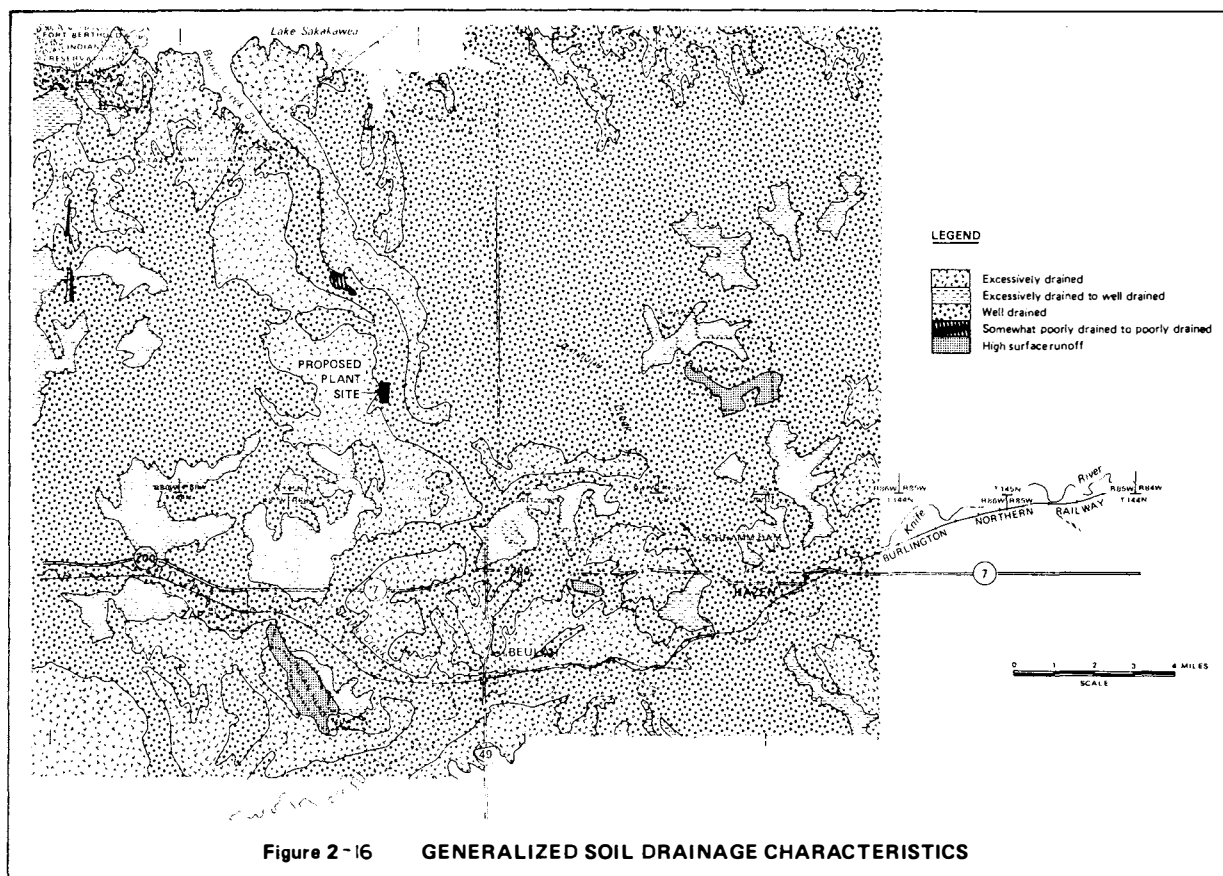
Source: Woodward-Envicon, Inc. Analysis, 1974.

USGS Water Supply Paper #1679, 1966.

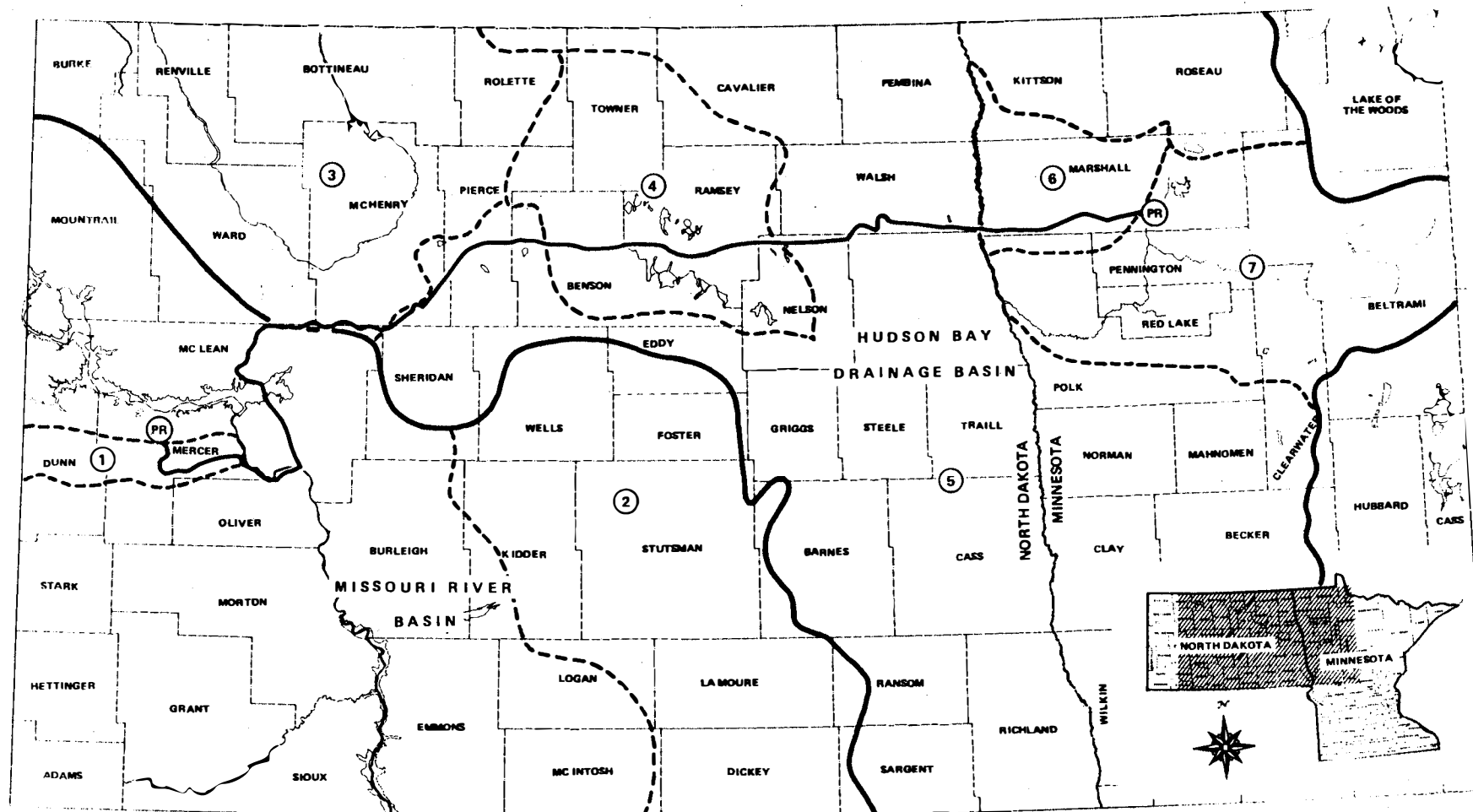
Three dams, Garrison, Colt, and Schramm, are the largest control structures affecting the study area. Most of the smaller control structures in the area are earthen dams or roadways. Many residents have impounded water in streams transecting their property. Consequently, runoff at the surface water stations is probably lower than the calculated values (Table 2-4).

Soil Storage: Figure 2-16 details the general soil drainage characteristics of the plant-mine study area (defined in Figure 2-14). Numerous shallow depressions dot the study area and retain ponds

of water during certain times of the year. Total surface area of these potholes is about 640 acres. For a maximum infiltration rate of 0.01 feet/day (7), and 10 months/year, the contribution to recharge of the underlying aquifers of these potholes would be about 1,900 acre-feet/year.



Product Pipeline: The proposed product pipeline crosses parts of two major drainage systems; the Missouri River and the Hudson Bay drainages. The drainages and their subbasins are shown in Figure 2-17. Natural streamflows range from dry or nearly dry conditions in late summer to flood stage during the spring thaw and occasional intense summer showers. However, an extensive reservoir system regulates streamflows on the major rivers, with the exception of the main stem of the Red River of the North. Whereas large extremes in runoff can occur, average annual runoff is relatively small; ranging from one-fourth of an inch in portions of the Devils Lake subbasin up to about 2 inches near Red Lake, Minnesota (15, 16).



- LEGEND:
- | | | |
|-----------------------------|---------------------------------|----------------------------|
| MISSOURI RIVER BASIN | HUDSON BAY BASIN | (PR) PROPOSED ROUTE |
| 1. KNIFE RIVER DRAINAGE | 3. SOURIS RIVER SUBBASIN | |
| 2. JAMES RIVER SUBBASIN | 4. DEVILS LAKE SUBBASIN | |
| | 5. RED RIVER SUBBASIN | |
| | 6. MIDDLE SNAKE RIVER WATERSHED | |
| | 7. RED LAKE WATERSHED | |

Figure 2-17 WATERSHEDS AND MAJOR DRAINAGES WITHIN THE PROJECT REGION*

* ADAPTED FROM: U. S. DEPARTMENT OF INTERIOR, WATER ATLAS OF THE UNITED STATES

The principal waterways crossed by the proposed route are shown in Figure 2-18. On the Missouri River Basin the Knife River would be crossed east of Hazen just above the mouth of Antelope Creek, and the Missouri River would be crossed above Washburn. In the Hudson Bay drainage system the major rivers crossed include the Big Coulee, various branches of the Forest River, the Marias River, the Red River of the North, and the Snake River.

In all, 86 water crossings are projected along the pipeline route (Table 2-6). These crossings are tabulated in Table 2-7. Group classifications in Table 2-7 are defined in Table 2-6; best use classifications are related to water quality standards. Flow data for most major streams are available (17) and need not be detailed here.

TABLE 2-6
CUMULATIVE TABULATION OF PROPOSED PIPELINE WATER CROSSINGS

GROUP	DESIGNATED GROUP TYPES	NUMBER(S)
I	DRAINAGE DITCHES AND/OR CANALS	1
II	INTERMITTENT STREAMS	38
III	INTERMITTENT POTHOLE LAKES	27
IV	PERENNIAL POTHOLE LAKES	5
V	RIVERS AND CREEKS	10
VI	MAJOR RIVERS	2
VII	MAJOR LAKES AND/OR IMPOUNDMENTS	3
TOTAL		86*

*INCLUDES 4 CROSSINGS OF THE SNAKE RIVER.

c. Ground Water

Current Use: Table 2-8 lists the amount of ground water withdrawn for various uses in Mercer County during 1969 through 1973. Most ground water is withdrawn for domestic and stock use from private wells throughout the county. The towns of Beulah, Hazen, Zap, and Golden Valley have municipal water supply wells for which statistics are listed in Table 2-9.

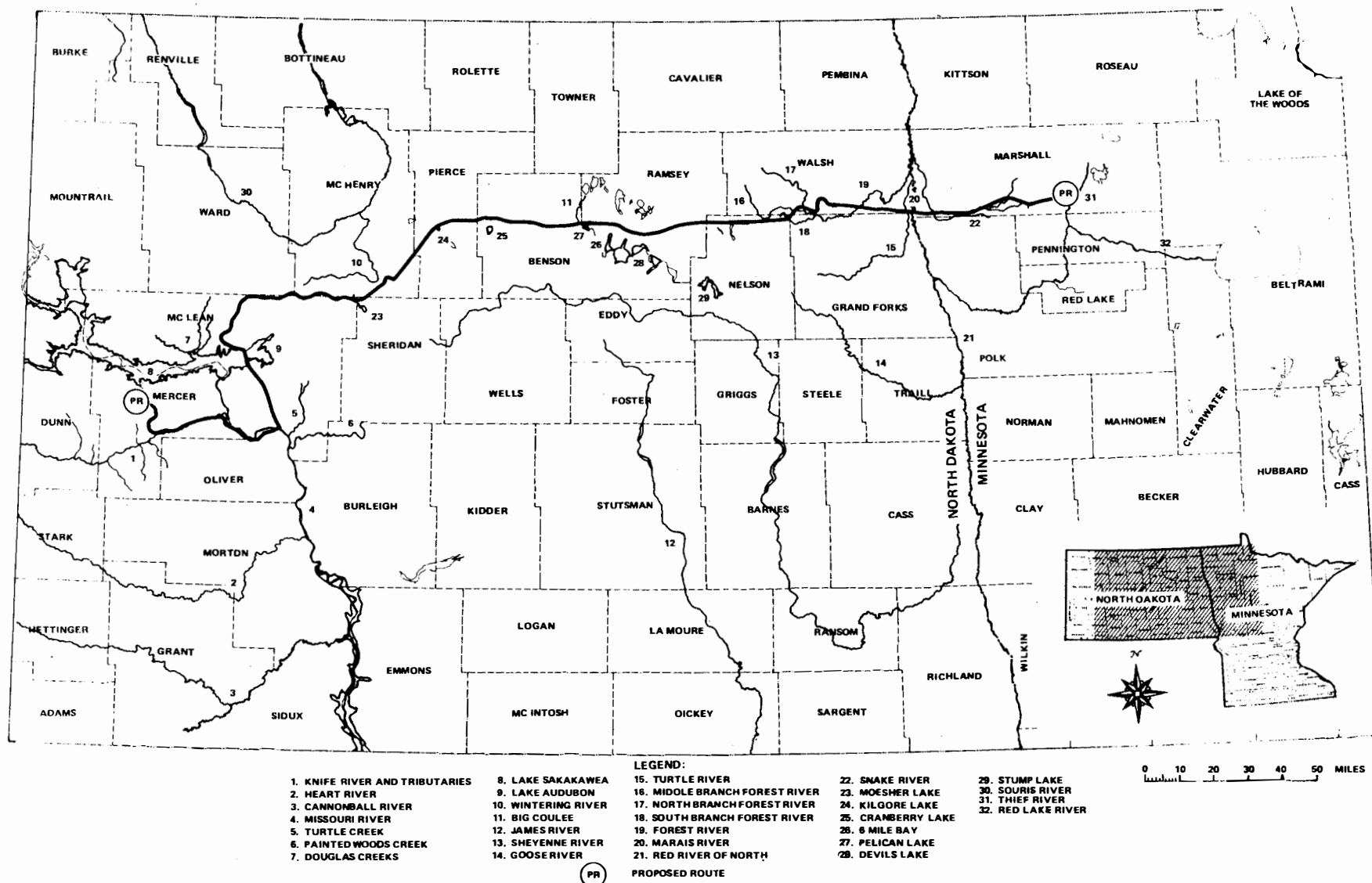


**TABLE 2-7
PIPELINE WATER CROSSINGS – PROPOSED ROUTE**

NORTH DAKOTA		
COUNTY AND CROSSINGS	GROUP	BEST USE CLASSIFICATION
MERCER		
2 TRIBUTARIES, ANTELOPE CREEK	II	NC*
KNIFE RIVER	V	CLASS II
KINNEMAN CREEK	II	NC
ALDERIN CREEK	II	NC
UNNAMED TRIBUTARY, MISSOURI RIVER	II	NC
OLIVER		
4 UNNAMED TRIBUTARIES		
MISSOURI RIVER	II	NC
MISSOURI RIVER	VI	CLASS I
MC LEAN		
BUFFALO CREEK	II	NC
3 POTHOLE	IV	NC
WOLF CREEK	II	NC
LAKE SAKAKAWEA	VII	CLASS I
LAKE AUDUBON	VII	CLASS I
UNNAMED TRIBUTARY, LAKE SAKAKAWEA	II	NC
BAY OF LAKE SAKAKAWEA	VII	CLASS I
POTHOLE LAKE	IV	NC
4 POTHOLE	III	NC
WARD		
POTHOLE LAKE	III	NC
UNNAMED TRIBUTARY	II	NC
MC LEAN		
4 POTHOLE LAKES	III	NC
MC HENRY		
UNNAMED TRIBUTARY, WINTERING RIVER	II	NC
MC LEAN		
3 UNNAMED TRIBUTARIES, COTTONWOOD LAKE	II	NC
SHERIDAN		
UNNAMED TRIBUTARY FROM MOESNER LAKE	II	NC
POTHOLE LAKE	III	NC
MC HENRY		
2 UNNAMED TRIBUTARIES, AYLMEER LAKE	II	NC
PIERCE		
TRIBUTARY OF KILGORE LAKE	II	NC
POTHOLE LAKE	IV	NC
POTHOLE LAKE	III	NC
TRIBUTARY SMALL RESERVOIR	II	NC
3 POTHOLE LAKES	III	NC

*NC – NON-CLASSIFIED

TABLE 2- 7 (Continued)
PIPELINE WATER CROSSINGS – PROPOSED ROUTE

NORTH DAKOTA (Continued)		
COUNTY AND CROSSINGS	GROUP	BEST USE CLASSIFICATION
BENSON		
UNNAMED TRIBUTARY, CRANBERRY LAKE	II	NC
TRIBUTARY, BIG COULEE	II	NC
3 POTHOLE LAKES	III	NC
2 TRIBUTARIES, DEVILS LAKE	II	NC
MARSH	III	NC
BIG COULEE	V	NC
POTHOLE LAKE	III	NC
RAMSEY		
TRIBUTARY, 6 MILE BAY	II	NC
5 POTHOLE LAKES	III	NC
NELSON		
3 POTHOLE LAKES	III	NC
MIDDLE BRANCH FOREST RIVER	II	NC
2 TRIBUTARIES, SOUTH BRANCH, FOREST RIVER	II	NC
GRAND FORKS		
2 TRIBUTARIES, SOUTH BRANCH, FOREST RIVER	II	NC
WALSH		
MIDDLE BRANCH, FOREST RIVER	V	NC
NORTH BRANCH, FOREST RIVER	V	CLASS III
2 TRIBUTARIES, FOREST RIVER	II	NC
FOREST RIVER	V	CLASS II
2 TRIBUTARIES, ARDOCH LAKE	II	NC
MARAIS RIVER	V	NC
RED RIVER OF THE NORTH	VI	CLASS I
MINNESOTA		
COUNTY AND CROSSINGS	GROUP	BEST USE CLASSIFICATION
MARSHALL		
RED RIVER OF THE NORTH	VI	CLASSES 1C, 2C, & 3B
TRIBUTARY, SNAKE RIVER	II	UNCLASSIFIED
4 CROSSINGS, SNAKE RIVER	V	CLASSES 2B, 3C, & 4A
TRIBUTARY CANAL, MIDDLE RIVER	I	UNCLASSIFIED

TABLE 2-8
GROUNDWATER USE (IN ACRE-FEET/YEAR) IN MERCER COUNTY

<u>Use Category</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>Average</u>
Industrial	101	101	101	101	101	101
Municipal	252	274	303	301	327	291
Domestic	194	194	179	179	166	182
Stock	335	354	380	404	435	382
TOTALS	882	923	963	985	1029	956

Calculated by: Woodward-Brown, Inc. 1974.

TABLE 2-9
MUNICIPAL WELLS IN MERCER COUNTY

<u>Location (township-range-section)</u>	<u>Municipality</u>	<u>Well Depth (feet)</u>	<u>Casing Dia. (in.)</u>	<u>Depth to 1st Perforation (feet)</u>	<u>Date Drilled</u>	<u>Aquifer</u>
144/88/25AD2	Beulah	153	8	----	1953	Sentinel Butte
144/88/25CA	Beulah	114	10	----	1961	Outwash
144/88/25CCA	Beulah	46	--	----	1952	----
144/88/25CD	Beulah	126	--	----	1961	Outwash
144/86/18ADA2	Hazen	69	12	59	1944	Outwash
144/86/18ADA3	Hazen	65	--	----	1944	Outwash
144/86/18ADA4	Hazen	---	--	----	1964	Outwash
144/89/14CDD	Zap	1281	--	1249	1969	Hell Creek - Fox Hills
144/90/15DB	Golden Valley	1325	6	1275	1968	Hell Creek - Fox Hills

Source: North Dakota Geological Survey, Bulletin #56, Part II, 1970.

Geohydrology: Table 2-10 presents a stratigraphic column of the units in the study area which make up major aquifers, and shows various aquifer characteristics. The Fox Hills formation of Cretaceous age is the oldest unit that supplies water to wells in the area. Deeper units have not been tapped to date. The permeable sands and sandstones of Cretaceous and Paleocene age make up the principle aquifers in the area; Paleocene lignite deposits make up the lesser aquifers. (Lesser aquifers yield less water than principle aquifers.) In addition, small areas of perched water occur locally in near-surface sediments. The most significant water bearing strata are the glacial and fluvial sands and gravels in the Beulah Trench. Wells into these sediments exhibit large yields of relatively good quality water.

Wells and Springs: An inventory of wells and springs in the impact area is summarized in Appendix E. In addition, well points and casing were installed in 13 coal boreholes. These wells are in, just below, and just above the Beulah-Zap bed, and within the lower seams. The wells selected for ground-water studies are shown in Figure 2-19.

Figures 2-20 and 2-21 show historic water levels (1966-1969) and flow patterns in aquifers in the study area. The cone of depression in the potentiometric surface of the Fox Hills - Basal Hell Creek aquifer is reportedly due to an estimated withdrawal of 0.5 mgd flowing from wells tapping the aquifer (8).

Figures 2-22 and 2-23 show ground-water level data obtained during the inventory and baseline survey. It is apparent that a ground-water divide exists in Beulah Trench a few miles south of Beaver Creek Bay (1865.8 water level). Figure 2-24 presents hydrographs of selected wells in the study area. The wells, located near Lake Sakakawea, Beulah Trench, Beulah, and Hazen, penetrate outwash aquifers (water table and artesian), lignite aquifers, and the Fox Hills - Basal Hell Creek aquifer. The water level declines in three wells (Hazen, northwest of Hazen, and south of Beulah) may be associated with their location in the areas of development and municipal ground-water use.

The relationship of water levels in wells near Lake Sakakawea to storage in the lake shows the effect that storage has on the total ground-water regime. A water level reading taken in 146-88-10DDC during July 1951, prior to the onset of storage in the lake (November 1953), indicates that the water level was more than 20 feet below what it was in 1967.

System	Series	Group or Formation		Dominant Lithology	Aquifer	Aquifer Thickness (ft)	Dip of Potentiometric Surface	Hydraulic Gradient (ft/mi)	Transmissivity (gpd/ft)	Storage	Expected Yield (gpm)
Quaternary	Holocene Pleistocene	Malsh Coleharbor		Silt, clay & sand Sandy loam, sand & gravel	Antelope Creek and Alluvial - all parameters variable -	0-250	North to South & South to North	Variable	----	(total) 260,000 acre-feet	100-500
Tertiary	Eocene	Golden Valley		Clay, sandstone & lignite	-----						
	Paleocene		Sentinel Butte	Shale, clay, sandstone & lignite	Tongue River -	Variable	Variable	Variable	Variable	Variable	Probably <10
		Fort Union Group	Tongue River	Shale, sandstone & lignite	Sentinel Butte -						
Cretaceous			Cannonball-Ludlow	Marine sandstone & shale	Upper Hell Creek - Lower Cannonball - Ludlow -	70-150	West to East	----	180-4,200	(coefficient) 1-4	5-100
			Hell Creek	Continental Sandstone & shale							
		Montana Group	Fox Hills	Marine sandstone & shale	Fox Hills - Basal Hell Creek	150-370	West to East	3.5-4.0	13-3,100 (avg. \$10)	(coefficient) 1-4 to 1-5	25-150

Source: North Dakota Geological Survey Bulletin 56 - Parts I and III, 1973.



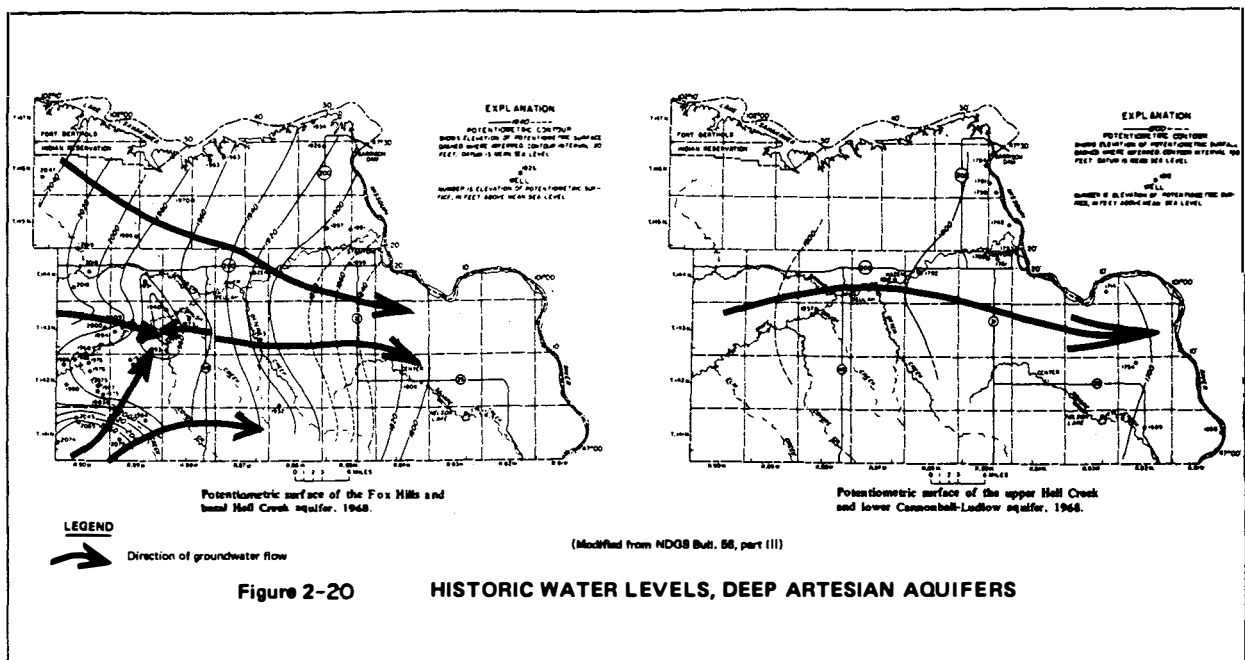


Figure 2-20 HISTORIC WATER LEVELS, DEEP ARTESIAN AQUIFERS

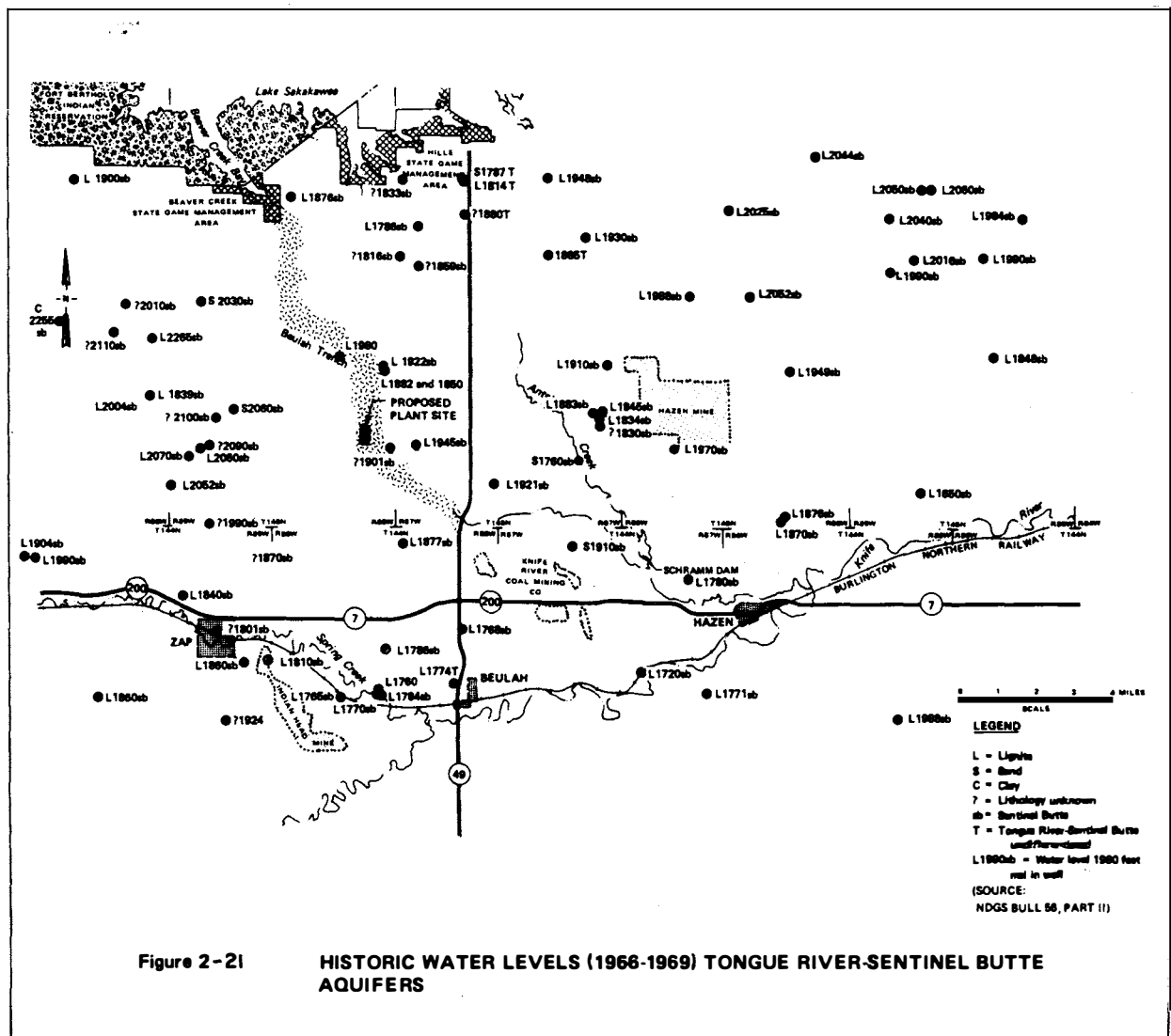
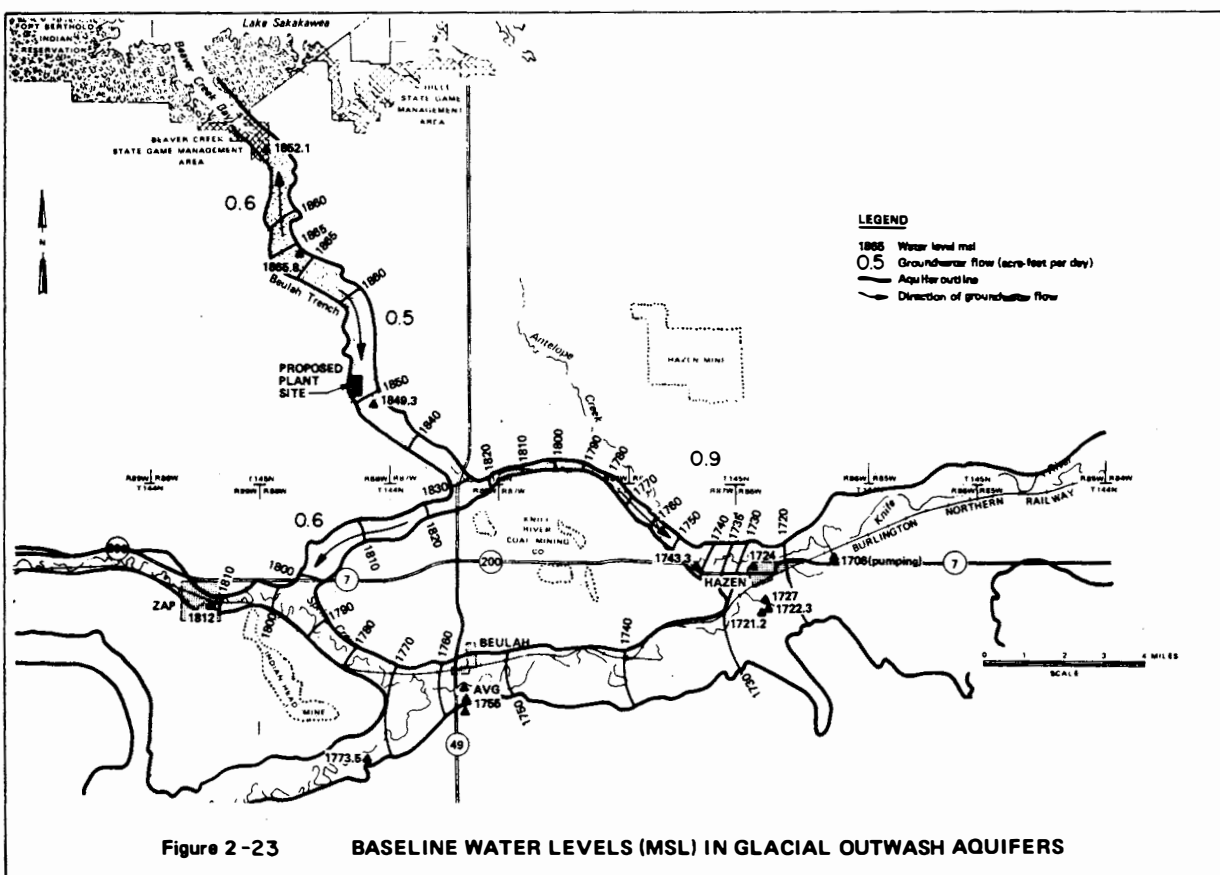
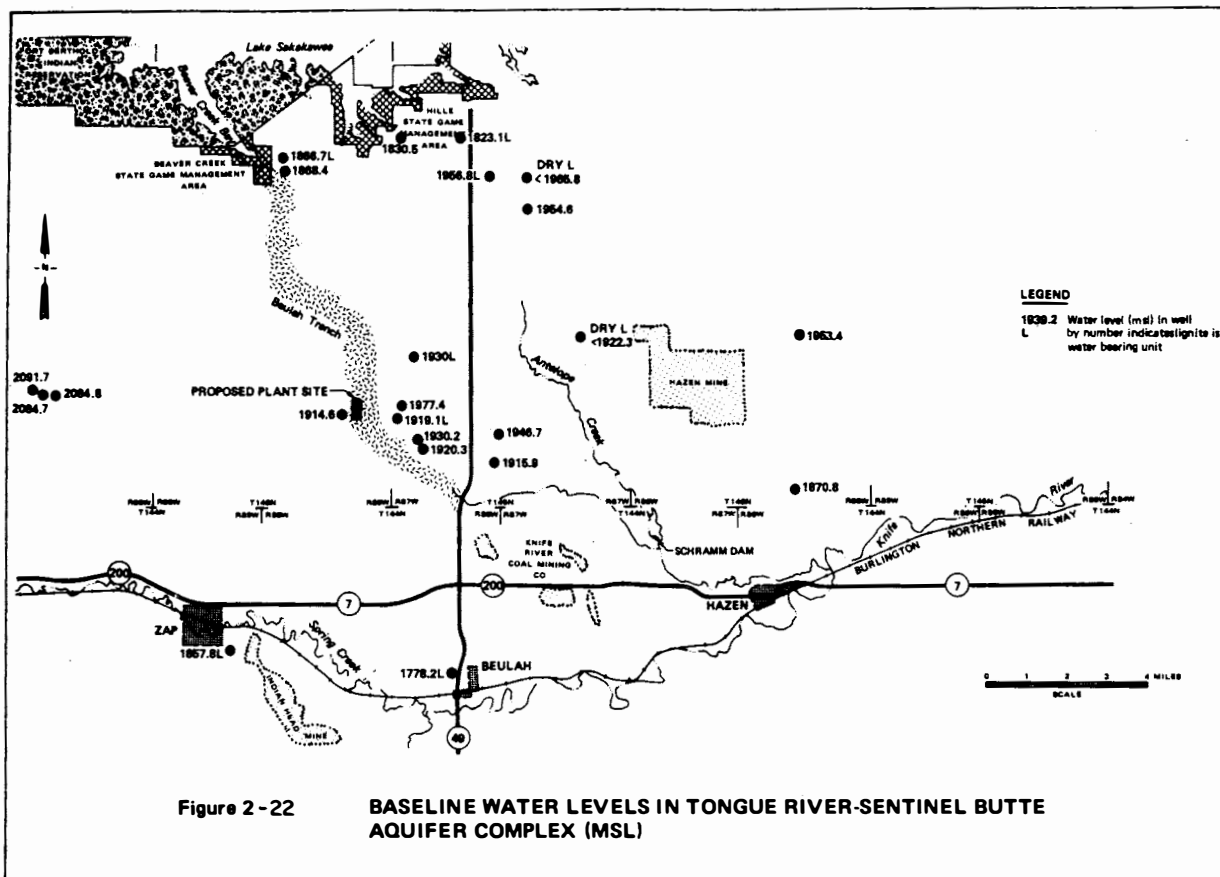
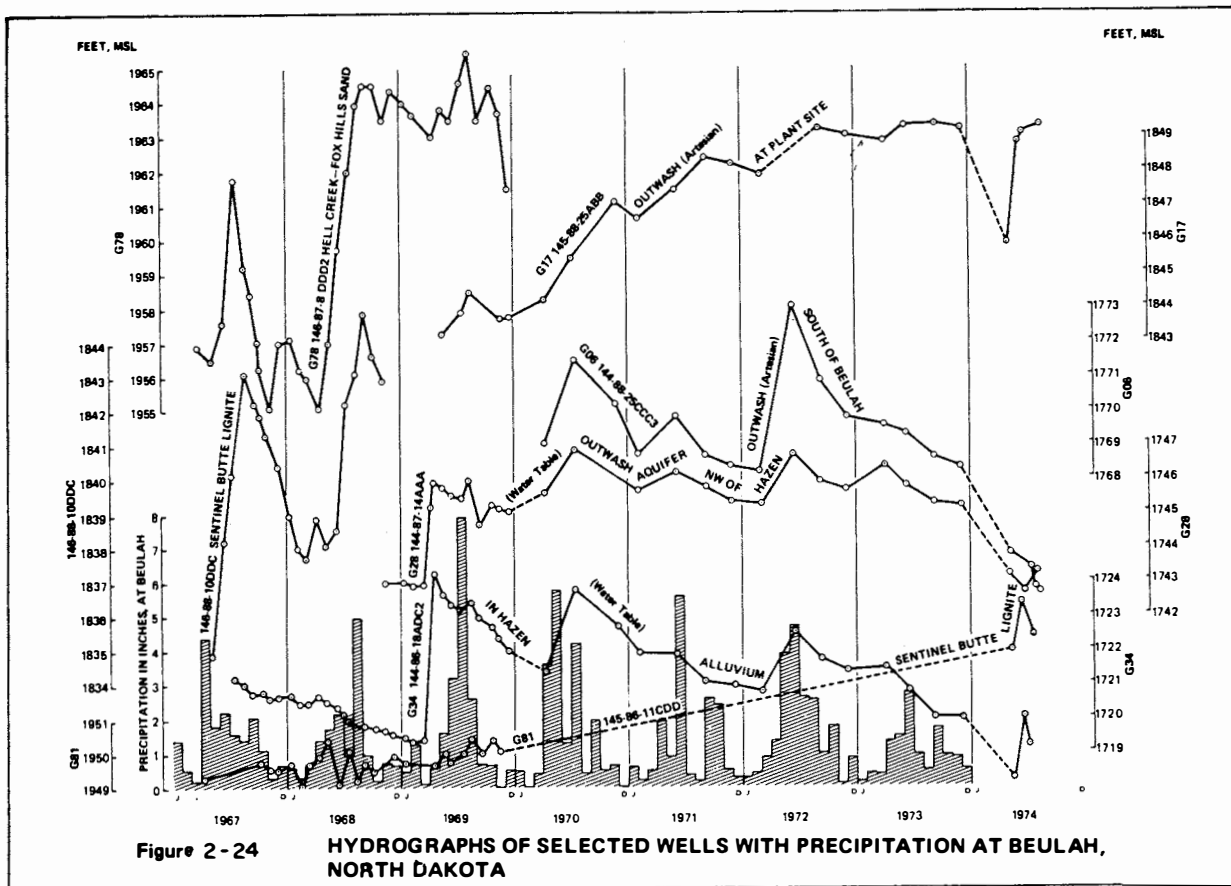


Figure 2-21 HISTORIC WATER LEVELS (1966-1969) TONGUE RIVER-SENTINEL BUTTE AQUIFERS





Data on springs indicate that total discharge from measured springs was about 8.26 gpm (or a total discharge of about 2.2 acre-feet) during May and June. This represents only a portion of total spring discharge in the study area as numerous other springs and seeps are known to occur. Many residents pipe these springs into stock watering troughs. Springs occur along the slopes of Beulah Trench and in the stream channels adjacent and perpendicular to the trench where water-bearing Sentinel Butte sediments are exposed. Such springs are intermittent, and their flow rates are proportional to water levels in the sediments. Surface discharge of water from localized alluvial aquifers also occurs intermittently in a number of locations.

Recharge, Movement, and Discharge: The Antelope Creek aquifer is composed of permeable, glaciofluvial sand and gravel deposits which extend from Lake Sakakawea to its confluence with the Knife River aquifer near Hazen. Sandy silts and clays serve as

confining layers. The aquifer is less than 1 mile wide, about 250 feet thick, and about 18 miles long. Water from the aquifer is used for irrigation. Precipitation is a significant source of recharge. Ground-water outflow from Beulah Trench is estimated to be about 1.1 acre-feet/day (Figure 2-23), which is probably conservative because if net recharge is 1 inch per year, inflow would exceed outflow by more than seven times.

Water is contained within numerous aquifers in the Sentinel Butte and Tongue River formations including permeable units of sand, sandstone, and fractured lignite. Each of the two formations attains a maximum thickness of about 500 feet in Mercer County. Water levels in the Tongue River-Sentinel Butte aquifers are similar to, but more gently sloping than, the topography of the water-bearing beds. In areas where artesian conditions exist, pressures are generally low as are yields of wells penetrating the aquifers. The baseline inventory indicated that lignites in the study area are not totally saturated and that water contained in them is commonly under water-table (nonartesian) conditions. Generalized cross sections of wells installed in coal boreholes are shown in Figures 2-25 and 2-26. Saturated thickness of the lignites ranges from 0-18 feet. Injection tests of wells G09W and G16W yielded transmissivity values of about 10 to 350 gpd/foot. The average saturated thickness of the Beulah-Zap bed was estimated to be about 4 feet; however, even if a thickness of 9 feet is assumed, flow of water through a cross section of the aquifer parallel to a water level contour would be less than 0.01 gpm/linear foot of cross section. Considering the case where G26W penetrates a water-bearing silty, clayey sand unit in the Sentinel Butte with a water level at 1977.4 feet (above msl) and G25W penetrates water-bearing lignite with a water level of 1919.1 feet, downward leakage of the sand to the lignite (assuming a hydraulic conductivity of 0.134 feet/day) is about 0.2 gpd/feet^2 .

The low leakage rate in to and out of lignite units from adjacent aquifers is believed to hold true for most of the impact area because of thick clays that separate the permeable units. The percentage of impermeable units in the overburden of the Beulah-Zap bed, calculated from stratigraphic logs of the 32 boreholes, ranges from 49 to 100 percent, averaging 88 percent. The strata between the Beulah-Zap bed and the lower seams is comprised of impermeable clays. No aquifers or potential aquifers have been identified between these horizons.

The overburden of the Beulah-Zap bed contains an average aggregate thickness of about 14 feet of permeable units, some of which may function as minor aquifers. Applying appropriate porosity values

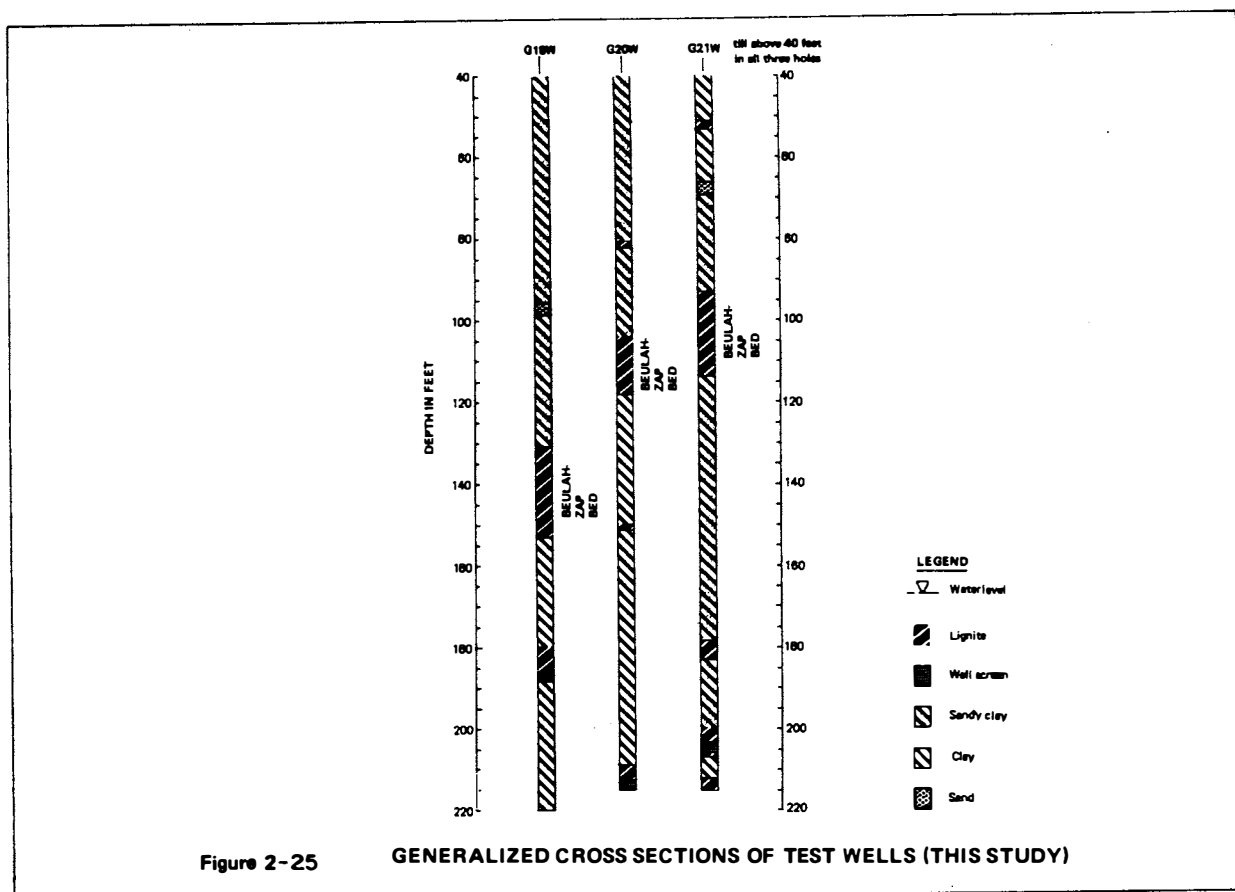


Figure 2-25

GENERALIZED CROSS SECTIONS OF TEST WELLS (THIS STUDY)

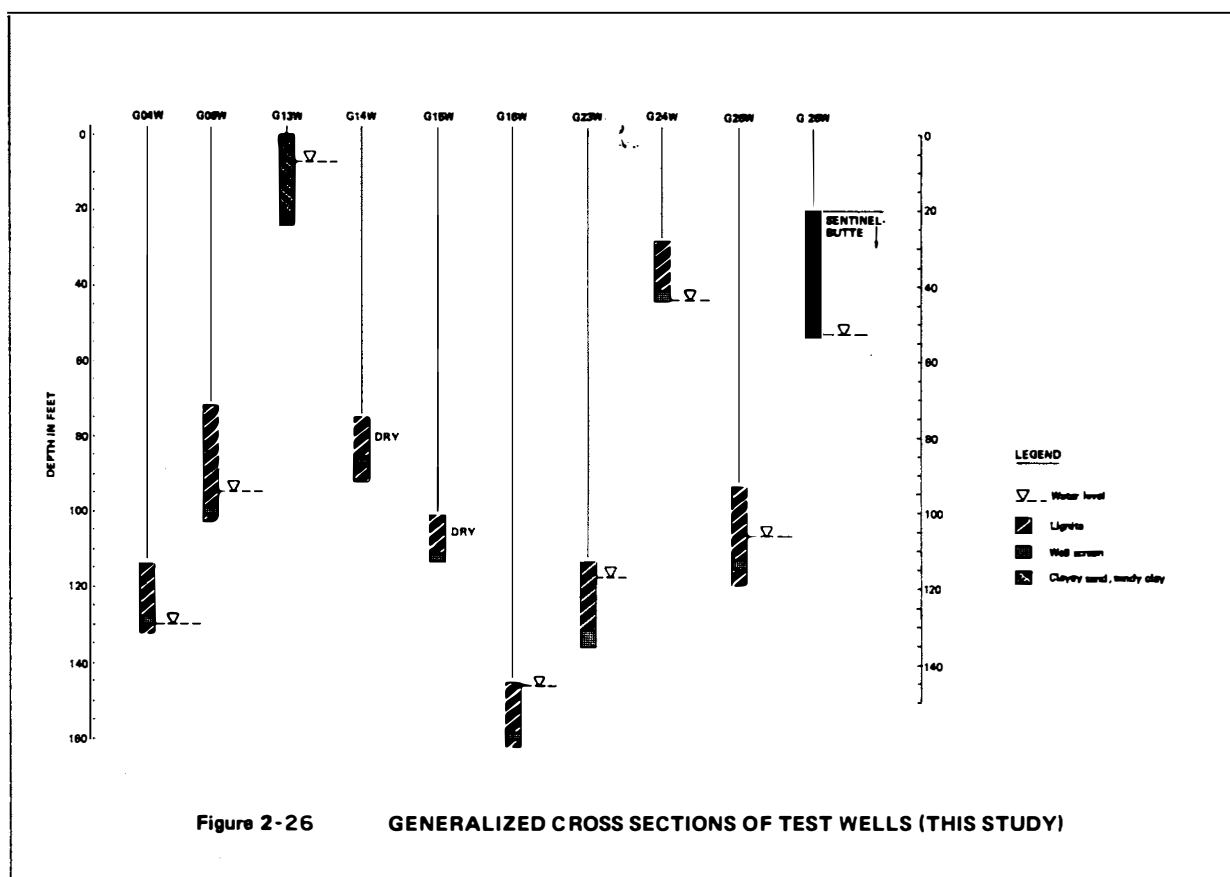


Figure 2-26

GENERALIZED CROSS SECTIONS OF TEST WELLS (THIS STUDY)

to the various lithic units, the total potential water content of permeable overburden averages about 4 feet/unit area. In many parts of the study area, no saturated permeable beds exist above the Beulah-Zap seam; therefore, actual water content of permeable overburden may be less than half the potential. Impermeable portions of the overburden contain water but do not function as aquifers. Clays frequently exhibit a water content of 20-30 percent of weight; however, this water is held in pore space and moves at extremely slow rates. Permeability of a slightly silty clay sample from Beulah Trench was calculated from compaction data to equal 0.34 feet/day. Depending on silt and sand content, permeability values of clay units may range from about 0.1 to over 10 feet/day. The impermeable character of the overburden and its low leakage rates, coupled with the semiarid climate of the area, suggest a low water content for the Tongue River-Sentinel Butte aquifers.

The average thickness of the Beulah-Zap bed within the mine area is 14 feet. If the bed were totally saturated throughout, it would contain about 3 feet of water per unit area. Wells for which stratigraphic data is available, however, indicate that saturation of the Beulah-Zap bed is highly variable, but averages about 1 foot/unit area. Some of the water in the Beulah-Zap bed slowly leaks downward through thick clays into lower seams. Since these seams are thin and contained by clays, their hydrologic characteristics are not significant enough to classify them as aquifers.

The upper Hell Creek-lower Cannonball-Ludlow aquifer underlies all of the study area and is composed of fine-grained sandstones. These sandstones lie near the formational boundary, and are underlain and overlain by continental siltstones, claystones, and a few thin beds of carbonaceous shale. Water from the aquifer is used for domestic and stock purposes.

The Fox Hills-Basal Hell Creek aquifer also underlies the entire study area. Water producing beds are sandstones of the upper Fox Hills and lower Hell Creek formations. Water from this aquifer is used for municipal, domestic, and stock purposes. Water age data indicates that recharge takes place very slowly. This is in part a function of the depth of the aquifer as well as its distance from recharge areas where it is at or near the surface.

Figures 2-27, 2-28, and 2-29 present the relationships between aquifers. Water from the Fox Hills-Basal Hell Creek aquifer moves upward to recharge the upper Hell Creek-lower Cannonball-Ludlow aquifer. Although the Tongue River-Sentinel Butte aquifers are primarily recharged by infiltration of rainfall and snowmelt, head

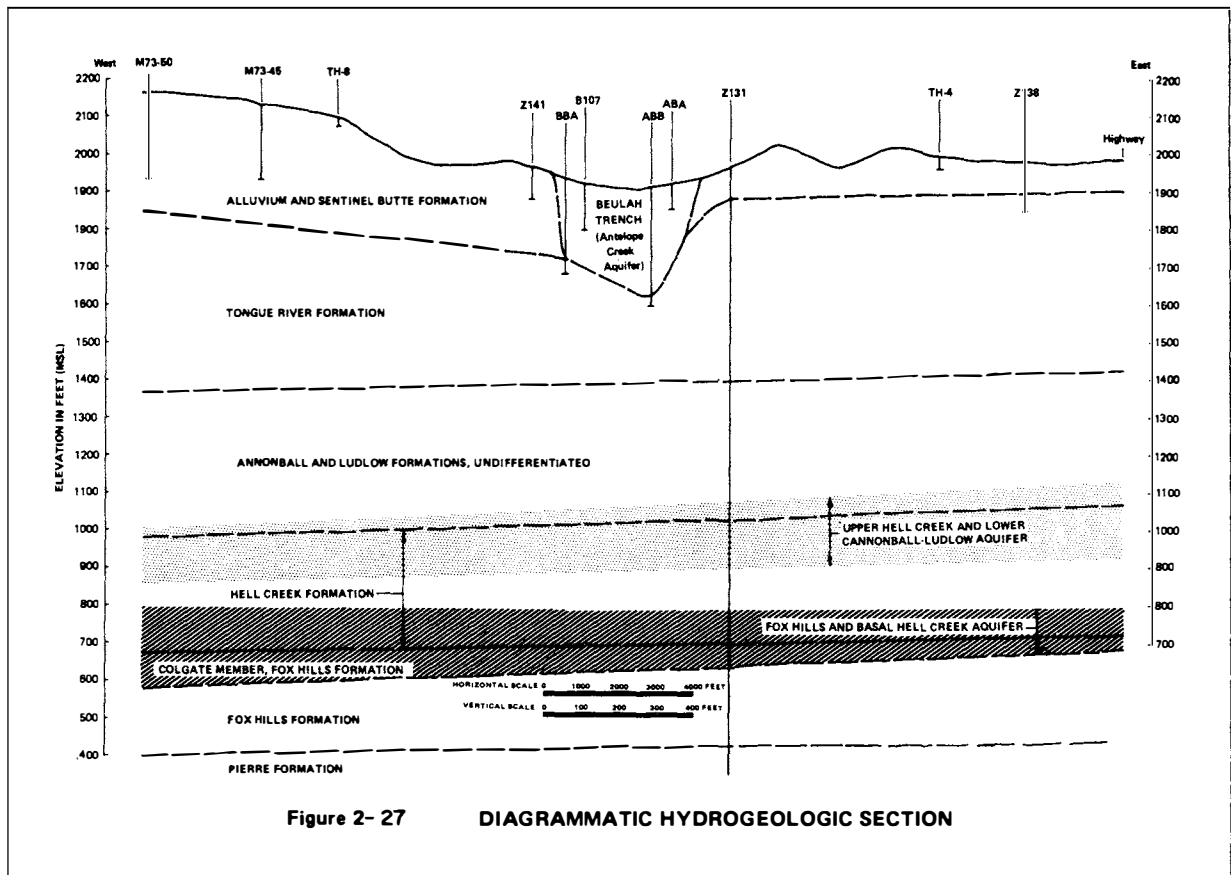


Figure 2- 27 DIAGRAMMATIC HYDROGEOLOGIC SECTION

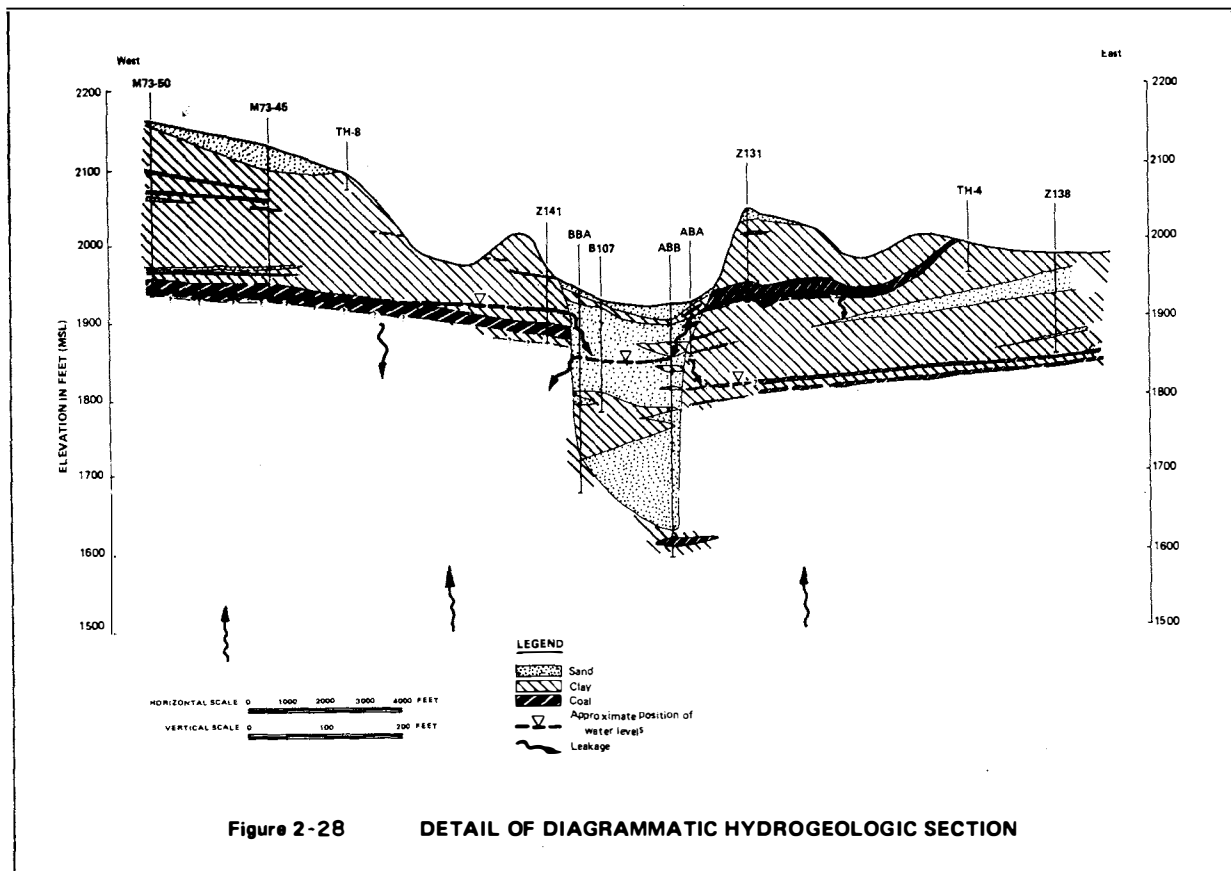


Figure 2-28 DETAIL OF DIAGRAMMATIC HYDROGEOLOGIC SECTION

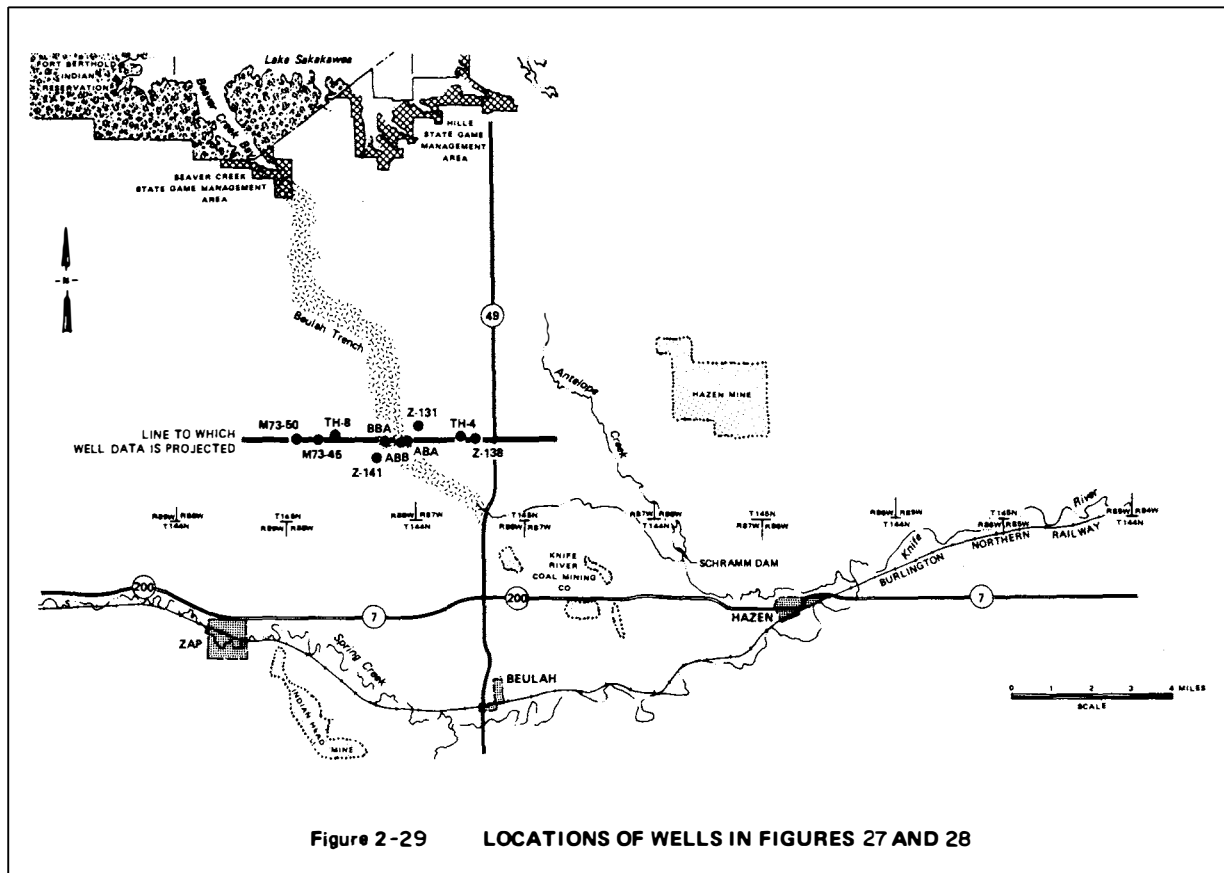


Figure 2-29 LOCATIONS OF WELLS IN FIGURES 27 AND 28

relationships indicate that some recharge from the deeper high pressure aquifers also takes place. In addition, both recharge from and discharge to the Antelope Creek aquifer takes place. Water from Lake Sakakawea enters the Antelope Creek aquifer when the lake is at a maximum elevation (1,850 feet) and percolates southward to the Knife River Valley near Hazen (8). Alluvial aquifers fed by precipitation serve as local recharge sources to underlying aquifers. Local and regional recharge and discharge and the seasonal fluctuations thereof are largely contingent upon the cumulative effects of climatological conditions. During the months when temperatures are below zero and all precipitation is frozen, no surface water infiltration to aquifers occurs.

Deep-Well Disposal: A deep-well feasibility study conducted by Woodward-Clyde Consultants (98) evaluated hydrologic and geophysical subsurface conditions beneath the plantsite vicinity. Data were derived from 5 deep wells in Mercer County, 10 in Dunn County, 4 in McLean County, and 5 in Oliver County.

Based on the above evaluations, the Dakota, Minnelusa, and Kibbey formations were each found to be a potential injection zone. Pertinent data regarding these zones are:

	<u>Dakota</u>	<u>Minnelusa</u>	<u>Kibbey</u>
Depth to top of zone (ft)	4,350	5,905	6,650
Thickness (ft)			
Upper Confining Layer	255	155	125
Injection Zone	400	175	170
Lower Confining Layer	200	125	125
Effective Thickness of I.Z. (ft)	250	100	60
Average Porosity (%)	26	22	12
Water Quality (ppm TDS - NaCl Equivalent)	5,000-7,500	150,000	150,000

The zone selected for the injection of 220 gpm of inorganic brine from the plant was the Minnelusa zone of the Absaroka sequence (Figure 2-30). The zone is about 4,000 feet below the closest freshwater aquifer and the quality of the water in the zone is already quite salty. The Dakota zone would have been the preferred reservoir except that its use as a ground-water source 180 miles east of the plantsite renders it institutionally undesirable as the receiving formation.

Product Pipeline: The only aquifer of importance to the product pipeline is in the basal Cretaceous sands in the bed of extinct Lake Agassiz in the Red Valley. Ground water is often within 10 feet of the surface here and artesian conditions are occasionally encountered in some of the depressions near the Red River of the North and the Snake River. The Cretaceous sands yield water freely, but the salinity of much of the water due to sulfates and chlorides discourages its use (18).

2.1.3.2 Quality

a. Garrison Dam and Renner Bay

Existing and historical water quality data for Renner Bay and Lake Sakakawea are presented in Appendix E.

Data from five water quality sampling stations on Renner Bay showed a slow pronounced stratification during the summer of 1974 (Figure 2-31). In May and June, surface waters warmed, while deeper waters remained fairly cool. Surface warming through July and August increased the stability of the thermocline, but surface

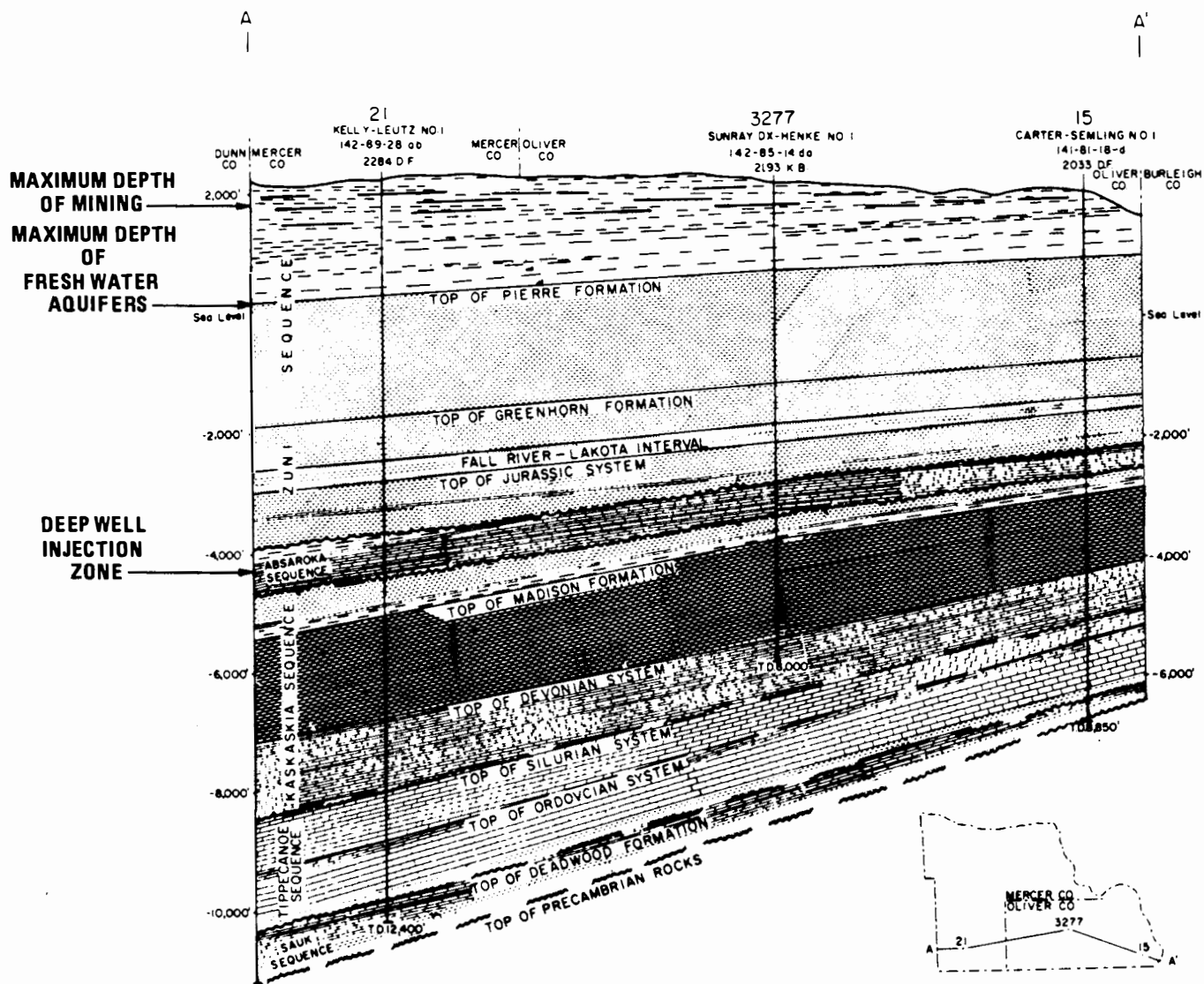
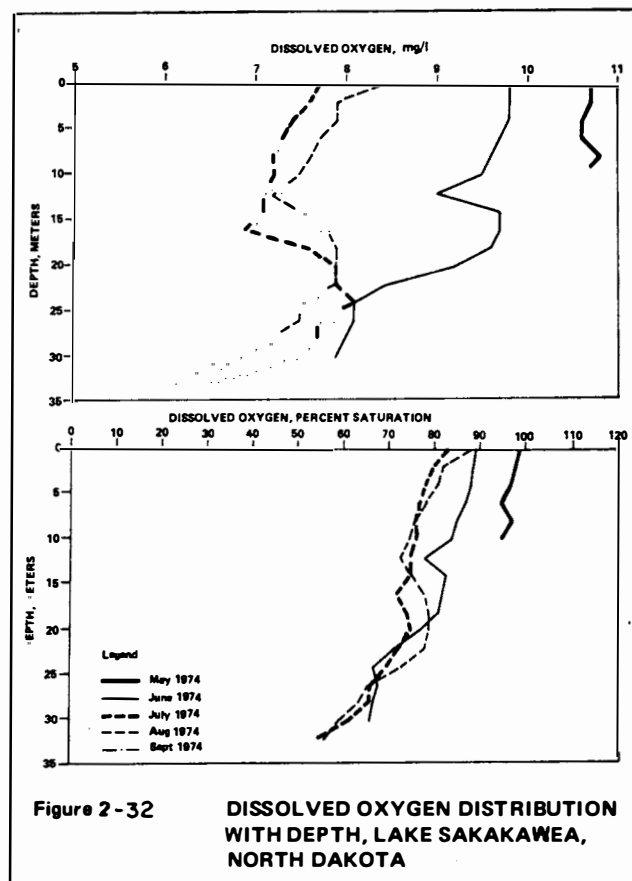
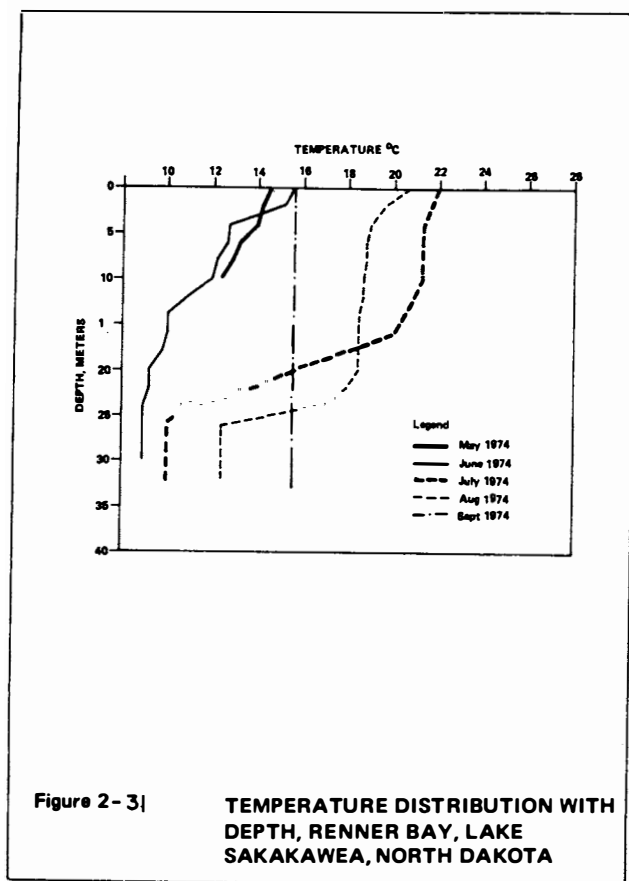


Figure 2-30 Cross sections of sedimentary rocks of Mercer and Oliver Counties.



cooling in September resulted in mixing and return of uniform temperature with depth. During July, the surface water temperatures of the bay neared 22° C (72° F).

Typical dissolved oxygen (DO) profiles for the late summer months give little evidence of hypolimnetic DO depletion; although a maximum decrease from 8.4 to 6.4 mg/l was noted between the surface and bottom in August (Figure 2-32). Percent saturation was always greater than 70 percent in the top 20 meters; but below 20 meters values decreased to almost 50 percent, although DO concentrations were always above 6 mg/l.

The waters of the lake exhibit a high degree of hardness. Levels at Garrison Dam historically ranged from 190 to 230 mg/l as CaCO₃. Measurements at Renner Bay ranged from 204 to 240 mg/l. Dissolved sulfate levels historically ranged from 120 to 190 mg/l at the dam, while total sulfate ranged from 112 to 169 mg/l in the Bay.

At Garrison Dam total dissolved solids (TDS) historically ranged from 400 to 448 mg/l. A slightly higher range, 422 to 514 mg/l, was found in Renner Bay. The State TDS criteria for Lake Sakakawea is 500 mg/l. Settlement of most suspended solids occurs within 10 miles of the entry of the Little Missouri and Yellowstone Rivers into Garrison Reservoir; thus, total solid concentrations are predominately TDS, with less than 5 mg/l being suspended solids. Less than 50 percent of the total solids present were volatile, which is a crude measure of organic content and decomposition or volatilization losses of certain mineral salts. Turbidity ranged from 1.3 to 2.6 FTU, indicating that the Bay's water is very clear. Secchi disk measurements of 3 to 4 meters confirmed these findings.

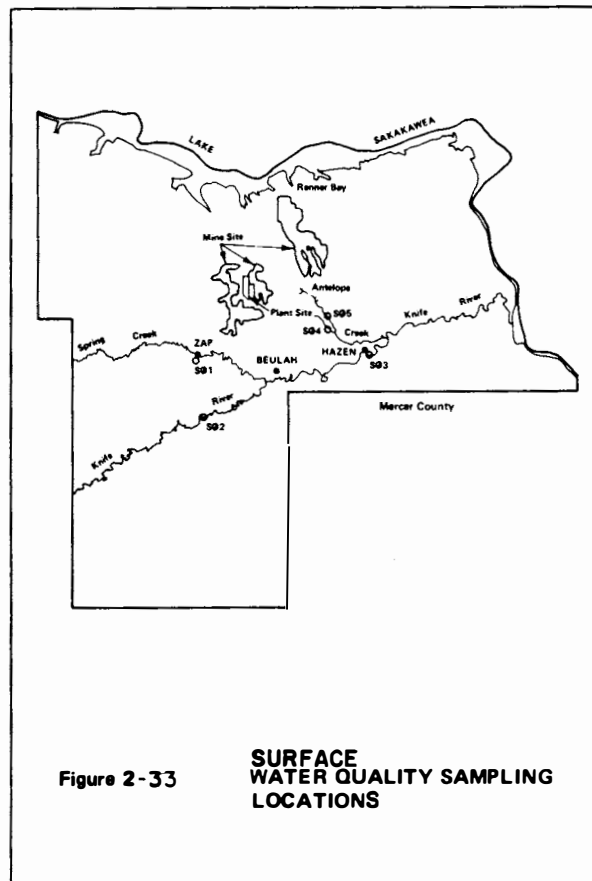
Metals found in the surface waters of the Bay included aluminum, calcium, iron, magnesium, potassium, sodium, zinc, and barium. Bottom waters of the Bay were slightly richer in aluminum, magnesium, sodium, and zinc. Traditionally, nitrate + nitrite and total phosphorous concentrations at the dam have varied from 0.09 to 0.13 mg/l and 0.01 to 0.08 mg/l, respectively. These nutrient ranges indicate that the lake is not significantly enriched (9).

b. Streams

Historically, water quality has been measured at Spring Creek near Zap (S01) and the Knife River at Hazen (S03). Additional locations were established on the Knife River below Zap (S02), the west branch of Antelope Creek (S04), and the east branch of Antelope Creek (S05) (Figure 2-33). The data gathered are summarized in Appendix E. Peak temperatures in both Spring Creek and the Knife River occurred in July and August, while Antelope Creek reached peak temperatures in June and July.

Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) levels ranged from 2 to 7 mg/l and 28 to 63 mg/l, respectively. During the high flow periods, the BOD increased noticeably due to runoff from nonpoint sources and the release of wastewater from treatment lagoons by communities on the Knife River and Spring Creek. The high value for Antelope Creek was probably due to rural drainage.

Mean TDS levels during the study period were 983 ± 246 mg/l in Spring Creek and $1,002 \pm 314$ mg/l in the Knife River. Water quality criteria limits TDS levels to 1,000 mg/l. The naturally occurring TDS levels in both streams appear to exceed this level about 48 percent of the time, based on historical data. In Antelope Creek the west branch typically contained 75 percent less solids than the east branch, which consistently contained greater than 1,000 mg/l.



Historical sulfate levels of the Knife River have been very high (68 to 640 mg/l) as have sulfate levels in Spring Creek (232 to 565 mg/l). Sodium sulfate and sodium bicarbonate are the major salts of the drainage basin (11). Hardness levels are also high; traditionally averaging 356 ± 83 mg/l for Spring Creek and 320 ± 101 mg/l in the Knife River.

For the period June through September 1974, the mean turbidity of Spring Creek was 24 ± 12 FTU, while that of the Knife River was 24 ± 7 FTU and 22 ± 8 FTU at Zap and Hazen, respectively. Antelope Creek was less turbid than either Spring Creek or the Knife River, but the west branch was more highly colored than the east branch. The waters of Spring Creek exceeded the 15 Pt-Co (platinum-cobalt scale) color criteria in all 1974 samples as did the Knife River and Antelope Creek.

Historically, total phosphate levels in the Knife River ranged from 0.01 to 0.18 mg/l. However, 1974 field phosphate readings

are significantly higher than the recorded historical maxima ranging from 0.09 to 0.28 near Hazen.

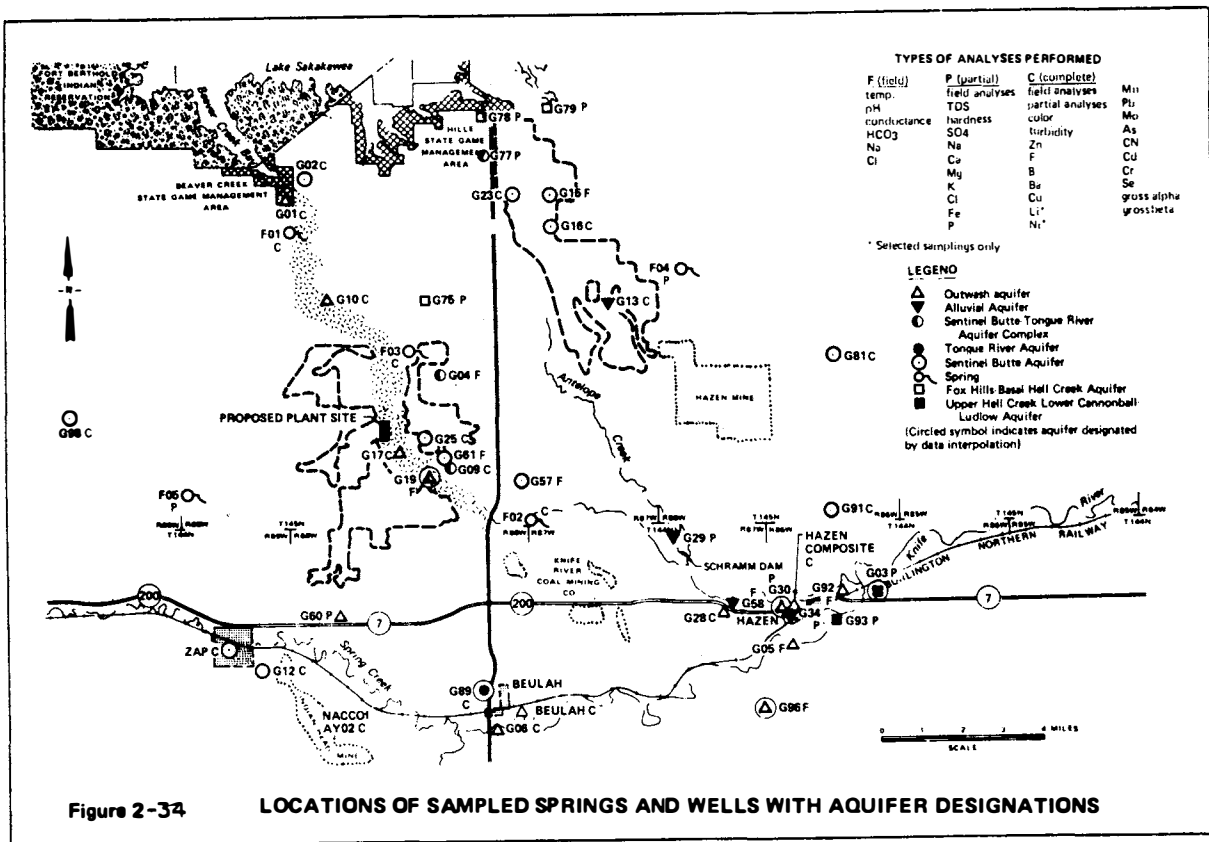
c. Ground Water

Ground-water samples representing various aquifers were also obtained during Summer 1974 (Figure 2-34). Data from this sampling is summarized in Appendix E. The general quality of ground-water sources within the study area was as follows:

<u>Source</u>	<u>Water Quality Type</u>
Fox Hills-Basal Hell Creek Aquifer	sodium bicarbonate, soft, chloride high, sulfate low
Upper Hell Creek-Lower Cannonball-Ludlow Aquifer	sodium bicarbonate, soft, chloride high, sulfate low
Lignite Aquifers	highly variable, discolored, iron content high
Antelope Creek Aquifer	calcium or sodium bicarbonate, moderately mineralized.

Most samples exceeded the 500 mg/l recommended TDS limits for Lake Sakakawea, and a good many exceeded the 1,000 ppm TDS standard for Knife River and Spring Creek. Among the ions contributing to this excessive mineralization, sodium and either bicarbonate or sulfate are primary. Their concentrations can be attributed to leaching of sodium salts from soils and dissolution of such salts contained in water-bearing strata. These salts also contribute to the alkaline pH values characteristic of the samples. The high sodium content of ground water limits the suitability of the water for irrigation purposes and has long been an inherent problem to the area.

Historical and field chemical analysis data show that iron, fluoride, boron, and manganese are relatively significant constituents of ground water. However, boron was the only element which showed abnormally high concentrations (due to the high boron content of the coal), exceeding local surface water criteria in most of the samples.



The two deep aquifers are chemically distinct from the other aquifers; the major difference being higher concentrations of chloride in the deeper aquifers. Temperature increases with depth as does mineralization. The exception here is that samples from the upper Hell Creek-lower Cannonball-Ludlow aquifer had higher TDS values than the deeper Fox Hills-Basal Hell Creek aquifer. The pH also increased with depth, which probably relates to TDS increases.

d. Springs

Analyses of spring samples (Appendix E) indicate that F01, F02, and F03 (Figure 2-34) are likely fed by Sentinel Butte sediments (including lignite) which outcrop nearby. Springs F04 and F05 show a chemical character partly similar to that of lignite aquifers and partly similar to that of alluvial or outwash aquifers. The geology near these springs would indicate that their flow could represent both sources.

e. Product Pipeline

Water quality in the various drainage subbasins along the proposed product pipeline route is highly variable. The Knife River drainage, the Missouri River, and the Eastern Dakota Subbasin generally have fair to good quality water (19). In contrast, water quality in the North Dakota portion of the Hudson Bay Drainage Basin and the Minnesota portion of the Red River Subbasin is rated poor and poor to fair, respectively, due to naturally high TDS levels.

The TDS concentrations for pertinent surface waters are shown in Table 2-11. Waters in the Missouri River Basin have generally lower TDS concentrations than the waters of the Hudson Bay Drainage. The chemical water quality of the Red River and its tributaries does not meet North Dakota and Minnesota Water Quality Standards or Public Health Standards for drinking water. However, due to lack of good quality ground water, many communities utilize surface water for domestic purposes.

The classification ratings in Table 2-7 refer to North Dakota and Minnesota Water Quality Standards and Best Use Classifications (24, 25). Class II waters differ from Class I waters primarily in that municipal use would require additional water softening in the treatment process. Class III waters usually would require saline water treatment methods for municipal use, have lower average flows, and prolonged periods of no flow.

2.1.4 Physiography

2.1.4.1 Regional Setting and Physiography

North Dakota and northwestern Minnesota can be divided into three physiographic areas: the Missouri Plateau, located in the southwestern half of North Dakota; the Drift Prairie, in east-central North Dakota; and the Red River Valley or Agassiz Basin of eastern North Dakota and western Minnesota (26, 27).

The Missouri Plateau includes the most southwesterly advance of the ice sheets. Glacial drift was deposited over all of the Plateau with the exception of the southwest corner. The Missouri slope (east of the Missouri River) leads up to an area known as the Missouri Coteau, a dissected escarpment. The Missouri Coteau occupies the eastern portion of the Plateau and is a 30- to 50-mile-wide land of "dead ice" moraines. East of this is the Drift Prairie which, together with the Red River Valley, is known as the Central Valley.

TABLE 2-II
RANGE OR AVERAGE CONCENTRATIONS OF TOTAL DISSOLVED SOLIDS
IN PERTINENT STUDY AREA SURFACE WATERS(19,21,22,23)

SURFACE WATER RESOURCE	TOTAL DISSOLVED SOLIDS RANGE OR AVERAGE
<u>MISSOURI RIVER BASIN</u>	
KNIFE RIVER	500 – 1000 mg/l*
MISSOURI RIVER	< 500 mg/l
LAKE SAKAKAWEA	< 500 mg/l
LAKE AUDUBON	< 500 mg/l
<u>HUDSON BAY DRAINAGE BASIN</u>	
DEVILS LAKE COMPLEX** (AVERAGE 1956–1970)	
DEVILS LAKE	8,380 mg/l
EAST BAY DEVILS LAKE	8,330 mg/l
EAST DEVILS LAKE	51,370 mg/l
WEST STUMP LAKE	6,820 mg/l
EAST STUMP LAKE	98,790 mg/l
FOREST RIVER	348 mg/l
RED RIVER OF THE NORTH AT OSLO, MINNESOTA	340 – 1000 mg/l
SNAKE RIVER AT WARREN, MINNESOTA	445 mg/l

*MILLIGRAMS PER LITER – GENERALLY EQUIVALENT TO PARTS PER MILLION (ppm)

< LESS THAN

**ALTHOUGH THESE STUDY AREA LAKES ARE NOT EXPECTED TO BE AFFECTED BY THE PROPOSED PIPELINE SYSTEM, THEY HAVE BEEN INCLUDED AND MAY REPRESENT TDS CONCENTRATIONS OF POTHoles AND SHALLOW LAKES WHICH ARE CROSSED BY THE PROPOSED ROUTE.

The Drift Prairie extends eastward from the Missouri Plateau to the Red River Valley. The western edge of the Red River Valley marks the eastern edge of the Great Plains. The Central Lowland is a product of several glacial advances which left drift deposits several hundred feet deep. The Red River Valley is the remnant of glacial Lake Agassiz. The level lake plain has deep, fertile soils; the eastern and western edges show sand and gravel ridges as evidence of glacial lake beaches.

The proposed plant-mine site is located near the eastern margin of the Williston Basin of the Missouri Plateau, which extends from eastern North Dakota to central Montana and from west-central South Dakota to southeast Saskatchewan (11). The Sentinel Butte Formation, the uppermost bedrock unit of the sedimentary series within the study area, dips westward towards the center of the basin (near Williston, N.D.) at 5 to 10 feet/mile.

The most striking physiographic features near the plant-mine site are the Beulah Trench and its western extension, the Zap Trench (Figures 2-14, 2-22, and 2-29). These were formed during the Wisconsin stage of glaciation (18,000 years ago), when a continental glacier diverted the Missouri River along the margins of the ice sheet to erode the trenches into the upland surface. The Beulah Trench is crossed by the Krem Moraine in the northern sector of the study area. The moraine forms a divide that causes streams within the trench to drain north as well as south. A second stream divide is in the Zap Trench which causes water from the Beulah Trench and a small section of the Zap Trench to drain eastward into the Antelope Creek drainage. The remainder of the Zap Trench drains westward.

2.1.4.2 Geology

Near the plant-mine site the only geologic units that crop out are the late Paleocene (+65 million years old) Sentinel Butte Formation and the Pleistocene to Holocene (5,000 to 1 million years old) Coleharbor Group. The geologic map (Figure 2-35) and geologic cross section (Figure 2-36) illustrate the relationship of these units.

The Sentinel Butte Formation is a continental deposit of interbedded calcareous clays, sandy clays, and lignite beds, with isolated lenses of fine-grained sands, silts, and limestones. These sediments were deposited mainly in swamps or in the flood plains of slow, meandering rivers.

In western Mercer County, the Sentinel Butte Formation is about 500 feet thick. The upper part of the formation has been removed by erosion in eastern Mercer County; thus, it is only about 350 feet thick. The major coal seam under the project is the Beulah-Zap bed located about 140 feet above the formation's base. The only bedrock formation to be disturbed by strip mining will be the Sentinel Butte Formation. The Golden Valley Formation, which is stratigraphically above the Sentinel Butte Formation elsewhere, is absent in the project area due to erosion; therefore, only the younger glacial deposits of the Coleharbor Group overlie the formation.

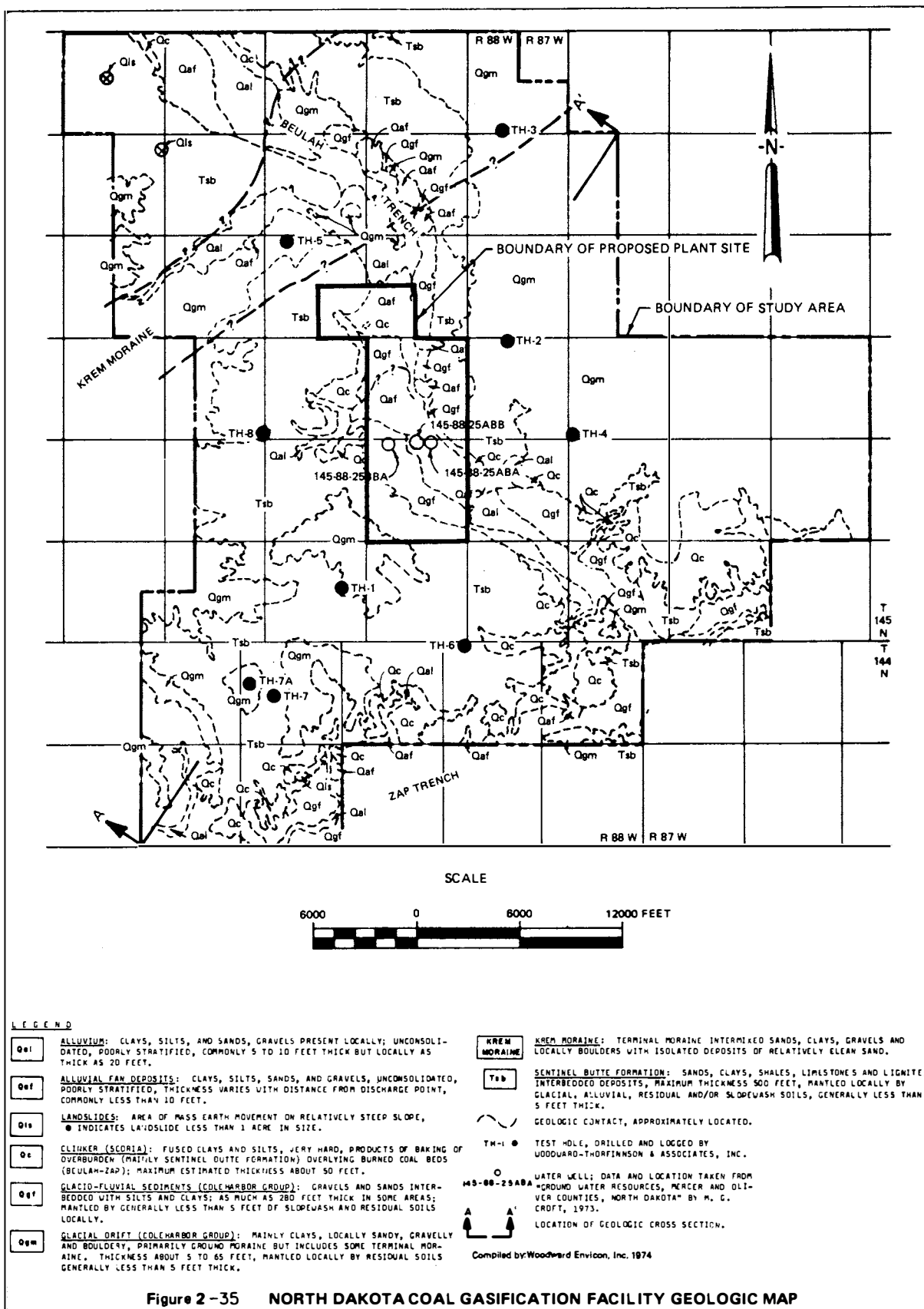
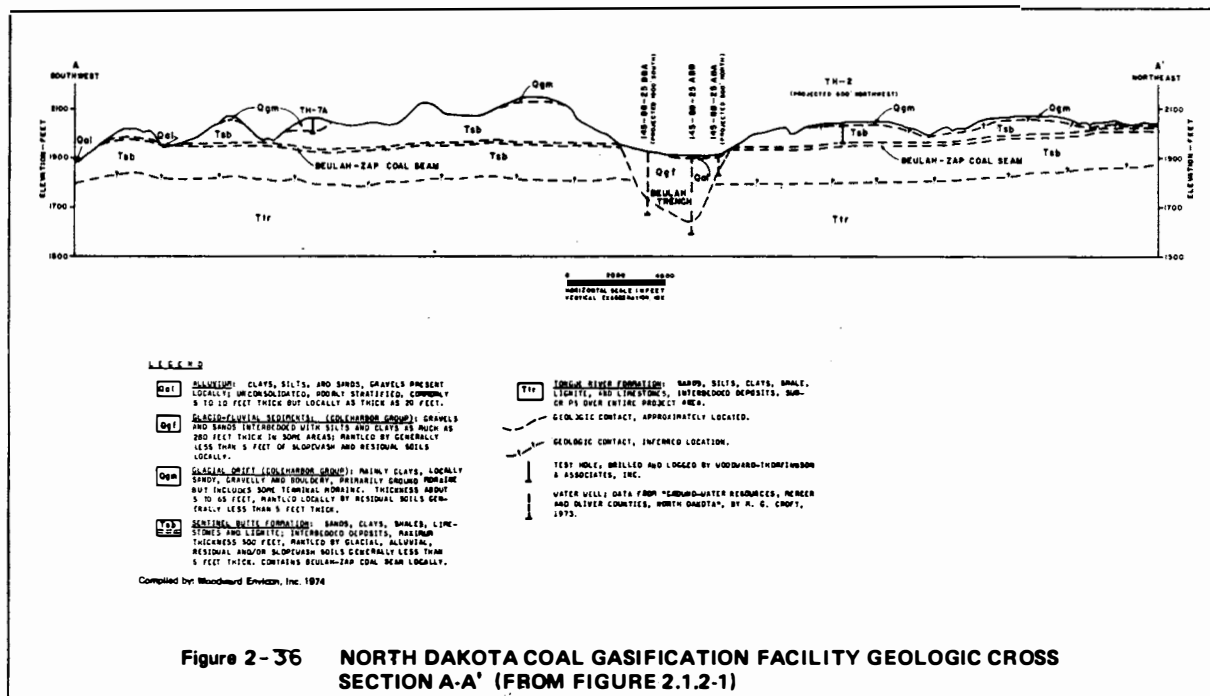


Figure 2-35 NORTH DAKOTA COAL GASIFICATION FACILITY GEOLOGIC MAP



The Coleharbor Group is composed of the moraines (till) of the upland area, the glacio-fluvial sediments in the Beulah and Zap Trenches, and the Krem Moraine. The morainal deposits (5 to 65 feet thick) are mainly clays locally mixed with sands, gravels, and boulders. The glacio-fluvial sediments, poorly stratified lenticular clays, silts, sands, and gravels, are as much as 280 feet thick in the Beulah and Zap Trenches (12). The Krem Moraine incorporates intermixed sands, clays, gravels, and locally, boulders with isolated deposits of relatively clean sand.

The Sentinel Butte Formation and Coleharbor Group are mantled by a variety of post-glacial surficial deposits. The glacio-fluvial deposits in the Beulah and Zap Trenches are masked by later stream-deposited alluvium, slopewash, and clays, silts, and sands deposited as alluvial fans. These deposits range in thickness from a few inches to 10 feet or more. "Clinker" deposits, a ceramic-like product produced by the baking of sediments over burning coal seams, are up to 50 feet thick locally. These deposits are commonly hard, variable dense to highly porous, and closely fractured. They are often used as surface material for "graveled" county roads.

2.1.4.3 Soils

a. Upper Horizons

Upper horizon soils within the plant-mine area are composed of loamy glacial till, loamy to sandy residuums from underlying siltstone and sandstone bedrock, and alluvium in the valley. Soil depths and reclamation potentials are shown in Figure 2-37. Depth of soil and the absence of sodic salt accumulations were the criteria for judging reclamation potential. Detailed U.S. Soil Conservation Service maps and soil ratings were also used in judging reclamation capabilities. Most of the topsoil present is suitable for reclamation; thus, sufficient topsoil is available to provide a productive growth medium over the mined areas.

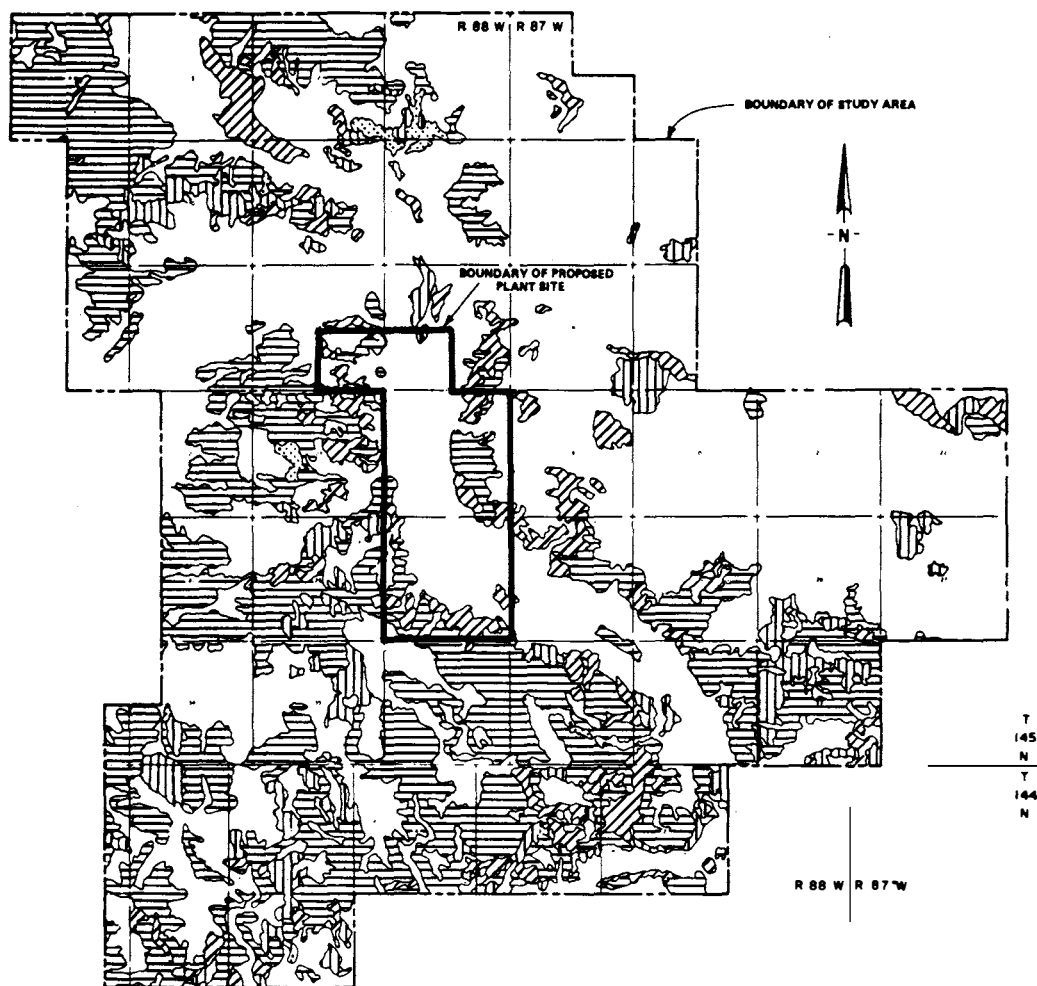
b. Lower Horizons

Materials from test holes were examined for trace elements, radioactivity, and chemical properties related to revegetation. Locations of the wells are shown in Figure 2-35 and geologic logs in Figure 2-38. Descriptions of the interval sample lithology and chemical analyses are shown in Appendix F.

Trace elements in the overburden samples occurred within a concentration range normally observed in soils, except that molybdenum was slightly outside normal range at one interval (TH-1; Sample 4). All samples with high pH values also had high exchangeable sodium percentages (ESP). Troublesome levels of soluble salts (conductivity greater than 4 mmhos/cm) exist in both the overburden and surface soils. Moderate to high levels of boron were found in a few intervals of TH-1 and TH-2. Copper, iron, and manganese were ample in all samples; zinc levels in the overburden were generally below amounts necessary for plant growth.

c. Product Pipeline

Over 40 different soil series can be found along the proposed product pipeline route. The parent material is primarily glacial drift. The route originates in Mercer County, North Dakota, where the soils are mostly derived from glacial till materials. Along the Knife River, sandy windblown soil materials mantle the glacial till. Bottomlands of alluvial soil are encountered at the Missouri River crossing, and poorly drained areas of these soils have become saline. From the Missouri River eastward, the route transverses a completely glaciated landscape having various types of glacial drift parent materials.



LEGEND

SOIL THICKNESS (ALL HORIZONS)	SUITABILITY
60 inches +	Good
24-60 inches	Good to fair
12-24 inches	Fair
0-12 inches	Poor
Barren soils, (variable thickness)	Problematic for reclamation

Compiled by Woodward Clyde, Inc. 1974



Figure 2-37 GENERAL SOIL SUITABILITY AND THICKNESS MAP

TABLE 2-12
DEGREE OF LIMITATION FOR RECLAMATION OF DISTURBED AREAS

SOIL ASSOCIATION	WATER EROSION HAZARD ^a	WIND EROSION HAZARD ^b	SALINITY ^c	REVEGETATION DIFFICULTY ^d
NORTH DAKOTA				
3. BARNES-HAMERLY	2	1	1	1
4. BARNES-SVEA	2	1	2	2
10. SVEA-HAMERLY	1	1	1	1
12. EMBDEN-GLYNDON	1	2	1	2
15. HECLA-HAMAR	1	2	1	3
16. MADDOCK-BARNES	2	2	1	3
18. RENSHAW	2	2	1	4
21. BARNES-BUSE	3	1	1	2
33. WILLIAMS	2	1	1	1
35. PARSHALL-LIHEN	1	3	1	3
40. WILLIAMS-ZAHL	2	1	1	2
45. HEGNE-FARGO	1	1	1	1
46. BEARDEN	1	1	1	1
49. GLYNDON-VALLERS	1	1	1	1
54. BEARDEN, SALINE	1	1	3	2
60. HAVRE-BANKS	3	2	2	2
63. BAINVILLE-FLASHER-AGAR	3	2	1	3
66. BAINVILLE-ZAHL	3	1	1	3
72. ZAHL-WILLIAMS	3	1	1	3
73. VALENTINE-HECLA-HAMAR	1	3	1	4
MINNESOTA				
34. FARGO	1	1	1	1
35. GRIMSTAD	1	2	1	1
37. ROCKSBURY-PEAT	1	1	1	3
38. ULEN-SIOUX-GRIMSTAD	1	3	1	3

^aWATER EROSION HAZARD 1 = SLIGHT 2 = MODERATE 3 = SEVERE

^bWIND EROSION HAZARD 1 = SLIGHT 2 = MODERATE 3 = SEVERE

^cSALINE AREAS 1 = NONE 2 = OCCASIONAL 3 = NUMEROUS

^dREVEGETATION DIFFICULTY 1 = EASY 2 = MOD. DIFFICULT 3 = DIFFICULT 4 = VERY DIFFICULT

TABLE 2-13

**MAXIMUM EXPECTED EARTHQUAKE INTENSITIES AND GROUND ACCELERATIONS
AT THE PROPOSED PROJECT SITE ¹**

<u>Earthquake Location</u>	<u>Maximum Epicentral Intensity of Record</u>	<u>Distance From Epicenter to proposed coal gasi- fication plant site</u>	<u>Maximum Probable Intensity at proposed coal gasi- fication plant site</u>	<u>Maximum Ground Acceleration at proposed coal gasi- fication plant site</u>
Habgen Lake, Montana (1959)	IX-X	480 miles	II	Less than 0.01g
Southeastern Saskatchewan, Canada (1909)	VII	225 miles	III	Less than 0.01g
Hypothetical Earthquake	VI	20 miles	V	Approximately 0.02g
Hypothetical Earthquake	VI	50 miles	IV	Approximately 0.015g

¹ Based on a projected life of about 100 years.

² Intensities based upon the Modified Mercalli scale (110;
see also page 14 of BLM's comments).

Geological hazards which may affect the long-term stability of the product pipeline include land movements, earthquakes, gully erosion, scour, subsidence, and sand blowouts. Nine areas along the route west of the Missouri River show evidence of mass movement (Table 2-14). East of the Missouri unstable streambanks of the Forest River, Red River of the North, and the Snake River are actively slumping.

Earthquake potentials for the pipeline route are the same as for the plant-mine site. Gully erosion potential exists along the Knife River, the Missouri River, the Missouri Escarpment, and the Pembina Escarpment. Scour hazards exist at any stream crossing, but the Missouri River and Red River of the North have the greatest potential. Subsidence problem areas include: the Soo Line

TABLE 2 -14
AREAS OF MASS MOVEMENT ALONG THE PROPOSED ROUTE
ON RAILROAD R.O.W. WEST OF THE MISSOURI RIVER

LOCATION				OBSERVATIONS BASED ON FIELD EVALUATIONS AND ANALYSIS OF AERIAL PHOTOGRAPHS
RIVER VALLEY	SECTION	TOWNSHIP	RANGE	
KNIFE RIVER	28	144N	87W	LARGE SLIDE, ACTIVE TOE
	27	144N	87W	REPAIRED SINCE 1965, TEMPORARILY STABILIZED
	22 & 23	144N	87W	LARGE SLIDE AREA, EXTENDING UP ADJACENT GULLY, LONG HISTORY OF MOVEMENT
	9 & 10	144N	86W	OLD SLIDE AREA WHICH WAS DITCHED
	2	144N	86W	20-FOOT HIGH CLIFF SHOWING EVIDENCE OF MASS MOVEMENT
	5	144N	85W	BUILT ON SLUMP BLOCK
	36	145N	85W	MASS MOVEMENT ALONG RIVER MEANDER
MISSOURI R.	18	144N	84W	2 SMALL SLIDES UNDER OLD ROAD
	5	143N	83W	40-FOOT HIGH SLIDE

embankment across Pelican Lake (N.D.), a wetland area west of Ramsey (N.D.), the lakes near Fillmore and Baker (N.D.), Davis and Ranch Lakes southwest of Balta (N.D.), and the Knife River Slough. The beach ridges of glacial Lake Agassiz may be susceptible to sand blowouts, as would the edge of glacial Lake Souris between Kief and Balta and portions of the Knife River Valley.

2.1.4.5 Land Use

The 1975 land use within Mercer County is tabulated below (83):

<u>Use</u>	<u>Acres</u>	<u>Percent</u>
Cropland	294,000	44.7
Pasture	4,200	0.6
Rangeland	303,600	46.1
Forest Service Property	13,000	2.0
Surface Water	27,000	4.1
Other (Including Mining)	16,200	2.5
Total	658,000	100.0

Cropland (e.g., small grains and forage crops) and rangeland comprised about 90.8 percent of Mercer County's land use in 1975.

Most of the land on the plant-mine site is also used for crop production or grazing. The entire area of the plant and mine is under private surface ownership; Coteau Properties owns the coal lease rights. Twenty-five farmsteads are in the proposed mine area; of 85 structures, 60 are vacant. All of the acreage that would be disturbed by mining (12,500 acres) is located on these 25 farmsteads. Agricultural production in the plant-mine area was worth about \$22,000/mi² according to 1973 crop prices (13).

The three counties near the plant-mine site have varying degrees of zoning regulations to regulate industrial and urban development. Mercer County has a comprehensive zoning ordinance to provide for orderly development and a functioning Planning Commission. Appropriate zoning changes and conditional use permits are required for changes in land use. A Planning Commission meets as the need arises in Dunn County to consider rezoning requests pursuant to that County's land use regulations. New regulations are being formulated and should be issued by June 1978. Oliver County has no zoning regulations; however, legislation is currently being drafted and should become effective during the fall of 1977.

Current land use along most of the proposed pipeline route is existing railroad right-of-way (ROW) in a natural or seminatural condition. Only 79 acres of new ROW will be required and current use of this land is agricultural. Wetlands encountered along the proposed route are discussed in Section 2.2.2.3.

2.2 Biological Environment

2.2.1 General

North Dakota lies entirely within the grasslands biome which encompasses most of the midwest and north-central portion of the United States. The occurrence of large areas of grassland is due largely to low rainfall, high evaporation rates, and high temperature. Over one-half the land has been agriculturally developed resulting in a mixture of natural communities and those resulting from man's activities.

Three main natural vegetation types occur in association with the proposed plant-mine site and product pipeline, including (1) mixed-grass prairie on the Missouri Plateau (described in detail in Section 2.2.2.2), (2) tall-grass prairie in the Red River Valley region, and (3) a transitional zone in the Drift Prairie region. A fourth vegetation type is the Northern flood plain forest which occurs along the major drainages. Characteristic plant species include cottonwood, ash, willow, and elm.

Field studies were conducted over a 49-section study area at the plant-mine site (Figure 2-39) from late May to mid-October, 1974, to provide baseline information on the ecosystems involved (4). Studies of a 22-section study area surrounding Mine No. 2 were conducted at a later date, and it was determined that no large differences existed in the ecosystems of the two areas. Weather in 1974 was unusually wet and resulted in an abnormal occurrence of annual plants. However, conditions were not so severe as to affect the relative abundance of perennial plants or higher animals. Four major plant communities were identifiable in the study area - agricultural, prairie, wetland, and woodland. Acreages of the various plant-mine site plant communities and habitat types within the communities are summarized in Table 2-15. Botanical compositions of sampled habitat types are found in Appendix G. No endangered plant species were noted in the study area.

2.2.2 Terrestrial Plant Communities

2.2.2.1 Agricultural

Plant-Mine Site: Approximately 59 percent of the 49-section study area surrounding the plant-mine site consisted of agricultural communities. This community is created and maintained by man at the expense of the native prairie grasslands. Almost all land in the area suitable for cultivation is developed; slopes are plowed to the steepest point where machinery can operate or to where the topsoil depth is less than plow depth. Five habitats are recognizable in this community - croplands, domestic haylands, retired croplands, fence rows, and farmsteads.

a. Croplands

About 72 percent of the agricultural community is used as cropland. Major crops in 1974 were spring wheat (45 percent), oats (22 percent), and corn (5 percent). Small acreages of barley, rye, flax, and sunflowers were also grown. (See Appendix G for a listing of plants on the plant-mine study area and scientific names.) Nearly 28 percent of the cropland was in summer fallow.

b. Domestic Haylands

Domestic haylands accounted for 26 percent of the agricultural community in 1974. Planted pastures are included in this habitat type. Hay species included alfalfa, sweetclover, smooth brome, and crested wheatgrass. Kentucky bluegrass is commonly encountered as a volunteer in planted hayfields.

c. Retired Cropland

Retired fields are generally seeded to a variety of grasses and legumes that include smooth brome, crested wheatgrass, western

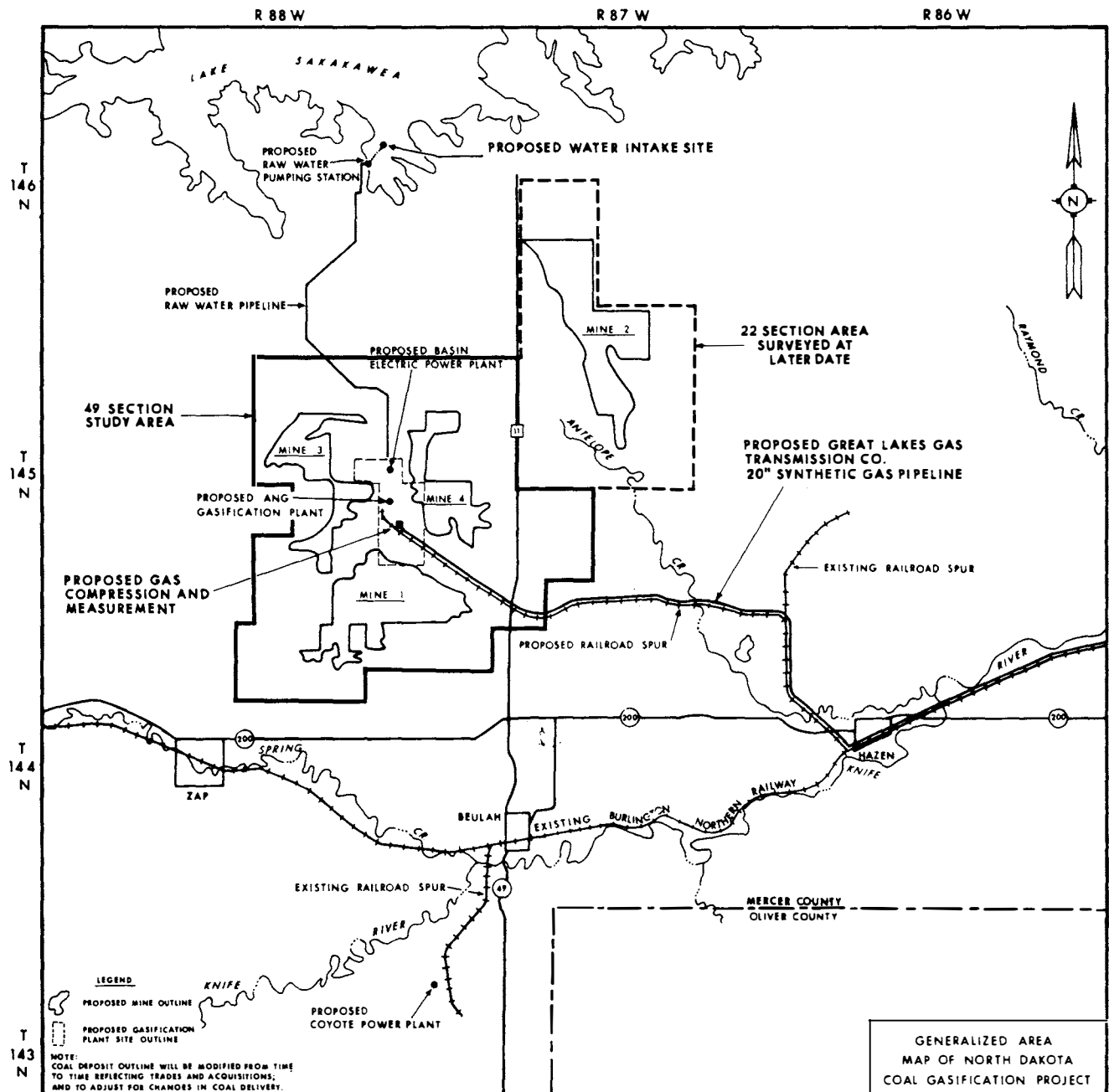


Figure 2-39
PROPOSED COAL GASIFICATION PLANT AND RELATED STRUCTURES IN RELATION TO SAMPLING AREAS

TABLE 2-15

Extent of Plant Communities Found Within a 49-Section Study Area
Encompassing the ANGCGC Plant-Mine Site

<u>Community and Habitat Type</u>	<u>Approximate Acreage ^{1/}</u>	<u>% of Community</u>
Agriculture (59%)		
Cropland	13,300	72
Domestic Hayland	4,800	26
Retired Cropland	100	1
Fencerow	100	1
Farmstead	300	1
	<u>18,600</u>	<u>100</u>
Prairie (40%)		
Subirrigated	100	1
Overflow	250	2
Saline Lowland	100	1
Closed Depression	100	1
Sandy	1,250	10
Silty	5,500	44
Clayey	250	2
Thin Upland	1,600	13
Shallow	2,250	22
Claypan	125	1
Shallow-Gravel	100	1
Very Shallow	125	1
Thin Claypan	500	4
	<u>12,250</u>	<u>100</u>
Wetland (0.3%)		
Wetmeadow Swale	15	14
Cropland Pond	1	1
Seasonal Ponds & Lakes	65	64
Semipermanent Ponds & Lakes	7	7
Stock Ponds	14	14
	<u>102</u>	<u>100</u>
Woodlands (0.7%)		
Natural	125	63
Tree Plantings	75	37
	<u>200</u>	<u>100</u>

^{1/} Approximate acreage based upon 15 quarter-section samples within the 49-section study area.

Source: Woodward-Envicon, Inc. 1974

wheatgrass, alfalfa, and yellow sweetclover. Coarse weed species are commonly associated with seeded grasses in retired cropland fields. The fields in the study area were utilized for hay in 1974.

d. Fence Rows, Section Lines, and Rights-of-Way

Narrow strips of weedy habitat often border croplands, hayfields, grazed prairie, fences, section lines, and rights-of-way. For nine sampled fence rows, three introduced grasses (smooth brome, Kentucky bluegrass, and crested wheatgrass) made up 60 percent of the total plant composition, native perennial grasses 14 percent, and annuals 19 percent (Appendix G). Many section lines and roadsides are planted in hay grasses and legumes, and are hayed annually. Fence rows adjacent to domestic hayfields contained mainly hay grasses; those adjacent to croplands contained a wide variety of annual weeds. The establishment of smooth brome generally resulted in a nearly pure stand of this species due to its early growth and its tendency toward dense stands.

e. Farmsteads

About 1 percent of the agricultural community was farmsteads. Abandoned farmsteads were about 15 percent of the total farmstead acreage. Grounds of these areas tend to become overgrown with weeds and brush and are important as wildlife habitat.

Product Pipeline: Agricultural land in the vicinity of the product pipeline is essentially of the same type as that of the plant-mine site. About 262 miles of the proposed route is bordered by cropland and 15 miles bordered by domestic hayland.

2.2.2.2 Prairie

Plant-Mine Site: Approximately 40 percent of the plant-mine study area consists of prairie. This community was further subdivided into 13 range-site categories based on soil type, field inspection, and vegetation sampling. These range sites represent a wide spectrum of pre- and post-climax plant communities resulting from local variations in soil, wetness, topography, etc. The range sites in the study area were: subirrigated, overflow, saline lowland, closed depression, sandy, silty, clayey, thin upland, shallow, claypan, shallow to gravel, very shallow, and thin claypan.

a. Subirrigated

This range site is present in the study area only as a part of other units. Its acreage is insignificant, but it represents a distinct community. Dominant plant species in a subirrigated plantsite in the study area were big bluestem, prairie cordgrass, and switchgrass (Appendix G).

b. Overflow

About 2 percent of the prairie in the study area was overflow range site. In two overflow range sites big bluestem was the dominant species; Pennsylvania sedge was second in abundance, and porcupine grass was third.

c. Saline Lowland

Less than 1 percent of prairie in the study area is saline lowland. Plant species tabulated on moderately well and poorly drained saline lowland sites are listed in Appendix G. Western wheatgrass, swollen bluegrass, and poverty weed dominated in the moderately well drained area whereas salt meadowgrass, saltgrass, hastate saltbush, western wheatgrass, and wild barley were the principal species where drainage was poorer.

d. Closed Depression

Less than 1 percent of the prairie in the study area is closed depression range site. Because this site is found in closed basins, the plant community is quite variable depending on recent weather conditions. Generally the dominant species is western wheatgrass, an upland species with high moisture tolerance. However, a succession of wet years may result in high percentages of northern reedgrass and sedges more characteristic of wet meadow sites.

e. Sandy

Sandy range is about 10 percent of the prairie in the study area. In two sandy range sites sampled, big sandgrass was the most abundant species, followed by prairie junegrass, blue grama, and needle-and-thread. Western wheatgrass was relatively low in importance.

f. Silty

The silty range site comprises about 44 percent of the prairie in the study area. Two silty range sites were sampled and both showed blue grama highest in relative abundance, with western wheatgrass and needle-and-thread second and third, respectively.

Blue grama is a short-grass understory species, and although abundant, it comprises a much smaller percentage of the stand by weight than the percent relative abundance indicates. Therefore, western wheatgrass was actually the dominant species.

g. Clayey

About 2 percent of the prairie of the study area is clayey range site. Examination of a clayey range site showed that western wheatgrass, green needlegrass, and blue grama were the dominant plant species.

h. Thin Upland

This range site was about 13 percent of the study area prairie. In two thin upland communities sampled, little bluestem was the most abundant species, followed by Pennsylvania sedge, porcupine grass, and big sandgrass.

i. Shallow

The shallow range site was about 22 percent of the prairie acreage. The dominant plant species of two sampling areas were little bluestem, threadleaf sedge, Pennsylvania sedge, and big sandgrass. The high occurrence of big sandgrass was due to the sandiness of the soil.

j. Claypan

Claypan was about 1 percent of the prairie of the study area. These sites are often characterized by shallow depressions where the underlying impervious subsoil is exposed by erosion. The vegetation of these depressions is sparse and many are almost barren. A claypan site in the study area was dominated by western wheatgrass, green needlegrass, and prairie junegrass.

k. Shallow to Gravel

The shallow to gravel range site was less than 1 percent of prairie acreage. One site in the study area was dominated by threadleaf sedge, blue grama, and fringed sage. Blue grama dominance was probably a result of heavy grazing.

l. Very Shallow

This range site was about 1 percent of the study area prairie. Plant communities on soils underlain by gravel are different than those on soils underlain by hard rock or clinker. In the study area, threadleaf sedge and needle-and-thread were the dominant

plants in areas underlain by gravel. Plains muhly, needle-and-thread, and little bluestem dominated over clinker areas whereas thickspike wheatgrass was the dominant grass over sandstone.

m. Thin Claypan

The thin claypan range site is about 4 percent of the prairie acreage. Examination of one site showed western wheatgrass as dominant. Significant percentages of blue grama, tumblegrass, gumweed, sandberg bluegrass, and buffalo grass were also present.

Product Pipeline: Typical plants of the various prairie regions along the proposed product pipeline route would include western wheatgrass, needle-and-thread, green needlegrass, big bluestem, little bluestem, Indian grass, and blue grama. The types of prairie (e.g., tall-grass, transitional, etc.) differ primarily in the species composition and/or densities of these species. Along almost all of the proposed route vegetation consists of brome, mixed grasses, and some shrub communities characteristic of idle lands along railroad rights-of-way. About 58 miles of the proposed route is bordered by natural prairie communities.

2.2.2.3 Wetland

Plant-Mine Site: Wetland communities occupy about 0.3 percent of the 49-section study area. Five different habitats are represented within this community: wet-meadow swales, cropland ponds, seasonal ponds and lakes, semipermanent ponds and lakes, and stock ponds.

a. Wet-Meadow Swales

Wet-meadow swales occur in shallow depressions that have not been cultivated and make up about 14 percent of study area wetlands. In two wet-meadow sites, smoothcone sedge, wild barley, and common spikerush were the most abundant plant species (Appendix G).

b. Cropland Ponds

Cropland ponds occur in basins where the soil is cultivated during dry years. Vegetation in noncrop years is dominated by pioneer species characteristic of early wet-meadow and shallow marsh successional stages. Cropland ponds are present, but were not sampled.

c. Seasonal (Pothole) Ponds and Lakes

About 65 percent of the wetlands in the study area were seasonal ponds and lakes. Two vegetative zones are generally present: a peripheral wetland range zone and a shallow marsh zone. Two

wetland range sites sampled were dominated by slough sedge and long-rooted smartweed. Other wetland range sites dominated by rivergrass were noted.

d. Semipermanent (Pothole) Ponds and Lakes

This habitat type was 7 percent of the wetlands in the study area. Two marshes were sampled, and burreed, long-rooted smartweed, broadleaved cattail, and river bulrush were the principal species. Hardstem and softstem bulrush were observed but were not represented in the sample.

e. Stock Ponds

Stock ponds comprised about 14 percent of wetland habitat in the study area. The edges of these ponds are usually trampled to the point that vegetation cannot grow, but occasionally small areas of marsh, wetland range, and/or wet-meadow vegetation are present.

Product Pipeline: About 19 miles of wetlands lie in close proximity to the proposed product pipeline route (Table 2-16). The pipeline would only be laid on one side of the railroad but whether the north or south side would be used is not known at this time; thus, Table 2-16 presents wetland data for both. Not all 155 or 162 wetlands would be crossed; as indicated on page 2-24, it is estimated that about 32 of these wetlands would be crossed by the pipeline. The wetlands occur primarily on the Missouri Couteau and portions of the Drift Prairie west of Pelican Lake (about 50 percent of the wetlands occur in Ramsey County alone). The vegetation associated with these wetlands would be essentially the same as that described above for the plant-mine site.

