OIL AND GAS

ENVIRONMENTAL ASSESSMENT OF BLM LEASING PROGRAM

DICKINSON DISTRICT

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

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INTRODUCTION

Chapter 1, Proposed Action, of this assessment pertains to oil and gas activities in the states of Montana, North Dakota, and South Dakota. It provides an overview of oil and gas operations and of the general oil and gas situation in this three state area. The remainder of this assessment, Chapters 2 through 5, focuses upon specific environmental considerations concerning oil and gas activities within the Dickinson District.

PURPOSE AND NEED

This Oil and Gas Environmental Assessment has been prepared pursuant to Section 102(2)(c) of the National Environmental Policy Act of 1969, as amended. It is designed to assess the impacts from federal oil and gas leasing by the Montana State Office of the Bureau of Land Management (BLM), United States Department of the Interior, in the states of Montana, North Dakota, and South Dakota.

INTRODUCTION

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CHAPTER 1

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PROPOSED ACTION

The Proposed Action is the continuation of BLM's oil and gas leasing program in Montana and the Dakotas in order to make federally administered oil and gas resources available to the region and nation.

This assessment, an integral part of BLM's leasing program, is designed to provide the foundation and framework for the utilization of environmental considerations required in the course of issuing oil and gas leases in the three-state area by the BLM. It identifies environmental factors requiring protection and attaches appropriate stipulations on oil and gas activity to insure that protective measures are implemented.

The objectives of the BLM oil and gas leasing program are: (a) continuation of federal oil and gas leasing with appropriate environmental protection in areas where oil and gas development is environmentally acceptable; and (b) identification of areas which, regardless of the stipulations, are not suitable to oil and gas leasing due to environmental considerations.

The analysis required to meet these objectives will allow BLM to stratify leasing decisions according to environmental sensitivity. This stratification provides a basis for continued leasing associated with meeting the objectives of the National Environmental Policy Act of 1969 as amended and BLM's Federal Land Policy and Management Act of 1976. In practice, a lease application for a given area will be reviewed concerning (1) the impact causing actions discussed in this chapter and (2) the area's sensitivity to these impact causing actions. These considerations will be the basis for a decision to either lease the area with appropriate stipulations which would effectively protect the resource(s) or not to lease because of extremely sensitive features in the area which cannot be protected with the existing range of stipulations.

Scope

The proposed action includes all practices by the BLM and the U.S. Geological Survey (GS) in issuing and administering oil and gas leases over the approximately 50 million subsurface acres under the management of the BLM in the three-state area.

Although the BLM is responsible for the leasing of federal oil and gas under Forest Service surface, this assessment will not attempt to study environmental impacts on those lands. Instead, the BLM will refer to site-specific environmental assessment and recommendations made by the Forest Service concerning oil and gas development on land it administers. It should be noted that the BLM and Forest Service coordinate closely in these matters based upon a 1978 cooperative agreement between the two agencies. This agreement encourages coordination in order to make both agencies aware of respective roles and responsibilities concerning environmental assessment. It also insures that the analytical approach and data bases used by both agencies are compatible and will facilitate reviews and recommendations between the two agencies.

In addition to its subsurface jurisdiction, the BLM currently administers approximately 8.4 million surface acres in the three-state area. The surface and subsurface acreage administered by the BLM in each state are shown in Figure 1-1.

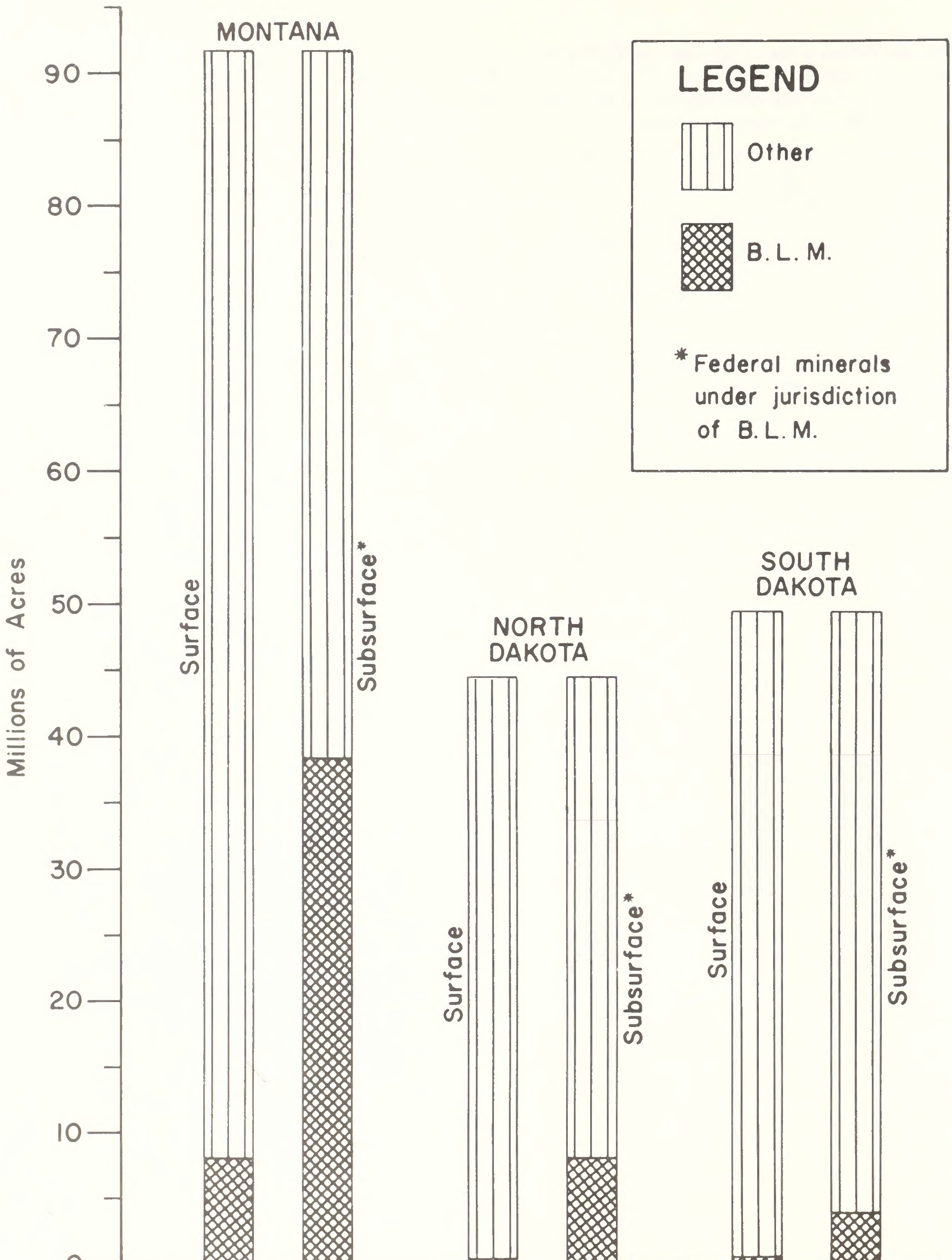
It is expected that this document can be used to assess environmental impacts from oil and gas development upon lands administered by the following agencies with surface management jurisdiction in Montana, North Dakota, and South Dakota in cases where these acreages overlie federal oil and gas subsurface:

Agency	Surface Acres
USDA—National Forest System Lands	
Region 1	18,102,368
Region 2	1,766,372
USDA—Agricultural Research Service	71,700
General Services Administration	714
USDI—Bureau of Reclamation	284,018
DOD—U.S. Air Force	8,916
DOD—U.S. Army	18,136
DOD—Corps of Engineers	607,678

In instances where the surface management agency has prepared its own site-specific analysis, this assessment will be available for reference with respect to likely environmental impacts.

FIGURE 1—1

SURFACE AND SUBSURFACE ACREAGE



Source: B.L.M. IN MONTANA, U.S.D.I., 1977 & Geologist, Branch of Lands & Minerals, M.S.O.

1.1 ENERGY BACKGROUND

The United States has experienced significant changes in its political and economic well being as a result of its dependence upon inexpensive foreign supplies of energy. The Arab oil embargo of 1973 precipitated an energy "crisis" in the sense that cheap, seemingly unlimited supplies of petroleum were no longer available to the U.S. The subsequent quadrupling of crude oil prices in the period of a few months made this nation and other industrial powers aware of their dependency upon nations which hold large reserves of petroleum. Domestic oil and gas development, in conjunction with energy conservation, was encouraged in the U.S. and elsewhere with the aim of reducing dependency upon foreign energy supplies. This effort has become increasingly more important in light of recent oil price increases ($20.71 per barrel) from foreign sources and because the U.S. is currently importing approximately 50% of the oil it uses.

The United States, the world's leading energy consumer, has historically been highly dependent upon both natural gas and petroleum as energy sources. In 1975, natural gas and petroleum together comprised approximately 74% of the nation's energy diet (petroleum 45%, natural gas 29%). This is a significant increase over the 47% contribution of these two fuels in 1947. Although overall energy consumption in the U.S. grew at an average annual rate of 2.8% between the years 1947 and 1975, the continued growth in petroleum and natural gas consumption averaged 8.4% per year, or approximately three times the annual growth rate of total national energy consumption. Figure 1-2 shows the increase in total energy consumption from 1947 to 1975 and the growing role of petroleum and natural gas in satisfying this demand.

It is obvious that national energy consumption would grow during this period as the nation became more populated. However, per capita energy consumption in the U.S. increased by 46% from 1947 to 1975. This means that, on the average, every individual in the U.S. in 1975 consumed approximately one and one-half times as much energy per day as in 1947. The increased growth in petroleum consumption in the United States has been made possible, to a great extent, by importing oil, and more recently liquefied petroleum gas, from other countries. Energy forecasts indicate that national consumption will continue to outstrip domestic production at least through the year 1990 (Figure 1-3).

Many areas of the world have supplied the United States' petroleum consumption during the last decade. In 1979 the U.S. was relying upon the Organization of Petroleum Exporting Countries (OPEC) for 72% of its annual oil imports (Figure 1-4). Forecasts of liquid hydrocarbon and natural gas supply through the year 2000 indicate a growth in imports of both fuels in order to keep pace with national consumption (Figures 1-5 and 1-6).

There exist many opportunities for energy conservation without a reduction in living standards in a nation which, with 6% of the world's population, accounts for approximately 34% of the earth's annual energy consumption. This rate of energy consumption is far greater than in many other modern societies with similar standards of living.

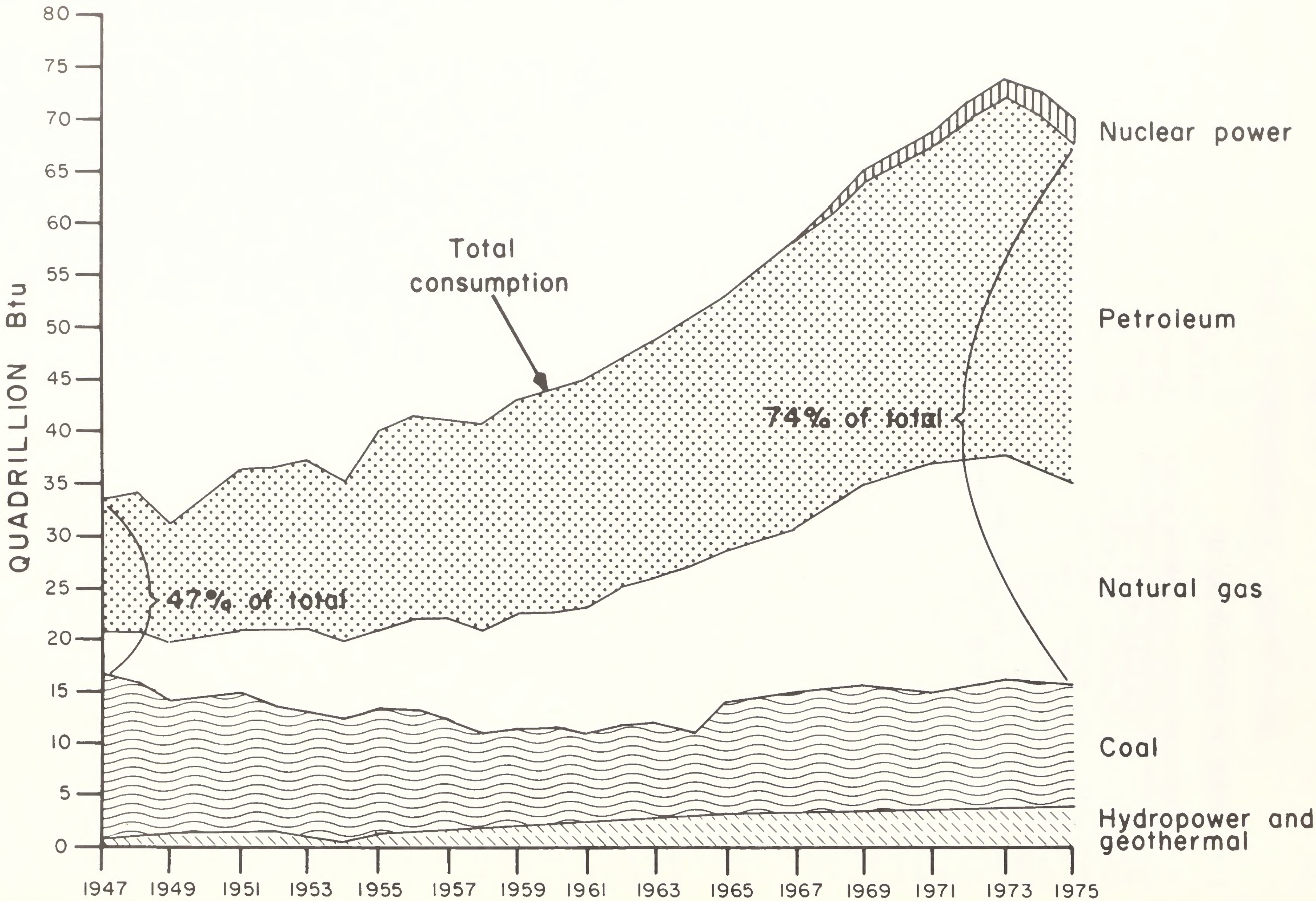
As a part of a national program sponsored by the U.S. Department of Energy, Montana, North Dakota, and South Dakota have begun implementation of state energy conservation programs designed to reduce energy consumption by 5% to 6% from projected levels by the year 1985. These state programs embrace many aspects of energy conservation such as home weatherization, industrial, commercial, and residential lighting standards, thermal efficiency standards, carpooling, and energy conservation education, to mention a few. It is likely that these programs will receive increasing attention as it becomes more apparent that energy conservation is an effective way to improve the nation's economic well-being while reducing our unnecessary dependence on foreign supplies of energy.

The oil and gas industry in Montana, North Dakota, and South Dakota is significant nationally. In 1976, Montana ranked 13th in crude oil production, with 1.1% of the nation's total, and 17th in natural gas production, producing 0.2% of the total. North and South Dakota ranked 17th and 30th, respectively, in oil production, and 19th and 50th in natural gas production. North Dakota supplied 0.9% of the nation's total crude oil production, and 0.1% of the gas production. South Dakota produced .01% of the nation's oil output, and currently has negligible natural gas production. Oil and gas activity in the study area is influenced by national trends; consequently, activity has increased with the nation's growing need for petroleum products.

Drilling activity fluctuates, but has generally been on the increase in the three-state area. As of December 1977, there were 3,330 producing oil wells in Montana, 69 wells in South Dakota, and 2,200 wells in North Dakota. Figure 1-7 shows total annual drilling activity in the three-state area from 1966 to 1977. Even though drilling activity has not changed significantly between 1966 and 1977, the actual annual production of oil and gas in Montana, North Dakota, and South Dakota decreased during the period 1967 to 1976 (Figure 1-8). Oil production decreased by 9% and gas production decreased by 8% during this period. Figure 1-9 shows that the proportion of total oil and gas production attributable to public subsurface in the three-state area is two to three times that for the nation.

FIGURE 1—2

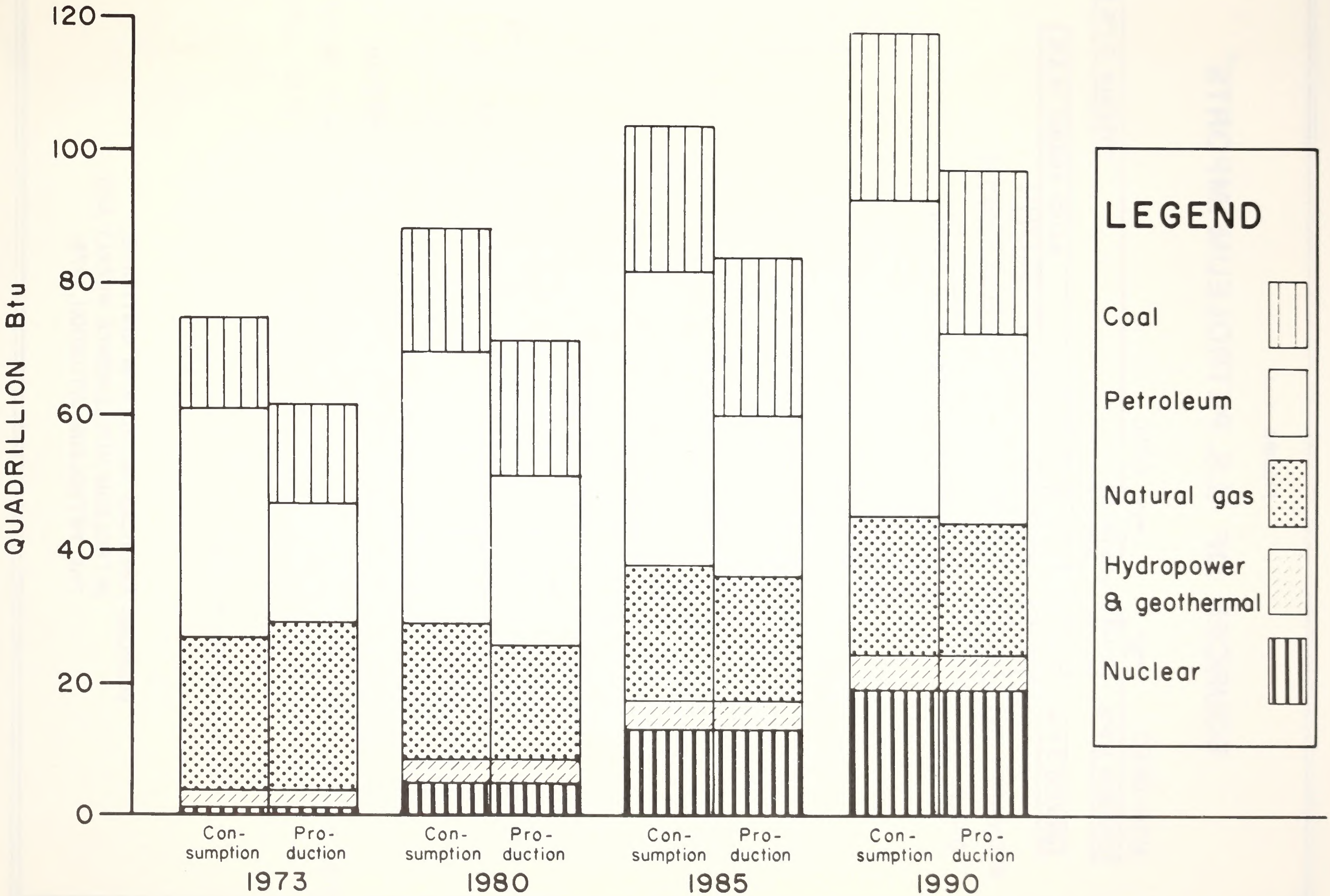
TOTAL U.S. ENERGY CONSUMPTION



Source: Energy Perspectives 2, U.S. Department of the Interior, 1976.

FIGURE 1—3

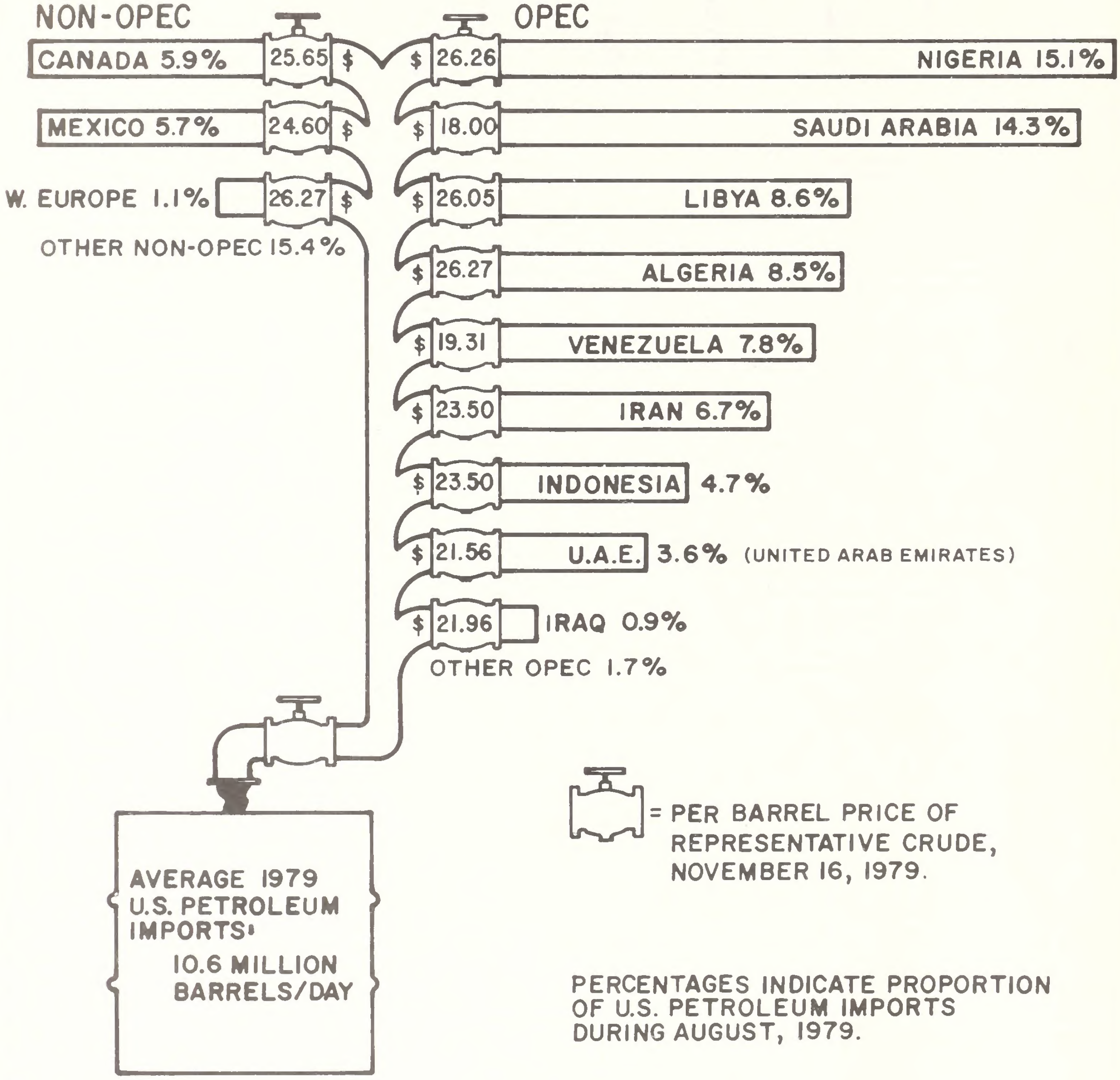
U.S. ENERGY PROJECTIONS, 1973-90



Source: Energy Perspectives 2, U.S. Department of the Interior, 1976.

FIGURE 1-4

SOURCES OF U.S. PETROLEUM IMPORTS*

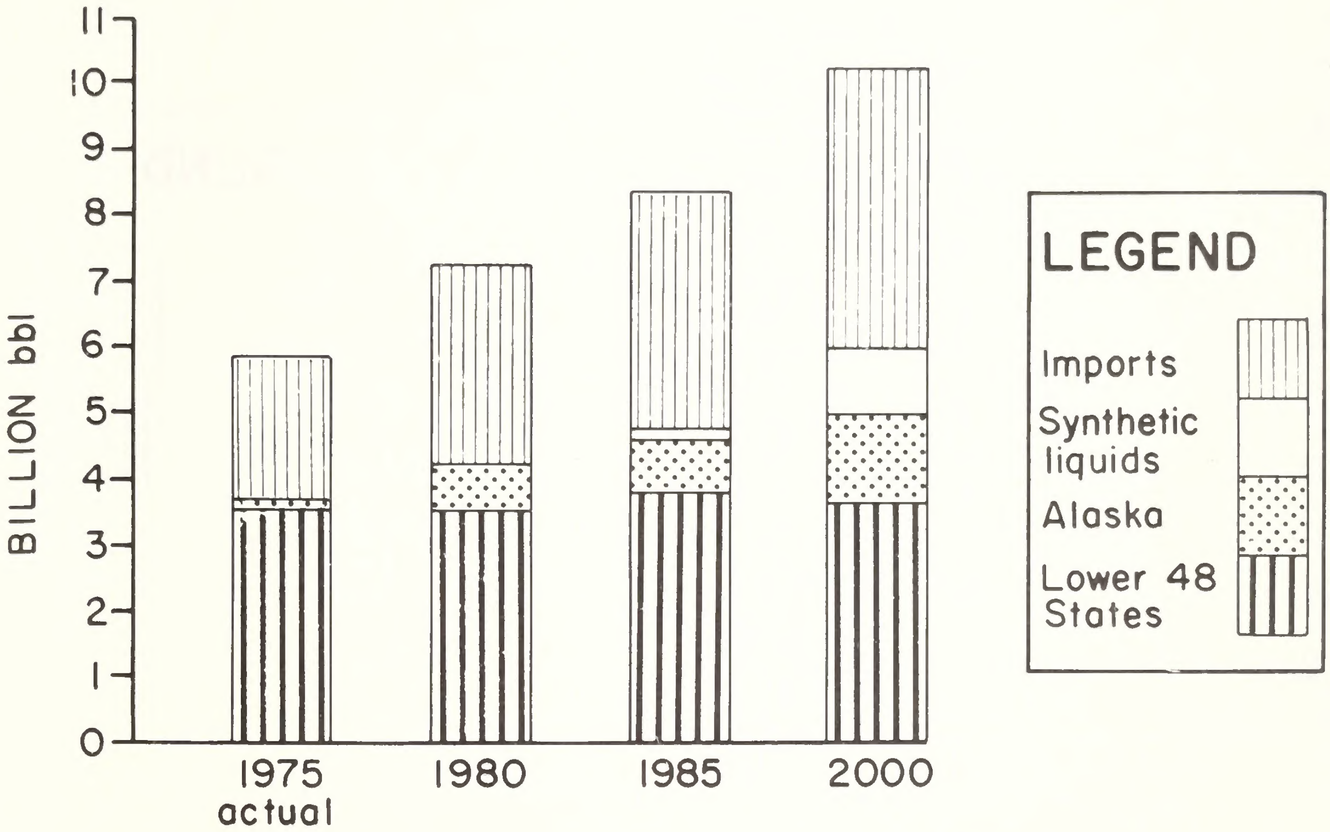


*DIRECT IMPORTS ONLY

SOURCES: AMERICAN PETROLEUM INSTITUTE, PETROLEUM INTELLIGENCE WEEKLY AND THE PETROLEUM SITUATION, 1979.

FIGURE 1—5

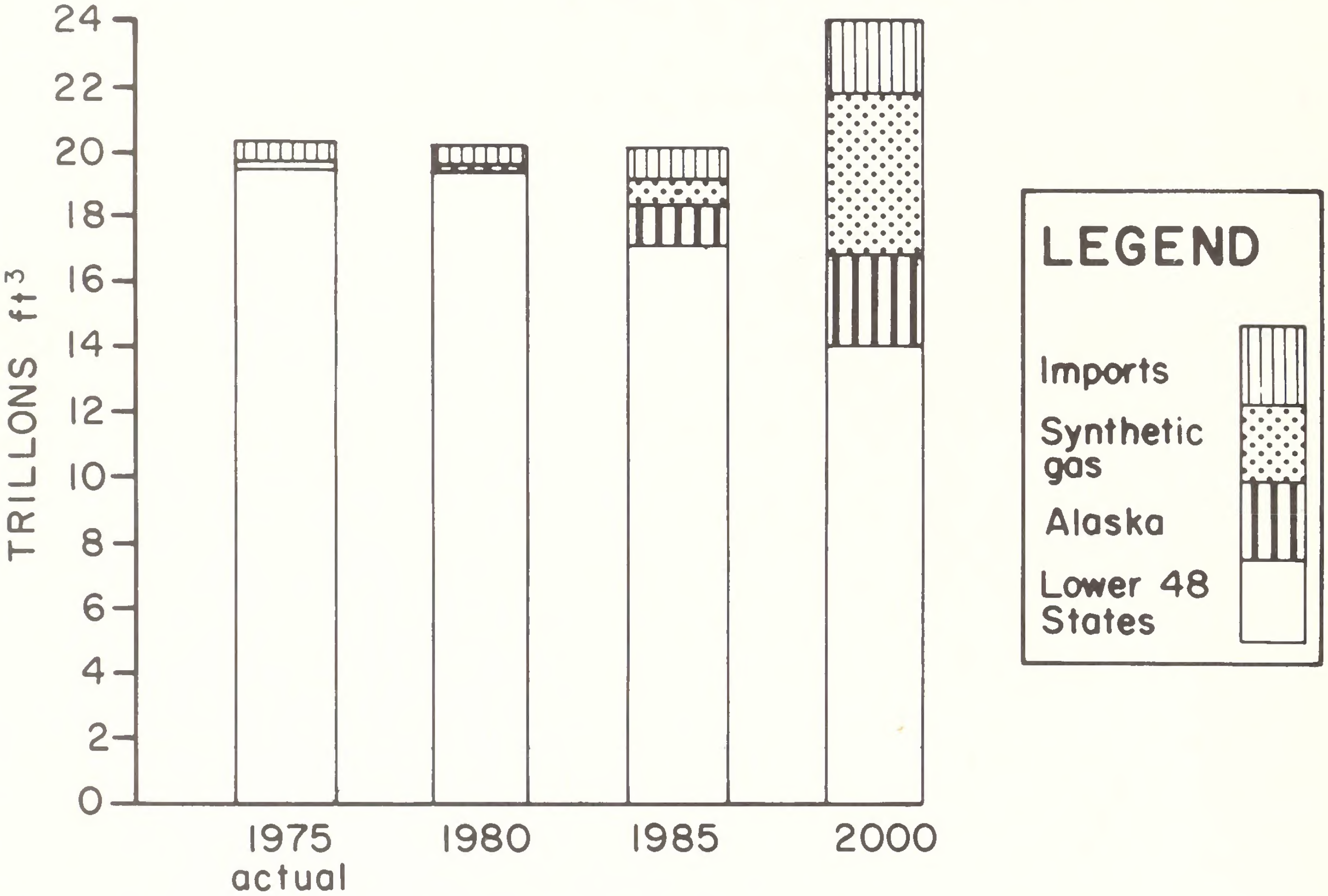
PROJECTIONS OF U.S. LIQUID HYDROCARBON SUPPLY, 1975-2000



Source: Energy Perspectives 2, U.S. Department of the Interior, 1976.
Note: U.S. Bureau of Mines estimates.

FIGURE 1—6

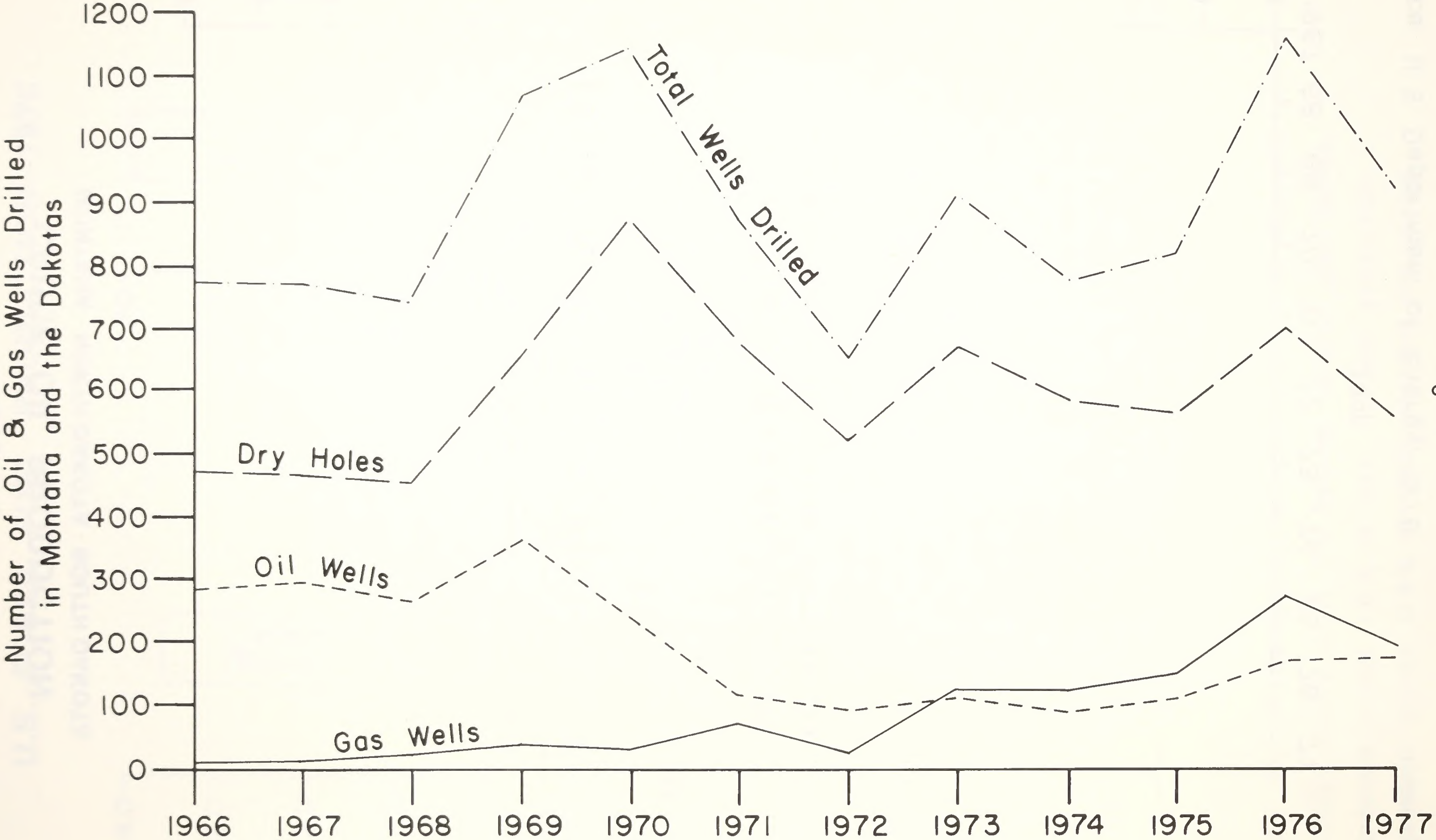
PROJECTIONS OF U.S. GAS SUPPLY, 1975-2000



Source: Energy Perspectives 2, U. S. Department of the Interior, 1976.
Note: U.S. Bureau of Mines estimates.

FIGURE 1—7

TOTAL WELL DRILLING ACTIVITY IN THREE STATE AREA

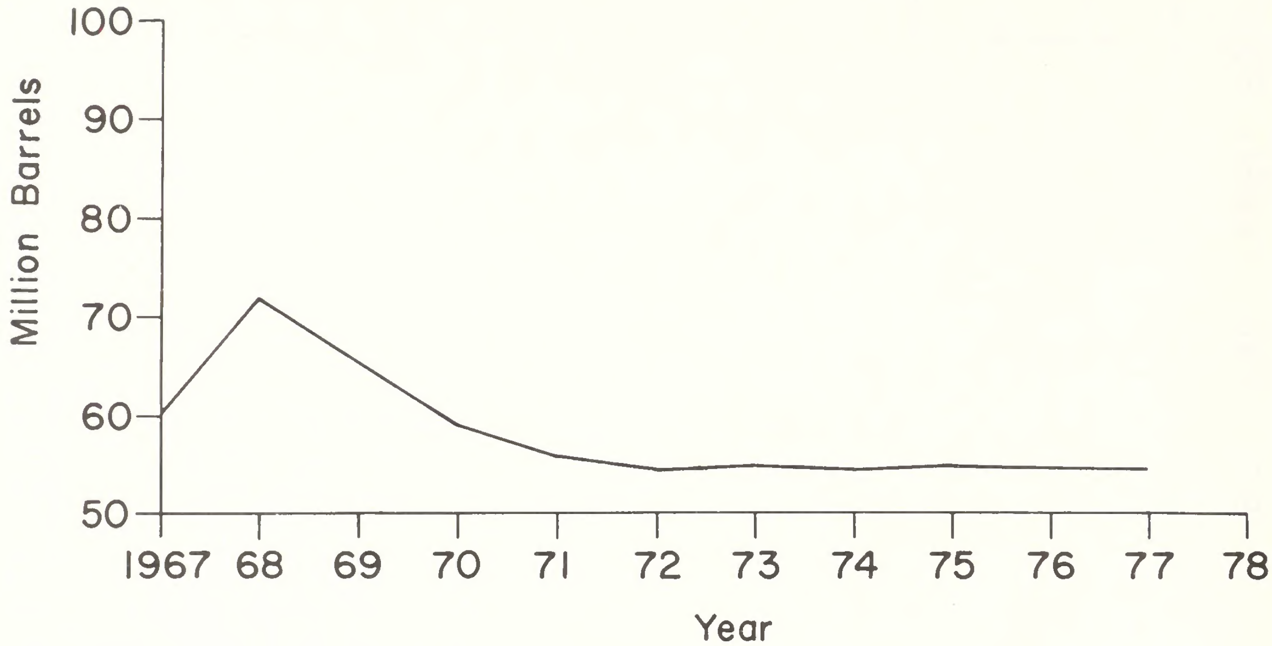


Source: Independent Petroleum Association of America.

FIGURE 1—8

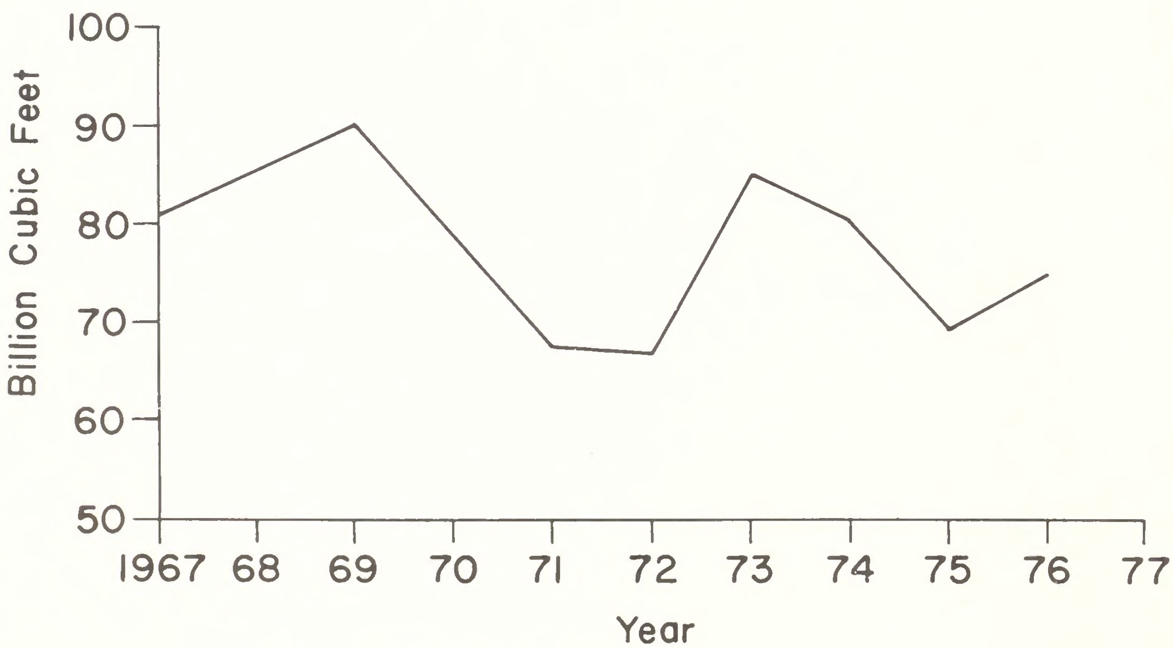
CRUDE OIL PRODUCTION

MONTANA - NORTH DAKOTA - SOUTH DAKOTA



NATURAL GAS PRODUCTION

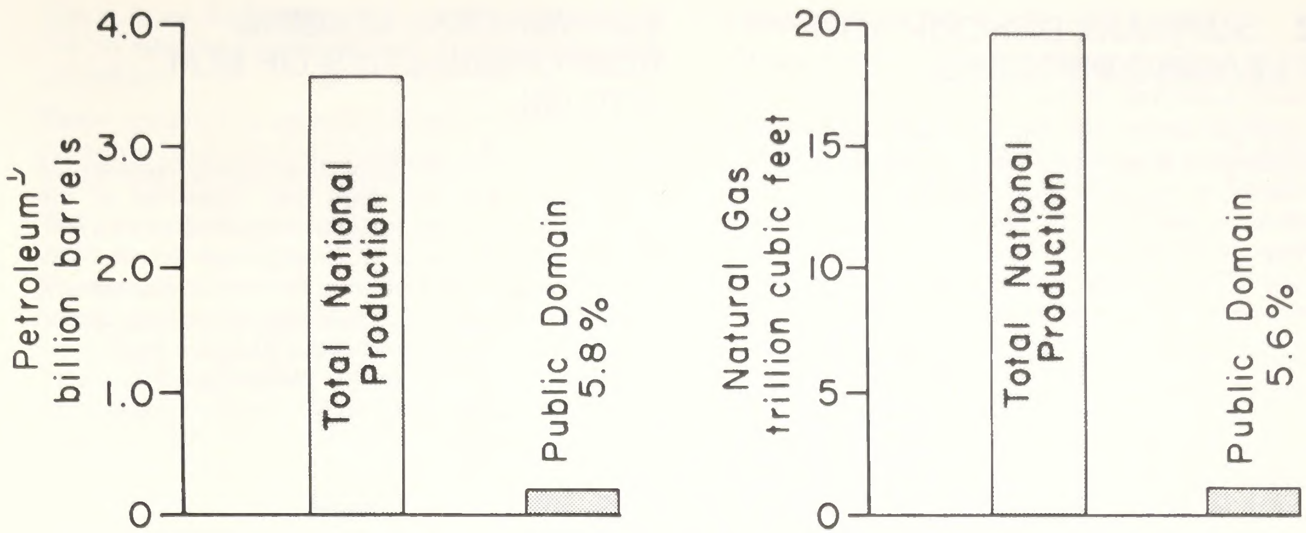
MONTANA - NORTH DAKOTA - SOUTH DAKOTA



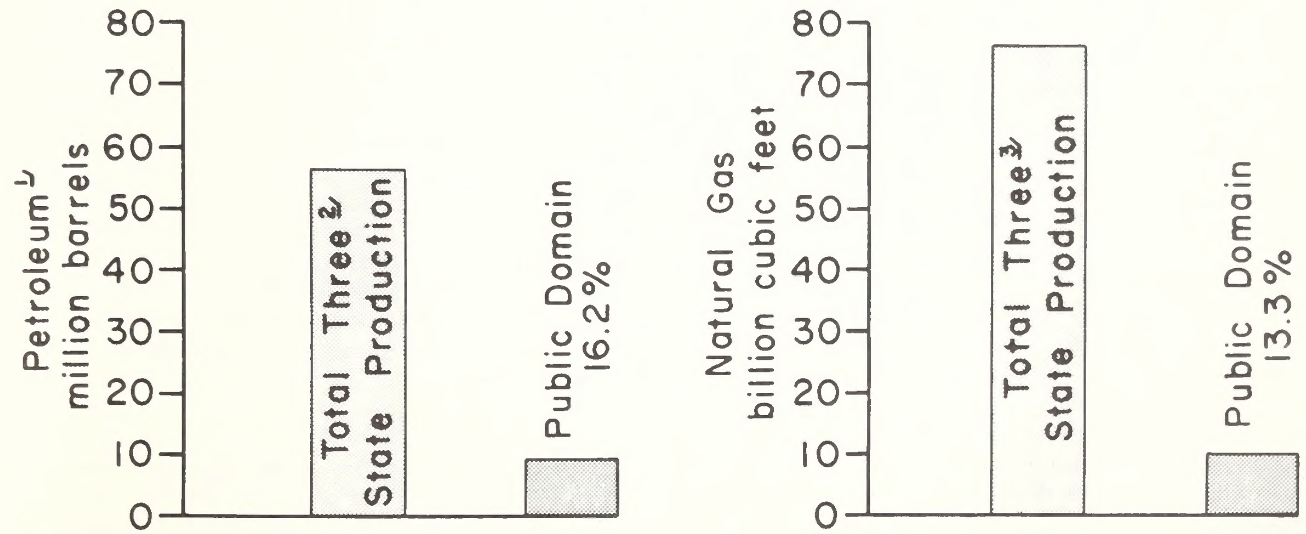
Source: U.S. Department of Energy, 1978

FIGURE 1—9

U.S. FOSSIL FUEL PRODUCTION—1976



MONTANA, NORTH DAKOTA, SOUTH DAKOTA FOSSIL FUEL PRODUCTION—1976



Source: M.S.O. Geologist, Branch of Lands & Minerals.

[1] Includes crude oil & the heavier natural gas liquids.

[2] Represents approx. 1.6% of total national production.

[3] Represents approx. 0.4% of total national production.

1.2 SUMMARY DESCRIPTION OF LEASING PROCESS

Oil and gas leases fall into two basic categories—competitive and noncompetitive. Competitive leases are issued in Known Geological Structures (KGS) which are areas known to contain producible oil and gas deposits. Noncompetitive leases are issued for land outside KGSs and are available as a result either of open over-the-counter offers or simultaneous filings.

KGS land may be offered for competitive leasing based on response to public request on Bureau initiative. If this occurs, the GS then prepares a report as to KGS status, recommends whether competitive leasing is in the public interest, and groups tracts into lease parcels. If leasing is recommended, land nominated by the public is combined with other GS nominations (in active KGS areas), and a competitive lease sale is scheduled after the BLM district office is consulted concerning conflicts with land use planning. The BLM offers the tracts for lease through competitive sealed bids. The adequacy of the high bids tendered is determined by a bid evaluation team composed of representatives from the GS and BLM. Each sealed bid must be accompanied by an initial payment of 20% of the bonus offered; the remaining bonus payment must be paid prior to lease issuance.

On noncompetitive (over-the-counter) leases, the applicant files an offer to lease on lands open to lease in non-KGS areas. If, through adjudication, the lands are available for lease, the BLM district office or other appropriate surface management agency responds with appropriate land use recommendations and, upon approval, a ten year lease is issued to the applicant.

Previously leased parcels in non-KGS areas (i.e., simultaneous and noncompetitive filings) are listed monthly as they become available following expiration, cancellation, or termination of the old leases. Once a list of available tracts is approved and advertised, all applications received during the filing period are considered to have been filed simultaneously. An applicant may file only one application per tract accompanied by a $10 filing fee. A drawing is held and three applications are drawn for each tract. A lease is offered on the parcel in order in which they were drawn (i.e., a winner and two alternates).

If there are no simultaneous lease offers for a tract, it becomes available to the first over-the-counter applicant subsequent to the drawing. All leases require rent payment in advance. Rent on noncompetitive leases is $1 an acre a year. Upon production of oil and gas, the minimum royalty charge is 12.5% of value. Prior to drilling, applicant must secure bond to insurance compliance with all terms of the lease. Rent and royalty schedules on competitive leases are described in the lease agreement.

1.3 MINERAL LEASING RESPONSIBILITIES OF BLM AND GS

The BLM and GS have joint responsibility to assure full compliance with the spirit and objectives of the National Environmental Policy Act (NEPA) of 1969, Federal Land Policy and Management Act of 1976, other federal environmental legislation, and supporting Executive Orders and regulations concerning oil and gas development. Prior to lease issuance, the Bureau has the prime responsibility in the exercise of the Secretary's discretionary authority whereas the GS has prime responsibility, with concurrence from BLM relative to protection of the surface resources, after the lease is issued. Generally, GS's responsibility is confined to the "area of operations." This area can be defined as that surface including and surrounding the drill pad necessary for the drilling, subsequent development, and possible production of the oil and/or gas well(s) in a safe and reasonable manner.

As previously mentioned, the Bureau has prime responsibility prior to lease issuance. In the exercise of this responsibility, standard stipulations have been formulated, with GS cooperation, to cover most items necessary for the protection of and subsequent rehabilitation of the surface resources. If additional stipulations are required, these are formulated and included prior to lease issuance. After lease issuance and prior to approval of any surface disturbing activities within the area of the lease, a detailed site-specific review and field examination is conducted by the GS and BLM or other surface administering agency. From this effort, site-specific requirements are formulated for the protection of the surface resources and subsequent rehabilitation, and imposed upon the lessee prior to approval of the proposed activity (i.e., geophysical work, well drilling). Although GS has prime responsibility at this point, they must have full concurrence from the surface managing agency. If differences exist, these are forwarded through various administrative levels and eventually to the Secretary.

1.4 FEDERAL, STATE, AND LOCAL ACTIONS

In order to better understand oil and gas leasing operations, the following discussion describes the responsibilities of the various governmental bodies in each phase of the operation.

Federal Actions

Exploration

There is no statutory authority for oil and gas exploration. Subpart 3045 of the Code of Federal Regulations (1970) established procedures to be followed in such operations.

Before geophysical operators conduct any operations on public lands, they are required to file a "Notice of Intent" with the District Manager, BLM.

The geophysical operator has a responsibility to cooperate and coordinate his operation with the District Manager. The operator's responsibilities are to:

— File a Notice of Intent on unleased lands, with maps showing proposed seismic lines and all necessary access routes before operations begin. The map should be a minimum scale of 1/2 inch to the mile.

— Be bonded.

— Notify the District Manager before he enters onto public lands.

— Obtain the District Manager's written approval for bulldozer or other dirt work.

— Notify the District Manager in writing of any changes in the original notice and secure written approval before proceeding.

— Comply with stipulations imposed by the District Manager at the pre-work conference and during field investigations.

— File a Notice of Completion.

The District Manager's responsibilities are to:

— Examine resource values and develop appropriate surface protection and reclamation measures.

— Conduct compliance inspections.

— Coordinate with the geophysical operator to explain the terms of the Notice of Intent, including operating practices to be followed or avoided, all relevant laws, and BLM administrative requirements.

— Complete final inspection after the Notice of Completion is filed. The inspection must determine that all instructions were complied with and all rehabilitation practices completed. A 90-day limit for the final inspection and notification of additional work is established by regulation. If further instructions are given to the operator at final inspection, an additional 90-day limit is established for the BLM after notification that the operator has completed his work.

— Release operator's bond.

A prospecting permit is required for geophysical work on Forest Service surface. This permitting process is similar to that used in BLM's Notice of Intent.

Operations

Once a federal lessee or designated operator indicates that he wishes to explore on or develop a lease, all proposed drilling operations and related surface disturbance activities must be approved before entry upon the lands involved. Approval will be in accordance with: (1) lease terms, including any additional lease stipulations; (2) Title 30 CFR Part 221, "Oil and Gas Operating Regulations," and (3) "Notice to Lessees No. 6" (NTL-6) issued by the GS effective June 1, 1976. The requirements that must be approved include the following:

Preliminary Review. A preliminary environmental review is required of all drilling proposals prior to entry on the ground to stake the location, access roads, and other surface-use areas. The operator must furnish a map of a scale not less than 1 inch equals 1 mile, that shows the preferred location and general topographic features, and explain the anticipated activity and surface disturbance to the District Engineer, GS, as well as the District Manager, BLM. This permits the district manager to identify any potential conflicts with other resource values. If conflicts are noted, a joint conference or field inspection is held involving USGS, BLM, and the operator.

Application for Permit to Drill. Prior to drilling or road construction on a federal lease, the operator must submit an Application for Permit to Drill (APD). The APD includes a Surface-Use and Operations Plan. Where private surface is involved, it should include a copy of the written agreement between the lessee or operator and the surface owner. A letter from the lessee or operator setting forth rehabilitation requirements agreed to with the surface owner is acceptable.

The APD provides operational and geologic information required by the GS. The Surface-Use and Operations Plan must allow assessment of the environmental effects expected from the proposed project. Bonding coverage must be obtained by the applicant before approval of the APD by GS.

GS sends this information to the BLM District Manager, who reviews the plan and recommends surface-protection stipulations for the approved permit. The BLM must decide at this time if it desires to obtain the well as a water well if oil or gas is not encountered in usable quantities.

Approval of Operations. Before repairing, deepening, or conditioning an existing well, a detailed written work plan must be submitted to GS.

In existing fields operators are required to submit, for GS approval, plans for new construction, reconstruction, or alteration of existing facilities, when additional surface disturbance will result.

Abandonment. Well abandonment requires prior approval by the GS and the BLM, which may require additional surface rehabilitation. These requirements are normally part of the approved abandonment plan. Abandonment will not be approved until surface rehabilitation work required by the drilling permit or abandonment notice is complete, and required vegetation is established to the satisfaction of the BLM District Manager.

Water Well Conversion. If the BLM decides to acquire the well as a water well, it must assume responsibility at the time of abandonment. The operator will plug the well at the bottom of the desired fresh-water zone and leave casing in place. The operator then will begin surface cleanup as required. The BLM must reimburse the operator for casing and labor to complete the well.

Other Requirements

The Environmental Protection Agency has issued regulations affecting all oil and gas lessees and operators (Title 40 CFR, Part 112). These regulations require owners or operators to prepare Spill Prevention Control and Countermeasure (SPCC) Plans. EPA does not make special inspections to see that operators have SPCC Plans. They may call for one from an operator if they desire; if an operator does not provide one, he is subject to a fine. After a hazardous material spill, EPA usually calls for the operator's SPCC Plan.

Oil and gas operators must also meet requirements of the Department of Transportation and the Interstate Commerce Commission.

Table 1-1 summarizes the seven basic procedural steps necessary in obtaining a Permit to Drill for oil and gas on federal leases.

State Actions

If a well is productive, the state requires notification and a monthly report. A completion or recompletion report is also required. The Oil and Gas Conservation Commission in Montana, the Industrial Commission of North Dakota, and the South Dakota Board of Natural Resources are primarily interested in production and conservation of the oil and gas. Surface protection requirements are a matter between the surface owner and the operator. The State Commissioner of Public Lands issues state leases and also holds operator's bonds. He releases such bonds whenever the surface owner or lessee is satisfied. Monetary settlement is acceptable to the state in lieu of rehabilitation. If a well is a dry hole, operators are required to follow state procedures for plugging.

The above mentioned agencies have final authority on any well location variances. They also must approve unitization agreements. In addition, the states control water and gas injection systems, and underground gas-storage projects. The GS works with them on this, although the state has final authority.

Oil and gas operators are regulated by the State Department of Environmental Quality. This Department issues burning permits, if needed, as well as production-water discharge permits.

Local Actions

County governments are involved with oil and gas operators with respect to zoning, rights-of-way, and access.

The petroleum industry is very active in the study area. The headquarters of the Petroleum Association of Montana, located in Billings, is the state chapter of the Rocky Mountain Oil and Gas Association (RMOGA), headquartered in Denver. The major producers in the area belong to this association.

1.5 PHASES OF ONSHORE OIL AND GAS ACTIVITY

Normally, onshore oil and gas operations progress through five phases: (1) Preliminary exploration, (2) Exploratory drilling, (3) Development, (4) Production, and (5) Abandonment. Preliminary exploration can occur on leased or unleased lands. The remaining four phases occur on leased lands. Each phase has a potential for causing some type of disturbance to the environment. A brief description of the purpose for each phase and those actions within a phase that could cause some type of environmental disturbance follows.

Preliminary Exploration

A clue to the presence of oil and gas may be revealed by a search for geological structures within the rock that may contain underground oil and gas "traps". Figure 1-10 shows typical structures that may contain oil or natural gas traps.

Surface maps and aerial photos help the geologist identify geologic structures. Additional data can be gathered by the use of aircraft. Low altitude reconnaissance flights, frequently at elevations of 100 to 500 feet, help identify rock outcrops that can be studied later on the ground. Higher altitude flights above 3,000 feet are often made to conduct photographic, geophysical magnetometer, and other sensing surveys.

On-the-ground geologic mapping, gravitational and magnetic prospecting may follow if the previous work shows promise of oil and gas traps or reservoirs. Figure 1-11 shows how the gravity methods works. Small trucks and jeeps with crews of several people can be used at this stage of subsurface data gathering, and off-road travel is likely.

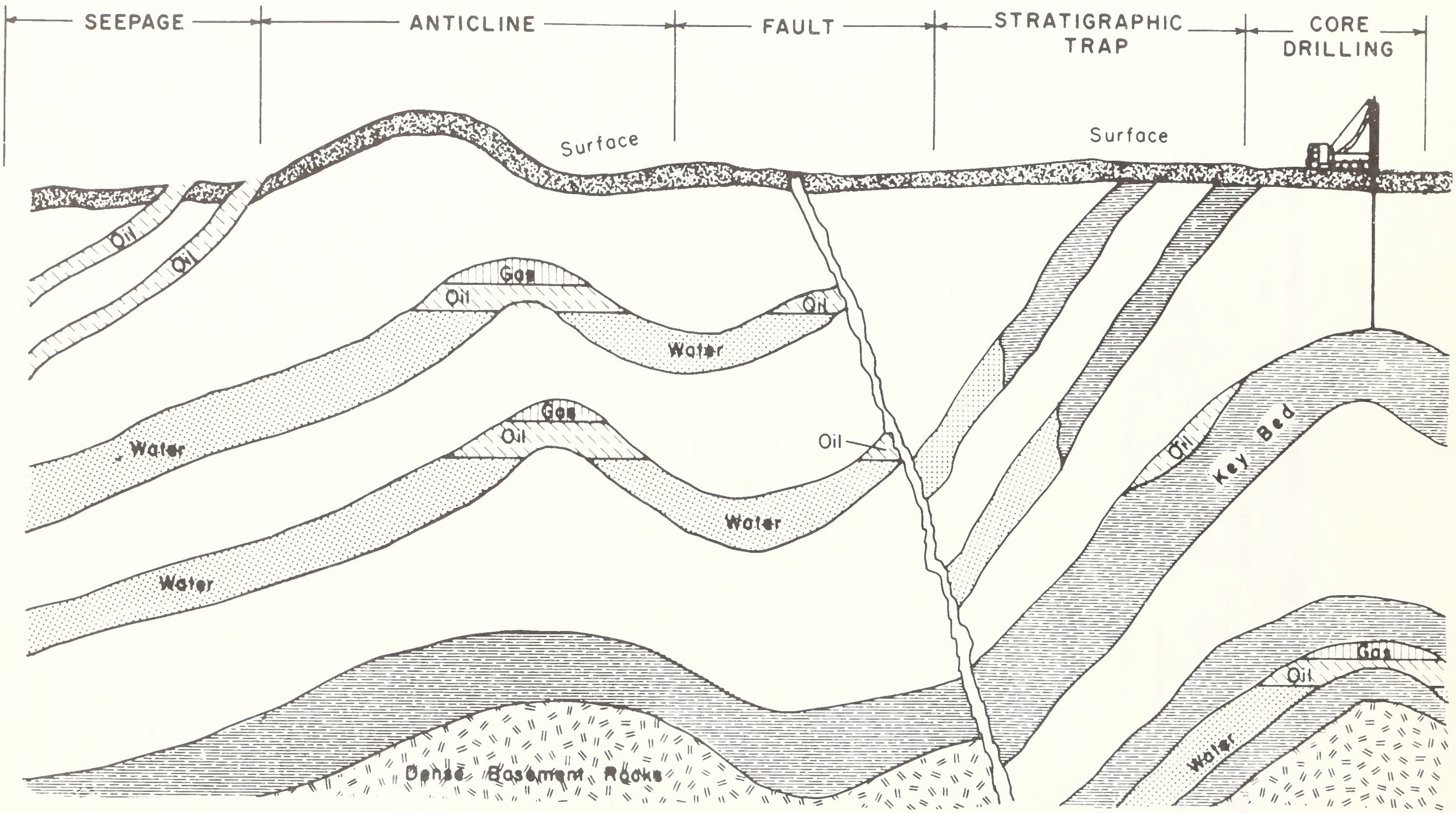
TABLE 1-1
PROCEDURAL GUIDELINES FOR ACTIONS ASSOCIATED WITH OIL AND GAS DEVELOPMENT

	Operator Action	Dept. of Interior Action	Field Activities	Normal Time Period
STEP I	1. Develops preliminary map and submits to GS and Bureau of Land Management 2. Identifies necessary off lease rights-of-way. 3. Attends joint field examination if requested by Interior.	1. Performs preliminary environmental review. 2. Reviews for other authorizations necessary. 3. Notifies operator if site conflicts with other resource values. Notifies operator if no archaeological survey is required. 4. Requests joint field examination if necessary.	1. Operator reviews on-the-ground site. 2. Joint field inspection, if necessary.	1. 15 days after receipt.
STEP II	1. Operator surveys well location and centerline of access roads. 2. Identifies necessary off lease rights-of-way. 3. Arranges for archaeological clearance work. 4. Develops Multi-point Surface Use & Operations Plan. Prepares Application for Permit to Drill. 5. Acquires private surface owner agreement if appropriate.		1. Survey and stake well site and other facilities, includes centerline staking of roads. 2. Archaeological survey performed.	1. Variable; contingent upon operator schedules.
STEP III	1. Operator files APD, Multi-point Surface Use & Operations Plan, private Surface Owner Agreement, and archaeological clearance. 2. Applies for necessary rights-of-way to Bureau of Land Management. 3. Attends joint field examination if requested by GS.	1. Reviews APD and Surface Use & Operations Plan. 2. Reviews archaeological survey. 3. Requests joint field examination, if appropriate. 4. Requests revision of plan if unacceptable. 5. Prepares necessary environmental analysis for APD and other federal actions required. 6. Prepares conditions of approval to APD and Multi-point Surface Use & Operations Plan. 7. APD approved or rejected. 8. Appropriate rights-of-way issued.	1. Joint field examination performed.	1. 30 days.
STEP IV	1. Performs in accordance with approval plan. 2. Files necessary reports to Geological Survey.	1. Compliance inspections.	1. Operator stakes well site exterior dimensions. 2. Operator begins construction and/or drilling activities. 3. Interior conducts compliance inspections.	1. Variable.
STEP V	1. Operator files Notice of Completion if well is a producer, plus modification to the Multi-point Surface Use & Operations Plan. Operator may need to arrange for additional archaeological survey on areas affected by plan modifications. 2. Operator files Notice of Intent to Abandon if well is dry hole. This can also be for a producer that has gone dry.	1. Reviews on-the-ground conditions for compliance and rehabilitation needs. 2. Reviews modifications to the Multi-point Surface Use & Operations Plan. 3. Requests joint field examination, if appropriate. 4. Requests revision of plan if unacceptable. 5. Prepares necessary environmental analysis for the plan and reviews archaeological survey. 6. Prepares conditions of approval to modified plan. 7. Plan approved or rejected. 8. Additional requirements for rehabilitation of disturbed areas developed for conditions of Intent to Abandon.	1. Joint field examination if necessary. 2. Field work performed to develop well and necessary 3. Field work performed to abandon well if this is the action. 4. Rehabilitation work begins on disturbed areas.	1. Review of plan, 30 days. 2. Rehabilitation work, one year.
STEP VI	1. Operator files Sundry Reports on a Well. Subsequent Report of Abandonment states all work is completed and ready for inspection.	1. Performs compliance checks to see that all conditions are met. 2. Approved final abandonment.	1. All work completed and ready for inspection.	1. Variable; one-two years for vegetation establishment.
STEP VII	1. Applies for release of the period of bond liability.	1. Performs final check, if necessary. 2. Approves release of the bond liability.	1. Possible field inspection by Bureau of Land Management.	1. 30 days.

SOURCE: Surface Operating Standards for Oil and Gas Exploration and Development, Second Edition 1978.

FIGURE 1—10

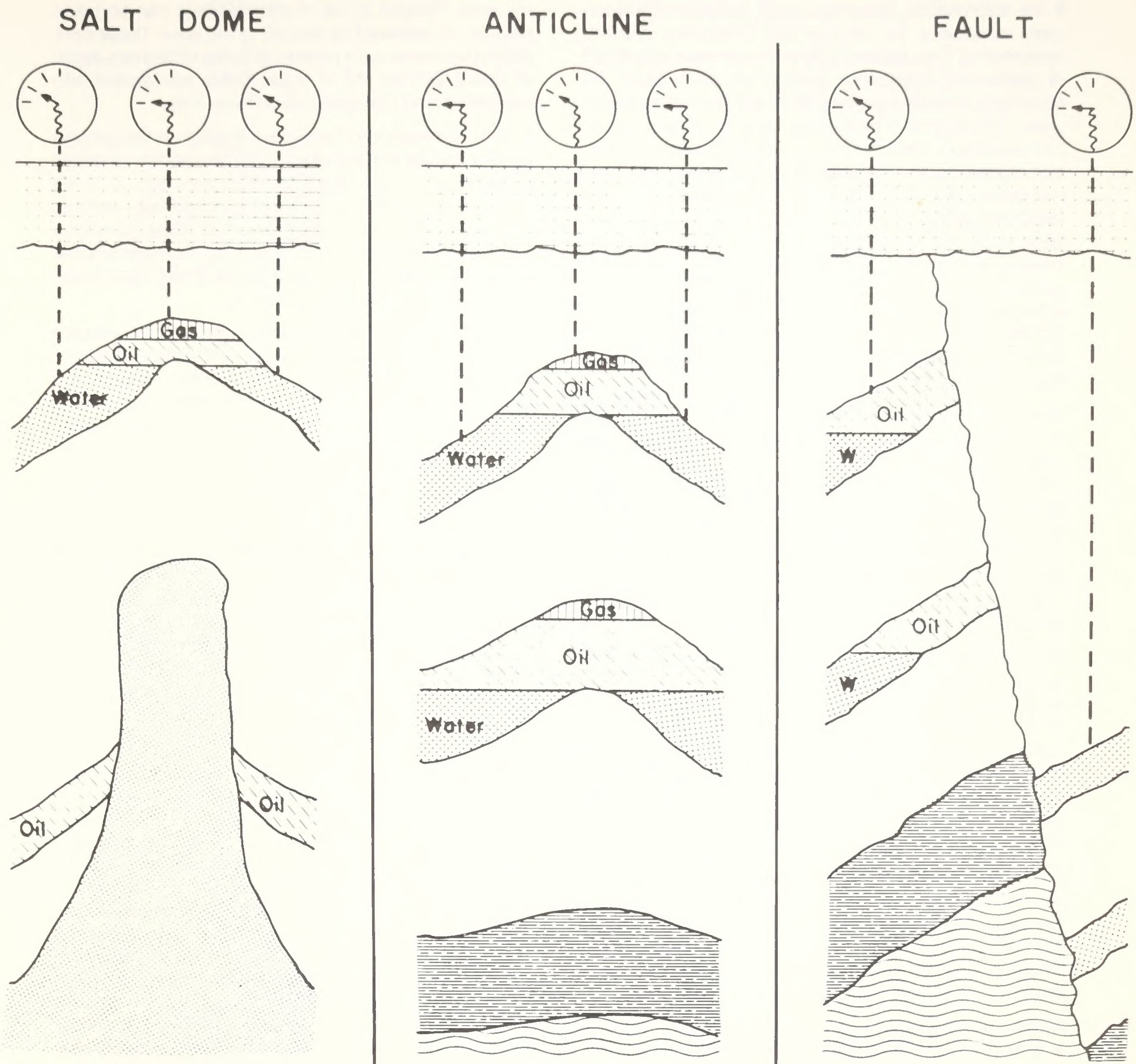
TYPICAL OIL AND GAS TRAPS



Source: U.S. Department of the Interior, Plain Facts about Oil, 1963.

FIGURE 1—11

GRAVIMETER



Gravity is slightly less over the salt dome because salt is lighter than the surrounding rocks.

Gravity is slightly stronger over the top of the anticline because the denser basement rocks are nearer the surface.

Gravity is slightly greater on the raised side of the fault because dense rock is closer to the surface there.

Source: U. S. Department of the Interior, Plain Facts about Oil, 1963.

If the information gathered is still indicative of structures conducive for oil and gas reservoirs, seismic prospecting may follow. A seismic survey is a method of gathering subsurface geological information by recording impulses from an artifically generated shock wave. The common procedure used in reflection seismic surveys on land consists of creating a shock wave, and recording; as a function of time, the resultant seismic energy as it arrives at a group of vibration detectors (seismometers) arrayed on the ground surface. Portions of the seismic energy reach the seismometers by several different routes. One portion spreads over the ground as a surface wave. Another travels along a subsurface layer and is refracted to the surface. A third travels downward until it reaches an abrupt change in lithology of rock characteristics and is then reflected back to the surface (Figure 1-12).

Seismic methods are usually described by the various methods of generating the shock wave. Seismograph units mounted on trucks are used to detect shock waves in the earth generated by thumpers, vibrators, or explosives. Ground vibrations are made by thumpers by dropping a steel slab weighing about three tons to the ground several times in succession along a predetermined line. The weight is attached by chains to a crane on a special truck. A typical thumper unit is shown in Figure 1-13.

The vibrator method is widely used and is replacing the explosive method. Typically, four large trucks are used, each equipped with a vibrator mounted between the front and back wheels (Figure 1-14). The vibrator pads (about four feet square) are lowered to the ground and vibrators on all trucks are triggered electronically from the recorder truck. After the information is recorded, the trucks move forward a short distance and the process is repeated.

Explosives have been widely used in the past to generate the seismic impulse or shock wave. Traditionally, the explosive charge is detonated at the bottom of a drill hole of 200 feet or less. Recently, however, techniques of detonating the explosives on the surface have been developed that give good results in some areas.

Subsurface charges are usually placed at the bottom of a 4 to 6 inch hole drilled with a truck-mounted drill. Access suitable to allow the drill and recording trucks to travel across the surface is required. Detonation of the charge in some areas causes no surface disturbance while in other areas a small crater (up to 6 feet in diameter) is created (Figure 1-15). Cuttings from the well are normally hauled to a suitable disposal site, scattered by hand near the "shot hole," or disposed of in the hole. Bentonite mud is often used to plug the surface of the shot hole.

Where access limitations, topography, or other restraints prevent use of truck mounted drill rigs or recording trucks, lightweight portable equipment can be used. Various kinds of portble drills can be backpacked or delivered by aircraft to the area. These portable operations use a pattern of holes drilled to a depth of about 25 feet. All of these holes are loaded with explosives and detonated simultaneously.

Surface charges can be placed directly on the ground surface, on the surface of snow, or on a variety of stakes or platforms. Paper cones, survey stakes, lath, or 2 x 4's up to 8 feet in length have been used with varying success in different areas. Use of tall stakes or explosives placed on the surface of two feet or more of snow results in good seismic data in some areas, while creating no visible surface disturbance.

The vibrations or waves traveling through the ground are recorded by seismographic units some distance away at several locations. The seismic sensors and energy source are located along lines on a one to two-mile grid. Existing roads are used if possible. Lines may require clearing of vegetation and loose rock to improve access for the trucks. Each mile of line cleared to a width of 8-14 feet represents disturbance of about an acre of land.

