PEATLANDS

ENERGY FROM PEATLANDS: OPTIONS AND IMPACTS

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A Report of the CURA Peat Policy Project

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PREFACE

This report has been developed as part of a study begun in July 1980 by the Center for Urban and Regional Affairs (CURA) at the University of Minnesota. A nine-member panel of University of Minnesota faculty was assembled to oversee the study and to formulate recommendations concerning peatland policy. The panel, drawn primarily from the membership of CURA's All-University Council on Environmental Quality, reflects a variety of backgrounds and disciplines: Perry Blackshear, Professor of Mechanical Engineering; Rod Squires, Assistant Professor of Geography; William Fleischman, Associate Professor of Sociology (Duluth); Howard Hobbs, Scientist, and Matt Walton, Professor and Director, Minnesota Geological Survey; Wilbur Maki, Professor, and Lee Martin, Professor, Agricultural and Applied Economics; and Thomas Anding, Associate Director of CURA. CURA's peat staff, Thomas Peek and Douglas Wilson, conducted the study and prepared the report for the Panel. In addition, CURA contracted Thomas Triplett and Loni Kemp of the Minnesota Project to study the legal, regulatory and citizen participation issues associated with peatland development. Penelope Burke staff to the All-University Council on Environmental Quality, assisted the project staff and assembled the report's bibliography.

The report provides lawmakers, agency staff, industry officials and citizens with an integrated summary of peatland research. An analysis of the options for using peatlands and a review of the potential economic, social, and environmental impacts of developing peatlands for energy are included. The existing legal and regulatory framework governing Minnesota peatlands is also examined.

The recommendations of the panel are designed to assist lawmakers and other government officials in their formulation of public policy regarding development of Minnesota peatlands for energy, and to suggest to industry ways of using the states peatland resource that will enhance the state's economy and energy position while minimizing detrimental economic, social, and environmental effects.

Dean Abrahamson

Dean E. Abrahamson April 1981

EXECUTIVE SUMMARY

Minnesota contains 5.9 million acres of peatland, most of which is located in the northern counties of Roseau, Lake of the Woods, Beltrami, Koochiching, St. Louis, and Aitkin. While the number of acres in Minnesota's peatland resource is large (exceeded in the United States only by Alaska), the state's commercial reserves are unknown. The acreage that can actually be used will be much less than the 5.9 million acre resource. Commercial viability depends not only on the surface area, but also on many other factors: the depth and quality of the peat, the size of the peatland, environmental limitations, ownership, transportation networks, and the public and private service systems needed to support adjacent economic expansion.

Despite a long history of use elsewhere in the world, peatlands in the United States have traditionally been used only for limited horticultural and agricultural purposes. In some regions they have been regarded as "wasteland," a resource too difficult and expensive to exploit. This is because the products derived from peatlands have been produced more cheaply from other sources. As these products--especially energy--become more expensive in the United States, commercial use of peatlands has drawn more interest. The interest in developing this Minnesota resource has been generated by projected shortages and increased prices of traditional energy supplies, coupled with the possibility that peatland development might improve the economy of northern Minnesota.

Current and anticipated uses of peatlands fall into three categories. Portions of these lands can be used for nonrenewable resource extraction, to produce peat for fuel in various forms and horticultural products such as potting soil and soil conditioners, and as a raw material for industrial chemicals such as peat coke, waxes, and steroids. Peatlands can also be utilized for renewable resource production, including agricultural production and forestry, and for growing energy crops that can be converted into various forms of energy.

Finally, peatland preservation may be appropriate in order to protect portions of these lands which may have either scientific value, unique natural systems, recreational value, historical or aesthetic importance, or which may provide a resource base important to future generations of Minnesotans.

ANALYSIS OF PEATLAND DEVELOPMENT FOR ENERGY

Examining the Options

Mined peat or harvested energy crops can be converted into specific forms of energy through several approaches. They include 1) direct burning to produce process heat or electricity with or without steam heat, 2) gasification to produce methane, 3) liquefaction to produce alcohol, and 4) briquetting or pelletizing for combustion.

A number of factors should be considered when comparing the economic feasibility and social desirability of these approaches to the development of Minnesota's peatlands for energy. First, the quality and quantity of energy demanded and its value in the market should be identified. The cost of each development approach is also a major concern. Components of total cost include private and public production costs, environmental costs, and user costs. The energy efficiency of each development approach is also of key concern and needs to be determined by considering energy inputs associated with all aspects of the approach. Finally, the long- and short-term energy supply stability is an important factor when evaluating the desirability of any of these development approaches.