Table 2-16
INVENTORY OF WETLAND IMPOUNDMENTS ALONG PRODUCT PIPELINE ROUTE

	<u>North Side of RR</u>	<u>South Side of RR</u>
Number of wetlands encountered	155	162
Total acreage of wetlands	7,123	7,167
Acreage within 50 foot ROW	113	114
Linear miles of wetland	18.5	18.7

All of the wetlands along the proposed route (about 19 miles) are in North Dakota. The most important waterfowl habitat is in the Missouri Couteau and the Drift Prairie west of Pelican Lake. Intermittent ponds and marshes are more extensive than permanent waters by 4:1. The potholes on the Couteau are on higher ground, are visually more distinct, and tend to be fresher than potholes of the Drift Prairie. The latter, being at or below the surrounding water table, are subject to inflow seepage and tend to be more saline.

2.2.2.4 Woodlands

Plant-Mine Site: Natural wooded communities near the plant-mine site can best be classed as prairie thickets. Several tree plantings are also present. Only 0.7 percent of the study area is occupied by woody vegetation over 6 feet high.

a. Natural Communities

Natural wooded communities make up 63 percent of the woody cover present. Three types of natural woodlands are present in the study area. Species composition relates closely to moisture conditions - hydric (wet), mesic (moist), and xeric (dry). Woody species in each of these types are shown in Appendix G. It appears that the natural wooded communities are gradually increasing in extent, particularly on north slopes. This might be a result of protection from fire, perhaps in conjunction with heavy grazing.

b. Tree Plantings

Long narrow strips of native and exotic trees and shrubs (shelterbelts) account for about 37 percent of wooded habitat in the impact area. Two wildlife habitat improvement plantings have been established in the study area. These are block plantings of 3 to 5 acres designed to provide food and winter cover for wildlife. Exotic plant species, particularly Chinese and Siberian elms, caragana, and Russian olive were the most common trees in tree plantings, although in older plantings native species such as green ash and cottonwood were present.

Product Pipeline: Natural woodlands in the vicinity of the product pipeline route consist of stands of bottomland hardwoods along major drainages; notably the Knife River, Missouri River, Forest River (and its branches), Red River of the North, and Snake River. There are also some scattered stands of bur oak, green ash, and aspen around the Missouri Coteau and scattered in other areas of stronger relief throughout the Missouri Coteau and Drift Prairie. Woody shrubs are also found in coulees west of the Missouri. Stands consisting primarily of aspen and jack pine are found scattered on some beach ridges around the Red River Valley. Also, scattered woodlots and occasional areas of tamarack swamp occur along the route where it leaves the Soo Line ROW west of Vicking to link with the Thief River Falls Compressor Station. Overall the pipeline route traverses about 22.7 miles of woodland habitat.

2.2.3 Terrestrial Fauna

2.2.3.1 Birds

Field studies near the plant-mine site during 1974 indicated the presence of 75 bird species during the breeding season. An additional 32 species observed only during early spring and/or late summer and fall are considered to be migrants. Bird species observed in and about the 49-section study area are listed in Table 2-17.

a. Water Birds

Waterfowl were given special attention in field studies. Six species nested or attempted to nest in the plant-mine study area (Table 2-18). The estimated spring (May) duck population was about 250 birds, including 104 pairs and 42 unpaired drakes. A brood count the second week of July located 135 ducklings in 22 broods. Blue-winged teal and ruddy duck broods were not observed, thus the estimated 21 percent nesting success rate is probably low. Use of the area was heavy during early spring when seasonal ponds contained water. Use decreased in July as these ponds began to dry out and breeding activity declined. By September 3, only 36 ducks were counted.

Twenty-six species of water birds other than waterfowl were observed on or in the study area. Of these, eight were seen only on Lake Sakakawea. Only three species, the American coot, killdeer, and upland plover, were numerous enough to allow calculation of population estimates.

Water birds are of primary importance throughout the region of the proposed product pipeline and utilize the area extensively. The

TABLE 2-17

BIRD SPECIES OBSERVED ON AND IN THE VICINITY OF THE STUDY AREA

Species	Status ¹	Habitat ²				Minimum ³ Breeding Population
		Agricultural	Prairie	Wetland	Wooded	
<u>Waterbirds</u>						
Common loon ⁴	-			100		-
Western grebe ⁴	-			100		-
Eared grebe	B			100		P
Pied-billed grebe	B			100		P
White pelican ⁴	-			100		-
Double-crested cormorant ⁴	-			100		-
Mallard	B			100		62
Pintail	B			100		32
Gadwall	B			100		19
American widgeon	M			100		-
Shoveler	B			100		70
Blue-winged teal	B			100		62
Green-winged teal	M			100		-
Redhead	M			100		-
Canvasback	M			100		-
Ring-necked duck	M			100		-
Lesser scaup	M			100		-
Ruddy duck	B			100		5
Great blue heron	M			100		-
American bittern	M			100		-
Sandhill crane	M			100		-
American coot	B			100		81
Sora	B			100		P
American avocet	M			100		-
Killdeer	B	8	64	28		10 ± 3/mi ²
Marbled godwit	M			100		-
Upland plover	B		91	9		6 ± 2/mi ²
Spotted sandpiper	M					-
Willet	B			100		P
Lesser yellowlegs	M			100		-
Long-billed dowicher	M			100		-
Semipalmated sandpiper ⁴	-					-
Wilson's phalarope	B			100		P
Common snipe	M			100		-
Herring gull ⁴	-			100		-
Ring-billed gull ⁴	-			100		-
Franklin's gull ⁴	-			100		-
Black tern	B			100		P
<u>Upland Gamebirds</u>						
Sharp-tailed grouse	B	50	22		28	1.6/mi ²
Ring-necked pheasant	B	15	28		57	
Gray partridge	B	51	10		39	P
<u>Raptors</u>						
Turkey vulture	M	33	67			-
Cooper's hawk	B				100	2 pr
Sharp-shinned hawk	M				100	-
Marsh hawk	M	47	52	1		6 pr
Red-tailed hawk	M	45	55			-
Swainson's hawk	B	35	60		5	2 pr
Prairie falcon	M		80		20	-
Sparrow hawk	M	100				-
Screech owl	M	100				-
Great horned owl	B	6	13	13	68	3 pr
Burrowing owl	B	12	88			3 pr
<u>Songbirds</u>						
Rock dove	B	100				P
Mourning dove	B	11	28		61	7 ± 3/mi ²
Black-billed cuckoo	B				100	P
Common nighthawk	B	50	50			P
Belted kingfisher	B			100		P
Yellow-shafted flicker	B				100	P
Eastern kingbird	B	22	38	40		13 ± 3/mi ²
Western kingbird	B		33		67	P
Eastern phoebe	B				100	P
Traill's flycatcher	B				100	P
Least flycatcher	B				100	P
Horned lark	B	62	35	3		82 ± 19/mi ²
Barn swallow	B					P
Tree swallow	B					P
Bank swallow	B					P
Rough-winged swallow	B					P
Blue jay	B				100	P
Black-billed magpie	B				100	P
Common crow	B				100	P
Black-capped chickadee	M				100	-

(continues)

TABLE 2-17 (cont'd.-1)

Species	Status ¹	Habitat ²			Minimum ³ Breeding Population
		Agricultural	Prairie	Wetland	
Rock wren	M		100		-
Long-billed marsh wren	M			100	-
Catbird	B			100	P
Brown thrasher	B		9	18	73
Robin	B		11		89
Loggerhead shrike	B		67		33
Starling	B	100			P
Philadelphia vireo	B	100			P
Yellow warbler	B				100
Myrtle warbler	M				100
Ovenbird	B				100
Yellowthroat	B	17			83
House sparrow	B		56		44
Bobolink	B	77	10	13	8
Western meadowlark	B	15	80		5
Yellow-headed blackbird	B	37		63	P
Red-winged blackbird	B	21	35	23	21
Brewer's blackbird	B	37	20	2	41
Common grackle	B		100		P
Brown-headed cowbird	B	30	52		18
Orchard oriole	B				100
Baltimore oriole	B				100
Rose-breasted grosbeak	B				100
American goldfinch	B				100
Dickcissel	B	100			P
Rufous-sided towhee	B				100
Grasshopper sparrow	B	28	68		4
Baird's sparrow	B		100		P
Lark bunting	B	60	39		1
Vesper sparrow	B	24	67	4	5
Clay-colored sparrow	B	2	2		96
Tree sparrow	M				100
Chipping sparrow	M				100
White-crowned sparrow	M				100
Song sparrow	B	37	13	37	13
McCown's longspur	B	100			P
Chestnut-collared longspur	B	27	72	1	114

¹ B = Breeding bird, M = migrating bird.

² Values indicate percentages of observations.

³ P = Present in low numbers; breeding population less than four (4) per square mile. Whole numbers indicate the estimated number of breeding individuals on the 48 square mile study area in 1974; pr = breeding pairs.

⁴ Observed only on Lake Sakakawea.

Source: Woodward-Envicon, Inc., Analysis, 1974.

TABLE 2-18

BREEDING POPULATIONS AND PRODUCTIVITY OF SIX SPECIES OF WATERFOWL ON THE STUDY AREA

Species	Estimated No. of Pairs	Unpaired Males	Spring Population	No. of Broods	No. of Young	Percent Nesting Success
Mallard	26	10	62	12	83	46
Pintail	13	6	32	4	20	31
Godwall	8	3	19	5	28	62
Shoveler	29	12	70	1	4	3
Blue-winged teal	26	10	62	0	0	0
Ruddy duck	2	1	5	0	0	0
Total	104	42	250	22	135	21

Source: Woodward-Envicon, Inc., Analysis, 1974.

prairie pothole region is especially important and is used heavily during breeding and migrations. Several species of ducks commonly nest in the area; blue-winged teal make up nearly one-fourth of the nesting ducks in the Dakotas, with pintails, mallards, and gadwalls comprising most of the rest (37). Coots, snipe, plovers, rails, and the American avocet breed on the shores of marshes and lakes. Sandhill cranes also use the area for feeding and resting during migration; the whooping crane and whistling swan are known to use the area for resting during migration.

b. Upland Game Birds

Three species of upland game birds inhabited the plant-mine study area--the sharp-tailed grouse, ring-necked pheasant, and gray partridge. The sharp-tailed grouse was present where ungrazed or lightly-grazed prairie, grain fields, and woody vegetation were in close proximity. These birds use ungrazed or lightly-grazed prairie for nesting (30); woody areas provide vital winter cover. During July and August the adult to juvenile ratio was 1:3.2, providing an estimated fall population of 6.7 birds/mi².

Spring surveys indicated a population of 0.8 male pheasant/mi². A male to female ratio of 1:2.0-3.3 (31) was used to estimate the breeding population of 2.4 birds/mi². Data on gray partridge were not sufficient to estimate populations.

Upland game birds along the proposed product pipeline route include ring-necked pheasant, gray partridge, sharp-tailed grouse, and greater prairie chicken.

c. Raptors

Eleven species of raptors were observed in the 49-section study area; six were present during the breeding season - Cooper's hawk, marsh hawk, Swainson's hawk, great-horned owl, and burrowing owl. Seven of the eight observations of burrowing owls were in prairie habitats where they nest in the abandoned burrows of various mammals; in the study area probably those of badgers.

d. Songbirds

In all, 57 species of songbirds (pigeons and doves, cuckoos, goat-suckers, swifts, kingfishers, woodpeckers, and perching birds) were observed in the plant-mine study area; 49 of these during the nesting season. Ten species, the chestnut-collared longspur, lark bunting, horned lark, western meadowlark, brown-headed cowbird, redwinged blackbird, clay-colored sparrow, Brewer's blackbird,

eastern kingbird, and vesper sparrow, accounted for over 85 percent of all songbird observations during the spring census. The first four of these species comprised over 60 percent of the observations. The widest variety of birds, 33 species, was observed where woody vegetation was present. Many prairie and wetland species use trees and shrubs for perches during territorial displays.

2.2.3.2 Mammals

a. Small Mammals

Small mammals include bats, shrews, and small rodents not of recreational or furbearing importance. Ten species were identified in the plant-mine study area (Table 2-19). Suitable habitat in agricultural areas was mainly in fence rows. Thirteen-lined ground squirrels and deer mice were the most abundant small mammals, as they were also in prairie habitat. Thirteen-lined ground squirrels and meadow jumping mice were the most common small mammals in wetland areas, whereas deer mice and meadow jumping mice were the most common in wooded areas.

b. Medium Mammals

Medium-sized mammals include small game mammals and furbearers. Eleven species were observed on the study area near the plant-mine site; sufficient data were gathered to calculate population estimates for five of these (Table 2-20). Raccoons were observed most often in agricultural areas, but tracks and droppings were often observed in wooded and wetland areas. Eight red fox dens were located in the spring, and two additional pairs were reported by a landowner.

The muskrat is probably the most abundant furbearing mammal in the region of the proposed product pipeline. Beaver, weasel, fox, mink, and raccoons are also taken for their fur. Predators such as coyotes, bobcats, skunks, and badgers are also often taken for their fur, or simply hunted as undesirable species. Tree squirrels, cottontail rabbits, and white-tailed jackrabbits are also present.

c. Large Mammals

Three species of large mammals were observed in the 49-section study area (Table 2-20). Only one mule deer was seen; white-tailed deer were not present in sufficient numbers to accurately estimate numbers, but at least 11 individuals were observed. Most observations of pronghorn were in the agricultural northeastern one-third of the study area. Four males had summer territories

Table 2-19

SMALL MAMMAL SPECIES CAPTURED ON THE STUDY AREA

<u>Species</u>	Spring and Summer <u>1/</u>				Fall Population <u>2/</u>	
	<u>Agricultural</u>	<u>Prairie</u>	<u>Wetland</u>	<u>Wooded</u>	<u>Agricultural</u>	<u>Prairie</u>
<u>Small Mammals</u>						
Masked shrew	--	--	--	3	6.4	--
Thirteen-lined ground squirrel	63	64	83	--	--	83.2
Northern pocket gopher	3	--	--	--	--	--
Wyoming pocket mouse	7	--	--	--	25.6	6.4
Deer mouse	24	36	--	51	812.8	710.4
Northern grasshopper mouse	--	--	--	--	57.6	25.6
Boreal redback vole	--	--	--	3	--	--
Prairie vole	1	--	--	--	--	--
House mouse	1	--	--	--	25.6	--
Meadow jumping mouse	1	--	17	43	--	--
Total	100	100	100	100	928.0	825.6

1/ Percent of small mammals captured within each habitat type.2/ Animals per mi².

TABLE 2-20
MEDIUM-SIZED AND LARGE MAMMAL SPECIES OBSERVED IN THE
STUDY AREA

<u>Species</u>	<u>Habitat</u> ¹				<u>Minimum Fall</u> <u>Population</u> ²
	<u>Agricultural</u>	<u>Prairie</u>	<u>Wetland</u>	<u>Wooded</u>	
Raccoon	79	16		5	1.18 + .88/mi ²
Long-tailed weasel	67	17		16	P
Mink	100				P
Badger	33	67			P
Striped skunk	83	14		3	1.82 + .68/mi ²
Coyote	20	70		10	.22 + .14/mi ²
Red fox	68	29		3	.64 + .24/mi ²
Fox squirrel				100	P
Porcupine	50			50	P
White-tailed jackrabbit	57	42		1	1.92 + .40/mi ²
Eastern cottontail				100	
Mule deer				100	P
White-tailed deer	40	20	7	33	11
Pronghorn	73	27			32

¹ Percent of observations.

² P = presence in low numbers or incidentally. Confidence limits about density estimates are equal to the standard error of the mean. Whole number indicates estimated numbers present on the 49 square-mile study area.

Source: Woodward-Envicon, Inc., Analysis, 1974.

within, or partly within, the study area; a bachelor herd of five males was also present. During two aerial surveys conducted in July and September, 65 and 37 pronghorn, respectively, were counted. The July survey revealed 11 males, 27 females, and 27 juveniles; the September survey showed 8 males, 15 females, and 14 juveniles. Reproductive success was excellent at 0.98 juveniles/female. A total of 32 pronghorns had their entire range within the study area; an additional 38 had ranges partly within the study area. Fall movements suggest a wintering area for a herd of about 21 pronghorn in Beulah Trench near the center of the study area.

The same large mammals occur in the vicinity of the product pipeline except that the pronghorn becomes less numerous east of the Missouri River.

2.2.3.3 Amphibians and Reptiles

Ten species of amphibians and reptiles were observed in the plant-mine study area (Table 2-21). Aside from the northern leopard frog, which was very common, the plains garter snake was the most commonly encountered species.

2.2.4 Aquatic Systems

2.2.4.1 Renner Bay (Lake Sakakawea)

a. Fish

Twenty-five species of fish were collected from Renner Bay during the field study (Table 2-22) by the use of gill nets, seines, and electroshocking. Species composition and measurements are shown in Appendix G. Goldeye was the most abundant species taken comprising 59.4 percent of the gill net catches. Other species were carp (11.2 percent), white sucker (8.0 percent), walleye (7.1 percent), sauger (3.4 percent), river carpsucker (3.3 percent), and yellow perch (3.0 percent). Electroshocking also indicated goldeye to be the most abundant species, followed by carp, walleye, yellow perch, and white sucker. Species composition of fish captured by seining differed from those captured by gill nets and electroshocking. Emerald shiners comprised 59 percent of the total catch, while yellow perch made up 32.8 percent.

Young-of-the-year emerald shiners, yellow perch, carp, white sucker, and white bass were collected in seine hauls. Carp were observed spawning from early June to mid-August. Eggs of another species (probably one of the shiners) were found attached to aquatic plants in shallow water.

b. Benthos

Eighteen macroinvertebrates of various taxonomic levels were collected from Renner Bay (Appendix G). Chironomidae were the most abundant with densities ranging from 33.3 to 1,095.2 larvae/m². There was no apparent difference in average midge densities among all benthic sample stations. Aquatic earthworms made up 20.2 percent and midge larvae 70 percent of all benthic macroinvertebrates collected.

c. Plankton

Plankton studies of Renner Bay indicate a low-standing crop and a highly mineralized environment. Most phytoplankton found (Appendix G)

TABLE 2-21

**AMPHIBIANS AND REPTILES OBSERVED ON AND IN THE VICINITY OF THE
STUDY AREA**

Species	Agricultural	Habitat ¹			Total
		Prairie	Wetland	Wooded	
Blotched tiger salamander	4	-	-	-	4
Great plains toad	-	1	-	-	1
Rocky Mountain toad ^b	-	-	-	1	1
Northern leopard frog ^c	-	-	-	-	-
Western painted turtle	-	-	14	1	15
Plains garter snake	6	8	19	-	33
Red-sided garter snake	3	-	5	1	9
Western hog-nose snake	1	-	-	-	1
Yellow-bellied racer	5	8	-	-	13
Smooth green snake	-	2	-	1	3
Bull snake	5	-	-	-	5

¹Number of observations in habitat.

²Observed only along the Knife River.

³Observations of the northern leopard frog were not recorded due to their extreme abundance in wetland areas.

Source: Woodward-Envicon, Inc., Analysis, 1974.

TABLE 2-22

**FISH COLLECTED FROM AQUATIC ECOSYSTEMS IN MERCER COUNTY,
NORTH DAKOTA, MAY THROUGH OCTOBER**

Species	Lake Sakakawea	Knife River Drainage	Ponds
Shovelnose sturgeon	X		
Goldeye	X	X	
Coho salmon	X		
Rainbow trout	X		
Northern pike	X	X	
Lake chub		X	
Carp	X	X	
Brassy minnow		X	
Plains minnow	X		
Flathead chub	^a	X	
Emerald shiner	X	X	
Sand shiner		X	
Northern redbelly dace	X	X	X
Fathead minnow	X	X	X
Blacknose dace		X	
Creek chub	X	X	
River carpsucker	X	X	
White sucker	X	X	
Smallmouth buffalo	X		
Bigmouth buffalo	X		
Shorthead redhorse	X	X	
Channel catfish	X	X	
Stonecat		X	
Black bullhead		X	
Burbot	X		
Brook stickleback			X
White bass	X		
Iowa darter	X	X	
Johnny darter	X	X	
<u>Etheostoma rigrum</u>			
Yellow perch	X		
Sauger	X	X	
Walleye	X	X	
Freshwater drum	X		
Total	25	22	3

Source: Woodward-Envicon, Inc., Analysis, 1974.

are either tolerant of a wide variety of conditions or are found specifically in highly mineralized environments. Most of the zooplankton, likewise, are known to occur in a wide variety of limnetic environments.

Twenty-eight zooplankton taxa were identified including 7 Copepoda, 6 Cladocera, 11 Rotifera, and 1 each of Protozoa, Chironomidae, Nemata, and Oligochaeta. Density was highest in late July (29.1 organisms/l) and lowest in September (16.6 organisms/l). Copepoda clearly predominated, comprising 59 to 91 percent of the total.

One hundred two phytoplankton taxa were found including 10 centric diatoms, 79 pennate diatoms, and 13 others (5 Chlorophyta, 3 Cyanophyta, 2 Pyrrophyta, 2 Chrysophyta, and 1 Euglenophyta). Phytoplankton density was highest in late June (240.8 cells/ml) and lowest in September (21.6 cells/ml). Pennate diatom density was 84 to 91 percent of total phytoplankton density throughout the study.

d. Rooted Aquatic Plants

Macrophytes were not abundant. The dominant submergent was sago pondweed. Very sparse growth of a broad-leaved pondweed was seen in portions of the bay. Smartweed was the most abundant subaquatic.

2.2.4.2 Knife River Basin

a. Fish

Twenty-two species of fish were collected from the Knife River and Spring Creek (Table 2-23). Measurements and numbers collected are presented in Appendix G. Minnows were 83.2 percent of the total fish collected, with sand shiners representing 70 percent of this total. Suckers accounted for 12.9 percent and gamefish less than 1.0 percent of the total. The carp, flathead chub, sand shiner, fathead minnow, blacknose dace, white sucker, shorthead redhorse, and Iowa darter were collected each month of the study. The walleye, stonecat, creek chub, and northern red belly dace were taken five of the six sample periods.

Young-of-the-year black bullheads were captured in drift nets. Young-of-the-year carp, sand shiner, river carpsucker, shorthead redhorse, white sucker, and channel catfish were also collected from the river drainage.

b. Benthos

Although siltation was evident, a diverse macroinvertebrate population was found in the Knife River drainage; 63 various taxonomic levels

TABLE 2-23
OF FISH
TOTAL NUMBER FOR EACH SPECIES TAKEN FROM EACH AREA OF THE
KNIFE RIVER DRAINAGE

Species	Spring Creek ¹		South Fork ²	Lower Area ³	
Goldeye			1		
Northern pike	4	2			
Lake chub			3		
Carp	32	86	21	33	21
Brassy minnow		1			
Flathead chub		8	76	48	9
Emerald shiner				1	
Sand shiner	811	602	940	1685	708
Northern redbelly dace	2	3	4		
Fathead minnow	2	24	73	243	50
Blacknose dace	8	69	16	18	3
Creek chub	1		30	8	10
River carpsucker			10	2	1
White sucker	203	258	79	30	27
Shorthead redhorse	28	64	45	57	71
Channel catfish				18	10
Stonecat		10	5	4	
Iowa darter	5	4	4		
Sauger				1	1
Walleye	2		3		2

¹ Stations 1 and 3

² Station 2

³ Stations 4 and 6

Source: Woodward-Environ, Inc., Analysis, 1974.

were identified (Appendix G), including 10 genera of mayfly nymphs, 11 genera of caddisfly larvae, and 16 genera of midge larvae. A unionoid clam and a crayfish were hand-collected from the drainage. Only minor differences in the species composition existed among six collection stations. Individual taxa varied in numbers between stations and among samples, but differences in habitats sampled and sampler selectivity may have contributed to these variations.

c. Ponds

Three ponds within the study area were surveyed for fish and aquatic macroinvertebrates. The brook stickleback, fathead minnow, and northern red belly dace were all collected from one pond (Table 2-22). Leeches, sideswimmers, dragonfly nymphs, damselfly nymphs, water boatmen, water striders, caddisfly larvae, predaceous diving beetles, crane fly larvae, soldier fly larvae, and a snail were collected from the three ponds.

2.2.4.3 Product Pipeline Route

There are two major types of aquatic ecosystems in the region of the proposed product pipeline: a standing-water (lentic) system, which includes lakes, impoundments, ponds, and wetlands, and a running-water (lotic) system, which includes springs, creeks, and rivers. In general, surface waters in the area undergo wide

seasonal temperature gradients and have relatively high concentrations of total dissolved solids. Most rivers have sluggish currents and are normally turbid. The major impoundments are adequate in respiratory gases and are less turbid than the rivers. Rivers normally have higher concentrations of respiratory gases, due to greater interface mixing.

a. North Dakota

The major standing-water ecosystems which border or are in the proposed pipeline route in North Dakota are Lake Sakakawea, Lake Audubon, and the lakes of the Devils Lake complex. Other lentic systems include many unnamed perennial potholes, lakes, ponds, and wetlands, plus numerous unnamed intermittent potholes and wetlands. Major running-water systems were listed in Table 2-7 and Figure 2-18.

The major fishing waters in North Dakota which may be affected by pipeline construction include:

1. The lower reaches of the Knife River supports an excellent sauger and walleye sports fishery. In the spring these waters are important as walleye, sauger, and forage fish spawning and nursery habitat.
2. The Missouri River near Washburn supports a commercial fishery (buffalo fish, bullhead, carp, etc.) and an important sports fishery for pike, walleye, and sauger. In addition, an experimental coho salmon stocking program is taking place at Garrison Fish Hatchery to establish a salmon sports fishery in the Missouri. The first generation of adult spawners is due in 1977.
3. Lakes Sakakawea and Audubon provide excellent habitat for both warm- and cold-water species, and thus support a sports fishery of national importance.
4. Devils Lake supports an excellent northern pike fishery, as well as a white bass and walleye sports fishery. Because of salinity problems, the fishery is managed on a put-and-take basis.
5. The Forest and Red Rivers provide a locally important sport fishery for warm-water species such as northern pike, sauger, walleye, largemouth bass, and smallmouth bass.

Tributaries of the aforementioned streams provide sports fishing of local value during spring runoff. They also provide spawning habitat for spring spawning fish.

b. Minnesota

Minnesota waters to be crossed by the proposed pipeline are the Red River of the North, Snake River, and a perennially flowing drainage canal which flows into the Middle River. The fishery of the Red River was outlined above and that of the Snake River is similar.

2.2.5 Unique Biological Resources

2.2.5.1 Unique Ecosystems

A unique community is one which is extremely limited in extent or occurrence and/or possesses attributes of special academic interest. One such community exists on a small flat-topped butte at T. 145 N., R. 88 W., 1.25 miles northwest of the proposed mine boundary. The flat top represents the level of a former geologic period, most of which has long since eroded away. The plant community is a rare, relict grassland stand which has escaped grazing and tillage. The butte top is roughly triangular with an area of about 0.5 acres. Western wheatgrass was the predominant plant species, comprising 90 percent of the stand. Green needlegrass, fringed sage, needle-and-thread, and plains reedgrass were present in small amounts. A uniform mulch layer of 1.5 inches is present with an additional 0.5 inch of humic mulch.

Wildlife areas that occur in close proximity or adjoin the proposed product pipeline route include the Lewis and Clark State Game Management Area (GMA), south of the route at the Missouri River crossing, the Wolf Creek GMA on the south side of Lake Sakakawea, and the De Trobriand GMA on the north side of Lake Sakakawea. Also, the route passes south of Lake Ardoch NWR in Walsh County and near the Marshall County State Game Refuge in Minnesota. The proposed route is on existing railroad ROW near all of these areas.

2.2.5.2 Endangered Species

The black-footed ferret is the only endangered mammal that might be found in the project area. It is closely associated with prairie dog towns and neither the ferret or any prairie dogs were observed near the plant-mine site. The area is also within the former range of the northern kit (swift) fox; however, the current (July 14, 1977; FR 42:135) List of Endangered and Threatened Wildlife and Plants describes this species as now restricted to Canada.

The project area is within the migratory range of the whooping crane. In fact, two confirmed sightings were recorded for Mercer County during the fall of 1975. The Eskimo curlew possibly migrates through the area if it is not already extinct. It is also possible that the arctic peregrine falcon could be found in the region during migration. No endangered species of fish, amphibians, and reptiles are known to occur in the study area. The product pipeline route has not been checked for the presence or absence of any of these species. However, ANGCGC is committed to a detailed biological survey of the proposed route before final alignment (99).

2.3 Socioeconomic Environment

2.3.1 Demography

Population: The region near the plant-mine site is a predominantly agricultural area with a low population density. The 1970 population in the eight counties within 75 miles of the site was 108,512 (Table 2-24). Mercer, Dunn, and Oliver Counties had a 1970 population of 13,392. Since 1970, however, coal-related developments at Stanton and Center have resulted in some increase in population in the area. A special census in Hazen in August of 1975 showed a population of 1,558; this was an increase of 318 persons over the 1970 population of 1,240 (79). Although special censuses have not been held in other area cities, it is probable that some may also have experienced a population increase (particularly Beulah and Center).

Local Work Force: In 1970, about 14,500 workers in relevant job categories lived within 75 miles of the plant-mine site; more than 6,200 were employed in construction or farming. About 7.2 percent of the civilian labor force in the three major impact counties (Mercer, Dunn, and Oliver) was unemployed as of June 1976 (78). This showed little change from the 1972 rate of 7.3 percent (39). Dunn County has the highest jobless rate (7.8 percent) and Mercer County has the lowest (6.4 percent); Oliver County currently has a 7.3 percent jobless rate.

The 1970 primary work force in construction and construction-related jobs is shown in Table 2-25; the overall secondary work force in related construction is listed in Table 2-26. Unions having membership in the area in 1974 are shown in Table 2-27. Technical workers needed for operation of the gasification plant are not available in the region; some of the maintenance workers could come from the existing blue collar work force.

2.3.2 Economy

Of the 38,262 workers living in the eight counties near the plant-mine site in 1970, nearly 32 percent were engaged in

TABLE 2-24

PROPOSED COAL GASIFICATION PROJECT AREA, U.S. CENSUS SUBDIVISION POPULATION

County	Minor Civil Division (MCD) Subdivision	Count of Persons (Population)	North Dakota City ¹	Count of Persons (Population)
Burleigh	Bismarck	35,496	Bismarck	34,703
	Northeast	788	Wing	223
	Northwest	1,315	Negan	74
	Southwest	1,198	Wilton (P)	116
	Southeast	1,917		
Dunn	Halliday	1,820	Dodge City	121
			Dunn Center	107
			Halliday	413
	Killdeer	1,899	Werner	21
	South Dunn	1,176	Killdeer	615
McLean	Dogden Butte	917	Benedict	72
			Butte	193
			Ruso	15
	Garrison	1,614	Garrison	1,614
	North Central	1,673	Max	301
	South Central	1,196	Wilton (P)	579
	Turtle Lake	1,541	Mercer	132
			Turtle Lake	712
	Underwood	1,971	Coleharbor	78
			Underwood	781
Mercer	Washburn	804	Washburn	804
	West McLean	1,535		
	Beulah	1,344	Beulah	1,344
	East Mercer	1,653	Pick City	119
			Stanton	517
Morton	Hazen	1,240	Hazen	1,240
	West Mercer	1,938	Golden Valley	235
			Tap	271
	Central Morton	1,105	Almont	109
	Flasher	1,113	Flasher	467
Morton	Glen Ullin	1,070	Glen Ullin	1,070
	Hebron	1,103	Hebron	1,103
	Mandan	11,093	Mandan	11,093
	Mandan North	1,859		
	Mandan South	1,227		
Oliver	New Salem	943	New Salem	943
	West Morton	717		
	Center	1,604	Center	619
	West Oliver	718		
Sheridan	East	1,090	Goodrick	300
	North	828	Martin	120
	Southwest	1,314	McClusky	664
Stark	Belfield	1,130	Belfield	1,130
	Dickinson	13,089	Dickinson	12,405
	Dickinson North	1,154	Gladstone	222
	Dickinson South	841		
	East Stark	2,319	Richardton	799
Stark	West Stark	1,080	Taylor	162
			South Heart	132
Regional Totals	40 MCD's	108,512	42 Cities	76,738

¹ Any incorporated place.

(P) = partial incorporation in U.S. Census subdivision.

Source: 1970 Census 1st count.

TABLE 2-25

CENSUS OF PRIMARY WORK FORCE IN RELATED CONSTRUCTION JOBS, 1970

County	Work Force		
	Construction	Farmers	Farm Laborers
Burleigh	1,600	705	178
Dunn	68	833	163
Mercer	151	592	107
McLean	261	1,032	166
Morton	533	787	423
Oliver	42	441	49
Sheridan	76	483	114
Stark	330	841	259
Subtotal	3,061	5,714	1,459
Total for Construction			10,234

Source: Thomas K. Ostenson. 1972. North Dakota employment characteristics by counties. North Dakota Agricultural Experiment Station. Fargo, North Dakota.

TABLE 2-26
SECONDARY WORK FORCE AVAILABLE IN RELATED
CONSTRUCTION JOBS, 1970

<u>Counties</u>	<u>Craftsmen Foremen</u>	<u>Operatives</u>	<u>Laborers</u>	<u>All Farmers</u>	<u>Laborers</u>	<u>Transport</u>
Burleigh	1,821	646	411	705	178	419
Dunn	95	18	27	833	163	30
McLean	334	86	84	1,032	166	83
Mercer	296	96	131	592	107	81
Morton	937	363	233	787	423	294
Oliver	78	11	18	441	49	0
Sheridan	92	18	517	483	114	25
Stark	638	356	231	841	313	223
Sub total	4,291	1,594	1,652	5,714	1,513	1,155
Total						15,905

Source: Thomas K. Ostenson. 1972. North Dakota employment characteristics by counties. North Dakota Agricultural Experiment Station. Fargo, North Dakota.

TABLE 2-27
CONSTRUCTION RELATED UNIONS IN NORTH DAKOTA, 1974

<u>Union</u>	<u>Local No.</u>	<u>Address</u>	<u>Jurisdiction</u>	<u>Members</u>	<u>Journeyman Wage per Hour</u>
Asbestos Workers	133	1641 N. 10th St., Fargo	N.D.	40	\$7.69
Boilermakers	647	117 S.E. Forest St., Minneapolis	N.D., S.D., Minn.	2000	8.90
Bricklayers	4	Rt. 4, Box 9A, Mandan	SW part of N.D.	75	7.13
Carpenters	1091	1323 E. Front Ave., Bismarck	Parts of west N.D.	NA	6.55
Cement Masons and Plasterers	897	107-6th Ave., N.W., Mandan	Parts of west N.D.	29	6.07
IBEW	714	Hwy. 83 North, Minot	Western N.D.	274	7.30
Homeworkers	793	403-7th Ave. N., Fargo	N.D.	343	7.80
Laborers	580	P.O. Box 1602, Grand Forks	N.D.	900	5.67
Millwrights	1091	1323 E. Front Ave., Bismarck	Parts of west N.D.	NA	7.56
Operating Engineers	49	P.O. Box 686, Bismarck	N.D.	NA	5.85
Painters	1962	911 Curtis Ave., Bismarck	N.D.	NA	5.65
Plumbers and Pipefitters	795 & 627	1323 E. Front Ave., Bismarck	Western N.D.	246	7.45
Sheetmetal Workers	553	120-19th St., S.E., Minot	All N.D. exc. SE part	125	7.90
Teamsters	123	1323 E. Front Ave., Bismarck	SW part of N.D.	NA	4.92

NA - Not Available

Source: Bismarck-Mandan Building and Construction Trades Council, 1974.
(Compilation of data submitted by each union listed in table)

finance and service industries, 22 percent in wholesale and retail trade, and 19 percent in agriculture (Table 2-28). The work force had a well balanced occupational structure--42 percent were professional and other white collar workers; 40 percent were blue collar workers, farmers, or farm workers; and 15 percent were service workers (Table 2-29). The eight county area contained over 5,700 farmers or farm managers, about 1,500 farm workers, and 8,300 other blue collar workers.

Although Mercer, Dunn, and Oliver Counties are predominantly agricultural, 211 small industrial firms were operating within these counties in 1972 (Table 2-30). In 1969, nearly 40 percent of the 1,961 farms in these counties were over 1,000 acres (40).

The three major impact counties had a combined taxable real estate valuation of about \$16.5 million in 1975 (Table 2-31). Taxable valuation is legally prescribed at 50 percent of the market value of real property. However, the Sales Ratio Study conducted in 1976 by the State Supervisor of Assessments for the purpose of comparing the 1975 assessed value of properties with their actual selling prices shows that assessments averaged only 11.7 percent of market value in Dunn County, 9.9 percent in Oliver County, and 8.9 percent in Mercer County. (The State average is 12.3 percent.)

The State may legally levy up to 4.00 mills annually on the taxable valuation of local property for the State Medical Center, but only 1.00 mill has been levied in recent years. Taxes levied on taxable property within the three impacted counties but outside of a municipal boundary include the State levy, county levy, unorganized township road and bridge levy, school district levy, and rural fire protection levy. Taxable property within a municipality is subject to the State and county levy, city levy, school district levy, a fire protection district levy, and often a park district levy. The State-wide average total property tax mill levy in 1975 was 183 mills.

The major source of revenues for the three counties in 1975 was from the general property tax levy and the special tax levy on any mobile homes, rural electric cooperatives, banks, trust companies, savings and loan associations, and mutual, cooperative, and small commercial telephone companies. Total revenues expected from property taxes levied in 1975 upon the various classes of property in each county were:

TABLE 2-28
EMPLOYMENT¹ BY INDUSTRY AND BY COUNTY, 1970

County	Agriculture	Mining	Construction	Manufacturing	Transportation, Communication, Public Utilities			Finance, Services	Government	Total	Percentage	
					Trade	Finance, Services	Government				Agriculture	Trade
Burleigh	942	42	1,600	841	1,121	3,844	5,819	1,654	15,866	5.9		60.9
Dunn	996	5	68	0	31	198	297	95	1,690	58.9		29.3
McLean	1,224	13	261	41	135	650	1,033	157	3,514	34.8		47.9
Mercer	713	115	151	9	245	349	459	91	2,132	33.4		37.9
Oliver	495	9	42	7	62	44	87	33	779	63.5		16.8
Sheridan	593	0	82	9	21	171	213	29	1,118	53.0		34.4
Stark	1,136	142	330	364	385	1,632	2,454	199	6,642	17.1		61.5
Morton	1,249	7	533	496	627	1,540	1,741	328	6,521	19.1		50.3
Total	7,348	333	3,067	1,767	2,627	8,428	12,103	2,586	38,262	19.2		53.6

¹Number of persons reported in 1970 Census.

Source: 1970 Census Data, Fourth Count, File B, MCD Reports.

Department of Agricultural Economics, North Dakota State University, 1972. North Dakota Employment Characteristics by Counties.

TABLE 2-29
EMPLOYMENT¹ - OCCUPATION BREAKDOWN BY COUNTY, 1970

County	Professional and Management	%	Farmers and Farm Managers	%	Farm Workers	%	Other ² Blue Collar	%	Other ² White Collar	%	Services ²	%	Total
Burleigh	4,795	30.2	705	4.4	178	1.1	3,297	20.8	4,407	27.8	2,484	15.7	15,866
Dunn	220	13.0	833	49.3	163	9.6	170	10.1	168	9.9	136	8.0	1,690
McLean	747	21.3	1,032	29.4	166	4.7	587	16.7	460	13.1	522	14.9	3,514
Mercer	346	16.2	592	27.8	107	5.0	604	28.3	210	9.8	273	12.8	2,132
Oliver	59	7.6	441	56.6	49	6.3	107	13.7	66	8.5	57	7.3	779
Sheridan	152	13.6	483	43.2	114	10.2	169	15.1	131	11.7	69	6.2	1,118
Stark	1,467	22.1	841	12.7	259	3.9	1,490	22.4	1,422	21.4	1,163	7.5	6,642
Morton	1,314	20.2	707	12.1	423	6.5	1,827	28.0	1,120	17.2	1,050	16.1	6,521
Total	7,917	20.7	5,714	14.9	1,459	3.8	8,251	21.6	7,984	20.9	5,754	15.0	38,262

¹Number of persons reported in 1970 Census.

²Categories listed in table are composed of the following occupations: Other White Collar - sales and clerical workers; Other Blue Collar - craftsmen and foremen, all operatives and non-farm laborers; Service - all service and private household workers.

Source: 1970 Census Data, Fourth Count, File B, MCD Reports.

Department of Agricultural Economics, North Dakota State University, 1972. North Dakota Employment Characteristics by Counties.

TABLE 2-30
**NUMBER AND TYPES OF INDUSTRIES IN
THE THREE-COUNTY AREA, 1972**

Industry	Dunn	Mercer	Oliver
Agricultural Services	0	0	0
Mining	0	3	1
Construction	4	9	1
Manufacturing	1	3	0
Transportation, Commu- nications, Public Utilities	2	10	2
Wholesale Trade	13	12	2
Retail Trade	31	45	8
Finance	3	8	0
Services	14	35	3
Total ¹	68	126	17

¹Includes firms in miscellaneous categories.

Source: U.S. Bureau of the Census, 1973. County Business Patterns, 1972. North Dakota CBP-72-36. Washington, D.C. U.S. Government Printing Office.

<u>County</u>	<u>Total Property Tax Revenues*</u>
Dunn	\$1,080,453
Oliver	572,564
Mercer	1,157,685

*Total collections might be somewhat less than this figure since not all projected revenues are collected.

Primary State revenues in North Dakota are derived from the 4 percent sales and use tax and the personal and corporate income tax. Sales and use tax revenues generated from the three counties in 1975 were:

<u>County</u>	<u>Total Sales</u>	<u>Taxable Sales</u>	<u>Tax Paid</u>
Dunn	\$10,139,601	\$ 4,100,826	\$163,783
Oliver	1,611,941	793,451	27,172
Mercer	37,143,692	21,721,426	866,577

Table 2-31

TAXABLE VALUATION OF PROPERTY SUBJECT TO GENERAL PROPERTY TAX IN 1975

<u>Taxable Valuation</u>	<u>Dunn</u>	<u>Oliver</u>	<u>Mercer</u>
Total Acres	1,066,420.10	441,556.00	603,991.20
Farm Lands	\$5,611,103.00	\$2,948,171.00	\$3,877,177.00
Other Real Estate	<u>557,566.00</u>	<u>208,387.00</u>	<u>1,913,288.00</u>
Total Real Estate	\$6,168,669.00	\$3,156,558.00	\$5,790,405.00
Personal Property	-0-	-0-	-0-
Railroad and Utility Property	<u>\$ 484,254.00</u>	<u>\$ 241,635.00</u>	<u>\$ 647,596.00</u>
Grand Total	<u>\$6,652,923.00</u>	<u>\$3,398,193.00</u>	<u>\$6,438,001.00</u>

Source: 1976 Statistical Report, 1975 Property Taxes Levied and 1976 Property Tax Valuation, North Dakota Tax Department

The North Dakota coal severance tax on existing mines effective July 1, 1977, was \$0.65/ton escalated on the basis of \$0.01/ton for each one-point increase in the wholesale price index. The revenues received from the severance tax are allocated to the State Coal Development Fund. This fund is divided as follows:

- a. 35 percent to a special fund for distribution to taxing districts impacted by coal development;
- b. 15 percent held in perpetual trust, the income from which goes to the State's General Fund;
- c. 20 percent allocated to the coal producing counties in proportion to the coal removed from the county; and
- d. 30 percent to the State's General Fund.

The 20 percent of the severance tax allocated to the counties is further allocated 40 percent to the county, 30 percent to school districts within the county, and 30 percent to the cities. Loans can be made from the State Trust Fund as a last resort to impacted counties, cities, and school districts for services and facilities at a maximum 6 percent interest rate; the loans would be paid back out of future severance taxes the various entities would receive. The old severance tax was \$0.50/ton escalated \$0.01/ton for each three-point rise in the wholesale price index; allocation was 35 percent to the special fund, 30 percent in trust, 5 percent to the counties, and 30 percent to the General Fund. The first distribution under the new formula will take place in October 1977.

North Dakota also has a coal conversion tax of \$0.10/mcf (or 2.5 percent of gross receipts whichever is greater) that would apply to the proposed gasification plant once it started operation. The tax would be allocated 65 percent to the State and 35 percent to the County; the allocation formula for the monies going to the County would be the same as for the severance tax.

About 38.5 percent of the families in the three county major impact area earned \$8,000 or more in 1969 (Table 2-32); 18.5 percent of the families earned incomes below the 1969 governmentally defined poverty level. The effective buying income of residents in the three counties was estimated to be \$30 million in 1972 (42). Estimated retail sales by this same source was \$15 million.

The economic base of the 14 counties traversed by the proposed product pipeline is primarily agricultural. Table 2-33 presents comparative earnings for seven categories: manufacturing, wholesale trade, retail trade, services, local government, agriculture, and mining for the counties affected by the pipeline in each State. Data on earnings of manufacturing do not represent sale of manufactured goods, but rather the value added as a result of manufacturing.

Wholesale and retail sales are the economic leaders in the area near the pipeline; North Dakota pipeline impact area wholesale

TABLE 2-32
FAMILY INCOME DISTRIBUTION IN THE THREE-COUNTY AREA, 1969

County	Number and Percentage of Families						Families Below Poverty Level		
	0-\$3,999	%	\$4,000-7,999	%	\$8,000+	%	Total	Number	%
Dunn	300	26.5	409	36.1	423	37.4	1,132	226	20.0
Mercer	429	26.3	541	33.2	659	40.5	1,629	289	17.7
Oliver	147	24.6	240	40.2	210	35.2	597	109	18.3
Total	876	26.1	1,190	35.4	1,292	38.5	3,358	624	18.6

Source: 1970 Census Data, Fourth Count, File B, MCD Reports. Department of Agricultural Economics, North Dakota State University, 1972. North Dakota Income Characteristics by Counties.

Table 2-33
EMPLOYMENT BY COUNTIES AND STATES FOR NORTH DAKOTA AND MINNESOTA*

	UNEMPLOYMENT 1970 PERCENT	MEDIUM FAMILY INCOME 1968 DOLLARS	MANUFACTURING 1967 (1,000)	WHOLESALE 1967 (1,000)	RETAIL 1967 (1,000)	SERVICES 1967 (1,000)	GOVERNMENT LOCAL FEDERAL 1967 1970		FARMING 1969 (1,000)	MINERAL INDUSTRY 1967 (1,000)
MERCER	3.6	6,710	(D)	52	193	41	200	37	1,330	200
OLIVER	1.8	6,529	(D)	(D)	19	(D)	92	10	1,052	NA
MC LEAN	6.2	7,092	(Z)	106	360	59	384	239	3,227	NA
WARD	4.9	8,370	.6	894	3,076	844	1,328	959	3,230	NA
MC HENRY	5.7	6,890	(Z)	82	250	21	306	76	2,404	NA
SHERIDAN	2.7	6,278	(D)	18	71	6	98	37	1,404	-
PIERCE	3.3	7,144	(D)	44	280	39	150	45	1,428	-
BENSON	9.2	6,318	(Z)	75	151	15	296	117	2,238	-
RAMSEY	4.6	8,179	.1	189	954	142	329	181	2,134	-
NELSON	4.7	6,318	(D)	81	229	49	262	44	1,668	NA
GRAND FORKS	4.3	8,458	.9	731	3,585	935	1,371	843	4,533	NA
WALSH	4.3	7,440	.2	282	757	118	489	92	5,455	NA
TOTAL	4.6	7,444	1.8	2,554	9,925	2,286	5,294	2,650	30,103	200
STATE OF N.D.	4.7	7,836	7.5	10,681	28,821	6,547	16,896	8,051	106,837	1.9
MARSHALL	12.2	6,244	(Z)	148	1,335	31	416	80	4,398	NA
POLK	5.8	7,677	1.0	504	1,400	97	992	144	8,929	NA
STATE TOTAL	9.0	6,961	--	652	2,735	128	1,408	224	13,327	NA
STATE OF MINN.	4.2	9,981	299.8	71,174	189,338	57,372	100,736	29,286	251,065	12.8

*ADAPTED FROM: U.S. DEPT. COMMERCE, COUNTY AND CITY DATA BOOK, A STATISTICAL ABSTRACT SUPPLEMENT, 1972.

LEGEND

- REPRESENTS ZERO
(D) WITHHELD TO AVOID DISCLOSURE
(Z) LESS THAN 1,000 PERSONS
NA NOT AVAILABLE

earnings totaled \$307 million and retail earnings totaled \$311 million in 1967, compared to \$190 million for agriculture. For the Minnesota pipeline impact area, wholesale earnings totaled \$67 million and retail totaled \$58 million, while agriculture produced \$64 million in earnings. A significant portion of retail and wholesale trade, however, is in support of agricultural activities.

Income and employment statistics for the product pipeline impact area show the North Dakota median family income to be \$7,444 (1969) with the largest employment in farming (Table 2-33). Similarly, median family income in the two county Minnesota area was \$6,961 with farming also the largest employer.

2.3.3 Community Services

Education: Each of the nine towns near the plant-mine site is represented by a different school district. These districts operate independently under the direction of the superintendent of schools in their district. Enrollment figures for the school years 1972-73 and 1975-76 are shown in Table 2-34. Enrollments have increased in the Beulah, Hazen, Center, and Dodge districts and have remained about the same or decreased in the Juzeler, Pick City, Stanton, Zap, and Halliday districts. The average annual education expense per pupil in 1975-76 was \$901.73.

No colleges, technical, vocational, or trade schools are present within Mercer, Dunn, or Oliver Counties. The closest post-secondary public schools are Bismarck Junior College (Bismarck) and Dickinson State College (Dickinson). Current total enrollment is 4,304 students. This was an increase of 33 percent between 1973 and 1976. Mary College, a private 4-year college, is also located in Bismarck.

Police Services: Mercer County law enforcement is accomplished through a county sheriff and five deputies; one deputy each in Stanton, Beulah, and Hazen, one shared by Stanton and Pick City, and one shared by Golden Valley and Zap. In addition, Beulah, Hazen, and Stanton each have one full-time city policeman and Hazen has a State Highway Patrol officer.

For other area cities, Center has a full-time city policeman and Dodge and Halliday have part-time city policemen. This is in addition to two sheriff's deputies located at Center.

Fire Services: The volunteer fire department program in the project area is divided into city fire districts and rural protection districts (Table 2-35). Fire protection classification ratings range from 10 to 1; a score of 10 represents no fire protection. This does not mean, however, that no fire protection is available. A community with a score of 10 may have a truck with a small tank, a pressure tank type of water system, or other tools useful in fire protection; but the tools may not be sufficient for a significant risk reduction by insurance underwriters. A score of 9 or less represents a recognized level of fire protection.

Table 2-34

SUMMARY OF EDUCATIONAL INFORMATION FOR SELECTED SCHOOL DISTRICTS
IN THE WEST RIVER COAL IMPACT AREA

School District	Total Enrollment		1975-1976 Pupil/Teacher Ratio		1974-75 Average Cost
	1972-73	1975-76	Elementary	Secondary	Per Pupil
Beulah	508	529	20.88	15.00	825.18
Hazen	487	515	17.12	18.70	817.69
Golden Valley	130	118	19.25	9.11	838.44
Pick City	252	239	18.80	12.25	1035.16
Stanton	251	244	17.20	16.60	726.49
Zap	121	93	10.33	8.45	1061.15
Center	451	460	18.65	16.29	809.48
Dodge	102	113	14.17	8.25	996.08
Halliday	252	223	13.11	15.00	1005.86

Community Water and Sewer Facilities: In the impact region, the wastewater treatment systems are predominantly waste stabilization lagoons (Table 2-36). The water systems are predominantly small well systems with a treatment plant.

Recreation: Recreation in the three county impact area is primarily outdoor oriented. Lake Sakakawea provides water-oriented recreation such as swimming, boating, hunting, fishing, and picnicking. Local picnic and boating access is available at Beaver Creek Bay, about 11 miles north of Zap; Beulah Bay, 15 miles north of Beulah; and the Hazen Recreation Area 15 miles north of Hazen. Lake Sakakawea State Park, already badly overcrowded during periods of peak use, provides access to the lake at Pick City.

TABLE 2-35
PROJECT IMPACT REGION FIRE DEPARTMENT STATUS
AND FIRE PROTECTION CLASSIFICATION AS OF
NOVEMBER 1, 1973

<u>County</u>	<u>City</u>	<u>Fire Department¹</u>	<u>Fire Protection² Classification²</u>
Dunn	Dodge	No	10
	Dunn Center	Yes	9
	Halliday	Yes	8B
	Killdeer	Yes	8
	Manning	No	10
	Marshall	No	10
	New Hradec	No	10
	Werner	No	10
	Hebron ⁴	Yes	8
	Gladstone ⁴	Yes	9
Mercer	Beulah	Yes	8B
	Beulah Protection District	Yes	8
	Golden Valley	Yes	9B
	Hazen	Yes	8B
	Hazen Protection District	Yes	8
	Pick City	No	NA ³
	Stanton	Yes	9
	Stanton Protection District	Yes	9
	Zap	Yes	9
	Glen Ullin ⁴	Yes	8
	Halliday ⁴	Yes	8
	Hebron	Yes	8
Oliver	Center	Yes	8B
	Fort Clark	No	10
	Hannover	No	10
	Hensler	No	10
	Price	No	NA
	Sanger	No	10
	New Salem ⁴	Yes	8
	Stanton ⁴	Yes	9

¹Arneson, Vance. Fifty-fifth Report of the State Fire Marshal of the State of North Dakota. July 1, 1972 - June 30, 1973.

²The fire protection classification is the rating established by the Staff of Insurance Services Office, 12 South Sixth St., Rm. 1229, Minneapolis, Minn. The classification used in establishing the rating is a composite weighted score based on water supply, fire department, alarm systems, and fire ordinance characteristics. The higher the classification score the lower the level of protection. Scores range from 10 to 1. Rural districts are classified on an ABC system. See text for detailed description of scoring.

³NA indicates data not available.

⁴City is not located in the county but served a portion of the county.

Source: WEI analysis 1974.

Other area recreation facilities include municipal parks, State Game Management areas, country clubs, and a small golf course. The Theodore Roosevelt National Park and Little Missouri Grasslands are about 100 miles west of the impact area. Private recreation facilities (including indoor facilities) have been largely unfeasible because of the limited population in the area.

Table 2-36

COMMUNITY WATER AND SEWER FACILITIES

<u>City</u>	<u>Water Production Rate (gpm)</u>	<u>Water Treatment</u>	<u>Water Treatment Capacity (gpm)</u>	<u>Annual Water Allocation (acre-ft)</u>	<u>Storage Capacity (gpm)</u>
Beulah	600	lime softening chlorination, fluoridation	400	226	680,000
Hazen	1,500	iron removal, chlorination, fluoridation	600	420	400,000
Golden Valley	75	chlorination	75	101	50,000
Zap	80	chlorination	80	112	50,000
Pick City	40	chlorination	40		
Stanton	private wells				

Medical and Social Services: Within Mercer, Dunn, and Oliver Counties there is only one hospital. It is located at Hazen, has a capacity of 39 beds, and is staffed by three physicians (Table 2-37). The current utilization rate is about 7 beds/1,000 residents and the current occupancy rate is 69.2 percent. Although hospitals exist at Turtle Lake, Garrison, Richardton, and Dickinson, the facilities used most often by area residents are those in Hazen and the two hospitals at Bismarck.

Nursing and retirement home facilities are available in Mercer County and the Bismarck-Mandan and Dickinson areas. The facilities outside of Mercer County are not heavily utilized by area residents.

Health clinics in Beulah and Hazen are staffed by three physicians, a general practitioner-surgeon and two general practitioners. These physicians serve about 6,222 persons, a ratio of 1 to 2,074; the U.S. average is about 1 to 700. Presently, one Beulah physician is approaching retirement age, an event that would place area residents in a critical situation. When specialized types of treatment are necessary, area residents visit Bismarck-Mandan physicians. However, care availability on an outpatient basis is limited by distance. No chiropractors, four dentists, one optometrist, and 19 registered nurses comprise the remaining medical personnel in Mercer, Oliver, and Dunn Counties.

The majority of mental health care services are provided to area residents by the Memorial Health Care Center at Mandan and an outreach worker located at Hazen. The center accepts cases primarily by referral and is an outpatient clinic. The outreach worker deals primarily with child welfare. At present both facilities are working at maximum capacity.

The total welfare funds expended in the three major impact counties during fiscal year 1975 were:

Mercer	\$334,435
Dunn	432,267
Oliver	89,758

Included are all categories of Federal, State, and county funding. The figures do not necessarily reflect county welfare costs because funds expended in one county often serve individuals from adjacent counties; e.g., the nursing home located in Mercer County serves Oliver and Dunn Counties as well.

Product Pipeline: The proposed product pipeline route passes through, or runs adjacent to, 45 incorporated or unincorporated

TABLE 2-37

MEDICAL FACILITIES IN THE INVOLVED COUNTIES

County	Hospitals		Nursing Homes		Retirement or Custodial		Clinics		Ambulance Firms
	Number	Beds	Number	Beds	Number	Beds	Number	Physicians	
Burleigh	2	453	3	241	1	126	3	68	2
Dunn	0	0	0	0	0	0	0	0	2
Mercer	1	39	1	40	2	58	2	3	2
McLean	2	78	2	135	2	45	1	3	4
Oliver	0	0	0	0	0	0	0	0	1
Sheridan	0	0	0	0	1	34	0	0	2
Stark	2	151	2	162	1	106	4	17	3
Morton	2	113	1	80	1	60	1	1	6
Total	9	834	9	658	8	429	10	92	22

Source: North Dakota Department of Health. 1973. Summary of Health Facilities and Manpower in North Dakota, Bismarck, N. D.

Fedje, Thomas, P., 1973. Emergency Medical Services in North Dakota; A Plan for North Dakota, Bismarck, N. D.

North Dakota South Central Health Plannings Council. 1974. (Unpublished).

communities in North Dakota and Minnesota (Figure 2-40). Eighteen incorporated cities are affected in North Dakota and two in Minnesota. Data regarding these cities and community services that may be impacted are summarized in Table 2-38.

2.4 Sociocultural Environment

2.4.1 Indian Culture

The proposed plant-mine site is located about 8 miles southeast of the 420,718-acre Fort Berthold Reservation. The water to be marketed would be drawn from Lake Sakakawea, which is bordered by the reservation. The Indians have claimed treaty rights to reservoir water on the reservation and are actively pursuing greater definition and quantification of those rights. They are concerned that sufficient quantities of reservoir water be reserved for all of their present and future needs.

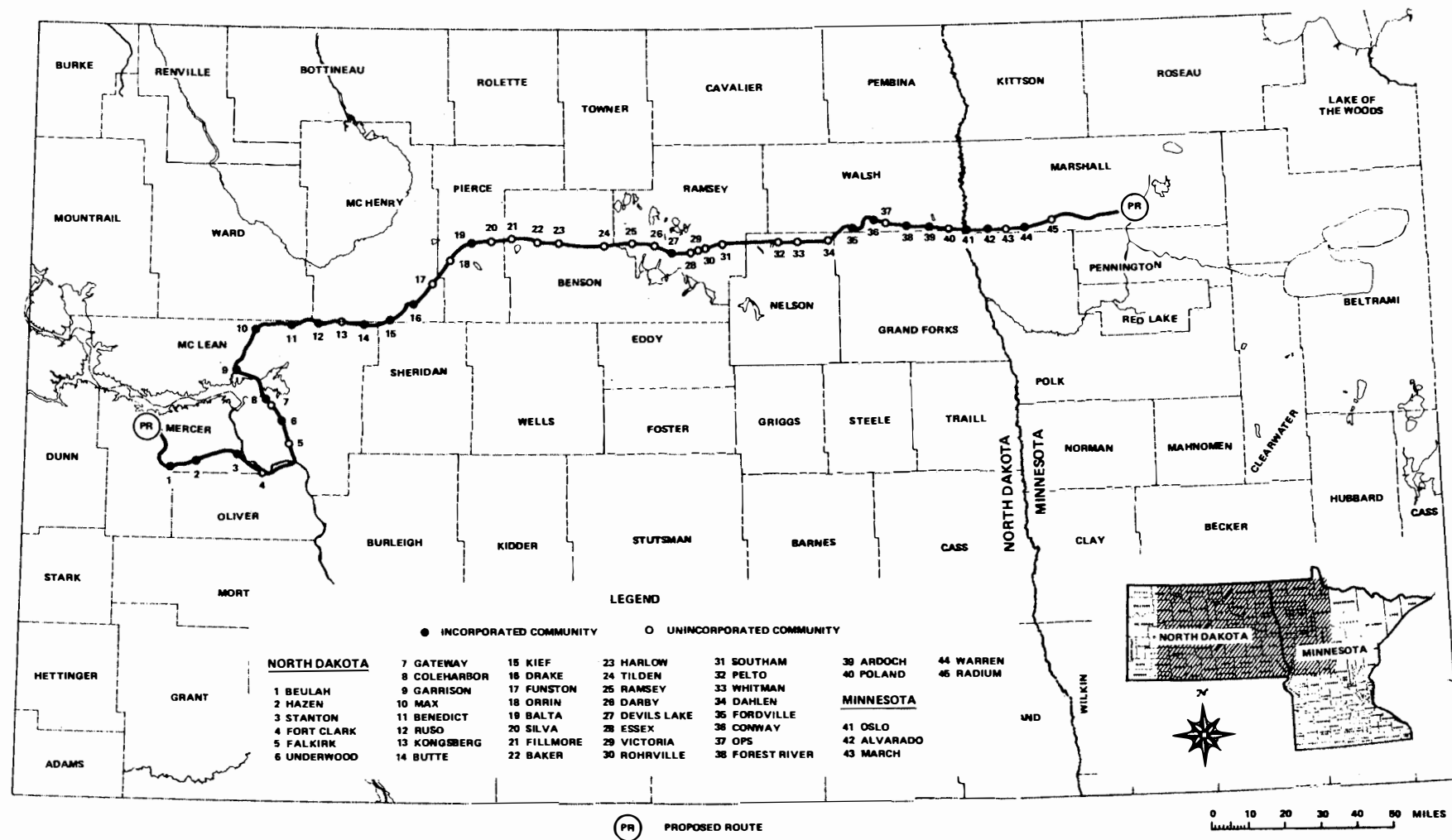


Figure 2-40 COMMUNITIES ALONG THE PROPOSED ROUTE

TABLE 2-38
INCORPORATED COMMUNITIES AFFECTED BY THE PROPOSED PRODUCT PIPELINE

<u>City</u>	<u>County</u>	<u>Population (1970)</u>	<u>Pipeline Route</u>	<u>Other</u>
<u>North Dakota</u>				
Beulah	Mercer	1,344	Through town	-
Hazen	"	1,240	Edge of town	Hospital Adjacent to ROW
Stanton	"	517	"	-
Falkirk	McLean	12	"	-
Underwood	"	781	Through town	Nursing Home 366 ft. from ROW
Coleharbor	"	78	Edge of town	-
Garrison	"	1,614	"	-
Max	"	301	"	-
Benedict	"	72	"	-
Ruso	"	15	"	-
Butte	"	193	Through town	-
Kief	McHenry	46	Edge of town	-
Drake	"	636	"	-
Balta	Pierce	165	"	-
Devils Lake	Ramsey	6,299	N. Edge of town	-
Fordville	Walsh	361	Edge of town	-
Conway	"	57	"	-
Forest River	"	169	"	-
Ardoch	"	70	"	-
<u>Minnesota</u>				
Oslo	Marshall	417	Edge of town	-
Warren	"	1,999	Through town	Hospital 100 ft. N. of ROW
Alvarado	"	302	"	-

Indians of three affiliated tribes (Mandan, Hidatsa, and Arikara) live on or near the Fort Berthold reservation. Reservation leaders have expressed great concern to many State and Federal agencies about the cultural and environmental issues accompanying coal development. The Tribal Council, which is composed of 11 elected members, has placed a moratorium on leasing and other mineral activity affecting the 4 to 20 billion tons of lignite reserves on the reservation (84).

As of May 1976, the Indian population of the Fort Berthold reservation was 3,226, with 3,051 living on the reservation and 175 in close proximity. Unemployment at the same time was 38 percent. Agriculture is the main reservation industry and wages and salaries income for area Indians is derived mainly from a small amount of local industry and the various tribal, Federal, and State agencies providing local services on the reservation.

2.4.2 Non-Indian Culture

The existing non-Indian culture in the three county major impact area might be described as predominantly white (primarily German-Russian), rural, and generally conservative. Many area residents enjoy the rural life style and have become self-reliant and independent. Most of their information on world and national affairs is obtained through television, radio, and newspapers. Because few indoor means of recreation exist in the immediate area and because of the limited merchantile base, area residents often make trips to the Bismarck-Mandan area for these purposes.

2.4.3 Historic and Archaeological Features

No national landmark or historic site is listed in the U.S. Federal Register for the plant-mine area as of February 1977.

Because of the long lead time for construction of the plant and mine and uncertainties about exact pipeline siting, detailed archaeological surveys have not been done in all of the areas to be disturbed by the proposed project. However, ANGCGC and Great Lakes have committed themselves to providing detailed surveys in accordance with the requirements of the National Historic Preservation Act and the State Historical Society of North Dakota (SHS) far enough in advance of construction to allow for proper mitigation (104, 105). Also, the North Dakota Public Service Commission (PSC) requires detailed surveys as part of ANGCGC's application for a Certificate of Site Compatibility under the North Dakota Energy Conversion and Transmission Facility Siting Act (Chap. 28-32 and 49-22, NDCC).

The present status of the required studies is as follows:

1. Plantsite: Detailed survey completed in June 1974.
2. Minesite: Preliminary survey completed in June 1974. Mine 2 is presently being studied by SHS under contract with Basin Electric. Results should be available in REA's EIS. Mine 4 will be studied in early 1977 through an ANGCGC contract; mines 1 and 3 may not be opened for up to 10 years.
3. Water System and Railroad Spur: ANGCGC is to contract for a detailed survey beginning in early 1977.
4. Product Pipeline: Literature search conducted in 1974. Detailed survey to be done prior to construction.

The archaeological surveys of the plant-mine site located eight archaeological sites. Four of the sites consist of tepee rings; the other sites consist of single examples of boulder effigies, burial sites, petroglyphs, and temporary campsites. Two of these sites lie near the plantsite:

1. The Adam Keller Site comprises 10 to 15 acres which served as a temporary prehistoric Indian camp site near a spring; and
2. The August Keller Site was identified in the 1930's as containing teepee rings and Indian burial remains.

The remaining six sites are located in the potential mine area. Of particular interest is a turtle effigy. Turtle effigies, with their outlines formed of prairie boulders, are scarce in the Northern Great Plains. This turtle effigy is one of only two known with its carapace filled with stones. The Voegele Petroglyph Site contains a late prehistoric carving of four deep parallel grooves in a slab of sandstone on top of a high conical hill. Petroglyphs are moderately rare in the region.

In addition to the eight sites of archaeological significance, two cemeteries (Boeckel and Saron) border the mine area. Also, two German-Russian mud houses, one on the plantsite and one in the mine area, are of possible historical significance.

A survey of the available literature indicates that the railroad ROW's utilized for the proposed product pipeline currently cross 5 archaeological or historical sites in North Dakota and that 19 more may be in close proximity (Figure 2-41; Table 2-39). These sites all are located in 4 counties and include 4 mound

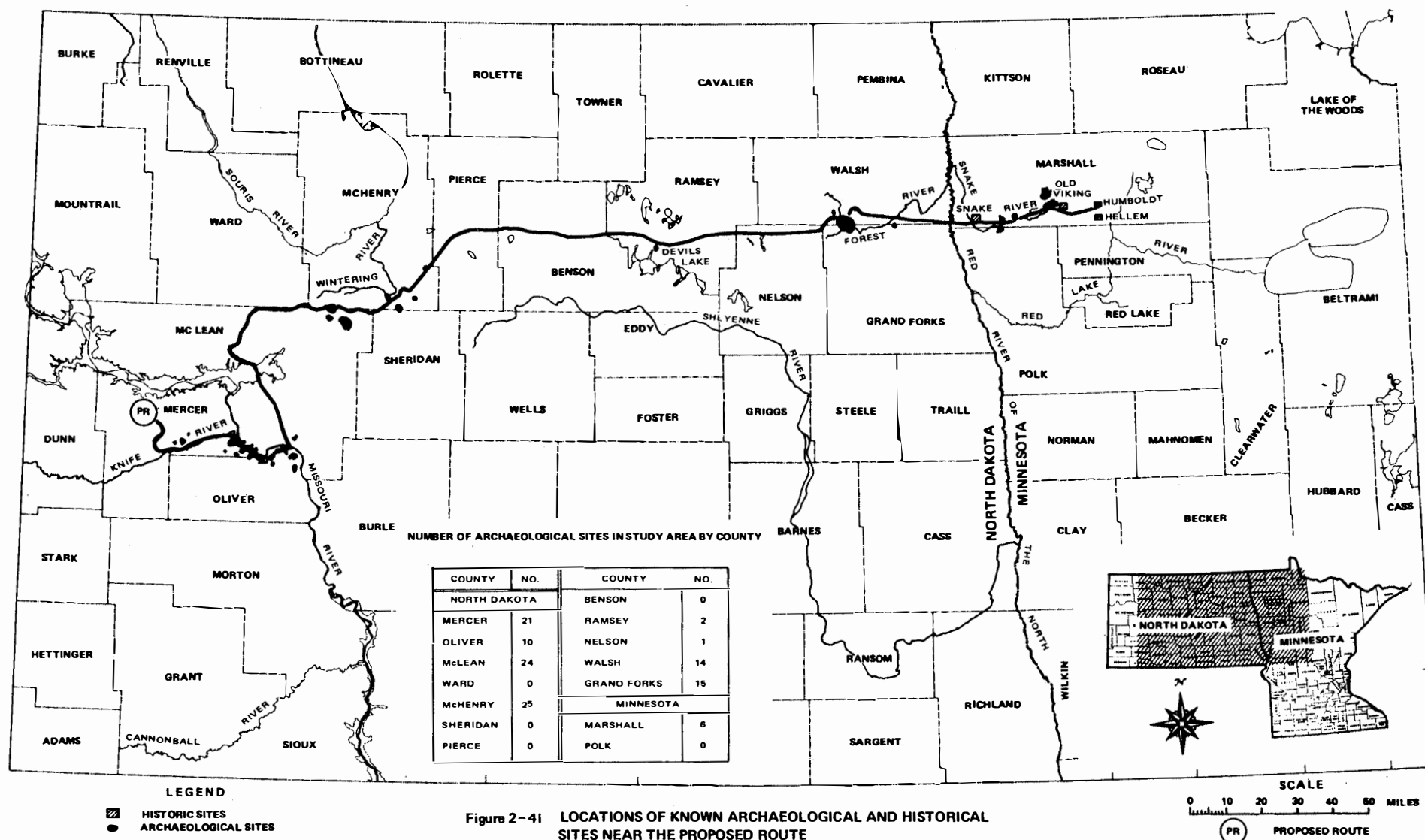


Figure 2-41 LOCATIONS OF KNOWN ARCHAEOLOGICAL AND HISTORICAL SITES NEAR THE PROPOSED ROUTE

Table 2-39

ARCHAEOLOGICAL SITES ALONG THE PROPOSED ROUTE

<u>Site Designation</u>			<u>Type</u>	<u>Potential Impact</u> (If Disturbed)
*	32ME2	Fort Clark	Early Historic Forts, Village Site, and Indian Cemetery	Major - State Historic Site
*	32ME7	White Buffalo Robe	Early Village Site	Major - High Research Potential
	32OL20	Connelly Site	Early Village Site	Major - High Research Potential
	32OL21	Mandan Lake	Multi-Component Village	Major - High Research Potential
	32OL22	Mahhaha	Multi-Component Village	Major - High Research Potential
*	32WA1 ^{1/}	Fordville Mound Group	77 Mound Group	Major - High Research Potential
	32OL19	Dennison	Village Site	Medium - Medium Research Potential
	32OL18	Hensler	Village Site	Medium - Medium Research Potential
+	32ME4	Alderin Creek Site	Village Site	Medium - Medium Research Potential
+		Lyman Aldren Site	Village Site	Medium - Medium Research Potential
	32ME5	Deapolis	1804 Mandan Village	Medium - Medium Research Potential
*+		Earthlodge Village	Village Site	Unknown - Insufficient Data
+			Village and Cemetery	Unknown - Insufficient Data
+		Boller	Village Site	Medium - Medium Research Potential
	32ME202		Village Site	Medium - Medium Research Potential
+			Mounds	Unknown - Insufficient Data
+			Small Habitation Site	Unknown - Insufficient Data
+			Small Habitation Site	Unknown - Insufficient Data
+			Small Habitation Site	Unknown - Insufficient Data
+			Small Habitation Site	Unknown - Insufficient Data

* Sites Crossed by Railroad

+ Unassigned

1/ Nominated to the National Register of Historic Places.

sites, 4 camp sites, 15 earthlodge village sites, some of which are historic, and an early fort (Ft. Clark) with an adjacent Indian burial ground.

In Mercer County proximal sites which may be affected by the proposed project include six village sites and one mound site. All six sites in Oliver County are village sites; as are four small sites in McHenry County. Toward the eastern end of the proposed route in Walsh County there is one mound site which may be within the proposed route.

Of the five sites presently crossed by the railroad, three are on the west bank of the Missouri: 1) White Buffalo Robe Site, an 18th century village; 2) another earthlodge village; and 3) Fort Clark, a State historic site. In addition, the Fordville Mound Group (Walsh County), consisting of 77 mounds, is traversed by the railroad.

Six known archaeological sites lie near the proposed pipeline route in Marshall County, Minnesota. One mound site on the Cambell Beach was built by members of the Arvilla culture; the cultural affiliation of another mound site is unknown. Three of the sites are habitation areas: one Archaic, one Blackduck focus, and one of unknown culture. The sixth site is in a gravel pit area.

2.5 Future Environment Without the Proposed Project

Even without the proposed project it is probable that some coal-related development would take place in the area near the plant-mine site. It is probable that the Coyote powerplant south of Beulah would be built and that the proposed Basin Electric powerplant would also be built. Because NACCO has the lease options on the lignite to be used for the proposed project, the coal may still be mined for other uses if the proposed gasification plant were not built--perhaps by Basin Electric.

The results of such development would be a rapid population increase in local communities for the foreseeable future, disturbance of land for strip mining, and a reduction in local air quality in the three county region.

CHAPTER 3
ENVIRONMENTAL IMPACTS OF
PROPOSED ACTION

3. Environmental Impacts of the Proposed Action

3.1 Impacts on the Physical Environment

3.1.1 Air

3.1.1.1 Climate

The proposed project should not significantly alter the temperature or humidity of the general area, although some minor changes could occur in the microclimate of the immediate plantsite. Heat emitted by the gasification plant would consist of heat exchanged in water cooling towers, heat from the flue gases, heat dissipated in air coolers, and heat dissipated from individual process units. Overall, the heat discharged into the atmosphere would be insignificant compared to the absolute heat content of the surrounding air.

Water vapor released from the evaporative cooling towers and other processes could cause a cloud to form over the site on cold mornings and perhaps localized ground fog. The generally low humidity of the ambient air, however, should adequately absorb the water vapor during most of the year. Thus, the climate of the area would not be significantly impacted by the proposed project.

3.1.1.2 Air Quality

a. Dust

The major sources of fugitive dust during construction of the plant and mine would be from handling loose dirt and fine aggregates, vehicular travel, blasting, grading, and wind erosion of disturbed areas. Major sources of fugitive dust during operations would be from mining activities such as vehicular travel, mining, blasting, coal loading, wind blowing over disturbed land and spoil piles, and reclamation.

There would be an increase in ambient dust levels due to the proposed project. Generally, the sources of fugitive dust above would be localized and largely intermittent. With proper dust abatement practices (Section 4.2.1.2), ambient dust levels should not be significantly greater than current levels that might occur during periods of heavy agricultural activity.

b. Emissions

(1) Construction

Combustion sources of air pollutants during construction of the plant and mine include heavy and light duty engines in equipment,

space heaters, boilers, dryers, and some open burning of debris. The number and types of equipment to be used during construction are unknown at this time and would vary during different stages of construction. However, tentative onsite emissions (Table 3-1) and downwind ground concentrations of pollutants (Table 3-2) were calculated assuming that diesel engines consume 200 gallons of fuel in a 16-hour workday and gasoline engines would consume 20 gallons; also, that 20 of each type of engine ran continuously for the entire 16-hour workday (Appendix I). The estimated ground-level concentrations (0.5 and 1.5 miles downwind) associated with construction are within Federal and State ambient air standards; possible impacts associated with these pollutants are discussed in Section 3.1.1.3.

Air pollution during construction of the product pipeline would result from the generation of fugitive dust and emissions from construction vehicles. Construction activities at any one point would be completed in a 30-day period so impacts would be limited to this time period. Construction at the Missouri River crossing would last about 50 days.

Estimated emissions from construction equipment per mile of pipeline construction are shown in Table 3-3. The overall impact of these emissions on existing air quality would be small.

Fugitive dust is likely to be generated during all phases of construction along the product pipeline route, but two portions of the route (between Beulah and Stanton and between Kief and Balta) are particularly susceptible to wind erosion due to sandy and

TABLE 3-1

Probable Maximum Onsite Engine Emissions
During the Plant Construction Phase

<u>Probable Maximum Onsite Engine Emissions</u>		
<u>Pollutant</u>	<u>lbs/hr</u>	<u>lbs/16-hr day</u>
Suspended Particulates	3.43	54.88
Sulfur Oxides (as SO ₂)	6.83	109.28
Carbon Monoxide	57.25	916.00
Hydrocarbons	9.38	150.08
Nitrogen Oxides (as NO ₂)	92.68	1,482.88
Fugitive Dust	1,025.80	16,412.80

TABLE 3-2
Estimated Ground-level Pollutant Concentrations During Construction

Pollutant (ug/m ³)	Averaging Time (hrs)	Maximum Estimated Concentration		North Dakota Standard	Federal Standards		
		I ¹	II ²		Primary	Secondary	Class II Deterioration
SO ₂	1	18.2	12.0	715 ³	-	-	-
	3	2.0	1.1	-	-	1300 ⁴	700 ⁵
	24	0.8	0.4	260 ³	365	-	100 ⁵
NO _x	1	100.2	65.8	200	-	-	-
CO	1	0.3	0.2	40 ⁴	40 ⁴	40 ⁴	-
	8	0.2	0.1	10 ⁴	10 ⁴	10 ⁴	-
HC	3(6-9AM)	2.7	1.5	160 ⁴	160 ⁴	160 ⁴	-
TSP	24	27.8	15.6	150 ⁵	260	150	30

- 1 0.5 mi. downwind of plantsite boundary.
2. 1.5 mi. downwind of plantsite boundary.
3. Maximum concentration.
4. Maximum concentration to be exceeded more than once per year.
5. Maximum increase not to be exceeded more than once per year.
6. Maximum concentration not to be exceeded 1 percent of the time in any 3-month period.

TABLE 3-3

Engine Emissions per Mile of
Pipeline Construction

<u>Pollutant</u>	<u>Emissions (lbs/mile)</u>	
	<u>Diesel Engines</u>	<u>Gasoline Engines</u>
Suspended Particulates	83.2	12.0
Sulfur Oxides	172.8	4.8
Carbon Monoxide	1440.0	64.0
Hydrocarbons	236.8	8.0
Nitrogen Oxides	2368.0	11.2

silty soils. Dust control measures would be used during pipeline construction with particular attention given to the two problem areas (See Section 4.2.1.2 for dust control measures).

(2) Mining

An itemized list of equipment to be used in mining was shown in Table 1-3. The diesel powered equipment would be the major source of emissions. The estimated hourly emissions from the various equipment types are shown in Table 3-4. The concentration of pollutants from these vehicles should decrease rapidly with distance from the active mining area and haul roads, and should not in themselves significantly affect ambient air quality.

(3) Railroad Operations

The estimated emissions (tons/year) from two trains/week traversing the railroad spur during normal operations would be as follows:

<u>NO_x</u>	<u>SO₂</u>	<u>TSP</u>	<u>CO</u>	<u>HC</u>
0.39	0.34	0.57	0.36	0.26

These emissions would be dispersed over the length of the spur and in themselves should not significantly affect ambient air quality.

(4) Product Pipeline Operations

During operations, fugitive dust would be created during periodic inspection and maintenance activities and at daily shift changes. Maximum emissions from the two compressor stations would be:

TABLE 3-4

Expected Vehicle Emissions from Mining Operations

		Emissions					
		Total Fuel Consumption Per Hour (gal)	NO _x lb/hr	HC lb/hr	CO lb/hr	Particulates lb/hr	SO _x lb/hr
Code	Item						
A	STRIPPING EQUIPMENT	17.7	6.54	0.65	3.98	0.23	0.48
B	LOADING EQUIPMENT	34.5	12.76	1.28	7.76	0.45	0.94
C	COAL AND ASH HANDLING EQUIPMENT	49.9	18.46	1.85	11.22	0.65	1.34
E	ROAD CONSTRUCTION AND MAINTENANCE	110.3	40.79	4.08	24.82	1.44	3.00
F	SUPPLY AND MAINTENANCE	30.0	11.10	1.11	6.75	0.40	0.80
I	PERSONNEL TRANSPORT	5.0*	0.38	0.29	2.66	0.05	0.02
K	RECLAMATION EQUIPMENT	50.7	<u>18.76</u>	<u>1.87</u>	<u>11.40</u>	<u>0.66</u>	<u>1.37</u>
	TOTAL		108.76	11.13	68.59	3.88	7.95

*Gasoline only. All others diesel.

NO _x (as NO ₂)	54.6 lbs/hr
SO ₂	Trace
CO	12.2 lbs/hr
HC	4.9 lbs/hr

Since the two compressor stations would be 100 miles apart and the first station would be over 100 miles from the plantsite, the emissions from the compressor stations would not be cumulative and their effect on overall air quality would be minor.

(5) Gasification Plant Emissions

The gasification process is, for the most part, an enclosed and pressurized system. There are, however, two basic categories of atmospheric emissions associated with the gasification plant: (1) those associated with normal plant operations and (2) those that occur intermittently during startup or emergency conditions. During startups, shutdowns, or emergencies, crude process gas would be burned in the startup incinerator or a separate flare system and be vented into the atmosphere. Emissions would consist of water vapor, CO₂, SO_x, and small quantities of NO_x. Such releases would be at high rates, but of a temporary duration, and would have a short-term negative impact on ambient air quality (Appendix I).

Maximum emission rates for the startup incinerator are listed in Appendix B. The scenario used to calculate these emission rates involves the startup of five gasifiers at the same time; three on air and two on oxygen. Initial startup of each phase would probably involve no more than three gasifiers at the same time. Each gasifier would produce at least 15 to 30 percent of its capacity for 2 to 3 days. Initial startup of the entire plant could involve several months before smooth operation was achieved.

Gasifier startups following maintenance shutdowns would occur on an intermittent but regular basis. Starting single gasifiers after these shutdowns would produce emissions as much as 9 percent of the operating time. The maximum amount of crude gas flared during these periods would be 1.3 percent of plant capacity.

The duration and frequency of emergency situations cannot be predicted. All equipment which could become overpressurized during emergencies would be equipped with pressure relief valves connected to the flare system. Maximum emissions from the emergency flares are shown in Appendix B. The most severe emergency situation would involve flaring 50 percent of the crude gas for 5 to 10 minutes; other situations would involve flaring smaller quantities of crude gas. The effect of all types of intermittent flaring on ground-level concentrations of the major pollutants is discussed in Appendix I.

Total gasification plant emissions of the primary pollutants from all sources except the startup and emergency flares are estimated to be as follows:

NO _x (as NO ₂)	1,100 lbs/hr
SO ₂	2,825 lbs/hr <u>1/</u>
TSP	265 lbs/hr
CO	364 lbs/hr
HC	140 lbs/hr

Gaseous streams containing hydrocarbons would be incinerated, but combustion may be incomplete. All of the above values assume full operation of all pollution control equipment at their design levels and an outside power source from the proposed Basin Electric powerplant.

The results of various trace element analyses for the coal to be mined for operation of the gasification and powerplant plants were shown in Table 1-3. In the gasification process most of the arsenic and mercury ends up in the sludge from the evaporators and almost all of the beryllium, boron, fluoride, and lead remains in the ash, and thus, would be buried in the mine (see Section 3.1.2.2).

Maximum ground-level concentrations of pollutants from the gasification plant emissions alone are shown in Table 3-5. The project would meet all applicable Federal and State ambient air standards (see Section 4.1.2.1). Again, it was assumed that the plant would have outside power provided by the Basin Electric powerplant. If the Basin Electric powerplant were not built, it is possible that ANGCGC would have to provide some of their own power by burning coal fines in steam boilers. If this were the case, the ground-level concentrations of many pollutants would be higher than those shown in Table 3-5.

(6) Basin Electric Powerplant

The estimated emissions of the major pollutants for the 880 MW Basin Electric powerplant alone are as follows:

NO _x (as NO ₂)	4,934 lbs/hr
SO ₂	11,832 lbs/hr
TSP	424 lbs/hr
CO	1,135 lbs/hr
SO ₃	438 lbs/hr

These emissions represent 0.5 lb. NO_x, 1.2 lbs. SO₂, and 0.1 lb TSP per MMBtu input. The powerplant would have a 600-foot stack for dispersion of emissions compared to a 400-foot stack for the gasification plant.

1/ Assumes the maximum of 1.7 percent sulfur in the coal.

TABLE 3-5

Maximum Ground-level Pollutant Concentrations Attributable to the
ANGCGC Project ($\mu\text{g}/\text{m}^3$)

Pollutant	Averaging Period	Maximum Estimated Concentration 1/ Existing Point Sources			Current Background Level	National Standards			North Dakota Standards ⁴
		ANG	Subtotal	Ambient Air		Deterioration			
				Primary		Secondary	Class II		
SO ₂	1-Hour	6.0	152.8	158.8	-	-	-	715 ⁴	
	3-Hour	4.0	61.8	65.8	-	1300 ⁵	700 ⁶	-	
	24-Hour	3.0	26.0	29.0	365 ⁵	-	100 ⁶	260 ⁴	
	Annual	2.3	2.4	4.7	< 5.0 ²	80	-	15	60
NO _x	1-Hour	3.0	32.5	35.5	-	-	-	200 ⁷	
	Annual	1.5	0.5	2.0	8.0 ²	100	100	-	100
TSP	24-Hour	8.0	12.7	20.7	260 ⁵	150 ⁵	30 ⁶	150 ⁵	
	Annual	0.8	0.1	0.9	24.0 ³	75	60	10	60

1 The dispersion analysis prepared by ANGCGC is presented in Appendix I; more detailed data are available in the analysis.

2 Seven-month average, September 1975 through March 1976. Monitoring instrument does not detect SO₂ levels below 5 $\mu\text{g}/\text{m}^3$ (56).

3 1975 Annual Average (56).

4 Maximum concentration.

5 Maximum concentration not to be exceeded more than once per year.

6 Maximum allowable incremental increase.

7 Maximum concentration not to be exceeded 1 percent of the time in any 3-month period.

In addition to the major pollutants, various volatile trace elements in the coal also escape with the flue gases from the powerplant into the atmosphere. Several of these elements are known to be harmful to plants and animals at certain concentrations--arsenic, cadmium, fluorine, lead, mercury, and selenium. The proposed powerplant would be equipped with an electrostatic precipitator and a wet-lime scrubber which would reduce the emissions of these elements into the air. Although the exact quantities of trace elements to be emitted by the proposed powerplant are not yet known, the following estimates based on EPA studies of powerplants with similar control devices (108) would be reasonable approximations:

<u>Element</u>	<u>Emission Rate From EPA Study (%)</u>	<u>Emission Rate From Proposed Powerplant (lbs/hr)</u>
Arsenic	5	7.50
Cadmium	4	0.02
Fluorine	8	9.60
Lead	8	8.00
Mercury	98	0.24
Selenium	28	1.40

(7) Total Emissions

Total emissions from all of the above sources are summarized in Table 3-6. The proposed ANGCGC and Basin Electric developments would emit about 6,143 lbs of NO_x, 14,665 lbs of SO₂, and 1,693 lbs of particulates into the atmosphere every hour. In addition, smaller amounts of hydrocarbons, carbon monoxide, and various trace elements would also be emitted. Potential impacts from these various pollutants are discussed in the next section.

3.1.1.3 Cumulative Impact on Ambient Air Quality- ANGCGC and Basin Electric

a. Ambient Air Quality

The estimated maximum ground-level concentrations of major pollutants from the joint operation of the proposed ANGCGC gasification plant and Basin Electric powerplant, along with existing ambient air concentrations, are shown in Table 3-7. Isopleths for SO₂, NO_x, and TSP are shown in Figures 3-1, 3-2, and 3-3, respectively.

These calculations do not include any changes in the existing ambient air concentrations that might occur due to the mining operations (which could be considerable at times) or due to the construction of other coal-related developments in the area such as the Coyote coal-fired powerplant proposed for construction 3.5 miles south of Beulah.

TABLE 3-6

Total Emissions from Proposed ANGCGC and Basin Electric Projects
Near Beulah, North Dakota (lbs/hr)

<u>Developments</u>	<u>NO_x</u>	<u>SO₂</u>	<u>TSP</u>
<u>Construction</u>			
Gasification Plant	61.8	4.6	2.4
Product Pipeline <u>1/</u>	148.7	11.1	6.0
Railroad <u>2/</u>	.4	.3	.6
<u>Operation</u>			
Mining	108.8	8.0	3.9
ANGCGC Gasification Plant	1,100.0	2,825.0	265.0
Basin Electric Powerplant	4,934.0	11,832.0	424.0
Subtotal <u>3/</u>	6,142.8	14,665.0	692.9

1/ Assumes 1 mile/day of construction and a 16-hour work day.

2/ Given in tons/year of railroad construction.

3/ Excludes construction and railroad emissions.

The frequency of occurrence of the meteorological conditions at the plantsite that would produce the maximum concentrations in Table 3-7 has been estimated by ANGCGC to be 0.21 percent. This was based on meteorological records gathered at the plantsite between February 1974 and March 1975. The frequency of similar conditions, based on 10 years of records gathered at Bismarck, was 0.74 percent.

b. Visibility

In North Dakota, clear air and unrestricted visibility are considered to be important environmental attributes. Particulate emissions from the ANGCGC and Basin Electric projects would be small and no direct visible plumes from the plants would be noticeable except during periods of startup and equipment malfunction. Nonvisible emissions, however, could affect visibility through the scattering of light and photochemical reactions thus causing a visible haze in the plant vicinity.

The reduction of visibility due to the increase in the ambient particulate and sulfate aerosol levels is summarized in Table 3-8.

TABLE 3-7

Maximum Ground-level Pollutant Concentrations Attributable to the
ANGCGC and Basin Electric Projects ($\mu\text{g}/\text{m}^3$)

Pollutant	Averaging Period	Maximum Estimated Concentration ¹				Current Background Level	National Standards ⁴			North Dakota Standards ⁴
		Existing Point Sources	Basin	ANG	Subtotal		Ambient Air		Deterioration Class II	
							Primary	Secondary		
SO ₂	1-Hour	6.0	328.5	152.8	487.3	-	-	-	715 ⁴	
	3-Hour	4.0	127.6	61.8	193.4	-	1300 ⁵	700 ⁶	-	
	24-Hour	3.0	50.2	26.0	79.2	365 ⁵	-	100 ⁶	260 ⁴	
	Annual	2.3	5.2	2.4	9.9	< 5.0 ²	80	-	15	60
NO _x	1-Hour	3.0	136.9	32.5	172.4	-	-	-	200 ⁷	
	Annual	1.5	2.1	0.5	4.1	8.0 ²	100	100	-	100
TSP	24-Hour	8.0	10.9	12.7	23.6	260 ⁵	150 ⁵	30 ⁶	150 ⁵	
	Annual	0.8	0.4	0.1	1.3	24.0 ³	75	160	10	60

1 Concentrations from ANGCGC and Basin Electric would not be strictly additive, but are added here to present the worst possible case. ANGCGC's more detailed dispersion analysis is presented in Appendix I.

2 Seven-month average, September 1975 through March 1976. Monitoring instrument does not detect SO₂ levels below 5 $\mu\text{g}/\text{m}^3$ (56).

3 1975 annual average (56).

4 Maximum concentration.

5 Maximum concentration not to be exceeded more than once per year.

6 Maximum allowable incremental increase.

7 Maximum concentration not to be exceeded 1 percent of the time in any 3-month period.

FIGURE 3-1
ISOPLETHS OF ANNUAL AVERAGE SO_2 CONCENTRATION ($\mu\text{GM}/\text{M}^3$)
FROM METEOROLOGICAL DATA FOR BISMARCK, NORTH DAKOTA
ISOPLETH INTERVAL $0.5\mu\text{GM}/\text{M}^3$

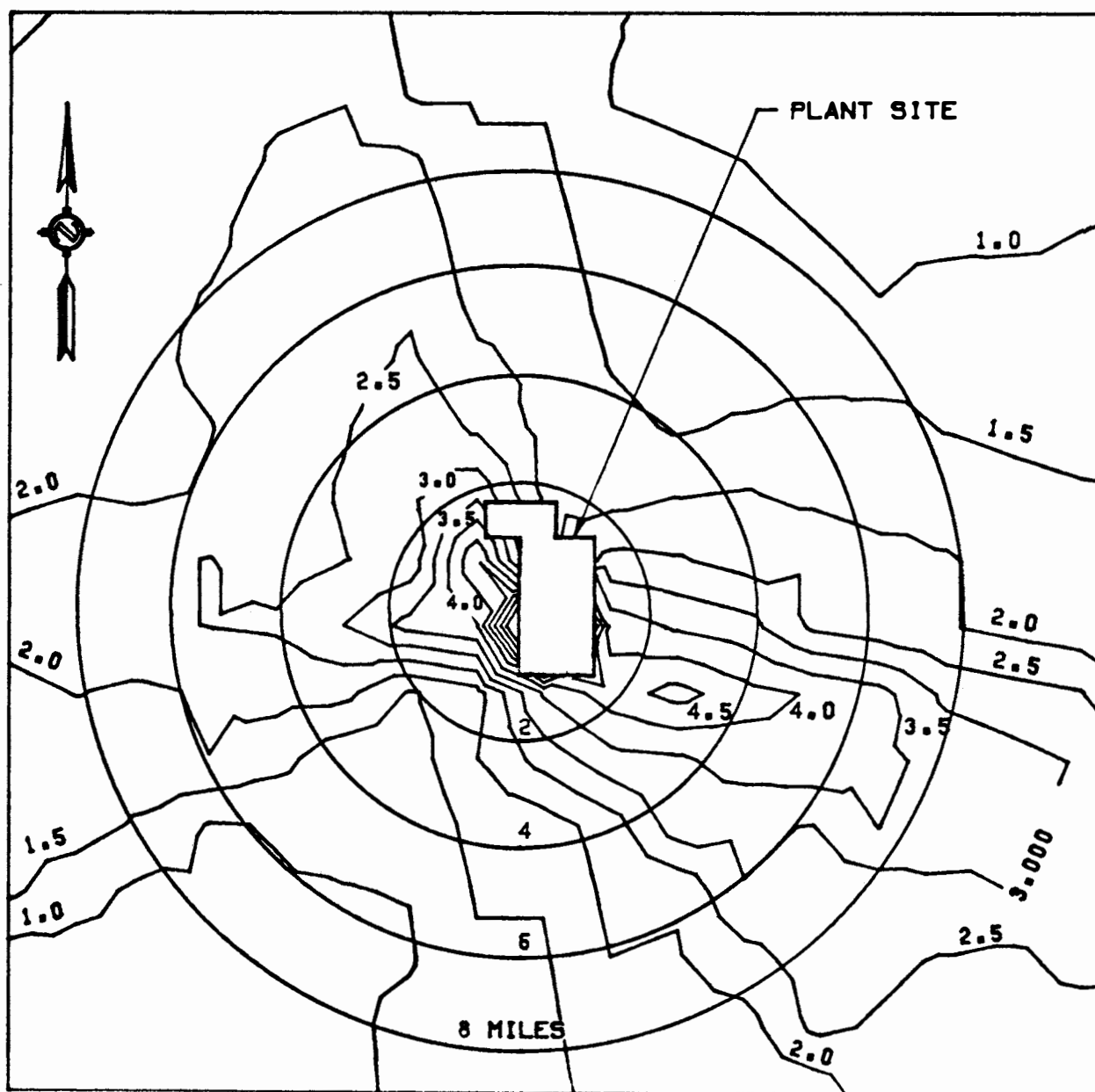


FIGURE 3-2
ISOPLETHS OF ANNUAL AVERAGE NO_x CONCENTRATION ($\mu\text{GM}/\text{M}^3$)
FROM METEOROLOGICAL DATA FOR BISMARCK, NORTH DAKOTA
ISOPLETH INTERVAL $0.5\mu\text{GM}/\text{M}^3$

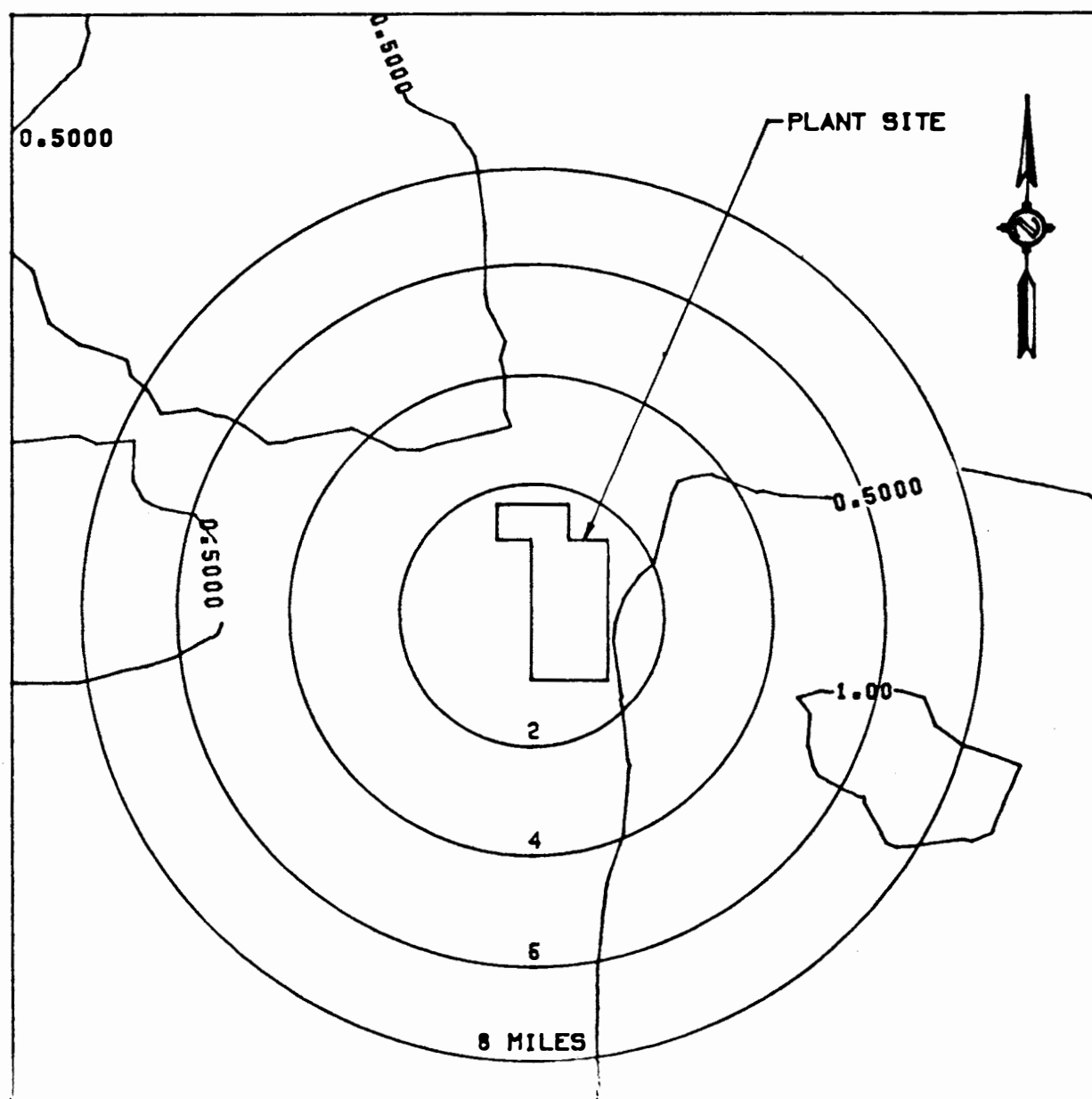


FIGURE 3-3

ISOPLETHS OF ANNUAL AVERAGE TSP CONCENTRATIONS ($\mu\text{GM}/\text{M}^3$)
FROM METEOROLOGICAL DATA FOR BISMARCK, NORTH DAKOTA
ISOPLETH INTERVAL $0.5\mu\text{GM}/\text{M}^3$

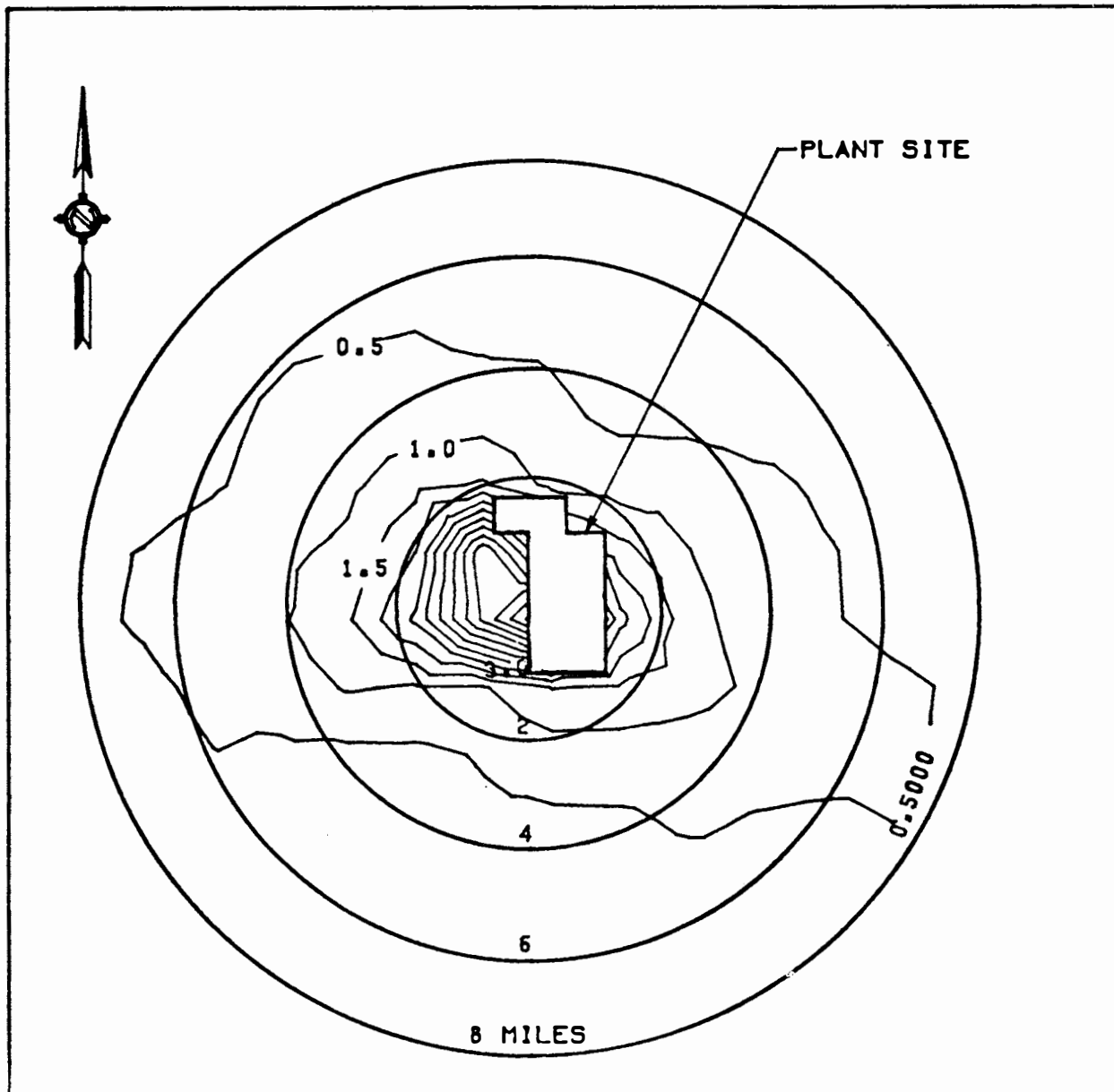


TABLE 3-8

Summary of Visibility Reductions from the ANGCGC and
Basin Electric Projects

Meteorological Conditions	Maximum Increase in TSP + Sulfate Concentration (ug/m ³)	Downwind Distance (km)	Visibility Reduction (%)		% Frequency of Occurrence
			I 1/	II 2/	
<u>Short-Term 3/</u>					
Neutral, 12 m/sec	9.2	21	23	8	1.1
Plume Trapping, 1 m/sec	13.8	16	31	12	0.1
Fumigation, 1 m/sec	63.9	34	68	39	0.2
<u>Long-Term</u>					
24-Hour	23.9	-		15 4/	-
Annual Average	2.4	-		4 5/	-

1/ Based on TSP background of $30 \mu\text{g}/\text{m}^3$ 2/ Based on TSP background of $100 \mu\text{g}/\text{m}^3$

3/ One-hour averages

4/ TSP background of $132 \mu\text{g}/\text{m}^3$, based on maximum 24-hour sample reported from
North Dakota air sampling network5/ TSP background of $53 \mu\text{g}/\text{m}^3$, based on the 1973 annual average reported for Bismarck.

The maximum long-term percentage reduction in visibility resulting from the joint project would range from 4 percent on an annual basis up to 15 percent for 24 hours. For short-term worst-case conditions, the combination of particulates and sulfate aerosols could reduce visibility 68 percent for baseline TSP concentrations of $30 \mu\text{g}/\text{m}^3$ and 39 percent for baseline TSP concentrations of $100 \mu\text{g}/\text{m}^3$. The worst-case conditions would occur about 0.3 percent of the time.

c. Potential Impacts of Emissions

Simply because all Federal and State air pollution standards would have to be met by the proposed ANGCGC and Basin Electric projects does not mean that there will be no impacts. For some pollutants, no standards exist because insufficient studies have been done to determine what concentrations can be tolerated. Other standards are based upon extensive study, but are a compromise between impacts and abatement costs.

Although it is difficult to precisely isolate the effects of air pollution on human health, medical research has shown that acute respiratory infections, chronic bronchitis, pulmonary emphysema, bronchial asthma, and lung cancer can be caused or aggravated by air pollution. No studies are available that have shown exactly what health effects might be expected from long-term exposure to the calculated ground-level concentrations (Table 3-7) of the proposed projects, but the levels at which air pollution is hazardous to human health is reflected in the air quality standards. These standards are designed to protect that element of the population (about 15-20 percent) that is particularly sensitive to pollutant induced respiratory problems. However, the air quality standards are not absolute because very little is known about pollution induced illness related to new technologies. Research is underway to more clearly define the health aspects of air pollutants from coal conversion processes (107), and some of the standards will undoubtedly be changed as new information becomes available.

The impacts to the plants and animals that might result from the emissions of the ANGCGC and Basin Electric projects are also largely unpredictable because few studies have been done on damage resulting from the concentrations that would result from the proposed projects. However, laboratory tests of SO_2 and NO_2 have established preliminary injury threshold values for various plant species. For many plants the injury threshold for an 8-hour exposure of SO_2 alone is about 800 ug/m^3 ; for conifers the injury threshold was lower, about 715 ug/m^3 (93). For NO_2 the injury threshold for a 4-hour exposure was about $4,700 \text{ ug/m}^3$. The maximum 8-hour SO_2 concentrations that would be reached due to the proposed projects would be 114 ug/m^3 ; the maximum 4-hour NO_x concentrations would be 58 ug/m^3 .

When SO_2 and NO_2 are both present, as will occur near the proposed projects, vegetation may be injured at much lower concentrations because of synergism of the two gases. For example, the injury threshold for tobacco for SO_2 and NO_2 together is 252 ug/m^3 SO_2 and 188 ug/m^3 NO_2 for a 3-hour exposure (94). Plant pathologists regard tobacco as being the middle range of plant sensitivity to air pollutants. The above values are somewhat higher than the estimated maximum 3-hour or less ground-level concentrations for the proposed projects (Table 3-7); thus, acute plant damage should not occur except to particularly sensitive species.

There may be some damage from an initial shock phenomenon which sometimes occurs with the introduction of phytotoxic gases into a relatively clean or pristine area (61). In addition, chronic damage may be caused by constant, low-level exposure to air pollutants, but this aspect of air pollution damage is subtle and not well understood at the present time.

The chief hazard to terrestrial animals near the proposed projects would be the ingestion of vegetation contaminated with fallout from the plume. Pathologically, ingestion of SO₂ (from gaseous uptake by plants used as food) depresses immunobiological responses and lowers the Vitamin C content of the blood (95). Thus, some animal populations may be reduced by way of natural disease as a result of eating vegetation contaminated with SO₂. Moreover, sulfur taken up by alfalfa has been reported to result in selenium deficiencies in cattle near the Stanton, North Dakota, powerplants, resulting in stillborn calves (comment by Dr. Hastings, Public Hearing Record, May 11, 1977). Selenium injections are reported to alleviate the problem. However, the extent of the overall hazard to terrestrial animals is not predictable at this time.

Effects from trace element emissions (i.e. arsenic, cadmium, fluoride, lead, mercury, and selenium) are likewise difficult to predict because of the wide variance of the three trace element analyses shown in Table 1-3. For example, these analyses indicate that for fluoride, the trace element present in highest amounts, concentrations in the coal may range from 24 to 83 ppm (by weight). Therefore, fluoride emissions from the proposed projects could run between 9.6 and 26.6 lbs/hr. However, even assuming the worst case condition, it does not appear likely that trace element emissions from the proposed project would cause acute plant or animal damage. Drift from the process water cooling tower would be composed of about 300 lbs/hr. acetate salts, 50 lbs/hr phenolic salts, and 50 lbs/hr inorganic salts. These compounds are rapidly degraded by micro-organisms, but should the drift settle on vegetation, productivity could be temporarily reduced.

The remainder of the pollutants that would result from the proposed projects would be emitted in amounts too small to be likely to, in themselves, cause any acute damage. However, as two of several coal-related developments proposed for the general area, ANGCOG and Basin Electric would contribute to an overall reduction in air quality in the region and any resulting impacts. Possible impacts of coal development in the region are discussed briefly in Section 3.6; more detailed analyses can be found in the Bureau of Reclamation's Water for Energy EIS (102) or will soon be available in BLM's West-Central North Dakota Energy Development EIS.

3.1.1.4 Odor

a. Construction

Odors associated with the construction of the gasification plant and pipelines would be from combustion sources, evaporation of fuels, and fugitive dust. Combustion gases which have perceptible odor characteristics would include (63, 64):

<u>Material</u>	<u>Odor</u>	<u>Perception Level</u>
SO ₂	pungent, sharp	1200 ug/m ³
NO ₂	strong, pungent, sweetish	7600 ug/m ³
HC,	gasoline smell	variable

The sources of combustion emissions during construction are diesel and gasoline engines, space heaters, dryers, boilers, and open burning. Projection of odor perception in terms of distance from source would not be possible because of the difficulty in quantifying the pollutant concentrations leading to odor perceptions. However, ground concentration levels shown in Table 3-2 are below the above threshold values. Most of the fugitive dust would be fine soil which would have a natural odor when detectable.

There would be an increase of odors on the plant-mine site. The smell of SO₂, NO₂, and hydrocarbons would be detectable in the vicinity of operating diesel engines. These odors should not be perceptible offsite. Natural type dust odors may occasionally be detected offsite due to increased particulate levels during construction.

b. Operation

The SO₂ and NO_x emissions from the stack should not cause any detectable offsite odors because estimated ground concentrations (Tables 3-5 and 3-7) are below perception levels. Other primary sources of potential odors are routed through various control processes (Section 4.2.1.3) in an enclosed piping system. However, no system is completely leak-proof, thus small leaks may cause slight sulfur odors in the immediate vicinity of the piping.

Odors produced by the mining operations would be those of diesel exhaust and dust. Operation of coal haulers and various pieces of smaller equipment would be the cause of both odors. The largest pieces of equipment (draglines, coal loaders) would be electric powered and thus produce only dust emissions in removing overburden.

Odors should not be detected during construction of the product pipeline except in the immediate vicinity of operating equipment.

3.1.1.5 Noise

a. Construction

Plant-Mine Site: Noise levels during plant construction would be significantly higher than the existing rural conditions. Because the distances from the construction areas to the optioned land boundary are as short as 100 feet, there frequently would be high noise levels (up to 92 dBA) at the site boundary and beyond. Noise levels would be increased at residences near the plantsite if the residences continue to be inhabited. Increased noise levels would also cause many species of wildlife to avoid the immediate area.

Typical construction activity noise levels at sites with ambient noise levels of 50 dBA are shown in Table 3-9 as derived by EPA (65). Although the ambient noise levels at the proposed plantsite are less than 50 dBA, the difference for noise impact assessment is minimal due to the much higher levels emanating from the equipment. Combining an ambient level of 50 dBA with construction levels of 80 dBA would only cause a 0.2 dBA increase in noise over that determined by using lower ambient levels.

The L_{10} parameters in Table 3-9 are the noise levels which would be exceeded 10 percent of the time. Noise levels for individual construction vehicles and equipment are shown in Table 3-10.

Normal noise attenuation is 6 dBA for each doubling of distance from the source (66). The approximate distances to lower noise levels starting with the highest average and L_{10} levels (Table 3-9) are:

	<u>50 feet</u>	<u>400 feet</u>	<u>$\frac{1}{2}$ mile</u>	<u>$1\frac{1}{2}$ miles</u>	<u>5 miles</u>
Average	89	71	55	45	35
L_{10}	98	80	64	54	44

The approximations given do not consider any background noise and are provided as a general guide. Since the existing noise environment is rural, primarily due to wind, and averages about 40 dBA (Section 2.1.2.3), residents who live within about $1\frac{1}{2}$ miles of the site would experience increased noise levels as shown above. Those living from $1\frac{1}{2}$ to 5 miles away would occasionally detect construction noise, but the population centers (Beulah, Zap, etc.) should not be affected.

The railroad would also increase noise levels, both during construction and operations. The noise level of a typical freight train is about 75 dBA at 50 feet; thus, persons residing near the railroad tracks would experience increased noise levels from the increased rail activity associated with the project.

Product Pipeline: Since pipeline construction would be done by various crews and equipment along a given spread, noise sources would move along the route as different spreads perform their duplicate functions. Noise levels associated with various equipment are shown in Table 3-11.

In communities along the pipeline route, the more congested conditions would expose more persons to noise impacts than in rural areas. Noise levels from construction would be significantly above normal background levels for these small urban areas. The period of impact should not be more than 30 days in urban areas except

TABLE 3.-9
TYPICAL RANGES OF NOISE LEVELS IN dB(A) AT CONSTRUCTION
SITES WITH AN AMBIENT LEVEL OF 50 dB(A)

<u>Activity</u>	<u>Office Bldg. Hospital School</u>	<u>Industrial Buildings</u>	<u>Roads Sewers Trenches</u>	
Ground clearing	84	84	84	Energy Average dB(A)
	7	9	8	Std Deviation
	93	95	94	L ₁₀ Level
Excavation	89	89	88	Energy Average dB(A)
	6	6	7	Std Deviation
	97	97	97	L ₁₀ Level
Foundations	78	77	88	Energy Average dB(A)
	3	4	8	Std Deviation
	82	82	98	L ₁₀ Level
Erection	87	84	79	Energy Average dB(A)
	6	9	9	Std Deviation
	96	95	90	L ₁₀ Level
Finishing	89	89	84	Energy Average dB(A)
	7	7	7	Std Deviation
	98	98	93	L ₁₀ Level

Source: U.S. Environmental Protection Agency, NTID 300.1. 1971.

TABLE 3.-10
NOISIEST EQUIPMENT TYPES AT CONSTRUCTION SITES

<u>Activity</u>	<u>Vehicle</u>	<u>Noise Level per Vehicle at 50 feet [dB(A)]</u>
Ground clearing	Truck	91
	Scraper	88
Excavation	Rock Drill	98
	Truck	91
Foundations	Jack Hammer	88
	Concrete Mixer	85
	Pneumatic Tools	85
	Scraper	88
Erection	Derrick Crane	88
	Jack Hammer	88
	Scraper	88
Finishing	Rock Drill	98
	Truck	91
	Paver	89

Source: U.S. Environmental Protection Agency, NTID 300.1. 1971.

TABLE 3-11

Peak Noise Levels of Equipment Used During
Pipeline Construction (at 50 feet)

<u>Equipment</u>	<u>Noise Level (dBA)</u>	<u>Degree of Use</u>
Chain Saws	97	Occasional
Dozer	105	Frequent
Rock Drilling	120	Occasional
Ripper	105	Occasional
Trencher, Backhoe, etc.	105	Frequent
Haulers	110	Frequent
Hoists	100	Frequent
Compactor	116	Occasional
Blasting	87 (250 feet)	Occasional

perhaps for Devils Lake, the largest city along the proposed route, where construction might take up to 45 days.

b. Operation

Major producers of noise during operation of the proposed gasification plant would include compressors and coal handling equipment such as crushers and screens; fans, blowers, and burners; steam lines; flares; and air coolers and cooling towers. Much of the equipment would be in buildings and the noise level outside would be reduced somewhat. Flare valves, steam valves, and escaping steam are also major producers of noise. Flare noise would result from high velocity steam injection into the hydrocarbon streams to reduce smoke. If emergency flaring occurs, the noise level around the flare may exceed OSHA standards. This should occur infrequently and be of short duration. Normal gasifier and general startup flaring would be at lower flaring rates and therefore at lower noise levels.

Typical noise levels from mining operations were determined by taking measurements near operating equipment at NACCO's Indian Head Mine:

Coal hauler at full power	- 50 feet	93 dBA
Coal hauler idling	- 150 feet	70 dBA
Coal shovel loading coal	- 150 feet	70 dBA
Coal tipple loading railroad cars	- 150 feet	74 dBA
Electric dragline	- 300 feet	65 dBA

Much of the equipment (such as coal haulers and draglines) to be used in the mining operation for ANGCGC, however, would be considerably

larger than those used at the Indian Head Mine, so somewhat higher noise levels could be expected. Equipment operating in the pit may be shielded somewhat; thus, reducing ambient noise. The coal haulers shuttling back and forth between the mines and plant have the greatest potential for causing noise. Also, blasting during the evening shift would disturb nearby residents during a normally relaxing period of the day. Overall, the impact of the proposed project would be to increase, and change the nature of, noise in the area. (Noise suppression measures are discussed in Section 4.2.2).

3.1.2 Water

3.1.2.1 Surface Water

a. Gasification Plant

Plant construction activities would alter the topography and land surface characteristics in the plantsite vicinity. The area is within the Antelope Creek drainage basin and construction could locally alter the direction and intensity of overland flow, its sediment load, and hence the water quality. Water flow in Antelope Creek is seasonally intermittent but construction would occur during the period of flow. Impacts upon the surface water would result from increased localized runoff from new paved surfaces and plant buildings, and erosion of excavated materials. The amount of sediment and dissolved constituents transported downstream from excavated material during plant construction would depend on the amount and intensity of rainfall.

Substances emitted during plant operation may enter area waters upon being returned to the surface and raise the concentrations of these elements in solution. Rates of possible contamination are not quantifiable; but because of the alkaline nature of soils and waters in the area, many elements may become chemically inert and thus would not pose a hazard to biological systems.

Runoff water from plant process areas would be routed to a storm-water retention pond and reused in the plant. This should minimize degradation of surface waters by contaminated runoff from the process areas. Extensive reuse of wastewaters within the plant would lessen the possibility of stream contamination by plant waters.

b. Mining

Assuming revegetation of strip-mined lands within 3 to 4 years after initial mining, about 1,500 to 2,000 acres of land would be exposed at any given time. The primary impacts to surface waters from mining would include (1) local alteration of the direction

and intensity of surface flow, (2) local alteration of sediment load, and (3) changes in water quality.

Due to the altered topography from mining, each mine pit would alter surface drainage patterns. As a result, a combination of runoff entrapment in mine pits and altered surface flow routing would occur. Based on the total area to be mined in each subbasin and assuming no runoff from reclaimed land, the approximate decrease in runoff, and hence, streamflows, for each subbasin can be estimated. Annual runoff in the west and east tributaries of Antelope Creek would be decreased about 13.3 and 14.3 percent, respectively. The decreased flow in the Lower Spring Creek-Upper Knife River at Hazen would be about 0.6 percent; any decrease in runoff in the Lake Sakakawea basin is too small to calculate.

The decreased streamflows in the Lower Spring Creek-Upper Knife River subbasin could cause an immeasurable increase in downstream TDS levels. In both tributaries of Antelope Creek downstream TDS levels would be increased during the summer months and the periods of no-flow would also be increased. The above estimates do not take into account placement of mine pits, which if placed at low elevations would entrap some overland runoff uphill from the pit. Increased evaporative losses would also result from entrapment further reducing downstream flows.

During mining, some erosion of stockpiled topsoil would take place in the time between its removal and the time that it is adequately protected by vegetative cover. However, the greatest potential for erosion is through the valleys between spoil piles. The nature of overburden materials, its unconsolidation during excavation, and its placement in a steeply graded pile renders these materials highly erodable. The erosion potential varies seasonally; the spring and summer storm season represents the period of greatest concern. Because an increase in sediment load and turbidity would occur, an increase in chemical concentrations in the affected streams would result due to the leaching of spoils.

When compared to surface water quality, water in existing mine pits generally exhibits more than twice the hardness and total dissolved solids, and more than twice the concentration of bicarbonate, sodium, calcium, magnesium, potassium, chloride, iron, and boron (4) (Appendix E; Analyses of Water Samples, Lignite Aquifers). In addition, sulfate concentrations are 10 times greater in mine pit waters and nitrate concentrations are increased as a result of the use of ammonium nitrate explosives.

As a part of the normal mining operation, water may be removed from the mine pits by pumping. This water would be disposed of by: (1) spraying roads for dust control, (2) pumping into adjacent

pits, (3) experimental irrigation of revegetated areas, (4) pumping into constructed impoundments, and (5) pumping into existing streams.

Spraying roads or pumping the water into other pits would have little effect on surface waters. Use of the mine pit water for irrigation would be tested, but due to the high concentrations of dissolved ions, irrigation is not likely to be feasible. Pumping the contaminated water into impoundments may adversely affect the indigenous biota and also increase the surface area for evaporation thus reducing surface runoff. The impoundments would also act as ground-water recharge sources and some of the materials might leach into various shallow aquifers used for domestic and stock watering purposes. Finally, pumping mine pit water into existing streams would affect water quality. The amount of such pumping that might occur is variable and would depend on precipitation amounts, leakage rate into pits, etc. If this pumping occurs, the pH of the affected stream would be lowered and the mineral content increased.

Effects of mining on the drainage patterns of surface water basins are partly based upon the final configuration of the reclaimed land surface. It is possible that local changes in the direction of drainage in the Antelope Creek basin could occur as a result of regrading the mined land. This may alter the size of the drainage subbasins making some slightly larger and some slightly smaller. Although some individual subbasins may be affected, surface flow patterns within the Missouri River drainage basin would not be changed.

Infiltration capacities of reclaimed land would be greater than that of the present land surface since the original topsoil would be replaced and no special effort made for step-wise compaction. The breaking up of consolidated layers during draglining, bulldozing, dumping, and spreading of topsoil would result in the surface of the reclaimed land having a higher permeability than before mining. Therefore, runoff and thereby downstream flows of affected surface waters would be decreased. Differences in the chemical quality of the runoff might occur during reclamation, prior to the establishment of vegetation, and in areas where sediment and leachate from new soils have ready access to surface water channels.

c. Water Intake

The maximum withdrawal of water from Lake Sakakawea for use in the proposed gasification plant and powerplant would be about 36,000 acre-feet/year (17,000 for ANGCGC and 19,000 for Basin Electric) or 22,500 gpm. The impact of operating the water intake would be controlled primarily by the intake design and its placement on the

bottom of Renner Bay. Modification in bay water quality might result from changes in circulation patterns adjacent to the intake possibly causing increases in turbidity in the same area. No impact on main-stem Missouri River water quality is anticipated.

The withdrawal of 22,500 gpm (about 50 cfs) would alter the circulation patterns within Renner Bay in that there would be a greater exchange of water between the bay and Lake Sakakawea. The effects of water withdrawal would tend to be uniform with depth throughout the bay during all seasons when the lake and bay are not stratified. During the summer, however, the bay stratifies with the formation of a thermocline. The intake would draw water from the hypolimnion during periods of stratification and may deepen the depth of the thermocline near the intake or, during drought periods, disrupt the stratification in the bay. Either case might allow warm-water fish to range nearer the intake increasing their chances for impingement.

The intake would be located several feet above the floor of Renner Bay to reduce scouring. Any material stirred from the bottom should be drawn towards the intake, thus having a minimal effect on overall bay water quality.

d. Product Pipeline

The major water quality impacts of the product pipeline would be increased construction-induced sediments resulting primarily from the 86 surface water crossings, but also from overland runoff from disturbed soils. The greatest impact on water quality would be increased sediment loads in rivers during stream crossings; the quality of water in ponds and lakes would also be degraded as they are crossed. The increased sediment load would reduce existing dissolved oxygen concentrations and increase the total dissolved solids in solution. The increased turbidity warrants concern along the Forest and Red Rivers since their waters are used for municipal supply by the cities of Minto and Oslo, respectively. Impacts of increased sedimentation on aquatic organisms are discussed in Section 3.2.3.

Other pipeline construction activities such as trench dewatering and flood plain clearing with subsequent erosion problems could result in short-term local reductions in water quality. No significant alteration of water quality is expected as a result of hydrostatic testing; test water would be released in accordance with North Dakota water quality standards and in such a manner to minimize scour, channel erosion, or flooding of adjacent lands.

3.1.2.2 Ground Water

The construction of the gasification plant would locally alter the recharge mechanism of the Antelope Creek aquifer which underlies

the plantsite. The largest plantsite excavation would be on the order of 45 x 90 x 70 feet; the water level in the Antelope Creek aquifer in the vicinity of the plantsite is about 60 feet deep. Some perched water also occurs locally in near-surface sediments. Hence, for construction, excavations penetrating the aquifer would require dewatering. Excavations which do not penetrate the aquifer may also require some dewatering of perched water. No plant foundation problems are expected because of the presence of the aquifer.