In remote areas where there is little known subsurface data, a series of short seismic lines may be required to determine the regional dip and strike of subsurface formations. After this, seismic lines will be aligned with these formations to make seismic interpretation more accurate. Although alignment may be fairly critical, spacing of the lines can often be changed up to a quarter of a mile on a one-mile grid, before the results will affect the investigation program.

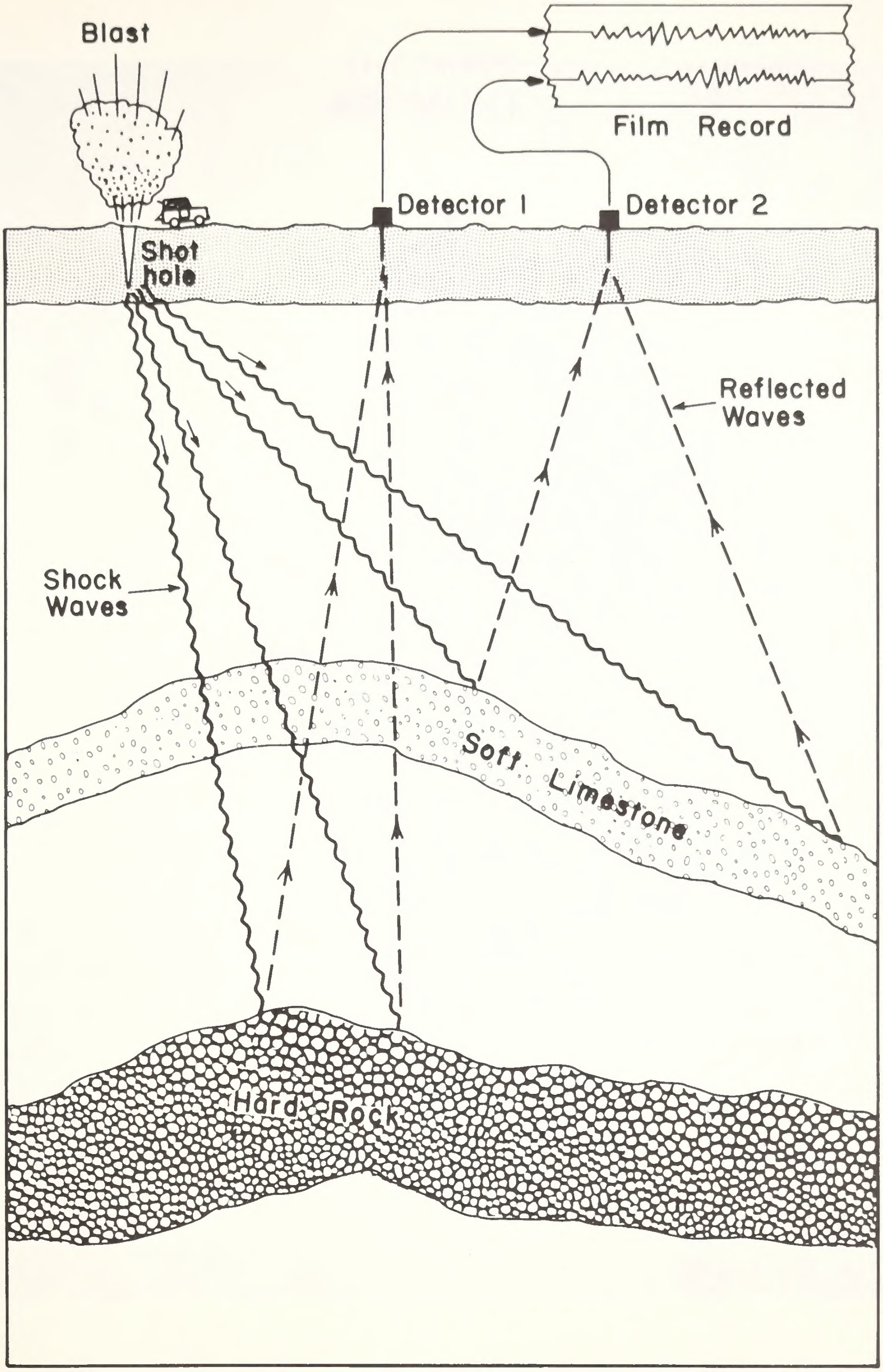
A network of low standard temporary roads and trails can result from this operation. Level topography with few trees and shrubs would require little or no road construction. An area with rugged topography and larger vegetative types such as trees and large shrubs would require more road preparations. Temporary roads and trails are usually constructed with bulldozers. The surface is cleared by removing vegetation and loose mineral material. Small streams and gullies are crossed by filling in the channel after placement of an appropriate culvert(s) or by dozing out the stream banks to provide a dip or gradual transition to enable equipment to cross. The alignment of these roads consists of straight lines, usually with little regard for gradient or steep slopes or rough terrain being traversed.

A typical seismic operation may use 10 to 15 men and five to seven trucks. Under normal conditions, three to five miles of line can be surveyed each day using the explosive method; five to ten miles are about average for a vibrator crew. The crews often work 70 to 80 hours a week in good weather.

If preliminary investigation on BLM lands does not result in significant impacts on the surface, the operator need not notify the district BLM office. However, if the investigation will create noticeable impacts (e.g., road

FIGURE 1–12

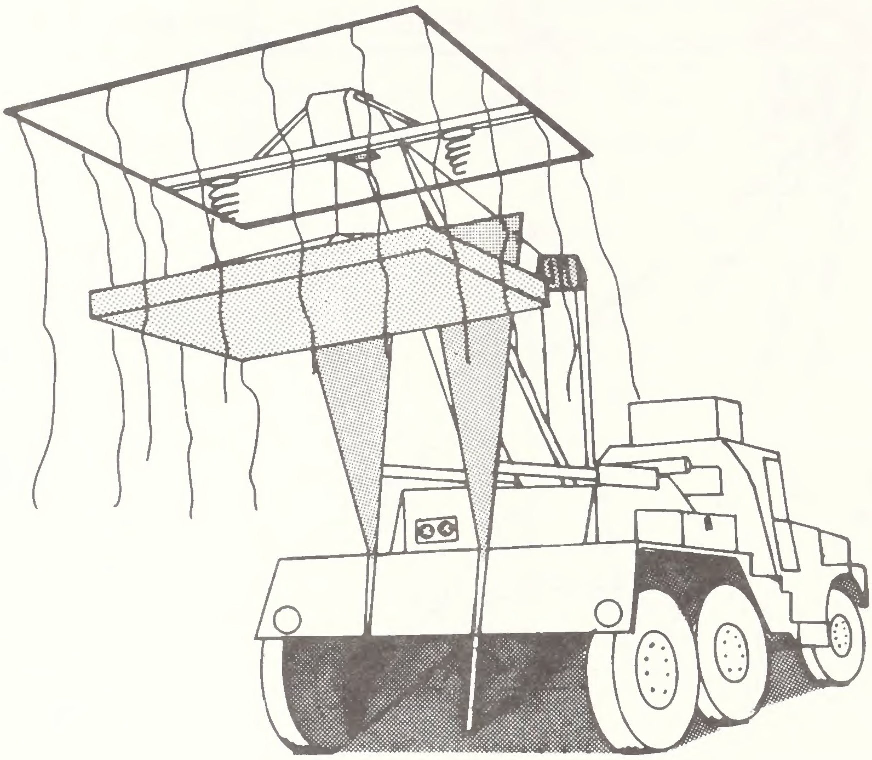
SEISMOGRAPH



Source: U.S. Department of the Interior, Plain Facts about Oil, 1963.

FIGURE 1–13

THUMPER



Thumper in action shows 6,000 pound steel slab, surrounded by safety chains to warn personnel, falling nine feet to strike earth and create shock waves. Weight-dropping aids the oil search as an effective economical substitute for dynamite in seismic operations.

Source: A Primer of Oilwell Drilling, University of Texas at Austin, 1976.

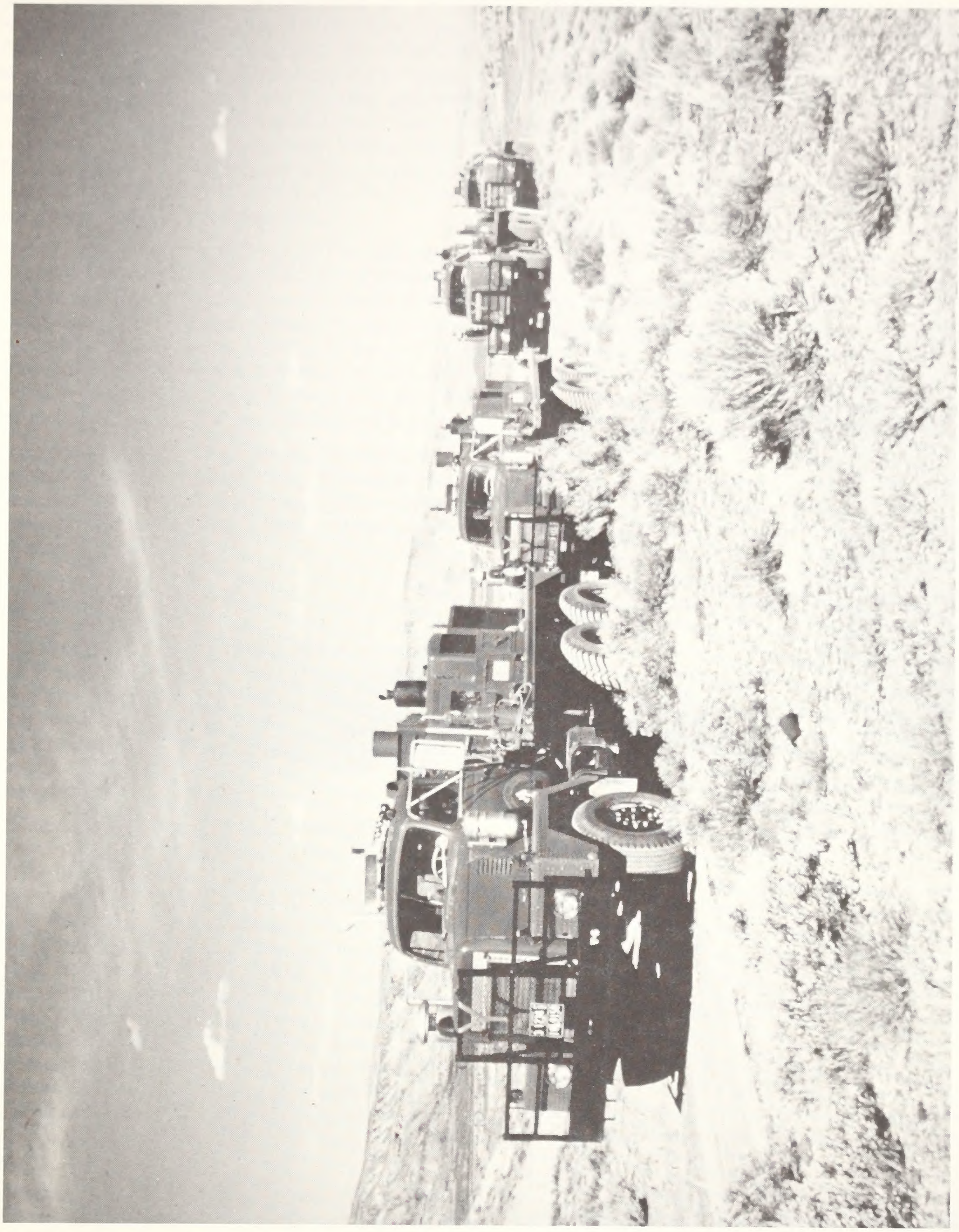


Figure 1-14
Vibrator Trucks During Seismic Operation
SOURCE: BLM

Figure 1-15
Shot Hole During Seismic Operation
SOURCE: BLM

construction or ground clearing), as it could in seismograph prospecting, the operator must be properly bonded and must file a Notice of Intent. Bonds may be in the form of a rider on existing nationwide or statewide oil and gas bonds. BLM personnel will then examine resource values in the area and stipulate appropriate surface protection and reclamation requirements. The operator notifies the district manager before entry onto the land. It should be noted that the U.S. Forest Service requires a Prospecting Permit for virtually any oil and gas activity on lands it administers.

During preliminary investigation, the operator will comply with the stipulations for surface protection and reclamation. The BLM is responsible for checking this compliance. The operator notifies the district of any proposed changes in his activity. At the end of the investigation, the operator files a notice of completion, the BLM makes a final inspection, and, if all requirements have been met, the operator's bond is released.

Since no statutory authorization is required for entry on the land, avoidance of adverse impacts is dependent on the cooperation of oil and gas exploration operators. However, rehabilitation of damage can be required by the government.

Exploratory Drilling

Drilling does not begin until a lease has been acquired by the operator. In cases where preliminary investigations are favorable and warrant further exploration, exploratory drilling may be justified. Figure 1-16 shows a typical exploratory rig working in prairie country. More precise data on the geologic structure is obtained by stratigraphic tests using shallow drill holes.

Additional subsurface information revealing the nature of near surface structural features may be obtained by drilling holes to depths of 2,000 to 3,000 feet or deeper. Drilling is accomplished primarily by rotary drill rigs. Rock chips and cuttings are brought to the surface from the bottom of the drill hole by high-pressure air flow or a flow of drilling mud. The chips and cuttings are collected, bagged, and identified as to depth of their origin. The chips are then examined to determine their composition and age, which helps to identify the formation and structure from which the chips originated. This kind of information will help the geologist find a marker zone or formation to correlate the previously obtained geologic and geophysical information to actual structures.

Temporary roads good enough to accommodate truck mounted drill rigs, water trucks, and other service equipment must be constructed. Where level, solid ground exists, little road construction is usually necessary. In hilly or mountainous areas, more road building would be necessary. Figure 1-17 shows an oil and gas access road in a mountainous area.

A space of about one-half acre or less is leveled and cleared of vegetation for the average drill site. If high pressure air is used to remove rock chips or rock cuttings, rock dust may be emitted to the air when samples are not being collected. If mud is used as a drilling fluid, mud pits may be excavated; more commonly, portable mud tanks are used. Usually, one to three days are required to drill the test holes.

Oil and gas are found in small spaces in porous rock somewhat like water in a sponge. It seeps slowly through the porous material until it is trapped by impervious rock, often appearing as a layer between water and gas. The preliminary exploration is done in an attempt to tentatively locate these traps. If preliminary exploration still indicates the possible existence of oil and gas, a "wildcat well" (i.e., a well drilled outside of a Known Geologic Structure) will be drilled into the suspected zone to determine if in fact the oil and/or gas are present and if its quality and quantity is adequate for profitable sale.

Nationally, approximately 1 out of every 16 wildcat wells produce significant amounts of oil or gas. Only 1 out of 140 wildcat wells produces enough to be financially successful. In recent years, success ratios for the three-state study area were considerably higher. During 1977, Montana's wildcat success rate was 25%, North Dakota's rate was 17%, and South Dakota's rate was 32%.

The depth of wildcat wells depends on the geology of an area. In the Williston Basin and Overthrust Belt areas, wells are commonly drilled to a depth of 10,000 feet or more. Drilling equipment could remain on this type of site for six months, while in other areas such as the northern part of Montana, shallower wells up to a few thousand feet are common and may be completed in a few weeks.

Prior to drilling, an area or drill pad must be cleared and leveled for drilling equipment. The well site, usually one to four acres, is cleared of all vegetation and graded nearly flat for the drilling rig, mud pumps, mud pit, generators, pipe rack, and tool house. Other facilities such as storage tanks for water and fuel are located nearby.

From 50,000 to 100,000 gallons of water a day may be needed for mixing drilling mud, cleaning equipment, cooling engines, etc. A surface pipeline may be laid to a stream or a water well, or the water may be trucked to the site.

A drilling rig may be moved from one site to the next after being dismantled. In some instances, rigs can be skidded short distances in level terrain which will shorten the tearing down and rigging up time. Moving a dismantled rig involves use of heavy trucking equipment for transportation and crews to erect the rig.

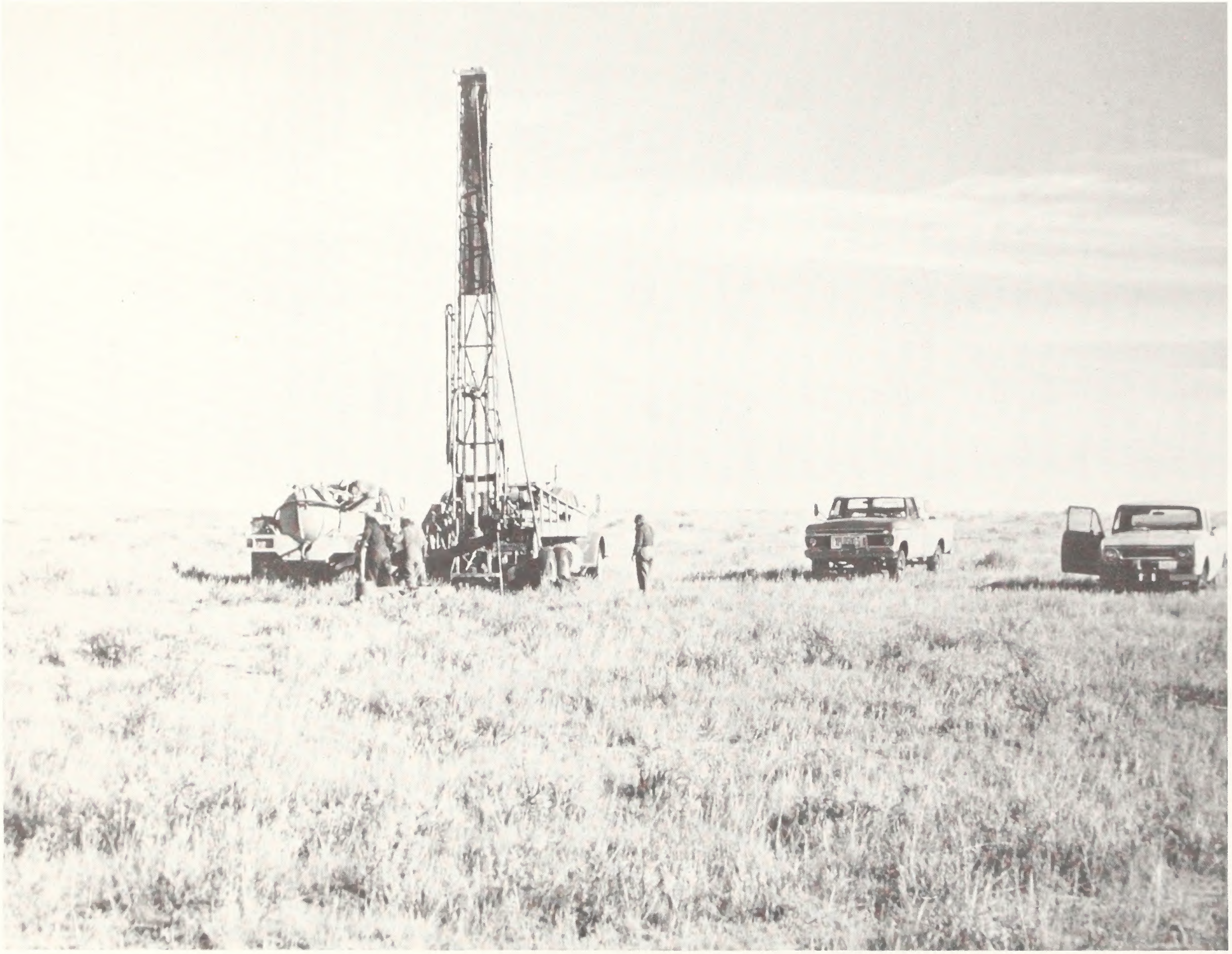


Figure 1-16
Exploration Drill Rig
SOURCE: BLM

Figure 1-17
Road Built During Exploratory Activity
SOURCE: BLM

In order to move a drilling rig from one drill site to another, temporary roads with a capacity sufficient to haul the drill rig, well service equipment, and to accommodate continuous traffic to and from the drill site are built (Figure 1-18). Time of year, topography, and duration of drilling activity are other factors which influence how the road is constructed.

Typically, a temporary road would not exceed 16 feet in width. In general, temporary roads should be designed for the minimum width needed for the activity. Turnouts, as shown in Figure 1-19, are made on single lane roads, blind curves, and approximately every 1,000 feet along the road. In hilly or mountainous areas, it may be necessary to cut and fill slopes. Cut slopes up to 3:1 (three feet horizontal and one foot vertical) and fill slopes of 2:1 are common. Construction of a road 16 feet wide would require approximately 1.9 acres per mile of road.

A single lane road with a ten foot wide running surface would require about 1.5 acres of surface per mile, plus road cuts and fills. In hilly and mountainous areas, the surface areas required for a road would increase depending on the topography and the number of cuts and fills. Bulldozers, maintainers, and other types of heavy construction equipment would be needed to construct and maintain temporary wildcat well roads. A part of this activity would include necessary culvert installation, setting of timbers, etc.

Drilling is started by "spudding in" the well; that is, starting the hole. Oftentimes, a short piece—10 to 12 feet—of conductor pipe is forced into the ground. Conductor pipe may be cemented by hand, driven into place using a piledriver, or it may be cemented in a hole drilled in the usual manner. The initial drilling usually proceeds rapidly and generally the string of surface casing is set before harder, deeper formations are encountered. The surface casing is a long length of steel pipe which is cemented into the well to protect against water or rock getting into the hole. It is smaller in diameter than the conductor pipe but large enough to allow subsequent lengths of casing to be set as the well is deepened. Also, surface casing provides for attachment of blowout preventers that are necessary in case a zone containing high-pressure gas, water, or oil is encountered. Without blowout protection, the contents of this zone could blow all the drilling mud out of the well (Figure 1-20).

During or at the completion of drilling, the well is logged. Logging involves the measuring of physical characteristics of the rock formations and associated fluids, with instruments lowered to the bottom of the well. As the equipment is raised to the surface, the instruments record various data from each formation of interest. After study of the well logs and drill stem test data, the geologist decides whether the well has encountered sufficient quantities of oil or gas in a pay zone to warrant completion of the well.

Completion requires installation of steel casing between the surface casing and the pay zone. The casing is selectively cemented, to provide stability and to protect specific zones, and then perforated adjacent to the suspected producing formation. If the formation produces oil or gas, the area is developed. If the formation does not produce, the well may either be extended to a greater depth or abandoned.

During 1977, 259 wildcat wells were drilled in the three-state study area. Other drilling activity was in known fields (KGSs).

Development

If a wildcat well becomes a "discovery" well (i.e., a well that yields commercial quantities of oil and gas), other wells are drilled to locate the boundaries of the field and to facilitate planning the best pattern of wells to drain the reservoir. As with wildcat wells, a field development will be staked and its exact location determined by surveyors, relative to land boundary lines and other geographic "fixes" tied into the geophysical surveys.

If the well is completed as a free-flowing well, the wellhead is simply closed off using a device known as a "Christmas tree" which consists of various valves and pressure regulators which are used to control oil or gas flow to facilities used in the production phase. If the well is a gas discovery, the operator is allowed to flare gas for a short period of time to determine capacity before shutting the well in or connecting the well to gas gathering pipelines.

Quite often, however, the producing zone will not have enough pressure to force the oil to the surface. In this situation, the oil must be pumped to the surface using "artificial lift" methods. When pump installation is complete, the well normally is tested for a period of days or months to determine whether the producing zone is adequate to support additional wells. More detailed seismic lines tying previous lines to the discovery well may be required. The discovery well may also be studied to draw upon previous seismic work and provide more accurate subsurface data.

A temporary well spacing pattern must be established before development drilling begins. Information considered in establishment of a spacing pattern includes data from the discovery well concerning porosity, permeability, pressure, composition, and depth of formations in the reservoir; well production rates and type (predominately oil, or predominately gas); and the economic effect of the proposed spacing on recovery.

Oil and gas well spacing, established by the state with concurrence from GS, can be from a few acres per well to a section or more. In general, well density for gas wells is much less than that for oil wells. Typically spacing restrictions require that gas wells be sited on 160 acres or more while oil wells can be sited on tracts

Figure 1-18

Temporary Road Built for Hauling Drilling Equipment from One Site to Another

SOURCE: BLM

FIGURE 1—19

TEMPORARY ROADS

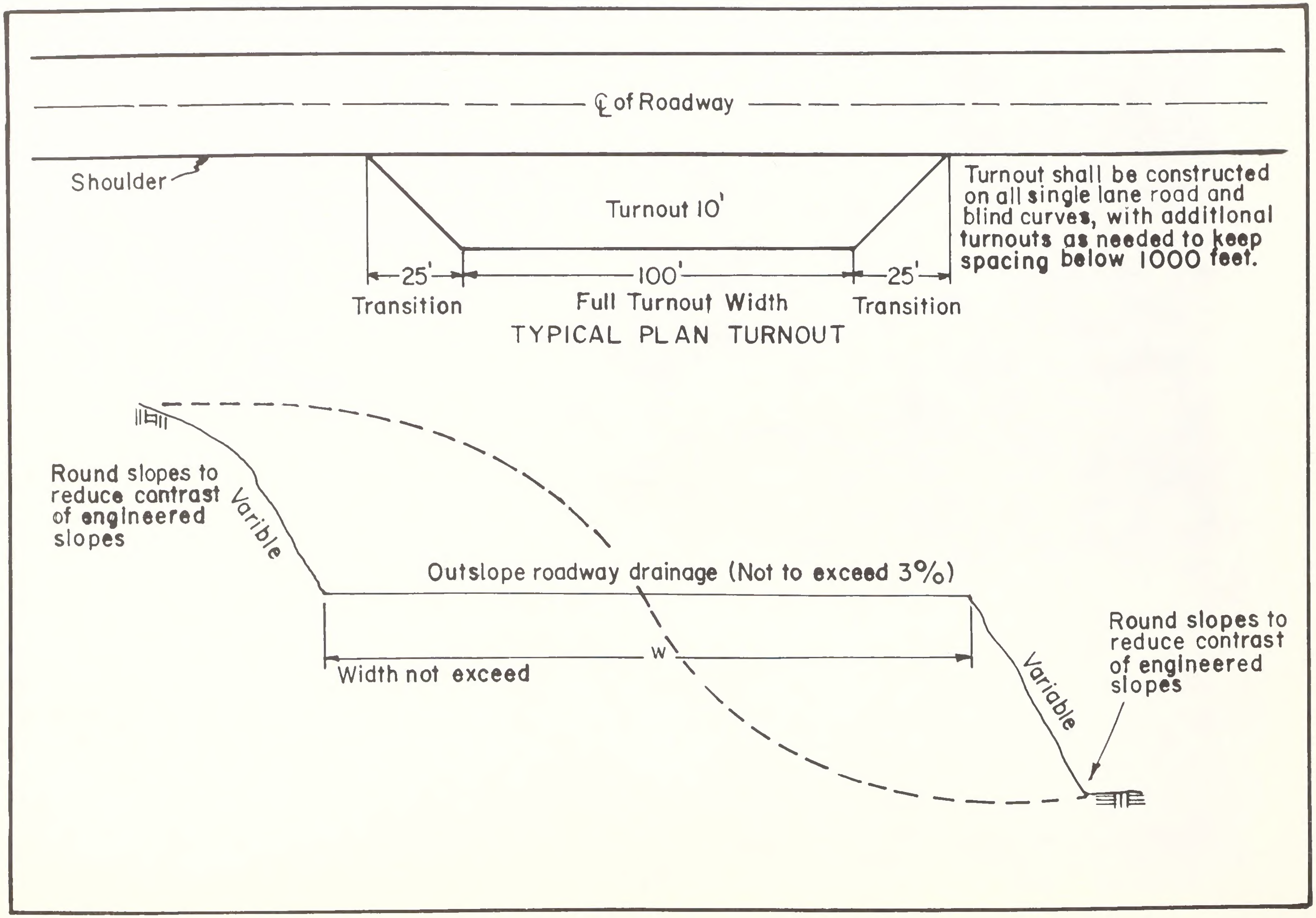
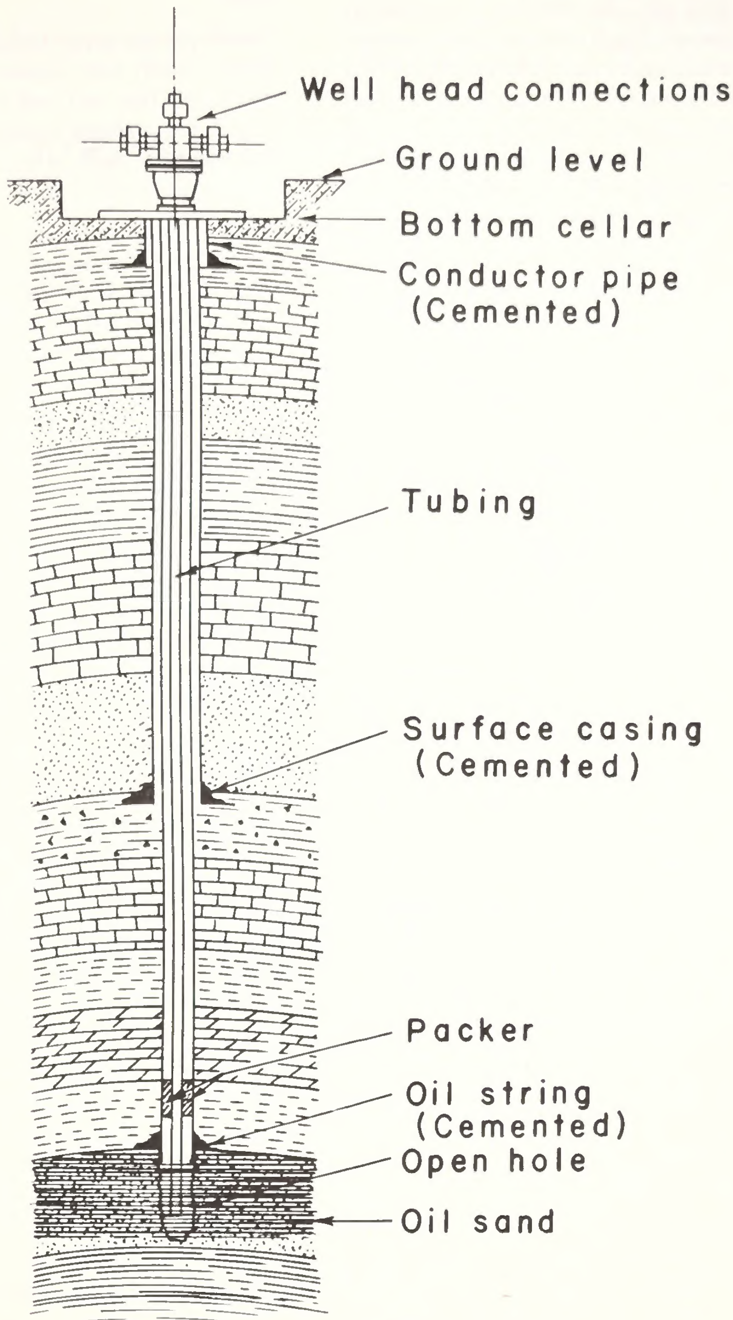


FIGURE 1—20

WELL CUTAWAY VIEW



Source: Primer of Oil & Gas Production,
American Petroleum Institute, 1978.

of 40 acres or more. This implies that, generally, a maximum of 16 oil wells or 4 gas wells can be located on one section (640 acres) of land.

Surface use in an oil and gas field also may be affected by unitization of the leaseholds. In many areas containing federal lands, an exploratory unit is formed before a wildcat is drilled. The boundary of the unit is based on geologic data. The developers "unitize" the field by entering into an agreement to develop and operate it as a unit, without regard to separate ownerships. Costs and benefits are allocated according to agreed terms.

Unitization reduces the surface-use requirements because all wells are operated as though on a single lease. Duplication of field processing facilities is minimized, because development and operations are planned and conducted by a single unit operator. Unitization may also involve wider spacing than otherwise, resulting in fewer wells and roads.

The rate at which development wells are drilled depends on such factors as whether the field is on a lease basis or unitized, the probability of profitable production, the availability of drilling equipment, protective drilling requirements, and the degree to which limits of the field are known.

Once well spacing has been approved, the operator plans development of the lease. The procedures for drilling development wells are about the same as those for wildcat wells, except that there is usually less subsurface sampling, testing, and evaluation. Surface uses for development drilling may include access roads, well sites, flowlines, storage tank batteries, facilities to separate oil, gas, and water, and injection wells for saltwater disposal.

Normally, access roads are limited to one main route to serve the lease area with a maintained road to each well. Typically, roads are constructed to standards shown in Figure 1-21. Upgrading of temporary roads may include ditching, draining, installation of culverts, gravelling, crowning, or capping the roadbed. Surface area needed for roads would be similar to temporary roads and also dependent on how level or hilly an area may be.

When an oil field is developed on the spacing pattern of 40 acres per well, the wells are approximately 1,320 feet apart in both north-south and east-west directions. If a section (a square mile) is developed with 16 wells, at least four miles of access roads are built. Although the size of most fields ranges from less than 1,000 acres to several thousand, a few major fields cover several townships. If a major field is discovered and developed on a 40-acre well spacing pattern, a township may have 576 wells and over 200 miles of road.

The most important factor in further development may be the quantity of production. If the discovery well has a large capacity and substantial reserves are indicated, development drilling may occur at a much slower pace. An evaluation period to observe production performance may follow between the drilling of successive wells.

Development on an individual lease basis may proceed more rapidly than under unitization, since each lessee must drill his own well to obtain production from the field. On a unitized basis, however, all owners within the participating area share in a well's production regardless of whose lease the well is on.

Drilling in an undeveloped part of a lease, to prevent drainage of petroleum to an offset well on an adjoining lease, is frequently required in fields of intermingled federal and privately-owned land. The terms of federal leases require such drilling or compensatory royalty if the offset well is on nonfederal lands, or on federal lands leased at a lower royalty rate.

Many fields go through several development phases. A field may be considered fully developed and produce for several years, then wells may be drilled to a deeper pay zone. Discovery of a new pay zone in an existing field is a "pool" discovery, as distinguished from a new field discovery. A pool discovery may lead to the drilling of additional wells—often from the same drilling pad as existing wells—with the bore holes separated only by feet or inches. Existing wells may also be drilled deeper.

Production

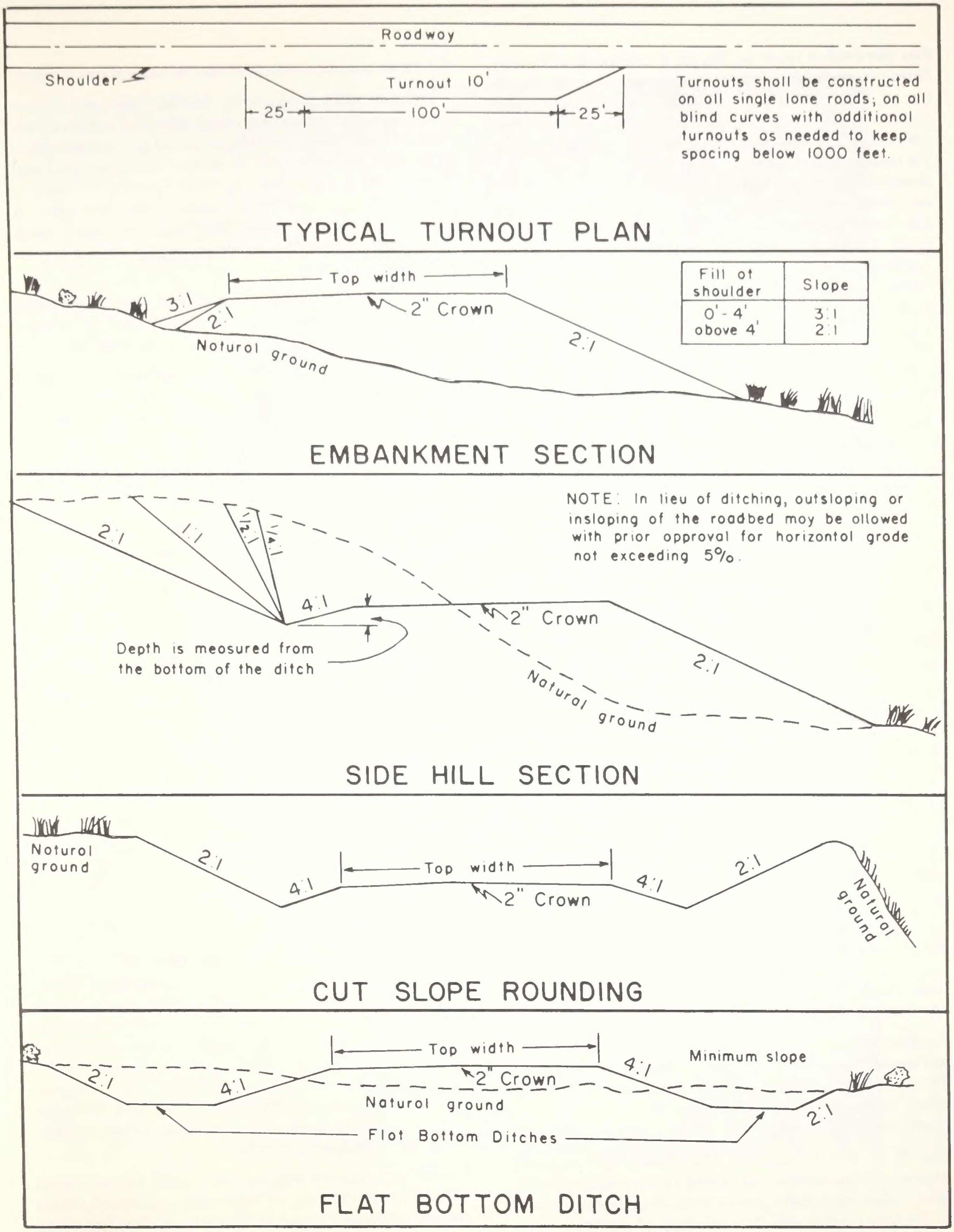
Production in an oil field begins soon after the discovery well is completed and often concurrently with development operations. Temporary facilities may be used at first, but as development proceeds and reservoir limits are learned, permanent facilities are installed. The extent of such facilities is dictated by the number of producing wells, expected production, volume of gas and water produced with the oil, the number of leases, and whether the field is to be developed on a unitized basis.

Production in a gas field does not begin until the pipeline to a market has been constructed. Sales pipelines are not justified until sufficient gas reserves are proved by drilling operations. Gas wells are often shut-in after completion for periods ranging from months to years until pipeline connections are available.

Some natural gas contains hydrogen sulfide which is a highly toxic and flammable gas. Presence of hydrogen sulfide in a formation can cause problems while drilling, as well as during production. High carbon steel, used for drilling and casing deep holes due to its high strength, will shatter like glass when exposed to high concentrations of hydrogen sulfide. Natural gas containing significant amounts of hydrogen sulfide is known as "sour gas." The hydrogen sulfide must be removed before the gas enters a commercial pipeline. If sour gas is produced in quantities insufficient to justify

FIGURE 1—21

TYPICAL ROAD SECTIONS



Source: Bureau of Land Management, 1977.

this removal, it must be flared. If combustion during flaring is complete, only sulfur dioxide is emitted into the air. If incomplete combustion occurs, other sulfur compounds including hydrogen sulfide are emitted into the air. Oil wells producig from formations containing hydrogen sulfide represent a hazard to personnel if dissolved hydrogen sulfide is present in the oil. Hydrogen sulfide smells like rotten eggs in low concentration, but prolonged exposure tends to dull the sense of smell. Hydrogen sulfide is heavier than air and will concentrate in low-lying areas and depressions. Under certain conditions, it can form an explosive mixture with air in concentrations over four percent by volume. Drill crews are aware of this problem and take precautionary measures to avoid this occurrence. Gas sweetening plants may be built to produce elemental sulfur from hydrogen sulfide in the natural gas.

Most wells in the three state study area require an artificial lift to bring the oil to the surface. Pumping and a technique known as "gas lift" are the two artificial lifts used. Naturally flowing wells and wells with gas lift facilities use a minimum of equipment at the surface and produce little or no sound. All surface pump systems require more surface equipment and make more noise than flowing wells and gas lift facilities.

Surface pumps are usually powered either by electric motors or internal combustion engines. Operators prefer electric motors because they make less noise, require less maintenance, involve less fire hazard, are more dependable, and can be more easily automated than internal combustion engines. However, internal combustion engines must be used in many oil fields where electric power is not available. If there is sufficient casing head gas (natural gas produced with the pumped oil), or another gas source is available, it may be used to fuel internal combustion engines. Butane and propane are also used as fuels. Single-cylinder engines operate at high noise levels, whereas multi-cylinder engines operate at lower noise levels.

Most existing wells in the three-state area have weak water pressure and require pumping. Both surface and subsurface (submersible) pumps are used; however, subsurface pumps are much less common. The horsehead pump (Figure 1-22) is most commonly used in the study area.

Surface units used with sucker rod pumps are fitted with guard rails, belt drive shields, and fences for safety. These pumps, as well as the accompanying tanks and other facilities, can be painted in earth tone colors to blend with the landscape.

Gas lift is used in some oil field where high pressure natural gas is available, and where pressure in the petroleum reservoir is sufficient to force the petroleum part of the way up the well. The addition of gas lowers the specific gravity of the petroleum so that it flows to the surface. However, this method will be used less in the future as supplies of high pressure natural gas decline.

Most gas wells produce by normal flow and do not require pumping. Surface use at a flowing well is usually limited to a 20-foot by 20-foot fenced area containing a gas well Christmas tree. If water enters a gas well and chokes off the gas flow, a pump may be installed to pump off the column of water. After the water is removed, the gas flows to the surface until water chokes it off again. Some gas wells may require almost continual water pumping.

Crude oil is usually transferred from wells to a central storage tank battery (Figure 1-23) before it is transported from the well site by truck or by pipeline.

Natural gas is often sold at the wellhead and transported directly off the lease. If processing is required to remove liquid hydrocarbons or water, however, the gas may be transferred to a central collection point prior to sale. On some leases, the production from several wells is piped to a central gathering station and then piped in a larger line to the storage batteries.

Pipelines used within the field are commonly from 4 to 6 inches in diameter between the well and gathering station. Pipelines between the gathering tanks and treating stations may be 4 to 8 inches in diameter. These pipelines may be buried without a protective coating in areas where soils are not corrosive. Briny water mixed with the oil can also corrode pipelines, causing them to wear out and develop leaks more rapidly. Such leaks are easier to detect and repair if the pipelines are placed on the surface rather than underground.

If the oil contains gas and water, they are separated before the oil is stored in the tank battery. The treating facilities are usually located at a storage tank battery (Figure 1-24).

Low pressure petroleum that must be pumped from the well is normally treated in a single separation; high-pressure flowing petroleum may require several stages of separation with a pressure reduction accompanying each stage.

If enough casinghead gas is separated in the field to make it economical to process it for marketing, a plant may be built to remove gasoline, butane, and propane. Some of the remaining gas is used to fuel the plant and the remainder is sold. If the volume of casinghead gas produced in a field is insufficient to warrant treatment in a gas plant, it is usually used as fuel for pump engines in the field and as heating fuel for oil treaters. If the gas exceeds fuel requirements on the lease, it may be flared or vented to the atmosphere.

If water is produced with the petroleum, it is separated before the gas is removed. In primary operations, where natural pressures or gravity cause the petroleum in the reservoir to flow to the wells, the degree of mixing usually is high enough to require chemical and heat treatment to separate the oil and water. Heat applied to

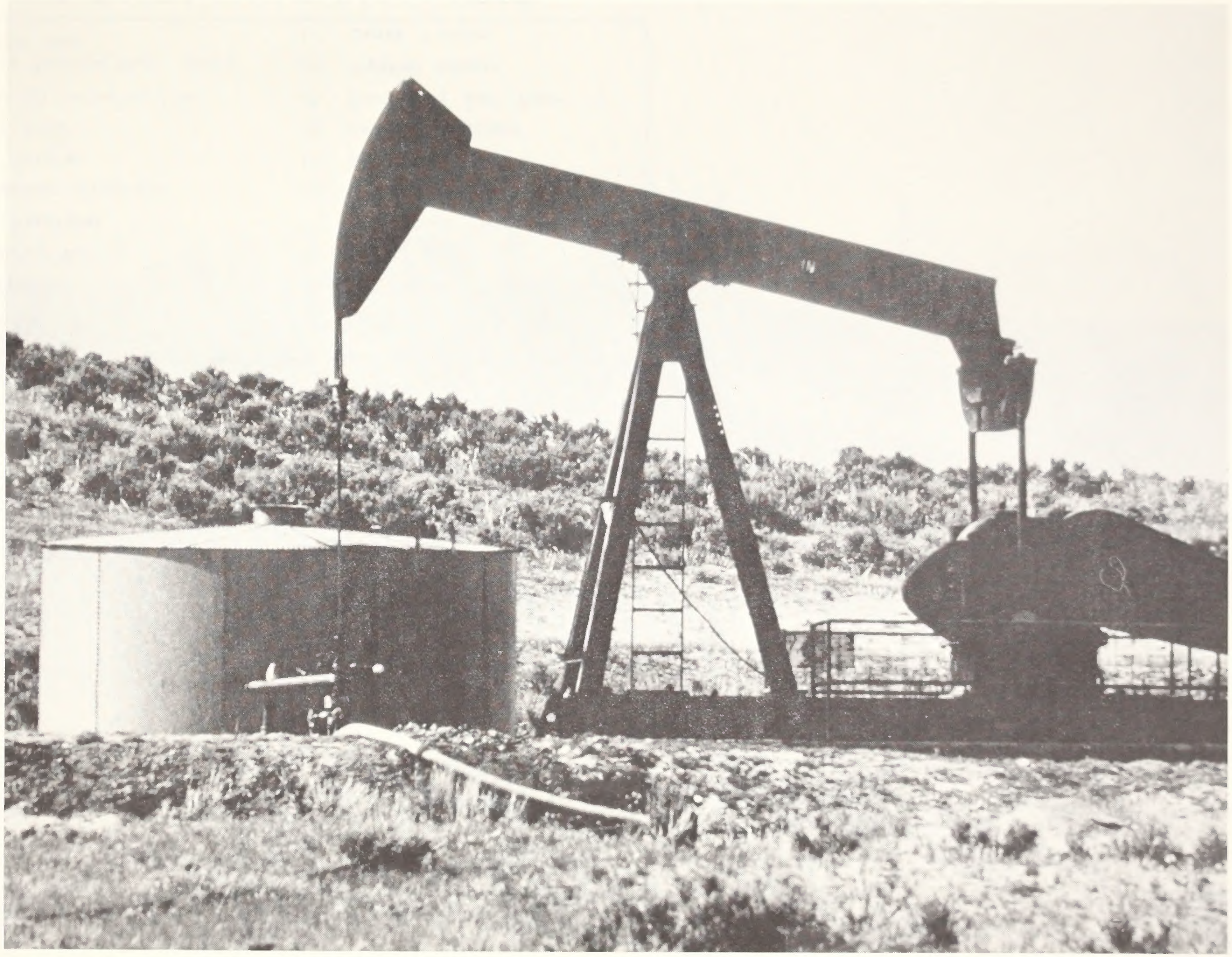
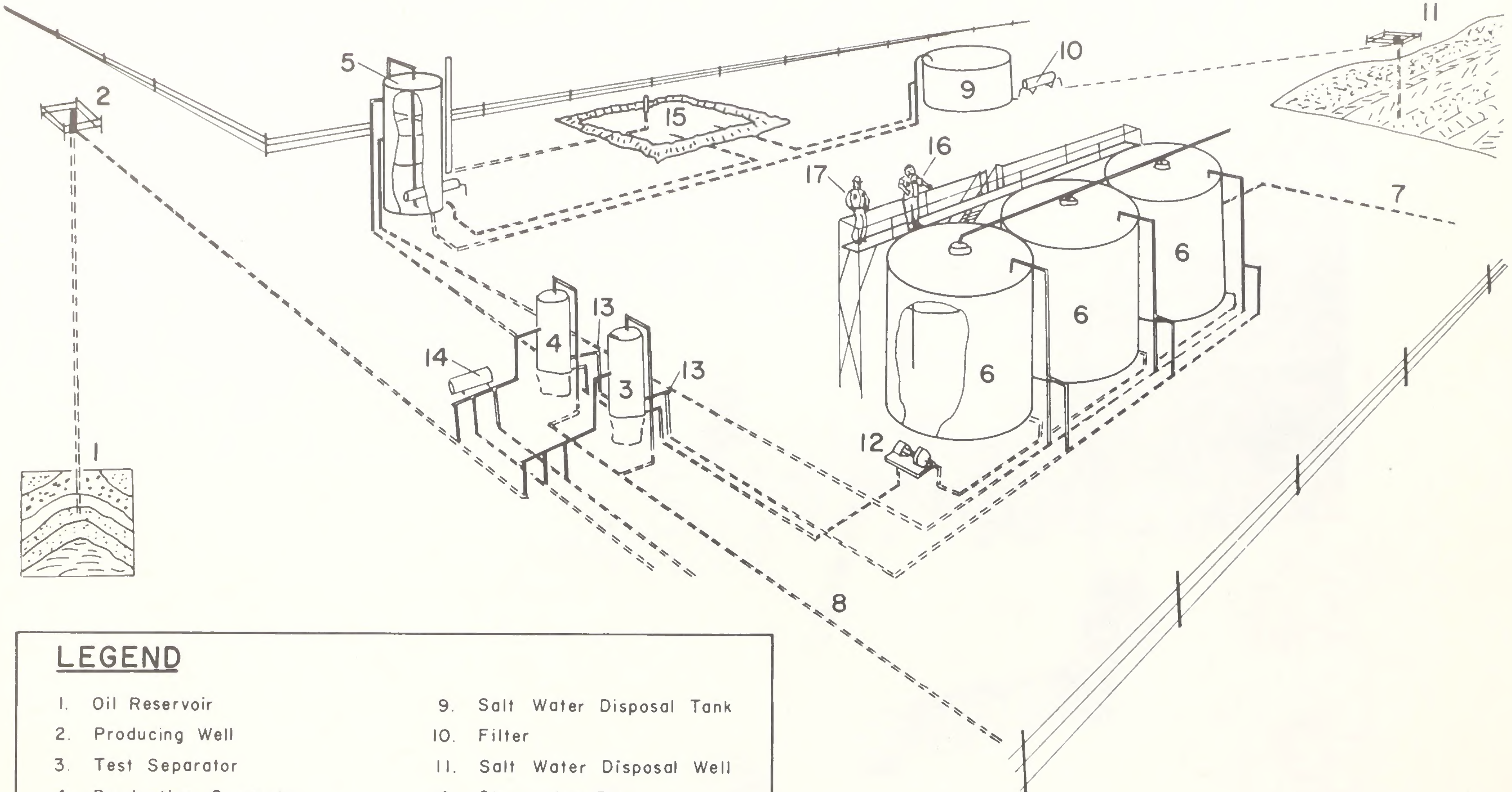


Figure 1-22
Horsehead Pump Used for Secondary Recovery
SOURCE: BLM

FIGURE 1—23

FLOWING OIL PRODUCTION



LEGEND

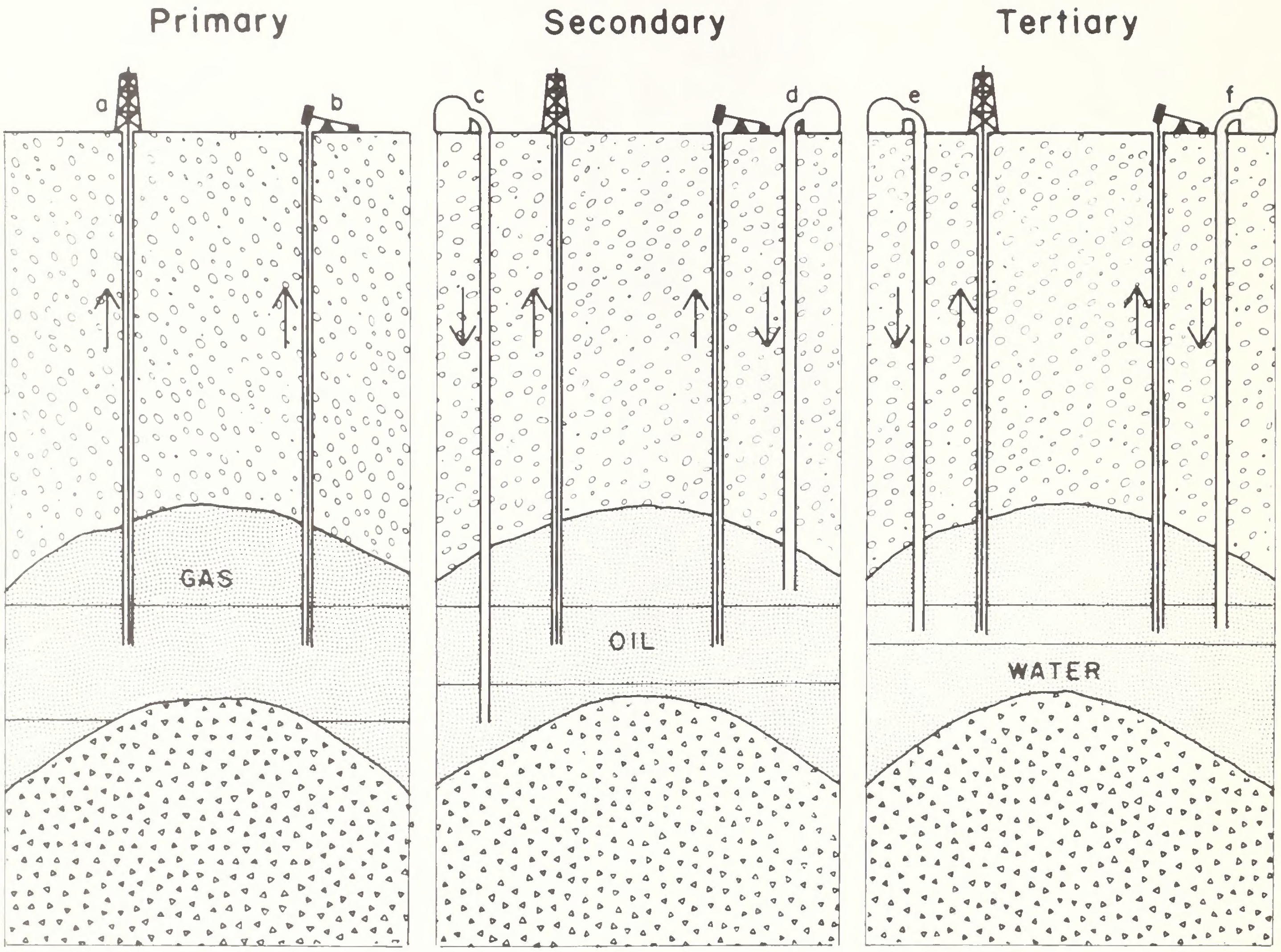
1. Oil Reservoir
2. Producing Well
3. Test Separator
4. Production Separator
5. Flow Treater
6. Stock Tank
7. Crude Oil Gathering Line
8. Gas to Gasoline Plant, Sales, or other uses
9. Salt Water Disposal Tank
10. Filter
11. Salt Water Disposal Well
12. Circulating Pump
13. Gas Meter
14. Chemical Injection
15. Emergency Salt Water Pit
16. Pipeline Gauger
17. Lease Pumper

Source: U. S. Department of Interior, 1963.

Figure 1-24
Oil Treatment Facilities Surrounding Storage Tanks
SOURCE: BLM

FIGURE 1—25

METHODS OF OIL RECOVERY

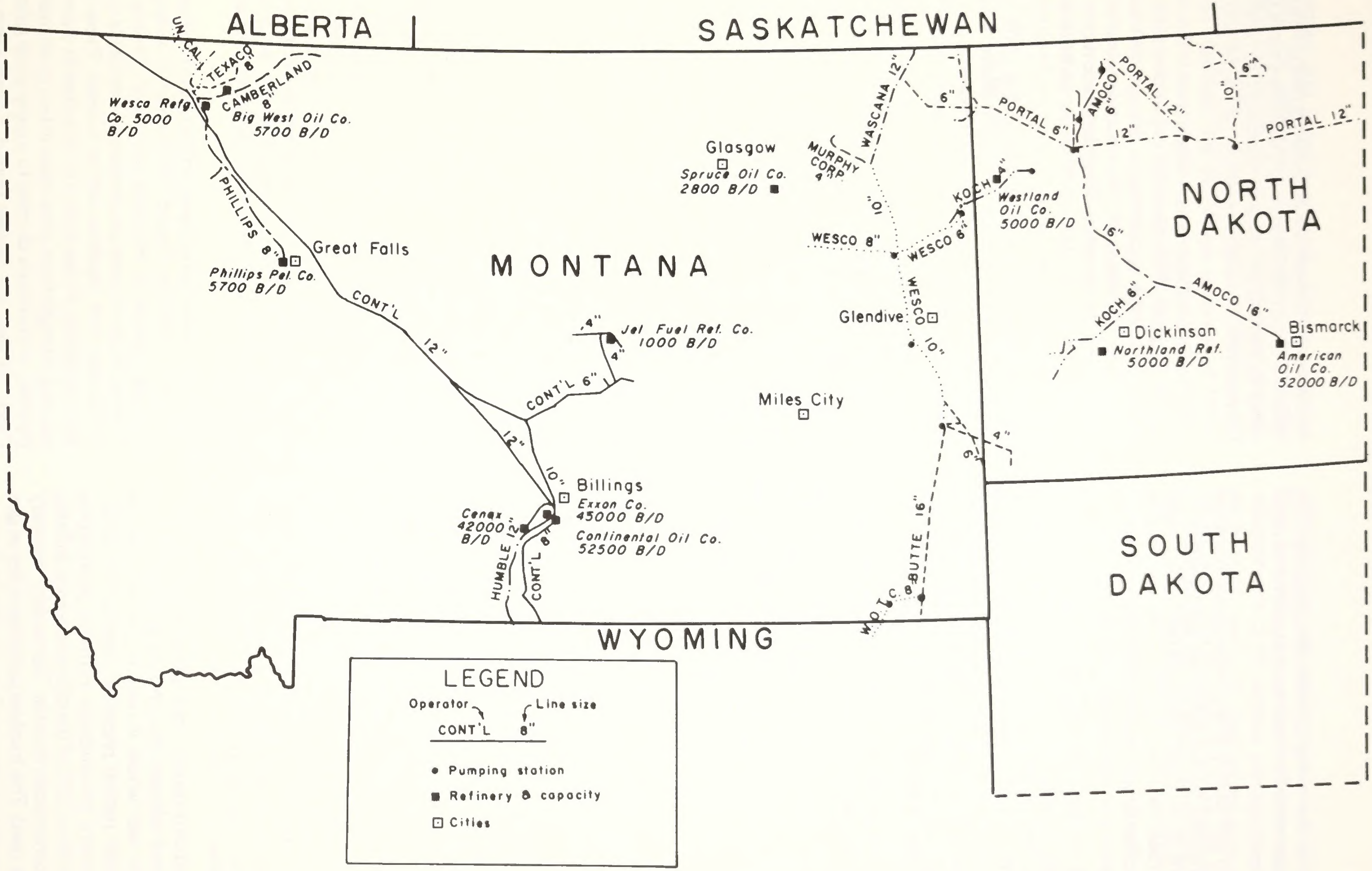


Oil is generally found under pressure in porous rock, often in a geological structure such as the one shown here. Drilling a well into the oil-bearing stratum releases the pressure, and in primary production the oil flows to the surface (a) or is pumped out (b). When the natural pressure is too low to bring the oil to the well, secondary recovery may be achieved by pumping water (c) or gas (d) into the field to increase the pressure. In tertiary recovery the oil's viscosity is lowered by injecting steam, which heats it (e), or by injecting a chemical (f).

Source: Scientific American, vol. 238, no. 38, March 1978.

FIGURE 1—26

MAJOR CRUDE OIL PIPELINE SYSTEM—1976



Source: Western Oil Reporter, July, 1976.

the bottom of the treaters breaks the emulsion. The heat is supplemented in most cases by chemical emulsion breakers.

In secondary production, where water injection or other methods are used to force additional petroleum to the well bore, the oil and water often are not highly emulsified. In this case, the oil and water may be separated by gravity in a tall settling tank. Water injection may require additional wells and maintenance roads.

After the oil and water are separated, the oil is piped to storage tanks located on or near the lease. There are normally at least two tanks so that at least one tank can be filled as the contents of the other are measured, sold, and transported. The number and size of tanks vary with the rate of production on the lease, and with the extent of automation in gauging the volume and sampling the quality of the tank's contents.

Although most produced waters are brackish to highly saline, some are fresh enough for beneficial use. In the past, ranchers have filed claims on oil field water so they can use it for agricultural or livestock purposes. Montana, North Dakota, and South Dakota law require that disposal permits be obtained from the Department of Health and Environmental Sciences, Department of Health, and Department of Environmental Protection, respectively. The discharged water must meet certain water quality standards.

Because water may not come from heater-treaters completely free of oil, oil skimmer pits may be established between separating facilities and surface discharge.

When salt water is disposed of underground, it is usually introduced into a formation containing water of equal or poorer quality. It may be injected into the producing zone from which it came or into other producing zones. In some cases, this stimulates oil production. In other cases, it could reduce the field's productivity and may be prohibited by state regulation or mutual agreement of the operators.

In some fields, dry holes or depleted producing wells are used for salt water disposal; occasionally, new wells are drilled for disposal purposes. Cement is squeezed between the casing and sides of the well to prevent the salt water from migrating up or down from the injection zone into other formations.

Underground oil is usually under pressure. Drilling into the oil reservoir releases the pressure and allows oil to flow into the well where it rises to the surface. Oil recovery under natural pressure conditions is considered "primary" production. Primary production accounts for about 25% of the oil in a reservoir. In fields where it is economically feasible, "secondary" recovery methods are used. This involves pumping water or gas into the reservoir to increase oil production by increasing the pressure in the reservoir. "Tertiary" recovery methods can sometimes increase recovery rates if the viscosity of the oil is lowered so that it flows more easily either by heating the oil or by injecting chemicals into the reservoir. Heating of reservoir oil can be accomplished by injecting steam into the reservoir. Tertiary recovery methods are not yet widely used in this country. By the year 2000, reservoir production from any given oil reservoir is expected to average 40% nationally. Figure 1-25 shows primary, secondary, and tertiary methods of oil recovery. Secondary recovery is currently used in 103 (about 50%) of the oil fields in the three-state study area.

Waterflooding is the method used in about 90% of the three-state area's secondary recovery efforts. Water is injected into the reservoir to increase reservoir pressure and drive additional oil to the surface.

The water supply is usually a brine obtained by drilling in the waterflood area. Fresh water is not desirable for waterflood purposes because it may form chemical bonds with clays in some reservoir rocks and reduce the permeability of the reservoir formation. When fresh water is used, the amount is not large (50 to 10,000 gallons a day) when compared to other uses of fresh water such as agricultural irrigation. About 93 fields in the three-state area are injecting water for secondary recovery purposes.

In some cases, formation fracturing is utilized. This is a method of stimulating production by increasing the permeability of the producing formation. Under extremely high hydraulic pressure, a fluid (such as water, oil, alcohol, dilute hydrochloric acid, liquefied petroleum gas, or foam) is pumped downward through tubing or drill pipe and forced into the perforations in the casing. The fluid enters the formation and parts or fractures it. Sand grains, aluminum pellets, glass beads, or similar materials are carried in suspension by the fluid into the fractures. These are called propping agents or proppants. When the pressure is released at the surface, the fracturing fluid returns to the well, and the fractures partially close on the proppants, leaving channels for oil to flow through them to the well. This process is often called a frac job. In most cases, this procedure requires significantly more land disturbance associated with preparing the drilling area because of the additional tanks and pumps required for the fracturing process.

Pipelines are needed to transport the oil from gathering stations to refineries. Figure 1-26 shows the existing oil pipeline network in Montana and North Dakota. As existing fields increase production or new fields begin production, new pipelines will be needed. These new lines would vary in size from 4 to 16 inches in diameter ranging in length from a few miles to tie into an existing pipeline, or hundreds of miles to supply an oil refinery. Crude oil lines are usually buried. Construction of a pipeline requires excavating and hauling equipment, temporary and permanent roads, pumping stations, clearing the right-of-way of vegetation, and possibly blasting. Figure 1-27 shows a typical pipeline construction spread while Figure 1-28 shows the laying out of pipe along the proposed route.

Pipelines for natural gas also would be needed to transport the gas from gas fields to the market place. Figure 1-29 shows the existing natural gas pipeline system in the three-state area. As with oil pipelines, the diameter and length would vary. Compressor stations may be necessary to increase production pressure to the same level as pipeline pressure and to maintain pipeline pressure. Construction techniques for natural gas lines are similar to those used for oil pipelines.

Abandonment

Well plugging requirements vary with the rock formations, subsurface water, and the well. Generally, however, the hole is filled with heavy drilling mud to the bottom of the cemented casing. A cement plug is installed at the bottom of the casing, the casing is filled with heavy mud, and a cement cap is installed on top. A pipe is required as a monument, giving location and name of well unless the requirement is waived by GS. If waived, the casing may be cut off and capped below ground level. Protection of aquifers and known oil and gas producing formations may require placement of additional cement plugs.

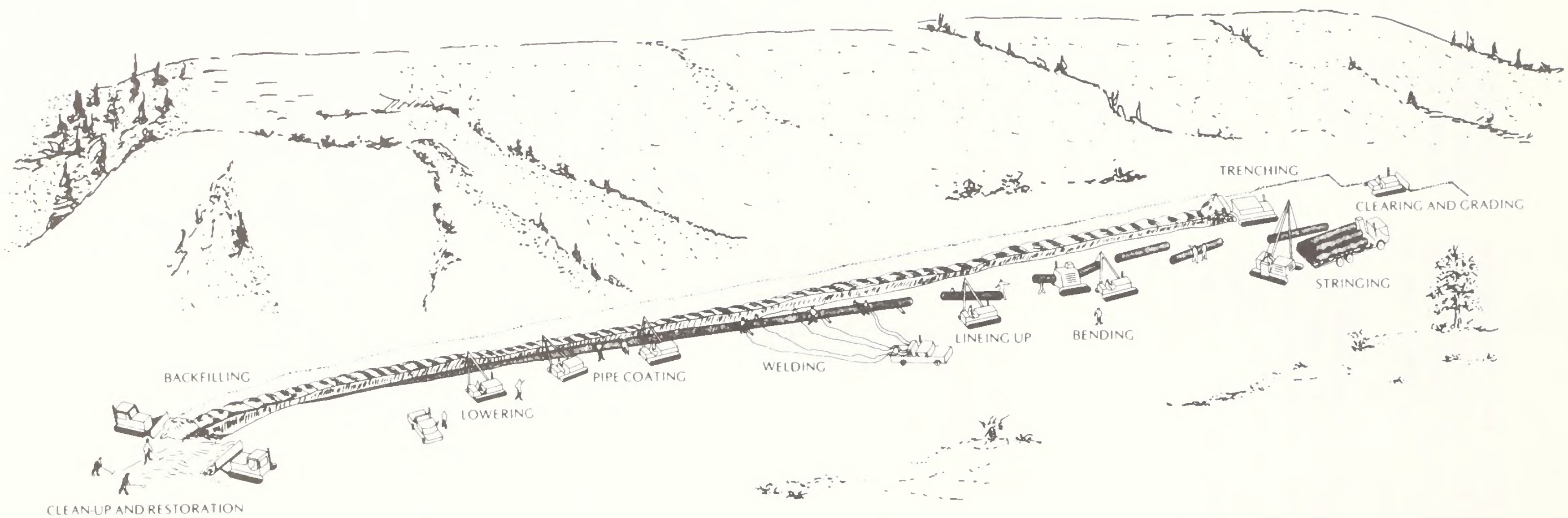
After plugging, the drilling rig is removed and the surface, including the reserve mudpit, is restored to the requirements of the surface management agency. In some cases, wells are plugged as soon as they are depleted. In others, depleted wells are not plugged immediately but are allowed to stand idle for possible later use in a secondary recovery program.

Truck-mounted equipment is used to plug former producing wells. In addition to the measures required for a dry hole, plugging of a depleted producing well requires a cement plug in the perforated section in the producing zone. If the casing is salvaged, a cement plug is put across the casing stub. The cement pumpjack foundations are removed or buried below ground level. When an entire lease is abandoned, the separators, treaters, and other processing and handling equipment are removed and the surface restored using topsoil which was stored when the site was leveled. Surface flow and injection lines are removed but buried lines are usually left in place and plugged at intervals as a safety measure.

Appendix 1-1 presents additional information and assumptions pertaining to the physical characteristics of an "average" drilling operation in Montana and the Dakotas.

FIGURE 1—27

TYPICAL PIPELINE CONSTRUCTION PROCEDURES



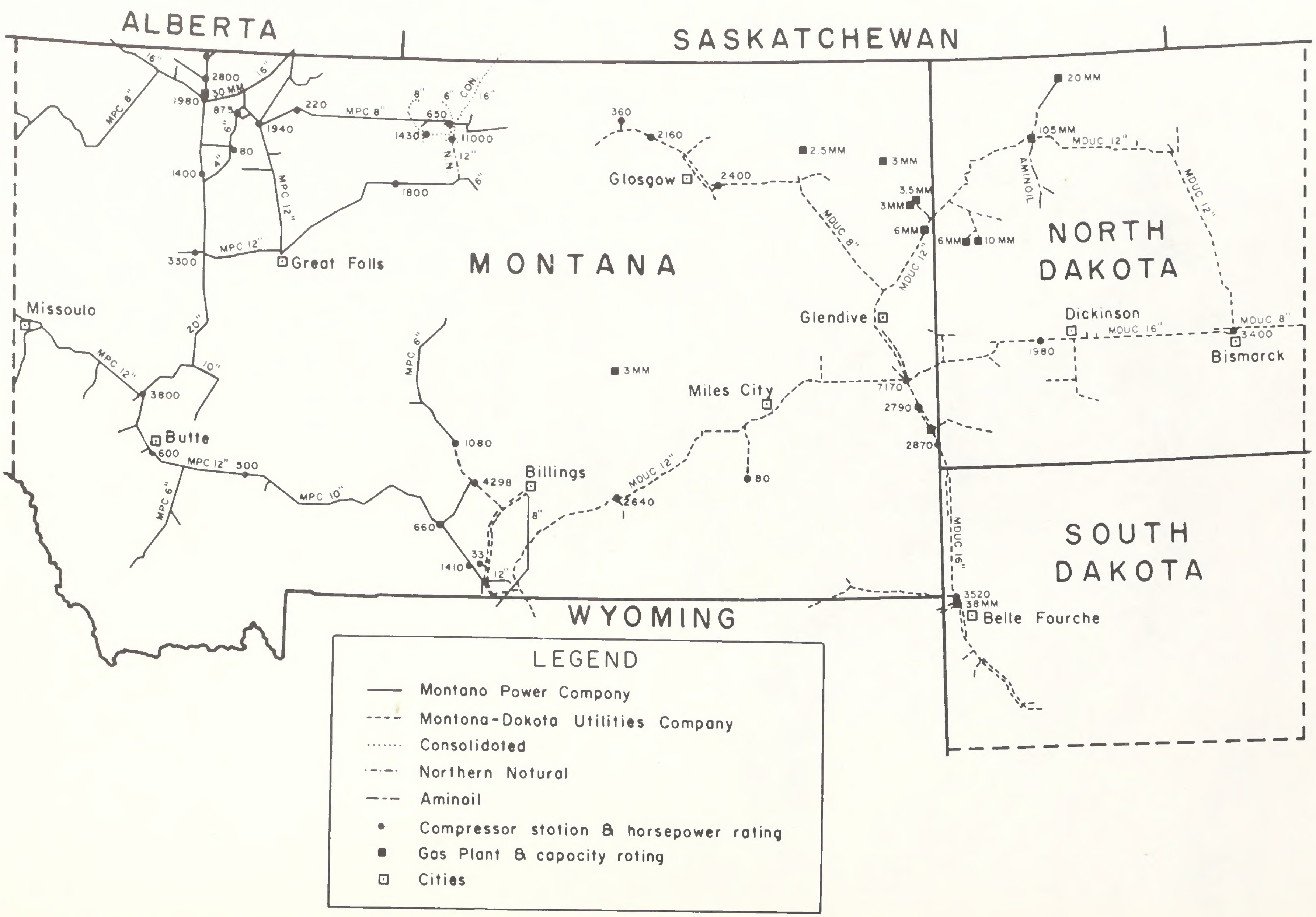
SOURCE: Modified From American Natural Gas Co., ANG Coal Gasification Co. 1977

CHAPTER 2

Figure 1-28
Oil Pipeline Route Awaiting Assembly and Burial
SOURCE: BLM

FIGURE 1—29

MAJOR NATURAL GAS PIPELINE SYSTEM—1976



Source: Western Oil Reporter, February, 1977.