While all of the energy approaches listed above are technically possible, their relative economic feasibility and social desirability have not been demonstrated. Based on examination of these alternatives, several general observations are noted:

- The quality and quantity of energy which could be produced from peatlands has not been identified. Nor has the market value of this energy been established. Thus, the profitability of any of these approaches has yet to be demonstrated. Those private efforts now underway have been heavily subsidized through public expenditures and for that reason do not necessarily indicate that peatland development for energy will be profitable.
- At present there is no reason to believe that it is not technically feasible to utilize either peat or biomass to produce energy through direct burning, gasification, liquefaction, or briquetting or pelletizing for combustion. However, economic factors will probably determine the forms of energy which

can practically be produced and used.

- Current industry and government proposals for deriving energy from the state's peatlands are geared almost exclusively to large-scale peat gasification. To a much lesser degree, gasification of energy crops is also being considered. This focus on gasification is somewhat puzzling in light of the fact that the major energy-supply problems for the country and the state are related to decreasing supply and increasing prices of liquid fuels. Moreover, Minnesota has given little attention to the direct combustion and briquetting approaches, despite the fact that these have been traditional uses of peat elsewhere in the world.
- The total cost associated with each approach has not been identified.
- Estimates of the energy efficiencies of the various approaches have been summarized in this chapter. The net-energy values of the approaches that involve peat extraction depend in part on the particular mining method used, with sod peat mining offering the highest pre-conversion energy efficiency. Hydraulic mining has a significantly lower net energy value. Gasification, cogeneration, and district heating all have similar net energy values, while briquetting is significantly more energy efficient.
- Growing energy crops, using peatlands as a renewable resource, provides significantly longer-term supply stability than all extractive approaches.

Examining the Impacts

Any proposal to develop a part of Minnesota's peatlands for energy should be assessed in terms of its economic, social, and environmental effects. These effects and how they occur in a particular situation will depend on the nature and scale of a specific project and its particular location in the state. The nature of a project is defined by the energy technologies and related activities associated with it. The scale of a project is its size in relation to other possible development approaches. The location provides the economic, social, and environmental context in which the development project is to occur.

The table on page 4 outlines the particular economic, social, and environmental impacts related to the nature and scale of a project. The degree to which these impacts are positive or negative de-

The Economic, Social and Environmental Impacts Related to the Nature and Scale of a Development Project.

ECONOMIC IMPACTS

Jobs and Workers

- number of new jobs created
- specific skills required of the labor force
- mix of local and imported workers

Economic Stability

- long- and short-term stability of economic activity in the region
- number of jobs which are seasonal or temporary

Public and Private Services

- commercial and industrial networks needed to provide goods and services to the development project
- public services demanded by the development project
- public and private services demanded by development-induced population growth
- time required to make services available to the population.
- ability of government to assume the costs of providing public services

Local Economies

- range of goods and services available
- degree to which commercial enterprises are locally owned and operated
- changes in cost of living

SOCIAL IMPACTS

Jobs and Workers

- stability of employment in affected communities
- variety of skills, education and background of workers
- mix of local and imported workers living in surrounding communities

Communities

- rate of economic and social change in affected communities
- ultimate size and character of affected communities after development occurs
- ability of affected communities to absorb changes in size and character
- mix of new and original residents
- diversity of religious practices
- range of social opportunities
- degree to which traditional lifestyles are disrupted
- changes in local politics and government

ENVIRONMENTAL IMPACTS

Land

- character and extent of land disturbance

Water

- potential changes in the quality of ground and surface waters
- degree to which such changes can be geographically contained

Air

- character and extent of air pollution
- degree to which pollutants can be geographically contained and technically mitigated or prevented

Wildlife

- potential alterations to native fish and wildlife habitats

Workers

- potential hazards to the health and safety of the labor force

Reclamation

- method of reclaiming mined land and the degree to which it can be restored to a usable state following peat extraction pends in part on the characteristics of the particular areas where a project is located.

Anticipating the potential economic, social, and environmental implications associated with the nature and scale of a project is essential for locating a project in a geographic area which can best accommodate those impacts. Such anticipation also makes it possible to plan for minimizing or preventing detrimental impacts. When a project is sited in an area that cannot accommodate such development, the following detrimental impacts can occur:

- Development which is rapid and nonorderly and therefore disruptive to existing social and economic systems.
- Reliance on imported rather than the local work force.
- Excessive demands or burdens on existing service networks.
- Budget shortfalls in local governments due to increased expenditures for public services.
- Increases in the cost of living due to rising demand for goods and services.
- Inadequate supply and increased prices of housing.
- Disruption or displacement of local commerce.
- Environmental impacts which cannot be contained, mitigated, or prevented.