Localized near-surface saturated strata exist in the mining areas. Mining would result in removal of these surficial water bearing materials. The amount of water in these patchy alluvial and glacial deposits of sand and gravel is not known. In areas where such deposits are located, saturated thickness is about 5 to 20 feet. These aquifers are discontinuous; thus, the effect of their removal should not extend much beyond the actual mine area.

The purpose of the proposed mining is to remove lignite from the Beulah-Zap bed. Coincidentally, the lignite aquifer would be destroyed. Gradual removal of about 12,500 acres of aquifer area would probably result in lower water levels in other lignite aquifers throughout much of the adjacent areas. The average water content of the lignite aquifer is estimated to be about 1 foot/acre and the average content of the overburden is about 2 feet/acre. Assuming these figures as reasonable approximations, the total amount of water displaced from the Sentinel Butte aquifer units during mining would average about 1,600 acre-feet/year. This could cause decreased water levels in wells near (within 1-mile) the mining activity.

Removal of permeable alluvium, overburden, and lignite would affect the source material of springs within the area. Two springs which may be destroyed (F03 and F04) were located during the baseline study. This would result in a loss of water supply by the users (human and animal) of these springs.

Infiltration of mine pit effluent would locally increase the mineralization of various shallow aquifers, and may affect the quality of the water from wells penetrating these aquifers (depending on flow patterns). Dewatering of the mine pit would cause a locally steeper hydraulic gradient and increased local in-seepage from adjacent ground-water sources.

a. Effects on Recharge Rates of Shallow Aquifers

Some recharge to the Antelope Creek aquifer takes place via flow from the Sentinel Butte aquifer complex. As a result of decreases in water levels in the Sentinel Butte complex (as well as stripping

of near-surface aquifers), ground-water recharge into the Antelope Creek aquifer would be reduced during mining. On the basis of head differential between the Beulah-Zap bed and the Antelope Creek aquifer, it appears unlikely that large scale recharge reversals would take place (i.e., that the Antelope Creek aquifer would recharge the Beulah-Zap bed). However, this could occur locally where perched water occurs within the Beulah Trench.

Reduction in recharge to the Antelope Creek aquifer could also result from altered surface drainage patterns within the mine area. Runoff from the minesite would be prevented from reaching Beulah Trench, resulting in reduced infiltration to the Antelope Creek aquifer and a consequent decline of water levels in the aquifer. If net recharge to Beulah Trench is considered, a potential loss of about 40 acre-feet/year could result.

b. Effects on Recharge Rates of Lower Aquifers

The displacement of water-bearing overburden and dewatering of mine pits would probably result in a reduction in recharge to aquifer segments beneath the Beulah-Zap bed. Therefore, water levels within these lower aquifers may also be decreased to some extent.

A pair of twin lignite seams are located beneath the Beulah-Zap bed at 50- to 100-foot depths. These are separated from the shallow seam by highly impervious clays. Thus, it seems doubtful that the effects of either increased or decreased recharge would be noticeable. Likewise, because of the lithologic similarity between the Beulah-Zap bed and the underlying twin lignite seams, it is unlikely that any alteration in water quality in the twin seams would take place. The potential effects on the deep, high-pressure Fox Hills-Basal Hell Creek-Cannonball-Ludlow aquifers should be small because of their high head and vertical separation from the base of the Beulah-Zap bed (Section 2.1.3.1).

Contamination of lower aquifers from salts disposed of via the deep well should not occur due to highly impervious clays separating the strata and the distance between strata. Such contamination is remotely possible, however, should operator error (e.g., hole in casing or accidental injection into casing) allow the disposal brine to enter an aquifer.

c. Effects of Reclamation on Ground Water

Although the Beulah-Zap aquifer and certain water-bearing overburden would be removed from the mined area, the overall permeability of the replaced material would probably be greater than that of the original strata due to sediment disaggregation during replacement

and the consequent increase in volume due to soil bulking. The relative homogeneity of the replaced soil could increase the ground-water movement through the mined area. Thus, the reclaimed land could cause an overall increase in ground-water levels and recharge to areas adjacent to the mines. The reclaimed land itself (which would eventually include the entire mine) could not be used as a shallow ground-water source area in the foreseeable future because leachates from the buried ash and sludge would make the water unusable.

Potential contamination of adjacent shallow aquifers could result from the leaching action of water moving through the ash and sludge buried under the reclaimed soil. Thick, impermeable strata separating the Beulah-Zap bed from deeper water-bearing units should prevent movement of leachate into underlying aquifers. Over the long-term, lateral movement of leachate into adjacent aquifers could occur by either transport of leached ions if saturation conditions exist, or by diffusion and dispersion under partial wetting of the ash. Increased ground-water levels due to increases in soil permeability could create a higher ground-water gradient forcing the leachate to move faster and farther than would occur under existing ground-water conditions.

ANGCGC has indicated that, based upon preliminary studies by Woodward-Clyde Consultants, they believe a mine pit sealing process is not necessary to prevent leachate movement into adjacent aquifers (97). However, the possibility of leachate contamination will be studied further by ANGCGC as part of an extensive drilling and hydrologic study of the project area over the next 2 years. If these studies, or other studies being conducted by the State, show that leachate contamination will occur, then ANGCGC has said they will take appropriate steps to prevent such contamination--including consideration of various methods of sealing the mine pits (97).

The main components expected in the leachate from the ash are the following salts (85):

K ₂ O	9 ppm
Na ₂ O	6,000 ppm
CaO	21 ppm
MgO	3 ppm
Al ₂ O ₃	16 ppm
Fe ₂ O ₃	4 ppm

In addition, the leachate would contain the trace elements that are found in the ash and the sludge from the evaporators. The estimated quantities of these trace elements buried in the mine per stream day would be:

	<u>Sludge</u> <u>(lbs/day)</u>	<u>Ash</u> <u>(lbs/day)</u>	<u>Total</u> <u>(lbs/day)</u>
Lithium	1.4	230.0	231.4
Beryllium	0.4	19.6	20.0
Boron	157.0	5766.0	5923.0
Fluorine	23.5	977.0	1000.5
Vanadium	--	269.0	269.0
Chromium	1.7	155.0	156.7
Cobalt	1.4	39.1	40.5
Nickel	8.4	78.6	87.0
Copper	14.0	161.0	175.0
Zinc	13.0	1.3	14.3
Arsenic	157.0	231.0	388.0
Selenium	33.2	1.7	34.9
Molybdenum	7.2	10.3	17.5
Silver	2.6	0.7	3.3
Cadmium	1.0	3.5	4.5
Tin	1.4	46.1	47.5
Antimony	1.0	2.4	3.4
Barium	--	46,300.0	46,300.0
Mercury	1.3	0.3	1.6
Lead	9.1	685.0	694.1
Thorium	--	23.1	23.1
Uranium	8.4	18.5	26.9

Since the mined areas will probably not be used as a ground-water source, alternative sources would have to be found for postreclamation use. Pumping from the Antelope Creek aquifer and from deeper aquifers would be feasible. Changes in ground-water use patterns would result in certain shifts in the hydrologic cycle, though no overall increase in ground-water depletion need be implied.

Twenty-eight wells and two springs are within 1 mile of the proposed plant- and minesites. Nine of these wells are too deep to be affected by the proposed action. Mining could result in water level declines in the remaining 19 wells and consequent interruption in their use, as well as reduction in the flow of the spring. Following reclamation, water levels could return to premining levels or higher making the 19 wells usable again if no reduction in water quality occurs. Postreclamation increases in water mineralization and/or contamination of these wells could result from ground-water inflow from replaced spoil and ash deposits within the mined areas. North Dakota law provides that if a landowner experiences decreases in water yield or quality, ANGCGC must construct a new well at no cost to the landowner. This law would only be effective during the life of the plant; well problems occurring after this time may remain unmitigated.

3.1.3 Physiography

a. Soils

The operation and construction of the mines and plant would have a major impact on the soils. Although part of the top horizon would be removed and saved during mining, the stratification of the remaining horizons would be totally disrupted. This could bring closer to the surface very highly mineralized strata less able to produce vegetation. Changes in overburden permeability due to mining have already been discussed (Section 3.1.2.2).

Soils that must be stockpiled for future use in reclamation may become biologically sterile, requiring mixing with fresh topsoil when used. Some soil microorganisms can become dormant and will survive stockpiling, but the extent of this adaptation in the soil microcommunity is not known.

Soils in or close to roads that are watered for dust suppression with mine pit water would experience a buildup of minerals over a long period of time. This increased mineralization could eventually reach the point where the soils could no longer support vegetative growth. The time required to reach mineral levels inhibiting plant growth would depend on a variety of factors (e.g., salinity of mine pit water, frequency of watering, soil composition, sensitivity of vegetation, etc.) and cannot be determined at this time.

A small coal seam about 3 feet thick and covering 3 square miles would be totally destroyed. It would be uneconomical to recover the coal from this seam; thus, the coal would be mixed into the overburden and returned to the mine pit.

Land would be mined at a rate of about 500 acres/year. Assuming 25 years of operation, about 12,500 acres of soils would be disturbed. An additional 1,400 acres of soil could be altered on property used for the gasification plant, coal preparation facilities, roads, etc.

Due to the disturbance and exposure during mining and construction, soil erosion would increase. This erosion would continue until such time as adequate vegetative cover has been reestablished. The amount of soil lost would be variable, depending on the severity of the weather.

Product Pipeline: Construction impacts related to soils would occur as a result of disturbing the vegetative cover and soil profile. The level of impact would be related to the difficulty in revegetating the disturbed area and the susceptibility of the site to erosion and mass movement. Some alteration of soil

productivity could result if the soil profile is not restored over the trench area, resulting in secondary impacts to wildlife habitat or agricultural production. Soil types and revegetation difficulties were shown in Table 2-6. Sensitive soil types, the portion of the proposed route in which they occur, and the degree of the potential erosion impact to the soils are summarized in Table 3-12.

b. Topography

The operation of the mine would cause a change in the appearance of the landscape. In actively mined areas the piles of spoil would rise steeply from the present gently undulating terrain. Reclamation may result in the landscape being flattened somewhat from the original topography as landowners may ask that the land be sloped to allow for cropland uses. The final highwall cuts may be graded into relatively large water impoundments where none now exist. There would be an overall increase of about 25 to 30 feet in the average elevation of the graded spoil piles. Before the piles were regraded they would resemble knobby ridges with numerous valleys.

The topography of the approximately 1,400 acres to be used for the gasification plant and associated facilities would be leveled to serve these functions. The topography of the unused portion of the property lease area would remain essentially unaltered. The overall effect on topography would be a flatter landscape with a large coal pile rising from it.

TABLE 3-12

Potential Soil Hazard Problems of Proposed Pipeline Route

<u>Route</u>	<u>Sensitive Soil Types Encountered</u>	<u>1/ Potential Impact</u>
Plantsite to Beulah	Bainville, Zahl	Large
Beulah to Stanton	Lihen, Parshall, Valentine	Large
Stanton to Washburn	Bainville, Wade	Moderate
Washburn to Falkirk	Zahl	Small
Falkirk to Max	Zahl, Oahe, Sioux	Moderate-Small
Kongsberg to Butte	Exline, Cavour	Small
Kief to Balta	Solonetz	Small
Balta to Filmore	Buse	Small
Filmore to Fordville	Solonetz	Small
Fordville to Ardoch	Gravel	Small
Ardoch to Morais River	Bearden	Small
Viking to Compressor Station	Peat	Small

1/ Those that by their composition are particularly subject to erosion when disturbed.

c. Land Use

The construction of the gasification plant and development of the mine would change the present land use from agricultural to industrial for the short term. The land use of the 1,400 acres used for the plantsite would change from agricultural to manufacturing; land used for the access road and railroad would change from agricultural to roadbed ROW. In the mine area, the land use would vary according to the stage of mine development. Some of the land would remain in agricultural use until mined. After reclamation the land would be returned to its existing use or altered for a different use at the option of the landowner (who retains surface ownership unless he sells it to the company).

About 2,500 acres would be out of agricultural use at any one time. The cumulative loss to annual agricultural sales over the 25-year projected life of the plant would be about \$8.4 million (assuming no reclamation). Successful reclamation could lower this figure to \$3.4 million. The loss in grazing would be about 60,000 animal unit months, assuming a 10-year reclamation period for pastureland and 7 months of grazing per year. In dollars, this would amount to a \$1.78 million loss in cattle production over the life of the plant. The remainder of the \$3.4 million loss in agricultural sales would be from lost cropland production.

Approximately 2,960 acres of prime farmland would be disturbed by the proposed project; 78,010 acres of land within Mercer County has been designated as prime farmland by the Soil Conservation Service (SCS). Prime farmlands are those whose value derives from their general advantage as cropland due to soil and water conditions (103). About 380 acres of prime farmland occurs at the proposed plantsite and would be lost to agricultural uses for the life of the plant. The remaining 2,580 acres of prime farmland would be disturbed temporarily by mining and construction activities. Since the mining to reclamation cycle would average about 5 years, about 515 acres of prime farmland would be disturbed at any one time. Most of this land would be returned to good quality cropland after reclamation, but whether or not the reclaimed cropland would constitute "prime" farmland as defined by the SCS has yet to be determined. No unique farmland would be affected by the proposed project.

Over the long term it is likely that existing prairie, currently used for grazing purposes and as wildlife habitat, would be converted to cropland if reclamation is successful. This would occur because many landowners would probably prefer to have the land restored for cropland uses rather than returned to grazing uses due to the greater cash yield from cropland. The result would be a change in

current land use to more intensive agriculture and a significant loss of habitat for those forms of wildlife closely associated with prairie habitat.

The influx of persons into the area associated with the proposed project would cause a large increase in urban area and an attendant impact on land use. Agricultural land would be needed for schools, roads, homes, parks, etc. This would be a major change in present use of the land.

d. Geological Hazards

Deep-well disposal of plant wastes (Section 2.1.3.1) does have the potential of causing earthquake activity. Potential mechanisms of creating earthquakes would be lubrication of an existing fault (as happened at Rocky Mountain Arsenal) or creation of a new fault by high underground pressures. However, 437 deep injection wells (132 low pressure wells in the Dakota Formation and 325 high pressure wells deeper than 5,000 feet) have been placed in operation in North Dakota since 1954 with no known earthquake problems.

Most of the potential landslide and sand blowout areas identified along the proposed product pipeline route (Section 2.1.4.4) could be reactivated as a result of construction. Intrusion of surface water and vibrations caused by blasting or the operation of heavy equipment could further contribute to causing slope failure. The major impact of potential landslides and sand blowouts would involve the loss of the integrity of the railroad embankments which would affect railroad operations resulting in an economic loss to the railroads and inconvenience to users.

Construction near the banks of the Red River of the North could cause bank slumping, although construction activity would be perpendicular to the streambank.

3.2 Impacts on the Biological Environment

3.2.1 Terrestrial Flora

(Within this section impacts are quantified first and an impact analysis presented at the end.)

3.2.1.1 Plantsite

a. Construction

Construction of the proposed gasification plant would require about 535 acres. This acreage would be lost as wildlife habitat and agricultural acreage for the life of the plant, estimated to

be a minimum of 25 years. About 95 percent of the proposed plantsite area (498 acres) is agricultural, of which a large portion (378 acres) is cropland (Table 3-13). Prairie communities comprise 5 percent (27 acres), wetland communities 0 percent, and woody communities less than 1 acre of the area to be covered by the plant. The remaining 905 acres of the 1,440 acres purchased by ANGCGC for the plantsite would be allowed to remain in and/or revert to a natural state, and act as a "buffer zone" between the plant and the surrounding land (57).

b. Operation

During plant operation, vegetation near the plantsite would be subject to various air pollutants including sulfur dioxide (SO_2) and nitrogen oxide (NO_x). Also, small amounts of hydrogen sulfide (H_2S) and carbonyl sulfide (COS) would be released into the atmosphere. Even though it is anticipated that all Federal and State air quality standards would be met, the plant community as far as 10.5 miles downwind of the site would be subjected to low levels of airborne contaminants over a long period of time. SO_2 and NO_2 have been known to cause physical injury to plants in ambient air concentrations below the Federal standards (44, 54, 67). However, the potential impacts of such exposure due to projected emissions from this project are not quantifiable at this time as very few studies have been done on this aspect of air pollution.

3.2.1.2 Surface Mining

Coal supply for the gasification plant and powerplant would require the mining of about 500 acres/year for the life of the facility, or a total of about 12,500 acres (Table 3-14). The time required to reestablish nonagricultural plant communities or to return mined land to productive agricultural use is not definitely known; however, 3 to 5 years for cropland and 10 years for range-land is assumed for this statement (111, 112). Projected long-term impacts on plant communities are based on current reclamation procedures.

Fugitive dust would be raised by the constant flow of trucks on roads. Localized settling of large amounts of dust on vegetation near the roads would alter photosynthetic rates and, hence, plant growth.

a. Agricultural Communities

About 7,260 acres of agricultural communities would be affected by mining. Postmining rehabilitation efforts would undoubtedly be directed toward establishing as much agricultural land as possible

TABLE 3-13

**HABITATS TO BE AFFECTED BY CONSTRUCTION OF THE
PROPOSED COAL GASIFICATION FACILITY**

<u>Habitat</u>	<u>Approximate Acreage¹</u>	
Agricultural communities	498	
Cropland		378
Domestic haylands		111
Abandoned farmstead		5
Gravel pit		4
Prairie communities	27	
Overflow range site		13
Closed depression range site		2
Silty range site		5
Thin upland range site		2
Shallow range site		1
Very shallow range site		T
Thin claypan range site		4
Wetland communities	0	
Seasonal ponds (wetland range site)		0
Woody plant communities	T	
Natural woody plant communities		T
Tree plantings		T
Total	535	

¹ Acreages less than one acre listed as trace (T).

Source: Woodward-Envicon, Inc. Analysis, 1974.

TABLE 3.-14

**HABITAT ACREAGES WITHIN THE AREA EXPECTED TO BE MINED
DURING THE FIRST 25 YEARS OF OPERATION OF THE PROPOSED COAL
GASIFICATION FACILITY**

<u>Habitat</u>	<u>Acreage</u> ¹	
Agricultural communities	7,260	
Cropland		~1864
Domestic hayland		~5305
Farmsteads		90
Gravel pit		1
Prairie communities	5,153	
Subirrigated range site		T
Overflow range site		75
Saline lowland range site		T
Closed depression range site		T
Sandy range site		522
Silty range site		2299
Clayey range site		100
Thin upland range site		695
Shallow range site		1156
Claypan range site		61
Shallow to gravel range site		4
Very shallow range site		35
Thin claypan range site		206
Rock outcrops		T
Wetland communities	50	
Wet meadow swales		14
(wet meadow range site)		
Seasonal ponds		16
(wetland range site)		
Semipermanent ponds		7
(marsh)		
Stock ponds		13
Woody plant communities	46	
Natural woody plant communities		29
Tree plantings		17
Total	12,509	

¹ Acreages less than one are listed as trace (T).

Source: Compiled by WEI. 1974.

through the construction of smooth topography. The ultimate acreage of agricultural land would depend on the extent that soils now containing prairie and wetland communities can be converted by redistribution and concentration of topsoil and the success of reclamation.

b. Prairie Communities

About 5,160 acres of present prairie plant communities would be affected by mining. Because the existing soil structure would be altered, the return of mined land to premining natural prairie would be difficult. After topsoil return, areas which are not converted to agricultural use would pass through a long period of secondary succession. Succession to a near-natural condition could take 20 to 40 years. Reclamation studies at NACCO's Indian Head Mine have resulted in substantial vegetative cover in as little as 3 years; however, natural communities resembling premining conditions may never be reestablished.

c. Wetland Communities

Wetland communities comprise about 50 acres of the area scheduled for mining. Wetland soils, due to their fertility and depth, would almost certainly be converted to agricultural use. However, increases in wetland habitat may result from mining. Impoundments are planned to confine drainage to the mine area and final cuts (which are not filled) would probably hold water. Proper grading of these areas to provide shallow water may provide conditions conducive to the establishment of wetland communities. In addition, the replaced overburden would settle unevenly over a long period of time creating shallow surface depressions that would also hold water.

d. Wooded Communities

About 46 acres to be mined are occupied by woody vegetation. The majority (29 acres) consists of native woody plant communities; tree plantings account for the remainder (17 acres). Native woody communities are irreplaceable, although such communities may develop over the long-term after reclamation. Woody habitat could increase after mining in the form of tree plantings at the discretion of the landowner. Woody species can often survive directly on spoil materials, particularly where spoil banks are not leveled. If soils are concentrated for agricultural use, the areas left without much topsoil can be made useful by development of woody stands for wildlife habitat.

3.2.1.3 Water Intake and Pipeline

The proposed pump station on Renner Bay is on U.S. (Corps of Engineers) property, which is actively managed by the North Dakota Department of Game and Fish as the Hille State Game Management Area. The pumping facility would occupy about one-fourth acre, currently prairie habitat, which would be lost.

Construction of the water intake would involve excavation of about 10,000 yds³ of overburden. Part of this overburden would be used to raise the grade of the pumphouse site; the remainder would be deposited in low lying areas near the site that are currently supporting relatively undisturbed prairie vegetation. Before spreading the spoil, existing topsoil would be removed and stockpiled for reclamation. After the deposition of the spoil, the topsoil would be replaced and disturbed areas seeded with species of grass similar to those already present. Thus, the existing habitat would be lost temporarily during construction of the facilities.

The water pipeline, 7.6 miles long, was aligned to avoid areas underlain by coal. The proposed route transverses 4.0 miles of agricultural lands (2.0 miles of croplands and haylands and 2.0 miles of road ROW) and 3.6 miles of prairie habitat. Based on a construction zone width of 150 feet, about 72 acres of agricultural land and 66 acres of prairie would be affected.

Effects in agricultural areas would likely be temporary, although reductions in soil productivity may occur due to the redistribution and mixing of soil horizons. Changes in prairie communities would be more permanent since excavation and backfill would alter the soil. Bared areas would be seeded to help stabilize soils, and in time some of the more adaptable native species may become reestablished. Until revegetation is adequate, water and wind erosion would occur. Water erosion problems should be small, however, since steep, long slopes are not present.

Operational impacts of the water intake system on the flora should be minor and related to maintenance and repair of the pumping facilities and pipeline.

3.2.1.4 Railroad Spur

The distance from the Burlington Northern mainline west of Hazen to the plantsite boundary is 12.1 miles. About 7.0 miles of agricultural, 1.5 miles of prairie, 3.1 miles of weedy ROW, and 0.5 miles of woody habitat will be traversed. Assuming an affected 150-foot width, about 127 acres of agricultural, 27 acres of prairie, and 9.1 acres of wooded lands would be lost. The railroad embankments would revegetate to the weedy habitat characteristic of the existing railroad ROW.

3.2.1.5 Product Pipeline

a. Farmlands

A short-term impact would result where construction of the pipeline passes through productive cropland. These are areas where the railroad has leased land for agricultural use, or where the route deviates from the railroad ROW. Some encroachment on land adjacent to the railroad ROW would be necessary for construction space or access. Most of the agricultural land affected would be planted in small grains or used as pasture/rangeland and would be lost for the season.

Construction through farmlands would result in the loss of the crop in the area disturbed for one growing season. A decline in soil productivity over the trench area could affect crop production for several additional growing seasons. Rangelands, pasturelands, and hayfields would require several seasons to become fully reestablished. Almost the entire route would be on existing railroad ROW with about 262 miles of cropland and 15 miles of hayland bordering the ROW. The 79 acres of new ROW would also be disturbed for one growing season but would revert back to its previous use after pipeline construction.

b. Woodlands

Most of the natural woodlands along the proposed route are stands of bottomland hardwoods along the perennial drainages. These hardwood stands are extremely important wildlife habitat. There are also scattered woodlots near the terminus at Thief River Falls and on the beach ridges of glacial Lake Agassiz. Where construction adheres to railroad ROW, woodlands would normally be avoided. However, woodlands may be encountered at stream crossings, where the route leaves the Soo Line ROW to link with the Thief River Falls Compressor Station, or where construction does not adhere to railroad ROW.

The impacts resulting from clearing the ROW or work space in woodlands include a loss in aesthetic quality, a loss of woodland habitat, loss of stream shading and bank stabilization, and loss of wind protection. There could also be localized loss of wildlife nesting and denning sites. Areas of woodland on or near the proposed route are shown in Table 3-15.

c. Wetlands

Significant, long-term impacts on wetlands could result if water levels were affected by trenching, spoil disposal, or backfilling. Where the rate of drainage was increased, communities adapted to dryer conditions would result. Most of the potholes along the proposed route are underlain by deep layers of clay till; trenching

TABLE 3-15

Woodland Areas Along Proposed Product Pipeline Route

<u>Area</u>	<u>Area Length (miles)</u>	<u>Woodland Types</u>
Knife River	3.6	Bottomland Hardwoods
Missouri River	5.5	Bottomland Hardwoods
Missouri Plateau, Drift Prairie, Red River Valley	6.4	Bur-oak Savannah, Shelterbelts
Forest, Morais, Snake, and Red River of the North	?	Bottomland Hardwoods
Glacial Lake Agassiz	<u>7.2</u>	Jack Pine, Aspen, Tamarack
Total	22.7	

should not increase permeability. In these situations, plugging the trenches where it enters and leaves the pothole and restoring the original contour would be done to ensure that the hydrologic characteristics would not be altered. In some cases trenching may increase the permeability of the bottom profile where the trench strikes outwash deposits. In these cases, the bottom would be sealed.

Even though measures would be taken to maintain the integrity of affected wetlands, one season's production would be lost in those wetlands or portions of wetlands disturbed during the spring months. Production would not be lost on wetlands affected during summer (after July 15) and fall if normal precipitation occurs after construction.

Another long-term impact may result if the productivity of the peripheral community was altered. Pothole sites are commonly farmed as close to the wetland as possible, so natural plant communities (Section 2.2.2.3) are normally restricted to narrow bands. Generally, two soil conditions prevail in the potholes: (1) ephemeral and intermittent potholes have soils similar to adjacent areas and (2) permanent potholes have an accumulated upper layer of peat or muck. Disruption of soil profiles would have an impact on revegetation of these natural communities. Wetlands comprising approximately 7,200 acres are contiguous to railroad ROW; about 115 acres of these wetlands lie within the 50-foot construction width.

3.2.1.6 Analysis of Impacts to Terrestrial Flora

The total approximate acreage of the main habitat types to be disturbed by the different associated facilities of the gasification complex is summarized in Table 3-16. Agricultural land that is disturbed by the mining and pipeline functions would be removed from production temporarily for a period of 3 to 5 years for cropland and 10 years for pastureland. Agricultural land removed from production by the plant and railroad spur would be lost for the life of the facilities, and probably for the indefinite future. The loss of the crops produced on affected land is not a significant loss on a State or national scale. Since an undetermined but large portion of existing prairie and wetland would be converted to agricultural use through reclamation, the eventual effect of the proposed project on total agricultural acreage would probably be a net gain.

Much of the native prairie habitat to be disturbed by the proposed project is likely to be lost or irreversibly altered. During reclamation much of the land currently covered by prairie would be converted to agricultural use; that designated to return to

TABLE 3-16

Habitats to be Affected by the Construction and Operation
of the ANGCGC Coal Gasification Complex

<u>Function</u>	<u>Acreage Affected</u>				<u>Existing ROW 1/</u>
	<u>Agricultural</u>	<u>Prairie</u>	<u>Wetland</u>	<u>Woodland</u>	
Plantsite	461	27	0	1	0
Mining	7,260	5,153	50	46	0
Water Intake & Pipeline	72	66	0	0	0
Railroad Spur	127	27	0	9	56
Roads	31	13	0	0	29
Product Pipeline	79	0	0	0	2,111
TOTALS	8,030	5,296	50	56	2,196

1/ Existing ROW contains some acreages of prairie, wetland, and woodland; the extent of disturbance to these communities are discussed in Section 3.2.1.5.

prairie would require decades to approximate its original condition. The amount of prairie involved in this project is in itself not significant on a regional scale. However, the cumulative effect of man's activities has resulted in the steady decline of prairie over the years and may eventually reach the point where even small encroachments into the existing prairie would be considered significant.

The net effect of the proposed project on wetlands is not well established. Most of the 50 acres to be lost is prime wetland, currently heavily used by ducks and other waterbirds for breeding and feeding areas. New water areas would be created by mining, particularly in the area of the last highwall cuts (which are not filled). The degree that wetland vegetation can become established in these new water areas would largely determine their value as wetlands, and this cannot be accurately predicted at this time. Overall, the net effect of the proposed project on wetland habitat is apt to be a short-term decrease and a negligible long-term impact.

The net effect of the proposed project on woodland habitat is also not well established. Replacement trees would be planted in

accordance with the landowner's wishes which may or may not equal the 56 acres of trees removed. However, tree plantings in North Dakota almost never reproduce naturally; thus, tree plantings provide only partial mitigation for the loss of native woodlands.

Part of the difficulty in accurately predicting what kinds of habitats, and in what amounts, would result from reclamation is the fact that North Dakota reclamation law provides that the mined land must be reclaimed according to the desires of the landowners. The desires of the landowner regarding reclamation are not obtained until just prior to the mining on his land, thus it is the wishes of the various landowners that would determine what the overall impacts to the various habitat types would be.

3.2.2 Terrestrial Fauna

(Within this section impacts are quantified first and an impact analysis presented at the end.)

3.2.2.1 Plantsite

The estimated numbers of animals that would be lost or displaced as a result of plant construction (based on 1974 populations) are shown in Appendix H.

A group of 21 pronghorn antelope was observed wintering on the plantsite in October 1974. The loss of winter habitat could reduce the number of pronghorn which the area can support. Pronghorn populations in the area are not high and winter habitat does not appear to be a major limiting factor, however; thus it is probable that the herd would find adequate winter habitat away from the plantsite.

Local populations of nongame species which might sustain significant losses as a result of plant construction would include the sora, Wilson's phalarope, and black-billed cuckoo. Other nongame species would also sustain losses, but because they are relatively common or losses relatively small, impacts to these species should not significantly reduce existing populations.

3.2.2.2 Surface Mining

Both short- and long-term habitat losses due to surface mining would result in proportional decreases in the numbers of animals present in the area. Resident species known to inhabit the 12,500-acre area scheduled for mining (1974 estimates) are also listed in Appendix H.

Waterfowl present on 50 acres of typical wetland during the 1974 breeding season included 32 mallards, 22 pintail, 5 gadwalls, 39 shovelers,

and 14 blue-winged teal. Based on an average breeding success of about 50 percent for ducks in southwestern North Dakota (45), mining would result in an annual production loss of about 127 young.

Only a portion of the numbers listed in Appendix H for each species would be lost or displaced at any one point in time. Depending on the rapidity and success of reclamation, those species able to tolerate nearby human activity could reinhabit reclaimed areas as soon as 3 to 5 years after mining. Species intolerant of human activity or requiring native prairie habitat would take much longer to reinvade mined areas if they return at all.

The North Dakota Game and Fish Department has provided data on the densities of some game and predator species that differ significantly from those found during the Woodward-Clyde field study and shown in Table 2-17 and 2-20. Based upon several years of censuses in the project area, Game and Fish Department estimates for the following species are:

<u>Species</u>	<u>Population Density</u>
Sharp-tailed grouse	6.0 birds/mi ² (spring)
Ring-necked pheasant	10.0 hens/mi ² (spring)
White-tailed deer	0.5 - 1.5/mi ² (fall)
Mule deer	0.5/mi ² (fall)
Coyote	0.3 - 0.5/mi ² (fall)
Red fox	1.0 - 1.3/mi ² (fall)

Using these data, the number of animals of these species that would be displaced or lost due to the proposed project would be:

<u>Species</u>	<u>Plantsite</u>	<u>Minesite</u>	<u>Total</u>
Sharp-tailed grouse	5	117	122
Ring-necked pheasant	10	234	244
White-tailed deer	1	20	21
Mule deer	0	5	5
Coyote	0	8	8
Red fox	1	23	24

3.2.2.3 Water Intake and Pipeline

Decreases in animal populations due to habitat loss from the pump station and water pipeline construction should be relatively small because of the small amount of acreage involved. Depending on the timing of construction, disturbance and/or destruction of nesting waterfowl and game birds would result.

The operation of the pumping station would cause a constant, low-intensity noise. As a result, resident wildlife may avoid the

area near the pumping station for an undetermined distance around it.

3.2.2.4 Railroad Spur

Response of animal populations to construction of the railroad spur would be a temporary loss or displacement of individuals followed by reinvasion of the ROW by those species able to use the weedy vegetation that would become established and able to tolerate the rail activity. The weedy habitat would be the relatively wide, permanent fence-row type which a variety of wildlife species often utilizes. Movement patterns of some species may be altered by railroad operation. Some accidental mortality may also occur.

3.2.2.5 Product Pipeline

Long-term impacts to waterfowl because of product pipeline construction would depend on the amount of wetland area lost. Careful attention to reestablishing disturbed wetland areas would minimize any long-term effects. Any permanent loss of wetlands caused by construction would result in a proportional reduction in the existing waterfowl population.

Short-term pipeline construction impacts to waterfowl would be disturbance of habitat, disturbance to waterfowl nesting and brood rearing, and nest destruction. Impacts to nesting waterfowl would be greatest in the latter part of May, in June, and most of July. In addition, total site disturbances may be greatest during this period as this is the time when the wetlands will have standing water and peripheral areas would be waterlogged. Greater work space may be required at this time.

Impacts to upland game during construction would result from temporary habitat loss and nest destruction. Throughout much of the Drift Prairie and the Red River Valley, the brome and mixed grass associations of the railroad ROW are heavily used by birds and small mammals because virtually all of the surrounding lands are used for agriculture. Impacts to ground nesting populations of sharp-tailed grouse and gray partridge would again be greatest during the spring nesting season. Construction during late summer and fall would result mainly in a dispersion of upland game, but local population reductions may occur the following winter where adequate cover has not yet redeveloped.

In some permanent potholes and marshes, destruction of muskrat houses and dens would occur during construction if they are present on the ROW. Long-term population reductions would result if existing water levels are not maintained, or if peripheral habitat was altered significantly.

Other predators and furbearers, such as fox, coyotes, and weasels would be temporarily displaced from portions of the ROW during construction to areas of unsuitable or already occupied habitat. Other birds and mammals which use old trees for dens, such as owls and raccoons, would be forced to permanently relocate where trees were removed and their populations would be reduced accordingly.

Construction should not have much impact on big game except for temporary movement of the animals away from construction activity.

Construction would result in the destruction of songbird and small mammal nestsites and dens, loss of habitat, and killing of some individual animals unable to run out of the path of construction equipment. Long-term impacts should not be significant after vegetation has been reestablished.

No adverse impacts to endangered species from the product pipeline are anticipated because the route would be surveyed prior to construction. However, it is unlikely that any endangered species would occur within the railroad ROW.

3.2.2.6 Analysis of Impacts to Terrestrial Fauna

Animals displaced from the plantsite and areas of mining activity would immigrate into adjacent habitat that is probably at or near its carrying capacity for many species. The result would be a temporary overcrowding of adjacent habitat and a reduction in habitat quality until such time as death, reduced birth rates, or other natural population control factors returned populations to preinvasion levels. The net effect would still be a loss of individuals equal, or nearly equal, to the original number displaced.

Noise and human activity associated with operation of the coal gasification plant and associated facilities would result in avoidance of adjacent areas by some species of wildlife. The effects of noise on wild animals are not well understood. Animals with large home ranges, such as most predators, are not expected to nest or rear young near activity centers, but it is not known whether the causes for this are due to noise or to human activity. Movements of some species, particularly antelope and white-tailed deer, would likely be adversely affected by increased traffic (rail and auto) and human activity related to plant and mine operation. Increases in the highway and railroad mortality rates of some animals such as the thirteen-lined ground squirrel and Eastern cottontail could also be expected.

Direct bird mortality may occur from the stacks that would be constructed as a part of the gasification and powerplants. Birds that migrate at night, such as warblers and vireos, have been

known to die in large numbers from collision with this type of tall structure. Any bright lights on the stacks would serve to increase the number of birds killed (46). (Potential impacts of plant emissions on animals were discussed in Sections 3.1.1.3 and 3.6.)

Long-term changes in animal populations would occur due to mining activity because postmining habitats would differ considerably from premining habitats. Species which rely on prairie habitats during all or part of their life cycle would be reduced in overall numbers after mining because of the probable conversion of existing prairie to agricultural uses. Species such as upland plover, western meadowlark, grasshopper sparrow, lark bunting, chestnut-collared longspur, Northern grasshopper mouse, prairie vole, pronghorn antelope, and smooth green snake would likely decrease in numbers.

The post-mining acreages of wetlands and woodlands to be established in the area are not known at this time. For the reasons discussed in Section 3.2.1.2., there is apt to be a slight increase in wetland area as a result of mining; the suitability of these areas for waterfowl and shorebirds would depend on the development of aquatic plant communities and macroinvertebrates to serve as food supplies. The amount of post-mining woody cover is largely at the discretion of the various landowners; any woody cover established would probably be exotic species that does not reproduce naturally in North Dakota.

Woody cover provides important winter cover for many upland game birds; thus, any decreases in woody areas would cause a corresponding decrease in upland game bird populations. However, the sharp-tailed grouse requires native prairie vegetation for nesting cover, so populations of this species will likely decrease even if woody cover were reestablished.

Repopulation of the mined area by predators would depend in part on availability of prey. Since many of the small bird and mammal prey species are well adapted to agricultural land use, they should readily repopulate reclaimed land and a majority of the predators should also. There are some exceptions. Burrowing owls nest most often in prairie habitats and a decrease in the amount of prairie after mining would reduce the amount of nesting cover for this species. The great-horned owl, Swainson's hawk, and Cooper's hawk nest in trees; repopulation by these species may depend upon the amount of post-mining nesting cover present in tree plantings.

Songbirds which utilize wetland habitats, such as yellow-headed and red-winged blackbirds, may benefit slightly from mining if

appropriate communities become established in post-mining wetlands. Increases in agricultural habitat may also benefit those songbirds adapted to agricultural land use such as the horned lark, house sparrow, and starling.

Amphibians and reptiles which use wetlands may also increase slightly if the appropriate communities become established. The smooth green snake is found most often in prairie habitat and would not be able to adapt to postmining agricultural conditions.

The influx of workers into Mercer County would cause an approximate 30 percent increase in males between 18 and 54 years old. As a result, the number of hunters afield, particularly in public hunting areas such as the Hille State Game Management Area, would increase. This increase may be sufficient to cause local overharvest of some game animals.

No endangered species should be effected directly by the proposed project because it is located outside the usual range of the endangered species resident in the State (Section 2.2.5.2).

Overall, the impact of the proposed project on existing animals would not be of State or national importance except that it would be one of numerous small activities continuing to rapidly convert the remaining prairie and wetland (and its associated wildlife) to other uses (See Section 3.2.2.6 for habitat impacts). Unless mined land is reclaimed specifically for wildlife values, the reclaimed land actually provides very little for wildlife compared to minimal or, in some cases, no reclamation. Unreclaimed or partially reclaimed land from previous mining operations in North Dakota often supports native vegetation, much of it woody, wetland areas, and is relatively inaccessible to humans. Such areas currently provide important winter cover and relatively undisturbed refuges for wildlife.

3.2.3 Analysis of Impacts to Aquatic Ecosystems

a. Lake Sakakawea

Construction of the water intake and pipeline to the pump station would temporarily increase turbidity, displace benthic communities, and release nutrients from the sediments within an estimated 30-yard radius of the intake. Fish may temporarily avoid the construction area and plankton levels may fluctuate because of turbidity and nutrient release. The potential impact of construction on fish spawning and nursery areas is not fully known; however, initial studies by the North Central Reservoir Investigations Team (a joint EPA and Fish and Wildlife Service project) indicate that spawning is probably limited to a very few warmwater species in the area of the proposed intake.

During operation of the water intake structure the probability of entrainment of larvae and young warmwater fish would be low when lake elevations are at or near normal levels (1,838 feet). Losses could be significant, however, during low water periods (1800 feet elevation or less) which might occur an average of 1 out of 8 years (74). Most adult and fingerling fish should be able to avoid the relatively low intake velocities (0.5 cfs at peak demand). Macro-invertebrates and plankton would also be subject to entrainment.

The loss of cold hypolimnetic waters may make an undetermined area around the intake unsuitable for cold-water fishes. Runoff of ground and surface waters from mining areas could increase siltation and mineralization in Renner, Beaver Creek, and Beulah Bays. Attempts would be made through impoundments to divert runoff to the Knife River Basin. However, runoff diversion does not solve the problem of increased siltation and mineralization but only changes its area of influence. Antelope Creek, which may be affected by such diversion, has recently been classified as a critical stream by the North Dakota Game and Fish Department because it provides excellent forage fish production, northern pike reproduction, and a sport fishery near its mouth with the Knife River for Northern pike, channel catfish, and walleye.

The influx of workers and their families would increase fishing pressure on Lake Sakakawea. This should not affect the reservoir fishery since present sport fishing is light in relation to reservoir size.

b. Knife River, Spring Creek, and Antelope Creek

Construction and operation of the gasification facility and associated mine may increase siltation and mineralization of Knife River Basin waters, particularly during periods of high-intensity storm runoff. The impacts associated with increased siltation might include reduction of both the kinds and numbers of organisms present, a limitation of habitat for macroinvertebrates, the smothering of fish eggs, and a reduction in the primary productivity of the ecosystem. Increased mineralization may also reduce the numbers and kinds of organisms present. In addition, some taxa of macroinvertebrates and fish eggs may be susceptible to plasmolysis induced by osmotic pressure changes.

The proposed plant is designed not to discharge liquid waste into surface waters. However, airborne emissions from the gasification plant which would be deposited on the ground downwind from the plant may enter surface waters and accumulate in aquatic organisms. This impact cannot currently be quantified but represents a possible long-term impact that may have important ecological significance by introducing such hazardous materials as arsenic, mercury, zinc, lead, and selenium into the various food chains.

c. Product Pipeline

The major impacts on aquatic ecosystems from the product pipeline would result from construction across waterways including the transport of equipment and discharge of hydrostatic test water. An additional factor would be the upland erosion from the construction. The impact of pipeline construction on water quality was discussed in Section 3.1.2.1; this section is concerned with the potential impact upon aquatic organisms.

Silt-loading impacts would be temporarily detrimental to the maintenance and propagation of aquatic biota. The benthic community would be disturbed at the point of crossing and for some distance downstream because of increased sedimentation. Similarly, construction induced sediments may be discharged to surface waters via overland runoff, affecting the receiving waters at the point of discharge and for some distance downstream. Primary productivity of the affected waters would be reduced by the increased sediment loads; however, these disruptions would be short-term, and repopulation of affected areas would begin after construction is completed.

The primary impact to fish populations would be a temporary reduction in reproductive success. Any spawning areas at the crossing sites would be destroyed and spawning areas some distance downstream may be inundated by siltation. Most concerned fish species spawn from early spring through early summer and water-crossing construction at other times would reduce the impact. An added impact would be the destruction of fish by blasting during stream crossings.

Potential biological impacts to the various groups of aquatic ecosystems defined in Table 2-16 are summarized in Table 3-17. Many of the potential impacts would be avoided by scheduling construction around wildlife and fishery reproductive and migration periods whenever possible.

3.3 Cumulative Impacts on the Socioeconomic Environment: ANGCGC-Basin Electric

This section discusses the social and economic impacts of the joint construction and operation of the proposed ANCGC and Basin Electric Projects. The project impact area has been chosen to be that portion of Mercer, Dunn, and Oliver Counties within a 30-mile easy commute radius of the plantsite. The northern and eastern portions of McLean County were excluded from the population in-migration analysis because of the limited access across Lake Sakakawea to the project site. Although workers would commute from areas greater than the 30-mile radius, the major effects would occur within that area, where the employment positions are created.

TABLE 3-17

Projected Biological Impacts to Aquatic Ecosystems
Product Pipeline

<u>Group</u>	<u>Potential Impacts</u>
I. Drainage Ditches and Canals	Minor fisheries impact
II. Intermittent Streams	Reduced fish reproductive success if crossed during spawning
III. Intermittent Potholes	Disruption of waterfowl production
IV. Perennial Potholes	Disruption of waterfowl production and impairment of any fishery
V. Rivers and Creeks	Disruption and siltation of spawning beds; the Knife River is of particular concern
VI. Major Rivers	Disruption and siltation of spawning beds and disruption of fish migration. Of particular concern would be disruption of migrating Coho salmon in Missouri River
VII. Major Lakes	Disruption of 600 feet of potential shoreline spawning grounds in Lake Sakakawea

Due to the recent and continuing influx of persons into the impact area related to other coal development in the region, it was assumed for this statement that the impact area would have little surplus social and economic infrastructure capacity to absorb socioeconomic impacts associated with the expected new population influx. Thus, new facilities and service capacity would be needed to accommodate most needs of the new population.

3.3.1 Economic Factors

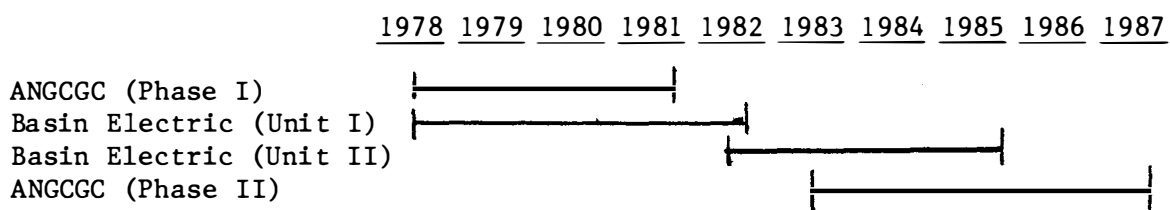
3.3.1.1 Anticipated Worker Requirements

a. Direct Employment

The average annual number of workers needed for the construction and operation of the proposed gasification plant and associated facilities, powerplant, and both projects combined is projected in Table 3-18. Workers migrating to the impact area would be largely limited to those associated with construction and operation of the plants and mine; railroad and pipeline construction crews are highly mobile and rarely migrate to the project area for projects of this size, and the pipeline operations crews would be based out of the impact area.

Construction is scheduled to start with 442 workers in 1978 and a peak of 3,049 construction and operation personnel (excluding product pipeline construction crews) would be reached in 1980. A second peak of 2,257 construction and operation workers is tentatively scheduled to be reached in 1984 due to the construction of the second phase of the gasification plant overlapping with the completion of the second unit of the powerplant. The rapid and large influx of workers could create an inflated local economy in peak construction years.

A tentative construction schedule is shown below:



The figures presented in Table 3-18 are the annual averages of the number of workers employed each year. During the year, the number of workers needed, especially for construction, could vary considerably. For example, the average number of workers needed for construction of the Basin Electric powerplant in 1979 is 582. However, quarterly estimates of manpower needs for that year are as follows:

1st Quarter (DJF)	424
2nd Quarter (MAM)	505
3rd Quarter (JJA)	621
4th Quarter (SON)	780

Thus, the actual number of employed workers could vary either above or below the values in Table 3-18 depending upon the manpower requirements for a particular time period. Estimates of operations personnel are less subject to variation.

Many of the construction workers needed for construction of the first phase of the gasification plant could find employment at other energy-related construction projects in the nearby area after completion of the proposed facilities, or they could be rehired by ANGCGC for the second phase of plant construction, now scheduled to start in 1983. Many of the construction workers and their families, therefore, could reside in the area for up to 9 years or more.

The annual average number of construction workers needed for both projects, by skill, for the peak construction period is presented in Table 3-19. The total number required in the peak year is somewhat less than the sum of the categories because peak uses of the various skills do not necessarily coincide with one another.

TABLE 3-18

Estimated Average Annual Employment of the Gasification Plant,
Powerplant, and Associated Facilities

<u>Construction:</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
Mine	130	320	250	240	30	200	200	200	0	0
Gasification Plant	312	1077	1796	812	300	267	808	1121	1136	313
Product Pipeline	0	0	1680 ^{1/}	0	0	0	0	0	0	50
Railroad Spur	50	0	0	0	0	0	0	0	0	0
Powerplant	<u>195</u>	<u>582</u>	<u>799</u>	<u>478</u>	<u>486</u>	<u>752</u>	<u>397</u>	<u>52</u>	<u>0</u>	<u>0</u>
Subtotal	687	1979	4525	1530	816	1219	1405	1373	1136	363
<u>Operation:</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987-2015</u>
Mine	47	81	147	278	278	278	278	278	310	360
Gasification Plant	0	0	0	414	414	414	414	414	414	640
Product Pipeline	0	0	0	10	10	10	10	10	10	12
Railroad Spur	0	5	5	5	5	5	5	5	5	5
Powerplant	<u>5</u>	<u>5</u>	<u>57</u>	<u>95</u>	<u>108</u>	<u>108</u>	<u>160</u>	<u>160</u>	<u>160</u>	<u>160</u>
Subtotal	52	91	209	802	815	815	867	867	899	1177 1160 ^{3/}
Total Direct Work Force in Impact Area ^{2/}	689	2065	3049	2317	1616	2019	2257	2225	2020	1473

^{1/} Construction will occur simultaneously in four spreads; each spread will require a maximum of 420 workers.

^{2/} Excludes product pipeline and railroad spur workers because it is unlikely they will migrate into the three-county impact area.

^{3/} Operations base for impact area.

TABLE 3-19

Annual Average Number of Construction Workers, by Skill,
Required for Peak Utilization Period

<u>Skill</u>	<u>ANGCGC</u>	<u>Basin Electric</u>
Boilermakers	135	108
Carpenters	125	73
Electricians	331	99
Asbestos Workers	51	38
Iron Workers	113	79
Laborers	174	88
Masons	70	10
Millwrights	113	31
Operating Engineers	70	48
Painters	32	18
Pipefitters	586	138
Teamsters	51	21
Others	13	73

After construction, about 1,160 workers would be used for gasification plant, powerplant, and mine operations. Most of the occupations would be classified as either maintenance or operations. Skills needed for maintenance work would vary greatly; the operatives are those persons who will actually handle the gasification and power generation processes, thus some technical expertise and training will be necessary. Most of the skilled labor would probably not be available locally.

Table 3-18 highlights three important aspects of the employment impact of the ANGCGC and Basin Electric projects. First, peak direct employment would exist for only a short time and in two separate time periods. Two time periods (1979-1980 and 1983-1985) have the largest numbers of temporary workers and would also be the most demanding on public and semipublic resources. Demands for these resources would decrease significantly between 1980 and 1983, and by 1988. If the public and private service sectors overreact to the short term high demand, consequent investment and development projects may be overstated or inefficient upon return to a more normal economic base. Second, the phased construction of both plants should help lessen some of the socioeconomic impacts--compared to simultaneous construction of both plants. And third, even with the phased construction program, the sharp decrease in the construction employment (about 1987) would have a considerable impact on the total economy. Facilities and services designed for the high demand periods would have to be readjusted to the more normal operational base.

b. Indirect Employment

Indirect employment (new employment caused by the influx of direct workers and their families) generated by the proposed ANGCGC and Basin Electric projects would also be significant (Table 3-20). Indirect employment would average about 1,272 workers between 1978 and 1987 and would peak at about 1,660 workers in 1987. Peak indirect employment does not coincide with peak direct employment because the number of indirect jobs generated by operational workers is several times above those created by construction workers.

c. Total Employment

The total new employment in the impact area, both direct and indirect, which would result from the ANGCGC and Basin Electric projects is also shown in Table 3-20. A peak total employment of about 4,178 workers would be reached in 1980 before declining to an operational phase employment of about 2,726. The same patterns discussed previously in sections a. and b. above appear in the total employment estimates.

TABLE 3-20

Average Annual Indirect Employment and Total
New Employment in Impact Area
Attributable to the ANGCGC and Basin Electric Projects

<u>Year</u>	<u>Indirect Employment</u>			<u>Direct Employment</u>	<u>Total New Employment</u>
	<u>Construction</u>	<u>Operation</u>	<u>Subtotal</u>		
1978	191	70	261	689	950
1979	594	116	710	2065	2775
1980	854	275	1129	3049	4178
1981	459	1062	1521	2317	3838
1982	245	1080	1325	1616	2941
1983	366	1080	1446	2019	3465
1984	422	1150	1572	2257	3829
1985	412	1150	1562	2225	3787
1986	341	1193	1534	2020	3554
1987	94	1566	1660	1523	3183
1988-2015	0	1566	1566	1160	2726

1/ Multipliers (ratios) used to generate the indirect employment data are:
Construction 0.30; Operation 1.35 (68).

3.3.1.2 Population Impacts

Construction and operation of the proposed facilities would cause a significant and rapid influx of workers and their families into the three-county impact area. The projected annual new population based on the total employment generated by the proposed projects, and one possible distribution among area cities are shown in Table 3-21. It should be emphasized that the distribution of the population among the area cities is only one hypothetical scenario and that the actual population distribution could vary significantly from that presented. The scenario is presented here as a reasonable possibility on which the magnitude of the social and economic impacts can be assessed. The population distribution scenario was based on such factors as the size of the city, distance from project site, existing recreational facilities, etc. Percentages of in-migrating workers allocated to the various communities were: Beulah-34, Hazen-32, Golden Valley-4, Pick City-1, Stanton-9, Zap-7, Center-5, Dodge-1, and Halliday-7.

In-migrant population peaks of about 6,194 and 6,131 persons will be reached in 1980 and 1984, respectively. A more normal operational population of about 4,743 persons would be attained in 1988. This population increase is in addition to that from the 440-MW Coyote powerplant.

TABLE 3-21

Estimated Average Annual New Population Attributable to the
ANGCGC and Basin Electric Projects and One Possible
In-Migration Scenario to Impact Area Cities

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988-2015</u>
Total New Employment	950	2775	4178	3838	2941	3465	3829	3787	3554	3133	2726
Construction	637	1979	2845	1530	816	1219	1405	1373	1136	313	0
Operation and Indirect	313	796	1333	2308	2125	2246	2424	2414	2418	2820	2726
Total New Population <u>1/</u>	1412	4080	6194	6100	4809	5568	6131	6070	5755	5333	4743
Beulah	480	1387	2106	2074	1635	1893	2085	2064	1957	1813	1613
Hazen	452	1305	1982	1952	1539	1782	1962	1942	1842	1707	1518
Golden Valley	56	163	248	244	192	223	245	243	230	214	190
Pick City	14	41	62	61	48	56	61	61	58	53	47
Stanton	127	367	557	549	433	500	552	546	518	480	427
Zap	99	286	434	427	337	390	429	425	402	373	332
Center	71	204	309	305	240	278	307	303	288	267	237
Dodge	14	41	62	61	48	56	61	61	58	53	47
Halliday	99	286	434	427	337	390	429	425	402	373	332

1/ Based on 25 percent local hire rate and 15 percent of workers commuting from further than a 30-mile radius of the industrial site. Multipliers used to generate total population data were: In-Migrant Construction Workers - 2.27; In-Migrant Operations and Indirect Workers - 2.90. These values take into account single workers and workers who do not relocate families (69, 70) and assume that single workers would make up 24.6 percent of the total worker force.

By 1980, it appears that the population of most area cities could more than triple from 1970 levels as a result of coal-related development. For example, by combining the values in Table 3-21 with projections of the manpower requirements for the Coyote powerplant (71), it appears the population of Beulah could grow from 1,344 in 1970 to about 4,685 in 1980. A more stable population in Beulah of about 3,426 would be reached in 1990. This same pattern would apply to the other impact area cities near the plantsite such as Hazen and Zap.

3.3.1.3 Income and General Economic Conditions

a. Personal Income

The labor force required to complete the ANGCGC and Basin Electric projects would generate additional personal income in all phases of construction and operation. Income estimates for a future population are made with considerable uncertainty. Major causes of this uncertainty are inflation, labor demand/supply, and the permanent residence of the transient or temporary labor force. However, certain data can provide an insight into the impact that these developments might have on the purchasing power in the impact area. The following annual wage rates per worker (1976 dollars) were based on Bureau of Reclamation estimates for the pertinent trades:

1. Construction	\$21,500
2. Operation and Indirect	\$15,000

Using the above data and the tentative construction and operational schedule, rough estimates can be made of the direct personal income resulting from the two projects (in 1976 dollars). During the peak activity periods of 1980 and 1984 about \$81.2 million and \$66.6 million of personal income would be generated, respectively (Table 3-22). In disposable income (income after taxes) these values would yield \$69.5 million and \$57.1 million of additional disposable income in the impact area resulting from the proposed projects.

Not all of the disposable income would be spent or remain in the impact area. Aside from that which would go into savings, etc., a significant amount of the disposable income may end up in the Bismarck-Mandan area because the closest large wholesale and retail trade centers are located there. Also, a significant portion would be sent by workers to those families residing outside the region.

It is important to note the impact resulting from the termination of construction employment. Personal income associated with plant

TABLE 3-22

Estimated Income Generated in Impact Area by the
ANGCGC and Basin Electric Projects in 1976 Dollars
(Millions of Dollars)

<u>Personal Income</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988-2015</u>
Construction	13.7	42.5	61.2	32.9	17.5	26.2	30.2	29.5	24.4	3.7	0.0
Operation and Indirect	<u>4.7</u>	<u>11.9</u>	<u>20.0</u>	<u>34.6</u>	<u>31.9</u>	<u>33.7</u>	<u>36.4</u>	<u>36.2</u>	<u>36.3</u>	<u>42.3</u>	<u>40.9</u>
Total	18.4	54.4	81.2	67.5	49.4	59.9	66.6	65.7	60.7	46.0	40.9
<u>Disposable Income (.856)</u>											
Construction	11.7	36.4	52.4	28.2	15.0	22.4	25.9	25.3	20.9	3.2	0.0
Operation and Indirect	<u>4.0</u>	<u>10.2</u>	<u>17.1</u>	<u>29.6</u>	<u>27.3</u>	<u>28.8</u>	<u>31.2</u>	<u>31.0</u>	<u>31.1</u>	<u>36.2</u>	<u>35.0</u>
Total	15.7	46.6	69.5	57.8	42.3	51.2	57.1	56.3	52.0	39.4	35.0

construction would drop to zero from an average of \$28.2 million received during the construction period. Another drop in personal income would occur in 1982 to \$49.4 million from the 1980 peak \$81.2 million. Post-1988 operations related income would be about \$40.9 million annually.

Two major economic impacts to individuals would result from the proposed projects. The first would be in the form of job opportunities and increased income for some. Construction activities, mining operations, plant operations, and new indirect employment would all be sources of these increased opportunities and incomes. However, not all persons in the impact area would benefit. There would be people whose occupational skills would not be utilized. In addition, the increase in local buying power would rapidly inflate the cost of living. Thus, those persons living on fixed incomes, or those with relatively low-paying jobs, would experience a significant decrease in their buying power.

Families on the 25 farmsteads (about 100 persons) to be affected by the proposed project would receive compensation (See Section 4.1.4.4). Those who retain surface ownership can designate how they wish to have the land reclaimed. Thus, these families would experience a temporary loss of employment (but perhaps not income) and could benefit economically in the long-term by acquiring cropland via the reclamation process from present grazing land.

b. Labor Force and Wage Structure

The number of jobs created represents a major addition to the existing blue collar and farm labor force of about 15,000 within 75 miles of the plantsites. Even with extensive immigration of workers, changes in the occupational structure of the existing population would result. Most of the new construction workers would have to be recruited from other jobs. This would create an increased demand for blue collar labor which may, in the short run at least, drive up wages. Firms facing a shortage of labor would either recruit over a wider area, improve productivity, or reduce business activity.

Many farmers may find new part-time employment (particularly under the area of new indirect employment opportunities) to supplement farm income. In 1969, 17 percent of North Dakota farmers worked 100 or more days off the farm. This is significantly lower than the 40 percent average for all U.S. farmers and may have been due partly to the absence of opportunities.

Upon termination of construction, surplus labor would exist to a degree dependent upon the availability of other employment opportunities in the area. Some of the construction workers might seek operational

jobs in the plants; others would leave the area and seek employment elsewhere.

North Dakota average wages for manufacturing production workers (\$4.75/hr) are lower than national wages (\$5.17/hr) based on 1976 figures. An influx of high-wage jobs into a low-wage area could escalate the wage rates of nonproject employees such as seasonal farm labor. Increased income per capita in the area would increase demands for goods and services and prices would rise.

In short, economic forces can serve to increase wage rates in some sectors and not in others. This would cause a redistribution of income toward those persons employed or associated with employment in energy related sectors. Persons living on fixed incomes or not engaged in energy related endeavors would be especially disadvantaged as inflation occurs.

Termination of construction could result in a significant amount of excess labor in the area which would lead to reduced demand for goods and services. This could add to the possible unemployment problem within the impact area. It is possible that other developments under construction could absorb some of the unemployment; how much excess labor they could absorb would depend on the number of developments and their timing, and this cannot be predicted at this time.

c. General Business

One critical factor associated with the construction and operation of the proposed facilities would be the rapid increase in demand and services that would arise. Retail trade facilities, amusements, services, motels, housing, etc., would all be in short supply during construction. False impressions of rapid prosperity could lure some entrepreneurs into starting businesses during the construction phase only to see them fail once the construction force leaves. Conversely, in view of the experiences associated with other inflated economies in the Upper Missouri Region, some businesses may be reluctant to expand and insufficient market capacity would exist.

d. Product Pipeline

In general, the product pipeline construction period would cause some disruption within the area of the railroad ROW in urbanized areas. Construction should not permanently affect land use adjacent to the ROW in these urban areas. The proposed pipeline would cross primary roads, collector roads, and some major highways. Some of the roads to be crossed, primarily located in urban areas, have public utilities within their ROW; some of these utilities

(e.g., sewers, water lines, gas lines, and telephone and electric conduits) may be temporarily disrupted.

Facilities located in the railroad ROW, such as grain elevators, graineries, and warehouses, have driveways and parking areas that are utilized rather extensively during the harvest season. If these areas are crossed during the harvest season, some inconvenience would result. If necessary, alternate access could be provided. The proposed pipeline would also cross the various railroad tracks (e.g., mainline, spurs, etc.) as required and may cause some temporary disruptions in service.

The proposed pipeline would avoid all existing major structures and no major facilities would be demolished or relocated as a result of the proposed construction. Some smaller structures within the railroad ROW (i.e., tool sheds, storage sheds, etc.) may be relocated or demolished if necessary.

Materials such as fencing, wire, cable, tile, tile support, gravel, concrete, repair parts, and small tools would be purchased locally when feasible. Materials such as gasoline, diesel fuel, oil, and grease would likely be purchased through contracts with local suppliers; materials such as welding rods and pipe would not be available locally and would be purchased elsewhere.

Pipeline spread crews are primarily specialized work forces requiring special skills and experience but some unskilled workers would be required. Most of the work force hired from the local area would be of the unskilled category, and would be about 30 percent of the work force.

The average weekly payroll per construction spread (300 workers) would be about \$125,000; about 40 percent of this would be spent by workers in the local communities. This amounts to a total expenditure by workers of about \$4.5 million during the 6-month construction period. The local tax base would also be benefited by the capital improvement within its taxing jurisdiction.

3.3.1.4 Summary and Analysis of Economic Impacts

The establishment of the proposed ANGCGC and Basin Electric projects in the impact area would have a significant impact on the regional economy. This impact would be focused primarily on the cities, towns, and commercial areas located near the development site. Stanton, Center, Zap, and particularly Beulah and Hazen would experience a period of rapid growth. This type of short-term economic growth is characterized by a shift in the regional employment-occupational structure to a predominantly construction-industrial labor base. This shift would increase population, wages, and economic opportunity in the area.

Increased population would stimulate the demand for housing, phones, power, water, sewage services, police and fire protection, education and other public facilities (see next section). Increased wages would stimulate the expansion of the service industries such as dry cleaners, barbers, theaters, fast foods, restaurants, bars, bowling alleys, etc. More money circulating in the regional economy would increase retail sales, investments, savings, and bank deposits, thus stimulating the growth of financial-banking institutions in the region.

The influx of the transient labor force associated with the product pipeline would also increase demands for commercial goods and services in local communities near the pipeline construction, and some local public and semipublic services. These public and semipublic services would include water and sewer facilities, recreation, health services, utilities, and fire and police protection. The transient work force on a mainline spread would be in excess of 300 workers. This work force and their family members could place a temporary strain on the services of smaller communities. In this case, short-term (on the order of 90 days) adverse impacts could occur.

Increased demand for goods and services, increased wages, and increased capital in circulation would inflate the local economy. Selected portions of the local economy would realize monetary benefits; others would experience decreases in their buying power directly proportional to the rate of inflation. Welfare enrollments could increase as a result.

Increased economic opportunity in the region would necessitate training or retraining much of the unemployed labor force. In the short term, new skills and training would increase the standard of living of the general population. However, in the long term the region would be characterized by a specialized economy with a skilled, technically-oriented labor force. This type of regional specialization is particularly sensitive to cyclical changes in demand for products or in the substitution of other resources to meet energy needs. Fluctuations in the local economy may also occur with a depletion of the more accessible coal reserves.

3.3.2 Impacts on the Socioeconomic Infrastructure

3.3.2.1 Housing

There would be a significant influx of in-migrating workers seeking housing accommodations in the nearby towns within the impact area. Table 3-23 summarizes the number of housing units required in the three-county major impact area based on the assumption that one dwelling would be required for every in-migrating worker (both

TABLE 3-23

A Scenario of the Number and Distribution of Housing Units Required in the Impact Area
to House New Direct and Indirect Employment Population Resulting
from the ANGCGC and Basin Electric Projects 1/

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988-2015</u>
Total Units Required	950	2775	4178	3838	2941	3465	3829	3787	3554	3133	2726
Beulah	323	943	1421	1305	1000	1178	1302	1288	1208	1065	927
Hazen	304	888	1337	1228	941	1109	1225	1212	1137	1003	872
Golden Valley	38	111	167	154	118	139	153	151	142	126	109
Pick City	9	28	42	38	29	35	38	38	36	31	27
Stanton	85	250	376	345	265	312	345	341	320	282	245
Zap	67	194	292	269	206	242	269	265	248	219	192
Center	48	139	209	192	147	173	190	189	178	157	136
Dodge	9	28	42	38	29	35	38	38	36	31	27
Halliday	67	194	292	269	206	242	269	265	249	219	191

1/ Assumes one housing unit required for each in-migrating worker.

direct and indirect workers). It should be remembered that the distribution of workers among the area cities is only one possible distribution and thus, housing needs for a particular city could vary considerably from that shown in Table 3-23.

The new housing can consist of single-family dwellings, multiple-family dwellings, or mobile homes. If the proportion of the new units is assumed to be 25 percent single-family units, 25 percent multifamily units, and 50 percent mobile homes (4), the approximate housing needs for each of the impact area cities for the peak population year (1984) are listed in Table 3-24.

The actual distribution of housing among cities could vary considerably from the hypothetical scenario in Table 3-24. For example, if housing and land prices are excessively high in cities near the plantsite, large mobile home parks or new subdivisions could develop in communities farther from the plants but still within reasonable commuting distance. Other factors that could also influence the distribution of housing needs would be the size of the town, presence of shopping centers, quality of schooling, availability of fuel, availability of recreation facilities, etc.

At an average of \$35,000 per new permanent dwelling unit (72)^{1/}, a total of about \$96 million would be spent on permanent housing for the operational level of employment.

A construction camp would be provided by ANGCGC to house about 20 percent of the peak construction force plus seasonal peaks. The camp would accommodate mostly single workers, short-term workers, and workers living in the impact area during the work week but commuting to their homes outside the area on weekends. The camp would lessen the need for new temporary housing in area cities during peak construction by about 400 units. The 60 percent in-migrant worker projection takes into account the presence of the construction camp.

No construction camps are planned for product pipeline construction; therefore, nonlocal workers would either provide their own living quarters in the form of mobile homes and rent space for their mobile homes, or would procure temporary housing in the area. Table 3-25 lists the total number of temporary housing units available, and the vacancy rate for 1970 for each of the counties involved. Although these figures indicate the general availability of housing, they may not be representative of the more rural areas affected by the proposed route. Nonlocal pipeline workers could take up much of the available temporary housing in local areas resulting in a short-term (60-day) shortage of temporary housing for other purposes. Many nonlocal workers would own mobile homes

^{1/} Includes a 40-percent inflation factor for the 10-year construction period.

TABLE 3-24

A Scenario of New Housing Unit Needs of Impact Area Cities
During the Peak Population Year (1980) ^{1/}

<u>City</u>	<u>Total New Housing</u>	<u>Single-Family</u>	<u>Multiple-Family</u>	<u>Mobile Home</u>
Beulah	1421	355	355	711
Hazen	1337	334	334	667
Golden Valley	167	42	42	83
Pick City	42	11	11	20
Stanton	376	94	94	188
Zap	292	73	73	146
Center	209	52	52	105
Dodge	42	11	11	20
Halliday	292	73	73	146

^{1/} Assumes 25 percent single-family units, 25 percent multiple-family units, and 50 percent mobile home. Includes workers living in construction camp.

and would only require temporary trailer spaces. In the Mercer-McLean County area these workers may take up trailer spaces desired by vacationers, but this should not be a problem elsewhere along the route. Local workers would have their own existing housing.

3.3.2.2 Education

The large influx of new employees and their families would exert considerable pressure on existing educational facilities and result in overcrowding. Crowding would, temporarily at least, decrease educational quality. Each of the nine cities in the impact area falls within a separate school district. On the short term, taxes in these districts could lag behind the need for expansion of the area schools. Over the long term (i.e., after the plant begins operation), taxes would increase the funds available for educational needs and could eventually increase educational quality.

Assuming that the new population would be comprised of 19 percent students enrolled in elementary schools and 7 percent students enrolled in high schools (72), the projected annual increase in student enrollment in each of the affected school districts is shown in Table 3-26. Again it should be emphasized that the

TABLE 3-25
INVENTORY OF TEMPORARY HOUSING FOR NORTH DAKOTA COUNTIES^a

COUNTY	YEAR ROUND UNITS ^b	VACANCY RATE ^c
MERCER	2,161	19.2
OLIVER	767	20.3
MC LEAN	3,917	8.0
WARD	14,361	5.0
MC HENRY	3,169	17.9
SHERIDAN	1,178	ZERO
PIERCE	2,046	9.7
BENSON	2,596	12.3
RAMSEY	4,313	8.9
NELSON	2,196	12.7
GRAND FORKS	18,074	5.3
WALSH	5,174	5.5

^a ADAPTED FROM: U.S. DEPT. COMMERCE, 1972. COUNTY AND CITY DATA BOOK. A STATISTICAL ABSTRACT SUPPLEMENT.

^b TOTAL YEAR ROUND UNITS EXCLUDE SEASONAL OCCUPANCY OR MIGRATORY LABOR.

^c PERCENT OF TOTAL RENTAL UNITS AVAILABLE YEAR ROUND.

figures are based upon a hypothetical distribution of the incoming population and that the actual new student population in a given district could vary significantly from that shown in Table 3-26. Also, the figures do not include any increase in population in the impact area due to other coal-related developments in the region.

The addition of about 1,600 school children to impact area schools by 1980 imposes significant problems. Based on a teacher:student ratio of 1:30, some 54 new classrooms and related facilities would be required by 1980. After the population stabilizes in 1988, about 41 of these classrooms would still be needed; any excess could be of a temporary nature. At 140 ft.²/student and \$40/ft.², school facilities for the additional students could require expenditures of about \$9 million by 1980.

3.3.2.3 Health Services and Safety

a. Health

Health care facilities in the area would be significantly impacted by the population influx. Assuming the need for one hospital bed

TABLE 3-26

A Scenario of the Annual Increase in Student Population in Each of the Impact Area
School Districts Due to the ANGCGC and Basin Electric Projects

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988-2015</u>
Total New Students	367	1016	1610	1586	1250	1449	1595	1579	1495	1387	1231
Beulah	124	345	547	539	425	493	542	536	509	472	419
Elementary	91	252	399	393	310	360	396	392	372	345	306
High	33	93	148	146	115	133	146	144	137	127	113
Hazen	117	325	515	508	400	464	510	505	479	444	394
Elementary	85	237	376	371	292	339	373	369	350	324	288
High	32	88	139	137	108	125	137	136	129	120	106
Golden Valley (Juzeler)	15	41	64	63	50	58	64	63	60	55	49
Elementary	11	30	47	46	37	42	47	46	44	40	36
High	4	11	17	17	14	16	17	17	16	15	13
Pick City	4	10	16	16	12	15	16	16	15	14	12
Elementary	3	7	12	12	9	11	12	12	11	10	9
High	1	3	4	4	3	4	4	4	4	4	3
Stanton	33	92	145	143	112	130	144	142	134	125	111
Elementary	24	67	106	104	82	95	105	104	98	91	81
High	9	25	39	39	30	35	39	38	36	34	30
Zap	26	71	113	111	88	101	112	111	104	97	86
Elementary	19	52	82	81	64	74	82	81	76	71	63
High	7	19	31	30	24	27	30	30	28	26	23
Center	18	51	81	79	63	72	79	79	75	69	62
Elementary	13	37	59	58	46	53	58	58	55	50	45
High	5	14	22	21	17	19	21	21	20	19	17

TABLE 3-26 (Con't)

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988-2015</u>
Dodge	4	10	16	16	12	15	16	16	15	14	12
Elementary	3	7	12	14	9	11	12	12	11	10	9
High	1	3	4	2	3	4	4	4	4	4	3
Halliday	26	71	113	111	88	101	112	111	104	97	86
Elementary	19	52	82	81	64	74	82	81	76	71	63
High	7	19	31	30	24	27	30	30	28	26	23

1/ Assume 19 percent of new population enrolled in elementary schools and 7 percent enrolled in high schools.

for each increment of 200 persons, about 24 new beds would be required to accommodate the stabilized population and operational labor force in 1988. This could be done either by expanding the present 39-bed hospital in Hazen or building a new facility. Over the peak construction period an additional eight beds would be needed for the temporary personnel peak.

If the present U.S. doctor-patient ratio of 1 doctor/700 persons is used, about nine additional doctors would be needed by 1980, with one additional doctor by 1984. About seven physicians would be required for the operations-related population after 1988. Because of the rural nature of the impact area, it is considered difficult to recruit the physicians necessary for adequate health care.

Initially, at least, existing medical facilities would be overcrowded. It is possible that hospital emergency room facilities would be particularly stressed because as people find it difficult to obtain a family doctor, they would use the emergency room for routine treatment (73). ANGCGC would have a nurse at the plantsite to provide emergency first-aid and to handle minor health problems of workers.

It is possible that rates of alcoholism, suicide attempts, divorce, and mental health problems would increase in the impact region (73) (See also Section 3.5.2.8). Since both the mental health outreach worker in Hazen and the mental health care center at Mandan are currently working at capacity, additional mental health services would be needed.

The likelihood of having adequate medical facilities and personnel available during the construction period is low because existing facilities are already near capacity and funding would lag behind growth. Also, it is extremely difficult to recruit medical personnel for rural areas in the region.

b. Safety

Plant and mining operations would have a direct effect on local safety conditions since a necessary corollary of any industrial development is the introduction of new and different safety hazards for people employed in the operation. Increased risks to the health and safety of residents and employees would be associated with many aspects of the operations of the plants, especially coal handling and blasting, the presence of flammable materials, and increased truck and automobile traffic. Some significant amounts of coal dust may be produced during blasting, loading, hauling, coal stacking, and reclaiming operations. This could have an

effect on the respiratory health of the employees. The companies involved would be required to obey applicable regulations on employee health.

The primary potential safety hazard associated with the gasification process equipment and process streams would be from potential leaks or spills of liquids or gases. Oxidizing agents would be present within the gas processing system. Also, there is a low possibility of an explosive mixture occurring inside the process components. Should a leak occur in any of the system's piping, vessels, etc., a combustible mixture could develop outside the process units. The likelihood of such a leakage is extremely small.

Other safety hazards would be associated with the presence of flammable materials at the plantsite. Many gasification process byproducts and chemicals, such as oils, tars, naphtha, methanol, and phenols are flammable. The probability of accidents from handling these substances should be very low as the petrochemical industry has considerable experience handling these substances. Additional hazards are associated with the possible leakage of toxic materials, such as hydrogen sulfide and ammonia, which can be lethal in high concentrations. For both fire and toxic gas hazards, the distance of the plant from populated areas should prevent injury to persons or property off the plantsite.

The considerable increase in local traffic may affect local health conditions, both with respect to increased traffic accidents and air pollution. Traffic on some local highways would increase many times over. Because miles traveled are positively correlated with the number of accidents, this too would be a negative safety impact of the proposed projects.

The product gas pipeline would be close to the shoulder of the roadway where the route crosses the Snake Creek embankment. Although the possibility of an explosion or rupture of the pipeline at this location is remote, if such an explosion or rupture did occur, it could have serious negative effects on public safety.

3.3.2.4 Government Services

The police and fire departments in the impact area would require additional personnel to provide adequate protection. Using the national average of 1.9 police officers per 1,000 people, about 12 additional officers would be needed by 1980 in the impact area. About 8 additional officers would be needed for the post-1988 operational level. Based on 1 additional fireman per 1,000 persons 6 additional firemen would be needed by 1980; this would drop to 5 by 1988. The rapid population growth may require not only additional firemen, but a change from volunteer to paid forces.

In organized communities adequate police and fire protection could be made available; however, it is unlikely that either adequate fire or police protection would be available to any unregulated development in the area. Widespread unregulated development is unlikely because of strict zoning regulations in the affected counties, but some development outside the organized communities would occur (See Section 2.1.4.5 for current land use regulations).

3.3.2.5 Utilities

Facilities for such items as telephones, gas, electricity, water, and sewer service would also be stressed by the development associated with the population influx. Each new dwelling unit would require electricity, water, and sewer service. The existing water distribution and treatment would have to be expanded in most impact area cities as would many existing sewage treatment and disposal systems.

It may take several years for these services to catch up with the population growth unless adequate capacity is constructed in advance. The impacts that would be associated with inadequate services include possible drinking water contamination, water rationing, substandard dwelling units, possible increase in water-borne diseases, and inconvenience to the consumer. Expenditures would have to be made for storm drains, water distribution, and sewage collection facilities.

3.3.2.6 Transportation

The main effect of the proposed gasification and powerplants on local transportation will be increased traffic. Employment of 3,049 workers during the peak construction period and an average of 1,160 during operations would have significant effects on existing roads. Added to this would be an increase in vehicle ownership brought about by wages paid to employees.

ANGCCG and Basin Electric would provide a rail spur to transport supplies and products to and from the plants. The majority of heavy freight would be carried by rail due to convenience and economic considerations. However, local truck traffic would be increased due to small commodity shipments to the area.

The project work force would require automobile access to the plantsites. Due to the increased traffic on the major traffic routes of Mercer County, many roads would require resurfacing once or twice during project construction. Taxes paid on the plant facilities, vehicles, and fuel would provide some additional revenues, but they would not defray all such costs (113).

Some disruption of existing secondary, unpaved roads would result from the proposed development (Figure 3-4). County Road 13 would be blocked by the gasification plant and County Road 14, west of the plantsite, may be excavated due to surface mining. Alternate roads would be constructed around the plant and through the mine; thus, inconvenience to users of these roads should be small. Coal haul trucks from Mine 2 would cross County Road 11 and an overpass would be constructed to separate mine and county road traffic. These local county roads generally carry only small amounts of local traffic and some recreational traffic to Lake Sakakawea. There may be increased traffic by commuters on secondary roads between the plant and Pick City if the project is constructed.

There should be a moderate increase in passenger traffic at the Bismarck Airport due to the proposed projects. Beulah's general aviation airport would experience a significant increase in air traffic.

All product pipeline construction activities, including the movement of equipment, would be coordinated with the railroad. However, public roads would be used to provide access to the construction site and this would result in a short-term increase in local traffic levels. It is not likely that the increase in local traffic would require additional public funds for public highway construction or maintenance.

3.3.2.7 Recreation

It is expected that the proposed development would cause a significant increase in demand on existing recreational facilities in the region, and that recreational demands would be greatest on nearby Lake Sakakawea and for indoor recreational facilities. Table 3-27 shows minimum recommended recreational standards for North Dakota (109) and the additional facilities that would be required to accommodate the population increase associated with the proposed projects.

Lake Sakakawea, especially that portion directly north of Beulah, would receive a large influx of persons seeking swimming, boating, fishing, and hunting opportunities. Access to the lake is provided at three points north of Beulah near the Hille State Game Management Area. These access points will probably become overcrowded during the summer thus creating such problems as a decrease in the quality of the recreational experience, litter, vegetative damage to the Game Management Area, and increased possibility of recreational accidents.

Visitation of Lake Sakakawea State Park would also increase compounding already overcrowded conditions. Demands might also

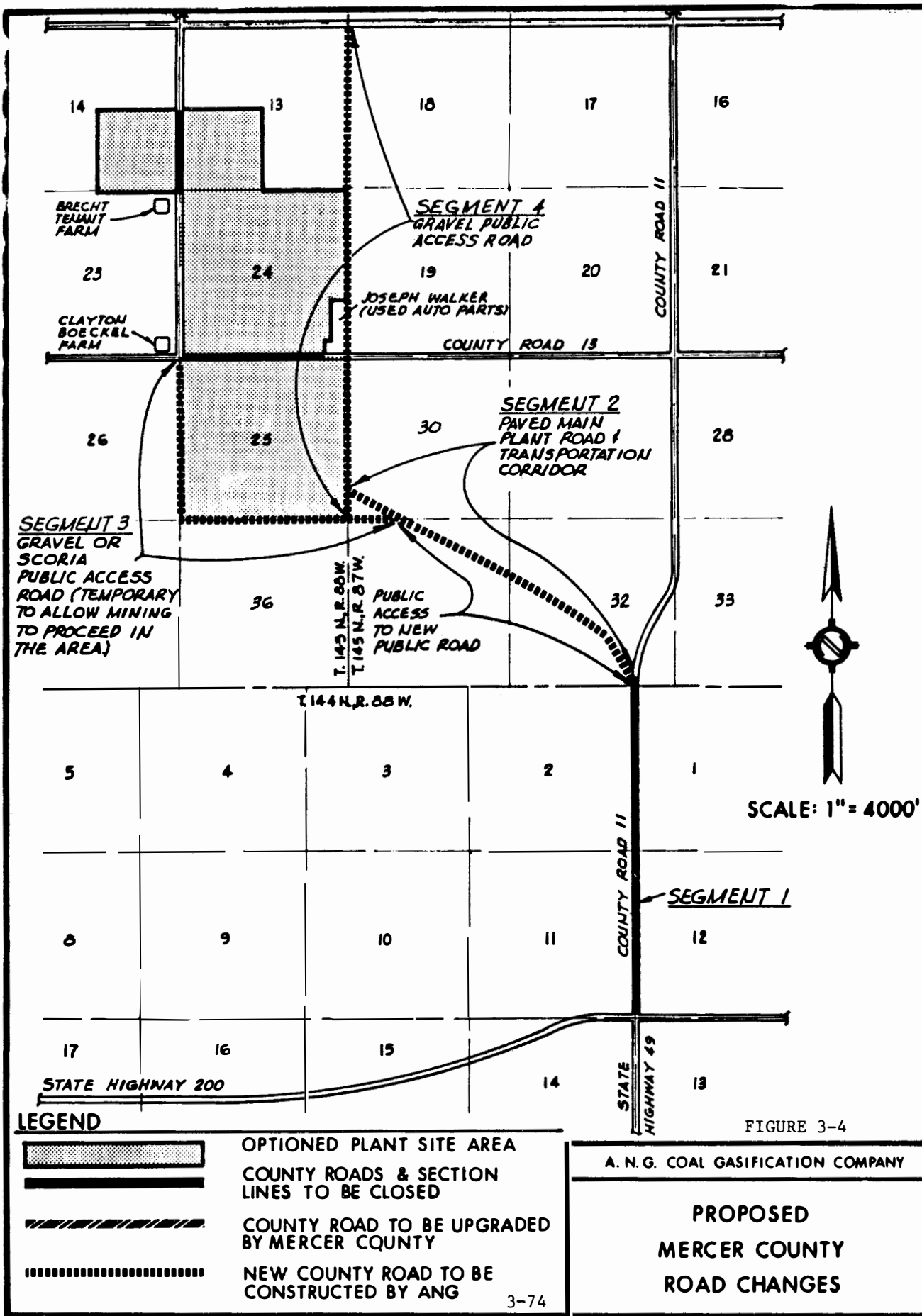


TABLE 3-27

North Dakota Recommended Minimum Recreation Standards
and Facilities Required in Impact Area
During Peak Construction Year (1980)

<u>Facilities</u>	<u>Recommended Standards</u>	<u>Additional Facilities Needed</u>
Park Space	1 acre/75 persons	83 acres
Picnicking	3 acres/1,000 persons	18 acres
	7 tables/acre	126 tables
Campgrounds	15 campsites/1,000 persons	90 campsites
Baseball	1 diamond/2,000 persons	3 diamonds
Tennis	1 court/2,000 persons	3 courts
Basketball	1 court/1,000 persons	6 courts
Track	1 field/8,000 persons	1 field
Volleyball	1 court/2,000 persons	3 courts
Horseshoe	1 court/1,000 persons	6 courts
Swimming Pools	1/7,500 persons	1 pool
Wading Pools	1/8,000 persons	1 pool
Archery, Trap, Skeet	1 range/7,500 persons	1 range
Golf	1 hole/800 persons	8 holes
Playground	at least 1	1 playground

increase significantly at Theodore Roosevelt National Park and the Little Missouri Grasslands.

Current indoor recreational facilities in impact area cities are not adequate to meet the projected increased demand. However, it is likely that private entrepreneurs would take advantage of opportunities by opening new facilities to satisfy some of the demands that would result from the increased population.

New parks and other public recreation facilities would be needed. At an average annual per capita cost of \$9 (72), about \$45,000 would have to be spent annually to provide adequate public park facilities for the post-1988 population. It is expected that recreation facilities would be crowded during peak construction activity.

3.3.2.8 Summary and Analysis of Infrastructure Impacts

The infrastructure in the impact area would experience increased pressure from the anticipated population influx. The most severe pressures would be experienced during the first 8 years of development. After that time the influx would have begun to level off, and a

more stable population would be reached by about 1988. In many cases, there could be a lag time between the need for a service and the provision of that service. Facilities requiring tax revenues would be especially sensitive to this time lag.

The severity of the socioeconomic impacts discussed above depends, in part, on the degree that local communities plan for, and construct in advance, the facilities necessary to accommodate the population influx. Some monies needed for the construction of the facilities could be obtained from coal severance tax funds and other sources; if these sources are utilized, many of the impacts would be lessened accordingly.

A Mercer County Task Force has been organized to bring county citizens together to assess socioeconomic impacts from energy development and to advise the County Commission as to possible methods of preventing or lessening these impacts. Chairmen of committees working on specific problems are appointed by the County Commission. The Task Force would coordinate planning activities, serve as a clearinghouse, and seek Federal and local assistance. Such a body could serve to effectively lessen impacts if it is able to function properly but the planning process in Mercer County is complicated by the scope of the proposed energy projects, long established municipal rivalries, and limited economic resources and expertise. Prevention or reduction of socioeconomic impacts in Mercer County could depend on the effectiveness of this Task Force.

Front-end funding for facilities and services needed to prevent or reduce socioeconomic impacts in the involved counties is a serious problem that needs solution. Some funding from coal severance tax funds was received in 1976 for expansion of educational facilities in the Stanton (\$251,000), Beulah (\$185,000), and Hazen (\$456,000) school districts. Also, the cities of Beulah, Hazen, and Zap have received \$275,800, \$184,000, and \$104,000, respectively, for water system, sewage disposal, and other improvements. In addition, Mercer County received about \$225,000 in 1976 from their share of the severance tax, but all of these monies are only a small part of what would be needed to substantially reduce impacts resulting from energy development. Coal conversion and other taxes on the ANGCGC and Basin Electric plants would more than double Mercer County's current tax revenues after the plants are in operation, but there is no provision in State law for prepaying these taxes to provide front-end financing.

The 1976-1977 Legislature made several changes in the allocation of coal severance and conversion taxes (see Section 2.3.2); it now seems probable that after a few years of plant and mine operation that adequate monies for community services would be available.

It does not appear, however, that the legislative changes will solve the problem of front-end financing. Impacted counties, cities, and school districts can borrow front-end monies from the Trust Fund but such borrowing incurs a long-term debt at 6 percent interest and is a last resort funding source (i.e., entities wishing to make loans must have explored private sources and been unable to find adequate money at reasonable interest rates or be bonded to capacity). Moreover, the fund is only expected to have about \$4 million available for loans before 1980.

The area's rapid growth, if the projects are implemented, would cause a considerable amount of internal strain. New residents of the area would bring in new ideas and some of the conservative values of the present community would be threatened by these new ideas. This internal stress could cause considerable controversy relating to education, public health, tax, zoning, and land use issues.

A population increase requires elaboration and differentiation in the social structure to accommodate new participants in the system. As new positions within the existing social structure are created, new roles, role expectations, and role behaviors emerge. Communications become more complex and the possibility of misunderstanding increases. Existing in-groups may be strengthened by the sudden appearance of newcomers who, because of their transient nature, may have difficulty in joining existing community groups, both formal and informal. Some resentment and polarization of groups is typical. Existing systems, which have regulated behavior between and within established groups in a community, become strained as the necessity for dealing with new residents emerges.

A population decrease produces effects within the social structure as well. A declining population causes a consolidation in the social structure and an accompanying concentration of position functions in fewer participants. During the transitional period, functions which had been routine may not occur because of ambiguity in role functions. Some social disruption is inevitable under such conditions.

A secondary effect of population increases and declines occurring within a short time frame is a decrease in the effectiveness of existing norms. Norms are the shared definitions of appropriate and inappropriate behaviors. Sociologists use the term "anomie" for a state of relative deregulation or normlessness in a social system where a consensus of norms no longer exists. Such a condition is experienced by participants variously as feelings of alienation, powerlessness, meaninglessness, estrangement, being controlled by powerful outside sources, and isolation. Such a decline in the effectiveness of normative regulation can be expected as a result

of population changes associated with the proposed projects. Anomie is closely associated with increased suicide, criminality, alcoholism, and other social problems.

The increases and declines in population projected for the study area over the next 11 years, and the primary and secondary social effects of development, are substantial. Effects of the kinds noted above can be expected to occur as a result. However, such changes would occur in any existing social system, but at a much slower rate and allowing some time for readjustment of personal norms.

In the existing community, success, upward mobility, status, and economic development are dominant cultural values. Attitudes favoring maintenance of small-town life are present. Current access to goals associated with values among residents of the impact area is reasonably high.

Future conditions without the developments would likely be perceived as adverse among residents in the impact area. The perceived likelihood of improving access in the economic structure depends largely upon increased development of coal in the area. Residents of the area are well aware that plans for such development exist. Expectations for economic advancement have developed accordingly. Thus, a continuance of existing economic conditions due to the lack of development would occur within the context of rising expectations. The resulting disparity between what was valued and expected versus that which would occur without development would be very large. Substantial frustrations and disappointment could result.

Perceived future conditions with the proposed development would not result in this kind of disparity. On the contrary, the perceived access to economic goals implied by the current value structure would be enhanced with the development. The number of positions in the opportunity structure would increase, affording more choice and a wider variety of ways of attaining valued economic goals.

The social control structure--the institutional structures which collectively sanction behaviors--would be affected by the proposed developments. As the number of participants in any social system increases, there is increased pressure upon the sanctioning institutions. The population changes projected for the impact area would require substantial expansion of local authorities who are responsible for maintaining social control. Under the social conditions anticipated, it would be more difficult to maintain regular, predictable, and fairly distributed sanctions for normative violation. It would, however, be more important to sustain orderly social life than regularity, predictability, and fairness of sanctions produced.

3.4 Impacts on the Sociocultural Environment

3.4.1 Impacts on Indian People

Because the Fort Berthold Reservation is 8 miles from the proposed gasification complex at its closest point, some direct impacts to the reservation would be inevitable. The largest potential environmental impact would be an intermittent reduction of air quality and visibility on the reservation from the proposed plant. The reservation is on the upwind side of the plant, but about 30 percent of the time winds from the southeast quadrant. This would cause some occasional reduction in visibility and increase in pollutants on portions of the reservation.

Economically, the construction and operation of the plant and mine could provide some jobs for Indians, either by direct employment at the plant or mine or through some of the indirect jobs created due to the influx of workers.

The population increase in the area could cause many problems for the Indian people and increase the burdens on the tribal Government. Because the tribes are a sovereign entity, many jurisdictional questions could arise from the non-Indians in the area which would occasionally enter the reservation. The presence of more non-Indians on the reservation would be an increased burden to tribal law enforcement and regulatory agencies.

It is possible that with the increased employment opportunities, some of the Indians now living off the reservation will return and commute to the jobsite. This would put increased stress on an already tight housing situation on the reservation. It would also mean increased burdens on the reservation agencies providing medical, social, and other services. The reservation would not be expected to realize any substantial amount of impact monies since Fort Berthold is located in portions of five counties, each of whom would be having problems funding necessary programs.

The ANGCGC gasification project by itself would not have a large impact on the traditional Mandan, Hidatsa, and Arikara cultures. However, as one of several planned industrial developments for the area, the ANGCGC project will contribute to the conflict these tribes will experience to maintain their traditional cultural identities in the face of increasing social interactions with other Americans.

3.4.2 Impacts to Historical and Archaeological Features

The eight archaeological sites in the area of the plant and mine may be disturbed; however, mitigation of effects on these sites would be carried out in cooperation with the North Dakota State Historical Society.

The Boeckel and Saron cemeteries, two German-Russian mud houses, and unique plant community on top of the flat-topped butte will be outside the areas slated for construction or mining. Since release of the draft EIS, studies by the North Dakota State Historical Society, financed by ANGCGC and Basin Electric, have located 140 cultural resource sites in the general area of activity of the proposed plant and mine. ANGCGC is working with the State Historical Society to avoid or mitigate impacts to these sites (see State Historical Society letter pages J-96 to J-98). The increased population associated with the proposed project would increase the potential for vandalism of these and other nearby sites.

The construction of the proposed product pipeline may disturb undiscovered extensions of 20 known archaeological areas but it would also provide the opportunity for discovering new areas. Four sites are currently crossed by the railroads along the proposed route, and 16 more are known to occur in close proximity (Table 2-39). Some of the latter sites could extend into the railroad ROW. It is unlikely that any remains are left in the ROW itself but if they do, the impact to 6 particularly valuable sites could be major; impacts to the 16 remaining site would be either unknown (7) or medium (7) (Table 2-39). The proposed route would cross the Fort Clark Historic site in North Dakota along the existing railroad ROW and pass close to the Knife River Indian Villages National Historic Site (but would not disturb it). Since the existing ROW goes through an Indian burial ground at the Fort Clark Site and since the Knife River Indian Villages Site could extend onto the ROW, any remaining archaeological material may be disturbed.

All studied archaeological sites occur in North Dakota. There have been no major studies of the six sites in Marshall County, Minnesota, so the significance of impacts to these unique features in this portion of the route are largely unknown.

3.5 Impacts in Market Area

Impacts in the market area (i.e., Michigan, Wisconsin) from the proposed project would be associated with the use of the product gas.

The purpose of the proposed project is to keep a constant supply of gas available to residential and light commercial customers. The impact of this constant gas supply would be to lessen the possibility of gas service curtailments and the resulting inconveniences and increased expenses to existing customers.

The provision of a continuing supply of natural gas would reduce the need of customers to switch to other, less clean burning fuels. The air pollutants produced by the consumption of SNG in the market area would be less than those produced by the use of oil or coal for the same purposes.

The increase in gas costs due to the addition of SNG to the American Natural Resource system would raise the price of gas in the entire system. Thus all system gas customers would experience an incremental increase in their gas costs due to this project.

3.6 Cumulative Impacts of Coal-Related Development

This section is designed to discuss in a general way the major impacts that could accrue to the impact area from the currently proposed projects within a 30-mile radius of Beulah (listed in Section 1.3.4.1). More detailed analyses of the impacts may be found in the Bureau of Reclamation and BLM North Dakota regional environmental statements discussed in Section 1.3.4.2.

The total estimated emissions from all of the currently proposed projects are summarized in Table 3-28. The estimates for NGPC were based on the fact that NGPC is proposing to generate some of the electrical power needs of their plant by burning coal fines. Thus, the estimates are slightly higher than those of ANGCGC who would receive their power from the Basin Electric powerplant.

The proposed coal-related developments in the vicinity of Beulah would emit about 22,640 lbs of NO_x, 38,937 lbs of SO₂, and 2,107 lbs of particulates into the atmosphere every hour. The NO_x emissions are higher than necessary with existing technology because coal-fired boilers are available for powerplants that only emit 0.5 lbs NO_x per MMBtu of input (56, 82). In addition, smaller amounts of hydrocarbons, carbon monoxide, and various trace elements would also be emitted.

TABLE 3-28

Total Emissions from Proposed Coal-Related Developments
Near Beulah, North Dakota (lbs/hr)

<u>Development</u>	<u>NO_x</u>	<u>SO₂</u>	<u>TSP</u>
ANGCGC	1,100	2,825	265
Basin Electric	4,930	11,832	424
Coyote <u>1/</u>	7,820	11,000	912
NGPC <u>2/</u>	1,870	2,840	255
MPC <u>3/</u>	6,920	10,440	251
Total	22,640	38,937	2,107

1/ Two 440-MW units. Emissions represent 0.86 lbs NO₂, 1.2 lbs SO₂, and 0.1 lb TSP per MMBtu of coal consumed.

2/ One 250-MMcf/day plant.

3/ One 440-MW and one 235-MW unit. Emissions represent 1.03 lbs NO₂, 1.2 lbs SO₂, and 0.1 lbs TSP per MMBtu of coal consumed.

In southwestern North Dakota where the existing ambient pollutant concentrations are much lower than Federal and State standards, the proposed developments could meet all pollution standards (which allow for some air quality degradation) yet significantly degrade existing air quality. If all of the proposed developments are built, further development could be curtailed by the Federal and State Significant Ambient Air Deterioration limits. The following discussion relates the kinds of effects that have been noted to result from industrial air emissions in other regions; the degree of impact in North Dakota will depend on local physical and biological conditions.

Acid rains can result from SO_2 emitted into the atmosphere. Normal rainwater has a pH value in the range of 5.5 to 5.7 due to the dissolution of CO_2 in water and thus is already slightly acidic. The presence of SO_2 decreases the pH of rainwater because it is soluble in water and forms sulfurous acid (H_2SO_3). This acid dissociates in two stages to produce hydrogen ions. This dissociation is significant in polluted atmospheres and increases the acidity of the rainwater. NO_2 emissions can also increase the acidity of rainwater by formation of nitric acid, but on a smaller scale than SO_2 emissions. Acid rains can increase the acidity of lakes and/or streams beyond the tolerance of aquatic plants and animals, or inflict physical damage to terrestrial plants (58).

Most North Dakota waters are presently alkaline; thus, little or no impact on North Dakota waters from increased rainwater acidity is expected. However, emissions from the proposed developments could travel large distances, and when combined with those from other industrial sources, contribute to acid rains elsewhere (i.e., Minnesota) where some waters are already acidic.

The various pollutants emitted into the atmosphere such as SO_2 , NO_x , fluoride, and heavy metals have the ability to singly and/or in combination cause visible and measurable adverse effects to the surrounding flora and fauna. Coniferous plant species in an area are generally the first plants to visibly manifest symptoms because of exposure to SO_2 and NO_x (dwarf needles, abnormal cellular arrangement, etc.). Few conifers occur naturally in the area of concern and it is not known what prairie plants might be sensitive to low-level emissions. However, almost all plants concentrate the pollutants in their tissues to some degree (54, 67) and the materials are then passed on to animals who consume the vegetation. A monitoring program should be established in the impact area to determine the effect of these emissions on prairie plants.

The best documented impacts of various trace elements on animals are those from fluoride and mercury. High fluoride accumulations in mammals are directly correlated with the contamination of the

vegetation ingested. In extreme cases, excess fluoride is stored in the bone structure to the extent of causing varying degrees of disfiguration and structural bone damage to the animal. Fortunately, little if any fluoride is stored in soft tissues or fluids thus decreasing the hazard to human health.

Aquatic organisms concentrate mercury within their bodies when the intake rate exceeds the elimination rate (59). The resultant buildup of mercury may become toxic to both the organisms themselves and humans who may consume them. For example, methylmercury concentrations in fish in Navajo Lake, New Mexico, and in Lake Michigan are near the lower range of mercury concentrations noted in fish thought to have caused human deaths (60). In North Dakota, the alkaline waters may "tie up" much of the mercury by precipitating it out, thus reducing the hazards to humans and animals.

Ambient concentrations of SO_2 , NO_x , and particulates are known to be among the factors involved in the formation of photochemical smog. Other factors include nonmethane hydrocarbon concentrations, moisture, and ultraviolet light. The chemical and physical mechanisms in smog formation are not well understood; thus, it is not possible to predict whether or not smog episodes would result if all the proposed projects are built. However, the normally good dispersion characteristics of the region would lessen the possibility of smog formation.

If all of proposed developments are built, about 29,600 acres of land would be disturbed (Table 1-2). Prairie grasses, forbs, and brush form the basis of the natural energy system on these lands which serve as wildlife habitat of varying degrees of quality. Long-term reductions in the wildlife habitat base would result from the proposed developments. Areas where structures and urban developments occur would be entirely lost, at least during the life of the developments. Strip-mined lands would also be permanently affected because of reclamation of mined land to cropland or pasture grasses rather than restoration of the entire spectrum of native vegetation. Gullies and ravines with patches of brush and trees, which provide food and shelter for wildlife, would be almost entirely absent from reclaimed lands.

Populations of some wildlife species (e.g., pronghorn antelope and sharp-tailed grouse) in the areas used for mining, industrial, and support facilities would be permanently reduced because of the loss of suitable prairie habitat. Competition for limited habitats would temporarily increase mortality rates of certain species.

Secondary effects of the proposed developments would be to increase air pollutants and surface fogs, which can reduce the photosynthetic rates of plants. The productivity of the affected areas would

therefore be reduced. Direct physical damage to plants from SO₂ and NO_x could also result, further reducing productivity. Trace elements can fall onto plants which are eaten by animals whose bodily condition can be adversely affected.

Erosion, habitat destruction, and construction leading to the siltation of surface waters may reduce populations of aquatic organisms (including fish). Indiscriminate use of chemicals and pumping mine-pit water into surface waters could affect aquatic plant and animal communities. Other possible impacts to the flora and fauna from the proposed developments would be similar to those discussed in Section 3.2 for the proposed project.

The estimated annual worker requirements for the five proposed developments are shown in Table 3-29. It should be emphasized that these are only preliminary estimates based on the best information available as of October 1976 and are subject to change as the various companies revise and reevaluate their plans. Also construction workers could work on more than one project thereby reducing the total number of new construction workers needed.

Based on an average of 3.5 persons moving into the area for each direct worker to account for indirect employment and worker families, the approximate total in-migrating population associated with the proposed developments would be as follows:

<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>
4,950	10,650	16,300	21,350	20,700	21,300	14,400	13,900	11,700	9,800	8,700

The existing population in the region of the proposed developments would be approximately quadrupled by 1981 from the influx of the construction and operations related population. The magnitude of the above increases and the subsequent decline of the construction population by 1988 would change the existing rural social structure of the impact area.

The costs to local governments could require increased long-term debt to expand community facilities to accommodate the increased population if adequate front-end financing is not provided. Educational, health, recreational, and other public service facilities would be overcrowded and stressed. Physical infrastructures such as utility, transportation, and communication facilities would also be overburdened by the rapid population influx. Persons with a limited ability to profit from the developments, such as those on fixed incomes, would be most severely affected. Once the construction phase is completed and the temporary segment of the population moves out, surpluses in housing and public facilities would also occur with attendant financial

TABLE 3-29

Approximate Annual Average Worker Requirements of the Proposed Coal-Related Developments
Near Beulah, North Dakota

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>
<u>Construction</u>											
ANGCGC	442	1,397	2,016	1,052	330	467	1,008	1,321	1,136	313	0
Basin Electric	195	582	799	478	486	752	397	52	0	0	0
Coyote	677	921	1,000	1,002	609	784	837	430	0	0	0
NGPC	0	0	350	2,500	3,400	3,000	200	0	0	0	0
MPC <u>1/</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Subtotal	1,314	2,900	4,165	5,032	4,825	5,003	2,442	1,803	1,136	313	0
<u>Operation</u>											
ANGCGC	47	81	147	692	692	692	692	692	724	1,000	1,000
Basin Electric	5	5	57	95	108	108	160	160	160	160	160
Coyote	0	0	231	231	231	231	261	271	271	271	271
NGPC <u>2/</u>	0	0	0	0	0	0	500	1,000	1,000	1,000	1,000
MPC	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>
Subtotal	<u>102</u>	<u>136</u>	<u>489</u>	<u>1,068</u>	<u>1,081</u>	<u>1,081</u>	<u>1,663</u>	<u>2,173</u>	<u>2,205</u>	<u>2,481</u>	<u>2,481</u>
TOTAL	1,416	3,036	4,654	6,100	5,906	6,084	4,105	3,976	3,341	2,794	2,481

1/ Construction would be completed by 1977.

2/ Estimate based upon ANGCGC operational worker needs.

problems for local governments, institutions, and commercial establishments.

Although adequate community planning and development of new housing, recreational, and other public and private services could lessen impacts, there is no clear cut strategy by either industry or governments to finance the short-term needs of local governments to accommodate a rapid population increase. Without the proper financial and technical resources, many of the local communities could be severely affected if the proposed developments actually occur.

CHAPTER 4

MITIGATING MEASURES AND AIR AND WATER QUALITY ASPECTS

4. Mitigating Measures and Air and Water Quality Aspects

This chapter discusses those actions, devices, procedures, or operating priorities which would be carried out by ANGCGC to minimize or prevent environmental degradation which might occur during the construction or operation of the proposed gasification plant and associated facilities. Many of the mitigating measures are required and are enforceable by governmental agencies under a variety of existing contracts, leases, laws, orders, or regulations. Others have been volunteered by ANGCGC in various reports furnished to assist in the preparation of this statement. A last category of mitigating measures would be stipulations or requirements that ANGCGC must comply with to obtain the governmental permits required to construct and operate the proposed plant and associated facilities.

4.1 Legal and Institutional Requirements

4.1.1 Contractual Requirements

Water for the ANGCGC coal gasification project would be provided from Lake Sakakawea (Garrison Reservoir) under a contract between ANGCGC and the Secretary of the Interior. Under that contract, the Secretary of the Interior would require the following:

The contractor shall, within its legal authority, comply with all applicable orders, laws, and regulations of the United States and the State of North Dakota concerning protection of the environment and relating to pollution of water and air.

4.1.2 Federal and State Standards

4.1.2.1 Air Quality

Extracts from the Federal (88) and State (89) Ambient Air Quality Standards and Significant Air Deterioration Limits (90, 92) that would be applicable to ANGCGC - Basin Electric project were shown in Tables 3-2, 3-5, and 3-7. In addition, both the Federal Government and the State of North Dakota have established New Source Performance Standards for fossil fuel fired steam boilers. The maximum unit emissions in pounds per MMBtu input are (Federal and North Dakota standards are identical):

<u>Pollutant</u>	<u>Gaseous</u>	<u>Fuel Type</u>	
		<u>Liquid</u>	<u>Solid</u>
Sulfur Dioxide	--	0.8	1.2
Nitrogen Oxides	0.2	0.3	0.7
Particulates	0.1	0.1	0.1

The nitrogen oxide standard for coal does not presently apply to lignite. Also, when more than one fuel type is used, the allowable input is based on the percentage Btu input of each type of fuel.

The proposed Basin Electric powerplant would meet the New Source Performance Standards for fossil fueled steam boilers. Applicability of existing New Source Performance Standards to the proposed gasification plant is more complicated, however, and a letter from the North Dakota State Department of Health to ANGCGC regarding the applicability of New Source Performance Standards is presented in Appendix B. The Environmental Protection Agency is currently establishing emission standards for coal gasification plants (106); the ANGCGC plant would have to meet such standards before it could actually be built. The estimated maximum ground-level concentrations of pollutants from both the ANGCGC and Basin Electric projects would be within Federal and State Ambient Air and Significant Deterioration standards. No Federal or State standards exist regarding the trace element emissions from the proposed plants.

While the ANGCGC and Basin Electric projects do not exceed the Federal Significant Ambient Air Deterioration Limits, they do use up a large portion of the allowable degradation of existing air quality. The region is designated as a Class II area and calculated pollutant concentrations including associated growth (Table XVII, Appendix I) would be about 27 percent and 87 percent of the allowable annual and 24-hour TSP degradation; and about 44 percent, 68 percent, and 25 percent of the allowable annual, 24-hour, and 3-hour SO₂ degradation. If these levels are actually reached, further coal-related industrial development in the immediate area could be limited.

4.1.2.2 Water Quality

It does not appear that the gasification plant and related facilities would cause any water quality standards to be exceeded, although existing water quality may be degraded at times. Laws governing water quality impacts exist at both the Federal and State levels. The Federal legislation which serves as a basis is the Federal Water Pollution Control Act Amendments of 1972. This Act was designed to reduce the cumulative effects of regional development on water quality. The Safe Drinking Water Act is also a pertinent piece of Federal legislation. The Federal Government has recommended different standards for drinking water, irrigation water, recreational uses, and effects on aquatic life--all of which would serve to mitigate impacts because discharges from the ANGCGC project would not be allowed to exceed the standards.

The North Dakota State Health Department is responsible for water quality control in North Dakota. They have established Standards of Surface Water Quality for North Dakota which apply to the proposed project (91). The Knife River and Antelope Creek have been designated Class II streams. North Dakota State Water Quality Standards contain an antidegradation policy which states: "Water whose existing quality is higher than the established standards will be maintained at the higher quality unless it can be affirmatively demonstrated that a change in quality is justifiable to provide necessary economic or social development and will not adversely affect the stated beneficial uses of the water. All exceptions must be supported by data."

4.1.3 Mining and Reclamation Requirements

Since the coal to be mined for the project, as proposed, does not involve Federal land or coal, Federal laws and regulations do not apply. The 1969 North Dakota Mining Control and Reclamation Law (SB 2095) with its 1971, 1973, and 1975 revisions, however, regulates the surface mining of coal on all lands within the State. A permit issued by the North Dakota Public Service Commission (PSC) is required for surface mining. The application must include a description of the tracts of land and estimated acreage to be affected. A permit is good for 3 years and must satisfy the requirements of the law.

Adequate protective measures must be included in the application which must be accompanied by a \$1,500/acre bond in the form prescribed by the Commission. The bond remains in effect until the mined acreage has been reclaimed and the reclamation approved by the PSC.

A reclamation plan is to be submitted to the PSC. After approval, the operator may engage in surface mining subject to the following requirements (extracted):

1. Land must be regraded to approximate the original contour unless a different topography is required for an intended use.
2. Suitable plant growth material to 5 feet deep must be saved and respread. If 5 feet of topsoil is not available, whatever is available must be spread.
3. Runoff water must be impounded, drained, or treated.
4. Final cuts and end walls must be backsloped to 35° or less unless an alternative use is intended such as a water impoundment.
5. All refuse from the mining operation must be removed or buried.

6. The reclamation plan must be based on advice and technical assistance of State agencies. The landowner is to be asked to state his preference for a reclamation plan.

7. The PSC shall approve in writing the vegetation to be planted.

8. Reclamation must be completed within 3 years after the mining permit expires.

9. Until reclamation satisfies the PSC, control of the land remains with the PSC.

10. If the landowner's water supply is disrupted or reduced in quality, the operator must provide a new supply at no cost to the owner.

4.1.4 Other Institutional Requirements

4.1.4.1 Cultural Resources

Two Federal statutes afford protection to historic, archaeologic, and paleontologic resources that might be disturbed by the proposed project. The Historic Preservation Act of 1966 (80 Stat. 915) requires that all Federal actions that will impact cultural resources must be reviewed by the Presidential Advisory Council on Historic Preservation prior to their implementation. Also, Executive Order 11593 (1971), "Protection and Enhancement of the Cultural Environment," directs that historic values be preserved (see also Section 4.4.2).

4.1.4.2 Railroad Spur

Chapter 49-11 of the North Dakota Century Code (NDCC) sets forth the basic requirements relative to railroad crossings of highways. These requirements include: (1) the restoration of any highway so that "its usefulness is not materially impaired" (Section 49-11-04), (2) standards for the construction of all crossings (Section 49-11-06), and (3) maintenance in a safe state of repair of all crossings so constructed (Section 49-11-05). Caution signs are required pursuant to Section 49-11-16.

In addition, the Mercer County Zoning Ordinance has been amended to provide for conditional uses for railroad trackage and spurs in agricultural and industrial districts. Conditions included in this amendment are:

1. No trackage shall be placed within 125 feet of a residence unless a written agreement is made with the owner of the residence and presented to the Planning Commission.

2. The applicant shall conform to all requirements regarding preservation, removal, or relocation of historical and archeological artifacts.

3. The applicant shall provide any reasonable information the Planning Commission deems necessary.

4.2 Mitigation Measures for the Proposed Project

This section discusses those measures which would be implemented at the proposed gasification complex and mine by ANGCGC (or Coteau Properties).

4.2.1 Air Quality

4.2.1.1 Atmospheric Emissions

Gaseous emissions from the gasification process would be passed through control facilities before emission into the atmosphere:

1. Dust generated by loading the coal locks would be processed to remove particulates;

2. The Stretford plant would be provided primarily to control H₂S generated in the plant system. This plant is mitigating because the production of byproduct sulfur for sale would be incidental to the primary purpose of the plant;

3. Gases escaping from several process units would be trapped and incinerated to convert H₂S and other sulfur compounds to SO₂; and

4. Stack would be of sufficient height to provide adequate dispersion of emissions.

4.2.1.2 Dust Control

The following measures would be in effect to control fugitive dust generated by the project:

1. Dumping of coal into receiving hoppers would occur in an enclosure equipped with inertial and bag-type filters;

2. Conveyors for crushed coal would be equipped with bag-type dust collectors;

3. All solid wastes would be treated with water;

4. Dry ash locks would be equipped with wet cyclones to collect ash for disposal;

5. Wet ash locks would water the ash before transport to the disposal area;

6. Major access roads and parking areas would be hard-surfaced; unpaved roads and right-of-way would be sprayed periodically with water as required;

7. Dust collectors would be installed in all coal handling areas as needed;

8. The reclaimed mine area would be graded to minimize airborne dust level and maximize vegetation; and

9. Ash would be returned to the mine and buried.

These dust suppression measures should be effective in controlling fugitive dust. Various governmental agencies could require more extensive dust suppression measures should a problem become apparent.

4.2.1.3 Odor

Primary sources of potential odors would be routed through the following control processes:

1. A CO₂ stream, containing 97 percent CO₂ and 3 percent H₂S, COS, CO, C₂H₄, H₂, CH₄, and C₂H₆ would be passed through a Stretford plant to remove elemental sulfur and the remaining stream incinerated in the superheater/incinerator furnace.

2. The expansion gas from the gas liquor area would contain CO and H₂S and would be incinerated.

3. The bulk of the coal lock gas would be collected, compressed, and returned to process; a residual vent would convey the remainder to the atmosphere.

4. The vent stream from the gas liquor collection pit would be conveyed to incineration.

4.2.2 Noise

Compressors and coal handling equipment such as crushers and screens would be located inside buildings designed to minimize noise. Fans, blowers, and burners would be designed to produce less noise by eliminating turbulence and streamlining the flow. Steam lines would be designed for flow velocities considered low enough not to create excessive noise. Also, since the winter temperatures in North Dakota are very low, heat insulation around steam lines would be heavy, contributing to further reductions in noise levels. An important parameter for selecting high pressure drop valves would be low noise characteristics.

Fan noise from air coolers and cooling towers would be controlled by locating the units to minimize boundary noise and by avoiding

the placement of many noisy pieces of equipment together. In addition, the tip speed of the fan can be designed to minimize noise, and noise barriers can be placed around the cooling units, if necessary.

Mine haul roads would be routed to avoid residences to reduce the potential for noise impact. Purchase orders for equipment would include noise control specifications. Where noise cannot be reduced by design, special noise barriers, foundation isolation, and other muffling methods would be provided.

4.2.3 Biological Systems

4.2.3.1 Terrestrial Flora

Although habitat loss as a result of the proposed gasification complex would be unavoidable, unnecessary habitat destruction would be avoided. During construction, disturbance would be confined to the immediate construction site. During mining operations, haul roads would be routed to avoid sensitive habitats and minimize wind erosion, and sediment control practices would be followed.

4.2.3.2 Terrestrial Fauna

Measures to minimize habitat disturbance would serve to minimize impacts on animals. It is the policy of ANGCGC that unnecessary disturbance of terrestrial fauna during all phases of construction and operation would be avoided.

4.2.3.3 Aquatic Systems

Tunneling would be used during construction of the water intake system to minimize bottom disturbance. The water intake was designed to be at a depth where, during normal pool elevations, few larval and fingerling fish should be present. Design intake velocities of 0.5 cfs (peak demand) should be low enough that most fingerlings and adults can avoid entrainment. A horizontal velocity cap inlet would be used to reduce fish entrapment.

Drainage from the mining area would be confined to, and impounded within, the perimeter of the mining area as much as possible. Sedimentation basins would be provided to reduce silt from any runoff leaving the minesite.

Construction of the product pipeline would cross 12 rivers or creeks (Section 2.1.3.1). Until such time as the exact crossing locations are known, specific mitigating measures cannot be detailed. However, the following discussion relates the kinds of mitigating measures generally practiced by pipeline construction contractors.

Specific construction methods used to minimize damage to stream-banks, adjacent drainage areas, and fish and wildlife habitat are

(1) scheduling construction during dry periods, (2) avoiding cutting off streamflow, and (3) avoiding crossings during fish spawning. Stone, broken masonry, or crushed rock is used as a mat to protect stream bottoms and to reduce bank erosion. Where appropriate, wood or steel bulkheads are constructed to also reduce erosion.

Contractors replace stream-bank plugs and grade banks to slopes equal to or less than the original angle. Sandbagging is used where banks are graded steeper than the original slope. Terraces are also constructed, where necessary, to control erosion. In slide areas, underground bulkheads of piles, wire mesh, and cables are installed. Fertilizer and seed, selected in consultation with the county agricultural agent, are applied to slopes vulnerable to erosion.

4.2.4 Reclamation

(As discussed in Section 4.1.3, Title 38 of the North Dakota Century Code (SB 2095) requires that the landowner state how he wants his land reclaimed. This is not done until just before mining the land; thus, a more detailed reclamation plan than that presented in this section is not possible at this time.)

Coteau Properties would perform the mining operations for ANGCGC. Prior to mining, Coteau Properties would make written application to the North Dakota Public Service Commission (PSC) for a surface mining permit. The permit would include both a limited (3-year) and extended (10-year) mining plan consisting of a legal description of the land, the identity of surface and subsurface owners, and the source of the operator's right to mine. The application would contain detailed hydrologic, geologic, topographic, and soil maps, plus the results of a comprehensive soil survey performed by a professional soil classifier.

A reclamation plan would be prepared and submitted with the application and would cover the land described in the limited mining plan. The plan will be prepared in detail before mining and will address the specific parcels of land to be mined. The reclamation plan would comply with the requirements of SB 2095 and the rules and regulations of the PSC.

Reclamation measures to be undertaken would include:

1. Regrading the area to the approximate original contour or topography, unless otherwise instructed by the PSC.
2. Saving, segregating, and resspreading suitable plant growth soil up to a maximum of 5 feet deep.
3. Impounding, draining, and/or treating all runoff water.

4. Backsloping final cuts, high walls, and end walls to an angle not exceeding 35°, except under those conditions permitted by the PSC.

5. Burying all waste material from the operation.

6. Replanting the regraded land with seeds, plants, cuttings, trees, shrubs, grasses, or legumes as approved by the PSC.

7. Fencing would be constructed for safety reasons, when only a portion of a landowner's property is mined, or if an existing fence is damaged or destroyed.

In addition, Coteau Properties would post a mandatory \$1,500 performance bond on each acre to be mined. The bond would be returned in portions as various stages of the reclamation program are completed to the satisfaction of the PSC.

Numerous studies on reclamation (i.e., fertilization, revegetation, soil productivity, etc.) are being conducted by governmental, university, and mining groups in southwestern North Dakota and adjacent areas. Some 13 reclamation studies are in progress at NACCO's Indian Head Mine about 10 miles southwest of the proposed plantsite. Results of these studies would be incorporated into the final reclamation plan.

Reclamation would utilize the most appropriate procedures for the particular parcels of land involved. Fertilizer type and application rate, types of grasses used, and the species of trees selected for the reclamation process would depend on soil characteristics and on the landowner's preference with regard to land use following reclamation. Extensive irrigation would probably not be used because annual precipitation is generally adequate to establish plant growth. Specific reclamation details cannot be set forth at present, but it is possible to indicate those practices that have shown success.

a. Grasses

Several grasses have been used on reclaimed lands at the Indian Head Mine. Unless otherwise specified by legal requirements or in light of new data, ANGCGC would use those grasses which have shown the best results. These include crested wheatgrass, smooth brome grass, western wheatgrass, and green needlegrass. The crested wheatgrass and smooth brome grass appear to be most successful, although all of the above have done well on areas where topsoil has been returned. Also, a legume, yellow sweet clover, has been used as a soil stabilizer and nurse crop. Other native and warm season grasses have been used mainly for research purposes, but a mixture of native grasses would be used to restore native rangeland when requested by the landowner.

b. Fertilizer

Soils of the coal areas are inherently low in phosphorous. A blend of 18 percent N, 46 percent P_2O_5 , 0 percent K_2O fertilizer applied at a rate of 125 lbs/acre has shown successful results. A study is currently underway at the Indian Head Mine to determine the possible benefits of refertilization.

c. Woody Vegetation

Since 1974, more than 5,800 trees and shrubs have been planted at the Indian Head Mine. Varieties used were: Hansen hedgerose, silver buffaloberry, American plum, green ash, Russian olive, caragana, hawthorn, golden currant, laurel-leaf willow, chokecherry, Siberian elm, ponderosa pine, and Eastern red cedar. The last two conifers were only recently planted and survival percentages have not been established.

The woody vegetation was planted on areas of varying soil conditions. Areas that received 2 feet of topsoil by far have the highest survival rates. (It is too early to have results on areas reclaimed with 5 feet of topsoil.) Species doing well on these areas include green ash, caragana, and Hansen hedgerose; silver buffaloberry, American plum, and Russian olive have only done fair. On areas without topsoil, the sodium adsorption ratio (SAR) seems to determine the survival percentage (i.e., the higher the SAR the lower the survival). Species showing some ability to survive in soils with high SAR's include: caragana, Russian olive, green ash, silver buffaloberry, and Siberian elm. These species would do well on areas left without much topsoil if topsoils are concentrated for agricultural use. Those doing poorly include: hawthorn, American plum, golden currant, and chokecherry.

4.3 Monitoring Programs

4.3.1 Air Quality

The diffusion calculations and impact analysis indicate that under all meteorological conditions diffusion of effluents would be thorough enough that ambient ground concentrations would be below limits set by North Dakota and the Federal Government. However, the occasional conditions of plume trapping or fumigation may lead to periods of high ground concentrations. An ambient air quality monitoring program would be established by ANGCGC to assess the validity of the projections and to determine what actual ground concentrations are reached.

The air quality monitoring program would be designed prior to the start of plant operation. From a conceptual standpoint, the

program would be based on the following considerations: (1) a minimum of two short periods of active monitoring would be conducted each year, one period during the worst month, and one during a different season; (2) passive monitoring would be conducted for the first full year of plant operation; (3) pollutants monitored would be SO₂, NO_x, and TSP; and (4) the program would be designed to meet with the approval of the State of North Dakota and the Federal EPA.

4.3.2 Water Quality

4.3.2.1 Surface Water

The location of surface water sites selected for flow and chemical quality monitoring are shown in Figure 4-1. In addition, records from the three USGS gaging stations in the area (Spring Creek-Zap, Knife River-Golden Valley, Knife River-Hazen) would be acquired as they become available. A rainfall gage would be installed at the plant.

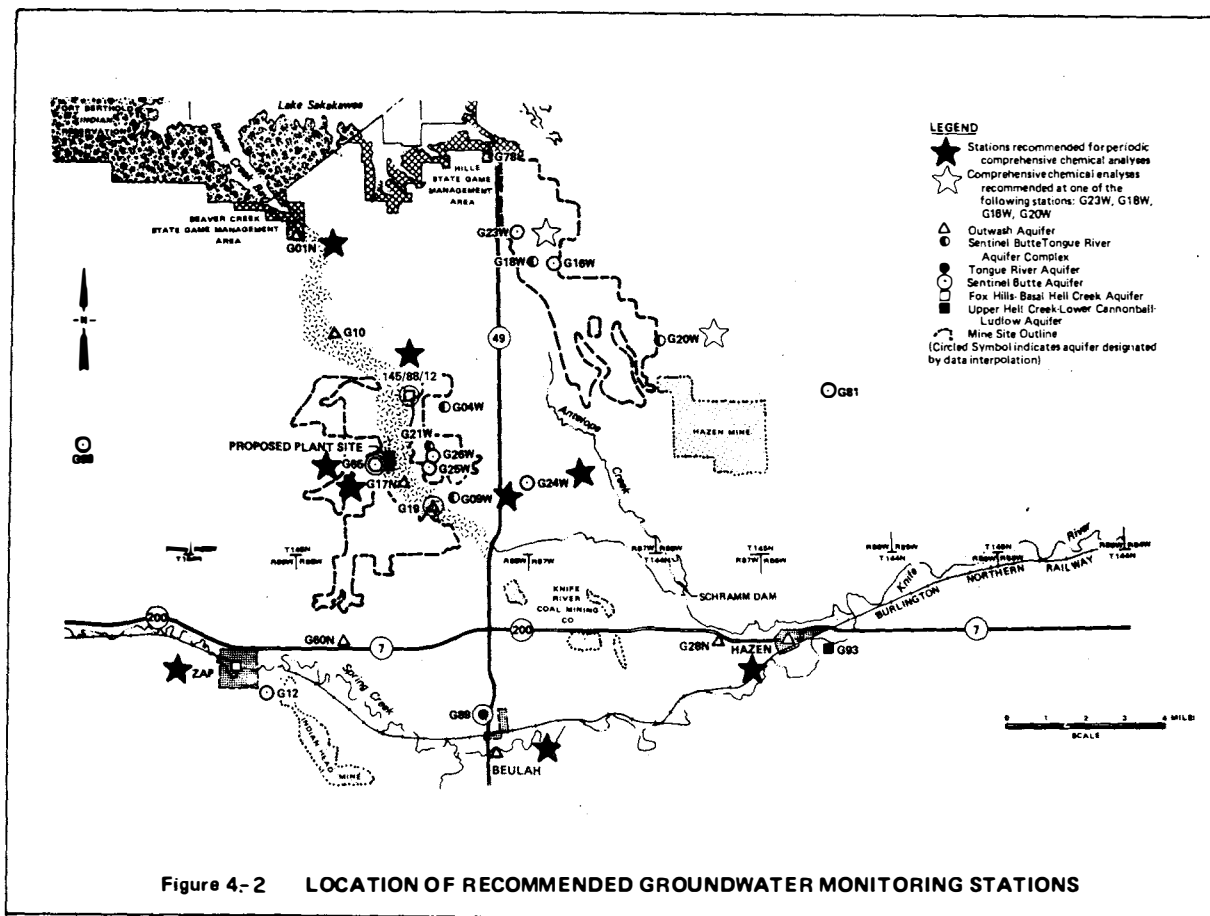
The surface water monitoring stations would vary from year to year, depending on the location of the mining activity. The progression of the monitoring program would be approximately as follows:

<u>Year</u>	<u>Station</u>
1978	S07C, S20C
1980	add S40S
1981	add S35G, S15S
1986	add S36S
1989	add S02I
1991	add S25I
1994	add S24I
2001	add S01I

One year prior to mining in each subbasin, the appropriate monitoring station would be activated. Spring snowmelt runoff would be measured and samples analyzed for dissolved oxygen, pH, color, suspended solids, turbidity, TDS, bicarbonate, sulfate, fluoride, sodium, boron, selenium, arsenic, mercury, iron, and molybdenum. The full gamut of toxic trace elements would be analyzed periodically.