CHAPTER 2
ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

In this assessment the entire state of North Dakota is analyzed for potential impacts from continuation of oil and gas leasing by the Bureau of Land Management; however, the emphasis is on the counties where oil and gas development has occurred.

Because it is impossible to determine in advance where new oil and gas discoveries will occur, for this assessment it is assumed that each oil and gas lease issued by the BLM will result in eventual development and production. Historically, in North Dakota less than 10 percent of BLM leases have reached the production phase.

There is currently a boom in oil and gas activity in the North Dakota Williston Basin. The activity in North Dakota began increasing in 1972 and reached boom proportions in 1978.

Crude oil production in North Dakota peaked in 1966 at 27,126,243 barrels, but it was followed by a steady decline from 1966 through 1974. However, production recovered in 1975 and increased to approximately 25 million barrels in 1978. Production has been restricted since 1976 by action of the North Dakota Industrial Commission to restrict production in wells where flared gas (natural gas being burned) is significant. It is likely that production will increase in the future, as new discoveries and their developments are put on line and the associated gas is made available for consumer use.

During 1978, 350 wells were drilled, totalling 2,500,000 feet and averaging 7,143 feet in depth. The success rate in wildcat areas was 33 percent in 1979. The success rate for development drilling was 89 percent. The overall success rate for all drilling was 69 percent.

Because of the increasing demand for domestic energy sources, it is anticipated that drilling will increase.

2.1 IMPACT SUMMARY

The following summary, broken down into environmental components, presents the most significant impacts that would result from the proposed action occurring within the Dickinson District. The components are arranged in the following order: geology, soils, topography, vegetation, water, animals, recreation, wilderness, visual resource management, cultural resources, economic conditions, social conditions, and land use. The reader is urged to consult the environmental impact assessment that follows for a more specific description of environmental sensitivities.

Climate and Air Quality

Impacts on air quality result from every phase of oil and gas development. Generally these impacts occur on a localized scale.

Geology

Impacts could occur on paleontological resources within the study area from the full range of the surface disturbing activities of petroleum exploration and development. These activities could also conflict with the development of other minerals, primarily coal.

Soils

Erosion and compacting are the most significant impacts on the soil resource caused by oil and gas activity. The degree of severity of these impacts depends on such factors as slope, rainfall, inherent soil characteristics, and vegetative cover. Soil productivity would be lessened by erosion and compaction.

Topography

No significant impacts are expected.

Vegetation

All phases of oil and gas activities would cause some destruction of plant cover. The degree and extent of site-specific impacts would be determined by slope, climatic conditions, soils, and vegetative types.

Water

Exploration activity may have some effect on local water wells. Oil and gas development may cause excess amounts of sediment or oil in surface waters. Ground water may be impacted in either quantity or quality. Special hazards would occur if developments are located on floodplains of the larger streams during the high water season.

Animals

Most phases of oil and gas activities would degrade or destroy wildlife habitat and domestic livestock forage by devegetation, resulting in decreased reproduction capacity and populations. Development facilities and human presence would cause specific wildlife species to vacate habitats. Critical habitats such as aquatic environs, winter ranges and nesting areas would be most severely damaged.

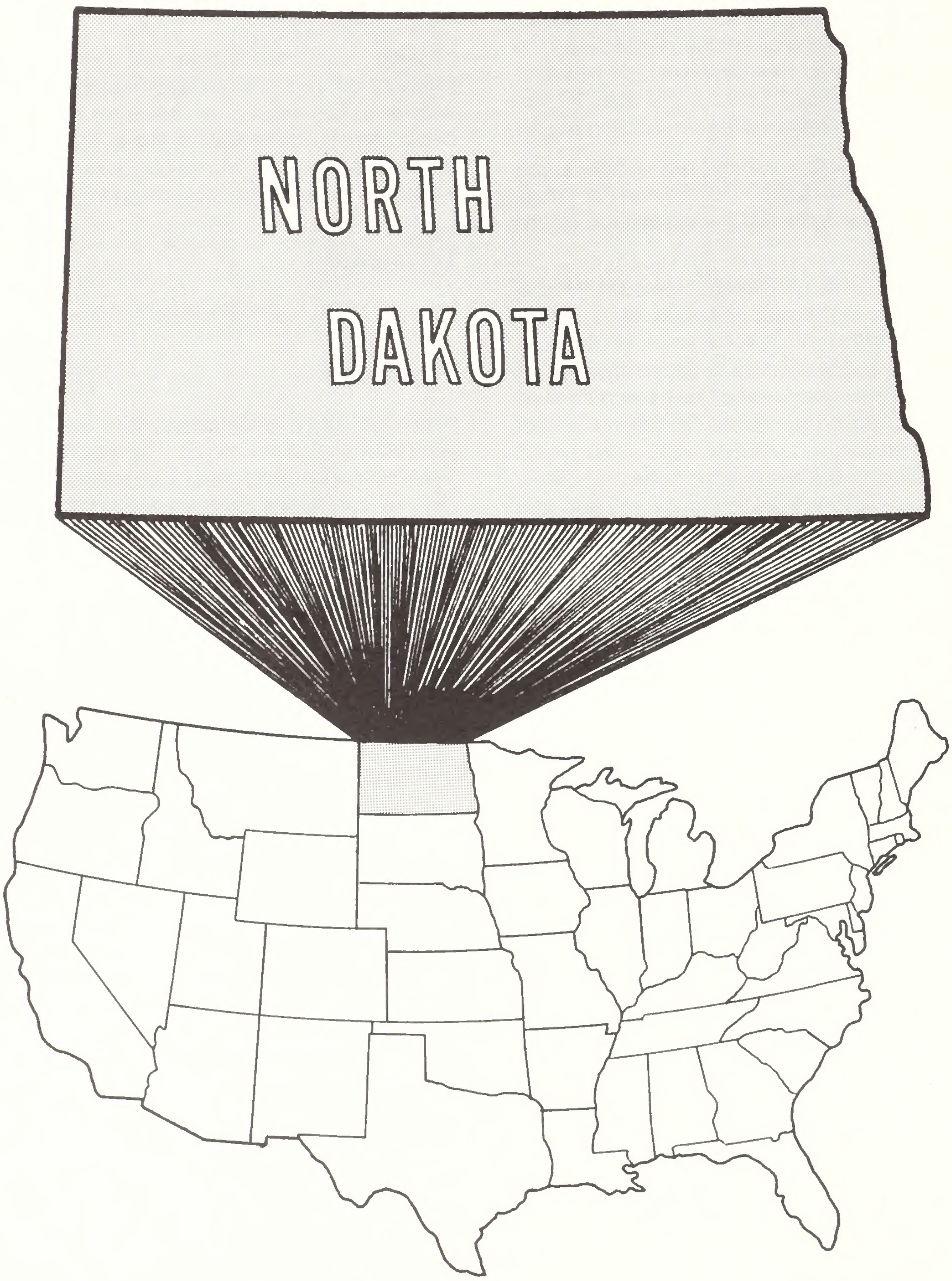
Recreation

The growth of the oil and gas work force is expected to increase pressure on public recreation facilities in western North Dakota. Development facilities would exclude some recreation from selected areas. New roads, required for development, would increase human access to isolated habitats.

FIGURE 2-1

LOCATION MAP

OIL AND GAS ENVIRONMENTAL ASSESSMENT



Visual Resource Management

Impacts would occur primarily in the long term. The breaks, badlands, Killdeer Mountains, buttes, and ponderosa pine forest areas are those most likely to be impacted. The field development phase, which includes the construction of pipelines and roads, would generate the greatest impacts.

Cultural Resources

Major impacts to cultural resources could include loss of spatial association of artifacts and the destruction of the artifacts themselves, particularly in areas of known high site density.

Economic Conditions

Economic impact would center around population growth in communities which do not have excess housing and services (schools, sewage treatment, water supply, etc.) capacity. Peak impacts would occur during the labor intensive development phase, which lasts approximately two to four years.

Social Conditions

The primary social effects resulting from the proposed action of continuing BLM oil and gas leasing would originate with the inmigration of people into the areas where exploration, development, and production is occurring or anticipated. In North Dakota, this is a 17 county area consisting of Adams, Billings, Bottineau, Bowman, Burke, Burleigh, Divide, Dunn, Golden Valley, Hettinger, McKenzie, Mountrail, Renville, Slope, Stark, Ward, and Williams counties. The anticipated oil and gas activity is expected to be most intense in Billings, Burke, Bottineau, Bowman, Dunn, Golden Valley, McKenzie, Mountrail, Renville, Stark, and Williams counties.

Some communities in the intense development area—such as Medora (Billings County), Bowbells (Burke County), Killdeer (Dunn County), and Watford City (McKenzie County)—could find it quite difficult to provide additional services should the need arise. It is in communities such as these that an expansion of services might depend largely on federal aid programs to meet new demands.

Those infrastructures most likely to be affected would be housing, education, health care facilities, police, fire, water and sewage services, and possibly transportation. To what degree each infrastructure would be affected would depend largely on four things: (1) the availability of these services now, (2) the proximity of communities to oil and gas activities, (3) the size and quality of the discovery, and (4) the particular phase of leasing which the community is experiencing. It is important to remember that the degree to which each infrastructure would be affected would vary greatly with each phase. Maximum impacts are felt during the developmental and production stages of leasing.

Land Use and Transportation

Exploration and development create an urgent need to change land uses and develop transportation facilities. In areas where significant oil development occurs, land is needed for drill pads, roads, pipelines, electric lines, and tank batteries. Additional changes in land uses could come with commercial development and urban and suburban expansion resulting from the oil activities. Agricultural lands would be taken to accommodate the uses.

2.2 ENVIRONMENTAL IMPACT ASSESSMENT

Introduction

This section describes the district-wide environmental impacts that could result from continued leasing of federal oil and gas resources in the Dickinson District, based on current oil and gas operating procedures and technological constraints. Where appropriate, the discussion of impacts is arranged according to the phases of oil and gas activity from which impacts are likely to occur. Environmental impacts can be caused by each of the five phases of onshore oil and gas activities:

Preliminary Exploration
Exploratory Drilling
Development
Production
Abandonment

These phases were described in detail in Chapter 1 (Proposed Action).

The present assessment is complemented by the Dickinson District map overlay file for oil and gas. This system of maps (1/2 inch to the mile) contains detailed, area-specific environmental sensitivity ratings for each of the environmental components.

Based upon current information presented in this EAR and on future resource information, this file can be considered an up-to-date and accurate representation of environmentally sensitive areas in the Dickinson District. The map overlay file is an integral component of this EAR, because of the continual updating and refining of information as new resource data becomes available. The reader is urged to consult this file for more specific information which cannot be readily presented in this EAR.

The following analysis is organized by environmental components, which are in the same sequence as in Chapter 1.

Climate and Air Quality

While every phase of oil and gas activity affects air quality, the impacts generally occur on a local scale. These impacts have not been well documented or quantified, because the current air quality monitoring system is not adequate for the purpose.

Particulates

During all phases of oil and gas development, there would be some road or trail building. As a result, vegetation would be removed and soil would be exposed to the wind, and vehicles using the roads would stir up dust. If explosives are used during the seismic phase when the holes are shot, more dirt will be stirred up. All of these actions would cause the introduction of more particulates into the air mass. The severity of this local impact would depend more on wind velocity than on soils; however, the finer soil particles would be blown more easily. This impact would be more critical in the vicinity of the two Class I air quality areas than in the remainder of the State. The impacts associated with increased particulates cannot be qualified.

Sulfides

Hydrogen sulfide (H_2S) is a highly toxic and sometimes flammable gas often found mixed with natural gas. It is often present at a site from the exploratory drilling phase through the production phase of activity. Because of its toxicity, it must be monitored closely to protect human life. A process is used to separate the natural gas and the hydrogen sulfide gas. If there happens to be too much H_2S to make this separation economical, then the natural gas (along with the H_2S) must be released.

In order to protect the environment from large amounts of gas being released, it is flared. If combustion is complete, sulfur dioxide is released as a product. Otherwise, other sulfide compounds, in addition to H_2S, are emitted into the air. Flaring of gas is a concern primarily during the production phase of activity. This impact cannot be quantified, due to the inadequate air quality monitoring network in oil and gas development areas.

Vehicle Emissions

As the number of internal combustion engines, in vehicles and equipment, being used in the area increases, so would the carbon monoxides and other exhaust pollutants. This impact would continue throughout all phases of oil and gas activity.

During the lifetime of the oil and gas activities, the air resource would suffer a small reduction in quality. Once this activity stops, the air quality should return to predevelopment levels. There would be no irretrievable resource commitments.

Geology

The benefits derived from the development of new oil and gas discoveries far outweigh the losses associated with local surface disturbance activities and any geologic impacts. Locating and developing our oil and gas resources (with proper environmental constraints) to help meet our nation's energy needs is a major priority. In addition, through oil and gas development—including surface and seismic activity, explorational drilling, and interpretation of geologic data from new wells—geologic knowledge of an area is greatly increased. Additional knowledge of structure, stratigraphy, and paleontology of a given area can aid in the discovery of new oil fields. New discoveries in North

Dakota, such as the Little Knife Field, have greatly increased explorational activity in the Williston Basin.

The lignite coal that underlies the western two thirds of North Dakota is the resource most likely to be adversely impacted by the development of oil and gas in the Dickinson District. If coal mining followed oil and gas development, mining would be temporarily delayed due to buffer zones around drill sites. However, coal mining could coexist with oil and gas activity, and recovery operations could be coordinated to keep resource conflicts to a minimum; also, information from oil and gas activity could help delineate coal deposits.

The effects of oil and gas development on other resources such as sand and gravel deposits, halite, and clay would be minor.

The actual loss of mineral resources located near the well site—such as coal, halite, sand and gravel, and clay—would also be minor. The drill site area (one half acre or less) could be lost to further development of other minerals, or this development could be delayed until oil and gas operations were completed. Hydraulic fracturing, acidizing, and the injection of chemicals or brine would occur at great depths (probably in excess of 10,000 feet) and would not affect minerals near the surface. The halite beds of the Devonian (Prairie Formation) would be protected by a salt mud mixture to avoid washing out the salt section. Most of the wells in the Williston Basin require engineered casing strings through salt sections. Near-surface fresh water aquifers are protected by a string of surface casing which is cemented into place by the operator. In wildcat drilling, blowouts, cave-ins (caused by bad areas of rock in the boring), and mud losses are always possible.

Preliminary exploration is of such a transitory nature that its impact would be minimal.

In some places paleontological resources could be impacted by oil and gas development through surface disturbing activities. However, with the removal of surface material, new exposures of fossiliferous rocks could provide valuable knowledge of the fossil record and depositional environment.

Soils

The primary effects of oil and gas development on the soil would be problems with erosion, compaction, rehabilitation, and (to a lesser extent) sterilization, and instability. The soil problems associated with the five phases of activity, along with the soil mapping units from Chapter 4 that display these problems, are discussed below.

Preliminary Exploration

During this phase, surface disturbance from off-road vehicle use would lead to an increase in erosion, especially in areas of steep slopes. If temporary roads and trails are constructed with bulldozers, erosion can increase quickly on sloping areas, particularly if little attention is paid to following the contour of the land and poor engineering techniques are used. Mapping unit 29 (Little Missouri Badlands) is the primary area where erosion problems could occur, because of the steep slopes and fragile nature of the soils and vegetation. Mapping unit 27 also has some steeply sloping areas scattered throughout the unit. Of particular concern are the Missouri River Breaks, where the upland drops down to the floodplain. Also, in the western half of the State there are many areas with only moderate slopes where erosion can easily occur.

Wind erosion can occur on any slope and can be extremely serious on coarse textured soils that are disturbed and not protected. Truck traffic, bulldozing, blasting, etc., associated with any phase of oil and gas development must be done with extreme care in such areas.

If accidental fires occur during preliminary exploration or any other stage of oil and gas activity, vegetation would be removed, thus increasing erosion hazards.

Vehicular traffic during preliminary exploration would also cause excess soil compaction, especially on wet, fine textured soils. Seriously compacted clayey soils exhibit altered soil structure and reduced soil porosity, which, in turn, reduces vegetative productivity and increases runoff.

Bulldozing roads and trails on steep slopes, shallow soils, and saline/sodic soils would cause difficulty in rehabilitation.

Exploratory Drilling

Off-road vehicular traffic during exploratory drilling would cause soil compaction, especially on fine textured soils. Disturbance related to road building in hilly and steep areas would increase erosion and soil stability concerns. Again, the most critical area would be mapping unit 29 in the Little Missouri Badlands.

For the average exploratory drill site, about one-half acre or less is leveled and cleared of vegetation. This disturbs the upper layers of soil, causing some erosion, compaction, and mixing. If mud pits are used, contamination of the surrounding soil can also occur.

Development

During the development phase, the well site, usually one to four acres, is cleared of all vegetation and graded nearly level for the drilling rig, mud pumps, mud pits, generators, pipe rack, and tool house. In mapping unit 29 (Little Missouri Badlands) and parts of mapping unit 27 (Missouri River Breaks) erosion could be greatly accelerated by disturbing the hilly and steep slopes. Soil instability is common in these areas because of shallow soils and soft, shaley parent material.

Preparing roads and sites for development would cause a mixing of soil material, creating a potential rehabilitation problem in soils with saline/sodic subsoil and/or parent material. Compaction would continue to be a problem, especially on wet, fine textured soils.

Development for other facilities, such as storage tanks, would also result in soil disturbance. Oil spills from storage facilities or wells and well blowouts would cause soil sterilization, adding to reclamation cost and difficulty. Also, spills from poorly constructed mud pits that fail or are not properly sealed would contaminate the soil.

Many areas in the Badlands have only a few inches of topsoil over parent material or no topsoil at all. It may be very difficult and costly to rehabilitate such areas.

Production

Many soil impacts associated with development carry through into production. Oil spills could cause soil sterilization. Erosion problems would continue along roads and facility locations. In hilly and steep areas, such as the Badlands of mapping unit 29, slumping and sloughing of material along steep cuts could occur. Piping (the formation of subsurface cavities and tunnels due to water movement) might occur along buried pipelines which transport oil and gas to storage facilities or processing points. Piping is common in drastically disturbed soils of fine texture, especially if excess sodium is present. The sodium disperses the clay particles when wet, causing them to go into solution. The cavities and tunnels then begin to form.

Untreated metals and pipelines would corrode rapidly and develop leaks in saline/sodic soils. Leaks from pipelines could cause soil sterilization.

Abandonment

The removal of oil and gas equipment, service roads, etc., would cause impacts to the soil similar to those associated with the development phase. Erosion would be accelerated because of the extra disturbance, and some excess compaction could occur during rehabilitation. Upon successful completion of rehabilitation, the disturbed soils would be stabilized and returned to their former use.

Soil Sensitivity Map

The map entitled "Soil Sensitivity to Oil and Gas Development" (Map 2.2-1) depicts the preceding analysis, based on broad mapping units of associated soils. This map should only be used to give the reader a general idea of the soil sensitivity to oil and gas development on a statewide basis. The soil sensitivity of a particular tract would not necessarily agree with the sensitivity rating given to a broadly outlined area; for example, there will be tracts within the Critically Sensitive (Class C) area which are Sensitive (Class B). Each lease area would need more specific soils information for application of "no occupancy" stipulations. The oil and gas map overlay file in the Dickinson District Office contains a more detailed representation of soil sensitivity.

Topography

Topographic impacts from oil and gas activities would be minor. Impacts would occur during the development stage and would be primarily visual in nature. Drilling pads, roads, pipelines, and other development activities would impact the natural landscape to some degree. On steeper slopes, grading and leveling would alter small areas.

Rehabilitation of disturbed areas may not return the topography to its original condition. In many cases a gentler slope would be created.

Vegetation

Impacts to vegetation are addressed according to the five phases of oil and gas activity. The assessment of the impacts is based on methods presently used to carry out these activities and present stipulations and governmental requirements placed on leases and permits.

Preliminary Exploration

This phase of oil and gas activity has occurred throughout most of the Williston Basin portion of North Dakota, and some areas have been seismographed several times by different companies. Impacts from seismic activities are significant because they occur on most BLM leases. In the past, the BLM had little or no control over seismic activities. "Dozer" trails were constructed at will, shot holes were left open or poorly plugged, and drill cuttings were left in a pile. Also, flagging and detonator wires were often left behind. At the present time, seismic exploration on BLM surface is only authorized when the oil companies file a Notice of Intent. Present seismic operations that are conducted according to the terms and conditions required by BLM cause limited impacts to vegetation.

In North Dakota, existing trails and roads usually provide access for equipment to the shot lines. However, dozer work may be required at drainage crossings, and old trails often require some blade work before they can be used. This results in the removal of vegetation, but it is generally limited to a few hundred square feet at crossings and 8-10 foot wide strips along trails. There are also some negative impacts to vegetation in the area around the seismograph holes. Some of the drilling mud usually remains, even after cleanup.

Exploratory Drilling

This phase of oil activity has a high impact on plants and the soil in which they grow. The drill pads and the access roads require stripping and grading. Normally the drill pad is a balanced cut and fill situation, with compaction required on the fill portion.

In level to rolling terrain, such as farmland, less acreage is disturbed (generally limited to a few acres) than in rangeland. This is due to the flatter topography and greater number of existing roads in cropland areas. In rough country such as the Badlands, road construction is most extensive. Existing trails have to be upgraded, and some new construction may be required.

Seventy-five percent of the exploratory locations are abandoned for lack of discovery, after which cleanup and reclamation begins. The mud pits on the location cause the biggest problem. They are slow to dry out, and they contain bentonite, drill cuttings, and additives that are undesirable as plant growth material.

Croplands are the easiest to reclaim, although it may take a long time for crop production to come back to what it was before. Soil fertility has to be restored for optimum plant growth. Reclamation of rangeland to cool season grasses has been very successful, but warm season grasses, such as blue grama, side oats grama, and little blue stem, are more difficult to establish.

Development

The oil and gas development phase causes the greatest environmental impact. Well sites, roads, and pipelines affect a particular area for 20-30 years. In addition, the expansion of a field associated with development makes the impact significant. While a wildcat is a single temporary location affecting a few acres, development can expand to many locations over hundreds of acres. The greatest impact is on soil fertility, and the reduced fertility will probably result in a lower vegetative productivity.

Production

Additional impacts to vegetation occur from maintenance activities, such as digging up pipelines to repair leaks, replacing old ones, and adding new ones. Oil spills have always been present in producing fields. Where they occur, plants die and the recovery period can take years. Recently, this has become less of a problem because there are several government agencies monitoring oil and gas field activities and, consequently, the oil companies are doing a better job in prevention and cleanup.

Abandonment

There are some minor impacts to vegetation in the removal operation. They result from pipelines being dug up and heavy equipment (including reclamation equipment) traveling over the area.

In summary, adverse impacts to vegetation can be minimized (and presently are being minimized) by adequate lease stipulations. If a good job is done on federal leases, the private lessees will want the same done on theirs.

Sensitivity Levels and Classification

The classification is very general at this level of planning; therefore, exceptions should be expected within each vegetative category. As additional information becomes available, the classification will be refined on the map overlay file.

All of North Dakota, except for the Badlands, is classified Nonsensitive, but there will be exceptions, such as other resource conflicts, rare and unique plants, etc. (see Map 2.2-2). The Badlands are in class C: Critically Sensitive, requiring further study due to the fragile nature of the soil and vegetation. The studies should be done as each lease comes up for renewal.

Summary

On a statewide basis, there would be no significant change in vegetative productivity caused by the proposed action, due to the fact that oil and gas operations occur only on a small percentage of the total surface. However, oil and gas activity is currently accelerating in North Dakota and moving into unexplored areas.

Successful wells, along with the necessary roads, tank batteries and other facilities, may occupy land for 30 years or more. If this occurs on highly productive producing farmland, the lost production could be significant to the individual farming unit. Crop production would be lower on these sites following reclamation, due to loss of top soil, and soil structure would have to be reestablished.

Water

All phases of oil and gas operations cause impacts to the water resource of an area. These impacts and their magnitude are usually dependent upon the factors involved at a specific site. The following discussions on impacts will be general and not quantified, because it is impossible to predict where oil and gas activity will occur, and because of the large area covered by this impact assessment. An attempt will be made to point out general areas where a certain impact has more of a potential of occurring, or where the magnitude of an impact may be greater or less. Map 2.2-3 shows general sensitivity classifications for hydrologic impacts across the State.

Preliminary Exploration

Sediment Yield. During the preliminary exploration phase, several types of on-the-ground seismograph surveys may be made. Most of these types of surveys require heavy equipment to have access along a line where the ground is vibrated or shook at periodic intervals. Sometimes roads are bladed, and sometimes the heavy vehicles are just driven cross-country. In either case, the heavy equipment compacts the soil, resulting in increased runoff along the trails. Earthmoving equipment removes the protective vegetation cover,

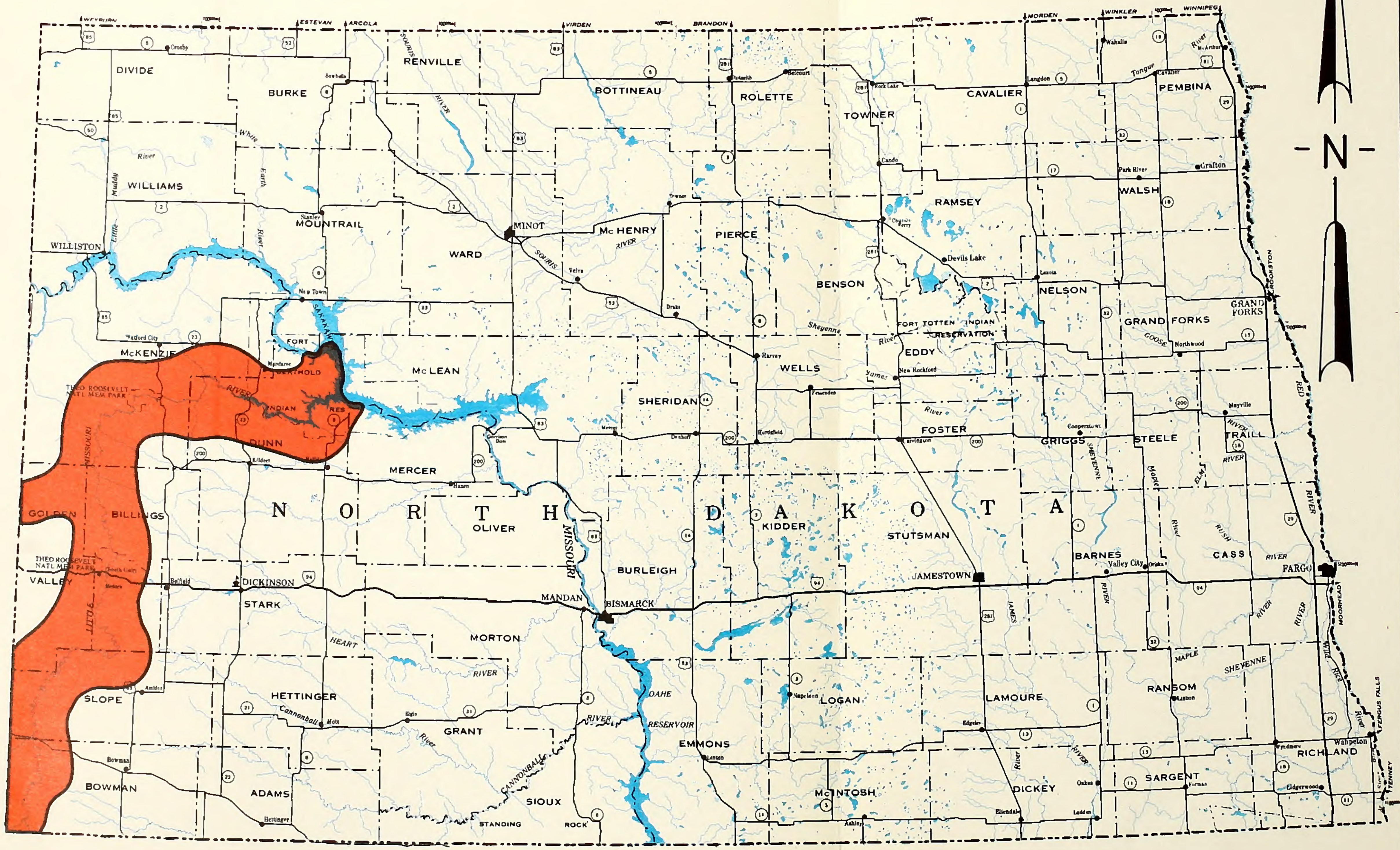
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

DICKINSON DISTRICT

ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

VEGETATION SENSITIVITY

MAP 2.2-2



Scale 1:2,150,000

LEGEND

Critically Sensitive (Class C)

Non-Sensitive (Class A)

This classification is general for North Dakota. Within each broad area there are exceptions. (Vegetative Types representative of other classifications)

SOURCE: BLM, 1980.

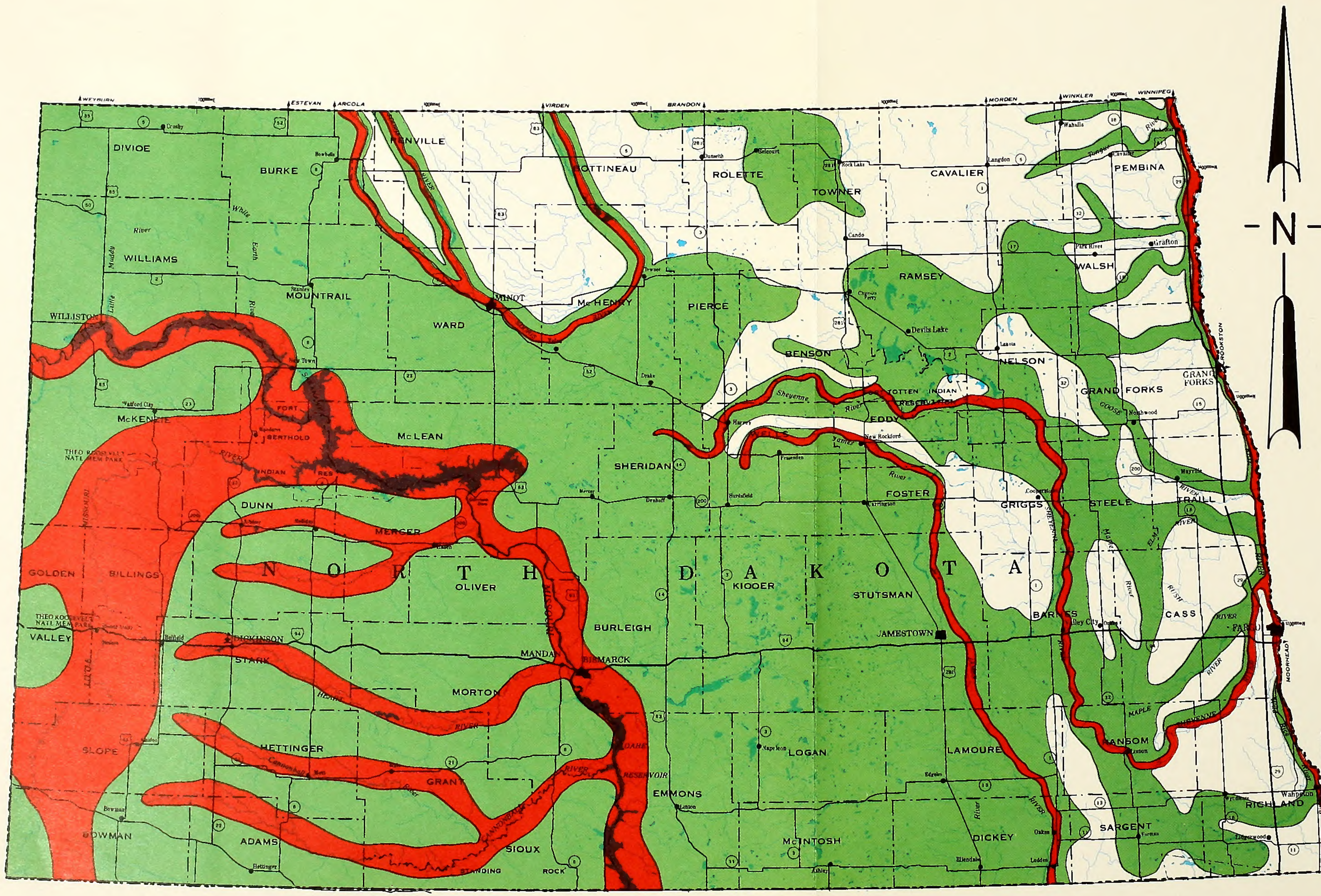
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

DICKINSON DISTRICT

ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

HYDROLOGIC SENSITIVITY

MAP 2.2-3



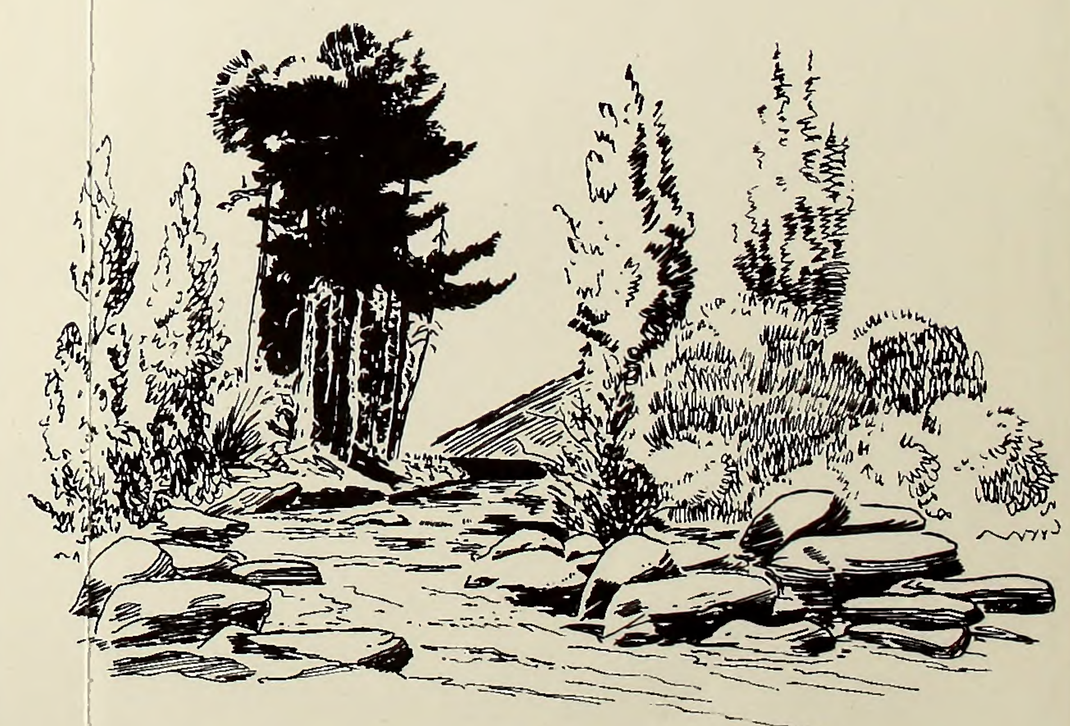
Scale 1:2,150,000

LEGEND

Critically Sensitive (Class C)

Sensitive (Class B)

Non-Sensitive (Class A)



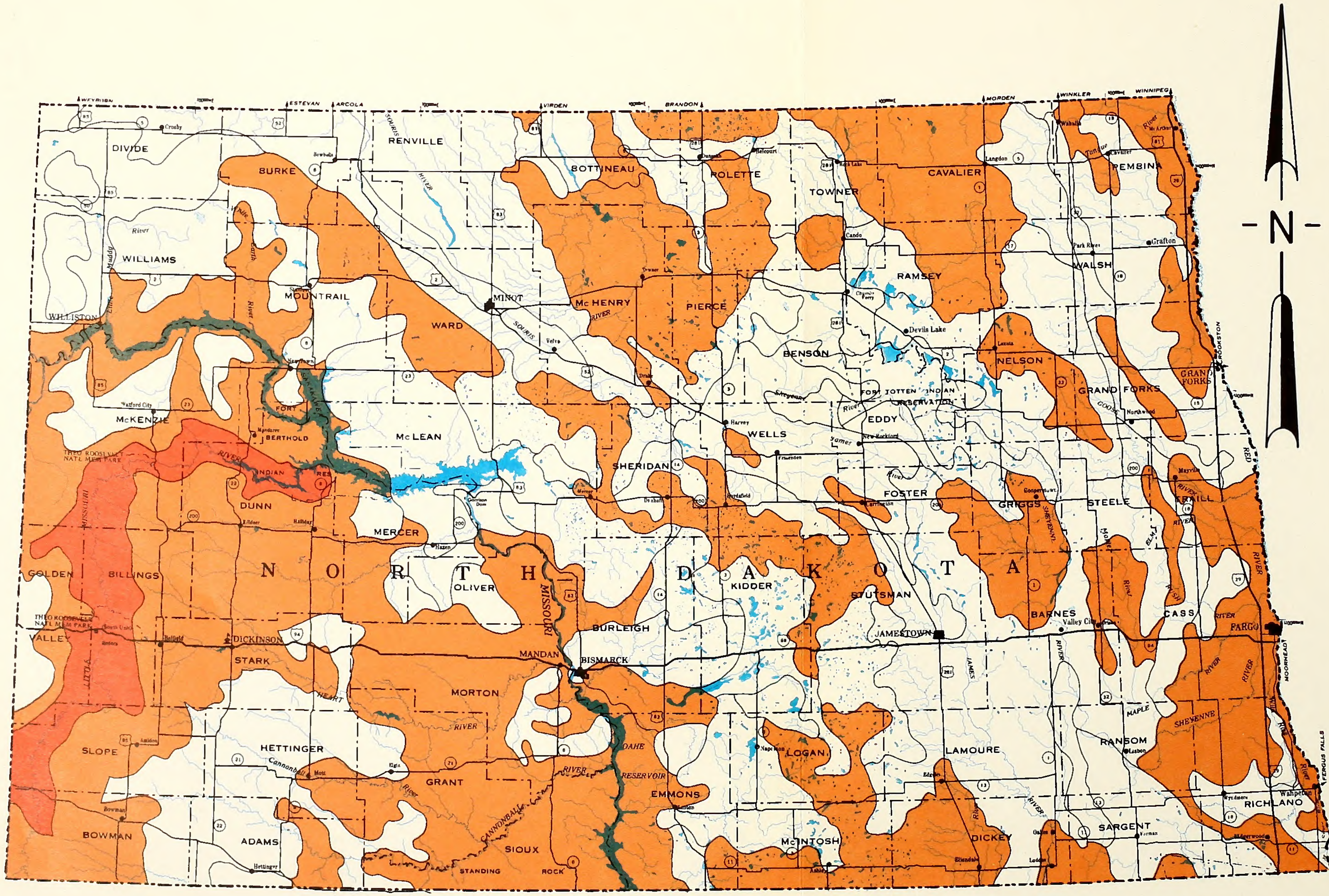
SOURCE: BLM, C.W. Pette, 1979.

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

DICKINSON DISTRICT
ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

SOIL SENSITIVITY

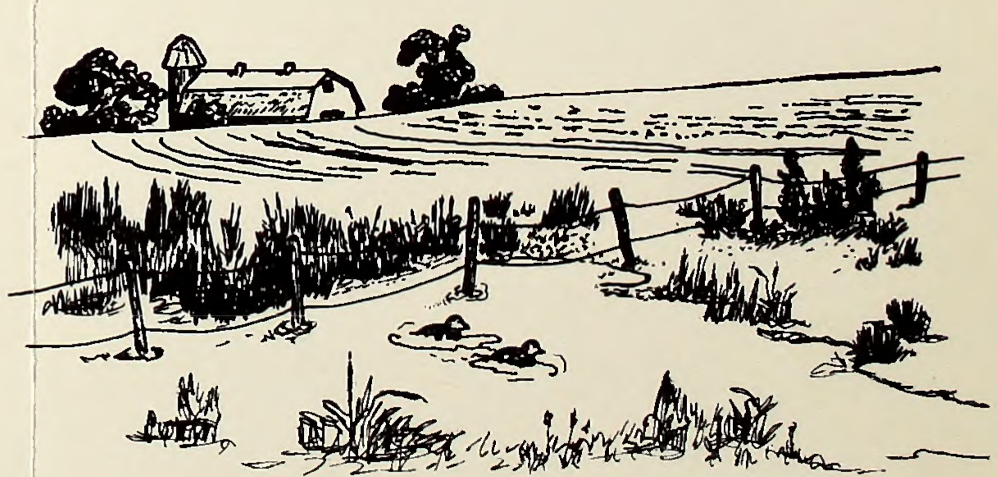
MAP 2.2-1



Scale 1:2,150,000

LEGEND

- Critically Sensitive (Class C)
- Sensitive (Class B)
- Non-Sensitive (Class A)



SOURCE: "The Major Soils of North Dakota." Bulletin No. 472 by H.W. Omodt, et al., Dept. of Soils, Ag. Exp. Sta. NDSU, Fargo, 1968. "Soils of North Dakota." Bulletin No. 5, S-35, 942 USDA, SCS, 1977.

which increases the sedimentation of runoff. Even when no trails are bladed in, trucks often leave ruts along the seismic line and along the access to the line. Depending upon the location and the time of year this exploration occurs, the impact could range from insignificant to severe. The impact would be more severe when larger areas are explored, when more miles of seismic lines are surveyed, and when earthmoving work is done (instead of driving cross-country). The impact would also be more severe when the line crosses areas with steep slopes and poor vegetation cover. One of the more important factors in contributing to sediment yields is the proximity of a seismic line to a water channel. Lines which cross ephemeral, intermittent, or perennial stream channels and wetlands will do the most damage. Another important factor is the time of year. Activity during a wet period will have more potential for increasing sediment yields than activity during periods when the ground is dry. Map 2.2-3 shows the general classifications of potential for sediment yield impact severity for the different hydrologic characteristic areas. Increased sediment loads in surface waters are detrimental to most water uses. High sediment loads are detrimental to aquatic life, increase the expense of municipal water treatment, often render water unsuitable for some industrial uses, and create an unpleasant sight.

Aquifer Characteristics. Shallow water wells and springs may be impacted by the detonation of explosives or by other methods of sending shock waves through the ground. In areas where a relatively brittle material forms an aquifer, explosions may cause the material to shatter, thereby altering the water yielding characteristics. This could either increase or decrease yields. A shock wave could cause a normally water-tight formation to shatter and, thus, cause water to drain from the adjacent aquifer zone. The potential for this impact occurs only where activity is in the immediate vicinity of a water well or a spring.

Exploratory Drilling

Sediment Yield. Drilling exploratory wells requires roads and drill locations capable of supporting very heavy drill rig equipment. These areas are completely cleared of vegetative cover and sometimes are covered with crushed rock. Whenever an area is disturbed, the potential for increased sediment production exists. The severity of sediment production is dependent upon the same factors outlined under the preliminary exploration phase of activity. The magnitude of this impact is greater during the exploratory drilling phase than in preliminary exploration, since disturbances are generally greater and the equipment heavier.

Water Use. During this phase about 5,000 to 10,000 gallons of water per well per day are consumed. Water is needed for making drilling mud and for cooling engines, cleaning equipment, etc. This water is made unavailable for further use.

Flooding. The lifetime of a particular site in the exploratory drilling phase is relatively short. It takes one to three months for a crew to move a drill rig in, drill, and move out. However, there always exists the possibility that a pay zone may be hit, in which case the lifetime of a site would be considerably lengthened. For this reason, consideration must be given to the location of a site, assuming that every site could become a producer and, therefore, a more permanent location.

Generally, locations are more sensitive to water impacts the closer they are to the stream channel. Floodplains, or the area immediately adjacent to the channel, are the most sensitve. Wetlands are other areas where periodic inundation can occur. Drill locations are large areas with exposed soil, equipment, drilling mud, etc. Flooding of this area would impact the turbidity, suspended solids, and dissolved solids load of the stream. This would adversely affect the municipal, agricultural, and industrial uses of the water. This impact could be more severe during the exploratory drilling phase, when the reserve pit is open and drilling mud is on the site, than during later phases.

Ground Water Quality. Shallow ground water can be contaminated by leakage from mud and reserve pits. This impact would depend upon the surface material in the area. If the drilling area is in a water-tight surface material such as shale, and there are no shallow water zones, then very little or no impact would occur. In a place where there is deep water-bearing alluvium, drilling activity could reduce the quality of the ground water in the vicinity of the well. Water from deeper aquifer zones could leak along the drill hole to other deep aquifer zones with different water quality. Neither of these two impacts has caused much concern in North Dakota.

Development

Sediment Yield. Development of a new producing well requires more dirt work: temporary roads must be upgraded, new roads may have to be built, pipelines and storage tanks must be installed, and possibly more treatment facilities would have to be constructed. All of this activity involves surface disturbances which increase sediment yields. The same critical factors that determine the severity of the sediment impact during the preliminary exploration phase are involved in the development phase of oil and gas work.

Floodplain. After equipment and drilling mud are removed from a drill site and the size of the site is reduced, the potential for impacts from inundation is reduced but not eliminated. In addition, the new facilities needed to transport the oil and gas increase the potential for high sediment loads resulting from flooding.

Production

Sediment Yield. Well sites and access roads continue to be in use during the production phase. The factors influencing sediment production presented earlier in this section apply to an oil or gas field throughout the production phase. As far as sediment yields are concerned, this phase is the least critical of the total oil and gas development process.

Flooding. Sites which are located in floodplains or wetland areas would continue to present problems in the event flooding occurs.

Disposing of Produced Waters. Often when a pay zone is found, water is produced along with the oil and gas. This water is usually of very poor quality. If this water is disposed by releasing it through surface drainages, it would degrade the surface water quality, making it unusable for municipal, agricultural, or industrial needs. Likewise, if it is injected into another ground water aquifer with better quality water, it would similarly degrade this source. Presently, there is no surface disposal of produced water; it is all pumped into ground water aquifers with equal or poorer water quality. Sometimes in the later stages of production, this produced water is pumped back into the producing formation where it will help squeeze a little more oil out.

Oil Spills. While oil spills are rare and not planned, there still exists a potential for them to occur, and they do pose an impact threat to surface waters. A small amount of oil in water can prove detrimental to aquatic, municipal, agricultural, or industrial uses. Spills generally occur during oil transport, and regulations require many precautions to prevent them. Potential for impacts to the water resource is greatest near larger perennial streams.

Abandonment

Sediment Yield. While pumping equipment, storage tanks, pipelines, etc., are being removed, there would be some more surface disturbance. After the disturbed areas are regraded and revegetated, sediment production would decline and should return to approximately the level which existed before activity began.

Flooding. Sites which are located in floodplain or wetland areas would have the potential for impact to water quality in the event of flooding. The severity of this impact would be low and would decline to predevelopment levels as reclamation of the site is accomplished.

During the lifetime of oil and gas development use in an area, (20-30 years), the water resource has limited use. Some water consumption occurs, as well as some degradation in water quality. In the long term, once oil and gas developments have been reclaimed, water consumption would stop, and water quality would return to predevelopment levels. There would be no irretrievable water resource commitments.

Animals

The following section describes the impacts on animals by each of the five major phases of oil and gas activity.

Preliminary Exploration Phase

Devegetated habitats amount to approximately one acre for seismic sites. Sometimes trails have to be built during seismographic operations to provide for heavy truck traffic. The trails are quickly constructed by devegetation with a crawler tractor between seismic points. Trail construction destroys forage that would otherwise be available to both domestic and wild animals, and it also destroys nesting cover, burrows, and escape cover. The explosive charges used in seismographic operations may collapse burrows and trap animals. Black-footed ferrets use prairie dog town habitat for feeding, reproduction, and escape cover. Trail construction and explosive charges on or near prairie dog towns would constitute an imminent threat to the endangered black-footed ferret if it is in prairie dog towns.

Livestock may change their grazing patterns when seismic trails provide new and easier access to previously inaccessible habitats. Consequently, vegetation available to wild animals as forage and cover would change, since the composition and quantity of vegetation responds to grazing intensity. Furthermore, animal populations and species composition would change when plant communities or individual plant species are altered. Competition between domestic animals and wildlife is intensified when livestock are concentrated or invade previously inaccessible areas. This competition may be relieved by more even distribution of livestock use.

Trail construction contributes to the sediment load of streams and wetlands. This increase in sediment levels either alters or destroys aquatic communities on and off-site and decreases aquatic diversity and populations.

Sage and Sharp-tailed Grouse. Seismic activities occurring in the period from March through May near sharp-tailed grouse and sage grouse leks would disrupt breeding and reproduction.

Raptorial Birds. Spring raptor territory establishment and nesting would be disrupted by seismic activities. Some species are very sensitive, and even a little disturbance could result in abandonment of reproduction for the year. The peregrine falcon, an endangered species, is especially sensitive to disturbances during territory establishment and nesting (March through May).

Eagle nesting efforts, particularily those of bald eagles, are sensitive to disturbances.

Exploratory Drilling Phase

Oil and gas activities intensify during this phase and last one to three months. Heavy duty roads are constructed to handle the traffic of drill crews and truck transport of heavy drilling equipment.

Habitat and forage for livestock and wildlife is destroyed by devegetation for drill sites and roads. Devegetated habitats amount to approximately two acres per mile of road and trail. Habitat loss would affect small mammals, birds, reptiles, and amphibians more severely than it would large mammals.

Human and equipment activity during spring territory selection and reproduction of bald eagle, golden eagle, peregrine falcon, other raptors, and waterfowl in the vicinity of drilling sites and roads generally causes nest abandonment. The critical period is February through June.

The destruction of any sharp-tailed and sage grouse leks would result in area-wide reproduction failure (see Table 2.2-4,-5). Leks are used most frequently from mid-March through May.

Deer, bighorn sheep, and antelope are very vulnerable to disruptions on winter ranges. Drilling slurry and waste dumped in reserve pits are toxic to animals. Pits are an open hazard for 4 to 5 months (until they are buried). A blow-out during drilling of an exploratory well results in the contamination of a large area with drilling and geologic materials, which are often toxic to terrestrial and aquatic ecosystems. The degree of toxicity and its duration in the environment is dependent on the material, modes of exposure, moisture conditions, potential to combine with soil, and numerous other factors. Other disturbance and destruction factors include driving off of established roads and blow-out of hydrogen sulfide (H_2S) gas, which is extremely toxic at moderate concentrations.

Table 2.2-4
SAGE GROUSE STRUTTING GROUNDS

Bowman County

1.	T130N	R107W	Sec. 26	SESW
2.	T129N	R107W	Sec. 25	SESE
3.	T130N	R106W	Sec. 21	SENW
4.	T131N	R105W	Sec. 9	NESW
5.	T130N	R105W	Sec. 13	NWSE
6.	T130N	R105W	Sec. 22	SWSE
7.	T129N	R105W	Sec. 36	NESW
8.	T129N	R104W	Sec. 28	NWSE

Slope County

1.	T135N	R105W	Sec. 7	SWNW
2.	T135N	R104W	Sec. 20	SWSE
3.	T135N	R104W	Sec. 31	SENW
4.	T134N	R105W	Sec. 7	SENW
5.	T134N	R106W	Sec. 16	NWNE
6.	T134N	R106W	Sec. 33	NWSE
7.	T135N	R104W	Sec. 20	SWSE
8.	T135N	R104W	Sec. 31	SENW
9.	T133N	R105W	Sec. 15	NENE
10.	T133N	R105W	Sec. 23	NWSE

Golden Valley County

1.	T136N	R106W	Sec. 25	SESE
2.	T136N	R105W	Sec. 20	S½SE

Source: North Dakota Game and Fish Department, September 1974.

Table 2.2-5
SHARP-TAILED GROUSE DANCING GROUNDS

Slope County

1.	T136N	R103W	Sec. 17	SESW
2.	T136N	R104W	Sec. 23	SENE
3.	T136N	R103W	Sec. 19	NESE
4.	T136N	R103W	Sec. 21	SWNE
5.	T136N	R103W	Sec. 29	SWNW
6.	T136N	R104W	Sec. 36	NWNE
7.	T136N	R104W	Sec. 35	NESE
8.	T136N	R103W	Sec. 32	SENE
9.	T136N	R103W	Sec. 33	NENE, SESE
10.	T135N	R103W	Sec. 4	NWSE
11.	T135N	R103W	Sec. 8	N½NE
12.	T135N	R104W	Sec. 12	SESE
13.	T135N	R104W	Sec. 14	SWNW
14.	T135N	R103W	Sec. 18	NESW
15.	T135N	R103W	Sec. 16	NENE, SESE
16.	T135N	R103W	Sec. 17	NWNW
17.	T135N	R104W	Sec. 23	SWNE
18.	T135N	R104W	Sec. 24	SESE
19.	T135N	R103W	Sec. 20	SWNE

Billings County

1.	T138N	R100W	Sec. 34	SESW
2.	T138N	R100W	Sec. 33	S½SE
3.	T138N	R100W	Sec. 31	SWSE
4.	T137N	R101W	Sec. 2	SENE
5.	T137N	R101W	Sec. 11	NWSW
6.	T137N	R101W	Sec. 12	SENE
7.	T137N	R100W	Sec. 10	NESW
8.	T137N	R101W	Sec. 14	NESE
9.	T137N	R100W	Sec. 16	NWNW

10.	T137N	R101W	Sec. 23	SWNW
11.	T137N	R101W	Sec. 24	NWNE
12.	T137N	R100W	Sec. 21	SESW
13.	T137N	R101W	Sec. 26	NWSW, SESE
14.	T137N	R100W	Sec. 29	NENW
15.	T137N	R100W	Sec. 27	NESW
16.	T137N	R100W	Sec. 32	SENW
17.	T137N	R100W	Sec. 33	NWNW, SESW
18.	T143N	R99W	Sec. 7	SENW, SESE
19.	T143N	R100W	Sec. 13	NWNE, SESE
20.	T143N	R99W	Sec. 30	NENW
21.	T143N	R99W	Sec. 29	NENE
22.	T143N	R100W	Sec. 36	SWNE
23.	T143N	R99W	Sec. 32	NESW
24.	T143N	R99W	Sec. 33	SWNE

Source: North Dakota Game and Fish Department, September 1974.

Production Phase

Pipelines or trucks are used to transport oil and gas products and production waste. Trucking requires wide, armored roads to haul heavy loads of oil, production water, and maintenance equipment. Gas is usually burned off. Other site equipment includes storage tanks, oil-gas-water separators, oil-gas-water pumps, and maintenance buildings. The network of roads becomes complex and well developed.

Roads, corridors for pipelines, and physical structures for production and maintenance precludes the use of the occupied, and, in some cases, adjacent lands by both livestock and wildlife for forage, reproduction, escape cover, and nesting cover needs. Devegetated habitats amount to approximately six acres for wells. A large oil and gas field with a typical 20 to 30 year lifetime produces severe negative impacts on the forage and habitat of domestic animals and wildlife. System failures of the oil and gas pipelines, water injection pipelines, separators, and other production equipment present impacts of varying degrees. Breakage of oil pipelines and storage tanks would subject localized areas to pollution from crude oil. Crude oil physically harms animals and renders forage and habitat useless. It contains various compounds which are toxic to animals, especially to aquatic organisms. A break in a water injection pipeline would pollute the environment with water which was originally pumped up with crude oil. This water, usually salty and contaminated with oil, would be detrimental to forage, aquatic ecosystems, and other habitats. Waste products—such as H_2S, other sulfur compounds, and salt water—are highly corrosive and increase the chances for system failures.

Abandonment Phase

Derelict equipment, asphalt surfaces, and residues of oil spills are point sources of pollution. Abandoned buildings and equipment encourage off-road trespass and preclude forage and wildlife habitat values.

Sensitivity of Wildlife to Oil and Gas Activities. Negative impacts to wildlife and habitat have been categorized as follows:

Sensitivity Class	Description
Nonsensitive	Not sensitive.
Sensitive	Oil and gas activities during one or more phases have the potential to adversely affect wildlife and its habitat.
Critically Sensitive	Wildlife involved in this classification are high-priority species (e.g., endangered, rare, high-value). Critically Sensitive habitat of these species include winter ranges of deer and bighorn sheep, breeding areas of sharp-tailed grouse and sage grouse, prairie dog towns where black-footed ferrets have been observed, wetlands, streams, and other aquatic habitats.
Requiring Further Study	Areas where information is lacking.

Bighorn sheep habitat is classified as Critically Sensitive, because its habitat is unique and limited. Human caused disturbance will often cause bighorns to vacate even their favorite areas.

Sage grouse leks and all other components of their habitat are considered to be Critically Sensitive, because their habitat is very limited. The range of sage grouse is shown in Map 2.2-4.

Deer habitat (including wooded areas, wooded draws, and tree plantings) is Sensitive throughout the year, except for winter range, which is Critically Sensitive. Wetlands, which occur throughout the subject area, are rated Sensitive. They are especially abundant in the Prairie Pothole Region (see Map 4-17). Breeding waterfowl use them in varying rates of intensity from April until freeze-up. Migrating waterfowl (including the whooping crane, an endangered species) use them during spring and fall migrations.

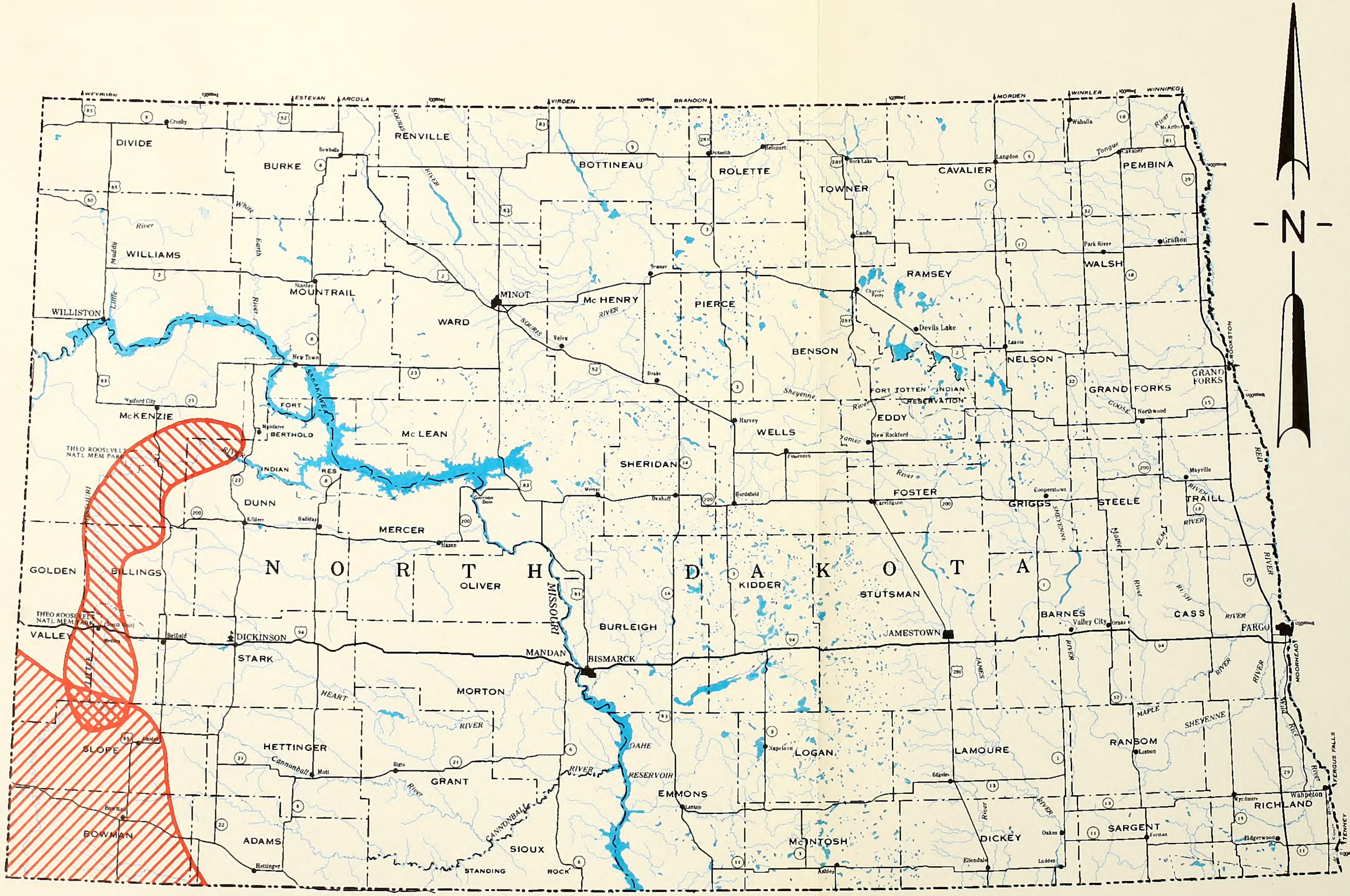
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

DICKINSON DISTRICT

ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

BIGHORN SHEEP AND SAGE GROUSE SENSITIVITY

MAP 2.2-4



LEGEND

Critically Sensitive Areas for Bighorn Sheep (Class C)

Critically Sensitive Areas for Sage Grouse (Class C)

SOURCE: North Dakota Game and Fish Department, 1975.

Recreation

Oil and gas leasing can affect recreational opportunities by rendering land surface unsuitable for recreation and by increasing recreational pressure on residual resources. Both the amount of land destroyed and the increase in demand depend on the oil activity phase and the magnitude of the activity and development.

Each of the five phases of oil and gas activity requires a different level and duration of employment. The size and duration of the work force expected for the preliminary exploration and exploratory drilling phases are relatively minor. During the development phase, they are much more significant. In the production phase a smaller work force is required than during development, but it is much longer in duration (20 to 30 years). During the abandonment phase, the work force is small but may last for some time, depending on the difficulty of reclamation.

Since demand for urban and developed outdoor recreational facilities already exceeds the supply in most North Dakota communities, any increase in demand adds to the already overburdened recreational programs and facilities. Rural recreation sites in general are not numerous statewide, and few have developed camping and picnicing facilities.

In the western half of the State, public land provides more opportunities for dispersed recreation (e.g., camping, hunting, hiking) than in the eastern half of the State, where there is little public land. The potential impact upon recreational facilities in the eastern half of the State is negligible, because little oil and gas leasing is expected there.

Oil and gas activities in the preliminary exploration and exploratory drilling phases would remove little land from potential recreation use. The amount of land which the development phase would preclude from recreation use would depend upon oil well spacing, nuisance hydrogen sulfide gas leakage, number and kind of roads, number of pipelines, production facilities, and maintenance facilities.

Land required for development would likely continue to be unavailable throughout the production phase (25 to 30 years), until the wells are abandoned and the area is reclaimed.

Visual Resource Management (VRM)

The visibility of various oil and gas activities in the different landscapes has been evaluated using the BLM contrast rating system as a measure. Contrast ratings were made for two conditions within each landscape: first for the worst/normal condition, and second for the optimum condition.

The worst/normal situation is from a normal observer position with the activity in a location that is the least flattering. If an activity is acceptable under this condition, it can be considered to be acceptable throughout the area for purposes of evaluation. Because areas are not uniform, however, detailed analysis on a site-by-site basis is necessary, unless the site is investigated and found to be "typical."

Optimum conditions make use of planning and design measures on a case-by-case basis. Small changes in location that take advantage of characteristics of the land, such as favorable slope or favorable location of vegetation, can be estimated. The contrast rating under these more ideal conditions shows the potential for adapting an activity to the land and the capability of the land to absorb that activity visually.

Impacts have been determined for key oil and gas activities for the short and long term. These are shown on Tables 2.2-6,-7. Impacts have been placed into three categories:

Category	Description
Low Susceptibility	Situations in which the contrast rating for an activity lies within the numeric criteria of the VRM Objective Class (VRMC); no significant impact is likely.
Moderate Susceptibility	Situations in which the contrast rating for an activity exceeds the VRMC criteria under the worst/normal condition, but does not exceed these criteria under optimum conditions.
High Susceptibility	Situations in which the contrast rating for an activity exceeds VRMC criteria under both worst/normal and optimum conditions.

In Low Susceptibility areas, the activity under consideration can be absorbed into the landscape without much difficulty.

In Moderate Susceptibility areas, more care is necesary. Detailed planning and design should precede all location work and permits should be denied until that consideration is made to the satisfaction of the District Manager.

In High Susceptibility areas, more extraordinary measures may be necessary to permit the activity yet protect the appearance of the land. These areas are shown on maps 2.2-5 through 2.2-9.

With sufficient planning and care, all oil and gas activities can be accomplished in harmony with the landscape. In every case it will require more thought and more money to do an adequate job, but the economic burden of protecting the land while developing oil and

Table 2.2-6
Oil and Gas Activities
Short-Term Impacts

Landscape and VRM Class	CG	TV	WD	FD	R	P	PT	AR	MR
Prairie III	■	●	★	★	★	■	★	★	■
Prairie IV	■	●	■	★	★	■	■	■	■
Tallgrass Prairie III	■	●	★	★	★	■	■	■	■
Tallgrass Prairie IV	■	●	■	★	★	■	■	■	■
Pasture/Range II	■	●	★	★	★	★	★	★	■
Pasture/Range III	■	●	★	★	★	★	★	★	■
Pasture/Range IV	■	●	■	■	★	■	■	■	■
Urban/Suburban II	●	●	★	★	★	★	■	●	●
Urban/Suburban III	●	●	★	★	★	★	■	●	●
Urban/Suburban IV	●	●	★	★	★	★	■	●	●
Flood Plains II	■	■	★	★	★	■	■	★	■
Flood Plains III	■	●	■	■	★	■	■	■	■
Flood Plains IV	■	●	■	■	★	■	■	■	■
Wooded Draws II	■	■	★	★	★	■	■	★	■
Missouri River II	■	■	★	★	★	■	■	★	■
Breaks II	★	●	★	★	★	★	★	★	★
Breaks III	■	●	★	★	★	★	■	★	■
Breaks IV	■	●	★	■	★	★	■	■	■
Badlands II	★	■	★	★	★	★	★	★	★
Badlands III	■	●	★	★	★	★	■	■	■
Turtle Mountains II	★	■	★	★	★	★	■	★	★
Turtle Mountains III	★	■	★	★	★	■	■	★	■
Sandhills III	■	●	★	★	★	■	★	★	■
Sandhills IV	■	●	■	★	★	●	■	★	■
Oak Savanna III	■	●	★	★	★	■	■	■	■
Oak Savanna IV	■	●	★	★	★	●	●	■	■
Buttes II	■	■	★	★	★	★	★	★	■
Ponderosa Pine Forest II	★	★	★	★	★	★	■	★	★

CG = Conventional Geophysical
WD = Wildcat Well Drilling
R = Refining
PT = Local Power & Telephone
MR = Maintenance Roads

TV = Thumper/Vibrator Geophysical
FD = Field Development
P = Pipelines
AR = Access Roads

● = Low
■ = Medium
★ = High

Table 2.2-7
Oil and Gas Activities
Long-Term Impacts

Landscape and VRM Class	CG	TV	WD	FD	R	P	PT	AR	MR
Prairie III	●	●	■	■	★	●	■	■	■
Prairie IV	●	●	■	■	★	●	■	■	■
Tallgrass Prairie III	●	●	■	■	★	●	■	■	■
Tallgrass Prairie IV	●	●	■	●	★	●	■	■	■
Cropland III	●	●	●	●	★	■	■	●	■
Cropland IV	●	●	●	●	★	■	●	●	■
Pasture/Range II	●	●	■	■	★	■	★	★	■
Pasture/Range III	●	●	■	■	★	●	■	■	■
Pasture/Range IV	●	●	●	■	★	●	■	■	■
Urban/Suburban II	●	●	●	●	★	★	■	●	●
Urban/Suburban III	●	●	●	●	★	★	■	●	●
Urban/Suburban IV	●	●	●	●	★	★	■	●	●
Flood Plains II	■	●	●	■	★	■	■	■	■
Flood Plains III	■	●	●	■	★	■	■	■	■
Flood Plains IV	■	●	●	★	■	■	■	■	
Wooded Draws II	■	●	■	■	★	■	■	■	■
Missouri River II	■	■	■	■	★	■	■	■	■
Breaks II	■	●	■	★	★	★	■	■	★
Breaks III	■	●	■	■	★	■	■	■	■
Breaks IV	●	●	●	■	★	■	■	■	■
Badlands II	★	■	■	★	★	★	■	■	★
Badlands III	■	●	■	★	★	■	■	■	■
Turtle Mountains II	★	■	★	★	★	■	★	■	★
Turtle Mountains III	■	●	●	★	★	●	■	■	■
Sandhills III	■	●	■	■	★	■	■	■	■
Sandhills IV	■	●	■	■	★	●	■	■	■
Oak Savanna III	●	●	●	★	★	●	●	■	■
Oak Savanna IV	●	●	●	■	★	●	●	●	■
Buttes II	■	■	■	★	★	■	★	■	■
Ponderosa Pine Forest II	■	■	★	★	★	■	★	★	★

CG = Conventional Geophysical
WD = Wildcat Well Drilling
R = Refining
PT = Local Power & Telephone
MR = Maintenance Roads

TV = Thumper/Vibrator Geophysical
FD = Field Development
P = Pipelines
AR = Access Roads

● = Low
■ = Medium
★ = High

gas resources can be lightened through planning and site design. In High Susceptibility areas the cost of that "adequate" job may be considerable; under these conditions, the decision must be made whether to sacrifice the activity or the visual value.

During the period of occupancy, the visual effect of activities is quite different from the traces of activity that remain in the long term. The perception of the activity during operating phases may elicit curiosity and interest or disgust. After the activity has been discontinued, however, inharmonious remnants in the natural and agrarian landscape, with few exceptions, are considered by most individuals to be counter-productive, wasteful, and unsightly.

During the actual operations, oil and gas development appears to be the use of the area and within this area can be viewed as necessary and productive, if not attractive visually: there is a "fit" of the use in the public's perception. Afterwards, however, the dominant use is agrarian and certain kinds of remaining disturbance do not fit. Exceptions are features of historical value, which may generate interest, and those rare locations, such as in industrial areas in towns and cities, where the differences in character are imperceivable.

Long-term impacts would result from changes in vegetation due to unsuccessful rehabilitation, changes in landform, or improper cleanup of the area. The sight of spoiled, unproductive land and inharmonious land character would be disturbing to the essentially agrarian residents.

Cultural Resources

Based on the small amount of inventory conducted in North Dakota—approximately 2 percent statewide and much less than 2 percent in federal gas and oil reserve tracts—the exact location of cultural resource impact areas cannot be determined (see Map 2.2-10). Even with this small amount of inventory, it has been demonstrated that impacts to cultural resources are likely to occur as a result of oil and gas development activities. Survey data indicates that from 5 percent (C. Dill, SHSND) to 20 percent (Loendorf, UND) of development activities impact cultural resources. A wide range of site densities can be expected across the State, but it is unlikely that any area is devoid of cultural resource sites (see Map 2.2-11).