Development of Minnesota's peatlands for energy could enhance the state's economic and energy situations. However, development plans and state policies designed to realize those potential benefits must reflect careful consideration of the energy, economic, social, and environmental implications of peatland development.

The factors of <u>nature</u>, <u>scale</u> and <u>location</u> will influence whether a peatland development project will be of social and economic benefit. The desirability of a particular energy development approach will depend on the quality and quantity of energy it produces, its value in the market, its cost and energy efficiencies, and its ability to contribute a stable supply of energy to Minnesota, especially over the long term. In this regard, growing energy crops provides an apparent advantage over extractive approaches, particularly because it produces renewable energy. However, the economic feasibility of any energy approach has yet to be demonstrated in Minnesota.

Appropriate scale is defined not in terms of absolute size, but by the ability of a particular project to provide economic and social benefits and minimal detrimental impacts in a specific location. The suitability of any location will depend on the nature and scale of the project planned as well as the characteristics of the site. Some locations will be inadequate for large-scale projects because they cannot absorb the economic, social, and environmental changes that development will bring. In such locations, smaller scale projects are more appropriate.

LEGAL AND REGULATORY FRAMEWORK

Because Minnesota has very little experience with peat development, peat is not specifically cited in most state laws governing mineral extraction or land use. Nevertheless, a panoply of federal, state, and local laws and regulations have general applicability to peatland development. Because peat is not a mineral or a traditional energy source in this country, and because peat extraction is not quite like any other surface use such as agriculture or forestry, the status of peat in this regulatory framework is often unclear.

Research and Development Funding

The federal government's commitment to synfuels has caused peat research and development to focus on large-scale gasification instead of small-scale, renewable uses. There is a need for a broader research focus which state efforts could help fill.

Peatland Development Policy

No level of government has adopted an explicit peat policy. Minnesota is in need of a general policy towards peatland development which integrates goals related to energy, agriculture, economy, and environment.

Land Use and Transfers

Different types of landowners can make peatlands available in different ways. Although the law is unclear, use of peat is generally considered a right of surface ownership and is not included in mineral rights. The state, which owns the largest portion of peatlands, may not sell peatlands but may lease them with the approval of the Executive Council. A wide variety of local planning and zoning authorities may influence decisions to use peatlands.

Certificate of Need and Site Selection

The Certificate of Need for major energy facilities would apply to major peatland developments for energy purposes.

Water Conservation and Drainage

An extremely complex and confusing regulatory structure exists for decisions relating to water use and drainage. Interpretation and coordination will be required to determine how peatland use will fit into the existing framework of laws.

Mining and Reclamation

A major gap in the current regulatory scheme is that no federal or state mining or reclamation laws are written to include coverage of peat mining.

Environmental Regulation and Studies

State and federal laws regarding protection of air and water quality and preparation of environmental impact statements are adequate and appear to apply to peatland development. However, some coordination between the various agencies involved is needed.

Taxation

There are several different taxation methods which should be considered if peatland development is to occur. They include production, occupation, property, and income taxes. In addition, methods of distributing tax revenues must be evaluated to assure fair disbursement to various governmental levels.

Social and Economic Development

Many agencies at federal, state, regional, and local levels of government may be concerned with the social and economic effects of new peatland development. Again, coordination is required to assure comprehensive but not duplicated efforts.

Legal and Regulatory Options

There are three general approaches Minnesota could take in administering decisions about peatland development. Option #1 would retain the current system but would clarify the ambiguities and fill the regulatory gaps as outlined above. Option #2 would continue emphasis on private initiative but provide for coordination of state regulation. It would create a mechanism for state and local government agencies to work together to simplify the peat decision-making process. Option #3 would create a new public-private structure. A public corporation could be given a range of powers, essentially allowing the state to be more directly involved in initiating the kind of peat development that would be most beneficial in the long run. Because peat could play such an important role in

Minnesota's energy, employment, and economic future, and because of the extent of public interest in this predominantly public-owned resource, a creative new structure may be desirable.

Public Involvement

Minnesota citizens will want to be involved in decision-making about the future of the state's peatlands. While Minnesota's regulatory structure allows substantial formal involvement in specific permit processes, broad public input regarding basic policy directions is much more difficult to achieve.

I. MINNESOTA'S PEATLANDS: CRUCIAL DECISIONS AHEAD

Minnesota contains some of the most extensive peatlands in the United States. Most of this 5.9 million-acre resource belongs to the public: approximately 61 percent is owned by state, federal, or county governments (Anderson November 1980). Although most of these lands are as yet underdeveloped, interest in utilizing them for energy has escalated during the past five years. This interest has been generated by projected shortages and increased prices of traditional energy supplies as well as the possibility that peatland development could improve the economy of northern Minnesota.