After the first year indicated, the same analyses would be obtained during spring snowmelt and during one of two other times: either directly following the first yearly occurrence of a major precipitation event, or directly following the first 7-day period in which a total of at least 2.90 inches of precipitation falls.

Surface water stations would be deleted from the program 1 year after completion of the reclamation program within a drainage



bottom of the mine pit only; those adjacent to ash disposal areas would be open at various depths. The number of wells, location, and depth of perforation would depend on local ground-water conditions.

4.3.3 Biological Systems

Biological monitoring during operations would be conducted with emphasis on the development of post-mining plant communities and wildlife habitat. Repopulation of the area by primary consumers (herbivores) and species of higher trophic levels would also be monitored. Particular emphasis would be placed on small mammals and songbirds due to their intermediate position in the food chain. Basically, the methods used in the field study would also be used for biological monitoring; the timetable would be developed after mining and rehabilitation programs have begun.

For aquatic systems, biological monitoring would include water quality sampling at the water intake depth in Renner Bay. Plankton

and larval fish studies would be conducted to determine the effect of the water intake on these taxa. Water quality monitoring of the Knife River has previously been described (Section 4.3.2.1).

4.4 Mitigation Measures Related to the Sociocultural Environment

4.4.1 Socioeconomic Environment

Several research studies have been undertaken by ANGCGC within the geographic area of the proposed plant to identify and plan mitigating measures for potentially sensitive areas of impact. The socioeconomic characterization was undertaken to specifically identify the community facilities which would be affected by relocation of a large construction work force and the change from a predominantly agricultural economy to one that contains a major industrial base. The information was given to the North Dakota Legislature so that proper legislation could be enacted.

The concept of a totally self-contained construction camp to house all construction workers was eliminated after discussions between ANGCGC and local Government planners. A desire to expand the local municipalities was expressed by local leaders. A mixed housing program was then adopted which assumes that 50 percent of the work force relocating to the area cities and 20 percent residing in a construction camp; 30 percent of the work force would be hired locally. The camp is designed to absorb work force peaks, single construction workers, and construction workers who return home on weekends.

Persons residing on the 25 farmsteads to be affected by mining would be compensated. Surface leases require that surface owners be reimbursed for all damage to growing farm crops and other property resulting from mining operations. The North Dakota Surface Owner Protection Act (NDCC, Chapter 38-18) further provides for compensation to surface owners for loss of agricultural production as well as all farm buildings within 500 feet of any mining operations. The compensation would be calculated on a fair market value basis or based upon the cost of removal to an area that will not come within 500 feet of mining.

4.4.2 Cultural Environment

A preliminary archaeological and historical assessment of the plant-mine site was conducted to identify the presence of any unknown sites. To avoid one site of possible historical significance, the layout of the plant has been shifted from its original location.

More detailed studies of the mine sites and product pipeline route will be conducted as outlined in Section 2.4.3. Under Public Law 93-291 (1974) ANGCGC and Great Lakes must agree that should any employee discover evidence of possible scientific, prehistorical, historical, or archeological data that the North Dakota

Historic Preservation Officer will be notified immediately in writing giving the location and nature of the findings. Where appropriate, the Historic Preservation Officer may order delays and/or changes in the work to accomplish salvage.

In addition, the following requirements are a part of the general conditions of Great Lakes' contracts for pipeline construction (extracted):

a. If fossil relics, artifacts, or other items of possible scientific, prehistorical, historical, or archaeological significance are unearthed during excavation operation by either company or contractor personnel, operations are to be halted and the appropriate company representative is to be notified of the type of material discovered and its location.

b. The company representative will promptly notify the State Historic Preservation Officer of the material and its location.

c. Before construction, Great Lakes will undertake a predictive study to determine areas of relative cultural resource potential along the route. Should cultural resource materials be unearthed, the contractors would go through the proper notification procedures and move their excavating equipment to the closest area previously identified as having a low cultural resource potential. Excavation of the discovery site would not resume until clearance has been received.

d. The company representative shall not clear the discovery site for excavation until clearance is received from the archaeological authority contacted or other responsible Government agency.

4.5 Governmental Permit Conditions

4.5.1 North Dakota State Water Permit Conditions

The North Dakota State Water Commission (SWC) attached a number of conditions to ANGCGC's conditional water permit which would help lessen the impact of the proposed project. These conditions are (extracted):

1. ANGCGC must use the most environmentally acceptable engineering and technological methods in the design of the gasification plant, and every effort shall be made to minimize evaporation and other wasteful uses of water.

2. ANGCGC shall prepare a comprehensive environmental statement and analysis concerning water appropriations for the plant, incorporating a detailed impact section.

3. ANGCGC shall comply in the design and operating procedures for its facilities with such orders as the SWC shall promulgate.

4. ANGCGC shall make available to North Dakota distributors or users such gas or byproducts requested for use entirely within the State of North Dakota and as permissible by Federal regulation.

5. ANGCGC shall consult and cooperate with and secure all necessary permits from all agencies of the State of North Dakota having an interest in the usage of water and the effects of the applicant's facilities upon the environment, economy, and governmental units within the State.

6. ANGCGC shall meet periodically with the Legislative Council Committee on Resources Development and the Governor's Task Force on Coal Gasification to answer questions and provide information related to its project and related matters affecting water and the quality of life in North Dakota.

7. ANGCGC shall be bound by all applicable State and Federal legislation and State regulations and orders now existing or hereinafter enacted, adopted, or promulgated.

8. Mined or disturbed lands shall be returned to at least the level of agricultural productivity that existed prior to mining or disturbance.

9. No assignment, transfer, or sale of any part of the water shall be made without prior SWC written approval.

10. ANGCGC shall provide metering devices to record the actual amounts of water diverted.

11. Should the SWC or legislature provide for a water user's fee, ANGCGC shall be subject to such fees.

12. Mining shall be in accordance with recommendations of the SWC with respect to the protection of existing ground-water supplies.

13. Upon termination of plant operations, all water supply and transmission facilities and their rights-of-way shall be conveyed to the State.

4.5.2 Mercer County Rezoning Permit Conditions

The Mercer County Board of County Commissioners has attached a number of stipulations to ANGCGC's conditional use permit, during rezoning of the plant-mine site from agricultural to industrial uses, that would lessen the impacts of the proposed project. The stipulations are as follows (extracted):

1. ANGCGC shall construct its proposed gasification plant in two separate phases. The initial conditional use permit shall apply only to the first phase; the second phase will require an additional conditional use permit.
2. Any right created by approval of the conditional use permit is created solely in ANGCGC and cannot be assigned except as approved by the Board.
3. ANGCGC shall submit to the Board an erosion and sediment control plan for the plantsite approved by the Mercer County Soil Conservation District Supervisors.
4. ANGCGC shall comply with all requirements and recommendations of the erosion and sediment control plan and shall employ accepted conservation practices to reduce runoff and retain natural vegetation at the plantsite.
5. Upon termination of operations, ANGCGC shall reclaim and return the plantsite to its original condition.
6. Approval of the conditional use permit does not imply that the Board authorizes obstruction of any section line or section line road unless such obstruction is permitted by law.
7. Prior to obstruction of any portion of County Road 13, ANGCGC shall construct three new roads bounding the plantsite on the east, south, and west section lines. Before obstructing any portion of County Road 14, ANGCGC shall construct roads around all such obstructions.
8. ANGCGC shall construct an access road from the plantsite to County Road 11. ANGCGC shall reimburse Mercer County for the maintenance costs of this access road as well as Mercer County's portion of the reconstruction and maintenance costs for County Road 11 from the access road to State Highway 200. The reimbursement shall be made annually until the Board deems that energy associated tax revenue is adequate for the County to assume such costs.
9. ANGCGC shall annually reimburse Mercer County for costs for maintenance of county roads designated as construction haul roads. These haul roads shall be designated by the Board after consultation with ANGCGC.
10. All annual reimbursement pursuant to Conditions No. 8 and No. 9 shall be due October 1 of each year.
11. Before construction of any deepwell waste disposal facility, ANGCGC shall submit to the Board a copy of the permit issued by the State Department of Health and provide the Board with any information it deems necessary.

12. ANGCGC shall neither draw or utilize ground water from underlying or adjacent aquifers following completion of the water pipeline and the start of water diversion from Garrison Reservoir.

13. ANGCGC shall provide the Board with a detailed report outlining the effects of the proposed gasification plant on area ground water quantity and quality in general, and underlying aquifers specifically.

14. ANGCGC shall make all reasonable efforts to avoid damage to the water supply and quality of Mercer County. ANGCGC shall be liable for any valid claim of damage due to disrupted or diminished water supplies or deteriorating water quality resulting from their project and shall restore ground water quantity and quality to levels existing prior to construction of the plant.

15. ANGCGC shall provide vehicles, equipment, and procedures to cope with fires, explosions, chemical spills, or other calamities occurring at the plant and shall have sole responsibility for dealing with such occurrences.

16. ANGCGC shall submit to the Board a report outlining ANGCGC's plan to comply with Condition No. 15.

17. ANGCGC shall permit free access to the plantsite to the county land use administrator or other representative of the Board. Such access shall be permitted at such times and under such circumstances so as not to create a safety risk or to violate any of ANGCGC's contractual secrecy obligations.

18. Upon request of the Board, ANGCGC shall report to the Board regarding ANGCGC's compliance with State and Federal legislation and regulations.

19. ANGCGC shall file with the Board a plan for financing the plant pollution control facilities. Such plan shall include Mercer County as one of the entities through which such pollution control facilities may be financed.

20. Upon ANGCGC's failure to comply with any conditions attached to the conditional use permit, Mercer County shall have available to it all civil and criminal enforcement provisions and remedies under North Dakota law or the Mercer County Zoning Ordinance.

21. ANGCGC shall submit to the Board a copy of the Certificate of Site Compatibility for the plant as obtained from the North Dakota Public Service Commission and a copy of the Permit to Construct as obtained from the North Dakota State Department of Health.

4.5.3 U.S. Fish and Wildlife Service Conditions to Corps of Engineers Permits

At least two stream crossings of the product pipeline, the Missouri River and Red River of the North, will require Corps of Engineer Section 10 and/or Section 404 permits. Under the Fish and Wildlife Coordination Act (48 Stat. 401, as amended), the U.S. Fish and Wildlife Service (FWS) is charged with evaluating impacts to fish and wildlife resulting from actions related to the permit application and recommending mitigating permit conditions to the Corps of Engineers.

Specific stipulations and recommendations are not possible until site specific applications are made by Great Lakes, and the FWS conducts site specific reviews. However, in general, the FWS would discourage routing the pipeline through brushy draws leading to stream banks. They would also suggest that the route avoid or minimize damage to stands of riparian vegetation. In addition, the FWS would request that disturbed vegetation be restored and that spoil materials be handled and disposed in a manner minimizing siltation. Normally, the FWS would suggest that the work be done during months of low water flows; the specific timing of the work could be significant if fish spawning or migration considerations exist.

Similarly, it is likely that Section 404 permits would be required from the Corps before some of the wetlands on the plant-mine site and product pipeline route can be disturbed. Again, the FWS would be required to review each application site by site and make recommendations. In general, the FWS would request that trenched wetlands be replugged and, if porous materials are encountered during trenching, the bottom sealed. The basin contour would need to be generally restored. The FWS would request that the work be done during dry periods and, where possible, the ponds not be drained. They would also suggest stipulations for trenching and spoil handling when working in standing water. Where the wetlands would be destroyed, the FWS would suggest replacement measures. Onsite coordination during construction could relieve many potential problems.

CHAPTER 5

UNAVOIDABLE ADVERSE EFFECTS

5. Unavoidable Adverse Effects

This chapter discusses the adverse effects which would occur as a result of the proposed action that cannot be avoided or sufficiently mitigated. These effects can occur both in the vicinity of the plantsites and mine, and in the gas service area where the product gas would be consumed.

5.1 Adverse Impacts to the Physical Environment

5.1.1 Air

Consumption of oxygen by the ANGCGC gasification facility would be about 6,000 tpd. The operation of the plant would simultaneously produce 1.3 tons of CO₂ per ton of oxygen. There are indications CO₂ concentrations in the atmosphere are increasing slightly and the scientific community has suggested that such an increase may ultimately affect the climate.

Visibility would be reduced by emissions from the ANGCGC gasification plant and Basin Electric powerplant stacks. This may result in decreased visibility at Lake Sakakawea.

Air quality would be degraded. Construction and mining activity would degrade air quality by emissions from engines, boilers, heaters, etc., and dust arising from roads and mining sites, as well as movement of surface vehicles. Emissions from gasoline- and diesel-powered equipment would include particulates, SO_x, CO, hydrocarbons, and NO_x. Accidental coal fires could add vapors and particles to the atmosphere.

The largest source of air quality degradation would be emissions from operation of the gasification plant and powerplant. Emissions from the two plants would equal 144,816 lbs. NO_x, 351,768 lbs. SO₂, and 16,536 lbs. TSP per day.

The trace elements and radioactive materials in the coal not trapped in the ash or removal systems would be emitted into the atmosphere.

Additional population in the area would increase the number of vehicles, residences, businesses, etc., in the region which would in turn locally increase the pollutants in the air.

Odors and noise would increase in the immediate vicinity of the plant; noise from blasting would disturb nearby residences during evening hours.

Gas produced in the ANGCGC plant would enter present pipeline systems and could encourage increased consumption due to expectations

that the project increases the total available supply rather than just keeping even with existing residential commitments. In this case, the major unavoidable impact would be an increase in the consumption of free oxygen and the related generation of CO₂.

5.1.2 Water

Water removed from the Missouri River system for this project could not be used for any other purpose for the life of the plant. ANCGC has a permit to withdraw 17,000 acre-feet of water per year, thus the annual loss of electrical generating capacity would be about 8 million kilowatt-hours (1 MW).

In the mining areas, surface disturbances present potential runoff problems which could increase sedimentation and mineralization in surface waters. Construction and mining activities would alter topography and land surface characteristics. This activity would lower runoff into area streams and thus their flow, and may alter some of the drainage patterns of the area. Emissions returning to the surface could contaminate surface waters.

The placement and operation of the water intake in Renner Bay may cause local increases in turbidity. Entrapment of fish and other aquatic organisms would occur in low-water years. Such impacts are unavoidable with the best existing technology.

The quantity of ground water in the vicinity of the plants and mines would be decreased by dewatering, interruption of flow, and destruction of the lignite aquifer and perched waters. Wells in the vicinity may be lowered.

Ground-water quality could also be affected. Contamination of shallow aquifers adjacent to the mine could result over the long term from leaching of the ash and sludge buried under reclaimed soil. Chemicals not readily available before mining could become available after reclamation because of the increased soil permeability after the overburden is replaced in a heterogeneous, unstratified condition. Leached water from the mine pit areas may infiltrate shallow aquifers increasing TDS.

5.1.3 Land

Coal mining activities would disturb about 500 acres of land surface each year. Land would be reclaimed at about the same rate; however, about 1,500 to 2,500 acres would be ungraded and disturbed at any one time. In addition, the gasification plant and related facilities would disturb about 535 acres for the life of the plant. Thus, about 14,000 acres would be disturbed over

the life of the plant with attendant increased dust levels, decreased water quality, and reductions in the flora, fauna, and aesthetics of the area. The success of reclamation would determine the permanence of these impacts.

The soil stratification would be disrupted and the productivity of the reclaimed land may be reduced as less fertile soils are brought to the surface. Topsoil that is stockpiled for any length of time could become biologically sterile further reducing productivity until microorganisms became reestablished. Soil erosion would be increased until such time as sufficient vegetative cover is reestablished.

The influx of persons with their families to construct and operate the mines and plants would significantly increase the size of urban areas and the resultant impacts on land areas. Land would be needed for schools, roads, commercial buildings, homes, utilities, parks, governmental services, transportation, and communication facilities, etc. Since the lands to be converted have yet to be defined, there is no way to measure the impact, but whatever the present use of the land, open space and agricultural potential would be lost.

Upon termination and abandonment of the proposed facilities, they may be disassembled. Facility dismantling would have impacts similar to the original site preparation and construction activities.

5.2 Adverse Impacts on the Biological Environment

5.2.1 Flora

The major impact on the flora would occur on the land areas disturbed by the mining, the plant, and related facilities. Mined lands would be reclaimed primarily for agricultural uses resulting in a net loss of native prairie; any land reclaimed to native vegetation would take decades to establish itself to predisturbance densities. Native wetland and woodland areas would be permanently lost.

Although few studies have been done on the long-term effects of low-level emissions from coal-burning industrial facilities, certain pollutants such as SO₂, NO₂, and heavy metals have caused visible and measurable effects to the surrounding flora. Resistance among plant species varies considerably and the magnitude of the impact is unpredictable.

5.2.2 Fauna

Wildlife would be greatly affected in the areas of the plant and mine by the destruction of vegetation and subsequent disruption of

food chains, and from the presence of a large industrial complex. Indigenous wildlife would be displaced from activity areas during operations; this will result in a reduction in populations until reclamation is completed. Reclamation would probably be directed toward agricultural uses and populations of wildlife species dependent on native ecosystems would be permanently reduced.

There is a possibility of faunal impacts outside of the immediate vicinity of the plant and mine from airborne emissions. Various trace elements (e.g., fluoride and mercury) can affect the health of mammals when consumed via vegetation or other animals. The impacts of such elements on animals is poorly understood.

Increased demand for outdoor recreation would affect deer, waterfowl, upland game, and fishery resources. The impact of increased hunting and fishing on these animals would be unavoidable, but whether or not it would be adverse would depend on whether or not harvest of any species exceeded the biological surplus of that species.

5.2.3 Aquatic Ecosystems

The major impacts on aquatic ecosystems would be from product pipeline construction across streams, potholes, and impoundments. Silt-loading during stream crossings would temporarily affect the aquatic biota by reducing both the kinds and numbers of organisms present, limiting macroinvertebrate habitat, and reducing the primary productivity of the ecosystem. Similar impacts could result from surface water runoff from the plant nonprocess areas and the mine. Operation of the water intake could entrap fish and other biota, particularly during low-water years.

The main impact of the project on the Missouri River system would be the removal of water and an immeasurable increase in salinity downstream. No return of hazardous effluents would accrue to the stream except in case of accidental discharge. Domestic water and sewage requirements and urban runoff would increase. No impacts to the downstream biota are expected.

5.3 Adverse Impacts on the Socioeconomic and Sociocultural Environments

5.3.1 Socioeconomic Conditions

The population within a 30-mile radius of the gasification and power plantsites would be unavoidably affected by the influx of the construction and operations related population. The total impact area population is expected to increase by 6,194 people by 1980, 6,131 by 1984, and to reach 4,743 persons by 1988, due only

to the ANGCGC and Basin Electric projects. The magnitude of this increase and decline in population would result in adverse impacts on the existing social conditions.

The cost of local government could require increased long-term debt to finance expansion of facilities. Once construction is completed and the plant and mine begin operation, the various coal severance and conversion taxes should provide enough monies to help repay the debts. Those persons who have limited ability to profit from construction or operations, and those on fixed incomes, would suffer from inflationary cost increases.

Educational and medical facilities, housing, and recreational and other social facilities could be overcrowded and stressed by the increased population. Physical infrastructures such as utilities, transportation, and communication systems would also be taxed by the rapid influx of persons. Due to the magnitude of the population influx, essential government services are apt to be inadequate because of the time lag between the creation of demand and the availability of tax revenues to construct facilities and provide the services.

5.3.2 Sociocultural Conditions

Unknown archaeological and paleontological resources located at the plant-mine site or product pipeline route may be destroyed and lost to mankind. Even if they were located and salvaged, they would be altered and some aspects of the site lost to future study. Construction and operation of the proposed facilities in an area completely devoid of any industrial facilities would change the natural character of the landscape.

CHAPTER 6
LONG- AND SHORT-TERM
ENVIRONMENTAL USES

6. The Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

6.1 Coal

The proposed coal gasification facility would require about 270,000 tons of lignite per week or about 351 million tons over the projected 25-year life of the plant. About 200,000 tons/week are used for direct conversion to SNG; the remainder would be burned in the Basin Electric powerplant. This coal consumption would be a short-term use of resources in that it could not be reconstituted or used for any alternative process. This short-term use of the resource must be related to its long-term value if not used at the present time. The short-term benefit of the use of the coal now would be the production of 250 MMcf/day of natural gas -- for a period of at least 25 years. For the 25-year period this would amount to 2.28 Tcf of gas, or more than 2 quadrillion Btu's of energy. This is equivalent to 377 million barrels of oil.

The long-term benefits of not using the coal are: (1) it avoids the environmental and social impacts that would be associated with the construction and operation of the plant, and (2) it preserves the coal as a resource that could be developed at some future date. Future development has the potential advantage that new technologies could be developed with higher conversion efficiencies.

6.2 Water

The use of 17,000 acre-feet of water annually would constitute the temporary use of a resource. Only about 15 percent, or about 2,550 acre-feet, is actually consumed annually; the remainder would be returned to the natural hydrologic cycle as water vapor. The use of the water would not reduce the world supply, but would preclude its use in the Missouri River Basin during the life of the plant, such as for the generation of about 8 million kilowatt-hours (1 MW) of hydroelectric power annually. Upon termination of the water service contract, the water would become available for irrigation or industrial uses depending upon the laws and regulations in effect at the time.

Mining activities would destroy a lignite aquifer in the area with a possible resultant water level drop in wells adjacent to the mine. The aquifer cannot be restored; thus, the short-term use of the coal would preempt the long-term use of water from the aquifer for rural agricultural purposes.

Over 16 million tons of ash would be deposited in the mined-out area and some leaching into nearby aquifers could possibly occur. If such leaching did occur, the use of water from affected aquifers for domestic purposes would also be preempted for the foreseeable future.

6.3 Oxygen

Large quantities of oxygen would be consumed in producing gas, operating various support systems, and burning the SNG in the service area. The use of the oxygen is short-term and most of it would likely be recycled from CO₂ to oxygen by natural processes and returned to atmosphere.

6.4 Atmosphere

The atmosphere would be the source of oxygen used in producing the SNG and burning it in the service area, and a sink for deposition of emissions from both processes. As a receptacle for emissions, the atmosphere would receive varying quantities of CO₂ water vapor, SO₂, NO₂, trace metals, and particulates. Except for CO₂, which should eventually be recycled by photosynthesis, these emissions are expected to oxidize or combine with water and settle to earth. The emissions would cause a short-term local deterioration of atmospheric quality but should not preempt its long-term use. However, the long-term effects of large quantities of emissions on the atmosphere are not well understood.

6.5 Land

About 14,000 acres of land would be disturbed by the proposed project. The use of the land is short-term, but even with successful reclamation there would be long-term changes in land use. Approximately 5,200 acres of natural prairie, 97 acres of natural wetland, and 46 acres of natural woodland would be lost. Much of the prairie would be converted to agricultural use; thus, only a small fraction would ever return to seminatural prairie, even in the long-term. There would also be a long-term disruption of soil structure of the mine area. Whether or not there would be an associated long-term impact on soil productivity would depend on reclamation success.

6.6 Economic and Social Aspects

The economic aspects of construction and operation of the gasification facility would be local and short-term. The impacts on social aspects could be longer lasting. The population increase in an essentially rural area for a period of at least 25 years could leave permanent changes in the existing social environment, even

after termination of the plant and the outmigration of persons associated with it. Whether or not these changes are adverse depends on the ability and desire of local citizenry and institutions to adapt to changes of these magnitudes.

6.7 Biota

Some adverse impacts would occur to the flora and fauna on the land used for the gasification plant and mine. What the long-term impacts would be cannot be precisely predicted because they would depend on how the land is reclaimed. Current trends in reclamation in North Dakota are to restore the land to agricultural uses, thus there would be a long-term loss of native prairie and wetland plant communities and the obligate wildlife associated with these communities. Animals and plants associated with agricultural areas would likely increase proportionately. The long-term effect on plants and animals associated with wetlands and woodlands would depend on the acreage of these habitat types established during reclamation, and that is not known at this time.

6.8 Cultural Resources

Some archaeological and historical sites may be destroyed on the land used for the gasification plant, mine, and associated facilities. Although these sites would be salvaged, some information would be lost that might be obtained by advanced techniques yet to be developed.

CHAPTER 7
IRREVERSIBLE AND
IRRETRIEVABLE
COMMITMENTS OF
RESOURCES

7. Irreversible and Irretrievable Commitment of Resources

7.1 Coal

About 351 million tons of lignite would be mined and totally and irretrievably consumed by the gasification plant or sold. This amounts to about 37 percent of the 947 million tons of currently recoverable lignite near the plant-mine site. Additional coal losses may occur if Federal coal within the proposed mining area is not mined. Commercially valuable byproducts would also be irretrievably consumed in their market area.

7.2 Land and Ecosystems

About 14,000 acres of land surface would be altered for the mining and gasification plant. Even if the land was successfully reclaimed, there would be a loss of at least a significant portion of the prairie ecosystem and its associated wildlife. It is also possible that other irreversible damage could occur to the land, soils, and biota.

7.3 Water

Some irreversible damage could occur to ground waters if waste materials were to leach into underground aquifers from the burial of ash and other material in the mine overburden. Ground water within the mined and reclaimed lands would be irretrievably lost to future use. One small lignite aquifer would be irretrievably lost.

7.4 Oxygen

Some atmospheric oxygen would be consumed by the gasification plant and by burning the SNG in the service area. The degree that this consumption represents an irretrievably loss is not known.

7.5 Building and Process Materials

Many of the building materials used for the gasification facilities would be irretrievably lost. The lumber products would deteriorate by the end of the project and have to be discarded. Some metal components would be salvaged if it is economical to do so. Cement structures would be irreversibly committed as would such items as glass, ceramics, paving material, paint, wiring, and insulation. Even if the facilities had some further use after the life of the plant, the materials used in their construction would be irretrievably committed.

Process materials used during operation of the facilities would also be irretrievably committed. The change in physical or chemical form of many process additives (chemical catalysts, etc.) would be

irreversible. Petroleum products used for the operation and maintenance of mechanical equipment would also be irretrievably committed to this project.

7.6 Labor

The labor required to construct and operate the facilities would be lost to other uses while construction and/or operation is in progress. Construction and operation of the plant and mine alone would require about 32,800 man-years of labor.

7.7 Capital

The financial resources (over \$1. billion) necessary to construct and operate the gasification facilities would be irreversibly committed. However, revenues generated by the plant should more than offset costs. The capital gains could then be used for other purposes.

7.8 Services

Construction and operation of the gasification facilities would require many governmental, utility, commercial, and transportation services. The labor and capital required to provide these services would be lost to use for other purposes at the same time.

7.9 Archeological and Paleontological Artifacts

Unknown archeological and paleontological artifacts that lie beneath the land surface which would be disturbed by the proposed project may be destroyed before they are recognized as being of historical value and could be irretrievably lost. Artifacts at the eight known sites would be avoided or salvaged. Even if artifacts are salvaged, disturbance of the site precludes future study with advanced techniques and constitutes an irreversible commitment.

7.10 Cultural Values

Traditional cultural and social values of an historically rural and sparsely populated environment would likely be lost, or severely altered, because of the rapid influx of people and capital into the area.

CHAPTER 8

ALTERNATIVES TO PROPOSED ACTION

8. Alternatives to the Proposed Project

The following discussions center on four areas of alternatives. The first relates to the alternative gas sources, designs, and processes available and considered by ANGCGC. Second are the siting alternatives studied by ANGCGC. The third group of alternatives concerns alternative uses of the resources that would be committed to the proposed project. The last category relates to other possible sources of energy to supply the future energy needs of the Nation.

8.1 ANGCGC's Design and Source Alternatives

8.1.1 No Project

If production of the SNG from coal is not pursued, Michigan-Wisconsin might not be able to supply the long-term gas needs of its residential and industrial customers. Regionally and nationally, this would further strain already insufficient energy supplies. The resultant impact would either be the use of environmentally less desirable fuels, or in the case of some existing industries, curtailment of operations and the socioeconomic consequences of unemployment. Even if low sulfur fuel oil were available as a substitute for gas, such use would substantially increase sulfur emissions in the Michigan-Wisconsin market area.

Without development of the proposed coal gasification project, the physical and biological impacts discussed in Chapters 3 and 5 would not occur. If there were no other large scale industrial projects in the area, the population would probably decrease slowly and the community structure would likely remain rural and sparsely populated. However, it is probable that some coal-related development will take place; thus, many of the impacts discussed in Chapters 3 and 5 will occur in varying degrees.

8.1.2 Alternative Sources of Gas

8.1.2.1 Importation

Gas could be imported into the United States either as pipeline natural gas or as liquid natural gas at the expense of a further decline in the United States balance of payments. Natural pipeline gas is presently imported into the United States from Canada and Mexico. In 1972, 1.0 Tcf were imported, via pipelines, from Canada, while 8 MMcf came from Mexico. There may be some prospect of increased import. Mexico has a relatively small proven natural gas base and a policy of energy self-sufficiency which indicates that an adequate supply of new gas might not be available for export. Present Michigan-Wisconsin gas contracts with Mexico expire in 1982 thus creating the possibility that if no new supplies are

released for export, natural gas imports from that country by Michigan-Wisconsin could cease.

Based on actions by the Canadian National Energy Board (NEB), it appears that future increases in natural gas imports from Canada may also be limited. In November 1971, the NEB rejected three license applications to export 2.7 Tcf of gas to the United States over a 15- to 20-year period. In addition, the Canadian Petroleum Association reported in 1973 that proven marketable reserves of natural gas experienced their first decline since 1954. These reserves dropped 4.5 percent, or 2.5 Tcf.

The impacts of pipelines carrying gas from Canada and Mexico would be essentially the same as those discussed for the product pipeline in this statement.

Liquified natural gas (LNG) is the other major potential source of gas imports. Plans are being made by the gas industry for base-load LNG imports under long-term contracts. Large scale shipping of LNG is a relatively new industry and the United States does not yet have facilities for receiving baseload shipments. The FPC recently approved two projects which together would deliver more than 1 MMcf/day of LNG. Various projections of LNG imports to 1985 (48) are:

	<u>1975</u>	<u>1980</u>	<u>1985</u>
	(Trillion cubic feet)		
Federal Power Commission	0.3	2.0	3.0
Department of Interior	0.5	0.9	1.6
National Petroleum Council	0.24	2.28	4.11

American Natural Resources is examining several possible locations for a LNG terminal; however, the need for LNG would be in addition to, not in place of, SNG from coal. The United States balance of payments would suffer as a result of extensive LNG imports. In addition, United States capital may be required for construction of foreign liquification plants. Further deficits could result from the purchase of tankers from a foreign source or the use of foreign tankers. The cost of the gas itself will, however, probably have the greatest influence on balance of payments. It is estimated that the f.o.b. price of gas would be \$1.30 to \$2.30/Mcf. Importing 1 Tcf could, therefore, result in a cash outflow of \$1.3 to \$2.3 billion (48).

Environmental impacts in the United States of LNG importation would largely be those of tankers, terminals, and regasification facilities, and transportation of the gas. The chance exists that a tanker might be involved in a collision or other mishap, but

several studies have shown that the LNG would likely vaporize and escape into the air. An open flame could ignite the flammable gas-air mixture escaping from a rupture, however.

Facilities would be required to transfer the LNG from the tankers, store it, and regasify it for pipeline transport. Transfer methods for two proposed facilities (Cove Point, Maryland and Savannah, Georgia) would involve initial dredging, and possibly continued dredging, and result in increased turbidity of the water and disruption of marine organisms, particularly bottom-dwelling organisms.

Regasification plants use natural gas heaters or water to regasify the LNG, so very few pollutants are released into the air or water. Plants using water would lower its temperature about 5-15° F between intake and return. However, these plants could be combined with heat-producing plants to minimize the effect of both on water temperatures.

The potential for fire or explosion is always present during the transportation, transfer, or storage of LNG. Pipelines would be needed for transport and their impacts would be similar to those of the product pipeline associated with the proposed gasification plant.

8.1.2.2 Domestic Supplies

The American Natural Resources Company has attempted to purchase new reserves in the United States, is active in the Arctic Gas project, and has expanded their own efforts to explore for and produce new reserves in the lower 48 states, including offshore reserves. ANR officials have said that they find it hard to purchase new supplies from independent producers because of the price advantage intrastate purchasers can offer over the interstate price. New system reserves and the Arctic Gas project are not expected to keep pace with the decline in production from old reserves and an anticipated drop in pipeline gas deliveries from Canada of 158 MMcf in 1981.

There are no uncommitted reserves of any magnitude available to ANR from within the area covered by their system. Also, there is no assurance that reserves of any substantial nature will be available in the near term which would be a viable alternative to the proposed project. The net contribution to ANR gas supplies from expanded exploration and drilling activities has not been significant to date.

The environmental impacts of increasing domestic supplies are those associated with road-building, drilling and production facilities, and the construction of pipelines to deliver the new gas to existing transmission systems.

8.1.2.3 Liquid Hydrocarbon Gasification

Synthetic natural gas (SNG) can be produced from various petroleum feedstocks, notably naphtha, crude oil, and methanol. Processes being developed include (1) thermal cracking in steam, (2) thermal cracking in hydrogen-rich atmosphere, (3) catalytic cracking in steam, and (4) partial oxidation. Potential commercial processes involve gasification of naphtha; one process developed by the British Gas Council (catalytic-rich gas) operates at 93 to 95 percent thermal efficiency. The general process of converting liquid hydrocarbons to SNG is similar to that for the gasification of coal except desulfurization occurs first.

Some of the liquid hydrocarbons required for use in these SNG conversion processes are used by the petrochemical industry and are not currently available for gasification in the quantities needed. In 1973, nearly all the industrial-chemical naphtha was used as feedstock in olefin manufacture (49). In recent years this usage has substantially increased in response to the expected short supply of natural gas liquids. For example, 12.1 percent of ethylene manufacture in 1971 utilized this feedstock compared to 18.7 percent in 1973. Since petroleum refining in the United States is being oriented increasingly toward gasoline output, the resulting naphtha production has decreased considerably.

Oil gasification depends upon a crude oil feedstock, which is already in short supply in the United States. In 1973, the United States refining capacity was 690.1 million tons/year while the ever increasing rate of consumption was 829.3 million tons/year (50). From 1970-73, all imports have increased from 12.1 percent to 26.1 percent of annual consumption. Annual imports increased 26.9 percent in 1971, 31.9 percent in 1972, and 46.4 percent in 1973. Besides the question of reliability of foreign supply, use of foreign crude is not in conformance with the goals of energy independence.

The environmental impact of liquid hydrocarbon processes would be those of extraction and transportation of crude oil, the conversion processes, and transportation of product gas. Inasmuch as supplies of crude oil would be imported, the environmental impacts are likely to be those of importing oil. Transportation of the product gas would cause impacts essentially the same as those of the proposed product pipeline. Because coal-to-gas and liquid hydrocarbon-to-gas plants would be similar in most respects (boilers, gas scrubbers, etc.), the environmental impacts would be similar in nature. However, the intensity of the impacts of liquid hydrocarbon-to-gas plants would be less than coal gasification plants because they have a higher thermal efficiency than coal-based plants and would be relatively free of ash, char, and particulates.

After the SNG is removed, there remains solids and/or liquids that represent additional fuel supplies and/or waste.

8.1.2.4 Nuclear Stimulation

Nuclear stimulation is an experimental method of fracturing low permeability gas reservoirs otherwise incapable of sustaining commercial production. It has the potential to add significantly to United States recoverable gas reserves. ERDA is conducting research and development of underground nuclear explosions to recover natural gas locked in tight geological formations. Most reserves amenable to nuclear stimulation lie in thick, deep reservoirs in the Rocky Mountain Region.

The low permeability and heterogeneity of the reservoir rock in the Rocky Mountain basin require tremendous fractures over vertical intervals of 2,000 to 4,000 feet thick to provide adequate productivity. Two techniques are potentially capable of creating the underground fracture systems needed: (1) multiple nuclear explosive fracturing, and (2) massive hydraulic fracturing. Both systems are still in the experimental stage to determine if adequate and sustained gas production can be achieved (48).

Assuming experimental success, commercial development could begin by the late 1970's or early 1980's. A scenario developed by the Lawrence Radiation Laboratory predicts that 80 wells/year could be developed by 1980 resulting in the production of 600 Bcf/year by that time. Favorable conditions might allow development of 100 wells/year beginning in 1981. This would result in production of 1.50 Tcf/year (4.35 Bcf/day) by 1985.

Environmental effects of nuclear stimulation are those related to radioactivity and seismic disturbance, primarily subsurface but with some surface seismic disturbance. The chance of above ground contamination and disturbance is considered extremely unlikely. Most radioactivity remains underground, trapped in resolidified rock. Water produced with the gas from nuclear stimulated wells contains small amounts of tritium. Methods of disposal of this contaminant are being developed. Gas production from the wells can be delayed until the short-lived radionuclides decay. The first gas from the wells contains high CO₂ levels, but after production of a few chimney volumes, the gas composition is essentially the same as that from conventional wells.

Ground motion following the underground explosion is predictable; hence, damage to existing ground structures can be minimized. It has been suggested that residual stress from a number of detonations might accumulate and present an earthquake hazard not present in a single explosion. Data from seismic wave generation and stimulated

fault motion at the Nevada Test Site indicate that the cumulative effect from many explosions is to reduce ambient stress levels rather than to increase them. Also, a recent series of high-precision geodolite measurements indicates that the residual strain field around a single explosion site tends to relax with time.

8.1.3 Alternative Designs, Processes, and Operations

8.1.3.1 Other Coal Gasification Processes

Presently, commercially proven technology for coal gasification has been demonstrated by Lurgi, Koppers-Totzek, and Winkler processes. ANGCGC selected the Lurgi process after detailed reliability, economic, and engineering studies of the three processes.

The Koppers-Totzek (K-T) process was developed in 1948 in cooperation with a German company. There are 16 K-T plants operating around the world, but none in the United States. The K-T process employs the partial oxidation of pulverized coal in suspension with oxygen and steam. A two-headed gasifier is capable of gasifying over 400 tpd of coal. Coal, oxygen, and steam are brought together in opposing gasifier burner heads. Reaction temperature at the burner discharge is 3,300 to 3,500° F and the operating pressure of the gasifier is slightly above atmosphere. The coal is gasified almost completely and instantaneously. Carbon conversion is related to the reactivity of coal, approaching 100 percent for lignites.

The Winkler process is an atmospheric fluid-bed route in which the gasifying media are oxygen and steam. The fluid-bed operates at 1,500 to 1,850° F, and most of the ash is carried over with the product gas. To prevent slagging of the ash, the gases are cooled by a radiant boiler section in the upper portion of the gasifier. The process is used at 16 plants in a number of countries, using a total of 36 generators.

The K-T and Winkler processes offer an advantage in not producing byproduct tars, oils, etc., due to their higher operating temperatures. The higher operating temperature, however, is also a disadvantage in SNG production. The SNG produced has a very low methane content (< 1 percent) and the size of the methanation unit must almost be doubled. Their other disadvantages are greater oxygen consumption and low operation pressure. The resultant SNG has to be compressed to a final pipeline pressure of 1050 psig.

The environmental impacts of the alternate gasification processes would be essentially the same as those discussed in Chapter 3 for the proposed project.

8.1.3.2 Alternatives Within the Process

A major portion of the gasification plant is a Lurgi process package. The Lurgi process areas are (1) gasification, (2) gas shift conversion, (3) gas cooling, (4) Rectisol, (5) Phenosolvan, (6) methanation, and (7) gas liquor separation. Lurgi proprietary equipment is used in areas 1, 4, 5, and 6 above; thus, gas quality and other performance guarantees only apply if Lurgi designs the total system. For this reason, no alternative process units in the above areas were considered once the Lurgi process was selected.

In the area of ammonia recovery, the Lurgi CLL process was compared with the U.S. Steel Phosam-W process. Since both processes utilize the same feed stream and both produce commercial grade anhydrous ammonia, the Phosam-W process was selected for economic reasons.

In terms of sulfur conversion, a combination of Stretford, Claus, and IFP processes were considered at first. In the Sasol coal analysis at an existing gasification plant, however, it was learned that in processing lignite from the Beulah-Zap bed that the sulfur concentrations given off were too low to be effectively recovered by the Claus and IFP processes. As a result, a total Stretford system was selected.

Considerable testing and evaluation was also done by ANGCGC in the area of coal preparation. Tests were conducted in the areas of coal drying, crushing, and screening. The Sasol test showed that drying was not required. Crushing tests were used to provide data on final coal sizing and equipment selection. In a full scale screening test, a high probability screen, new to the American market, proved to be the best screen to use in the gasification plant.

8.1.3.3. Alternative Sources of Power

As an alternative to receiving power from the Basin Electric powerplant, ANGCGC could obtain some power from the existing grid system and provide the remainder from one of three internal systems: (1) low Btu fuel gas generation with gas-fired power boilers, (2) low Btu fuel gas generation with combined cycle power generation, or (3) direct firing of coal fines in a steam boiler with stack gas scrubbing.

Direct firing of coal fines would be preferable to low Btu gas generation for several reasons: low Btu gas generation involves high investment and operating costs, thus increasing SNG cost; it has lower thermodynamic efficiency than direct firing of coal fines because of conversion losses in the gasifiers; and, if the gas generation system malfunctions, product SNG would have to be

used. Also, if Lurgi low Btu gasifiers were used, coal fines could not be used resulting in the need to purchase more coal and the creation of additional fines.

Obtaining power from the Basin Electric plant is preferable to the direct burning of coal fines because (1) burning coal fines would require investment in coal-fired steam boilers and SO₂ scrubbing equipment thus raising the cost of the SNG produced, (2) the process would not use all of the coal fines generated so the remainder would have to be shipped offsite by rail and sold, (3) emissions from the gasification plant would be increased, and (4) the cost of the facilities to be shared by ANGCGC and Basin Electric (i.e., water intake and pipeline, railroad spur) would have to be borne by ANGCGC alone thus adding to the cost of the product SNG.

8.1.3.4 Alternative Wastewater Treatment Methods

Alternative wastewater treatment methods considered by ANGCGC were (1) biological waste treatment; (2) solar evaporation ponds; (3) multiple effect evaporators, spray dryers, chemical landfill; and (4) deep-well disposal.

Biological waste treatment was discarded because several compounds in the wastewater may be either resistant or toxic to biological organisms, making complete biological treatment improbable. The solar evaporation ponds would require in excess of 1,000 acres of land and could not be justified on the basis of land commitment or cost.

Preliminary studies have shown that a combination of evaporators to remove organic wastes and deep-well injection of the inorganic brine to aquifers sufficiently below those used for water supplies would be feasible. Combined with a cooling tower which circulates and concentrates the process water, this method appears to provide the most efficient and complete method of handling plant wastewaters.

8.1.3.5 Other Water Intake Structures

Several alternate design configurations and construction methods for the water intake structure were evaluated by ANGCGC. The main methods considered were: (1) offshore tower with pumps and causeway to shore, (2) offshore tower with boat access instead of a causeway, (3) submerged pumps with buried pipeline, and (4) open channel cut to onshore pump station.

The offshore tower, with or without causeway, was discarded for environmental considerations (including high visual impact) and high maintenance costs. The submerged pump with buried pipeline

alleviated the aesthetic problem, but reliability and accessibility would be poor. The open channel provided good reliability, accessibility, and low maintenance cost, but the visual impact and environmental problems associated with surface withdrawal were present. The submerged intake and tunnel to an onshore pump station, although having higher construction costs, provided good reliability and accessibility, low maintenance cost, low visual impact, and minimal operations impact.

8.1.3.6 Alternatives to Proposed Mining Plan

The Federal Government has retained extensive coal rights in the vicinity of the proposed project and these reserves are under the administration of the Bureau of Land Management (BLM). Prior to May 1971, leases to mine the coal were granted on a case by case basis without regard to total reserves under lease (87). From May 1971 until February 1973 no new leases were granted while the Department of the Interior reassessed Federal coal leasing policies. One result of the study was the recommendation to resume coal leasing under an Energy Minerals Activity Recommendation System (EMARS) which is a leasing system based upon expressed demands from the public and industry and a multiple use planning system for federally administered lands.

Figure 8-1 shows the Federal coal reserves and four proposed BLM lease tracts (designated N-1A, N-2A, N-2B, and S-1^{1/}) near the proposed project. BLM intends to offer the lease tracts for competition bidding. Coteau Properties already has leases on several areas of Federal coal in these tracts and could obtain the rights to mine the remaining Federal coal, some of which could go to the proposed ANGCGC and Basin Electric projects. The mining plan for the proposed project (Figure 1-8) was based on privately owned coal and the project could proceed without Federal coal; however, use of a combination of Federal and private coal would allow more efficient mining and would result in a reduction of overall mining costs.

In formulating the Program for leasing of Federal coal tracts, BLM designed the tracts so that each tract would (114):

1. Contain sufficient reserves to provide the needs of gasification, power generation, and/or export,
2. Have a stripping ratio of less than 10:1 (overburden to coal depth) to result in low mining costs,

1/ "S" tracts are proposed for immediate leasing; "N" tracts are recommended for leasing before 1990.

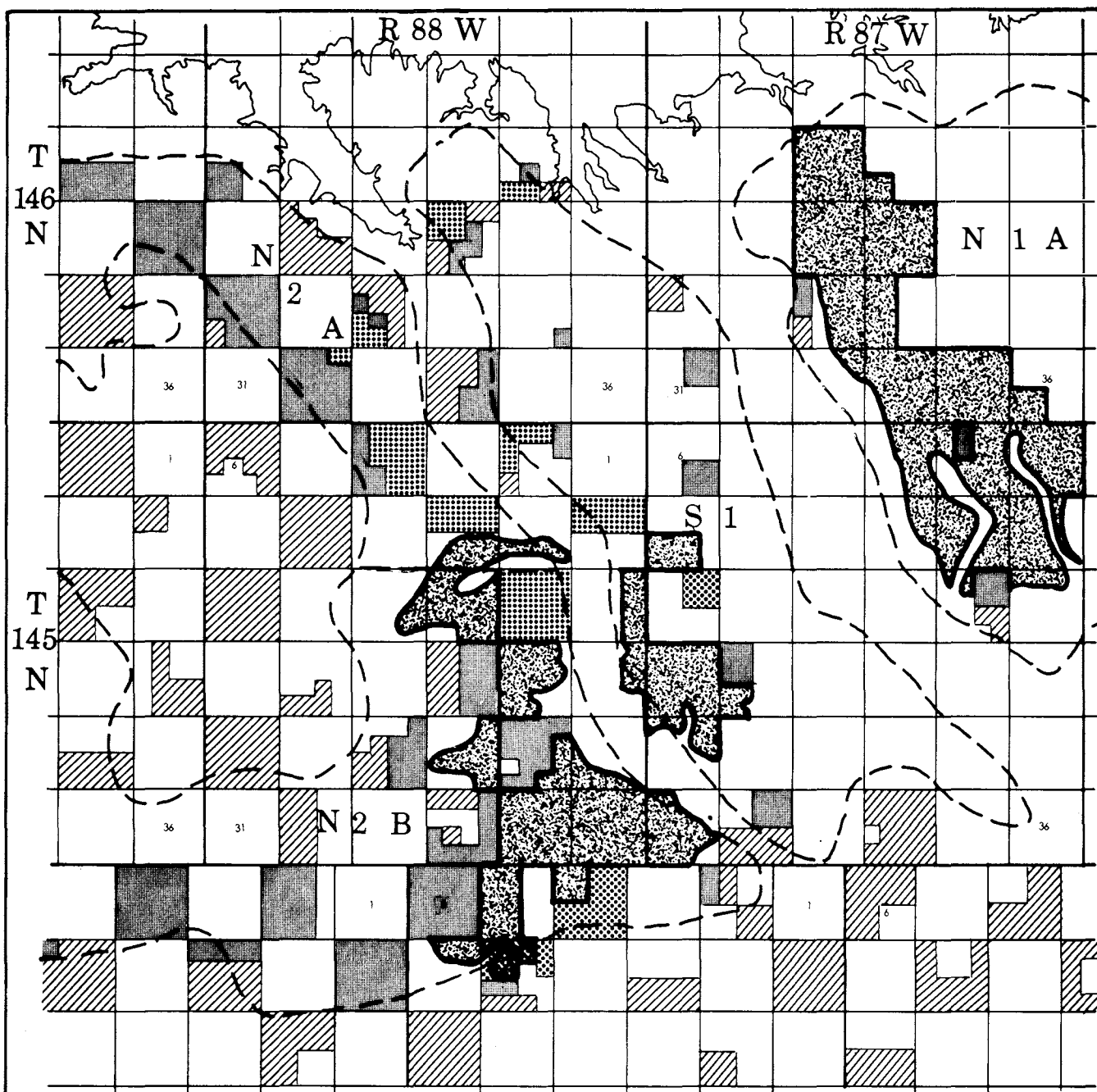
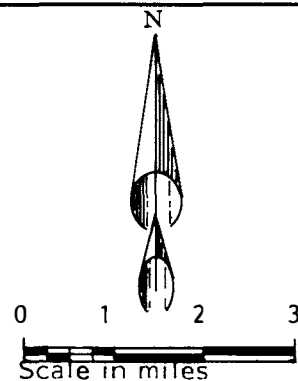


Figure 8 - 1
FEDERAL COAL RESERVES
and
ANG CCG PROPOSED MINING PLAN

- LEGEND
- FEDERAL LEASING TRACTS
 -  ANG PROPOSED MINING AREA
 -  EXISTING COAL LEASES (FEDERAL)
 -  COAL LEASE APPLICATION (FEDERAL)
 -  OTHER FEDERAL COAL



3. Be topographically amenable to mining and relatively easy to reclaim,
4. Be within areas classified as Known Recoverable Coal Resource Areas by the U.S. Geological Survey,
5. Be within reasonable distance of a sufficient water source,
6. Be reasonably close to existing rail lines and highways to facilitate movement of equipment or the coal itself,
7. Be near existing or proposed developments,
8. Have an identified immediate need for the coal,
9. Have low Federal coal ownership; thus, mining could readily proceed without it.

Federal coal reserves within the four lease tracts total 182.906 million tons broken down as follows:

<u>Tract</u>	<u>Reserves (Million Tons)</u>
N-1A	8.948
N-2A	65.135
N-2B	67.549
S-1	41.274

Privately owned reserves in these tracts total 717.918 million tons.

Of the total of 38,856 strippable acres of coal in the four proposed tracts, 8,257 acres are Federal; 798 are State; and 29,801 acres are private coal. Surface ownership of coal acreage is distributed as follows:

<u>Tract</u>	<u>Federal</u>	<u>State</u>	<u>Private</u>	<u>Total</u>
N-1A	0	0	11,956	11,956
N-2A	0	289	6,227	6,516
N-2B	0	484	9,619	10,103
S-1	0	0	10,281	10,281

The four proposed lease tracts lie within the study area described in Chapter 2, thus the description of the existing environment in that chapter would apply to the proposed lease tracts also. The

impacts of mining the Federal coal would be essentially the same as those described in Chapter 3 related to mining privately owned coal except for the differences noted below:

1. About 570 acres of prime farmland lies within the four proposed lease tracts as follows: N-1A - 444 acres; N-2A - 126 acres; N-2B - 0 acres; S-1 - 0 acres. No unique farmland is found within the tracts (114).

2. Mining in the northern portion of tract N-1A would destroy the Weidner Campground adjacent to the Hille Game Management Area and lower the quality of the recreation experience at the Hille Game Management Area and the Beulah Bay Recreation Area. Tract N-2A is also close to the Lake Sakakawea shoreline and would lower the quality of the recreation experience at the lake.

3. Acreages of the various plant communities within the proposed tracts are as follows:

<u>Tract</u>	<u>Cropland</u>	<u>Prairie</u>	<u>Woodland</u>	<u>Wetland</u>
N-1A	15,409	5,946	154	64
N-2A	3,800	8,132	714	0
N-2B	12,960	12,864	104	25
S-1	12,576	5,931	18	0

4. The large amount of woodland in N-2A, if mined, would result in a higher-than-average loss of important winter cover for wildlife and populations of woodland associated wildlife (e.g., white-tailed deer, black-capped chickadee). The large amount of prairie in N-2A would result in higher-than-average losses of grassland species (e.g., sharp-tailed grouse, burrowing owl) if it were mined.

Since the Federal contribution to the total coal available in the proposed tracts is so small, and because of the random distribution of Federal coal within the tracts, not to mine the coal would result in the loss of the resource to future generations as it would not be economically feasible to try and extract such small, isolated pockets of coal. If the Federal coal were not mined, it would also result in higher costs and lower mining efficiencies to the proposed mining operations as Coteau Properties would have to mine around the Federal coal.

8.2 ANGCGC's Siting Alternatives

8.2.1 Plant Location Alternatives

a. North Dakota

ANGCGC in conjunction with Coteau Properties, studied 11 potential sites for the proposed gasification facility located near 5 coalfields in southwestern North Dakota. The coalfields studied were:

	<u>Coalfield</u>	<u>Approximate Location</u>	<u>No. of Sites Studied</u>
1.	Underwood	18 mi NE Hazen	1
2.	Otter Creek-Center	10 mi SE Hazen	3
3.	Beulah-Hazen	8 mi NW Beulah	2
4.	South Beulah	12 mi SSW Beulah	2
5.	Dickinson	30 mi SE Dunn Center	3

The sites were rated according to socioeconomic, geotechnical, and meteorological factors (Table 8-1), and biological factors (Table 8-2).

Sites at the Underwood and South Beulah coalfields were eliminated because of potentially large impacts to terrestrial and aquatic organisms (Table 8-3), and undesirable geotechnical and hydrological factors. Desirable sites in the Otter Creek-Center and Dickinson coalfields were eliminated largely because of engineering and economic factors. Consequently, the currently proposed site (3B) was selected as being the least environmentally damaging and most economically feasible alternative.

b. Sites Nearer the Market Area

Locating the gasification plant nearer the market area (i.e., Michigan) was an alternative considered by ANGCGC. To feed such a plant, coals from Illinois, Iowa, Ohio, and West Virginia were evaluated. It was found that the Lurgi gasification process could not operate well on Eastern coals because of their high caking tendencies (see Section 8.1.3.1 for other gasification processes). Thus, Western noncaking coals were needed and North Dakota lignite reserves, being closest to the Michigan-Wisconsin market area, were selected by ANGCGC.

The possibility of mining the lignite in North Dakota and shipping it by rail to a point closer to the market was also considered by ANGCGC. Two logical plantsites tying into existing ANR system pipelines were at Thief River Falls, Minnesota, and Crystal Falls, Michigan. At current, unit train rates of 17 mils/ton mile, rail shipment of 36,767 tpd of North Dakota lignite would add \$0.68/thousand cubic feet (Mcf) to the cost of gas produced in Minnesota, and

Table 8-1

Ranking of Various Alternative Sites According to
Socioeconomic, Geotechnical, and Meteorological Factors

	<u>Site</u>										
<u>Criteria Used</u>	<u>1A</u>	<u>2A</u>	<u>2B</u>	<u>2C</u>	<u>3A</u>	<u>3B</u>	<u>4A</u>	<u>4B</u>	<u>5A</u>	<u>5B</u>	<u>5C</u>
<u>Socioeconomic Ranking</u>											
Land Size	1	1	1	2	1	1	3	3	2	2	1
Dedicated Land Use	3	2	3	3	2	3	3	3	3	3	3
Traffic Disturbance	2	1	2	3	2	1	3	3	3	1	3
Labor Force/Unemployment	2	1	1	1	3	3	3	3	3	3	1
Proximity to Urban Area	1	2	2	1	3	3	3	3	1	1	3
Median Family Income	1	3	3	3	2	2	2	2	1	1	3
Aesthetics	2	2	2	1	3	2	2	2	1	1	2
Total	12	12	14	14	16	15	19	19	14	12	16
<u>Geotechnical Ranking</u>											
Seismicity	3	3	3	3	3	3	3	3	3	3	3
Foundation	2	1	3	3	2	2	1	1	1	2	2
Drainage	2	1	2	2	2	2	1	1	3	1	3
Topography	2	3	3	3	2	2	1	1	3	3	3
Construction Material Avail.	1	3	3	3	3	1	3	3	2	2	1
Mineral Resource Avail.	1	2	2	2	3	1	2	2	1	2	2
Ground Water Avail.	2	2	2	2	3	2	2	2	2	2	2
Total	13	15	18	16	18	13	13	13	15	15	16
<u>Meteorological Ranking</u>											
Population Center	3	3	3	3	3	3	3	3	1	1	3
Downwind Frequency	2	3	2	3	3	3	3	3	2	1	3
Sulfur Oxides	2	2	2	2	3	3	3	3	3	3	3
Particulates	2	2	2	3	3	3	3	3	3	3	3
Total	9	10	9	11	12	12	12	12	9	8	12

Note: Sites are ranked relative to one another. Score of 3 indicates better site; 1 a poorer site.

Source: Woodward-Envicon, Inc. Analysis, 1974.

TABLE 8-2
BIOLOGICAL RANKING

Most Desirable (no undesirable criteria affected)	Site 5C
Desirable (presence of natural prairie)	Site 3A
Less Desirable (some biological disturbance of a unique area)	Site 2A Site 3B Site 5A
Undesirable (disturbance of one or more unique areas)	Site 1A Site 2B Site 2C Site 4A Site 4B Site 5B

Source: Woodward-Environ, Inc. Analyses, 1974.

TABLE 8-3
SITE EVALUATION SUMMARY

	SITES									
	1A	2A	2B	2C	3A	3B	4A	4B	5A	5C
Socioeconomics, Land Use, & Demography	2	2	2	2	3	3	3	3	2	3
Geotechnical Factors & Hydrology	1	2	3	2	3	1	1	1	2	2
Meteorology & Air Quality	2	2	2	3	3	3	3	3	1	3
Terrestrial & Aquatic Biology	0	1	0	0	2	1	0	0	1	3
TOTAL	5	7	7	7	11	8	7	7	6	11

Note: As part of each evaluation, sites were placed into one of four judgment categories: 3 - Most Desirable, 2 - Desirable, 1 - Less Desirable, 0 - Undesirable. Judgment categories are based on approximate ranking values presented in Tables 8.3-1 through 8.3-4.

Source: Woodward-Environ, Inc. Analyses, 1974.

\$1.58/Mcf to gas produced in Michigan. Comparable costs for pipelining gas from North Dakota to these points is \$0.20 and \$0.39/Mcf, respectively.

Aside from the economic incentive for pipelining gas rather than rail-ship coal, there are other less obvious advantages. The shipment of coal by rail hopper car results in a 1 percent loss of fines, most of which is lost in the first 50 miles. This corresponds to about 370 tpd of particulate matter spread over the environment near the tracks. The particulate matter emitted by the gasification plant would amount to 2.8 tpd. An additional impact would be the disturbance caused by long coal trains passing through towns along their path every 6 hours.

A coal slurry pipeline was also considered as an alternative to rail shipment. While the effects on environment and communities along the route are less than those of rail shipment, other considerations make slurry transport undesirable: pipeline shipment requires particle size smaller than 1/10 inch, whereas the Lurgi gasification system cannot effectively handle coal particles smaller than about 3/8 inch; water requirements for the slurry would be about 6,100 gpm, or nearly the entire gasification plant requirement; and, finally, the energy requirement for slurry pipelining (including preparation, pumping, and dewatering) is about three times greater than that for rail shipment.

8.2.2 Alternative Product Pipeline Routes

An overriding constraint in the selection of the proposed product pipeline route was that a pipeline constructed to transport SNG would presumably not have the power of eminent domain. With this constraint in mind, the area was evaluated for location of existing utility corridors and other rights-of-way (ROW) that could accommodate the pipeline and minimize the crossing of private lands. The proposed route was selected as coming the closest to existing pipeline facilities while needing only a minor amount of trespass through private land. Other possible routes include (1) a direct route from the plant to the Thief River Falls compressor station, (2) a straight-line connection to the proposed Northern Border Pipeline, and (3) essentially the same route with a connection to an existing Mid-western Transmission Company pipeline (Figure 8-2).

a. Direct Route

The first alternate route is a combination of a nearly straight-line route from the proposed plant site to the Missouri River and a similar straight-line or great circle route from the Missouri River to the Thief River Falls compressor station. A major consideration west of the Missouri River was the avoidance of lignite deposits which are likely to be mined at a future date.

East of the Missouri River this alternative was first considered as a great circle and adjusted slightly to avoid urban areas and the many National Wildlife Refuges which are common in the region. But a major obstacle to this route was the Bureau of Reclamation's Garrison Diversion Unit, which is presently under construction in the area. Because multiple crossings of the irrigation system would be required, the great circle route was modified southward to completely avoid the Garrison project.

The proposed route was chosen over the great circle alternative primarily because it could be constructed on existing railroad ROW. In addition, Alternative 1 would cross numerous potholes,

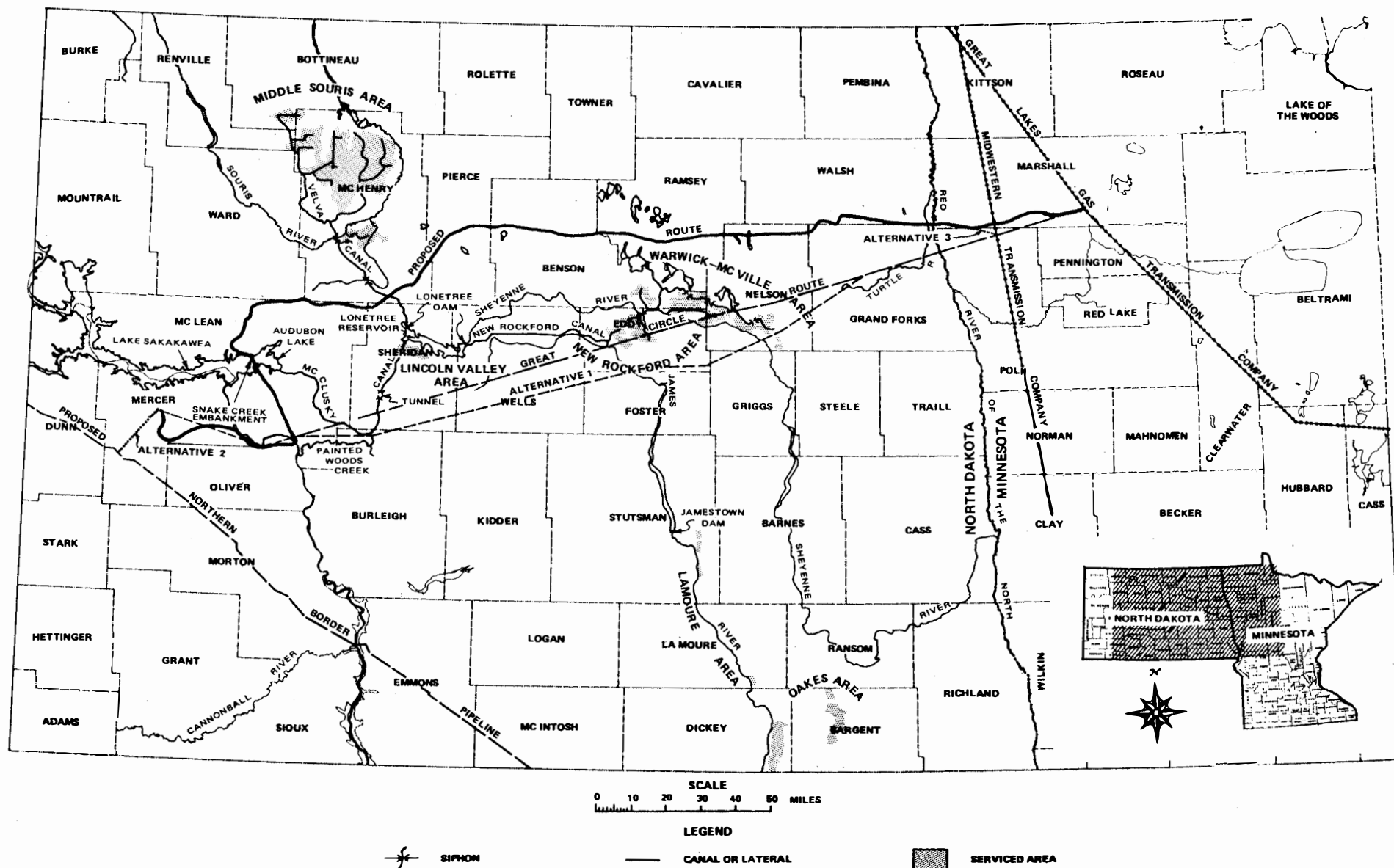


FIGURE 8-2

GARRISON DIVERSION UNIT* WITH PROPOSED ROUTE AND ALTERNATIVES FOR THE DAKOTA TRANSPORTATION PROJECT

*ADAPTED FROM: U.S. DEPT. INTERIOR, BUREAU OF RECLAMATION.
1973. GARRISON DIVERSION UNIT.

ponds, lakes, and wetlands which provide significant waterfowl habitat. The pipeline would have to be constructed so as to avoid many of these water areas, not only from environmental considerations, but from construction feasibility as well. While the proposed route crosses wetlands also, these are already crossed by the railroad. Potholes crossed by the railroad are interconnected with conduit to equalize water levels. Construction of the pipeline adjacent to the railroad may not be feasible at all pothole crossings, and some deviation from the ROW may be required.

Another significant difference between the proposed route and Alternative 1 is the amount of agricultural land impacted during construction. Since construction would occur during the summer and fall growing season, at least one season's crop would be lost on disturbed lands. The proposed route will be constructed within the railroad ROW and no cultivated areas will be crossed except for occasional parcels leased by farmers. Alternative 1 would be constructed primarily on agricultural land.

The total cost of the project and, thus, the cost of the delivered SNG, is increased by the increased length of the proposed route. Alternative 1 would be about 70 miles shorter and would require 8 perennial stream crossings to the proposed route's 12 (excluding the Snake Creek Embankment). The overall human hazard would also be less with Alternative 1 because of its rural location. A pipeline constructed in urban areas is more susceptible to accidental disruption by human activity.

b. Connect with Northern Border Pipeline

The shortest of the three alternatives studied would be a 25-mile pipeline to the closest point of intersection with the proposed Northern Border Pipeline (NBP) which would be bringing Alaskan natural gas into the 48 contiguous States. Because of the competitive proposals for transporting Alaskan gas, a question exists as to whether or not the NBP will even be built. Also, the NBP would require significant changes in capacity to handle the SNG on top of Alaskan gas. Add to these the problems associated with intermixing the lower Btu-rated SNG into a multicompany pipeline and this alternative does not appear viable at this time.

c. Connect with Mid-Western Pipeline Facilities

This alternative would require essentially the same pipeline route as either the proposed route or Alternative 1 to an intersection with an existing 24-inch-diameter gas pipeline in Polk County, Minnesota, owned by the Mid-western Pipeline Company. The environmental impacts, therefore, would be about the same as those for either the proposed pipeline or Alternative 1. There is some

doubt that the 24-inch pipeline has the additional capacity to handle the volume of SNG produced without extensive modification.

8.2.3 Alternative Railroad Spur Routes

Five alternative routes were considered for the railroad spur from the existing Burlington Northern mainline to the plantsite (Figure 8-3). The fifth alternative was selected by ANGCGC because: (1) it is the shortest distance to existing track in the primary shipping direction, (2) it has only moderate grades, (3) it would involve the least amount of earthmoving, and (4) it would have the lowest construction and operating costs. In addition, about 25 percent of the proposed ANGCGC siding would involve the use of existing track, thus the degree of environmental impact would be less than that of the other alternatives because they would require longer lengths of new track.

8.3 Resource Use Alternatives

8.3.1 Local Use Alternatives

8.3.1.1 Coal

The two most viable alternative uses for energy production of the coal committed to the proposed project would be for liquefaction or steam electric generation.

a. Coal Liquefaction

As an alternative to gasification, coal may be converted, either by pyrolysis or by dissolution in a solvent, into a range of fuels. These include clean gas, low-sulfur oils, solid char, and solvent refined coal. All of the pyrolysis and dissolution processes are broadly referred to as "coal liquefaction," although the end products include gas and solid fuels as well as liquid fuels.

Pyrolysis involves heating the coal at pressures of about 10 psig to clean out the volatile hydrocarbons, and then catalytically hydrotreating the hydrocarbon liquids to desulfurize them. Relatively large amounts of gas and solid char are produced along with the hydrocarbon liquids. Some of the gas or char can be converted to supply the hydrogen needed for hydrotreating the liquid products, or the char can be gasified to produce additional clean gas. The heat required for pyrolysis can be obtained by burning some of the char with oxygen or air (55).

The dissolution processes actually dissolve coal in a hydrogenated solvent oil at temperatures of 750 to 850° F and pressures of 150 to 2,500 psig. The end products (after recovery of the solvent

oil) include gas, oil, and char or a coking feedstock. In one process, solvent refined coal is produced.

None of the pyrolysis or dissolution processes have yet been commercially developed. Many small pilot plants are operating or planned, but unless funding and development are accelerated, it will be 4 to 6 years before a large commercial plant will be feasible. The overall thermal efficiency of the coal liquefaction processes is expected to be 65 percent -- which compares well with the 66 percent thermal efficiency of a Lurgi coal gasification plant.

Lacking detailed designs for liquefaction plants, it is not possible to detail particulate, NO_x , or SO_2 emissions. However, it has been estimated (47) that SO_2 emissions would be in the area of 13 to 20 tpd compared to about 30 tpd by a gasification plant. Generally speaking, all other environmental factors involved with coal liquefaction would be about the same as those associated with coal gasification. However, since liquefaction processes can use high-sulfur coal, the coal would come from underground mines in the Eastern and Mid-western States instead of being strip-mined on the surface. Underground mining generally has less environmental impact than strip-mining.

b. Steam Electric Generation

Producing electricity from coal involves feeding pulverized and blended coal into a furnace by fuel nozzles. In the furnace, the coal is mixed with preheated air and ignited. Heat energy given off during combustion is transferred through furnace walls to convert water into steam. The steam is then piped through superheaters, heated to $1,000^\circ \text{F}$, and piped to a turbine where its energy is used to rotate the shaft of an electric generator. The resulting electrical output is delivered to an exterior transmission system after being transformed to a higher voltage in an adjacent switchyard. The thermal efficiency of a coal-fired generating plant varies between 30 to 40 percent depending on the age of the plant, the type of plant, and the types of generators and boilers used.

Land use impacts of such a facility would be similar to those of the proposed gasification project. Land requirements of the two types of plants are comparable; water requirements for the generating plant would be somewhat greater.

Even with available emission control measures, a coal-fired power-plant would produce greater emissions of particulates, SO_2 , NO_x , and heavy metals than those produced by the proposed gasification plant. This would result in a degradation of ambient air quality and possible damage to the adjacent flora and fauna.

8.3.1.2 Water

The water that would be used by the proposed gasification plant could be used to supply about 8 million kilowatt-hours (1 MW) of hydropower annually. It could also be used for navigation purposes to achieve a slight increase in the navigation season downstream. There would be no environmental consequences from either of these uses in regards to the present situation.

Because of the large amount of water available in the Missouri main-stem reservoirs, the use of 17,000 acre-feet annually for the coal gasification facility does not preclude irrigation, recreation, or other industrial use. Thus, the hydrogeneration of about 8 million kilowatt-hours of electricity is the only viable alternative in the foreseeable future to the use of the water that would be used by the gasification plant.

8.3.1.3 Land

The alternative uses of the land involved in the project would be for cropland, grazing land, and/or wildlife habitat. Again, the environmental impact of such use would not differ from present day levels.

8.3.2 Exportation Alternatives

8.3.2.1 Coal

Coal could be exported to almost any place in the United States for use in an industrial facility in or near the area to be serviced. The impacts of the mining operation in Mercer County would be similar to those of the proposed gasification project. Impacts of transporting the coal are discussed in Section 8.2.1. The major favorable aspect of using the coal in the service area is that the user of the finished product would have to bear some of the environmental costs. For example, air and water pollution would increase in the service area rather than the minesite. Social impacts of the work force would be less intense or entirely masked by locating the plants near large population centers, but larger numbers of potentially susceptible persons would be exposed to the pollutants.

8.3.2.2 Water

The water could be physically transported to another area for industrial, irrigation, municipal, or other uses. To transport the water, pipelines or canal systems and pumping facilities would have to be constructed. These facilities would cause land to be disturbed along the routes and could result in such impacts as habitat loss, erosion, reduced soil productivity, and decreased

water quality. There would also be environmental impacts in the areas receiving the water depending on what type of facilities were constructed.

8.4 Alternative Energy Sources

8.4.1 Oil

Additional sources of oil could come from domestic or foreign supplies. United States crude oil production peaked in 1970 and reserves have fallen each year since 1966 (51). Only the discovery of the Prudhoe Bay field in the Alaskan North Slope was a temporary exception to the downward trend. Outer Continental Shelf (OCS) development could also add significantly to United States crude production, but the move into frontier areas and deeper waters will impose higher costs on oil production. Even with increased exploration and drilling, however, it is doubtful that United States crude oil production can even keep up with demands much less provide a reasonable alternative to coal development.

The availability of large volumes of foreign crude oil is by no means assured. World oil supplies are finite and the United States will increasingly find itself competing with the rapidly expanding economies of other countries for the foreign oil. The cartel of oil-producing countries has controlled the price of foreign crude and has threatened to use it to influence United States foreign policy. Foreign oil supplies will certainly become more costly and tenuous as competition for energy supplies increases.

Environmental impacts of oil production include those of drilling, extraction, transportation, and refining. Oil spills and discharges are the most notable hazards to offshore drilling and foreign crude importation.

8.4.2 Coal

Since coal is the most abundant fossil fuel in the United States, consideration should be given to its use in solid form. One advantage to using coal solids would be that the Btu loss in conversion processes would not occur. The major problems are those of air quality and substitutability. The problems are particularly significant for coal-fired electrical generation because the largest market for coal--and many severe air quality problems--are in the East and many major deposits of coal are in the West. Considerable research is being devoted to the development of economically feasible processes for the treatment of coal before burning to remove excess sulfur, to improve combustion processes, and to remove pollutants from stack gases after combustion. Where air quality standards can be met, coal can substitute for gas at facilities designed to use either.

Environmental impacts associated with increased use of solid coal would be those associated with mining, transportation of the coal product (i.e., electrical transmission lines), and the construction and operation of coal-fired facilities.

8.4.3 Generation of Electricity

8.4.3.1 Hydroelectric

The total conventional hydroelectric power potential of the United States is estimated to be about 179,000 MW (53). The better hydroelectric sites are concentrated in areas of heavy precipitation and large topographic relief. Although most available sites for the economical production of hydroelectric energy have been developed, some additional capacity will be provided by new sites, expansion of existing facilities, and development of new technologies to obtain better operational efficiencies. Use of hydroelectric power to service peak loads enhances benefits, permitting consideration of possibilities that were formerly marginal or uneconomic under higher capacity factor standards.

The environmental impacts are primarily those of construction and the irretrievable commitment of the land resources beneath the dam and lake. Operation of the hydroelectric powerplant itself produces no air pollution, radioactivity, or waste heat. Studies conducted in 1971 indicate that high nitrogen levels in the Columbia and Snake Rivers pose a serious threat to the salmon and steelhead resources of the region. The Corps of Engineers and Bureau of Reclamation are actively engaged in studying and testing several approaches to solving the nitrogen problem.

8.4.3.2 Nuclear

The use of nuclear power as a commercial electrical energy source could increase considerably in the next 15 years. Installed capacity in June 1974 was 28,000 MW which represents about 6 percent of the Nation's electricity. Nuclear power development is presently being slowed by various siting, construction, and environmental problems. If nuclear facilities are not constructed, the equivalent of any one fossil fuel required annually to fill the existing gap by 1990 would be 26.9 Tcf of natural gas, 1.28 billion tons of coal, or 5.28 billion barrels of oil. Up to 10 years are required to construct nuclear powerplants; in the short term, nuclear development cannot be greatly increased.

Environmental impacts of nuclear powerplants are those of construction, waste heat disposal, radioactive waste disposal, and the small amounts of radionuclides discharged in the cooling water and gaseous plant effluents. The removal of vegetation and the creation

of waste rock and overburden result from mining the uranium. To minimize the risks of accidents or their adverse effects if one does occur, plants are located away from high population areas and are designed to prevent accidents and to contain the effects of accidents if they do occur. Radioactive wastes must be isolated from the biosphere for hundreds of thousands of years if adverse effects to living organisms are to be totally avoided. Waste is presently disposed of in underground man-made facilities. Pilot studies of storage in salt beds are being conducted.

8.4.4 Geothermal Steam

The greatest potential for geothermal energy exists in the western third of the United States. The Geysers field in California was producing 552 MW of electrical energy by the end of 1974. Three areas planned for initial development soon are: Imperial Valley, Mono Lake-Long Valley, and Clear Lake Geysers, all in California. Within 20 years geothermal energy may account for 1 to 2 percent of the total United States energy, but in California, it could account for up to 5 percent of the State's energy consumption.

The major environmental objection to geothermal power development stems from the intrusion of industrial development into pristine areas. Other potential environmental impacts include those associated with construction, drilling, and transport. Air quality could be affected at sites where relatively large quantities of ammonia, hydrogen sulfide, and methane are associated with the steam. Generally, however, geothermal impacts on air quality are smaller than those associated with conventional fossil-fuel powerplants.

8.4.5 Oil Shale

Oil shales of the Green River Formation in Colorado, Utah, and Wyoming represent a very large energy resource. The deposits occur over a 17,000-mi² area (11 million acres), and contain an estimated 600 billion barrels of oil (52). The ultimate size of the oil shale industry will most likely not be determined by the size of the resource but will probably be limited by other factors, such as the availability of water and environmental considerations. In addition, since economics and technology are still uncertain and in the early stages, oil shale development could be severely affected by soaring costs and the general uncertainty in the energy situation.

Environmental impacts of oil shale development would be those of roads, mining, plantsites, waste disposal areas, utility and pipeline corridors, and associated services. These activities would change the existing patterns of land use, alter the existing

topography, and affect natural vegetative cover until revegetation begins. Revegetation would be difficult because of the arid climate.

8.4.6 Solar Energy

Solar energy conversion systems which could work as an alternative energy supply are still in developmental stages. Conversion efficiencies of existing systems are relatively low averaging about 30 percent for conversion to heat and 5 percent for conversion to electricity. A 1,000 MW solar powerplant would require about 37 mi² of collector surface, assuming a normal solar climate and using presently available technology. The most promising method of using solar energy is a hybrid system for house heating and cooling. Such a hybrid system could use either gas, oil, or electricity as the auxiliary energy supply. Approximately 75 percent of the energy required for a home in the Southwest would be supplied by solar energy; the remainder would come from auxiliary systems. Development of such a hybrid system could extend the Nation's fossil-fuel reserves considerably.

Since solar energy systems are still experimental, the environmental impacts are not known. The largest potential impact is the large amount of land surface required for collector systems. If this problem could be solved, other impacts would probably be relatively minor.

8.4.7 Other Sources

Other possible sources of energy include tidal power, wind energy, and biological energy. The only practical opportunities for tidal power in the United States appear to be at Passamaquoddy Bay, Maine, and Turnagain Bay, Alaska. However, economic considerations have prevented development of this energy source in the past. Environmental problems would be considerable. Damming with alternative filling and draining of the bays would affect shipping, sport and commercial fisheries, wildlife, water quality, aesthetics, and numerous other uses of the bays and estuaries.

A fixed device could capture the kinetic energy of wind by rotation about an axis and, coupled to a generator or gears, convert it to mechanical or electrical form. The high cost of equipment, energy storage, and backup equipment coupled with the intermittent characteristics of the wind preclude a favorable cost benefit of wind energy at the present time. The chief environmental impact is the adverse aesthetic effect of large numbers of towers and assorted equipment.

Systems to use biological waste to make energy are still in the experimental or pilot stages (81). The potential energy that

could be derived from this source could be of significant magnitude; an estimated 2 billion tons of organic waste is produced in the United States each year. This waste could be used to generate 147 trillion Btu's of energy within 10 years. Environmental impacts associated with this resource will be unknown until such time as specific systems are devised and developed.

Implementation of conservation measures could significantly help save energy and make our existing fossil-fuel resources last longer. In 1972, the Office of Emergency Preparedness estimated that a list of proposed conservation measures could reduce United States energy demands by 15.35 quadrillion Btu (QBtu) by 1980, and 34.9 QBtu by 1990. However, the proposed list of conservation measures included many admittedly with low "public acceptability" and "likelihood of implementations," so it is highly unlikely that such high energy savings could realistically be achieved.

CHAPTER 9

CONSULTATION AND COORDINATION

9. Consultation and Coordination

9.1 Environmental Statement Coordination

Before preparing the Draft Environmental Statement, a copy of the Woodward-Clyde Environmental Report (4) was submitted to a number of Federal and State agencies for review and comment. Agencies contacted as a part of this effort included:

a. Federal Agencies

U. S. Forest Service, Region 2
Omaha District Corps of Engineers
U. S. Environmental Protection Agency, Region VIII
Federal Energy Administration, Region VIII
Chairman, Federal Power Commission
Department of Health, Education and Welfare, Region VIII

b. Department of the Interior

Bureau of Land Management, Billings, Montana
U. S. Fish and Wildlife Service, Region VI
U. S. Geological Survey, Lakewood, Colorado
Bureau of Indian Affairs, Aberdeen, South Dakota
Bureau of Outdoor Recreation, Denver, Colorado

c. North Dakota Agencies

Honorable Arthur A. Link, Governor
State Intergovernmental Clearinghouse, State Planning
Division
State Natural Resource Advisor
State Energy Coordinator
North Dakota Department of Health
Secretary and State Engineer, State Water Commission
State Game and Fish Department
State Outdoor Recreation Agency
North Dakota State Tax Department
State Public Service Commission
State Geologist
State Historical Society

In addition, an advance copy of this statement was reviewed and commented on by the West Central North Dakota Regional EIS team which is comprised of 17 Federal and 32 State of North Dakota agencies for which the Bureau of Land Management is the lead Federal agency. Comments on the advance copy were also requested from:

Federal Power Commission, Washington, D.C.
Rural Electrification Administration, Washington, D.C.
U.S. Fish and Wildlife Service, Billings
U.S. Corps of Engineers, Omaha
Bureau of Indian Affairs, Aberdeen
ANG Coal Gasification Company
U.S. Department of Interior, Washington, D.C.

The draft of this environmental impact statement was prepared by the Upper Missouri Region, Bureau of Reclamation, Billings, Montana. Several meetings were held with ANGCGC representatives at Billings to gain additional data; further data and information were asked for and provided in numerous communications between the Bureau of Reclamation and ANGCGC. Persons from several different disciplines were involved in the preparation of the statement. These disciplines include:

Fish and Wildlife Biology
Limnology
Sociology
Economics
Environmental Engineering

Hydrology
Ecology
Civil Engineering
Electrical Engineering

9.2 Consultation During Preparation of Final Environmental Statement

Notice of the Draft Environmental Statement's availability was printed in the Federal Register on March 22, 1977; copies were distributed to the entities listed in the summary on March 23, 1977. Additional copies were made available from the Office of Ecology, Bureau of Reclamation, Washington, D.C.; the Office of the Regional Director, Upper Missouri Region, Bureau of Reclamation, Billings, Montana; and the Missouri-Souris Projects Office, Bureau of Reclamation, Bismarck, North Dakota.

Public hearings on the DES were held in Beulah, North Dakota, on May 10, 1977, and in Bismarck, North Dakota, on May 11, 1977. Notice of the two hearings was published in the Federal Register on March 31, 1977. On April 10, 1977, notices of the hearings were released to the wire services (AP and UPI), all daily and weekly newspapers, and radio and television stations in the area of concern. Notices were also published in local newspapers during the week of May 2, 1977. Total registered attendance at the two hearings was 91.

The public hearing record includes a transcript of all oral testimony and written comments submitted for the record. Relevant comments from the public hearings are summarized in this chapter along with the Bureau of Reclamation's responses and cross-references to appropriate sections of the final statement.

All written comments received during the review period from governmental agencies as well as letters from the public, are contained in Appendix J. All written comments on the draft statement and all written and oral testimony from the hearing record were considered during preparation of the final environmental statement.

One major area of concern was that the EIS should cover the cumulative impacts of all coal-related development proposed for the region surrounding the proposed ANGCGC plant. This statement is a site-specific EIS for the ANGCGC plant only and coverage of cumulative impacts is necessarily limited. A BLM-North Dakota Regional EIS near completion in August 1977 is designed to fulfill the requirement to study cumulative impacts. In addition, this statement provides limited coverage of the Basin Electric Company powerplant to be constructed adjacent to the ANGCGC plant. The Rural Electrification Administration will issue the site-specific EIS for the Basin Electric proposal.

Copies of the public hearing record are available for public inspection at the Office of the Director of Communications, Department of the Interior, Washington, D.C., and at the following Bureau of Reclamation offices: Assistant to the Commissioner, Ecology, Washington, D.C.; Technical Services and Publications Branch, Engineering and Research Center, Denver, Colorado; Upper Missouri Regional Office, Billings, Montana; and the Missouri-Souris Projects Office, Bismarck, North Dakota. At the state and local levels, copies are available at the North Dakota

State Planning Agency, Bismarck, North Dakota; the Office of Budget and Program Planning, Helena, Montana; the Bismarck Public Library, Bismarck, North Dakota; and the Beulah City Library, Beulah, North Dakota.

SUMMARY OF COMMENTS FROM PUBLIC HEARINGS
ON DRAFT ENVIRONMENTAL STATEMENT

Nature of Comments about
Draft Statement

1. The permit for the gasification plant should require that essential public facilities and services be in place before plant construction begins.
2. To avoid developing a biased DES, data compiled by the Bureau of Reclamation should have been used instead of that compiled and provided by the ANG Company.
3. The DES does not include a description of the present state of educational facilities in the impacted area.
4. Projected classroom needs should be based on the State recommended classroom ratio of 1:24 and the laboratory instructor-student ratio of 1:15, rather than the overall ratio of 1:30 used in the DES.
5. The DES omitted consideration of projected gymnasium and vocational education facility needs for the impacted area.
6. The community of Hazen will have to provide adequate educational facilities for the incoming population. However, there are severe funding problems because the Hazen School District is at present bonded to capacity and is not located so that it will benefit from increased property taxes from the plant. Too, there is a time lag in getting grant requests approved.

Bureau of Reclamation Responses

1. The USBR has no authority to place these kinds of stipulations on water service contracts. There are numerous permits issued by the State of North Dakota where such a stipulation could be attached if necessary.
2. It is Department of Interior policy that baseline environmental data for private developments be provided by the company. The data used in the DES was compiled by reliable consulting firms and governmental sources and subjected to detailed review and analysis by USBR personnel.
3. The present status of educational facilities in the impact area was discussed in Section 2.3.3 of the DES.
4. The projected needs are based upon the premise that the student-teacher ratio will likely increase because the temporary nature of a part of the population would preclude the expenditure of limited funds to provide permanent facilities which would no longer be used once the temporary population moves out.
5. The general discussion in Section 3.3.2.2 on educational facilities includes gymnasiums and Vo-Tech facilities. We feel that specific needs should be determined by the local school boards based upon their greater familiarity with local values and wishes.
6. As a last resort, loans could be made from the State Coal Severance Tax Fund to be paid back from future severance taxes (See Section 2.3.2). However, whether or not to utilize this source is strictly a local decision.

Nature of Comments about
Draft Statement

- 9-6
7. The capacity of the public health care system in the impacted area will be considerably exceeded as a result of the additional population influx. The present physician to patient ratio in the area is 1:4,000, against a State average of 1:1,500. Moreover, the area will need a new hospital and at present there are no funds available for new facilities or to recruit additional physicians and other health care personnel. Funds received from the Coal Impact Office are adequate only to maintain and rehabilitate existing structures.
 8. The DES deemphasizes solar energy and conservation alternatives. This represents a fossil fuel bias.
 9. Alternative uses of the coal for producing petrochemicals and as coking coal should be discussed.
 10. The DES does not mention the presence or absence of lower coal seams. If the land is to be disturbed by strip-mining, all possible energy should be recovered.
 11. The DES does not include information about the rate structure that will govern sale of the gas produced. Will this rate structure encourage energy conservation or excessive and wasteful use of energy?

Bureau of Reclamation Responses

7. Again, it would be possible to borrow funds from the State Trust Fund if other possible sources have been exhausted.
8. The USBR fully supports solar energy and conservation as alternatives to the long-term use of fossil fuels. As short-term alternatives to the proposed gasification plant they do not appear to be feasible at this time.
9. Alternative use of the coal for producing petrochemicals was discussed in Section 8.3.1.1 of the DES. Lignite is not considered a good coal for coking purposes because the moisture content is too high, the volatile content is generally too low, and the fixed carbon content is too low.
10. There are no economically recoverable coal seams below the Beulah-Zap bed.
11. The Federal Power Commission will determine the rate structure governing the sale of the SNG. Current proposals to average the cost into the existing rate structure were discussed as page 1-3 of the DES.

Nature of Comments about
Draft Statement

- 9-7
12. The acreage of land projected to be disturbed by mining appears to be underestimated. The expected 10 percent accuracy of the projections as stated in the DES appear not to be accurate within 25 percent. For example, using the commonly accepted acreage of 1,750 tons per acre-foot (of coal), the total land mined during 25 years would amount to 16,250 acres, which is nearly 4,000 acres more than is projected in the DES. Also, the DES should point out that a total of 29,175 acres will be disturbed by the combined ANG and Basin Electric mining activities.
 13. The statement that farmers will want their land reclaimed as cropland has no basis other than the attraction of short-term high wheat prices.
 14. The total amount of water released into the atmosphere will be 5,600 gallons per minute instead of 4,700 gallons per minute as stated in the DES, since the 800 gallons per minute discharged from the oxygen cooling plant is not included.
 15. The discussion of water evaporation from the ANG and Basin Electric plants does not adequately emphasize the effects of increased humidity and "mugginess." Also, the combination of increased humidity with sulfur and nitrous oxide emissions increases the likelihood of acid rains occurring.
 16. There is no source referenced for the statement on page 3-81 that the alkaline waters in North Dakota will reduce mercury hazards to humans and wildlife by precipitating it out. This statement should either be omitted or its source cited in the text.

Bureau of Reclamation Responses

12. The acreages used in the DES were based on measurements of the thickness and quality of the seam to be mined, not a statewide overall average. As stated on page 1-11 of the DES, the Basin Electric plant would require about 100 acres to be mined annually thus disturbing a total of about 16,000 acres for both projects.
13. The basis for the statement was the generally higher dollar-per-acre yield of cropland over rangeland.
14. Updated data sets the evaporation loss at 7,720 gpm. Evaporation and drift from both cooling towers are included in this estimate but blowdown is not. Section 1.5.5.4 has been revised to include the revised data.
15. Because of the comparatively low relative humidity of the area, it is not likely that "mugginess" or local acid rains would develop because of water evaporation from the gasification plant.
16. The statement was based on chemical laws and reactions well known in the science of chemistry and no one particular reference served as a source.

Nature of Comments about
Draft Statement

17. Will the Bureau of Reclamation sell water to ANG even though the DES concludes that the project will adversely affect air quality and ground water quality and quantity; that wildlife habitats will be permanently altered; and that the social structure of the area will be significantly affected by the increased population?
18. Consideration should be given to compiling statistical data the incidence of diseases under pre-plant conditions. Such a data base is essential for monitoring conditions after the plant is in operation.
19. The DES does not give adequate attention to the effects of trace elements on air and water quality radioactivity, or possible carcinogens. The deleterious effects of toxic tract elements on humans, animals and plants should be mentioned as well as the lack of official emission standards.
20. Sulfur dioxide from lignite and coal-fire powerplants may cause selenium deficiencies in cattle, resulting in stillborn or weak calves. Reportedly, the sulfur dioxide is absorbed by alfalfa and, when eaten by cattle, the resulting sulfate reduces selenium levels. Two such occurrences have been reported in North Dakota: one was on a ranch 1 mile from a thermoelectric powerplant and oil refinery; the other was on a ranch 6 miles from a thermoelectric complex. Studies are underway to determine better ways of diagnosing and preventing this problem.

Bureau of Reclamation Responses

17. The Secretary of the Interior will have to decide whether or not to issue a water service contract after weighing the impacts of the proposal against the benefit to the nation of the synthetic natural gas produced.
18. We agree with this comment and have advised ANGCGC accordingly.
19. The effects of toxic trace elements was discussed on pages 3-16, 3-17, and 3-81 of the DES. A sentence regarding the lack of tract element emission standards has been added to Section 4.1.2.1. Radioactivity from either source should not be a problem because of the very low occurrence of radioactive elements in the coal. Very little is known about the carcinogenicity of the emissions and to place more emphasis on this potential effect would be to engage in "scare tactics" not warranted by existing knowledge.
20. No response necessary.

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(References used in the Woodward-Clyde report (4) were not all included in this bibliography but are contained on pages 10-25 through 10-80 of that report.)

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APPENDICES

Appendix A
Glossary

Glossary of Abbreviations

ANGCGC	ANG Coal Gasification Company
ANR	American Natural Resources Company
Bcf	billion cubic feet
BLM	Bureau of Land Management
BOD	Biological Oxygen Demand
Btu	British thermal unit
CEQ	Council on Environmental Quality
cfs	cubic feet per second
dBa	decibels A weighted
°C	degrees Centigrade
°F	degrees Fahrenheit
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
FPC	Federal Power Commission
ft	feet
FTU	Formazin Turbidity Units
GMA	Game Management Area
gpd	gallons per day
gpm	gallons per minute
HHV	Higher Heating Value
km	kilometer
KV	Kilovolt
L ₉₀ , L ₅₀ , L ₁₀	Loudness 90, 50, 10. That dBA level exceeded 90 percent of the time, 50 percent of the time, or 10 percent of the time.

lb	pound
ug/m ³	microgram per cubic meter
mg/l	milligrams per liter
mg/m ³	milligrams per cubic meter
MMcf	Million cubic feet
Mcf	Thousand cubic feet
MCD	Mercer Census Division
MDU	Montana-Dakota Utilities
MW	Megawatt
m/sec	meters per second
NACCO	North American Coal Corporation
NGPC	Natural Gas Pipeline Company of America
NWR	National Wildlife Refuge
ppm	parts per million
PSC	Public Service Commission (North Dakota)
psig	pounds per square inch gage
REA	Rural Electrification Administration
ROW	right-of-way
scf	standard cubic foot
SNG	Synthetic Natural Gas
SWC	State Water Commission (North Dakota)
mi ²	square miles
Tcf	Trillion cubic feet
TDS	Total Dissolved Solids
tpd	tons per day
tph	tons per hour
TSP	Total Suspended Particulates
USGS	U.S. Geological Survey

Chemicals

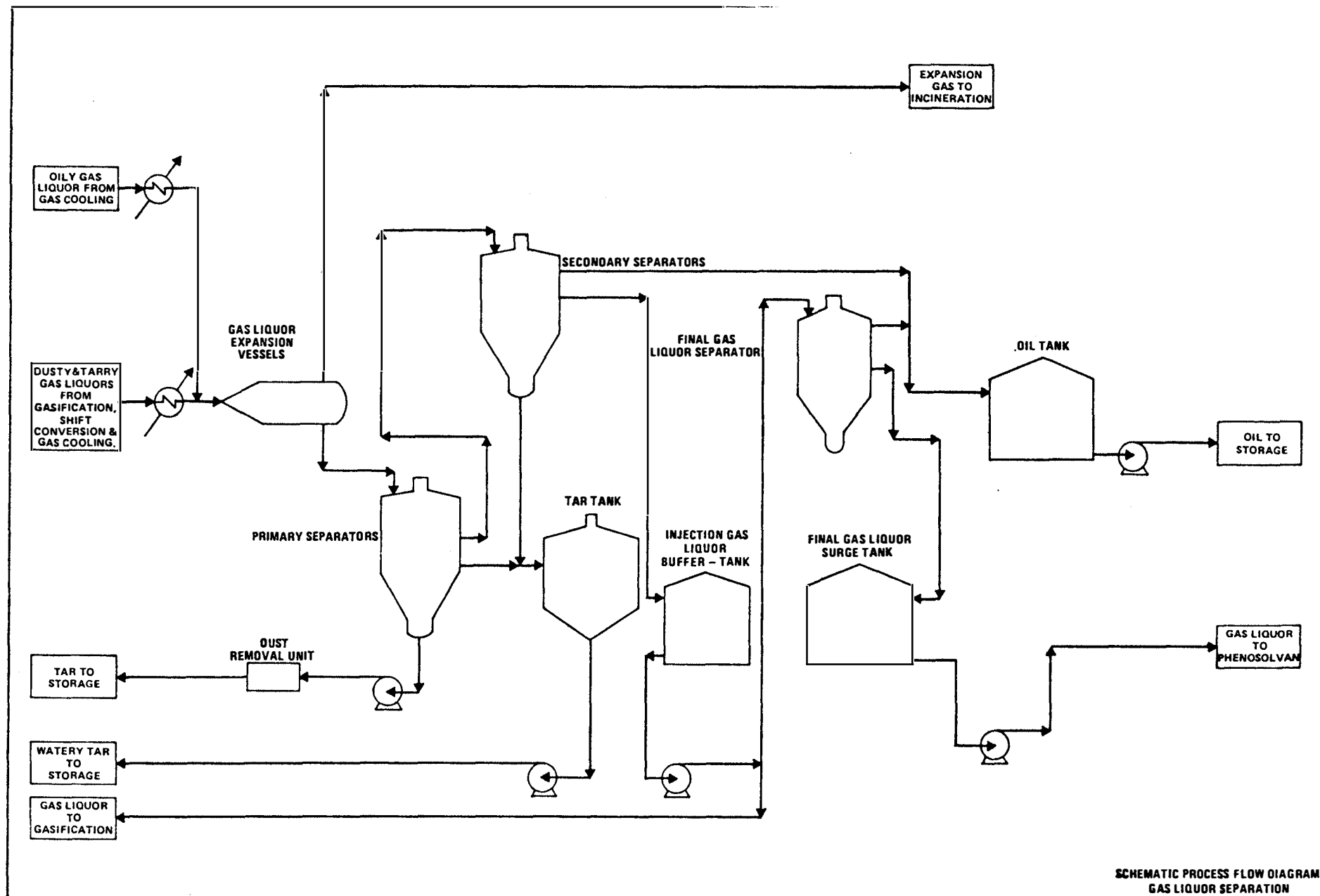
As	arsenic
B	boron
Ba	barium
Be	beryllium
Br	bromine
C	carbon
Ca	calcium
Cl	chlorine
CO	carbon monoxide
COS	carbonyl sulfide
CO ₂	carbon dioxide
CH ₄	methane
C ₂ H ₈	ethane
F	fluorine
HC	hydrocarbons
HCN	hydrogen cyanide
Hg	mercury
H ₂ S	hydrogen sulfide
Mn	manganese
Na	sodium
NO _x	oxides of nitrogen
NO ₂	nitrogen dioxide
NH ₃	ammonia
Pb	lead
SO ₂	sulfur dioxide
SO ₄	sulfate
Zn	zinc

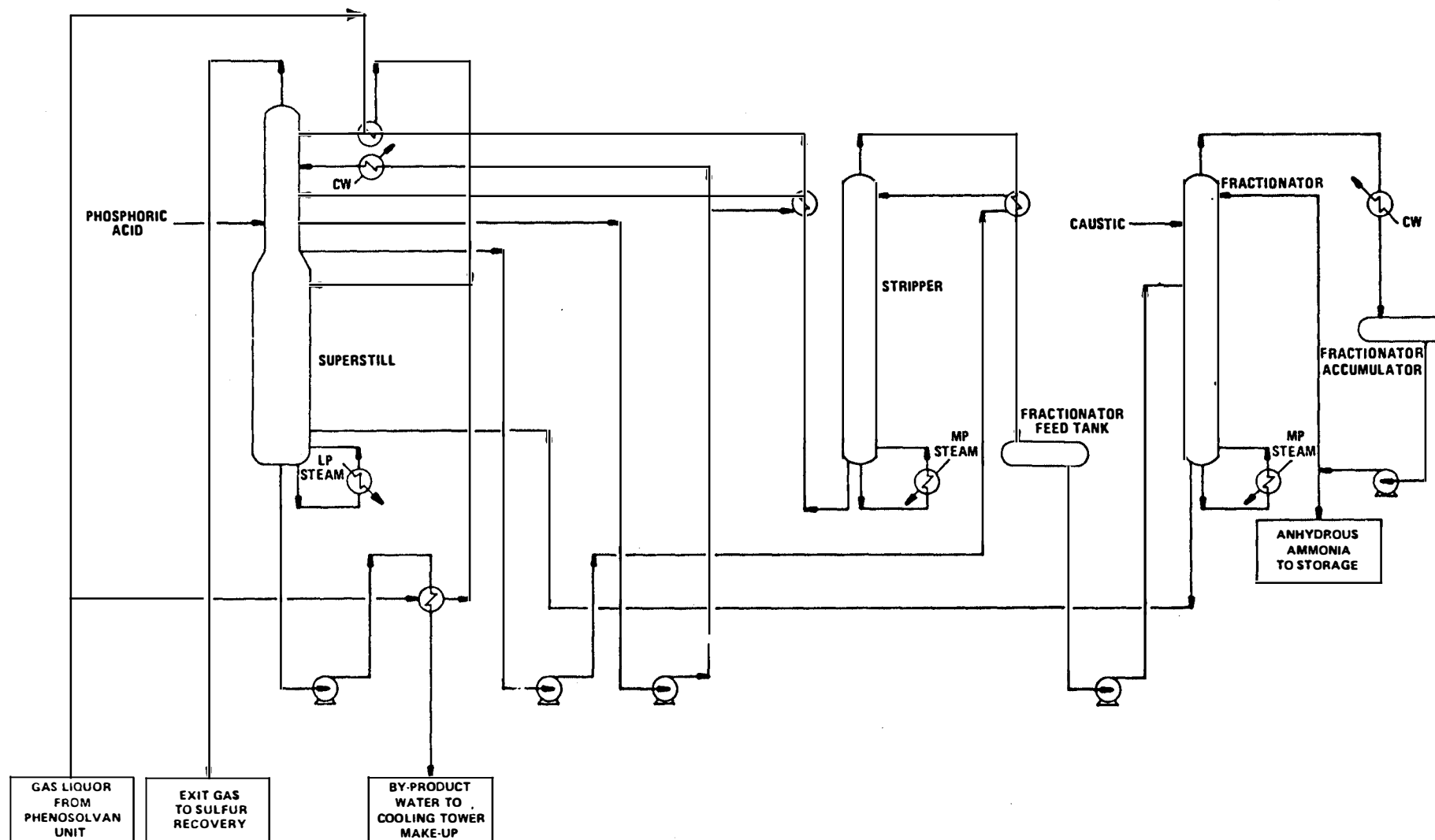
Appendix B

Flow Diagrams for Rectisol, Gas Liquor Separation,
and Ammonia Recovery
Gasification Material Balance
Trace Element Mass Balance
Plant Energy Balance
Pollutant Emissions and Abatement
Sulfur Disposition Diagram
North Dakota Health Department Letter



**SCHEMATIC PROCESS FLOW DIAGRAM
RECTISOL UNIT**





SCHEMATIC PROCESS FLOW DIAGRAM
AMMONIA RECOVERY

GASIFICATION MATERIAL BALANCE¹

<u>Input</u>	<u>From</u>	<u>To</u>	<u>lbs/hr.</u>
Coal	Coal Handling	Lurgi Gasifiers	2,236,780
Steam + BFW	Steam Generation	Lurgi Gasifiers	2,363,775
Oxygen	Air Separation Plant	Lurgi Gasifiers	452,685
Water	Steam Condensate	Rectisol	62,170
	Return		
Total			5,115,410
 <u>Output</u>			
Ash	Lurgi Gasifiers	Ash Handling	146,940
Tar	Gas Liquor Separation	Plant Fuel	70,120
Tar Oil	Gas Liquor Separation	Plant Fuel	11,815
Crude Phenol	Phenosolvan	Plant Fuel	13,550
Naphtha	Rectisol	Plant Fuel	11,340
Ammonia	Ammonia Recovery	Sales	17,800
Dephenolized	Phenosolvan	Cooling Tower	2,199,945
Water			
Off-Gas	Rectisol	Stretford Sulfur	1,819,710
		Recovery	
 <u>Output</u>			
Tail Gas	Ammonia Recovery	Stretford Sulfur	47,555
		Recovery	
Condensate	Methanation	Steam Generation	297,475
Expansion Gas	Gas Liquor Separation	L.P. Flare	5,700
Product SNG	Product Gas	Sales	473,460
	Compression		
Total			5,115,410

¹Plant Operating at above rate for 7972 HRS/YR.

TRACE ELEMENT MASS BALANCE

ELEMENT	COAL			ASH			GAS LIQUOR			TAR			OIL			% BAL- ANCE
	ppm <u>2/</u>	g/t <u>1/</u> coal	ppm	mg/t coal	% distr	ppm	mg/t coal	% distr	ppm	mg/t coal	% distr	ppm	mg/t coal	% distr		
Lithium	20	13.1	60	4.35	33	0.02	0.02	0.2	5	0.18	1.4	0.5	0.004	-		35
Beryllium	2.0	1.3	5	0.36	28	0.008	0.008	0.6	0.1	0.003	0.2	0.05	0.0004	-		29
Boron	300	197	>1500	109	55	3	3.0	1.5	20	0.73	0.4	30	0.24	0.1		57
Fluorine	24	15.8	230	16.7	106	0.5	0.5	3.2	12	0.44	2.8	0.06	0.0005	-		112
Vanadium	10	6.6	70	5.1	77	0.003	0.003	-	0.05	0.002	-	0.15	0.001	-		77
Chromium	6	3.9	40	2.9	74	<0.03	0.03	0.8	1	0.04	0.9	0.6	0.005	0.1		76
Cobalt	2	1.3	10	0.73	56	<0.03	0.03	2	0.05	0.002	0.2	0.02	0.0002	-		59
Nickel	3	2.0	25	1.8	91	<0.2	0.2	10	10	0.37	18	1.5	0.01	0.6		120
Copper	5	3.3	50	3.6	109	0.3	0.3	9	0.1	0.004	-	2	0.01	0.3		118
Zinc	0.6	0.4	0.5	0.04	10	0.4	0.4	100	6	0.2	50	0.4	0.003	0.8		161
Arsenic	30	19.7	60	4.3	22	3	3	15	2	0.07	0.4	1.7	0.01	-		39
Selenium	1	0.66	1.5	0.11	16	2	2	303	0.2	0.007	1	<0.01	-	-		320
Molybdenum	0.5	0.33	4	0.29	88	<0.2	0.2	61	0.02	0.0007	0.2	0.02	0.0001	-		149
Silver	0.1	0.066	0.7	0.05	77	<0.2	0.2	303	<0.2	0.007	11	<1	0.008	12		403
Cadmium	<0.1	0.066	<1	0.07	106	<0.03	0.03	45	<0.1	0.004	5	<0.1	-	-		156
Tin	4	2.63	12	0.87	33	<0.03	0.03	1	0.2	0.007	0.3	<0.05	-	-		34
Antimony	0.1	0.066	1	0.07	110	<0.03	0.03	45	<0.05	0.002	3	<0.02	-	-		158
Barium	2500	1642	1.2%	870	53	-	-	-	15	0.55	-	0.5	0.004	-		53
Mercury	0.05	0.033	<0.1	0.007	22	<0.03	0.03	91	<0.1	0.003	11	<0.1	0.0008	2.4		126
Lead	20	13.1	200	14.5	111	0.2	0.2	1.5	1.5	0.055	0.4	0.15	0.001	-		113
Thorium	1	0.66	6	0.43	66	-	-	-	2	0.07	11	<1	0.008	1		78
Uranium	1	0.66	6	0.43	66	<0.2	0.2	30	5	0.18	28	<1	0.008	1		125

1/ Grams/metric ton (wet)2/ Parts per million (dry)

Energy Balance (MM Btu/D)

Gasification Efficiency (based on HHV)

<u>Input</u>	
Coal to Gasifier	(27,272)(2,000)(7,230) = 394,400
<u>Output</u>	
SNG	(275) (997) = 268,700
Tar, Oils, Naphtha	41,900
Phenols	4,500
Ammonia	4,200
Stretford Off Gas	<u>14,500</u>
Total	338,800
Efficiency	$\frac{338,800}{394,400} 100 = 84.6\%$

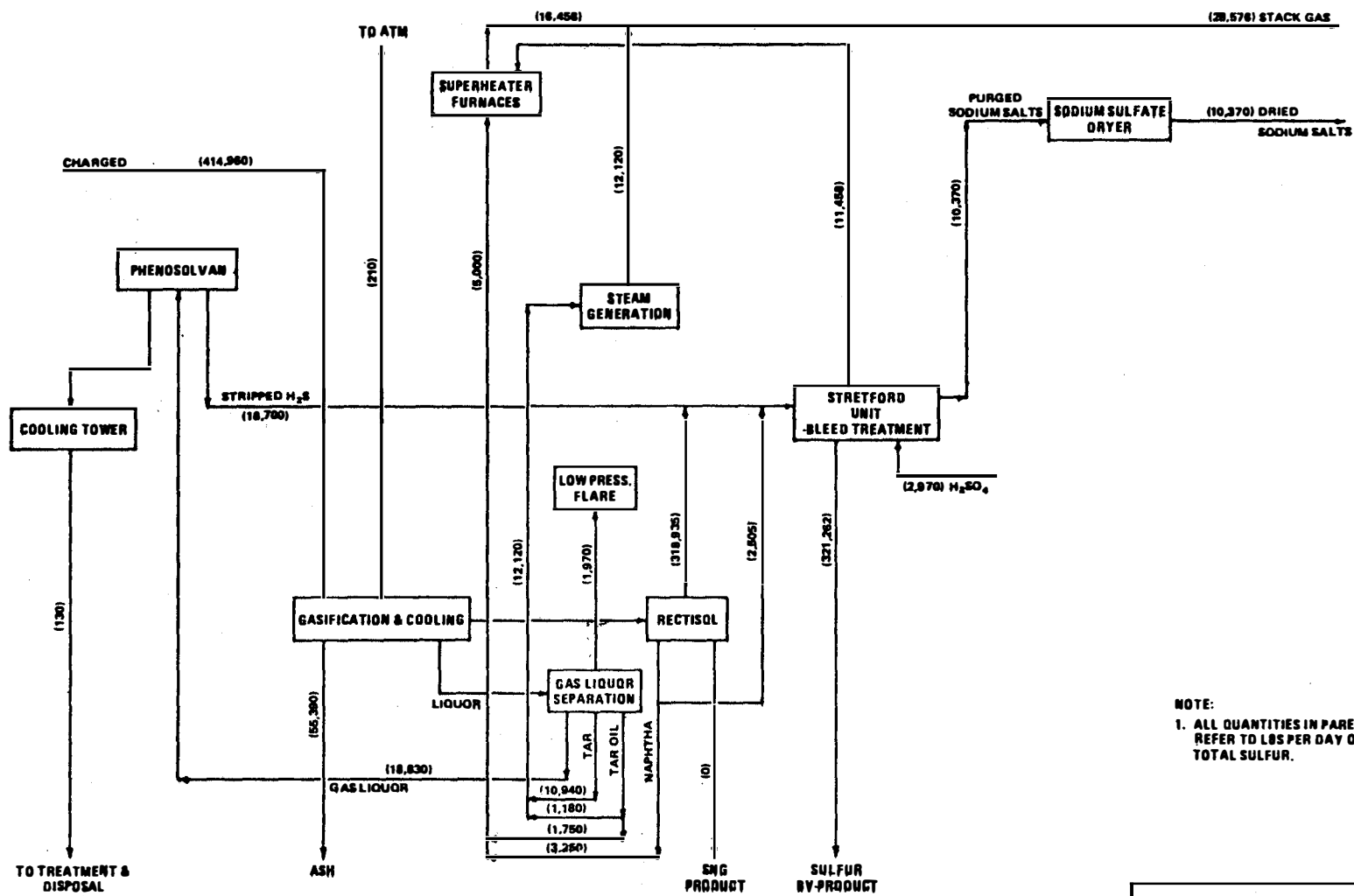
Overall Efficiency

<u>Input</u>	
Coal to Gasifier	394,400
Electric Power - Plant (3.25 MM KWH/D)	11,100
Electric Power - Mine (0.16 MM KWH/D)	600
Vehicles (7 x 10 ⁶ gallons/yr @ 150 M Btu/gal)	<u>2,900</u>
Total	409,000
<u>Output</u>	
SNG	268,700
Ammonia	<u>4,200</u>
Total	272,900
Efficiency	$\frac{272,900}{409,000} 100 = 66.7\%$

POLLUTANT EMISSIONS AND ABATEMENT (lbs/hr)

Item	Pollution Control	SO ₂ (7)	NO _x	Non-Methane Hydro-Carbons	Particulates	COS	CO	H ₂ S	% Removal Efficiency
Coal Lock Ejector	Low Energy Scrubber	-	-	-	Trace	0.5	380	11.5	N.D. (4)
Ash Lock Fan	Low Energy Scrubber	-	-	-	Trace	-	-	-	N.D.
Start-up Incinerator (1)									
(Intermittent)	None	1,150	-	-	-	-	-	-	-
Flare (2) (Intermittent)	None	18,090	-	-	-	-	-	-	-
Steam Boilers	Hot. El. Stat. Prec.	1,010	780	60	130	-	110	-	80%
Steam Superheater	None	1,595	320	30	40	-	250	-	-
Stretford Plant (6)	Incineration	-	-	-	-	-	-	-	99% (5)
Shift Catalyst									
Regeneration (3)									
(Intermittent)	None	2,750	-	-	-	-	-	-	-
Gas Liquor Vent Gas (2)	Low Pressure Flare	219	-	-	-	-	-	-	-
Coal Handling:									
Primary Crusher Stn.	Baghouse	-	-	-	9.4	-	-	-	N.D.
Sec. Crusher Station	Baghouse	-	-	-	13.4	-	-	-	N.D.
Belt Conveyor Transfer & Sampling Station	Baghouse	-	-	-	10.6	-	-	-	N.D.
Fine Screening & Crus. Station	Baghouse	-	-	-	11.7	-	-	-	N.D.
Belt Conveyor Transfer Station	Baghouse	-	-	-	2.7	-	-	-	N.D.
Fines Storage Silo & Belt Conveyor Transfer Station	Baghouse	-	-	-	1.5	-	-	-	N.D.
Gasifier Building	Baghouse	-	-	-	28.5	-	-	-	-
Belt Conveyor Transfer & Sampling Station	Baghouse	-	-	-	13.4	-	-	-	-
Live Storage Reclaim Tunnel Ventilation	None	-	-	-	2.3	-	-	-	-
Ash Handling:									
Ash Dewatering Vent	None	-	-	-	-	-	-	-	-
Ash Dewatering Clarifier	None	-	-	-	-	-	-	-	-
Refuse Incineration	Scrubber	-	-	-	N.D.	-	-	-	N.D.

- (1) Maximum case, start-up of 5 gasifiers 3 on air, 2 on oxygen.
 (2) Maximum case during upset conditions.
 (3) During Catalyst Regeneration Only, maximum case, 1.5% of total operating time.
 (4) Not determined.
 (5) H₂S Removal Efficiency.
 (6) The Stretford off gases are incinerated in the superheater and account for approximately 1200 lb/hr of the SO₂ emissions from the superheater.
 (7) Based on 1.7 wt. % sulfur in DAF coal.



NOTE:

1. ALL QUANTITIES IN PARENTHESES
REFER TO LBS PER DAY OF CONTAINED
TOTAL SULFUR.

ANG COAL GASIFICATION COMPANY
NORTH DAKOTA COAL GASIFICATION PROJECT

SULFUR BALANCE
13 WT. % SULFUR IN DAF COAL

Environmental Control
Division of
Environmental Engineering
MISSOURI OFFICE BUILDING
1200 MISSOURI AVENUE
BISMARCK, NORTH DAKOTA
58505

GENE A. CHRISTIANSON, P.E.
DIRECTOR
(701) 224-2348

North Dakota State



JONATHAN B. WEISBUCH, M.D.
STATE HEALTH OFFICER

W. VAN HEUVELEN, CHIEF
ENVIRONMENTAL CONTROL

Department of Health

April 13, 1977

Mr. Gary N. Weinreich
Environmental Coordinator
Synthetic Fuels
American Natural Gas Service Company
One Woodward Avenue
Detroit, Michigan 48226

Re: December 17, 1976 Request for Interpretation of
Applicability of Regulation R23-25-12, New Source
Performance Standards, for Proposed Coal
Gasification Plant

Dear Mr. Weinreich:

This Department has reviewed your December 17, 1976 request for interpretation of the applicability of Regulation R23-25-12, New Source Performance Standards, as it pertains to sulfur dioxide and nitrogen oxides emissions from the steam boilers and steam superheaters of your proposed coal gasification plant.

Two interpretations are requested in your December 17, 1976 letter. The first interpretation requests that the sulfur dioxide (SO₂) resulting from the incineration of Stretford unit off-gas in the steam superheaters be exempt from the 0.8 pounds SO₂ per million BTU heat input emission standard of Section 12.401 (4)(a)(i) of Regulation R23-25-12 for liquid fossil fuel-fired steam generators and that only the sulfur dioxide resulting from the burning of the liquid fuels be subject to the standard.

The second interpretation requests that the steam boilers and steam superheaters be exempt from the nitrogen oxides (NO_x) emission standards of Section 12.401 (5)(a) of Regulation R23-25-12 for fossil fuel-fired steam generators burning gaseous, liquid or solid fossil fuels either individually or simultaneous in any combination.

With respect to the sulfur dioxide (SO₂) emission standard of Section 12.401 (4)(a)(i) of Regulation R23-25-12, the Department has determined that the Stretford unit off-gas burned in the steam superheaters would not be subject to the 0.8 pound per million BTU heat input standard. This is because the off-gas is a waste byproduct not produced for the purpose of generating useful heat. Therefore the off-gas is not a fossil fuel as defined in Section 12.401 (2)(b) of Regulation R23-25-12.

April 13, 1977

The monitoring of the total sulfur content and quantity of the off-gas stream before it is incinerated in the steam superheaters will be required so that compliance with the 0.8 lbs SO₂/10⁶ BTU heat input standard for the burning of the liquid fuel can be adequately determined as required by Section 12.401 (6)(b) of Regulation R23-25-12. This requirement will be included as condition to a permit to construct, upon issuance.

The emissions of sulfur dioxide from a coal gasification plant are regulated by Regulation R23-25-15, Prevention of Significant Deterioration of Air Quality. This regulation requires that best available control technology be applied to control sulfur dioxide emissions not subject to a New Source Performance Standard as is the case for the Stretford unit off-gas.

The Department would require the submission of a detailed discussion, with supporting evidence, of why you feel that your present design of a Stretford unit plus incineration is the best available control technology for controlling SO₂ emissions from the gasification portion of the plant. Upon review and approval of the information submitted, the Department will specify an SO₂ emission limit for the Stretford off-gas as per Section 15.102 (2)(b)(ii) of Regulation R23-25-15. This limit will be included as condition of a permit to construct, upon issuance.

With respect to the nitrogen oxides (NO_x) emission standards of Section 12.401 (5)(a) of Regulation R23-25-12, the Department has determined that the steam boilers and the steam superheaters should be exempt from these standards. The Stretford unit off-gas, to be burned in the steam superheaters, would not be subject to the NO_x standards as it is a waste byproduct not produced for the purpose of generating useful heat. Therefore it is not a fossil fuel as defined in Section 12.401 (2)(b) of Regulation R23-25-12. The liquid fuels (tars, tar oils, naphtha and phenols) to be burned in the steam boilers and steam superheaters are byproduct fuels derived from the lignite gasification process. The best available control technology required to meet the 0.3 pound NO_x per million BTU heat input emission standard for liquid fuels of Section 12.401 (5)(a)(ii) consists of well designed low NO_x emission burners, which reduce the peak flame temperature, and remove oxygen from the volatilization zone. Because the liquid fuels contain a high nitrogen and oxygen content, the application of this control technology would result in 0.557 pound NO_x per million BTU heat input compared to the 0.3 pound NO_x per million BTU heat input allowed. Laboratory attempts to reduce the nitrogen and oxygen content of the liquid fuels prior to burning have been unsuccessful. It is the policy that a fuel should be subject to a New Source Performance Standard if, and only if, there is evidence that the general type of control equipment on which the standard was based can be used to meet the standard for the fuel in question, or that the standard was intended to preclude use of such fuel. Since the NO_x standard for liquid fuels

Mr. Gary N. Weinreich

-3-

April 13, 1977

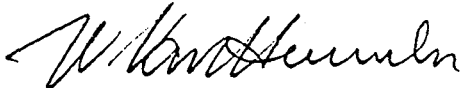
was based on control techniques which will not reduce NO_x emissions for these byproduct liquid fuels and since there is no evidence that indicates that these fuels should be precluded from use; it would appear appropriate that the steam boilers and steam superheaters be exempted from meeting the NO_x emission limits specified in Section 12.401 (5) (a) of Regulation R23-25-12.

The Department would require the submission of a detailed discussion with supporting evidence that the best available control technology has been employed in the design of the steam boilers and steam superheaters for NO_x control and that the emission rate of 0.557 pounds NO_x per million BTU heat input for liquid fuels burned in the steam boilers and the emission rate of 0.24 pounds NO_x per million BTU heat input for the liquid fuels and the Stretford off-gas burned in combination in the steam superheaters are the lowest emission rates for NO_x control achievable with present best available control technology. Upon review and approval of the information submitted, the Department will specify NO_x emission limits and NO_x monitoring requirements for the steam boilers and steam superheaters. These limits will be included as conditions to a permit to construct, upon issuance.

The information requested above should be submitted as soon as possible so the appropriate emission limit conditions for SO₂ and NO_x can be drafted and the processing of your permit to construct will not be delayed.

If you have any questions concerning this letter, please feel free to contact this office.