The oil and gas operations that have the most impact on cultural resource sites are those operations that disturb the ground. This kind of disturbance has the most impact because of the nature of cultural resources. These resources are made up of features and artifacts which represent the living activities of humans in the past. In order to interpret what features and artifacts mean, their position relative to one another and to their surroundings must be preserved intact.

A concentration of stone tools and animal bones close to a fire hearth can provide important information, such as when the camp was used, an approximation of the number of people using the site, what animals were used for food, what kind of stone tools were being made, and a general idea of the climatic conditions prevailing at the time the site was occupied. All of these things lead to a better understanding of man's relationship to his environment, and this relationship cannot be fully understood if any part of a cultural resource site is disturbed.

Oil and gas activities may also cause indirect impacts to cultural resources. Some of these impacts are caused by an increase in the number of people in the vicinity of cultural resources. When the number of people increases, there is often an increase in vandalism to sites and collection of artifacts from them. The degradation of the natural setting in the vicinity of a cultural resource site is another secondary impact. Without the natural setting, the resource loses some of its values. Many other secondary impacts exist, and care must be taken to protect cultural resource sites from them.

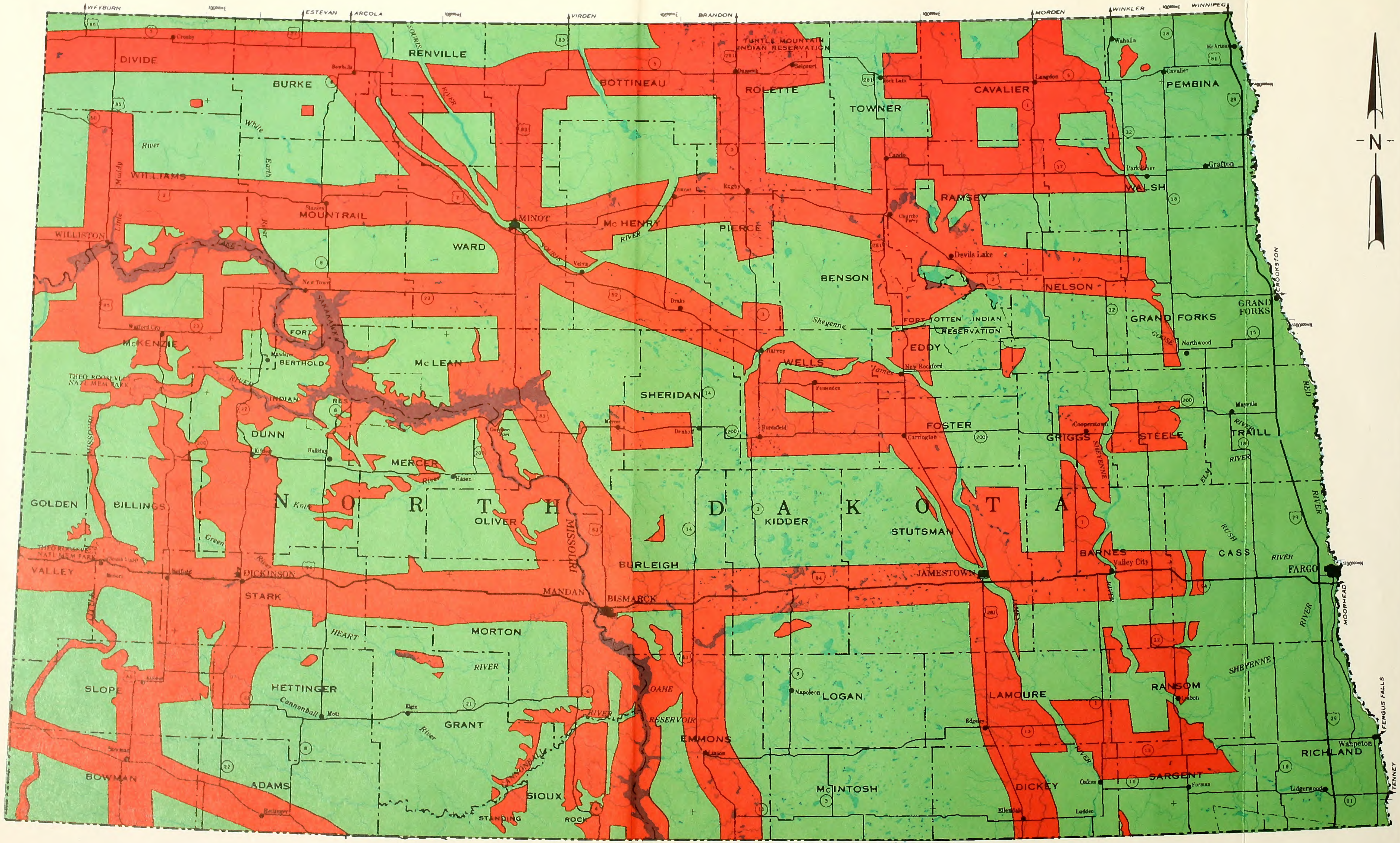
Preliminary Exploration

The majority of preliminary geophysical exploration procedures do not entail significant ground disturbing activity. However, certain terrain problems or specific methods could impact prehistoric or historic features.

Even though rubber-tired trucks are normally used, rough terrain or drainage crossings may require dirt work. It is not possible to delineate major areas of the State where geophysical operations would not entail limited road construction. However, the Badlands and Breaks regions have greater potential for dirt work, due to rough terrain, than other regions. While some regions have generally rolling or gentle topography, isolated areas exist within these regions that would require work before rubber-tired vehicles could be used. Scraping of snow to clear routes or work areas could also cause ground disturbances and thus affect sites.

The vibrator and thumper methods of geophysical exploration may minimally disturb sites if they are conducted immediately on or over a site. More serious impacts might be caused by the use of explosives to generate measurable sound waves. If explosives are used on or near the surface, they could cause cratering that would damage sites. Shock waves from the explosion could also crack or alter rock formations in the immediate vicinity of the explosion and, therefore, could damage petroglyphs and pictographs.

Pot-hunting, collecting, and vandalism by members of work crews conducting these geophysical operations might occur. Also, the increase in the number of roads could allow greater public access to cultural resource sites and could lead to deterioration or destruction of the resource.



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DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

VISUAL CHANGE SUSCEPTIBILITY GEOPHYSICAL EXPLORATION

LEGEND

MAP 2.2-5

SUSCEPTIBILITY TO VISUAL CHANGE

- Moderate Susceptibility
- High Susceptibility

Conventional Seismic Exploration — Short Term
Vibrasizor Exploration — Short Term
Access Road Construction — Short Term

SOURCE: BLM Staff Analysis, 1980.

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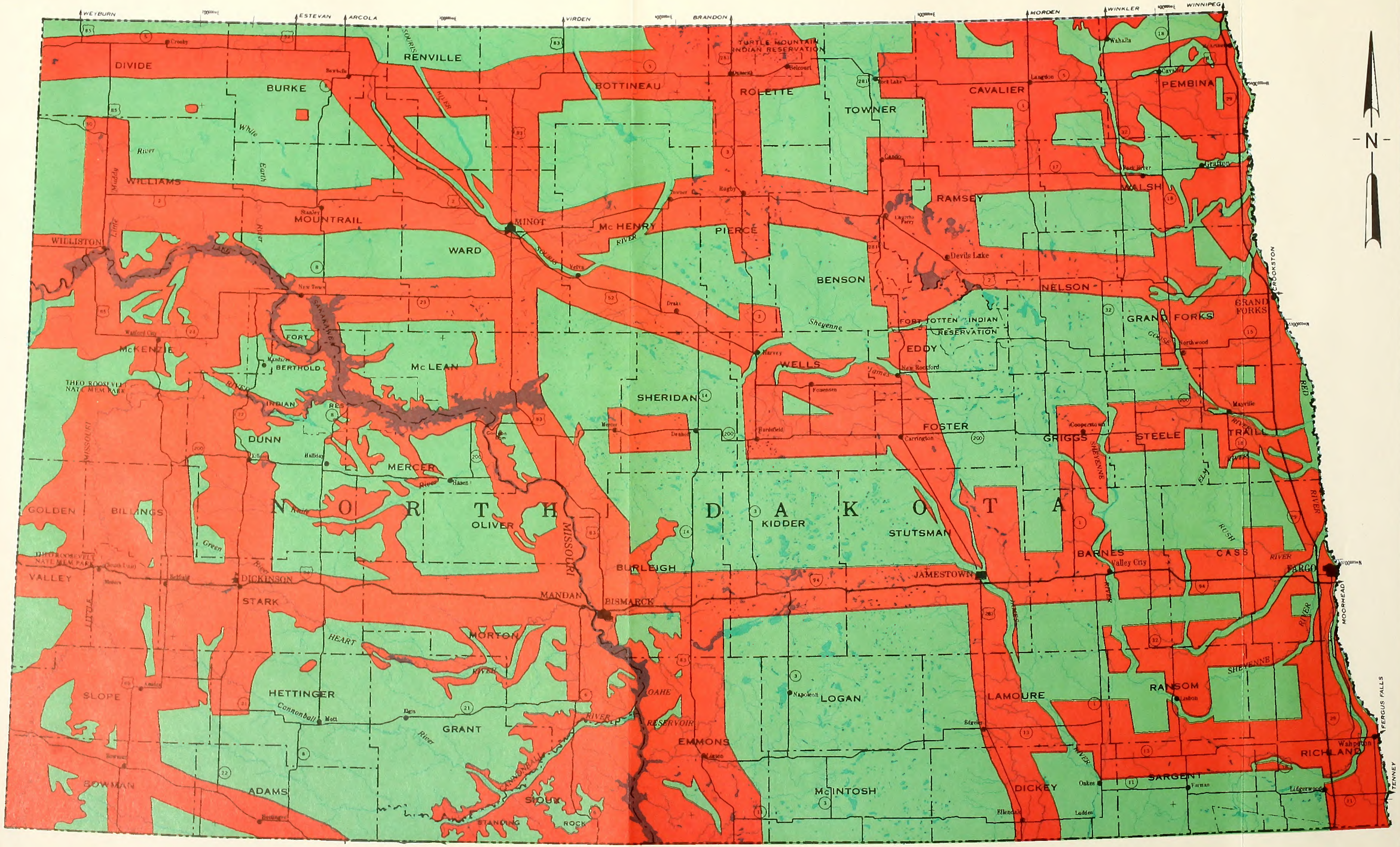
DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

VISUAL CHANGE SUSCEPTIBILITY EXPLORATORY DRILLING



LEGEND

MAP 2.2-6

SUSCEPTIBILITY TO VISUAL CHANGE

- Moderate Susceptibility
- High Susceptibility

Exploratory Drilling — Short Term
Access Road Construction — Short Term

SOURCE: BLM Staff Analysis, 1980.

UNITED STATES DEPARTMENT OF THE INTERIOR
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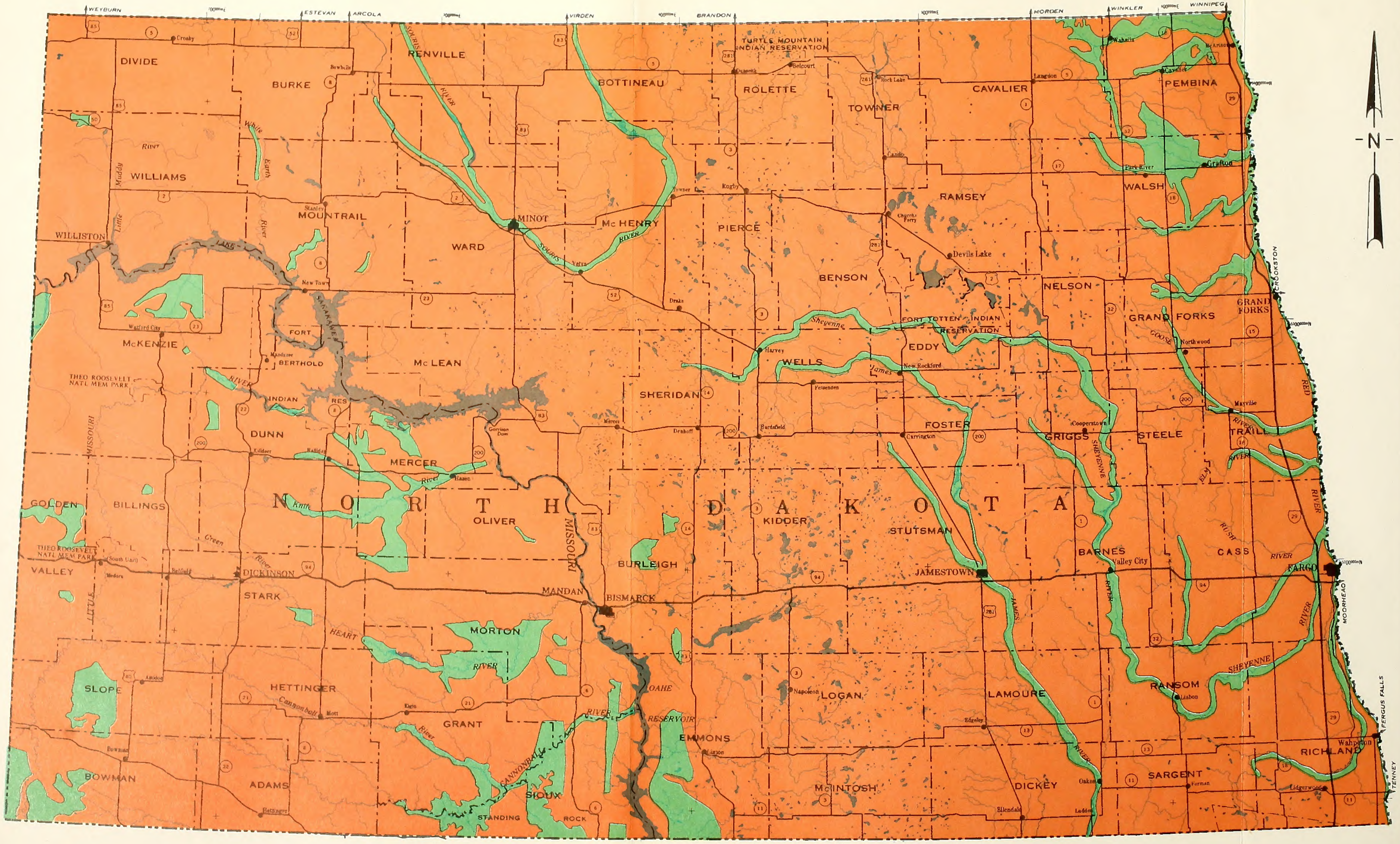
DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

VISUAL CHANGE SUSCEPTIBILITY

PRODUCTION



LEGEND

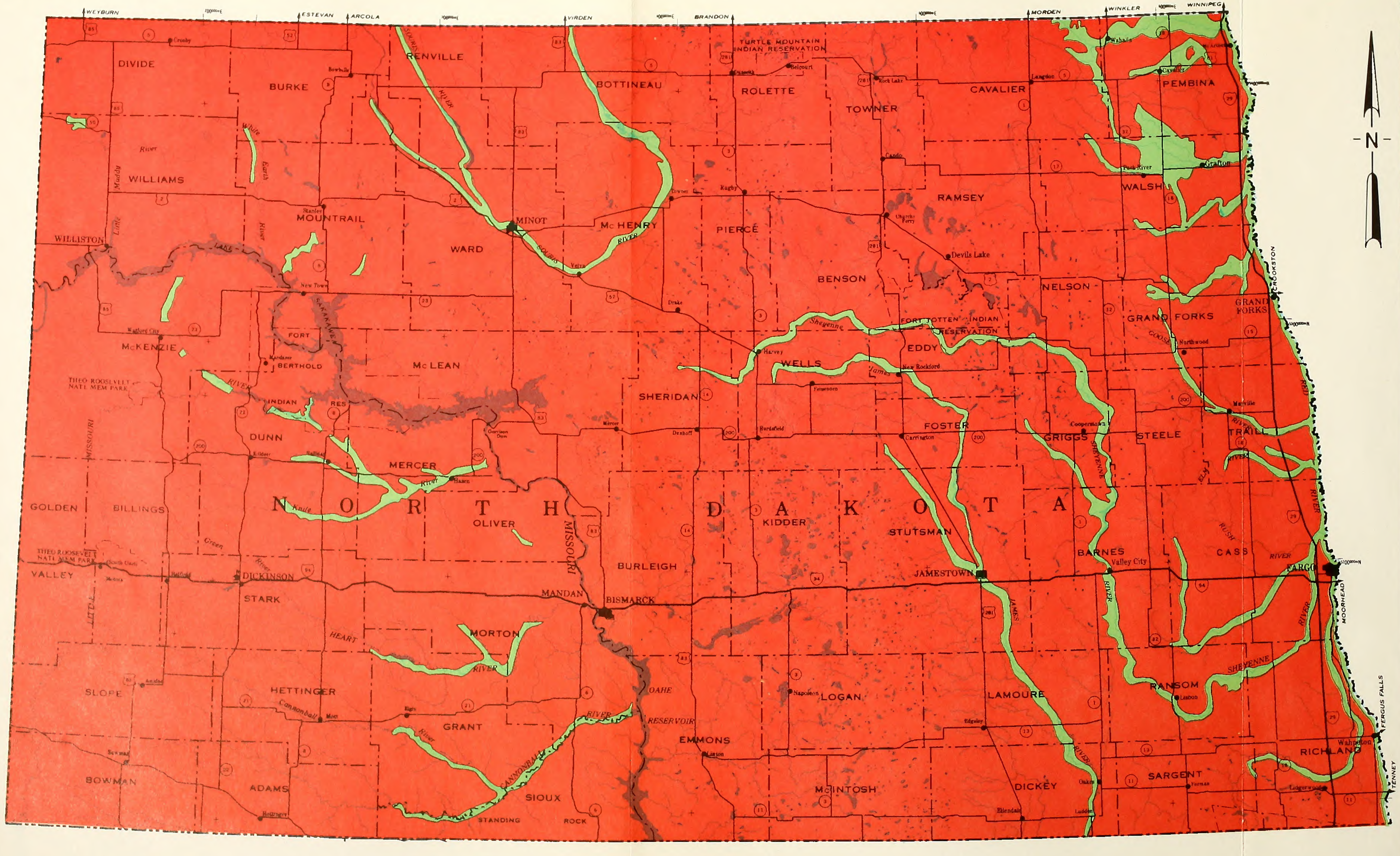
MAP 2.2-7

SUSCEPTIBILITY TO VISUAL CHANGE

- Moderate Susceptibility
- High Susceptibility

Production Facilities — Short Term
Pipelines — Long Term
Local Power and Telephone — Long Term
Access Road Construction — Long Term
Maintenance Roads — Long Term

SOURCE: BLM Staff Analysis, 1980.



UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

VISUAL CHANGE SUSCEPTIBILITY FIELD DEVELOPMENT

LEGEND

MAP 2.2-8

SUSCEPTIBILITY TO VISUAL CHANGE

- Moderate Susceptibility
- High Susceptibility

Field Development — Short Term
Pipeline Construction — Short Term
Local Power and Telephone — Short Term
Access Road Construction — Short Term
Maintenance Road Construction — Short Term

SOURCE: BLM Staff Analysis, 1980.

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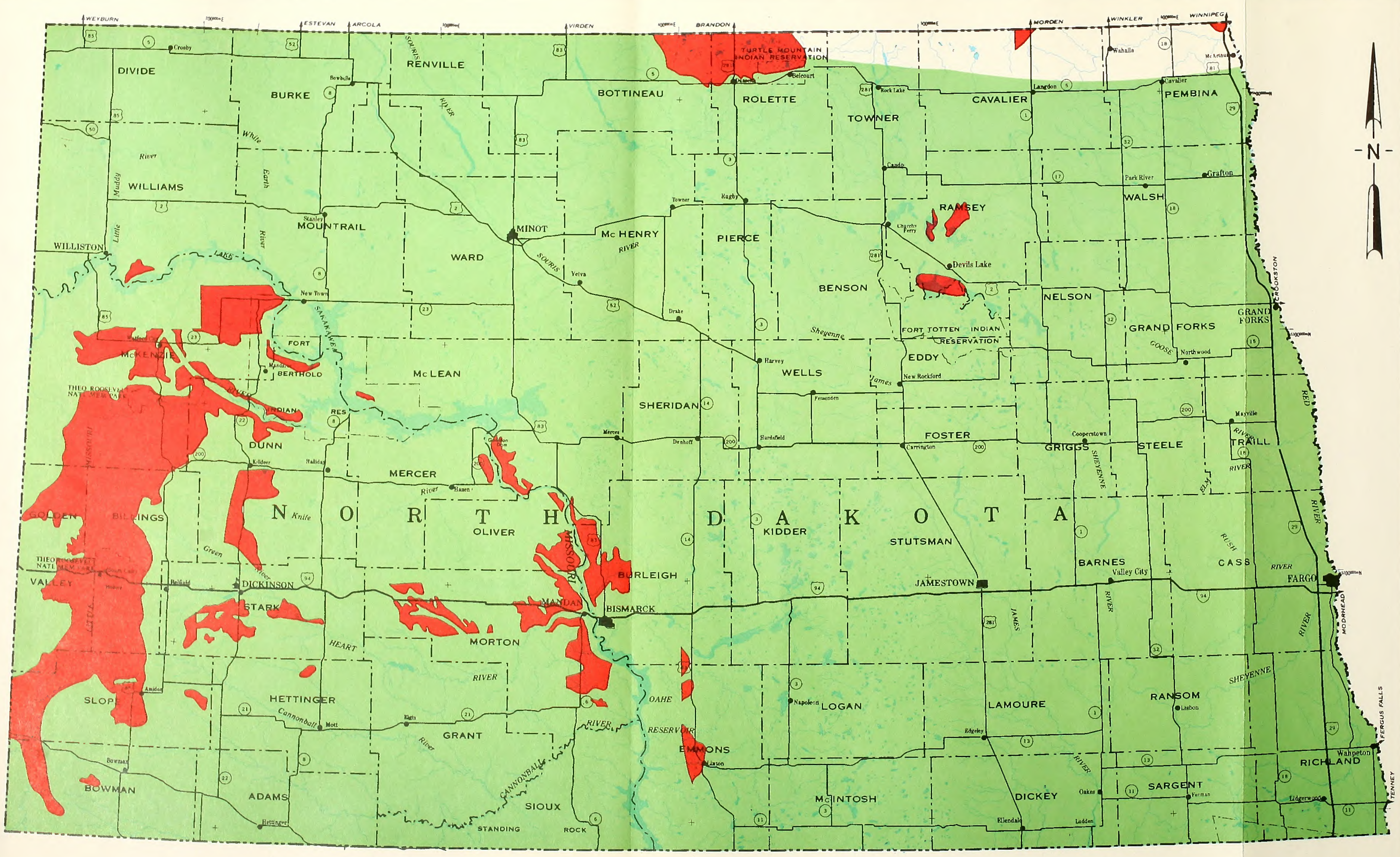
DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

VISUAL CHANGE SUSCEPTIBILITY

ABANDONMENT



LEGEND

MAP 2.2-9

SUSCEPTIBILITY TO VISUAL CHANGE

- Moderate Susceptibility
- High Susceptibility

Conventional Seismograph Exploration — Long Term
Vibrasizor Exploration — Long Term
Exploratory Drilling — Long Term
Field Development and Production — Long Term
Pipelines — Long Term
Local Power and Telephone Service — Long Term
Access Roads — Long Term
Maintenance Roads — Long Term

SOURCE: BLM Staff Analysis, 1980.

UNITED STATES DEPARTMENT OF THE INTERIOR
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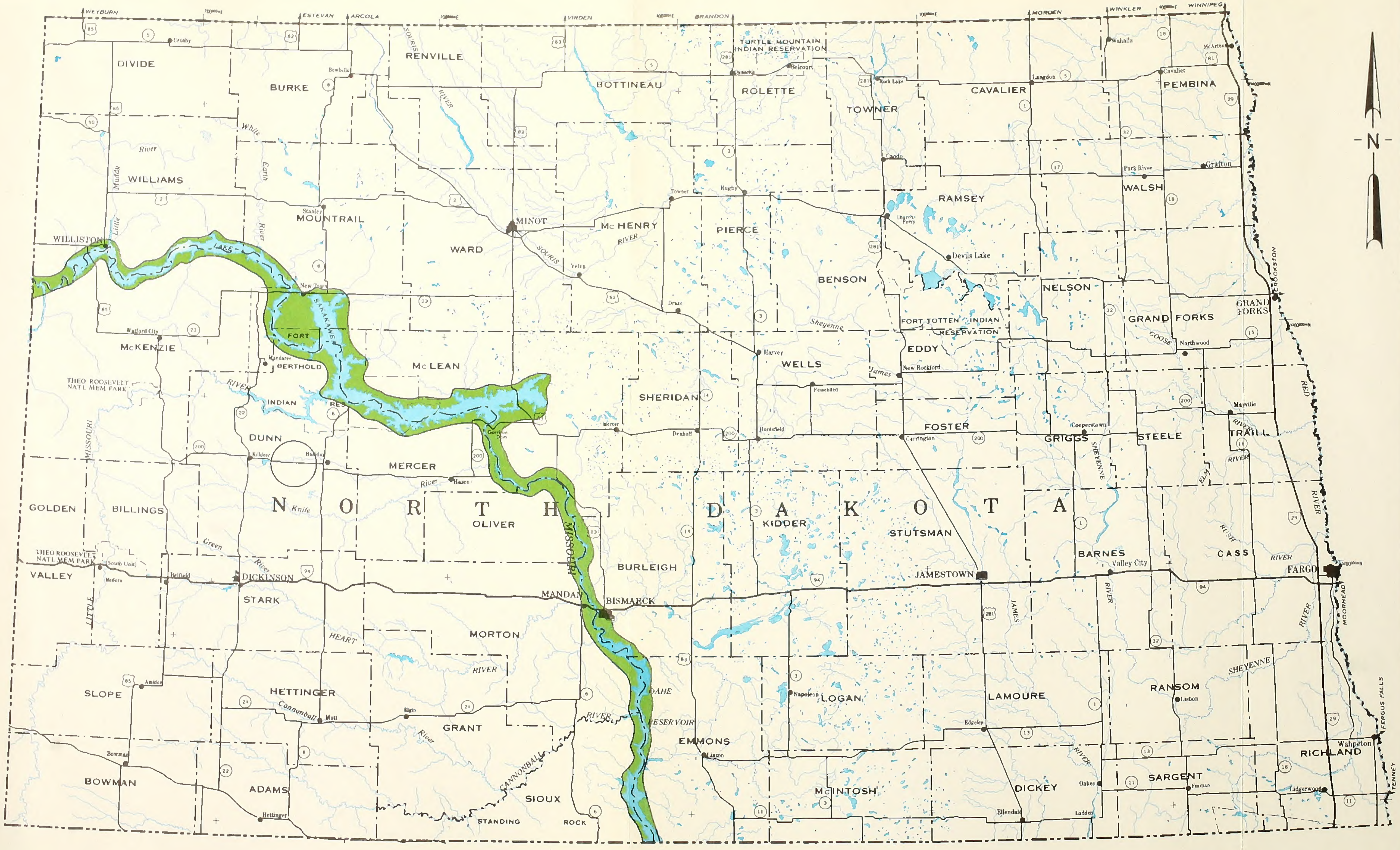
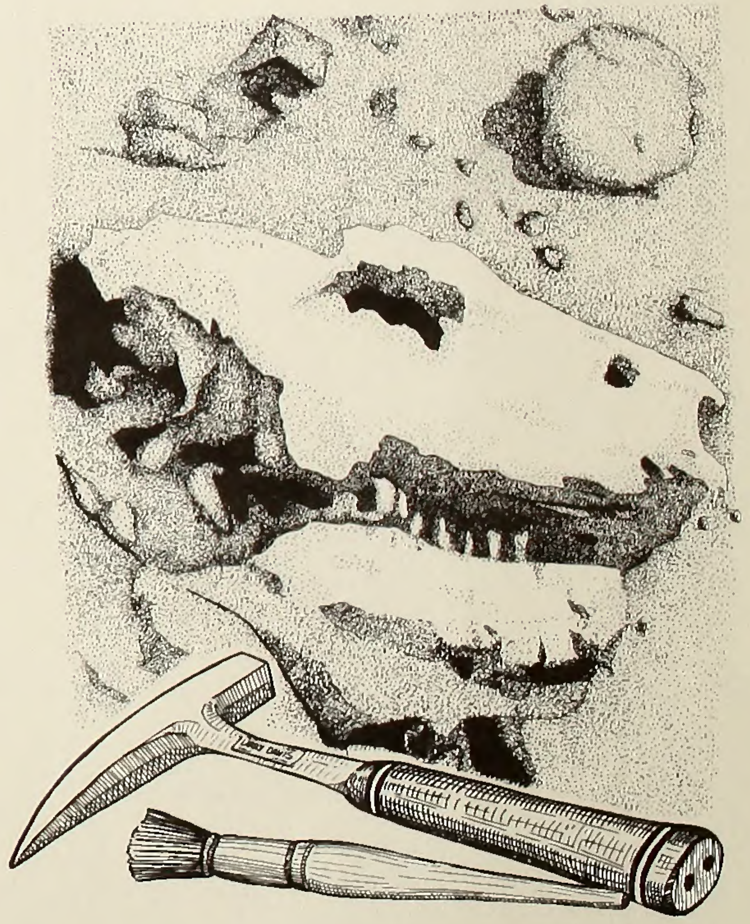
DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

RELATIVELY HIGH ARCHAEOLOGICAL SITE DENSITY
(West of the 100th Meridian)

LEGEND **MAP 2.2-10**

Sensitive Areas





SOURCE: BLM Staff Analysis, 1980.

UNITED STATES DEPARTMENT OF THE INTERIOR
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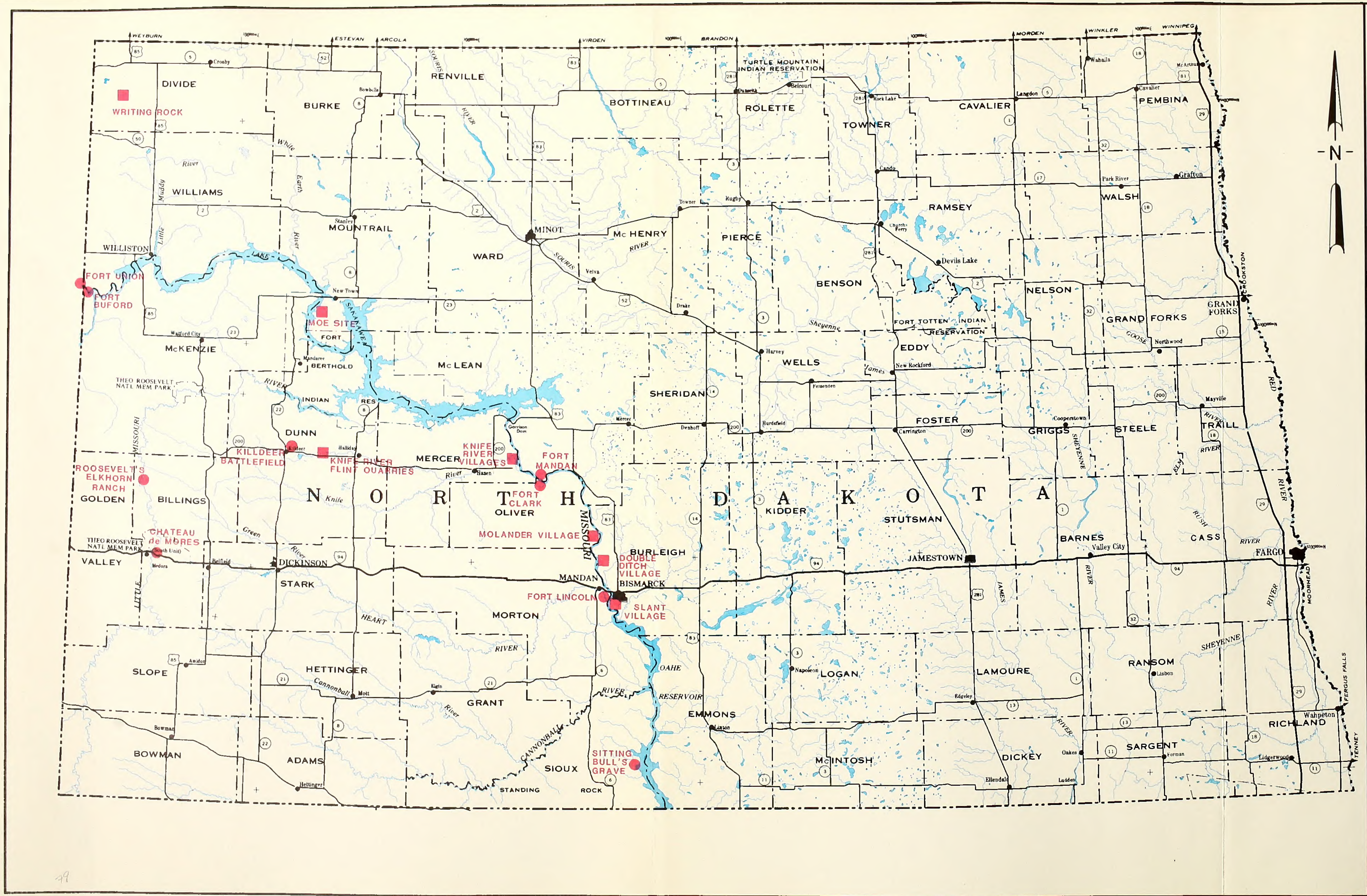
DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

ARCHAEOLOGIC, PREHISTORIC AND HISTORIC SITES



MAP 2.2-11

LEGEND

■ Critically Sensitive Prehistoric Cultural Resource Sites

● Critically Sensitive Historic Cultural Resource Sites

SOURCE: BLM Staff Analysis, 1980.

Exploratory Drilling and Development

The activity with the most impact to prehistoric and historic features could be exploratory drilling and development of discovered oil and gas resources. These actions always require construction of a drill pad, and—for development—ancillary facilities, including mudpits, waste piles, reserve pits, tanks, and flowlines. Although not always the case for stratigraphic exploration drilling, road construction may be required. All of these activities require ground disturbance, the impacts of which result in severe damage to and probable destruction of any historic or prehistoric sites located where this disturbance would occur.

Secondary impacts could result from pot-hunting and vandalism by drilling, construction, and maintenance personnel and by the public (because of increased access). Visual intrusions to cultural resources would also result and continue as long as the drilling and/or development structures remain.

Production

This phase of oil and gas activities would cause no further ground disturbance impacts, unless new wells were drilled. Direct impacts would then be limited to the location and pad of any new wells, or to the oil/gas gathering lines serving new wells.

The secondary impacts of pot-hunting, vandalism, and disturbance of the integrity of cultural resources by visual intrusions could occur.

Abandonment

Unless rehabilitation of the well site entailed new ground disturbance beyond that of the original drill pad and facilities, no major impacts to historic and prehistoric features would be expected to occur. Disturbance of cultural features by work crews could result in impacts to sites.

The probable magnitude of the impacts discussed above cannot be anticipated for the State, due to the absence of extensive inventory or federal oil and gas tracts. However, based upon what inventory has taken place and upon the sites that are known in the State, the following sensitivity classifications for oil and gas operations can be made:

Sensitivity Class	Description
Class A, Non-Sensitive Area	Tracts that have been inventoried and in which no sites were identified;
Class B, Sensitive Areas	Known historic and prehistoric sites;
Class C, Critically Sensitive Areas	Recorded sites that are known to have exceptional value, because they may yield important scientific information, or because of their potential for interpretation and public enjoyment;
Class D, Requires Further Study	Areas that have never been extensively inventoried for cultural resources.

At present, only a few Class C sites are known, (see Table 2.2-8). The sites included in this table occur within the impact zone of a federal oil and gas reserve tract. They may not necessarily occur on the federal oil and gas estate tracts themselves. The number of sites in the Class C category is expected to increase as more sites are located and identified and more is learned about existing known sites.

Table 2.2-8
Critically Sensitive Cultural Resource Features

1. Double Ditch Village — Large 18th-century Earthlodge Village, T140N, R80W, Section 21 and 22.
2. Medicine Rock — Petroglyph/Rock Alignment Site, T133N, R88W, Section 31.
3. Big Mound Battlefield Area — Battle of July 24, 1863, T140N, R71W, Section 4, T141N, R71W, Section 24, Tappen Area.
4. Cannonball Stage Station — Station on the Bismarck-Black Hills Trail, T132N, R86W, Section 29.
5. Camp Weiser — Sibley Campsite, July 13-14, 1863, T137N, R57W, Section 33.
6. Knife River Flint Quarries — Prehistoric Flint Quarries, Dunn and Mercer Counties.

Economic Conditions

Economic impacts resulting from oil and gas activity are most likely to occur during large-scale field development. Most of these impacts would occur within communities in which the oil and gas workers chose to reside and/or recreate. The most immediate economic and social impacts in areas of past oil and gas activity center around the population influx generated by increased earnings and employment.

Development

For the purpose of this analysis, it is assumed that likely direct and indirect employment levels associated with development of a major oil and/or gas field are as follows: 190 direct, 173 indirect, 363 total.

These direct employment levels were observed in the Bell Creek Field of southeastern Montana, which experienced a major oil and gas development in the late 1960's. The remaining phases of oil and gas activity are not expected to create significant economic impacts and are not analyzed further.

It is assumed that 50 percent of all direct oil/gas development workers are married and that 50 percent of those bring their families along, i.e., 25 percent of the total, or 48 workers. Consequently it is likely that major field development would result in a total direct population association of approximately 310 individuals, assuming 3.5 members per family.

95 — Unmarried
48 — Married, with family along
120 — Family (wife plus 1.5 children)
47 — Married, family not along

310 — Total

The indirect workers would most likely be available in the study area and consequently would not result in an in-migration of population.

In most cases the in-migrating married workers (48) with families along would prefer to reside in houses or apartments. Consequently, all of them are assumed to seek housing in town. Of the remaining 142 workers (190 total direct workers—48 workers with families along), it is assumed that all would choose to live separately and that half (71) would attempt to find housing in town, with the other half living in mobile homes on the outskirts of town or near the development site.

Under this set of circumstances, the work force would require 119 housing units (48 plus 71)—excluding mobile homes—in a town within commuting distance of the oil/gas field. The population influx into a town within commuting distance from a major field would be approximately 240 individuals.

71 — workers without families (including married without family along and single)
48 — workers with families
120 — family members (wife plus an average of 1.5 children)

239 — Rounded to 240 persons

Based upon this impact scenario, it is possible to estimate general sensitivity concerning impacts resulting from nearby oil/gas field development. The above direct population and employment levels expected to be associated with major field development constitute approximately 0.1 percent of the total estimated 1980 population base of the study area and 0.1 percent of the 1977 employment base. While this is not a significant impact when measured across the entire study area, it could create severe problems if it occurred in one of the communities within the study area. Table 2.2-9 shows the percentage change in population, employment, and personal income levels in each county if major oil/gas field development of this level occurred nearby. It is, of course, unlikely that major field development would occur in all of the locations listed; however, the table does show what the total impact would be if major development does occur in one or more of these locations.

Table 2.2-9
Estimated Direct Impacts from Major Field Development

County	Percentage Population Increase[1]	Percentage Employment Increase[2]	Percentage Personal Income Increase[3]
Adams	6	10	19
Billings	24	30	71
Bottineau	2	4	7
Bowman	5	9	17
Burke	6	9	17
Burleigh	—	1	1
Divide	6	8	16
Dunn	6	10	20
Golden Valley	9	16	30
Hettinger	5	9	19
McKenzie	4	6	11
Mountrail	3	5	10
Renville	6	11	20
Slope	19	28	51
Stark	1	2	4
Ward	—	1	1
Williams	2	2	3
Total	0.1	0.1	0.3

Note: Community income and employment levels not available. See Table 2.2 for population impact estimates for selected communities.

[1]Population influx of 240 people resulting from major field development, measured against 1980 population forecasts.

[2]Assumes direct employment levels of 190, measured against 1977 level (latest year for actual employment data).

[3]Measured against actual 1977 personal income levels. These percentages are calculated using an average annual wage rate of $21,000/year for 190 direct oil/gas field workers associated with major field development.

Table 2.2-10 shows that several communities in the study area would experience a 20 percent or greater increase in population if the estimated population influx (240 people) associated with major field development were to actually occur during a period of two to three years. Similarly, six of the 17 counties would experience employment increases of 10 percent or more as a result of the direct employment associated with major field development.

Although the likely impacts from full major field development would be relatively short-lived (i.e., 4 to 6 years), the intensity of the impacts could be severe in communities which do not have excess service capacity with respect to water, health services, sewage treatment, and other infrastructure items. It is assumed that any community which experiences a 20 percent growth in population as a result of energy development during this four to six year period would experience severe problems providing housing and basic public services. For this reason, the major economic impact indicator used in the analysis is the effect of the population influx (240 people) associated with major oil or gas field development on the communities' general infrastructures.

Table 2.2-10
Estimated Direct Population Impacts on Communities From Major Field Development

Community	1976 Population Estimate	Percentage Increase[1]
Hettinger	1,630	15
Medora	19	202
Bottineau	2,859	8
Bowman	2,045	12
Bowbells	556	43
Bismarck	39,838	1
Crosby	1,503	16
Killdeer	651	37
Beach	1,291	19
Mott	1,372	17
Watford City	1.800	13
Stanley	1,822	13
Mohall	958	25
Marmarth	198	121
Dickinson	12,509	2
Minot	32,885	1
Williston	11,692	2

[1]Influx of 240 people measured against 1976 population estimate.

Source: Population estimates from Population Estimates & Projections, U.S. Dept. of Commerce, Census Bureau — 1979.

Social Conditions

This section describes the social impacts on communities in western North Dakota that would result from the leasing of federal oil and gas described in the proposed action. The impacts are presented according to the phase in which they occur and whether they occur in the (overall) 17 county area or only in Billings, Bottineau, Bowman, Burke, Dunn, Golden Valley, McKenzie, Mountrail, Renville, Stark, and Williams counties, the intensive study area.

Preliminary Exploration

Social impacts which develop during the preliminary exploration phase of oil and gas activity will only be felt minimally throughout the 17 county study area. In those communities where oil and gas discoveries are marginal, the impacts during the preliminary exploration phase might not even be noticed.

Housing. In the intensive study area, which is experiencing the heaviest concentration of oil and gas activity, it would be difficult to provide temporary housing during the preliminary exploration phase; whereas in the other counties in the study area, where oil and gas activity is not expected to be as intense, impacts would be minimal. Examples of communities within the intensive study area that would be under stress to provide motel rooms and apartments to meet new demands would be Watford City, in McKenzie County; Stanley, in Mountrail County; Bowbells, in Burke County; Medora, in Billings County; and Golva, in Golden Valley County.

Social impacts on public housing in the preliminary exploration stage would not be felt in either the general or intensive study area, because public housing is specifically designated for that segment of the population which is either retired or on welfare.

Education. The preliminary exploration phase is associated with transient workers who are constantly moving in and out of the area. They would probably not create a strain on the education system, because these workers do not normally bring their families with them during this phase; however, since the school systems are inadequate in Billings and Slope counties, there is the possibility that even the slightest increase in population might have an impact on them. Because of this, these counties should be prepared to examine ways of expanding their school systems if the need arises.

Health Care Facilities. Health care services would not ordinarily be impacted by oil and gas activity during the preliminary exploration phase in the 17 county study area. Small, temporary influxes of population would not significantly increase the demand for health care services even in the counties with intense seismograph activity.

Police, Fire, Water, and Sewage Services. During preliminary exploration phases of oil and gas activity, it is unlikely that additional law enforcement personnel would be needed. This prediction is based on two factors: first, most communities in western North Dakota have very low crime rates; and, second, preliminary exploration activity does not significantly raise population levels to a point where there is a corresponding rise in crime rates.

Preliminary exploration for oil and gas would not significantly increase the need for fire protection in any of the 17 counties.

During the preliminary exploration phase of oil and gas activity, it is doubtful that the influx of population would be sufficient to impact the water and sewage system of any community to any measurable extent. This might not be true for the 11 county intensive study area, because the intensity of the activity would create a greater influx of people into the area during this phase.

Transportation. Transportation in the 17 county study area during preliminary exploration is not likely to be impacted. Since the main mode of transportation in the area is by private automobile, minimal increase in population under this phase of leasing will not affect either private or public transportation. The amount of increased traffic which would occur during the preliminary exploration phase of oil and gas activity would certainly not be sufficient to impact common carriers. This is also true of the 11 county intensive study area.

Exploratory Drilling Phase

Housing. It is doubtful that impacts to housing would surface during the exploratory drilling phase of oil and gas activity. During this phase oil and gas discoveries might materialize, but oil field workers with their families would not make plans to move into the area until actual development begins. Demand for motels and apartments in certain communities would increase. Impacts to public housing would not be felt, because public housing is constructed for elderly and low-income people.

Education. Education during the exploratory drilling phase would not be substantially impacted by new oil and gas activity, for at this point, new oil and gas discoveries would not as yet have reached the labor intensive developmental phase. New discoveries would only be anticipated; therefore, population growth or in-migration would not begin yet on a permanent basis. Oil field workers would be at the planning stage of bringing their families into the area at this point; therefore, local community schools would not yet be receiving additional enrollees. If additional students were enrolled in Billings and Slope counties due to in-migration during this phase, these two counties would experience a significant impact, because of currently inadequate school systems.

Health Care Services. Health care services during the exploratory drilling phase of oil and gas activity would not sustain any significant impacts, but the need for medical services would increase proportionately to the amount of in-migration.

Police, Fire, Water, and Sewage Services. Police, fire, water, and sewage services would only be affected minimally in the general and the intensive study areas during the exploratory drilling phase. Of these, police protection is the service which would probably be the most affected. In this phase of oil and gas activity, workers come into an area on an intermittent schedule. For the most part, they do not bring their families with them. After work hours they have a lot of leisure time to spend without their families; therefore, they tend to spend this time in local bars. The more time spent in bars, the more chances for illegal behavior to take place. This type of entertainment would increase the need for additional police protection and would be needed most in those counties where intense oil and gas activity is most likely to occur. This would be in Billings, Bottineau, Bowman, Burke, Dunn, Golden Valley, McKenzie, Mountrail, Renville, Stark, and Williams counties.

Transportation. Transportation in the 17 county study area would not be affected to any great extent during the exploratory drilling phase of oil and gas activity, except that there would be more traffic and heavier equipment rolling over local roads. Public transportation would not be affected significantly during the exploratory drilling phase of oil and gas activity.

Development Phase

Housing. The same assumptions used for the economic discussion (preceding section) are used here, i.e., employment levels of 190 direct, 173 indirect. Housing is probably the one area more than any other which would be most affected during the developmental stage of oil and gas activity. All of the communities which would be called upon to provide housing for the incoming workers would be strained to provide it. In the 17 counties where new oil and gas discoveries are anticipated, communities such as Crosby, Mott, Amidon, Bowbells, Stanley, Watford City, Williston, and Killdeer, might experience difficulty in providing additional housing.

Public housing in these communities would also feel an impact. Those persons living in public housing because of low income might find that after securing a higher paying job in the oil and gas industry they might be ineligible for this type of housing.

Education. Educational facilities would also be strained during the development phase of oil and gas activity. With an average of over 3 persons per family, the addition of a number of families into a particular area would cause problems in a local school system. In those counties in the general study area, but not in the intensive study area, it is anticipated that there would be enough education facilities to accommodate the additional school enrollment adequately. However, in Billings, Bottineau, Bowman, Burke, Dunn, Golden Valley, McKenzie, Mountrail, Renville, Stark, and Williams counties, where new oil and gas discoveries are anticipated to be the largest and richest, greater school enrollment would be a real problem. This would be particularly true where school districts and schools are just sufficient to meet current needs now. Communities that could encounter problems with school enrollment would be Mohall, in Renville County; Beach, in Golden Valley County; and Marmarth, in Slope County.

Health Care Services. Impacts to health care services would probably not be significant during the development phase of oil and gas activity. Medical needs associated with oil and gas activity result from mechanical injury, burns, or hydrogen sulfide poisoning. Four of the counties within the study area appear to have adequate medical facilities at the present time; however, only one of these, Stark County, is within the intensive study area. The anticipated influx of 240 persons into a given community within the 17 county area warrants minimum consideration for expansion of present medical facilities.

Police, Fire, Water, and Sewer Services. The need for police services during periods of oil and gas development would continue to grow, as it did during the exploratory drilling phase. Even though oil field workers would now have their families with them and would be living in a home environment with more leisure time spent at home, there would be more population to provide protection for. This is particularly true of the intensive area of oil and gas, where the population influx would be the heaviest.

Water and sewage services may be impacted quite severely during the developmental stage of oil and gas activity. Next to housing, it is probably the most impacted infrastructure. Every new home which is built would have to have the proper amount of accessible water lines and sewage disposal units to accommodate incoming families. If the influx of people is too great, community officials would have to look for alternative sources of water to supplement their present capacity, which could mean purchasing water at a very high cost. This could happen in Killdeer, Marmarth, Bowman, or Hettinger (Dunn, Slope, Bowman, and Adam counties, respectively).

Fire services would not be impacted to any great extent during the developmental phases of oil and gas activity, but the probability of fires would increase, simply because there would be more houses in the communities. However, the percentage increase of homes would not be sufficient in either the general or intensive study area to warrant an increase in fire protection due to oil and gas activity.

Transportation. Present forms of transportation would be affected very little due to oil and gas activity in either the general study area or the intensive study area. However, the amount of traffic which flows through the area and the weight of the equipment which is necessary to conduct oil activity would increase the need for road maintenance. This increased maintenance could become a priority issue in the communities.

Production Phase

In the 17 county study area, those impacts described in the developmental phase of oil and gas activity are also applicable during the production phase; therefore, there is no further discussion regarding the impacts during the production phase. This is true for all infrastructures in the intensive study area as well as the general study area.

Abandonment Phase

Housing. In the general study area, there are some very clear and definite social impacts which could occur to housing during this phase of oil and gas activity that are distinguishable from impacts in other phases. During this phase of oil and gas activity there would probably be a large number of homes for sale, property might go down sharply, and there might be an increase in the demand for public housing. In small communities such as Golva, Marmarth, and Parshall (Golden Valley, Slope, and Mountrail counties), this could be a major impact. It is estimated that up to 119 homes in a community close to an abandoned field might be vacated during this phase of oil and gas activity.

Education. Education in the general study area would be one of the least affected infrastructures in the abandonment phase of oil and gas activity. No significant impacts on schools in either the general or intensive study area should be felt.

Health Care Services. Health care services would not be impacted as a result of the abandonment phase of oil and gas activity. This would be true for the intensive as well as general study area. Present health care arrangements seem to be adequate to take care of present and future needs in the study area, regardless of oil activity or not.

Police, Fire, Water, and Sewer Services. Less police protection would be needed during the abandonment phase of oil and gas activity in the general study area. If communities had expanded their police force to accomodate an influx of population, which would probably have been the case in the intensive oil and gas areas, they may lay off some officers during abandonment.

Fire protection would remain static during the abandonment phase of oil and gas activity.

Water and sewage services would be negatively impacted during the abandonment phase of oil and gas activity in both the general study area and the intensive study area. With the out-migration of about 240 persons from a community, there would be approximately 119 homes no longer needing water. Communities such as Watford City, Beach, and Stanley would have to anticipate a reduction in need for water services during the abandonment of oil and gas activity.

Transportation. Since the main mode of transportation in the general study area is the private automobile, transportation would not be impacted to any extent and therefore will not be discussed.

Land Use and Transportation

Oil and gas activities have a wide range of effects of varying duration. The intensity of the oil operation is the biggest factor in determining whether or not there will be significant changes within a given area. As the intensity of the oil and gas activity increases, so does the demand for land and transportation.

The ownership distribution, whether it be federal, state, or private, has little to do with impacts associated with oil and gas exploration and development. Virtually all areas that are considered to have high potential are under lease. The oil companies' operations usually are conducted in similar manner within given areas, regardless of ownership.

Preliminary Exploration

The major impact of preliminary exploration is trampling of the land along seismographic lines. Some compaction may occur on clay soils if there is sufficient moisture. The trampling of grass and crops usually causes only a shor-term loss. The cuttings from seismic holes that are scattered on the nearby area usually cause very little damage or production loss. In rough topography it is necessary to clear vegetation and blade a temporary road to gain access to some areas. Other than compaction, the thumper process causes very little surface disturbance.

Exploratory Drilling

Although exploratory drilling is not as widespread as the initial seismic work, it usually causes more disturbance in localized areas. The drill pad usually consists of about one-half acre. This is usually a one to three day operation. Some operations blow the chip cutting out of the hole and scatter it nearby, while other operations require a mud pit. All of these impacts, if occurring during the growing season, temporarily reduce production of crops or grass in the operation area.

A temporary increase of road usage is associated with exploratory drilling, but public roads are usually adequate to handle the increased activity. Temporary roads are usually needed to provide access from the public roads to the drill site. They occupy approximately two acres per mile of road length.

Wildcat drilling occurs on areas where exploratory drilling has shown a good possibility for oil or gas to exist. The number of wildcat wells are greatest near the new field discoveries. Wildcat drilling may last for six months. These localized areas are impacted by removing land from production during the drilling process. The number of wells per section varies according to the State of North Dakota's spacing regulations for a particular oil and gas field. Each well location requires 1-4 acres of land for the drill pad and approximately 2-6 acres for an access road (assuming a 50-foot-wide right-of-way and a length of from 1/4 mile to 1 mile). The land used for roads and drilling pads is abandoned if sufficient quantities of oil or gas are not discovered. This land can then be returned to its origial use.

Development

Development occurs when there is a discovery. Up to 16 oil wells or 4 gas wells per section may be drilled if the field is capable of supporting this many. These wells occupy the same size area (1-4 acres) as a wildcat well during the drilling period; however, the total land area occupied after the pump is in place is usually less than 1/2 acre. The area used for roads remains approximately the same as that for a wildcat.

The development of more than one pool could increase the density of wells. Sometimes two or more pools may be tapped from the same drill pad. Multi-tiered pool discoveries are common within the Williston Basin. The extent of developing two or more pools from one location and the impacts associated with this type of development are impossible to predict.

Production

During the production phase additional land is required, such as well sites, flowlines, separators, treaters, tank batteries, roads, pipelines, and powerlines. Most of the land that is acquired for these uses is agricultural. Pipelines are generally buried, occupying minimum surface area. Also, powerlines occupy very little area. Tank batteries and treatment facilities may occupy 1-3 acres. The increased vehicle activity associated with production often requires low-standard county roads to be upgraded, usually by widening and adding rock surfacing material. Roads that had been constructed at drilling time are usually upgraded to provide a permanent all-weather road.

The impacts on land use and transportation that are associated with oil and gas production cannot be fully assessed, because of the wide variation that may exist between oil fields.

Abandonment

During the abandonment phase most of the oil and gas facilities are removed, but buried pipelines are usually left in place, because the salvage value does not justify the removal expense. The abandoned land area can return to its prior use, assuming good reclamation practices are followed.

A few of the roads that serve more than just oil and gas workers will be left in place, and these may become public use roads. Some roads may deteriorate, due to a lack of maintenance.

The use of lands for oil and gas exploration, development, and production is considered to be a short-term use with local significance. The short-term use period ranges from a few weeks for exploration work to 20-30 or more years for production from a good field. While less than five percent of the land within a developed field is usually occupied by oil or gas facilities, the average state-wide development would occupy considerably less than five percent of the State. Agricultural use of the affected lands is precluded during the short-term use. With proper reclamation, lands used for oil and gas facilities can be returned to an agricultural use, and long-term productivity can be ensured.

The increase in oil and gas activities has placed additional demands on all transportation facilities. Vehicle traffic has increased on city, county, and state systems. Any additional activity in the Williston Basin will increase traffic congestion even more. The basic road system that existed prior to 1975 was generally adequate to absorb a certain amount of traffic increase. However, some new streets and roads have been improved to handle some congested areas. As the traffic count continues to rise, so will road construction and improvement.

Counties within the active areas are experiencing—and can expect to continue to experience—road maintenance problems, because the county road systems were generally designed for farm use. The heavy loads of oil field equipment and supplies can cause the roadbed to break up. These roads have to be upgraded to withstand the loads of oil and gas traffic.

Airport and other public transportation facilities near major oil strikes are experiencing increased use. Expansion of these facilities may be necessary to keep up with the growing demand.

Benefits derived from oil and gas production are significant in terms of economics and resource development. Oil and gas production is greatly needed to supply the State and Nation with a much needed energy supply.

Irretrievable resources are those which are lost during the short-term use period with no way to get them back. Crops, livestock, and wildlife are irretrievably lost when the land use change requires that the vegetative cover be removed. The extent of these losses is considered to be insignificant when comparing the size of the conversion area to the size of the area that is still productive.

2.3 MITIGATING MEASURES

Introduction

This section describes measures which would reduce or eliminate negative impacts resulting from oil and gas activity in the Dickinson District.

The geographic scope of this assessment makes it extremely difficult to formulate mitigating measures that would apply to each site. Consequently, many of the mitigating measures which follow will not apply to all sites. Instead, these measures apply to those areas exhibiting environmental features that are especially sensitive to oil and gas activity (e.g., fragile soils, endangered species).

At the time of lease or during the predrill inspection, the full range of mitigating measures will be considered, with the objective in mind of protecting those sensitive or critically sensitive features found within a specific lease area.

The existing BLM/GS stipulations package is found in Appendix 2-1. This is a listing of the mitigating measures most often used by the two agencies that are most directly involved with leasing of federal oil and gas resources. Appendix 2-1 does not contain a complete listing of mitigating measures.

Special lease stipulations could limit the lessee's normal enjoyment of the lease. For example, the stipulations might state that portions of the lease area cannot be occupied or used during certain parts of the year to protect wildlife or watershed. Also, they could require unique or unusually expensive steps by the lessees. Special situations could involve extremely unstable formations, extremely high pressure water flows, or identified critical habitat for threatened or endangered species, etc.

When a lease goes to the development stage, the lease operator files an application for permit to drill (APD) and a Multipoint Surface Use and Operating Plan, as required by NTL-6 (see chapter 1, Table 1-1). After the APD and Multipoint Plan have been filed, an on-site inspection (referred to as a predrill inspection) is conducted. At this time representatives from BLM, USGS, the operator, and dirt contractor make a site-specific inspection, and additional stipulations for protection of the environment are developed.

Methods of seedbed preparation and seed mixtures can be left open until the time the actual rehabilitation operation is begun. However, if a need for hard-to-find native seed, special seedings, or tree or shrub planting is anticipated, it should be stipulated at the time the application for the drilling permit is being approved.

The need for using special stipulations must be supported by this assessment or by documentation included with the recommendation for applying the stipulation. This documentation is included in the lease file.

In addition to those stipulations attached at the time of the lease, other mitigation measures can be implemented at the time of the predrill inspection.

Some of the following mitigating measures would appropriately be used at the time of lease; others would be more appropriate when the application for the drilling permit is being processed.

Climate and Air Quality

The Ambient Air Quality Standards must not be exceeded during any oil and gas development.

Roads and pads must be kept watered or oiled to control dust. This keeps suspended particulates at a minimum.

Wells yielding hydrogen sulfide gas in too great a concentration to be separated from the natural gas must be flared. This will reduce hydrogen sulfide and natural gas pollutants entering the atmosphere.

Keep all equipment being used in efficient operating condition. This will minimize the amount of vehicle exhaust emissions.

Geology

Known paleontological sites should be protected by proper stipulations, and—if necessary—a "no occupancy" stipulation.

If paleontological sites are encountered by surface disturbances directly related to oil and gas activities, the sites should be left intact and the district engineer, U.S.G.S. should be notified.

Direct resource conflicts (existing coal mines, sand and gravel pits, etc.) should be avoided if possible. Special stipulations should be prepared on a case-by-case basis by the district manager, BLM.

If a proposed oil and gas drilling site falls within an existing coal mining operation, the development of the coal resource should have precedence. The proposed drilling site could possibly be offset to avoid a direct conflict. If there is no actual mining of the coal resource in the area of the proposed drilling site, then oil and gas development should proceed.

Soils

The following lease terms are designed to protect the surface, natural resources, and improvements, and to keep oil and gas lessees from unnecessarily causing (or contributing to) soil erosion or damage to crops, forage, or timber.

During preliminary exploration allow no blading, dirt work, or tree removal without written permission from the district manager. Operate all vehicles at a reasonable rate of speed. Use existing roads and trails wherever possible; if new roads and trails are constructed, follow natural contours of the land where feasible. Reseed all disturbed areas until adequate vegetative cover is established. Rehabilitate disturbed areas concurrently with geophysical operation in so far as possible. Save and respread suitable plant growth material on disturbed areas to help insure that adequate vegetative cover is established.

Backfill drill and seismic shot holes with cuttings and the material thrown out by the explosion and tamp to form a solid plug. Haul extra material to a disposal site or scatter to ground level.

Restrict exploration, drilling, or other development during muddy and/or wet periods. This will help minimize erosion, instability, and compaction. This limitation does not apply to maintenance and operation of producing wells.

Establish restrictions on the following: the location of drilling or other exploratory or developmental operations, or the manner in which the operations are to be conducted; the types of vehicles that may be used and areas in which they may be used; and the manner or location in which improvements such as roads, buildings, pipelines, or other improvements are to be constructed. Such restrictions, where necessary, will protect the soil from excessive erosion and compaction and will reduce problems with instability and sterilization. These restrictions will help ensure successful rehabilitation.

Place oil and gas occupancy and activity restrictions on specified areas or within a specified distance from those areas to protect the soil. These restrictions can limit the distance between drilling or storage facilities and specifed objects or areas. They can prohibit surface disturbance on slopes in excess of a specified percent. They can also restrict exploration, drilling, and other development activity during a specified period for an identified area, for stated reasons.

Place seasonal restrictions on surface disturbing activities from oil and gas development in order to minimize watershed damage and protect fragile soils. This is important to the soil resource, especially in helping to control erosion and reduce excess compaction.

Where alternate routes provide adequate access, avoid road construction on steep hillsides and near watercourses. Avoid disturbance of drainages and high erosion hazard areas. Construct temporary and permanent roads to adequate specifications to avoid problems with erosion and instability. Place drainage structures and crossings at proper locations in the roadbed in order to maintain the natural drainage of the area. This will help control excess erosion and keep the road from washing out. Stockpile surface soil material for later rehabilitation of the roadway. Avoid soil loss or mixing with less desirable material by careful placement and protection of the stockpiles. The stockpiling of suitable plant growth material during surface disturbance is an important procedure in all phases of oil and gas development.

As much as possible, construct pipelines and flowlines to avoid steep hillsides and water courses. Also, to minimize surface disturbance, construct them alongside existing roads. Compact pipeline trenches during backfilling to prevent problems with piping and gullying. Avoid soils that are corrosive to metals, if possible. Treat pipelines with a protective coating before burial or lay them on the surface if corrosive soils cannot be avoided.

Locate well sites, tank batteries, pumps, reserve and mud pits, etc., on the most nearly level location obtainable that will accommodate the intended use. In order to minimize earthwork and resulting problems with erosion, instability, and rehabilitation, adjust the site layout to best fit the topography. Construct reserve pits that will not fail. Line them to prevent contamination of ground water and soil. Develop, if necessary, drainage at site locations, so that if any type of spill or well blowout occurs, the oil, drilling mud, or other contaminant would flow into reserve pits. This will decrease the threat of soil sterilization. Rehabilitate all portions of a site not required for the continued operation of the well as soon as possible to prevent erosion, and put the land back into forage or crop production.

Provide a seedbed for establishment of desirable vegetation and shape the landscape to blend with the natural contour when reclaiming abandoned sites. Use rippers, discs, and/or other implements to initially break up the surface. Rehabilitation may include contour furrowing, terracing, reduction of steep cut and fill slopes, waterbarring, etc. Seed by drilling on the contour whenever practical to control erosion. Mulching, fertilizing, fencing, or other practices may be required to retard erosion, provide a good supply of available nutrients to the new seedlings, and protect the area from disturbances.

Confine vehicular traffic to prepared roadbeds and site location as much as possible throughout the time that oil and gas activity is occuring. This will help to minimize excess compaction and erosion.

Locate borrow pits and borrow areas away from roads and public use areas. Stablize and revegetate borrow areas after use.

Vegetation

Comply with state regulations for plugging seismograph shot holes. Continue the restriction of bulldozer work in seismograph operations.

Avoid constructing well sites too close to drainages to minimize watershed contamination.

Keep access road widths to a minimum and avoid steep slopes.

Construct protective dikes around all production facilities (i.e., tank batteries, treaters).

Line reserve pits where necessary to protect watershed resources.

Limit by advance planning unnecessary surface disturbance for roads, pipelines, and other facilities.

Require proper rehabilitation practices to obtain revegetation of unused areas as quickly as possible. Shaping of the site, proper seedbed preparation, mulching, seeding, fertilization, and protective fencing are to be emphasized.

Fence and flag reserve pits and other hazardous areas to protect livestock and wildlife.

Require contingency plans from operators for control of oil spills.

Water

The amount of soil disturbance must be minimized. By keeping the area disturbed to a minimum, the availability of sediment loading material will be minimized.

Avoid any routes that cross areas with greater than 30 percent slopes. Soil erosion, and hence sediment loading, generally becomes critical at slopes greater than 30 percent.

Avoid any routes which cross or enter ephemeral, intermittant, or perrenial stream channels with a drainage area greater than 10 square miles above the crossing. Avoiding stream channel crossings will protect the riparian zone and reduce sediment loading. Where channel crossings cannot be avoided, allow no access during muddy and/or wet periods. Wet or muddy conditions promote surface disturbances, and activity during these periods unnecessarily increases sediment loading.

Do not allow the detonation of explosives within 500 feet of any water well or spring.

District personnel will continue on-the-ground examination of all exploration activity sites both before work begins and after completion. As impacts are often site-specific, most problems are found and solved by an on-site examination.

Whenever possible, construct drill pads on level or nearly level ground. The more slope there is on drill pad sites, the more sediment is produced.

Minimize the size of the drilling pad and the amount of earth moving work necessary for pad and road construction, because a smaller disturbed area produces less sediment.

Require that pipelines, storage and treatment sites, and roads and their associated water control features be constructed according to the "Surface Operating Standards for Oil and Gas Exploration and Development" (Prepared by Bureau of Land Management, U.S. Geological Survey, and Forest Service). Culverts must be able to handle a 50-year runoff event.

Washed out roads and culverts are often responsible for the largest impacts on sediment loading of local streams.

Require no occupancy on the 100-year floodplain of the Little Missouri, Missouri, Souris, Knife, Spring Creek, Heart, Cedar, Cannonball, James, Red, and Sheyenne rivers. If possible, avoid 100-year floodplains of wetlands and of any streams (other than those named) which have a drainage of greater than 20 square miles upstream from the proposed site. Where this is unavoidable, the district hydrologist will be consulted for a recommendation on site acceptability and location. Locating drilling activity out of floodplain areas will prevent sediment and other water pollutants from entering streams during periodic flooding and will avoid placement of mud pits in generally porous alluvial valley fill.

Any produced waters may be reinjected into groundwater reservoirs containing equal or poorer water quality than the produced water. Water which is not reinjected into groundwater aquifers cannot be discharged from the well site. This prevents the degradation of good quality surface and ground water sources.

There are many state and federal regulations that require reporting oil spills and minimizing downstream impacts of the spills. The operator must report any spill incident as soon as practical, but within a maximum of 18 hours. The operator must then clean up the mess. Most established oil fields will have catchment basins or mechanical skimmers located on streams which drain the oil field.

To the extent practical, restore all disturbed areas to their original condition. Restoration of contour, stream channel stabilities, and vegetative cover will bring sediment production back to pre-development levels.

Animals

Listed below are special stipulations and mitigating measures for specific wildlife resources.

1. Do not allow oil and gas activity within a half mile of sharp-tailed and sage grouse breeding grounds from March 15 to June 15.

2. No occupancy will be allowed on Critically Sensitive winter ranges of mule deer, white-tailed deer, and bighorn sheep between November and April 15.

3. No occupancy, seismographing with explosive charges, or roads will be allowed on or within 500 feet of

prairie dog towns; and one-half mile from confirmed black-footed ferret habitat.

4. Occupancy will be restricted within 800 feet of Critically Sensitive waterfowl nesting areas from March 1 to July 1 and from August 15 to January 1.

5. Occupancy and other oil and gas activities will be restricted within a half mile of critical habitat of threatened and/or endangered species. The spirit and intent of the Endangered Species Act is to forbid any action which degrades endangered species and/or habitat. The endangered species which could be adversely affected by oil and gas leasing are the whooping crane, swift fox, peregrine falcon, bald eagle, and black-footed ferret.

The Bald Eagle Act further protects bald eagles and extends protection to golden eagles. The definition of "take" encompasses any tangible or intangible disturbance of an active nest.

6. The BLM and the oil and gas lease company cooperatively formulate plans for conducting seismographing operations and developing oil fields to minimize the amount of land and vegetation impacted by roads and trails.

7. Seismographic operations will not be allowed in roadside ditches from March through mid-July in intense farming areas to minimize disturbance to the only available habitat for nesting birds.

Recreation

The following special stipulation is recommended:

Forbid any surface disturbances on or within 660 feet of recreational sites.

Cultural Resources

When leasing and developing oil and gas reserves, companies are required to comply with cultural resource related laws that include the Antiquities Act of 1906, the National Historic Preservation Act of 1966, the National Environmental Protection Act of 1969, Executive Order 11593, the Archaeological and Historic Preservation Act of 1974, and the Federal Land Policy and Management Act of 1976. The oil and gas companies are committed to this compliance through Standard Lease Terms, Section 2.q., and through additional cultural resource stipulations attached to all oil and gas leases (MSO 3100-47) emanating from the Montana State (BLM) Office. These stipulations and requirements also entail a commitment to satisfy 36 CFR 60 and 36 CFR 800, regulations to enforce the National Historic Preservation Act of 1966.

The Montana State Office stipulations (MSO 3100-47) require that: (1) the area to be disturbed by oil and gas operations be inventoried for prehistoric and historic features by a qualified archeologist; (2) an inventory report including descriptions of the area inventoried and features present be submitted; and (3) appropriate mitigating measures be applied. Also, if previously undiscovered cultural remains are found during oil and gas operations, it is required that the ground disturbance halt immediately and the discovery be reported to the USGS district engineer for appropriate action (see Appendix 2-1).

In Class A, Non-sensitive Areas, it is presumed that inventory has taken place and reporting has shown no surface indication of prehistoric or historic cultural features. Oil and gas operations can proceed in these areas, with the operators using caution to observe for unreported cultural resources. Operators are also required to take whatever measures are necessary to preserve cultural resources, so that secondary impacts to sites, by vandalism or pot-hunting by work crews, can be controlled.

Class B, Sensitive Areas are areas that have been completely or partially inventoried and in which cultural resource features are known to exist. Special stipulations should be added to the lease that specify the mitigating measures required by MSO 3100-47. These measures may require avoidance of the site, further inventory, collecting, mapping, testing, literature and title searches, photography, or excavation of a site to recover data. The preferred mitigation is to avoid cultural resource sites by relocation or redesign of the disturbing activity. Generally, such relocation is a minor adjustment for the operator. Larry Loendorf of the University of North Dakota has stated that in all inventories he has conducted for oil and gas operations, it has been possible to avoid cultural resources when they are encountered by moving the operation a short distance away. Chris Dill of the State Historical Society of North Dakota states that all sites evaluated as "significant" by cultural resource professionals and found to be directly impacted by oil and gas operations have been mitigated by avoidance. Minimally significant sites have occasionally been mitigated by recording and testing prior to disturbance or destruction by the proposed activity. Previously undiscovered sites and secondary impacts of pot-hunting and vandalism are to be treated in the manners previously discussed.