Yours truly,



W. Van Heuvelen, Chief
Environmental Control

WVH/DKM:lrr

cc: John Dale, EPA

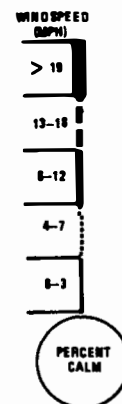
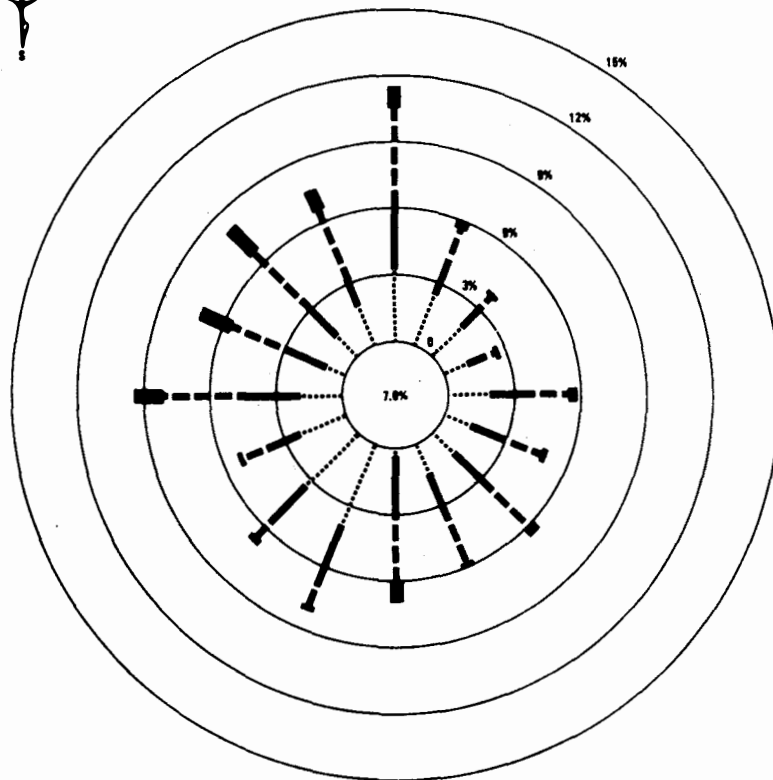
Appendix C
Environmental Studies

ENVIRONMENTAL STUDIES OF PROPOSED PLANT AND ASSOCIATED SYSTEMS

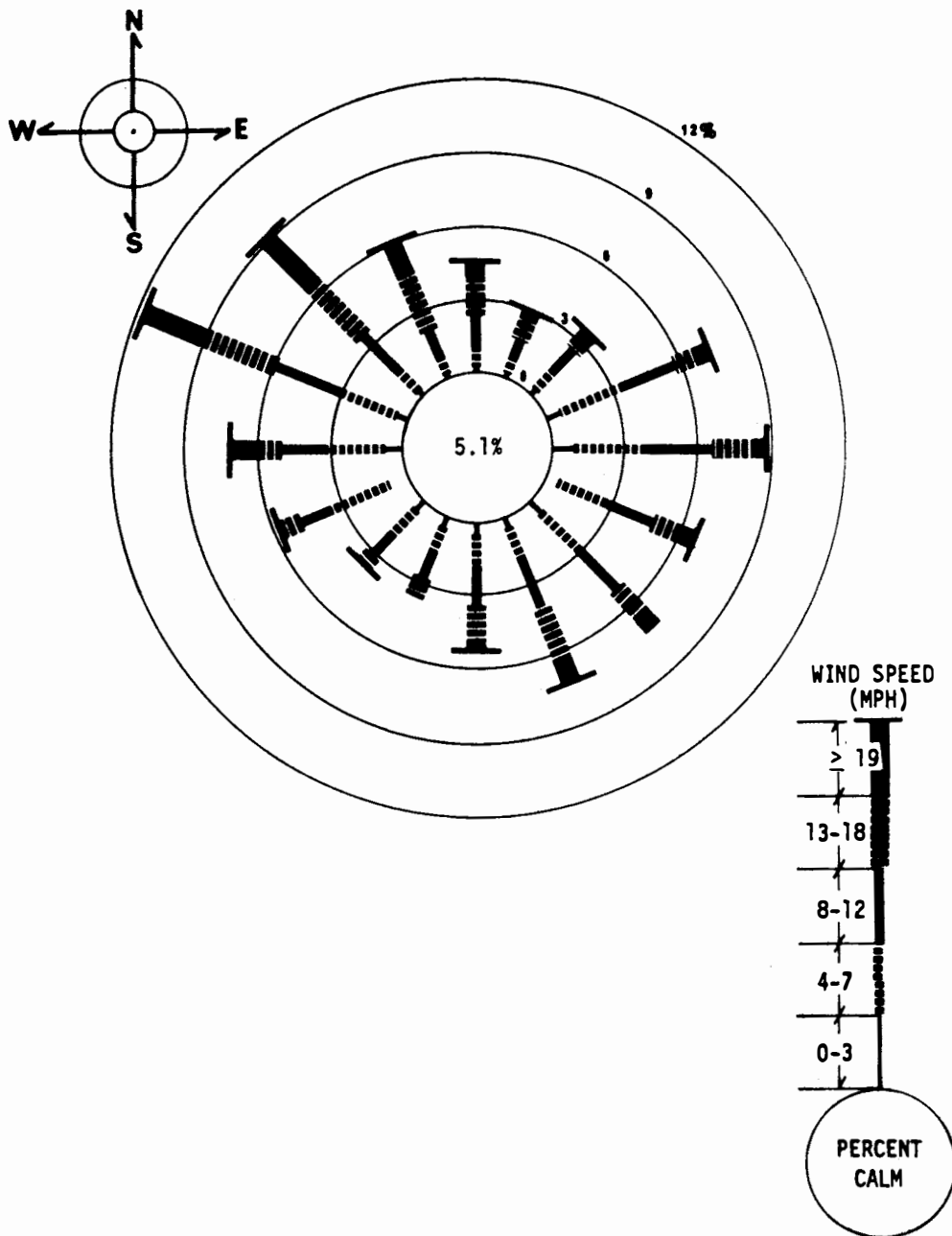
Title of Study	Organization	Frequency of Study	Reporting Schedule	Completion Date
Environmental Geologic Investigation	Woodward-Thorfinnson & Assoc.	Once	Final Report	July 1974
Environmental Soil Survey	Woodward-Thorfinnson & Assoc.	Once	Final Report	August 1974
Archaeological/Historical Assessment	Woolworth Research Assoc.	Once	Final Report	August 1974
Detailed Environmental Analysis of Gasification Plant and Mining Sites	Woodward-Clyde Consultants	Once	Final Report	March 1975
Detailed Environmental Analysis of Product Pipeline Route	Ecology and Environment, Inc.	Once	Final Report	March 1975
Environmental Impact Narrative for Water Intake and Pipeline	Environmental Engineering	Once	Final Report	April 1975
Environmental Impact Analysis of Railroad Spur	ANG	Once	Final Report	May 1976
Noise and Odor Monitoring	ANG	Continuing	Annual	Duration of plant and mining
Air and Water Quality Monitoring	ANG	Continuing	Annual	Duration of plant and mining
Biotic Community Monitoring	ANG	Continuing	Annual	Duration of reclamation

Appendix D

Annual Wind Roses for Williston and Bismarck
North Dakota Air Quality Data
Plant Site SO₂, Sulfation, Suspended Particulates, and Dustfall Data



D-1



ANNUAL PERCENTAGE FREQUENCY OF WIND SPEED AND DIRECTION,
BISMARCK, NORTH DAKOTA, 1955 THROUGH 1964

**SUMMARY OF AIR QUALITY MEASUREMENTS FROM BISMARCK, MANDAN,
AND DICKINSON, NORTH DAKOTA, 1970-1974**

	<u>Suspended Particulates</u>		<u>Suspended Sulfates</u>		<u>Reactive Sulfur (Sulfation)</u>		<u>Dustfall</u>		<u>Coefficient of Haze</u>
	Annual Geometric Mean ($\mu\text{g}/\text{m}^3$)	Maximum 24-hour Sample ($\mu\text{g}/\text{m}^3$)	Annual Average ($\mu\text{g}/\text{m}^3$)	Maximum 24-hour Sample ($\mu\text{g}/\text{m}^3$)	Annual Average ($\text{mg}/100$ cm^3/day)	Maximum 1-Month Sample ($\text{mg}/100$ cm^3/day)	Annual Average (tons/ mi^2)	Maximum 3-Month Sample (tons/ mi^2)	Annual Geometric Mean (coh/1000 ft)
Bismarck									
1970	68	136	2.80	8.30	0.16	-	8.1	11.8	NA ²
1971	55	147	3.92	7.70	0.09	0.16	4.8	7.7	0.21
1972	59	406	3.63	10.43	0.12	0.25	5.7	8.3	0.18
1973	53	158	4.30	10.46	0.10	0.22	4.6	11.9	0.06
1974 ¹	- ³	132	-	6.17	-	0.22	-	14.0	-
Mandan									
1970	42	83	3.20	5.40	<.1	<.1	NA	NA	NA
1971	52	100	3.99	8.12	0.09	0.26	NA	NA	NA
1972	42	112	3.48	12.00	0.12	0.26	NA	NA	NA
1973	41	116	3.56	7.60	0.10	0.16	NA	NA	NA
1974 ¹	-	98	-	3.72	-	0.23	+	+	+
Dickinson									
1970	46	126	1.70	6.20	NA	NA	NA	NA	NA
1971	41	98	2.08	3.90	0.05	0.10	NA	NA	NA
1972	42	105	2.60	5.51	0.05	0.09	NA	NA	NA
1973	49	149	3.66	24.28	0.07	0.17	NA	NA	NA
1974	-	156	-	2.45	-	0.11	+	+	+

¹ 1974 Data indicates data through June 1974

² No measurements available

³ Not yet available

Source: Woodward-Envicon, Inc. 1974.

**MEASURED SO₂ CONCENTRATIONS, PERCENT FREQUENCY OF OCCURRENCE,
16 JUNE, 1974 THROUGH 14 AUGUST, 1974**

PPM	24 Hour Average		1 Hour Average	
	No. Obs.	% Occurrence	No. Obs.	% Occurrence
.000 - .005	6	11.1%	204	15.7%
.006 - .010	6	11.1	189	14.6
.011 - .015	5	9.3	180	13.9
.016 - .020	7	13.0	136	10.5
.021 - .025	7	13.0	96	7.4
.026 - .030	7	13.0	103	7.9
.031 - .035	5	9.3	103	7.9
.036 - .040	3	5.6	57	4.4
.041 - .045	4	7.4	47	3.6
.046 - .050	3	5.6	53	4.1
.051 - .055			27	2.1
.056 - .060			24	1.9
.061 - .065	1	1.9	18	1.4
.066 - .070	54		11	0.9
.071 - .075	Max. = .063 ppm		19	1.5
.076 - .080			9	0.7
.081 - .085			5	0.4
.086 - .090			5	0.4
.091 - .095			7	0.5
.096 - .100			2	0.2
.101 - .105			1	0.1
			1296	

Source: Woodward-Envicon, Inc., 1974.

**SULFATION DATA FROM PASSIVE DEVICES - 1974 (REACTIVE SULFUR)
MILLIGRAMS/100 CM²/DAY**

STATION		GENERAL PLANT AREA NETWORK PERIOD							
Elev. (Ft.)	No.	2/23/74 3/14/74 (Mar)	3/14/74 4/13/74 (Apr)	4/13/74 5/15/74 (May)	4/23/74 5/23/74 (May)	5/15/74 6/13/74 (Jun)	5/23/74 6/24/74 (Jun)	6/24/74 7/24/74 (Jul)	Arith- metic Avg.
1 (10)							<.13	<.13	<.13
2 (10)							<.13	<.13	<.13
3 (10)		<.20	<.14	<.13	+	<.14	Δ	<.13	<.15
4 (10)							+	<.13	<.13
5 (10)							<.13	<.13	<.13
6 (10)							<.13	<.13	<.13
7 (10)							<.13	<.13	<.13
8 (10)							<.13	<.13	<.13
9 (10)							<.13	<.13	<.13
10 (100)			<.14	<.13	+	<.14	+	<.13	<.13

STATION NAME		NORTH DAKOTA STATE NETWORK PERIOD						
		(Mar) 1974	(Apr) 1974	(May) 1974	(May) 1974	(Jun) 1974	(Jun) 1974	(Jul)* 1974
Bismarck		0.22	0.16	0.14	0.14	0.12	0.12	
Dickinson		0.11	0.10	0.05	0.05	N.D.	N.O.	
Williston		0.08	0.18	0.06	0.06	0.02	0.02	

+ = Data invalid
 - = Station not yet activated
 Δ = Different sample period
 N.D. = No Data
 * = Data not available

Compiled by: Woodward-Envicon, Inc. 1974.

RESULTS OF ANALYSIS OF HI-VOL SAMPLES FOR SUSPENDED PARTICULATES, METEOROLOGICAL TEST SITE AND NORTH DAKOTA STATE AIR QUALITY NETWORK

Location Period Element	Meteorological Test Site			Arithmetic Averages ($\mu\text{g}/\text{m}^3$) North Dakota State Air Quality Network											
	June & July 1974			June & July 1972			June & July 1973			June 1974					
	Max.	Min.	Avg.	Fox.	Dic.	Bis.	Fox.	Dic.	Bis.	Fox.	Dic.	Bis.	Dev.		
Sulfates ($\mu\text{g}/\text{m}^3$)	4.90	0.49	3.19	2.06	1.73	4.02	4.41	1.97	2.77	0.61	1.10	1.43	1.44		
Nitrates ($\mu\text{g}/\text{m}^3$)	0.44	0.33	0.39	0.94	1.01	1.53	2.28	0.94	2.13	0.39	0.48	0.74	1.59		
Fluorides ($\mu\text{g}/\text{m}^3$)	.022	.003	.009	.009	.003	.015	.034	-	-	0.01	0.01	0.02	0.03		
pH	9.6	9.2	9.4	9.38	9.38	9.38	8.59	8.64	8.87	7.00	7.11	7.22	7.78		
Trace Metals ($\mu\text{g}/\text{m}^3$)															
(Mercury)			<0.0003												
(Arsenic)			<0.0042												
(Molybdenum)			<0.017												
(Selenium)			<0.083												
(Lead)			<0.041												
(Antimony)			<0.025												
(Beryllium)			<0.0015												
(Cadmium)			0.0												
(Vanadium)			<0.003												
(Manganese)			0.060												
(Chromium)			0.003												
(Copper)			0.114												
(Nickel)			0.011												
(Zinc)			0.049												
(Iron)			1.50												
(Barium)			0.0												
(Boron)			0.0												
Radionuclides (pci/m^3)															
Alpha			0.002 $\pm$ 0.001												
Beta			0.319 $\pm$ 0.022												
				0.25	.203	.271	0.09	.039	.046	0.41	0.32	0.37	0.35		

Legend: Fox (Foxholm, North Dakota)
Dic (Dickinson, North Dakota)
Bis (Bismarck, North Dakota)
- No values during period

Source: Woodward-Environ, Inc., 1974.

RESULTS OF DUSTFALL ANALYSIS CONCENTRATIONS (TONS/MI²/MONTH)

Station		General Plant Network Periods									
	Elev. (Feet)	2/23/74 3/14/74	3/14/74 4/13/74	4/13/74 5/15/75	4/23/74 5/23/74	5/15/74 6/13/74	5/23/74 6/24/74	6/13/74 7/15/74	6/24/74 7/24/74	Arithmetic Mean	
No.	ACU	(Mar)	(Apr)	(May)	(May)	(Jun)	(Jun)	(Jul)	(Jul)		
1	(10)	-	-	-	2.918	Δ	4.659	Δ	6.432	4.67	
2	(10)	-	-	-	1.473	Δ	5.162	Δ	18.589	8.41	
3	(10)	0.533	2.024	1.412	Δ	3.201	Δ	4.328	Δ	2.30	
4	(10)	-	-	-	2.401	Δ	5.744	Δ	34.136	14.43	
5	(10)	-	-	-	3.372	Δ	3.340	Δ	4.140	3.62	
6	(10)	-	-	-	14.370	Δ	13.319	Δ	12.705	13.47	
7	(10)	-	-	-	2.495	Δ	6.447	Δ	6.527	5.16	
8	(10)	-	-	-	3.937	Δ	3.888	Δ	8.691	5.51	
9	(10)	-	-	-	2.932	Δ	3.452	Δ	12.956	6.45	
10	(100)	-	1.914	1.741	Δ	2.196	Δ	2.541	Δ	2.10	

Station		North Dakota State Network Periods							Arithmetic Mean
Name		(Mar)	(Apr)	(May)	(May)	(Jun)	(Jun)	(Jul)	
Bismarck 1974		4.7	14.7	Δ	12.2	Δ	7.7	Δ	N.D.
Bismarck 1973		11.9	5.5	Δ	3.0	Δ	1.2	Δ	7.2
Bismarck 1972		3.6	10.6	Δ	6.3	Δ	8.0	Δ	7.08

- = Station not yet activated.
 Δ = Different sample period.
N.D. = No data

Source: Woodward-Environ, Inc. 1974.
North Dakota Department of Health.

Appendix E

Water Inventory and Quality Data

GROUNDWATER AND SPRING INVENTORY DATA

Well No.	Elevation (ft. MSL)	Owner	Use	Depth (ft)	Diam (in)	Casing Depth (ft)	Pump-type	Aquifer	Water Bearing Material	Location
G01	1855	NDSWC		229.82	-	-	-	OW	SG	146/88/21DDO
G02	1890T	A. Cristman	S	35.75	18	-	R	SB	L	146/88/22CBB1
G03	1774T	F. Hoffman	D	940R	2	-	N	MC-L?	-	144/86/9DCB
G04	2060T	WNAI	T	129.9	2	-	N	SB	L	145/87/18AAA
G05	1735	NDSWC	U	224	1	-	N	OW	C	144/86/19ABA
G06	1775	NDSWC	U	156	1	-	N	OW	C	144/88/23CCC3
G07	1770	NDSWC	U	103.6	1	-	N	OW	S	144/88/368BC2
G08	1790	NDSWC	U	85.45	1	-	N	OW	GS	144/88/31NCC
G09	2015	WNAI	T	103.0	2	97.5R	N	SB	L	145/87/30ADB
G10	1925T	Eisenbeie	D&S	155	4	115R	W,R	OW	G	145/88/3ACC
G11	1830T	B. Dechaak	D	56.5	4	-	E	AL or OW	-	144/89/14DC3
G12	1875T	E. Beick	D&S	24.5	48	-	P	SB	L	144/89/24MCC
G13	2080	WNAI	T	23.8	2	-	N	AL	S	145/87/2E-1/A
G14	2010	WNAI	T	87.7	2	85.2	N	SB	L	145/87/11DDO
G15	1079	WNAI	T	113.2	2	110.7	N	SB	L	146/87/22E 1/A
G16	2100	WNAI	T	160.7	2	158.2	N	SB	L	146/87/27ctr
G17	1910	NDSWC	U	198.8	1	210R	N	OW	S	145/88/25ABB
G18	2060T	WNAI	T	188.4	-	185.9	N	SB-TR	L	146/87/28ADD
G19	1900T	H. Boeckel	S	23.6	24	-	W,P	OW?	C	145/87/30CCA
G20	2185T	WNAI	T	212.8	2	215.3	N	SB-TR	L	145/86/6CBB
G21	2040T	WNAI	T	206.2	2	203.7	N	SB-TR	L	145/87/19BNC
G22	1862	NDSWC	U	16.82	1	44	N	OW?	S	145/87/32DC
G23	2070	WNAI	T	135.3	2	132.8	N	SB	C,L	146/87/21S-1/A
G24	1990	WNAI	T	43.7	2	41.2	N	SB	L	145/87/28ABA
G25	2030	WNAI	T	114.8	2	112.3	N	SB	L	145/87/19CCB
G26	2030	WNAI	T	53.2	2	50.7	N	SB	CS	145/87/19CBB
G28	1760	NDSWC	U	230	1	-	N	OW	S	144/87/14AAA
G29	1820	Knoll	U	15.8	-	-	-	AL? OW?	-	144/87/3A
G30	1748T	Weigum	-	-	-	-	-	OW?	-	144/86/18ABA
G34	1741	NDSWC	U	62.5	1	-	N	AL	S	144/86/18ADC2
G38	1740T	NDSWC	U	164.2	1	-	N	OW	GS	144/86/18DAB
G45	1736	NDSWC	U	203.5	1	-	N	OW	GS	144/86/18DDCA
G46	1795T	-	-	27	-	-	-	OW	-	143/88/4DCD
G57	1930T	T. Toeske	S	33.5	24	-	R	SB	L	145/87/28CDD
G58	1763T	E. Oster	U	18.3	36	-	N	AL	-	144/87/14AA1
G60	1840	NDSWC	U	225.4	1	-	N	OW	S	144/88/17BCD
G61	1950T	D. Boeckel	-	40R	24	-	W,P	SB?	-	145/87/30ABB
G65	1950T	C. Boeckel	D	45	6	-	E	SB	-	145/88/23DDB2
G75	2063T	E. Boeckel	D&S	1370R	4- 400'	-	R	MC-PH	-	145/87/6CBB3
G77	2020T	H. Hafner	D	320R	4	-	R	SB-TR	L	146/87/17DDO2
G78	1915	H. Hafner	D	1205R	2	-	F	MC-PH	S	146/87/8DDO2
G79	1940T	H. Hafner	S	1299R	2	-	F	MC-PH	S	146/87/10DBC
G81	1995T	E. Richter	D&S	72.3	4	-	E	SB	L	145/86/11CDO
G89	1820T	F. Ost	D	147R	4	-	E	TR?	L	144/88/26AA1
G91	1930T	W. Kahn	S	68.5	24	-	P	SB	L	145/86/35CC1
G92	1730T	L. Sailer	S	41.50	4	-	E	OW	-	144/86/8DDO1
G93	1732	F. Hoffman	S	730R	2	-	N	MC-L	S	144/86/17AD
G96	1790T	B. Schwarz	D	28	24	-	R	OW or AL	S	144/87/25ADC2
G98	2100E	Schlender	S	52.85	6	-	R	SB	-	145/89/22BB2
FO1	1889	B. Sailer	D&S	-	-	-	-	SB?	L	146/88/28DAC
FO2	1860T	J. Sailer	S	-	-	-	-	-	-	145/87/33DC1
FO3	1980T	E. Keller	S	-	-	-	-	-	-	145/88/12CDC4
FO4	2140T	R. Knecht	S	-	-	-	-	-	-	146/86/31DDA
FO5	2100E	Mittel- Steadt	S	6.16	48	-	N	-	-	145/89/31BNC
180	1870T	Weidner	D&S	210R	6	-	R	SB	-	146/87/18CCA
187	2100E	H. Buechler	S	48.65	18	-	R	SB?	C	145/89/22ABB2
188	2100E	Schlender	U	28.33	36	-	R	SB?	-	145/89/22BB
199	1890T	A. Christman	D	36	6	-	E	SB	-	146/88/22CBB2

KEY TO ABBREVIATIONS

Elevation - T - from Topographic map
 E - estimated
 Owner NDSWC - North Dakota State Water Commission
 - North Dakota Geology Survey

Use D - domestic
 S - stock
 T - test
 U - unused

Depth, Casing Depth
 R - reported

Pump Type - E - electric
 F - flow valve
 P - Pitcher
 R - red jacket
 W - windmill

M.P. - measuring point
 B - at or above basement floor
 L&D - land surface datum

Aquifer AL - alluvium
 OW - outwash
 SB - Sentinel Butte
 TR - Tongue River
 L - Cannonball-Ludlow
 MC - Hell Creek
 PH - Fox Hills
 P - perched

Water Bearing Material
 C - clay
 CS - clayey sand
 GS - gravelly sand
 SG - sandy gravel
 L - lignite
 G - gravel
 S - sand

Location 145/ - Township North
 /87/ - Range West
 /10ACB - Section, 4, 4 of 4, 4 of 4 of 4
 A - northeast
 B - northwest
 C - southwest
 D - southeast

Source: North Dakota Geological Survey, Bulletin 56, Part II, 1970.
 Woodward-Emvicon, Inc. Analysis, 1974.

RENNER BAY,

WATER QUALITY DATA.

28 JUNE, 1974 THROUGH 26 SEPTEMBER, 1974 1/

Parameter	Date	Location					Mean ± Deviation without LOS
		LO1	LO2	LO3	LO4	LO5	
Biochemical Oxygen Demand, mg/l	6/28	0.7	0.5	0.8	0.5	0.7	0.6 ± 0.2
	7/22	0.5	0.4	0.3	0.4	0.8	0.4 ± 0.1
	8/23	0.3	0.2	0.4	0.4	0.9	0.3 ± 0.1
	9/26	0.4	0.3	0.6	0.5	0.5	0.5 ± 0.1
Chemical Oxygen Demand, mg/l	6/28	11.0	11.0	8.6	7.4	8.2	9.5 ± 1.8
	7/22	10.6	11.0	15.0	11.0	15.0	11.9 ± 2.1
	8/23	6.1	8.8	8.6	8.3	10.4	8.0 ± 1.3
	9/26	8.6	9.3	14.4	11.9	11.9	11.1 ± 2.6
Total Hardness, mg/l (as CaCO ₃)	6/28	236	236	237	235	240	236 ± 1
	7/22	212	213	214	214	216	213 ± 1
	8/23	208	208	208	208	219	208 ± 0
	9/26	204	204	204	204	206	204 ± 0
Sulfate, mg/l	6/28	128	112	123	117	115	120 ± 7
	7/22	132	125	123	130	124	127 ± 6
	8/23	115	116	117	120	121	117 ± 2
	9/26	167	166	166	163	169	166 ± 2
Chloride, mg/l	6/28	9.5	9.3	9.5	9.7	9.5	9.5 ± 0.2
	7/22	10.4	10.4	10.4	10.4	10.4	10.4 ± 0
	8/23	9.9	9.9	10.2	9.9	10.0	10.0 ± 0.2
	9/26	9.4	9.4	9.4	9.4	9.4	9.4 ± 0
Total Solids, mg/l	6/28	438	440	438	474	482	448 ± 18
	7/22	470	518	476	476	478	485 ± 22
	8/23	430	428	430	478	492	441 ± 28
	9/26	444	446	476	442	468	452 ± 16
Total Dissolved Solids, mg/l	6/28	436	439	436	473	474	452 ± 20
	7/22	458	514	472	468	475	478 ± 25
	8/23	428	422	428	476	414	419 ± 25
	9/26	442	444	474	440	466	450 ± 16
Total Volatile Solids, mg/l	6/28	104	108	106	100	112	105 ± 9
	7/22	90	162	216	132	138	155 ± 32
	8/23	218	184	200	238	110	210 ± 23
	9/26	76	94	90	96	110	89 ± 9
Total Alkalinity, mg/l (as CaCO ₃)	6/28	164	168	164	160	168	164 ± 3
	7/22	165	166	167	164	170	166 ± 1
	8/23	164	164	164	164	174	164 ± 0
	9/26	166	164	165	168	168	166 ± 2
Apparent Color Pt-Co units	6/28	7	6	9	9	9	8 ± 2
	7/22	7	8	8	7	7	8 ± 1
	8/23	9	7	8	9	10	8 ± 1
	9/26	9	9	9	9	9	9 ± 0
Turbidity, FTU	6/28	0.7	0.7	0.9	0.7	0.2	0.8 ± 1
	7/22	2.5	2.0	1.9	2.1	1.6	2.1 ± 0.3
	8/23	2.3	2.6	2.4	2.2	1.5	2.4 ± 0.2
	9/26	1.8	1.6	1.4	1.3	2.4	1.5 ± 0.2
Ammonia, mg/l	6/28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02 ± 0.01
	7/22	<0.01	<0.01	0.03	0.01	0.01	0.04 ± 0.01
	8/23	0.03	0.06	0.04	0.04	0.05	0.04 ± 0.01
	9/26	0.03	0.03	0.02	0.02	0.03	0.03 ± 0.01
Organic Nitrogen, mg/l	6/28	0.16	0.10	0.16	0.14	0.16	0.14 ± 0.03
	7/22	0.16	0.24	0.16	0.15	0.27	0.18 ± 0.04
	8/23	0.11	0.10	0.07	0.08	0.10	0.09 ± 0.02
	9/26	0.29	0.30	0.25	0.28	0.24	0.28 ± 0.02
Nitrate, mg/l	6/28	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	7/22	0.01	0.01	0.01	0.01	0.01	0.01
	8/23	0.01	<0.01	0.01	<0.01	0.01	<0.01
	9/26	0.03	0.04	0.04	0.04	0.04	0.04 ± 0.01
Nitrite, mg/l	6/28	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	7/22	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	8/23	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	9/26	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Phosphate, mg/l	6/28	0.01	0.01	0.01	0.01	0.01	0.01
	7/22	0.08	0.04	0.06	0.07	0.09	0.06 ± 0.02
	8/23	0.02	0.02	0.01	0.02	0.05	0.01 ± 0.01
	9/26	0.02	0.02	0.02	0.02	0.02	0.02
Ortho Phosphate, mg/l	6/28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	7/22	0.01	<0.01	0.01	<0.01	0.01	<0.01
	8/23	0.01	0.01	0.01	0.01	0.04	0.01
	9/26	0.01	0.01	<0.01	0.01	0.01	<0.01
Temperature, °C	6/28	18	17	18	18	9	17.8 ± 0.5
	7/22	23	23	23	23	10	23 ± 0
	8/23	18	18	19	18	11	18.3 ± 0.5
	9/26	15	16	16	15	16	15.5 ± 0.6
Dissolved Oxygen, mg/l	6/28	9.2	8.9	8.7	9.1	9.2	9.0 ± 0.2
	7/22	7.5	8.0	8.1	7.9	7.9	7.9 ± 0.2
	8/23	8.9	8.9	8.9	8.9	9.1	8.9 ± 0
	9/26	8.6	8.6	8.4	8.6	7.8	8.4 ± 0.3
Conductivity, umhos/cm	6/28	730	710	710	710	680	715 ± 10
	7/22	690	690	680	700	690	690 ± 8
	8/23	680	680	670	690	690	680 ± 8
	9/26	650	650	740	650	650	673 ± 45
pH, standard units	6/28	8.7	8.5	8.6	8.1	-	8.5 ± 0.3
	7/22	8.5	8.4	8.3	8.4	7.0	8.4 ± 0.1
	8/23	8.9	8.8	8.8	8.0	-	8.6 ± 0.4
	9/26	-	7.9	7.8	-	-	7.9 ± 0.1

Aluminum, mg/l	7/22	0.10	0.060	0.072	0.072	0.080	0.076 $\pm$ 0.017
Arsenic, mg/l	7/22	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium, mg/l	7/22	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium, mg/l	7/22	55	59	53	98	52	66 $\pm$ 20
Chromium, mg/l	7/22	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper, mg/l	7/22	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, mg/l	7/22	0.043	0.029	0.033	0.033	0.083	0.035 $\pm$ 0.006
Lead, mg/l	7/22	0.02	0.02	0.02	0.024	0.02	0.021 $\pm$ 0.002
Manganese, mg/l	7/22	<0.005	<0.005	<0.005	<0.005	<0.006	<0.005
Magnesium, mg/l	7/22	20	20	20	22	66	21 $\pm$ 1
Potassium, mg/l	7/22	4.1	4.2	4.3	4.5	4.3	4.2 $\pm$ 0.2
Sodium, mg/l	7/22	56	60	60	65	69	60 $\pm$ 4
Zinc, mg/l	7/22	0.22	0.027	0.027	0.015	0.040	0.072 $\pm$ 0.099
Mercury, mg/l	7/22	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Barium mg/l	7/22	0.50	0.50	0.80	0.50	0.50	0.6 $\pm$ 0.13
Molybdenum mg/l	7/22	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron, mg/l	7/22	-	-	-	0.11	0.11	-
Fluoride, mg/l	7/22	-	-	-	0.46	0.42	-
Phenol, mg/l	7/22	-	-	-	1.8	0.8	-

Source: Woodward-Clifton, Inc., 1974.

- 1/ Sampling locations were established on Renner Bay during the Spring of 1974. L01 and L02 were located south and west of the proposed water intake, respectively. L03 was located in the mouth of Renner Bay, and L04 (surface) and L05 (bottom) were in the vicinity of the proposed intake.

**LAKE SAKAKAWEA, - WATER QUALITY
HISTORICAL SUMMARY, OCTOBER 1972 THROUGH JULY 1974**

Parameter	N	Mean	Deviation	Maximum	Minimum	Begin	End
Temperature, °C	18	6.8	4.2	13	2.5	10/72	6/74
Discharge, cfs - monthly	20	13780	6164	36500	16900	10/72	6/74
Color Pt-Co units	18	7	4	20	4	10/72	6/74
Conductivity, umhos/cm	20	658	30	722	610	10/72	6/74
BOD, mg/l	2	1.0	0.3	1.2	1.8	7/74	7/74
pH	20	8.1	0.2	8.4	7.7	10/72	6/74
Carbon Dioxide, mg/l	21	2.6	1.7	5.6	1.0	10/72	6/74
Total Alkalinity (as CaCO ₃ , mg/l)	21	146	24	159	146	10/72	6/74
Bicarbonate, mg/l (HCO ₃) ₃	21	182	7	198	174	10/72	6/74
Carbonate (CO ₃) mg/l	21	0.6	2	8	0	10/72	6/74
Total Nitrogen - N, mg/l	2	0.58	.32	.80	.35	4/74	6/74
Organic Nitrogen - N, mg/l	2	.42	.31	.64	.20	4/74	6/74
Ammonia Nitrogen - N, mg/l	2	.05	.035	.02	.07	4/74	6/74
Total Kjeldahl Nitrogen - N, mg/l	2	0.47	.35	.71	.22	4/74	6/74
Total Nitrate + Nitrate, mg/l	2	0.11	.03	.13	.09	4/74	6/74
Dissolved Nitrate + Nitrate, mg/l	18	.16	.07	.39	.08	10/72	6/74
Total Phosphorus as P, mg/l	2	.05	.05	.08	.01	4/74	6/74
Dissolved Phosphorus as P, mg/l	18	.02	.01	.03	0.0	4/74	6/74
Cyanide (CN), mg/l	3	0.0	0.0	0	0	4/74	6/74
Total Hardness (as CaCO ₃ , mg/l)	21	202	17	230	190	10/72	6/74
Dissolved Calcium, mg/l	21	49	4	55	36	10/72	6/74
Dissolved Magnesium, mg/l	20	20	1	22	16	10/72	6/74
Dissolved Sodium, mg/l	21	59	5	66	54	10/72	6/74
Sodium Absorp. Ratio	21	1.8	0.1	1.9	1.6	10/72	6/74
Percent Sodium	21	38	2	41	36	10/72	6/74
Dissolved Potassium, mg/l	21	4.3	0.9	4.5	3.8	10/72	6/74
Dissolved Chloride, mg/l	18	9.2	1.1	11.0	7.8	10/72	6/74
Dissolved Sulfate, mg/l	18	170	16	190	120	10/72	6/74
Dissolved Fluoride, mg/l	18	0.5	0.2	1.1	0.4	10/72	6/74
Total Fluoride, mg/l	1	0.8	-	-	-	4/74	4/71
Dissolved Silica, mg/l	18	7.3	0.4	7.9	6.2	10/72	6/74
Dissolved Arsenic, µg/l	18	2	2	5	0	10/72	6/74
Dissolved Barium, µg/l	4	0	0	0	0	4/73	4/74
Dissolved Beryllium, µg/l	4	0	0	0	0	4/73	4/74
Dissolved Boron, µg/l	18	118	25	170	40	10/72	6/74
Total Boron, µg/l	1	330	-	-	-	4/74	4/74
Dissolved Cadmium, µg/l	18	1	1	2	0	10/72	6/74
Dissolved Chromium, µg/l	4	2.5	5	10	0	4/73	6/74
Dissolved Cobalt, µg/l	4	1	1	2	0	4/73	6/74
Dissolved Copper, µg/l	4	5	3	7	2	4/73	6/74
Dissolved Iron, µg/l	4	20	12	30	9	4/73	6/74
Dissolved Lead, µg/l	4	2	2	4	0	4/73	6/74
Total Lead, µg/l	1	100	-	-	-	4/74	4/74
Dissolved Manganese, µg/l	4	23	30	67	0	4/73	6/74
Dissolved Molybdenum, µg/l	4	2	1	3	1	4/73	6/74
Dissolved Nickel, µg/l	4	3	3	6	0	4/73	6/74
Dissolved Silver, µg/l	4	0	-	-	-	4/73	6/74
Dissolved Strontium, µg/l	4	510	74	560	400	4/73	6/74
Dissolved Vanadium, µg/l	4	.2	0.1	.3	0	4/73	6/74
Dissolved Zinc, µg/l	4	33	33	80	10	4/73	6/74
Total Zinc, µg/l	1	430	-	-	-	4/74	-
Total Aluminum, µg/l	1	300	-	-	-	4/74	-
Dissolved Aluminum, µg/l	4	5	6	10	0	4/74	6/74
Dissolved Lithium, µg/l	4	50	11	60	40	4/74	6/74
Dissolved Selenium, µg/l	4	4	4	4	0	4/74	6/74
Suspended Solids, mg/l	2	2	0	2	-	4/74	6/74
Dissolved Solids, mg/l	20	432	23	448	400	10/72	6/74

Source: U.S. Environmental Protection Agency, STORET System, 1974.

**KNIFE RIVER AT HAZEN, WATER QUALITY HISTORICAL SUMMARY,
SEPTEMBER 1969 THROUGH MARCH 1974**

Parameter	N	Mean	Deviation	Maximum	Minimum	Begin	End
Temperature, °C	39	8.61	8.30	25.00	0.00	10/69	9/73
Flow, cfs	43	464.7	1150.8	5930	13	9/69	9/73
Conductivity, µmhos	42	1403	485	2150	300	9/69	9/73
pH	28	7.89	.26	8.30	7.00	9/69	6/73
Total Alkalinity, mg/l as CaCO ₃	28	402	136	621	89	9/69	6/73
NO ₃ -N, dissolved, mg/l	16	.33	.30	1.29	0.00	10/70	6/73
Ortho-PO ₄ , mg/l	8	.03	.05	.14	.00	6/71	6/73
Total Hardness, mg/l as CaCO ₃	28	320	101	530	81	9/69	6/73
Ca, dissolved, mg/l	28	69.0	21.9	130	22	9/69	6/73
Mg, dissolved, mg/l	28	35.80	13.13	67.0	6.3	9/69	6/73
Na, dissolved, mg/l	28	228.5	79.6	330	32	9/69	6/73
% Sodium	28	59.18	5.60	72.00	43.00	9/69	6/73
K, dissolved, mg/l	28	6.93	1.23	8.90	1.60	9/69	6/73
Chloride, mg/l	28	3.75	2.71	9.10	.00	9/69	6/73
Sulfate, mg/l	28	404	131	640	68	9/69	6/73
Fluoride (f), dissolved, mg/l	28	.43	.25	.90	.00	9/69	6/73
Silica, dissolved, mg/l	28	11.23	3.6	18	4.8	9/69	6/73
Boron, dissolved, mg/l	28	.263	.303	1.300	0.00	9/69	6/73
Iron, dissolved, mg/l	16	.186	.235	.740	.00	10/70	6/73
Manganese, dissolved, mg/l	16	.0219	16.0	.060	10	10/70	6/73
Dissolved solids, mg/l	28	1002	314	1550	219	9/69	6/73
NO ₃ , total, mg/l	8	1.18	0.73	2.8	.00	11/70	9/71
NO ₃ , dissolved, mg/l	28	1.22	1.11	5.7	.00	9/69	6/73
DO, mg/l	5	9.60	1.95	11.4	6.3	10/73	3/74
BOD, mg/l	2	2.95	.78	3.5	2.4	10/73	11/73
PO ₄ - Total	5	0.08	0.09	.18	.01	10/73	3/74
Total Coliform #/100 ml	5	212	283	710	20	10/73	3/74
Fecal Coliform #/100 ml	5	26.00	16.7	50	10	10/73	3/74

Source: U. S. Environmental Protection Agency, STORET System, 1974.

**SPRING CREEK AT ZAP, WATER QUALITY HISTORICAL SUMMARY,
SEPTEMBER 1969 THROUGH MARCH 1974**

Parameter	N	Mean	Deviation	Maximum	Minimum	Begin	End
Temperature, °C	28	7.46	7.91	24.00	0.0	10/69	9/73
Flow, cfs	31	107	277	1120	4.2	9/69	9/73
Conductivity, µmhos	31	1306	462	1870	180	9/69	9/73
pH	15	7.91	0.25	8.30	7.40	9/69	6/73
T-Alkalinity as CaCO ₃ , mg/l	15	374	101	509	157	9/69	6/73
NO ₃ -N, dissolved, mg/l	3	.23	-	-	-	6/72	-
Ortho PO ₄ , mg/l	3	.087	.085	.17	.00	6/72	6/73
Total Hardness as CaCO ₃ , mg/l	15	356	83	458	185	9/69	6/73
Ca, dissolved, mg/l	15	77	16.8	99	40	9/69	6/73
Mg, dissolved, mg/l	15	.40	12	56	21	9/69	6/73
Na, dissolved, mg/l	15	206	607	283	91	9/69	6/73
% Na	15	55	4	61	48	9/69	6/73
K, dissolved, mg/l	15	7.01	.55	7.90	6.00	9/69	6/73
Cl, mg/l	15	9.36	3.06	12.00	0.00	9/69	6/73
SO ₄ , mg/l	15	425	106	565	232	9/69	6/73
Fluoride, dissolved, mg/l	15	0.40	.21	.80	.10	9/69	6/73
Silica, dissolved, mg/l	15	10.88	3.86	18	6	9/69	6/73
Boron, dissolved, µg/l	15	.266	172	.560	0.00	9/69	6/73
Iron, dissolved, µg/l	3	.090	123	.230	0.00	6/72	6/73
Mn, dissolved, µg/l	3	.0433	30.55	.070	10	6/72	6/73
TDS, mg/l	15	983	246	1310	529	9/69	6/73
NO ₃ , dissolved, mg/l	15	.75	.75	2.5	.00	9/69	6/73
Fe, total, µg/l	12	847	1002	3000	0.00	9/69	8/70
DO, mg/l	5	10.16	1.11	11.3	8.4	10/73	3/74
BOD, mg/l	2	2.4	1.13	3.2	1.6	10/73	11/73
T-PO ₄ - mg/l	5	0.064	.120	.28	.01	10/73	3/74
T-Coliform #/100 ml	5	254	313	800	30	10/73	3/74
F-Coliform #/100 ml	5	28	27	70	10	10/73	3/74

Source: U. S. Environmental Protection Agency, STORET System, 1974.

**STREAM WATER QUALITY DATA, MERCER COUNTY, NORTH DAKOTA,
28 JUNE, 1974 THROUGH 26 SEPTEMBER, 1974**

Parameter	Date	Location				
		801	802	803	804	805
Total Hardness mg/l as (CaCO ₃)	6/28	392	323	348	362	380
	7/22	327	285	299	283	344
	8/23	347	284	279	268	372
	9/26	370	326	328	-	-
Total Alkalinity, mg/l (as CaCO ₃)	6/28	460	480	460	484	432
	7/22	478	528	486	454	480
	8/23	490	582	469	510	410
	9/26	510	598	524	-	-
Sulfate, mg/l	6/28	304	372	300	152	330
	7/22	284	318	251	177	287
	8/23	327	376	229	137	302
	9/26	524	444	339	-	-
Color Pt-Co, units	6/28	40	45	35	30	50
	7/22	50	50	50	55	60
	8/23	45	45	45	50	50
	9/26	40	40	40	-	-
Turbidity, FTU	6/28	37	24	21	5.5	5.6
	7/22	26	32	32	12	10
	8/23	23	26	23	17	16
	9/26	7.7	15	13	-	-
Biochemical Oxygen Demand, mg/l	6/28	3.9	3.2	3.7	3.7	3.8
	7/22	1.8	2.8	2.0	3.7	3.6
	8/23	2.7	3.5	5.6	7.3	3.2
	9/26	1.9	3.7	3.8	-	-
Chemical Oxygen Demand, mg/l	6/28	40	38	38	39	41
	7/22	40	36	37	47	47
	8/23	28	32	38	63	38
	9/26	28	33	32	-	-
Chloride, mg/l	6/28	5.3	4.5	5.5	6.5	7.0
	7/22	6.5	4.5	5.0	5.5	7.9
	8/23	7.1	4.0	5.9	6.8	7.9
	9/26	6.7	3.5	5.5	-	-
Total Solids, mg/l	6/28	1152	1290	1168	852	1116
	7/22	1150	1300	1148	882	1114
	8/23	1220	1376	986	872	1104
	9/26	1320	1298	1104	-	-
Total Dissolved Solids, mg/l	6/28	1098	1255	1127	828	1106
	7/22	1106	1242	1087	860	1089
	8/23	1134	1242	888	800	1072
	9/26	1308	1274	1080	-	-
Total Volatile Solids, mg/l	6/28	236	174	256	200	238
	7/22	222	236	246	176	226
	8/23	180	230	296	252	260
	9/26	270	166	176	-	-
Ammonia, mg/l	6/28	0.05	0.04	<0.01	<0.01	<0.01
	7/22	0.01	<0.01	<0.01	<0.01	0.02
	8/23	0.03	0.04	0.03	0.04	0.06
	9/26	0.03	0.02	0.05	-	-
Organic Nitrogen, mg/l	6/28	0.87	0.77	-	0.88	1.08
	7/22	0.98	1.01	0.78	1.60	1.44
	8/23	1.41	1.55	1.84	2.06	1.70
	9/26	0.63	1.02	0.84	-	-
Nitrate, mg/l	6/28	0.01	0.01	0.01	0.01	0.01
	7/22	0.01	0.02	0.01	0.01	0.01
	8/23	<0.01	<0.01	0.01	<0.01	<0.01
	9/26	0.02	0.02	0.01	-	-
Nitrite, mg/l	6/28	<0.01	<0.01	<0.01	<0.01	<0.01
	7/22	<0.01	<0.01	<0.01	<0.01	<0.01
	8/23	<0.01	<0.01	<0.01	<0.01	<0.01
	9/26	<0.01	<0.01	<0.01	-	-
Total Phosphate, mg/l	6/28	0.14	0.11	0.12	0.23	0.35
	7/22	0.30	0.29	0.28	0.41	0.63
	8/23	0.17	0.11	0.15	0.31	0.20
	9/26	0.05	0.09	0.09	-	-
Ortho Phosphate, mg/l	6/28	<0.01	<0.01	<0.01	0.07	0.17
	7/22	0.02	0.01	0.01	0.14	0.30
	8/23	0.03	0.02	0.02	0.07	0.11
	9/26	0.01	0.01	0.01	-	-
Temperature, °C	6/28	22	20	25	24	19
	7/22	24	23	24	24	20
	8/23	16	16	18	16	14
	9/26	15	15	17	-	-
Dissolved Oxygen, mg/l	6/28	7.5	6.9	7.0	5.4	5.6
	7/22	7.8	7.0	7.8	4.7	1.4
	8/23	7.8	7.3	10.0	6.3	6.3
	9/26	8.2	7.6	8.5	-	-
Conductivity	6/28	1750	1800	1600	1200	1600
	7/22	1600	1700	1500	1300	1600
	8/23	1800	2000	1450	1300	1650
	9/26	1800	1800	1500	-	-

(Continues)

Parameter	Date	Location				
		SO1	SO2	SO3	SO4	SO5
pH, su.	6/28	8.4	8.5	8.3	8.2	8.6
	7/22	8.2	8.1	8.1	8.2	7.7
	8/23	8.9	8.8	8.9	9.1	8.4
	9/26	8.5	8.2	8.1	-	-
Aluminum, mg/l	7/22	0.68	0.72	0.56	0.10	0.10
Arsenic, mg/l	7/22	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium, mg/l	7/22	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium, mg/l	7/22	79	105	64	69	50
Chromium, mg/l	7/22	0.008	<0.005	<0.005	<0.005	<0.005
Copper, mg/l	7/22	<0.01	<0.01	<0.01	<0.01	0.030
Iron, mg/l	7/22	2.8	1.1	1.3	0.28	0.73
Lead, mg/l	7/22	0.030	0.028	0.027	0.026	<0.02
Manganese, mg/l	7/22	0.25	0.21	2.2	0.65	0.22
Magnesium, mg/l	7/22	44	35	35	37	53
Potassium, mg/l	7/22	10	11	10	10	10
Sodium, mg/l	7/22	227	322	268	161	237
Zinc, mg/l	7/22	0.030	0.030	0.034	0.015	0.013
Mercury, mg/l	7/22	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Barium, mg/l	7/22	0.94	1.1	1.1	1.0	0.62
Molybdenum, mg/l	7/22	<0.01	<0.01	<0.010	<0.01	<0.01
Boron, mg/l	7/22	0.42	0.21	0.27	-	-
Fluoride, mg/l	7/22	0.46	0.38	0.38	-	-
Phenol, mg/l	7/22	2.2	2.0	2.4	-	-

Source: Woodward-Envicon, Inc. analyses, 1974.

CHEMICAL ANALYSES¹ OF SELECTED WATER SAMPLES

Parameter ²	Upper Well Creek- Lower Cannonball- Judlow Aquifer		Fox Hills-Basel Well Creek Aquifer			
	G03/940' Well/Depth	G93/730' Well/Depth	G75/1370' Well/Depth	G78/1205' Well/Depth	G79/1299' Well/Depth	Zap/1281' Well/Depth
Date	740620	740620	740621	740711	740621	740812
Temp (°C)	13.2	13.6	8.8	13.5	14.1	16.7
pH (units)	8.0	8.2	8.32	8.48	8.55	8.38
Color (units)				7		17
Turb (Jackson units)				J<25		J<25
Cond (µmhos/cm)	2350	2450	2050	2230	2180	2300
TDS	1600	1690	1465	1470	1410	1464
Hardness	14	16	10	11	10	8
MC03	1285	1287	1179	1171	1025	1231
SO ₄	1.5	1.3	1.6	10.9	4.8	<1.0
Na/SAR	545/74	565/74	530/85	500/54	498/80	590/86
Ca	2.5	2.5	2.0	5.0	2.0	2.8
Mg	0.92	1.1	0.58	0.84	0.59	0.48
K	2.5	2.3	2.2	2.0	2.0	2.0
Cl	236	274	212	185	228	250
Fe	0.23	0.45	0.63	0.36	0.18	4.5
Zn				13.6		0.065
F				4.2		5.2
B				1.8		2.3
Ba				0.94		<0.10
P	0.191	0.198	0.154	0.19	0.138	0.22
Cu				<0.01		0.010
Li				0.065		
Mn				0.01		0.087
Pb				0.05		<0.02
Mo				0.011		0.01
Ni				0.020		
As				<0.01		<0.01
CW				<0.01		
Cd				0.013		<0.005
Cr				0.010		<0.005
Se				<0.005		<0.005
Gross Alpha/Precision (pCi/l)				17/6		5.7
Gross Beta/Precision (pCi/l)				23/21		0/42

¹Field analyses.

²All values in ppm unless otherwise indicated.

Source: Woodward-Envicon, Inc., 1974.

CHEMICAL ANALYSES¹ OF SELECTED WATER SAMPLES, LIGNITE AQUIFERS

Parameter ²	G77/320' Well/Depth	G81/72.3' Well/Depth	G89/417' Well/Depth	G91/68.5' Well/Depth	NACC01 3/ Well/Depth	NACC02 3/ Well/Depth
	740701	740711	740712	740712	740719	740719
Date	740701	740711	740712	740712	740719	740719
Temp (°C)	9.6	9.2	9.2		8.26	6.52
pH (units)	8.48	7.05	7.48	7.15		40
Color (units)		14	4	85	30	3500
Turb (Jackson units)	J<25	J<25	J<25	J<25	J<25	J<25
Cond (µmhos/cm)	2600	1600	1400	6500	2400	5200
TDS	2030	1270	987	4800	1972	5051
Hardness	51	472	25	809	551	1607
MC03	1257	783	788	1115	349	244
SO ₄	412	394	182	2420	1136	3305
Na/SAR	688/46	266/5	342/30	1390/22	426/8	800/9
Ca	6.5	105	5.0	108	100	380
Mg	6.5	49	1.1	115	81	167
K	4.4	11	3.5	13	12	19
Cl	105	2.4	3.0	54	16	16
Fe	6.4	4.1	0.08	1.2	0.37	8.6
Zn		0.32	0.037	0.23	0.012	0.20
F		0.72	0.087	0.66	0.70	<0.1
B		0.51	0.61	0.83	0.63	1.1
Ba		0.46	0.46	0.40	0.61	<0.1
P	0.297	<0.1	<0.1	<0.1	<0.01	<0.01
Cu		0.088	0.017	0.013	<0.01	0.049
Li			0.054		0.044	0.20
Mn		0.44	0.27	0.039	0.037	0.32
Pb		0.061	<0.02	0.053	0.02	0.032
Mo		0.01	<0.01	0.01	<0.01	0.014
Ni		<0.01	<0.01	<0.01	0.023	0.078
As		<0.01	<0.01	<0.01	<0.01	<0.01
CW		<0.01	0.033	<0.01		
Cd		0.005	<0.005	0.009	0.006	0.009
Cr		0.010	<0.005	0.006	<0.005	<0.005
Se		<0.005	<0.005	0.082	<0.005	<0.005
Gross Alpha/Precision (pCi/l)		6.1/	8.0/		67/12	290/45
Gross Beta/Precision (pCi/l)		4.4	4.1	40/16	68/27	280/120
		6.8/		275/69	68/27	280/120
		14.2	0/13	275/69		

¹Field analyses.

²All values in ppm unless otherwise indicated.

Source: Woodward-Envicon, Inc., 1974.

3/ Taken from mine pits at Indian Head Mine.

CHEMICAL ANALYSES¹ OF SELECTED WATER SAMPLES, LIGNITE AQUIFERS

Parameter	G02/36' Well/Depth	G04/120' Well/Depth	G09/100' Well/Depth	G12/25' Well/Depth	G15/113' Well/Depth	G16/140' Well/Depth	G23/120' Well/Depth	G25/110' Well/Depth	G57/335' Well/Depth
Date	740711	740718	740706	740710	740629	740629	740629	740706	740622
Temp ² (°C)	6.9	12.1	10.9	6.7	9.9	9.2	9.0	11.2	6.3
pH ² (units)	7.72	8.45	7.28	7.05	7.79	6.98	7.88	8.77	7.37
Color (units)	11	-	12	40	-	11	12	10	-
Turb. (Jackson unit)	J<25	-	3350	J<25	-	3320	J115	J240	-
Cond ² (umhos/cm)	2850	1225	1275	3800	1000	1190	1000	650	285
TDS	2200	-	1530	5570	-	934	741	482	-
Hardness	231	-	660	1803	-	529	369	143	-
HCO ₃ ²	827	594	652	1093	637	590	564	242	110
SO ₄	1000	-	599	3010	-	256	142	123	-
Na/SAR	590/16	285	250/5	867/9	-	115/2	126/3	99/3	-
Ca	49	-	85	400	-	87	73	24	-
Mg	34	-	71	158	-	53	36	20	-
K	8.6	-	9.2	19	-	9.2	7.3	7.4	-
Cl	4.0	<36	8.8	15	<36	15	5.6	5.6	<36
Fe	0.48	-	8.9	0.88	-	10.1	7.4	10.5	-
Zn	0.27	-	13.5	2.5	-	2.2	0.48	0.42	-
F	0.16	-	0.63	0.72	-	1.4	1.4	1.0	-
B	0.92	-	0.79	1.0	-	0.71	0.55	0.45	-
Ba	0.40	-	1.3	0.7	-	1.7	1.2	1.0	-
P	<0.1	-	<0.1	<0.1	-	<0.1	0.12	0.36	-
Cu	0.027	-	0.49	0.15	-	0.63	0.75	0.39	-
Li	0.091	-	-	0.082	-	-	-	-	-
Mn	0.056	-	1.6	0.060	-	0.36	0.23	0.16	-
Pb	0.019	-	0.19	0.055	-	0.12	0.12	0.2	-
Mo	<0.1	-	<0.01	0.02	-	0.02	0.025	<0.01	-
Ni	0.018	-	-	0.041	-	-	-	-	-
As	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	-
CN	<0.01	-	0.021	<0.01	-	0.018	<0.01	0.041	-
Cd	0.007	-	0.005	0.008	-	0.025	0.017	<0.005	-
Cr	0.007	-	0.019	0.007	-	0.015	0.011	0.019	-
Se	<0.005	-	<0.005	0.005	-	<0.005	<0.005	<0.005	-
Gross Alpha/Precision (pCi/l)	52/9	-	42/8	170/20	-	22/4	4/7	23/4	-
Gross Beta/Precision (pCi/l)	64/22	-	18/15	145/40	-	13/14	24/13	14/2	-

¹Field analyses.

²All values in mg/l unless otherwise indicated.

Source: Woodward-Environ, Inc., 1974.

CHEMICAL ANALYSES¹ OF SELECTED WATER SAMPLES, OUTWASH AQUIFER

Parameter	G01/229 Well/Depth	G05/224 Well/Depth	G06/156 Well/Depth	G10/155 Well/Depth	G17/200 Well/Depth	G28/230 Well/Depth	G60/225 Well/Depth	G92/41 Well/Depth	Beulah/46	Hazen
Date	740718	740727	740710	740727	740710	740727	740618	740620	740812	740812
Temp ² (°C)	-	8.4	9.4	8.9	7.7	8.8	8.8	9.1	8.8	9.2
pH ² (units)	7.99	7.82	7.66	7.42	7.75	7.99	7.35	7.18	7.5	7.45
Color (units)	7	-	15	5	5	35	15	-	29	65
Turb. (Jackson)	J<25	-	J240	J35	J800	J<25	140	-	J<25	J<25
Cond ² (umhos/cm)	1080	310	770	1850	750	590	700	460	850	1100
TDS	673	-	808	1410	1471	375	576	-	590	746
Hardness ²	209	-	302	568	368	216	302	-	283	335
HCO ₃	793	178	691	1030	527	427	305	377	539	661
SO ₄	6.4	-	136	426	79.2	5.6	94	-	95.6	149
Na/SAR	180/5	19.8/	150/4	289/5	43/0.8	59/2	-	-	85/2	150/4
Ca	31	-	74	153	148	51	-	-	72	76
Mg	33	-	33	56	48	20	-	-	37	29
K	9.7	-	11.2	9.9	6.7	5.1	-	-	4.8	5.8
Cl	5.6	-	9.6	2.4	6.4	6.8	11	<36	5.6	13
Fe	0.63	-	15	9.3	51	1.5	-	-	0.66	7.1
Zn	1.2	-	1.6	0.097	18.5	0.055	-	-	0.24	0.045
F	1.0	-	0.80	0.87	0.84	0.76	-	-	0.30	0.45
B	0.53	-	0.41	0.77	0.40	0.66	-	-	0.19	0.1
Ba	0.46	-	1.6	0.50	2.9	<0.1	-	-	<0.1	<0.1
P	<0.01	-	0.01	<0.1	<0.01	0.09	2.23	-	0.33	0.02
Cu	<0.01	-	0.082	<0.012	0.046	<0.01	-	-	0.033	0.037
Li	-	-	-	0.061	-	-	-	-	-	-
Mn	0.059	-	0.79	0.69	2.5	0.082	-	-	0.055	0.12
Pb	0.02	-	0.045	0.035	0.047	0.031	-	-	<0.02	0.022
Mo	<0.01	-	<0.01	<0.1	0.011	<0.01	-	-	0.01	0.01
Ni	-	-	-	0.02	-	-	-	-	-	-
As	<0.01	-	0.011	0.01	0.026	<0.01	-	-	<0.01	<0.01
CN	0.18	-	<0.01	<0.01	0.037	0.046	-	-	-	-
Cd	<0.005	-	0.005	<0.005	0.006	<0.005	-	-	<0.005	0.006
Cr	<0.005	-	0.02	<0.005	0.030	<0.005	-	-	<0.005	<0.005
Se	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-	<0.005	<0.005
Gross Alpha/Precision (pCi/l)	0/1.6	-	1/2.2	26/6	1.9/2.6	0.5/1.5	-	-	0/2.6	0.7/
Gross Beta/Precision (pCi/l)	4/13	-	18/13	29/15	0/13	0/11	-	-	0/20	2.6

¹Field analyses.

²All values in mg/l unless otherwise indicated.

Source: Woodward-Environ, Inc., 1974.

CHEMICAL ANALYSES¹ OF SELECTED MISCELLANEOUS WATER SAMPLES

Parameter ²	G19/23.6 OW ³ Well/Depth Aquifer	G29/15.8 AL/OW ⁴ Well/Depth Aquifer	G30 OW Well/Depth Aquifer	G61/40 SB ⁵ Well/Depth Aquifer	G96/28 OW Well/Depth Aquifer	G98 SB Well/Depth Aquifer	G13 23.8 AL Well/Depth Aquifer	G34 62.5 AL Well/Depth Aquifer	G58 18.3 AL Well/Depth Aquifer
Date	740622	740620	740620	740622	740621	740710	740629	740727	740621
Temp (°C)	6.9	11.7	10.6	6.7	8.3	7.7	8.9	7.7	8.7
pH	7.03	7.46	7.55	7.01	7.27	7.4	7.48	7.77	7.56
Color (units)						7	4		
Turb (Jackson units)						J<25	J800		
Cond (umhos/cm)	1800	3650	1150	1150	1650	1900	590	820	600
TDS		3178	902			3280	491	496	
Hardness		1686	237			172	350	288	
CO ₃	712	618	755	553	377	586	412	605	471
SO ₄		894	156			630	83.2	39.2	
Na/SAR		239/3	241/7			393/13	26/0.6	79/2	
Ca		205	48			43	90	102	
Mg		249	22			18	32	49	
K		6.1	5.1			6.6	21	8.7	
Cl	<36	192	6.0	29	<36	8.8	2.0	16	<36
Fe		0.13	3.1			3.4	29.8	59	
Zn						0.44	2.0		
P						0.11	12.5		
B						0.53	11.5		
Ba						0.20	3.2		
P		0.054	0.011			<0.1	0.23	0.583	
Cu						0.011	2.5		
Li						0.25	0.66		
Mn						0.028	0.23		
Pb						<0.01	0.016		
Mo						<0.01	<0.01		
Ni						<0.01	<0.01		
As						<0.01	<0.01		
CM						0.005	0.64		
Cd						<0.005	0.045		
Cr						<0.005	<0.005		
Se						7.4/			
Gross Alpha/Precision (pCi/l)						3.9	53/7		
Gross Beta/Precision (pCi/l)						17/15	46/13		

¹Field analyses.

²All values in ppm unless otherwise indicated.

³Outwash.

⁴Alluvium or outwash.

⁵Sentinel Butte.

Source: Woodward-Environ, Inc., 1974.

CHEMICAL ANALYSES¹ OF SELECTED WATER SAMPLES FROM SPRINGS

Parameter ²	F01 Spring	F02 Spring	F03 Spring	F04 Spring	F05 Spring
Date	740621	740622	740702	740622	740710
Temp (°C)	8.9	8.0	8.8	8.3	9.0
pH (units)	7.35	7.05	6.67	6.05	7.77
Color (units)	11	47	45		
Turb (Jackson units)	J<25	J<25	J<25		
Cond (umhos/cm)	2250	2150	1250	950	1180
TDS	1600	1930	808	987	880
Hardness	131	350	363	834	468
CO ₃	777	821	434	179	508
SO ₄	944	795	329	494	315
Na/SAR	473/19	505/12	158/4	27/0.5	107/2
Ca	18	58	73	105	113
Mg	17	45	35	63	49
K	6.7	8.9	8.5	4.6	8.6
Cl	2.6	4.8	0.8	5.6	0.4
Fe	0.14	0.17	5.0	11	0.43
Zn	0.010	0.22	0.10		
P	0.9	0.7	0.33		
B	0.87	0.76	0.48		
Ba	0.46	0.46	0.62		
P	<0.1	<0.1	<0.1	0.047	0.029
Cu	0.01	<0.01	0.015		
Li					0.062
Mn	0.033	0.014	0.11		
Pb	0.046	0.059	0.038		
Mo	<0.01	<0.01	<0.01		
Ni					0.011
As	<0.01	<0.01	<0.01		
CM	<0.01	<0.01	<0.01		
Cd	<0.005	0.006	<0.005		
Cr	<0.005	<0.005	<0.005		
Se	<0.005	<0.005	<0.005		
Gross Alpha/Precision (pCi/l)	49/7	94/9	62/8		
Gross Beta/Precision (pCi/l)	50/21	103/16	102/14		

¹Field analyses.

²All values in ppm unless otherwise indicated.

Source: Woodward-Environ, Inc., 1974.

Appendix F
Drill Hole Core Data

**SUMMARY OF INTERVAL SAMPLE STRATA - DRILL HOLES TH-1, TH-2, TH-3,
TH-4, TH-5, TH-6, TH-7A AND TH-8**

Sample No.	Depth, ft		Description
	From	To	
<u>Drill Hole TH-1</u>			
1	1.0	9.0	Silts, sands, and clays, some concretion fragments.
2	9.0	33.0	Sands and clays, interbedded and intergraded.
3	33.0	48.0	Sands, clays, and silts, interbedded and intergraded.
4	48.0	53.0	Claystone with a hard lignite layer.
5	53.0	69.0	Claystone with some coal stringers and thin sandstone layers.
6	69.0	74.0	Claystone with lignite layers and carbonaceous stringers.
7	74.0	82.0	Sandstone and claystone, interbedded and intergraded, hard 1-ft limestone layer removed.
8	82.0	97.3	Claystone and sandstone, interbedded and intergraded.
9	97.3	98.8	Sandstone, well cemented, hard, very fine grained.
10	98.8	103.0	Sandstones, some clay, some lignite stringers.
11	103.0	108.5	Sandstone and claystone, lignite layer at top and coal layer at bottom of interval.
12	108.5	126.5	Sandstones, silty and argillaceous, some very hard and cemented.
13	126.5	137.0	Sandstone and claystone, interbedded and intergraded.
14	137.0	149.3	Claystone with thin lenticular sandstone layers.
<u>Drill Hole TH-2</u>			
15	1.5	8.0	Clay, some pebbles and concretion fragments.
16	8.0	15.0	Clay.
17	15.0	23.0	Claystone.
18	23.0	31.5	Claystone, grey, with silt, sand, and lignite.
19	31.5	48.0	Sandstone and claystone.
20	48.0	62.0	Claystone and sandstone, interbedded and intergraded, some thin hard limestone layers.
21	62.0	71.5	Claystone, some sands and layers of lignite.
<u>Drill Hole TH-3</u>			
22	5.0	28.0	Clay, with some aggregates, pebbles, sand, and silt.
23	28.0	63.0	Clay, some silt and sand.
<u>Drill Hole TH-4</u>			
24	8.0	33.0	Clay, silty, sandy, and with gravel and crystallized aggregates.
<u>Drill Hole TH-5</u>			
25	4.0	20.0	Sands and clay, some silt and gravel.
<u>Drill Hole TH-6</u>			
26	3.5	10.0	Clay, silty, sandy, with some gravel.
27	10.0	19.0	Claystone.
28	19.0	22.0	Sands and silt, very fine grained, uniform texture, loose.
<u>Drill Hole TH-7A</u>			
29	1.0	40.0	Clay and silt, some sand and gravel.
<u>Drill Hole TH-8</u>			
30	4.0	15.0	Clay, silty, with some gravel.

Source: Colorado School of Mines Research Institute, 1974.

**CHEMICAL ANALYSIS DATA - DRILL HOLES TH-1, TH-2, TH-3, TH-4, TH-6,
TH-8, TH-7A, AND TH-8**

Sample No.	Depth, ft		pH Water (1)	pH 0.01M CaCl ₂ Solution (2)	Soluble Salts Extract Conductivity millimhos/cm		Sodium Water Soluble (1)	Sodium NH ₄ Acetate Soluble milliequivalents/100 g	Cation Exchange Capacity	Exchangeable Sodium Percentage (4)
	From	To			(1)	(3)				
<u>Drill Hole TH-1</u>										
1	1.0	9.0	7.7	7.6	0.23	1.1	0.15	0.54	26.8	1.5
2	9.0	33.0	7.7	7.4	0.96	5.9	0.20	0.62	19.1	2.2
3	33.0	48.0	7.9	7.2	0.23	1.4	0.20	0.52	17.4	1.8
4	48.0	53.0	6.7	6.7	0.48	1.8	0.31	0.80	49.5	1.0
5	53.0	69.0	8.2	7.4	0.45	1.2	0.76	2.30	30.4	5.1
6	69.0	74.0	7.7	7.0	1.00	2.0	1.93	5.90	42.3	9.3
7	74.0	82.0	8.8	7.8	0.78	1.6	1.61	6.55	26.5	18.6
8	82.0	97.3	9.0	8.4	0.80	1.2	1.78	9.98	31.0	26.5
9	97.3	98.8	9.4	8.2	0.55	2.1	1.13	5.29	13.7	30.4
10	98.8	103.0	9.3	8.5	0.95	1.6	1.95	10.2	29.9	27.6
11	103.0	108.5	7.4	6.8	0.95	2.0	2.07	11.5	66.2	14.2
12	108.5	126.5	9.1	8.4	0.95	1.5	2.00	10.6	30.8	27.9
13	126.5	137.0	8.8	8.5	0.95	1.2	1.93	2.99	32.6	3.3
14	137.0	149.3	9.0	8.6	0.90	1.2	1.86	12.8	23.4	46.8
<u>Drill Hole TH-2</u>										
15	1.5	8.0	8.3	7.6	2.30	6.4	2.56	3.86	39.7	3.3
16	8.0	15.0	8.4	7.8	1.28	2.4	2.34	6.25	39.0	10.0
17	15.0	23.0	8.5	7.7	0.55	1.1	1.04	3.45	36.5	6.6
18	23.0	31.5	6.8	6.4	1.45	2.9	2.73	5.47	69.0	4.0
19	31.5	48.0	8.8	7.7	0.75	1.2	1.43	7.81	23.9	26.7
20	48.0	62.0	9.1	8.4	0.93	1.1	1.91	13.9	32.1	37.4
21	62.0	71.5	8.4	7.6	1.20	1.6	2.63	3.47	47.7	1.7
<u>Drill Hole TH-3</u>										
22	5.0	28.0	7.8	7.6	3.00	9.7	0.89	1.00	27.8	0.4
23	28.0	63.0	7.7	7.5	1.10	3.5	0.51	1.00	31.5	1.6
<u>Drill Hole TH-4</u>										
24	8.0	33.0	7.8	7.7	4.10	12.5	3.34	3.65	30.8	1.0
<u>Drill Hole TH-5</u>										
25	4.0	20.0	7.8	7.4	3.77	13.9	1.02	1.22	22.4	0.9
<u>Drill Hole TH-6</u>										
26	3.5	10.0	7.9	7.8	2.30	6.6	1.02	1.39	34.3	1.1
27	10.0	19.0	7.5	7.4	3.80	9.9	0.89	1.22	31.0	1.1
28	19.0	22.0	5.6	5.2	1.45	6.3	0.32	0.42	8.68	1.2
<u>Drill Hole TH-7A</u>										
29	1.0	40.0	7.7	7.3	1.45	4.8	0.49	0.95	27.1	1.7
<u>Drill Hole TH-8</u>										
30	4.0	15.0	8.1	7.8	2.15	5.7	3.30	3.82	32.6	1.6

(Continues)

Sample No.	Depth, ft		Potassium Available ppm	Phosphorus NaHCO ₃ Soluble ppm	Nitrate ppm	Ammonium ppm	Organic Matter %	DTPA Extractable				Boron Water Soluble ppm
	From	To						Cu ppm	Fe ppm	Mn ppm	Zn ppm	
<u>Drill Hole TH-1</u>												
1	1.0	9.0	360	0.6	4.0	2	5.1	7.2	108	36.6	3.8	1.1
2	9.0	33.0	265	33.0	3.3	1	4.7	5.1	94	44.8	2.6	<1.0
3	33.0	48.0	275	22.0	2.3	5	2.6	1.8	104	37.2	2.4	<1.0
4	48.0	53.0	395	3.3	3.3	12	>8.0	4.0	140	36.0	6.6	3.2
5	53.0	69.0	525	8.8	1.5	18	4.1	6.6	148	16.0	5.6	<1.0
6	69.0	74.0	640	4.4	5.3	17	>8.0	7.8	126	11.2	7.2	3.4
7	74.0	82.0	605	1.0	4.5	18	3.6	6.0	188	23.6	5.2	1.3
8	82.0	97.3	680	1.0	2.5	17	4.3	8.6	138	12.8	6.6	1.9
9	97.3	98.8	310	12.0	2.0	15	2.1	3.8	152	28.0	2.4	<1.0
10	98.8	103.0	595	4.0	2.8	21	3.0	7.2	118	8.0	5.4	<1.0
11	103.0	108.5	425	0.6	1.0	15	>8.0	4.4	152	28.8	4.8	5.0
12	108.5	126.5	540	6.0	3.8	15	2.6	4.2	126	12.0	4.4	7.8
13	126.5	137.0	180	1.8	1.8	22	3.3	8.4	146	14.0	7.6	3.6
14	137.0	149.3	740	0.6	1.3	31	3.8	4.8	162	10.0	7.6	3.8
<u>Drill Hole TH-2</u>												
15	1.5	8.0	300	14.4	<1.0	9	1.0	5.4	206	76.4	2.4	<1.0
16	8.0	15.0	575	3.0	1.8	8	2.4	4.2	138	26.4	0.8	<1.0
17	15.0	23.0	285	1.0	2.0	8	2.0	6.2	116	40.8	1.2	<1.0
18	23.0	31.5	520	1.0	2.3	21	>8.0	7.2	344	54.8	5.2	3.6
19	31.5	48.0	565	0.6	1.5	13	2.1	4.6	156	11.6	3.0	1.3
20	48.0	62.0	720	6.0	5.5	24	2.5	14.8	228	18.0	6.2	1.9
21	62.0	71.5	185	7.6	5.0	23	>8.0	10.8	174	16.0	7.0	6.2
<u>Drill Hole TH-3</u>												
22	5.0	28.0	440	1.0	2.0	11	1.5	5.2	178	98.0	1.6	<1.0
23	28.0	63.0	700	7.2	3.8	25	2.8	7.6	260	45.6	3.6	<1.0
<u>Drill Hole TH-4</u>												
24	8.0	33.0	395	10.0	5.0	12	1.8	5.0	150	48.4	1.0	<1.0
<u>Drill Hole TH-5</u>												
25	4.0	20.0	420	4.4	1.3	6	1.0	2.6	162	55.6	1.0	<1.0
<u>Drill Hole TH-6</u>												
26	3.5	10.0	300	3.0	<1.0	9	0.8	3.6	136	43.6	0.6	<1.0
27	10.0	19.0	470	0.6	25.0	9	1.4	7.6	94	24.4	0.6	<1.0
28	19.0	22.0	155	3.6	7.8	21	0.6	2.2	244	3.2	3.0	<1.0
<u>Drill Hole TH-7A</u>												
29	1.0	40.0	405	11.8	23.8	6	0.5	3.4	178	83.6	0.8	<1.0
<u>Drill Hole TH-8</u>												
30	4.0	15.0	460	6.0	17.0	4	0.5	4.2	162	55.2	1.0	<1.0

(Continues)

Sample No.	Depth, ft		Selenium Available ppm	Arsenic Total ppm	Cadmium Total ppm	Fluoride Total ppm	Lead Total ppm	Mercury Total ppm	Molybdenum Total ppm	Nickel Total ppm	Radioactivity (5)
	From	To									
<u>Drill Hole TH-1</u>											
1	1.0	9.0	0.04	<2	0.20	220	12	0.035	<1	26	0.33
2	9.0	33.0	0.03	<2	0.15	160	8	0.040	<1	27	0.58
3	33.0	48.0	0.02	2	0.15	150	8	0.050	1	27	0.53
4	48.0	53.0	0.02	5	0.25	240	12	0.075	8	50	0.42
5	53.0	69.0	0.03	2	0.30	350	14	0.075	1	37	0.13
6	69.0	74.0	0.02	2	0.40	330	21	0.140	1	37	0.17
7	74.0	82.0	0.03	<2	0.40	260	8	0.070	<1	34	0.52
8	82.0	97.3	0.02	2	0.45	310	16	0.100	<1	42	0.50
9	97.3	98.8	0.02	<2	0.10	130	7	0.045	<1	16	0.41
10	98.8	103.0	0.03	<2	0.35	250	11	0.080	<1	30	0.28
11	103.0	108.5	0.04	10	0.35	180	7	0.130	2	15	0.40
12	108.5	126.5	0.03	<2	0.30	100	8	0.065	<1	25	0.80
13	126.5	137.0	0.02	<2	0.50	410	16	0.100	<1	42	0.62
14	137.0	149.3	0.03	<2	0.40	310	14	0.100	<1	35	0.57
<u>Drill Hole TH-2</u>											
15	1.5	8.0	0.04	2	0.20	260	13	0.040	1	27	0.46
16	8.0	15.0	0.03	<2	0.40	230	14	0.080	<1	34	0.44
17	15.0	23.0	0.01	<2	0.45	290	17	0.085	<1	35	0.39
18	23.0	31.5	0.02	10	0.35	180	9	0.120	2	30	0.45
19	31.5	48.0	0.04	2	0.25	170	9	0.045	<1	29	0.75
20	48.0	62.0	0.03	<2	0.45	150	15	0.065	<1	35	0.62
21	62.0	71.5	0.03	5	0.50	370	17	0.120	2	35	0.62
<u>Drill Hole TH-3</u>											
22	5.0	28.0	0.03	2	0.25	250	11	0.050	2	24	0.46
23	28.0	63.0	0.03	2	0.30	320	12	0.060	1	26	0.73
<u>Drill Hole TH-4</u>											
24	8.0	33.0	0.02	2	0.35	210	13	0.050	<1	29	0.61
<u>Drill Hole TH-5</u>											
25	4.0	20.0	0.02	<2	0.25	170	10	0.050	<1	26	0.52
<u>Drill Hole TH-6</u>											
26	3.5	10.0	0.03	<2	0.30	150	11	0.060	<1	26	0.61
27	10.0	19.0	0.03	<2	0.45	280	14	0.070	<1	35	0.70
28	19.0	22.0	0.04	2	0.05	80	3	0.090	1	4	0.52
<u>Drill Hole TH-7A</u>											
29	1.0	40.0	0.03	<2	0.25	210	11	0.050	1	26	0.53
<u>Drill Hole TH-8</u>											
30	4.0	15.0	0.03	<2	0.35	290	14	0.065	1	30	0.17

1/ Sample to extract ratio: 1 to 2

2/ Sample to extract ratio: 1 to 5

3/ Estimated conductivity for a saturation extract; basis, 1 to 2 ratio conductivity and 1/3 bar water-holding capacity data

4/ Calculated from the equation: exchangeable sodium percentage = $\frac{(100)(\text{Na, ammonium acetate soluble} - \text{Na, water soluble})}{(\text{cation exchange capacity})}$

5/ Ratio of sample activity to activity of a quartz monzonite standard (Lucius-Pitkin Company) containing 6 ppm U, 22 ppm Th, and 3.2% K.

Source: Colorado School of Mines Research Institute, 1974.

Appendix G

Plant Species
Botanical Compositions of Habitat Types
Aquatic Sampling Data

**PLANT SPECIES PRESENT IN THE AREA OF THE PROPOSED COAL
GASIFICATION FACILITY SITE IN MERCER COUNTY, NORTH DAKOTA**

Common Name	Scientific Name ¹	Longevity ²	Origin ³	Life Form ⁴	Response to Grazing ⁵	Comments
Absinth	<u>Artemisia absinthium</u>	P	I	F	I	Half-shrub
Alfalfa	<u>Medicago sativa</u>	P	I	F	-	Cultivated legume
Alumroot	<u>Heuchera richardsonii</u>	P	N	F	-	---
Anemone, Canada	<u>Anemone canadensis</u>	P	N	F	-	---
Arrowgrass	<u>Triglochin maritima</u>	P	N	F	-	---
Arrowhead	<u>Sagittaria cuneata</u>	P	N	F	-	Emergent aquatic
Artichoke, Jerusalem	<u>Helianthus tuberosus</u>	P	N	F	-	---
Ash, green	<u>Fraxinus pennsylvanica</u>	-	N	W	-	Tree
Aspen, quaking	<u>Populus tremuloides</u>	-	N	W	-	Tree
Aster, aromatic	<u>Aster oblongifolius</u>	P	N	F	-	---
Aster, golden	<u>Chrysopsis villosa</u>	P	N	F	I	---
Aster, rush	<u>Aster junceiformis</u>	P	N	F	-	---
Aster, tall white	<u>Aster coeruleascens</u>	P	N	F	-	---
Aster, white prairie	<u>Aster ericoides</u>	P	N	F	-	---
Aster, white upland	<u>Aster ptarmicoides</u>	P	N	F	-	---
Barley	<u>Hordeum vulgare</u>	A	-	G	-	Crop species
Barley, wild	<u>Hordeum jubatum</u>	P	N	G	IV	Mid-grass
Bearberry	<u>Arctostaphylos uva-ursi</u>	-	N	W	-	Trailing shrub
Beardtongue, slender	<u>Penstemon gracilis</u>	P	N	F	D	---
Beardtongue, white	<u>Penstemon albidus</u>	P	N	F	D	---
Bedstraw, northern	<u>Galium boreale</u>	P	N	F	-	---
Bergamont, wild	<u>Monarda fistulosa</u>	P	N	F	D	---
Bindweed, field	<u>Convolvulus arvensis</u>	P	I	F	-	---
Bluebell	<u>Campanula rotundifolia</u>	P	N	F	-	---
Bluegrass, fowl	<u>Poa palustris</u>	P	N	G	IV	Mid-grass
Bluegrass, Kentucky	<u>Poa pratensis</u>	P	I	G	IV	Mid-grass
Bluegrass, plains	<u>Poa arida</u>	P	N	G	D	Mid-grass
Bluegrass, swollen	<u>Poa glaucifolia</u>	P	N	G	D	Mid-grass
Bluegrass, Sandberg	<u>Poa secunda</u>	P	N	G	I	Short-grass
Bluestem, big	<u>Andropogon gerardi</u>	P	N	G	D	Tall-grass
Bluestem, little	<u>Andropogon scoparius</u>	P	N	G	D	Mid-grass
Boneset, false	<u>Kuhnia eupatorioides</u>	P	N	F	-	---
Box-elder	<u>Acer negundo</u>	-	N	W	-	Tree
Breadroot, indian	<u>Pasoralea esculenta</u>	P	N	F	D	Legume
Brome, smooth	<u>Bromis inermis</u>	P	I	G	IV	Hay grass
Broomweed	<u>Gutierrezia sarothrae</u>	P	N	F	I	Half-shrub
Buckwheat, wild	<u>Polygonum convolvulus</u>	A	N	F	IV	---
Buffaloberry	<u>Shepherdia argentea</u>	-	N	W	-	High shrub
Buffalograss	<u>Buchloe dactyloides</u>	P	N	G	I	Short-grass
Bulrush, hardstem	<u>Scirpus acutus</u>	P	N	S	D	Emergent aquatic
Bulrush, prairie	<u>Scirpus paludosus</u>	P	N	S	D	---
Bulrush, river	<u>Scirpus fluviatilis</u>	P	N	S	D	Emergent aquatic
Bulrush, softstem	<u>Scirpus validus</u>	P	N	S	D	Emergent aquatic
Burningbush	<u>Kochia scoparia</u>	A	N	F	IV	---
Burreed	<u>Spergularia eurycarpum</u>	P	N	-	-	Emergent aquatic
Buttercup, marsh	<u>Ranunculus septentrionalis</u>	P	N	F	-	---
Cacti	<u>Mamillaria sp. and Opuntia sp.</u>	P	N	-	I	---
Candleabra, fairy	<u>Androsace occidentalis</u>	A	N	F	-	---
Caragana	<u>Caragana arboreaescens</u>	-	I	W	-	High shrub
Carillon-flower	<u>Salix herbacea</u>	P	N	F	-	---
Catafoot	<u>Antennaria sp.</u>	P	N	F	I	---
Cattail, broad-leaved	<u>Typha latifolia</u>	P	N	-	-	Emergent aquatic
Cattail, narrow-leaved	<u>Typha angustifolia</u>	P	N	-	-	Emergent aquatic
Cedar, creeping	<u>Juniperus horizontalis</u>	-	N	W	-	Trailing shrub
Cherry, choke	<u>Prunus virginiana</u>	-	N	W	-	High shrub
Cherry, ground	<u>Physalis lanceolata</u>	P	N	F	-	---
Cherry, Mankin	<u>Prunus tomentosa</u>	-	I	W	-	Tree
Cherry, sand	<u>Prunus pumila</u>	-	N	F	-	Low shrub
Chickweed, prairie	<u>Cerastium arvense</u>	P	N	F	-	---
Cinquefoil, Pennsylvania	<u>Potentilla pennsylvanica</u>	P	N	F	-	---
Cinquefoil, rough	<u>Potentilla norvegica</u>	B	N	F	IV	---
Cinquefoil, silverweed	<u>Potentilla anserina</u>	P	N	F	I	---
Cinquefoil, tall	<u>Potentilla arguta</u>	P	N	F	-	---
Clover, owl	<u>Orthocarpus luteus</u>	A	N	F	-	---
Clover, purple prairie	<u>Fetalostemum purpureum</u>	P	N	F	D	Legume
Clover, sweet	<u>Medicago sp.</u>	B	I	F	-	Cultivated legume
Collomia	<u>Collomia linearis</u>	A	N	F	IV	---
Coneflower, long-headed	<u>Ratibida columifera</u>	P	N	F	IV	---
Coneflower, purple	<u>Brauneria angustifolia</u>	P	N	F	D	---
Cordgrass, alkali	<u>Spartina gracilis</u>	P	N	G	D	Mid-grass
Cordgrass, prairie	<u>Spartina pectinata</u>	P	N	G	D	Tall-grass
Corn	<u>Zea mays</u>	A	-	G	-	Crop species
Cottonwood	<u>Populus deltoides</u>	-	N	W	-	Tree
Crab, Siberian	<u>Malus baccata</u>	-	I	W	-	Tree
Creep, Virginia	<u>Parthenocissus inserta</u>	-	N	W	-	Vine
Currant, golden	<u>Ribes odoratum</u>	-	N	W	-	Low shrub
Currant, wild black	<u>Ribes americanum</u>	-	N	W	-	Low shrub
Dock, curled	<u>Rumex crispus</u>	P	I	F	-	---
Dock, golden	<u>Rumex pericarioides</u>	B	N	F	-	---
Dock, willow-leaved	<u>Rumex mexicanus</u>	P	N	F	I	---
Dogbane, spreading	<u>Apocynum androsaemifolium</u>	P	N	F	-	---
Dropsed, prairie	<u>Sporobolus heterolepis</u>	P	N	G	D	Mid-grass
Dropsed, sand	<u>Sporobolus cryptandrus</u>	P	N	G	I	Mid-grass
Dropsed, tall	<u>Sporobolus asper</u>	P	N	G	D	Mid-grass
Elder, marsh	<u>Ira xanthifolia</u>	A	N	F	IV	---

(continues)

Common Name	Scientific Name ¹	Longevity ²	Origin ³	Life Form ⁴	Response to Grazing ⁵	Comments
Elm, American	<u>Ulmus americana</u>	-	N	W	-	Tree
Elm, Chinese	<u>Ulmus parvifolia</u>	-	I	W	-	Tree
Elm, Siberian	<u>Ulmus pumila</u>	-	I	W	-	Tree
Eriogonum, yellow	<u>Eriogonum flavum</u>	P	N	F	-	Half-shrub
Fescue, six-weeks	<u>Festuca octoflora</u>	A	N	G	IV	Short-grass
Flax, common	<u>Linum usitatissimum</u>	A	-	F	-	Crop species
Flax, Lewis' wild	<u>Linum lewisii</u>	P	N	F	D	-
Flax, sciffateu	<u>Linum rigidum</u>	A	N	F	IV	-
Fleabane, daisy	<u>Erigeron sp.</u>	-	N	F	-	-
Frenchweed	<u>Thlaspi arvense</u>	A	N	F	IV	-
Gaura	<u>Gaura coccinea</u>	P	N	F	-	-
Goatsbeard, large	<u>Tragopogon dubius</u>	P	N	F	-	-
Goldenrod, early	<u>Solidago missouriensis</u>	P	N	F	-	-
Goldenrod, giant	<u>Solidago gigantea</u>	P	N	F	-	-
Goldenrod, soft	<u>Solidago mollis</u>	P	N	F	D	-
Goldenrod, stiff	<u>Solidago rigida</u>	P	N	F	I	-
Goldenrod, tall	<u>Solidago altissima</u>	P	N	F	-	-
Gooseberry, Missouri	<u>Ribes missouriense</u>	-	N	W	-	Low shrub
Grass, blue	<u>Bouteloua gracilis</u>	P	N	G	I	Short-grass
Grass, side-oats	<u>Bouteloua curtipendula</u>	P	N	G	D	Mid-grass
Grass, indian	<u>Sorghastrum nutans</u>	P	N	G	D	Tall-grass
Porcupine, porcupine	<u>Stipa spartea</u>	P	N	G	D	Tall-grass
Grass, western porcupine	<u>Stipa spartea (var.)</u>	P	N	G	D	Mid-grass
Gumweed	<u>Grielandia squarrosa</u>	B	N	F	IV	-
Hawthorn, round-leaved	<u>Crataegus rotundifolia</u>	-	N	W	-	High shrub
Hemp, indian	<u>Apocynum sibiricum</u>	P	N	F	-	-
Honeyauckle	<u>Lonicera sp.</u>	-	I	W	-	High shrub
Morsetail, Kansas	<u>Equisetum kansanum</u>	-	N	-	-	Spore-bearing
Indigo, dwarf wild	<u>Amorpha nana</u>	-	N	W	-	Low shrub
Ironweed, cut-leaved	<u>Aplopappus spinulosus</u>	P	N	F	I	-
Ivy, poison	<u>Hedera radicans</u>	-	N	W	-	Low shrub
Juneberry	<u>Amelanchier alnifolia</u>	-	N	W	-	High shrub
Junegrass, prairie	<u>Koeleria cristata</u>	P	N	G	D	Mid-grass
Juniper, Rocky Mountain	<u>Juniperus scopulorum</u>	-	N	W	-	High shrub
Juniper, trailing	<u>Juniperus horizontalis</u>	-	N	W	-	Trailing shrub
Kinghead	<u>Ambrosia trifida</u>	A	N	F	-	-
Knotweed	<u>Polygonum sp.</u>	A	N	F	-	-
Lamb's-quarter	<u>Chenopodium album</u>	A	N	F	IV	-
Leadplant	<u>Amorpha canescens</u>	-	N	W	D	Low shrub, legume
Lettuce, blue wild	<u>Lactuca pulchella</u>	P	N	F	D	-
Lettuce, prickly	<u>Lactuca serriola</u>	A	N	F	D	-
Licorice, wild	<u>Glycyrrhiza lepidota</u>	P	N	F	-	Legume
Lilac	<u>Syringa vulgaris</u>	-	I	W	-	High shrub
Loco, purple	<u>Oxytropis lambertii</u>	P	N	F	I	Legume
Lupine, false	<u>Thermopsis rhombifolia</u>	P	N	F	I	Legume
Mallow, red	<u>Sphaeralcea coccinea</u>	P	N	F	I	-
Manna-grass, American	<u>Glyceria grandis</u>	P	N	G	D	Tall-grass
Meadowgrass, salt	<u>Puccinellia nuttalliana</u>	P	N	G	D	Mid-grass
Milkvetch, striate	<u>Astragalus striatus</u>	P	N	F	-	Legume
Milkvetch, tufted	<u>Astragalus triphyllus</u>	P	N	F	-	Legume
Milkweed, common	<u>Asclepias syriaca</u>	P	N	F	-	-
Milkweed, whorled	<u>Asclepias verticillata</u>	P	N	F	I	-
Milkwort, white	<u>Polygala alba</u>	P	N	F	D	-
Mint, wild	<u>Mentha arvensis</u>	P	N	F	-	-
Muhly, marsh	<u>Muhlenbergia racemosa</u>	P	N	G	D	Mid-grass
Muhly, wet	<u>Muhlenbergia richardsonii</u>	P	N	G	I	Short-grass
Muhly, plains	<u>Muhlenbergia cuspidata</u>	P	N	G	D	Short-grass
Mustard, taney	<u>Descurainia sp.</u>	A	N	F	IV	-
Needle-and-thread	<u>Stipa comata</u>	P	N	G	I	Mid-grass
Needlegrass, green	<u>Stipa viridula</u>	P	N	G	D	Mid-grass
Oats	<u>Avena sativa</u>	-	-	-	-	Crop species
Oats, spike	<u>Avena hookeri</u>	P	N	G	-	Mid-grass
Oats, wild	<u>Avena fatua</u>	A	I	G	-	-
Olive, Russian	<u>Euonymus angustifolia</u>	-	I	W	-	High shrub
Onion, white wild	<u>Allium textile</u>	P	N	F	-	-
Osier, red	<u>Cornus stolonifera</u>	-	N	W	-	High shrub
Panicum, Wilcox	<u>Panicum wilcoxianum</u>	P	N	G	D	Short-grass
Paraleip, wild	<u>Muhlenbergia divaricata</u>	P	N	F	-	-
Paranip, meadow	<u>Zizia aurea</u>	P	N	F	-	-
Paranip, water	<u>Sium aquaticum</u>	P	N	F	-	-
Pasque-flower	<u>Anemone patens</u>	P	N	F	-	-
Pennyroyal, rough	<u>Hedeoma pinnatifidum</u>	A	N	F	IV	-
Peppergrass	<u>Lepidium densiflorum</u>	A	N	F	IV	-
Phlox, moss	<u>Phlox hoodii</u>	P	N	F	I	-
Pine, ponderosa	<u>Pinus ponderosa</u>	-	N	W	-	Tree
Plantain, alkali	<u>Plantago eriopoda</u>	P	N	F	I	-
Plantain, Pursh's	<u>Plantago purshii</u>	A	N	F	IV	-
Plantain, water	<u>Alisma subcordatum</u>	P	N	F	-	Emergent aquatic
Plum, ground	<u>Astragalus caryocarpus</u>	P	N	F	-	Legume
Plum, wild	<u>Prunus americana</u>	-	N	W	-	High shrub
Pondweed, sago	<u>Potamogeton pectinatus</u>	-	N	-	-	Submerged aquatic
Poverty weed	<u>Lythrum axillare</u>	P	N	F	-	-
Pricklypear, brittle	<u>Opuntia fragilis</u>	P	N	-	I	-
Pricklypear	<u>Opuntia polyacantha</u>	P	N	-	I	-
Primrose, tooth-leaved evening	<u>Oenothera serrulata</u>	P	N	F	-	Half shrub
Quackgrass	<u>Agropyron repens</u>	P	I	G	IV	Mid-grass
Rabbitbrush	<u>Chrysothamnus graveolens</u>	-	N	W	I	Low shrub
Ragweed, perennial	<u>Ambrosia coronopifolia</u>	P	N	F	I	-
Redtop	<u>Agrostis alba</u>	P	I	G	IV	Mid-grass
Reed-canarygrass	<u>Phalaris arundinacea</u>	P	N	G	D	Tall-grass

(continues)

Common Name	Scientific Name ¹	Longevity ²	Origin ³	Life Form ⁴	Response to Grazing ⁵	Comments
Reedgrass, northern	<u>Calamagrostis inexpectata</u>	P	N	G	D	Mid-grass
Reedgrass, plains	<u>Calamagrostis montanensis</u>	P	N	G	D	Short-grass
Rivergrass	<u>Scolochloa festuacea</u>	P	I	G	D	Tall-grass
Rockrose, Holboell	<u>Arabis holboellii</u>	-	N	F	-	--
Rose, prairie wild	<u>Rosa arkansana</u>	-	N	W	I	Low shrub
Rose, western wild	<u>Rosa woodsii</u>	-	N	W	I	Low shrub
Rush, Baltic	<u>Juncus balticus</u>	P	N	-	IV	--
Sage, fringed	<u>Artemisia frigida</u>	P	N	F	I	Half-shrub
Sage, green	<u>Artemisia glauca</u>	P	N	F	I	--
Sage, white	<u>Artemisia ludoviciana</u>	P	N	F	-	--
Sagebrush, silver	<u>Artemisia cana</u>	-	N	W	I	Low shrub
Saltbush, hystate	<u>Atriplex hastata</u>	P	N	F	-	--
Saltgrass	<u>Distichlis stricta</u>	P	N	G	I	Short-grass
Sandgrass, big	<u>Calamovilfa longifolia</u>	P	N	G	D	Tall-grass
Scratchgrass	<u>Muhlenbergia asperifolia</u>	P	N	G	I	Short-grass
Seablite	<u>Suaeda depressa</u>	A	N	F	IV	--
Sedge, fescue	<u>Carex brevior</u>	P	N	S	D	--
Sedge, long-beaked	<u>Carex sparganii</u>	P	N	S	-	--
Sedge, needleleaf	<u>Carex eleocharis</u>	P	N	S	I	--
Sedge, Pennsylvania	<u>Carex pennsylvanica</u>	P	N	S	I	--
Sedge, Sartwell	<u>Carex sartwellii</u>	P	N	S	-	--
Sedge, slim	<u>Carex praegracilis</u>	P	N	S	I	--
Sedge, slough	<u>Carex atherodes</u>	P	N	S	D	--
Sedge, smoothcone	<u>Carex lasiocarpa</u>	P	N	S	-	--
Sedge, threadleaf	<u>Carex filifolia</u>	P	N	S	I	--
Sedge, wooly	<u>Carex lanuginosa</u>	P	N	S	D	--
Silverberry	<u>Elaeagnus argentea</u>	-	N	W	I	Low shrub
Silverleaf	<u>Paorale argophylla</u>	P	N	F	-	Legume
Skeletonweed	<u>Lygodesmia juncea</u>	P	N	F	I	--
Skunkbush	<u>Rhus trilobata</u>	-	N	W	-	Low shrub
Sloughgrass, American	<u>Beckmannia syzigachne</u>	A	N	G	IV	Mid-grass
Smartweed, long-rooted	<u>Polygonum coccineum</u>	P	N	F	-	--
Sorrel, upright	<u>Oxalis stricta</u>	A	N	F	IV	--
yellow-wood						
Southistle, spiny	<u>Sonchus asper</u>	A	N	F	-	--
Spikemoos	<u>Selaginella densa</u>	-	-	-	-	Spore bearing
Spikerush, common	<u>Eleocharis palustris</u>	P	N	S	I	--
Spikerush, needle	<u>Eleocharis acicularis</u>	P	N	S	I	--
Spurge	<u>Euphorbia sp.</u>	-	N	F	-	--
Star, evening	<u>Mentzelia decapetala</u>	B	N	F	-	--
Star, narrow-leaved	<u>Liatris punctata</u>	P	N	F	D	--
blazing						
Stickseed	<u>Hackelia americana</u>	B	N	F	-	--
Sunflower, common	<u>Helianthus annuus</u>	A	N	F	IV	--
Sunflower, narrow-leaved	<u>Helianthus maximiliani</u>	P	N	F	D	--
Sunflower, Rydberg's	<u>Helianthus rydbergii</u>	P	N	F	D	--
Sunflower, stiff	<u>Helianthus rigidus</u>	P	N	F	D	--
Switchgrass	<u>Panicum virgatum</u>	P	N	G	D	Tall-grass
Threeweed, red	<u>Aristida longiseta</u>	P	N	G	I	Short-grass
Thistle, bull	<u>Cirsium vulgare</u>	B	N	F	IV	--
Thistle, prairie	<u>Cirsium undulatum</u>	P	N	F	I	--
Ticklegass	<u>Agrostis scabra</u>	P	N	G	IV	Short-grass
Toadflax, bearded	<u>Commandra pallida</u>	P	N	F	-	--
Trefoil, prairie	<u>Lotus americanus</u>	A	N	F	IV	Legume
bird's-foot						
Tumblegrass	<u>Schedonnardus paniculatus</u>	P	N	G	IV	Short-grass
Vervain, swamp	<u>Verbena hastata</u>	P	N	F	-	--
Vetch, American	<u>Vicia americana</u>	P	N	F	D	Legume
Vetch, prairie	<u>Vicia spargifolia</u>	P	N	F	D	Legume
Wallflower, western	<u>Erysimum asperum</u>	B	N	F	-	--
Wedgrass, prairie	<u>Sphenopholis obtusata</u>	P	N	G	-	Mid-grass
Wheat	<u>Triticum aestivum</u>	A	-	G	-	Crop species
Wheatgrass, bearded	<u>Agropyron subsecundum</u>	P	N	G	D	Mid-grass
Wheatgrass, crested	<u>Agropyron cristatum</u>	P	I	G	-	Hay grass
Wheatgrass, Montana	<u>Agropyron albican</u>	P	N	G	D	Mid-grass
Wheatgrass, slender	<u>Agropyron trachycavium</u>	P	N	G	D	Mid-grass
Wheatgrass, thickspike	<u>Agropyron dasystachyum</u>	P	N	G	D	Mid-grass
Wheatgrass, western	<u>Agropyron smithii</u>	P	N	G	D	Mid-grass
Whitlowwort	<u>Paronychia sessiliflora</u>	P	N	F	-	--
Wild-rye, Canada	<u>Elymus canadensis</u>	P	N	G	D	Tall-grass
Wild-rye, Macoun	<u>Elymus macounii</u>	P	N	G	D	Mid-grass
Wild-rye, Virginia	<u>Elymus virginicus</u>	P	N	G	D	Mid-grass
Willow, golden	<u>Salix elba</u> Var. <u>vitellina</u>	-	I	W	-	Tree
Willow, heart-leaved	<u>Salix cordata</u>	-	N	W	-	High shrub
Willow, laurel-leaved	<u>Salix pentandra</u>	-	I	W	-	Tree
Willow, Missouri	<u>Salix missouriensis</u>	-	N	W	-	High shrub
Willow, peach-leaved	<u>Salix amygdaloides</u>	-	N	W	-	Tree
Willow, pussy	<u>Salix discolor</u>	-	N	W	-	High shrub
Willow, sandbar	<u>Salix interior</u>	-	N	W	-	High shrub
Winterfat	<u>Eurotia lanata</u>	P	N	F	-	Half-shrub
Wolfberry	<u>Symphoricarpos occidentalis</u>	-	N	W	-	Low shrub
Yarrow	<u>Achillea lanulosa</u>	P	N	F	I	--

¹ According to Stevens (1963)

² A = Annual, B = Biennial, P = Perennial

³ N = Native, I = Introduced

⁴ G = Grass, S = Sedge (Grass-like), F = Forb, W = Woody

⁵ I = Increaser, D = Decreaser, IV = Invader; according to U.S.D.A. Soil Conservation Service, 1957 (Unpublished).

Compiled by Woodward-Envicon, Inc., 1974.

BOTANICAL COMPOSITION (PERCENT¹) OF FENCEROW PLANT COMMUNITIES
AS DETERMINED BY THE PACE-POINT METHOD

<u>Species</u>	<u>Sample Number</u>									<u>Average</u>
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	
<u>Introduced Grasses</u>										
Smooth brome	87	55	11	69	T	25	1	14	3	29
Kentucky bluegrass	4	11	1	3	60	22	44	56	10	23
Crested wheatgrass	--	T	--	15	4	45	1	--	--	7
Total	91	66+	12	87	64+	92	46	70	13	60
<u>Native Perennial Grasses</u>										
Western wheatgrass	--	1	9	--	14	6	24	13	18	9
Slender wheatgrass	--	6	1	--	T	--	1	--	6	2
Green needlegrass	--	--	--	--	1	--	6	1	3	1
Prairie junegrass	--	--	--	--	9	--	--	--	--	1
Wild barley	--	4	--	--	--	--	--	--	--	T
Blue grama	--	--	--	--	3	--	--	--	--	T
Needle-and-thread	--	--	--	--	2	--	--	--	--	T
Total	--	12	11	--	29+	6	31+	14	27+	14
<u>Sedges</u>										
Pennsylvania sedge	1	--	--	--	2	--	T	--	4	1
Smoothcone sedge	--	--	T	1	--	--	T	--	--	T
Total	1	--	T	1	2	--	T	--	4	1
<u>Perennial Forbs and Half-shrubs</u>										
Alfalfa	1	12	--	--	1	T	--	--	--	1
Field Bindweed	4	--	1	1	--	T	--	1	1	1
Long-rooted smartweed	--	--	--	3	--	--	--	--	--	T
Jerusalem artichoke	--	--	1	T	--	--	--	--	--	T
Prairie vetch	--	--	--	--	T	--	--	--	1	T
Total	6	14+	3	4+	2+	T	T	1+	3+	3

<u>Species</u>	<u>Sample Number</u>									<u>Average</u>
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	
<u>Annuals and Biennials</u>										
Burningbush	3	1	37	--	--	--	10	3	6	7
Wild oat	--	--	16	--	--	--	2	1	8	3
Wild buckwheat	--	--	2	--	T	--	1	2	16	2
Tansy mustard	1	--	4	--	--	--	3	5	2	2
Spiny sowthistle	1	T	1	1	T	--	1	--	9	1
Kinghead	--	--	1	T	--	--	--	7	--	1
Large goatsbeard	--	1	1	--	1	--	T	--	2	1
Frenchweed	--	--	1	T	--	--	--	7	--	1
Lamb's quarter	--	--	1	T	--	--	--	--	3	T
Collomia	--	--	1	--	--	--	--	--	1	T
Total	5	3+	66+	1+	2+	--	17+	26	48+	19
<u>Woody Plants</u>										
Wolfberry	1	--	2	--	--	--	--	--	--	T
Prairie wild rose	--	T	--	T	--	--	--	--	--	T
Total	1	T	2	T	--	--	--	--	--	T

1 Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc., 1974

PLANT COMMUNITY COMPOSITION OF SUBIRRIGATED RANGE SITE

Species	Estimated Percent By Weight ^{1,2}
Grasses	
Big bluestem	35
Porcupine cordgrass	30
Switchgrass	20
Slender wheatgrass	5
Wild barley ("Foxtail")	3
Canada wild-rye	2
Perennial Forbs	
Narrow-leaved sunflower	3
Common milkweed	
Water parsnip	
White prairie aster	2
Whorled milkweed	
Wild bergamot	
Annual Forbs	
Prickly lettuce	T
Miscellaneous	
Kansas horsetail	T

¹Inclusion in "Amor-Werner loams" mapping unit.

²Extent of this range site was insufficient for sampling.

³Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Environ, Inc., Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT¹) OF THE OVERFLOW RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1 ²	Sample 2 ³	Average
Grasses			
Big bluestem	33	53	43
Porcupine grass	12	2	7
Kentucky bluegrass	6	7	6.5
Marsh muhly	--	7	1.5
Bearded wheatgrass	2	2	2.0
Fowl bluegrass	--	4	2.0
Canada wild-rye	--	1	0.5
Green needlegrass	1	--	0.5
Prairie cordgrass	--	1	0.5
Prairie junegrass	1	--	0.5
Mat muhly	T	--	T
Ticklegrass	--	T	T
Western wheatgrass	T	--	T
Sedges			
Pennsylvania sedge	26	7	16.5
Fescue sedge	T	5	2.5+
Smoothcone sedge	--	3	1.5
Perennial Forbs			
Prairie thistle	3	--	1.5
Wild bergamot	3	--	1.5
Yarrow	2	--	1.0
Canada anemone	1	--	0.5
Northern bedstraw	1	--	0.5
Skeletonweed	1	--	0.5
Soft goldenrod	1	--	0.5
White sage	1	--	0.5
Blue wild lettuce	T	--	T
Ground cherry	T	--	T
Prairie chickweed	T	--	T
Stiff sunflower	--	T	T
Tall goldenrod	T	--	T
Annual Forbs			
Upright yellow wood sorrel	--	1	0.5
Spurge	T	--	T
Woody Plants			
Wolfberry	3	--	1.5
Prairie wild rose	1	--	0.5
Miscellaneous			
Kansas horsetail	--	2	1.0

¹Percentages less than 1.0 are listed as trace (T).

²Inclusion in "Channeled Straw and Korchia Soils" mapping unit; average of three transects.

³Inclusion in "Cohagen-Weber fine sandy loams" mapping unit; average of two transects.

Source: Woodward-Environ, Inc., Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF A SALINE LOWLAND RANGE SITE¹ IN A MODERATELY WELL DRAINED AREA

Species	Estimated Percent By Weight ²
Grasses	
Western wheatgrass	60
Swallen bluegrass	20
Perennial Forbs	
Gumweed	2
Fringed sage	1
Annual and Biennial Forbs	
Povertyweed	15
Large goatsbeard	1
Miscellaneous	
Brittle prickly pear	1

¹Harriet clay.

²Extent of this range site was insufficient for sampling.

Source: Woodward-Environ, Inc., Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF A SALINE LOW- LAND RANGE SITE¹ IN A POORLY DRAINED AREA

Species	Estimated Percent By Weight ^{2,3}
Grasses	
Salt meadowgrass	25
Saltgrass	20
Western wheatgrass	10
Wild barley ("Foxtail")	10
Swallen bluegrass	5
Sedges	
Prairie bulrush	5
Common spikerush	T
Annual Forbs	
Hastate saltbush	20
Knotweed	3
Peppergrass	1
Pursh's plantain	1

¹Harriet clay.

²Extent of this range site was insufficient for sampling.

³Percentage less than 1.0 are listed as trace (T).

Source: Woodward-Environ, Inc., Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT¹) OF SANDY RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1 ²	Sample 2 ³	Average
<u>Grasses</u>			
Big sandgrass	14	19	16.5
Prairie junegrass	8	13	10.5
Blue grama	11	8	9.5
Needle-and-thread	8	9	8.5
Red threeawn	8	4	6.0
Wilcox panicum	4	4	4.0
Porcupine grass	2	2	2.0
Plains muhly	2	1	1.5
Western wheatgrass	2	T	1.0+
Little bluestem	1	T	0.5+
Kentucky bluegrass	1	--	0.5
Green needlegrass	1	--	0.5
Bearded wheatgrass	T	--	T
Side-oats grama	--	T	T
<u>Sedges</u>			
Pennsylvania sedge	21	18	19.5
Threadleaf sedge	2	1	1.5
<u>Perennial Forbs and Half-shrubs</u>			
White sage	2	3	2.5
Stiff sunflower	1	3	2.0
Blue wild lettuce	2	1	1.5
Skeletonweed	1	2	1.5
Fringed sage	T	2	1.0+
Purple loco	T	2	1.0+
Silverleaf	T	2	1.0+
Soft goldenrod	1	1	1.0
Golden aster	T	1	0.5+
Green sage	T	1	0.5+
Pasque-flower	1	T	0.5+
Prairie chickweed	1	T	0.5+
Purple coneflower	1	T	0.5+
Bastard toadflax	1	--	0.5
White prairie aster	1	--	0.5
<u>Perennial Forbs and Half-shrubs (cont'd.)</u>			
Prairie thistle	--	1	0.5
Early goldenrod	T	T	T
Daisy fleabane	T	--	T
Narrow-leaved blazing star	T	--	T
Stiff goldenrod	T	--	T
Wild licorice	--	T	T
Yarrow	T	--	T
<u>Annual Forbs</u>			
Owl clover	--	T	T
<u>Woody Plants</u>			
Prairie wild rose	1	2	1.5

¹Percentages less than 1.0 are listed as trace (T).

²Vegetation fine sandy loam; average of four transects.

³Vegetation fine sandy loam; average of three transects.

Source: Woodward-Envicon, Inc. Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT¹) OF THE SILTY RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1 ²	Sample 2 ³	Average
<u>Grasses</u>			
Blue grama	12	17	14.5
Western wheatgrass	9	10	9.5
Needle-and-thread	4	10	7.0
Prairie junegrass	5	6	6.5
Thickspike wheatgrass	9	1	5.0
Green needlegrass	5	2	3.5
Porcupine grass	6	T	3.0+
Red threeawn	2	2	2.0
Kentucky bluegrass	1	--	1.5
Plains muhly	1	2	1.5
Saltgrass	1	--	0.5
Side-oats grama	--	1	0.5
Plains reedgrass	T	--	T
Sandberg bluegrass	T	--	T
Ticklegrass	T	--	T
<u>Sedges</u>			
Pennsylvania sedge	19	12	15.5
Needleleaf sedge	1	9	5.0
Threadleaf sedge	3	3	3.0
<u>Perennial Forbs and Half-shrubs</u>			
Fringed sage	3	3	3.0
Blue wild lettuce	T	4	2.0+
Green sage	1	2	1.5
White prairie aster	1	2	1.5
Stiff goldenrod	--	3	1.5
White sage	2	1	1.5
Striate milkvetch	--	2	1.0
Aromatic aster	T	1	0.5+
Daisy fleabane	1	T	0.5+
Moss phlox	T	1	0.5+
<u>Perennial Forbs and Half-shrubs (cont'd.)</u>			
Silverleaf	T	1	0.5+
Soft goldenrod	1	T	0.5+
Catsfoot	--	1	0.5
Narrow-leaved blazing star	--	1	0.5
Prairie chickweed	1	--	0.5
Red mallow	--	1	0.5
Yarrow	1	--	0.5
Early goldenrod	T	T	T
Prairie thistle	T	T	T
Bastard toadflax	--	T	T
Gaura	T	--	T
Ground plum	--	T	T
Pasque-flower	T	--	T
Povertyweed	T	--	T
Prairie vetch	T	--	T
Purple coneflower	T	--	T
Stiff sunflower	--	T	T
<u>Biennial Forbs</u>			
Sweet clover	2	1	1.5
Large goatsbeard	1	1	1.0
<u>Annual Forbs</u>			
Collomia	T	--	T
Prairie bird's-foot trefoil	T	--	T
Fairy candelabra	T	--	T
Stiffstem flax	--	T	T
<u>Woody Plants</u>			
Prairie wild rose	T	2	1.0+
Wolfberry	--	1	0.5

¹Percentages less than 1.0 are listed as trace (T).

²Graill silt loam; average of four transects.

³Williams loam; average of three transects.

Source: Woodward-Envicon, Inc. Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF CLAYEY RANGE SITE¹

Species	Estimated Percent by Weight ^{2,3}
<u>Grasses</u>	
Western wheatgrass	45
Green needlegrass	15
Blue grama	10
Kentucky bluegrass	2
Prairie junegrass	T
Ticklegrass	T
<u>Sedges</u>	
Pennsylvania sedge	5
<u>Perennial Forbs and Half-shrubs</u>	
White sage	5
Silverleaf	5
White prairie aster	3
American vetch	5
Fringed sage	
Green sage	
Long-headed coneflower	
Prairie thistle	
Soft goldenrod	
Yarrow	
<u>Annual Forbs</u>	
Prairie bird's-foot trefoil	1
Owl clover	1
Pursh's plantain	1
<u>Woody Plants</u>	
Prairie wild rose	1
Wolfberry	1

¹ Belfield silty clay loam.

² Extent of this range site was insufficient for sampling.

³ Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc. Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT¹) OF THIN UPLAND RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1 ²	Sample 2 ²	Average
<u>Grasses</u>			
Little bluestem	30	31	30.5
Porcupine grass	5	4	4.5
Big sandgrass	1	7	4.0
Prairie junegrass	5	2	3.5
Kentucky bluegrass	T	6	3.0+
Blue grama	3	3	3.0
Needle-and-thread	4	T	2.0+
Plains muhly	1	2	1.5
Red threeawn	1	2	1.5
Thickspike wheatgrass	--	2	1.0
Green needlegrass	--	1	0.5
Spike oat	--	1	0.5
Western wheatgrass	T	--	T
<u>Sedges</u>			
Pennsylvania sedge	13	12	12.5
Threadleaf sedge	4	5	4.5
<u>Perennial Forbs and Half-shrubs</u>			
Stiff sunflower	4	0	2.0
Pasque-flower	3	T	1.5+
Prairie chickweed	2	1	1.5
Prairie thistle	--	3	1.5
Silverleaf	1	2	1.5
White prairie aster	1	2	1.5
Bluebell	2	T	1.0+
Narrow-leaved blazing star	2	T	1.0+
Blue wild lettuce	1	1	1.0
Broomweed	1	1	1.0
Fringed sage	1	1	1.0
Northern bedstraw	--	2	1.0
Purple coneflower	2	--	1.0
Catsfoot	1	T	0.5+
Long-headed coneflower	1	T	0.5+
Purple prairie clover	T	1	0.5+
Aromatic aster	1	--	0.5
Green sage	1	--	0.5
Indian breadroot	1	--	0.5
Moss phlox	1	--	0.5
Prairie vetch	--	1	0.5
Striate milkvetch	--	1	0.5
White sage	1	--	0.5
Early goldenrod	T	T	0.5
Alumroot	T	--	T
Cottonweed	T	--	T
Purple loco	T	--	T
Skeletonweed	T	--	T
Yarrow	T	--	T
<u>Annual Forbs</u>			
Prairie bird's-foot trefoil	T	--	T
Rough pennyroyal	T	--	T
<u>Woody Plants</u>			
Prairie wild rose	1	T	0.5+
Dwarf wild indigo	1	--	0.5

¹ Percentages less than 1.0 are listed as trace (T).

² Sahl silt loam; average of three transects.

Source: Woodward-Envicon, Inc. Analysis, 1974.

**BOTANICAL COMPOSITION (PERCENT¹) OF SHALLOW
RANGE SITE PLANT COMMUNITY AS DETERMINED
BY THE PACE-POINT METHOD**

Species	Sample 1 ²	Sample 2 ³	Average
<u>Grasses</u>			
Little bluestem	18	16	17
Big sandgrass	7	6	6.5
Red threeawn	6	6	6.0
Needle-and-thread	5	4	4.5
Blue grama	5	3	4.0
Prairie junegrass	2	2	2.0
Porcupine grass	2	1	1.5
Wilcox panicum	2	1	1.5
Plains muhly	2	--	1.0
Green needlegrass	1	T	0.5+
Thickspike wheatgrass	--	1	0.5
Kentucky bluegrass	T	--	T
<u>Sedges</u>			
Threadleaf sedge	13	12	12.5
Pennsylvania sedge	11	13	12.0
<u>Perennial Forbs and Half-shrubs</u>			
Stiff sunflower	3	7	5.0
Purple coneflower	6	3	4.5
Aromatic aster	1	3	2.0
Prairie thistle	T	3	1.5+
Bastard toadflax	2	1	1.5
Green sage	1	2	1.5
Pasque-flower	3	--	1.5
White prairie aster	1	2	1.5
Blue wild lettuce	T	2	1.0+
Fringed sage	1	1	1.0
Narrow-leaved blazing star	T	1	0.5+
False boneset	--	1	0.5
Early goldenrod	T	T	T
Golden aster	T	T	T
Striate milkvetch	T	T	T
<u>Perennial Forbs and Half-shrubs (cont'd)</u>			
Purple prairie clover	T	T	T
White sage	T	T	T
False lupine	--	T	T
Indian breadroot	--	T	T
Long-headed coneflower	T	--	T
Gaura	T	--	T
Silverleaf	T	--	T
Skeletonweed	T	--	T
Green sage	T	--	T
<u>Biennial Forbs</u>			
Bull thistle	--	T	T
Large goatsbeard	--	T	T
<u>Annual Forbs</u>			
Prairie bird's-foot trefoil	--	T	T
<u>Woody Plants</u>			
Prairie wild rose	1	1	1.0

¹Percentages less than 1.0 are listed as trace (T).

²Cohagen fine sandy loam; average of four transects.

³Cabba-Werner complex; average of three transects.

Source: Woodward-Envicon, Inc. Analysis, 1974.

**PLANT COMMUNITY COMPOSITION OF A CLAYPAN
RANGE SITE¹**

<u>Species</u>	<u>Estimated Percent By Weight^{2,3}</u>
<u>Grasses</u>	
Western wheatgrass	40
Green needlegrass	12
Prairie junegrass	10
Blue grama	5
Needle-and-thread	5
Kentucky bluegrass	2
Red threeawn	T
Six-weeks fescue	T
<u>Sedges</u>	
Pennsylvania sedge	8
Threadleaf sedge	5
Needleleaf sedge	T
<u>Perennial Forbs and Half-shrubs</u>	
Fringed sage	2
Green sage	2
Cut-leaved ironweed	6
Indian breadroot	
Narrow-leaved blazing star	
Red mallow	
Silverleaf	
Skeletonweed	2
White sage	
<u>Annual and Biennial Forbs</u>	
Collomia	2
Rough pennycroyal	
Peppergrass	
Pursh's plantain	
Sweet clover	
<u>Miscellaneous</u>	
Brittle prickly pear	T

¹Savage clay loam.

²Extent of this range site was insufficient for sampling.

³Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc. Analysis, 1974.

**PLANT COMMUNITY COMPOSITION OF A
SHALLOW TO GRAVEL RANGE SITE¹**

Species	Estimated Percent By Weight ²
<u>Grasses</u>	
Blue grama	20
Needle-and-thread	8
Western wheatgrass	5
Prairie junegrass	2
<u>Sedges</u>	
Threadleaf sedge	25
Pennsylvania sedge	5
<u>Perennial Forbs and Half-shrubs</u>	
Fringed sage	10
Silverleaf	8
Golden aster	5
Green sage	5
Gumweed	5
Catsfoot	2
Long-headed coneflower	
Pasque-flower	
Skeletonweed	
Yarrow	

¹Lehr loam.

²Extent of this range site was insufficient for sampling.

Source: Woodward-Envicon, Inc. Analysis, 1974.

**PLANT COMMUNITY COMPOSITION
OF A VERY SHALLOW
RANGE SITE UNDERLAIN BY GRAVEL¹**

<u>Species</u>	<u>Estimated Percent By Weight^{2,3}</u>
<u>Grasses</u>	
Needle-and-thread	25
Blue grama	8
Prairie junegrass	5
Little bluestem	7
<u>Sedges</u>	
Threadleaf sedge	30
Needleleaf sedge	2
<u>Perennial Forbs and Half-shrubs</u>	
Fringed sage	8
Broomweed	4
Golden aster	3
Green sage	3
Silverleaf	2
Narrow-leaved blazing star	2
Skeletonweed	2
Bull thistle	2
Moss phlox	
Purple coneflower	
Purple prairie clover	
White milkwort	
<u>Annual and Biennial Forbs</u>	
Biennial wormwood	2
Collomia	
Rough pennyroyal	
Large goatsbeard	
<u>Woody Plants</u>	
Prairie wild rose	2

¹ Wabek soils.

² Extent of this range site was insufficient for sampling.

³ Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc. Analysis, 1974.

**PLANT COMMUNITY COMPOSITION
OF A VERY SHALLOW
RANGE SITE UNDERLAIN BY SANDSTONE¹**

<u>Species</u>	<u>Estimated Percent By Weight^{2,3}</u>
<u>Grasses</u>	
Thickspike wheatgrass	35
Plains muhly	2
Prairie junegrass	2
Plains reedgrass	1
<u>Sedges</u>	
Threadleaf sedge	3
Pennsylvania sedge	2
<u>Perennial Forbs and Half-shrubs</u>	
False lupine	15
Fringed sage	15
Broomweed	5
Golden aster	5
Pasque-flower	
Purple coneflower	
Purple loco	
Tufted milkvetch	
Yellow eriogonum	
<u>Woody Plants</u>	
Creeping cedar	15
<u>Miscellaneous</u>	
Brittle prickly pear	T

¹ Inclusion in "Cohagen-Verbar fine sandy loams" mapping unit and sandstone outcrop.

² Extent of this range site was insufficient for sampling.

³ Percentages less than 1.0 are listed as trace (T).

**PLANT COMMUNITY COMPOSITION
OF A VERY SHALLOW
RANGE SITE UNDERLAIN BY CLINKER¹**

<u>Species</u>	<u>Estimated Percent By Weight^{2,3}</u>
<u>Plains muhly</u>	
Needle-and-thread	30
Little bluestem	20
Blue grama	15
	5
<u>Sedges</u>	
Threadleaf sedge	10
<u>Perennial Forbs and Half-shrubs</u>	
Stiff sunflower	4
Fringed sage	2
Purple coneflower	1
Tooth-leaved evening primrose	1
Bastard toadflax	7
Bluebell	
Early goldenrod	
Evening star	
Narrow-leaved blazing star	
Purple prairie clover	2
Red mallow	
Western wallflower	
Yellow eriogonum	
<u>Annual Forbs</u>	
Collomia	2
Prairie bird's-foot trefoil	
Stiffstem flax	
<u>Woody Plants</u>	
Prairie wild rose	1
Sand cherry	1
<u>Miscellaneous</u>	
Prickly pear	1
White wild onion	T

¹ Ringling loam.

² Extent of this range site was insufficient for sampling.

³ Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc., Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF THIN CLAYPAN RANGE SITE¹

Species	Estimated Percent By Weight ^{2,3}
<u>Grasses</u>	
Western wheatgrass	45
Blue grama	10
Tumblegrass	10
Buffalograss	5
Sandberg bluegrass	5
Kentucky bluegrass	3
Prairie junegrass	2
Green needlegrass	T
Needle-and-thread	T
<u>Perennial Forbs and Half-shrubs</u>	
Gumweed	10
Fringed sage	3
Long-headed coneflower	2
Red mallow	2
Yarrow	1
<u>Annual Forbs</u>	
Prairie bird's-foot trefoil	2
Rough pennyroyal	
Peppergrass	
Pursh's plantain	
<u>Miscellaneous</u>	
Brittle prickly pear	T

¹Rhoades clay loam.

²Extent of this range site was insufficient for sampling.

³Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc., Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT¹) OF WETLAND RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1 ²	Sample 2 ³	Average
Slough sedge	56	83	69.0
Long-rooted smartweed	39	11	25.0
Smoothcone sedge	1	3	2.0
Broad-leaved cattail	3	--	1.5
Northern reedgrass	--	3	1.5
Rivergrass	--	1	0.5
Burreed	T	--	T

¹Percentages less than 1.0 are listed as trace (T).

²Parnell silt loam; average of two transects.

³Inclusion in "Marsh" mapping unit; one transect.

Source: Woodward-Envicon, Inc., Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT¹) OF THE WET MEADOW RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1 ²	Sample 2 ³	Average
<u>Grasses</u>			
Wild barley ("Foxtail")	16	3	9.5
Prairie wedggrass	T	13	6.5+
Fowl bluegrass	5	1	3.0
American sloughgrass	T	5	2.5+
Prairie cordgrass	3	--	1.5
<u>Sedges</u>			
Smoothcone sedge	60	44	52.0
Common spikerush	3	32	18.0
Needle spikerush	T	2	1.0+
<u>Perennial Forbs</u>			
Tall white aster	4	--	2.0
Willow-leaved dock	2	--	1.0
Spreading dogbane	T	--	T
<u>Annual Forbs</u>			
Spiny sowthistle	1	--	0.5

¹Percentage less than 1.0 are listed as trace (T).

²Inclusion in "Dimmick silty clay" mapping unit; average of two transects.

³Inclusion in "Parnell silt loam" mapping unit; average of two transects.

Source: Woodward-Envicon, Inc., Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT) OF THE MARSH PLANT COMMUNITY AS DETERMINED BY THE PACE- POINT METHOD

Species	Sample 1 ¹	Sample 2 ¹	Average
Burreed	60	34	47.0
Long-rooted smartweed	27	32	29.5
Broad-leaved cattail	--	25	12.5
River bulrush	13	--	6.5
Wedggrass	--	3	1.5
Arrowhead	--	2	1.0
Common spikerush	--	2	1.0
Water plantain	--	2	1.0

¹Average of two transects.

Source: Woodward-Envicon, Inc., Analysis, 1974.

WOODY PLANT COMMUNITIES OCCURRING IN HYDRIC, MESIC AND XERIC MOISTURE SITUATIONS

<u>Hydric</u>	<u>Mesic</u>	<u>Xeric</u>
Box-elder	American elm	Buffaloberry
Cottonwood	Choke cherry	Wolfberry
Heart-leaved willow	Green ash	
Missouri willow	Junberry	
Peach-leaved willow	Missouri gooseberry	
Pussy willow	Poison ivy	
Red osier	Quaking aspen	
Sandbar willow	Round-leaved hawthorn	
	Western wild rose	
	Wild black currant	
	Wild plum	
	Wolfberry	
	Virginia creeper	

Source: Woodward-Envicon, Inc., Analysis, 1974.

TREES AND SHRUBS ENCOUNTERED IN PLANTED WOODY STANDS

<u>Species</u>	<u>Native</u>	<u>Exotic</u>
American elm	X	
Box-elder	X	
Buffaloberry	X	
Caragana		X
Chinese elm		X
Choke cherry	X	
Cottonwood	X	
Green ash	X	
Golden currant	X	
Golden willow		X
Honeysuckle		X
Laurel-leaved willow		X
Lilac		X
Nanking cherry	X	
Ponderosa pine	X	
Red osier	X	
Rocky Mountain juniper	X	
Russian olive		X
Sand cherry	X	
Siberian crab		X
Siberian elm		X
Wild plum	X	

Source: Woodward-Envicon, Inc., Analysis, 1974.

**NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED WITH 200-FOOT
EXPERIMENTAL GILL NETS FROM A DEPTH OF 100 FEET IN RENNER BAY,**

Month	Species	Number	Length (mm)		Weight (g)	
			Min-Max	X	Min-Max	X
June	Carp	2	446 - 455	450	1134 - 1247	1190
July	Carp	1	440		794	
August	Channel catfish	1	636		2098	
September	White sucker	4	266 - 409	336	182 - 700	415

Source: Woodward-Envicon, Inc., Analysis, 1974.

**NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED WITH ELECTROFISHING
EQUIPMENT IN RENNER BAY**

Month	Species	Number	Length (mm)		Weight (g)	
			Min-Max	X	Min-Max	X
May	Carp	17	395 - 483	434	800 - 1400	1065
	Emerald shiner	15	40 - 93	73	0.4 - 4.8	3.4
	Walleye	12	210 - 409	298	50 - 600	266
	White sucker	11	191 - 395	344	50 - 750	498
	Yellow perch	6	64 - 146	92	4.0 - 40	13.8
	Goldeye	6	275 - 337	311	50 - 380	257
	Freshwater drum	1	424		838	
	River carpsucker	1	504		1800	
	Bigmouth buffalo	1	502		1800	
	Shorthead redhorse	1	386		1500	
	Total	71				
June	Carp	24	412 - 585	448	343 - 1600	863
	Goldeye	13	133 - 302	246	19 - 246	130
	White sucker	4	349 - 395	372	440 - 622	562
	Emerald shiner	3	74 - 88	80	4.2 - 6.7	4.9
	Walleye	2	368 - 750	559	380 - 3543	1962
	Yellow perch	1		68	3.7	
	Sauger	1		275	130	
	River carpsucker	1		542	1743	
	Total	49				
July	Carp	14	419 - 660	468	400 - 2200	796
	Goldeye	7	225 - 332	264	142 - 330	192
	Emerald shiner	4	60 - 87	68	1.7 - 6.4	3.2
	Shorthead redhorse	1	386		576	
	White bass	1	336		446	
	Yellow perch	1	189		72	
	Sauger	1	226		69	
	Total	29				
August	Goldeye	34	174 - 334	284	48 - 322	192
	Carp	19	409 - 547	441	770 - 2157	1094
	Yellow perch	10	111 - 181	145	18 - 80	44
	Walleye	6	222 - 319	287	84 - 264	165
	White sucker	5	166 - 359	232	38 - 522	166
	Freshwater drum	3	376 - 432	416	538 - 900	722
	River carpsucker	2	540	540	2214 - 2400	2307
	Northern pike	1	785		3500	
	Shorthead redhorse	1	376		538	
	White bass	1	100		14	
	Total	82				
September	Goldeye	40	276 - 350	320	164 - 380	282
	Carp	15	400 - 510	436	750 - 1685	1097
	Sauger	3	318 - 340	327	210 - 270	233
	Walleye	2	237 - 316	277	118 - 230	174
	Northern pike	1	527		792	
	White bass	1	107		20	
	Yellow perch	1	125		42	
	Total	63				
October	Goldeye	68	279 - 383	321	190 - 384	286
	River carpsucker	6	421 - 555	505	964 - 2041	1436
	Carp	4	421 - 571	482	737 - 1247	915
	Sauger	4	292 - 365	313	178 - 300	217
	Yellow perch	3	118 - 216	156	20 - 128	57
	White sucker	1	407		662	
	Walleye	1	341		340	
	Shorthead redhorse	1	391		600	
	Total	88				

Source: Woodward-Envicon, Inc., Analysis, 1974.

**NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED WITH GILL NETS
IN RENNER BAY, LAKE SAKAKAWEA, NORTH DAKOTA**

Month	Species	Number	Length (mm)			Weight (g)		
			Min	Max	X	Min	Max	X
May	Goldeye	244	273	415	315	124	558	220
	White sucker	63	266	445	368	172	1000	529
	Carp	55	382	565	464	700	2100	1343
	Walleye	38	232	486	328	88	900	379
	Sauger	33	273	415	315	124	558	220
	River carpsucker	18	437	619	492	1200	3300	2150
	Channel catfish	8	432	750	576	620	5000	3047
	Northern pike	8	698	978	799	1750	7400	3844
	Shorthead redhorse	6	339	441	373	379	744	549
	Smallmouth buffalo	3	492	525	509	1700	2100	1967
	Yellow perch	2	156	227	192	39	100	70
	Bigmouth buffalo	1	566			3000		
	Freshwater drum	1	454			1500		
	Shovelnose sturgeon	1	612			809		
	Total	481						
June	Goldeye	172	215	352	312	50	476	282
	Carp	51	372	555	456	800	2400	1243
	White sucker	23	193	443	348	78	920	477
	River carpsucker	11	479	542	512	1371	2143	1792
	Walleye	11	257	441	317	108	668	258
	Sauger	9	225	345	290	72	300	151
	Freshwater drum	3	380	573	430	573	1314	860
	Northern pike	2	679	764	722	2342	3600	2972
	Shorthead redhorse	2	391	472	431	622	1057	840
	Channel catfish	2	289	545	417	164	1371	768
	Coho salmon	1	416			730		
	Yellow perch	1	165			42		
	Total	288						
July	Goldeye	297	160	378	300	20	339	234
	Carp	40	440	541	463	343	1429	717
	Walleye	13	251	745	720	110	3800	817
	River carpsucker	9	469	515	480	914	1257	1000
	White sucker	7	252	391	315	160	578	329
	Bigmouth buffalo	3	492	638	562	1000	3257	2095
	Shorthead redhorse	3	350	400	381	200	670	435
	Channel catfish	2	257	291	274	118	164	141
	Sauger	1	553			1029		
	Smallmouth buffalo	1	356			1657		
	Freshwater drum	1	435			860		
	Total	378						
August	Walleye	36	209	634	380	75	2114	506
	Goldeye	29	170	332	306	164	430	286
	Yellow perch	23	152	226	197	49	122	90
	White sucker	17	245	383	320	156	586	355
	Carp	9	378	562	448	620	2114	1140
	Shorthead redhorse	6	334	410	387	378	725	606
	River carpsucker	5	472	574	517	1429	2514	1766
	Channel catfish	4	374	636	485	482	2114	1090
	Sauger	3	286	395	325	138	356	216
	Burbot	1	437			460		
	Freshwater drum	1	740			416		
	Total	134						
September	Goldeye	152	266	364	310	164	430	271
	Carp	31	430	557	474	950	2514	1417
	Yellow perch	26	149	225	201	38	132	92
	Walleye	16	228	722	392	201	3429	776
	White sucker	12	266	409	345	182	598	433
	Sauger	10	282	341	313	168	261	198
	River carpsucker	5	490	514	503	1429	1914	1687
	Shorthead redhorse	4	372	435	402	592	822	683
	Bigmouth buffalo	1	580			2857		
	Northern pike	1	783			3771		
	Total	238						
October	Goldeye	141	214	356	304	120	394	262
	White sucker	17	186	400	355	62	664	481
	Walleye	10	282	694	396	178	3855	870
	Carp	9	405	528	472	397	2098	1090
	River carpsucker	8	480	534	504	907	2325	1644
	Shorthead redhorse	5	350	428	397	438	872	668
	Sauger	4	277	484	352	148	764	344
	Freshwater drum	3	373	450	408	670	851	781
	Channel catfish	2	458	482	470	710	1021	866
	Northern pike	2	690	1010	850	1899	6877	4398
	Rainbow trout	1	551			1474		
	Creek chub	1	186			52		
	Total	263						

Source: Woodward-Environ, Inc., Analysis, 1974.

**NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED WITH A 50-FOOT BAG
SEINE IN RENNER BAY,**

Month	Species	Number	Length (mm)		Weight (g)	
			Min-Max	X	Min-Max	X
May	Yellow perch	50	50 - 73	64.5	1.1 - 4.3	2.5
	Johnny darter	2	53 - 57	55.0	1.7 - 2.1	1.9
	Total	52				
June	Emerald shiner	65	26 - 92	70.4	0.3 - 8.9	3.8
	Yellow perch	25	22 - 90	70.0	0.1 - 9.0	4.3
	White sucker	3	104 - 122	22	11.9 - 19.0	15
	Carp	1	420		930	
	Northern redbelly dace	1	50		0.9	
	Total	95				
July	Yellow perch	1953 ¹	27 - 108	36	0.1 - 16.4	0.7
	Carp	223	22 - 37	27	0.1 - 0.7	0.3
	Emerald shiner	118	48 - 103	78	0.9 - 10.4	3.0
	White sucker	101	27 - 39	30	0.1 - 0.7	0.5
	Sand shiner	3	29 - 65	50	0.1 - 2.8	1.6
	Johnny darter	3	23 - 29	26	0.2	0.2
	Goldeye	1	153		32.9	
	Flathead chub	1	125		24.8	
	Total	2403				
August	Emerald shiner	3434 ²	22 - 99	62	0.1 - 7.2	2.1
	Yellow perch	65	52 - 70	61	1.5 - 3.8	2.4
	White bass	57 ³	92 - 102	96	10.3 - 14.3	12.2
	White sucker	39	46 - 67	56	1.4 - 3.4	2.1
	Johnny darter	34	20 - 46	39	0.1 - 1.2	0.7
	Plains minnows	31	65 - 102	96	2.5 - 12.1	9.3
	Flathead minnow	3	32 - 57	48	0.3 - 2.1	1.5
	Carp	2	30 - 37	34	0.4 - 0.9	0.7
	Total	3665				
September	Emerald shiner	35	67 - 79	73	2.6 - 4.4	3.2
	Yellow perch	5	62 - 72	66	2.9 - 4.0	3.3
	Johnny darter	5	28 - 56	43	0.3 - 1.8	1.0
	Iowa darter	1	45		0.8	
	Total	46				
October	Emerald shiner	135	23 - 97	56	0.1 - 7.1	2.2
	Johnny darter	15	44 - 58	51	0.7 - 2.4	1.5
	Yellow perch	9	64 - 69	67	2.7 - 3.9	3.4
	Rainbow trout	1	134		29	
	White sucker	1	68		3.5	
	Flathead chub	1	71		3.5	
	Total	162				

¹ 350 were weighed and measured.

² 619 were weighed and measured.

³ 6 were weighed and measured.

Source: Woodward-Envicon, Inc. Analysis, 1974.

**MACROINVERTEBRATES COLLECTED FROM AQUATIC ECOSYSTEMS, MERCER
COUNTY, NORTH DAKOTA,**

<u>Common Name</u>	<u>Scientific Name</u>	<u>Lake Sakakawea</u>	<u>Knife River Drainage</u>	<u>Pond's</u>
Roundworms	Nematoda	X	X	
Horsehair worms	Nematomorpha		X	
Aquatic earthworms	Oligochaeta	X	X	
Leeches	Hirudinea		X	X
Sideswimmers	<u>Hyalella arteca</u> <u>Gammarus</u> sp.	X	X X	X
Crayfish	<u>Orconectes</u> sp.		X	
Stonefly nymphs	<u>Perleste</u> sp.		X	
Mayfly nymphs	<u>Hexagenia</u> sp. <u>Ephoron</u> sp. <u>Baetis</u> sp. <u>Pseudocloeon</u> sp. <u>Tricorythodes</u> sp.	X X X	X X X X X	
	<u>Caenis</u> sp. <u>Isonychia</u> sp. <u>Leptophlebiinae</u> <u>Leptophlebia</u> <u>Stenonema</u> sp. <u>Heptagenia</u> sp.	X X	X X X X X X	
Dragonfly nymphs	<u>Gomphus</u> sp. <u>Libellula</u> sp.		X	X
Damselfly nymphs	<u>Aeschna</u> sp. <u>Agriion</u> sp. <u>Enallagma</u> sp.	 X	X X X	X
Water boatmen	Corixidae		X	X
Water striders	Gerridae		X	X
Alderfly larvae	<u>Sialis</u> sp.		X	
Caddis fly larvae	<u>Hydropsyche</u> sp. <u>Cheumatopsyche</u> sp. <u>Polycentropus</u> sp. <u>Ocetis</u> sp. <u>Athripsodes</u> sp.	X X	X X X X X	
	<u>Leptocella</u> sp. <u>Trisnoides</u> sp. <u>Limnephilus</u> sp. <u>Pycnopsyche</u> sp. <u>Astenophylax</u> sp.		X X X X	X
	<u>Ptilostomis</u> sp. <u>Phryganea</u> sp. <u>Agrypnia</u> sp.		X X	X
Riffle beetles	Elmidae		X	
Predaceous diving beetles	Dytiscidae			X
Crane fly larvae	Tipulidae		X	
Black fly larvae	<u>Simulium</u> sp.		X	
Midge larvae	<u>Pentaneurini</u> <u>Procladius</u> sp. <u>Chironomus</u> sp. <u>Dicrotendipes</u> sp. <u>Cryptochironomus</u> sp.	 X X X X	X X X X X	
	<u>Paracladopelma</u> sp. <u>Endochironomus</u> sp. <u>Xenochironomus</u> sp. <u>Glyptotendipes</u> sp. <u>Polypedium</u> sp.	X X	X X X X X	
	<u>Paralauterborniella</u> sp. <u>Paratendipes</u> sp. <u>Strictochironomus</u> sp. <u>Microtendipes</u> sp. <u>Tanytarsus</u> sp.	 X X	X X X X X	
	<u>Diamesinae</u> <u>Eukiefferiella</u> sp. <u>Cricotopus</u> sp.		X X X	
Biting midge larvae	Ceratopogonidae	X	X	
Soldier fly larvae	<u>Odontomyia</u> sp.			X
Horsefly larvae	Tabanidae		X	
Snails	<u>Physa</u> sp. <u>Lymnaea</u> sp.		X X	
Mussels	<u>Unionidae</u> <u>Sphaerium</u> sp.		X X	
Total		18	63	10

Source: Woodward-Envicon, Inc. Analysis, 1974.

**NUMBER OF MACROINVERTEBRATES PER SQUARE METER AND PERCENT
RELATIVE ABUNDANCE COLLECTED IN RENNER BAY,**

Station 1											
Organism	May		June		July		Aug.		Sept.		Oct.
Nematoda	4.8 ¹	0.7 ²	28.6	3.6	--	--	--	--	--	--	--
Oligochaeta	104.8	16.3	--	--	33.3	15.2	19.0	12.9	9.5	3.9	--
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	6.2 2.2
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	--	--	--	--	4.8	2.2	--	--	--	--	--
Chironomidae	533.3	82.9	766.8	96.4	180.9	82.6	128.7	87.0	233.3	96.1	281.2 97.8
Procladius sp.	323.8	50.4	14.3	1.8	52.4	23.9	81.0	54.8	223.8	92.2	281.2 97.8
Chironomus sp.	161.9	25.2	304.8	38.3	9.5	4.3	14.3	9.6	--	--	--
Dicrotendipes sp.	--	--	23.8	3.0	--	--	--	--	--	--	--
Cryptochironomus sp.	38.1	5.9	42.9	5.4	14.3	6.5	4.8	3.2	9.5	3.9	--
Paracladopelma sp.	--	--	--	--	--	--	--	--	--	--	--
Polypedium sp.	--	--	366.7	46.1	85.7	39.1	--	--	--	--	--
Paratendipes sp.	--	--	4.8	0.6	--	--	--	--	--	--	--
Tanytarsus sp.	4.8	0.7	--	--	--	--	--	--	--	--	--
Genus A	--	--	--	--	9.5	4.3	28.6	19.4	--	--	--
Pupae	4.8	0.7	--	--	9.5	4.3	--	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--
Total	643.0	99.9	795.4	100.0	219	100.0	147.7	99.9	242.8	100.0	287.4 100.0
Station 2											
Organism	May		June		July		Aug.		Sept.		Oct.
Nematoda	--	--	--	--	--	--	--	--	--	--	--
Oligochaeta	52.4	7.0	19.0	7.1	57.1	15.6	4.8	4.8	219.0	75.4	81.0 27.4
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--
Cheumatopsyche sp.	--	--	--	--	--	--	4.8	4.8	--	--	--
Oecetis sp.	--	--	--	--	--	--	--	--	--	--	--
Chironomidae	695.4	93.0	247.6	92.9	309.6	84.4	90.6	90.4	71.3	24.5	214.3 72.6
Procladius sp.	681.0	91.1	209.5	78.6	300.0	81.8	66.7	66.6	38.0	13.1	181.0 61.3
Chironomus sp.	4.8	0.6	--	--	4.8	1.3	14.3	14.3	9.5	3.3	--
Dicrotendipes sp.	4.8	0.6	--	--	--	--	--	--	--	--	--
Cryptochironomus sp.	--	--	9.5	3.6	--	--	4.8	4.8	4.8	1.6	33.3 11.3
Paracladopelma sp.	--	--	19.0	7.1	--	--	4.8	4.8	19.0	6.5	--
Polypedium sp.	--	--	4.8	1.8	--	--	--	--	--	--	--
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	4.8	0.6	--	--	--	--	--	--	--	--	--
Genus A	--	--	--	--	4.8	1.3	--	--	--	--	--
Pupae	--	--	4.8	1.8	--	--	--	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--
Total	747.8	99.9	266.6	100.0	366.7	100.0	100.2	100.1	290.5	99.9	295.3 100.0
Station 3											
Organism	May		June		July		Aug.		Sept.		Oct.
Nematoda	--	--	--	--	--	--	--	--	--	--	--
Oligochaeta	14.3	1.3	100.0	35.0	14.3	3.7	23.8	5.0	4.8	1.2	14.3 7.7
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--
Caenis sp.	--	--	--	--	--	--	--	--	9.5	2.4	--
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	4.8	0.4	--	--	4.8	1.2	--	--	--	--	--
Chironomidae	1095.2	98.3	185.7	65.0	371.6	95.1	447.5	95.0	375.6	96.3	171.4 92.3
Procladius sp.	1042.8	93.6	138.1	48.3	304.8	78.0	119.0	25.2	209.0	53.6	23.8 12.8
Chironomus sp.	23.8	2.1	19.0	6.6	4.8	1.2	--	--	9.5	2.4	--
Dicrotendipes sp.	--	--	14.3	5.0	--	--	--	--	--	--	--
Cryptochironomus sp.	4.8	0.4	--	--	14.3	3.7	47.6	10.1	95.2	24.4	119.0 64.1
Paracladopelma sp.	--	--	14.3	5.0	4.8	1.2	--	--	23.8	6.1	--
Polypedium sp.	--	--	--	--	14.3	3.7	261.9	55.6	33.3	8.5	14.3 7.7
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	4.8	0.4	--	--	4.8	1.2	--	--	--	--	14.3 7.7
Genus A	19.0	1.7	--	--	23.8	6.1	9.5	2.0	--	--	--
Pupae	--	--	--	--	--	--	9.5	2.0	4.8	1.2	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--
Total	1114.3	99.9	285.7	99.9	390.7	100.0	471.3	99.9	389.9	99.8	185.7 100.0

Station 4												
Organism	May		June		July		Aug.		Sept.		Oct.	
Nematoda	--	--	--	--	--	--	--	--	--	--	--	--
Oligochaeta	233.3	34.7	142.9	31.3	157.1	15.3	42.9	8.0	23.8	22.7	109.5	50
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--	--
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	--	--	--	--	--	--	--	--	--	--	--	--
Chironomidae	438.1	65.2	314.2	68.7	866.7	84.7	490.5	92.0	80.9	77.3	109.5	50
Procladius sp.	414.3	61.7	261.9	57.3	714.3	69.8	423.8	79.4	19.0	18.1	85.7	39.1
Chironomus sp.	14.3	2.1	--	--	42.9	4.2	4.8	1.0	--	--	--	--
Dicrotendipes sp.	--	--	23.8	5.2	--	--	--	--	--	--	--	--
Cryptochironomus sp.	9.5	1.4	--	--	9.5	0.9	38.1	7.1	4.8	4.6	19.0	8.7
Paracledopisma sp.	--	--	9.5	2.1	9.5	0.9	--	--	57.1	54.5	--	--
Polypedium sp.	--	--	19.0	4.2	--	--	--	--	--	--	--	--
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	--	--	--	--	--	--	--	--	--	--	4.8	2.2
Genus A	--	--	--	--	90.5	8.8	--	--	--	--	--	--
Pupae	--	--	--	--	--	--	23.8	4.5	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--	--
Total	671.4	99.9	457.1	100.1	1023.8	99.9	533.4	100.0	104.7	99.9	219.0	100.0

Station 5												
Organism	May ³		June		July		Aug.		Sept.		Oct.	
Nematoda	--	--	--	--	--	--	--	--	--	--	--	--
Oligochaeta	--	--	14.3	4.6	90.5	16.2	33.3	36.8	19.0	13.8	133.3	40.6
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--	--
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	--	--	--	--	--	--	--	--	--	--	--	--
Chironomidae	--	--	295.3	95.4	466.8	83.8	57.2	63.2	119.1	86.2	195.3	59.4
Procladius sp.	--	--	252.4	81.5	404.8	72.6	38.1	42.1	109.5	79.3	181.0	55.1
Chironomus sp.	--	--	4.8	1.6	4.8	0.9	4.8	5.3	--	--	4.8	1.5
Dicrotendipes sp.	--	--	19.0	6.1	--	--	--	--	--	--	--	--
Cryptochironomus sp.	--	--	--	--	4.8	0.9	9.5	10.5	4.8	3.5	9.5	2.9
Paracledopisma sp.	--	--	14.3	4.6	42.9	7.7	--	--	--	--	--	--
Polypedium sp.	--	--	--	--	--	--	4.8	5.3	--	--	--	--
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	--	--	--	--	--	--	--	--	--	--	--	--
Genus A	--	--	--	--	9.5	1.7	--	--	--	--	--	--
Pupae	--	--	4.8	1.6	--	--	--	--	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	4.8	3.5	--	--
Total	--	--	309.6	100.0	557.3	100.0	90.5	100.0	138.1	100.0	328.6	100.1

Station 6												
Organism	May		June		July		Aug.		Sept.		Oct.	
Nematoda	--	--	--	--	--	--	--	--	--	--	9.5	22.2
Oligochaeta	400.0	46.6	204.8	48.3	57.1	29.2	114.3	50.0	19.0	21.0	--	--
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--	--
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	--	--	--	--	--	--	4.8	4.8	--	--	--	--
Chironomidae	458.9	53.4	219.1	51.7	138.1	70.8	109.6	47.9	71.4	79.0	33.3	77.8
Procladius sp.	444.6	51.8	161.9	38.2	81.0	41.5	81.0	35.5	71.4	79.0	19.0	44.4
Chironomus sp.	9.5	1.1	4.8	1.1	9.5	4.9	--	--	--	--	9.5	22.2
Dicrotendipes sp.	--	--	14.3	3.4	--	--	--	--	--	--	--	--
Cryptochironomus sp.	--	--	33.3	7.9	9.5	4.9	--	--	--	--	--	--
Paracledopisma sp.	--	--	4.8	1.1	9.5	4.9	23.8	10.4	--	--	--	--
Polypedium sp.	--	--	--	--	9.5	4.9	--	--	--	--	--	--
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	--	--	--	--	4.8	2.5	--	--	--	--	4.8	11.2
Genus A	4.8	0.6	--	--	--	--	--	--	--	--	--	--
Pupae	--	--	--	--	4.8	2.5	4.8	2.1	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--	--
Total	858.9	100.1	423.9	100.0	195.2	100.2	238.7	100.1	90.4	100.0	42.8	100.0

¹Mean density number per square meter

²Percent relative numerical abundance

³Samples not taken

Source: Woodward-Envicon, Inc., Analysis, 1974.

ZOOPLANKTON MAJOR GROUP DENSITY¹ AND PERCENT ABUNDANCE² FROM LAKE SAKAKAWEA (RENNER BAY) FOR JULY - SEPTEMBER 1974

		Depth										Mean (4 Depths)	
		1 Meter		8 Meters		15 Meters		30 Meters					
Date	Major Group	Density	Percent	Density	Percent	Density	Percent	Density	Percent	Density	Percent	Density	Percent
Early July	Cladocera	2.0	(10.2)	1.6	(9.0)	0.2	(0.7)	0.2	(0.7)	1.0	(4.3)		
July	Copepoda	16.5	(84.2)	14.9	(83.7)	25.3	(95.8)	28.2	(95.9)	21.2	(91.0)		
	Rotifera	1.1	(5.6)	1.3	(7.3)	0.9	(3.5)	1.0	(3.4)	1.1	(4.7)		
	Total	19.6		17.8		26.4		29.4		23.3			
	(all zooplankton)												
Late July	Cladocera	4.3	(13.0)	2.6	(10.1)	2.4	(9.6)	0.2	(0.6)	2.4	(8.2)		
July	Copepoda	24.0	(72.5)	18.6	(72.7)	20.1	(80.8)	31.9	(96.4)	23.6	(81.2)		
	Rotifera	4.8	(14.5)	4.4	(17.2)	2.4	(9.6)	1.0	(3.0)	3.1	(10.6)		
	Total	33.1		25.6		24.9		33.1		29.1			
Early August	Cladocera	8.8	(30.3)	1.0	(6.0)	0.8	(3.8)	0.9	(2.3)	2.9	(11.0)		
August	Copepoda	13.4	(46.6)	11.1	(71.7)	18.9	(89.1)	36.0	(94.1)	20.1	(76.5)		
	Rotifera	6.7	(23.1)	3.7	(22.3)	1.5	(7.1)	1.4	(3.6)	3.3	(12.5)		
	Total	29.0		16.6		21.2		38.3		26.3			
Sept.	Cladocera	3.9	(16.4)	5.6	(25.0)	2.1	(17.2)	1.1	(14.1)	3.2	(19.3)		
	Copepoda	13.6	(57.2)	12.9	(57.6)	7.5	(61.5)	5.6	(71.8)	9.9	(59.6)		
	Rotifera	6.3	(26.4)	3.9	(17.4)	2.6	(21.3)	1.1	(14.1)	3.5	(21.1)		
	Total	23.8		22.4		12.2		7.8		16.6			

¹Density units: organisms per liter (liter⁻¹).

²Percent of total zooplankton density.

Source: Woodward-Environ, Inc., Analysis, 1974.

ZOOPLANKTON DENSITY¹ AND PERCENT ABUNDANCE² (PREDOMINANT TAXA) FROM LAKE SAKAKAWEA (RENNER BAY) FOR JULY - SEPTEMBER 1974 AT 4 DEPTHS

Date	Taxa	Depth										Mean (4 Depths)	
		1 Meter		8 Meters		15 Meters		30 Meters					
		Density	Percent	Density	Percent	Density	Percent	Density	Percent	Density	Percent		
Early July	Daphnia	1.9	(9.7)	1.6	(9.0)	0.2	(0.7)	0.1	(0.3)	0.9	(3.9)		
	Mesocyclops	8.9	(45.4)	8.2	(46.1)	17.0	(64.3)	19.4	(66.0)	13.4	(57.5)		
	Cyclopoida	3.3	(16.8)	4.0	(22.5)	6.9	(26.1)	8.5	(28.9)	5.7	(24.5)		
	Diaptomus	4.1	(20.9)	2.7	(15.1)	1.3	(4.9)	0.4	(1.4)	2.1	(9.0)		
	Polyarthra	0.8	(4.0)	0.8	(4.5)	0.4	(1.5)	0.3	(1.0)	0.6	(2.5)		
	Total (all zooplankton)	19.6		17.8		26.4		29.4		23.3			
Late July	Daphnia	4.3	(13.0)	2.6	(10.1)	1.9	(7.6)	0.1	(0.3)	2.2	(7.5)		
	Mesocyclops	9.3	(28.1)	7.6	(29.7)	7.8	(31.3)	19.6	(59.2)	11.1	(38.0)		
	Cyclopoida	9.9	(29.9)	7.7	(30.0)	9.2	(36.9)	11.3	(34.1)	9.5	(32.5)		
	Diaptomus	4.6	(13.9)	3.2	(13.5)	2.5	(10.0)	0.7	(2.1)	2.7	(9.2)		
	Polyarthra	4.2	(12.7)	3.8	(14.8)	2.1	(8.4)	0.4	(1.2)	2.6	(8.9)		
	Total	33.1		25.6		24.9		33.1		29.2			
Early August	Daphnia	8.7	(30.0)	1.0	(6.0)	0.8	(3.8)	0.9	(2.3)	2.8	(10.6)		
	Mesocyclops	4.9	(16.9)	6.9	(41.6)	11.7	(55.2)	23.0	(60.0)	11.6	(44.1)		
	Cyclopoida	6.8	(23.4)	3.9	(23.5)	5.5	(25.9)	12.1	(31.6)	7.1	(27.0)		
	Diaptomus	1.8	(6.2)	1.1	(6.6)	1.5	(7.1)	1.1	(2.9)	1.4	(5.3)		
	Polyarthra	6.4	(22.1)	3.6	(21.7)	1.2	(5.7)	0.9	(2.3)	3.0	(11.4)		
	Total	29.0		16.5		21.2		38.3		26.3			
Sept.	Daphnia	3.7	(15.5)	5.4	(24.1)	1.8	(14.7)	0.9	(11.5)	3.0	(18.1)		
	Mesocyclops	4.0	(16.8)	5.4	(24.1)	3.6	(29.5)	2.5	(32.1)	3.9	(23.5)		
	Cyclopoida	6.0	(25.2)	5.2	(23.2)	3.2	(26.2)	2.6	(33.3)	4.2	(25.3)		
	Diaptomus	3.8	(16.0)	2.2	(9.8)	0.8	(6.5)	0.4	(5.1)	1.8	(10.8)		
	Polyarthra	6.1	(25.6)	3.9	(17.4)	2.6	(21.3)	0.9	(11.5)	3.4	(20.5)		
	Total	23.8		22.4		12.2		7.8		16.6			

¹Density units: organisms per liter (liter⁻¹).

²Percent of total zooplankton density.

Source: Woodward-Environ, Inc., Analysis, 1974.

PHYTOPLANKTON DENSITY¹ AND PERCENT ABUNDANCE² FROM LAKE SAKAKAWA (RENNER BAY) FOR JUNE - SEPTEMBER, 1974

Date	Major Group	Depth								Mean (4 Depths)	
		1 Meter		8 Meters		15 Meters		30 Meters			
		Density	Percent	Density	Percent	Density	Percent	Density	Percent	Density	Percent
Late June	Centrales	30.2	(12.6)	33.1	(12.0)	39.1	(16.0)	38.4	(18.9)	35.2	(14.6)
	Pennales	203.0	(85.0)	242.9	(87.8)	200.5	(81.9)	162.9	(80.2)	202.3	(84.0)
	Other Phyto.	5.7	(2.4)	0.7	(0.2)	5.2	(2.1)	1.8	(0.9)	3.2	(1.4)
	Total	238.9		276.7		244.8		203.1		240.8	
	(all phytoplankton)										
Early July	Centrales	3.5	(9.8)	5.9	(8.8)	11.3	(11.1)	20.7	(22.8)	10.4	(14.1)
	Pennales	31.1	(87.1)	60.1	(89.7)	88.0	(86.3)	70.0	(77.1)	62.3	(84.3)
	Other Phyto.	1.1	(3.1)	1.0	(1.5)	2.7	(2.6)	0.1	(0.1)	1.2	(1.6)
	Total	35.7		67.0		102.0		90.8		73.9	
Late July	Centrales	4.1	(11.6)	5.0	(9.3)	10.8	(7.1)	5.5	(14.6)	6.4	(9.2)
	Pennales	31.0	(87.6)	48.4	(90.5)	140.0	(92.4)	32.3	(85.4)	62.9	(90.4)
	Other Phyto.	0.3	(0.8)	0.1	(0.2)	0.7	(0.5)	--	--	0.3	(0.4)
	Total	35.4		53.5		151.5		37.8		69.6	
Early August	Centrales	0.6	(3.6)	1.5	(9.7)	5.5	(11.6)	4.8	(11.0)	3.1	(10.1)
	Pennales	15.1	(89.9)	12.5	(80.6)	40.8	(86.1)	38.4	(88.3)	26.7	(86.7)
	Other Phyto.	1.1	(6.5)	1.5	(9.7)	1.1	(2.3)	0.3	(0.7)	1.0	(3.2)
	Total	16.8		15.5		47.4		43.5		30.8	
Late August	Centrales	1.0	(12.8)	1.6	(11.3)	2.7	(7.9)	4.8	(10.6)	2.5	(9.8)
	Pennales	8.2	(79.5)	12.0	(84.5)	31.0	(90.4)	40.5	(89.4)	22.4	(88.2)
	Other Phyto.	0.6	(7.7)	0.6	(4.2)	0.6	(1.7)	--	--	0.5	(2.0)
	Total	9.8		14.2		34.3		45.3		25.4	
Sept.	Centrales	1.6	(8.2)	2.5	(14.3)	2.6	(15.2)	3.1	(9.5)	2.4	(11.1)
	Pennales	16.2	(83.6)	14.4	(82.3)	14.0	(81.9)	29.4	(89.9)	18.5	(85.7)
	Other Phyto.	1.6	(8.2)	0.6	(3.4)	0.5	(2.9)	0.2	(0.6)	0.7	(3.2)
	Total	19.4		17.5		17.1		32.7		21.6	

¹Density units: cells per milliliter (ml⁻¹).

²Percent total of total phytoplankton density.

Source: Woodward-Environ, Inc., Analysis, 1974.

PHYTOPLANKTON DENSITY¹ AND PERCENT ABUNDANCE² (PREDOMINANT TAXA) FROM LAKE SAKAKAWA (RENNER BAY) FOR JUNE - SEPTEMBER 1974

Date	Taxa	Depth								Mean (4 Depths)	
		1 Meter		8 Meters		15 Meters		30 Meters			
		Density	Percent	Density	Percent	Density	Percent	Density	Percent	Density	Percent
Late June	<i>Melosira italica</i>	29.3	(12.3)	32.0	(11.6)	37.0	(15.1)	35.8	(17.6)	33.5	(13.9)
	<i>Asterionella formosa</i>	75.7	(31.7)	62.0	(22.4)	64.0	(26.1)	40.8	(20.1)	60.6	(25.1)
	<i>Fragilaria crotonensis</i>	107.0	(44.8)	158.5	(57.3)	109.0	(44.5)	77.4	(38.1)	113.0	(46.9)
	<i>Fragilaria virescens</i>	8.2	(3.4)	13.1	(4.7)	8.2	(3.3)	23.4	(11.5)	13.2	(5.5)
	Total	238.9		276.7		244.8		203.1		240.9	
	(all phytoplankton)										
Early July	<i>Melosira italica</i>	1.3	(3.7)	3.5	(5.5)	8.3	(8.3)	18.7	(20.6)	7.9	(10.9)
	<i>Asterionella formosa</i>	7.7	(22.2)	7.5	(11.8)	8.0	(8.0)	10.1	(11.1)	8.3	(11.5)
	<i>Fragilaria crotonensis</i>	10.7	(30.8)	12.5	(19.7)	22.0	(22.0)	36.3	(40.0)	20.4	(28.2)
	<i>Fragilaria virescens</i>	4.4	(12.7)	15.0	(23.6)	12.0	(12.0)	8.6	(9.5)	10.0	(13.8)
	<i>Navicula capitata</i>	1.3	(3.7)	5.5	(8.7)	12.3	(12.3)	1.5	(1.7)	5.2	(7.2)
	<i>Nitzschia recta</i>	0.8	(2.3)	4.0	(6.3)	8.7	(8.7)	3.4	(3.7)	4.2	(5.8)
	Total	34.7		83.5		100.0		90.8		72.3	
Late July	<i>Melosira italica</i>	2.7	(7.6)	3.0	(5.6)	6.7	(4.4)	3.9	(10.3)	4.1	(5.9)
	<i>Asterionella formosa</i>	5.3	(14.8)	8.5	(15.9)	13.0	(8.6)	6.7	(17.7)	8.4	(12.1)
	<i>Fragilaria crotonensis</i>	8.0	(22.4)	5.5	(10.3)	23.7	(15.6)	3.7	(9.8)	10.2	(14.6)
	<i>Fragilaria virescens</i>	3.0	(8.4)	8.5	(15.9)	20.0	(13.2)	6.5	(17.5)	9.5	(13.6)
	<i>Navicula capitata</i>	4.7	(13.2)	7.0	(13.1)	22.7	(15.0)	3.1	(8.2)	9.4	(13.5)
	<i>Nitzschia recta</i>	2.7	(7.6)	4.5	(8.4)	13.0	(8.6)	3.3	(8.7)	5.9	(8.5)
	Total	35.7		53.5		151.7		37.8		69.7	
Early August	<i>Melosira italica</i>	0.3	(2.2)	1.1	(7.1)	3.2	(6.7)	2.1	(5.5)	1.7	(5.9)
	<i>Achnanthes</i>	1.6	(11.7)	0.3	(1.9)	2.0	(4.2)	1.7	(4.4)	1.4	(4.8)
	<i>Asterionella formosa</i>	1.1	(8.0)	3.3	(21.3)	2.2	(4.6)	10.9	(28.4)	4.4	(15.2)
	<i>Fragilaria crotonensis</i>	0.4	(2.9)	2.5	(16.1)	2.3	(4.8)	3.5	(9.1)	2.2	(7.6)
	<i>Fragilaria virescens</i>	5.5	(40.1)	2.0	(12.9)	14.0	(29.2)	5.0	(13.0)	6.6	(22.8)
	<i>Navicula capitata</i>	1.4	(10.2)	1.3	(8.4)	8.0	(16.7)	5.5	(14.3)	4.1	(14.2)
	<i>Nitzschia recta</i>	0.6	(4.4)	0.5	(3.2)	2.4	(5.0)	2.7	(7.0)	1.6	(5.5)
	Total	13.7		15.5		48.0		38.4		28.9	
Late August	<i>Melosira italica</i>	0.2	(2.5)	0.2	(1.4)	0.8	(2.5)	1.4	(2.9)	0.7	(2.7)
	<i>Achnanthes</i>	0.4	(5.0)	0.6	(4.1)	2.2	(6.9)	1.6	(3.3)	1.2	(4.6)
	<i>Asterionella formosa</i>	0.4	(5.0)	1.1	(7.6)	0.3	(0.9)	5.4	(11.1)	1.8	(7.0)
	<i>Fragilaria crotonensis</i>	0.2	(2.5)	1.1	(7.6)	1.5	(4.7)	2.8	(5.8)	1.4	(5.4)
	<i>Fragilaria virescens</i>	1.9	(23.8)	2.7	(18.6)	5.7	(17.8)	4.3	(8.8)	3.7	(14.3)
	<i>Navicula capitata</i>	1.2	(15.0)	2.3	(15.9)	6.3	(19.7)	6.4	(13.2)	4.1	(15.9)
	<i>Nitzschia recta</i>	0.4	(5.0)	1.1	(7.6)	3.7	(11.6)	4.2	(8.6)	2.4	(9.3)
	<i>Stephanodiscus</i>	0.6	(7.5)	1.2	(8.3)	1.5	(4.7)	6.0	(12.3)	2.3	(8.9)
	Total	8.0		14.5		32.0		48.6		25.8	
Sept.	<i>Melosira italica</i>	0.5	(2.6)	0.4	(2.3)	0.4	(2.3)	0.8	(2.4)	0.5	(2.3)
	<i>Achnanthes</i>	1.3	(6.7)	0.4	(2.3)	0.7	(4.0)	2.0	(6.1)	1.1	(5.0)
	<i>Asterionella formosa</i>	2.9	(15.0)	0.6	(3.4)	2.0	(11.7)	3.4	(10.3)	2.2	(10.1)
	<i>Fragilaria crotonensis</i>	0.4	(2.1)	0.2	(1.3)	1.5	(8.7)	0.9	(2.7)	0.8	(3.7)
	<i>Fragilaria virescens</i>	2.7	(14.0)	1.7	(9.7)	2.3	(13.3)	6.2	(18.8)	4.3	(19.7)
	<i>Navicula capitata</i>	4.0	(20.7)	5.8	(33.1)	2.6	(15.0)	5.4	(16.4)	4.5	(20.6)
	<i>Nitzschia recta</i>	0.5	(2.6)	1.6	(9.1)	0.9	(5.2)	2.3	(7.0)	1.3	(6.0)
	<i>Cyclotella</i>	0.7	(3.6)	0.8	(4.6)	0.6	(3.5)	1.0	(3.0)	0.8	(3.7)
	<i>Stephanodiscus</i>	0.8	(4.1)	1.9	(10.8)	1.8	(10.4)	2.0	(6.1)	1.4	(6.4)
	Total	19.3		17.5		17.3		33.0		21.8	

¹Density units: cells per milliliter (ml⁻¹).

²Percent of total phytoplankton density.

Source: Woodward-Environ, Inc., Analysis, 1974.

NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED IN THE KNIFE RIVER DRAINAGE

SPRING CREEK STATION 1						
Month	Species	Number	Length (mm)		Weight (g)	
			Min-Max	X	Min-Max	X
May	White sucker	4	99 - 258	170.8	10 - 102	47.9
	Carp	2	465 - 520	492.5	1465 - 1500	982.5
	Iowa darter	2	47 - 50	48.5	1.0 - 1.5	1.2
	Walleye	1	272		160	
	Northern redbelly dace	1	58		1.7	
	Total	10				
June	Shorthead redhorse	5	262 - 394	300.6	164 - 562	264.4
	Sand shiner	3	40 - 46	44.0	0.7 - 1.1	0.9
	White sucker	2	282 - 404	343.0	232 - 734	367.0
	Carp	1	495		1474	
	Creek chub	1	70		3.4	
	Iowa darter	1	29		0.2	
	Total	13				
July	White sucker	107	38 - 218	49.2	0.6 - 129	4.4
	Sand shiner	29	40 - 60	51.4	0.5 - 2.3	1.4
	Carp	20	24 - 36	20.8	0.1 - 0.8	0.4
	Blacknose dace	3	29 - 33	30.3	0.1 - 0.2	0.1
	Shorthead redhorse	1	155		40.5	
	Northern pike	1	637		1588	
	Total	161				
August	Sand shiner	159	23 - 65	48.8	0.2 - 3.0	1.5
	White sucker	72	40 - 156	68.0	0.9 - 46.0	3.6
	Shorthead redhorse	8	38 - 48	43.0	0.7 - 1.5	1.0
	Carp	3	62 - 480	155.2	3.7 - 1474	375.6
	Northern pike	2	448 - 574	511	910 - 1229	1070
	Walleye	1	258		152	
	Iowa darter	1	28		0.2	
	Northern redbelly dace	1	56		1.9	
	Total	244				
September	Sand Shiner	236	25 - 70	46.4	0.1 - 3.6	1.3
	White sucker	14	70 - 100	82.7	3.9 - 10.8	6.6
	Shorthead redhorse	13	46 - 305	96.2	1.4 - 252.0	35.9
	Carp	6	52 - 121	93.2	2.8 - 30.0	17.1
	Blacknose dace	5	45 - 57	50.4	0.9 - 2.1	1.4
	Northern pike	1	384		324	
	Iowa darter	1	31		0.3	
	Total	276				
October	Sand shiner	384	35 - 64	42.0	0.4 - 2.7	0.8
	White sucker	4	93 - 197	137	8.5 - 95.4	41.6
	Fathead minnow	2	34 - 40	37.0	0.4 - 0.7	0.6
	Shorthead redhorse	1	195		89.9	
	Iowa darter	1	37		0.4	
	Total	392				
KNIFE RIVER STATION 2						
May	Sand shiner	226	23 - 68	38.7	0.1 - 3.2	0.8
	Flathead chub	16	86 - 155	116.9	6.2 - 39.2	17.6
	White sucker	11	82 - 129	96.0	3.2 - 23.6	13.6
	Fathead minnow	9	38 - 43	37.5	0.4 - 1.1	0.7
	Blacknose dace	7	37 - 50	44.1	0.5 - 1.3	0.9
	River carpsucker	3	46 - 60	55.0	1.1 - 2.3	1.9
	Shorthead redhorse	3	116 - 269	171.6	17.6 - 220	87.2
	Stonecat	3	44 - 49	47.3	1.0 - 1.6	1.4
	Total	278				
June	Sand shiner	120	25 - 65	38.4	0.2 - 2.8	0.7
	Flathead chub	8	63 - 119	104.3	2.5 - 17.5	12.5
	White sucker	5	89 - 134	105.4	7.8 - 25.4	13.1
	Shorthead redhorse	4	72 - 305	162.8	4.0 - 258	79.8
	Fathead minnow	3	35 - 37	36.0	0.5 - 0.7	0.6
	Blacknose dace	1	55		2.0	
	Creek chub	1	130		22.2	
	Walleye	1	174		66	
	Iowa darter	1	55		1.7	
	Total	144				
July	Sand shiner	87	26 - 53	39.4	0.2 - 1.6	0.7
	Flathead chub	7	114 - 163	133.1	14.4 - 44.5	23.6
	Blacknose dace	5	29 - 70	39.0	0.3 - 4.5	1.2
	Shorthead redhorse	4	60 - 268	164.0	2.5 - 178.0	86.3
	White sucker	3	105 - 134	124.0	12.5 - 26.3	21.2
	Walleye	2	200 - 226	213.0	78.0 - 110.0	94.0
	Iowa darter	2	33 - 46	39.5	0.4 - 1.3	0.8
	Goldeye	1	55		1.3	
	Northern redbelly dace	1	63		3.3	
	Total	112				
August	Sand shiner	179	25 - 63	44.9	0.1 - 2.8	1.0
	White sucker	40	54 - 158	82.4	1.7 - 46.2	8.6
	Shorthead redhorse	13	33 - 117	56.6	0.6 - 17.4	3.5
	Carp	9	45 - 75	55.7	1.6 - 6.8	3.0
	Flathead chub	6	110 - 160	142.5	12.2 - 38.6	28.5
	Creek chub	5	46 - 52	49.0	1.1 - 1.6	1.3
	Lake chub	3	26 - 35	31.3	0.2 - 0.6	0.4
	Fathead minnow	2	39 - 40	39.5	0.5 - 0.6	0.6
	Stonecat	2	104 - 105	104.5	13.4 - 14.2	13.8
	Iowa darter	1	31		0.3	
	Total	260				

(continues)

Month	Species	Number	Length (mm)		Weight (g)		
			Min-Max	X	Min-Max	X	
September	Sand shiner	268	21 - 70	42.9	0.1 - 2.9	0.9	
	Shorthead redhore	21	40 - 120	64.5	0.7 - 18.9	4.8	
	White sucker	9	60 - 172	131.3	2.3 - 55.2	31.3	
	Creek chub	5	56 - 62	58.0	1.9 - 2.5	2.1	
	Carp	5	60 - 70	65.8	3.8 - 5.6	4.9	
	Flathead chub	3	53 - 119	89.0	1.7 - 16.7	9.0	
	Fathead minnow	2	41	41	0.6	0.6	
	Blacknose dace	1	75		5.2		
	River carpaucker	1	67		4.0		
	Total	313					
October	Sand shiner	60	30 - 62	46.8	1.1 - 3.3	2.0	
	Fathead minnow	57	32 - 61	46.3	0.4 - 2.6	1.2	
	Flathead chub	36	42 - 162	95.1	0.6 - 40.0	14.8	
	Creek chub	19	54 - 122	64.5	1.6 - 18.0	3.5	
	White sucker	11	74 - 191	127.4	4.5 - 64.0	27.0	
	Carp	7	55 - 71	64.7	4.0 - 6.9	5.4	
	River carpaucker	6	55 - 147	79.0	3.1 - 47.0	11.3	
	Blacknose dace	2	38 - 45	41.5	0.6 - 0.9	0.8	
	Total	178					
SPRING CREEK STATION 3							
May	Shorthead redhore	4	136 - 287	211.2	24.7 - 225.0	123.2	
	White sucker	3	186 - 335	237.0	78 - 398	237.0	
	Carp	2	435 - 520	477.5	1300 - 2000	1650	
	Stonecat	2	125 - 141	133.0	20.7 - 38.3	29.5	
	Blacknose dace	2	49 - 58	53.5	1.1 - 1.2	1.2	
June	Sand shiner	2	59 - 90	74.5	1.8 - 7.5	4.6	
	Fathead minnow	1	67		3.4		
	Total	3					
July	Sand shiner	6	28 - 47	37.0	0.3 - 1.0	0.6	
	White sucker	5	45 - 358	161.8	3.0 - 396	103.7	
	Shorthead redhore	4	145 - 340	274.2	29.0 - 356	224.8	
	Iowa darter	2	41 - 49	45.0	0.8 - 1.3	1.0	
	Flathead chub	1	175		56		
	Northern redbelly dace	1	59		1.4		
	Total	19					
August	White sucker	59	29 - 40	33.3	0.2 - 0.8	0.4	
	Sand shiner	19	34 - 46	42.9	0.6 - 1.3	0.8	
	Shorthead redhore	5	261 - 419	332.4	148 - 736	363.6	
	Blacknose dace	3	33 - 50	39.0	0.4 - 1.6	0.8	
	Carp	2	39 - 40	39.5	1.3	1.3	
	Northern pike	1	271		94		
	Northern redbelly dace	1	46		1.2		
	Total	90					
September	Sand shiner	128	30 - 60	48.0	0.3 - 2.2	1.2	
	White sucker	122	22 - 166	58.1	0.2 - 59.6	3.3	
	Carp	39	29 - 85	53.3	0.4 - 11.8	3.0	
	Blacknose dace	23	28 - 112	50.1	0.2 - 16.1	2.2	
	Stonecat	5	30 - 144	97.2	0.2 - 36.7	19.7	
	Fathead minnow	1	35		0.6		
	Flathead chub	1	150		35.7		
	Brassy minnow	1	64		2.6		
	Iowa darter	1	43		0.7		
	Total	321					
October	Sand shiner	291	27 - 63	44.5	0.2 - 2.4	0.9	
	White sucker	60	55 - 146	69.6	2.2 - 34.1	4.4	
	Shorthead redhore	45	36 - 140	46.4	0.6 - 30.4	1.7	
	Carp	41	35 - 79	55.8	0.7 - 9.3	3.6	
	Blacknose dace	33	34 - 85	42.6	0.2 - 6.3	1.0	
	Fathead minnow	10	43 - 51	47.4	0.9 - 1.6	1.1	
	Flathead chub	6	130 - 180	157.2	21.0 - 60.0	39.6	
	Stonecat	2	30 - 165	97.5	0.3 - 52.0	26.1	
	Northern redbelly dace	2	38 - 43	40.5	0.5 - 0.9	0.7	
	Total	490					
November	Sand shiner	156	27 - 63	40.0	0.1 - 2.6	0.6	
	Fathead minnow	12	34 - 65	42.8	0.4 - 3.2	1.0	
	White sucker	9	55 - 232	98.2	1.8 - 146.0	11.2	
	Blacknose dace	8	35 - 75	49.1	0.5 - 4.6	1.7	
	Shorthead redhore	6	41 - 50	44.8	0.9 - 1.5	1.2	
	Carp	2	40 - 55	47.5	1.2 - 3.1	2.2	
	Northern pike	1	322		218		
	Stonecat	1	30		0.5		
	Iowa darter	1	54		1.6		
	Total	196					
KNIFE RIVER STATION 4							
May	Sand shiner	23	36 - 72	46.9	0.3 - 3.3	1.0	
	Blacknose dace	5	45 - 68	59.2	0.9 - 2.9	2.2	
	Flathead chub	3	97 - 159	124.3	8.6 - 38.3	20.6	
	White sucker	1	78		5.2		
	Shorthead redhore	1	275		211.6		
June	Sand shiner	64	30 - 64	43.9	0.3 - 2.4	0.9	
	Blacknose dace	4	48 - 76	58.3	1.1 - 5.0	2.4	
	Flathead chub	4	83 - 173	113.8	5.5 - 44.3	17.8	
	Shorthead redhore	4	61 - 176	98.8	2.6 - 58.7	17.7	
	Emerald shiner	1	76		3.3		
	Total	77					

(continues)

Month	Species	Number	Length (mm)		Weight (g)	
			Min-Max	x	Min-Max	x
July	Sand shiner	374	17 - 65	43.7	Tr ² -	3.4 1.0
	Flathead minnow	38	39 - 51	44.8	0.5 -	1.5 1.0
	White sucker	16	20 - 205	54.0	0.3 -	98.3 9.7
	Stonerat	3	75 - 165	108.3	8.0 -	36.6 16.4
	Blacknose dace	2	72 - 74	73.0		4.6
	Carp	1				4.6
	Total	434			902	
August	Sand shiner	340	28 - 67	50.2	0.1 -	2.6 1.4
	Shorthead redhorse	23	35 - 284	76.2	0.4 -	174 14.2
	Carp	23	43 - 468	72.2	1.4 -	1077 49.3
	Flathead minnow	18	30 - 54	45.6	0.5 -	2.0 1.3
	Flathead chub	13	50 - 158	121.3	1.4 -	34.2 20.4
	Channel catfish	12	31 - 55	43.2	0.2 -	1.4 0.7
	Creek chub	4	51 - 95	63.5	1.4 -	8.9 3.4
	White sucker	4	51 - 54	53.0	1.4 -	1.7 1.5
	Blacknose dace	2	31 - 42	36.5	0.4 -	0.8 0.6
	Stonerat	1			6.5	
	Sauger	1	390		384	
	Total	441				
September	Sand shiner	434	25 - 57	38.4	0.1 -	2.0 0.6
	Flathead minnow	57	29 - 65	39.5	0.2 -	3.2 0.7
	Shorthead redhorse	16	43 - 215	75.9	1.0 -	98.1 10.3
	Flathead chub	7	130 - 177	155.6	20.2 -	55.8 32.6
	Channel catfish	6	45 - 49	46.5	1.0 -	1.2 1.1
	White sucker	6	75 - 230	169.5	5.1 -	298 81.3
	Blacknose dace	5	37 - 46	41.6	0.7 -	1.1 0.8
	Creek chub	3	53 - 75	60.6	1.3 -	4.3 2.4
	Carp	3	58 - 65	62.3	3.1 -	4.6 3.8
	River carpsucker	1	34		0.3	
	Total	538				
October	Sand shiner	450	26 - 65	41.0	0.1 -	3.0 0.9
	Flathead minnow	168 ³	32 - 62	38.4	0.4 -	2.7 0.9
	Flathead chub	21	67 - 175	139.9	3.6 -	56.0 30.3
	Shorthead redhorse	13	45 - 274	95.1	1.1 -	180.0 22.4
	Carp	6	50 - 71	63.3	2.3 -	6.3 4.7
	White sucker	3	65 - 120	91.7	3.3 -	20.0 10.3
	Creek chub	1	68		3.7	
	River carpsucker	1	51		1.8	
KNIFE RIVER STATION 6						
May	Sand shiner	22	28 - 65	42.1	0.2 -	2.4 0.8
	White sucker	7	70 - 108	82.7	3.5 -	11.4 6.4
	Flathead chub	2	123 - 126	124.5	19.6 -	23.1 21.3
	Total	31				
June	Sand shiner	76	24 - 69	40.4	0.2 -	3.5 0.8
	Shorthead redhorse	14	63 - 92	71.4	2.8 -	8.0 4.1
	White sucker	6	87 - 117	104.8	5.6 -	14.8 10.6
	Flathead minnow	2	54 - 55	54.5	1.6 -	1.9 1.8
	Flathead chub	2	112 - 114	128.0	16.4 -	29.4 22.9
	Total	101				
July	Sand shiner	16	24 - 54	38.7	0.1 -	1.6 0.8
	Carp	13	25 - 34	27.4	0.2 -	0.5 0.4
	White sucker	9	23 - 130	41.7	0.2 -	24.0 3.0
	Flathead minnow	5	36 - 47	43.4	0.6 -	1.4 1.0
	Blacknose dace	3	34 - 39	37.0	0.4 -	0.8 0.6
	Total	46				
August	Sand shiner	70	27 - 60	33.4	0.2 -	2.3 0.4
	Shorthead redhorse	16	40 - 135	57.8	0.7 -	27.2 4.5
	Flathead minnow	6	25 - 38	30.3	0.1 -	0.7 0.3
	Channel catfish	4	41 - 50	45.3	0.7 -	1.1 1.0
	White sucker	2	125 - 134	129.5	22.0 -	27.7 24.8
	Carp	1	31		0.4	
	Creek chub	1	46		1.2	
	Sauger	1	305		162	
	Walleye	1	283		138	
	Total	102				
September	Sand shiner	246	21 - 62	37.1	Tr ¹ -	2.3 0.6
	Shorthead redhorse	40	43 - 137	53.7	0.8 -	27.9 2.4
	Flathead minnow	20	23 - 33	23.8	0.1 -	0.4 0.2
	Creek chub	8	50 - 66	57.9	1.6 -	3.3 2.2
	Carp	7	40 - 70	52.3	1.4 -	5.9 2.8
	Channel catfish	6	35 - 48	46.2	0.5 -	1.3 1.2
	White sucker	2	61 - 66	63.5	2.9 -	3.6 3.2
	Walleye	1	325		238	
	Total	330				
October	Sand shiner	278	34 - 63	42.1	0.2 -	3.7 0.8
	Flathead minnow	17	32 - 45	39.2	0.5 -	1.1 0.7
	Creek chub	1	63		2.9	
	River carpsucker	1	36		0.6	
	White sucker	1	204		84	
	Shorthead redhorse	1	126		18	
	Total	399				

¹40 were weighed and measured.

²Trace.

³44 were weighed and measured.

Source: Woodward-Envicon, Inc., Analysis, 1974.

**NUMBER OF MACROINVERTEBRATES PER SQUARE METER AND PERCENT
RELATIVE ABUNDANCE COLLECTED IN THE KNIFE RIVER DRAINAGE,**

Spring Creek Station 1													
Organism	May		June		July		August		September		October		Avg. No. Per Sample
	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	
Nematoda	33.3	9.1			7.4	1.2		0.8	3.7	0.3	12.5	1.4	10.1
Oligochaeta	85.2	23.2	37.0	40.0	37.0	6.2	29.6	6.1	66.7	5.9	85.2	9.4	56.8
Hyalella asteca					7.4	1.2					7.4	0.8	2.5
Ephoron sp.					25.9	4.4							4.3
Baetis sp.			3.7	4.0	40.7	6.9	11.1	2.3	118.5	10.6	7.4	0.8	30.2
Caenis sp.	3.7	1.0	3.7	4.0	59.3	10.0							11.1
Isonychia sp.					3.7	0.6							0.6
Leptophlebia sp.											51.8	5.7	8.6
Steronema sp.			7.4	8.0					3.7	0.3	270.4	30.0	46.9
Gomphus sp.					3.7	0.6			14.8	1.3			3.1
Corixidae (A) ¹	3.7	1.0			18.5	3.1	33.3	6.9	25.9	2.3	3.7	0.4	14.2
Sialis sp.							7.4	1.5			3.7	0.4	1.8
Hydropsyche sp.					7.4	1.2	7.4	1.5	66.7	5.9	70.4	7.8	25.3
Chamaecorys sp.					285.2	48.1	44.4	9.8	240.7	21.4	200.0	22.2	178.4
Polycentropus sp.							11.1	2.3					1.8
Leptocella sp.					7.4	1.2							1.2
Elmidae (L) ²	11.1	3.0			7.4	1.2			37.0	3.3	3.7	0.4	9.9
Tipulidae											66.6	7.4	11.1
Simulium sp. (L)			18.5	20.0			3.7	0.8	229.6	20.5	56.2	6.2	51.3
Simulium sp. (P) ³									3.7	0.3			0.6
Pentaneurini					25.9	4.4	3.7	0.8					4.9
Procladius sp.			7.4	8.0									1.2
Chironomus sp.	3.7	1.0							11.1	1.0			2.5
Cryptochironomus sp.	22.2	6.0	3.7	4.0	18.5	3.1	81.5	16.8	111.1	9.9	3.7	0.4	40.1
Polydora sp.	44.4	12.1			14.8	2.5	29.6	6.1	25.9	2.3			19.1
Strictochironomus sp.							7.4	1.5					1.2
Microtandipes sp.	7.4	2.0			3.7	0.6					10.4	1.2	3.6
Tanytarsus sp.	11.1	3.0	3.7	4.0			166.7	34.4	100.0	8.9			46.9
Chironomidae (P)	140.7	38.4			18.5	3.1	40.7	8.4	33.3	3.0			38.9
Ceratopogonidae			7.4	8.0			3.7	0.8	25.9	2.3	31.2	3.4	11.4
Tabanidae									3.7	0.3	14.6	1.6	3.0
Total	366.5	99.8	92.5	100.0	592.4	99.6	485.0	100.2	1122.0	99.8	902.6	99.9	593.5
Knife River Station 2													
Nematoda					3.7	0.5					7.4	1.6	1.8
Oligochaeta	40.7	34.4	77.8	48.9	18.5	2.5	100.0	13.6	29.6	3.2	51.8	11.6	53.1
Hyalella asteca											3.7	0.8	0.6
Hemagenia sp.											29.6	6.6	4.9
Ephoron sp.							3.7	0.5	3.7	0.4			1.2
Baetis sp.					174.1	23.8	18.5	2.5	11.1	1.2	3.7	0.8	34.6
Caenis sp.									3.7	0.4	7.4	1.6	1.8
Isonychia sp.					18.5	2.5							3.1
Leptophlebia sp.											3.7	0.8	0.6
Steronema sp.	3.7	3.1	14.8	9.3	59.3	8.1	48.2	6.6	181.5	19.9	107.4	24.0	69.2

(continues)

Organism	May		June		July		August		September		October		Avg. No. Per Sample
	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	
Heptagenia sp.					44.4	6.1			3.7	0.4			7.4
Gomphus sp.											18.5	4.1	3.1
Corixidae (A)							3.7	0.5	37.0	4.1	7.4	1.6	6.0
Stellia sp.	25.9	21.9			14.8	2.0	18.5	2.5	133.3	14.6	3.7	0.8	32.7
Hydropsyche sp.													
Chumatopsyche sp.	7.4	6.2			325.9	44.7	407.4	55.6	411.1	45.1	92.6	20.7	207.4
Polycentropus sp.					3.7	0.5							0.6
Simulium (A)					11.1	1.5			3.7	0.4			2.5
Simulium (L)	7.4	6.2									11.1	2.5	3.1
Tipulidae											14.8	1.3	2.5
Simulium (L)			32.3	20.9			35.9	3.5	51.8	5.7	37.0	8.3	24.7
Simulium (P)									7.4	0.8			1.2
Pentaneurini							3.7	0.5	11.1	1.2	3.7	0.8	3.1
Cryptochironomus sp.	3.7	3.1			14.8	2.0			3.7	0.4			3.7
Endochironomus sp.							59.3	8.1					9.9
Strictochironomus sp.			3.7	2.3									0.6
Microtendipes sp.	18.5	15.6			37.0	5.1	22.2	3.0			18.5	4.1	16.0
Tanytarsus sp.	3.7	3.1	18.5	11.6					3.7	0.4			4.3
Chironomidae (P)	3.7	3.1	7.4	4.6			3.7	0.5	3.7	0.4			3.1
Ceratopogonidae			3.7	2.3							22.2	5.0	4.3
Tabanidae							14.8	2.0	11.1	1.2	3.7	0.8	4.9
Sphaerium sp.	3.7	3.1			3.7	0.5	3.7	0.5					1.8
Total	118.4	99.8	159.2	99.9	729.5	99.8	733.3	99.9	910.9	99.8	447.9	99.8	516.4

Spring Creek Station 3

Heptagenia sp.			18.5	13.5	7.4	1.4			3.7	0.4	11.1	1.0	8.9
Oligochaeta	40.7	28.2	22.2	16.2	111.1	21.0	33.3	3.1	88.9	9.3	29.6	2.6	54.3
Hyalella asteca					7.4	1.4					51.8	4.6	9.9
Perlesta sp.					3.7	0.7							0.8
Heptagenia sp.							11.1	1.0					1.8
Ephoron sp.					7.4	1.4	3.7	0.3	7.4	0.8			3.1
Baetis sp.			3.7	2.7	14.8	2.8	7.4	0.7	14.8	1.6	3.7	0.3	7.4
Tricorythodes sp.							11.1	1.0	3.7	0.4	3.7	0.3	3.1
Cannia sp.			3.7	2.7	18.5	3.5	3.7	0.3	11.1	1.2			6.2
Isonychia sp.					14.8	2.8	14.8	1.4	3.7	0.4			5.8
Leptophlebia sp.											3.7	0.3	0.8
Stenonema sp.			11.1	8.1					14.8	1.6	170.4	15.1	22.7
Gomphus sp.									7.4	0.8			1.2
Agrion sp.									3.7	0.4			0.8
Corixidae			3.7	2.7	7.4	1.4	329.6	30.9	240.7	25.1	3.7	0.3	97.5
Stellia sp.							14.8	1.4					2.5
Hydropsyche sp.	7.4	5.1	7.4	5.4	133.3	25.2	251.8	33.6	192.6	20.1	203.7	18.1	132.7
Chumatopsyche sp.					55.7	10.5	244.4	22.9	277.8	29.0	337.0	29.9	182.5
Polycentropus sp.											3.7	0.3	0.8
Leptocella sp.					7.4	1.4							1.2
Acrispis sp.											7.4	0.8	1.2
Simulium (A)			3.7	2.7	11.1	2.1							2.5
Simulium (L)			3.7	2.7	3.7	0.7	3.7	0.3	29.6	3.1	7.4	0.8	8.0
Tipulidae											70.4	6.2	11.7
Simulium sp. (L)	3.7	2.6	68.2	35.4	18.5	3.5	3.7	0.3	18.5	1.9	11.1	1.0	17.3
Simulium sp. (P)					14.8	2.8							2.5
Pentaneurini							3.7	0.3					0.8
Procladius sp.			3.7	2.7									0.6
Cryptochironomus sp.					3.7	0.7	11.1	1.0	3.7	0.4			3.1
Endochironomus sp.							40.7	3.8					8.9
Polypedium sp.	18.5	12.8			3.7	0.7	3.7	0.3					4.3
Strictochironomus sp.	7.4	5.1											1.2
Microtendipes sp.	63.0	43.8			70.4	13.3	55.8	5.2	27.9	2.9	162.7	14.4	65.3
Simuliidae	3.7	2.8	3.7	2.7							14.8	1.3	3.7
Chironomidae (P)			3.7	2.7	7.4	1.4	7.4	0.7	3.7	0.4			3.7
Tabanidae							3.7	0.3					0.8
Phryga sp.							3.7	0.3	3.7	0.4	18.5	1.8	4.3
Sphaerium sp.					7.4	1.4	3.7	0.3			11.1	1.0	3.7
Total	144.4	100.0	337.0	100.2	529.6	100.2	1066.4	99.4	957.4	100.2	1125.5	99.5	860.2

Knife River Station 4

Heptagenia sp.	3.7	1.5	7.4	2.4	14.8	2.9	14.8	1.5					8.8
Oligochaeta	100.0	41.7	203.7	85.5	11.1	2.2	11.1	0.1	7.4	2.2	22.2	2.3	59.2
Ephoron sp.					74.1	14.5	3.7	0.4					13.0
Baetis sp.			11.1	3.6			29.6	3.0			7.4	0.8	8.0
Pseudocloeon sp.									3.7	1.1			0.8
Tricorythodes sp.							7.4	0.8					1.2
Cannia sp.	3.7	1.5			11.1	2.2					3.7	0.4	3.1
Isonychia sp.					11.1	2.2							1.8
Leptophlebia sp.											7.4	0.8	1.2
Stenonema sp.	18.5	7.7	3.7	1.2	44.4	8.7	85.2	8.6	111.1	33.7	303.7	31.1	94.4

(continues)

Organism	May		June		July		August		September		October		Avg. No. Per Sample
	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	Number Per M ²	% of Total	
<i>Heptagenia</i> sp.					11.1	2.2	3.7	0.4	22.2	6.7			6.2
<i>Camphus</i> sp.					11.1	2.2			11.1	3.4			1.8
Corixidae							3.7	0.4					1.8
<i>Stelis</i> sp.					51.8	10.1	85.2	8.6	14.8	4.5	148.1	15.2	0.6
<i>Hydropsyche</i> sp.	37.0	15.4	7.4	2.4									57.4
<i>Chamaetopseus</i> sp.	25.9	10.8	7.4	2.4	151.8	29.7	588.9	59.6	18.5	5.6	351.8	36.0	190.7
Elmidae (A)					3.7	0.7							1.2
Elmidae (L)	7.4	3.1							7.4	2.2	3.7	0.4	3.1
Tipulidae									37.0	3.8			6.2
<i>Simulium</i> (L)			59.3	19.1					3.7	1.1	7.4	0.8	12.7
<i>Simulium</i> (P)					48.2	9.4							8.0
Pentaneurini	7.4	3.1					3.7	0.4	18.5	5.6			4.9
<i>Chironomus</i> sp.					7.4	1.4			7.4	2.2			1.2
<i>Cryptochironomus</i> sp.							81.5	8.2	14.8	4.5			3.7
<i>Endochironomus</i> sp.													13.6
<i>Paratendipes</i> sp.	3.7	1.5											1.2
<i>Stictochironomus</i> sp.			3.7	1.2									1.2
<i>Microtendipes</i> sp.	11.1	4.6			55.6	10.9	37.0	3.7	33.3	10.1	33.3	3.4	28.4
<i>Tanytarsus</i> sp.	11.1	4.6							7.4	2.2			3.1
Dimeptinae			3.7	1.2									1.2
<i>Cricotopus</i> sp.	3.7	1.5	3.7	1.2									1.2
Chironomidae (P)	7.4	3.1			3.7	0.7	33.3	3.4	22.2	6.7			11.1
Ceratopogonidae									7.4	2.2	3.7	0.4	1.8
Tabanidae											48.1	4.9	8.0
Total	240.6	100.0	311.1	100.2	511.0	100.0	988.8	99.1	329.4	499.6	977.5	100.3	558.6

Knife River Station 6

Rematoda	3.7	8.2	3.7	3.2	3.7	0.9							1.8
Oligochaeta	48.1	28.3	7.4	6.4			40.7	8.7	29.6	4.8	118.5	13.1	40.7
Perlesta sp.			3.7	3.2									0.6
<i>Hydropsyche</i> sp.					55.7	11.8							9.3
<i>Stelis</i> sp.			11.1	9.7	33.3	7.0			18.5	3.0	3.7	0.5	11.1
<i>Tricorythodes</i> sp.							11.1	2.4	3.7	0.6	3.7	0.5	3.1
<i>Chaetia</i> sp.					22.2	4.7	18.5	3.9					6.8
<i>Isomyia</i> sp.			3.7	3.2			22.2	4.7					4.3
<i>Cryptochironomus</i> sp.											35.9	3.3	4.3
<i>Stenomus</i> sp.					55.7	11.8	70.4	15.0	251.8	41.2	507.4	64.6	147.6
<i>Heptagenia</i> sp.					14.8	3.1	7.4	1.6	3.7	0.6			4.3
<i>Camphus</i> sp.											3.7	0.5	0.6
Corixidae					140.7	29.7	111.1	23.6	63.0	10.3			52.5
<i>Stelis</i> sp.									11.1	1.8			1.8
<i>Hydropsyche</i> sp.			14.8	12.9	44.4	9.4			11.1	1.8	7.4	0.9	13.0
<i>Chamaetopseus</i> sp.	3.7	2.2	40.7	35.5	14.8	3.1	118.5	25.2	114.8	18.8	85.2	10.8	63.0
<i>Polycapnos</i> sp.											3.7	0.5	0.6
<i>Leptocella</i> sp.									7.4	1.2			1.2
<i>Astenophylla</i> sp.			3.7	3.2									0.6
Elmidae (A)					3.7	0.9			3.7	0.6			1.2
Elmidae (L)	7.4	4.3									11.1	1.4	3.1
Tipulidae											7.4	0.9	1.2
<i>Simulium</i> (L)			11.1	9.7							7.4	0.9	3.1
Pentaneurini					7.4	1.6	3.7	0.8	3.7	0.6			2.5
<i>Cryptochironomus</i> sp.	33.3	19.6			60.7	8.6	11.1	2.4	37.0	6.1			20.4
<i>Endochironomus</i> sp.							14.8	3.2					2.5
<i>Polypedium</i> sp.	48.1	28.3	3.7	3.2									8.6
<i>Paraleuterborniella</i> sp.							7.4	1.6					1.2
<i>Microtendipes</i> sp.	3.7	2.2			7.4	1.6	14.8	3.2	37.0	6.1			10.5
<i>Tanytarsus</i> sp.	18.5	10.9			18.5	3.9							8.2
Chironomidae (P)	3.7	2.2	7.4	6.4	11.1	2.3	3.7	0.8	7.4	1.2			5.6
Ceratopogonidae			3.7	3.2			14.8	3.2	7.4	1.2			4.3
Total	170.2	100.2	114.7	99.8	474.1	100.4	470.2	100.3	610.9	99.9	785.1	99.9	437.6

- 1 Adult
2 Larvae
3 Pupae

Source: Woodward-Clifton, Inc., Analysis, 1974.

Appendix H

Animal Numbers Lost During Construction and Mining

Birds ²	Number of Individuals ³	Birds ²	Number of Individuals ³
Song sparrow	3	Red-winged blackbird	77
Pied-billed grebe	2	Brewer's blackbird	3
Mallard	32	Common grackle	8
Pintail	22	Brown-headed cowbird	8
Gadwall	5	Orchard oriole	N
Shoveler	39	Baltimore oriole	N
Blue-winged teal	14	Rose-breasted grosbeak	N
Ruddy duck	N	American goldfinch	P
American coot	28	Dickcissel	5
Sora	N	Rufous-sided towhee	N
Killdeer	24	Grasshopper sparrow	P
Upland plover	2	Baird's sparrow	N
Willet	N	Lark bunting	118
Wilson's phalarope	16	Veasler sparrow	6
Black tern	N	Clay-colored sparrow	7
Sharp-tailed grouse	P	Song sparrow	P
Ring-necked pheasant	P	McComb's longspur	N
Gray partridge	P	Chestnut-collared longspur	13
Marsh hawk	P		
Cooper's hawk	N		
		Mammals ⁴	
Swainson's hawk	P	Masked shrew	N
Great-horned owl	P	Thirteen-lined ground squirrel	P
Burrowing owl	N	Northern pocket gopher	P
Rock dove	N	Wyoming pocket mouse	P ⁵
Mourning dove	P	Deer mouse	870
Black-billed cuckoo	N	Northern grasshopper mouse	P
Common nighthawk	P	Boreal red-backed vole	N
Belted kingfisher	N	Prairie vole	N
Yellow-shafted flicker	N	House mouse	P
Eastern kingbird	9	Meadow jumping mouse	P
Western kingbird	N	Raccoon	1
Eastern phoebe	N	Long-tailed weasel	P
Traill's flycatcher	N	Mink	N
Least flycatcher	N	Badger	P
Horned lark	44	Striped skunk	2
		Coyote	P
Barn swallow	12	Red fox	1
Tree swallow	N	Fox squirrel	N
Bank swallow	N	Porcupine	N
Rough-winged swallow	3	White-tailed jackrabbit	2
Blue jay	N		
Black-billed magpie	N	Eastern cottontail	N
Common crow	N	Mule deer	N
Catbird	N	White-tailed deer	P
Brown thrasher	N	Pronghorn	20
Robin	3		
		Amphibians and Reptiles	
Loggerhead shrike	N	Blotched tiger salamander	N
Starling	N	Great Plains toad	N
Philadelphia vireo	N	Northern leopard frog	P
Yellow warbler	N	Western painted turtle	P
Ovenbird	N	Plains garter snake	P
Yellowthroat	15	Red-sided garter snake	P
House sparrow	6	Western horned snake	N
Bobolink	18	Yellow-billed racer	P
Western meadowlark	9	Smooth green snake	N
Yellow-headed blackbird	14	Bull snake	N

² Numbers represent the estimated spring (breeding) populations based on site specific field studies.

³ N = not observed on proposed plant site; known to occur in the vicinity;
P = present in low unknown numbers.

¹Based on estimated fall population levels.

⁵Based on site specific trapping studies.

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**ESTIMATED NUMBERS OF INDIVIDUALS OF RESIDENT FAUNAL SPECIES
CORRESPONDING TO 12,500 ACRES OF TERRESTRIAL HABITAT INCLUDED
IN PROPOSED SURFACE MINES BASED ON 1974 POPULATION LEVELS**

Birds ¹	Estimated No. of Individuals ²	Generalized Habitat Utilization ³			
		Agricultural	Prairie	Wetland	Wooded
Eared grebe	P			N,F	
Pied-billed grebe	P			N,F	
Mallard	10			N,F	
Pintail	P			N,F	
Gadwall	10			N,F	
Shoveler	P			N,F	
Blue-winged teal	15			N,F	
Ruddy duck	P			N,F	
American coot	P			N,F	
Sora	P			N,F	
Killdeer	195	N,F	N,F	N,F	
Upland plover	120		N,F		
Willet	P			N,F	
Wilson's phalarope	P			N,F	
Black tern	P			N,F	
Sharp-tailed grouse	30	F	N,F		F,W
Ring-necked pheasant	50	N,F	F		F,W
Gray partridge	P	N,F	F		W
Cooper's hawk	2				N,F
Marsh hawk	5	F	N,F	F	
Swainson's hawk	2	F	F		N
Great-horned owl	2	F	F	F	N,F
Burrowing owl	2		N,F		
Rock dove	P	N,F			
Mourning dove	135	F	F		N
Black-billed cuckoo	P				N,F
Common nighthawk	P	N,F	F	F	N,F
Belted kingfisher	P			F	N
Yellow-shafted flicker	P				N,F
Eastern kingbird	250	F	F		N,F
Western kingbird	P	F	F		N,F
Eastern phoebe	P				N,F
Trail's flycatcher	P				N,F
Least flycatcher	P				N,F
Horned lark	1600	N,F	N,F		
Barn swallow	P	N,F	F	F	F
Tree swallow	P	F	F	F	N,F
Bank swallow	P	F	F	N,F	
Rough-winged swallow	P	F	F	N,F	
Blue jay	P				N,F
Black-billed magpie	P	F	F		N,F
Common crow	P	F	F		N,F
Cat bird	P				N,F
Brown thrasher	P	F	F		N,F
Robin	95	F	F		N,F
Loggerhead shrike	P	F	F		N,F
Starling	P	N,F	F		N,F
Philadelphia vireo	P	F	F		N,F
Yellow warbler	80				N,F
Ovenbird	P				N,F
Yellow throat	80			N,F	N,F
House sparrow	95	N,F			N
Bobolink	155	N,F		N,F	
Western meadowlark	915	N,F	N,F		
Yellow-headed blackbird	P			N,F	
Red-winged blackbird	605	N,F	F	N,F	
Brewer's blackbird	275	N,F			
Common grackle	P	F			N
Brown-headed cowbird	820	N,F	N,F		N
Orchard oriole	P				N,F

(cont'd-1)

Birds ¹	Estimated No. of Individuals ²	Generalized Habitat Utilization ³			
		Agricultural	Prairie	Wetland	Wooded
Baltimore oriole	P				N,F
Rose-breasted grosbeak	P				N,F
American goldfinch	P	F	F		N
Dickcissel	P	N,F			
Rufous-sided towhee	P				N,F
Grasshopper sparrow	135	N,F	N,F		
Baird's sparrow	P	N,F	N,F		
Lark bunting	1800	N,F	N,F		
Vesper sparrow	215	N,F	N,F		
Clay-colored sparrow	275				N,F
Song sparrow	P	F	F		N
McCown's longspur	P		N,F		
Chestnut collared longspur		N,F	N,F		
<u>Mammals⁵</u>					
Masked shrew	60	X			X
Thirteen-lined ground squirrel	950	X	X		
Northern pocket gopher	6100	X	X		
Wyoming pocket mouse	300	X			
Deer mouse	15000	X	X		X
Northern grasshopper mouse	800	X	X		
Boreal red-backed vole	P				X
Prairie vole	P	X	X		
House mouse	250	X			
Meadow jumping mouse	P				X
Raccoon	23	X	X	X	X
Long-tailed weasel	P	X	X		X
Mink	P			X	
Badger	P	X	X		
Striped skunk	35	X	X	X	X
Coyote	4	X	X	X	X
Red fox	12	X	X	X	X
Fox squirrel	P				X
Porcupine	P				X
White-tailed jackrabbit	37	X	X		
Eastern cottontail	P				X
Mule deer	P		X		X
White-tailed deer	4	X	X		X
Pronghorn	13	X	X		
<u>Amphibians and Reptiles</u>					
Blotched tiger salamander	P	X		X	X
Great Plains toad	P		X	X	
Northern leopard frog	P			X	
Western painted turtle	P			X	
Plains garter snake	P	X	X	X	
Red-sided garter snake	P	X	X	X	
Western hognose snake	P	X	X		
Yellow-bellied racer	P	X	X		
Smooth green snake	P		X		X
Bull snake	P	X	X		

¹ Population levels of bird species pertain to the breeding season (spring).

² P = Present in low unknown numbers.

³ N = nesting, F = feeding, W = wintering.

⁴ Population levels of mammal species pertain to fall.

Source: Woodward-Envicon, Inc, 1974.

Appendix I

ANGCGC's Air Quality Dispersion Analysis

SUMMARY

This report summarizes the dispersion analyses used to evaluate the impact on the air quality resulting from the construction and operation of the proposed ANG Coal Gasification Plant and Basin Electric proposed coal fired electric generating stations. The dispersion modeling was based upon techniques and methods developed by the Environmental Protection Agency as published in the Workbook of Atmospheric Dispersion Estimates and Guidelines for Air Quality Maintenance Planning and Analysis, Volume 10 Reviewing New Stationary Sources. Whenever possible the programs available in EPA's UNAMAP model were utilized. An additional subroutine was added to the PTDIS, PTMAX and PTMPT programs in order to allow for the evaluation of emissions from sources with jet (non-bouyant) plumes. The program modification is described in the Appendix. Existing power plants and those proposed power plants which have been granted a water permit prior to the preparation of this report were also considered.

Based upon the estimated concentrations obtained through dispersion modeling and using preliminary engineering information the proposed joint projects will meet all applicable North Dakota and Federal ambient air standards, including the significant deterioration Class II standards for sulfur dioxides and Class II for total suspended particulates.

A. Description of Air Emissions Resulting From the Proposed Project

The following report analyzes the air emissions generated during construction and operation of the proposed ANG Coal Gasification Plant and Basin Electric proposed electric generating facility. The impact on the air quality resulting from the growth associated with the project is also discussed.

Fugitive dust emissions created during plant construction and emissions generated from the construction equipment are evaluated in Section I. These emissions are summarized in Table I.

In Section D the air emissions resulting from the operation of the proposed project are analyzed. These emissions include: those emissions generated by the combustion of coal fines in the Basin's steam generators and by the combustion of tar by-products in the superheaters (sulfur dioxide, nitrogen dioxide, hydrocarbons, carbon monoxide, and particulates); the particulate emissions from the coal handling operations, and the fugitive dust emissions created by the mining operations. Intermittent emissions from ANG's start-up incinerator, refuse incinerator and flares are also considered. The emission rates, stack design data and the location of each of the above sources, are summarized in Table II.

The majority of the hydrocarbon emissions from the gasification plant are controlled either by incineration in the superheaters or by flaring (Table II). However, small intermittent quantities of hydrocarbons will also be released from the by-product storage area. The hydrocarbon emissions from the storage area are given in Page 162 of the application. The dispersion of the emissions from the storage area will be very localized, and therefore, the effects of these hydrocarbon emissions were not evaluated.

Although it is frequently cited that the operation of a coal gasification plant will increase the formation of photochemical oxidants in a region (Northern Great Plains Resource Program (NGPRP), and Nordesick, et.al) an increase in the oxidant level due to the operation of ANG's plant is not anticipated. The formation of photochemical oxidants is dependent not only on the ambient NO_x concentration but also the ambient hydrocarbon concentration. As previously cited, the hydrocarbon emissions are well controlled. Furthermore, as stated in ANG's Environmental Impact Report (EIR), the background hydrocarbon concentration in the area is well below state and federal

TABLE I

ON-SITE AIR EMISSIONS DURING CONSTRUCTION
PHASE USED FOR DISPERSION MODELING

VEHICLE EMISSIONS (1):	MAXIMUM EMISSION RATE (lb/hr)
Total Suspended Particulates	3.43
Sulfur Oxides	6.83
Carbon Monoxide	57.25
Hydrocarbon	9.38
Nitrogen Dioxide	92.68
FUGITIVE DUST EMISSIONS (2):	1025.80
From The Total Construction Site	

- (1) Emissions are based on the data presented in Table 3.1.41 of ANG's EIR, assuming the simultaneous operation of 20 heavy duty diesel engines and 20 light duty gasoline engines for a 16-hour work day.
- (2) Emissions are based on a particulate emission factor of 1.2 ton/acre-month of heavy construction. A 50% reduction for watering was also assumed. 636 acres will be under construction during site preparation which will begin in March, 1976. The heavy construction will last approximately four months. Due to wind erosion, it was assumed that fugitive dust would be generated 24 hours per day.

TABLE II

SUMMARY OF SOURCE INPUT DATA
FOR UNAMAP PROGRAMS

SOURCES	STACK HEIGHTS (M)	STACK DIAMETER (M)	STACK DATA STACK GAS EXIT VELOCITY (M/SEC)	STACK GAS VOLUME (M ³ /SEC)	STACK GAS TEMPERATURE (K°)	SO ₂	MAXIMUM EMISSION RATES (g/sec)				LOCATION (1)	
							NO _x	TSP	CO	HC	X Km	Y Km
ANG Mainstack (3) E010	121.92	7.32	15.43 (14.88)	649.40 (626.62)	483.0	679.39 (333.21)	138.60	21.42	45.36	16.34	8.43	8.37
Main Flares (5) E020A	60.96	4.33 (4)	219.45	3232.80 (4)	1588.75	1139.04	Neg.	Neg.	Neg.	Neg.	9.14	7.44
E020B	60.96	4.33 (4)	219.45	3232.80 (4)	1588.75	1139.04	Neg.	Neg.	Neg.	Neg.	9.34	7.49
Coal Handling												
E101	9.14	1.52	15.24	25.96	294.10 (7)	-	-	1.18	-	-	8.99	8.64
E102	9.14	1.75	15.24	36.82	294.10	-	-	1.69	-	-	9.01	8.79
E103	9.14	1.60	15.24	29.26	294.10	-	-	1.33	-	-	9.03	8.68
E104	9.14	1.68	15.24	32.10	294.10	-	-	1.47	-	-	8.95	8.96
E105	9.14	0.84	15.24	7.55	294.10	-	-	0.34	-	-	9.08	8.96
E106	9.14	0.61	15.24	4.01	294.10	-	-	0.19	-	-	8.63	9.42
E107	9.14	2.59	15.24	77.88	294.10	-	-	3.57	-	-	8.62	8.69
E108	9.14	1.75	15.24	36.82	294.10	-	-	1.69	-	-	8.63	8.95
E110	9.14	0.76	15.24	6.37	294.10	-	-	.29	-	-	9.07	7.72
Start-Up Incinerator (5) E201	48.76	3.66	30.34	319.20	1366.50	145.90	Neg.	Neg.	Neg.	Neg.	8.62	8.76
Phenosolvan Gas (6) Liquor Separator Flare E207	36.58	0.77(4)	57.91 (25.81)	27.30(4) (12.02)(4)	1588.75	74.90 (27.50)	Neg.	Neg.	Neg.	Neg.	8.85	8.50
Refuse Incinerator (5) E600	9.14	0.56	6.36	1.60	977.40			0.25	Neg.	Neg.	Not Defined	
Basin Unit #1	182.88	6.92	21.30	802.60	356.90	718.0	299.2	59.85	Neg.	Neg.	8.50	9.49
Basin Unit #2	182.88	6.92	21.30	802.60	356.90	718.0	299.2	59.85	Neg.	Neg.	8.50	9.57

(1) For PTMPT program the origin was assumed to be the point 5 miles west and 5 miles south of the common corner of Section 23, 24, 25 and 26.

(2) For PTMAX and PTDIS programs the stack heights given in the table were adjusted (reduced by 21.34 meters) to reflect the difference in the elevation of the plant site (1930') and the surrounding terrain (2000').

(3) Includes the intermittent emissions from the shift catalysts regeneration unit; () does not include the regeneration unit.

(4) Based on the heat released and the design exit velocity the equivalent volume and equivalent diameter of the flare were calculated and used as input data.

(5) Intermittent

(6) Maximum case during upset conditions, () values assumed during normal operations.

(7) Ambient temperature.

TABLE III - INVENTORY OF EXISTING AND PROPOSED POWER PLANTS
NORTH DAKOTA - NRDA - AQMA

<u>Plant Name</u>	<u>Owned By</u>	<u>Unit #</u>	<u>Megawatts</u>	<u>Startup Date</u>	<u>Diam M</u>	<u>Velocity M/S</u>	<u>Temp °K</u>	<u>Height M</u>	<u>TSP g/sec</u>	<u>SO₂ g/sec</u>	<u>NO₂ g/sec</u>
Montana-Dakota Utilities	Montana-Dakota Utilities	1	2.8	Existing	1.7	6.4	447	22.6	4.2	4.0	2.4
Beulah, N.D.	Bismarck, N.D.	2	2.8	Existing	1.7	6.4	447	22.6	4.2	4.0	2.4
		3	2.8	Existing	1.7	6.4	458	26.5	6.1	4.6	2.8
		4	2.8	Existing	1.5	9.7	491	22.6	24.0	11.6	7.1
		5	2.8	Existing	1.5	9.7	491	22.6	24.0	11.6	7.1
Leland Olds Power Plant	Basin Electric Power Coop	1	210	Existing	5.3	23.6	466.3	106.7	1.5	453	341
Stanton, N.D.	Bismarck, N.D.	2	450	Sept. 75	6.7	18.3	455.2	152.4	2.8	988	---
Milton R. Young Power Plant	Minnkota Power Coop	1	235	Existing	5.8	21.3	450	76.2	22	807	345
Center, N.D.	Grand Forks, N.D.										
Milton R. Young Power Plant	Square Butte Electric Coop	2	450	March 76	9.1	14.0	440	152.4	20	699	482
Center, N.D.	Grand Forks, N.D.										
United Power Association	United Power Association	1	180	Existing	4.6	22.9	450	77.7	22	513	237
Stanton, N.D.	Elk River, MN										
Coal Creek Station	UPA/CPA	1	545	Late 1978	6.4	27.1	523	198	45	879	---
Underwood, N.D.	Elk River, MN	2	545	Late 1979	6.4	27.1	523	198	45	879	---

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ambient air standards.

Emissions from other sources listed in attachment AP-100-II are either negligible or the ambient air quality standards listed in R 23-25-02 are not applicable.

To predict compliance with State and Federal sulfur dioxide (SO_2), nitrogen dioxide (NO_x), total suspended particulates (TSP), carbon monoxide (CO), and hydrocarbons (HC), ambient air standards the cumulative impact of the joint venture and the existing and proposed sources in the area were examined. The nearest existing power plant to the proposed plant site is MDU's small 14.0 megawatt power plant in Beulah. It is located approximately 7.5 miles south by southwest of ANG's proposed plant site. Because of the close proximity of MDU's Beulah Station and the proposed plant site, the combined emissions from these facilities may affect the short-term (e.g., one-hour, three-hour, etc.) air quality. The long-term impact (annual average) on the air quality of the region may be affected not only by MDU's Beulah station but also by other existing and proposed power plants within a 35-mile radius of the proposed ANG and Basin plant sites. A listing of the major sources and the other pertinent emission and engineering data was obtained from the North Dakota State Health Department and is summarized in Table III.

The impact of the air emissions resulting from growth associated with the project's development and operation is discussed in Section E.

B. Meteorological Data

As discussed in Section 2 of the EIR, ANG has maintained a meteorological tower in the vicinity of the proposed plant site since February, 1974. The vertical temperature gradient recorded during the period from February through December, 1974 has been categorized according to the associated stability class. The frequency of occurrence of the three main stability classes are summarized below:

<u>Vertical Temperature Gradient °C/100m</u>	<u>Stability Category</u>	<u>Pasquill Stability Class</u>	<u>% Frequency of Occurrence *</u>
-1.9 to -1.5	Unstable	A, B, C	24.5
-1.5 to 0.5	Neutral	D	28.5
0.5 to 4.0	Stable	E, F, G	47.0

* Based on 7477 hours of observations from February through December, 1974.

Under stable conditions, which at the plant site occurred most frequently during the nighttime, late evening and early morning hours, the buoyancy of a plume decays as it rises. A hot plume emitted from tall stacks will rise until it reaches a layer where the density of the air diluted plume is the same as the density of the surrounding air. As the equilibrium is achieved the plume will retain its effective height for many miles since the air below the plume is cooler and the air above the plume is warmer. Under stable conditions there is very limited vertical mixing of the plume. However, there is gradual horizontal spreading. The ground-level concentration below such plumes are negligible. Wind speeds from 2-5 m/sec were used for the dispersion analyses for stable conditions.

Neutral atmospheric stability conditions are usually brought about by vigorous atmospheric mixing. The atmospheric turbulence increases the rate of plume dilution. For this region of North Dakota over 75% of the wind speeds associated with this stability class were over 12 mph. Under these conditions the plume disperses rapidly and generally fits a coning model. The ground-level concentrations under neutral conditions were predicted for wind speeds varying from 0.5 to 20.0 m/sec.

Under unstable conditions the buoyancy of a plume increases as it rises. On warm afternoons, with light winds, hot plumes may rise several thousand feet. On very unstable days large vertical velocity fluctuations may develop due to strong convection eddies created by the warming of air masses near the earth's surface. This large-scale vertical mixing causes the

plume to loop. High transitory maximum ground-level pollutant concentrations relatively near the source will occur under these conditions. In this region of the State, the unstable conditions are mostly concentrated during late morning and afternoon hours. Wind velocities associated with these stability conditions were generally (approximately 88% of the time) under 12 mph (1).

High transitory ground-level pollutant concentrations may also be experienced during early morning inversion breakup and other transit periods when the temperature inversion breakup occurs. Due to relatively cloud-free skies and low humidities of this region, nocturnal radiative heat losses may be quite large. Large nocturnal heat losses from the ground result in the air next to the ground being cooled more rapidly than the air aloft, and an inversion is formed. In this stable layer which may be several thousand feet high; hot plumes emitted from tall stacks will rise until they reach a level where the density of the air-diluted plumes is the same as the surrounding air. As the plumes lose their buoyancy, they become trapped in a narrow vertical band aloft since the air below the plume is cooler and the air above the plume is warmer. Such trapped plumes may then drift with the winds at this level for 20 or more miles. Because of this inverted temperature profile, ground-level pollutant concentrations below such plumes will be negligible.

As the sun rises, the incoming solar radiation heats the ground surface and thermal eddies develop. If the incoming solar radiation is sufficiently strong, the thermal eddies will spread from the ground upward to the level where the pollutant-bearing plume has been trapped aloft, they rapidly mix with the plume pulling it towards the ground. The inversion aloft

- (1.) Based on analyses of ten year meteorological data tapes for Bismarck, Minot, Williston and Dickinson, North Dakota obtained from the National Climatological Center.

prevents upward dispersion. This "inversion breakup" or fumigation is short-lived but can result in high ground level concentrations for short periods of time.

Early morning fumigation may last from several minutes to 30 minutes depending upon the meteorological conditions. On the average, in this region, it lasts only 15 minutes (Packnett, 1973). The highest ground level concentrations will result from very stable air and light winds. Stability class F and 1.0 m/sec wind speed were selected as representative. Pollutant concentration calculations, however, must be made for fumigating conditions for comparison with short term (one hour) State ambient air standards. The stability category following inversion break-up might be either neutral or unstable. For the purposes of these calculations, stability class C with 2.0 m/sec wind speeds were chosen as representative. The maximum concentration also will occur when the base of the inversion is as low as possible, but high enough to trap all of the plumes from all the sources. Various inversion heights were examined to determine which heights meet this criterion.

On some occasions (i.e., heavy cloud covering) the incoming solar radiation is not strong enough to produce surface heating which will completely destroy the nighttime surface inversion. This condition may also occur when incoming solar radiation is reflected from snow covered ground. When this occurs the inversion will be eliminated to some level aloft, resulting in slightly unstable or neutral conditions at the lower levels, and inversion layer aloft. If the inversion layer is high enough so that the hot plumes cannot penetrate through the layer, the plume may become "trapped" below the inversion layer. Since the dispersion of the plume is limited high maximum ground-level concentrations may be experienced under these conditions.

C. Estimate of Ambient Air Quality Deterioration During Plant Construction

To determine compliance with Federal and State ambient air standards the maximum ground level concentration resulting from the construction activities was estimated, using the procedures to evaluate area sources which are described by Turner (1969). Using Turner's procedures the fugitive dust emissions and the vehicle emissions were combined, and these areawide emissions were treated as a point source having an initial horizontal standard deviation (σ_{y0}). Using σ_{y0} , the virtual distance (x_y) was found and the appropriate values of the horizontal standard deviation (σ_y) were determined, for various downwind distances.

In performing these calculations it was assumed that:

- . the peak construction activity will occur during site preparation and that all 636 acres will be under construction during this period.
- . the plant site (area emission grid) is approximately 1 mile square.
- . the emissions in Table I are continuous and uniformly distributed over the emission grid.
- . all sources within the grid are ground-level sources (effective stack height = 0)
- . fugitive dust emissions created by the construction activity which are greater than 100 μ m in diameter will quickly settle out (Hazen and Wooduff, 1973).
- . 60% of the fugitive dust emissions listed in Table I are within the suspended particulate size range (EPA, 1974), and that only 40% of particles within this range will be carried in suspension. (Chepil, 1945, estimated that 3 to 40 percent of the dust particulates smaller than 100 μ m could be

carried in suspension).

Based on these assumptions, the Pasquill-Turner diffusion equation can be simplified:

$$x = \frac{Q}{\pi \sigma_y \sigma_z u}$$

and the initial value was approximated by $\sigma_{y0} = S/4.3$ where S is equal to the length of the emission grid. Using the calculated value of σ_{y0} the virtual distance $-x\gamma$ was determined using Figure 3.2 of Turner's Workbook of Atmosphere Dispersion.

Since the vertical and horizontal dispersion coefficients presented in Figure 3.2 and Figure 3.3 (Turner, 1969) are generally representative of 10-minute averaging times the predicted ground-level concentrations are also representative of 10-minute averages. The North Dakota State Health Department, Division of Environmental Engineering suggests that for this particular region the predicted concentration for Stability Class A and B be considered to be representative of 10-minute averaging times, Stability Class C - one hour, Stability Class D - 3 hours and Stability Classes E and F - 10 minutes to one hour. To convert the model predicted concentration to concentrations with time intervals equal to State and Federal standards, the North Dakota State Health Department also suggested that the following equation be used:

$$x_2 = x_1 \left[\frac{t_2}{t_1} \right]^{-B}$$

where x_1 = concentration predicted by the UNAMAP model

x_2 = adjusted concentration

t_1 = time interval predicted by model

t_2 = adjusted time interval

B = 0.44

To determine compliance to the State's one-hour ambient air standards for SO_2 , NO_x and CO, the relative ground level concentration under worst case conditions (Stability Class F with low wind speeds) was estimated. Meteorological records gathered at the plant site indicated that during the daytime hours neutral stability conditions are most prevalent. Therefore, since most of the construction activity will occur during daytime hours, the relative ground level concentrations representative of longer averaging times were calculated for neutral stability conditions (Stability D) with moderate winds (7 m/sec).

The results of these computations are summarized in Table IV. As indicated in the Table, all applicable North Dakota and Federal ambient air standards including significant deterioration Class II standards will be maintained during the plant construction phase.

Fugitive dust emissions will be localized and largely intermittent. Ambient dust levels should not be significantly greater than current levels that might occur during periods of heavy agricultural activity.

TABLE IV

ESTIMATED GROUND LEVEL POLLUTANT CONCENTRATION
DURING THE CONSTRUCTION PHASE

POLLUTANT	AVERAGING PERIOD	MAXIMUM ESTIMATED CONCENTRATION ¹		NORTH DAKOTA AMBIENT AIR STANDARDS	NATIONAL STANDARDS AMBIENT AIR		FEDERAL AND STATE SIGNIFICANT DETERIORATION CLASS II
		I ²	II ²		PRIMARY	SECONDARY	
SO ₂ (ug/m ³)	1-hour	18.2	12.0	715 ³	-	-	No classification
	3-hour	2.0	1.1	-	-	1300 ⁴	700 ⁵
	24-hour	0.8	.4	260 ³	365 ⁴	-	100 ⁵
NO _x (ug/m ³)	1-hour	100.2	65.8	200 ⁶	-	-	No classification
CO (mg/m ³)	1-hour	0.3	0.2	40 ⁴	40 ⁴	40 ⁴	No classification
	8-hour	0.16	0.09	10 ⁴	10 ⁴	10 ⁴	No classification
HC (ug/m ³)	3-hour (6 to 9 a.m.)	2.7	1.5	160 ⁴	160 ⁴	160 ⁴	No classification
TSP (ug/m ³)	24-hour ⁴	27.8	15.6	150 ⁴	260	150	30.0

1. One hour estimates are based on: Stability Class F; 2.0 m/sec wind speed. $\sigma_{y0} = 374$; $xY = 14.0$ Km [Figure 3.2 (Turner)] therefore:

	I	II
x (Km)	1.61	3.22
x + xy (Km)	15.6	17.22
σ_z (m)	19	27
σ_y (m)	410	440
x/Q ($\frac{\text{sec}}{\text{m}^3}$)	2.04×10^{-5}	1.34×10^{-5}

all other estimates are based on: Stability Class D; 7.0 m/sec wind speed. $\sigma_{y0} = 374$; $xY = 6.4$ [Figure 3.2 (Turner)] therefore:

	I	II
x (Km)	1.61	3.22
x + xy (Km)	8.01	9.62
σ_z (m)	44	67
σ_y (m)	460	540
x/Q ($\frac{\text{sec}}{\text{m}^3}$)	2.25×10^{-6}	1.26×10^{-6}

2. I. Maximum ground level concentration 1/2 mile downwind of the plant site boundary.
(1.61 Km from the center of the emission grid.)
- II. Maximum ground level concentration 1-1/2 mile downwind of the plant site boundary.
(3.22 Km from the center of the emission grid.)
3. Maximum concentration.
4. Maximum concentration not to be exceeded more than one per year.
5. Maximum allowable incremental increase.
6. Maximum concentration not to be exceeded over 1% of the time in any three month period.

D. Estimates of Ambient Air Quality Deterioration During Plant Operation

To determine compliance with Federal and State ambient air quality standards, both the short-term and long-term pollutant concentrations were predicted.

1. One Hour Standards

The State of North Dakota ambient air standard for sulfur dioxide (SO_2) and carbon monoxide (CO) are expressed in terms of maximum one-hour concentration. The State's one-hour standard for nitrogen dioxide is not to be exceeded over 1% of the time in any three month period. Therefore, to determine compliance to State standards, pollutant concentrations occurring not only during non-inversion cases, but also those concentrations resulting from inversion break-up and plume trapping must be examined.

Non-Inversion Cases

Under non-inversion conditions the short term maximum ground-level concentrations for each individual source were estimated using the PTMAX program of the EPA UNAMAP model. The PTMAX program utilizes the Briggs plume rise equations and assumes a steady state Gaussian plume model. For non-buoyant plumes, jet plume rise equation was utilized (See Appendix). The input data used for the program is summarized in Table II. The stack heights were corrected to reflect the difference in elevation of the plant site and the nearby surrounding terrain. Since the programs in the UNAMAP package use the vertical and horizontal dispersion coefficients presented in Figure 3.2 and 3.3 of Turner's Workbook of Atmospheric Dispersion Estimates, the predicted concentrations are generally representative of 10-minute averaging times. To convert the model predicted concentration to concentrations with time intervals equal to State and Federal standards, the procedure recommended by the North Dakota State Health Department was used.

The results of PTMAX programs for SO_2 , CO, and NO_2 emission, adjusted to reflect one-hour averaging time, are summarized in Table V, VI, and VII, respectively.

To evaluate the short term cumulative impact of all the sources the PTDIS and PTMPT programs were used. The PTDIS program was used to evaluate the ground level pollutant concentration as a function of downwind distance from the source. Based on the output of the PTDIS programs, the locations of various receptors were chosen for usage in PTMPT programs. The short-term cumulative impact from the various sources are given in Table VIII.

TABLE V

ESTIMATED MAXIMUM ONE-HOUR GROUND LEVEL SO₂ CONCENTRATION
FOR NON-INVERSION CASES

SOURCE	VARIABLES	STABILITY CONDITIONS					
		A	B	C	D	E	F
E010	u (m/sec)	3.0	5.0	15.0	20.0	2.0	(2)
	d (Km)	1.2	3.2	3.1	9.6	51.1	
	x (µg/m ³)	88.9	43.5	108.4	73.7	24.4	
E020 (A or B)	u (m/sec)	(2)	5.0	15.0	20.0	5.0	(2)
	d (Km)		9.7	8.6	8.6	97.7	
	x (µg/m ³)		8.2	28.6	14.7	7.9	
E201	u (m/sec)	3.0	5.0	15.0	20.0	2.0	2.0
	d (Km)	1.2	2.8	2.1	4.7	27.0	79.0
	x (µg/m ³)	22.1	12.4	48.2	7.8	14.0	5.8
E207	u (m/sec)	3.0	5.0	15.0	20.0	2.0	2.0
	d (Km)	0.6	0.8	0.5	0.8	6.3	11.9
	x (µg/m ³)	88.6	76.6	299.4	426.0	72.7	63.1
Basin (3) (Both Units)	u (m/sec)	3.0	5.0	10.0	15.0	2.0	(2)
	d (Km)	1.1	2.8	4.1	14.2	67.0	
	x (µg/m ³)	250.8	116.8	209.0	114.4	37.6	

- (1.) The concentrations derived from the PTMAX program were adjusted to reflect one hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.
- (2.) No concentration estimates were attempted since the distance to the point of maximum concentration is so great that the same stability is not likely to persist long enough for the plume to travel this far.
- (3.) Due to close proximity of unit 1 and unit 2 the emissions are treated as being generated from one unit.
- (4.) Based on maximum emissions during upset conditions.

TABLE VI.

ESTIMATED MAXIMUM ONE-HOUR GROUND LEVEL CO CONCENTRATION FOR
NON-INVERSION CASES

<u>SOURCE</u>	<u>STABILITY CONDITIONS</u>					
	A	B	C	D	E	F
E010 u(m/sec)	3.0	5.0	15.0	20.0	2.0	(2)
d(Km)	1.2	3.2	3.1	9.6	51.1	
x(mg/m ³)	0.002	0.001	0.003	0.002	0.0006	

1. The concentration derived from the PTMAX program were adjusted to reflect one hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.
2. No concentration estimate was attempted since the distance to the point of maximum concentration is so great that the same stability is not likely to persist long enough for the plume to travel this far.

TABLE VII

ESTIMATED MAXIMUM ONE-HOUR GROUND LEVEL NO_x CONCENTRATION FOR
NON-INVERSION CASES

<u>SOURCE</u>	<u>STABILITY CONDITION</u>					
	A	B	C	D	E	F
E010 u(m/sec)	3.0	5.0	15.0	20.0	2.0	(2)
d(Km)	1.2	3.2	3.1	9.6	51.1	
x($\mu\text{g}/\text{m}^3$)	18.1	8.9	22.1	15.0	5.0	
Basin u(m/sec)	3.0	5.0	10.0	15.0	2.0	(2)
d(Km)	1.1	2.8	4.1	14.2	67.0	
x($\mu\text{g}/\text{m}^3$)	104.5	48.7	87.2	47.7	15.7	

1. The concentrations derived from the PTMAX program were adjusted to reflect one hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.
2. No concentration estimate was attempted since the distance to the point of maximum concentration is so great that the same stability is not likely to persist long enough for the plume to travel this far.
3. Due to close proximity of unit 1 and unit 2 the emissions are treated as being generated from one unit.

TABLE VIII
CUMULATIVE IMPACT FOR NON-INVERSION
CONDITIONS

<u>POLLUTANT</u>	<u>MAXIMUM ONE-HOUR CONCENTRATION ($\mu\text{g}/\text{m}^3$)</u>	<u>WIND DIRECTION</u>	<u>WIND SPEED (m/sec)</u>	<u>STABILITY CLASS</u>	<u>DISTANCE TO MAXIMUM (1) (Km)</u>
SO ₂	283.2	S	15.0	C	5.1
NO _x	98.9	S	15.0	C	5.1

(1) The cumulative effects were evaluated only at receptor sites outside the plant boundaries. The distance given is the distance from ANG's main stack.

Inversion Breakup:

The maximum ground-level concentration during inversion breakup (fumigation) was approximated using the following equation (Turner, 1970):

$$(i) \quad X_F = \frac{Q}{(2\pi)^{0.5} \sigma_{yF} h_i u}$$

where

- X_F = estimated maximum fumigation concentration (g/m^3)
- Q = pollutant emission rate (g/sec.)
- σ_{yF} = $\sigma_y + \frac{H}{8}$ (m)
- σ_y = horizontal dispersion standard deviation (m)
- H = $h + \Delta h$ = effective stack height (m)
- h = physical stack height (m)
- Δh = plume rise (m)
- h_i = $H + 2\sigma_z$ (m) = height of the base of the inversion
- σ_z = vertical dispersion standard deviation (m)
- u = mean wind speed in the stable layer (m/sec.)

Equation (i) however, cannot be used near the stack. The nearest downwind distance which can be considered for an estimate of the maximum fumigation concentration must be great enough, based on the time required, to eliminate the inversion. Hewson (1945) suggested that the time required to eliminate the inversion be estimated by the following equation:

$$(ii) \quad t = \frac{h_i^2 - h^2}{4K}$$

where

- K = eddy diffusivity for heat = $3 \text{ m}^2/\text{sec}^4$
- h_i = height of base of the inversion (m)
- h = physical stack height (m)

Therefore, the nearest distance at which equation (i) should be applied is:

$$(iii) \quad X = Ut = U \frac{(h_i^2 - h^2)}{4K}$$

where X = distance to fumigation (m)
 U = mean wind speed through the stable layer

The plume rise (Δh) for a bouyant plume in calm winds into stable air was approximated using the formula derived by Briggs.

$$(iv) \quad \Delta H = 5 F^{0.25} \left[\frac{g}{T} \left(\frac{\partial \theta}{\partial Z} \right) \right]^{-0.375}$$

where

$$F = 2.45 V_s d^2 \frac{(T_s - T)}{T_s} \text{ buoyancy flux} \\ (\text{m}^4/\text{sec}^3)$$

$$V_s = \text{stack exit velocity (m/sec)}$$

$$d = \text{stack exit diameter (m)}$$

$$T_s = \text{stack exit temperature (K}^\circ\text{)}$$

$$T = \text{ambient air temperature (K}^\circ\text{)}$$

$$g = 9.8 \text{ gravitational acceleration (m/sec}^2\text{)}$$

$$\frac{\partial \theta}{\partial Z} = 0.035 = \text{vertical potential temperature gradient (}^\circ\text{K/m)}$$

Using the preliminary engineering design data given in Table II, the plume rise from the main stack was calculated for 1 m/sec wind speed and 65°F ambient air temperature (Table IX). Due to their high heat capacities it was assumed that the plumes from the flares and the start-up incinerator could penetrate the strongest inversions, and that special case of inversion breakup was not applicable to these sources.

Equation (i) approximates the maximum fumigation concentration assuming that the inversion has been eliminated up to the height approximated by the definition of h_i . Various values of the vertical dispersion coefficient (σ_z) were then reexamined (Figure 3-3, Workbook of Atmospheric Dispersion Estimates) to determine the acceptability of the first approximation. Calculations revealed that the minimum height of the inversion base, which was high enough to entrap the plumes from all the stacks was 600m. Using equation (ii), the nearest downwind distance which could be considered was determined. From Figure 3-2 from Workbook of Atmospheric Dispersion Estimates, the horizontal dispersion coefficients for the given distances were found (Table VIII). The relative 10-minute average ground level concentration (X/Q) was calculated using equation (i).

As previously stated, fumigation lasts for brief periods, 15-minutes on the average (Packnett, 1973). It is generally followed by neutral (Stability Class D) or slightly unstable (Stability Class C) conditions. Therefore, the pollutant concentration for the remaining 45 minutes was assumed to occur for Stability Class C, with 2 m/sec wind speeds.

To calculate the maximum ground-level concentration ($Z=0$, $y=0$) the diffusion equation according to Turner (1970) was used.

$$(v) \quad X = \frac{Q}{\pi \sigma_y \sigma_z u} e^{\left[-0.5 \left(\frac{H}{\sigma_z}\right)^2\right]}$$

The plume rise for a buoyant plume under unstable conditions was approximated using the formula derived by Briggs.

$$(vi.a) \quad \Delta h = \frac{42A^{0.75}}{u} \quad \text{if } A \leq 24 \text{ m}^3/\text{sec}$$

or

$$(vi.b) \quad \Delta h = \frac{66.4A^{0.60}}{u} \quad \text{if } A > 24 \text{ m}^3/\text{sec}$$

where

$$A = v_s d^2 \frac{(T_s - T)}{T_s} = \text{buoyancy parameter m}^3/\text{sec}$$

The remaining terms are as previously defined.

For the conditions discussed above, the relative 10 minute average concentration (X/Q) for each source was calculated (Table IX). Adjusting the results to reflect the proper time intervals and using time-weighted averages the maximum one-hour concentration for each source was calculated using the following equation.

$$(vii) \quad X_{1 \text{ hr}} = \left(Q \frac{X_F}{Q}\right) T_{CF1} \left(\frac{15}{60}\right) + Q \left(\frac{X_C}{Q}\right) T_{CF2} \left(\frac{45}{60}\right)$$

where

$X_{1 \text{ hr}}$ = one-hour maximum pollutant concentration (g/m^3)

Q = pollutant emission rate (g/sec)

T_{CF1} = time correction factor for converting 10-minute average concentration to 15-minute average concentration

T_{CF2} = time correction factor for converting one-hour average concentration to 45-minute average concentration

$\frac{X_F}{Q}$ = relative 10-minute average ground-level pollutant concentration during fumigation

$\frac{X_C}{Q}$ = relative 10-minute average ground-level pollutant concentration following fumigation

The contribution to the ground level concentration at the receptor site from the existing power plant in Beulah was determined using similar procedures, and the engineering data presented in Table III. It was assumed (although it is highly unlikely) that the wind direction was such that the centerlines of the plumes from all the sources the (proposed ANG stack, Basin Electric stacks and the five stacks at MDU's Beulah facility) were in line at the time fumigation occurred. The cumulative maximum estimated one-hour concentration for sulfur dioxide and nitrogen dioxide and the contribution from each source are summarized in Table IX.

Plume Trapping

As previously mentioned, under certain meteorological conditions plume trapping may occur. In this particular region it is unlikely that limited mixing would occur during extremely unstable conditions (Stability Class A) since such conditions are generally associated with strong incoming solar radiation. To insure that the plume would be trapped beneath the inversion "lid", the height of the "lid" was chosen to be just above the effective stack height. The maximum ground-level concentration resulting from plume trapping was approximated using diffusion equation according to Turner, 1970:

$$(viii) \quad X = \frac{Q}{(2\pi)^{0.5} \sigma_y L u}$$

where L = height of the base of the inversion

The remaining terms are as previously defined.

The maximum ground-level concentration occurs at twice the distance ($2x$) where the plume is assumed to have a Gaussian distribution which occurs when $\sigma_z = 0.47L$. It was assumed that the worse case would occurred for Stability Class B under low wind speeds (1.0m/sec). Under these conditions the maximum effective stack height was 2425 meters. The height of the stable layer was assumed to be 2400 meters. The results are summarized in Table X.

TABLE IX: PARAMETERS FOR DETERMINING MAXIMUM ONE-HOUR GROUND LEVEL CONCENTRATION DURING AN INVERSION BREAKUP

I. Inversion Break-up:

Stability Class F
1.0 m/sec. windspeed
65°F ambient temperature
h_i = 600 meters

<u>Calculated Parameters</u>	<u>ANG</u>	<u>Basin</u>
Predicted Plume Rise (m)	333.8	288.2
Adjusted Effective Stack Height (m)*	434.3	449.7
Distance to nearest receptor (Km)	30.0	27.8
σ_y (m)	730	680
σ_{yF} (m)	784.3	736.2
$\frac{X}{Q}$ (sec/m ³)	0.848 x 10 ⁻⁶	0.903 x 10 ⁻⁶

II. Condition Immediately After Inversion Break-up:

Stability Class C
2.0 m/sec windspeed
65°F ambient temperature

<u>Calculated Parameters</u>	<u>ANG</u>	<u>Basin</u>
Predicted Plume Rise (m)	1062.4	747.0
Adjusted Effective Stack Height (m)*	1163.0	908.6
Distance to the receptor (Km)	30.0	27.8
σ_y (m)	2200.0	2050.0
σ_z (m)	1350.0	1300.0
$\frac{X}{Q}$ (sec/m ³)	0.037 x 10 ⁻⁶	0.047 x 10 ⁻⁶

III. Estimated Maximum One-Hour Ground-Level Concentration During An Inversion Break-up:

<u>POLLUTANT</u>	<u>MAXIMUM ESTIMATED CONCENTRATION</u> <u>μg/m³</u>		
	<u>ANG</u>	<u>BASIN</u>	<u>COMBINED</u>
SO ₂	152.8	328.5	481.3
CO	10.9	-	10.9
NO _x	32.5	136.9	169.4

* Adjusted to reflect the difference in elevation between the surrounding terrain (2000 ft.) and the plant site (1930 ft.).
H = h_p + Δh - 70' (0.3048 ft./m)

TABLE X. PARAMETER FOR DETERMINING MAXIMUM ONE-HOUR GROUND
LEVEL CONCENTRATION DURING PLUME TRAPPING

Plume Trapping

Stability Class B
1.0 m/sec windspeed
65°F ambient temperature
L = 2300 meters

<u>Calculated Parameters</u>	<u>ANG</u>	<u>BASIN</u>
Adjusted Effective Stack Height (m) ¹	2249.8	1655.7
σ_z (m)		1081.0
$x L$ (km) ²		8.0
$2xL$ (km)		16.0
σ_y (m) ²		1800.0
$\frac{x}{Q}$ (sec/m ³) ³		0.096x10 ⁻⁶

<u>Concentration Estimates</u> ⁴	<u>ANG</u>	<u>BASIN</u>	<u>COMBINED</u>
SO ₂ (µg/m ³)	29.6	62.6	92.2
NO _x (µg/m ³)	6.0	26.1	32.1
CO (µg/m ³)	0.7	-	0.7

- (1) Adjusted to reflect the difference in elevation between the surrounding terrain and the plant site.
- (2) Obtained from Figure 3-2 and 3-3, Turner's Workbook.
- (3) Applicable for both proposed sources.
- (4) Adjusted to reflect one hour averaging time.

2. Three-Hour Standards

Federal ambient air standards for sulfur dioxide and hydrocarbons and the significant deterioration regulations for sulfur dioxide are based on a three-hour averaging period. Using the output from the PTMAX program, the highest one-hour concentrations were determined and the concentration adjusted to reflect the proper time interval. The time correction formula supplied by the North Dakota State Health Department was used. The maximum three-hour concentration for sulfur dioxide and hydrocarbons are summarized in Table XI and Table XII respectively.

3. 24-Hour Standards

There are both Federal and State 24-hour standards for sulfur dioxide and total suspended particulates. To compute maximum the 24-hour concentration, the maximum one hour concentration occurring during slightly unstable conditions (Stability Class C) was used. The PTMAX program was used to estimate the maximum ground-level concentration attributable to stationary sources. The estimated maximum 24-hour ground level SO₂ and TSP concentration resulting from these sources are summarized in Table XIII and Table XIV, respectively. The TSP attributed to the fugitive dust emissions from the mining operations were evaluated using the procedure to evaluate area sources as described in Section C. The results of these computations are summarized in Table XV.

Annual Concentrations

There are State and Federal annual ambient air standards for sulfur dioxide, nitrogen dioxide and total suspended particulates. The annual estimates for the proposed sources were determined by multiplying the 24-hour concentration by 10%. The maximum annual concentration resulting from the cumulative effect of the existing and proposed sources listed in Table III were determined using EPA's CDM program. The cumulative concentration from these sources at a

* The maximum persistent annual wind direction is 10% (from Bismarck 5-year averages).

TABLE XI

ESTIMATED MAXIMUM THREE-HOUR⁽¹⁾ SO₂ CONCENTRATION

<u>SOURCE</u>	<u>MAXIMUM CONCENTRATION ($\mu\text{g}/\text{m}^3$)</u>	<u>STABILITY CLASS</u>	<u>WIND SPEED (m/sec)</u>	<u>DISTANCE TO THE POINT OF MAXIMUM (Km)</u>
E010	66.1	C	15.0	3.2
E020 (A or B)	17.7	C	15.0	8.6
E201	29.7	C	15.0	2.1
E207 (3)	293.0	D	20.0	0.8
Basin (Unit #1 or #2)	127.6	C	10.0	4.1
Cumulative (2)	172.7	C	12.0	5.1

- (1) The concentration derived from the PTMAX program were adjusted to reflect three-hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.
- (2) The cumulative effects were evaluated only at receptor sites outside of the plant boundaries. The distance given is the distance from ANG's main stack.
- (3) Based on maximum emissions during upset conditions.

TABLE XII

ESTIMATED MAXIMUM THREE-HOUR⁽¹⁾ HYDROCARBON CONCENTRATION

<u>SOURCE</u>	<u>MAXIMUM CONCENTRATION ($\mu\text{g}/\text{m}^3$)</u>	<u>STABILITY CLASS</u>	<u>WIND SPEED (m/sec)</u>	<u>DISTANCE TO THE POINT OF MAXIMUM (Km)</u>
E010	4.9	D	20.0	9.6

- (1) The concentration derived from the PTMAX program were adjusted to reflect three-hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.

TABLE XIII

ESTIMATED MAXIMUM 24 - HOUR (1)
SO₂ CONCENTRATION

<u>SOURCE</u>	<u>MAXIMUM CONCENTRATION (ug/m³)</u>	<u>DISTANCE TO THE POINT OF MAXIMUM (Km)</u>
E010	26.0	3.1
E201	11.6	2.1
E207 (4)	21.4	0.5
Basin (Both Units) (2)	50.2	4.1
Cumulative (3)	67.8	3.3

- (1) The concentrations derived from the PTMAX program were adjusted to reflect 24-hour averaging time. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.
- (2) Due to the close proximity of unit 1 or unit 2 the emissions are created as being generated from on unit.
- (3) The cumulative effects were evaluated only at receptor sites outside of the plant boundaries. The distance given is the distance from ANG's main stack.
- (4) Based on normal operations.

ESTIMATED MAXIMUM 24 - HOUR (1) TOTAL
SUSPENDED PARTICULATE CONCENTRATION

<u>SOURCE</u>	<u>MAXIMUM CONCENTRATION ($\mu\text{g}/\text{m}^3$)</u>	<u>DISTANCE TO THE POINT OF MAXIMUM (Km)</u>
E010	0.82	3.1
E101 (2)	15.48	0.19
E102	19.23	0.17
E103	16.31	0.20
E104	17.36	0.17
E105	8.06	0.19
E106	6.25	0.18
E107	27.50	0.19
E108	19.22	0.17
E110	7.61	0.18
E600	7.15	0.17
Basin (Both Units)	4.18	4.1
Cumulative (3)	23.60	3.3

- (1) The concentration derived from the PTMAX program were adjusted to reflect 24-hour averaging times.
- (2) Stack heights for sources E101-E110 were not adjusted to reflect the difference in the terrain since the distance to the point of maximum is still within the trench.
- (3) The cumulative effects were evaluated only at receptor sites outside of the plant boundaries. The distance given is the distance from ANG's main stack.

TABLE XV

ESTIMATED GROUND LEVEL TSP CONCENTRATION
FROM THE MINING OPERATIONS

Distance From The Mine Site		Dispersion Parameters				Maximum 24-Hour Concentration (2) ($\mu\text{g}/\text{m}^3$)
		$X_t X_F$ (1) (Km)	σ_z (m)	σ_y (m)	X/Q (sec/m^3)	
(Miles)	(Km)					
0.5	0.8	1.3	50	130	7.0×10^{-6}	14
1.0	1.6	2.1	90	210	2.4×10^{-6}	5
1.5	2.4	2.9	130	280	1.3×10^{-6}	3
2.0	3.2	3.7	170	340	0.8×10^{-6}	2

- (1) The size of the emission grid was assumed to be 15.5 acres ($s=250$ m), $\sigma_{yo} = 58.4$, $xy = 0.53$.
- (2) The estimated ground-level concentration was based on Stability Class C, 7.0 m/sec wind speeds. The emission rate from each mine site was calculated to be approximately 8.5 grams/sec. The emission rate was calculated based on an emission factor of 4.6 tons/acre, which was developed from a survey of one of Consolidated Coal's mines in Stanton. (Pedco Environmental Inc.) 16% of these emission were attributed to haul road traffic. Under ANG's mining plans a total of 500 acres/year will be initially mined at three of the four mine sites. Based on the emission factor developed from the survey, 3.4 tons/day of fugitive dust emission will be created at each mine site. To calculate the total suspended particulate emission rate it was assumed that 60% of the fugitive dust emissions are when the suspended particulate size range and that only 40% of these particles will be carried in suspension.

receptor site which coincided with the maximum estimated ground-level concentration resulting from the proposed project was determined. The meteorological input was supplied from Day/Night STAR program and the 10-year meteorological data tapes for Bismarck, North Dakota, obtained from the National Climatological Center. The input data used in CDM is summarized in Table XVI. The cumulative maximum annual sulfur dioxide, nitrogen dioxide and total suspended particulates concentrations and the contribution from the existing sources and from each proposed source are summarized in Table XVII.

Summary of Results

The maximum ground-level pollutant concentration estimates are summarized in Table XVII along with the applicable Federal and North Dakota ambient air standards.

Based upon the estimated concentrations obtained through dispersion modeling and using preliminary engineering information, it was determined that the combined project will meet all applicable North Dakota and Federal ambient air standards for sulfur dioxide, nitrogen dioxide, hydrocarbon, carbon monoxide and total suspended particulates, including significant deterioration Class II standards for sulfur dioxides and Class II for total suspended particulates.

TABLE XVI. SUMMARIZATION OF THE INPUT DATA USED IN CDM

Meteorological Data

Average afternoon mixing height	1488 meters	
Nocturnal mixing height	359 meters	
Ambient air temperature	5.67°C	
Decay Rate of SO ₂	24 hours	(1)
Decay Rate of NO ₂	24 hours	(1)

Source Emission Data

Data presented in Table II was used in the program, with exception of stack gas temperature which were converted to degrees centigrade.

To adequately cover the area of concern, a 60 mile by 60 mile grid, with one mile spacings was used. Since the precise locations of the existing power plants were not available at the time the calculations were performed, the following grid locations were assumed:

<u>Plant Name</u>	<u>Grid Location</u>	
	<u>X</u>	<u>Y</u>
Montana - Dakota Utilities, Beulah, North Dakota	13.0	19.7
Lelands Olds Power Plant Stanton, North Dakota	33.5	21.2
Milton R. Young Power Plant Center, North Dakota	38.2	49.0
United Power Association Stanton, North Dakota	32.0	20.0
Coal Creek Station Underwood, North Dakota	43.5	27.0
ANG Coal Gasification Plant, Beulah (2)	11.0	24.0

- (1) The rates of decay for SO₂ and NO₂ are dependent upon meteorological factors such as temperature and relative humidity, and the presence of others gases in the atmosphere. Although the half life of SO₂ and NO₂ is frequently referenced as 3 hours and 9 hours, respectively, a 24-hour half live was chosen to simulate the "worse case" conditions.
- (2) Emission data not considered in predicting cumulative impact in CDM programs.