Class C, Critically Sensitive Areas, should be avoided. These types of areas can only be mitigated by avoidance, or by extensive excavation that may require many months. Some of these areas have socio-cultural values that could never be recovered once destroyed. Should avoidance be impossible, measures must be taken to fully comply with "Procedures for the Protection of Historic and Cultural Properties" (36 CFR 800). Criteria for determining eligibility for the National Register of Historic Places must be applied if this has not already been done. If the site has been (or is) determined to be eligible by the keeper of the National Register, it is necessary to consult with the State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation regarding disturbance to the site. If the SHPO and advisory council comment that the oil and gas operation will have an adverse effect on the site, the BLM district manager can—upon the advisory council's advice—require the operator to avoid the area containing the site. Such a decision rests with the district manager.

Class D Areas (Requires Further Study) are areas that have had no inventory for historic and prehistoric features. Some sites or site leads may exist for the area, but the data may be an isolated occurrence or may lack confirmation. This classification does not prevent leasing, but does require the applicant (operator) to follow all sections of MSO 3100-47: inventory, reporting, and mitigation of impacts to prehistoric and historic features. Mitigation could take the form of three different actions: (1) if cultural resources were present, the operator could move his operation to avoid the site; (2) if the site were critically sensitive and the operator could not move his operation, the site would fall under the enforceable measures of Class C, above; and (3) if the site could be mitigated by data recovery and the operator could not move his operation, the operator would be required to take the appropriate measures for recovery of data, up to complete excavation of the site, after compliance with 36 CFR 800.

Previously unknown features located during oil and gas activities in Class D areas would be treated in the manner previously discussed. Section 2.q. of the Standard Lease Terms commits the applicant to take whatever measures necessary and reasonable to protect historic and prehistoric sites, features, and artifacts from disturbance, destruction, or removal; thus, it requires the applicant to prevent pot-hunting, collecting, vandalism, and other worker-caused impacts.

Visual Resource Management (VRM)

1. Design and planning and all activities for new facilities should give long-term rehabilitation precedence over short-term visual impacts. Design and planning criteria shall include:

a. Use of flatter slopes, rather than steep slopes, for all grading activity;
b. Avoidance of treed areas and use of vegetation for screening;
c. Use of natural breaks in vegetation for road and utility construction;
d. Use of natural topographic breaks for road and utility construction;
e. Joint use of access roads and strict limitations of vehicle use on other than established roads by operators during field development and recovery phase;
f. Avoidance of hard rock areas, where possible, to eliminate irreparable headwalls or reduce their height;
g. Avoidance of side hill locations for access roads where possible;
h. Avoiding construction of slopes steeper than 3:1, where this does not make long-term rehabilitation more costly;
i. Use of native plant materials for rehabilitation and use of the types of vegetation existing on the site before construction;
j. Use of rehabilitation techniques compatible with future use of the area.

2. It shall be required that the district manager approve all plans and designs. Information contained therein shall be mutually satisfactory to the BLM district manager and the local representatives of USGS, in terms of the portrayal of site conditions and the prognosis for successful rehabilitation. The lessee shall be required to provide all necessary additional information at his own expense before the permit shall be processed, shall modify plans and designs to the satisfaction of the district manager, and shall provide adequate lead time for the processing of permits.

3. Structures in areas of rustic pastoral character (as determined by the district manager) shall be free from clutter and painted in earth tones. The colors shall not necessarily blend with the natural or pastoral landscape, but should present a well-maintained and clean appearance. Drab grey and dark green should be avoided. Colors shall be approved by the district manager, where not specified by the Occupational Safety and Health Administration.

Economic Conditions

Primary impacts would be in communities that are called upon to provide services and housing to incoming oil/gas workers. The main impacts would be a shortage of housing and public services needed to accommodate the population influx associated with the development nearby of a major oil/gas field. Consequently, mitigation of these impacts would center around reducing the total population influx by hiring local labor whenever possible and by the oil/gas development company providing some services whenever practicable.

The following measures would, if implemented, reduce these impacts in direct proportion to the degree to which they are implemented:

Basic training of local labor by the oil/gas companies to reduce population influx.

Company-sponsored temporary housing in the form of bunkhouses or trailer pads/hookups. This could be combined with appropriate incentives to insure that these units are utilized (e.g., bus service provided by the oil/gas companies on weekends to retail trade and recreational centers).

Company-sponsored physical and mental health care for workers.

Company-sponsored training concerning the dangers of hydrogen sulfide. This should include oil and gas workers, as well as residents of areas where hydrogen sulfide is expected to be a problem.

Social Conditions

The primary social infrastructures that would be impacted as a result of oil and gas activity in the 17 county study area would be housing, water and sewage services, education, police and fire protection, and health care services.

Mitigating the social impacts would consist of hiring and training local residents whenever possible. This would mean establishing upward mobility positions in as many areas as possible, in order that local persons in the community could be prepared to take over upper-echelon positions as they are vacated by persons who were brought into the community from other areas. It means that private oil and gas companies should be prepared to offer some type of assistance to local communities in helping to establish better health and educational services. This would be particularly appropriate in Billings and Slope counties in the study area. In Billings County there is just one school district for some 1,139 square miles, and in Slope County there is 1 LPN for 1,224 square miles. The oil companies should also help prepare temporary living quarters to accommodate the new families. If needed, they should also assist in providing some form of transportation to and from the job site where necessary.

Land Use and Transportation

To lessen adverse impacts associated with oil and gas development is very important. Cooperation between government and the general public is essential to prevent degradation of our land.

The enforceable measures that can be applied to land use are the approved "Surface Disturbance Stipulations" to control the location, design, construction, and abandonment of improvements used for oil and gas activities. Minimal soil and vegetation disturbance should be emphasized in all operations. As facilities are abandoned, the land which they occupy should be reclaimed to its prior use. Lessee should be required to build, improve, and maintain roads to suggested standards and specifications as outlined in the oil and gas handbook (Surface Operating Standards for Oil and Gas Exploration and Development). Close supervision by the BLM can insure strict compliance with the surface disturbance stipulations.

2.4 RESIDUAL IMPACTS

This chapter discusses likely adverse impacts remaining from section 2.2, Environmental Impact Assessment, after application of the measures discussed in section 2.3, Mitigation.

Climate and Air Quality

The mitigation described in section 2.3 will keep air quality impacts at a minimum but will not eliminate them. It is impossible to estimate what this residual level will be, but it should be small. The present air quality monitoring system is inadequate, but as this system improves, the magnitude of these residual impacts will become clearer.

Geology

If oil and gas development occurs simultaneously with coal mining, some coal reserves could be permanently lost by bypassing the buffer zone surrounding the drill site. If oil and gas was not discovered, conflicts would be minimal, and coal mining would only be delayed temporarily. Coal beds near the drill site would be protected by a string of surface casing during drilling operations.

Soils

Even if all rules and regulations are followed and the best procedures are used in all phases of oil and gas development, there will always be some problems with soil erosion, compaction, sterilization, and instability. These problems have a direct bearing on the success of rehabilitation. Soil sterilization will seldom be a problem, because enforceable measures will keep blowouts, and other contaminating accidents spills, etc. from infrequently occurring. However, when these accidents do occur, the size of the area affected is usually from less than an acre to several acres. Soil productivity could be lost for several years on these sites.

Soil instability and rehabilitation problems can usually be solved by applying various engineering and agricultural practices. Occasionally, however, oil and gas facilities will be placed on sensitive and critically sensitive soils. One to several acres could be involved at a specific site. Impacts may not be easily mitigated where steep slopes of about 15 percent or more are combined with highly erosive soils, or where highly saline/sodic soils are present.

Some soil erosion and/or compaction is always going to occur, no matter how well rules and regulations are followed or how much care is taken by the lessee. Most excess soil compaction can be satisfactorily reduced by using rippers, discs, and other implements to break up the soil. In some small areas, however, a soil layer may be compacted so hard that compaction may be visible even after ripping and discing. Many years may pass before these soils return to their natural condition. Since only small areas are normally involved, this problem is usually not of significant proportions, especially in comparison to excess compaction from other activities such as farming.

Erosion would be greatest during development and abandonment of oil and gas facilities. Rehabilitation would stabilize the sites, with erosion returning to predevelopment levels. Soil loss to erosion may not be any greater on an oil and gas site than if the same area were used for some other activity, such as farming or grazing, over the same period of time.

Vegetation

Reestablishing vegetation will be the most difficult on abandoned well sites and roads, especially in critical areas, such as those found in the Badlands. Grass cover can be reestablished on range, but it will take a long time for species diversification to return. On cropland, the productivity may never return to 100 percent of pre-development productivity.

Other impacts to vegetation are considered short-term, or the area of impact is very small when considering the total environment.

Water

If the previously mentioned mitigation measures are applied, sediment yields to stream channels can be held to an insignificant level under normal runoff conditions. The mitigation described would (at best) reduce any increases in sediment loading by 70 or 80 percent under normal conditions; thus, 20 to 30 percent of any increases would be residual impacts.

Of course, the possibility always exists that unusual events will occur—such as runoff exceeding the 50-year flow of culvert designs, or floods exceeding 100-year flood levels. There is a 45.5 percent chance of exceeding a 50-year event in 30 years, and a 26 percent chance of exceeding a 100-year event in 30 years.

The mitigation measures will also make accidents such as oil spills, leaks, and reservoir failures less likely to happen. However, the possibility of some water quality degradation will still exist.

Any water consumed during oil and gas activity will be unavailable for other uses. During peak periods of drilling activity, this amounts to enough water to supply a town of about 3000 people. Much of this water consumed, however, is brackish and unsuitable for most other water uses.

Animals

The greatest residual impact to wildlife and livestock would occur when a federal lease area is developed into a producing field. The magnitude of the negative impact is relative to the size of the field, spacing of wells, kind and number of roads, pipelines, necessary vehicle traffic, contaminants in oil or gas (H2S), amount of salt water, and the number and type of production facilities.

Large acreages of wildlife habitat and livestock forage would be lost for several decades in a large field. Continuous disturbance by vehicles and equipment would eliminate sensitive wildlife species, e.g., peregrine falcon (an endangered species) and mule and white-tailed deer. Intolerant wildlife would not use these sites until the field has been abandoned and reclaimed, even if there would be areas of suitable habitat available within oil and gas fields. Peregrine falcon and similar species are often adversely affected on off-site territories. Small mammals, reptiles, amphibians, and nestlings would be destroyed during the construction of oil field facilities.

Despite the best precautions, failures will occur. Adverse effects resulting from oil spills and blow-outs would depend upon the quantity of oil and gas or waste product released and the effectiveness of the clean-up. Even when reasonable efforts are expended for clean-up, some habitat and forage would be destroyed for one to five years. Aquatic ecosystems would be more severely degraded than upland sites from contaminating oil and waste products. The impact of hydrogen sulfide gas, which is toxic to wildlife, livestock, and vegetation, would be directly related to the quantity of the gas and the sensitivities of exposed animals and plants.

Recreation

Land occupied by and influenced by oil and gas activities would be lost to dispersed recreational opportunities (e.g., hunting, hiking, and camping) until the field is abandoned and reclaimed (estimated 20-35 years).

There are no standard or special stipulations which may be used to mitigate the increased demand for developed recreational facilities and programs, caused by oil and gas workforces.

Cultural Resources

Cultural resources avoided by oil and gas activities would not be adversely impacted. Sites that are not avoided can be evaluated using existing methodologies, but this will not recover all of the information that the resources contain. Therefore it is important that some cultural resources be left undisturbed in the oil development areas so that they can be evaluated in the future with improved methodologies.

Another residual adverse impact would result from non-avoidance of Critically Sensitive Areas. These sites have potential interpretive value through visitor-use and, hence, a socio-cultural value to a community, and/or they are difficult to mitigate by data recovery (for example, a historic townsite or a site that is important because of its association to a particular historic personality). Damage or destruction to a site of this class could not be mitigated.

The increase in the number of roads into an area due to oil and gas operations would provide increased access to cultural resource sites and could lead to an increase in amateur collecting, vandalism, and other human-caused disturbances to sites. This increase of human activities in an oil and gas area could accelerate deterioration of cultural resources, and this impact could not be mitigated entirely.

Economic Conditions

A certain level of population influx would be inevitable if major field development occurred. For this reason, a community close to a major development will almost certainly experience some strain on public services as a result of population growth. The exact level and intensity of both development and application of mitigating measures is unknown at the present; consequently, it is impossible to quantify the level of residual adverse economic impacts.

Social Conditions

Those impacts which would be left after applying mitigation measures cannot accurately be determined for the study area. However, one can deduce that the magnitude of residual impacts would depend on two things: the intensity of the oil and gas activity and the effectiveness of the mitigation used in the study area.

Land Use and Transportation

Land taken from agricultural use to support oil and gas operations would be unavailable for the production of grass, crops, and wildlife habitat until the area is abandoned and rehabilitated.

Oil wells generally have a life span of 35 years or less, but roads that provided access to oil or gas facilities may continue to be used for other purposes after an oil/gas field has been abandoned. The agricultural productivity of the lands occupied by these roads would be lost for an indefinite period.

Oil spills could cause a permanent reduction in the productivity of the soil.

CHAPTER 3

CHAPTER 3

ALTERNATIVES TO THE PROPOSED ACTION

INTRODUCTION

Chapter 3 addresses potential impacts from discontinuing BLM's oil and gas leasing program in North Dakota. The structure of BLM's oil and gas leasing program allows the discontinuation of leasing for appropriate reasons but does not provide for the setting of arbitrary production/leasing levels for federally administered oil and gas resources. Consequently, the No Action alternative is examined below, but accelerated or decelerated leasing levels are not analyzed, but would result in graduated levels of impacts in comparison to those discussed.

The discontinuation of BLM's Montana State Office oil and gas leasing program would result in the curtailment of future production of federal oil and gas resources. Immediate impacts would be: (1) a loss of these two fossil fuel sources to the State and Nation; (2) direct loss of employment and income for those oil and gas workers associated with the exploration, development, and production of federal oil and gas resources; (3) loss of economic production, due to elimination of this energy source; (4) indirect (secondary) losses in employment and income; (5) loss of federal oil and gas bonuses, rents, royalties, and filing fees; and (6) elimination of future surface disturbance on lands overlying federal oil and gas resources.

The following analysis discusses, by environmental component, the implications of discontinuing federal oil and gas leasing in the Dickinson District.

CLIMATE AND AIR QUALITY

If the No Action alternative were chosen, the resulting situation would not be significantly different from that described in chapter 4. Considering only federal oil and gas leasing, there would be no further impacts to the air resource, no mitigations would be necessary, and there would be no residual impacts to air or irretrievable air resource commitments.

GEOLOGY

The acceptance of a No Action alternative would be intolerable because of the energy needs of the Nation. A greater dependence on other forms of energy (coal, nuclear, solar, etc.) would be required, and development of these energy sources on a national scale would take many years.

SOILS

A discontinuation of federal oil and gas leasing by the BLM in North Dakota would not change the existing conditions of the soil. As there would be no further negative effects on the soil from this activity, no mitigations would be necessary. As a result, there would be no residual impacts to the soil. However, impacts to the soil will continue from other activities such as farming and ranching, even if oil and gas activity were to stop.

VEGETATION

There would be no additional impacts to vegetation if the government stopped issuing oil and gas leases. However, oil and gas activity would continue on the adjoining nonfederal leases, whether the BLM leases or not. These activities could have an adverse effect on the adjoining lands. With adequate lease stipulations, the BLM can control oil and gas activity on federal leases and also influence the activity on the adjoining lands.

WATER

If the No Action alternative is chosen, then many of the impacts discussed in the previous chapters would not occur. There would remain some preliminary exploration for the purpose of delineating oil and gas fields on adjoining lands. All other phases of oil and gas activity would not occur. Any impacts, mitigations, and residual impacts previously discussed pertaining to the preliminary exploration phase of activity would continue under the No Action alternative.

ANIMALS

If the federal leasing program is discontinued, existing leases would remain in effect until they expire or are developed. Impacts from oil and gas activities on effective leases would end as leases are terminated and oil and gas fields are abandoned. However, if oil and gas leasing and subsequent development activities continue on adjacent private lands, impacts similar to those previously described for federal lands onto private, will "overflow" onto lands above federal oil and gas estate.

RECREATION

If federal oil and gas leasing is discontinued, there would be no additional impact to recreational resources (attributable to federal leasing) beyond that already accumulated. Recreational impacts from effective leases would disappear as leases are terminated and oil and gas fields are abandoned.

CULTURAL RESOURCES

The only impacts to cultural features anticipated in the absence of leasing are those identified in chapter 2 for geophysical exploration.

VISUAL RESOURCE MANAGEMENT

Where small parcels of land overlying federal oil and gas are not leased within areas of intensive oil and gas activity (nonfederal), a contrast between those parcels and the developed area would occur. This contrast would be virtually unnoticeable, because of the character of oil and gas fields and the dispersion of unaffected areas within a developed field. For these small parcels, not leasing federal oil and gas would have a negligible affect on the appearance of the area as a whole.

Where larger blocks of lands overlying federal oil and gas occur, the effect of not leasing would be a lack of change in the visual surface of the land, except where public lands abut developed private lands. The effect of these adjacent lands on lands overlying federal oil and gas would be negative; the effect on public lands that are not adjacent to developed private lands would be neutral.

ECONOMIC CONDITIONS

The discontinuation of leasing federally owned oil and gas deposits in the 17 county study area would result in an eventual annual loss of 767,894 mcf of gas and 3,024,533 barrels of oil a year. Considering the estimate by the North Dakota Energy Office that it takes 283 mcf to heat and cool one single family house in North Dakota for one year (283,000,000 Btu's = 1 year of heating and cooling; 1,000,000 Btu = 1 mcf), this would mean that 2,713 homes would have to go without heating and cooling gas for a year or find alternative sources of heating and cooling. In regards to loss of oil, it would mean that 3,024,533 barrels of oil would be deleted from the American market, a loss of 16,967,630 million Btu's annually (5.61 million Btu = 1 barrel; 16,967,630 million Btu = 3,024,533 barrels annually). However, what should be considered is what this would mean to the local economy of the area. It would mean that an anticipated job market of 302 direct positions would never materialize. (Estimated direct employment—See Appendix 3-1, Economic Section.)

It would mean less revenues to the state of North Dakota because less royalties would be paid into the State's general revenue fund. In North Dakota this is 6.25 percent of each barrel. The 17 county study area generated 3,024,533 barrels of oil in 1978. At $36.73 a barrel (December 1979 market price), this would mean a projected loss of some $6,943,193.57 (3,024,533 bbl x $36.73 per barrel x .0625) annually to North Dakota.

SOCIAL CONDITIONS

The social impacts associated with the continuation of federal oil and gas leasing would not occur if this leasing were discontinued. Of course, those social impacts caused by nonfederal leasing would continue.

LAND USE AND TRANSPORTATION

If federal oil and gas leasing is discontinued, new exploration and development would be restricted to nonfederal lands.

Impacts associated with exploration and development would be limited to what is needed to conduct operations on the adjoining nonfederal lands.

CHAPTER 4

CHAPTER 4
AFFECTED ENVIRONMENT

This chapter describes, by environmental component, the physical, biological, social, and cultural features within the Dickinson District. Particular emphasis is placed on describing those features which are expected to experience impacts from oil and gas activity.

CLIMATE AND AIR QUALITY

Located in the geographic center of North America, North Dakota has a typically continental climate. The State lies in the paths of air masses originating from three sources. The Rocky Mountains to the west modify the air masses from the Pacific Ocean. There are no barriers to modify air masses coming from the polar or tropical regions. Due to the lack of relief across the State, these latter two types of air masses often result in large and rapid changes in weather conditions.

The mean annual precipitation varies from about thirteen inches in the west to about twenty inches in the east (see Map 4-1). Most of this falls in the form of rain during the spring and early summer months. The late summer and fall are normally dry, and during winter light precipitation is received, nearly always in the form of snow. Figure 4-1 shows the mean monthly precipitation across the State.

The mean annual temperature varies from about 37 degrees F. in the northeast to about 43 F. in the south. There is considerable temperature variation during the course of a day or a year. During the winter, low temperatures of twenty or thirty below zero are not uncommon, while nearly every summer the high temperature will rise above one hundred for a couple of days somewhere in the State. Figure 4-1 shows the mean monthly temperatures across the State.

Winds in North Dakota normally reach maximum velocities during late winter and early spring, and minimum velocities usually occur in the summer. High winds over large areas are often associated with winter storms. Thunderstorms during the summer, on the other hand, will have high winds over a localized area. Prevailing wind direction varies from one location to another, but is generally considered to be north or northwest over the western two-thirds of the State.

Ambient air quality parameters are monitored across the State by the North Dakota State Department of Health. The locations of these monitoring sites are shown in Map 4-2, and the type of station is shown in Table 4-1. Most of the stations in this network have only recently been established. Two stations were started in 1958, two more in the late 60's, and the remainder have been established within the last ten years. In addition to these, there are industrial site monitors located at two power plants, one mining operation, and one natural gas processing/sulfur recovery plant.

Table 4-1
North Dakota State Department of Health
Air Quality Monitoring Locations

Site Location	Parameter Level	Date Site Established	Type of Site
Beulah	II	April 1974	Residential
Beulah	II	July 1974	Rural
Bismarck	II	January 1958	Commercial
Bismarck	II	December 1976	Rural
Bowman	III	September 1974	Rural
Devils Lake	III	January 1970	Commercial
Dickinson	III	January 1970	Commercial
Dickinson	II	December 1975	Rural
Fargo	II	January 1964	Commercial
Fargo	III	February 1971	Rural
Garrison	II	September 1974	Rural
Grand Forks	III	January 1970	Commercial
Jamestown	III	January 1972	Residential
Lake Tschida	II	September 1976	Rural
Mandan	II	October 1970	Commercial
Mandaree	III	August 1976	Rural
Medora	II	September 1974	Rural
Minot	III	April 1967	Commercial
Parshall	III	September 1974	Rural
Stanton	I	September 1974	Rural
Foxholm	III	January 1958	Rural
Valley City	III	January 1972	Residential
Wahpeton	III	October 1970	Residential
Williston	III	May 1970	Residential
Theodore Roosevelt National Memorial Park, North Unit	II	December 1978	Commercial Rural

Source: North Dakota State Department of Health, Air Pollution Control Program, Keith J. Ganzer, 1979.

Present data indicates that the general air quality of North Dakota is good. There are no ambient air quality nonattainment areas, but there have been isolated instances when air quality standard violations have occurred. The north and south units of Theodore Roosevelt National Memorial Park are Class I air quality areas. The rest of the State is Class II.

With respect to oil and gas development activity, the present monitoring network is inadequate. A much more dense network would be needed to detect impacts specific to a particular field or a particular area of federally owned oil and gas.

GEOLOGY

The landscape of North Dakota varies from flat plains to rugged badlands. Elevations range from 750 feet above sea level at Pembina, in the northeast, to 3506 feet above sea level at White Butte, in the southwestern part of the State. North Dakota is divided by the Missouri Escarpment into two major physiographic provinces: the Central Lowlands and the Great Plains. Map 4-3 shows these two areas and their subdivisions.

The Central Lowland largely consists of the Red River Valley and the Drift Prairie. The Red River Valley, covering a narrow strip of land along the eastern edge of the State, was the site of glacial Lake Agassiz. Separating the Red River Valley and the Drift Prairie is the Pembina Escarpment, which reaches up to 500 feet high. West of the Pembina Escarpment, the Drift Prairie covers a wide area extending all the way to the Missouri Escarpment. The area is a gently rolling plain covered by glacial deposits, with two drift-covered bedrocks outliers, the Turtle Mountains and the Prairie Coteau.

The Drift Prairie terminates at the Missouri Escarpment, which marks the eastern edge of the Great Plains. A 30-to 50-mile wide strip known as the Missouri Coteau (Hills of the Missouri) occurs immediately west of the escarpment and marks the beginning of the Great Plains. It is a hummocky area, over which glacial stagnation occurred.

In addition to the Missouri Coteau, the Great Plains includes the Missouri Plateau (which includes the Coteau Slope) and the Little Missouri Badlands. The Missouri Plateau is essentially composed of horizontal layers of sandstone and shale. The Coteau Slope is that part of the Missouri Plateau that lies between the Missouri Coteau and the Missouri River. It is essentailly a dissected bedrock surface of low relief, covered with a small amount of glacial drift. West of the river, the Missouri Plateau is characterized by wide and gentle slopes for the most part, but in the vicinity of main streams, steep and rugged topography may be the rule. The most prominent of these areas of rugged topography is the Little Missouri Badlands. This area is important enough to be considered a separate part of the Great Plains.

Stratigraphy

North Dakota contains a sedimentary section of every geologic period from the Cambrian through the Quaternary. In McKenzie County, near the deepest part of the Williston Basin, the section is about 15,000 feet thick. Six sedimentary sequences which begin and end with major unconformities have been identified in North Dakota. They are, in ascending order: Sawk, Tippecanoe, Kaskaskia, Adsaroka, Zuni, and Tegas. Figure 4-2 shows the six sequences and the formations (with dominant lithology) which occur within the sequence. Map 4-4 shows the bedrock geology of the State.

The initial sequence, the Sawk, dates from all the Upper Cambrian to Lower Ordovician. It is represented by the Deadwood Formation, which is a stable shelf deposit extending eastward from the Cordillearan geosyneline.

During the Middle Ordovician period, the Williston Basin began to be filled with a relatively thin elastic sequence, followed by predominately carbonate deposition. Carbonate deposition continued through Middle Siluian time, followed by a period of erosion which marks an unconformity.

During the Middle and Upper Devonian, the Williston Basin was part of a larger Canadian Basin, which was characterized by predominately carbonate deposition with a thick evaporite in the lower part and cyclical carbonate with thin elastic and evaporite beds in the upper part. Deposition was continuous or nearly so into the Mississippian, with the center of the Madison depositional basin nearly coincident with the present Williston Basin. Mississippian deposition began with carbonates, evaporites increasing in the upper part. Predominantly elastic deposition followed the evaporites. Another unconformity ended the Mississippian.

The Pennsylvanian and Permian periods are represented by elastics with minor carbonates and some evaporites. This was a time of only slight subsidence, with the Williston Basin a part of a larger depositial area. Similar conditions continued through the Triassic, which ended with an unconformity. As the Williston Basin had little effect on Jurassic or Cretaceous sedimentation, these periods are represented by eastward extensions of predominately fine-grained clastics from the Rocky Mountain area seas. The Tertiary period is represented by a wedge of predominately nonmarine beds that thicken westward.

Structure

Most of North Dakota (about 51,600 square miles) is part of the Williston Basin, a structural and sedimentary basin which has been an area of subsidence over most of its existence. The basin is centered just to the south and east of Williston, North Dakota and extends northward into Canada and westward into Montana. Map 4-5 shows the Williston Basin, two other structural features, and some associated oil fields.

The regional dip is generally toward the center of the basin and averages about 60 feet per mile, or less than one degree. This increases slightly with depth. The regional dip may be interrupted by small structures in many areas, but only two major structures—the Nesson and Cedar Creek anticlines—are known in North Dakota.

The Nesson Anticline is a north-trending, southward-plunging anticline, located in northwestern North Dakota. The main structure is about 75 miles long, with smaller structures superimposed on the main trend. The Madison Formation (Mississippian) has been a major producing unit along this structure, and many oil pools coincide with smaller structural features along the trend. The amount of folding of the smaller structures increases with depth, but the size of the structures decreases with depth. This suggests that development of the structure has been intermittent from the Paleozoic onward.

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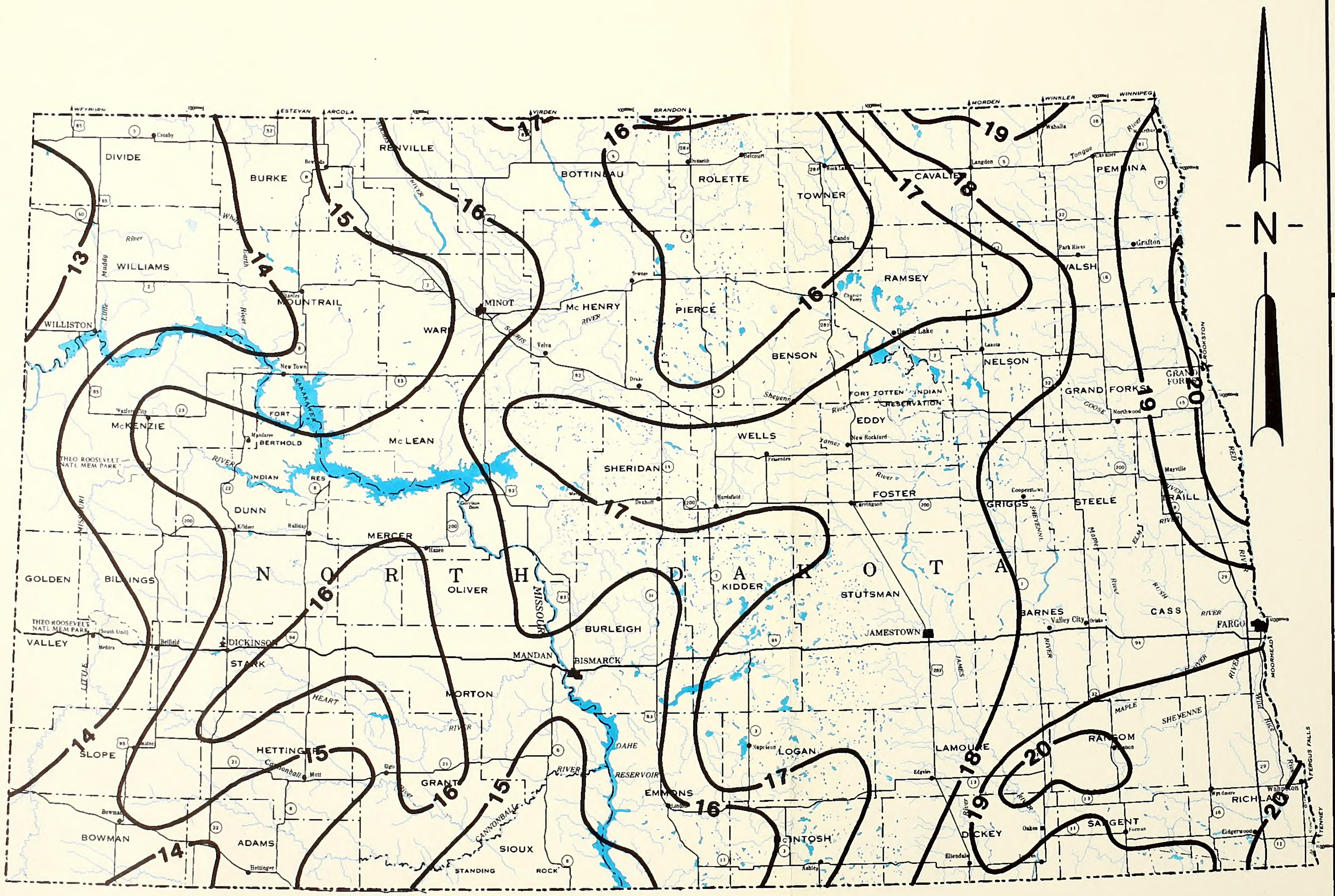
DICKINSON DISTRICT

ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

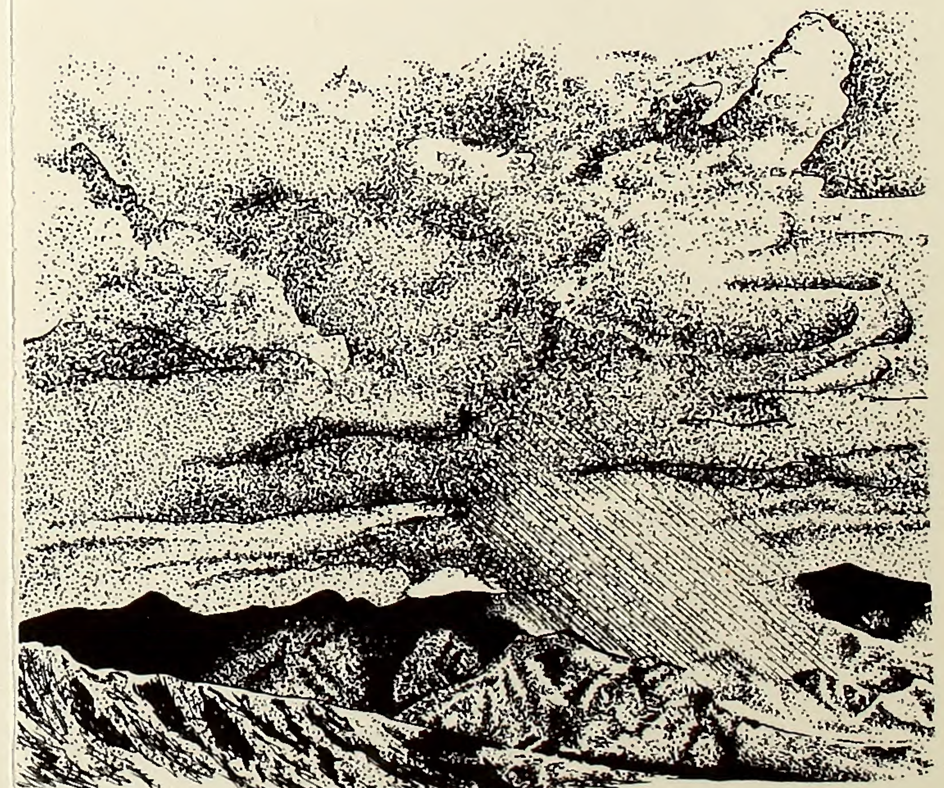
ANNUAL MEAN PRECIPITATION

ANNUAL PRECIPITATION IN INCHES

MAP 4-1



LEGEND



SOURCE: Climate of North Dakota, North Dakota National Weather Service, NDSU, Fargo, N.D., Based on 1931-1960.

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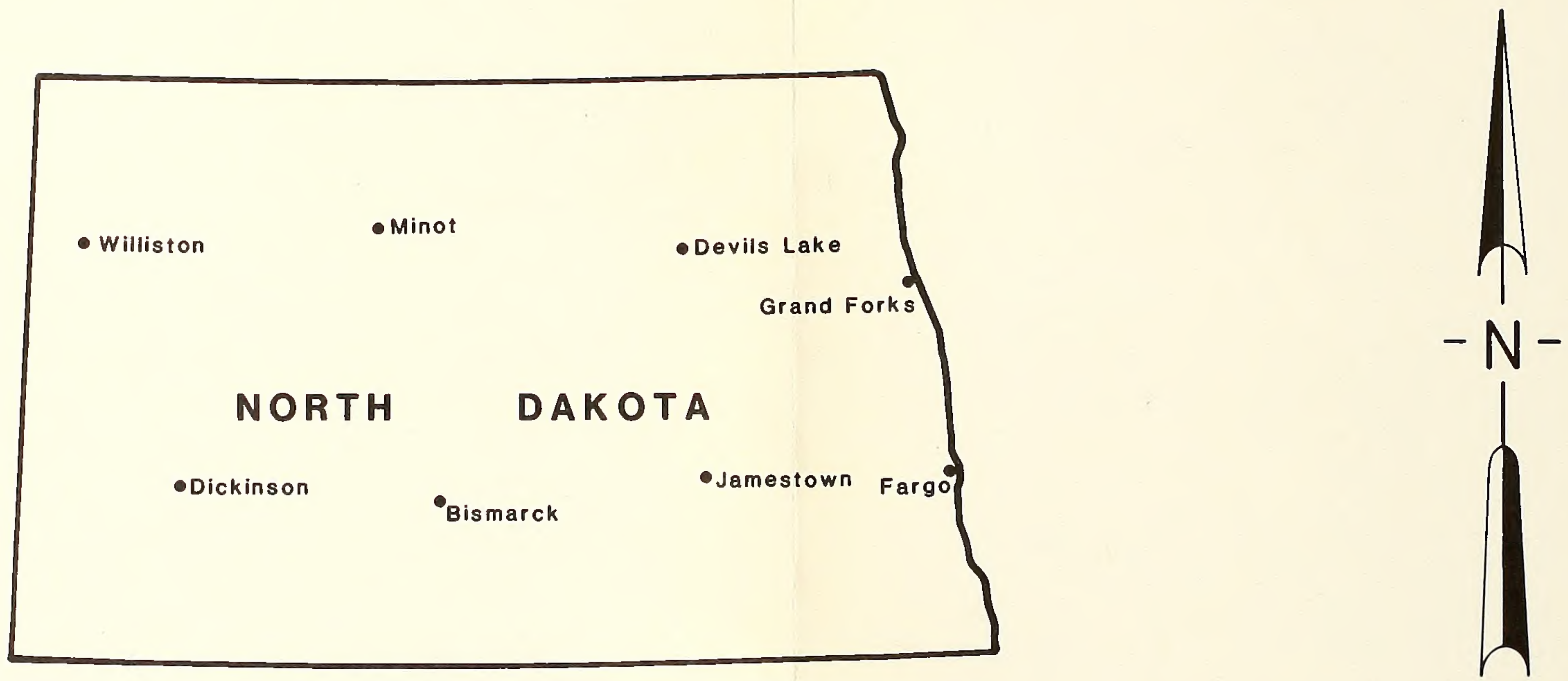
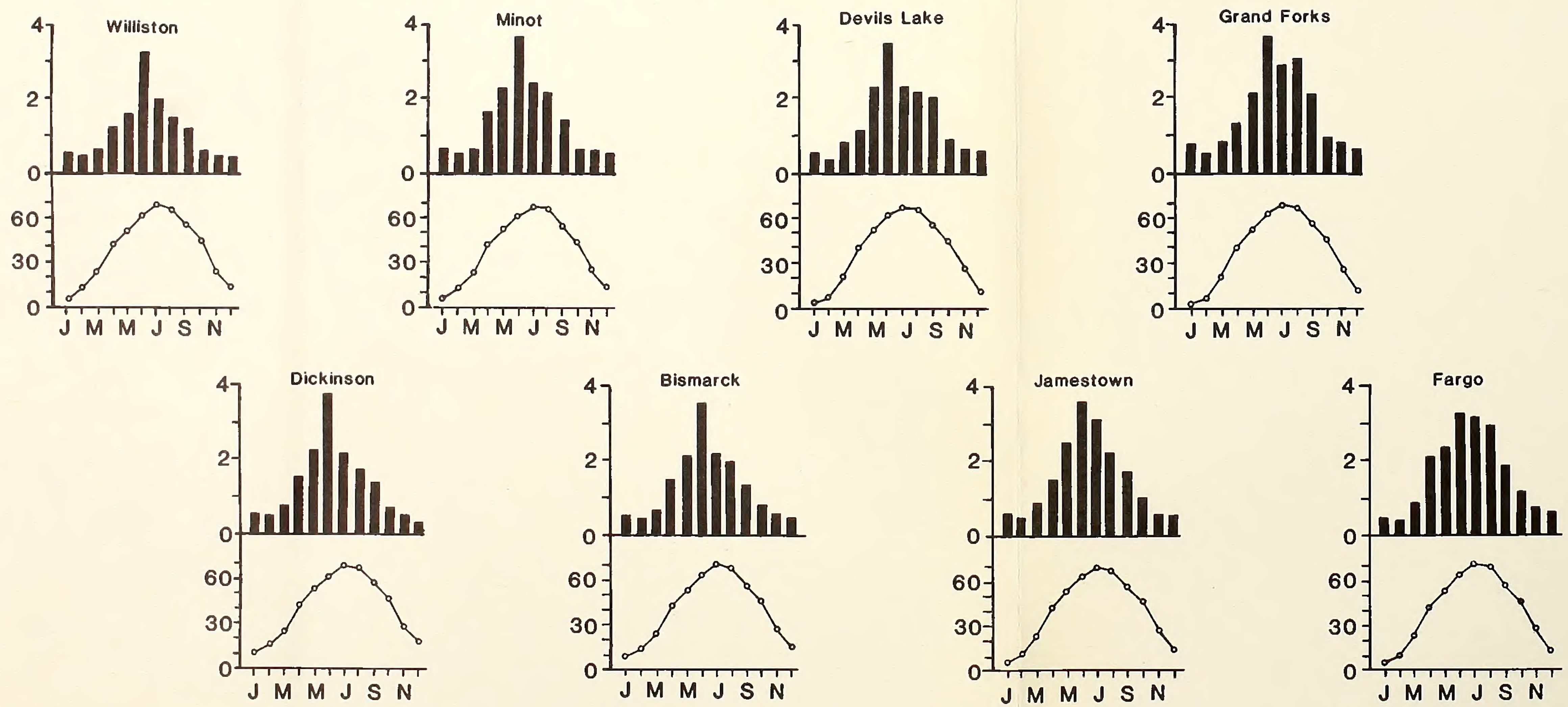
ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

MONTHLY NORMALS – TEMPERATURE AND PRECIPITATION

FIGURE 4-1





Scale 1:2,150,000

LEGEND

Precipitation is in inches.

Temperature is in degrees Fahrenheit.

SOURCE: Climatology of the United States No. 81 (North Dakota), USDC, NOAA, National Climatic Center, Asheville, N.C., August 1973.

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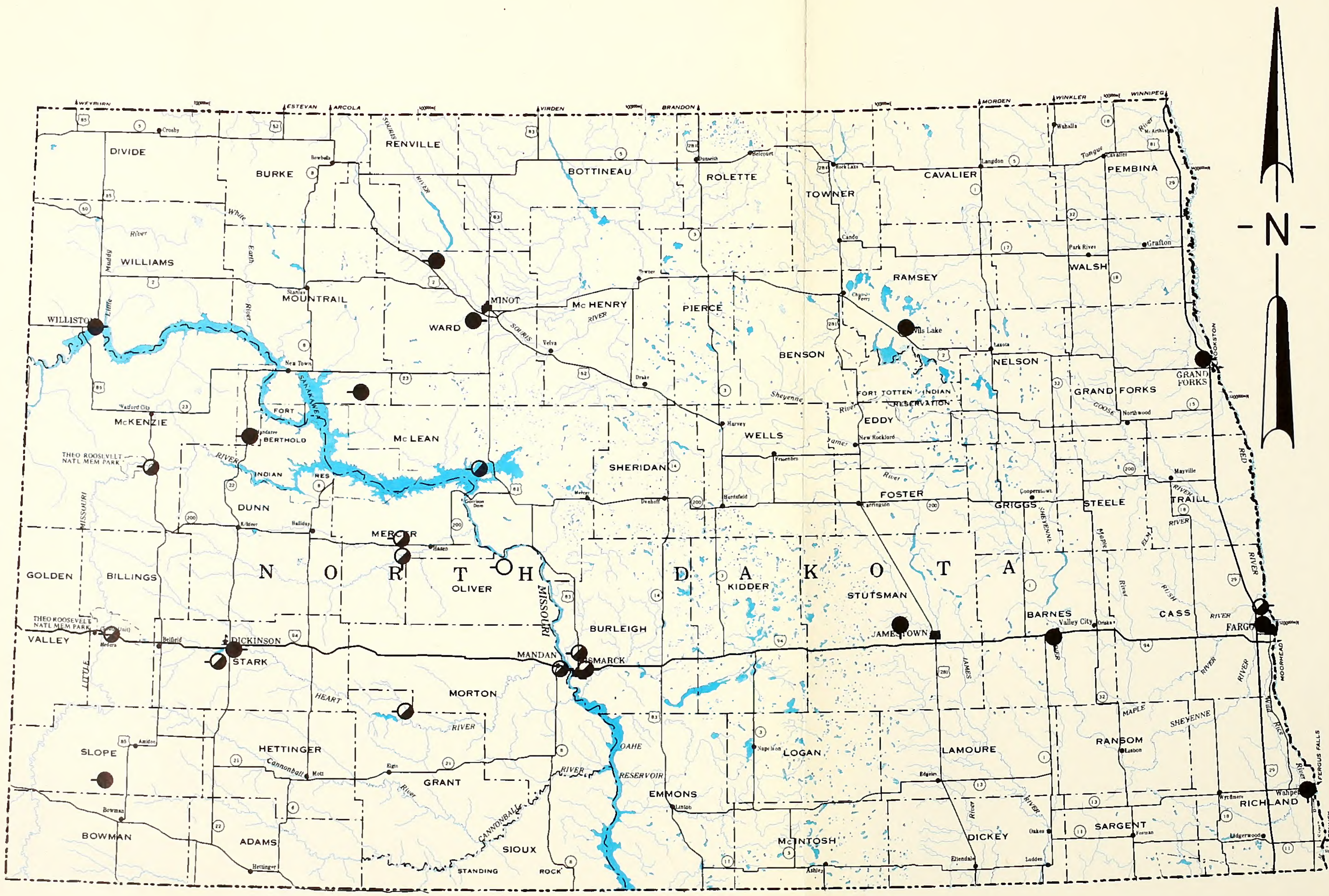
DICKINSON DISTRICT

ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

AIR QUALITY MONITORING LOCATIONS

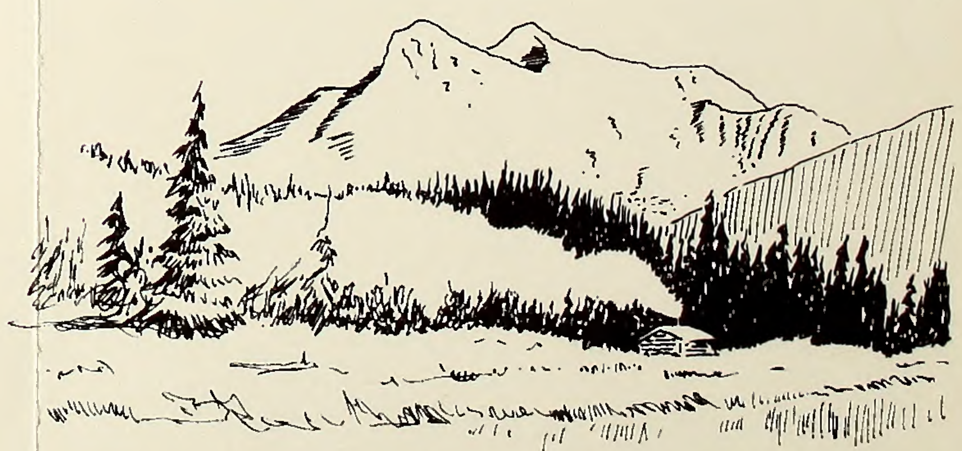
MAP 4-2



LEGEND

- ○ Parameter Level I
- ◐ Parameter Level II
- ● Parameter Level III

- ○- Commerical Site
- ⫯ Industrial Site
- -○ Rural Site
- ⚲ Residential Site



Scale 1:2,150,000

SOURCE: North Dakota State Department of Health, Air Pollution Control Program, Keith J. Ganzer, 1979.

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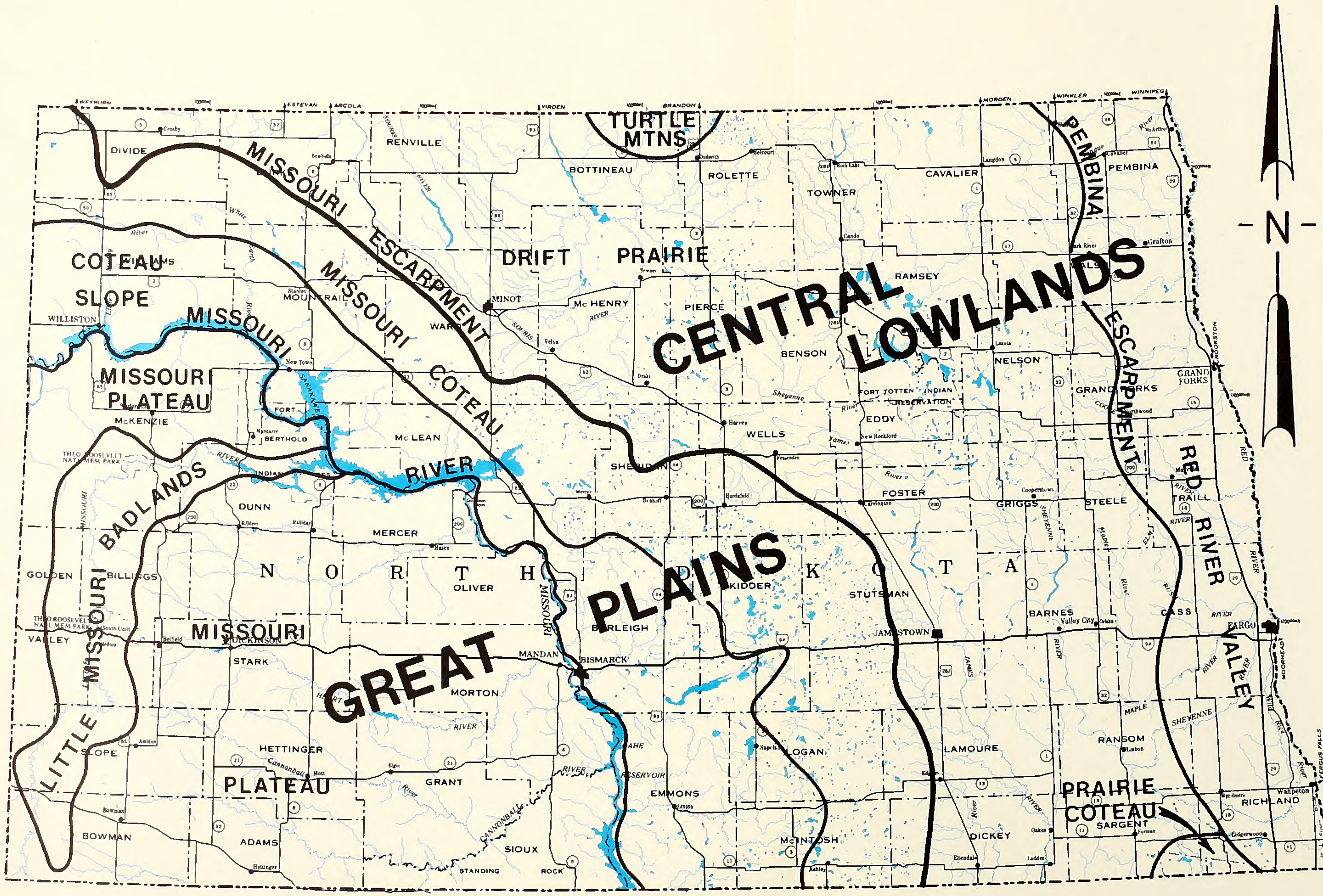
ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

TOPOGRAPHIC AREAS

MAP 4-3



Scale 1:2,150,000

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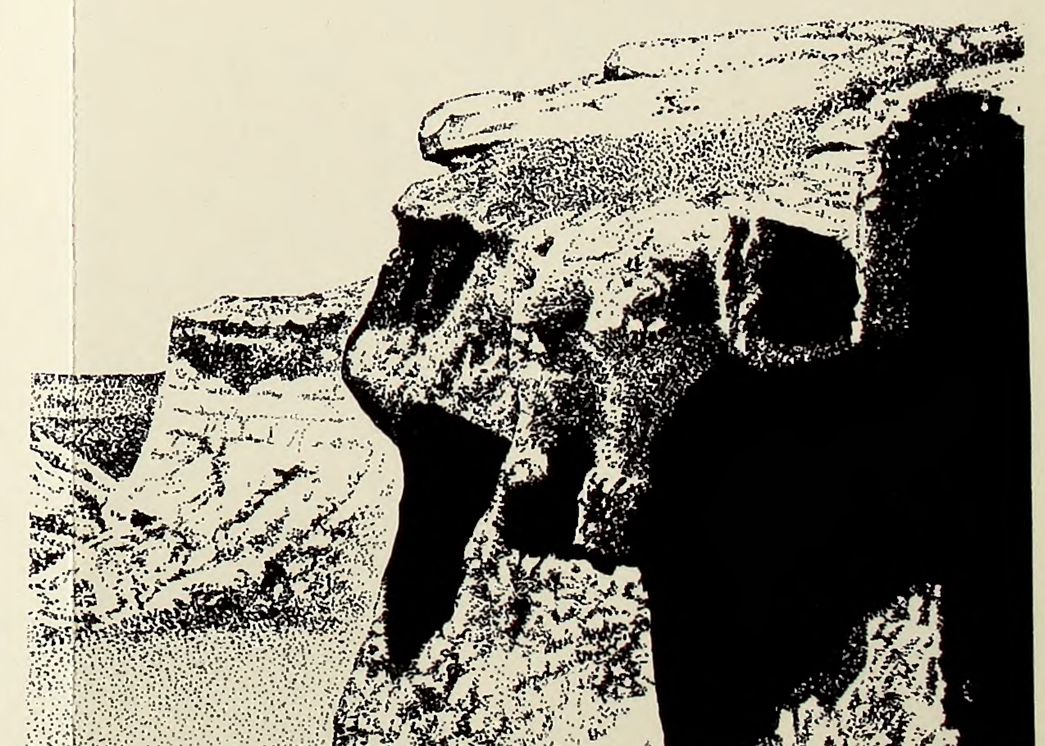
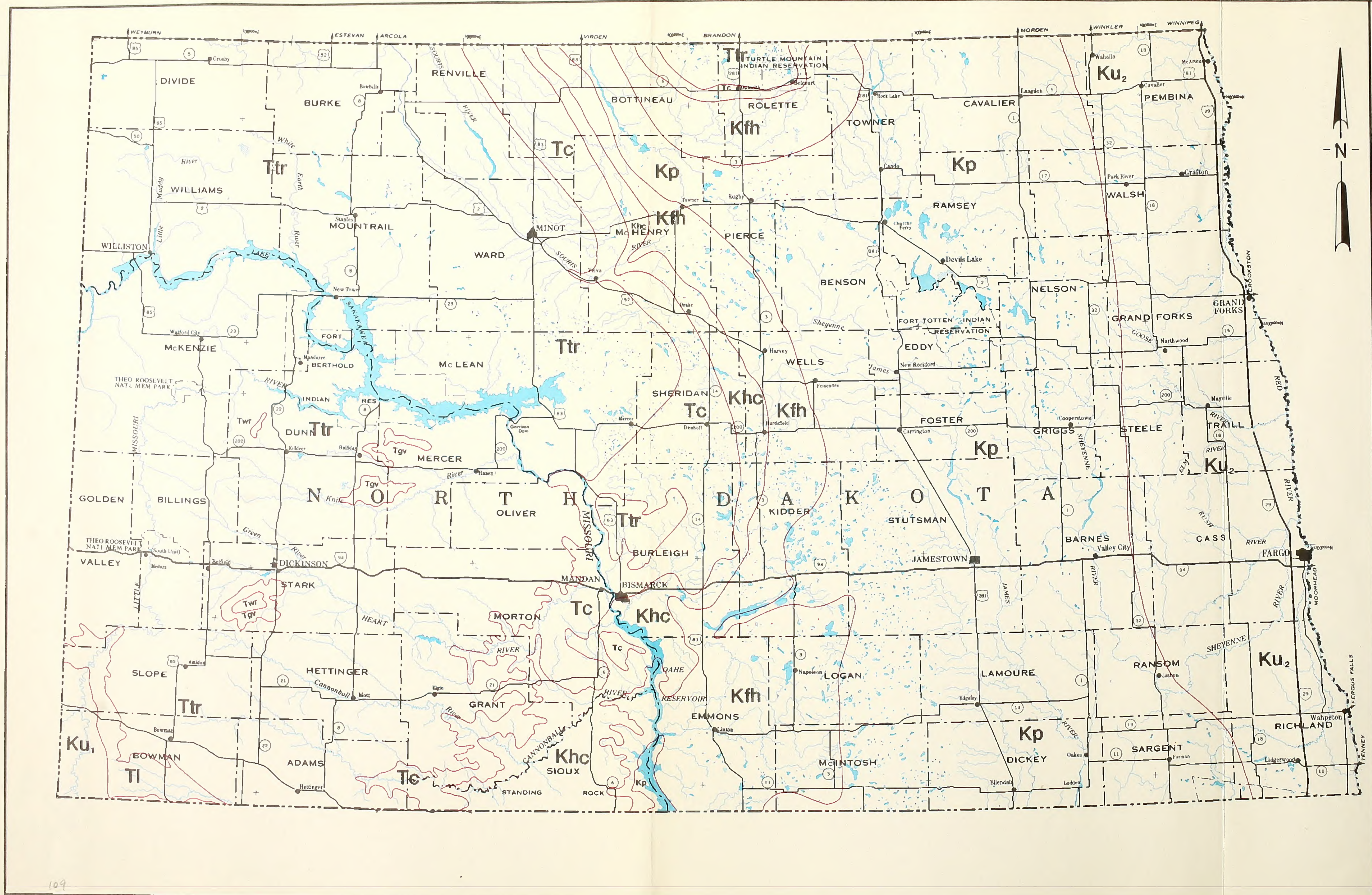


SOURCE: Modified from NDGS Bulletin 63, 1973.



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GEOLOGIC BEDROCK

LEGEND

MAP 4-4

- Kfh White River — Oligocene
- Tgv Golden Valley — Eocene
- Ttr Tongue River — Paleocene
- Tc Cannonball — Paleocene
- Tl Ludlow — Paleocene
- Khc Hell Creek — Cretaceous
- Kfh Fox Hills — Cretaceous
- Kp Pierre — Cretaceous
- Ku_1 Cretaceous, Undifferentiated (Pierre, Fox Hills, Hell Creek)
- Ku_2 Cretaceous, Undifferentiated (Niobrara in Eastern North Dakota)

SOURCE: N.D.G.S. Miscellaneous Map No. 8, Wilson M. Laird, State Geologist.

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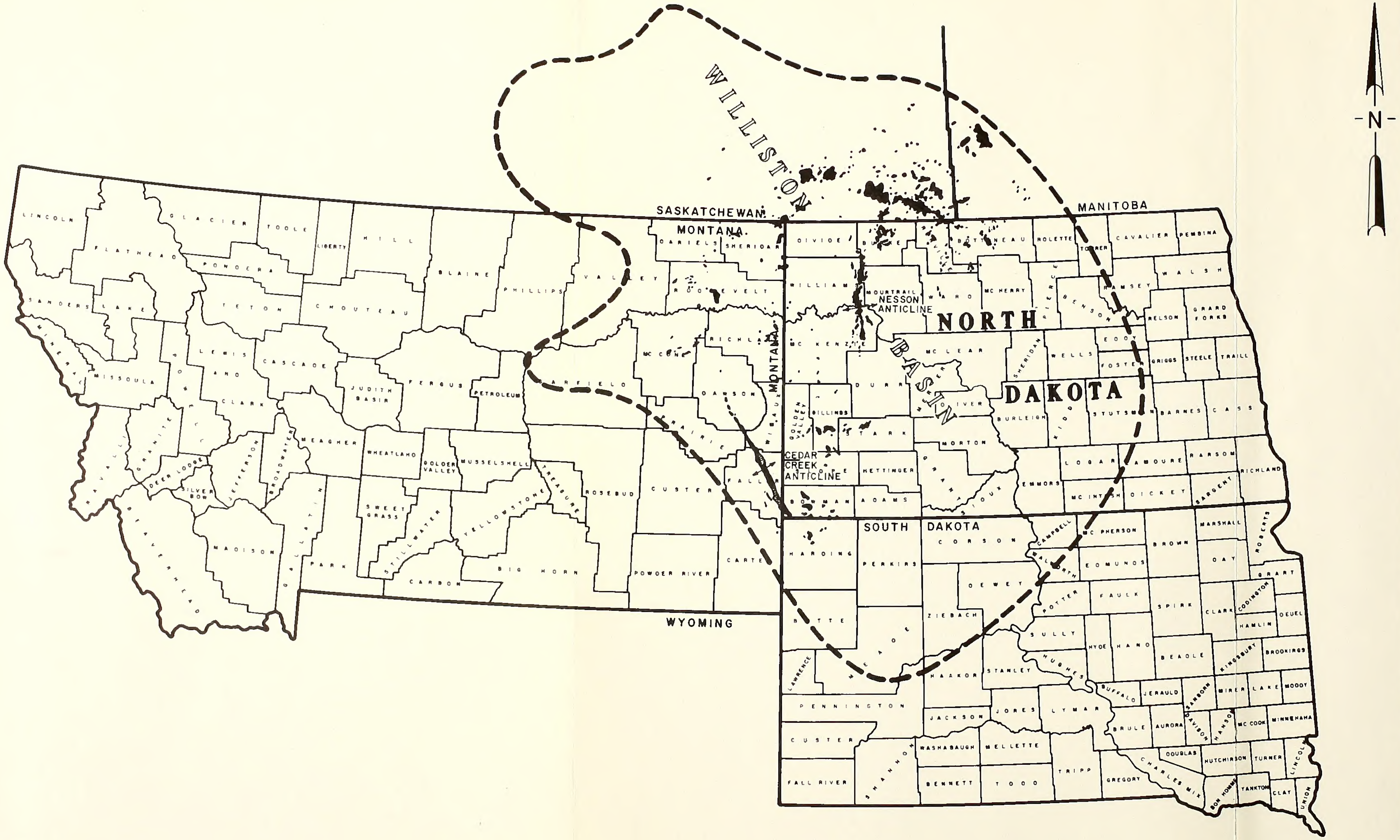
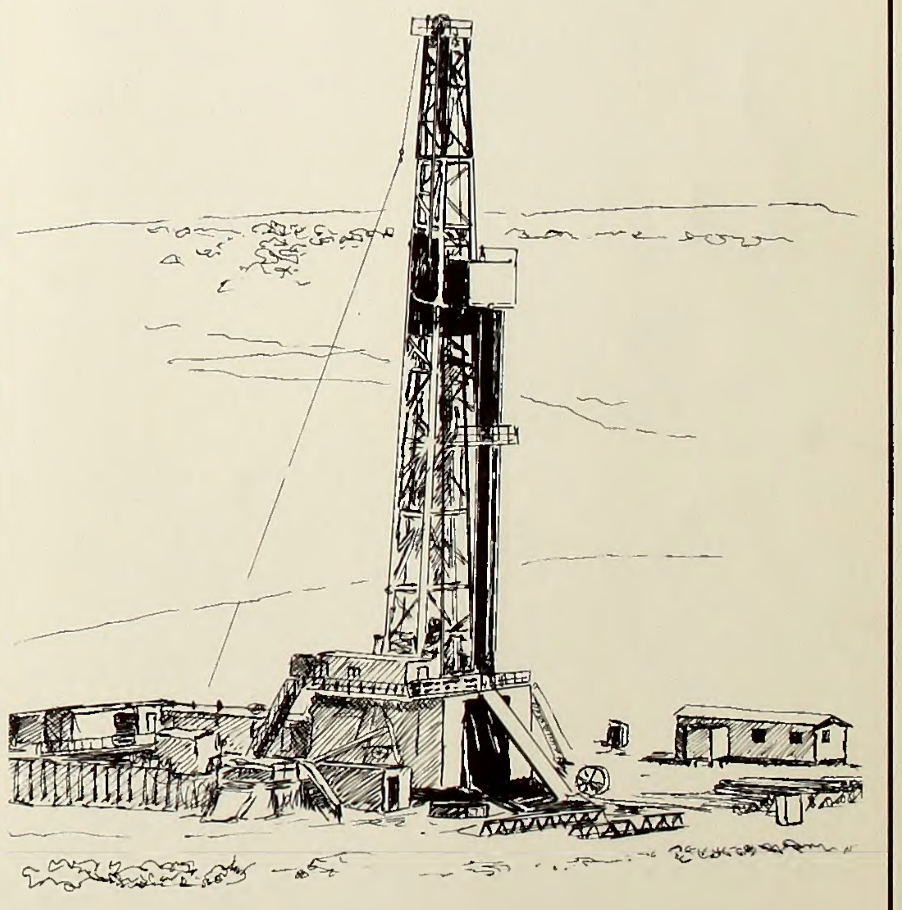
WILLISTON BASIN



LEGEND

MAP 4-5

- Williston Basin, showing two of its major structural features
- Known Oil Fields
- Anticline



SOURCE: Carlson and Anderson, 1970.

FIGURE 4-2

SEQUENCE	SYSTEM	GROUP OR FORMATION		Production	DOMINANT LITHOLOGY
TEJAS	TERTIARY	GLACIAL DEPOSITS			Glacial Drift
		WHITE RIVER			Clay, Sand and Limestone
		GOLDEN VALLEY			Clay, Sand and Silt
		FORT UNION GROUP	TONGUE RIVER		Shale, Sandstone and Lignite
			CANNONBALL		Marine Sandstone and Shale
			LUDLOW		Sandstone, Shale and Lignite
ZUNI	CRETACEOUS	HELL CREEK		○	Sandstone, Shale and Lignite
		MONTANA GROUP	FOX HILLS		Marine Sandstone
			PIERRE		Shale
		COLORADO GROUP	NIOBRARA		Shale, Calcareous
			CARLILE		Shale
			GREENHORN		Shale, Calcareous
			BELLE FOURCHE		Shale
		DAKOTA GROUP	MOWRY		Shale
			NEWCASTLE		Sandstone
			SKULL CREEK		Shale
			FALL RIVER		Sandstone and Shale
			DAKOTA		Sandstone and Shale
	JURASSIC	MORRISON			Shale, Clay
		SUNDANCE			Shale, green and brown, and Sandstone
		PIPER			Limestone, Anhydrite, Salt, and red Shale
ABSAROKA	TRIASSIC	SPEARFISH		●	Siltstone, Shale and Sandstone
	PERMIAN	MINNEKAHTA			Limestone
		OPECHE			Shale, Siltstone and Salt
	PENNSYLVANIAN	MINNELUSA			Sandstone and Dolomite
		AMSDEN		●	Interbedded Dolomite Limestone, Shale and Sandstone
KASKASKIA	MISSISSIPPIAN	BIG SNOWY GROUP	HEATH		Shale
			OTTER		Sandstone and
			KIBBEY	●	Limestone
		MADISON		●	Interbedded Limestone and Evaporites
					Limestone
		BAKKEN		●	Siltstone and Shale
	DEVONIAN	THREE FORKS		●	Shale, Siltstone and Dolomite
		BIRDBEAR		●	Limestone
		DUPEROW		●	Interbedded Dolomite and Limestone
		SOURIS RIVER			Interbedded Dolomite and Limestone
		DAWSON BAY			Dolomite and Limestone
		PRAIRIE			Halite
		WINNIPEGOSIS		●	Limestone and Dolomite
TIPPECANOE	SILURIAN	INTERLAKE		●	Dolomite
	ORDOVICIAN	STONEWALL			Dolomite and Limestone
		STONY MOUNTAIN FM.	GUNTON MEMBER		Limestone and Dolomite
			STOUGHTON MEMBER		Argillaceous Limestone
		RED RIVER		● ○	Limestone and Dolomite
		WINNIPEG GROUP ○	ROUGHLOCK		Calcareous Shale & Siltstone
			ICEBOX		Shale
			BLACK ISLAND		Sandstone
SAUK	CAMBRIAN	DEADWOOD		● ○	Limestone, Shale and Sandstone

● Oil Production ○ Gas Production

Source: North Dakota Geological Survey Bulletin 28.

The northwest-trending Cedar Creek Anticline extends for a total of about 150 miles through Montana, North Dakota, and South Dakota. The anticline is asymmetrical throughout most of its length, but it becomes symmetrical in South Dakota. Strata dip steeply off the southwest flank and more gently to the northeast. The anticline has a slight plunge to the north. A number of normal faults have been mapped on the eastern flank. The structure interrupts the gentle dip of the Williston Basin and is thought to be the result of sedimentary strata draping over a large fault in the Precambrian basement rocks.

Mineral Resources

North Dakota is primarily an agricultural state, but mineral production is becoming increasingly important as a major source of income. In recent years petroleum, natural gas, and coal have accounted for about 90 percent of the value of the State's mineral production. The remaining 19 percent is the result of the production of sand and gravel, stone, clay, salt, and other mineral commodities.

Oil and Gas

Those areas in North Dakota where exploration and development of oil and gas are likely to occur are of prime importance. The major oil and gas activity in North Dakota has occurred in McKenzie, Billings, Dunn, Williams, Renville, Burke, and Bottineau counties. The current major producing fields are shown on Map 4-6, and defined Known Geologic Structures (KGSs) are shown on Map 4-7. For the forseeable future, it is believed that the part of the State east of the 100th Meridian has little potential for oil and gas production.

In western North Dakota the major oil traps are primarily structurally controlled. Major structures, such as the Nesson and Cedar Creek anticlines, have been heavily explored. In the Williston Basin the major oil-producing formations are the Red River (Ordovician), Interlake (Silurian), Duperow (Devonian), and the Mission Canyon (Mississippian).

The Nesson Anticline is the most productive trap and the largest single structure in North Dakota. The structure extends from the Little Missouri River in northeastern Dunn County to the Burke County line. In Burke County, northeast of the Nesson Anticline, oil has been trapped by infilling of the limestone by anhydrite. In addition, in Renville and Bottineau counties, some oil accumulations are found where limestone of Mississippian age is truncated by an unconformity and covered by shales and silty sands of the Triassic Spearfish Formation.

In southwestern North Dakota oil is trapped in beach and bar sands that were deposited along the south edge of a sea which occupied the Williston Basin in late Mississippian and early Pennsylvanian time. South of Dickinson, at Rocky Ridge, the oil-bearing sand fills an ancient stream channel. In the Medicine Pole Hills Field in Bowman County, oil has accumulated in a reef in the Red River Formation, formed during Ordovician time.

Oil production first occurred in North Dakota in April 1951, when the Beaver Lodge Field was discovered on the Nesson Anticline in Williams County. In February 1977, Gulf Energy and Minerals Company U.S.A. discovered the Little Knife Field. This discovery is largely responsible for the great increase in drilling activity in the basin during the past two years. Improved seismic techniques, potential multizone completions, higher oil prices, and an unusually high success rate have also contributed to the recent oil and gas boom reminiscent of the early 1950's.

Little Knife is a north-south anticlinal structure, about 12 miles long and 2-3 miles wide. Production is from the Mississippian Mission Canyon limestone. Pay sections vary from 5 to 40 feet thick, and porosity varies across the field but is generally good.

According to figures released by the North Dakota Geological Survey, oil production in North Dakota rose 6.6 percent in 1978, reaching 24,816,800 barrels. At present the Mondak and Little Knife fields are among the largest.

With increased drilling activity and improved geophysical techniques, it is expected that a greater number of stratigraphic traps will be found. It is probable that large stratigraphic traps exist on the eastern and southeastern flanks of the Williston Basin, caused by pinch-outs in Mississippian limestone. The Williston Basin remains one of the least explored of U.S. oil provinces, and its future potential is virtually unlimited.

Coal

Lignite underlies much of the western two-thirds of North Dakota, but significant production is currently occurring only in Mercer, Oliver, Burke, Ward, and Bowman counties. Electric power plants close to the mines consume most of the lignite mined in North Dakota. There are an estimated 16 billion tons of strippable reserves in beds greater than 5 feet thick.

The earliest recorded production of coal in North Dakota occurred in 1884, when about 35,000 tons were mined; although small quantities had been mined for domestic use prior to that time. About 1919 Whittier Coal Company and the Truax Brothers began operations in North Dakota that led to the development of the modern lignite stripping industry.