TABLE XVII

MAXIMUM GROUND-LEVEL POLLUTANT CONCENTRATION
(All Values in Micrograms per Cubic Meter Unless Indicated)

POLLUTANT	AVERAGING PERIOD	ESTIMATED MAXIMUM CONCENTRATION (1)							NORTH DAKOTA AMBIENT AIR STANDARDS	NATIONAL STANDARDS AMBIENT AIR		FEDERAL & STATE DETERIORATION CLASS II
		ANG MAIN STACK	BASIN STACKS	COMBINED PROJECT	ASSOCIATED GROWTH (3)	COMBINED IMPACT	EXISTING POINT SOURCES (3)	TOTAL		PRIMARY	SECONDARY	
SO ₂	1-hour fumigation	152.8	328.5	481.3	-	481.3	6.0	487.3	-	-	-	-
	non-inversion	108.4	209.0	283.2	4.3	287.5	2.0	289.5	715 (4)	-	-	-
	3-hour	66.1	127.6	172.7	1.1	173.8	4.0	177.8	-	-	1300(5)	700(6)
	24-hour	26.0	50.2	67.8	0.4	68.2	3.0	71.2	260 (4)	365(5)	-	100(6)
	Annual	2.4 (11)	5.2	6.7	-	6.7	2.3	9.0	60 (7)	80(7)	-	15(8)
NO ₂	1-hour fumigation	32.5	136.9	169.4	-	169.4	3.0	172.4	200 (9)	-	-	-
	non-inversion	21.6	104.1	98.9	7.3	106.2	1.0	107.2	-	-	-	-
	Annual	0.5	2.1	2.9	0.7	3.6	1.5	5.1	100(7)	100(7)	100(7)	-
TSP	24-hour	0.8	4.2	23.6	2.5	26.1	8.0	34.1	150 (5)	260(5)	160(5)	30(6)
	Annual	0.1	0.4	2.4	.3	2.7	0.8	3.5	60 (10)	75(10)	60(10)	10(8)
CO (mg/m ³)	1-hour fumigation	0.1	Information not Available	0.1	-	0.1	Information not Available		40 (5)	40(5)	40(5)	-
	non-inversion	0.1		0.1	-	0.1						
	8-hour	-		-	-	-						
HC	3-hour	1.6			0.5	2.1			160 (5)	160(5)	160(5)	-

- Negligible

(1) Based on Briggs plume rise equations.

(2) Includes the emission from the mining area.

(3) The estimated concentration from these sources were determined at a receptor site which coincided with the maximum estimated concentration from the proposed project.

(4) Maximum concentration.

(5) Maximum concentration not to be exceeded more than once per year.

(6) Maximum allowable incremental increase.

(7) Maximum annual arithmetic mean.

(8) Maximum allowable increase over annual baseline air quality.

(9) Maximum concentrations not to be exceeded over 1% of the time in any three month period.

(10) Maximum annual geometric mean.

(11) Does not include the emissions from the shift catalyst regeneration unit, since the operation of the unit will be intermittent.

TABLE XVIII

ESTIMATED AIR EMISSION RESULTING FROM
ASSOCIATED RESIDENTIAL GROWTH

<u>CITY</u>	PROJECTED NUMBER OF HOUSING UNITS REQUIRED DURING PEAK EMPLOYMENT	ESTIMATED EMISSIONS FROM THE REQUIRED HOUSING (lb./hr.)				
		<u>SO₂</u>	<u>NO₂</u>	<u>TSP</u>	<u>CO</u>	<u>HC</u>
Beulah	377	2.10	3.55	2.96	1.98	0.89
Hazen	354	1.97	3.34	2.78	1.39	0.83
Golden Valley	44	0.25	0.42	0.35	0.17	0.10
Pick City	11	0.06	1.08	0.09	0.45	0.54
Stanton	100	0.56	0.95	0.79	0.39	0.47
Zap	78	0.43	0.73	0.61	0.30	0.36
Center	55	0.31	0.52	0.43	0.21	0.26
Dodge	11	0.06	1.08	0.09	0.45	0.54
Halliday	78	0.43	0.73	0.61	0.30	0.36
Construction Camp	334		1.91	0.49	1.91	0.19

(1) Source Addendum B (ANR-Basin Joint Project) to the
Environmental Impact Report North Dakota
Gasification Project for ANG Coal Gasification Company
May, 1976, page B-20.

(2) Emission rates are based on EPA Emission factors (EPA, 1970). It was
assumed that the furnace for the average residential home was
110,000 BTU/hr., oil burning unit and the furnace for mobile unit in the
construction camp were propane-fired, 75,000 BTU./hr. units.

E. Estimates of Ambient Air Quality Deterioration Due to Associated Growth

The ambient air quality deterioration resulting from the growth of the residential communities associated with the construction and operation of the proposed plant was estimated using the procedures , as described in Section C, to evaluate the impact of air emissions from area sources.

For the purpose of these calculations it was assumed that the majority of emissions resulting from the associated growth would come from new residential dwellings. The effect on the ambient air quality resulting from an increase in automobile traffic was assumed to be negligible, since the work force will reside in several surrounding communities and traffic to and from work will not be highly concentrated.

The predicted increase in the number of residential dwellings and their location during peak plant employment period is summarized in Table XVIII.

To evaluate the impact on the air quality the following assumptions were made.

- 1.) All new residential dwellings will be localized in one area of the community and each new residence (house) occupies a quarter acre lot. The size of the area grid source were computed based on this assumption.
- 2.) The emissions listed in Table XVIII are continuous, and uniform over the grids and
- 3.) The effective stack height for each dwelling is 20 feet.

All estimates of maximum ground-level concentrations were calculated for neutral stability conditions (Stability Class D) with moderate winds (7 m/sec). The results of the computations are summarized in Table XIX. As indicated in the table the impact, which is negligible, will be very localized.

TABLE XIX

ESTIMATED AMBIENT AIR QUALITY DETERIORATION DUE TO ASSOCIATED GROWTH
OF THE RESIDENTIAL COMMUNITIES IN BEULAH 7

POLLUTANT	AVERAGING PERIOD	MAXIMUM CONCENTRATION		NORTH DAKOTA AMBIENT AIR STANDARDS	NATIONAL STANDARDS AMBIENT AIR		FEDERAL AND STATE SIGNIFICANT DETERIORATION CLASS II
		I ²	II ²		PRIMARY	SECONDARY	
SO ₂ (ug/m ³)	1-hour	4.3	1.9	715 ³	-	-	No classification
	3-hour	1.1	0.6	-	-	1300 ⁴	700 ⁵
	24-hour	0.4	0.2	260 ³	365 ⁴	-	100 ⁵
NO _x (ug/m ³)	1-hour	7.3	3.2	200 ⁶	-	-	No classification
CO (mg/m ³)	1-hour	Negligible		40 ⁴	40 ⁴	40 ⁴	No classification
	8-hour			10 ⁴	10 ⁴	10 ⁴	No classification
HC (ug/m ³)	3-hour (6 to 9 a.m.)	0.5	0.3	160 ⁴	160 ⁴	160 ⁴	No classification
TSP (ug/m ³)	24-hour	0.5	0.3	150 ⁴	260	150	30.0

2. One hour estimates are based on: Stability Class F; 2.0 m/sec wind speed; S=0.804 Km; $\sigma_{yo} = 186$; $\chi Y = 6.5$ Km [Figure 3.2 (Turner)] and the emission rates in Table XVIII therefore:

	I	II
x (Km)	1.61	3.22
x + Xy (Km)	8.11	9.72
σ_z (m)	19	27
σ_y (m)	230	370
x/Q ($\frac{\text{sec}}{\text{m}^3}$)	6.4×10^{-6}	15.9×10^{-6}

all other estimates are based on: Stability Class D; 7.0 m/sec wind speed S= 0.804 Km; $\sigma_{yo} = 186$; $\chi Y = 3.0$ [Figure 3.2 (Turner)] and the emission rates in Table XVIII therefore:

	I	II
x (Km)	1.61	3.22
x + xy (Km)	4.61	6.22
σ_z (m)	44	67
σ_y (m)	260	320
x/Q ($\frac{\text{sec}}{\text{m}^3}$)	4.0×10^{-6}	2.1×10^{-6}

2. I. Maximum ground level concentration 1 mile downwind of the community.
II. Maximum ground level concentration 2 mile downwind of the community.
3. Maximum concentration
4. Maximum concentration not to be exceeded more than one per year.
5. Maximum allowable increase over the baseline air quality not to be exceeded more than once per year.
6. Maximum concentration not be exceeded over 1% of the time in any three month period.
7. The air quality deterioration due to the growth of other communities listed in Table XVIII would be less.

```

SUBROUTINE JET (HF, DELHX, HP, VS, D, TS, T, U, KST, DTHDZ)      000100
C   JET PLUME FORMULAS ACCORDING TO EPA'S 'GUIDELINES FOR AIR    000110
C   QUALITY MAINTENANCE PLANNING AND ANALYSIS' VOL 10: 1974, P 25 000120
C   OUTPUT VARIABLES ARE                                         000130
C   HF      EFFECTIVE STACK HEIGHT                               000140
C   DELHX   PLUME RISE FOR SPECIFIED STABILITY CONDITION         000150
C   INPUT VARIABLES ARE                                           000160
C   HP      PHYSICAL STACK HEIGHT                                 000170
C   VS      STACK GAS EXIT VELOCITY                              000180
C   D       STACK DIAMETER                                        000190
C   TS      STACK GAS EXIT TEMPERATURE                           000200
C   T       AMBIENT TEMPERATURE                                  000210
C   U       WIND SPEED                                            000220
C   KST     STABILITY CONDITION                                   000230
C   DTHDZ   POTENTIAL TEMPERATURE LAPSE RATE                     000240
C   RISE IS USED INTERNALLY FOR THE PLUME RISE.                  000250
C   GO TO (10, 10, 10, 10, 20, 20, 20), KST                     000260
C   GO TO 20                                                       000270
C   CALCULATE PLUME RISE FOR UNSTABLE AND NEUTRAL CONDITIONS.    000280
10  DELHX = 3.0 * VS * D / U                                       000290
C   GO TO 50                                                       000300
C   CALCULATE PLUME RISE FOR STABLE CONDITIONS. IF WIND SPEEDS ARE 000310
C   LESS THAN 1 M/SEC USE FORMULA FOR LIMITING CASE OF CALM OR NEAR 000320
C   CALM CONDITIONS                                              000330
20  DTHDZ = 0.035                                                  000340
C   IF KST = 5 THEN DTHDZ = 0.02; IF KST = 6 THEN DTHDZ = 0.035 000350
C   IF (KST .EQ. 5) DTHDZ = 0.02                                  000360
C   IF (U .GT. 1.) GO TO 30                                         000370
C   DELHX = 4 * ((T * V * D) ** 2.0 / (39.2 * TS * DTHDZ)) ** 0.25 000380
C   GO TO 50                                                       000390
30  DELHX = 0.945 * ((T ** 3 * VS ** 4 * D ** 4) / (TS ** 2 * U ** 2 * 000400
X    9.8 * DTHDZ)) ** 0.1667                                       000410
C   DETERMINE THE EFFECTIVE STACK HEIGHT                          000420
50  HF = DELHX + HP                                                000430
C   RETURN                                                         000440
C   END                                                            000450

```

I-38

APPENDIX

ATTACHMENT AP-100-V
Page 74 S

REFERENCES

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APPENDIX J

Written Comments on Draft Environmental Statement
and Bureau of Reclamation Responses

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Advisory Council on
Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

April 6, 1977

Mr. Donald D. Anderson
Acting Commissioner
Bureau of Reclamation
U. S. Department of the Interior
Washington, D. C. 20240

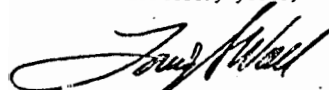
Dear Mr. Anderson:

This is in response to your request of March 22, 1977 for comments on the draft environmental statement for the ANG Coal Gasification Company, North Dakota. The Council has reviewed the statement and notes that the undertaking will affect numerous archeological and historical resources that may be eligible for inclusion in the National Register of Historic Places.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, (16 U.S.C. 470f, as amended, 90 Stat. 1320) Federal agencies must, prior to the approval of the expenditure of any Federal funds on an undertaking or prior to the granting of any license, permit or other approval for an undertaking, afford the Council an opportunity to comment on the effect of the undertaking upon properties included in or eligible for inclusion in the National Register of Historic Places. For your convenience, a copy of the Council's "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800) is enclosed.

Until the requirements of Section 106 are met, the Council considers the draft environmental statement to be incomplete in its treatment of historical, archeological, architectural and cultural resources. To remedy this deficiency, the Council will provide substantive comments on the undertaking's effect on the previously mentioned properties through the Section 106 process. Please contact Brit Allan Storey of the Council's Denver staff at (303) 234-4946, an FTS number, to assist you in completing this process as expeditiously as possible.

Sincerely yours,



Louis S. Wall
Assistant Director, Office
of Review and Compliance

Enclosure

The Council is an independent unit of the Executive Branch of the Federal Government chartered by the Act of



IN REPLY
REFER TO: 420

SW

125.3
United States Department of the Interior

BUREAU OF RECLAMATION
WASHINGTON, D.C. 20240

JUN 10 1977

OFFICIAL FILE COPY		JUN 13 1977	
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934			

Mr. Louis S. Wall
Assistant Director, Office
of Review and Compliance
Advisory Council on
Historic Preservation
1522 K Street, NW.
Washington, D.C. 20005

Dear Mr. Wall:

On May 6, 1977, the Bureau of Reclamation responded to your April 6, 1977, letter concerning the draft environmental impact statement for the ANG Coal Gasification Company, North Dakota. We informed you that the American Natural Gas Service Company and the Great Lakes Gas Transmission Company have agreed to provide the information necessary for the Bureau of Reclamation's compliance with Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f, as amended, 90 Stat. 1320). Enclosed for your information is a copy of a May 26, 1977, letter from the American Natural Gas Service Company stating its intent to provide us with the necessary information for Reclamation's compliance with section 106.

Sincerely yours,
(SGD) E. F. SULLIVAN

ASSISTANT
Commissioner

NOTICE
If you detach enclosures, please
insert your code number 203

Enclosure



United States Department of the Interior

BUREAU OF INDIAN AFFAIRS

ABERDEEN AREA OFFICE
115 FOURTH AVENUE S.E.
ABERDEEN, SOUTH DAKOTA 57401

IN REPLY REFER TO:

Environmental
Quality

APR 13 1977

Memorandum

To: Director, Bureau of Reclamation, Washington, D. C.
From: Office of the Area Director
Subject: Draft Environmental Statement--ANG Coal Gasification
Company, North Dakota Project (DES 77/11)

By memorandum dated March 25, 1977 our Central Office has referred the subject statement to us for review and comment.

Section 2.4 seems to adequately point out the concerns of the Three Affiliated Tribes on Indian water rights. There may be additional concern to Law and Order as indicated with projected influx of families.

Section 3.4. It is difficult to project in-migration of Indian families for the purpose of employment. However, since the prevailing winds at times would be from the southeast, the odor and particulate affects to the reservation may be of concern. The Tribal Council is considering changing the air quality designation from Class II to Class I. At this point in time it cannot be definitely stated whether the Tribes will carry through with this change.

Section 8.2.2 gives a sketchy discussion on the alternative routes of the product pipeline. From this description the proposed route would probably allow the least impact to the Indian residents of the Fort Totten Reservation. Right-of-way for the Great Circle Route would be difficult, if not impossible, to obtain across the Fort Totten Reservation. It is assumed that alternative 1 would by-pass the reservation to the south, but it is difficult to estimate how far.

No response necessary.

Section 3.4.1 discusses the possibility of emissions reaching the reservation; no odors should be detected on the reservation.

Alternative 1 would pass about 15 miles south of the reservation.



Save Energy and You Serve America!

We have provided copies of this draft to the Tribe and our Agency office at New Town, North Dakota; we have not received their comments yet.

We appreciate the opportunity to review and comment on your proposal.

Stanley W. Zepher
Area Director



United States Department of the Interior

BUREAU OF OUTDOOR RECREATION
WASHINGTON, D.C. 20240

IN REPLY REFER TO:

LBR/ND
DES-77/11

MAY 4 1977

Memorandum

To: Commissioner of Reclamation
From: Acting Director, Bureau of Outdoor Recreation
Subject: Draft Environmental Statement--ANG Coal Gasification
Company, North Dakota Project

We have reviewed the subject materials as requested in your memorandum of March 22, 1977, and submit the following comments.

General Comments

The information in the statement is very general. Both the maps and narrative are of such a general nature that it is difficult to determine the impact this proposal will have on recreational resources in the area.

The following incorporated communities affected by the proposed product pipeline have projects that receive assistance from the Land and Water Conservation Fund: Beulah, Hazen, Drake, Garrison, Underwood, Cole Harbor, and Devils Lake. Information as presented in this statement is not of sufficient detail to determine the impacts this project may have on recreation resources in these communities. Park and recreation areas receiving monies from the Fund are subject (in their entirety) to the provisions of Section 6(f) of the Land and Water Conservation Fund Act of 1965, as amended. Section 6(f) permits no changes from recreational land use in a park so assisted without approval of the Secretary of the Interior. The Secretary can approve such a conversion only if it is in accord with the State Comprehensive Outdoor Recreation Plan, and then only upon the substitution of other properties of at least equal fair market value and reasonable equivalent usefulness and location. There is no provision under this section for acceptance of cash in payment for other areas.

We suggest that you coordinate this project with the State liaison officers in both North Dakota and Minnesota to avoid possible conversions of parklands. Their names and addresses are as follows:

Gary Leppart, Coordinator
State Outdoor Recreation Agency
RR #2, P.O. Box 139
Mandan, North Dakota 58554

Specific impacts to recreational resources are discussed in Section 3.3.2.7.

We know of no parks which will be affected; however, if land use changes of park and recreation areas receiving Land and Water Conservation Fund monies occur, the Secretary will have to approve the changes. No impacts other than increased use of these areas are anticipated. If any parks are affected by the pipeline, the company will have to comply with provisions of Section 6(c) of the Land and Water Conservation Fund Act.

The Bureau of Reclamation has been coordinating the project with the agencies mentioned and will continue this coordination in the future.

Mike O'Donnell, Commissioner
Department of Natural Resources
301 Centennial Building
658 Cedar Street
St. Paul, Minnesota 55101

Specific Comments

Page 1-59: This section of the report indicates that with minor exceptions most of the right-of-way would use existing Burlington Northern and Soo Line Railroad right-of-way. Additional information should be provided on what the present use is of the 79 acres of new right-of-way to be acquired.

Page 1-61: Figure 1-18 (map) should clearly delineate and identify the proposed route of the new transmission line.

Page 3-47, b. Knife River, Spring Creek, and Antelope Creek: The Knife River from Hazen Riverside Park, one-half mile south of the community to the junction with the Missouri River near Stanton, has been identified in the North Dakota Statewide Comprehensive Outdoor Recreation Plan as an extensively used scenic and recreational river. The final environmental statement should be more specific as to what precautions will be taken to protect this recreational resource.


Fred J. Jones
Mary Lou Grier

As mentioned on pages 2-57 and 3-38 of the DES, the current use of all 79 acres is agricultural.

Figure 1-18 has been clarified.

This reach of the Knife River would experience increased TDS and mineral levels as discussed in Sections 3.1.2.1 and 3.2.3 of the DES; however, these increases would be so slight that it is not possible to predictively quantify them at this time. Any significant changes in water quality would be detected through the U. S. Geological Survey's monitoring program and the State could order corrective action, thus no effects on recreation are anticipated. No special precautions other than those discussed in Section 4.2.3.3 to protect water quality are necessary to protect recreational aspects of this reach of the river.



United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

OFFICE OF THE DIRECTOR

In Reply Refer To:
EGS-DES-77/11
Mail Stop 760

APR 28 1977

Memorandum

To: Commissioner of Reclamation

Through: Assistant Secretary--Energy and Minerals

From: Director, Geological Survey

Subject: Review of draft environmental statement for ANG Coal
Gasification Company's North Dakota Project

We have reviewed the subject draft environmental statement as requested in your memorandum of March 22.

Page 1-23, par. 3: The statement explains that about 19 million gallons of potable water, which would be required for the mines, may come from existing wells. This seems to conflict with Mercer County permit conditions (p. 4-17, item 8) which state that ANGCGC shall neither draw nor utilize ground water from underlying or adjacent aquifers following completion of the water pipeline and commencement of water diversion from Lake Sakakawea; the apparent discrepancy should be explained.

Page 1-44, 1-45, 3-8: More information is needed on the proposed operation of the deep disposal well, especially anticipated or planned injection pressures at which 220 gallons per minute would be injected--and a statement concerning whether the 220-gpm figure represents a firm maximum. If some of the other injection wells mentioned as operating in the State utilize the same injection zone, information on their operating pressure range, history of injection, and volume range would help in impact evaluation. Also, any available information on the hydrologic characteristics of the Minnelusa Formation should be included. The statement should indicate whether any State regulations govern injection pressures or rates.

The mining company, Coteau Properties, is an independent company unrelated to ANGCGC. The Mercer County permit stipulations apply only to ANGCGC. Coteau will obtain all the necessary permits related to mining, including those related to ground water use. If the same permit stipulation is applied to Coteau, the potable water could be obtained from the plant (as mentioned in the same paragraph).

Deep well injection potentials have been studied for ANGCGC by Woodward-Clyde Consultants. Copies of their reports can be obtained from ANGCGC, One Woodward Avenue, Detroit, Michigan 48226. The updated average 234-gpm is the expected injection rate for Phase I. Hydrologic characteristics of the Minnelusa Formation were included in Section 2.1.3.1 of the DES. The Water Supply and Pollution Control Division of the State Health Department, State Water Commission, and State Geological Survey will review injection pressures and rates before approving construction of the deep well disposal system.



Page 1-47, item a: "Stormwater from clean areas of the plant" apparently would include runoff from the dead- and live-storage coal piles. If so, effects of leachates and suspended solids on downstream waters should be discussed.

Page 1-47, 3-22: Details concerning the natural or constructed sealing of the retention pond should be given in the text.

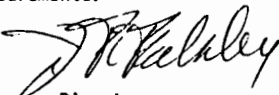
Page 2-21, table 2-5: Estimates of flood magnitudes for drainages only larger than 10 square miles are shown. However, mining and reclamation procedures would require impoundments on drainages smaller than 10 square miles. The flood design standards of dams and spillways for these impoundments should be discussed.

Page 3-24, par. 1 and 3: "Altered" pH and mineral content and "differences" in chemical quality are mentioned. Should these changes be considered as improvements or degradation of the quality of water?

Page 3-29: Mitigation for post-gasification-plant-life and post-reclamation damage to wells should be discussed, inasmuch as North Dakota law does not protect well owners after the life of the plant. From aquifer characteristics it should be possible to anticipate the general order of magnitude of any lengthy delays in movement of pollutants. Plans for decommissioning or abandoning the facilities at the end of the project should be more fully explained.

Page 3-47, item a, par. 3: Runoff from the mining area would be into the Knife River basin, either naturally or by diversion. The effects on this basin from mining-area runoff are not discussed. These effects could be potentially more significant than runoff effects from the plant site and the pipeline which are discussed in items b and c.

Page 4-11, sec. 4.3.2.1: Surface water is proposed to be monitored from one year prior to mining to one year after reclamation in each subbasin. One year is too short a period to obtain significant baseline or post-reclamation data in this semiarid climate. A five-year period both prior to mining and after reclamation would be more likely to yield usable data. The longer periods should be considered for at least one or possibly more of the 10 subbasins. Suspended sediments should also be included in the measurements.


J. H. Kelsey
Director

The stormwater runoff from the coal piles would be routed into the clean water retention pond. The pond would not have an outflow except if a 25-year flood event is exceeded, thus leachates and suspended solids would rarely reach downstream waters. The text has been clarified.

Sealing would consist of an engineered clay lining if suitable clay is available or a synthetic membrane liner if suitable clay cannot be obtained.

The impoundments would be constructed to meet the 25-year flood criteria of the North Dakota State Engineer's Office, State Water Commission, and are covered under MESA laws. A discussion to this effect has been added to Section 1.5.5.2.

The sentence has been clarified to point out that the pH would be lowered (a probable improvement) and mineralization increased (a probable degradation). Neither change is expected to be large enough to affect usage.

Contrary to the assumption that North Dakota law would apply, Condition No. 14 of the Conditional Use Permit (Section 4.5.2) holds ANGCGC responsible without time limit. Presumably this contract can be enforced so long as ANGCGC is in business. Post-mining aquifer characteristics within the pit would differ from present characteristics, thus movement of pollutants cannot be predicted. Per condition No. 5 of the Conditional Use Permit the plantsite must be returned to its present condition and productivity.

Impacts to surface waters from mining-area runoff, including the Knife River Basin, were discussed in Section 3.1.2.1 of the DES; this section analyzes impacts to aquatic organisms from the effects on water noted in Section 3.1.2.1.

Details of the water monitoring program would be specified by the State Health Department and Public Service Commission who have jurisdiction in this area. The suggestion for a 5-year monitoring period has been conveyed to ANGCGC. Since mining in a subbasin would continue for several years, monitoring would continue long after reclamation of certain areas. Suspended solids has been added to the parameters to be measured.



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Area Office - North Dakota
1500 Capitol Avenue
P. O. Box 1897
Bismarck, North Dakota 58501

MAY 3 1977

MEMORANDUM

TO: Commissioner of Reclamation, Bureau of Reclamation
Washington, D.C.

FROM: Area Manager
Bismarck, North Dakota

SUBJECT: Review of Draft Environmental Statement for the ANG Coal
Gasification Company, North Dakota Project

In accordance with your request of March 22, 1977, we have reviewed the draft environmental statement for the subject project. We are pleased to offer the following comments pertaining to fish and wildlife aspects for consideration in the planning activities.

General Comments

It appears that most of the biological data presented in the statement are adequate and fish and wildlife related environmental impacts have been considered. However, as pointed out in the Specific Comments section, we do not concur with all anticipated impacts as stated.

The statement minimizes the potential adverse impacts to fish and wildlife from coal-fired development emissions due to the fact that quantifiable effects of stack emissions are still unknown. More attention should be given to cumulative impacts. Although adverse effects are still largely unknown, it would be inappropriate to assume that such emissions will result in anything less than significant environmental degradation.

Specific Comments

1.4 Relationship to Other Projects

Under Subsection 1.4.1, page 1-12. Include Basin Electric's 212-MW (Unit I) and 440-MW (Unit II) coal-fired power generating plants and United Power Association (UPA) 172-MW coal-fired generating plant all located near Stanton, North Dakota in Mercer County.

No response necessary.

We try to make it clear that little is known about the actual effects of emissions, but still point out potential impacts; to do otherwise would be to speculate about impacts without any supporting data. As mentioned in Section 1.4.2, the BLM-North Dakota Regional EIS will consider cumulative impacts, thus they were only briefly discussed in this EIS.

This section was designed to discuss proposed projects. It is not necessary to discuss all of the existing projects, as any effect they have on the plantsite are already included in the baseline data. The BLM-North Dakota Regional EIS will consider the cumulative impacts of these facilities.



UPA-CPA's two proposed 486-MW coal-fired generating plants near Falkirk, North Dakota, in McLean County, should also be included in this section.

These projects are close enough to contribute to cumulative impacts upon the region.

2.2.2.3 Wetland

Under Subsection Product Pipeline, page 2-65. Expressing impacted wetlands along the proposed pipeline route in terms of miles is unsatisfactory. Pipeline construction through wetlands will have an adverse effect on the entire wetland. A complete inventory of wetlands to be impacted should be undertaken revealing both the number and acres of each wetland type (as per Circular 35 USDI) affected by the product pipeline.

2.2.4.3 Product Pipeline Route

Under Subsection a. North Dakota, Paragraph 6, page 2-78. Replace number 4 with the following material:

Devils Lake is presently the best northern pike producing water in North Dakota, as well as supporting a white bass and a walleye fishery. Because of the salinity problems, the fishery is managed on a put-and-take basis for some species.

2.2.5.2 Endangered Species

Paragraph 1, page 2-80. Insert the following material after the first sentence:

In fact, two confirmed sightings are recorded for Mercer County during the fall of 1975. It is also probable that the arctic peregrine falcon could be found in the region during migration.

3.1.1.3 Cumulative Impact on Ambient Air Quality - ANGCGC and Basin Electric

Under Subsection c. Potential Impacts of Emissions, Paragraph 5, page 3-16. Delete the last sentence and add the following material:

Emission particulates contain numerous trace elements such as selenium, arsenic, mercury and cadmium which acting singly or together can change or damage the physical properties and biological systems of the area they impact.

3.2.1.2 Surface Mining

Under Subsection c. Wetland Communities, page 3-36. Delete the material and replace with the following:

Wetland communities comprise about 50 acres of the area scheduled for mining. Wetland soils, due to their fertility and depth, would

These proposed plants were not included because they are over 35 miles from, and the prevailing wind direction is away from, the ANGCGC site. In addition, these plants lie in the same airshed as the proposed plant, thus it was decided that any effect of these plants in the ANGCGC impact area would be minor and already included in the baseline data.

Data on numbers and acres of wetlands has been added. The entire wetland would seldom be affected. The ROW generally crosses only a corner of the wetland, thus cofferdams and other construction practices would be used to minimize disturbance to the entire wetland.

The paragraph has been changed to reflect this comment.

The paragraph has been changed to reflect this comment.

We agree that these elements may be toxic, however, without studies that show that the low levels of these elements emitted by the proposed project would probably cause damage, we do not feel that such a statement is justified. The discussion of trace elements in this paragraph has been clarified.

Because of differential land subsidence, construction of impoundments to intercept runoff, and nonfilling of the last highwall cut, there is little doubt that there will be some wetland area after mining. What is not known is the degree to which vegetative and invertebrate communities will become established. We recommend that the Fish and Wildlife Service monitor the evolution of post-mining wetlands to determine their ultimate wildlife value.

almost certainly be converted to agricultural use. Even with proper grading it is not known if the final cuts in the mine area will hold water, or if soil conditions will support wetland communities. Therefore, a loss in wetland habitat is expected.

3.2.1.5 Product Pipeline

Under Subsection c. Wetlands, first paragraph, page 3-38. Add the following material after the paragraph:

These construction practices will be followed on all wetlands impacted so as to maintain the integrity of the wetland. However, production on these wetlands would be lost for one season.

First paragraph, page 3-40. Last sentence. Change 22 miles to the correct acreage figure.

3.2.1.6 Analysis of Impacts to Terrestrial Flora

Third paragraph, page 3-40. Delete last sentence and add the following material:

Overall, the net effect of the proposed project on wetland habitat will be a permanent decrease in wetland acres as well as other short and long term impacts. Stack emission impacts on wetland vegetation could be significant.

Table 3-16, page 3-41. The 47 acres of wetlands affected by the plantsite is not accurate. A field review of the proposed plantsite by personnel from this office revealed that a Type IV wetland of approximately 150-200 acres will be impacted.

It is our opinion that a Section 404 permit will be required if significant portions of this wetland are filled. We recommend that careful consideration be given to avoid altering the wetland. The statement accurately reflects its high value to wildlife. The location in an area of few natural marshes increases its importance. There are several springs flowing into the marsh. Some water was present even during the current drought conditions.

3.2.2.2 Surface Mining

First paragraph, page 3-42. In the first sentence, change short term to long term.

3.2.2.3 Water Intake and Pipeline

First paragraph, page 3-43. Change last sentence to read as follows:

This impact will be minimized by scheduling construction around the nesting season.

The paragraph has been revised to reflect that the construction practices would be used. A paragraph discussing production loss has been added to Section 3.2.1.5.

The correct acreage figure has been added.

See above response to comment on Section 3.2.1.2 on page J-9. The potential impacts of emissions on vegetation were discussed in Section 3.2.1.6 and are not expected to be major. Our review of the literature gives no reason to believe that emission impacts to wetland vegetation would be significantly different from those discussed for vegetation in general.

The 47 acres was that portion of the wetland that was within the original ANGCOG plant site. A field review with FWS personnel on June 30, 1977, showed that the wetland lies outside the revised boundary of the proposed gasification plant. However, REA has informed us that about 60 acres of the wetland would be affected by the Basin Electric powerplant.

See response to above comment.

This correction has been made.

ANGCOG has indicated that construction cannot be scheduled around the nesting season; therefore, the sentence has been deleted.

3.2.2.6 Analysis of Impacts to Terrestrial Fauna

Paragraph 4, page 3-45. Replace the paragraph with the following material:

Postmining rehabilitation efforts will undoubtedly be directed toward establishing as much agricultural land as possible. Consequently, acreages of wetlands and woodlands in the area will decrease as a result of mining, thus those animal species utilizing these habitats will also decrease.

Paragraph 1, page 3-46. Change the first sentence to read as follows:

The decrease in postmining woody cover will negatively impact upland game birds by decreasing the winter carrying capacity of the area.

Paragraph 3, page 3-46. Delete the first sentence because an increase in wetland habitat is not expected.

Paragraph 4, page 3-46. Delete the first sentence because an increase in wetland habitat is not expected.

Paragraph 6, page 3-46. Replace the entire paragraph with the following material:

Endangered species could be impacted directly by the proposed project because it is located within the range of the endangered species that occur in the general region (Section 2.2.5.2).

Paragraph 7, page 3-46. Replace the entire paragraph with the following material:

Overall, the impact of the proposed project on existing animals would be of state and national importance because it is one of numerous projects continuing to rapidly convert the remaining prairie and wetland (and its associated wildlife) to other uses. Unless mined land is reclaimed specifically for wildlife values, the reclaimed land actually provides very little habitat for wildlife compared to minimal or, in some cases, no reclamation.

3.2.3 Analysis of Impacts to Aquatic Ecosystems

Under Subsection a. Lake Sakakawea, Paragraph 2, page 3-47. Replace the entire paragraph with the following material:

During operation of the water intake structure the probability of entrainment of larvae and young warmwater fish would be low when lake elevations are at or near normal levels (1,838 feet). However, during this time entrainment of young coldwater fish (rainbow trout, lake trout, whitefish, coho salmon and rainbow smelt) could

The paragraph has been rewritten to clarify impacts on wetlands and woodlands.

The paragraph has been changed to reflect this comment.

We do not agree that over the long term wetland habitat would necessarily decrease. The text has been changed (p. 3-47) to indicate that postmining acreages are uncertain. See response to above comment.

We do not agree with this reasoning. No endangered species have been found in the vicinity of the plant-mine site during studies in the area by Woodward-Clyde and the North Dakota Game and Fish Department. The entire United States lies within the general range of one endangered species or another, thus the same statement could be said of any project in any location.

We believe the paragraph as written accurately reflects the state and national importance of the proposed project on existing animals.

The intake area was surveyed by the North Central Reservoir Investigations Team and they did not find any larvae or young of the mentioned coldwater fish in the vicinity of the proposed intake. The paragraph has been revised to emphasize warmwater species.

be significant. Losses could also be significant for warmwater species during low water periods (1800 feet elevation or less) which might occur an average of 1 out of 8 years (74). Most adult and fingerling fish should be able to avoid the relatively low intake velocities (0.5 cfs at peak demand). Macroinvertebrates and plankton would also be subject to entrainment.

Paragraph 3, page 3-47. Add the following material at the end of the paragraph:

Runoff diversion does not solve the problem of increased siltation and mineralization but only changes its area of influence. Antelope Creek has recently been classified as a critical stream by the North Dakota Game and Fish Department because it provides excellent forage fish production, northern pike reproduction, and a moderate sport fishery near the mouth on northern pike, channel catfish, and walleye.

Under Subsection c. Product Pipeline, Paragraph 4, page 3-48. Change the last sentence to read as follows:

Many of the potential impacts will be avoided by scheduling construction around wildlife and fishery reproductive and migration periods.

3.6 Cumulative Impacts of Coal-Related Developments

First paragraph, page 3-79. Change the first sentence to read as follows:

This section is designed to discuss in a general way the major impacts that could accrue to the impact area from the currently proposed projects within a 50-mile radius of Beulah.

This would be more realistic because it adds an additional five coal-related developments that will definitely add to the cumulative emissions.

Paragraph 3, page 3-79. Adjust the total emission figures to include the five additional coal-related developments discussed in Section 1.4.1.

Add the following material between paragraphs 3 and 4:

A better understanding of emission densities can be gained from a comparison of projected North Dakota region emissions with the Kaiparowits scenario. Kaiparowits is a good example for comparison because the project was halted apparently due to its adverse environmental impacts. Those quantified impacts can now be used to measure the limit that society can reasonably be expected to endure. Kaiparowits was a proposed 3,000 megawatt generating complex in planning since 1962. The plant would have used the vast deposits of low sulfur coal in southern Utah and when fully operational, would generate electricity for 3 million customers in Arizona and southern California. The plant would have burned more than 1,000 tons of coal an hour and the environmental groups objected to the fact

The material has been added to the paragraph.

The sentence has been modified to reflect this comment.

This section was not meant to be detailed regional analysis of the cumulative impacts of coal development. Rather it is a general discussion of cumulative impacts from coal development within a reasonable proximity to the proposed plantsite. The scope of the BLM-North Dakota Regional EIS would cover the developments you mention.

See response to above comment.

The differences in the magnitude of the emissions, general climate, ecosystems, and airsheds make comparing the Kaiparowits and ANCCGC plant inappropriate. Further, we understand that the withdrawal of the Kaiparowits Project by its sponsors was based primarily upon economic concerns.

that its stacks would have spewed at least 300 tons of pollutants a day into the air. The National Park Service agreed that the plant's emissions would harm the region. The National Park Service concluded the plant's emissions would cause significant aesthetic intrusion within 60 miles of the plant and moderate adverse visual impact up to 100 miles from the plant. The emission levels that caused these concerns should be displayed and compared with the projected emissions (at least 800 tons per day) for the coal-related developments in southwestern North Dakota.

Since most of the effects of these pollutants on man, wildlife and plants are still unknown, the 800 tons of pollutants cast into the atmosphere a day should be viewed with grave concern.

Paragraph 3, page 3-80. Add the following material to the paragraph:

Since coniferous plant species are the first to visibly manifest symptoms and many near-by communities contain coniferous trees, a monitoring program should be established in these communities to check effects of plant emissions.

4.1.2.2 Water Quality, Paragraph 1, page 4-2. Add the following material after the second sentence:

North Dakota State Water Quality Standards contain an antidegradation policy which states: "Water, whose existing quality is higher than the established standards, will be maintained at the higher quality unless it can be affirmatively demonstrated that a change in quality is justifiable to provide necessary economic or social development and will not adversely affect the stated beneficial uses of the water. All exceptions must be supported by data."

4.2.3 Biological Systems

Under Subsection 4.2.3.1 Terrestrial Flora, Paragraph 1, page 4-7. During reclamation much of the land currently covered by prairie would be converted to agricultural use. Therefore, our recommendation is to seed native grasses and woody plants and construct wetlands on public and company-owned lands in the mine area.

The FWS Office of Biological Services is knowledgeable on developing wildlife habitat on reclaimed strip mined areas and would provide assistance in this area. This would help minimize the loss of wildlife habitat due to the project.

Another practice to minimize losses would be to exclude mining operations from gullies and ravines with patches of brush and trees. These areas provide critical food and shelter for wildlife. This practice would help to insure a more diverse biological community in the area during post mining periods.

About 10.8 tons rather than 800 tons of pollutants would be emitted each day by ANGCCC. Cumulative impacts of emissions will be presented in the BLM-North Dakota Regional EIS.

The paragraph has been changed to recommend a monitoring program to determine the effect of emissions on prairie plants; the effects of emissions on conifers are being studied in Montana in association with the Colstrip powerplants and results from these studies would apply to North Dakota also.

The second paragraph was changed to reflect this comment.

We agree that these measures would help minimize impacts and should be implemented.

This offer has been conveyed to ANGCCC.

It is seldom feasible to isolate small gullies and ravines from mining operations even though desirable from a wildlife habitat standpoint.

4.3.2.1 Surface Water

Paragraph 3, page 4-11. Add selenium, arsenic, and mercury to the parameters in the last sentence.

4.3.3 Biological Systems

Paragraph 1, page 4-13. Add the following material to the paragraph:

Wildlife populations will be monitored in nonmine areas to reveal the effects of stack emissions on wildlife.

5.1.2 Water

Paragraph 3, page 5-2. Change the second sentence to read as follows:

Entrapment of fish and other aquatic organisms will occur.

8.2.1 Plant Location Alternatives

Under Subsection b. Sites Nearer to Market Area, Paragraph 1, page 8-13. Add the following paragraph:

One advantage of locating the gasification plant nearer the market area would be the elimination of adverse environmental effects to North Dakota caused by the plant and the product pipeline. If all coal-related developments were built close to the market area, North Dakota could continue to enjoy clean air and unrestricted visibility, which now are considered to be important environmental attributes.

Wm. Ault/athic

cc:
Central Office, Washington (EC)
Regional Office, Denver (AENV)

These elements have been added to the parameters.

The Bureau of Reclamation has recommended such a monitoring program to ANGCGC; however, no definite monitoring program to detect effects of stack emissions is planned by ANGCGC at this time.

The sentence has been changed to reflect this comment.

This thought was expressed in Section 8.3.2.1.



United States Department of the Interior

BUREAU OF MINES
2401 E STREET, NW.
WASHINGTON, D.C. 20241

May 5, 1977

DES-77/11

Memorandum

To: Commissioner of Reclamation

Through: Assistant Secretary--Energy and Minerals

From: Director, Bureau of Mines

Subject: Draft environmental statement for ANG Coal Gasification Project,
Mercer County, North Dakota

We have no major objections to the document, however, we suggest two revisions that we feel would contribute to better understanding of the project.

The document should clarify the relationship between total coal production and actual coal consumption of both the gasification plant and Basin Electric's powerplant. For example, the document indicates that the gasification plant would require 11.5 million tons per year (31,500 tpd). However, actual consumption would amount to 9.4 mtpy; the balance (2.1 mtpy as excess fines) would be utilized by the powerplant or sold. A tabulation or a simple flow diagram would do much to clarify the production-consumption picture.

Secondly, although the statement provides an appraisal of anticipated dollar loss to agricultural production consequent to installation of the project (p. 3-32), the methodology used to derive such costs is not presented. A brief description of all assumptions and the analytical approach used to account for agricultural losses would provide the necessary support for assessing the adequacy of that appraisal.

Thank you for the opportunity to review this statement.

Acting Director

J.D. Morgan



Table 1-2 shows coal consumption of the ANGCGC and Basin Electric plants would total 14.6 million tons/year. The fact that the mine would produce 14.6 million tons/year has been added to Section 1.5.3.1.

The study was conducted by the Department of Agricultural Economics of North Dakota State University and is available from ANGCGC or that institution. Including a description of all assumptions and analytical approaches used in arriving at conclusions presented in the EIS would preclude keeping the document clear and concise as directed by Executive Order 11991. However, the general method used involved average production for the various soil types in the area times 1974 dollar values for the various crops.



United States Department of the Interior

NATIONAL PARK SERVICE
WASHINGTON, D.C. 20240

BUREAU OF RECLAMATION
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Rec'd
MAY 10 1977

IN REPLY REFER TO:

840. L7621 (RMR)PC
PICKSLOAN M.E.E.

MAY 9 1977

TO	INIT.	DATE
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Memorandum

To: Commissioner, Bureau of Reclamation

Through: Assistant Secretary for Fish and Wildlife and Parks

From: ~~Assistant~~ Director

Subject: Draft Environmental Statement - ANG Coal Gasification Company,
North Dakota Project (DES 77-11)

As requested in your memorandum of March 22, 1977, we have reviewed the subject statement and offer the following comments.

There is no reference in this document to Knife River Indian Villages National Historic Site. The final environmental statement should identify its existence and address the impact of the proposed plant upon it. If that impact will be negative, it should so state.

Page 2-99 presents a chart of archeological sites along the route of related developments. We note it includes an archeological site identified as Buchfink. This site which forms one of the components of Knife River Indian Villages National Historic Site is incorrectly reported as being probably destroyed.

It is unclear from the draft environmental statement whether an adequate cultural resource determination has been made concerning the effects of this project on the cultural resources of Marshall County, Minnesota. Page 2-100 identifies six sites. However, we do not know whether this determination was the result of an archeological survey or a records search. If the latter possibility is correct, we suggest that the State Historic Preservation Officer for Minnesota be contacted concerning this project. He is Mr. Russell W. Fridley, Director, Minnesota Historical Society, 690 Cedar Street, St. Paul, Minnesota 55101.

We note that the draft environmental statement does not include correspondence from the respective State Historic Preservation Officers concerned. Accordingly, the final statement should include their letters of comment concerning the project. Other related correspondence such as that

Table 2-39 has been revised to delete the Buchfink site which is a component of the Knife River Indian Villages National Historic Site because these sites lie outside the area affected by the project. Section 3.4.2 has been revised to clarify the lack of impacts.

See response to above comment.

Please refer to the letters of comment received from the North Dakota State Historical Society, Minnesota Historical Society, and the Advisory Council on Historic Preservation.

Letters of comment were received from the Advisory Council on Historic Preservation (page J-79), North Dakota Historical Society (page J-96), and the Minnesota Historical Society (page J-99), and are included in the final statement.



originated by the Advisory Council on Historic Preservation, or by the State Archeologist for either North Dakota or Minnesota, should also be included in the final statement. Such correspondence will facilitate and expedite the review process.

We are pleased to note the degree to which cultural resources have been addressed in this document. In this connection, we offer one further brief comment which relates to the protection of fragile archeological sites. Page 2-98 includes an archeological and historical resource location map. It is our view that in order to preclude unnecessary loss of the resources due to vandalism, that this map be excluded from the final statement.



We agree with the concern expressed for protection of sites and have excluded certain information regarding exact locations of sites from the final statement. At a scale of 50 miles to 1 inch we believe that Figure 2-41 is not specific enough about locations to result in vandalism. Also, comments from other agencies suggest that the figure is useful (e.g. letter from the Department of the Army).



United States Department of the Interior

BUREAU OF LAND MANAGEMENT
WASHINGTON, D.C., 20240

IN REPLY REFER TO:

1792 (731)

Memorandum

MAY 23 1977

To: Commissioner, Bureau of Reclamation
From: Director, Bureau of Land Management
Subject: Review of Draft Environmental Statement, ANG Coal Gasification
Company North Dakota Project

The Bureau of Land Management's (BLM) comments concerning the subject document are enclosed in two parts.

1. General Substantive Comments prepared as overview of various sections of the EIS. Inquiries concerning these comments should be addressed to Director (260), Bureau of Land Management, Washington, D. C. 20240.
2. Specific Substantive Technical comments prepared by BLM personnel assigned to the preparation of our West Central North Dakota Coal Regional Environmental Statement. Since the ANG Coal Gasification Project is a specific proposal to be discussed under the umbrella of this regional statement, we feel that these comments are very important to the overall quality of the regional document. Inquiries concerning these specific technical comments should be addressed to USDI, Bureau of Land Management, State Director, Montana, P. O. Box 30157, Billings, Montana 59107.

Our primary area of concern is the fact that the subject EIS does not cover in specific detail the issue of Federal coal connected with the ANG Project.

In order to meet the requirements of covering major Federal actions in the North Dakota Regional EIS, this issue must be more thoroughly addressed in the site-specific ANG document.

Ernst Berklund

Enclosure

cc: SD, Montana

Many of the technical comments transmitted by this letter were actually prepared by other Federal agencies and the State of North Dakota, and were sent directly to us by those agencies. For example, the comments on page 5-8 were provided by the State Health Department. Responses, therefore, are sometimes directed toward the agency originating the comment.

See response to this comment on next page.



Bureau of Land Management Comments on Draft Environmental
Statement ANCO Coal Gasification Company North Dakota Project

Part 1. General review comments concerning the subject DES

Chapter 1

Federal coal leasing and its relationship to other programs have not been addressed in this chapter. Page 8-9, paragraph 8.1.3.6 briefly mentions EMARS under the subtitle "Alternatives to the Proposed Mining Plan."

Table 1-1 (p. 1-8) must include the source(s) of this data.

Page 1-45. Estimates of the amount of water and chemical contaminants in this water should be provided in Table 1-16 or the text.

Page 1-64. A description and locations of two compressor stations are needed. What is their power source and what efforts will be taken to mitigate pollutants and noise during their operation.

Chapter 2

P. 2-57 and 2-58. The relationship between the vegetation types (p. 2-57) and the plant communities should be clarified.

P. 2-58. The source(s) of information leading to the conclusion that no endangered plant species were noted in the study area should be provided. Also, it must be stated whether a field survey for these plant species was conducted.

P. 2-59 (Figure 2-34). Instead of this figure showing sampling areas, a figure or figures should be provided showing the plant mine sites with the boundaries of the habitat types drawn in. This presentation should give a much clearer presentation of the relationship between the proposal and the existing environment.

Pp. 2-67 through 2-80, "Wildlife." Again, the relationship between the existing wildlife resources and the proposal would be made clearer by the addition of some figures showing crucial wildlife habitats, ranges of "important" species, migration routes, etc., and project components.

P. 2-79 -- 2-80, "Endangered Species." The information presented in this section is very sketchy. One observation does not support any conclusions about the existence of the species in the area. First, sources of information must be included. Were universities and natural history museums checked for occurrence data? This section should indicate if any critical habitat of the black-footed ferret, whooping crane, etc., is found in the study area. More definite information is needed to support the analysis.

As originally proposed, the project would not use any Federal coal; however, now that BLM may resume leasing, Federal coal use is discussed as an alternative in Section 8.1.3.6 as agreed with BLM representatives.

The source has been added to the Table 1-1.

Figure 1-16 has been revised; chemical analysis of the raw water is presented in Appendix E.

Locations of the stations are given on p. 1-64 (Miles 120 and 240). A description and the power source has been added to Section 1.5.6.1. Power would come from pipeline SNG. No special mitigation measures are proposed to reduce pollutants (Section 3.1.1.2) and the compressor would be enclosed to reduce noise.

The plant community descriptions on the following pages more fully describe the major vegetative type present at the plant-mine site.

As stated in the same paragraph, a field study was conducted and the list of plant species found is shown in Appendix G; none of the plant species in Appendix G are proposed for inclusion on the list of endangered plants.

This level of detail was not determined during the field study.

We disagree with the philosophy that some species of wildlife are more important than others. Most forms of wildlife, with the exception of those with very specialized habitat requirements (e.g. waterfowl), can be found throughout the project area. Only 29 acres of scattered woodlands which might be regarded as "crucial" to some species would be affected. There are no terrestrial migration routes in the area. The section has been rewritten to reflect information provided by the U. S. Fish and Wildlife Service. As mentioned on page 2-79 no prairie dog towns (critical ferret habitat) are present in the study area and, as mentioned on page 2-80, the whooping crane only migrates through the general region.

Under "Meteorology" 2.1.2.1, the statement is made that inversions are most prevalent during the summer months; what are the summer months for this area as compared to the spring months for which inversions are least prevalent?

Under "Quality" 2.1.2.2. a. Plant Mine Site. Approximately one-month's sampling of the criteria pollutants at the Plant-Mine Site appears to be considerably sparse. How can such meager data be used quantitatively and qualitatively in the impact analysis in Chapter Three on air quality as representative? What is the rationale for its use?

What are the sources for figures 2-3, 2-4, 2-5, 2-6, 2-7, 2-8, 2-9, 2-10, 2-11, 2-12, 2-13, 2-14, 2-15, 2-16, 2-17, 2-18, 2-19, 2-20, 2-21, 2-22, 2-23, 2-24, 2-25, 2-26, 2-27, 2-28, 2-29, 2-30, 2-31, 2-32, 2-33, 2-34, 2-40 and Tables 2-6, 2-7, 2-11, 2-14, 2-16, 2-19, 2-34, 2-38, and 2-39.

Chapter 3

Vegetation/Wildlife. These sections must contain a discussion of the effects of acid rains caused by the reaction of plant air pollutants and precipitation on terrestrial and aquatic flora and fauna. A recommended source of information is Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystems (USDA Forest Service General Technical Report NE-23, 1976).

An additional impact not addressed in the potential impacts of emissions on page 3-14 is that increment donated by the increase in the human population as a result of the proposed action. This would include housing, shopping centers and other commercial construction, auto emissions as the result of increased population, and the net increase in consumption of energy in all forms because of the project and its supportive industries.

Wildlife

Pp. 3-38/3-40, "Wetlands." This analysis is very indefinite and provides no concrete assessment of the impacts of the proposal on this resource. Instead of an indefinite assessment like this, it would be better to present a "worst case" and most probable case analysis. The use of "ifs" and "shoulds" does not provide the reader or decisionmaker with useful information. If a conclusion about the impact cannot be made because of insufficient supporting data, this should be so stated in the environmental statement.

P. 3-42, "Surface Mining." The impacts on terrestrial fauna described in this section are too generalized. "Those species able to tolerate nearby human activity . . ." should be identified. This section should contain an analysis of the amount of habitat lost for "important" species, the length of time for recovery, if any, and an estimate of total population losses.

June, July, and August are considered summer months; spring months would be March, April, and May.

Passive monitoring has been conducted continuously since 1974. Because the State conducts air quality monitoring in the area, a one month program of active monitoring by ANGCGC was considered adequate. The analysis in Chapter 3 was based on 2 years of meteorological data.

As stated on page 2-1 of the DES, most of the data used in the description of the existing environment came from studies conducted by Woodward-Clyde Consultants and Ecology and Environment, Inc.; all of the figures and tables mentioned were based on data in those reports except Table 2-34. Table 2-34 was based on data provided by the North Dakota Department of Public Instruction.

Acid rains would not result from the emission levels of the proposed plant, thus it would be inappropriate to discuss them here. Acid rains were discussed in relation to total proposed coal development on page 3-80 of the DES and will be discussed in greater detail in the BLM-North Dakota Regional EIS.

While not singled out on page 3-14 of the DES, these impacts were considered and are detailed in Appendix I.

The section has been revised to make the assessment more definite; see also responses to Fish and Wildlife Service comments on page J-10.

During our consultation with the Fish and Wildlife Service, they indicated that the data presented were adequate. See also their letter of comment on page J-8. As to species able to tolerate human activity, we were speaking only in general terms here; specific examples would be mice, skunks, starlings, house sparrows, etc. As stated on page J-19, we consider all wildlife species important. Short-term population losses were shown in Appendix H; long-term losses would depend on how the land is reclaimed and, as stated in several places in the DES (e.g. page 3-41), that is not predictable at this time.

P. 3-44, Section f, "Endangered Species." This statement conflicts with the statement on page 2-80. It must be made clear if ANGCCG is committed to a survey for endangered or threatened species' critical habitat of the proposed pipeline route. This commitment must be stated in Chapter 1 if the conclusion of "no adverse impacts" is made on p. 3-44.

Page 3-48 (last paragraph). Table 3-14 and not Table 2-14 should be referenced here.

Chapter 4

The narrative fails to relate what specific actions will be taken by the applicant to comply with the Historic Preservation Act of 1966 (80 Stat. 915) and Executive Order 11593, in section 4.1.4.1. entitled "Cultural Resources," Page 4-4.

Mitigation measures applied by the applicant must be real and enforceable. The phrase "would be" should be replaced by "will be" or "shall be." The latter phrases connote a definite commitment on the part of the applicant.

The most serious weakness of Chapter 4 is its lack of quantification with respect to reduction of certain impacts by mitigation measures.

It is necessary not only to analyze the effectiveness of each measure in reducing the impact, but to quantify where possible the reduction which would occur.

P. 4-7. The mitigation measures are so general it is impossible to adequately assess the unavoidable adverse impacts. For example, the specific sensitive habitats that would be avoided should be named. Also, the phrase "... unnecessary disturbance of terrestrial fauna ..." would be avoided "... provides no specifics on the mitigation measures to be instituted.

P. 4-10, "Monitoring Programs." Although monitoring of air, water and biological systems are discussed, no mention is made of action to be taken if the monitoring programs indicated additional mitigation should be required.

Chapter 5

The unavoidable adverse impacts described in this chapter should be quantified. Of course, the degree of quantification in this chapter is dependent upon the degree of quantification in Chapter 3. The data provided in Appendix H on loss of animals due to the proposed plant should be used to make conclusions in this chapter.

The sentence has been changed to reflect this comment. The commitment by Great Lakes was stated in page 2-80 of the DES. The pipeline ROW is outside the range of all endangered species except whooping cranes, peregrine falcons, and blackfooted ferrets. It would not provide suitable habitat for any of these.

The citation has been corrected to Table 2-6.

Specific actions were discussed in Section 4.4.2 of the DES.

The phrase "would be" makes the same commitment for a proposal still not approved. Regardless of the wording in the EIS, enforceability will be determined by statutes and permit stipulations.

The analysis in Chapter 3 already takes into account mitigation measures as they are an integral part of the plant design. Emission reductions, for example, could only be quantified in Chapter 4 by stating emissions with and without control equipment. We feel such a discussion is not necessary to the environmental analysis.

This description only refers to objectives proposed by ANGCCG to show their intention to minimize impacts whenever possible

Specific actions would depend on the nature of the problem and cannot be predicted at this time. ANGCCG has indicated that they will take the necessary corrective measures.

We have quantified the more significant impacts in Chapter 5 (e.g., land use changes, emissions, water and coal consumption, etc.). The data in Appendix H were used to draw conclusions in Chapter 3.

Part 2 Specific Technical Comments Concerning Subject DES Submitted by
BLM West Central North Dakota Regional Environmental Impact Statement
Team

DEVELOPMENT AND PROJECTS

Page 1-14 The table lists the water use for the following projects as:

Coyote 21,000 acre-feet/year
NGPC 17,500 acre-feet/year

The actual water use is as follows:

Coyote 11,000 acre-feet/year
NGPC 11,750 acre-feet/year

Page 1-15 Reference is made to mine disturbance over 25 years of about 13,000 acres. Following this statement in the text is a table (page 1-18) that shows mine acreage disturbed of 12,500.

Page 1-27 I recognize that the manpower requirements table is showing average workforce; however, the table does not explain whether the figures are average or peak. The title should explain what the figures represent.

The document should clarify the relationship between total coal production and actual coal consumption of both the gasification plant and Basin Electric's powerplant. For example, the document indicates that the gasification plant requires 11.5 million tons per year (31,500 tpd). However, actual consumption would amount to 9.4 mtpy; the balance (2.1 mtpy of excess fines) would be utilized by the powerplant or sold. A tabulation for a simple flow diagram would do much to clarify the production-consumption picture.

Although the EIS provides an appraisal of anticipated dollar loss to agricultural production consequent to installation of the project (p. 3-32), the methodology used to derive such costs is not presented. A brief description of all assumptions and the analytical approach used to account for agricultural losses would provide the necessary support for assessing the adequacy of that appraisal.

We understand that the question of Federal coal tracts will be addressed as soon as the information necessary for analysis is available. (See second comment under the Geology, Topography and Minerals section.)

CLIMATE AND AIR QUALITY

Sanitary wastes: On page 1-29, reference is made to a package treatment plant for sanitary wastes with the effluent to be "further polished in an oxidation pond before release." On page 1-47, reference is made again to

As mentioned on page 1-12, the data on Coyote is for two 440 MW units. The data for NGPC is based on their request to purchase water; they may not actually use that much, but we consider it a maximum resource requirement of the proposed project.

The figure on page 1-15 has been changed to 12,500.

The word "average" has been added to the title.

These comments originated from the Bureau of Mines, see responses on page J-15 of this appendix.

See response to above comment.

See response to above comment.

this package type sanitary waste treatment unit, but if there states that the effluent is to be reused in the ash handling facilities or other process areas. No mention is made of oxidation pond nor of a release of treated waters on page 1-47. If a release into a watercourse is anticipated, a Discharge Permit will be required.

The highest volume use of the treatment plant will probably occur during the construction period. How will the effluent from the waste treatment facility be disposed of at this time as the plant will not be in operation and the waters could not be used in any plant processing?

What sanitary facilities will be provided during the construction phase which involves the package treatment waste treatment facility, waste collection lines, and other related appurtenances?

On page 2-42, it is inferred that during high flows in the Knife River and Spring Creek that increased BOD levels were the result of the release of waste waters from treatment lagoons by communities. High flows are generally the result of either snow melt or runoff from rainfall. Nonpoint sources as well as the municipal lagoons should be included as an explanation for the increased BOD levels during high flows.

The proposal indicates that certain wastes will be disposed of by deep well injection. Has it been determined that the geology of the proposed disposal zone is such that the quality and quantity of the proposed disposal zone is such that the quality and quantity of those wastes can be injected into the zone without operational problems? A discharge permit will be required for this method of disposal.

On page 4-12 of the statement it is noted that a regular monitoring program will be established for groundwater quality data after mining begins. The monitoring of groundwater quality, especially around the mine areas that are being used for ash and sludge disposal, should begin prior to such activities. Perimeter wells around the mine areas should be constructed and monitoring begun before the area is used for waste disposal. Also, the question of monitoring frequency, length of time monitoring is expected to be continued, and the elements of parameters of quality to be determined should be addressed.

Table 2-36 should be updated to reflect present conditions.

Paragraph A of Section 1.5.4.6 Gasification Units states that "the gas escaping during the operation of the coal lock would be exhausted together with excess air by coal lock ejectors to incineration." To date, ANG has indicated that no provisions have been made for the incineration of the coal lock exhaust gas emissions as stated in this paragraph.

The text indicates that the description on page 1-29 refers to waste treatment only during construction; the description on page 1-47 refers to waste treatment only during operation of the plant. An application for discharge during construction will be filed by ANGCGC with the State Health Department and will have to comply with Health Department requirements.

The effluent will be handled either by portable facilities with holding tanks or by treatment in a package unit. ANGCGC will present detailed plans to the State Health Department for approval before construction.

See response to above comment.

The paragraph has been changed to reflect this comment.

As mentioned on page 2-38, a feasibility study was conducted by Woodward-Clyde Consultants. A copy of the study report was provided to the North Dakota State Health Department in October 1976 by ANGCGC. The study concluded that wastes could be injected.

We agree with this comment; ANGCGC and NACCO have indicated they will work with the State Health Department, the Water Commission, and the Public Service Commission to develop a satisfactory groundwater monitoring program.

Table 2-36 has been updated.

The paragraph has been changed to reflect that 98 percent of the gas would be collected and processed, and the remaining 2 percent would be exhausted into the atmosphere. The remaining gas cannot be safely incinerated due to the presence of coal dust and oxygen (an explosive mixture) in the gas.

Paragraph B of Section 3.1.1.2 Air Quality lists open burning of debris as a combustion source of air pollutants. Open burning of debris is not permissible under the North Dakota Air Pollution Control Regulations.

Paragraph B of Section 3.1.1.2 Air Quality states that small quantities of SO_x and NO_x would be emitted from the venting or flaring of the process gas during start-ups or emergencies. These emissions, although small when averaged over an annual time period, may be significant when considered over a 1-hour time period.

Paragraph B of Section 3.1.1.2 Air Quality states that "gaseous streams containing hydrocarbons (primarily from operation of the coal locks) would be incinerated." ANG, at present, does not plan to incinerate the gaseous streams from the coal locks.

Section 5.1 lists emissions from the two plants (ANG and Basin) which do not agree closely with North Dakota State Department of Health estimates. Also, emissions listed in the Pollutant Emissions and Abatement Table found on page B-7 of Appendix B differ from figures assembled by this Department. This table also does not reflect the emissions from the refuse incinerator.

The sulfur disposition diagram shown on page B-8 of Appendix B does not agree with the latest information submitted to the North Dakota State Department of Health by ANG (letter under date of February 17, 1977, from P. Brooks of ANG of this Department).

The information submitted in Table 1-7 does not correlate with the latest information submitted to this Department in ANG's supplemental application submitted on December 17, 1976.

Table II and Table XVI of Appendix I ANGCGC's Air Quality Dispersion Analysis does not correlate with information submitted by ANG's supplemental application on December 17, 1976.

Information submitted as Appendix I does not include all the information submitted to the North Dakota State Department of Health. In particular, the Draft Environmental Impact Statement does not include an equation (iv) which, in information submitted to the Department, was the equation for calculating the plume rise for a buoyant plume in calm winds into stable air which ANG approximated using the formula derived by Briggs.

Page 1-49 of the Draft Environmental Impact Statement states that the volume of the flue gas from the refuse incinerator will be approximately 60,000 standard cubic feet per hour with a particular concentration of 0.2 grains per standard cubic foot. This results in an emission rate of 1.71 pounds

The burning of debris has been deleted.

The short-term emissions from venting and flaring were shown in Appendix I.

The reference to coal lock gas has been omitted. See also response to comment on Paragraph A, Section 1.5.4.6 on page J-23.

Updated emissions data have been added to Section 5.1, Section 3.1.1.2, and Appendices B and I. (ANGCGC June 15, 1977).

An updated diagram has been substituted. (ANGCGC June 15, 1977).

An updated Table 1-7 has been substituted. (ANGCGC June 15, 1977).

An updated Appendix I has been substituted (ANGCGC June 15, 1977).

See response to the above comment.

per hour. The refuse incinerator is estimated to have a load of one to two tons per day which averages to between 250 and 500 pounds per hour based on an 8-hour day. At a load of 500 pounds per hour, the incinerator would be allowed to emit particulates at a rate of 1.38 pounds per hour. Therefore, the refuse incinerator under these operation conditions would not be in compliance with the North Dakota Air Pollution Control Regulations.

Page 1-52 of the Draft Environmental Impact Statement cites an efficiency of the electrostatic precipitator for the steam boilers of about 99%. In the application for a permit to construct ANG cites an efficiency for the electrostatic precipitator of about 80%.

Page 3-20 states that the maximum daytime noise standard for industrial zones in North Dakota is 80 dba. The North Dakota State Department of Health does not have such type of noise standard.

The emission values for NO_x as shown on page 3-80 for Coyote and MPC of 1.32 pounds/10⁶ BTU and 3.0 pounds/10⁶ BTU, respectively, are high.

Page 4-2 states that there are no New Source Performance Standards that apply to this proposed gasification plant or its steam boilers (106). This is not true.

The time periods discussed on pages 4-10 and 4-11 for the various phases of the air quality monitoring program appear to be insufficient.

Section 3.1.1.4 Odors references rather high values of "perception level" for SO_2 and NO_2 (page 3-17). The levels referenced of 1200 $\mu\text{g}/\text{m}^3$ and 7600² $\mu\text{g}/\text{m}^3$, respectively, represent the highest or least sensitive detection threshold of literature referenced to date by this Department.

The following comments from our review of the preliminary Draft Environmental Impact Statement submitted to this Department on October 1, 1976, were either not sufficiently addressed or not addressed at all by this Draft Environmental Impact Statement:

Comment 3 which stated that the size, type, and arrangement of the liquid fuel burners in the steam boilers and superheater furnaces which contribute to a low formation of NO_x , should be discussed.

Comment 8 which requested the identification of the major access roads that will be hard-surfaced and when they will be hard-surfaced in relation to construction of the plant. The Department also requested the identification of unpaved roads and right-of-way to be sprayed with water to control fugitive dust.

A letter has been sent to the State Health Department by ANGCGC stating that the specifications for the incinerator when it is ordered would be such that they would meet State air pollution criteria.

The efficiency has been changed to 80 percent.

The reference to standards has been deleted.

The values for Coyote and MPC have been updated. (Otter-Tail Power Company May 16, 1977, ANGCGC June 15, 1977).

A letter from the State Health Department regarding the applicability of the standards has been added to Appendix B. EPA has yet to establish standards for coal gasification plants.

ANGCGC has indicated they will work with the State Health Department to establish an adequate monitoring program. The time periods were presented as minimum periods.

The values listed represent concentrations that are detectable in outdoor situations. Under laboratory conditions, trained persons can detect concentrations of SO_2 and NO_2 down to 865 $\mu\text{g}/\text{m}^3$ and 230 $\mu\text{g}/\text{m}^3$, respectively. However, these lower levels would not reflect the everyday impact of the proposed project.

After consultation with the State Health Department, this information was provided to them by ANGCGC but it is too detailed for inclusion in the EIS.

As stated on page 1-29 of the DES, the main access road to the plant would be the only paved road. It would be paved prior to plant construction. All unpaved roads and rights-of-way would be sprayed with water to control fugitive dust.

Comment 13 which requested that the expected particulate emission rate from the sodium sulfate dryer to be addressed and compared to the allowable emission rate.

Comment 18 which requested that the air quality effects of two product pipeline compressor stations be discussed.

Comment 19 which requested that the air quality effects of a half-size plant (125 MM cfd) versus the full-size plant (250 MM cfd) be discussed.

Questions concerning these comments should be addressed to Gene Christianson, commercial number (701) 224-2348.

WATER RESOURCES

In general, the subject of water resources is fairly adequately addressed. Exceptions are, first, the lack of any information on the amount of groundwater used for stock and ranch supplies in the area to be impacted; and, second, the lack of specific details regarding the impact of the proposed action on groundwater quality.

Some parts do not seem hydrologically sound. For instance, it is stated with no supporting evidence that the groundwater moves up from the deep aquifers to recharge the shallower ones. Quality of water does not seem to support this idea as a concentration of sodium in the water would likely increase as it moves up through the thick clay beds. In another place, movement of water is indicated in the Beulah Trench from Lake Sakakawea toward Knife River. This is on page 2-38. A groundwater divide higher than the maximum lake level would prevent such movement (see Figure 2-23 on page 2-32). Following are detailed comments on specific items.

Chapter 1

Page 1-10 The appropriation of underground water is controlled by the North Dakota State Water Commission and the State Engineer. The State Engineer should be added to this list.

Page 1-12, Subject NGPL Proposals. The write-up identifies the water needs as 17,500 acre/feet annually for the Dunn Center area. This should be corrected.

Page 1-13 under the topic "Use of Natural Resources." The mine for the NGPL Project is identified as being just north of Dunn Center. I believe it should be east of Dunn Center.

Page 1-37 and Figure 1-15 on page 1-38. The last sentence concerning gasification says "a block flow diagram of the entire process is shown in Figure 1-15." This figure does not show any ash involved.

The flue gas from the dryer is mixed with steam boiler flue gas and treated in the electrostatic precipitator; emissions after treatment are negligible (0.79 lbs/hr).

The effects of the stations on air quality would be insignificant; however, a paragraph on these stations has been added to Section 3.1.1.2.

The proposed project is a 250 MMcfd plant; however, the emissions of a half-size plant would be about half those of a full-sized plant.

Groundwater use was shown in Table 2-8; impacts on groundwater quality were included in Section 3.1.2.2.

Although the water quality may not reflect upward migration of water, pressure differentials are such that upward seepage may occur at low rates between some aquifers. The groundwater divide is not necessarily fixed in location or elevation, but may move in response to various conditions, in particular, water levels in Lake Sakakawea. The 1865-foot elevation only refers to the top of the water at the divide; water from the Lake could move through at a lower elevation.

The State Engineer has been added to the list.

See first response on page J-22 regarding page 1-14 of the DES.

The word "north" was changed to "east."

An arrow indicating ash byproduct has been added.

Page 1-45, line 6. The parenthetical expression reads "silt and CaCO_4 ." Would this be CaCO_3 and CaSO_4 ?

Page 1-47 and Figure 1-16 on page 1-44. No identification is given as to the character of the sludge to be disposed into the mine.

Chapter 2

Page 2-18, Table 2-2. It seems odd that the highest flood on the Knife River near Golden Valley during a period of 60 years only has a 21-year occurrence interval. The record for Knife River at Hazen is not 1844-1963. It is 1884-1963. This implies a continuous record which probably is incorrect. Also, why does this table include data only to 1963? The last 13 years of data are also available. Maximum flood shown for the Knife River at Hazen is in 1966. This table needs revision.

Page 2-19, Table 2-3. Was industrial water use exactly the same every year? Could this be the amount of water right rather than the amount of water used?

Page 2-38, lines 4, 5, and 6. The statement indicates that water goes from Lake Sakakawea to the Knife River valley near Hazen through the Antelope Creek aquifer. If maximum lake elevation is 1,850 feet, water from Lake Sakakawea cannot percolate across a groundwater divide that is identified at an altitude of 1,865.8 on page 2-29 and also shown on page 2-32 in Figure 2-23.

Page 2-42, subject "Streams." The first paragraph should be followed by a table listing the state standards of water quality for the various types of streams. Some of the water quality criteria are indicated in subsequent paragraphs, particularly dissolved solids and color, but the others should be shown for comparisons. Also same page, the second paragraph under "streams" describes the BOD as increasing with the release of waste water from treatment lagoons along the Knife River and Spring Creek. How far did this increase persist? Also, what was the magnitude of the increase?

Page 2-43, Figure 2-33. The title of this figure should be "Surface-Water Quality Sampling Locations."

Page 2-44. The first sentence below the table on groundwater qualities is ambiguous. The exceeding of standards for Lake Sakakawea and Knife River and Spring Creek is irrelevant. What would be relevant is the relationships between the dissolved solids from the various aquifers and the state water quality standards. It suggested that this sentence be removed and recast, possibly moved to page 2-39 where the topic is "Surface Waters."

" Ca CO_4 " has been changed to " Ca CO_3 ."

The estimated composition of the sludge has been added.

Table 2-2 has been revised.

The value assumes the amount authorized is the amount used; the amount actually used is probably somewhat less.

Croft ("Ground water Resources, Mercer and Oliver Counties, North Dakota," NDGS Bulletin #56, Part III, 1973) indicates that the aquifer acts as a conduit when the lake is at maximum elevation. See also fifth response on page J-26.

State water standards are readily available and are too lengthy for reproduction in the EIS (19 pages). The State Health Department attributes some of the increase to nonpoint sources. Data available on the increase was shown in Appendix E. Criteria which may be affected by the project were included.

The title has been changed as indicated.

The sentence was included to give an idea of the quality of the water to the nontechnical reader who may not understand all the technical data presented in Appendix E.

Chapter 3

Page 3-16. The second paragraph. The impact of sulfur dioxide and nitrogen dioxide on tobacco has no particular relevance to western North Dakota.

Page 3-23, fourth paragraph, last sentence. The statement that AnFo is responsible for increased nitrate concentrations should be documented. Also, it is stated that sulfate concentrations in existing mine pit waters is 10 times that of adjacent streams. The supporting data for these statements should be added to the appendix or should be included at this point.

Page 3-23, last paragraph. The first sentence which pertains to the little effect on surface waters receiving water from the pits is negated by much of the rest of the paragraph. Revision of the paragraph would involve recasting and reversal of the first sentence.

Page 3-24, third paragraph. This paragraph should include a statement that the increased erosion of reclaimed land will probably be a temporary impact but that a long term degradation of chemical quality of water is possible and probable.

Page 3-27, last complete paragraph. The last sentence in this paragraph indicates that reclaimed land could not be used as a shallow groundwater source because of leachates from the buried ash and sludge. This is a major impact and should be expanded. The reclaimed land by the end of mining would include the entire mine.

Page 3-29, second paragraph, fourth sentence. The statement that water levels could return to premining levels or higher following reclamation is of doubtful validity. The 19 wells would not be usable after mining unless they were deepened.

Page 3-29, same paragraph. The last two sentences concerning replacement of water supplies may belong under "Mitigation" rather than under "Impact."

Page 3-32, first paragraph under topic d, "Geological Hazards." The fact that 762 wells have been placed in operation in North Dakota since 1954 with no known earthquake problems has very little, if anything, to do with the possibility of problems caused by deep well disposal of plant wastes. Deep well injection would result in the addition of water and possibly the increase of underground pressures. The wells cited are extraction wells whose operation would be to reduce underground pressures.

Page 3-36, topic c, "Wetland Communities." The last sentence in this paragraph should be deleted as it pertains to mitigation rather than impact.

The relevance was indicated when it was pointed out that tobacco is considered average in its sensitivity to air pollutants.

The supporting data was included in Appendix E.

We believe the sentence is accurate; the paragraph does not deal with the transfer of water from pits to other surface waters.

These impacts on water quality were discussed on pages 3-27 to 3-29 of the DES.

The paragraph has been expanded to clarify that the reclaimed land would eventually include the entire mine.

It was decided that this was a logical place to briefly discuss what could be done if the wells were actually affected.

The DES specifically deals with 437 injection wells (132 low pressure and 325 high pressure) rather than 762 extraction wells. The work "injection" has been added for further clarification.

The mitigation was an integral part of ANGCCC's proposal and cannot be deleted.

Chapter 4

Page 4-2, first paragraph under "Water Quality." Federal and state standards for water quality are indicated at this point. They should be tabulated either here or in the appendix and referred to at this point.

Page 4-12 topic "Groundwater" first paragraph. Monitoring of groundwater should begin before mining begins, as would be done with surface water.

Chapter 5

Page 5-2, last paragraph under "Water." The last sentence states that leached water from the mine pit areas may infiltrate shallow aquifers increasing TDS. What specific elements or radicals would be increased and what would be the specific impacts on usage?

Chapter 7

Page 7-1, topic 7.3 "Water." The state is incomplete in that it does not include the irreversible damage to groundwater within the mined and reclaimed area. Also, there is no mention in this paragraph of the irreversible damage done to the Minnelusa Formation by injection of wastes from the deep well.

Chapter 8

Page 8-19, last sentence in the second full paragraph. The statement "underground mining generally has less environmental impact than strip-mining" should be deleted or considerably qualified. The statement as it stands is incorrect.

Appendix B

Some of the arrows on the flow diagrams need to be reversed. Specifically in the Rectisol Unit diagram, gas from cooling should be one of the inputs. In the Ammonia Recovery diagram, gas liquor probably should go into the process--according to the diagram, nothing goes in.

Appendix E-10

The chemical analyses of selected miscellaneous water samples appears to have a transposition of conductivity and total dissolved solids for Sample C-98.

GEOLOGY, TOPOGRAPHY, AND MINERALSChapter 1

Page 1-20. Can the precise area that contains 1.5 billion tons of coal be delineated on a map? Is the reserve within the current stripping depth limitations of 120 feet of overburden and a stripping ratio of less than 8:1? What are technical parameters of the reserve category?

Federal and State standards need not be duplicated in every EIS that is written; such standards are easily available to interested persons and need only to be referenced in the EIS.

An adequate groundwater monitoring program will be specified by the State Health Department as a condition to the project's solid waste disposal permit.

Components of the leachate were detailed on pages 3-28 and 3-29 of the DES. This chapter is a summary of major impacts described in Chapter 3 and is not intended to include all details of previously described impacts.

The paragraph has been changed to note the loss of groundwater within the mined area; the water in the Minnelusa formation is already so salty that it is doubtful that any significant damage will result from the proposed project.

The word "generally" qualifies the sentence and we believe that it is correct, as underground mining does not totally disrupt the top 100-120 feet of the earth's surface.

The arrows have been corrected.

The values do appear to be transposed, but a check of the field notes revealed identical values.

The limits of the reserve have not been accurately determined. The 1.5 billion tons is only an estimate as is the 947 million currently recoverable tons. The coal varies from 20 to 200 feet deep with a stripping ratio of 7.63.

What is the source of the coal analyses? Can it be cited?

This would be a good place to indicate that the proposed action does not include the Federal tracts within the proposed mining area. Also, it could be pointed out that there is in fact both a lease application and EMARS nomination for much of the Federal coal within the proposed mining area.

Chapter 2

Table 2-13 should be explained. What scale is the intensity shown in the second column? What is the intensity shown in the fourth column? If the Modified Mercalli scale is the one used, enclosed is a copy of the description of the various scale intensities and the associated effects at each grade of intensity (enclosure 1). There are descriptions for the Richter Scale in various publications, also. A description of the various intensities would be useful to the reader.

Reference - C. F. Richter, Elementary Seismology, W. H. Freeman and Co., San Francisco and London, 1958. S. T. Algermissen "Seismic Risk Studies in the United States," Fourth World Conference in Earthquake Engineering, Chile, 1969.

Pages 2-46 to 2-48. A physiography map would show what is being discussed. A one-page map that could be used pretty much as is can be found in the Guide to the Geology of North Dakota by John Bluevale prepared by the North Dakota Geological Survey, page 6.

Pages 2-48 to 2-53. The discussion of the physical environment should include consideration of deep salt collapse structures and their possible impact upon the gasification plant. Even though the ANG plant is to be situated near the fringe of the deep salt collapses, such collapse structures have been identified elsewhere in the Williston Basin, in some cases resulting in active subsidence of the land surface.

Page 2-48. Perhaps a bit more discussion of the contact between the Sentinel Butte and Tongue River. Current U. S. Geological Survey usage places the contact at the top of the HT Butte coal bed. According to a report of the Knife River KCLA being prepared by Ronald Law, Conservation Division, for OPEN FILE release, the stratigraphy interval ranges from 170 to 260 feet between Beulah-Zap and HT Butte beds in the area. The thickness given is consistent with the interval shown on the cross-section, Figure 2-35, so be sure to change the figure if you change the text.

In Law's report, a map shows about three feet of Schoolhouse bed in about 3 square miles of Mine No. 1 and No. 3. Seems to me this should be mentioned here and in impacts as it amounts to about 10 million tons of coal that might be mined or irretrievably committed to the spoil pile.

Commercial Testing and Engineering Company of Chicago, Illinois.

The possibility of mining Federal coal is discussed in Section 8.1.3.6 as agreed with BLM representatives.

The fact that the intensities are based on the Modified Mercalli scale and a reference have been added; the reader has also been referred to page 14 of BLM's comments (page J-32) for a description of the Modified Mercalli scale. A description of the Richter Scale can be found in standard texts on geology.

See above response.

The map was examined and was found to differ significantly from the discussion, thus it was not included.

As discussed on page 2-53 of the DES, no deep salt collapse structures are known to occur at the plant-mine site.

The presence of the HT bed does not affect the proposed project or its impacts because it is 170 to 260 feet below the Beulah-Zap bed and is too deep and thin to be economically mined at this time.

The seam is too thin (2-3 feet thick) to be economically mined at this time, thus it would be destroyed. This impact has been added to Chapter 3.

Page 2-50, second paragraph. Do the clinker deposits have any commercial value? Do any of the materials described in the geology section have any commercial or aesthetic values?

Chapter 3

What would earthquakes do to the plant site and pipeline if they should occur at the maximum rates shown in Table 2-13? See Modified Mercalli Intensity Scale on Page 14 of these comments.

Will the sand and gravel, clinkers, and other possible construction materials at the site be stockpiled, but back as part of the overburden and lost to future uses, or be made available for future use?

If the Federal coal is not mined, will it be lost to future generations as an energy source? How much would be or could be lost? Would mining Federal coal make the mining more efficient? Less efficient? How much coal will be lost as a result of recovery rates?

How much sand and gravel will be used and where will it come from? Will areas be disturbed as a result of sand and gravel excavation? Changes in topography, new roads, destruction of forage, etc., are just a few of the impacts that could occur.

How much coal, oil and gas, clinker, sand and gravel could be excluded from near future or future development as a result of construction of pipelines, powerlines, plant facilities, etc.? Is subsidence of the reclaimed mined areas likely or unlikely? What would the long term effects of subsidence be?

If these types of questions are applicable and they cannot be answered, they should be spelled out as unknowns, at least in the impact section of the PDES.

Page 7-1. Additional coal losses could occur if Federal lands within the proposed mining area are not mined.

The clinker deposits to be disturbed by the plant and mine do not have any commercial value but would be used in facility construction to the extent possible; the other materials do not occur in large enough deposits to have commercial or other values.

All structures have been designed to protect the plant against the maximum probable earthquake.

Sand, gravel, and clinker will be recovered and used where economically feasible.

See discussion of the Federal coal alternative in Section 8.1.3.6; mining Federal coal would be more efficient. The recovery factor for all areas is approximately 92.5 percent thus 7.5 percent of the coal mined would be lost, or about 28 million tons for the life of the project.

Sand and gravel would be obtained from local suppliers. About 15,000 cubic yards of both sand and gravel would be required.

No deposits of these resources would be excluded from future development. No subsidence other than settling of soils due to compaction is expected. The long-term effect of this subsidence would be the creation of wetlands in some areas.

See above responses.

A sentence to this effect was added to Section 7.1.

MODIFIED MERCALLI INTENSITY SCALE

The Modified Mercalli Intensity Scale describes earthquakes by their effects for twelve grades of intensity. Each grade is assigned a Roman Numeral as listed below.

- I. Not felt. Marginal and long-period effects of large earthquakes
- II. Felt by persons at rest, on upper floors, or favorably placed.
- III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
- IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frames creak.
- V. Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
- VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knick-knacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken.
- VII. Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments - CFR). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving-in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
- VIII. Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

No response necessary.

- IX. General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas, sand and mud affected, earthquake fountains, sand craters.
- X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches, and flat land. Rails bent slightly.
- XI. Rails bent greatly. Underground pipelines completely out of service.
- XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

PLANTS AND SOILS

Certain elements in the draft are well done such as the comments made concerning the effects of deteriorated air quality on human, animal, and plant health as noted on pages 3-15 and -16. Certain aspects of the statement need to be strengthened. There could be more acreage figures instead of or in addition to statements delineating percentages of one type of habitat or another. Some statement as to the likelihood of reclamation on different types of vegetative communities and also what kind of management would be required to maintain the various communities in a "reclaimed" state would be desirable.

Other comments are as follows:

Chapter 2

Page 2-58, first sentence. Who were the studies conducted by and for whom?

Page 2-58. Add rye to crops grown.

Pages 2-62 to 2-64. Perhaps a one or two sentence description of each range site type would be helpful for the layman. Example, tell why an overflow site is called an overflow site.

Page 2-66, Plant-Mine Site. Are the prairie thickets mentioned in the first sentence also known as "woody draws" or "hardwood draws?"

Page 66, b, tree plantings. The long narrow strips referred to in the first sentence are known as shelterbelts or windbreaks.

How productive are the croplands and rangelands in comparison to other similar lands in the area?

No response necessary.

We prefer percentage figures because they give the reader an immediate impression of how much a particular habitat comprises of the total habitat disturbed. Also, exact acreage figures would be subject to change as current plans change. The likelihood of reclamation of various plant communities is not well established and is currently being studied in North Dakota. Reclamation management practices are also not well established as attempts at reclamation have only recently begun in the region. The preliminary outlook is good, however. Also, we pointed out on page 3-40 that we believe much of the reclaimed land would go into crop production.

As mentioned on page 2-1, the studies were conducted by Woodward-Clyde, Inc. for ANG.

Rye has been added.

Detailed descriptions of the sites are contained in the Woodward-Clyde EIR. They were not included in the EIS because the names of the various sites are self-descriptive and further descriptions are not necessary for the impact analysis.

No. The thickets consist of a high shrub-low tree variable composition of junberry, choke cherry, round-leaved hawthorne, and wild plum.

The text has been changed to reflect this comment.

The SCS advises us that the productivity is essentially the same.

Chapter 3

Page 3-22. If woodlands can be reclaimed to their original condition more than 3-4 years would be required. Make a specific statement about the reclamation of woodlands ("woody draws").

Page 3-22. What criteria are used to make these statements on economic losses incurred to agriculture and the AUMs that would be lost?

Page 3-36, in line 3, change may to would.

Page 3-36, wooded communities. Cite reference for the statement "woody species can often survive directly on spoil materials."

Pages 3-40 and 3-41. Good comment on the loss of native prairies - also should mention reclaimed range is not as valuable for full season grazing as native range is.

Chapter 4

How about using irrigation for the initial establishment of vegetation during the reclamation process?

ANIMALS

The North Dakota Game and Fish Department, Bismarck, North Dakota and the U. S. Fish and Wildlife Service Area Office, Bismarck, North Dakota have submitted detailed comments on this draft EIS in correspondence addressed to Mr. Robert L. McPhail, Regional Director, Bureau of Reclamation, P. O. Box 2553, Billings, MT 59103 (April 26, 1977) and Commissioner, Bureau of Reclamation, Washington, D. C. (May 3, 1977), respectively. This correspondence adequately expresses the concerns of the Animals Work Group with regard to wildlife considerations.

The subject of domestic animals is not adequately treated in this draft EIS. Some attempt should be made to enumerate the livestock types found in and around the project area and to assess impacts on these animals. To aid in the start of this analysis, a table showing domestic animal populations in Mercer and Oliver Counties is enclosed. There is no mention of domestic animal diseases associated with soil disturbances or possible air pollution effects on domestic animals. Information on the effects of deteriorated air quality might be found in USDA Handbook No. 380 "Air Pollutants Affecting the Performance of Domestic Animals" by R. J. Lille.

The page numbers are apparently in error. Reclamation of woodlands was discussed on page 3-36 of the DES. We doubt if there will be any attempt to reestablish woody draws.

Average present productivity of the land that would be disturbed by the proposed project.

The word "may" was changed to "would."

This statement was based on personal observation by USBR personnel during field trips to the area.

We know of no study sufficient in scope to generalize about relative productivity of reclaimed and native range.

Irrigation would not be necessary during years of normal precipitation, but could be used during drought years.

Responses to comments from the North Dakota Game and Fish Department are included in this Appendix.

Impacts to grazing by domestic animals was discussed on page 3-32 of the DES. The table listing numbers of domestic animals county-wide is not necessary to the impact analysis. Domestic animals were included in the discussion of pollutant effects in Section 3.1.1.3 of the DES.

Domestic Animals Populations of Mercer & Oliver Counties

County	<u>CATTLE</u>			<u>HOGS</u>		
	<u>Five Year average</u>	<u>1975</u>	<u>1976</u>	<u>Five Year average</u>	<u>1974</u>	<u>1975</u>
Mercer	64,000	70,000	69,000	5,000	4,000	4,100
Oliver	38,000	42,000	40,000	6,200	5,000	6,000

County	<u>SHEEP</u>		<u>HORSES</u>		<u>CHICKENS</u>
	<u>Five Year average</u>	<u>1975</u>	<u>1974</u>		<u>1974</u>
Mercer	2,400	1,900	300		10,700
Oliver	2,900	2,800	300		9,300

(USDA and the State of North Dakota, 1975)

HUMAN LEISURE PURSUITS AND VALUES

AESTHETICS:

As indicated in earlier reviews, visual resource analysis is lacking. The brief discussion of topography mentions landscape modification due to mining; however, the visual impact of the gasification plant is not discussed. Impacts of the vertical plant structures, i.e., stacks with strobe lights, tanks, conveyors, cooling towers, massive buildings, etc., may be a significant contrast to the rolling landscape of the project site. A discussion of plant appearance and measures to mitigate visual impacts should be included in the final environmental impact statement.

The analysis of construction and operation noises is incomplete. The discussion of noise impacts on page 3-20 suggest that persons living from 1.5 to 5 miles from the construction site would occasionally detect construction noise but that population centers (Beulah and Zap) should not be affected. This statement may be misleading. Residents of Beulah (approximately four miles from the plant site) may experience annoying noise levels during construction, especially if construction occurs at night. Gasification plant operating noises may also prove annoying to Beulah and Zap residents. The FES should note that, although individual reactions to noise are highly variable, noise can cause annoyance, impair hearing and speech communication, interfere with sleep, impair education and learning, lower job performance, and reduce property values. Measures to mitigate noise should deal specifically with steps to avoid increased nighttime noise levels.

There are numerous other existing coal production facilities within a 50-mile radius of this development. Also, the plant would be located in a valley where it would not be visible for great distances. In view of these circumstances and the fact that local people are familiar with coal conversion facilities, we feel that the visual impact of coal development activities were both self-evident and not significant.

Beulah is approximately 7 miles from the plantsite and should not be exposed to any loud noise from the project. The impacts mentioned are associated with very loud noise far and above that which would be experienced by the residents of nearby communities.

RECREATION

Indoor recreation is still the main concern. The social impact of added population would be lessened if indoor recreation facilities and programs were adequate. As the EIS states on page 3-73 - Private entrepreneurs would likely fill some demands. Publicly funded facilities and programs are the major concern, however. AWC inventoried indoor facilities near the proposed site in 1976. Although a list of facilities would not be necessary in the EIS, a general evaluation of how well they now meet community needs should be made. How crowded are these facilities? Are towns planning to expand their facilities or programs? A few telephone calls would give authors a more accurate picture of indoor recreation needs.

After school and summer use of school gymnasiums should be investigated, and suggested as a mitigating measures. A discussion of needs for public libraries was also missing from the three drafts, and should be included in the final EIS. Adequate library facilities and books would also mitigate social and recreation impacts.

The impact of added people on public hunting lands was not discussed. The North Dakota Game and Fish Department personnel anticipate upland game hunting would be most affected by the project by way of habitat loss and by increased hunting pressure. In Lake Sakakawea, walleye fishing is improving while at the same time, northern pike fishing is declining due to habitat loss. Information on man-days of outdoor recreation use is available for the last few years for Hille Game Management Area (nearest the project).

HISTORY AND PREHISTORY:

Chapter 2

Page 2-97, line 13. Teepee should be spelled tipi.

Pages 2-97, 2-101. A number of archaeological terms are used to describe many of the sites present that will possibly be in the project areas. These terms are not explained or otherwise qualified in order to give the lay reader an idea of their context or importance. Examples include campsites, earthledge village, mount sites, and such cultural terms as the Arvilla culture, Archaic, and Blackduck focus. These terms are also not used and therefore not explained further in Chapters 3 and 4.

Pages 2-99, table 2-39. This table includes a list of sites with the potential of archaeological data loss if impacted. Although the sites on this table are carried through to the analysis in Chapter 3 (Impacts), they are not again mentioned in Chapter 4 (Mitigation).

These comments originated from the North Dakota Park Service; see responses on pages J-89 and J-90 of this appendix.

See response to above comment.

See response to above comment.

It is spelled tepee in the DES; either tepee or tipi is correct according to Webster's dictionary.

We acknowledge the comment related to cultural terms but feel that the lay reader interested in this aspect would have a basic understanding of these terms.

Mitigation measures related to the sites along the proposed pipeline route (Table 2-39) were discussed in Section 4.4.2 of the DES.

Page 2-96, section 2.4.2. This short section contains little content on non-Indian culture. In following this section through to the analysis chapters, there are no impacts detailed in Chapter 3 nor any mitigating measures in Chapter 4.

Chapter 3

Page 3-78. Although this section details the fact that no direct impacts will occur to archaeological and historic sites as a result of plant construction or mining, there is no mention in indirect impacts occurring from amateur artifact collecting by construction and maintenance crews or the general population. This will probably occur.

Chapter 4

Page 4-14. There is an inconsistency in the titling of the section containing archaeological and cultural treatment in this chapter. In all other chapters, this section is entitled Socio-Cultural, but in this chapter, it is entitled Cultural. This would make it hard for a lay reader to track the section from chapter to chapter.

Pages 4-14 and 4-15. Although there are sections on Indian and non-Indian culture in Chapter 2 and a section on Indian culture in the Impacts, Chapter 3, there is no mention of these two items in Chapter 4 or succeeding chapters.

Pages 4-14 and 4-15. The mitigation section is weak. There are no specific mentions of the mitigating measures which would be applied to sites identified in Chapter 2 and analyzed for impacts in Chapter 3. Although it is mentioned in Chapter 2 that inventories will be conducted on mine sites, railroad right-of-way, and pipeline right-of-way, these subjects are not covered in Chapter 4. The historic preservation requirements including those dealing with inventory requirements should be detailed in this chapter.

Chapters 4 and 5

Natural and unique features are not present in these chapters. They were not detailed in Chapter 2 or Chapter 3.

Pages 5-5. This short section is very general and contains no specific coverage of the sites mentioned in earlier chapters. There would be no way for the decisionmaker to analyze which sites would still be adversely impacted following mitigating measures.

Chapter 6

There is no carry through of the Indian and non-Indian cultural sections nor of the archaeological and historical sections.

Socioeconomic impacts were discussed in Section 3.3.2.8 of the DES; we know of no proposed mitigation measures related to the non-Indian culture per se.

We agree that "pot hunting" is a possibility, but since the locations of these sites are not generally known and since they are on private land not subject to unlimited trespass, it is extremely doubtful that these sites would be subject to artifact collecting because of the proposed project.

The heading has been changed from Cultural to Sociocultural.

Although socioeconomic impact and effects on archeological resources are covered and would be mitigated, we know of no proposed mitigation measures related to the maintenance of these present cultures per se.

Specific mitigation measures have yet to be determined; however, the North Dakota State Historical Society is working with ANGCCC to develop mitigation programs. (See letter of comment page J-96 to J-98.) Reference to the inventory requirements outlined in Chapter 2 for the product pipeline has been added to Section 4.4.2.

Natural and unique features would not be affected thus mitigation is not necessary. These features were detailed in Section 2.2.5 of the DES.

As discussed in Section 3.4.2, although several sites lie near the proposed pipeline route, we know of none which will be impacted. In the event that presently unknown sites were discovered, mitigation measures (as discussed in Section 4.4.2.) would be carried out.

Cultural concerns were discussed in Section 6.6 of the DES. A section discussing archeological and historical resources has been added to Chapter 6.

Chapter 8

There is no mention of any of the socio-cultural factors described and analyzed in the preceding chapters.

ECONOMIC CONDITIONS

Chapter 2

A comparison of the publication density in the eight county area with that in North Dakota and the U. S. would be helpful (1970 Census data).

Bismarck Junior College is now offering a Power Plant Technology Course. Consequently, the statement on page 2-80 that technical workers needed for operation of the gas plant may not be available in the region may be in error.

Employment by activity is available for 1975. This new information would update table 2-28. (U. S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System)

Section 2.3.2 provides various items of significance to a discussion of the existing economic conditions in the ANG project area. However, there needs to be better organization and continuity of this section. Possibly the discussion of state and local government revenue mechanisms could be moved into its own portion of Section 2.3.3, since community services are financed through public sector revenues.

The reference on page 2-85 to personal income tax collections data availability should be deleted. Personal income tax collection information for 1975, if deemed necessary, is now available from the North Dakota Tax Department.

A new state severance tax on coal will take effect July 1, 1977 (expired June 30, 1977) which raises the base rate of the tax to \$0.65/ton with an escalator of \$0.01 for each full point rise in the national wholesale price index over the June 1977 index. Thus, coal mined in the first quarter of Fiscal Year 1978 (July 1-September 30, 1977) would be taxed at \$0.65/ton; the rate for the second quarter would be \$0.65 plus the amount the wholesale price index rose between the June and September 1977 indexes; etc.

The state coal conversion facility production tax which would apply to a gasification plant is also an important state and local revenue source and should be discussed along with the severance tax.

Section 2.3.3 should be expanded somewhat to discuss specifically the existing capacity and capability of all facilities in those towns which would be impacted by new project related population. Also, the method of financing those services should be included so that an assessment of impacts on public revenue systems could be made in Chapter 3.

For most of the alternatives, the sociocultural effects would be similar to those described for the proposed project. Differences were highlighted in Sections 8.1.1., 8.3.2.1., and 8.4.3.2. Socio-cultural effects of the various energy alternatives have been discussed in detail in "Energy Alternatives" published by CEQ.

Such a comparison is not necessary for the impact analysis, as its relevance is not apparent.

A course on powerplants would not prepare workers to operate gasification plants.

Employment by activity tends to vary from year to year; the data in Table 2-28 is adequate, as minor differences would not affect the impact analysis.

We consider the organization adequate, as state and local revenues are a measure of the economy of the region.

The reference was deleted.

The section on coal severance and conversion taxes has been updated.

The coal conversion tax has been included.

Such an analysis of just the ANGCC proposal would be of little utility as there are four other coal-related developments proposed for the impact area that would cause additional strains. The BLM-North Dakota Regional EIS is designed to analyze the cumulative impact of all five projects during the same time period, thus the most meaningful analysis of this type should be available in that EIS.

UNITED STATES DEPARTMENT OF AGRICULTURE
RURAL ELECTRIFICATION ADMINISTRATION
WASHINGTON, D.C. 20250

MAY 2 10 24 AM '77

APR 20 1977

SUBJECT: ANG North Dakota Project DEIS

TO: Mr. Robert L. McPhail, Regional Director
Bureau of Reclamation
P. O. Box 2553
Federal Building
Billings, Montana 59103

REPLY NECESSARY	DATE
BY	
DATE	
160	

We have reviewed the subject Draft Environmental Impact Statement and find it to be a thorough, well-written document. The following comments primarily refer to information presented which conflicts with information REA has obtained during the preparation of our DEIS on Basin Electric Power Cooperative's Antelope Valley Station. The comments are referenced by the section, page, and paragraph in which they appear in the DEIS.

(a) 1.1.1, 1-3, paragraph 1: We were under the impression that the railroad spur would be 13.8 miles long and would be built by ANG and Basin Electric.

(b) 1.4.1, 1-11, paragraph 3: We understand that construction on Basin Electric's second unit at Antelope Valley is scheduled to begin in November of 1980.

(c) 1.5.2, 1-15, paragraph 1: It is our understanding that the Basin Electric Antelope Valley plant site is 448 acres.

(d) 3.1.1.2: In this section there appears to be an inconsistency in the usage of NO_x and NO₂. For example, in estimating ground-level concentrations Table 3-2 refers to NO_x while Tables 3-5 and 3-7 refer to NO₂. It should be pointed out that the Federal ambient air standards are in terms of NO_x while the North Dakota ambient air standard is in terms of NO₂. It has been estimated that of the total NO_x emitted from a fossil fuel electric generating station, 90 percent is initially in the form of NO and the remaining 10 percent is NO₂. We believe that the ambient NO₂ concentrations you have presented in Tables 3-5 and 3-7 actually represent total NO_x. The percentage of NO_x as NO₂ will have to be determined to see whether the North Dakota ambient NO₂ standard will be exceeded. We also believe that the estimated NO₂ emissions for the gasification plant and power plant presented on pages 3-6 and 3-7, respectively, actually represent total NO_x and should be so indicated.

ANGCCG and Basin Electric would pay Burlington Northern to do the construction. Only 9.0 miles of new construction would be required.

The date has been changed to 1980.

The paragraph has been revised to include this acreage.

The section has been modified to use NO_x as indicated. Both the Federal and State ambient air standards are in terms of NO₂. Although out-of-the-stack emissions are largely NO, it is oxidized to NO₂ and smaller amounts of NO₃ in the presence of ozone. Also, most current monitoring devices do not distinguish between NO, NO₂, or NO_x. For these reasons, most Federal and State agencies lump all atmospheric nitrogen measurements as NO₂.

Mr. Robert L. McPhail, Regional Director

2

(e) page 3-6, paragraph 4: The air quality dispersion analysis is Appendix I.

(f) page 3-6, paragraph 5: We are under the impression that the estimated SO₂ emissions from the gasification plant are 5040 lbs/hr.

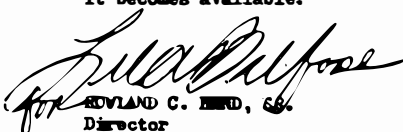
(g) page 3-7, paragraph 3: The following are Basin Electric's estimated emissions from the Antelope Valley station;

NO	4930 lbs/hr.
SO ₂	11832 lbs/hr.
TSP	420 lbs/hr.

(h) 5.2.1, 5-3: A discussion on the degree of impact of the proposed gasification plant on prime and unique farmland should be included.

(i) 8.2.1, 8-11, paragraph 1: The two sites studied in the Beulah-Hazen area should be identified and described in a bit more detail. Was site 3A selected as the proposed site?

Thank you for allowing us to comment on the ANG North Dakota Project DEIS. This office would like to receive a copy of the Final EIS when it becomes available.


DUANE R. RUFF, Sr.
Director
Power Supply and Engineering
Standards Division

The reference has been corrected to Appendix I.

The values given are normal operating emissions and do not include intermittent sources; the intermittent sources were included in Appendix I.

Updated emission estimates have been substituted (ANGCCG July 29, 1977).

A discussion of impacts to prime and unique farmland has been added to Section 3.1.3.

ANGCCG has requested that the exact locations of the alternative sites not be revealed, as they represent areas of possible future development (letter dated July 29, 1977). Since the environmental impacts of the alternate sites would be similar to those of the proposed site (because the environment of the general area is basically the same), we do not believe it is necessary to specify locations in the EIS. In addition, selection of any of the other locations considered by ANGCCG would not lessen any of the environmental or social impacts of the proposed project. 3A was the site selected.



DEPARTMENT OF THE ARMY
OMAHA DISTRICT, CORPS OF ENGINEERS
6014 U.S. POST OFFICE AND COURTHOUSE
OMAHA, NEBRASKA 68102

MROPD-M

Mr. R. K. Higginson, Commissioner
United States Dept. of the Interior
Bureau of Reclamation
18th & C Street N.W.
Washington, D.C. 20240

Dear Mr. Higginson:

This responds to your letter notice of 22 March 1977 (your ref. 430) with which you transmitted copies of the draft EIS for the ANG Coal Gasification project for our review and comment.

We have completed our review of the draft EIS and are submitting the following comments.

A statement to the effect that some work to be accomplished under this project may cause unknown archeologic, scientific, prehistoric, or historic resources of undetermined significance to be lost should be included in the summary.

In the summary, paragraph 3; the surface water quality impacts related to mine drainage should be considered (i.e., disposal of water that is pumped from the strip mine).

Page 1-10, Under Water Supply and Pollution Control Division; NPDES permit for disposal of mine drainage should be added.

Page 1-3, paragraph 3; the term "rolled-in" should be explained.

Page 1-24, Table 1-3; the data base for trace element analysis should be more substantial in terms of number of samples and should also be recent data.

Pages 2-97 and 2-100, paragraph 2.4.3; the organization in this section is confusing. We would suggest the addition of the survey results immediately after they are mentioned. Also, instead of four listings, the "present status" could be organized as follows:



The summary is designed to discuss major, known impacts; a discussion of possible impacts to these resources is presented in Section 3.4.2. Virtually every construction project could have these impacts.

Again, the exact impacts are not known, but the range of possibilities are presented in Section 3.1.2.1.

This permit requirement has been added.

The paranthetical term (i.e. rolled-in) is defined in the same sentence.

We agree with this comment; however, the data provided gives enough of a range to allow for an analysis of impacts.

The section is already organized basically as suggested; however, the headings are not used.

MROPD-M

Mr. R. K. Higginson

1. a. Plantsite
b. Minesite
2. a. Water system
b. Product pipeline

Page 2-98, Figure 2-41; add a dot for "archeological sites" at the junction of the Knife and Missouri Rivers (west of Missouri and north of the Knife) for the Big Hidatsa Village National Register Site.

Page 2-99, Table 2-39; the following two additions should be inserted after the Fordville Mound Group:

<u>Site Designation</u>	<u>Type</u>	<u>Potential Impact</u>
Big Hidatsa Village	More than 108 earth-lodges, depressions, and several fortification ditches	Major-National Register Site, High research potential
Knife River Indian Villages	5 Hidatsa Villages	Major-National Register Site, High research potential

Page 2-100, first paragraph; there is no mention here of the Big Hidatsa Village National Register Site. It is located north of the Knife River. The Northern Pacific Railroad currently runs to the west of Stanton (south of the Knife River; 6 $\frac{1}{2}$ miles south of the Big Hidatsa Village), and does not interfere with the National Register Site.

Page 2-100, third paragraph; there is no mention of sites in North Dakota. If the pipeline is the same route as the railroad, mention should be made to refer to last paragraph page 2-97.

Paragraph 3.1.2.1, b. on page 3-22 states that mine drainage will be pumped out of the mine and disposed of in a number of ways. One means of disposal discussed is to simply pump the water into existing streams. Lignite coal mine drainage is usually of extremely poor quality and the discharge of such drainage into surface waters should be avoided. This impact should be discussed here.

There was a dot at this location, but it did not reproduce well; the size of the dot has been expanded.

The fact that the Knife River Indian Villages National Historic Site would not be affected by the proposed project has been added to this section. The Big Hidatsa Village is not close to the proposed route.

The Big Hidatsa Village Site is approximately 7 miles north of the proposed route and would not be affected by construction or operation of the pipeline.

The previous three paragraphs refer rather clearly to sites in North Dakota. The fact that the pipeline parallels the railroad is mentioned throughout the EIS.

We agree the impacts might be serious if Coteau Properties decides on this course of action; however, an NPDES would be required from the State Health Department to pump the water into existing streams. Impacts are discussed on page 3-24.

MROPD-M

Mr. R. K. Higginson

Page 3-33, paragraph 3.2.1.1.,a.; this paragraph states that 47 acres of wetland would be affected by the proposed gasification facility. The U.S. Fish and Wildlife Service has conducted a field survey and has estimated the size of this wetland to be a minimum of 200 acres. This inconsistency should be resolved. An accurate description of this wetland should be given in Chapter 2. Also, an accurate description of the impacts on this wetland should be given in the summary and Chapters 3 and 5.

Page 3-47, paragraph 2, page 4-7, paragraph 4.2.3.3., and page 5-4 paragraph 5.2.3.: consideration should be given at these points concerning the aquatic ecosystem impacts related to the discharge of mine drainage into surface waters, i.e., the introduction of hazardous materials and the possible effects on aquatic life.

Page 3-78, second paragraph, eighth line; change "7" to "9" (with addition of the Big Hidatsa Village site and the Knife River Indian Villages to Table 2-39).

Also, third paragraph - we suggest survey of Marshall County, Minnesota.

Page 4-2, paragraph 4.1.2.2; it would appear that the first sentence may be an incorrect statement. Coal mine drainage is usually of very poor quality, and if discharged into surface waters, may cause significant degradation and possibly violations of water quality standards.

Page 4-11, paragraph 4.3.2.1, subparagraph 3; the analyses for surface water samples should also include periodic (or at least occasional) analysis of the full gamut of toxic trace elements.

Page 4-15, paragraph 4.4.2,a.; between end of line one and beginning of line two add the following words . . .

" . . . scientific, prehistorical, historical or . . ."

Also in paragraph b.; the words "liaison officer for historical preservation" should be changed to "Historic Preservation Officer". The wording as it stands may be confusing to field workers and may waste coordination time if they don't realize that the liaison officer is the same person (or office) as the State Historic Preservation Officer.

A field review with representatives of the U. S. Fish and Wildlife Service on June 30, 1977, showed that the proposed gasification plantsite would not encompass the marsh. The EIS has been changed accordingly.

The statement has been clarified to show that the impacts discussed in these sections relate to mining also.

The paragraph has been corrected to "8."

Please see responses to letters of comment of the Minnesota Historical Society and the Advisory Council on Historic Preservation.

The fact that several control measures have been incorporated into the design of the mine and that various State agencies will monitor the effectiveness of these measures suggests that violations of water quality would not occur under normal circumstances.

Trace element analysis would be performed on periodic water samples as suggested (ANGCCC July 29, 1977).

The sentence has been revised to reflect this comment.

"liaison officer for historical preservation" has been changed to "Historic Preservation Officer."

MEOPD-M

Mr. R. K. Higginson

Also paragraph c. should be reworded as follows:

"Contractors are not to move their excavating equipment around the material to resume operations at a new site nor will excavation of the discovery site resume until the State Historic Preservation Officer has determined that no cultural remains are present."

Page 5-5, paragraph 5.3.2; add the word "Unknown" as the first word of the paragraph.

Also, delete the second sentence - it's not a true statement. If the resources were professionally located and salvage excavations implemented, the data recovered would be available for future study. This in itself is a mitigative action.

Page 7-2, paragraph 7.9; sentences 1 and 3 are redundant and could be combined into one sentence - such as . . . "Unknown archeological and paleontological artifacts that lie beneath the land surface which will be disturbed by the proposed project may be destroyed before they are recognized as being of historical value and could be irretrievably lost."

Also, sentence 2 reviews a preservation method (avoid the sites) and a mitigation method (salvage - stipulate "professionally conducted salvage operations") and perhaps should not be included under this heading.

Also, the last sentence (number 4) is not a totally true statement. Unprofessional, intentional disturbance of the site precludes future study with advanced techniques and constitutes an irreversible commitment. However, preservation of the site through redesign of the project at the time of discovery or mitigation through professional archeological salvage excavations at the site provides two alternatives for data retrieval for future use. Of these two alternatives, preservation of the site for future study with advanced techniques is the most desirable.

We appreciate having had the opportunity to review this draft document. We would also appreciate a copy of the final environmental statement when it becomes available.

Sincerely yours,


JOHN E. VELEHRADSKY, P.E.
Chief, Planning Division

The paragraph has been reworded to continue work at sites of low cultural resource potential.

The word "unknown" has been added.

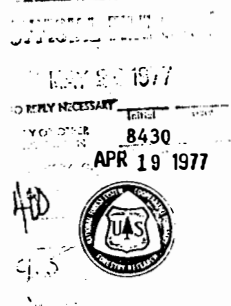
The sentence has been clarified.

Sentences 1 and 3 have been rewritten in light of the above two comments.

Sentence 2 reviews the fate of the eight known sites discussed in Section 2.4.3. We believe one sentence briefly mentioning what would become of those sites is appropriate here.

We believe the last sentence is accurate. Even if a site is salvaged, certain aspects of that site are lost to future study with advanced techniques or new knowledge as to what to look for. In addition, salvage operations are often hurried affairs and even information that can be obtained with existing methods is irretrievably lost.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FEDERAL BUILDING MISSOULA, MONTANA 59807



USDI Bureau of Reclamation
P.O. Box 2553
Federal Office Building
316 North 26th St.
Billings, MT 59103

Gentlemen.

We have reviewed your ANG Coal Gasification Company North Dakota Project Draft Environmental Impact Statement and have some general comments on the air quality consequences of the ANGCGC - Basin Electric development.

The statement is explicit in demonstrating that National and North Dakota State standards for sulfur dioxide will not be exceeded, but points out that because of our lack of knowledge concerning long-term effects of gaseous pollutants, some damage to biota may occur. Background oxidant concentrations are rather high in North Dakota, as the Statement indicates, but possible synergistic effects of SO₂ - ozone are not mentioned. Current literature indicates that SO₂ at levels lower than air quality standards may cause damage to vegetation when acting synergistically with ozone. However, it is impossible at this time to predict the impact on biotic systems.

Recent data obtained from a field study involving controlled dosages of SO₂ to natural range vegetation showed rather significant visual effects on several species of grass at concentrations below the federal standards. This was an EPA funded study in which the University of Montana and Colorado State University were a part.

The extensive development of the coal resource of the Fort Union Basin in Montana, North Dakota, and Wyoming is going to have a highly significant impact on man and his environment in that area. As the number of coal-fired steam electric power plants, coal gasification plants, and other energy conversion facilities increases, there will be a concomitant decrease in air quality, including reduced visibility, and increased acidity of precipitation. Reduced diversity of ecological systems will occur. A critical evaluation of the total expected development and

We agree with the possibility of SO₂-ozone synergism may be possible; however, the author of the comment knew of specific documentation and our examination of the literature did not locate any.

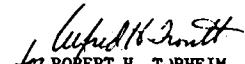
Reports of the studies were obtained and although they show a significant uptake of sulfur by range plants, no harm to the plants was demonstrated at levels below Federal standards.

As discussed in Section 1.4.2, the BLM-North Dakota Regional EIS has been designed to cover the cumulative impacts of coal-related developments in southwestern North Dakota. We agree that such regional analyses are important; however, they are beyond the scope of this site-specific EIS.

analysis of possible impacts is in order coupled with a standard national energy policy. These are points that are not addressed by this draft EIS but should be considered in significantly more detail.

Thank you for the opportunity to review the Environmental Impact Statement.

Sincerely,

for 
 ROBERT H. TORHEIM
 Regional Forester

No response necessary.



DEPARTMENT OF STATE

Washington, D.C. 20520

BUREAU OF OCEANS AND INTERNATIONAL
ENVIRONMENTAL AND SCIENTIFIC AFFAIRS

May 5, 1977

Mr. D. D. Anderson
Acting Commissioner
Bureau of Reclamation
U.S. Department of the Interior
Washington, D.C. 20240

Dear Mr. Anderson:

Thank you for the opportunity provided by your letter of March 22, 1977, for the Department to comment upon the Draft Environmental Impact Statement regarding the ANG Coal Gasification Company, North Dakota Project.

In keeping with the spirit of the US-Canadian Boundary Waters Treaty, the United States has made a consistent effort to reduce transboundary environmental impacts of projects at or near the border. In reviewing the draft EIS we noted that a significant potential may exist for transmission of airborne pollutants to Canada from a plant of this character and magnitude in the area in which it will be constructed.

We believe that possible Canadian concern on this point should be taken into account. We therefore are providing informally a copy of the draft EIS to the Canadian authorities for any comment they may wish to make. We routinely make available to Canadian officials copies of EIS's where there may be a potential impact in Canada from a federally-sponsored or funded project in the U.S.

Sincerely,

Donald R. King
Director

Office of Environmental Affairs

No response necessary.

The air quality model shows that a significant transport of air pollutants into Canada from this project should not occur, as the proposed project is approximately 116 miles from the Canadian border and the prevailing wind direction is away from the border.

No response necessary.

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

Commissioner
Bureau of Reclamation
United States Department of
the Interior
Washington, D.C. 20240

OFFICIAL FILE COPY	
MAY 23 1977	
NO REPLY NECESSARY	Initial Date
FOR OFFICE	Initial Date
ACTION TAKEN	Initial Date
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Dear Commissioner:

The environmental staff of the Federal Power Commission's Bureau of Natural Gas has reviewed the Bureau of Reclamation's draft environmental impact statement (DEIS) on the ANG Coal Gasification Company North Dakota Project, and offers the attached list of comments.

We hope that you will find these comments helpful and we appreciate the opportunity to work with you in the formulation of the final document.

No response necessary.

Very truly yours,

Kenneth F. Plumb

Secretary

Attachment

cc: Bruce Blanchard
Director, Office of
Environmental Review
U.S. Department of the Interior
Washington, D.C. 20240

Mr. E. P. Denson
Bureau of Reclamation
Post Office Box 2553
Billings, Montana 59103



General Comments

The Summary Page of the DEIS states that "A 40-year water service contract would be issued if the project were approved" but that "The proposed facilities would have a 25-year...life."

All subsequent environmental impact calculations are based on the latter (25-year) figure. However, since a 40-year period of operations would substantially increase the acreage mined (and the overall environmental impact), we suggest that the discrepancy between the 25-year and the 40-year figures be resolved.

Page 1-15--Section 1.5 should discuss the 217 miles of 36-inch pipeline looping proposed by Great Lakes Gas Transmission Company (Great Lakes) and the 28 miles of 30-inch looping with 20,000 horsepower of additional compression facilities proposed by Michigan-Wisconsin Pipe Line Company (Michigan-Wisconsin). Since these new facilities would be necessary to transport the proposed synthetic natural gas (SNG) volumes, the environmental impact of the facilities should be discussed throughout the final environmental impact statement (FEIS). A map showing the proposed looping should be included in Section 1.5.

Gasification Plant Engineering

Page 1-45--The FEIS should discuss any planned automatic safety systems designed to detect combustible gases and fires, and to initiate plant shutdown in the event of an emergency.

Page 1-48--Section 1.5.5.3 should include a separate description of the phenosolvan gas liquor separation flare. According to Table II, Appendix I, this flare would continuously emit 10 percent of the total sulfur dioxide (SO₂) effluent through a separate 120-foot tall stack. However, in Section 1.5.5.3 it is not clear that this flare is separate and continuously operated.

The contract term would begin on the date of execution which would be before construction of the plant. Also, phased facilities are involved; the second phase may not begin until 5 years or more after the first phase. The term of the contract was designed to provide adequate leeway for the uncertainties involved. Except for the acreage mined, we do not feel the overall environmental impact would change substantially.

The pipeline looping would carry natural gas from many sources, not solely SNG. In determining the scope of the EIS, it was decided that once the SNG entered existing transmission systems and was commingled with gas from other sources that this was as far as we could reasonably trace the impacts of contracting water service to ANGCGC. Wording suggested during subsequent consultation with FPC has been added to Section 1.5.

At this time, ANGCGC does not plan to incorporate any such automatic shutdown devices, although alarm systems would be installed. Fire protection systems are discussed in Section 1.5.4.7 of the EIS.

A description of the flare stack has been added to Section 1.5.5.3. The SO₂ emissions in Table II, Appendix I are emissions during "upset" (near emergency) conditions; under normal operations the emissions would be about one-third those indicated. Appendix I has been updated to clarify which emissions occur during plant upset.

Page 1-64--Section 1.5.6.2 should explain the rationale for placing the proposed water intake tunnel 175 feet below the reservoir bottom, as shown in Figure 1-21. An estimate of the volume of material that would be excavated in constructing the proposed water pipeline tunnel should be given. The impact of spreading the excavated material over areas of undisturbed prairie habitat should be discussed in Section 3.2.1.3.

Appendix B--Incorrect process flow directions are indicated in the schematic flow diagrams on Pages B-1 and B-3. On Page B-1, the arrowhead from "Crude and Converted Gas From Cooling" should be reversed. On Page B-3, the arrowhead from "Gas Liquor From Phenosolvan Unit" should be reversed.

Air Quality

Page 3-6--The estimated length of time that the gasification plant would require to reach the 91 percent on-line factor should be clearly stated. If the 2 to 3-day figure on Page 3-6 is such an estimate, it appears to be extremely optimistic. Failure to achieve the 91 percent on-line factor over a significant timespan would result in air quality impact more serious and of longer duration than indicated in Section 3.1.1.2.

Page 4-2--It states, "There are, however, no New Source Performance Standards that apply to the proposed gasification plant or its steam boilers (106)."

The New Source Performance Standards (NSPS) for fossil-fuel fired steam generators defines "fossil fuel" as "...natural gas, petroleum, coal, and any form of solid, liquid, or gaseous fuel derived from such materials for the purpose of creating useful heat." It would appear that the steam boilers and superheater furnaces fueled with liquid and/or gaseous byproducts from the gasification process would be subjected to the requirements of the NSPS, except for the lignite exemption with respect to nitrogen oxides (NO_x).

Page 4-2--The FEIS should compare the performance of coal gasification emission control systems to the performance standards soon to be proposed by the U.S. Environmental

The condition of the rock makes tunneling easier at elevation 1580 and any differences in environmental impacts are minor. We do not believe it is necessary to discuss the rationale in the EIS. A paragraph discussing the impact of spreading 10,000 yards of excavated material has been added to Section 3.2.1.3.

The direction of the two arrows has been changed.

The discussion has been revised to indicate that the 2-3 day figure applies to individual gasifiers.

New information regarding the applicability of the standards has been added to Section 4.1.2.1 and Appendix B.

The draft standards have been changed several times since November 1976 and will likely be modified further, thus any discussion would be meaningless. The proposed plant would meet the latest draft standards reviewed (March 1977).

Protection Agency (EPA). These standards appear in Volume I of EPA's draft entitled Standards Support and Environmental Impact Statement: Proposed Standards of Performance for Lurgi Coal Gasification Plants (November 1976).

Appendix I--Table II on Page I-4 lists NO_x emissions from the main flares and the phenosolvan gas liquor separation flare as negligible. Both units have stack temperatures of 1588.75°K, a temperature at which NO_x can form in significant quantities. Table II should include an estimate of NO_x emissions from these sources or the "negligible" emission should be substantiated.

Appendix I--The estimated 1-hour maximum concentrations listed in Tables V, VI, and VII on Pages I-16, 17, and 18, respectively, are the results of EPA's PTMAX air pollution dispersion program. The estimated plume heights for most of the meteorological conditions in these tables are large and it is noted in the PTMAX program "...that extreme caution should be used in interpreting this computation as this stability type may not exist to this height...." The appendix should qualify the accuracy of the estimates in these tables with reference to this statement.

Appendix I--A procedure for calculating the maximum 1-hour pollutant concentrations for inversion breakup fumigation is presented on Pages I-20 through I-22 of Appendix I. The results of the calculations shown on Page I-23 appear to be in error which results in an underestimate of the maximum 1-hour concentration:

- a) The predicted plume rise listed for inversion breakup apparently uses the high estimate for buoyant plumes under stable conditions ("Guidelines for Air Quality Maintenance Planning and Analysis, Volume 10, Reviewing New Stationary Sources," EPA, Page 25). The use of the lower estimate, as suggested in this reference, would reduce the estimated plume rise to 211.3 and 171.5 meters for the ANG Coal Gasification (ANG) and Basin Electric Power (Basin Electric) plants, respectively. When these plume rise heights are substituted into equation (iii) on Page I-20, the nearest downwind distance to fumigation is reduced to about 13.5 kilometers (km) and 14.0 km for the two plants, respectively.

NO_x emissions from these sources would be negligible. Substantiation has been provided to the FPC, but is not included in the EIS because of the highly detailed nature of the data.

Tables V, VI, and VII are labeled as being applicable to non-inversion conditions only. Results of dispersion analyses for severe inversion conditions were presented in Tables IX and X.

After consultation with the FPC, responses to these comments were provided to them but are not included in the EIS because of the highly technical nature of both the comment and response. The air quality modeling calculations have also been provided to the Environmental Protection Agency and the North Dakota State Health Department. The original calculations were considered correct.

See response to above comment.

- b) Equation (vii) on Page I-21 incorporates time correction factors for converting 10-minute average concentrations to 15- and 45-minute averages for stability classes F and C, respectively. However, Page I-11 states that predicted concentrations for stability class C are representative of 1-hour periods and classes E and F are representative of 10-minute to 1-hour periods. It is therefore unnecessary to include the time correction factors in equation (vii).

See response to above comment.

When the above two points are corrected, the maximum 1-hour SO₂ concentrations are increased to about 410 micrograms per cubic meter (µg/m³) for ANG and 880 µg/m³ for Basin Electric. The combined 1-hour maximum then becomes 1,290 µg/m³.

See response to above comment.

- c) The predicted plume rises for stability class C also appear to be excessive. It is questionable if stability class C could actually exist at the large effective stack heights shown on Page I-23.

See response to above comment.

- d) The use of a 15-minute fumigation period conflicts with information submitted to the FPC. In response to a staff interrogatory of April 9, 1976, ANG submitted calculations for ambient concentrations during inversion breakup fumigation. The calculations used a 30-minute fumigation period as opposed to the 15-minute period suggested in Appendix I. Substituting a 30-minute fumigation period into equation (vii) would nearly double the 1-hour concentrations shown in the preceding paragraph.

See response to above comment.

Tables 3-5 and 3-7 should reflect the corrected calculations for inversion breakup fumigation, and increase the 1-hour maximum SO₂ and NO₂ concentrations accordingly. Correcting points a) and b) above is sufficient to result in estimated ambient concentrations greater than those permitted by the North Dakota ambient air quality standards.

See response to above comment.

Water Quality

Page 1-47--It indicates that all process areas and other sources of contaminated liquids would be paved with concrete, and that drainage from these areas would be collected and treated. Conversely, runoff from clean areas on the plant site would be collected, diverted, and discharged into the natural drainage system. In which category are the coal storage piles included? Investigation 1/ indicates that leachate concentrations from the "dead storage" pile would stabilize once contaminants are flushed out, assuming the pile remains in an inactive mode. However, one would assume that leachate concentrations from the "live storage" pile would continue at relatively high levels as this pile is replenished throughout the life of the plant.