The Fort Union Formation of Paleocene Age contains all of the estimated coal resources of North Dakota. The Fort Union is composed of four members: the Cannonball, Ludlow, Tongue River, and Sentinel Butte. The Ludlow, Tongue River, and Sentinel Butte are nonmarine and lignite-bearing; whereas the Cannonball is

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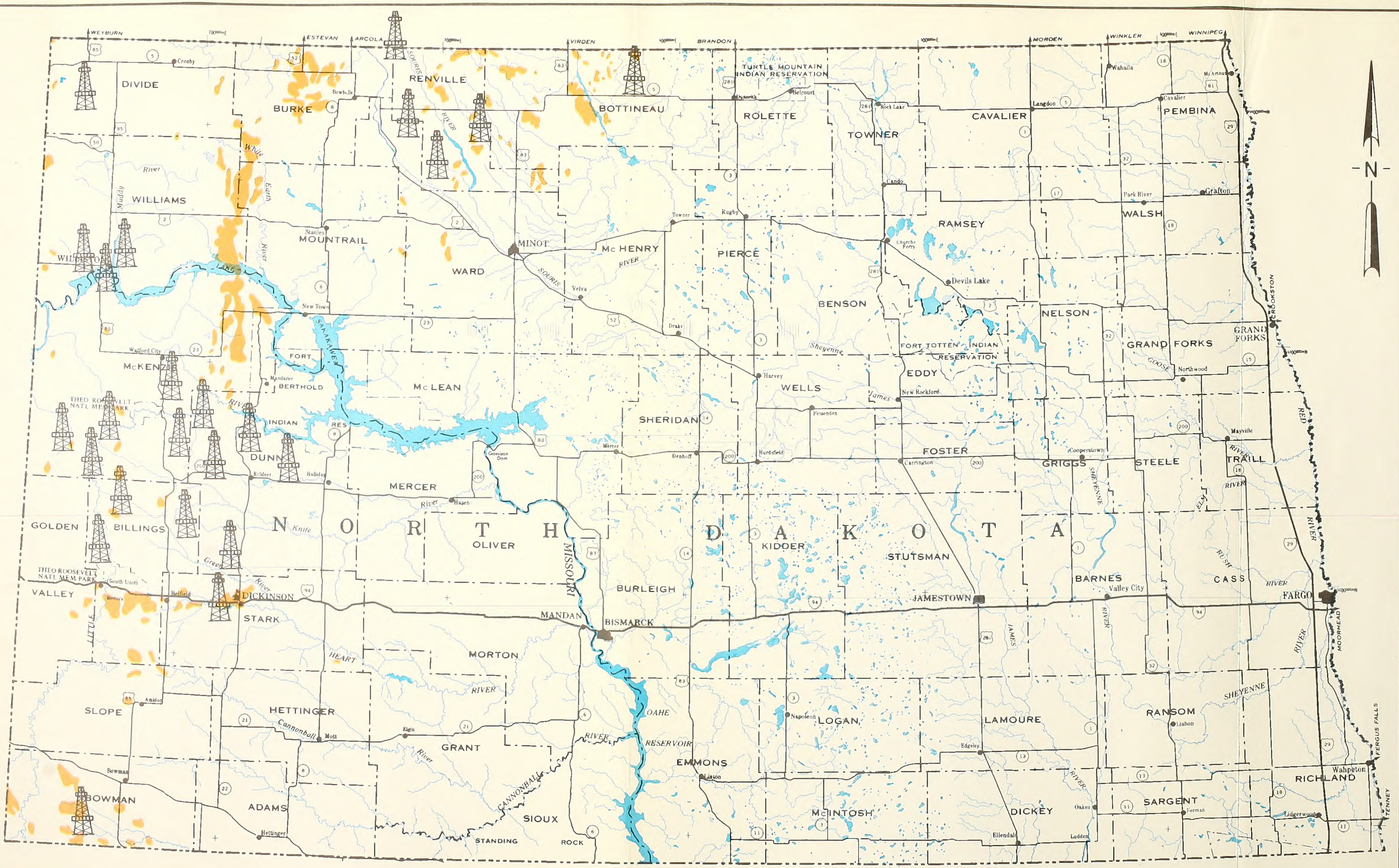
MAJOR OIL AND GAS FIELDS

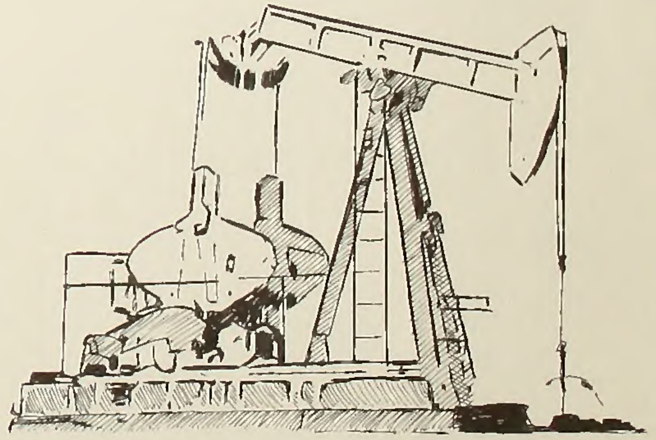


LEGEND

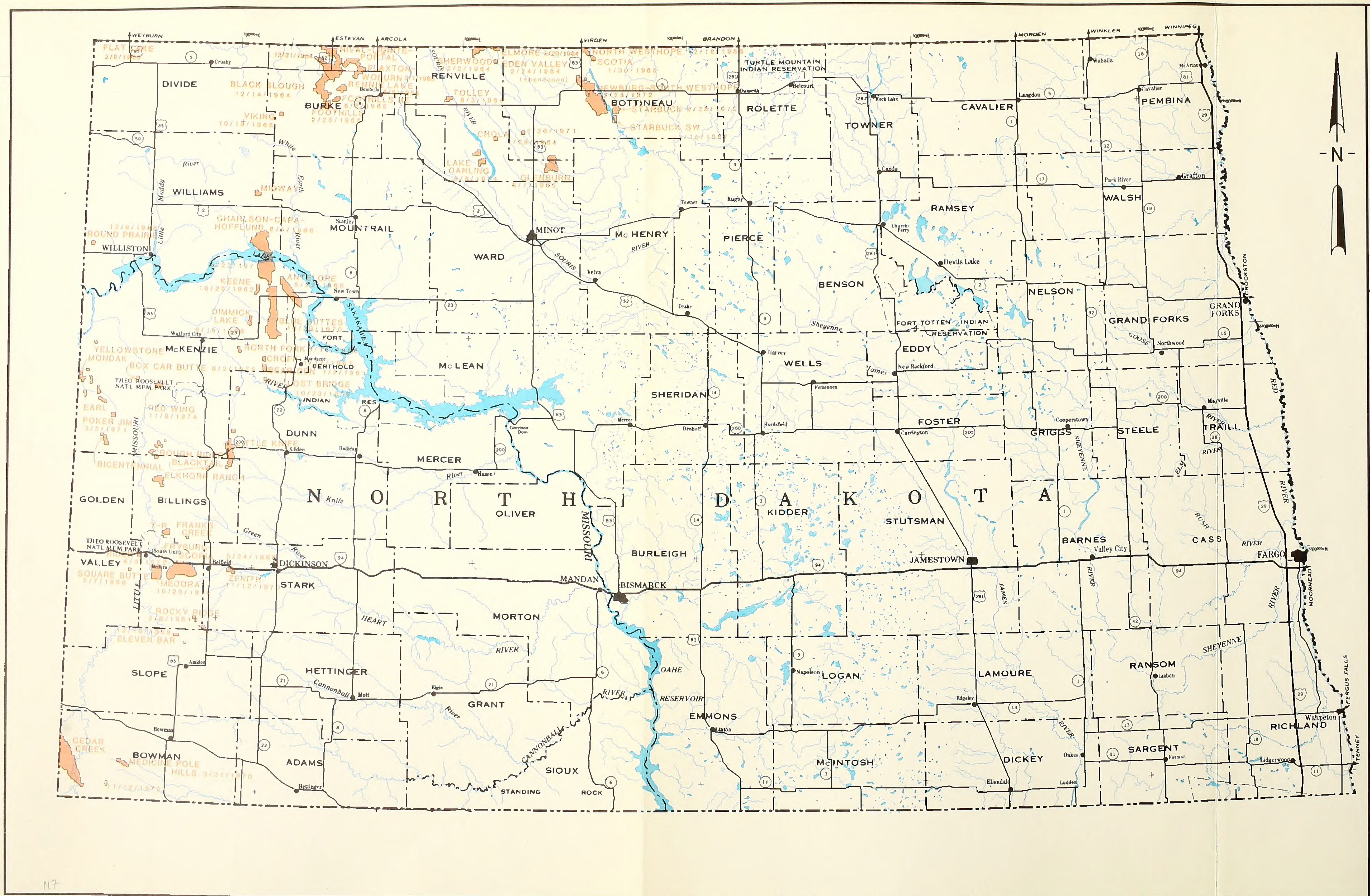
MAP 4-6

Defined and Undefined Oil Fields 1976—1977

New Field Discoveries 1978



SOURCE: N.D.G.S. Misc. Series, 1979.



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KNOWN GEOLOGICAL STRUCTURES

LEGEND

MAP 4-7

Known Geologic Structure, with Effective Date

SOURCE: U.S. Geological Survey, 1968.

marine and does not contain coal. The Ludlow Member is best exposed in Bowman County, in the southwestern corner of the state, where it contains coal beds up to 40 feet in thickness. The Tongue River Member contains most of the estimated coal resources of North Dakota, with the lowest half of the member containing the thickest and most continuous beds. The Sentinel Butte Member, which overlies the Tongue River Member, contains coal beds but is present over a smaller area and, hence, contains less coal reserves.

The lignite coal reserves of North Dakota may become increasingly important as the need for electric power increases. Large strippable blocks of lignite are also available for use in producing gaseous hydrocarbon fuels.

Industrial Minerals

In terms of value, the production of sand and gravel ranks behind oil and gas and lignite coal in North Dakota, but ahead of all other minerals. North Dakota sand deposits are suitable for use in the building industry. Most of the gravel produced in the State is used for highway construction and for concrete aggregate in the building industry.

Most sand and gravel deposits are found in the glaciated part of the State, mainly northeast of the Missouri River. These deposits are mostly derived from beaches of glacial lakes and ancient or modern river beds. Large, sheetlike deposits of gravel and sand are found in Kidder, McLean, Eddy, Benson, Nelson, Logan, Ransom, and Sheridan counties.

Vast deposits of halite (rock salt) have been discovered in North Dakota while drilling for oil. Potash (sylvite, KCL) occurs with halite in the Prairie Formation of Devonian Age. Northwestern North Dakota contains the thickest and economically most important salt and potash deposits. The Hardy Salt Company of Williston currently produces salt from a 200-foot bed at a depth of 8,000 feet. The salt is recovered by injecting fresh water into the salt bed to dissolve it, pumping the mixture to the surface, and then evaporating it. The salt that is produced by the Hardy Salt Company is Mississippian in age. No potash is presently being produced in North Dakota.

Salt is used mainly in chemical manufacturing, ice removal, food preservation, and water softening, and as additives in oil well drilling solutions, and stock feeds.

The stone industry in North Dakota deals mainly with crushed rock. The siliceous Okanah Member of the Pierre Formation is crushed and used for road surfacing in Cavalier and Pembina Counties in northeastern North Dakota. Chert, found in southwestern North Dakota, is used as riprap on small dams and stream channels. Scoria, found in southwestern North Dakota, is used primarily for road surfacing. The stone industry in North Dakota will remain relatively stable unless a cement industry (that would utilize limestone deposits) is developed.

Clay deposits in North Dakota are found in formations of Pleistocene, Tertiary, and Cretaceous Ages. In southwestern North Dakota in Stark, Morton, Hettinger, Dunn, and Mercer counties, kaolinitic clays of potential importance are found in the Golden Valley Formation. Montmorillonitic clay beds occur in the White River, Bullion Creek, Sentinel Butte, and Ludlow Formations in Slope, Stark, and Billings counties. Montmorillonitic clay beds also occur in the eastern part of the State in the Carlile, Niobrara, and Pierre Formations.

Tertiary clays of the Golden Valley Formation have been used in the manufacture of face brick, building tile, and fire brick. The plant at Hebron, North Dakota, in operation since 1905, is the oldest and largest brick plant in the State. The plant produces about 12 million brick units annually and uses about 36,000 tons of clay.

North Dakota also produces a small quantity of leonardite (about 50,000 tons per year), which is formed by the natural weathering of lignite. It has commercial value as a dispersant and viscosity control in oil well drilling muds, as a stabilizer for ion exchange resins in water treatment, as a soil conditioner, and as a source for water-soluble brown stain for wood finishing.

Additional mineral resources found in North Dakota include volcanic ash, peat, sulfur, sodium sulfate, uranium, and molybenum.

Paleontology

Fossil localities are not abundant in North Dakota. In eastern North Dakota exposures of the Cretaceous Niobrara Formation has produced fish scales and coccoliths. The Cretaceous Pierre Formation has produced some echinoids, a mosasaur in Barnes County, and abundant clam fragments of Inoceramus.

The Cretaceous Fox Hills Formation is especially fossiliferous in parts of south-central Sioux County (where oysters and clams are abundant) and in parts of Emmons County. Clams, snails, fossil crab burrows, and at least one type of cephalopod have been found in this formation. The Hill Creek Formation contains dinosaur bones, fish bones, and mollusks.

A triceratops skeleton was taken from sediments in Slope County, in southwestern North Dakota. Fish bones are common in the Hill Creek Formation in Morton County, near Huff, North Dakota.

The Paleocene Cannonball Formation contains lobster, crab, and clam fossils. Teredo-bored petrified wood is also present in the formation. The Ludlow Formation was deposited on land at the same time the Cannonball Formation was deposited offshore. The Ludlow Formation contains an abundant fossil assemblage, including fossil fish, turtles, fossilized crocodiles, and champsosaurs, as well as a few scattered fossils of primitive horses and primates.

The Paleocene Bullion Creek and Sentinel Butte Formations contain abundant petrified wood, lignite, and mollusks. Excellent fossil leaves and plant casts from the coal are found in some places.

The sediments of the Eocene Golden Valley Formation and the Oligocene White River Group contain plant and animal fossils. At White Butte, in Slope County, fossil fish, frogs, reptiles, a bird, and mammals—including rodents, carnivores, pantodonts, perrisodactyls, and artiodactyls—have been collected from the Golden Valley Formation. A few fossils, including titanothere bones and a rhinoceras have been found in the White River Formation.

The Pleistocene Coleharbor Group sediments have produced fossil assemblage, including pollen from trees and small plants. Glacial and postglacial lake sediments contain numerous fish, aquatic snail and clam shells, land snails, insect fossils, and ostracodes. Larger fossils found in North Dakota dating to the Pleistocene include beaver, caribou, bison, and mammoth remains.

SOILS

The general soil units of North Dakota are shown on Map 4-8 and Table 4-2. Each mapping unit is comprised of one soil series or several dominant soil series associated together. The general soil map is useful for general planning purposes but specific decisions require maps with more detail, such as a county soil map.

The mapping unit descriptions in Table 4-3 give soil properties and limitations that may be impacted by oil and gas development. The textural classes are: coarse—sands and loamy sands; moderately coarse—sandy loam, fine sandy loam; medium—very fine sandy loam, loam, silt loam, silt; moderately fine—clay loam, sandy clay loam, silty clay loam; and fine—sandy clay, silty clay, and clay. Soils are moderately deep (20-40 inches) or deep (40 inches) unless otherwise stated. More detailed soils information can be obtained from the references cited in chapter 5.

Map 4-9 shows susceptibility of soils to compaction. Compaction alters soil structure and reduces soil porosity, thereby reducing vegetative productivity and increasing runoff. It occurs when a compressing weight at the surface causes spaces in the soil to collapse. The soil then becomes more dense. This occurs most often when a layer below the surface of the soil is saturated with water after a rain or snowmelt, with the soil surface appearing dry. Once this layer is compacted, a return to its previous state may require many years. Compaction susceptibility is highest on moderately fine and fine soils, because of the extremely small clay particles which become tightly compressed together. Moderately coarse and coarse textured soils have low susceptibility to compaction, because of the predominance of sand particles which are large enough to keep the soil from being tightly compressed together.

Maps 4-10 and 4-11 show susceptibility to water and wind erosion respectively. Water erosion occurs under a variety of conditions and may be caused by rainfall, snowmelt, irrigation water, or by stream flow. Water erosion is the most widespread kind of erosion in the State. Hill and gully erosion may be severe regardless of soil type. Slope is an important factor, as steeper slopes are more easily eroded.

Wind erosion most commonly occurs on the coarser textured soils and those soils kept loose by summer fallowing. The wind has the best opportunity to pick up these soils when there is an unconsolidated surface condition.

Vegetative cover plays an important role in controlling erosion. Water and wind erosion susceptibility is usually low in areas supporting a good stand of vegetation. Cultivation of soils suited for cropland and overgrazing of soils unsuitable for cropland are assumed in classifying the erosion susceptibility.

VEGETATION

Introduction

The two major categories of vegetative cover in North Dakota are croplands and rangelands. The majority of the land cover in the State is cropland (over 60 percent). Less than 30 percent still remains in rangeland. The lands that remain in native range almost always have some limitations to farming, such as steep slopes, irregular topography, wetlands, woodlands, rocky soils, or low precipitation.

Counties in the southwestern part of the State have the highest percentages of rangeland. The lands drained by the Red River in the eastern part of the State are predominantly cropland. This is displayed on the North Dakota Land Use Map (Map 4-17).

Vegetative Zones of North Dakota

North Dakota has a wide range of prairie vegetative types (see Map 4-12). At the east end of the State there is the Tallgrass Prairie, of which—due to farming—little remains. As one moves west into the pothole region, the grassland changes to a transition zone. Even farther west, about halfway across the State, the mixed grass prairie begins. At one time most of the southwest half of the State was covered with this range type. The primary species are a mixture of midgrasses (western wheat

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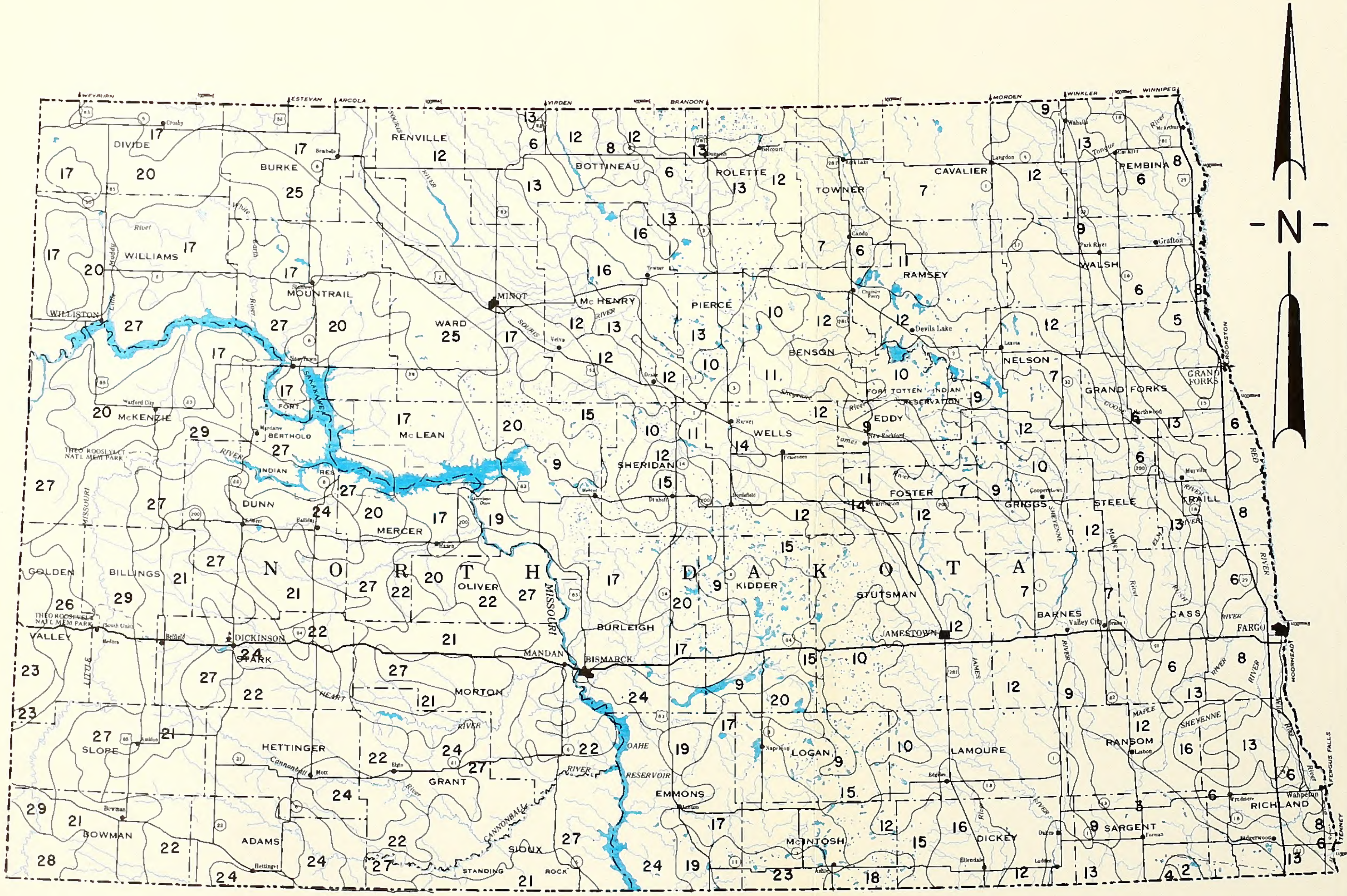
SOIL MAP

MAP 4-8



LEGEND

SEE SOILS LEGEND — PAGE

SOURCE: "Soils of North Dakota." Bulletin No. 5, S-35, 942. USDA, SCS, Lincoln, Nebr., 1977.

Scale 1:2,150,000

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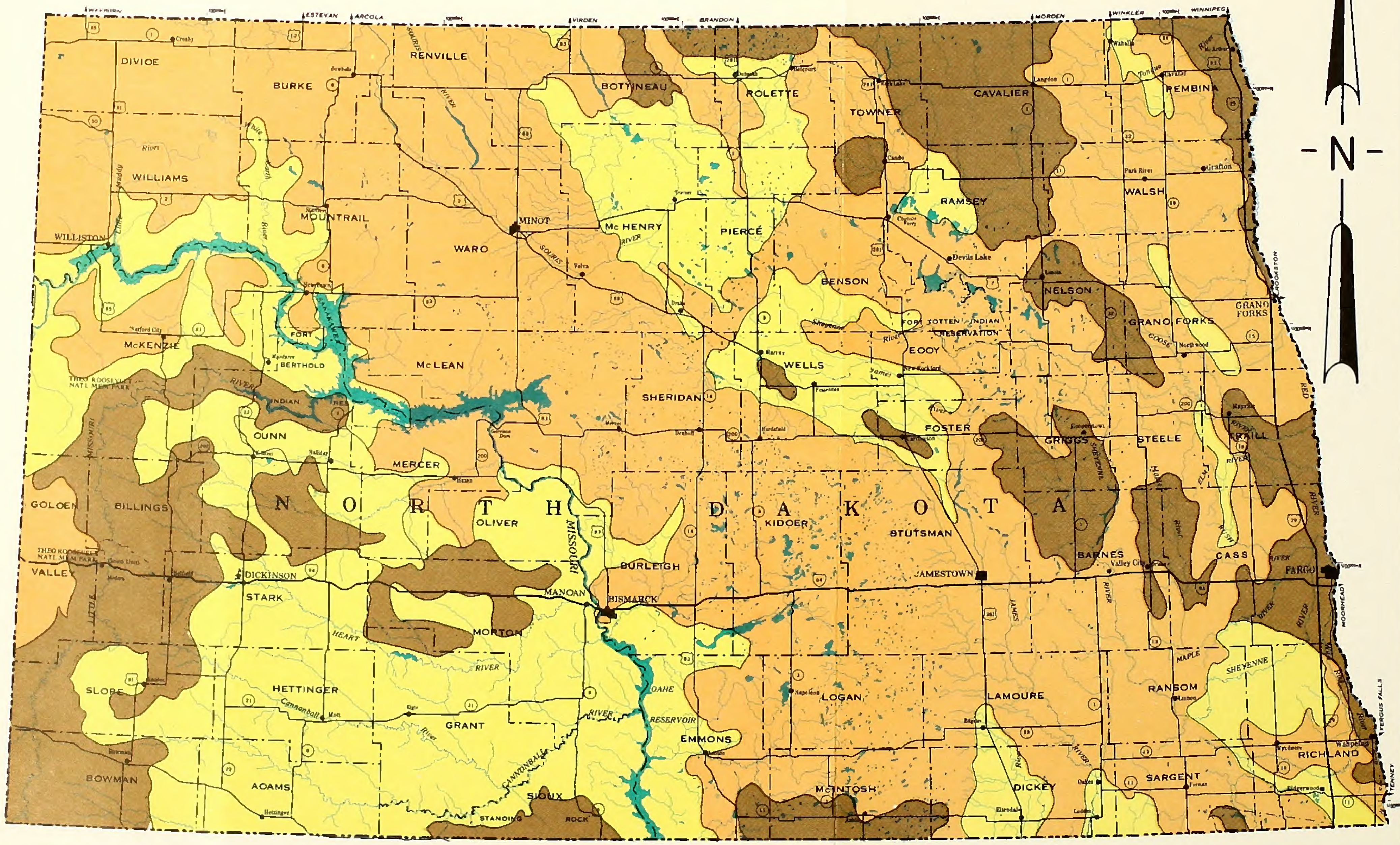
SOIL COMPACTION SUSCEPTIBILITY

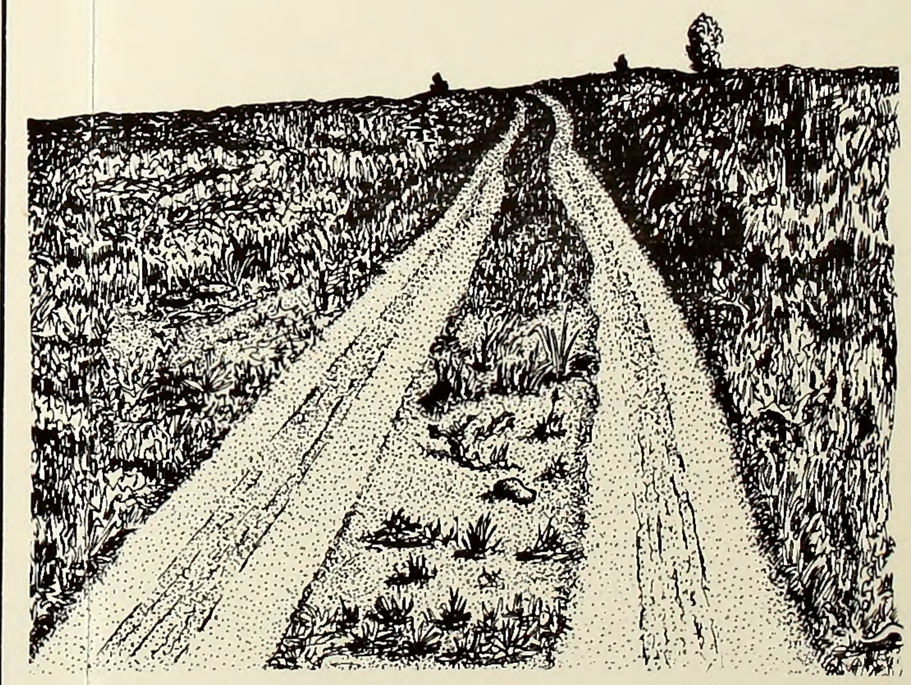
MAP 4-9



- N -

LEGEND

- Low
- Moderate
- High



SOURCE: "The Major Soils of North Dakota." Bulletin No. 472 by H.W. Omodt, et al., Dept. of Soils, Ag. Exp. Sta. NDSU, Fargo, 1968. "Soils of North Dakota." Bulletin No. 5, S-35, 942 USDA, SCS, 1977.

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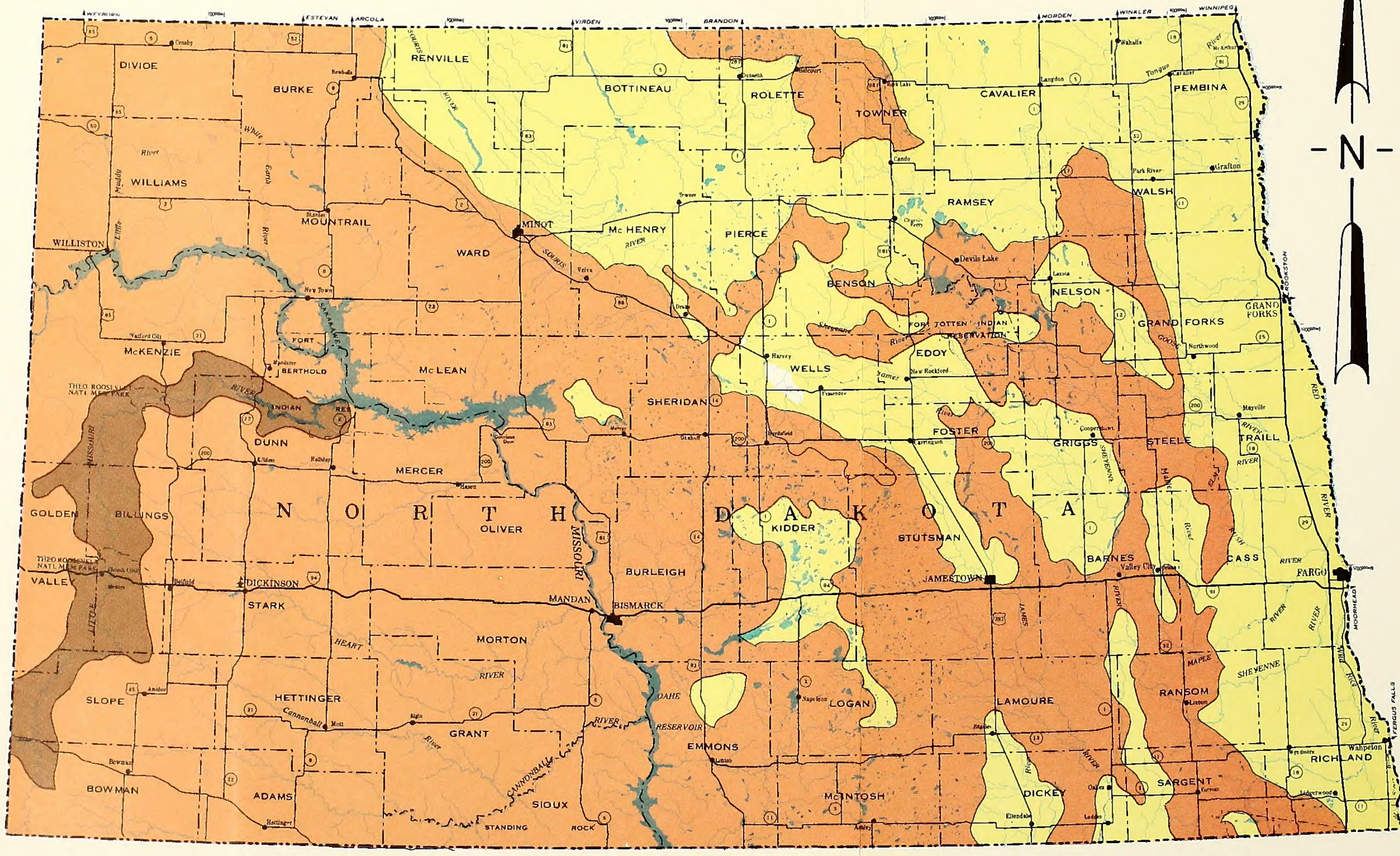
WATER EROSION SUSCEPTIBILITY

MAP 4-10



LEGEND

- Low
- Moderate
- High

SOURCE: "The Major Soils of North Dakota." Bulletin No. 472 by H.W. Omodt, et al., Dept. of Soils, Ag. Exp. Sta. NDSU, Fargo, 1968. "Soils of North Dakota." Bulletin No. 5, S-35, 942 USDA, SCS, 1977.

Scale 1:2,150,000

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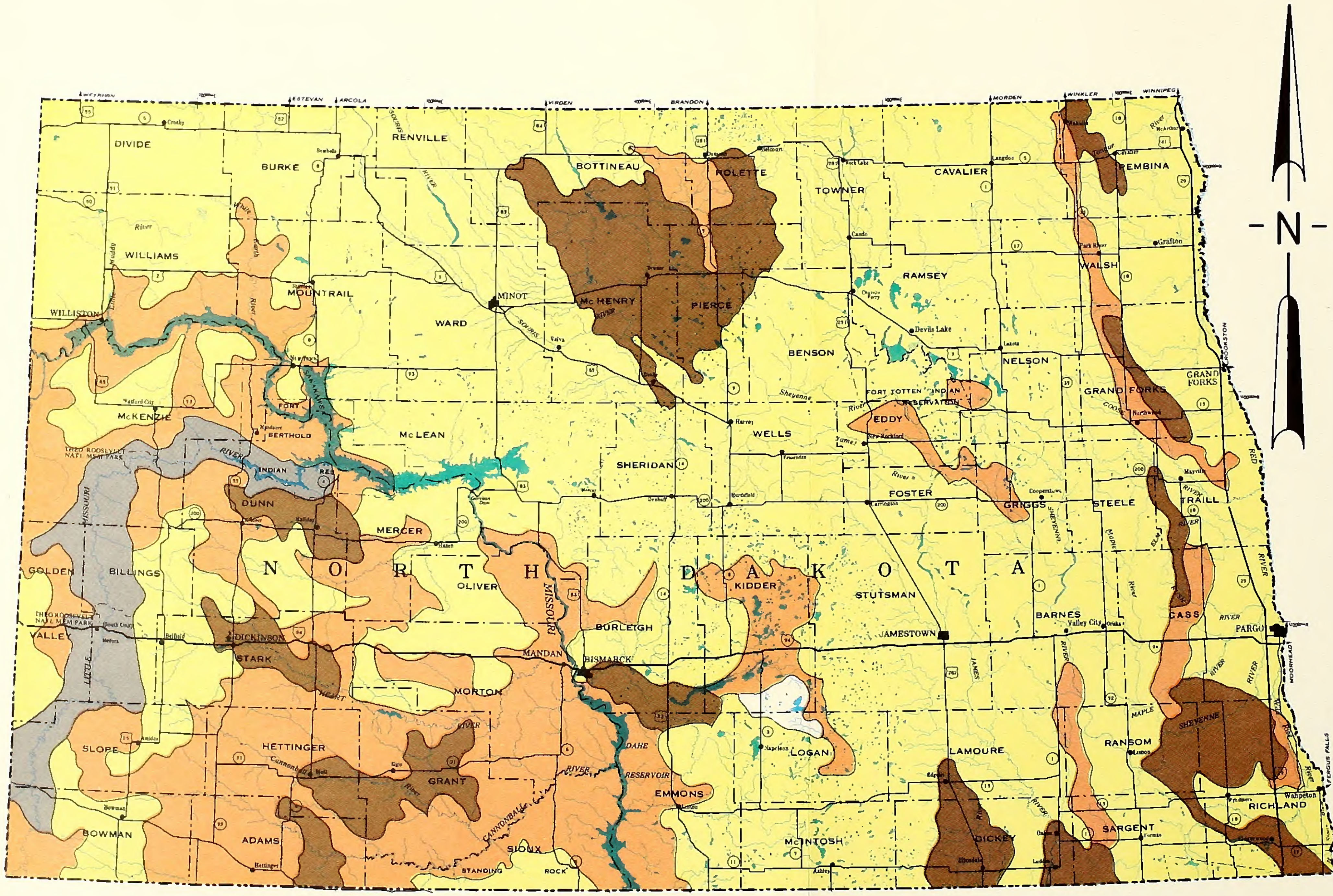
WIND EROSION SUSCEPTIBILITY

MAP 4-11



LEGEND

- Low
- Moderate
- High
- Unclassified (Highly Variable)

SOURCE: "The Major Soils of North Dakota." Bulletin No. 472 by H.W. Omodt, et al., Dept. of Soils, Ag. Exp. Sta. NDSU, Fargo, 1968. "Soils of North Dakota." Bulletin No. 5, S-35, 942 USDA, SCS, 1977.

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Table 4-2
Soil Legend

Mapping Unit	Major Soil Series Included	Percent Slope
1	Bottineau, Kelvin, Rolla	3-15
2	Forman, Aastad	0-8
3	Forman, Aastad, Barnes	0-8
4	Forman, Aastad, Barnes, Buse	3-30
5	Bearden, Saline	0-3
6	Bearden, Glyndon, Gardena, Overly	0-3
7	Hamerly, Barnes, Svea, Tonka	0-3
8	Fargo, Bearden, Hegne	0-3
9	Renshaw, Brantford	0-3
10	Barnes, Buse	3-15
11	Heimdal, Emrick, Fram	0-8
12	Barnes, Svea, Hamerly	0-8
13	Hecla, Maddock, Renshaw, Divide, Hamar	0-3
14	Cresbard, Cavour	0-8
15	Barnes, Buse, Zahl, Zahill, Langhei, Williams	3-30
16	Serden	3-15
17	Williams	0-8
18	Williams, Bowbells, Tonka, Zahl	0-8
19	Williams, Temvik, Wilton, Grassna, Bryant	0-15
20	Williams, Bowbells, Zahl, Zahill	0-15
21	Morton, Rhoades, Cabba	0-15
22	Morton, Cabba	0-15
23	Morton, Cabba, Wayden	0-15
24	Vebar, Williams, Flasher	0-15
25	Zahl, Williams	3-30
26	Chama, Cabba, Cohagen, Cherry	3-30
27	Cabba, Wayden, Morton	3-30+
28	Cabbart, Yawdim, Absher, Ladner, Ekalaka, Desart	3-30
29	Badlands Miscellaneous Area, Cabbart, Lisam, Yawdim	3-30+

Source: "Soils of North Dakota" Bulletin No. 5, S-35,942, USDA-SCS, Lincoln, Nebraska, 1977.

Table 4-3
Mapping Unit Descriptions

Mapping Unit	Major Series Included	Slope	Textures	Compaction Susceptibility	Water Erosion Susceptibility	Wind Erosion Susceptibility	Other Limitations	Location in State
1	Bottineau, Kelvin	undulating (3-8%) —rolling (8-15%)	medium and fine	high	moderate	low	—	North-Central (Turtle Mtns.)
2	Forman, Aastad	level (0-3%)— undulating (3-8%)	medium to moderately fine	moderate to high	low	low	early spring wetness; slow surface drainage	Southeast
3	Forman, Aastad, Barnes	level (0-3%)— undulating (3-8%)	moderately fine and medium	moderate	moderate	low	intermittent ponding in depressions	Southeast
4	Forman, Aastad, Barnes, Buse	undulating (3-8%) —hilly (15-30%)	moderately fine and medium	moderate	moderate	low	intermittent ponding in depressions	Southeast

5	Bearden (Saline)	level	moderately fine	moderate	low	low	salinity; wetness	Northeast (Grand Forks area)
6	Bearden, Glyndon, Gardena, Overly	level	medium	moderate	low	low	early spring wetness; slow surface drainage	North-Central and Red River Valley
7	Hamerly, Barnes, Svea, Tonka	level - with some undulating	medium and fine	high	low	low	intermittent ponding of Tonka; early spring wetness of Hamerly	Northeast and East-Central
8	Fargo, Bearden, Hegne	level	fine and moderately fine	high	low	low	poor surface drainage and wetness	North-Central and Red River Valley
9	Renshaw, Brantford	level	medium and moderately coarse	moderate	low	moderate	limited water holding capacity	scattered in East half
10	Barnes, Buse	undulating to rolling	medium	moderate	moderate	low	intermittent ponding in depressions	East-Central
11	Heimdal, Emrich, Fram	level to undulating	medium	low	low	low	intermittent ponding in depressions	Central
12	Barnes, Svea, Hamerly	level to undulating	medium	moderate	low to moderate	low	intermittent ponding in depressions	East half and North- Central
13	Hecla, Maddock, Hamar Renshaw, Divide	level	coarse medium	low	low	high	seasonal high water table	North-Central and East
14	Cresbard, Cavour	level to undulating	medium and moderately fine	high	low	low	wetness, intermittent ponding, excess sodium	Central
15	Barnes, Buse, Zahl, Zahill, Langhei, Williams	undulating to hilly	medium and moderately fine	moderate	moderate	low	—	Central
16	Serden	undulating to rolling	coarse	low	low	high	—	North-Central and Southeast
17	Williams	level to undulating	medium to moderately fine	moderate	moderate	low	—	Central and Northwest
18	Williams, Bowbells, Tonka, Zahl	level to undulating	moderately fine	high	moderate	low	intermittent ponding in depressions	South-Central (McIntosh Co.)
19	Williams, Temvik, Witton, Grassna, Bryant	level to rolling	medium	moderate	low to moderate	low	—	Central and South-Central

20	Williams, Bowbells, Zahl, Zahill	level to rolling	medium and moderately fine	moderate	moderate	low	—	South-Central to Northwest
21	Morton, Rhoades, Cabba	level to rolling	medium and moderately fine	high	moderate	low	excess sodium for Rhoades; shallow depth (10-20") for Cabba	Southwest
22	Morton, Cabba	level to rolling	medium to moderately fine	low to moderate	moderate	low to moderate	shallow depth for Cabba	Southwest
23	Morton, Cabba, Wayden	level to rolling	medium and moderately fine; fine for Wayden	moderate to high	moderate	low	shallow depth for Cabba and Wayden	Extreme West and South-Central
24	Vebar, Flasher	level to rolling	coarse and moderately coarse	low	moderate	high	shallow depth for Flasher	Southwest and South-Central
	Williams		medium to moderately fine					
20	Williams, Bowbells, Zahl, Zahill	level to rolling	medium and moderately fine	moderate	moderate	low	—	South-Central to Northwest
21	Morton, Rhoades, Cabba	level to rolling	medium and moderately fine	high	moderate	low	excess sodium for Rhoades; shallow depth (10-20") for Cabba	Southwest
22	Morton, Cabba	level to rolling	medium to moderately fine	low to moderate	moderate	low to moderate	shallow depth for Cabba	Southwest
23	Morton, Cabba, Wayden	level to rolling	medium and moderately fine; fine for Wayden	moderate to high	moderate	low	shallow depth for Cabba and Wayden	Extreme West and South-Central
24	Vebar, Flasher	level to rolling	coarse and moderately coarse	low	moderate	high	shallow depth for Flasher	Southwest and South-Central
	Williams		medium to moderately fine					
25	Zahl, Williams	undulating to hilly	medium to moderately fine	moderate	moderate	low	—	Northwest
26	Chama, Cabba	undulating to hilly	medium	moderate	moderate	moderate	shallow depth for Cabba and Cohagen	Extreme West
	Cohagen		moderately coarse					
	Cherry		moderately fine					

27	Cabba, Morton Wayden	undulating (3-8%) to steep (30%)	medium to moderately fine fine	low	moderate	moderate	shallow depth for Cabba Wayden; steep slopes	West half
28	Ekalaka, Desart, Ladner Cabbart Yawdim, Absher	undulating to hilly	moderately coarse medium fine	high	moderate	moderate	shallow depth for Yawdim and Cabbart; excess salinity-sodium for Absher and Ladner	Extreme Southwest
29	Badlands Landtype, Cabbart, Lisam	undulating to steep	medium and fine	high	high	unclassified (highly variable)	lack of soil; steep slopes; generally fragile	Southwest (Little Missouri Badlands)

Source: "The Major Soils of North Dakota" Bulletin No. 472, by H.W. Omodt, et al., Dept. of Soils, Ag. Exp. Sta., NDSU, Fargo 1968; "Official Soil Series Descriptions" USDA-SCS-Lincoln, NE 1974-1979; "Soils of North Dakota" Bulletin No. 5, S-35, 942 USDA-SCS-Lincoln, NE 1977.

grass, needle grass, and prairie sandreed) and short-grasses (grama grasses, little bluestem, June grass, and carex), along with numerous forbs and shrubs (fringe sagewort, snowberry, and wild rose).

Within these three broad types are several minor vegetative plant communities. Areas that have more favorable moisture conditions—such as north slopes, river bottoms, and drainage-ways—support stands of trees and shrubs, including green ash, American elm, chokecherry, wild plum, buffaloberry, cottonwood, and aspen. These sites exist because of added moisture from runnoff, flooding, or ground water. Disturbance of these sites by man can cause them to dry out, resulting in the trees and shrubs dying off.

In the central portion of the State much of the original vegetation still remains on the wetlands. These low-lying areas (marshes, sloughs, or potholes) contain critical wildlife habitat.

The Badlands region in the western part of the State is also quite varied. It is basically grassland lying on broken topography, with trees and shrubs occupying the wetter sites. Ponderosa pine and juniper can be found here. However, bare soils are common on steep south slopes and gumbo nobs.

Unique or Rare Plant Species

So far there has not been any plant species in North Dakota placed on the "National List of Threatened or Endangered Plants," but North Dakota does have an "Annotated Plant List of Rare and Unique Plant Species" on a statewide basis. These plants are most commonly found at isolated locations that have not been disturbed by modern man, machinery, or his livestock. Some feature of the landscape has protected areas. These areas identified as having rare or unique plants will be shown on the Dickinson District Oil and Gas Map Overlay File.

Croplands

Small grains (wheat, barley, and oats) are by far the leading crops grown in North Dakota. North Dakota ranks second in the Nation as a wheat producer. In 1975, 55 percent of the cash receipts on North Dakota farms were from wheat sales, while only 16 percent of the cash receipts were from the sale of cattle and calves. Wheat is an important crop in every county of the State.

Other crops grown in the State are flax, corn, rye, potatoes, sugar beets, soybeans, and field beans. The best row crop production is achieved in the Red River Valley.

Map Overlay

More detailed information will be available in the map overlay file. The base source for existing ground cover will be REAP's (Regional Environmental Assessment Program) Land Cover Maps. The interpretation is by computer processing of LANDSAT (satellite) imagery taken from an altitude of 570 miles. The level of interpretation is not adequate for a site-specific analysis, but it is useful as an indicator of what ground cover one might expect to find on a particular lease. Much of this REAP interpretation can be verified by recent aerial photos.

The future trends of existing vegetation are expected to remain stable. A large conversion of rangeland to cropland is not expected, as most of the remaining rangeland is submarginal for cropping.

There may be some changes in crops planted—for example, there is currently much interest in growing sunflowers—but cattle and wheat will remain as North Dakota's leading commodities for many years to come.

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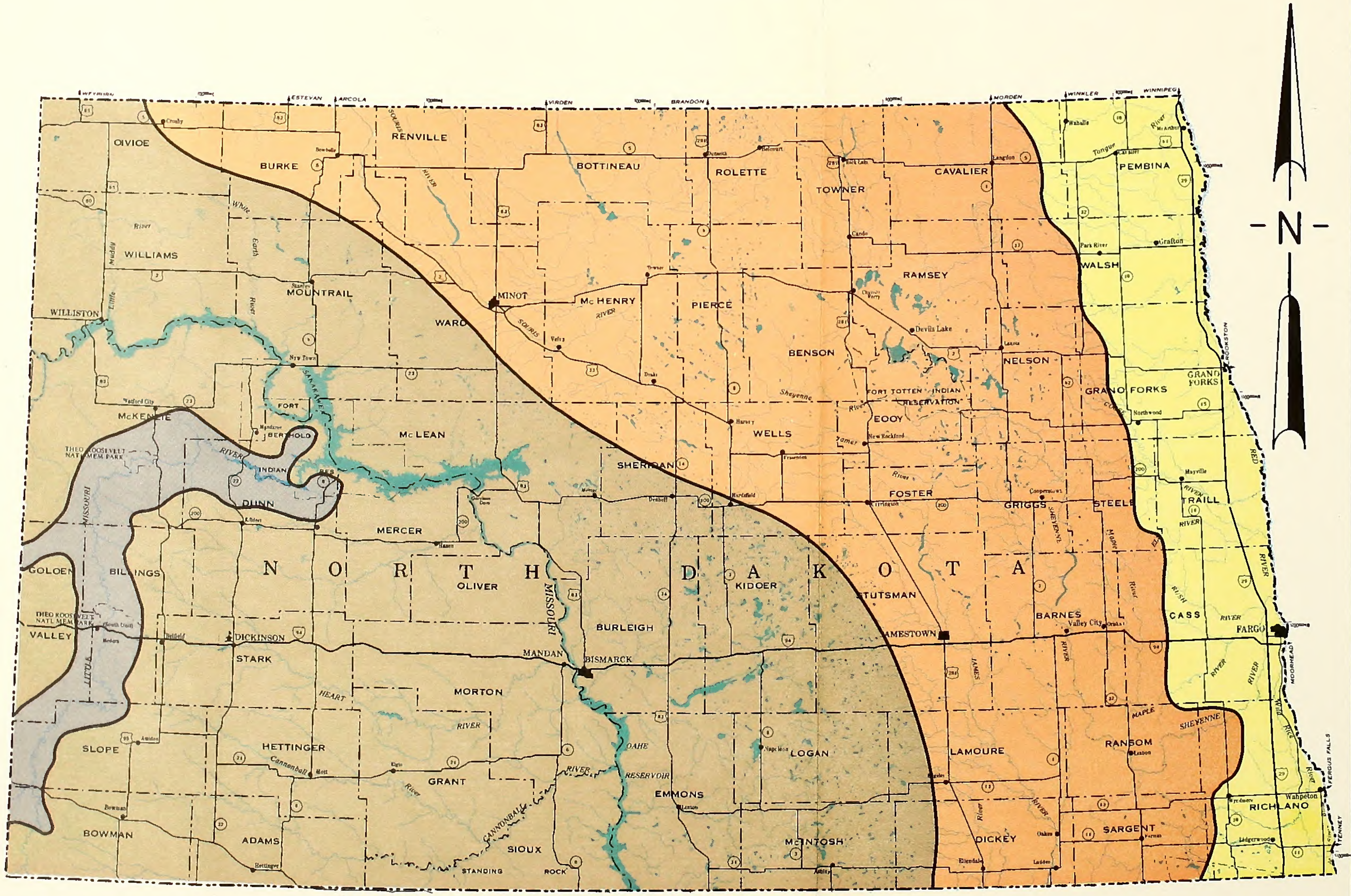
ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

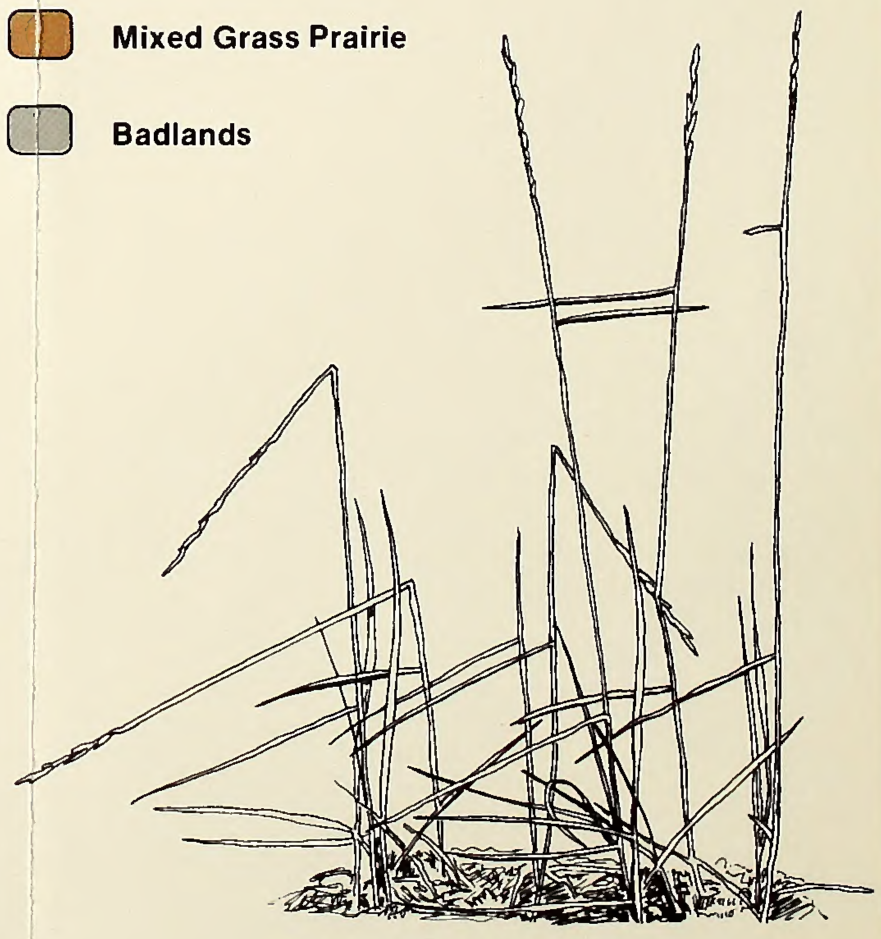
VEGETATIVE ZONES

MAP 4-12



LEGEND

- Tall Grass Prairie
- Transition Zone
- Mixed Grass Prairie
- Badlands



Scale 1:2,150,000

SOURCE: Adopted trom SCS Family of Maps. DRWG. 5, S-32, 814 (5-74).

WATER

The climate of North Dakota is continental, with warm and dry summers and very cold winters. The average annual precipitation varies from 13 inches in the west to 20 inches in the east. Most of this falls in the form of rain during the spring and early summer months. These climatic conditions result in two peak runoff periods: the first occurring after the spring snowmelt, and the second following rainstorms during spring or early summer.

The geology of North Dakota consists of sedimentary rocks which were deposited in the sporadically sinking Williston Basin. This basin, formed by Precambrium rocks, reaches a depth of over 15,000 feet at its center in McKenzie County. Following the deposition of the sedimentary rocks, several glaciations occurred over all but the southwest corner of the State. This series of geological events has created several water-bearing zones within sedimentary rocks, as well as many surficial features typical of glaciated country.

Surface Water

North Dakota has historically had problems with the distribution of runoff—in terms of both time and area. The only large source of surface water which is consistent throughout the year is the Missouri River. The Missouri River derives most of its flow from the mountains to the west, but also drains the southwest half of North Dakota. The northwestern part of the State drains into the Hudson Bay through the Red and Souris rivers (see Map 4-13).

The State can be divided into six general areas according to surface drainage characteristics. The Surface Hydrology Characteristic Map (Map 4-14) indicates a certain type characteristic for general areas; however, at its scale, there may be small areas with drainage characteristics different from those of the general area shown.

The Badlands have a very dense drainage network. Stream channels are deeply cut into the easily eroded sandstone and shale beds, so slumping and head cuts are common. The slopes are steep, and vegetative cover varies from good to none at all. These conditions lead to streamflows which respond quickly to rain or snowmelt events. Another result of these conditions is the large amount of dissolved solids and suspended sediments found in streams of the Badlands. Because of the lack of development in the area, flooding is not a problem.

The unglaciated prairie areas have a medium textured drainage pattern. The topography is rolling, with few steep slopes. Cover is provided by grasses, with some taller shrubs and trees in draws and windrows. Stream channels have stable banks and are well defined. Flooding can occur during the spring snowmelt period due to snowmelt and ice jams. Because of the gentle slopes and good cover, sediment is not usually a problem in this area. Concentrations of dissolved solids are high, however, consisting of sodium sulfates and bicarbonates.

The semiglaciated prairie is nearly identical with the unglaciated prairie, because the glaciation that occurred was not heavy enough to alter the topography very much. However, as the glacial ice melted, channels were formed, which were subsequently buried by later glaciers. These shallow buried glacial valleys are connected to surface channels and some shallow aquifer zones, forming a water bearing network. Surface channel conditions, cover, topography, and water quality are similar to the unglaciated prairie.

The prairie pothole area was formed when stagnated glacial ice melted unevenly, leaving a hilly terrain where water fills the low spots. This area forms the drainage divide between the Missouri River and the Hudson Bay, but it does not contribute much surface runoff to either. The surface drainage is undeveloped, because of the small closed pothole basins found throughout the area. Water levels of these ponds are determined by precipitation, basin area, evapotranspiration, and ground seepage. Depending upon the relative importance of these factors, water in a pothole pond may have low or high concentrations of dissolved solids, but they rarely will have much sediment. Flooding can occur in or around these ponds during wet periods, as the water levels rise.

The glaciated prairie area was formed when glaciers came through and sheared off the hilltops and filled in the valleys with till. The relief and regional slope here is very low. Stream channels are poorly developed and have stable banks. Streamflow is slow in response to rain or snowmelt events. Flooding can occur over relatively large areas and is slow to subside. Sediment is rarely a problem in this area, but dissolved solids concentrations can be high.

The Lake Agassiz Plain consists of lake deposits of ancient Lake Agassiz. This area is very flat. Streams are sluggish, meandering, and have well protected banks. Here sediment loads and dissolved solids loads in streams are low, but nutrient levels are high.

Ground Water

Ground water in North Dakota is more evenly distributed over the State than surface water, but wells in most aquifers yield small amounts of water. Although yields are generally not large enough for commerical uses, they are adequate for domestic and livestock uses. A very large number of rural and municipal water users depend upon ground water for their water source. There are seven primary water-yielding zones located beneath the State. These and a few of their characteristics are listed in Table 4-4 according to their sequence in the stratigraphy. The areal extent of these is shown in Map 4-15.

Generally, wells tapping aquifers in the Fox Hills-Hell Creek zone and above will yield fresh water. While these are considered to yield fresh water, dissolved solids concentrations are usually 1,000-3,000 mg/l and locally can be as high as 10,000 mg/l. Table 4-4 shows the lower aquifers yeilding saline water, but in the eastern part of the State—where they are close to the surface—they can yield fresh water. In the western two-thirds of the State, the upper aquifers yield fresh water and are used by most ground water users, while the lower ones yield saline water and are not used except in oil and gas development. In the eastern third of the State, the geology containing the upper aquifers is missing, and the lower ones are used where they yield fresh water.

Table 4-4
Properties for the Major North Dakota Ground Water Zones

System/ERA	Formation	Water Quality	Depth (feet)	Yield (gpm)
Quaternary	Alluvium and Glacial Drift	Saline or Fresh	0 — 500	0 — 500
Tertiary	Fort Union	Saline or Fresh	0 — 1100	0 — 100
Cretaceous	Fox Hills—Hell Creek	Saline or Fresh	Few — 2500	0 — 150
	Pierre	Saline	—	0 — 100
	Dakota	Saline	100 — 5600	0 — 500
Paleozoic		Saline	150 — 13,500	—
Precambrium		Fresh	300	Few

Source: Mineral and Water Resources of North Dakota, Bulletin 63, North Dakota Geological Survey, E.A. Noble — State Geologist, 1973.

ANIMALS

Biotic Regions in North Dakota

Wildlife habitats in North Dakota fall into four biotic regions (Stewart 1975). These regions are: (1) The Agassiz Lake Plain, (2) Prairie Pothole, (3) Turtle Mountain, and (4) Southwestern Slope. The Prairie Pothole and Southwestern Slope regions are subdivided into subregions based on secondary differences in biotic relationships and prevalent habitats (see Map 4-16).

About ten percent of the State is covered by the Agassiz Lake Plain region. It is generally a flatland. Agriculture has replaced almost all the climax tallgrass prairie vegetation, because soils are generally very fertile. Rolling dunes occur at the places where the five major streams empty into the Red River. Only a remnant riparian habitat remains along the larger streams, and a few woodlands, shelterbelts, and tree claims break the monotony of the cropland. Wetlands are limited, and consist mostly of streams, oxbows, marshes, and ponds.

Glaciation of the Prairie Pothole Region left glacial associated landforms and numerous wetlands. About 50 percent of the State is encompassed by this region. Even though farming is prevalent, some fairly large tracts of the climax eastern mixed-grass prairie still exist. There are four subregions: the Missouri Coteau, Northeastern Drift Plain, Southern Drift Plain, and the Northwestern Drift Plain.

The Missouri Coteau differs from the other three drift plain subregions in both vegetation and topographic features, while vegetal relationships form the basis of differentiation among the Northeastern, Southern, and Northwestern Drift Plains. In the Missouri Coteau, the knob-and-kettle topography has resulted in numerous glacial outwash areas, especially in Kidder and McLean counties. Wetlands in these outwashes tend to be saline. Other nonglacial outwash wetlands are deeper and larger than those in the other three subregions.

In addition to wetlands, other important habitat in the Prairie Pothole Region are isolated woodlands, stockponds, dugouts, wooded draws, and riparian communities.

The Turtle Mountain Region is characterized by knob-and-kettle topography and an elevation slightly higher than the surrounding region. Its poor drainage system results in numerous ponds and lakes which are fairly deep and permanent, but there are also large numbers of seasonal wetlands. Swamps with heavy stands of shrubs and trees are also present. Even though large tracts have been cleared for agriculture, much of the northern deciduous forest vegetation still exists.

The Southwestern Slope Region covers nearly 40 percent of the State. It is largely unglaciated, and its topo-

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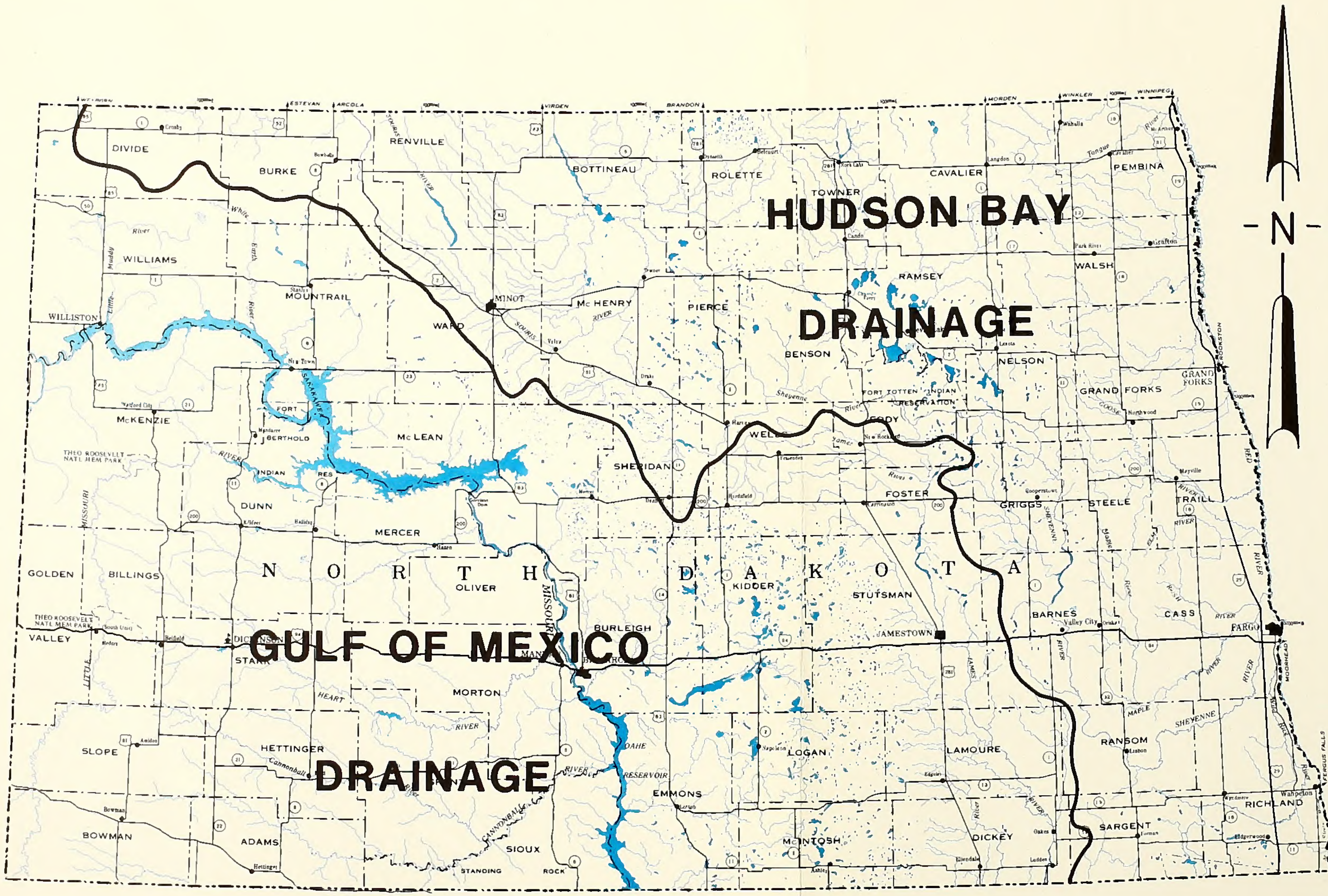
SURFACE DRAINAGE PATTERN

MAP 4-13



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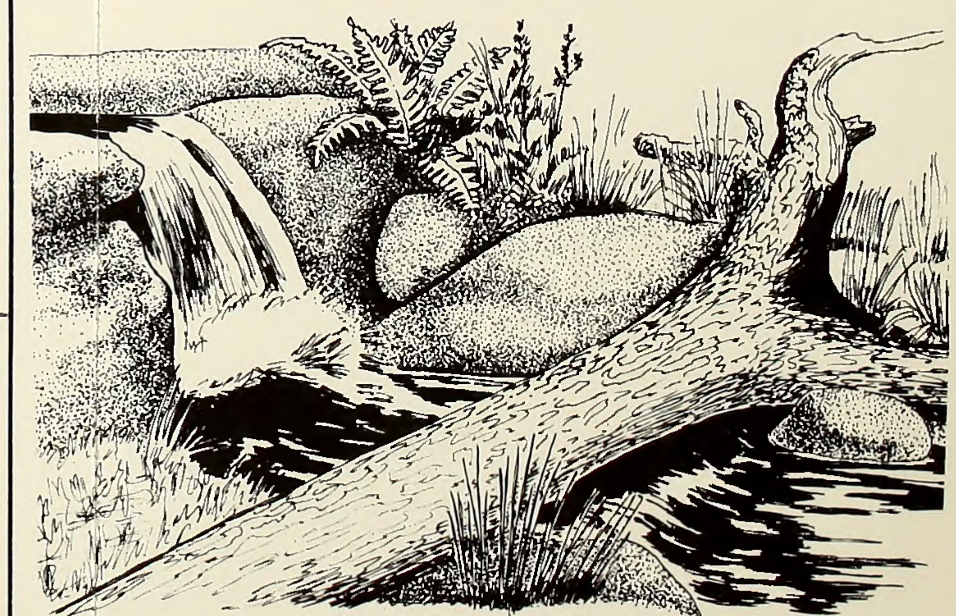
LEGEND

Surface Divide



SOURCE: Hydrologic Unit Map of North Dakota, U.S. Geological Survey, Reston, Va., 1974.

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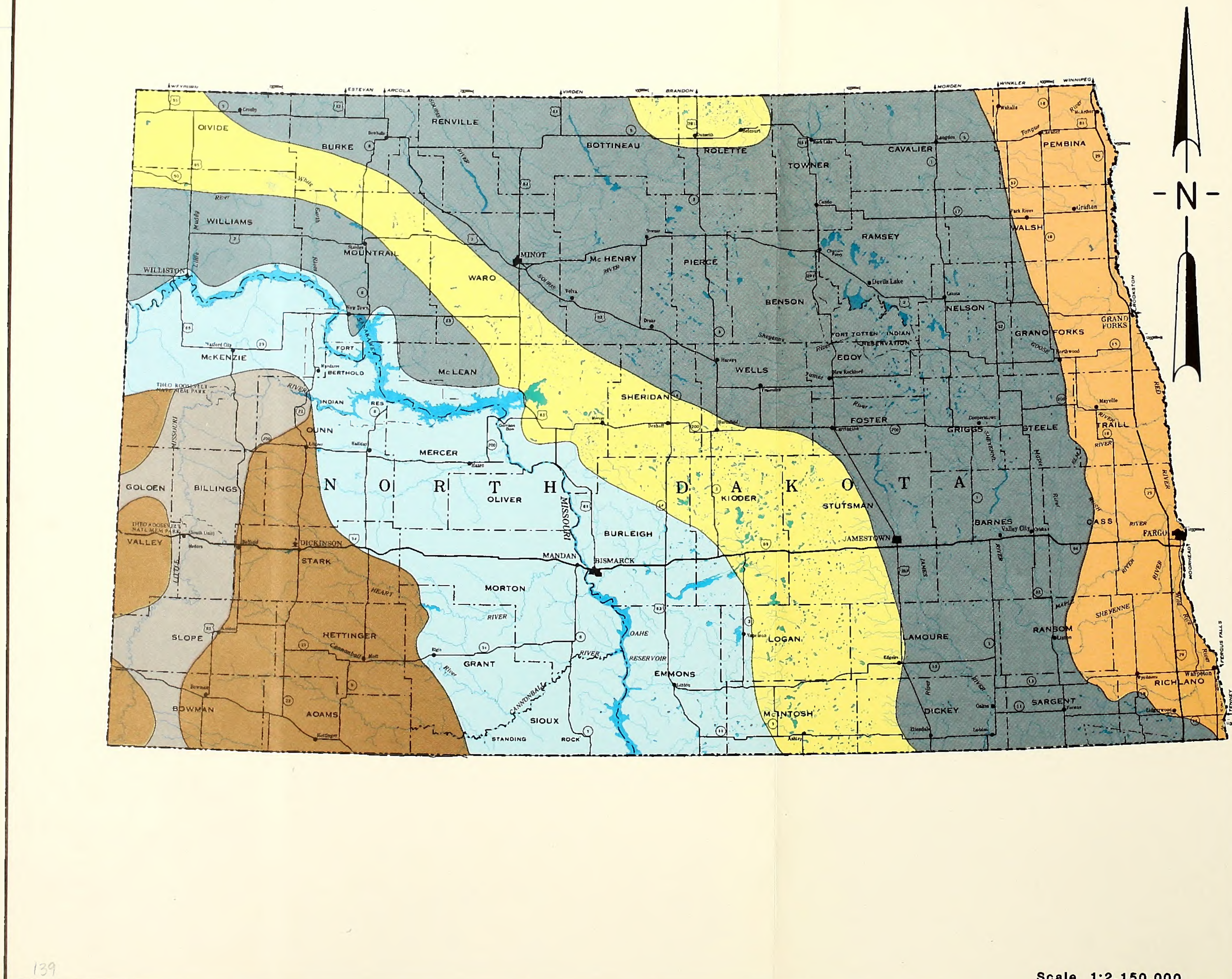
SURFACE HYDROLOGY CHARACTERISTICS

MAP 4-14



LEGEND

SURFACE HYDROLOGY CHARACTERISTICS

- Lake Agassiz Plain
- Glaciated Prairie
- Prairie Pothole
- Semiglaciated Prairie
- Badlands
- Unglaciated Prairie

SOURCE: BLM—C.W. Pettee, 1979, and Mineral and Water Resources of North Dakota, Bulletin 63, North Dakota Geological Survey, 1973.

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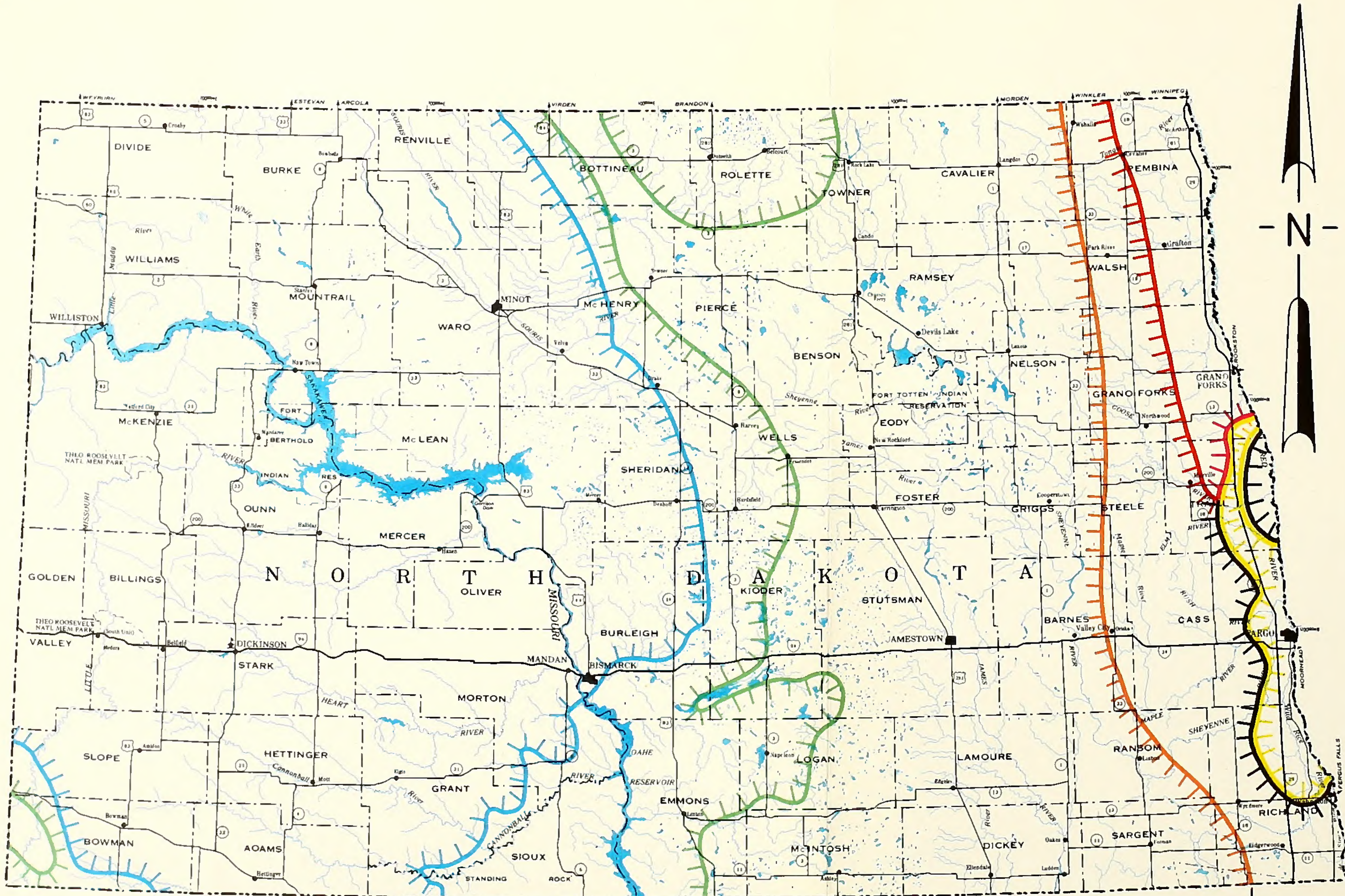
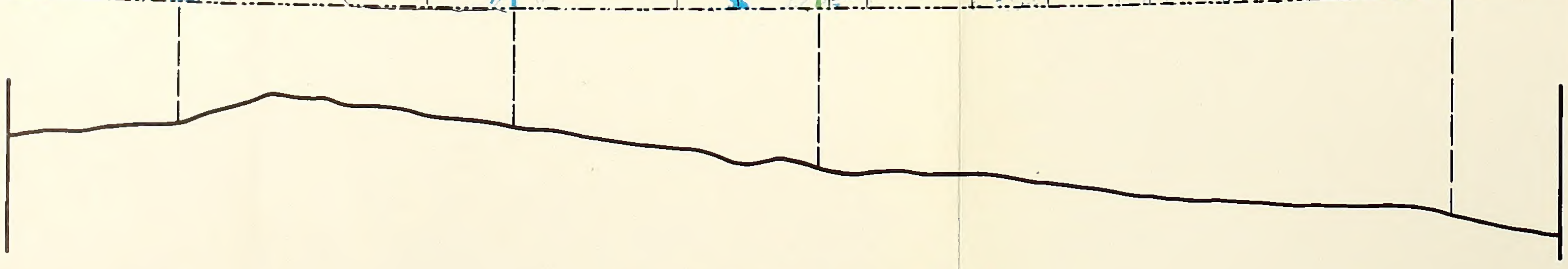
MAJOR BEDROCK AQUIFERS

MAP 4-15





Cross Section of the State

Scale 1:2,150,000

LEGEND

Areal Extent of Major Consolidated Bedrock Aquifers

- Fort Union Aquifer
- Fox Hills—Hell Creek Aquifer
- Pierre Aquifer
- Dakota Aquifer
- Paleozoic Aquifer
- Precambrian Aquifer
- Common Boundary (Dakota and Paleozoic Aquifers)

SOURCE: Mineral and Water Resources of North Dakota, Bulletin 63, North Dakota Geological Survey, 1973.

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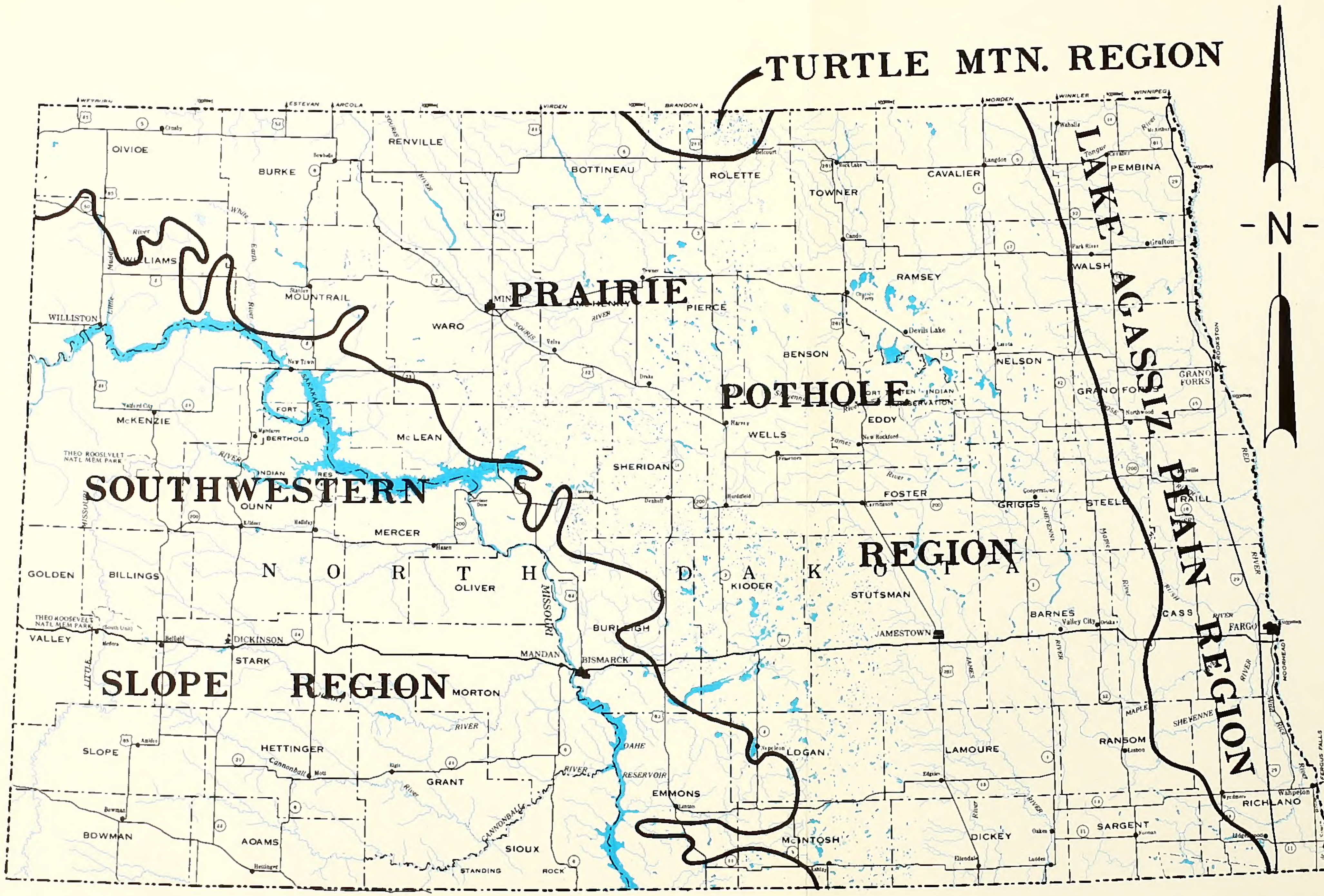
BIOTIC REGIONS

MAP 4-16



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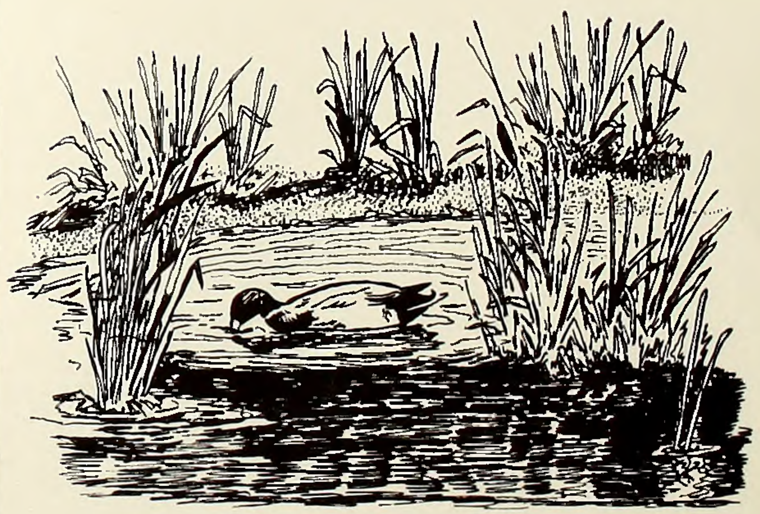
LEGEND



SOURCE: R.E. Stewart, 1975, Breeding Birds of North Dakota.

graphic features and biotic relationships differ from those of the other three regions. The climax vegetation is the western mixed-grass association, which is an integration of the eastern mixed-grass prairie and the short-grass prairie. Large areas of this native prairie, although grazed by cattle, still exist; but, conversion to cropland steadily decreases it. Drainage systems are well developed and, consequently, wetlands are scarce. There are three subregions: the Coteau Slope, Missouri Slope, and Little Missouri Slope.

The low to moderate relief of the Coteau Slope is occasionally interupted by a butte. The slight to moderate glaciation has left only a few wetlands and bluffs along the larger streams and valleys. Wooded draws along the Missouri River provide habitat for a greater variety of wildlife.

Glaciation occurred only in the extreme eastern part of the Missouri Slope subregion, and the few wetlands are generally restricted to the glaciated areas. Some badlands are evident along the Heart and Cannonball Rivers, and some degraded land occurs in western Bowman County.

The Little Missouri Slope Subregion is characterized by the "badlands vegetation complex", a mosaic mixture of grasslands, bushlands, and sparsely vegetated, steeply eroded slopes. Other important habitats are riparian communities primarily along the Little Missouri River, hardwood draws on the uplands, and a few areas of coniferous forest. Very little of this subregion has been converted to cropland. It is largely grazed by domestic animals.

Domestic Animals

The counties with greater proportion of rangelands are located mostly in the west-central and southwestern areas of the State (Shaver, 1977) (see Map 4-17). There was an average of 2,500,000 cattle in North Dakota during 1972-1976 (Price and Hamlin, 1977).

Important Game and Nongame Animals

White-tailed deer are generally associated with riparian bottomlands, larger windrows, and tree claims throughout the State (see Map 4-18). The natural hardwood draws are important habitat for both winter survival and escape cover.

Mule deer are usually associated with the open shrub grasslands that are interspersed with hardwood draws and broken terrain (see Map 4-19). Very typical habitat is that found in the Badlands (within the Little Missouri Slope Slope Region). Other important wintering areas are the hardwood draws and riparian bottomlands in other subregions.

Pronghorn antelope are common in the western half of the State (see Map 4-20). The greatest numbers are found in the rolling grassland/sagebrush habitats in the extreme southwestern counties of Bowman, Slope, and Golden Valley.

Sage grouse are restricted to the grassland/sagebrush habitats in the extreme southwestern counties (see Map 4-21). Their leks (breeding grounds) are restricted to specific sites. These leks are critical to the survival of sage grouse.

Sharp-tailed grouse occur throughout all regions, except the Agassiz Lake Plain. They prefer large areas of interspersed rangeland and hardwood draws/shrubby areas. Leks are typically on ridgetops in short-grass prairie.

Small bands of bighorn sheep are found in the badlands habitats along the Little Missouri River (see Map 4-21).

Numerous wetlands provide very important habitat to waterfowl, wading birds, and other aquatic animals. Most of these wetlands are located north and east of the Missouri River (see Map 4-22). North Dakota generally produces the most waterfowl among the lower 48 states.

In addition to waterfowl production, wetlands provide resting and feeding areas for migrating waterfowl and other aquatic birds. Many of these wetlands are part of the National Wildlife Refuge System. This system consists of (1) lands that are managed and owned by the U.S. Fish and Wildlife Service and (2) privately owned lands with restrictive easements that protect wetlands.

Threatened and Endangered Species

Black-footed ferrets are dependent upon prairie dog towns for habitat. Prairie dog towns in North Dakota are restricted in distribution to the area south and west of the Missouri River. The heaviest density probably occurs in the Badlands and in the degraded lands of Bowman County (see Table 4-5). Reports of black-footed ferret sightings are given in Table 4-6.

Whooping cranes migrate through North Dakota using various wetland habitats for feeding and resting, and are often observed on alkali ponds. There are several wildlife refuges which traditionally attract the majority of the cranes. Most observations have been made in the Missouri Coteau and Coteau Slope subregions.

The historic distribution of the peregrine falcon is apparently confined to the western half of North Dakota. There are no active eyries known. The last record of possible nesting was in 1954, when a pair was observed with young near Bullion Butte, in Billings County. Peregrine falcons need cliffs with ledges for their eyries, but will travel considerable distances to feed. Potential eyrie sites include the badlands and buttes with large cliff faces which typically occur in the Little Missouri Subregion.

Table 4-5
Summary of Known Black-tailed Prairie Dog Towns in North Dakota

County	Number of Towns	Number of Acres			
		Federal	State	Private	Total
Adams	3	—	80	100	180
Billings[1]	34	614	—	333	947
Bowman	33	70	190	901	1161
Dunn[2]	17 (6)	—	—	1175	1175
Golden Valley	27 (11)	24	—	136	160
Grant	8	—	—	125	125
Hettinger	—	—	—	—	—
McKenzie[1 2]	16	776	—	210	986
Mercer[2]	1	—	—	90	90
Morton	14	—	—	601	601
Sioux	67 (45)	—	—	616	616
Slope	22 (1)	220	—	279	499
Stark	6	—	—	230	230
Totals	245 (63)	1704	270	4796	6770

( ) Number of towns for which acreage was not determined.

[1]Does not include 14 towns totaling 433.75 acres in Theodore Roosevelt National Memorial Park (letter dated August 23, 1973 from W.K. Pfeifer, BSFW, Area Office, Bismarck, North Dakota).

[2]Unknown number of towns on Fort Berthold Indian Reservation.

Compiled by C.R. Grondahl, N.D. Game and Fish Department.

Table 4-6
Reported Black-footed Ferret Sightings in North Dakota

Year	County	Location	Reported or Sighted By	Source of Information
1910	Bilings	Medora vicinity	Howard Eaton	Bailey[1]
1912	Emmons	Fort Rice vicinity	H.C. Fish	Bailey
1913	Dunn ?	Quinion (between Killdeer and Medora)	S.G. Jewett	Hillman[2]
1915	Mercer	Stanton	Kellogg	Bailey
1933	Billings	Ash Coulee (Sec. 16, R142N, R101W	J. Harold Johnson	Hillman
1936	Billings	Blacktail Creek (Sec. 14, T143N, R101W)	Art Elkins and J. Harold Johnson	Hillman
1945	Golden Valley	Sec. 34, T144N, R103W	Francis Boyce	Bishop[3]
1948	Slope	Sec. 32, T135N, R105W	Merle Clark	Bishop
1955	Adams ?	15 miles east of Hettinger	Irving Mork	Leppart[4]
1957	?	Cedar River	Ernest Pittsley	Leppart
1961	Burleigh	East of Bismarck	S.H. Richards	NDGFD[5]
1963	Kidder	Sec. 12, T139N, R73W	Herb Troester	Hillman
1964	?	Fort Berthold Indian Reservation	Dr. Ralph Hubbard	Hillman
?	?	Theodore Roosevelt National Park	Dr. Ralph Hubbard	Hillman
1965	?	Fort Berthold Indian Reservation	Sam Miller	Leppart
1966	Bowman	Near Bowman	Morris Erickson	Hillman
1966	Bowman	3 miles south Marmarth (This reported as 7 mi. south by Leppart)	Morris Erickson	Hillman
1969	Billings	Sec. 19, T138, R102W	Muggs Vanvig	Bishop
1960s	?	Theodore Roosevelt National Park	Dr. Harold Goetz	Hillman
1967	Golden Valley	Sec. 20, T143N, R104W	Irving Mork	NDGFD
1967	Mountrail	1 mi. northwest Parshall	Don Strube and Dennis Eltestad	Leppart
1968	Morton	Sec. 21, T137N, R80W	John Goertell	NDGFD
1971	Morton	Sec. 28, T135N, R80W	Lowell E. Siebels	NDGFD
1973	Bowman	Sec. 25, T130N, R106W	Thomas M. Lavelle	BSFW[6]
1973	Slope	Sec. 26, T136N, R100W	J.A. Schaeffer	BSFW

[1]Bailey, V. 1926. A biological survey of North Dakota, N. Amer. Fauna No. 49. 226 pp.
[2]Letter dated June 5, 1973, from Conrad Hillman, Research Biologist, BSFW, 919 Main St., Rapid City, South Dakota.
[3]Bishop, N. 1972. Black-footed ferret and black-tailed prairie dog survey, 1972. Unpub. Report. Medora Ranger District, U.S. Forest Service, Dickinson, North Dakota. 21 pp.
[4]Leppart, G. 1970. Black-footed ferret — a vanishing species. North Dakota Outdoors 32(11):18-20.
[5]North Dakota Game and Fish Department files, Bismarck, North Dakota.
[6]Personal communication with William K. Pfeifer, Wildlife Biologist, Area Office, BSFW, Bismarck, North Dakota.

Compiled by C.R. Grondahl, N.D. Game and Fish Department.

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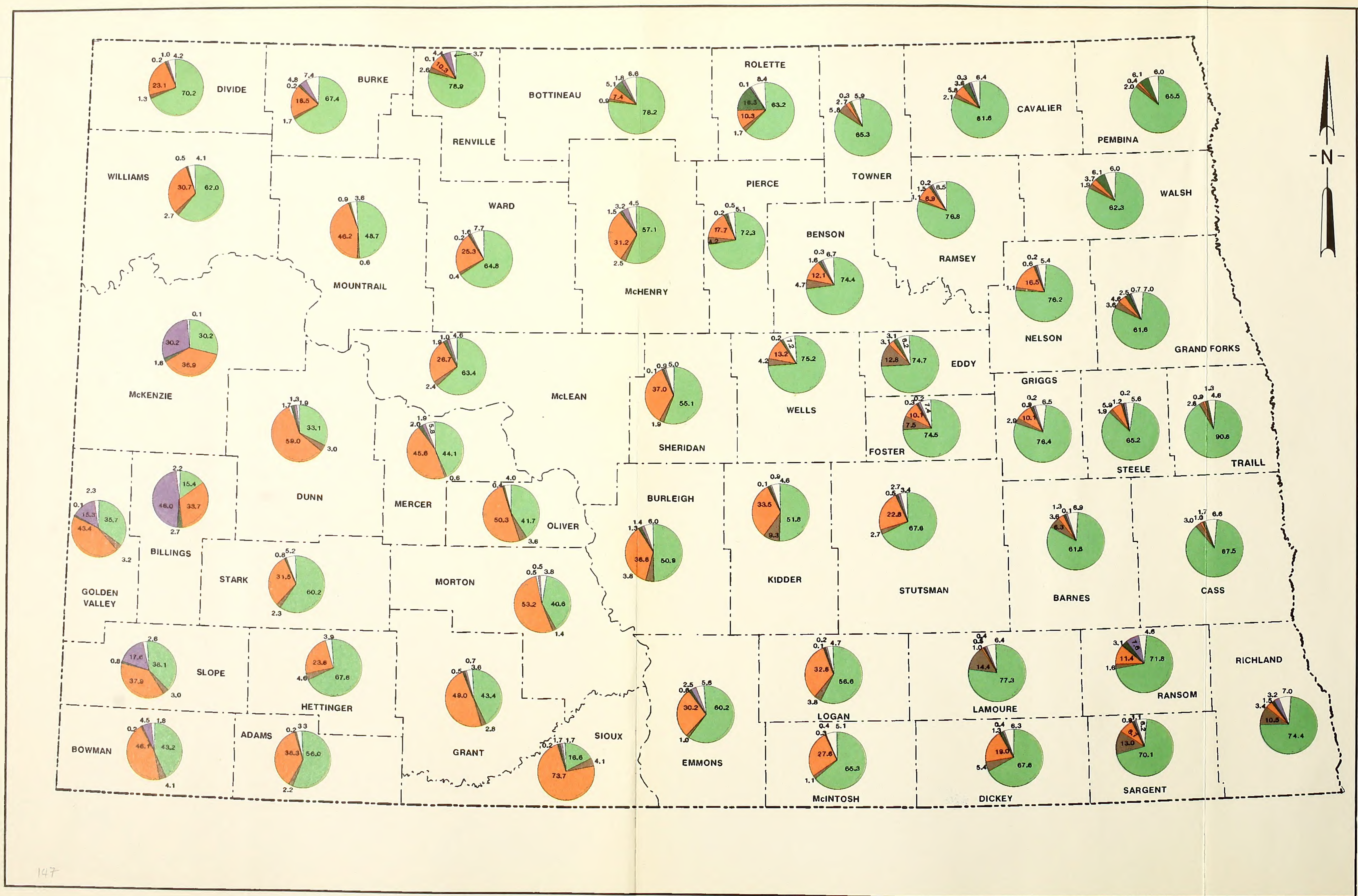
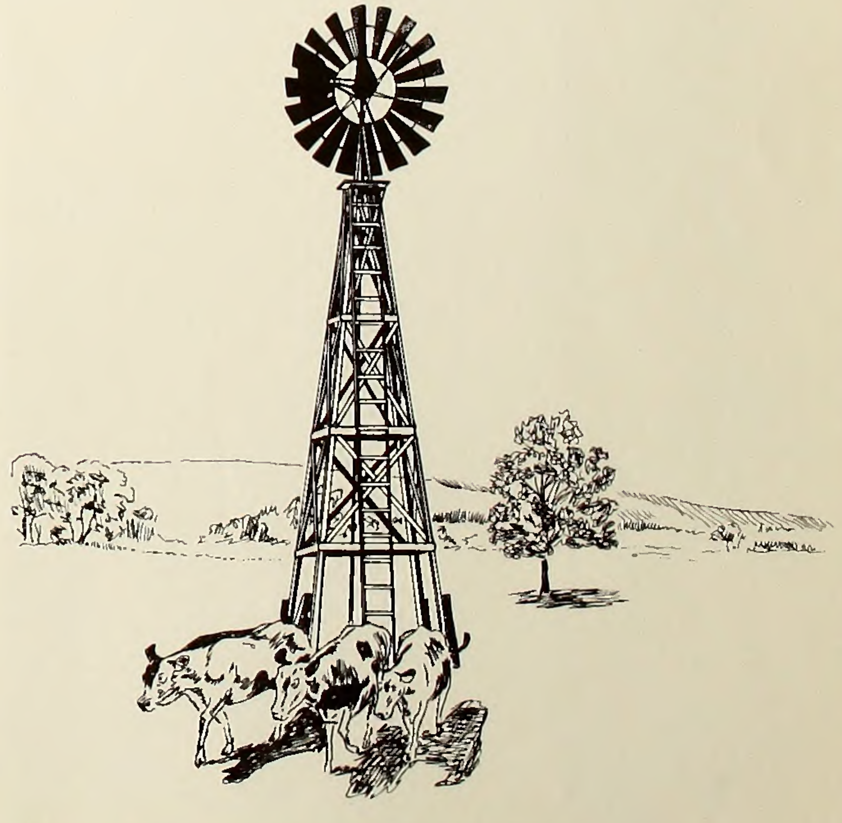
LAND USE



LEGEND

MAP 4-17

- Cropland
- Pastureland
- Rangeland
- Woodland
- Federal Noncropland
- Other Land



SOURCE: SCS Drawing No. 5, S-32, 814, 1974.

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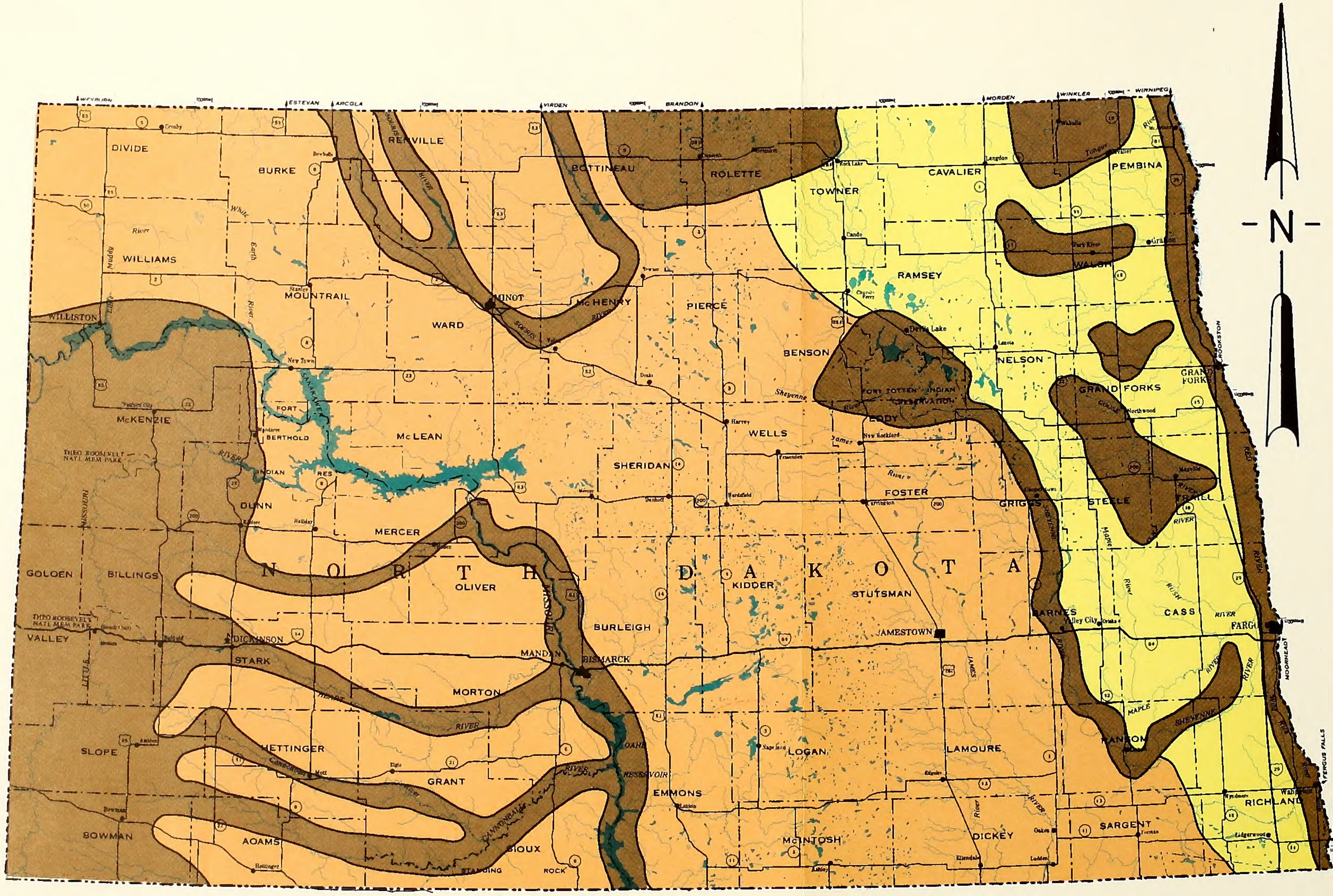
WHITE-TAILED DEER

MAP 4-18



Scale 1:2,150,000

LEGEND

Relative White-tailed Deer Densities

- Low
- Medium
- High

SOURCE: North Dakota Game and Fish Department, 1975.

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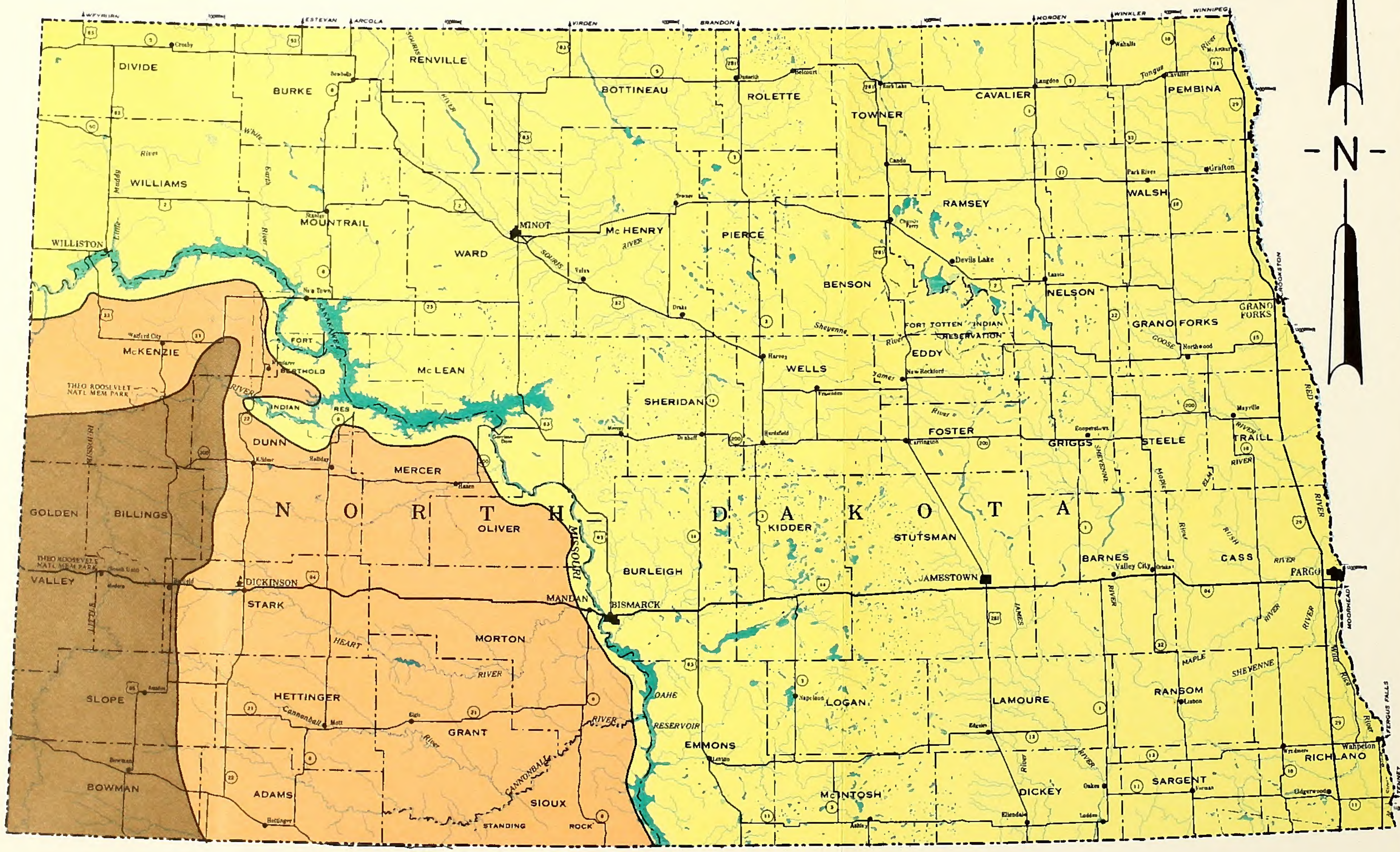
MULE DEER

MAP 4-19



Scale 1:2,150,000

LEGEND

Relative Mule Deer Densities

- Low
- Medium
- High

SOURCE: North Dakota Game and Fish Department, 1975.

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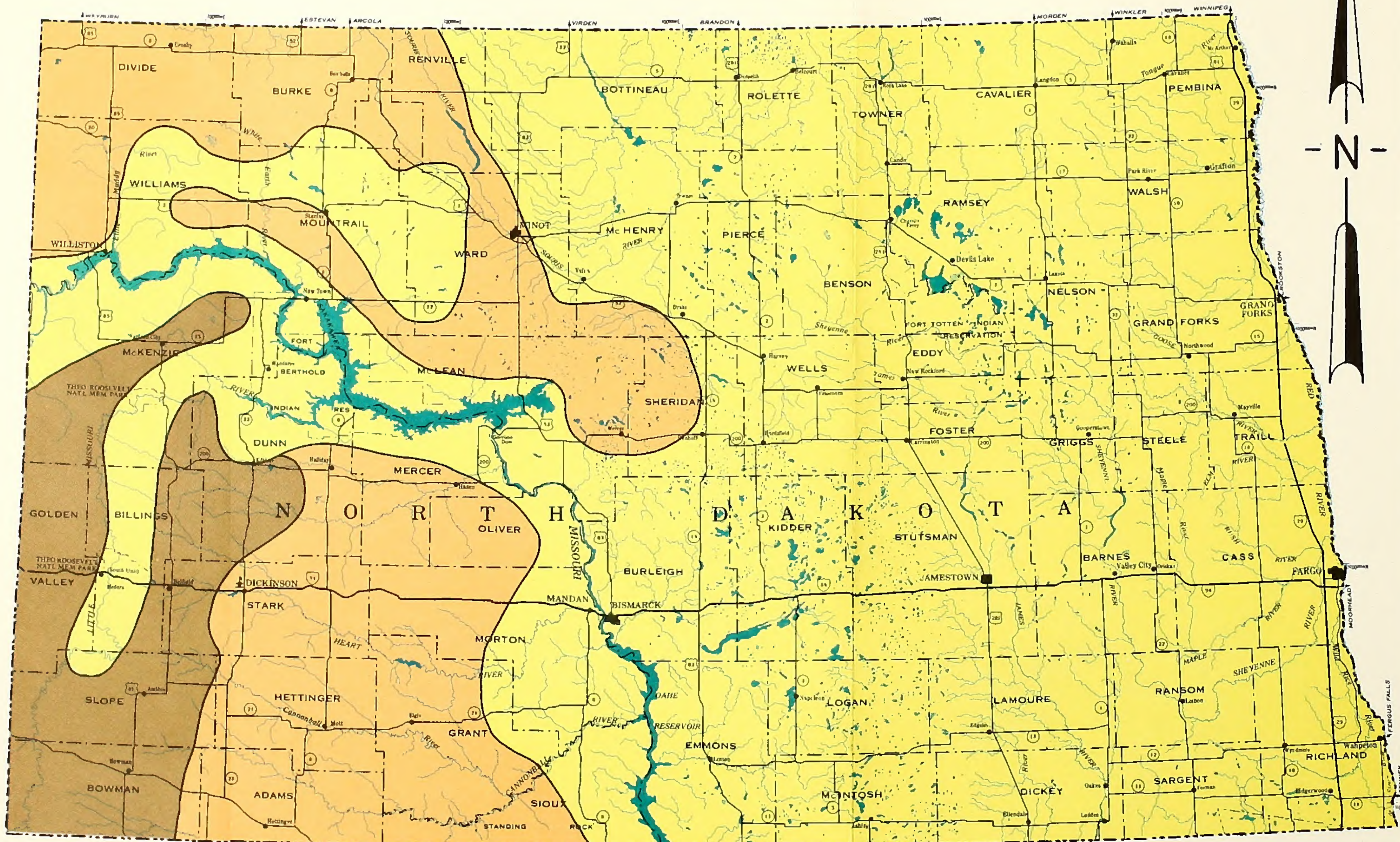
ANTELOPE

MAP 4-20



Scale 1:2,150,000

LEGEND

Relative Pronghorn Antelope Densities

- Low
- Medium
- High

SOURCE: North Dakota Game and Fish Department, 1975.

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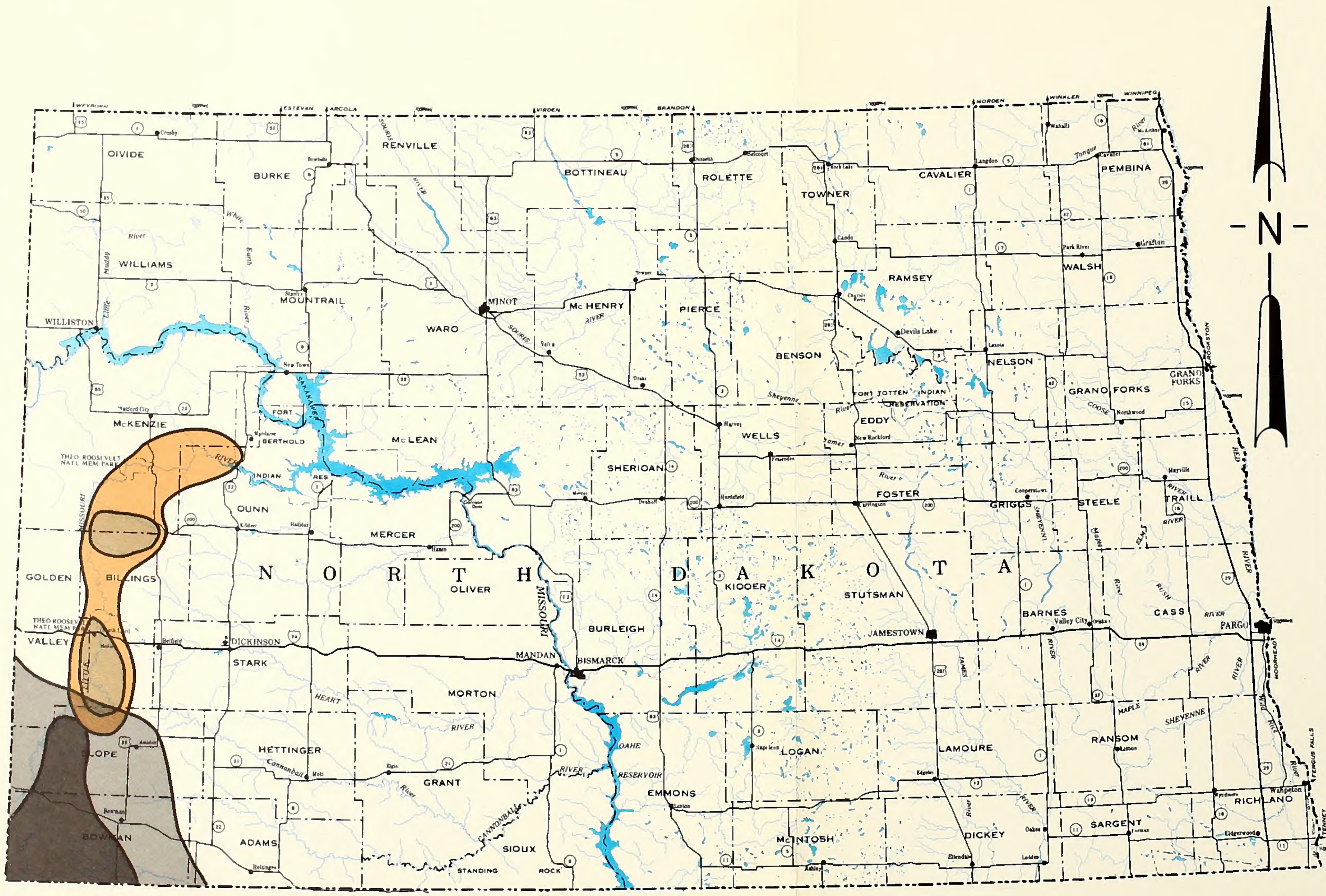
BIGHORN SHEEP AND SAGE GROUSE

MAP 4-21



Scale 1:2,150,000

LEGEND

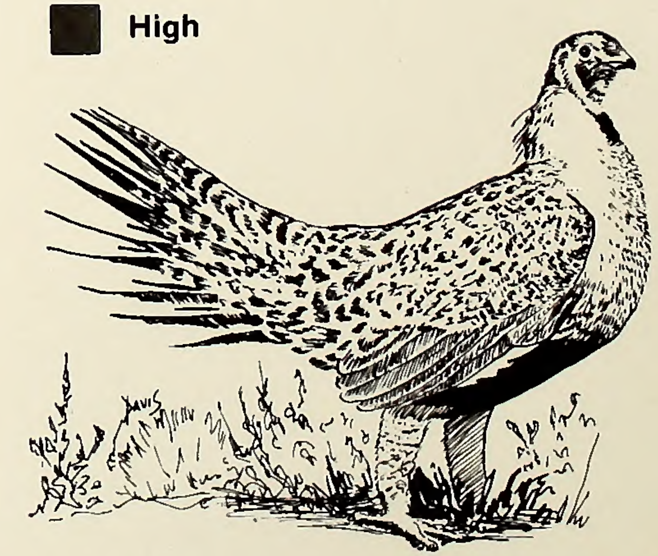
Relative Population Densities

Bighorn Sheep

- Moderate
- High

Sage Grouse

- Moderate
- High



SOURCE: North Dakota Game and Fish Department, 1975.

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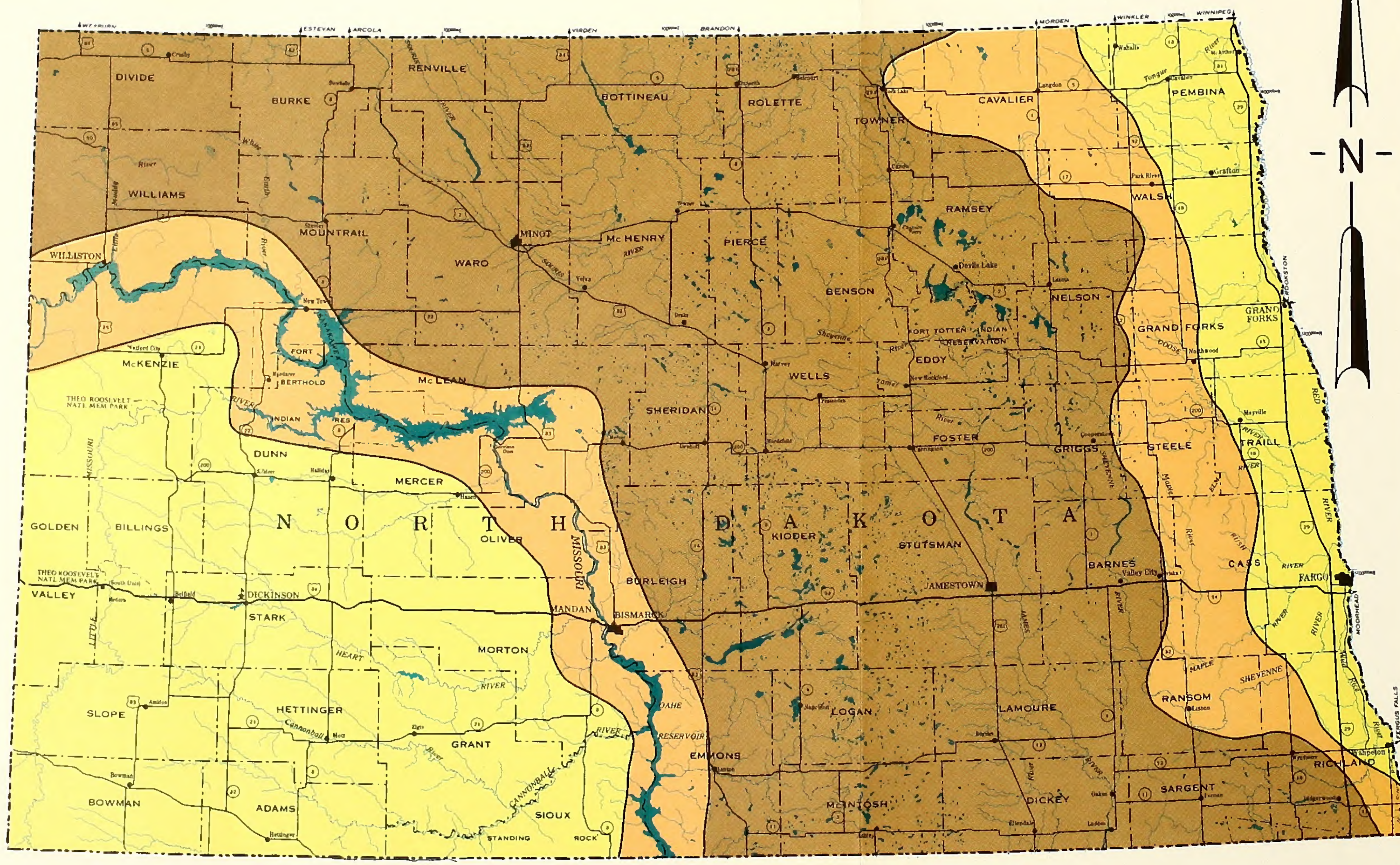
WATERFOWL

MAP 4-22



Scale 1:2,150,000

LEGEND

Relative Waterfowl Population Densities

- Low
- Medium
- High

SOURCE: North Dakota Game and Fish Department, 1975.

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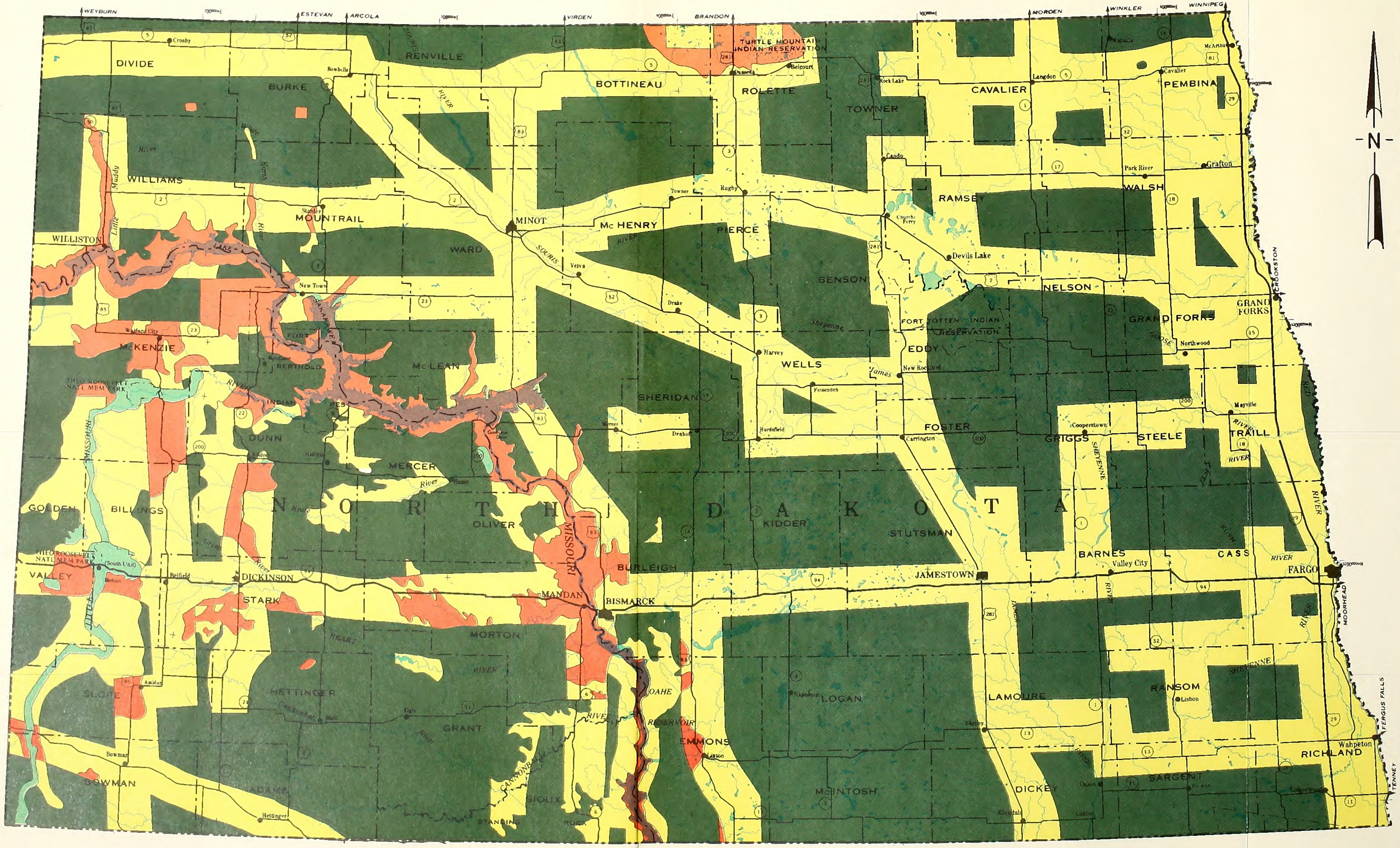
DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

VISUAL CLASSES



LEGEND

MAP 4-23

OBJECTIVES FOR VISUAL MANAGEMENT GENERALIZED

Note: All woody bottoms within areas rated Class III and Class IV shall be considered Class II. No Class I areas are under BLM jurisdiction.

VRM classes represent a numerical objective for the visibility of an object or activity in the area described. Class IV areas are more lenient than Class III, Class II or Class I. An object or activity would be permitted to be more visible in areas with a higher VRM class number and meet the objectives of the planning system for visual change.

- Class I
- Class II
- Class III
- Class IV

SOURCES: Blumle, J.P., Geologic Highway Map of North Dakota. N.D.G.S., Educational Series II, Misc. Map, 1977.
Traffic Flow Map, N.D. State Highway Department, 1972.
Omodt, H.W. et al., N.D.S.U., Agricultural Exp. Station, Bulletin 472, 1968.

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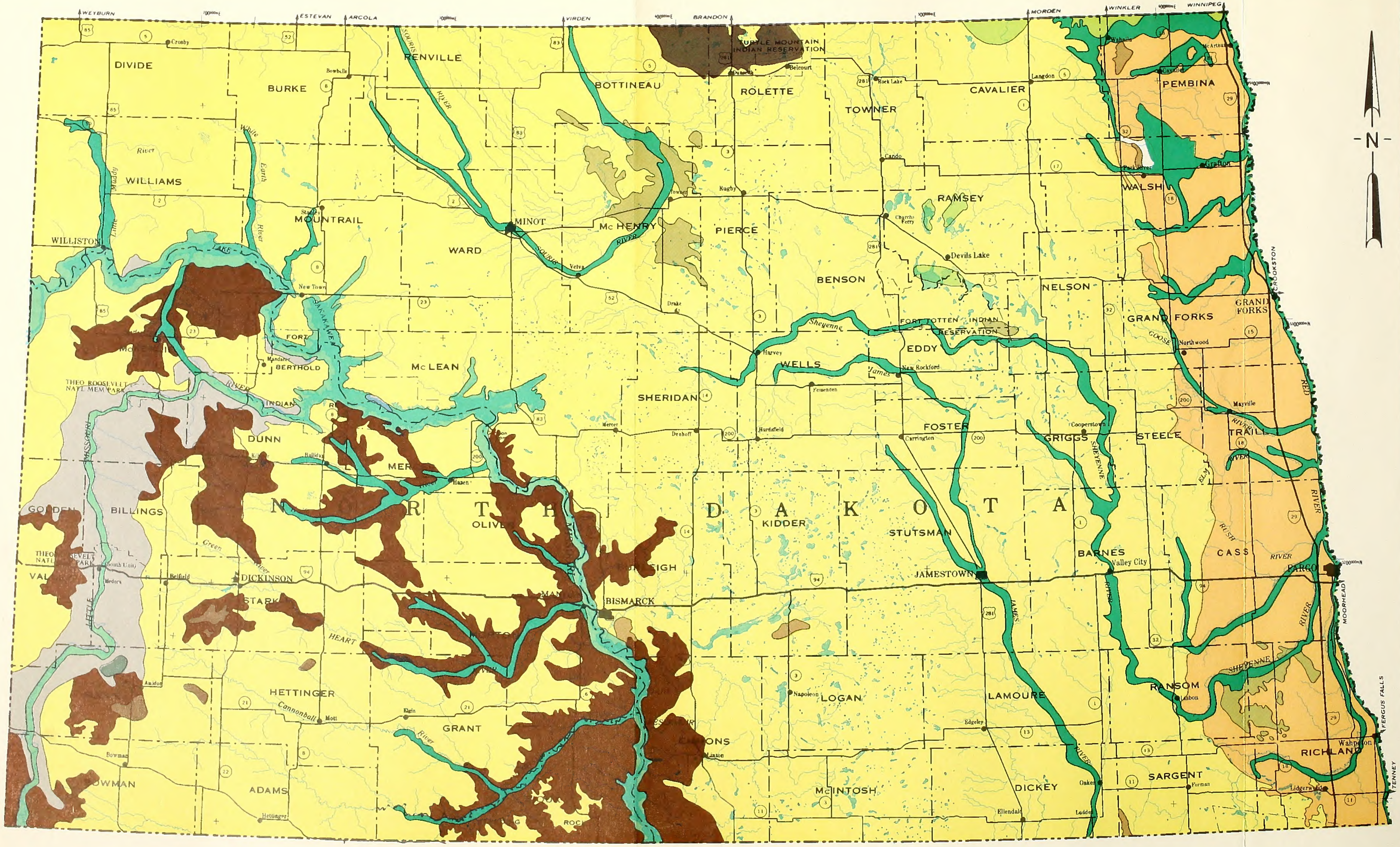
ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

LANDSCAPES



LEGEND

MAP 4-24

- Prairie
- Tall Grass Prairie
- Badlands
- Breaks
- Buttes
- Oak Savanna
- Missouri River
- Sand Hills
- Sand Hills/Oak Savanna
- Turtle Mountains/Oak Savanna
- Ponderosa Pine Forest
- Flood Plain, Deciduous Forest

SOURCE: Hainer, John L., The Geology of North Dakota. North Dakota Geological Survey Bulletin 31, 1956.
Bluemle, John P., Geologic Highway map of North Dakota. N.D.G.S., Educational Series 11, Map 19, 1977.
Omodt, G.A., Johnsgard, G.A., Patterson, D.D., Olson, O.P., Bulletin 472, 1968.
Shaver, J.C., North Dakota Rangeland Resources, 1977.

The present distribution of the northern swift fox in North Dakota is unknown, and historical sightings and records have been scarce. The most recent observation was made in Slope County (where the badlands habitat prevails) in 1975.

Although the gray wolf is not known to be found in North Dakota, it may wander into the State from Canada.

VISUAL RESOURCE MANAGEMENT (VRM)

If an object, activity, or use cannot be seen, beauty or ugliness is not determinable. The VRM system measures visual change as visibility, using the contrast rating system. The more a change differs, or contrasts, visually with the setting it is in, the more visible that change will be. The amount of visual change that is acceptable is determined during planning through the assignment of VRM Classes I, II, III, or IV (see Appendix 4-1). These classes indicate the level of visibility an activity can be allowed to reach. Within the VRM system, "visibility" and "contrast rating" can be used synonymously.

The VRM classes that are assigned through the BLM planning system (Manual 8411) are used in analyzing impacts. A visual change that exceeds the VRM class criteria can be considered a significant impact, though the nature of the impact, positive or negative, cannot be determined. VRM objectives for the visual resource (VRM classes) are shown on Map 4-23. A contrast rating is specific to a specified action in a specified setting. Areas where the contrast rating for an activity will be similar can, however, be mapped in a general way. Variation within these areas would result in more or less contrast; therefore, this approach to analysis—while establishing a means of determining the general visual impacts—cannot be substituted for measuring visual change on a site-specific basis.

North Dakota has been divided into 11 "landscapes" in which the visual change would be similar for the various oil and gas actions. These landscapes are defined on Map 4-24 and described below.

Prairie Landscape

The bulk of North Dakota is prairie landscape—varying from flat to rolling with low ground cover, primarily grass. In some areas, lakes and ponds are scattered throughout the landscape, and, in other areas, boulders are strewn through an otherwise uniform area. The prairie landscape includes both shortgrass and mixed-grass vegetation, which are similar from a visual standpoint. The landscape is severely horizontal in aspect and appears uniform, with little variation of any kind.

Tallgrass Prairie Landscape

The tallgrass prairie landscape is concentrated on the east side of the State, primarily in the Red River Valley. This landscape is similar to the prairie landscape except the height and lushness of the vegetation.

Missouri River Landscape

The Missouri River itself tends to be brown and murky except where large reservoirs intercept its silt load. The banks vary from densely vegetated with deciduous trees, especially along the shoreline, to barren on steep bluffs. The aspect of the landscape is horizontal due to the following features: edge of the river, bands of vegetation, strata exposed on the faces of the bluffs, and the crisp horizontal horizon line formed by the top of the surrounding landform. This horizontality is modified somewhat where rolling topography supplants the bluffs.

Flood Plains Landscape

The flood plains landscape includes areas with lush vegetation along banks of streams (with scattered trees elsewhere) to a forested condition. The trees are largely deciduous trees, such as poplar and aspen. Fall color can be dramatic though short lived.

These areas are generally flat and more lush than the surrounding landscapes and are defined by hills at the edges. They heal more rapidly when disturbed than surrounding landscapes. Opportunities are present to hide activities in the trees or by planning the pattern of vegetative regrowth. The area, however, is sensitive to indiscriminate tree cutting and clearing, especially in straight, hard-edged swaths.

Much of this area has been modified for use as cropland and rangeland.

Breaks Landscape

This landscape is similar to the Badlands landscape except for the scant vegetation and reduced verticality of the breaks. The breaks landscape is composed of irregularly dissected "broken ground" between broad, flat plateau areas. Vegetation varies from grass to sagebrush and includes areas of virtually bare ground.

Badlands Landscape

While vertically aspected, the Badlands maintain a horizontality through the flat-topped nature of bluffs and butt-like vertical features and through horizontal strata that mark exposed hillsides. Vegetation is scant and much bare ground is evident.

Turtle Mountains Landscape

This landscape is considered unique in North Dakota. The appearance is similar to ideal landscapes of the English landscape school, including broad areas of grass with clumps of trees and solitary trees, with larger masses of forest on hillsides. The relationship of open spaces to tree mass is significant and gives this landscape the artificial "park" character that represents "nature" in the collective mind of romantic western man.

Sand Hills Landscape

The sand hills landscape is virtually indistinguishable from the surrounding prairie but is composed of stabilized sand that is sensitive to wind erosion. The visual effect of surface-disturbing activity, therefore, can be emphasized.

Buttes Landscape

This landscape is not fully represented on the map. Because the North Dakota landscape is generally uniform and horizontally aspected, vertical features gain an importance they would not ordinarily command. The buttes landscape, therefore, should include solitary or near solitary hills, as well as buttes, to reflect that interest. The important characteristic is verticality. Often these features are wooded, particularly on the north side, but can also have prairie vegetation and display rock outcrops or bare ground on steeper slopes.

Oak Savanna Landscape

These landscapes include some sand hills areas. They are typified by oak stands varying from dense clumps of oak with lush understory growth to solitary trees and clumps of trees of the kind found in the Turtle Mountains. The topography varies little from the surrounding prairie.

Ponderosa Pine Forest Landscape

This landscape is limited in size and occurrence. It consists of steep forested areas of dense to scattered pine with little understory. Rock outcrops mark the hills. Under other circumstances this landscape would be considered common, but in North Dakota it is rare and, thus, scenically important.

An additional four landscape types can be found within these 11 landscapes, but they are too small to be shown on the map or are so intermixed with the other landscapes that a meaningful separation cannot be made.

Cropland Landscape

Agricultural use of the land in North Dakota is extensive and influences most views. These landscapes are dynamic and change in appearance through the seasons and over the years. A checkerboard appearance results from this activity when seen from a distance or from aircraft. Individual blocks of farmland are uniform in appearance with some variety resulting from structures, farm equipment, domestic animals, and irrigation works. Because this landscape is evident in other landscapes, particularly the prairie landscape and tallgrass prairie landscape, the State as a whole is more rustic and pastoral than "natural."

Pasture/Range Landscape

Rangeland is that area where grazing of cattle is the predominant agricultural use. This landscape appears "natural" to the casual observer. The key differences are the presence of grazing-related facilities such as fences and of scattered hay fields.

Urban/Suburban Landscape

This landscape is typified by small farming communities within all other landscapes. These communities are often tidy but can appear disorganized. All are subject to rapid and not always predictable change on any given site within the town. The most critical areas are at the edges of the towns where activity can be seen on a day-by-day basis by local residents.

Larger communities, such as Bismarck, are large enough to almost totally eliminate natural qualities and are large enough for suburban areas to develop. Here, suburban and residential areas are most sensitive to visual change.

In most areas where visual change is possible, the urban/suburban character is relatively small scale. Buildings are generally lower than two stories. Street tree plantings and residential plantings tend to reduce architectural influences in some areas; debris and disorganization, typical of any area of human habitation, are common in others.

Wooded Draws Landscape

Wooded draws are typically groves of deciduous trees that follow intermittent drainages. The draws are valuable to the residents of the area from a visual standpoint because of their perceived rarity in an essentially treeless prairie.

The draws are generally in moderately sloped folds between hills that vary in size from shallow, where the trees are clearly visible, to deep, where the trees are occluded by the sides of the hills.

Wooded draws may be found in the prairie landscape types but are more common in the western part of the State.

RECREATION

Since North Dakota is rural in nature, developed recreational facilities are sparse. Most outdoor recreational activites are dispersed—for example, picnicking, hiking, camping, sight-seeing, fishing, hunting, and pleasure driving. Urban recreational facilities are usually below demand in most communities, but recreational programs for baseball, softball, football, basketball, and tennis are fairly well developed.

On a statewide basis, hunting is probably the most important recreational activity occurring on private and public lands where the oil and gas estates are federally administered. Separate recreational hunting statistics are not available for lands where the oil and gas estates are federally owned, but statewide statistics are available (see Table 4-7).

Table 4-7
Recreation Days Spent Hunting in North Dakota, 1975*

Big Game	Recreation Days
Mule Deer	17,416
White-tailed Deer	131,328
Antelope	4,010
Turkey	1,050
Small Game	
Sharp-tailed Grouse	117,603
Sage Grouse	2,346
Gray Partridge	130,181
Pheasant	89,947
Squirrels, Cottontails	91,958
Waterfowl	
Ducks	381,212
Geese	300,571

*North Dakota Game and Fish Department, Bismarck.

Public lands administered by the BLM in North Dakota have no developed recreational facilities, but do provide opportunities for dispersed recreation, such as camping, hunting, hiking, and picnicking. Although there are no separate statistics for recreational use on public lands, the low population density and the dispersed public land pattern suggest light use. Isolation and questionable public access may be additional contributing factors.

North Dakota has numerous national wildlife refuges, state game management areas, state parks, waterfowl production areas, and public recreation areas. These areas are listed and depicted in the district map overlay file when they are over or in the vicinity of federal oil and gas estate lands.

The BLM does not administer and has not proposed any wilderness areas in North Dakota, but the U.S. Forest Service recently proposed a wilderness study area near Medora in Billings and Golden Valley counties. Several small acreages of privately owned land with federal oil and gas are included within its boundaries. Under FLPMA (Federal Land Policy and Management Act of 1976—BLM) and RARE II (Roadless Area Review—Forest Service), no activity may be permitted which would degrade its wilderness qualities; thus, until the boundaries are redefined, these oil and gas lands may not be leased. The U.S. Fish and Wildlife Service has established two wilderness areas on the Lostwood and the Chase Lake National Wildlife Refuges. They are located in southern Burke County and west-central Stutsman County.

CULTURAL RESOURCES

Cultural resources consist of prehistoric, historic, and architectural sites and features. At present, a total of approximately 8700 such sites have been recorded for North Dakota, with only 1800 of these sites having been verified through on-the-ground surveys by professional archeologists.

Relatively little of North Dakota has received intensive cultural resource inventory. Chris L. Dill, State Survey Archaeologist for the State Historical Society of North Daktoa (SHSND), estimates that between 1 to 2 percent of the acreage in the State has been inventoried on the ground and that this has been the result primarily of large survey projects, (i.e., approximately 20 sections or more). These large projects have resulted in blocks of land being surveyed in the following areas:

1. Ransom County and around Fargo (Rian Vehic);
2. The adjoining edge areas of Benson, Nelson, Eddy and Ramsey counties (UND);
3. Coal Mine Lake area, including portions in McHenry, Wells and Sheridan counties;
4. Along the Missouri River (Missouri River Basin Survey);
5. South of Lake Darling, in Ward County (Burlington Survey);
6. Dunn County, southeast of Dunn Center (Coal Mine Survey);
7. Oliver County and Mercer County (Glenharold Survey).

Additional smaller tracts of land (i.e., several sections, portions of sections, and a few acres) have been inventoried for legal compliance purposes for oil and gas drilling, road construction, transmission lines, pipelines, etc. The BLM, Dickinson District, has conducted a reconnaissance survey of BLM surface and split-estate lands in Golden Valley County for planning purposes. Large portions of the State have received no systematic and intensive inventory (e.g., Mountrail County), and no statewide predictive models of site density can yet be projected.

The SHSND is developing a site density predictive model based on ecological zones. Eight ecozones have been defined for the State, based on natural vegetation and supposing the absence of industry or development (i.e., aboriginal vegetative zones). The SHSND is working on a statewide survey, and blocks of land are being inventoried at an average rate of 100 square miles per year.

At present, only Mercer County has had enough inventory work and data collection for predictive modelling. Mercer County has been classified as a talus slope ecozone in this model. After the validity of the model has been tested in Mercer County, it will be necessary to test the model in other parts of the State also classified as talus slope zones to verify the validity of the model for a particular zone.

In a few years the statewide predictive model may be ready to use for all ecological zones. It would be valuable for archeologists involved in research and for industry involved in planning and development. However, at present, site density can only be suggested for the coal region. Signe Snortland-Coles (SHSND, personal communication) has estimated 3.5 sites per square mile for that area (i.e., Mercer County coal areas). C.L. Dill, in the Antelope Valley Station/ANGCGC survey (1978), has obtained a figure of 3.44 sites per square mile over a 43.3 square mile survey project area.

Inventories conducted for oil and gas drilling programs have resulted in the location and identification of cultural resources. Larry Loendorf (UND) has stated that surveys he has conducted under contract to oil companies have resulted in locating approximately 1 site per 5 well sites; in other words, 20 percent of the oil well inventories he has conducted have resulted in identification of sites (Loendorf, Oil and Gas Meeting, Answers to Questions, February 7, 1979, Dickinson, North Dakota). Dill has stated that, overall, 1 in 20 of the oil and gas archeological contract inventory reports received by the State Historic Preservation Office (SHPO) have sites located as a result of the survey, or approximately 5 percent. Burt Williams (BLM, Montana State Office, Archaeologist) has estimated that 5 percent of the oil and gas inventories conducted in Montana have resulted in the identification of Cultural Resources.

ECONOMIC CONDITIONS

The nature of the study area is predominantly rural, with a significant portion of social and economic activities in the area revolving around agriculture. Economic activities and social attitudes/values in the area have changed very slowly in the past, but recent energy development (e.g., coal, oil, gas) has accelerated the rate of both social and economic change.

Population

The total estimated 1980 population in the study area is 210,155. This represents a four percent increase over the 1975 population estimate of 201,771. Population forecast through 1985 indicates that the total population in the study area will grow by nine percent from 1975 to 1985 (Table 4-8). Burleigh, Bowman, Mountrail, and Ward counties are expected to realize the greatest percentage increase in population during this ten-year period.

Employment

Total employment levels increased by roughly five percent from 1975 to 1977 (Table 4-9). Burleigh and Stark counties experienced the greatest percentage increase in employment (10 percent) during this period, primarily as a result of the trade centers located in those counties. Available employment figures for the study area show that there are significant numbers of oil and gas workers directly involved with oil and gas activity (Table 4-10). These direct employment figures include well servicing and other directly related activities which are associated with oil and gas exploration and production. In addition, Table 4-10 shows the estimated indirect employment generated by the expenditure of direct oil and gas employment payrolls. As such, these numbers give an indication of the total employment associated with oil and gas activity in this portion of the study area. The 2,940 direct employees shown in Table 4-10 represent three percent of the total 1977 employment (104,466) in the study area, while the total (direct and indirect) oil and gas related employment level of 5,612 represents approximately five percent of the total 1977 employment in the study area. Direct county-by-county oil and gas employment as a percent of total employment is also shown in Table 4-10. McKenzie and Billings counties appear to have the highest percentage of oil and gas employees in the study area.

Personal Income

Total personal income in the study area increased by 11 percent from 1975 to 1977 (Table 4-11). Burleigh, Bowman, and Stark counties experienced growth in personal income of 20 percent or more during this period.

Table 4-8
Population Estimates

County	1975*	1980*	1985*	% Change 1975-1985
Adams	3,792	3,820	3,849	2
Billings	1,040	935	857	-18
Bottineau	9,332	9,640	9,803	5
Bowman	4,146	4,464	4,824	16
Burke	4,375	4,105	3,890	-12
Burleigh	45,629	51,816	58,572	28
Divide	4,224	4,002	3,821	-10
Dunn	4,564	4,354	4,247	-7
Golden Valley	2,597	2,646	2,716	5
Hettinger	4,031	4,936	5,023	2
McKenzie	6,092	6,142	6,226	2
Mountrail	8,688	9,190	9,818	13
Renville	3,786	3,844	3,924	4
Slope	1,328	1,251	1,219	-8
Stark	18,971	18,538	18,102	-5
Ward	61,555	64,587	69,639	13
Williams	16,721	14,885	13,103	-22
Total	201,771	210,155	219,633	9

Source: Richard Ludtke, N.D. County Population Projections: 1970-1995. Division of Health Planning, N.D. State Health Dept. 1975 (unpublished).

*See Table 2-2 for 1976 community population estimates.

Table 4-9
Total Study Area Employment

County	1975	1976	1977	% Change 1975-1977[1]
Adams	1,972	2,024	1,995	1
Billings	597	593	637	7
Bottineau	4,259	4,368	4,360	2
Bowman	2,124	2,174	2,216	4
Burke	2,051	2,079	2,047	—
Burleigh	24,344	25,409	26,820	10
Divide	2,508	2,495	2,399	-4
Dunn	1,717	1,730	1,838	7
Golden Valley	1,138	1,150	1,157	2
Hettinger	2,100	2,114	2,118	1
McKenzie	2,823	2,949	3,018	7
Mountrail	3,893	3,898	3,909	—
Renville	1,717	1,716	1,716	—
Slope	701	693	670	-4
Stark	8,272	8,683	9,087	10
Ward	30,098	30,422	30,400	1
Williams	9,396	9,786	10,079	7
Total	99,710	102,283	104,466	5

[1]Percentages rounded to nearest whole number.

Source: Bureau of Economic Analysis, REIS-1980

Table 4-10
Estimated 1979 Oil & Gas Development by County

County	Direct Employment 1979[1]	Direct Employment as % of Total 1977 County Employment	Indirect Employment[2]	Estimated Total (Direct & Indirect) Employment[2]
Adams	23	1	21	44
Billings	197	31	179	376
Bottineau	111	3	101	212
Burke	69	3	62	131
Burleigh	201	1	183	384
Divide	20	1	18	38
Dunn	167	9	152	319
Golden Valley	87	8	79	166
Hettinger	16	1	15	31
McKenzie	483	16	439	922
Mountrail	45	1	41	86
Renville	23	1	21	44
Slope	40	6	36	76
Stark	441	5	401	842
Ward	122	1	111	233
Williams	895	9	814	1,709
Total	2,940	2	2,672	5,612

[1]Direct employment estimates from Job Service of North Dakota — "Area Reports by Major Industry" 1979.

[2]An industry employment multiplier of 1,909 was used to calculate total employment (including indirect) associated with direct work force levels.

Note: 1979 total employment figures by county are not available for comparison in Column 2 above.