Page 1-47--It indicates that sludge generated in the multieffect evaporator would be buried in the mine. The FEIS should indicate the composition of this sludge and determine what impact it could have on surface and ground water quality.

Page 2-35--Figure 2-25 should indicate the water levels in the test wells described.

Page 2-43--The abbreviation should identify "Pt-Co" used in the discussion of color as representing the "platinum-cobalt" scale.

Reclamation and Biology

Page 2-15--It would be helpful if Figures 2-13, 2-37, and others of a similar type indicated the outlines of the proposed mining areas.

1/ Anderson, W.C. and M.P. Youngstrom. "Coal Pile Leachate - Quantity and Quality Characteristics," Journal of the Environmental Engineering Division, ASCE (Dec. 1976), pp. 1239-1253.

Runoff from the coal storage piles would be routed into the clean water retention pond. Page 1-47 has been changed to clarify that there would not be any discharge from the clean water retention pond into the natural drainage system.

The composition of the sludge has been added to Section 1.5.5.2; potential impacts of leachates from ash and sludge buried in the mine were discussed in Section 3.1.2.2 of the DES.

The water levels were not determined during the field study.

"Platinum-cobalt scale" has been added in parenthesis.

The entire mine area could not be put on these figures because of their scale. The mine areas are shown on a number of other figures and we believe that the reader should be able to judge where the mines are located in relation to the plantsite, which is common to all figures.

Page 2-48--The DEIS states, "The most striking physiographic features near the plant-mine site are the Beulah Trench and its western extension, the Zap Trench." If these topographic features would be altered either by mining or by haul road construction, this point should be brought out in the discussion.

Does the cover illustration represent the topography which would surround the proposed plant? If so, this cover would provide a more useful illustration of the proposed gasification plant's aesthetic impact if the direction of view and the visible topographic features, roadways, and streams were identified in the FEIS.

Page 3-31--The DEIS states, "After reclamation the land would be returned to its existing use or altered for a different use at the option of the landowner (who retains surface ownership unless he sells it to the company)." Has the company acquired any surface rights in the project area? If surface rights are acquired, what type of reclamation would the company choose for such lands?

Page 3-33--It states that the time required to reestablish nonagricultural plant communities on mined lands or to return them to productive agricultural use is not known, but assumes 3 to 5 years for cropland and 10 years for rangeland. Some basis for these assumptions should be included for evaluation in the FEIS. Also, the question of whether reclaimed rangelands are as agriculturally productive as the existing natural prairie should be addressed.

Page 3-37--The DEIS states, "If soils are concentrated for agricultural use, the areas left without much topsoil can be made useful by development of woody stands for wildlife habitat." However, Page 3-41 states that "tree plantings in North Dakota almost never reproduce naturally; thus tree plantings provide only partial mitigation for the loss of native woodlands." If the tree plantings are unable to reproduce and therefore unable to sustain woodland habitat, it is difficult to see how they would provide any mitigation against the loss of native woodlands. Also, if topsoil is concentrated for agricultural use, thereby leaving some lands in a less productive condition, it is unclear how the State Water Permit Condition #8 (Page 4-16) would be met: "Mined or disturbed lands shall be returned to at least the level of agricultural productivity that existed prior to mining or disturbance."

The features as geologic formations would not be changed by the proposed project.

No; it is simply an artists representation of a typical gasification plant.

NACCO has acquired surface rights to about 5 percent of the mine area. These areas would be reclaimed for uses that landowners would not normally request, specifically wildlife habitat and wetlands.

The times were largely based upon results of studies of the reclamation potential of lands in the Northern Great Plains; these studies have been referenced. The question of comparative productivity has not been studied in sufficient scope to draw generalized conclusions.

Planting would re-establish woodlands relatively rapidly. Although the plantings would eventually die out, we believe native woodlands re-establish themselves before this occurred. Topsoil would be spread as needed for reclamation. The statement "concentrated for agricultural use" was intended to mean that some areas might have less topsoil than before and tree plantings here would be beneficial. Also, the permit condition was written prior to current reclamation law which allows landowner discretion. The condition may have to be rewritten before the final permit is issued to conform with the reclamation laws.

Page 4-8--Section 4.2.4 refers to numerous studies on reclamation conducted by governmental, university, and mining groups, but fails to cite specific studies. These studies should be referenced in the bibliography. Land areas near the proposed project site which have already undergone, or are currently undergoing reclamation efforts should be described in Section 2 (Description of the Existing Environment) of the FEIS.

Page 4-9--The DEIS states that \$1,500 in performance bonds per mined acre would be committed to the reclamation effort. Would the \$1,500 per acre amount be sufficient to compensate for possible future inflation? Some discussion should be provided to substantiate whether \$1,500 per acre would be adequate to accomplish reclamation based on presently available knowledge and techniques.

Socioeconomics

Page 2-80--The DEIS states, "In 1970, about 14,500 workers in relevant job categories lived within 75 miles of the plant-mine site." The term "relevant job categories" should be defined. The inclusion of the larger cities of Bismark and Mandan within the data collection area tends to obscure the rural character of the communities and lands within reasonable commuting distance of the project site.

Page 2-86--The discussion concerning the coal severance tax raises two unanswered questions: What is the total amount of money which has been raised from the tax, and how do present coal mining volumes in North Dakota compare with the new volumes which would be achieved if the proposed project is developed? On Page 3-75 of the DEIS it states that the monies which have been made available from the present coal severance tax and from other sources would not be sufficient to substantially reduce the adverse socioeconomic impact of energy development. An estimate of how much money would be needed to substantially alleviate the impact of energy development would be helpful.

Page 3-59--Job opportunities created by the project could lead to a shortage of farm workers in the project area, making farms more difficult to operate, and possibly causing temporary

No information from these studies other than their existence is included in the discussion, thus it is not appropriate to cite them in the bibliography. As stated on page 4-9 of the DES, reclamation is currently going on at NACCO's Indian Head mine 10 miles from the project area; this is generally outside the area described in Chapter 2.

In addition to the performance bond, mining permits are only valid for 3 years and the mining company must comply with reclamation regulations to receive a new permit. These factors should also insure that reclamation is accomplished. The \$1,500/acre bond alone is currently adequate in most cases; the State legislature can raise the bond if necessary in the future.

"Relevant job categories" includes those skills required at the plant or so closely related so that a worker could readily change to a required skill. The larger cities were included because a number of workers will likely be drawn from these cities which are within what is considered an acceptable commuting distance in the region.

The discussion has been rewritten in light of recent changes in the severance tax. Total taxes collected in the State and mining volumes are not necessary to the impact analysis; what is important is how much money is reaching the counties to be impacted and this was discussed in Section 3.3.2.8. We did not analyze how much money would be needed because four other coal-related developments are proposed for the area and the BLM-North Dakota Regional EIS is designed to determine the economic needs considering all five proposed projects.

losses in agricultural production in the affected counties. The response of farm managers to this situation could be to reduce labor requirements through greater investment in new machinery and more capital-intensive production techniques. Accordingly, the number of farm labor job opportunities could be permanently reduced. This would be a long-term impact on the socioeconomic character of the rural communities beyond that which is anticipated from the simple addition of a new industrial sector to the local economy.

Page 3-70--Traffic increases and their attendant environmental impact should be given more emphasis in the FEIS. Increased traffic congestion, higher accident frequencies, and possible degradation of air quality could be among the most noticeable changes affecting local communities during project development. In addition to direct and indirect employment-related traffic, job seekers and even tourists could contribute to a significant increase in traffic. Auto insurance and fuel prices could become locally inflated.

Page 4-18--Would the proposed construction workcamp be built early in the project construction phase in order to provide housing during the peak period of population influx presently scheduled to occur in 1978? This peak growth period occurs several years before the actual peak population period.

Product Pipeline

Page 1-18--The land requirements of the proposed product pipeline are given as 2,190 acres. Does this figure include the land areas that would be disturbed by the construction of the five communication towers, two compressor stations, and the district headquarters mentioned in Section 1.5.6.1? A detailed physical description of all appurtenant pipeline facilities including land requirements, compressor horsepower, and communication tower dimensions, should be provided in Section 1.5.6.1. The environmental impact associated with the construction and operation of these appurtenant pipeline facilities should be addressed in all appropriate sections of the FEIS.

Since dryland wheat and hay farming are already highly mechanized forms of agriculture, the farm labor force in the area is already very small. It seems doubtful that farmers would invest large sums of money in additional machinery because of an anticipated 2-3 year shortage in available labor.

Traffic increases were discussed in Section 3.3.2.6 and increased auto accidents in Section 3.3.2.3 of the DES. Air pollution from vehicles would not be significant in this generally windy area.

The construction camp would be built to accommodate the peak influx, now scheduled for 1980. The camp would be constructed in 1978 and would be dismantled after construction of both phases of the gasification plant.

The figure did not include the 32 acres required for these facilities and has been corrected. The air quality impact of the compressor stations has been added to Section 3.1.1.2; other impacts are included in the general discussion of impacts of the product pipeline. See also response #4 on page J-19.

Page 1-59--All locations where the pipeline might deviate from the railroad right-of-way should be discussed, with attention given to specific details of land use and ownership, vegetation, topography, and impact mitigation measures.

Page 1-63--Procedures used to restore the right-of-way after pipeline construction should be outlined.

Page 1-70--A full description of right-of-way maintenance procedures should be inserted in Section 1.5.6.1, including a statement as to whether herbicides would be used. The impact of pipeline maintenance practices on flora, fauna, and the aquatic environment should be discussed in the appropriate sections of the FEIS.

Page 2-39--The reference to Lake Agassiz is confusing until the reader proceeds to Page 2-47 and finds that the lake is extinct. A detailed description of the pipeline geology, topography, and physiography should precede any other mention of potholes, Lake Agassiz, or other unusual or unique physiographic features.

Page 2-56--Referring to Table 2-14, it is suggested that pipeline milepost numbers be used throughout the FEIS to designate locations along the proposed pipeline route. A key map showing the milepost locations should be provided.

Page 2-57--Land uses along the proposed pipeline right-of-way should be more fully identified, including descriptions of any national, state, and local forests, parks, and other managed areas.

Page 2-61--Section 2.2.2.1(d) should describe the specific vegetational communities found on the railroad right-of-way, and should discuss their value as wildlife habitat.

Page 2-65--The FEIS should include a map and describe in detail the major plant communities which would be traversed by the proposed SNG pipeline. Particular emphasis should be given to the description of any wetland and woodland areas or unique ecosystems that would be affected.

The three known areas of pipeline deviation from railroad ROW were shown in Figure 1-18 of the DES, and the land use (privately owned agriculture) of the 79 acres of the new ROW was discussed in Section 3.2.1.5. The general discussions on vegetation (Section 2.2.2), topography (Section 2.1.4.1), and mitigation (Chapter 4) apply to these 79 acres also.

These procedures were illustrated in Figure 1-19 of the DES to supplement the discussion on page 1-63.

The railroad companies would continue to maintain the ROW as they presently do with no special changes due to the proposed project. Maintenance activities by Great Lakes would include aircraft patrol, maintenance of signs, maintenance of facilities, etc.

The word "extinct" has been inserted before "Lake Agassiz."

Since the final alignment is not set, exact milepost locations are not known; the location of features in relation to the pipeline is not necessary to understanding environmental impacts. Since the text and references are not based on a milepost system, a key map would be of little value.

Land uses along the proposed pipeline route were discussed in Section 2.2.5.1 of the DES. Other than the wildlife areas discussed in Section 2.2.5.1, no forests, parks, or other managed areas would be affected.

The vegetational communities along the right-of-way are described in Section 2.2.2.1(d); wildlife values are discussed in Section 2.2.2.3.

The major plant communities were discussed in Section 2.2.1 of the DES, wetlands were discussed on page 2-65 of the DES, and woodlands were discussed on page 2-67. Since most of the vegetation disturbed would be weedy ROW, maps showing major plant communities would be of only minor value.

Page 2-67--There is a discrepancy between Section 2.2.2.4 which states that the proposed pipeline route would traverse 8 miles of woodland and Page 3-39, Table 3-15, which indicates that the pipeline would traverse 31.8 miles of woodland. In addition, both figures appear to conflict with Table 3-16 on Page 3-41 which gives no definite indication that woodlands would be affected by the proposed pipeline. The number of acres of woodland to be cleared, both on and off the railroad right-of-way, should be clearly indicated on Table 3-16.

Page 2-79--Endangered species of plants and animals and their respective habitats known to occur along the pipeline route should be tabulated.

Page 3-7--Section 3.1.1.2 does not discuss the air quality impact that could result from operation of the two proposed compressor stations. This impact, as well as the compressor noise impact, should be evaluated.

Page 3-25--Section 3.1.2.2 should discuss whether the proposed SNG pipeline construction would affect the near-surface groundwater flow conditions in the Red River Valley, mentioned on Page 2-39.

Page 3-31--The soil types listed for the proposed SNG pipeline route in Table 3-12 are inconsistent with those listed in Table 2-12. For both tables the criteria used in determining erosion potential and/or revegetation difficulty should be explained and the data sources identified. Would it be possible to mitigate or avoid the "large" potential erosion impact identified for soils near the proposed plant site in Table 3-12?

Page 3-32--The impact of constructing the pipeline within areas of potential subsidence and sand blowouts, noted on Page 2-56, should be evaluated.

Page 3-38--In Section 3.2.1.5(a), it is stated that 79 acres of cropland would be permanently lost to agricultural production because of right-of-way maintenance. This statement should be further researched to assure its accuracy inasmuch as the

The values in Section 2.2.2.4 and Table 3-15 have been corrected. Table 3-16 is correct as the railroad ROW through the woodlands is generally already cleared and the amount of additional clearing necessary for the pipeline would be small, but is not exactly known.

Except for migrant birds, no endangered plants or animals would be found along the route.

A paragraph on the air quality impacts of the two compressor stations has been added to Section 3.1.1.2. We do not believe the noise of the compressors would be audible more than a few feet away from the buildings in which they would be enclosed.

As mentioned on page 2-39 of the DES, the closest point of the aquifer to the surface is 10 feet. Since the bottom of the pipeline trench would be 6½ feet deep, there would be no impact.

Table 12 refers to soil associations which are broad categories including two or more soil series. The basis for determining erosion and/or revegetation problems was standard Soil Conservation Service definitions for these soils. Special precautions will be taken to avoid or correct the problem areas shown in Table 3-12, as any disruptions of the pipeline would be very costly to ANGCCC.

The second paragraph under Section 3.1.3(d) has been rewritten to include sand blowouts.

The 79 acres would only be lost for one season (during construction) and the section has been revised accordingly.

maintenance of pipeline rights-of-way does not normally preclude using the land for cropland or pasture.

Page 3-48--Section 3.2.3(c) incorrectly refers to aquatic ecosystems defined in Table 2-14. The reference should be to Tables 2-6 and 2-7, not Table 2-14.

Page 3-49--The 600 feet of spawning grounds mentioned in Table 3-17 should be fully discussed in the FEIS, including the name of water bodies involved and the species using the spawning grounds.

Page 4-4--Mitigating measures to reduce the adverse impact of constructing and operating the proposed SNG pipeline, compressor stations, communication towers, and district headquarters building, should be discussed in detail in Section 4 under a separate heading.

Plant and Product Pipeline Alternatives

Page 8-2--The DEIS states, "Because of the geographical location of the American Natural Resources System away from coastal areas, they do not consider LNG imports an economically attractive alternative." It should be noted that the Michigan-Wisconsin Pipeline Company pipeline system, which comprises a major portion of the American Natural Resources System, presently extends to natural gas production areas in the Gulf of Mexico. An LNG terminal proposed by Trunkline LNG Company for the same general gulf coast area has recently been approved by the Federal Power Commission and will provide service to the upper Midwest.

Page 8-11--It is impossible to derive a satisfactory understanding of the site selection process from the material presently given in Section 8.2 of the DEIS. No explanation is given of the siting criteria or site selection methodology used. No maps are provided to indicate the location of the alternative sites relative to their surroundings. At least two sites, designated as 3A and 5C, appear to merit more detailed discussion than is presently given through the numerical rating format used in the DEIS.

The reference has been corrected to Table 2-6.

The fact that the 600 feet of potential spawning grounds is along the shoreline of Lake Sakakawea has been added to the EIS; species sampled along the shoreline were shown in Appendix G.

Mitigating measures for these facilities are discussed in Chapter 4 in relation to the resource impacted, rather than by project feature.

The paragraph has been rewritten in light of a reevaluation of LNG imports by American Natural Resources Company.

Inclusion of a detailed explanation of all siting criteria, many of which have no environmental bearing, would not add to this Chapter which is intended to portray the environmental aspects of different alternatives. Since the alternative sites are potential sites for future development, their locations are not revealed except to Government agencies upon special request and under strict confidentiality.

Page 8-14--The prospect of various new coal-related energy developments in the general project area suggests the need for coordinated regional planning of utility transmission corridors. The FEIS should discuss what authority or ongoing programs the states of North Dakota and Minnesota have to implement a planned utility corridor concept. The FEIS should give recognition to the potential savings such a planned utility corridor might provide for the proposed project by allowing a more direct pipeline route configuration. The FEIS should provide a map illustrating regional coal resources and the location of any presently proposed electric power transmission lines or coal slurry pipelines associated with proposed electric generating facilities under consideration for the general project area.

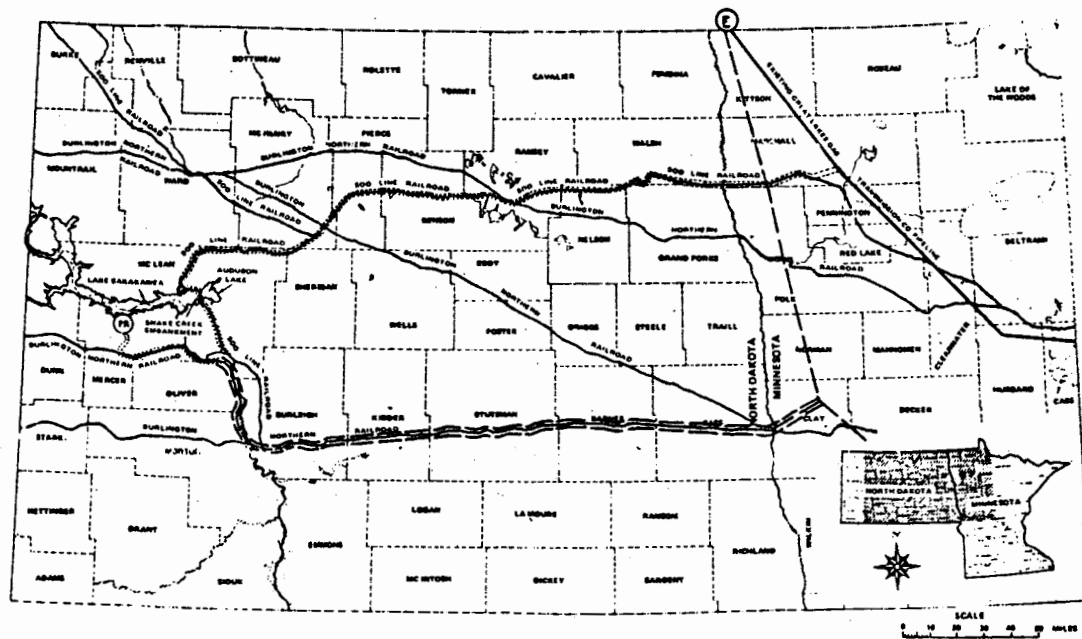
Page 8-16--The alternative of connecting the proposed SNG pipeline with the proposed Northern Border Pipeline Company project (Northern Border) merits more attention than it is presently given in the DEIS. In its recommendation to the President of the United States, the FPC has endorsed an overland Alaska gas pipeline route, which would include some version of the Northern Border pipeline. While the Northern Border pipeline could require changes in capacity to accommodate the proposed volumes of SNG, the associated economic and environmental costs associated with these changes would in all likelihood be far less than those associated with development of the applicant's proposed SNG pipeline route. Differences in BTU-rating between the SNG and Alaskan natural gas is not a significant problem and should not exclude more detailed consideration of the Northern Border alternative.

Page 8-16--The FEIS should consider an alternative SNG pipeline route designed to interconnect with the 24-inch Midwestern Gas Transmission Company (Midwestern) pipeline at a point in Clay County, Minnesota. (See attached diagram.) This route would follow an existing Burlington Northern Railroad right-of-way for most of its distance and would be approximately 60 miles shorter than the presently proposed SNG pipeline configuration. Natural gas which is presently transported by the Midwestern 24-inch pipeline would be diverted to the existing Great Lakes pipeline at an exchange point near the Canadian border. This exchange of gas would allow the Midwestern 24-inch pipeline to accommodate the proposed volumes of SNG. It is expected that the pipeline looping requirements on the Great Lakes and Michigan-Wisconsin pipeline systems would remain essentially the same as currently proposed.

As mentioned on page 1-13 of the DES, the BLM-North Dakota Regional EIS is designed for regional planning and these matters should be discussed in their document.

We agree that the Northern Border Pipeline would be an excellent alternative to the proposed pipeline if it is actually built. However, a large degree of uncertainty exists as to if the pipeline will be built, where it would be routed, and if it would be built soon enough to provide a connection to the proposed plant.

About 25 miles of additional pipeline looping would be required, thus the actual distance savings would only be 35 miles. About 30 miles of Missouri River bottom would be traversed between Washburn and Bismarck; this area has an abundance of bottomland hardwoods which is extremely valuable wildlife habitat. The FPC route would go through the major cities of Mandan, Bismarck, Jamestown, Fargo, and Moorehead with attendant adverse environmental and social impacts not present with the proposed route. Also, the FPC route would parallel Interstate 94 between Bismarck and Fargo (193 miles) and may result in traffic interference and public safety hazards during construction. For the above reasons, the proposed route is considered more suitable.



- PG Proposed Gasification Plant Site
- Applicant's Proposed SNG Pipeline Route
- ===== FPC Environmental Staff's Proposed Alternative SNG Pipeline Route
- E FPC Environmental Staff's Proposed Gas Exchange Point
- Existing Midwestern Gas Transmission Co. Pipeline



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

MAY 13 1977

Mr. D.D. Anderson
Acting Commissioner
United States Department of the Interior
Bureau of Reclamation
Washington, D.C. 20240

Dear Mr. Anderson:

We have reviewed the draft Environmental Impact Statement for the DoI/BR ANG Coal Gasification Company, N. Dakota Project and we feel that with the following exception the expected environmental impacts of the proposed project have been adequately addressed.

A rather serious printing and collating error occurred in Section 2 which made it difficult to have an appreciation of the existing environment in the section of North Dakota planned for this project.

In Section 3, it would be appropriate to include an impact analysis on occupational health. For this purpose, the impact statement writers could take advantage of a recent draft document from NIOSH on recommended guidelines for occupational exposures in coal gasification pilot plants. Certain pilot plant operations differ considerably from full scale plant operations. The NIOSH document, however, describes each unit operation and problem areas encountered during normal operation, maintenance, and emergency situations that could produce significant employee exposure to hazardous materials.

We appreciate the opportunity to review this document.

Sincerely,

Charles Custard
Director
Office of Environmental Affairs

No response necessary.

Apparently this error was only in the one copy of the statement, not the entire printing.

ANGCGC has obtained and reviewed the draft document from NIOSH on recommended guidelines for occupational exposures in coal gasification pilot plants. ANGCGC agrees that measures can and would be taken to restrict personnel exposure to harmful substances. ANGCGC's chief physician is experienced in occupational health applications and will develop final specifications governing health and safety measures to be employed at the new facility. The NIOSH report has been made available to him for use in developing the criteria. We believe there would be no unusual impacts to occupational health if proper measures are taken.



UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

MAY 31 1977

J. 11

NO REPLY NECESSARY	
ONLY OR OTHER ACTION TAKEN	
INFO. COPY TO:	
4/10	
4/15	

Office of the Regional Director
ATTN: 415
Bureau of Reclamation
P. O. Box 2553, Federal Building
Billings, Montana 59103

Dear Sir:

This is in response to your transmittal dated March 22, 1977 in which you invited the Energy Research and Development Administration (ERDA) to review and comment on the U. S. Department of the Interior, Bureau of Reclamation's draft environmental impact statement on the ANG Coal Gasification Company, North Dakota Project.

We have reviewed the draft statement and have determined that the proposed action will not conflict with current or known future ERDA programs. However, we are enclosing staff comments which relate basically to socioeconomic effects. You may wish to consider these comments in the preparation of the final statement.

Thank you for the opportunity to review and comment on this draft statement.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
ERDA Staff Comments

cc w/enclosure:
Council on Environmental
Quality (5)

No response necessary.

ERDA STAFF COMMENTS
DOI/BOR DRAFT ENVIRONMENTAL STATEMENT
RELATED TO THE ANG COAL GASIFICATION COMPANY
NORTH DAKOTA PROJECT

In general, this appears to be a good document in describing the physical impacts and associated mitigating measures of the project. Physical disturbances such as emissions, ground aquifer and surface water disturbances were determined to be significant as were the socioeconomic impacts created by a large population of new workers. Cumulative impacts of the ANG project and six other similar projects in Mercer County, appear to be of greater significance than those from only the ANG facilities. These cumulative impacts, as noted in the document will be evaluated in a follow-on EIS. Our specific comments to the ANG EIS are as follows:

Section 1

The "Description of the Project" does not take into account the socioeconomic impacts of the electric powerplant. Labor force data do not appear to reflect the associated powerplant facility.

Socio-demographic characteristics of the existing population and government structures are missing. This is an impediment to a comprehensive assessment of the impacts of the project and a more meaningful discussion of "Mitigating Measures."

Section 3

In general the coverage is adequate and the emphasis is well directed. All tables should be referenced, however, and methodology clearly stated.

Basis for estimating the immigrant worker population is not given.

The method for estimating population should take into account family size by age, for construction and separately for operating and secondary work force.

Since population estimates are a key issue, and the findings are not consistent with such sources such as the Construction Worker Profile, it is difficult to evaluate the estimate.

No response necessary.

Labor force data for the powerplant were shown in Table 3-18 of the DES. They were not included in Chapter 1 because the Basin Electric powerplant is not the subject of this EIS.

Socio-demographic characteristics of the existing population were discussed in Sections 2.3 and 2.4 of the DES.

Except for those specifically referenced, the Tables in Chapter 3 were produced by Bureau of Reclamation personnel based on information provided by ANCCGC, Woodward-Clyde Inc., and Ecology and Environment Inc., and other State and Federal agencies. Methodology where appropriate is footnoted.

The basis for immigrant worker projections were footnoted in Table 3-21 of the DES.

These factors were taken into account in the multipliers used to estimate the immigrant population.

Several sources were used in making population estimates and these were cited in the DES; the Construction Worker Profile was one, but not the only one, of the sources used.

- In-migrant workers data in table 3-21, appear to be inconsistent with the scenario described on the preceding page.
- If earnings include secondary workers, the estimate appears to be high.
- The basis for estimating school age population is not given. Without estimates of population by age it is difficult to evaluate the percentages.
- Recreation needs are very well analyzed.

Section 4

Section 4.3 describes plans for monitoring of air, water and biological (wildlife) environments. It was noted in Section 3.1.13(c) that there may be potential adverse impacts on human health due to particulates and trace pollutants from strip mining and coal gasification operations. Since the degree of impact is uncertain, we would recommend the addition of health effects monitoring in Section 4.3.

Section 8

The mitigating measures for socioeconomic emphasis are inadequate. This is an important part of the EIS since it can provide guidelines to state and local decisionmakers. North Dakota is one state that does have substantial existing and potential mechanisms for alleviating adverse impacts, yet none are mentioned.

We can find no inconsistencies in the scenario or table.

The earnings include secondary workers, and we believe the estimate is accurate.

The source for the school age population estimate was referenced on page 3-65 of the DES.

No response is necessary.

We acknowledge and agree with this comment; the suggestion has been transmitted to ANGCCC.

State measures available to lessen socioeconomic impacts were discussed in Sections 2.3.2. and 3.3.2.8. of the DES. These measures were not included in Chapter 4 because they were considered to be general mechanisms, not mitigating measures that can be imposed upon the applicant by the Federal Government.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII
1860 LINCOLN STREET
DENVER COLORADO 80203

JUN 13 1977

Ref: 8W-EE
D-IBR-J09C01-ND

Mr. D. D. Anderson
Acting Commissioner
Bureau of Reclamation
U.S. Department of the Interior
Washington, D.C. 20240

Dear Mr. Anderson:

We have reviewed the draft EIS for ANG Coal Gasification Company's North Dakota Project. Our concerns about the project cover a broad range of environmental issues. These issues are summarized below and outlined in more detail in the attached comments.

1. The EIS does not adequately discuss the emissions of air pollutants from the plant and the incremental effects of these emissions on the region's overall air quality.
2. The increased noise levels caused by the project appear to have been underestimated.
3. Solid waste disposal in the mined out areas may contaminate near-surface aquifers and adversely impact wells and springs in the project area.
4. Impacts on water quality are not adequately addressed, especially as these impacts may affect the ability of streams to meet State water quality standards.
5. Post mining land use and reclamation efforts are addressed only vaguely.
6. The project will destroy nearly 100 acres of prime wetlands and disturb an unknown acreage of additional wetlands.

See response under comments section of letter.

See response under comments section of letter.

See response under comments section of letter.

See response under comments section of letter.

See response under comments section of letter.

See response under comments section of letter.

7. The socioeconomic environment is not adequately described, impacts on the socioeconomic environment are discussed in vague terms, and few specific measures to mitigate these impacts are provided in the EIS.
8. Adverse secondary impacts on significant historical and archaeological resources may occur unless mitigating measures to protect these values are implemented.
9. The discussion of alternative sites is inadequate, and only a narrow range of possible alternatives to the proposed project was considered.

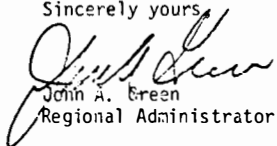
See response under comments section of letter.

See response under comments section of letter.

See response under comments section of letter.

In view of these concerns we have rated the EIS ER-2, which means that EPA has serious reservations about the environmental impacts of the project, and that the EIS is deficient in some major areas of information. Please do not hesitate to contact this office if you have any questions about our review.

Sincerely yours,


John A. Green
Regional Administrator

Enclosure

Detailed Comments: ANG Coal
Gasification Company EIS

Description of Proposed Project

Section 1.2.2. The synthetic natural gas (SNG) supplies shown in Table 1-1 for 1982-1984 are incorrect in that the second 125 MM cf (Phase II) is not scheduled to be operational until 1987. In addition, the value for SNG supplies for 1981 should be 45,625 MM cf (instead of 48,500 MM cf) unless ANG is including additional SNG to be produced by development that is not addressed in the EIS.

This section also discussed the need for the project and displays the priority categories of customers. To what degree is the project needed in order to provide service to new customers? Insofar as the costs of the project will be borne by all of ANG's customers, to what extent are they subsidizing expansion of the company and its markets?

Section 1.5.4.6 According to the latest information available to EPA the final decision as to what will be done with the gas escaping during the operation of the coal lock has not yet been made. The first paragraph in 1.5.4.6.a should be revised to reflect the uncertainty of the situation, rather than stating that the gas will be ejected from the lock and incinerated.

Section 1.5.4.7 The emergency steam supply that is to be purchased from Basin Electric should be addressed in more detail. First, if Basin Electric is to provide this emergency steam, will additional capacity have to be built into the powerplant, and, if so, at whose expense (Basin Electric's customers or ANG) will the additional capacity be provided? Will Basin Electric experience a reduction in generating capacity when emergency steam is being supplied to ANG? Will emergency steam be provided only until the gasification plant can be shut down, or is longer term use of steam from Basin Electric contemplated? What will be the fate of the ANG project if the Basin Electric facility is not built, or is delayed?

Section 1.5.5.3 We have the following questions and comments regarding the gaseous effluent system discussed in this section.

1.) For H₂S removal:

a. What is the CO₂ concentration of the gas stream entering the Stretford Unit?

b. What is the H₂S concentration of the gas stream entering the Stretford Unit?

c. What is the SO₂ and sulfur compound concentration of the gas stream entering the Stretford Unit?

The table has been revised in line with this comment.

As shown on Table 1-6, the SNG would be used to maintain existing supply, not to develop new markets. In as much as no new markets would be created, the company is not expanding.

The paragraph has been revised to say that 98 percent of the gas would be returned to process, and 2 percent exhausted into the atmosphere.

No additional capacity is planned for the powerplant. The powerplant would probably experience a short-term loss of production while providing steam to ANGCGC. Steam would be provided only for short periods of time. The ANGCGC facility would be built even if the Basin Electric plant is not (See discussion of alternative sources of power in Section 8.1.3.3).

Approximately 95.5 percent.

Approximately 1.0 percent.

There is no SO₂ in this stream. The total COS and organic sulfur content would be about 240 ppm.

2. For NO_x:

a. Are any procedures to minimize NO_x formation contemplated? (e.g. overfire air, steam injection, etc.)

b. What is the nitrogen content of the tar and tar oil? What are the feed rates of tar and tar oil to the boiler and superheater?

Finally, coal lock ejector gas is no longer being considered for use in the superheaters because of technical difficulties (See comments on Sec. 1.5.4.6).

Section 1.5.5.6. In addition to complying with State and Federal regulations concerning emissions of hydrocarbons from the storage facilities discussed in Section 1.5.5.6 and Table 1-9, ANG may be required to develop a Spill Prevention Control and Counter Measure Plan (SPCC) for the facility. We also recommend monitoring groundwater in the vicinity of the underground storage tanks for anhydrous ammonia, so that leaks can be detected and repaired promptly.

Section 1.5.6.1 The last paragraph of this section mentions that two compression stations encompassing 10 acres each will be built at some time in the future, however, the impacts of these activities are not specifically addressed in the EIS. Will an addendum document be prepared to discuss the impacts from construction of these facilities?

Air Quality Impacts

According to Figure 2-2, the winds in the study area do not prevail from the east on an annual basis, suggesting a need for a more detailed study of the meteorological conditions during the fire at the coal mine east of the meteorological test site so that the extent of the fire's contribution to the SO₂ values measured at the site can be determined. The concentrations of total suspended particulate matter (TSP) at the same site were high; what is the explanation for these values? Why were repeat samples not conducted for TSP as they were for SO₂? These observations, since they consist of measurements of air quality under "real life" meteorologic and atmospheric conditions, may provide valuable insight into the behavior of pollutants under the climatic regimes of the study area and thus supplement the postulations of the air quality model.

Although fugitive dust control is discussed in regard to pipeline construction, it is not addressed in relation to the construction phase of the plant, nor are fugitive dust emissions from operation of the mine included in the air quality model. Since preliminary emission factors for strip mining operations are now becoming available, the fugitive dust emissions from the ANG/Basin Electric project's mine should be estimated and included in the air quality model. What, if any, fugitive dust controls will be implemented during construction of the plant and mine?

Yes; tangential firing, overfire air, and low excess air firing.

Approximately 1.0 wt percent and 0.6 wt percent, respectively. Feed rates to the boilers are: Tar 70, 120 lbs./hr., Tar Oil 9,390 lbs./hr.; for the superheater: Tar Oil 14,000 lbs./hr.

Section 1.5.4.6 has been revised.

We acknowledge this comment and have sent the recommendations to ANGCGC.

Air quality impacts of the compressor stations have been added to Section 3.1.1.2.(4). See also response #4 on page J-19.

Meteorological data for the summer months in question show that winds from the east and southeast are quite prevalent. Examination of hourly data collected during the monitoring period indicated that there was a correlation between periods of easterly and south-easterly winds and high SO₂ levels. The TSP levels were not high considering the active farming in adjacent areas. Extension of TSP monitoring was not necessary because the State Health Department maintains an air monitoring site at the same location.

Fugitive dust emissions related to plant construction were discussed on pages 3-1 and 3-2 of the DES and the method used to estimate these emissions was discussed on page I-3. Modeling procedures for these emissions were given on pages I-10 and I-11 of the DES. On page I-29, fugitive dust emissions related to mining were discussed. Dust abatement practices were discussed in Section 4.2.1.2.

Tables 3-1 and 3-4 display expected emissions from vehicles used at the plant and the mine sites respectively, however, it is unclear if the emissions listed are for all of the engines or just one. Does table 3-4 include emissions from generating the electricity needed to power the draglines and electric loading shovel (cf. Sec. 1.5.3.1.d)? What emission factors were used to calculate these emissions and why were hours of operation chosen over vehicle miles traveled (VMT)?

The discussion of odors in Section 3.1.14 overlooks the possibility that if leaks do occur in the piping system at the plant H₂S emissions could become a significant odor problem. EPA believes that the whole subject of non-criteria pollutants that may be emitted from the project requires more attention, both in assessing and in mitigating their possible impacts on air quality. Although these emissions are discussed in vague terms where blowdown from the plant is discussed, we feel that the toxicity of some of these pollutants merits more serious and detailed discussion. Section 4.1.2.1 correctly states that the plant would have to meet EPA's forthcoming New Source Performance Standards for coal gasification operations. There is, however, a minor error in the NSPS figures tabulated at the bottom of page 4-1; at the present time, there is no SO₂ standard for steam boilers burning gaseous fuels.

The discussion of Prevention of Significant Deterioration (PSD) requirements in the EIS needs improvement. First, tables 3-5 and 3-7 incorrectly note that the Class II PSD requirements for 3-hour and 24-hour SO₂ levels may not be exceeded more than once per year. Actually, under Class II these levels of pollution are never to be exceeded. What is the basis for the allowable Class II PSD increment that is shown for the project in Section 4.1.2.1, and what percentage of the allowable increment will be used by the Coyote plant? The possibility that Dunn County will be designated a Class I area should also be taken into consideration since the proposed project could impact air quality there during periods when the air is stagnant or moving from east to west.

The section on cumulative impacts on air quality (3.1.1.3) should be expanded to include more scenarios, including (a) ANG without Basin Electric using an outside source of power, (b) ANG without Basin Electric, with power being generated by ANG, and (c) ANG, Basin Electric, and the Coyote plants together. Although the impacts of ANG and Basin Electric are tabulated together in table 3-6, the cumulative effects of both facilities on the total pollutant concentrations in the region is not addressed.

Insofar as the Dispersion Analysis (Appendix I) is an important element of the overall air quality analysis, the following comments are specifically addressed at the modeling effort for the project. EPA will provide an independent air quality modeling effort during its PSD new source review. The preliminary review and proposed decision to approve

As stated on page 3-2 of the DES, the emissions are based on 20 engines of each type. The emissions for generating power to operate the dragline and shovel are included in Basin Electric's emissions on page 3-7 of the DES. For heavy equipment, hours of operation are more appropriate than VMT.

Any leaks in the piping system which emit H₂S would be quickly recognized and corrected by plant personnel. Any emissions of noncriteria pollutants would be of short duration. Safety equipment would be available to plant personnel and detectors with alarms will be installed in enclosed buildings where any build up of these gases could occur.

The tables have been corrected. As stated on page 4-2 of the DES, the bases for the increments were the calculated ground-level concentrations in Table 3-7. Incremental use by the Coyote plant will be discussed in the REA site-specific EIS. Preliminary evaluations indicate that only the ANGGC plant could meet a Class I designation in Dunn County.

The proposed action is ANG with Basin Electric and the impacts of the proposed action are discussed. As mentioned on page 1-13 of DES, the BLM-North Dakota Regional EIS is designed to study cumulative regional impacts; therefore, such impacts are not covered in great detail in our site-specific EIS.

No response necessary.

or disapprove the permit to construct the ANG plant will be made available for public inspection and comment during July.

1. A sub-routine was added to the Unamap models to allow for jet (non-bouyant) plumes. Why were not sub-routines added to account for low temperature plumes? (e.g., coal handling equipment, etc.)

2. Are the fugitive emissions from the mining operations included in the fugitive dust emissions from the total construction site (see Table I)?

3. The emission rates and stack parameters listed in Table II are not identified as average or maximum values.

4. Table II does not include emissions from the Coyote power plant. Why is this facility not included in the analysis?

5. In Table IV, the second maximum pollutant concentrations for short-term values and the location of the receptor where the value is predicted should be listed.

6. When the CDM was run for ANG, was it calibrated with known air quality data? If so, where is the calibration curve?

7. Can the estimated pollutant concentrations due to community growth be added to the industrial values at the same receptor locations? Furthermore, what are the estimated vehicle miles traveled (VMT) as a result of the project, and does this figure support the assumptions about the impacts of automobile traffic shown on Page I-35 of the document?

8. Basin is to meet the NSPS 1.2 lb SO₂/10⁶ BTU and a scrubber for SO₂ is to be installed. Uncontrolled emissions from Basin burning 1.7% S lignite yields 1.45 lb SO₂/10⁶ BTU and maximum emissions from 1.7% S lignite yield 3.5 lb SO₂/10⁶ BTU. What is the control efficiency of the SO₂ scrubber and what percentage sulphur content in lignite is the efficiency based on?

Noise Impacts

We are concerned about the possible impacts of noise on rural inhabitants of the study area, some of whom may have chosen to live in the area expressly for the purpose of escaping from the noise of more developed areas. Although only a few people may be impacted by the increased noise that is anticipated as a result of the project, its impacts on these individuals may be significant because of high expectations and desires for an environment that is free from the intrusions of industrial noise.

Low temperature plumes have little bouyancy and were considered jet plumes in the modeling.

No, they were shown in Table XV, page I-29.

The table has been changed to indicate that they are maximum rates.

Emission and stack data for this facility were not available when the table was prepared but should be included in the BLM-North Dakota Regional EIS.

The pollutant concentrations in Table IV are maximum concentrations outside the plant boundary.

No., existing and proposed plants were included in the CDM; the following values were used as background: NO₂-5µg/m³, SO₂-5µg/m³, TSP-25µg/m³.

The estimated pollutant concentrations due to community growth were given in Table XVI, Appendix I. Estimates of VMT are 15,000 miles/day; however, since 25 percent of the workers would commute over 50 miles/day, effect on air quality cannot be related to any specific receptor point.

The control efficiency of Basin's SO₂ scrubber would be 42 percent for lignite with 0.68 percent sulfur and 70 percent for 1.22 percent sulfur.

Most of the inhabitants are descendants of persons who settled the area in the late 1800's. Noise impacts are unpleasant and these impacts have been discussed in Section 3.1.1.5. of the EIS.

Noise levels measured by EPA 100 feet from railroad rights-of-way showed the following:

- 1) L_{eq} (24) at 8 sites ranged between about 65 and 70 dB(A) and L_{dn} ranged between about 69 and 73 dB(A).
- 2) Hourly L_0 (or maximum sound level) at three sites ranged from 50 to 114, 53 to 110, and 58 to 105 dB(A) respectively.

Although these data do not specifically single out the effects of the typical freight train servicing the project, they do suggest that 75 dB(A) at only 50 feet distance is a low estimate of the noise levels caused by rail traffic. Furthermore, we recommend the practice of reducing train speeds through populated areas as this decreases noise levels and provides some additional safety benefits as well.

The 40 dB wind induced average ambient sound level used on page 3-20 in analyzing the construction noise impact may not be a true representation of the audible ambient noise levels in the area. While noise monitoring microphones are extremely sensitive to pressure fluctuations caused by wind, the human ear is not, and the actual audible ambient level would be less than 40 dB. In fact, as figure 2-11 indicates, at wind speeds of less than 10 mph the actual ambient, without wind error, would be 30 dB or less. Hence, using a 30 dB ambient in the analysis of construction noise would suggest that noise associated with this activity could be audible at 5 miles (as is displayed on page 3-20) as opposed to 1-1/2 miles using the 40 dB ambient (as indicated in the text of the first paragraph of page 3-20).

We recommend that noise abatement and control be designed into the building design and purchase specifications for the project, as the most effective and economical solutions to interior noise attenuation problems can be implemented through good design practices. For example, depending on the design and materials selected, transmission loss in walls may range from less than 20 dB to as much as 50 dB.

Finally, we believe that efforts should be made at the county planning level to assure that development plans for the area in the vicinity of the project are compatible with the operation of the plant and the mine. We believe that such measures are less costly and far more efficient if they are implemented before conflicting uses occur.

Solid Waste Impacts

We are concerned that the draft EIS is vague in its discussion of solid waste disposal, especially in regard to potential contamination of groundwaters. In planning for a project of this type and magnitude all solid

The reference to 75 dBA at 50 feet from the railroad was taken from a pamphlet entitled "Noise Pollution" which was published by EPA, 1972. The trains would operate at low speeds on the spur line thus minimizing noise.

A wind screen was used on the microphone to reduce sensitivity to the wind. The noise levels presented reflect this reduction. The average wind speed at the plantsite was 11.6 mph (page 2-3) and the L_{50} noise level associated with this wind speed is about 40dBA (Figure 2-11). We acknowledge that during calm conditions noise would travel further.

ANGCGC has indicated that noise abatement and control measures would be designed into the plant buildings and specified on equipment orders.

We agree with this comment. County planning efforts are discussed in Section 3.3.2.8 of the EIS.

wastes from the plant should be analyzed to determine their chemical constituents, toxicity and solubility. These data, coupled with the moisture content of the wastes and the geohydrologic conditions of the site will determine whether wastes can be deposited in the mine without contaminating groundwaters. The draft EIS alludes to the possibility that groundwaters could be impacted by "infiltration of mine pit effluent (page 3-26)," but it addresses neither the possible impacts of the solid waste disposal practices contemplated by the company nor studies of the type outlined above. We believe that, as a minimum, the final EIS should display the results of this kind of an investigation, including a determination of what measures (e.g. chemical fixation, sealing the solid waste disposal areas, dewatering of wastes, reprocessing catalysts, etc.) might be needed in order to assure that the wastes deposited in the mine do not eventually contaminate near-surface aquifers and wells.

Finally, the Division of Solid Waste Management in the State Health Department should be consulted regarding the permits required in order to dispose of wastes in the mine pit, as well as any special requirements for the disposal of hazardous waste materials. Permits may also be required for evaporation ponds and storage tanks if the possibility of leakage or uncontained spills exists.

Water Quality Impacts

Despite the fact that the major Federal Action being addressed in the EIS is ANG's application for Missouri River water, the document contains little discussion of either the impact of the proposed use of the water (17,000 afy for ANG and 19,000 afy for Basin Electric) on programs like the Bureau of Reclamation's Water for Energy Program or the impacts of construction and operation of the intake structure. In regard to the former, does the proposed withdrawal of 36,000 afy impact the "Water for Energy-Missouri River Reservoirs" program? What is the status of the agreement between the Bureau and the State of North Dakota on marketing Missouri River water? Regarding the intake structure, how is it designed, how will it be constructed so as to minimize damage to aquatic ecosystems and water quality, and what kinds of maintenance or repair operations are envisioned in the last paragraph of section 3.2.1.3?

Another area of impact that should be clarified in the final EIS is the approximate amount of water that will be released into the atmosphere of the study area and the probable impacts of water releases on local climatic conditions. The total amount of water to be discharged into the atmosphere by ANG as indicated in section 1.5.5.4(c) appears to be incorrect; if blowdown shown in table 1-8 is excluded, the total discharge of water into the atmosphere amounts of 5094 gallons per minute rather than 4700 gpm.

As mentioned on page 3-28, a 2 year geohydrologic study of the mine area is being undertaken and determinations as to the necessity of mine pit sealing will be made after the study is completed. We do not believe the final statement should be held up 2 years to await final solution of this problem as the State Health Department and Public Service Commission will review this problem before any permits are issued to allow the disposal of wastes in the mine pit.

The State Health Department will require a permit for solid waste disposal and the North Dakota State Water Commission will require permits for any ponds having a potential discharge.

The water to be sold to ANGCOG and Basin Electric is part of the industrial water marketing program and was included in the Water for Energy EIS. North Dakota has declined the USBR's offer of joint contracting of industrial water. Design and construction features of the intake were discussed in Section 1.5.6.2 of the DES; impacts were discussed in Sections 3.1.2.1, 3.2.1.3, 3.2.1.6, 3.2.2.3, and 3.2.3. Maintenance and repair operations would entail oiling and inspecting the pumps, replacing inoperative parts, etc.

The amount of water released into the atmosphere has been reevaluated and is now estimated to be 7,720 gpm. Section 1.5.5.4 has been revised accordingly. Section 3.1.1.1 discusses the impacts of water releases on local climatic conditions.

Furthermore, the discussion of the impacts of these discharges on the climatic conditions of the study area should be expanded to include the cumulative impacts of ANG and Basin Electric's evaporation and drift. Finally, are these evaporative losses of water consistent with the first condition attached to North Dakota's water permit (Sec. 4.5.1)?

EPA supports the strategy of diverting stormwater runoff from clean areas on the plant site and natural drainage from surrounding areas into open ditches and ultimately into the natural drainage system (Sec. 1.5.5.2). These onsite drainage ditches should, however, be designed to minimize the erosive force of the runoff, using adequate drop structures and other energy dissipators as needed. The stormwater runoff collection and retention systems for paved areas, materials storage areas, and other on-site sources of potential contamination should also be adequately sized to handle the runoff from the 24-hour once in ten years precipitation event. Another problem that should be given consideration in this regard is the method of handling accumulations of contaminated snow. Snow that is removed from contaminated areas should not be left in natural drainages to melt and release pollutants into surface waters.

In view of the wide variety of soils that will be encountered during pipeline construction (See table 2-12) and the sensitivity of some of these soils to wind and water erosion, extra care should be taken to assure that construction practices do not result in erosion problems. Field construction crews should include someone who is knowledgeable in conservation practices suited to the locality and has the authority to require that conservation practices are implemented during construction.

The discussion of water quality monitoring programs (Sec. 4.3.2.1) does not include any indication of the frequency of monitoring in the subbasins prior to mining. Will samples be collected only once, at the beginning of snowmelt, or will a sampling program begin at that time and continue at intervals through the year? Regarding discontinuation of monitoring stations after completion of the reclamation program within the subbasins we have two questions. First, does completion of reclamation mean successful revegetation and establishment of the post-mining land use (e.g. cropland), or does it mean simply that the land will have been shaped to its ultimate topography and topsoiled? Secondly, what does ANG regard to be unacceptable in the criteria for continued water quality monitoring in these subbasins, and what kinds of corrective measures are they committed to taking? Finally, in regard to the baseline data presented in the EIS we noted an inconsistency between Figure 2-32, which shows the dissolved oxygen change in June is from approximately 10 mg/l to 8 mg/l and the text (Sec. 2.1.3.2.a), which states that the change is from 10 mg/l to 6 mg/l.

Contrary to the last paragraph in Sec. 2.1.3.1, the "best use" classifications shown in table 2-7 are not discussed in the section on water quality or elsewhere in the EIS. The whole issue of whether or not North Dakota and Minnesota water quality standards will be violated as a result

The entire discussion on air quality includes impacts of the Basin Electric powerplant, thus the cumulative impacts of evaporative drift are discussed. The BLM-North Dakota Regional EIS will include the impacts of all five projects proposed for the region.

The storm water structures would be designed to minimize erosion as suggested. Drop structures and energy dissipators are not needed due to the relatively level topography and the absence of steep gradients. Runoff collection and retention systems are designed to handle a 25-year precipitation event and snow from contaminated areas would be placed so that the runoff enters the treatment systems.

We agree with this comment. It is also in the best interest of the pipeline company to insure that erosion does not occur so as to minimize maintenance costs.

Details of the water quality monitoring program will be specified by the State Health Department and the Reclamation Division of the Public Service Commission. Mined areas would be monitored until the reclaimed land is released from bond by the PSC. Since mining in a subbasin would continue for many years, water quality monitoring would continue long after release of certain areas. The State Health Department would determine what criteria are unacceptable and the corrective measures needed would depend on the nature of the problem. The reference on page 2-41 has been corrected.

As mentioned on page 4-2 of the DES, the project would not violate any water quality standards. We have no reason to believe that Minnesota waters would be measurably affected at all. The reference in Section 2.1.3.1 has been deleted.

of construction and operation of the project was also omitted from the draft EIS. The water quality analysis in the final statement should include an assessment of the impacts of the proposed project on the ability of the surface waters of the area to continue to meet water quality standards.

The EIS should address the question of mine dewatering in more detail. Of particular concern to EPA is the quality of this water and the method of disposal. Using waters from the mine pit to control dust on roads could adversely impact surface waters if the mine water is of poor quality. Poor quality mine waters could also have detrimental effects on the environment if used to irrigate revegetated areas. Since waters pumped from the mine pit are considered to be point source discharges, an NPDES permit may be required. A discharge permit for disposal of water used in hydrostatic testing of the product pipeline may also be required.

Frequent references in the EIS to anticipated deterioration of groundwater is disturbing to EPA, especially in regard to the shallow wells and springs that will be impacted by the project. Our concerns about the quality of subsurface waters arise from the impacts of the solid waste disposal methods proposed, the impacts of disrupting the present groundwater relations, and the impacts of deep well injection of wastewater. Our concerns about solid waste disposal are addressed elsewhere in these comments.

The EIS is vague in its analysis of the water quality impacts of disrupting the present groundwater regimes, particularly as these activities will impact the uses or potential future uses of near-surface aquifers for water supply purposes. The final EIS should establish a closer link between the proposed project, its impacts on the quality and quantity of groundwaters, and the effects of those changes on organisms that rely on groundwaters in their present state. Finally, in regard to the deep well disposal of plant effluents, we recommend that ANIC be prepared to comply with the forthcoming EPA regulations on deep well injection. These regulations, which are designed to protect existing and potential supplies of fresh water will probably contain both design criteria and operational requirements for deep well disposal, as well as monitoring requirements. Draft regulations (40CFR Part 146) which are presently being revised, were published in the Federal Register on August 31, 1976 (4FR36730).

Land Reclamation/Land Use

Post mining land use and reclamation of disturbed areas are vitally important to EPA because they are so closely tied to water quality and the long-term productivity of the land. Our first concern is that nowhere in the EIS is "successful reclamation" defined. Since reclamation means so many things to so many people, we recommend that the term be clearly defined in the final EIS and that the document describe what the mining company's commitment to reclamation is. We realize that the kind of use that reclamation efforts will be aiming toward depends upon the wishes of the surface

The quality of mine pit water was presented on page 3-23 and Appendix E of the DES. Water sprayed on roads would evaporate rather than enter surface waters. The infeasibility of irrigating with mine pit water was discussed on page 3-23 of the DES. We acknowledge (and Coteau Properties is aware) that a NPDES permit may be required for discharge of mine pit water,

We agree with the concern; however, these impacts were discussed in the EIS (Section 3.1.2.2) and we view these as unavoidable adverse impacts if the project is approved (Section 5.2.2).

The DES points out in Section 3.1.2.2 that a lignite aquifer would be destroyed, perched water areas would be dewatered, the quality of water in nearby aquifers could be lowered, that recharge rates would be altered, and that 19 wells and one spring could be affected by mining. We do not consider this analysis "vague" in view of the many uncertainties involved. The deep well injection program is designed to comply with existing EPA policy and ANCCGC will continue to comply with all future applicable Federal, State, and local regulations.

"Successful reclamation" would be determined by the North Dakota Public Service Commission. The basic requirements of the PSC regarding reclamation were discussed in Section 4.1.3.

owner, however, we believe that a preliminary survey of the owners' desires should be made and included in the EIS in order to provide at least an approximation of the post-mining land use in the area. In this regard, the question of land ownership assumes importance -- to what extent do energy companies and other corporations already own the surface of areas to be mined? Will the mining company attempt to purchase surface ownership of areas to be mined? To what extent might the kind of surface ownership (i.e. private individual vs private corporation) influence the kinds of reclamation goals and commitments? EPA believes that a project of this magnitude should include plans to mitigate the impacts of the development on wetlands, woodlands and other important ecosystems, even if this requires purchase of surface ownership and reclamation aimed at establishing or restoring these ecosystems or acquisition and protection of replacement lands that might otherwise be threatened by incompatible development.

As noted in Sec. 1.5.6.1, segregation of topsoil during pipeline construction may be required by an agency or a landowner. Since most of the pipeline will follow railroad rights-of-way, will the owners or managers (railways) require topsoil segregation and other special treatments?

In spite of the uncertainty about landowner desires for reclamation, the EIS should address the reclamation potential of the lands in question. Sufficient studies of revegetation have been conducted at other sites in the Northern Great Plains to provide some insight into the potential of the site for crop production and various other uses after mining. These observations would help establish limits within which postulations about reclamation success can be made and could also be useful to the landowner in selecting a post-mining use for the land.

Finally, long-term efforts at soil conservation and crop protection should be planned and begun in the early stages of the project. Wind breaks, for example, could be planted now so that they can provide protection to areas that will be mined and reclaimed in future years. Such plantings could also help to mitigate some of the wildlife habitat losses that are anticipated as a result of the project. The EIS should also address various environmentally sound alternatives for long-term use of the site and facilities following abandonment.

Impacts on Wetlands

The impact of the project on wetlands appears to be quite severe. In addition to destroying nearly 100 acres of prime wetlands at the plant and mine site itself, an unknown amount of wetland area will be disturbed by pipeline construction. We feel that the final EIS should do a better job of describing the impacts of the project on these wetlands and project plans should be modified to do a better job of avoiding or mitigating adverse impacts on wetland habitat. We suggest that wetlands be avoided wherever possible in construction and operation of all phases of

A survey of landowners' preferences would not necessarily yield an accurate description of final land uses. Surface ownership and owners' desires would certainly change from year to year over the life of the project. The mining company owns a very small percentage of the surface rights (less than 5 percent) and would have very little control of final land uses. Those lands owned by the company, however, would be reclaimed largely to wetland or wildlife habitat. We know of no statutory authority to require the company to purchase surface rights.

Since most of the ROW was disturbed years ago by construction of the railroad, it is not anticipated that topsoil segregation would be required or of much value.

Reclamation potentials were discussed in Section 2.1.4.3 of the DES.

We agree with the suggested soil conservation and crop protection measures and have recommended them to ANCCGC. Condition #5 of the Conditional Use Permit requires that the site be returned to its original condition.

The plantsite has been adjusted slightly to accommodate the Basin Electric powerplant and the 47 acres of wetland would not be disturbed by the gasification plant. The 50 acres of wetland in the mine are minimal for the amount of land to be mined. New data on wetlands near the proposed pipeline route have been added to Section 2.2.2.3 of the EIS.

the project. Replacement wetlands should also be included in post-mining reclamation plans, even if this necessitates acquisition of surface ownership of some of the lands in question.

Finally, all wetlands and other surface waters should be inventoried and the need for Sec. 404 permits should be assessed. We anticipate that substantially more Sec. 404 permits than the two mentioned in Sec. 4.5.3 will be necessary since the final phase of the Sec. 404 permit program includes all streams with greater than 5 cfs of flow and their adjacent wetlands. The U.S. Fish and Wildlife Service and State fish and game agencies should be consulted about wetland habitat values, mitigation measures, and techniques that can be used to provide replacement habitat.

Socio-economic Impacts

The discussion of the socio-economic impacts of the proposed project reveals that the study area is already under considerable stress due to existing energy development activities in the region. Judging from the expected influx of people caused by ANG/Basin Electric and the further population growth anticipated with the construction of the Coyote Project and other developments, severe impacts on the socio-economic environment are almost certain to occur. Critical needs fall in all the major sectors of municipal life, including: housing, schools, health care, police and fire protection, recreation facilities, transportation systems, etc. Towns in the impact area may have major difficulties obtaining funds because of the competition for municipal bonds and low bond ratings that potential "boom and bust" communities receive in the municipal bond market.

The final EIS should include a concise summary of the existing socio-economic environment, including data and descriptive material on local demography and economics as well as life styles or quality of life aspects of the study area. The discussion of socio-economic impacts should address the impacts of development on both the populace that lived in the study area before energy development and the people who will move to the area because of energy development, as the impacts on these two groups and the appropriate mitigating measures to alleviate the impacts may be different.

The final EIS should also address the anticipated benefits of the project on unemployment at the Fort Berthold Indian Reservation, how the company expects to meet its obligations to Mercer county concerning socio-economic impacts under the agreement on rezoning (Sec. 4.5.2), and what planning and front end financing efforts are being undertaken to mitigate ANG's share of the impacts of regional energy development.

Only the 47 acre wetland at the original ANGCOG plantsite would have required a Section 404 permit. The proposed Basin Electric powerplant would impact this wetland and they will have to acquire the necessary permit.

We agree with this comment and discussed such impacts in Section 3.3 of the DES.

The existing socioeconomic environment was discussed in Sections 2.3 and 2.4 of the DES. Impacts to current residents versus immigrants were discussed in Section 3.3.1.4 of the DES.

Benefits of the project on Indian unemployment were discussed in Section 3.4.1 of the DES. The stipulations to the rezoning permit have been changed and the final stipulations do not require ANGCOG to arrange financing. All planning and front end financing efforts proposed by ANGCOG were included in Section 4.4.1 of the DES.

Impacts on Cultural Resources

The historical and archaeological resources of the area appear to have been inventoried adequately in the EIS. However, the secondary impacts of development on these resources are not addressed. Even though the project itself may not directly affect these resources, we are concerned that the influx of people into the area and the accessibility of historical and archaeological sites may result in the loss of these resources due to vandalism and the depredations of amateur collectors of archaeological or historic objects. We believe that this problem should be addressed in the final EIS and that effective measures to protect the cultural resources of the area should be implemented.

Alternatives

The discussion of alternative plant sites (Sec. 8.2.1) is extremely confusing because the alternative sites are not precisely identified by location and there appears to be no meaningful correlation between the sites listed in Sec. 8.2.1.a and the sites shown in tables 8-1 through 8-3. At present, it is impossible for readers of the EIS to make meaningful comparisons among alternative sites and draw independent conclusions about any of the alternatives.

In discussing alternative energy sources (Sec. 8.4.2) the EIS perpetuates a misleading comparison that is often made between the sulfur contents of eastern and western coals. The comparison between the sulfur content of eastern and western coals is more meaningful when it is based on the energy equivalent of the coals rather than the absolute sulfur content by weight, and thus the difference between the "low sulfur" coal of the west and the "high sulfur" coal of the east diminishes when the lower energy content of western coal is taken into account.

Finally, several alternatives to the project as it is proposed are not discussed even though they could reduce the need for the project and thus alleviate the impacts of rapid energy development in the study area while conserving resources that should be available to future generations. These include such alternatives as greater emphasis on energy conservation, elimination of low efficiency gas appliances and appliances that require continuous pilot lights, and limitations on new customers for gas service. These alternatives are compatible with maintaining a high standard of living while providing for gradual development of energy resources in the primary impact area of the project and enhancing the range of alternative energy uses that will be available to future generations.

Since all archaeological and historical sites are on private property and since trespass on this property is restricted, we do not feel that vandalism of these sites will necessarily result because of the proposed project. We know of no measures that the Federal Government can take to preclude private acts of vandalism. The additional potential for vandalism due to additional population has been added to Section 3.4.2.

See response to this same comment from REA on page J-40.

We agree with this comment and have deleted the reference to the low sulfur content of Western coals.

The alternative of energy conservation was discussed on page 8-25 of the DES. The other alternatives suggested are simply methods of conserving energy. Limiting new gas customers may conserve natural gas, but does nothing to provide for the energy needs of those persons.



APR 28 1977

NORTH DAKOTA GAME AND FISH DEPARTMENT

PHONE - 224-2180

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April 26, 1977

Mr. Robert L. McPhail
Regional Director
Bureau of Reclamation
P. O. Box 2553
Billings, Montana 59103

Re: Draft Environmental Statement ANG Coal Gasification Company
Mercer County, North Dakota

Dear Mr. McPhail:

The Game and Fish Department has reviewed the draft EIS on the above project. Following are our comments regarding the same.

Specific Comments:

Pages 2-67 - 2-74 One of the major weaknesses of the sections on birds and mammals is the fact that field studies were conducted from late May to mid-October. As a result, the migratory bird estimates, especially for waterfowl, are low because the majority of the migration occurs prior to late May or after mid-October in this area. Furthermore, the importance of this area for wintering species is not reflected in these figures.

Page 2-70 (2.2.3.1a) To our knowledge there are no records of nesting sandhill cranes in the 49 section study area. In fact, since the early 1920's there has been only one nesting record of sandhills in North Dakota and that occurred in 1973 in McHenry County. Sandhill crane use is restricted to resting and feeding during spring and fall migration.

Page 2-70 (2.2.3.1b) We question the reliability of the sharp-tailed grouse population density figures. The draft EIS indicates a fall population of 6.7 birds/mi² yet Department estimates put the spring breeding population at over 6.0 birds/mi² for this area.

We acknowledge this comment; however, since the field study was designed to gain the maximum amount of information in a reasonable amount of time, it was decided to concentrate on breeding birds and mammals because these populations would be those most affected by the proposed project.

The sentence has been changed to reflect this comment.

A paragraph discussing these data has been added to Section 3.2.2.2.

RUSSELL W. STUART

M. H. SUTZER

DALE MOWBRAY

C. B. GRONDAHL

WILBUR BOLDY

R. L. MORGAN

PERSHING CARLSON

Likewise the breeding population of pheasants appear quite low. The draft EIS states a breeding population of 2.4 birds/mi², while we estimate the spring breeding population for this area is approximately 10 hens/mi².

Page 2-70 (2.2.3.2c) Department population estimates for deer in northern Mercer County are as follows:

whitetails - 0.5-1.5/mi²
mule deer - less than 0.5/mi²

Page 2-73 (Table 2-20) The estimated fall populations for coyote and fox are too low. Our census results indicate coyote densities are approximately 0.3 to 0.5/mi² and fox densities are 1.0 to 1.3/mi² for this area.

Page 2-80 (2.2.5.2) Even though ANGCGC is "committed" to a detailed biological survey of the proposed route before final alignment, this should have been done prior to releasing the draft EIS.

Page 3-22 (3.1.2.1b) This paragraph indicates that 1,500 to 2,000 acres of land will be exposed at any one time, yet on page 3-32 the figure is 2,500 acres. Why the discrepancy? The figures should be consistent.

Page 3-33 (3.2.1.2) The three to five year period given to return mined land to productive agricultural use may be too optimistic. Our experience based on present reclamation activities is that few areas reach their full productivity within this span of time.

Page 3-36 (3.2.1.2b) While it is true that natural communities resembling premining conditions may never be reestablished, a productive plant community consisting of native species can be established.

Page 3-36 (3.2.1.2d) Woodland habitat is critical in this area of the state and every effort should be made to preserve this habitat type. The hardwood draws in particular are for all practical purposes impossible to reclaim and should not be mined. On the other woody cover our standard recommendation for replacement is on a 2:1 basis (2 acres artificial for every 1 acre natural destroyed).

Page 3-37 (3.2.1.3) Where the water pipeline crosses native prairie or hayland, this right of way should be reseeded to similar species to lessen the chances of undesirable species invading this area.

Page 3-38 (3.2.1.5a) Again where the product pipeline crosses rangeland, pastureland or hayland this right of way should be reseeded in kind.

Page 3-38 (3.2.1.5c) Approximately how many wetland basins are represented in the 22 miles of pipeline?

Page 3-46 (3.2.2.6) It should be pointed out that marsh hawks nest in more than wolfberry thickets. It is doubtful whether this will be a limiting factor for them.

See response to above comment.

See response to above comment.

The final alignment of the pipeline will not be made for several years, thus a detailed biological survey could not be included in the EIS. However, a general corridor study was conducted to provide data for the EIS.

The 2,500 acres refers to land out of agricultural use; some of the land may have vegetative cover, but not be reclaimed enough for release by the PSC.

The 3 to 5 years refers only to cropland; about 10 years would be required for return to rangeland. References supporting these estimates have been added to the text.

We agree with this comment and indicated so in the discussion on reclamation (Section 4.2.4).

We agree that native woodland habitat should not be mined whenever possible; however, only 29 acres of scattered native woodlands would be disturbed by this project and it is not possible to mine around these scattered tracts.

We agree with this comment and ANGCGC has agreed to reseed as suggested if the appropriate seed is available.

See response to above comment.

About 155 wetland basins are close to the railroad ROW.

The paragraph has been changed to reflect this comment.

Appendix H (Pages 1-3) Based on our data, the estimates given for individual species are excessively low, especially the game species. For example, according to this report, only 30 grouse are found on the 12,500 acre mining area. Our data indicates this is a high density sharptail area with a minimal breeding population of over 6.0 sharptails/mi². Based on these data, the spring population is approximately 120 birds or four times higher than indicated. When reproduction is calculated, this further expands this number.

Likewise, pheasant, fox, coyote, deer and antelope estimates, to mention a few, appear to be low. We suggest more reliable data on the game species be presented in this report.

General Comments

The end result of the proposed action on fish and wildlife resources will likely be one of negative impacts. The permanent alteration of wildlife habitat, the unknowns of air and water quality and the rapid influx of workers into Mercer County are certain to result in reduced wildlife populations and recreational opportunities. The long-term cumulative affects of this and other energy development proposals in this vicinity could result in these losses being of statewide significance.

Perhaps one of the most disturbing factors in this entire endeavor is the fact that there are absolutely no guarantees that "mitigating measures" will be carried out. The draft EIS points out that post-mining land use will be at the discretion of the land owner and very likely the majority of the grassland acres will be converted to cropland use. Furthermore, in the discussion on the plant facility and product pipeline the report indicates mitigation measures will be geared to "unnecessary habitat destruction".

Our position is similar to the one stated on page 3-46:

"Unless mined land is reclaimed specifically for wildlife values, the reclaimed land actually provides very little for wildlife compared to minimal or, in some cases, no reclamation. Unreclaimed or partially reclaimed land from previous mining operations in North Dakota often supports native vegetation, much of it woody, wetland areas, and is relatively inaccessible to humans. Such areas currently provide important winter cover and relatively undisturbed refuges for wildlife."

We too are of the opinion that unless some areas are managed specifically for wildlife purposes, the project will result in a net loss for wildlife. Our recommendation is that consideration be given to actually

A paragraph discussing the data presented in this letter has been added to Section 3.2.2.2.

See response to above comment.

We agree with this comment and have included these impacts in the EIS.

State of North Dakota laws and regulations confer such discretion to the landowners.

No response necessary.

Mr. Robert L. McPhail

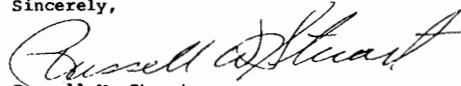
April 26, 1977

Page 4

replacing wildlife habitat destroyed as a result of project action including the plant facility, mine and product pipeline. We believe through careful planning it would be possible to develop a mutually acceptable habitat plan and in turn minimize the overall impacts. We welcome the opportunity to discuss the matter further with ANGCGC representatives.

Thank you.

Sincerely,



Russell W. Stuart
Commissioner

RWS/jg

cc. Public Service Commission
Riverdale District Office (Enyeart)
District Warden, Hazen (Burkett)

This suggestion has been passed on to ANGCGC. As much as we sympathize with the desire to preserve wildlife habitat, we know of no legal basis for requiring privately owned land to be devoted to that purpose.

NORTH DAKOTA STATE PLANNING

STATE CAPITOL—FOURTH FLOOR—BISMARCK, NORTH DAKOTA 58505
701.224-2818

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May 9, 1977

STATE INTERGOVERNMENTAL CLEARINGHOUSE "LETTER OF COMMENT"
ON PROJECT REVIEW IN CONFORMANCE WITH OMB CIRCULAR NO. A-95

To: U.S. Department of Interior - Bureau of Reclamation
STATE APPLICATION IDENTIFIER: 7703287329

Mr. Robert L. McPhail
Regional Director
U.S. Department of Interior
Bureau of Reclamation
P.O. Box 2553
Billings, Montana 59103

Dear Mr. McPhail:

Subject: Draft Environmental Impact Statement by the Bureau of Reclamation on ANG Coal Gasification Company's proposed coal gasification complex in Mercer County, North Dakota.

This Draft EIS was received in our office on March 28, 1977.

In the process of the A-95 review, the attached comments were received from the Attorney General, Regional EIS, ND Geological Survey, ND Park State Health Department and the ND Highway Department.

This document and attachments constitute the comment of the State Intergovernmental Clearinghouse, made in compliance with OMB Circular No. A-95. The ND State Intergovernmental Clearinghouse requests the opportunity for complete re-review of applications for renewal or continuation grants or applications not submitted to or acted on by the funding agency within one year after the date of this letter.

Sincerely yours,

Leonard E. Banks
Mrs. Leonard E. Banks
Associate Planner

LEB/ds

Attachment

No response necessary.

NORTH DAKOTA STATE PLANNING DIVISION

STATE CAPITOL—FOURTH FLOOR—BISMARCK, NORTH DAKOTA 58505

701-224-2818

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MAY 18 1977

REPLY NEEDED
BY OTHER
DATE TAKEN

DATE TO:

160

May 16, 1977

STATE INTERGOVERNMENTAL CLEARINGHOUSE SUPPLEMENTARY "LETTER OF COMMENT"
ON PROJECT REVIEW IN CONFORMANCE WITH OMB CIRCULAR NO. A-95

To: U.S. Department of Interior - Bureau of Reclamation

STATE APPLICATION IDENTIFIER: 7703287329

Mr. Robert L. McPhail
Regional Director
U.S. Department of Interior
Bureau of Reclamation
P.O. Box 2553
Billings, Montana 59103

Dear Mr. McPhail:

Subject: Draft Environmental Impact Statement by the Bureau of Reclamation on ANG Coal Gasification Company's proposed coal gasification complex in Mercer County, North Dakota.

This Draft EIS was received in our office on March 28, 1977.

In the process of the A-95 review, the attached comments were received from the Regional EIS Office, Mr. John E. Velehradsky, Ms. Arlene Wilhelm, Mr. Ted Nace and United Plainsmen Association.

This document and attachments constitute the further comment of the State Intergovernmental Clearinghouse, made in compliance with OMB Circular No. A-95. Previous comments were received with a "Letter of Comment" dated May 9, 1977.

Sincerely yours,

Mrs. Leonard E. Banks
Associate Planner

LEB/ds

Attachments

All of the comments attached to this letter were received previously in the letter from the BLM-North Dakota Regional EIS Team or during the public hearings in Beulah and Bismarck and are addressed in those sections.

NDSIC FORM B (9/71)

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Allen I. Olson
Attorney General

ISSUED BY: DOI - Bureau of Reclamation

PNRS NO.

77-324
Date Received



DATE: March 30, 1977

NAME OF PROJECT: D-EIS: ANG Coal Gasification Company

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

7-85 ☒ No comment *This is not an indication that the Attorney General's office considers the EIS to be "satisfactory". It simply indicates that no comment will be made at this time.* ☐ Meeting desired with applicant
☐ Comments submitted herewith

No response necessary.

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: Shirley Ann Spaulding Smith Date: 4-7-77
Title: Assistant Attorney General - Natural Resources Section Tele: 224-2712

NDSIC FORM B (9/71)

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Dr. Gary Johnson

Regional EIS

ISSUED BY: DOI - Bureau of Reclamation

PNRS NO.

77-329
Date Received



DATE: March 30, 1977

NAME OF PROJECT: D EIS: ANC Coal Gasification Company

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

1-86

☐ No comment

☐ Meeting desired with applicant

☐ Comments submitted herewith

☒ *Comments will be forwarded directly -*

See letter of comment from BLM.

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

Comments will be submitted with BLM Billing Office and forwarded directly to Bureau of Reclamation

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: *[Signature]* Date: 4-12-77
Title: State Planning Division Tel: 31411

NDSIC FORM B (9/71)

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

PNRS NO.

77-329
Date Received

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Mr. Erling Brostuen
ND Geological Survey
Grand Forks, ND 58201



ISSUED BY: DOI - Bureau of Reclamation

DATE: March 30, 1977

NAME OF PROJECT: D EIS: ANCO Coal Gasification Company

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

J-87

- ☐ No comment ☐ Meeting desired with applicant
☒ Comments submitted herewith

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

Comments are attached.

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: Erling A. Brostuen Date: April 14, 1977
Title: Geologist Tele: 777-2231

Comments on draft EIS: ANG Coal Gasification Company.

Section

1.5.5.2 Where will the 5 million cu. ft. pond be located? An unlined pit located on the Berilah Trench could cause pollution problems due to permeability of soil and surface materials.

2.1.3.1c Will the brine designated for deep well injection be compatible with formation fluids and materials?

3.1.2.2c No data is presented to support preliminary statement that mine pit sealing is unnecessary.

The movement of leachate from buried ash and sludge is a distinct possibility. Many of the salts and trace elements are highly soluble. The absence of carbonaceous material which originally retained the salts and trace elements may result in their lateral movement into adjacent aquifers.

The quantity of sludge to be disposed of is not given. I assume that it is in addition to the 90 T/hr. figure given for ash disposal.

The feasibility of recovering some of the valuable or hazardous trace elements should be considered. As an example, the ppm. concentration of uranium is low, but 26.9 lbs./day is a considerable amount to dispose of into the mined area. Inasmuch as the lignite has been mined, burned and the uranium concentrated in the ash, the cost-benefit ratio of additional processing to extract the uranium may be economically acceptable.

4.1.2.2 This statement does not consider the possible effect of leachate from buried solid waste on ground water.

Preliminary studies are frequently referred to but are not supported by data.

The pond would be located in the south or southeastern portion of the plantsite. The pond would contain relatively clean stormwater runoff and would be lined to minimize seepage.

The brine would be compatible with fluids and materials in the Minnelusa and Dakota formations.

This was ANGCGC's position based upon a Woodward-Clyde report dated November 14, 1975. The report can be made available to your agency upon request to ANGCGC. We, however, do not believe that a definite decision can be made regarding migration of leachates into adjacent aquifers based upon available data; ANGCGC is still studying the problem.

About 30 gpm of evaporator concentrate would be disposed of in the mine. This would be in addition to the ash.

Recovery of the relatively small quantities of materials would require extensive processing which makes the concept economically unfeasible at this time.

The statement assumes corrective action would be taken if leachate movement is detected in the monitoring wells.

Detailed data will be provided to your agency through ANGCGC upon request.

NORTH DAKOTA



PARK SERVICE

FORT LINCOLN STATE PARK
ROUTE 2 BOX 139
MANDAN, NORTH DAKOTA 58554
PHONE 663-9571

April 20, 1977

Bonnie Banks
State Planning Division
State Capitol
Bismarck, ND 58505



Dear Mrs. Banks:

The following comments deal with recreation aspects of the Draft Environmental Impact Statement for ANG's proposed gasification plant, prepared by the Bureau of Reclamation. In September, 1975, I commented on a draft environmental report for the project (letter attached). In October, 1976, we commented again on the preliminary D.E.S. (letter attached). Several concerns were raised in both letters and were not addressed adequately in this draft E.I.S. In general, I find the socio-economic sections of this report need strengthening.

Indoor recreation is still ^{my} the main concern. The social impact of added population would be lessened if indoor recreation facilities and programs were adequate. As the E.I.S. states on page 3-73 - Private entrepreneurs would likely fill some demands. Publicly funded facilities and programs are the major concern, however. ANG inventoried indoor facilities near the proposed site in 1976. Although a list of facilities would not be necessary in the E.I.S., a general evaluation of how well they now meet community needs should be made. How crowded are these facilities? Are towns planning to expand their facilities or programs? A few telephone calls would give authors a more accurate picture of indoor recreation needs.

After school and summer use of school gymnasiums should be investigated, and suggested as a mitigating measure. A discussion of needs for public libraries was also missing from the three drafts, and should be included in the final E.I.S. Adequate library facilities and books would also mitigate social and recreation impacts. Both of these suggestions have been previously offered.

The impact of added people on public hunting lands was not discussed. As stated in my October, 1976 B.L.M. letter "Game and Fish Department personnel anticipate upland game hunting would be most affected by the project through habitat loss and by increased hunting pressure. At Sakakawea, walleye fishing is improving while northern pike fishing is declining due to habitat loss." Man-days of outdoor recreation is available for the last few years for Hille Game Management Area (nearest the project). 1974 figures are found on page 2 of the October, 1976 letter.

The attached letters referred to the Woodward-Clyde Report, and a preliminary draft of the DES that were circulated to other agencies to define areas of concern. The comments received were incorporated as much as possible, and the remainder of the original comments are not applicable to the DES and are not included.

The discussion in Section 2.3.3 points out that private (including indoor) recreation facilities are limited; this would indicate that they are overcrowded. Impacts to indoor recreation facilities were discussed in Section 3.3.2.7. The towns would like to expand indoor recreation programs and facilities, but financing is a problem in view of all the other coal-related demands. We believe many impacts on indoor recreation in rural communities are self-evident and lengthy discussions are not required.

The use of school gymnasiums would help alleviate impacts but would not be "mitigation" provided by ANGCGC. Libraries were considered education needs and the discussion of education impacts and needs includes libraries.

The impact of added people on public hunting lands was discussed on page 3-46 of the DES; the effects of habitat loss on wildlife was discussed in Section 3.2.2.6. The proposed project would not affect northern pike habitat. The effect of increased population on the Hille Game Management Area was discussed on page 3-73 of the DES.

No response necessary.

Needs for recreation facilities (page 3-74) were calculated using minimum standards established by our agency in 1970. This method is a common, easy one, but has many shortcomings. We hope, in the Regional E.I.S., to describe a better method for calculating these needs.

I hope these suggestions and those in the attached letters are helpful.

Sincerely yours,



Karen F. Thompson
Recreation Planner/Analyst
State Parks & Recreation Department &
Regional Environmental Impact Statement

KFT/kmm
Enclosures

NDSIC FORM B (9/71)

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: WILLIS VAN HEUVELN
STATE HEALTH DEPARTMENT
STATE CAPITOL
BISMARCK

ND 58505

PNRS NO.
77-324
Date Received



ISSUED

BY: DOI - Bureau of Reclamation

DATE: March 30, 1977

NAME OF PROJECT: D EIS: ANG Coal Gasification Company

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

☐ No comment

☐ Meeting desired with applicant

☒ Comments submitted herewith

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

(See attached sheets)

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: W. Van Heuveln Date: April 27, 1977

Title: Chief, Environmental Control Tele: 224-2371

840. 415

JUL 1 1977

Gene A. Christianson, P.E.
Division of Environmental Engineering
North Dakota State Department of Health
1200 Missouri Avenue
Bismarck, North Dakota 58501

Dear Mr. Christianson:

Thank you for your comments on the ANG Coal Gasification Company Draft Environmental Statement. As agreed during your recent telephone conversation with Mr. Crase of my staff, we are enclosing a copy of ANG's responses to your comments. In addition, your comments as provided through the BLM-North Dakota Regional EIS team, as well as the appropriate responses, will be included in the final statement.

If you have any questions regarding this matter, please contact Dean Loomis or Fred Crase at (406) 657-6605.

Sincerely yours,

DENNIS E. SCHROEDER

for James A. Rawlings
Regional Supervisor
Division of Water and Land

Enclosure

bc: (415)

The comments referred to in the third sentence were nearly identical with the comments submitted directly by the Department of Health.

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

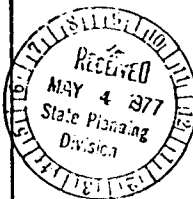
ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Mr. Robert Bradley
ND Highway Department

ISSUED BY: DOI - Bureau of Reclamation

PNRS NO.

77-329
Date Received

DATE: March 30, 1977

NAME OF

PROJECT: D EIS: ANR Coal Gasification Company

1-92 The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

☐ No comment

☐ Meeting desired with applicant

☒ Comments submitted herewith

-
1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

See Attachments

2. Reasons why meeting is desired with applicant:

Reviewer's

Signature: R.E. Bradley

R.E. Bradley
Chief Engineer

Date: May 2, 1977

Title: _____

Tele: 224-2584

NORTH DAKOTA STATE HIGHWAY DEPARTMENT
Comments on Bureau of Reclamation
Draft EIS "AVG Coal Gasification Company"
April 28, 1977

The statement gives only a cursory reference to impacts on state and local road systems in Section 1.5.2, 1.5.4.1 and 3.3.2.6. The report does mention access to the plant site and also to the pipeline construction areas.

Historically in similar situations of industrial plant construction a very large percentage of the construction materials are delivered by truck on the highway systems rather than by rail.

In this entire area the local roads or bridges are not constructed in a manner or to a standard that will carry this expected increased traffic volume or increased truck weights.

The statement should include enough of an in-depth study of the existing road systems and projected traffic volumes both in light vehicles and heavy trucks, the construction and maintenance needs and the resultant costs should be included. It is certain that any such study would disprove the accuracy of the statement "it is not likely that the increase in local traffic would require additional funds for public highway construction and maintenance." The study should include the highway user costs of all routes that might be closed or lengthened such as the indirection that would be involved in the relocation of County Road 13 through the plant site.

Using the Snake Creek embankment as the location of the Great Lakes Transmission Line is of great concern from a safety standpoint.

Placement of the pipeline between the railroad and highway will require closing two lanes of traffic on U.S. 83 during construction. The pipeline will be very close to the shoulder of the roadway. If the pipeline should explode or rupture there would be the possibility of serious effects on public safety.

We have previously commented on Environmental Impact Statements for both the Coal Gasification Plant and Transmission Pipeline, copies of our comments on the previous statements are attached.

Section 3.3.2.6 described increased traffic, the need to resurface existing roads, and destruction of secondary roads.

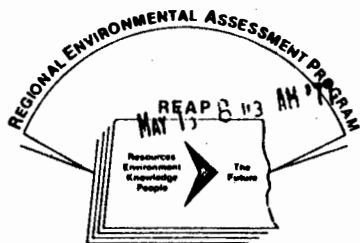
As discussed on pages 1-67 and 3-71 of the DES, present estimates indicate that about 90 percent of the construction materials would be brought in by rail.

See response to above comment.

The "In-House Planning Overview Report" prepared by the North Dakota State Highway Department included traffic data for the proposed gasification plant and powerplant provided by ANGCGC. Conclusions in Section 3.3.2.6 were drawn partially from that report which is cited in the bibliography.

We do not believe there is a significant hazard, but it is discussed in Section 3.3.2.3.

The attachments referred to copies of the Woodward-Clyde Report, and a preliminary draft of the DES that were circulated to other agencies to define areas of concern. The comments received were incorporated as much as possible, and the remainder of the original comments are not applicable to the DES, thus the attachments are not included.



316 North Fifth Street, Room 521 - Bismarck, North Dakota 58505
Telephone (701) 224-3700

May 17 1977
A. William Johnson, Director
NO REPLY NEEDED
Initial
Code No.

INFO. COPY TO:	DATE	INITIALS
415	5/19	

Mr. Robert L. McPhail
Regional Director
Bureau of Land Management
P.O. Box 2553
Billings, Montana 59103

Dear Mr. McPhail:

I wish to make the following concerns a part of the record in order that these be appropriately addressed by those responsible for the final environmental impact statement on the ANG Coal Gasification project.

I have examined the table included in Section 2.1.4.5, the 1975 land use within Mercer County. The North Dakota Regional Environmental Assessment Program has just completed a computer categorization of land cover of the entire state, using LANDSAT imagery. The land cover acres for Mercer County do not agree with those included in the draft impact statement. While there are some assumptions in the REAP data, there is no explanation for the approximately 40 percent fewer acres of water reported by the NDSU source. This is one category which is most accurately assessed through the LANDSAT technique. Adding another more than 10,000 acres of wetlands (present in 1975) merely compounds the error. What I suggest is that the NDSU source be questioned further or that the new REAP data be submitted.

The second point I wish to make concerns the evaluation of historical and archaeological sites. REAP now has the most current identification and documentation of such sites in North Dakota and examination of the records in our files indicates additional sites not shown on the map on page 2-98. In addition, the draft statement neglects fossil sites completely; REAP also has the most complete list of these sites. Whereas the State Historical Society has approximately five such sites for North Dakota, REAP has now compiled 1,225 paleontological sites. It is urged that reference be made to this new information and that consideration of the possible impact of the project on these sites be included.

We realize that different methods of gathering land use statistics will come up with somewhat different data; wetlands would be the most variable statistic depending on the weather prior to data gathering. However, differences in land use data for Mercer County as a whole would not change the impact analysis as use of land to be disturbed by the proposed project was based on on-site surveys of the various areas.

As mentioned in Section 2.4.3, ANGCOG and Great Lakes have made commitments to conduct detailed surveys of the areas affected by their project before any actual disturbance takes place. These surveys will be reviewed by the North Dakota Historic Preservation Officer. ANGCOG contacted REAP and found that no paleontological sites were known at the plant-mine site; Great Lakes will make the same inquiry regarding the product pipeline once the final alignment is set (Great Lakes, August 19, 1977).

Mr. Robert L. McPhail

-2-

May 13, 1977

If REAP can be of any assistance, please call on us.

No response necessary.

Very truly yours,



John R. Reid, Ph.D.
Associate Director

JRR:amb

cc: Dr. A. William Johnson
Ms. Bonnie Banks



December 2, 1977

Much of the data provided in this letter concerns developments after the draft statement was issued and after the cutoff date for the data base used in the FES (September 1, 1977). However, we have included as much of the data in the final statement as possible. As discussed on pages 2-96 and 2-97, work is continuing on surveying and mitigating losses to cultural resources in conjunction with the North Dakota Historical Society and it was not possible to include all the more recent data in the final statement. An independent consulting firm is under contract to provide an archeological survey of the product pipeline route, and the State Historical Society (SHS) will be consulted for evaluation and mitigation of impacts to all sites, including potential and existing National Register sites. In consultation with the SHS, it was agreed that the several years before pipeline construction allows adequate time for the FPC to afford the Advisory Council on Historic Preservation an opportunity to comment on impacts to National Register sites and on the proposed mitigation measures. The Bureau of Reclamation has called the attention of the FPC to the fact that consultation with the Advisory Council will be required when pipeline construction details are firmed up.

rings). The turtle effigy reported in the 1974 survey is of questionable validity; the Voegle Petroglyph is outside the project area and had been stolen prior to the 1976 field project.

Page 2-99, Table 2-39: Corrections and additions

- Line 1: Add 32ME2; the site includes two historic forts, one village site and an Indian Cemetery. It is a "State Historic Site."

Line 3: Add Connelly Site

Line 6-7: Both the Blasky and Fordville mound groups are presently considered to be part of one site complex (the correct name is "Fordville Mound Group"). This site has a high research potential and is currently being nominated to the National Register of Historic Places. Site Number: 32WA1.

Lines 8,9,10,11,12,17 & 18: All of these sites have a medium to high research potential.

Line 10: Add 32ME4; the correct name is "Alderin Creek Site."

Lines 13 & 14: 32MEB and 32ME9 are several miles away from the project area; they will not be affected by the project and should be deleted from this listing. Both still exist in part.

Lines 15,16,19,21,22,23 and 24: We presume that numbers and evaluations would be available for these sites if locational data were provided to this office.

Line 20: No such site exists; this is considered to be part of the Fordville Mound Group, 32WA1.

Page 2-100, paragraph 3:
Fordville and Blasky are considered to be one site; see Table 2-39 comments.

Page 3-78, section 3.4.2, paragraph 1:

Documentation for the suggestion that 8 sites located will not be affected in a major manner should be given; does this imply that areas will be actively protected from major and ancillary facility construction and use? The plant colony mentioned here (line 5) is not relevant to this section. Lines 6-7: 140 cultural resources sites are now known to exist in the plant-mine area.

This information has been added to Table 2-39.

This site has been added to Table 2-39.

These corrections have been added to Table 2-39.

Table 2-39 has been corrected.

Table 2-39 has been corrected.

These sites were deleted from Table 2-39.

Locational data has been provided to the State Historical Society by ANGCGC but are not included in the final statement because the cutoff date for data in the EIS was September 1, 1977.

The site has been deleted.

The paragraph has been corrected.

The paragraph (page 3-79) has been revised to clarify that the eight sites may be disturbed; however, the degree of disturbance is not known at this time. The unique plant community may be considered a cultural resource in line with the National Heritage Program currently under study.

Bureau of Reclamation
Page 2
December 2, 1977

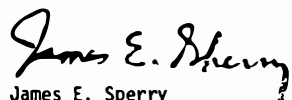
Page 3-78, section 3.4.2, paragraph 2, lines 6-8:

There is no evidence to support the contention that these sites do not continue to exist in the railway right-of-way. Some of the features associated with Plains Village tradition sites have been recorded to a depth of more than 10 feet. Lines 11-13: If the pipeline follows the railway right-of-way through the Fort Clark State Historic Site complex, burials will almost certainly be disturbed.

Page 3-79, section 3.6:

No mention is made of indirect adverse impact on cultural resource sites. Such impacts as vandalism resulting from increased awareness and activity in the area should be considered.

Thank you for your consideration of these comments.



James E. Sperry
State Historic Preservation Officer
(North Dakota)

Sincerely,



C.L. Dill
Survey Archeologist

CLD/je

This sentence refers to surface sites. The discussion in Section 4.4.2 points out that if any underground artifacts are discovered, work will be halted and the State Historic Preservation Officer notified. Lines 11-13 point out that burials may be disturbed. If burials are unearthed the pipeline could be rerouted slightly to avoid the site.

This impact has been added to page 3-80 of the FES.



MINNESOTA HISTORICAL SOCIETY

Fort Snelling Branch (Building 25), Fort Snelling, St. Paul, Minnesota 55111 • 612-726-7171

19 April 1977

Regional Director, Attention: 415
Upper Missouri Region
Bureau of Reclamation
P.O. Box 2553
Billings, Montana 59103

Dear Gentlemen:

RE: ANG Coal Gasification Company
North Dakota Project

In reviewing this project I find no reference to possible impacts that the gas pipeline may have on cultural resources in Marshall County, Minnesota, or to our letter of November 3 outlining our concerns and recommendations. I have attached a copy of this letter for your information. I see no reason to change our comment.

Sincerely,

Charles W. Skrief
Environmental Assessment Officer

CWS/fr
Encl.

A discussion of impacts to cultural resources in Marshall County, Minnesota, was made on page 3-78 of the DES. It was in response to your letter of November 3 that we elicited a commitment from Great Lakes to conduct a detailed survey of the entire pipeline route, including that portion of the route in Marshall County, Minnesota, before construction.



MINNESOTA HISTORICAL SOCIETY

Fort Snelling Branch (Building 25), Fort Snelling, St. Paul, Minnesota 55111 • 612-726-1171

3 November 1976

Mr. James M. Verzuh
Regional Director
United States Department of the Interior
Bureau of Reclamation
Upper Missouri Region
P.O. Box 2553
Billings, Montana 59103

Dear Mr. Verzuh:

RE: Great Lakes Gas Transmission Company
Marshall County

The proposed pipeline will have no effect on any known archaeological site (either historic or prehistoric) in the State of Minnesota. Furthermore, we do not feel that there are any historic archaeological sites in the pipeline right-of-way which might as yet be unknown.

The only systematic archaeological survey conducted in Marshall County of which we are aware was a shoreline survey of the Snake River. The survey was conducted for the Corps of Engineers by Dr. Richard Lane, St. Cloud State University. This covered a strip of land about 50 feet wide on either side of the main channel.

Lane's survey does not enlighten us as to the possible distribution of prehistoric sites in Marshall County but it is interesting in that of the 30 sites or "activity area/zones" found, only two had been previously recorded, a fact which clearly documents the inadequacy of our current records regarding prehistoric archaeological sites (at least in Marshall County). The fact that the pipeline will not affect known sites in Marshall county, therefore, means little at this point.

It is my understanding that the Great Lakes Transmission Company has agreed to halt construction should prehistoric or historic archaeological sites be encountered and to notify the State Historic Preservation Officer. This is laudable, but we question the ability of construction personnel to identify archaeological sites. Therefore we feel that a better means of identification would be to conduct an archaeological survey prior to the commencement of construction.

Great Lakes has agreed to conduct a survey. (See reference on page 2-96 of the DES to Great Lakes' letter dated November 11, 1976).

770.
GARRISON

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415	SH	11/9
700	SH	11/9

copying sent to
Great Lakes
11/11

J-100

Mr. James M. Verzuh

2

3 November 1976

This office does not feel that the entire route need be examined. Experience up to this point suggests that most prehistoric sites in the midwest are associated with permanent bodies of water, extinct or extant. Few sites lie more than 1000 feet from the edge of a body of water. In Marshall County, areas where prehistoric sites are likely to be found include areas adjacent to extant creeks and rivers, and beach features associated with glacial Lake Agassiz. We feel that at least the following portions of pipeline route should be examined:

Section	Twp.	R	
1	154	50	Stream crossing
6	154	49	SNAKE RIVER crossing
1, 2, 3	154	48	Pipeline passes near SNAKE RIVER
33	155	47	SNAKE RIVER crossing
14, 15, 21, 22	155	46	Stream and River crossings
20, 21, 27, 28	155	45	SNAKE RIVER crossing, glacial lake beach ridges
31, 32	155	44	Glacial lake beaches and back swamps

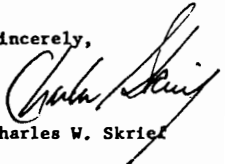
We are not precisely certain of the route of the last several miles of the pipeline -- however, it would appear that at least one more set of beach ridges should be investigated to the east of the last location.

We also note that most of the pipeline will be placed within the existing railroad right-of-way. There is a very good chance that prehistoric archaeological sites that were crossed by the railroad may already be so thoroughly disturbed that the pipeline construction will have little additional impact, obviating the need for mitigation, and, perhaps also the need for a survey. These decisions should be made by a qualified archaeologist only after visual inspection of the area.

There are no sites of historic or architectural significance on or eligible to the National Register in the project area.

Thank you for your attention to cultural resources in your planning process.

Sincerely,


Charles W. Skriet

CWS/fr

EIS B261

North
Dakota

BOX 1872

NATURAL SCIENCE SOCIETY

JAMESTOWN, NORTH DAKOTA 58401

March 28, 1977

JAN 30 1977		
NO ENTRY NECESSARY		
REPLY OR OTHER ACTION TAKEN		
INFO. COPY TO:		
400		
415	AK	736

Regional Director, Attn: 415
Upper Missouri Regional Office
Bureau of Reclamation
P. O. Box 2553
Billings, Montana 59103

Dear Sir:

We have briefly reviewed the draft EIS on the ANA Coal Gasification Complex in Mercer County, North Dakota.

The draft statement appears suitable. However, we urge that studies of the long-term effects of plant emissions on the human environment be completed before construction is authorized. We are particularly concerned about fallout of toxic metals and the harmful effects of synergistic gaseous byproducts. To answer these questions, laboratory experiments with small-scale Lurgi pressure gasifiers using North Dakota lignite should be considered.

Additional plants of this type have been proposed for western North Dakota. Therefore we feel that a dangerous potential for cumulative adverse impacts exists. Until the companies reveal their long-term plans for gasification plants and other energy-related facilities, a single impact statement on a single facility will not fulfill the public need.

Sincerely yours,



Harold Kantrud
President

We agree that long-term studies are desirable; we believe they are more properly the responsibility of the national health agencies, EPA, or ERDA. It has been suggested to ANG that they monitor human health in the area over the long term.

We agree with this comment; as mentioned in Section 1.4.2, the BLM-North Dakota Regional EIS will consider the cumulative impacts of all proposed energy-related facilities in the area.

215 South Cascade Street

Otter Tail

POWER COMPANY

Phone 218-736-5411

Fergus Falls, Minnesota 56537

May 16, 1977

MAY 2 1977

RECEIVED

400
415

Regional Director
Upper Missouri Region
Bureau of Reclamation
P. O. Box 2553
Billings, MT 59103

Attention: 415

Subject: ANG Coal Gasification Company
Draft EIS

Gentlemen:

The subject draft EIS was made available to the public on March 17, 1977, with a 45 day comment period. Although it appears that the comment period has now expired, we wish to attempt to correct some figures which were just brought to our attention.

We refer now to Table 3-38 on Page 3-80 of the draft EIS, and specifically to the figure of 12,000 pounds per hour of NO_x emitted from two 440 MW units of the Coyote Station. According to Footnote 1 this emission represents 1.32 pounds of NO₂ per MMBTU of coal consumed.

Evidently the emission rate was based on some information the Coyote Project had developed quite some time ago. The earlier calculation for NO_x emission was based on an NO_x concentration of 750 ppm in the combustion gases. Later investigation conducted at a similar 440 MW cyclone-fired unit at the Big Stone Power Plant determined that NO_x was actually about 450 ppm. Therefore, subsequent calculations for our own impact assessment were based on 500 ppm to allow for a reasonable safety factor. This, then, results in a revised emission rate of 3,910 pounds per hour of NO_x for Unit #1 of the Coyote Station.

It seems quite probable that regulations limiting emission of NO_x from lignite boilers will become effective prior to the construction of Coyote Unit #2. Thus, it seems logical to assume that NO_x emitted per hour from the second unit will certainly be somewhat less than from the first. However, even if it is the same, the total emission for both units should be not more than 7,820 pounds per hour of NO_x, not the 12,000 pounds per hour quoted in Table 3-28.

Yours truly,

O. E. Johnson
O. E. Johnson, Project Manager

OBJ:VM:ckk

CC: Mr. Gene Christianson
ND Dept. of Health

No response necessary.

The updated data have been included; however, the coal used at the Big Stone powerplant is not from the South Beulah mine which would supply the Coyote project. Since the nitrogen content of coal varies from mine to mine and since the nitrogen content in large part determines the NO_x concentrations in the combustion gases, the updated data must only be considered tentative.

See above comment.

5-103

AMERICAN NATURAL GAS SERVICE COMPANY

MEMBER OF THE AMERICAN NATURAL GAS ASSOCIATION

ONE WOODWARD AVENUE, DEERFIELD, ILLINOIS 60015

May 18, 1977

TO:	BY:	DATE:
400		
413	12	9/19

Department of the Interior
Bureau of Reclamation
Upper Missouri Region
P. O. Box 2553
Billings, Montana 59103

Attn: Mr. Dean Loomis

Re: Comments on the Draft Environmental Statement

Dear Mr. Loomis:

Attached are our comments on the Draft Environmental Impact Statement, ANG Coal Gasification Company - North Dakota Project (DES 77-11). We would appreciate the opportunity to provide additional comments, if necessary, during the process of finalizing the draft.

If you have any questions concerning either our comments or the questions raised during the hearings, please inform.

Yours very truly,

Gary N. Weinreich
Gary N. Weinreich
Environmental Coordinator
Synthetic Fuels

GNW:jcs
attachment

DRAFT ENVIRONMENTAL IMPACT STATEMENT
NORTH DAKOTA PROJECT
COMMENTS ON DRAFT BY ANG COAL GASIFICATION COMPANY

<u>Page</u>		
1-12	Add to Paragraph 4 - NGPC has subsequently joined ANGCG as a co-owner of the Mercer County gasification project.	A paragraph describing the role of NGPC in the project has been added to Section 1.1.
1-18	Paragraph 4 - The coal gasification plant requires approximately 27,000 tons of lignite per annual average day.	That plant ~~consumes~~ 27,000 tons of lignite/day; it <u>requires</u> that 31,500 tons be mined per day to provide the 27,000 tons.
1-20	Paragraph 1, Line 7 - Add after ANGCGC: The location of federally owned coal which has been nominated for use on this project under the BLM's EMARS system is shown on page 8-10.	Discussion of the Federal coal alternative is presented in Section 8.1.3.6.
1-29	Paragraph 1 - The construction camp will house approximately 20 percent of the annual work force plus seasonal peaks.	The sentence has been changed to reflect this comment.
1-44	Replace Figure 1-16 (Water Balance) with revised and updated figure to be supplied under a separate cover.	The updated figure has been included.
1-105 1-47	Paragraph 2 - Although the final design of the retention ponds are still to be determined through meetings with the State Health Department and State Water Commission, the current sizing of the contaminated water pond is 570,000 cubic feet, not 5 million cubic feet as stated.	This new information has been incorporated.
1-47	Paragraph 3, last sentence - The clarifier overflow would be sent to the process water cooling tower, not to the deep well as stated.	This new information has been incorporated.
1-47	Paragraph 4 - Stormwater runoff from clean areas would be collected in open ditches and culverts, routed through a 3,750,000 cubic foot retention pond, before being returned to the natural drainage system	This new information has been incorporated.

PAGE

- 1-48 Paragraph 2, Sentence 1 - Overflow from the contaminated rainwater clarifier will not be injected into the deep well as stated. Strike "and overflow from the contaminated rainwater clarifier." The overflow will be reused in the process water cooling tower.
- 1-51 Paragraph 4, line 5-9 - All rates of emissions given are based on utilizing coal with the maximum sulfur (1.7% DAF) and, as a result, the average emission rates would be less. We suggest the fourth, fifth and sixth sentences in the paragraph read as follows: "Assuming maximum sulfur coal is being used, the combined tar and tar oil would have a maximum SO₂ emission rate of 0.78 lb. SO₂/MMBTU and the combined tar oil, naphtha, and phenol would have a maximum SO₂ emission rate of 0.80 lb. SO₂/MMBTU. Including the Stretford tail gas and coal lock ejector gas, the maximum superheater emission rate would be 0.96 lb. SO₂/MMBTU.
- J-106 1-52 Paragraph 4 - The design efficiency of the electrostatic precipitators is 80%.
- 1-53 Paragraph 3 - The third sentence should be changed to read: "The two main flare stacks would be 200 feet above grade and have a tip diameter of 36 inches. The low pressure flare stack is 120 feet above grade and has a 10-inch diameter."
- 1-57 Paragraph 4; Sentence 2 - Should read "Residue from the multiple effect evaporators ..." The residue may have solid or liquid properties depending on water content at the particular time.
- 1-64 Third full paragraph - Strike the third sentence. Moving the water as indicated is not feasible. The used test water will be clean and will be discharged from each section after testing.

This new information has been incorporated.

The sample size on which the sulfur content was based was not large enough or extensive enough to firmly establish that 1.7 percent sulfur is the highest sulfur content of the coal that would be used during the 25 years of plant operation. Thus we do not believe that overemphasis on these being maximum emissions is justified.

This new information has been incorporated.

This new information has been incorporated.

The sentence has been corrected.

This new information has been incorporated.

Paragraph 1 - This paragraph should be revised as follows:

The North Dakota coal severance tax became effective on July 1, 1975 and was \$0.50/ton escalated on the basis of \$0.01/ton for each increase of three points in the wholesale price index. The revenues received from the severance tax are allocated to the State Coal Development Fund. This fund was originally divided as follows:

- a. 35 percent to a special fund for distribution to taxing districts impacted by coal developments;
- b. 30 percent held in perpetual trust, the income from which goes to the State's General fund;
- c. 5 percent allocated to the coal producing counties in proportion to the coal removed from the county; and
- d. 30 percent to the State's General Fund.

The 1976-1977 Legislature revised the severance tax to \$0.65/ton effective July 1, 1977 and escalated on the basis of \$0.01/ton for each one-point increase in the wholesale price index. Furthermore, the Legislature revised the distribution formula for the State Coal Development Fund, granting a larger share to the impacted areas as follows:

- a. 35 percent to a special fund for distribution to taxing districts impacted by coal development,
- b. 15 percent held in perpetual trust, the income from which goes to the State's General Fund;
- c. 20 percent allocated to the coal producing counties in proportion to the coal removed from the county; and
- d. 30 percent to the State's General Fund.

This new information plus additional facts regarding recent changes in North Dakota's coal taxes has been added to this Section.

PAGE

2-88 Paragraph 2, line 4 - "county" should be changed to "district".

2-92 Paragraph 1, line 3 - The hospital in Hazen is currently staffed by three doctors.

2-93 Table 2-37 - Mercer County currently has a total of 3 physicians as a result of successful recent recruiting.

3-6 Paragraph 1 - Start-up gas is burned in a separate incinerator - not in the main flares.

3-7 Two of the three power plants examined in the EPA studies of trace element emissions were equipped with mechanical collectors only. The remaining power plant had an electrostatic precipitator but was not equipped with a wet scrubber. None of the plants in the EPA studies had as effective particulate removal system as the one proposed by Basin. The trace element emission from the Basin facility therefore, will be lower than those indicated.

3-9 Paragraph 1 - Total hourly emissions are based on the assumption that the maximum sulfur coal (1.7% DAF) is being used. The average sulfur in the coal is 1.3% DAF (dry ash free) and average sulfur emissions would be approximately 25% lower.

3-9 Table 3-6 - Gasification plant emissions should be footnoted to reflect that they are based on maximum 1.7% sulfur in coal.

3-14 Paragraph 4 - The reduction in visibility were calculated for maximum emission rates under worse case conditions. The percent frequency of occurrence is based on the meteorological conditions (wind speed and stability) alone do not reflect the relative frequency that the maximum emission rates, might occur. The combined frequency of both occurrences would be much lower. Also,

The sentence has been corrected.

This new information has been incorporated.

This new information has been incorporated.

This new information has been incorporated.

Perhaps. None of the particulate removal systems are capable of removing gaseous mercury; the effectiveness of Basin's system will vary for each specific element and the effectiveness of the system has yet to be determined. The emissions indicated are only meant to be approximations and not exact predictions. It should also be pointed out that the indicated emissions were based on the trace element analysis from the Sasol coal analysis and that other analyses show significantly higher amounts of some of these elements present in the coal.

The fact that emissions were based on 1.7 percent sulfur was indicated on page 3-6 of the DES. See also above response to comment regarding page 1-51.

See response to above comment.

It was indicated on page 3-14 that the figures given were maximum reductions. What is not calculable, however, are visibility reductions under other than worst case conditions; these could vary anywhere from near zero to the 68 percent figure indicated. depending upon existing weather conditions. Any time the worst case conditions occur visibility reductions would only be slightly less than those indicated even if coal with less than 1.7 percent sulfur was being used at the time because several other elements are involved in visibility reductions.

PAGE

the reduction in the visibility would be apparent to an observer only if he was located on the plume center line at the designated distances. It would not be an area wide problem as implied.

3-15 Paragraph 1 - The human health effects enumerated in this paragraph are in no way associated with the concentration of emissions resulting from the project. The ambient air concentrations of pollutants are controlled below the safe tolerance levels established by government agencies. Furthermore, health statistics in the vicinity of a coal gasification plant in South Africa have been examined and give no evidence of such adverse effects.

3-16 Paragraph 4 - This paragraph which addresses health effects on animals appears to have certain discrepancies. SO₂ is a gas and will not fallout on vegetation as stated. The paper cited appears to state that SO₂ was "infused into plants," which suggests some form of artificial injection of the gas. Finally, no concentration levels are given at which the adverse effects were observed. The gasification plant with its pollution control devices will emit less SO₂ than existing power plants and we know of no such demonstrated immunobiological effects resulting from existing installations.

3-16 Paragraph 5 - The variations between the trace element analyses shown in Table 1-3 are not errors or discrepancies but normal ranges expected when different samples of a heterogenous substance such as lignite are analyzed for trace elements in very

The percent reductions indicated would only be registered by such an observer; other percent reductions would be visible to other observers in other locations.

We consider the discussion to be a fair and accurate description of the possible effects of the proposed plants on human health. The "health statistics" were obtained and the data dealt with lack of cancer in plant workers having contact with process byproducts. No data related to any of the health effects discussed on page 3-15 or to health hazards from plant emissions was included in the cited South African report.

"Fallout" refers to the descent to earth of pollutants. Since SO₂ is heavier than air it tends to settle near the ground as it cools. It is also taken up by moisture, converted to sulfuric acid, and comes to earth in condensation or precipitation. "Infusion into" has been changed to "uptake by." No studies have been undertaken to determine if immunobiological responses are taking place due to pollution from existing plants; the lack of study does not mean that such effects are not occurring.

We agree; however, this paragraph merely points out that the emission rates of these elements would vary from those shown on page 3-7, which were based on only one sample (Sasol), depending upon the amount of these elements present in the coal being used.

PAGE

low concentrations.

3-22 Paragraph 3 - Mention should be made of the fact that no plant wastewaters are discharged to surface streams.

3-33 Paragraph 3 - The effects of air emissions on vegetation is expected to be minimal. Existing facilities in the vicinity emit greater amounts of SO₂ and NO_x than the proposed gasification plant with no adverse effects on vegetation demonstrated.

3-48 Paragraph 2 - Since appreciable amounts of deposited airborne material have not been detected in studies conducted by the University of North Dakota at two large lignite-fired power plants at Stanton, North Dakota, similar effects are not anticipated as a result of this project.

3-64 Paragraph 1 - The construction camp will house approximately 20% of the work force plus seasonal manpower peaks.

3-70 Paragraph 5 - The impacts on water supply and public health indicated in this paragraph are certainly not probable impacts, especially in light of the water improvements cited on page 3-74 and 75.

3-80 & 81 The adverse air quality and water quality impacts enumerated on these pages are not likely to occur as a result of the proposed projects. Dispersion characteristics in the project vicinity are excellent and will result in adequate dispersion of all emissions. Other facilities in North Dakota do not experience the types of adverse effects indicated on these pages.

3-81 Paragraph 5 - No mining will occur near urbanized areas.

3-82 Paragraph 2 - As shown in Table 3-8 on page 3-15, the percent frequency of occurrence for significant visibility reduction periods is less than 1.5% or less than 6 days per year. Even

Mention of this was made in Section 1.5.5.2 of the DES and need not be repeated here.

No studies have been conducted in the vicinity to determine what effects the emissions may be having. The lack of study is not a valid reason for saying there are no effects.

The study mentioned did not run analyses on surface waters but did find some deposited material in the soil near the powerplants. Soils downwind of the plants where the main effect of the plume would be felt were not examined.

The sentence has been corrected.

The improvements cited on pages 3-74 and 3-75 are only a part of the improvements that would be required to accommodate the potential population influx from all proposed developments in the area. Whether or not the water supply and public health impacts actually occur depends on local community action to further expand the appropriate facilities.

The actual likelihood of the occurrence of these impacts will increase as the number of coal-fired plants in North Dakota increases. Emitted pollutants must go somewhere and recent studies throughout the U.S. have found that the pollutants end up in soils, waters, plants, and animals. There is nothing about North Dakota that would exempt the State from the same chemical and physical laws that operate elsewhere.

The paragraph does not say mining will occur near urban areas.

The paragraph refers to the cumulative impacts of all currently proposed coal development in the area; your figures only apply to the ANCCGC and Basin Electric plants.

PAGE

during these infrequent periods of unusual meteorological conditions, visibility reduction would average less than 20%. This should not affect photo-synthesis or crop productivity. Direct damage to crops from SO₂ or NO_x has not been demonstrated from existing sources in the area and no adverse effects on animal species has been attributed to emissions from existing sources.

- 3-82 Paragraph 3 - No chemicals will be used indiscriminately at the facility.
- 3-84 Paragraphs 1 and 2 - The overcrowding and stressing of public services is not necessary if proper advance planning and mitigative measures are adopted. The population remaining after the construction peak need not be burdened with debt obligation since coal severance and conversion tax revenues are redistributed to the affected counties to cover these impact costs.
- 4-84 Paragraphs 1 and 2 - Since the release of the Draft EIS, the North Dakota Legislature has passed legislation which will enable the short and long-term financial needs of the local governments to be accommodated.
- 4-1 Paragraph 3 - There are no SO₂ New Source Performance Standards (NSPS) for gas-fired steam boilers as shown in the table.
- 4-2 Paragraph 2 - NSPS for fossil fuel-fired steam boilers are applicable for such steam boilers, within a gasification plant if they are fired by fossil-fuels.
- 4-6 Item #2 - The expansion gas contains CO₂ and H₂S, not CO and H₂S.

No studies have been undertaken to determine if such effects are occurring or not.

There is always a possibility of human carelessness.

We agree; however, such advance planning and construction of new facilities is not taking place thus it seems more and more likely that these impacts will occur. Recent changes in North Dakota coal tax distribution laws make the long-term financial outlook less severe and the section has been modified accordingly.

The new legislation should help meet the long-term financial needs of local governments (see Section 2.3.2); however, short-term and front-end financial needs are still a problem as long-term debts would be acquired by local communities. Local leaders may be hesitant about assuming long-term debts.

The standards have been corrected.

The paragraph has been revised in line with the most recent information regarding the applicability of the standards to the proposed plant.

The sentence has been corrected.

PAGE

- 4-8 Paragraph 2 - Title 38 of the North Dakota Century Code should be substituted for SB 2095.
- 4-16 to 4-18 The conditions to the Mercer County Conditional Use Permit have been changed by the Mercer County Planning Commission and will be forwarded under separate cover.
- 5-1 Paragraph 3 - The visibility reduction referred to here occurs rarely and only under certain meteorological conditions.
- 5-1 Paragraph 4 - Although an accidental coal fire occurred at an abandoned mine in the area, no such occurrence is expected at a manned facility, where operators will be constatly observing the coal piles for early signs of oxidation.
- 5-1 Paragraph 9 - Increased consumption of gas as a result of this project is very unlikely. During the period that this plant is in operation, the effect of 250 million cubic feet of SNG per day will be to slow the rate of reserve depletion and to help maintain, not increase, existing supply levels.
- 5-2 Paragraph 3 - Contamination of surface waters due to air emissions is extremely unlikely. Studies conducted by a state university in the vicinity of two existing power plants in North Dakota did not detect any such phenomenon (Research Report #12, UND Institute for Ecological Studies).
- 5-3 Paragraph 3 - Qualification is required with regards to the effects of SO₂, NO_x and heavy metals. The study sited above in 5-2 stated that the opposite was true in the vicinity of the Stanton, North Dakota power plants. We know of no evidence that conclusively links emissions at the low concentrations resulting from these proposed projects with damage to exposed flora.

The sentence has been corrected.

The new conditions have been included.

See above response to comment regarding page 3-14.

Such fires are always a possibility

Increased consumption over and above what would have been consumed without the availability of SNG is a distinct possibility.

The referenced study did not conduct analyses of surface waters to determine if such a phenomenon was taking place. Since such contamination has been demonstrated in other areas of the country, it is likely that some contamination would occur. Whether or not it would occur at levels which would be harmful has yet to be determined.

We believe you mean paragraph 5. The cited study did not examine plants for effects from pollutants thus it seems inconsistent for it to conclude that no such effects existed.

PAGE

- 5-4 Paragraph 2 - The possibility of any affect on faunal species due to the emission of trace elements into the atmosphere is extremely remote. The excellent dispersion characteristics of the area and the low emission rates of trace elements make the potential for affecting faunal species negligible. Again, no such effects have been discovered in the vicinity of existing plants in North Dakota.
- 5-4 Paragraph 5 - An immeasurable increase in salinity is not a major impact as suggested in this paragraph.
- 5-5 Paragraph 2 - The cost to local governments and the increase in long-term debt will occur only if other measures are not adequately implemented. This impact is not an unavoidable impact as proper legislation has the potential to completely mitigate this potentially adverse impact.
- 5-5 Paragraph 3 - Recent legislation has made tax revenues available for the construction of facilities and for the provisions of services in a timely manner, eliminating the time lag indicated in this paragraph.
- 6-1 Paragraph 1 - Weekly coal consumption is approximately 190,000 tons and total useage is approximately 245 million tons over 25 years.
- 6-1 Paragraph 2 - It should be pointed out that waiting for second generation gasification processes will do nothing to satisfy needs in the immediate future. Second generation processes are not likely to be commercialized prior to 1995 and will probably not show any significant advantages from efficiency or cost points of view. Furthermore, and while speculative, preserving the coal as a resource for a longer period may render it valueless if solar

One effect to animals recently noted in North Dakota is an increased incidence of stillborn calves downwind of the Stanton powerplants. Again, the lack of study does not mean that there are no effects.

The word "major" was changed to "main."

Since the proper legislation has not been passed, the spectre of long-term debt is more and more unavoidable.

A discussion of recent coal tax legislation has been added to Section 2.3.2. The new legislation does not solve the problem of communities having to incur long-term debts.

See response to comment below regarding page 7-1.

The paragraph refers to all future technologies, not just future gasification technologies. If solar or other forms of energy are successfully harnessed then the impacts associated with the proposed project would have been a waste of human and environmental resources because the coal would still be valueless.

and other forms of energy are successfully harnessed, eliminating the need for coal. In effect, coal is needed most at the present time and should be utilized as an important part of the national energy program.

7-1 Paragraph 1 - The first two sentences should read: "About 245 million tons of lignite would be mined and totally and irretrievably consumed by the gasification plant. This amounts to 16 percent of the 1.5 billion ton reserve near the plant-mine site." Sales to Basin Electric's Antelope Valley Station should not be included as part of the gasification plant consumption.

B-7 Footnote 2 - Should read "maximum case during upset conditions." Also electrstatic precipitator efficiency should be 80%.

I-4 Emissions from the phenosolvan gas liquor separator flare (low pressure flare) should be footnoted to indicate that the value given is the maximum case during upset conditions.

The 351 million tons of lignite would have to be mined for the gasification plant whether sold or not; therefore, the 351 million tons is a resource commitment to the proposed project. The 351 million tons represents 37 percent of the 947 million tons of currently recoverable lignite near the plant site.

This new information has been incorporated.

This new information has been incorporated.

Iowa Confederation of Environmental Organizations

MAY 23 1 03 PM '77 P.O. Box 1147 • Ames, Iowa 50010

May 20, 1977

Mr. Robert L. McPhail
Bureau of Reclamation
U.S. Department of the Interior
Federal Building
Billings, MT 59101

Dear Sir:

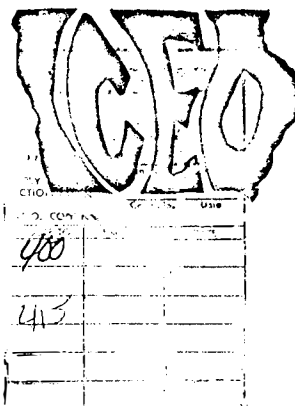
With regard to the Draft EIS (DES 77-11) on the ANG Coal Gasification site in Mercer County North, Dakota, there are two considerations unique to this project which we feel should be discussed.

1. The practice of "rolled in" costs of SNG as described in the EIS would require a clarification by the FPC and subsequent Benefit/Cost considerations to each class of consumer.
2. The emissions unique to such a Lurgi process which include a large family of carcinogenic compounds have not been examined in the degree of detail commensurate with their threat to health.

The EIS casually dismisses these as occasional or insignificant or lumps them in the hydrocarbon class, implying that meeting the state and federal regulations of the Clean Air Act is sufficient. This is not the case. NEPA requires a "full disclosure" and assessment of these unique threats.

The relationship of cancer incidence to humans exposed to carcinogenic organics in the synthetic fuel industry has been summarized by D. Y. Sauter in a report, "Synthetic Fuels and Cancer", November 1975, released by the Scientists Institute for Public Information. The documented incidences observed for cancer occurring in workers in the synthetic fuel industry should be considered carefully and discussed in the EIS.

The emissions anticipated under both normal and worst conditions should be discussed and considered in comparison with emission of similar installations in Scotland, Europe and South Africa.



This matter will be considered by the FPC during its hearings for a Certificate of Public Convenience and Necessity.

The gasification process is an enclosed process and exposure could only occur from tar, tar oils, and vent gases. The tars and tar oils would be incinerated in the boilers and superheaters. Vent gases would incinerated in the flares except for a small amount of residual raw gas which would be released into the atmosphere. These emissions would meet all health, safety, and environmental standards.

No increased incidence of cancer has been found in workers at the Sasol plant after average exposures of 8 to 12 years. See also response to comment from the Department of Health, Education, and Welfare regarding occupational health.

Emissions in the EIS are for worst case conditions; normal conditions would entail lower emissions. Similar installations in other countries do not have the control devices the proposed plant would contain thus any comparison would be meaningless.

Mr. Robert L. McPhail

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May 20, 1977

The proposed boiler fuel for steam generation, namely the by-products, tar, oils, naptha and phenols, are to be combusted in such large amounts that specific information on the experience with such combustion techniques and their efficiencies should be available. The incomplete combustion of these heavy cyclic hydrocarbons present possibilities of additional airborne carcinogenic compounds such as benzo(a)pyrene, etc.

The polycyclic aromatic hydrocarbons released from this Lurgi gasification process are new in the regional threats they pose and become particularly awesome if one considers this ANG plant the first of many proposed for the Western North Dakota region.

Sincerely yours,

M. M. O'Toole

M. M. O'Toole
Acting Secretary
Iowa Confederation of Environmental
Organizations

The by-product fuels would be burned in the boiler at 3500° F. and in the superheater at 1600° F. Complete combustion should result at these temperatures. During start-up of the boilers, auxillary fuel would be used until operating temperatures are reached.

See above responses.

Beulah, ND 58523
May 22, 1977

OFFICIAL FILE	
JUN 6 1977	
NO BULKY PROCEEDINGS	FILE
REPLY OR OTHER ACTION TAKEN	FILE
INFO. COPY TO:	INITIALS
410	
415	

Gentlemen:

We understand and respect the position of the energy company. But we the Landowners have needs also. Agriculture cannot be sacrificed in North Dakota.

We will list some of our major concerns. We realize it will take the combined efforts of the Landowners and the energy companies, to overcome many of these concerns.

1. Sixty percent of our wells are located in the coal veins. Massive mining will destroy these wells.
2. Mine roads, power lines, and water lines will definitely hamper our farming operations. We maintain that when ever possible they should follow section and quarter section lines.
3. Our way of life will be destroyed. Our grandfathers spent endless hours and money to homestead and improve these lands which we now call home.
4. Our health facilities are not adequate for this impact.
5. Our recreation facilities will not be adequate.
6. Our elderly citizens will be hurt by higher prices, lack of medical facilities, and general lack of facilities.
7. ^{Coal} Taxes are not reasonable to protect Mercer County. Energy companies were definitely not helpful when we tried to pass an adequate severance tax.
8. Deafael North Dakota is being exploited by the energy companies. Our land and water will be consumed but reclamation has not been proven to us. We are especially concerned about the cost of reclamation. At some future time the cost may be too high and we will be left with spoils for land.

JUN 14 1977

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Mr. Eugene E. Keller, President
Mercer County Landowners
Beulah, North Dakota 58523

Dear Mr. Keller:

We have received your letter of May 22, 1977, listing major concerns regarding ANCO Coal Gasification Company's proposed gasification plant for Mercer County. We are aware that these are major problems and we have tried to address them in our draft environmental statement which was released March 17, 1977. Unfortunately, we have no ready solution for these issues. We agree that their resolution will take the combined efforts of the landowners and the energy companies.

By copy of this letter we are forwarding your correspondence to ANCO Coal Gasification Company for further response. If there are any questions please contact Dean Loomis or Fred Crase at (406) 657-6605.

Thank you for informing us of your concerns.

Sincerely yours,

Robert L. McPhail

Regional Director

cc: Mr. Earl C. Kirchmer, Assistant Director, Coal Reserves, Mining, and Community Services, American Natural Resources Company, One Woodward Avenue, Detroit, Michigan 48226 (w/copy of incoming correspondence)

bc: 415

9. Last, but not least important, we do not feel that Antelope Valley is a proper site for a gasification complex. Antelope Valley is underlain by an aquifer. During heavy rainfall the Valley is flooded. Wastes could easily end up in Hazen.

Sincerely yours,

Mercer County Landowners
Eugene E. Keller President
Gilbert Ost Vice President
Walter Keller Director
Floyd Weigum Director
Leon Waf - Director
Joe Weidrich - Sec. & Treas.