Table 4-11
Total Study Area Personal Income
(Millions of Dollars)

County	1975	1976	1977	% Change 1975-1977
Adams	17.7	16.9	20.7	17
Billings	4.7	5.7	5.6	19
Bottineau	58.5	56.9	54.3	-7
Bowman	19.4	20.5	23.8	23
Burke	23.7	23.3	24.1	2
Burleigh	286.0	304.6	343.5	20
Divide	26.0	28.9	25.7	-1
Dunn	17.1	20.7	20.4	19
Golden Valley	12.9	13.7	13.5	5
Hettinger	18.5	21.7	21.3	15
McKenzie	35.7	34.0	37.5	5
Mountrail	41.0	41.1	39.5	-4
Renville	24.1	20.0	20.5	-15
Slope	6.9	8.5	7.9	14
Stark	90.0	101.5	111.5	24
Ward	350.9	368.9	394.4	12
Williams	115.7	124.7	134.8	16
Total	1,148.9	1,211.6	1,275.3	11

Source: Bureau of Economic Analysis, REIS — 1980.

Due to the lack of reliable oil/gas field income data, it is necessary to estimate the average oil/gas worker's income in order to calculate the contribution of this activity to county income totals.

Assuming that the average oil/gas worker currently earns approximately $21,000 per year, it is possible to estimate the percentage contribution of oil and gas related incomes to total county income (Table 4-12). Indirect income generated by direct oil and gas income expenditure can be estimated by using an oil and gas income multiplier of 1.560. Table 4-12 indicates that total oil and gas related income exceeded 20 percent of the county total in Billings, Dunn, Golden Valley, McKenzie, and Williams counties.

Table 4-12
Estimated 1979 Oil & Gas Personal Income as Percentage of County Totals
($000)

County	1979 Estimated Direct Oil & Gas Personal Income[1]	Estimated Total (Direct & Indirect) Oil & Gas Income[2]	Total Estimated 1979 Oil & Gas Personal Income as % of 1977 Total[3]
Adams	483	753	4
Bilings	4,137	6,454	22
Bottineau	2,331	3,636	7
Burke	1,449	2,260	9
Burleigh	4,221	6,585	2
Divide	420	655	3
Dunn	3,507	5,471	27
Golden Valley	1,827	2,850	21
Hettinger	336	524	2
McKenzie	10,143	15,823	42
Mountrail	945	1,474	4
Renville	483	753	4
Slope	840	1,310	17
Stark	9,261	14,447	13
Ward	2,562	3,997	1
Williams	18,795	29,320	22
Total	61,740	96,314	8

[1]Assumes annual average personal income of $21,000 per direct worker.

[2]Assumes an oil and gas personal income multiplier of 1.560 (i.e., direct personal income figures are multiplied by 1.560 to determine total (direct and indirect) personal income).

[3]1979 personal income data not available.

SOCIAL CONDITIONS

The following is an overview of the social conditions in the general and intensive study area. It will be specific in those areas where oil and gas activity is occurring. The infrastructures to be discussed will be housing, education, medical services, police, fire, water and sewer services, and transportation where appropriate. The general study area consists of 17 counties in western North Dakota: Adams, Billings, Bottineau, Bowman, Burke, Burleigh, Divide, Dunn, Golden Valley, Hettinger, McKenzie, Mountrail, Renville, Slope, Stark, Ward, and Williams. The intensive study area includes only Billings, Bottineau, Bowman, Burke, Dunn, Golden Valley, McKenzie, Mountrail, Renville, Stark, and Williams counties.

Housing

In the general study area in 1970, there were a total of 64,850 housing units, including public housing units under the authority of the Office of Housing and Urban Development. The county totals were as follows: Adams 1,317 units, Billings 382, Bottineau 4,019, Bowman 1,365, Burke 1,813, Burleigh 12,983, Dunn 1,605, Divide 1,667, Golden Valley 915, Hettinger 1,579, McKenzie 2,227, Mountrail 3,176, Renville 1,395, Slope 478, Stark 5,747, Ward 17,402, and Williams 6,780 units. Of these 64,850 units in the general study area, 1,340 units were used seasonally by migrant workers (see Table 4-13).

Ordinarily, housing would be sufficient to meet growth needs; however, with the increase in oil and gas activity over the past few years, the demand for more housing is increasing more rapidly. The greater the employment opportunities in an area, the greater demand for more housing is going to be. The greater demand for housing may cause the cost of housing to rise sharply.

In 1978, there were 1,272 new residential authorized construction permits reported in the study area (Statistical Abstract of North Dakota 1979, Prepared by the Bureau of Business and Economic Research, UND.). This figure is incomplete because all counties did not report their residential permits; however, even with the statistics reported, it appears there is a substantial increase in number of permits issued in 1978 over 1977. The statistics also reveal that the areas within the study area which experienced the greatest amount of growth are Burleigh, Stark, and Ward counties. These counties already had the largest urban areas and population before oil and gas activity became prevalent. This information reflects two things: one, construction is proceeding for the purpose of providing permanent residents to individuals; and two, they are being built for family occupancy. It also is an indication of the size and expected longevity of recent oil and gas discoveries.

Rental units, which are in great demand during the developmental stage of oil and gas activity, may alleviate a housing shortage for the single oil field worker; however, the oil field worker who brings his wife and family would be hardpressed for suitable living arrangements, and more and more oil field workers are bringing their families with them. The most popular size home being built today in the study area is the six-room house. The medium figure for owner-occupied units is higher (5.4) (Statistical Abstract of North Dakota 1979) than the medium figure for renter-occupied units (4.2) in the study area.

Table 4-13
Occupancy Utilization Characteristic 1970[1]
Non-Public

Occupancy	Adams	Billings	Counties Bottineau	Bowman	Burke	Burleigh
All other housing units	1,313	361	3,272	1,365	1,813	12,964
Seasonal & migratory	4	21	747			19
Total housing units	**1,317**	**382**	**4,019**	**1,365**	**1,813**	**12,983**

Occupancy	Divide	Dunn	G. Valley	Hettinger	McKenzie
All other housing units	1,643	1,567	911	1,579	2,133
Seasonal & migratory	24	38	4		94
Total housing units	**2,667**	**2,605**	**915**	**1,579**	**2,227**

Occupancy	Mountrail	Renville	Slope	Stark	Ward	Williams
All other housing units	3,072	1,323	478	5,736	17,361	6,547
Seasonal & migratory	104	72		11	41	233
Total housing units	**3,176**	**1,395**	**478**	**5,747**	**17,402**	**6,780**

Source: Federal Aid Coordinator's Office, State of North Dakota, State Capitol, Bismarck, North Dakota.

[1]Occupancy utilization characteristic for housing for the year 1970 are the latest available figures we have at our disposal.

Public housing units in 1977 in North Dakota numbered 10,011. Of these, 5,412 were designated for elderly residents (elderly not defined clearly) and 4,599 were for low-income families. Of these, the study area had 2,710 subsidized housing units in 1978, 1,472 for elderly residents and 1,238 for low-income families.

Since rental rates for local housing authorities are set by local housing authority boards that are regulated by the Office of Housing and Urban Development, it is doubtful that oil and gas activity in the area would have a major effect on public housing, although it might cause some change in the amount of rent a tenant has to pay.

Education

Education facilities in the 17 county area and throughout North Dakota appear to be adequate at this time. The study area has 140 elementary schools, including one-room rural schools and 70 secondary schools. All of the counties except Billings and Slope have secondary school districts and secondary schools. All of the counties except Burke, Golden Valley, Hettinger, and Renville have elementary school districts, and all 17 counties in the study area have elementary schools (see Table 4-14).

The average number of pupils in the secondary school system is 195 per school. The average number of pupils in the elementary school system is 178 per school. Because of these low averages and because these figures have remained relatively static over the past few years, it would appear that educational facilities are sufficient to meet an increase in enrollment without the need for additional funds. A possible exception would be McKenzie County, where oil and gas activity is anticipated to be the greatest and the secondary school system is one of the smallest. Those counties that have no school districts and/or no secondary schools, but which anticipate oil and gas activity, are going to have to be prepared to make some type of arrangements to accomodate extra school children. It appears that Billings and Slope counties might need some assistance in preparing themselves for this situation.

Medical Facilities

Medical and health care facilities in the 17 county study area are very unevenly distributed. Burleigh, Ward, and Williams counties, three of the largest counties in the study area, have almost more medical personnel and facilities than the rest of the counties combined, with

Table 4-14
Education

County	Elementary Enroll.	Elementary School	Secondary Enroll.	Secondary School	Teachers/School Elem.	Teachers/School Second.	Districts Elem.	Districts Second.
Adams	401	3	275	2	2,556	2,126	1	2
Billings	105	8	0	0	1,300	0	1	0
Bottineau	1,204	10	658	7	7,900	5,465	3	7
Bowman	420	5	599	3	4,173	3,218	2	1
Burke	487	6	290	5	3,848	3,086	0	5
Burleigh	6,258	34	3,060	6	30,175	16,319	8	3
Divide	310	4	212	2	2,400	1,443	1	1
Dunn	443	2	278	3	3,380	2,095	3	3
Golden Valley	292	2	221	2	1,600	1,650	0	2
Hettinger	449	5	356	4	3,883	2,743	0	3
McKenzie	814	9	320	3	4,739	2,131	5	2
Mountrail	1,155	6	623	5	6,992	4,622	1	5
Renville	501	4	311	4	3,400	2,802	0	4
Slope	66	3	0	0	700	0	4	0
Stark	2,256	11	1,567	6	12,622	10,455	3	5
Ward	7,011	22	3,367	10	24,920	20,716	5	9
Williams	2,726	6	1,534	8	10,264	14,400	1	8
Total	24,898	140	13,671	70			38	60

Source: Statistical Abstract of North Dakota 1979, prepared by Bureau of Business and Economic Research, UND.

the exception of Stark County, where Dickinson is located. Burleigh County alone has 120 doctors, most of whom are located in the city of Bismarck. Those counties which anticipate having the most oil and gas activity are those areas which presently have the fewest doctors, hospitals, and other medical personnel. For instance, Dunn County, which is anticipating a great amount of oil and gas activity, has no hospitals or doctors. Neither does Billings County, which lies adjacent and to the southwest of Dunn County. The nearest medical facility for a person requiring medical attention in Dunn County would be in Dickinson. For statistical information on health care services, see Table 4-15.

Table 4-15
Health Care Services

County	Hospital	Hospital Beds	Pharma-cists	Dentists	Optome-trists	Chiro-practors	R/N's	LPN's	Nursing Homes Unskilled No.	Nursing Homes Unskilled Beds	Nursing Homes Intermediate No.	Nursing Homes Intermediate Beds	Patients
Adams	1	46	5	1	1	0	41	13	1	88	0	0	8
Billings	0	0	0	0	0	0	2	1	0	0	0	0	0
Bottineau	1	41	6	2	1	1	65	16	2	85	1	71	4
Bowman	1	40	3	3	1	1	36	9	1	42	0	0	2
Burke	0	0	1	0	0	0	15	5	0	0	0	0	1
Burleigh	2	453	35	30	12	12	650	243	3	281	0	0	120
Divide	1	28	2	1	0	0	28	8	0	0	1	81	4
Dunn	0	0	1	1	0	0	9	6	0	0	0	0	0
Golden Valley	1	27	1	1	0	0	19	5	0	0	0	0	1
Hettinger	0	0	3	1	0	0	6	14	0	0	1	60	2
McKenzie	1	26	4	1	0	0	23	10	1	47	0	0	2
Mountrail	1	28	7	2	0	0	51	19	2	111	2	76	4
Renville	1	30	4	2	0	0	17	5	0	0	1	59	1
Slope	0	0	0	0	0	0	0	1	0	0	0	0	0
Stark	2	150	13	10	3	3	137	85	2	193	1	75	21
Ward	3	497	33	30	6	5	479	153	2	246	1	129	74
Williams	2	139	15	9	4	3	130	112	2	148	1	55	22

Source: Statistical Abstract of North Dakota, 1979, Bureau of Business and Economic Research UND.

Transportation

The main form of transportation in the 17 county study area is the automobile. Even with new oil and gas fields, the automobile is not likely to change as the main mode of transportation.

Police, Fire, Water and Sewage

North Dakota is probably the safest state in the Nation to live in, and the 17 county study area is even safer than the rest of the State. Those counties which have the largest urban population—Burleigh, Stark, Ward, and Williams—have the highest crime rate. In order they rank 1, 10, 11, 15 (see Table 4-16).

Among crimes involving property, larceny leads all categories, with burglary a distant second. Automobile theft was third. The study area is reported to be so safe, however, that in recent interviews in Golden Valley County people let it be known that they were not afraid to leave their homes unlocked while they went to town shopping. The lack of crime in the study area has convinced people living in this area that additional police officers are not needed.

With the exception of the four most populated counties, Burleigh, Stark, Ward, and Williams, fire protection consists of volunteer fire departments which function when the occasion arises. In those four counties which have organized fire departments, fire protection is very adequate.

Water and sewage services are old but adequate within the 17 county study area. Most of the communities with a population of 0-150 have septic tank systems with a drainfield. Those communities which are over 150 have gone to a lagoon sewage system. Both the septic tank with a drainfield and the lagoon system of waste disposal are obsolete at this time.

Only Bismarck, in Burleigh County, has a waste treatment facility at the present time. Its present facility consists of a 5.04 MGD extended aeration treatment plant, which is capable of serving a population equivalent of 59,300. In order to meet projected State Health Department baseline requirements, an additional extended aeration process train will have to be constructed. Estimated cost of this is 1.4 million dollars. The city has recently completed construction of a lime sludge drying facility for the municipal water treatment plant. In this facility sludge is concentrated in a sludge thickener and dewatered by vacuum filters. The dewatered sludge is trucked to a dumping site and the excess water returned to the plant for treatment.

Table 4-16
Law Enforcement
Crime Rates by North Dakota County 1978

County	Crime Rate*	County Rank
Adams	324.3	4
Billings	272.7	49
Bottineau	1,704.1	15
Bowman	3,581.4	5
Burke	744.2	35
Burleigh	4,427.2	1
Divide	96.4	52
Dunn	604.2	40
Golden Valley	960.0	31
Hettinger	617.0	39
McKenzie	1,720.6	14
Mountrail	376.5	42
Renville	297.3	48
Slope	307.7	46
Stark	2,726.8	7
Ward	2,378.9	10
Williams	2,113.4	11

*Total "index offenses" per 100,000 population, all 53 counties reporting.

Source: North Dakota Uniform Crime Reporting Program.

With present water and sewage systems being obsolete and with growth being anticipated in the study area, it becomes essential that upgrading of water and waste systems become a reality. For information on community water systems in the 17 county study area, see Table 4-17.

LAND USE AND TRANSPORTATION

Land and Mineral Ownership

A split ownership of minerals and surface estate is very common in the western two-thirds of North Dakota. The mineral estate ownership is often complicated by a division of a particular mineral or combination of minerals from the total mineral estate. Fractional (percentage) ownerships also are common. This split and fragmented mineral ownership makes the job of compiling a comprehensive inventory of the mineral estate almost impossible. However, the BLM inventory of its mineral estate—as well as that of its surface estate—within North Dakota is considered to be complete. The inventory of the surface estate administered by other federal agencies is usually well documented, but the subsurface estate may not all be inventoried. The transfer of the surface management from one federal agency to another to accommodate a particular use may leave the mineral estate management and inventory in question. Table 4-18 shows the federal ownership of the surface and the oil and gas estate within North Dakota (Map 4-25).

Federal land surface ownership comprises approximately 5 percent of the total surface area of North Dakota, but the federal oil and gas acreage ownership makes up only 3 percent of the total for North Dakota. In other words, 40 percent of the federal surface lies over nonfederal oil and gas (Map 4-26).

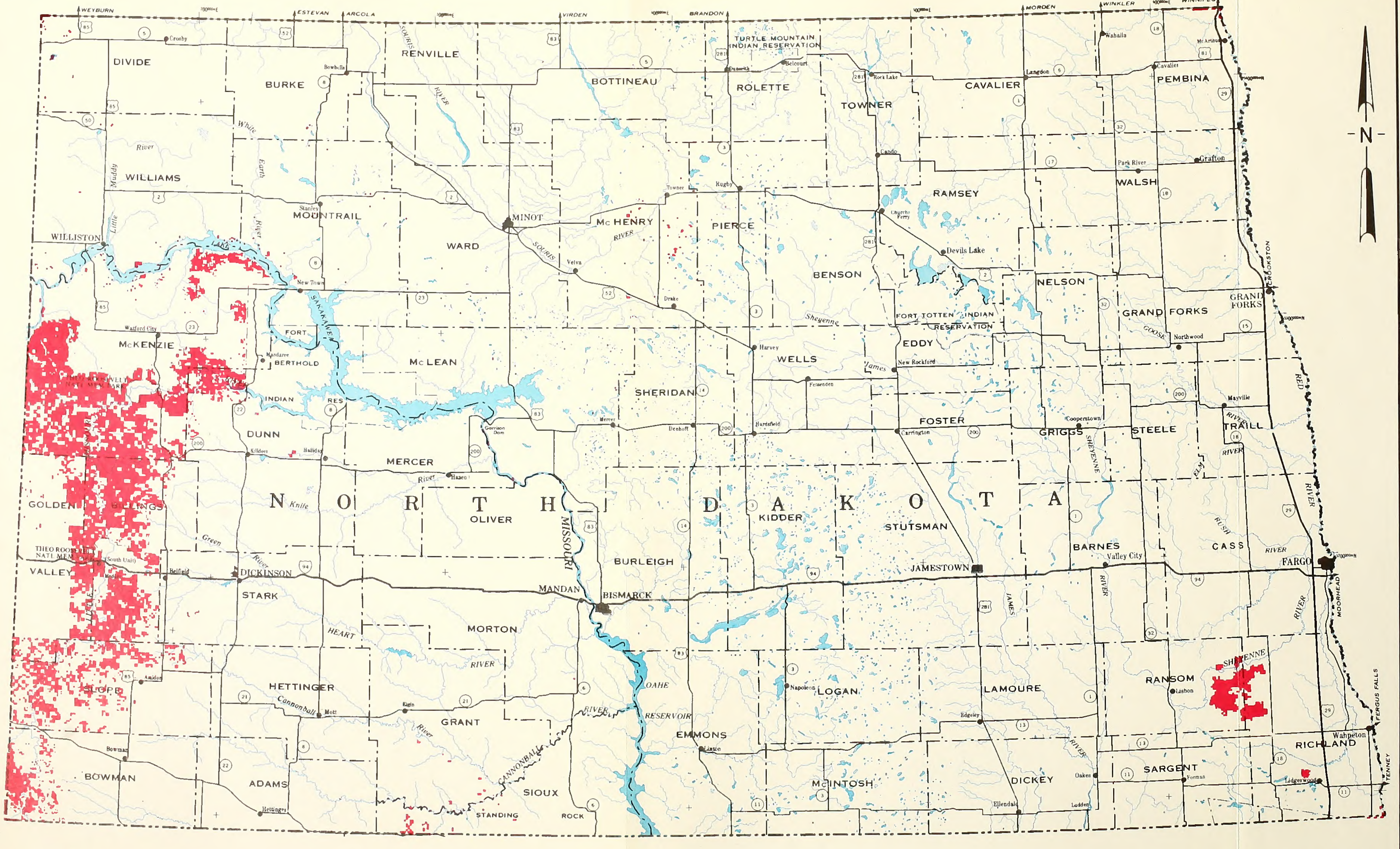
The federal oil and gas is significant because of its location: almost all of the federal oil and gas rights are located in the western one-third of the State, where the potential for finding oil or gas is the greatest.

Much of the current exploration and development of the federally owned oil and gas is within the area where the U.S. Forest Service manages the surface, but most of the oil and gas rights that are administered by the BLM are located under privately-owned surface. This split-estate situation calls for close coordination among the land owner, oil company, and the BLM. Because the BLM surface ownership in North Dakota is so small, the use or development of these surface lands will never be significant.

Land Use

North Dakota encompasses approximately 45,226,000 acres. Of this total, approximately 27,502,000 acres are cropland and 12,517,000 acres are rangeland and pastureland. The other use classifications are urban—1,083,000 acres; federal noncropland—1,583,000 acres; water—984,000 acres; woodland—650,000 acres; and other—917,000 acres. Table 4-19 lists the use classification, total acres of each classification, and percentage of land area these uses comprise for the year 1967 (North Dakota Conservation Needs Inventory, July 1970). Since 1967, the rangeland has decreased by more than 2,000,000 acres. Cropland acreages have increased and the other use classifications have not significantly changed. In 1978, 6,600,000 acres were in summer fallow. This is 300,000 acres less than in 1965 (North Dakota Crop and Livestock Statistics, Annual Summary for 1977 and Revisions for 1976).

The North Dakota Land Use Map (Map 4-18) shows land uses as a percent of the total for each county and the State. For some categories these percentages are a little different from those shown in Table 4-19 because



UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

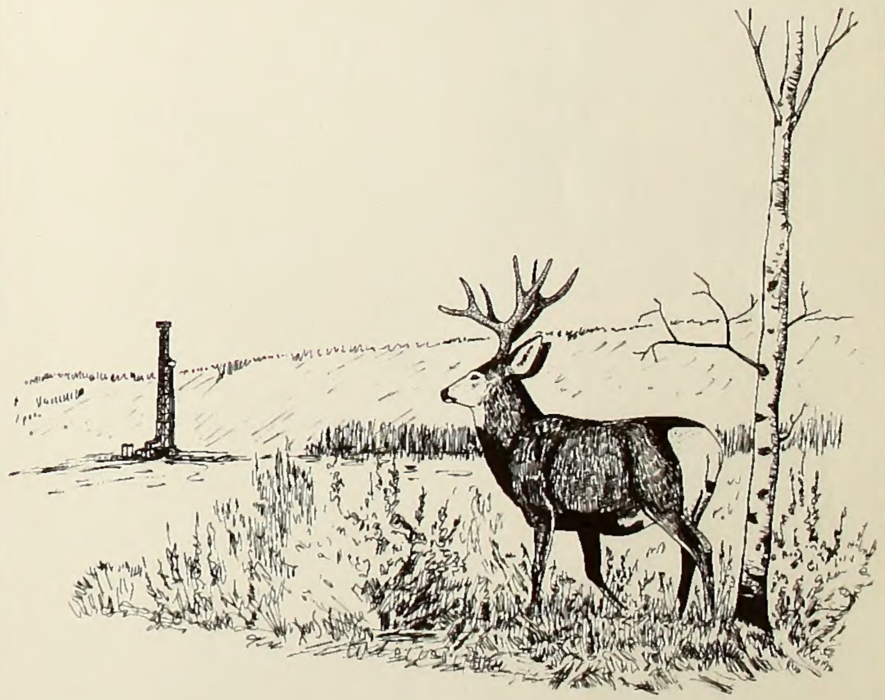
DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

FEDERAL MINERAL ESTATE OIL AND GAS

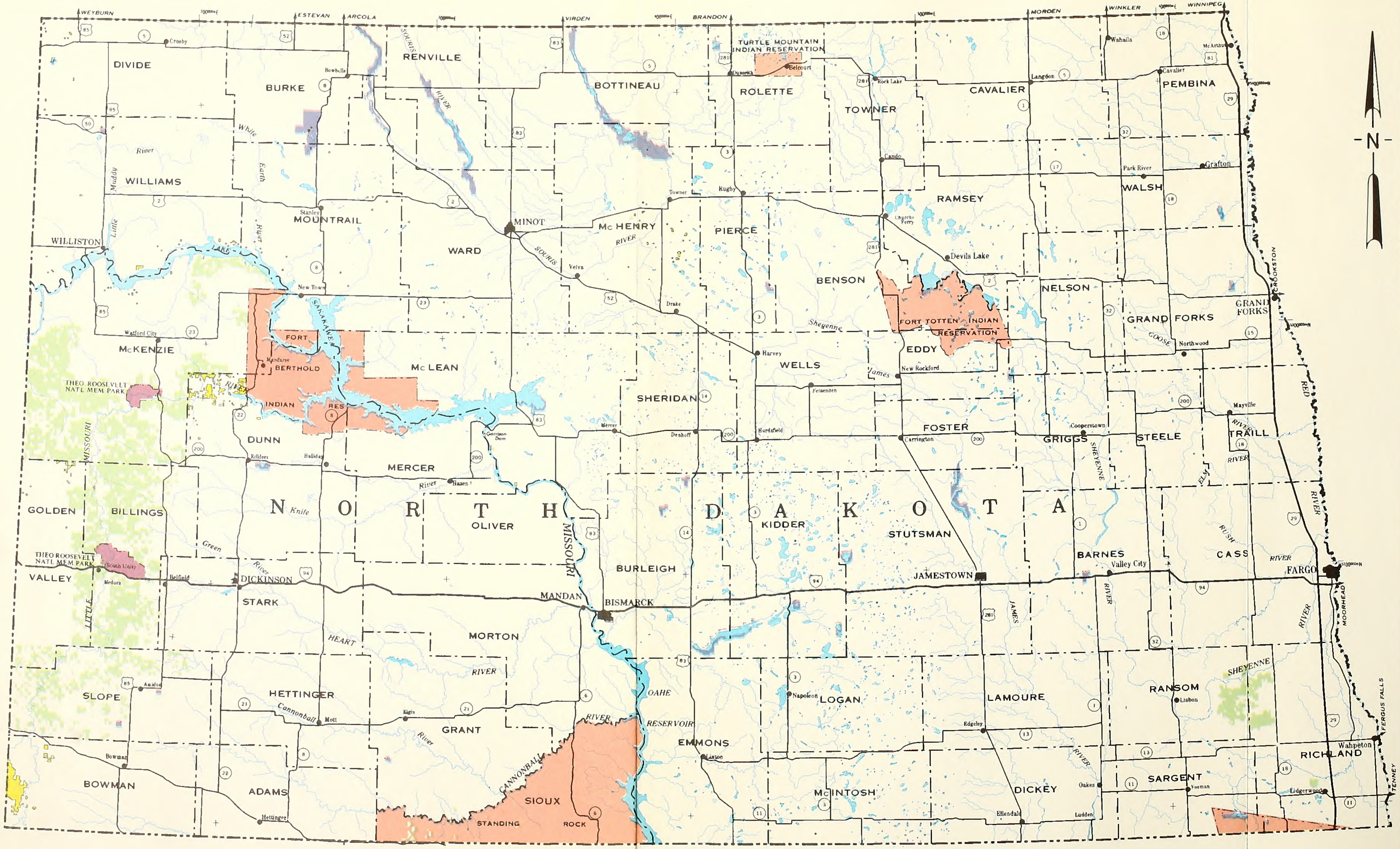
LEGEND

MAP 4-25

Oil and Gas Owned or Reserved by the Federal Government



SOURCE: BLM, 1980.



UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

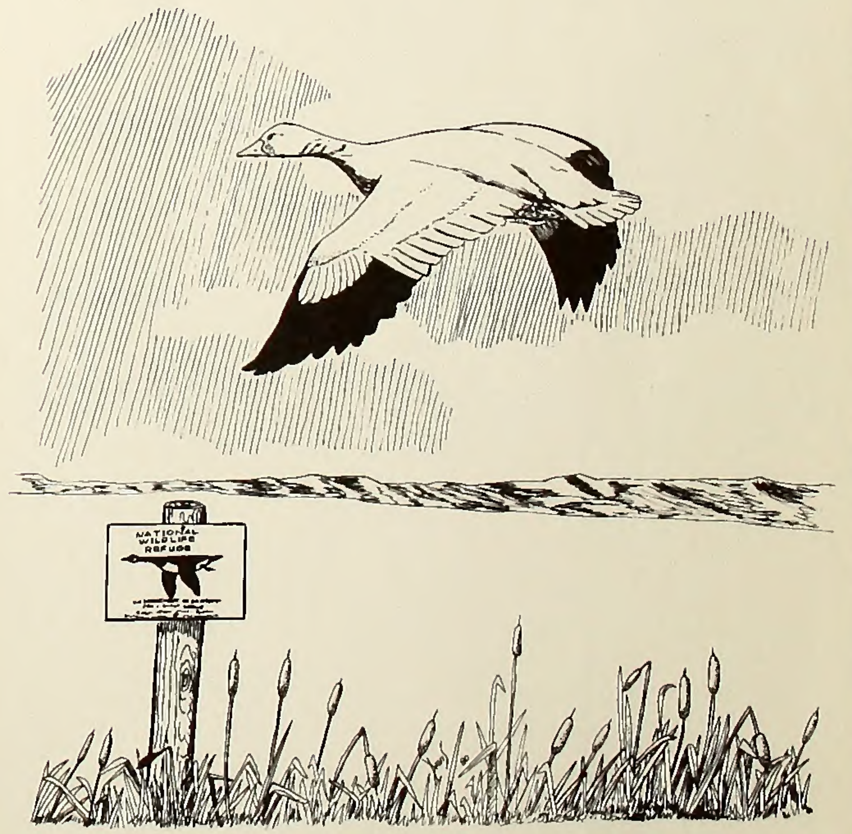
FEDERAL SURFACE LAND OWNERSHIP

LEGEND

MAP 4-26

FEDERAL LAND OWNERSHIP

- Indian Lands
- Federal Wildlife Refuges
- National Parks
- Vacant Public Domain Lands
- National Forest Lands



SOURCE: BLM, 1980.

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Table 4-17

County	Town	Treatment	Capacity (gals/day)	Source	Population Served	Problem Areas
Golden Valley	Beach	N	100,000	G	1,350	
Golden Valey	Golva	C	20,000	G	115	
Golden Valley	Home on the Range (Sentinal Butte)	N	10,000	G	65	
Hettinger	Mott	C	250,000	G	1,400	
Hettinger	New England	C	296,800	G	899	Fluorides
Hettinger	Regent	C	50,000	G	411	
McKenzie	Alexander	F	60,000	G	263	
McKenzie	Bar A Acres TC (Amegard)	N	5,000	G	30	
McKenzie	Watford City	F	1,250,000	G	1,768	
Mountrail	New Town	S	650,000	G	1,428	
Mountrail	Parshall	S	400,000	G	1,246	
Mountrail	Plaza	S	50,000	G	294	
Mountrail	Stanley	C	180,000	G	1,800	
Mountrail	Ross	N	6,000	G	125	
Renville	Glenburn	C	100,000	G	500	
Renville	Mohall	S	200,000	G	1,100	
Renville	Sherwood	N	60,000	G	367	
Renville	Upper Souris Water Users I	F	104,000	G	1,308	
Renville	Upper Souris Water Users II	F	23,000	G	25	
Slope	Marmarth	C	50,000	G	247	
Stark	Belfield	N	100,000	G	1,130	Fluorides
Stark	KOA Campground (Dickinson)	N	14,000	G	120	Fluorides
Stark	Morningside Heights (Dickinson)	N	12,000	G	85	
Stark	Gladstone	C	40,000	G	222	Fluorides
Stark	Richardton	C	254,000	G	785	
Stark	Assumption Abbey (Richardton)	N	40,000	G	160	
Stark	Sacred Heart Priory (Richardton)	N	5,000	G	30	
Stark	South Heart	C	12,000	G	132	Fluorides
Stark	Taylor	C	25,000	G	162	Fluorides
Stark	Dickinson	C	3,600,000	S	14,000	Water Shortage
Ward	Northland MHP (Minot)	N	1,000	G	50	
Ward	South Minot Utility (Minot)	C	14,000	G	200	
Ward	Spoklies TC (Minot)	N	3,000	G	60	
Ward	North Prairie Water Users I	S	120,000	G	2,550	
Ward	North Prairie Water Users II	F	50,000	G	550	
Ward	Minot	S	11,000,000	S	50,000	
Ward	Berthold	N	53,000	G	398	
Ward	Burlington	C	79,000	G	650	
Ward	Kenmare	N	45,000	G	1,937	
Ward	Makoti	C	8,000	G	159	
Ward	Ryder	C	50,000	G	210	
Ward	Sawyer	C	50,000	G	400	
Ward	Surrey	C	55,000	G	735	
Ward	Ruthville TC (Ruthville)	N	3,400	G	30	
Ward	Battleground Addition (Minot)	N	3,000	G	90	
Ward	Colony Park TC (Minot)	N	4,500	G	120	
Ward	Country Acres MHP	N	2,800	G	50	
Ward	East Side Estates (Minot)	N	8,000	G	72	
Ward	Holiday TC (Minot)	N	4,800	G	200	
Ward	Imperial Manor MHP (Minot)	C	4,500	G	150	

Treatment Legend

N — None
C — Clorination
F — Filtration
S — Softening

Source Legend

G — Groundwater
S — Surface Water

*Information on Williams County is not available.

Source: North Dakota State Department of Health, Missouri Office Building, Bismarck, North Dakota 58505.

Table 4-18
Federal Ownership of Surface and Oil and Gas Estates Within North Dakota[1]

Federal Agency	Surface Estate[2] Acres	Oil and Gas Estate[3] Acres
Bureau of Land Management	67,963 [2]	460,394
Forest Service	1,105,585	963,285
Bureau of Reclamation	118,016	1,388
Fish and Wildlife Service	415,443 [4]	8,371
Corps of Engineers	559,071	9,807
Air Force	12,374	0
Bureau of Indian Affairs	6,414	0
National Park Service	69,620	10,444 [2]
Totals	2,354,486	1,453,689

[1]Agencies with minor ownership not included.

[2]Public Land Statistics 1976 unless otherwise identified.

[3]BLM Dickinson District Inventory Record. Includes all oil and gas rights administered by BLM and USFS but ony oil and gas rights on Public Domain lands of other agencies.

[4]U.S. Fish and Wildlife Service, Bismarck, 1979.

Table 4-19
Land Use Acres and percentages of the Total for North Dakota, 1967[1]

Land Use	Acres/Thousands	Percent of Area
Cropland	27,502	60.8
Pasture and Rangeland	12,517	27.7
Other	917	2.0
Federal Noncrop	1,573	3.5
Urban and Build-Up	1,083	2.4
Woodland	650	1.4
Lakes, Streams, Rivers and Ponds	984	2.2
State Total	45,226	100.0

[1]North Dakota Conservation Needs Inventory July 1970.

of the way some special uses were classified; however, the general relationship of cropland, rangeland, and other uses in each county has remained the same. In general, this map shows the eastern one-third of the State as having a higher percentage of the land area planted to crops, in contrast to the western two-thirds of the State, where rangeland and pastureland are the predominant uses.

The land use category of "other" includes roads, powerlines, etc.

Oil and gas exploration and development will, generally, affect crop, range, and pastureland more than other use classifications. Woodlands, streams, lakes and ponds, and urban areas are usually avoided.

Transportation

Transportation consists of highways, railroads, air, and transmission facilities.

Highway construction and maintenance responsibilities are divided between several different administration jurisdictions: federal, state, county, organized township, city, and private. All classes of roads, except the private roads, are built and maintained with federal, state, or local taxes. Many of the private roads are short roads leading from a public road to an oil well location, ranch, or farmstead. These roads are maintained by either the oil companies, farmers, or ranchers. The private roads are on the increase with new oil and gas development. Many of the oil field service roads are maintained in as well as or better condition than some public roads. Increased use is occurring on many county and township roads in areas of intensive oil development. Map 4-27 shows major roads in North Dakota.

North Dakota is served primarily by three railroad companies. They are the Burlington-Northern, Inc., Soo Line Railroad Company, and the Milwaukee Railroad. Burlington-Northern has the most trackage, with almost state-wide coverage. The Soo trackage is intermingled with that of Burlington-Northern in the northern and eastern part of the State, while the Milwaukee serves the southwestern corner of North Dakota. Map 4-28 shows the locations of the railroads within North Dakota. The total trackage for all companies within North Dakota is 5,234 miles.

Commercial air carrier service is limited to only a few larger cities within the State. Grand Forks, Fargo, Jamestown, Bismarck, Williston, Devils Lake, and Dickinson have commercial service. Several other areas are served by charter service and municipal and private facilities.

West-Central North Dakota is a major producer and exporter of electrical energy; therefore, the State has numerous electrical transmission lines radiating in all directions. Many of these are headed southeast into Minnesota. Electrical transmission line density is greatest in Oliver, McLean, and Burleigh counties.

Oil and natural gas pipelines are the predominant transmission pipelines within North Dakota. Very few miles of water and petroleum products lines are in the State. Natural gas transmission lines connect most of the major cities and towns. The major oil transmission lines are the Matador and Amoco pipelines, which supply the Amoco refinery at Mandan. Several new pipelines are under study, including the Northern

Border natural gas line and the Northern Tier oil line. More lines will be needed as oil and gas continues to be developed within North Dakota. Map 4-29 shows pipeline locations within North Dakota.

Gathering lines within the oil fields add up to many miles of small diameter lines. These are constantly being constructed as the oil fields are developed and expanded.

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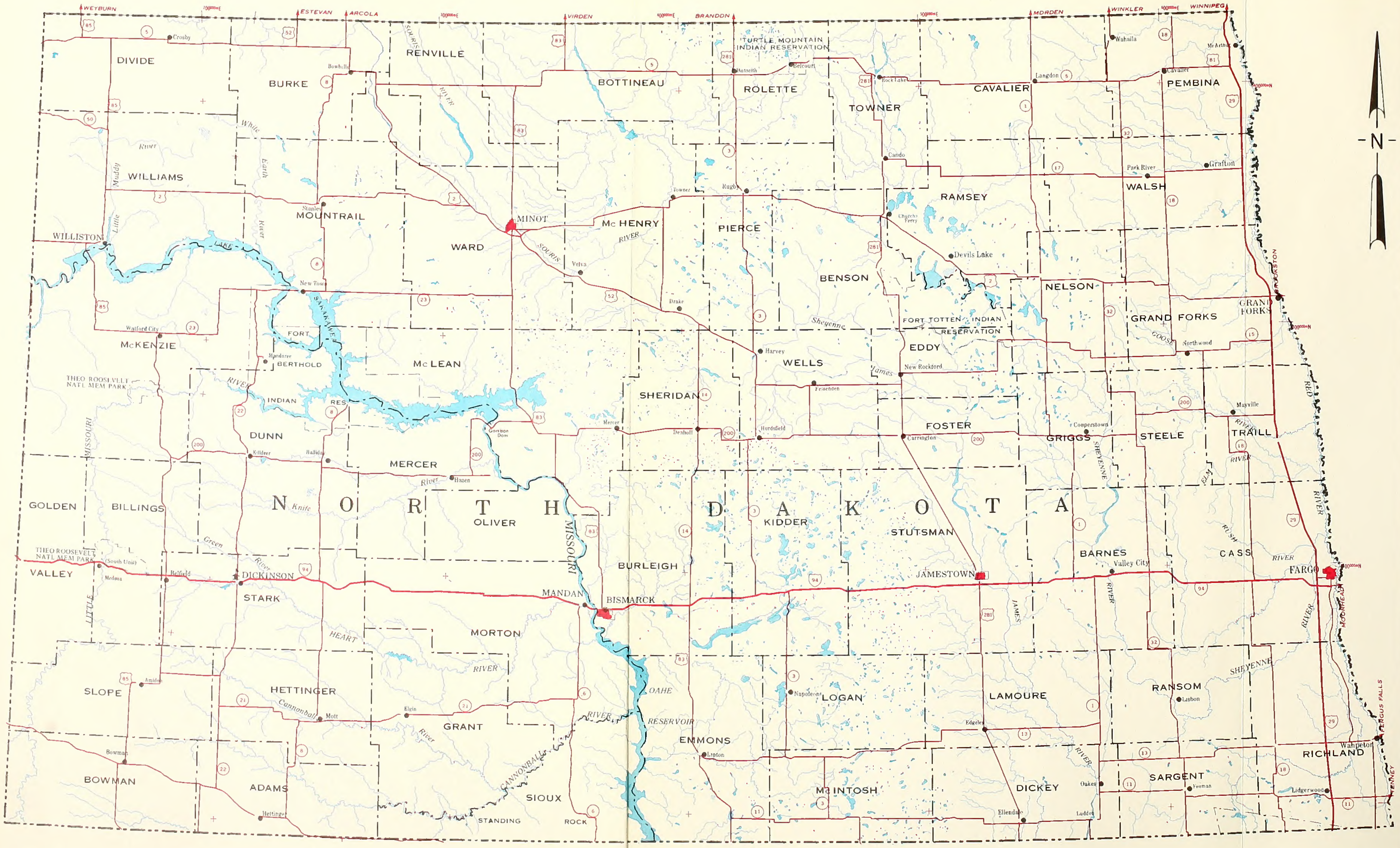
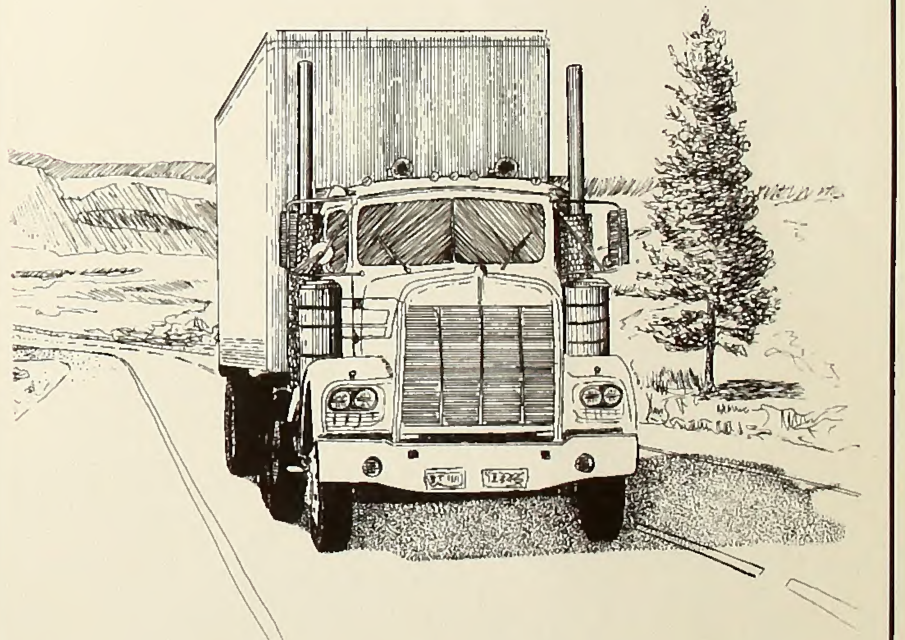
DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

HIGHWAYS



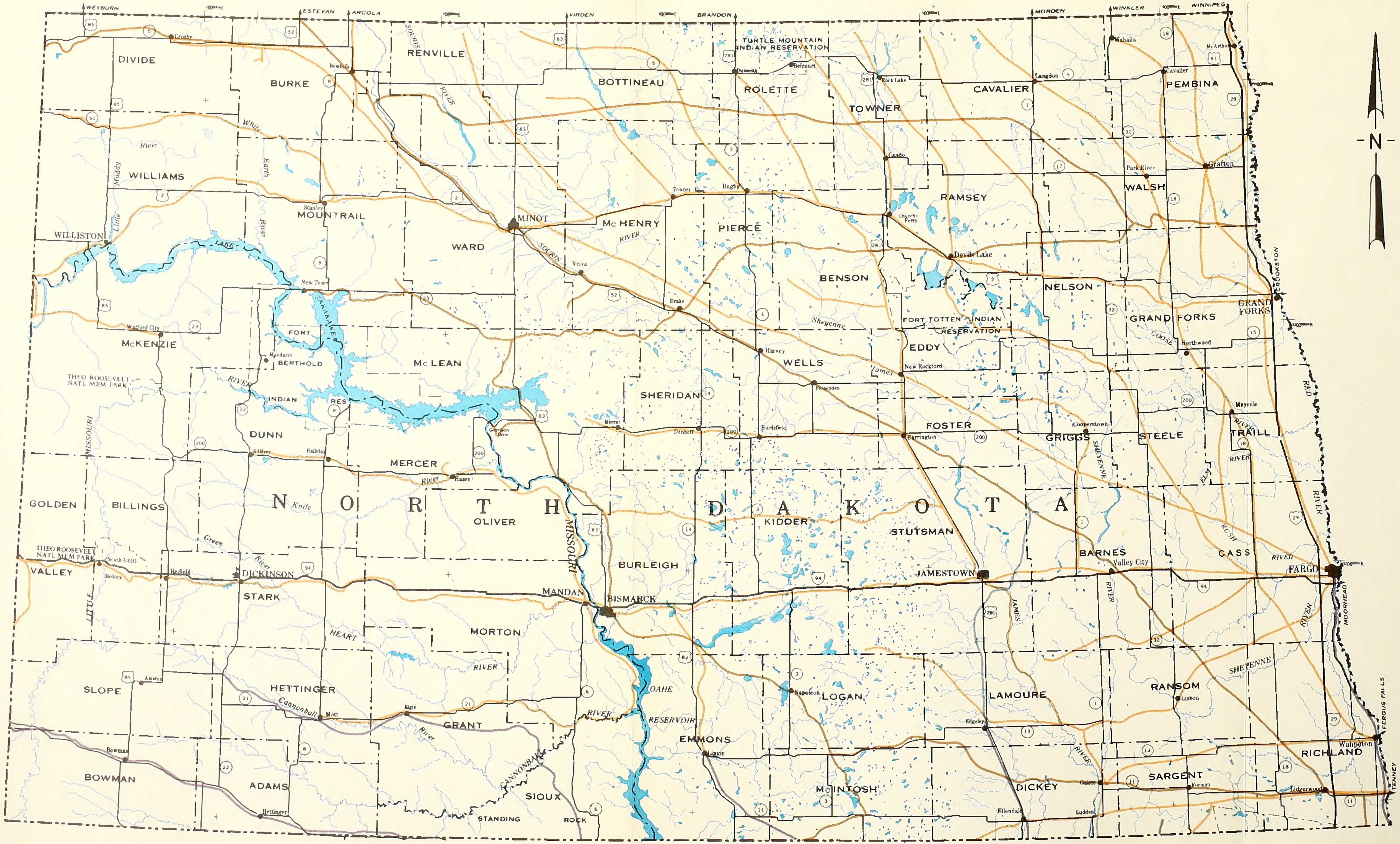


LEGEND

MAP 4-27

FEDERAL and STATE Highways

SOURCE: N.D. State Highway Map.



UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

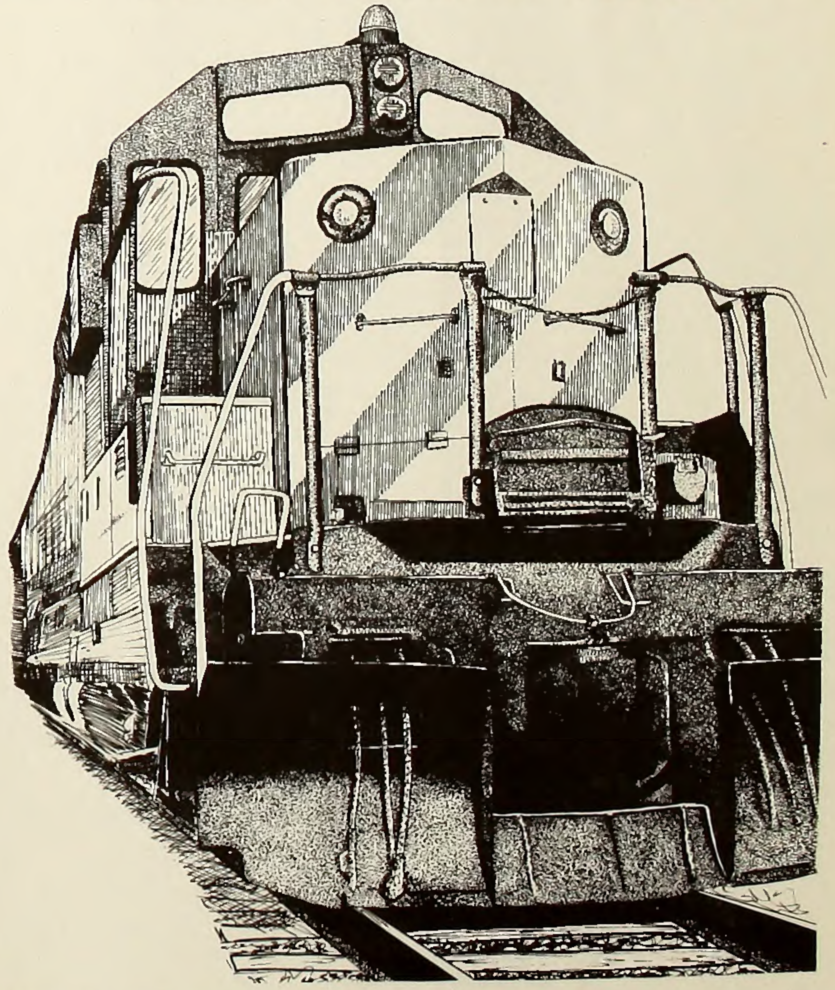
DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

RAILWAY SYSTEMS

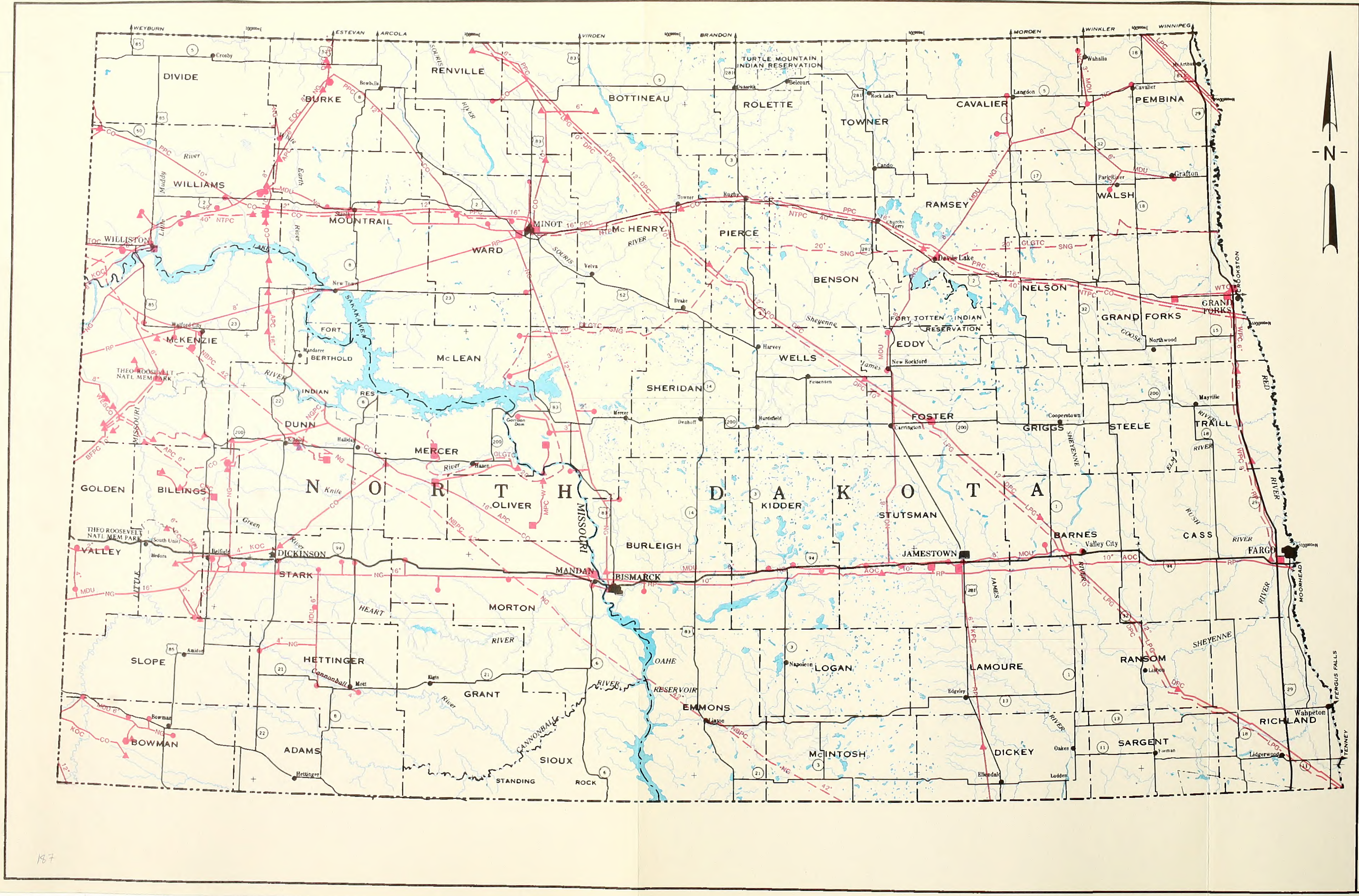
LEGEND

MAP 4-28

- Chicago and Northwestern Railroad
- Chicago—Milwaukee Railroad
- Soo Line Railroad
- Burlington Northern Railroad
- Midland Continental Railroad



SOURCE: N.D. Dept. of Public Instruction, Business and Industry.



UNITED STATES DEPARTMENT OF THE INTERIOR
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DICKINSON DISTRICT ENVIRONMENTAL ASSESSMENT OF OIL AND GAS LEASING PROGRAM

PIPELINE SYSTEMS

LEGEND

MAP 4-29

- EXISTING TRANSMISSION LINE
- PROPOSED TRANSMISSION LINE
- TERMINAL OR REFINERY
- COMPRESSOR OR PUMP STATION
- GAS DISTRIBUTION
- GAS PROCESSING PLANT

TRANSMISSION LINE PRODUCT

CO	CRUDE OIL
W	WATER
NG	NATURAL GAS
LPG	LIQUIFIED PETROLEUM GAS
RP	REFINED PRODUCT
SNG	SYNTHETIC NATURAL GAS

OWNERSHIP OF FACILITIES

MPI	MATADOR PIPELINE INC.
BFPC	BELLE FOURCHE PIPELINE CO.
MDU	MONTANA DAKOTA UTILITIES CO.
KOC	KOCH OIL CO.
DPC	DOME PIPELINE CORP.
PPC	PORTAL PIPELINE CO.
AOC	AMOCO OIL CO.
WTC	WESTERN TERMINAL CO.
WPC	WILLIAMS PIPELINE CO.
CPC	CENEX PIPELINE CO.
APC	AMOCO PIPELINE CO.
LPC	LAKEHEAD PIPELINE CO.
MPC	MINNKOTA POWER COOP.
CPA	COOPERATIVE POWER ASSOC.
UPA	UNITED POWER ASSOC.
KPC	KANEB PIPELINE CO.
NTPC	NORTHERN TIER PIPELINE CO.
NBPC	NORTHERN BORDER PIPELINE CO.
BEPC	BASIN ELECTRIC POWER COOP.
GPGA	GREAT PLAINS GASIFICATION ASSOC.
WESCO	WESCO PIPELINE CO.
TOC	TRUE OIL CO.
EOC	ENERGY OPERATING CO.
GLGTC	GREAT LAKES GAS TRANSMISSION CO.
NGPC	NATURAL GAS PIPELINE CO.

SOURCE: N.D. Public Service Commission, Siting Division.

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CHAPTER 5

CHAPTER 5
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APPENDIX

APPENDIX 1-1

ASSUMPTIONS AND GUIDELINES

Because this assessment considers the possible exploration, development, and production of oil and gas from federal leases, it is necessary to outline several of the physical/operational characteristics which can be expected of the average drilling facility in Montana and the Dakotas. For analytical purposes, the assumption is made that any leasing action can result in oil and gas production, although historically only a small percentage of leases issued have gone into the production stage. Below are assumptions and guidelines which will be useful in the analysis of potential impacts resulting from oil and gas development.

Technology

For purposes of this analysis, it is assumed that the technology of oil and gas production will not change significantly. This assumption may not be objectively valid, but it is difficult to determine what direction improved technology may take in the future.

Supply and Demand

Many factors significantly affect oil and gas activity in the study area. For instance, demand for domestic oil and gas may decrease due to development of new energy sources. Alternatively, it may increase because of export restrictions imposed by foreign oil and gas suppliers or because of import restrictions imposed by the U.S. It is possible that a major oil or gas field could be discovered in the study area, resulting in increased activity. Since there is no way to accurately predict these changes, it is assumed that supply, demand, and production activity will follow current trends.

Preliminary Exploration

Preliminary exploration activity is expected to increase at a rate of about 10% a year, with most of it in the deep formations. Exploratory drilling is expected to increase at a rate of about 15% a year, in response to an increasing demand for petroleum products. Drilling is expected to be in the deep formations and on the fringes of existing fields. Development is expected to continue at about the current level as existing fields are further exploited. Production has decreased at about 2% annually over the last several years as reserves have been depleted, and it is anticipated that this trend will continue during the short run. Abandonments are expected to increase at a rate of about 5% a year as older fields are depleted.

Land for Producing Facilities

Land-use intensity decreases as well-spacing increases. The land use by all facilities in a developed field may range from more than 64 acres per square mile, with a 40-acre-per-well spacing, to about 4 acres per square mile with 640-acre-per-well spacing. These acreages are adequate for most field operations. The amount of land actually used may be greater in some areas and less in others. Most spacing patterns for oil wells on federal leases require a minimum of 40 acres per well.

Land use in gas fields is usually less than in oil fields because gas production usually does not require storage on the lease. Most patterns for production of gas on federal leases require spacing of 160, 320, or 640 acres per well.

Employment

The number of people required to operate a field varies with production and the number of leaseholds in the field. If the wells flow without pumping, one employee in a large, automated field can control production of about 25 wells. When wells are pumped, one employee in a large modern field can control production on 10 to 20 wells. If oil storage tanks are manually gauged and sampled, one employee can service approximately 25 tanks. If automatic gauging and sampling devices have been installed, one person can service the equivalent of 100 to 150 tanks. In a large, modern field, one five-man maintenance crew can service up to 50 wells. If the field contains many small, non-utilized leaseholds, more people will be needed to control production and maintain facilities.

APPENDIX 2-1

________________ (OG SIM Serial No.)

________________ (Serial Number)

OIL AND GAS LEASE STIPULATIONS

(% of lease affected by stipulation)

( ) No occupancy or other activity on the surface of the following-described land is allowed under this lease: ( )

This limitation may be modified when specifically approved in writing by the District Engineer, Geological Survey (GS), with concurrence of the District Manager, Bureau of Land Management (BLM).

( ) No occupancy or other surface disturbance will be allowed within ______ feet of the ________________________. This distance may be modified when specifically approved in writing by the District Engineer, Geological Survey (GS), with the concurrence of the District Manager, Bureau of Land Management (BLM). ( )

( ) No drilling or storage facilities will be allowed within ______ feet of ________________________ located in ____________________________. This distance may be modified when specifically approved in writing by the District Engineer, Geological Survey (GS), with the concurrence of the District Manager, Bureau of Land Management (BLM). ( )

( ) No occupancy or other surface disturbance will be allowed on slopes in excess of ______ percent, without written permission from the District Engineer, Geological Survey (GS), with the concurrence of the District Manager, Bureau of Land Management (BLM). ( )

( ) In order to ________________________________, exploration, drilling, and other development activity will be allowed only during the period from ________________ to ________________. Lands within the leased area to which this stipulation applies are described as follows: ( )

Exceptions to this limitation in any year may be specifically authorized in writing by the District Engineer, Geological Survey (GS), with the concurrence of the District Manager, Bureau of Land Management (BLM).

( ) The ____________________ will not be used as an access road for activities on this lease. This limitation may be modified when specifically approved in writing by the District Engineer, Geological Survey (GS), with concurrence of the District Manager, Bureau of Land Management (BLM). ( )

________________ Date

________________ Lessee's Signature

MSO 3100-45 (May 1978)

(Serial Number)

OIL AND GAS LEASE STIPULATIONS

CULTURAL RESOURCES — Prior to undertaking any surface disturbing activities on the lands covered by this lease, the lessee or operator shall, unless notified to the contrary by the District Manager, Bureau of Land Management:

A. Engage the services of a qualified cultural resource specialist to conduct an intensive cultural resource inventory of the areas to be impacted for evidence of cultural resource values.

B. Submit an acceptable report to the authorized officer of the surface management agency and the District Engineer of the U.S. Geological Survey.

C. Take such measures as deemed necessary to preserve or avoid destruction of cultural resource values. Mitigation may include relocation of proposed facilities, testing and salvage or other protective measures deemed necessary by the authorized officer. All costs of the survey and salvage of cultural resource values will be borne by the lessee or operator and all data and materials salvaged will remain under the jurisdiction of the U.S. Government as appropriate.

Should significant paleontological values be encountered in areas of the proposed action, prior to surface disturbance, the information will be forwarded to the District Manager, Bureau of Land Management, for evaluation and appropriate action to follow.

The lessee or operator shall immediately bring to the attention of the District Engineer, U.S. Geological Survey, any antiquities or other objects of scientific interest discovered as a result of operations under this lease and shall leave such discoveries intact until directed to proceed by the District Engineer, U.S. Geological Survey.

ESTHETICS — To maintain esthetic values, all semi-permanent facilities may require painting or camouflage to blend with the natural surroundings. The paint selection or method of camouflage will be subject to approval by the District Engineer, Geological Survey (GS), with the concurrence of the District Manager, Bureau of Land Management (BLM).

EROSION CONTROL — In order to minimize watershed damage, during muddy and/or wet periods, the District Manager, Bureau of Land Management (BLM) through the District Engineer, Geological Survey (GS), may prohibit exploration, drilling or other development. This limitation does not apply to maintenance and operation of producing wells.

Date

Lessee's Signature

MSO 3100-47 (May 1978)

_____________________ (OG SIM Serial No.)

_____________________ (Serial Number)

OIL AND GAS LEASE STIPULATIONS

(% of lease affected by stipulation)

(   ) In order to ______________________________, (   ) exploration, drilling, and other development activity and maintenance and operation of producing wells and facilities that requires on site access will be allowed only during the period from ______________ to ______________. Lands within the lease area to which this stipulation applies are described as follows:

Exceptions to this limitation in any year may be specifically authorized in writing by the District Engineer, Geological Survey (GS), with the concurrence of the District Manager, Bureau of Land Management (BLM).

_____________________ Date

_____________________ Lessee's Signature

MSO 3100-49 (May 1978)

(OG SIM Serial No.) | (Serial Number)

OIL AND GAS LEASE STIPULATIONS

(% of lease affected by stipulation)

( ) In order to minimize watershed damage and protect fragile soils, surface disturbing activities will be allowed only during the period from ______ to ______ . Lands within the leased area to which this stipulation applies are described as follows: ( )

Exceptions to this limitation in any year may be specifically authorized in writing by the District Engineer, Geological Survey (GS), with the concurrence of the District Manager, Bureau of Land Management (BLM).

______ Date

______ Lessee's Signature

MSO 3100-50 (May 1978)

(OG Sim Serial Number) (Serial Number)

OIL AND GAS LEASE
WILDERNESS PROTECTION STIPULATION

(% of lease affected)

( ) By accepting this lease, the lessee acknowledges that the lands contained in this lease which are identified below are being inventoried or evaluated for their wilderness potential by the Bureau of Land Management under section 603 of the Federal Land Policy and Management Act of 1976, 90 Stat. 2743, 2785 (43 U.S.C. Sec. 1782). ( )

☐ All lands within the lease

☐ Part of the lands within the lease described as follows:

Until the BLM determines that the lands described above do not meet the criteria for a wilderness study area as set forth in section 603, or until Congress decides against the designation of lands included within this lease as "wilderness," the following conditions apply to this lease, and override every other provision of this lease which could be considered as inconsistent with them and which deal with operations and rights of the lessee:

1. Any oil or gas activity conducted on the leasehold for which a surface use plan is not required under NTL-6 (for example: geophysical and seismic operations) may be conducted only after the lessee first secures the consent of the BLM. Such consent shall be given if BLM determines that the impact caused by the activity will not impair the area's wilderness characteristics.

2. Any oil and gas exploratory or development activity conducted on the leasehold which is included within a surface use plan under NTL-6 is subject to regulation (which may include no occupancy of the surface) or, if necessary, disapproval until the final determination is made by Congress to either designate the area as wilderness or remove the section 603 restrictions.

If all or any part of the area included within the leasehold estate is formally designated by Congress as wilderness, oil and gas exploration and development operations taking place or to take place on that part of the lease shall become subject to the provisions of the Wilderness Act of 1964 which apply to national forest wilderness areas, 16 U.S.C. Sec. 1131 et. seq., as amended, the Act of Congress designating the land as wilderness, and Interior Department regulations and policies pertaining thereto. If it is found that the area does not have wilderness characteristics or is not suitable to be designated a part of the National Wilderness Preservation system, development and/or surface occupancy will be subject to the remaining lease terms and the special stipulations.

Date Lessee's Signature

MSO 3100-51 (June 1978)

APPENDIX 2-2

MONTANA BUREAU OF LAND MANAGEMENT POLICY WITH REGARD TO THE NATIONAL HISTORIC PRESERVATION ACT

Compliance with the 35 CFR 800 Regulations is done according to the following Bureau of Land Management policy in Montana, North Dakota, and South Dakota.

Application

These regulations apply to all federal undertakings which might affect a cultural property. The definition of federal undertaking is very broad and includes all actions, activities, or programs, or any type of assistance, support, or sanction of nonfederal undertakings. The procedures shall be applied in time to be included in the preparation of Environmental Analysis Reports or Environmental Statements in order to provide sufficient lead time for the consultation explained below. In any case, these procedures shall be completed prior to BLM final approval or action on an undertaking.

Identification of Cultural Properties

For Bureau initiated actions, all cultural properties which would be impacted must be identified. For general land use decisions (e.g., an oil and gas lease offering), at a minimum known properties from the district Class I inventory and the current listing of National Register and eligible properties must be consulted before the decision is formally made. Before specific ground disturbing actions under these land use decisions are authorized (e.g., Application for Permit to Drill), a Class III inventory must be completed over the area of impact. For all other Bureau-initiated ground disturbing actions, whether covered by a general land use decision or not, a Class III inventory must be completed over the area of impact before authorization. For non-Bureau initiated actions, the same general provisions apply, but the applicant may be required to fund and contract actual field work.

Evaluation of Cultural Properties

Once all cultural properties within the impact zone are identified, they must have the criteria for eligibility in the National Register applied to them. After the criteria are applied to all cultural sites, these determinations (with documentation) must be sent to the SHPO as part of the consultation process described below.

Consultation for Identification and Evaluation Phases

The SHPO should be consulted as early during decision planning as possible. Consultation must be done on large scale projects or land use decisions by writing the SHPO at the planning stage to request inventory information. The SHPO should supply a list of all previously inventoried cultural properties, evaluation of the quality of those inventories, and recommendations for further inventory needs, methods, and boundaries. The SHPO's recommendations should be given serious consideration before the inventory is done.

For all ground disturbing actions, a Class III inventory will be done for the area of impact. The inventory report will be part of the consultation document. It should be adequate to define impact area and inventory methods, and to evaluate sites for National Register eligibility. The inventory report with the site forms should be sent to the SHPO with the BLM's opinion on eligibility and effect (if Register eligible properties are present). If no properties are found or properties are found and avoided, SHPO comment must be obtained before project authorization can be given.

If BLM and SHPO agree that no site meets the criteria for eligibility, this must be documented and the undertaking can proceed without further SHPO, National Register, or Advisory Council review. If BLM and SHPO agree on the eligibility determination for all sites, documentation showing that both agree must be developed. This documentation must be sent to the Secretary of the Interior for his formal eligibility determination.

If the BLM and SHPO disagree on eligibility, a request for determination of eligibility can be made directly to the Secretary of Interior through the National Register. It is probable that the Secretary will request further information, and substantial time delays in project clearance would result. If it is thought that the BLM and SHPO will disagree, more complete documentation on the BLM's opinion should be prepared in order to aid the Secretary's decision.

Determination of Effect on Cultural Properties

For all properties on or eligible for the National Register, a determination of the effect of the project on the property must be made in consultation with the SHPO. If BLM determines that there will be no effect, it must notify the SHPO of that decision. If SHPO objects, the Advisory Council will be given opportunity to comment. Effect is defined as the condition when the undertaking will make any change in integrity of location, design, setting, materials, workmanship, feeling, or association that contributes to the significance of the National Register or eligible property.

If BLM determines that an effect will occur, the criteria for determining adverse effect must be applied to the properties, again in consultation with the SHPO. This can be done concurrently with the initial determination of effect, by documenting those effects predicted to occur to the property. The determination may result in a no adverse effect decision or an adverse effect decision. A no adverse effect determination must be documented and sent to the SHPO with a data recovery plan (if applicable) for his written opinion. An adverse effect determination must be documented through preparation of a preliminary case report, and also sent to the SHPO for his written opinion. Adverse effects are those effects which: (1) destroy or alter the property, (2) isolate from or alter the property's surroundings, (3) introduce visual, audible, or atmospheric elements out of character with the property, (4) neglect the property to the point of deterioration or destruction, or (5) allow the property to pass from federal ownership without protecting stipulations.

When effect has been documented, this documentation, along with SHPO's written opinion, must be sent to the Advisory Council for comment. A no adverse effect determination would allow the undertaking to proceed under the conditions of the no adverse effect documentation. An adverse effect determination will usually require a Memorandum of Agreement, written by the Advisory Council, with signatories including the BLM, Advisory Council, SHPO, and in the case of non-Bureau initiated actions, the Applicant. In most cases the major portion of the Memorandum of Agreement will consist of the Preliminary Case Report developed by BLM staff.

APPENDIX 3-1

In 1978, the total production of oil and gas from federal leases in the Dickinson District was 3.025 million bbls and 768,000 mcf, respectively. In order to convert these energy volumes to a common denominator, they were both converted to Btu equivalents using the following Department of Energy conversion factors:

5.61 million Btu's/barrel of oil
1.02 million Btu's/mcf of natural gas

Using these conversion factors, the Btu equivalent of the oil and gas production is as follows:

Oil: $(3.025 \times 10^6$ bbls$)(5.61 \times 10^6$ Btu/bbl$) = 16.9 \times 10^{12}$ Btu
Gas: $(0.768 \times 10^6$ mcf$)(1.02 \times 10^6$ Btu/mcf$) = 783 \times 10^9$ Btu
Total: 17.8×10^{12} Btu $= 17{,}800 \times 10^9$ Btu

The total Btu equivalent from federal oil and gas production in the Dickinson District in 1978—17.8 trillion Btu's—is 10.3% of the Btu equivalent for all oil and gas production in the district. Assuming that the Btu production/worker ratio is similar for both oil and gas workers, it is reasonable to expect that the reduction in Btu equivalent oil and gas production from a discontinuation of federal oil and gas leasing would affect both oil and gas employment opportunities in a similar manner.

Applying the federal oil and gas proportion of 10.3% to the estimated total direct oil/gas employment in the district (i.e., 2940 employees), it is estimated that the cessation of federal oil and gas leasing in the district could result in a loss of approximately 302 direct jobs (.103 x 2940) and the attendant direct annual payroll of $6,342,000 ($21,000 x 302).

APPENDIX 4-1
VISUAL RESOURCE MANAGEMENT CLASSES

The following visual resource management classes are to be used as tentative minimum management objectives for the visual management units identified above. Each visual resource management class describes the acceptable amount of visual change that can take place in a landscape. The visual resource management classes represent the management objectives for maintaining the character of the existing landscape.

Class I—This class provides primarily for natural ecological changes only. It is applied to primitive areas, some natural areas and other similar situations where management activities are to be restricted.

Class II—Changes in any of the basic elements (form, line, color, or texture) caused by a management activity should not be evident in the characteristic landscape.

Class III—Changes in the basic elements (form, line, color, or texture) caused by a management activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

Class IV—Changes may subordinate the original composition and character but must reflect what could be a natural occurrence within the characteristic landscape.

Class V—Change is needed. This class applies to areas where the naturalistic character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding countryside. This class would apply to areas identified in the scenery evaluation where the quality class has been reduced because of unacceptable modifications. It should be considered an interim short-term classification until one of the other objectives can be reached through rehabilitation or enhancement.