Among those demonstrating interest in the development of Minnesota's peatlands are Minnesota Gas Company (Minnegasco), Northern Natural Gas, Minnesota Power Association, United Power Association, Control Data Corporation, and business people interested in small-scale briquetting.

The United States Department of Energy (U.S. DOE), which has had a strong commitment to developing synthetic fuels, has taken an interest in Minnesota's peatlands and has contributed to a major research and development effort for application in Minnesota. The Minnesota Energy Agency (MEA) is also committed to the development of Minnesota-based sources of alternative energy. At present, the MEA apparently prefers using Minnesota's peatlands as a medium for growing energy crops such as cattails and willows, rather than for peat extraction.* This renewable use of Minnesota's peatlands would produce plant material which can be converted to fuel in various forms.

Citizen groups interested in the environmental implications of peat development are particularly concerned that steps be taken to identify and protect from development those peatlands with geologically or biologically unique characteristics. Organizations showing interest include the Minnesota chapters of The Nature Conservancy, the Isaak Walton League, the Sierra Club, the Audobon Society, Defenders of Wildlife, Minnesota Public Interest Research Group, and Clear Air - Clear

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* Conversations with Ronald Visness, Assistant Director of Alternative Energy Development and Ronald Rich, Manager of Alternative Energy Projects, 1980.

Water Unlimited.

This burgeoning interest indicates that portions of Minnesota's peatlands--perhaps significant portions--will be seriously considered for development over the next several decades. According to Ronald Visness of the Alternative Energy Development Division at the MEA, "it's not a question of whether we use the peatlands, but how we use them..." (CURA Peat Policy Panel Meeting of October 15, 1980).

Until now, most peat research has focused on the technical aspects of development, particularly on technologies for converting peat to fuel. There is no doubt that this research is essential if peatland development for energy is to go forward. However, it is also important to examine the broader implications of peatland development, particularly in these early stages when policy decisions can be made before development begins.

Minnesota may soon embark on widespread peatland development despite the fact that many aspects of Minnesota's peatlands and their development are not well understood. There is much to be learned about the biological, geological, and hydrological characteristics of Minnesota peatlands and the effects that development may bring about. Some of the techniques being considered have been used extensively in European countries. Others--particularly peat gasification and the production and conversion of energy crops--have not been widely used and are not well understood. In addition, the socio-economic analyses of peatland development done so far are at best preliminary. Site and scale analyses of development implications have not yet begun.

For all these reasons, the need to carefully consider all implications of Minnesota peatland development cannot be overemphasized. This is a cautious but necessarily prudent approach; hastily formulated industry decisions or narrowly considered public policy can produce serious ramifications.

Several important considerations should be made as Minnesota moves forward in developing its peatland resource.

- As an energy-dependent state, Minnesota is faced with shortages of traditional sources of energy and rising energy prices, particularly for oil. Unless Minnesota can either reduce its demand for energy or increase its supplies of alternative energy, the state may face severe economic hardships. While these hardships will fall on all Minnesotans, they could be especially burdensome for residents of particular regions of the state and for lower-income people and those on fixed income.

- The length of time that Minnesota's peatlands can provide energy will depend in large measure on the kind of development that occurs, particularly on whether renewable or nonrenewable approaches are used.
- Some hope that development of the state's peatlands could improve the economic health of portions of the state, particularly on the Iron Range. If decisions to promote economic activity through peatland development are to be effective, they must be based not only on the levels of increased economic activity that are possible but also on the nature and location of new industrial and commercial growth, prospects for long- and short-term employment stability, efficient use of the natural resource base, and the effects of development on existing public and private service networks. Dramatic increases in economic activity--depending on where and how much development occurs--can cause shortages of public and private services and disrupt the economic and social character of communities. Radical increases in development are difficult for most communities to absorb.
- The state's government and businesses are faced with the responsibility of formulating decisions that could permanently affect millions of acres of heretofore undeveloped land. Some of these landscapes are unique, and decisions made by government or industry could alter or destroy their character forever.

Obviously, decisions made in the next few years will have serious long-term consequences for Minnesota and its people.

II. PEAT AND PEATLANDS: WHAT CAN BE USED?

WHAT ARE PEATLANDS?

"Mires," "moors," "muskeg," "swamps"--these are names for the terrain generally known as peatlands. They are lands of peat, the dead and partially decomposed plant material which accumulates in wet environments that inhibit decomposition of organic matter. Peatlands continually collect organic material slowly expanding both in surface area and depth.

Peatlands are found world-wide, but the largest concentration is in arctic and subarctic regions, areas with short, cool and moist summers favorable for peatland formation (U.S. DOE 1979, p. 13). Some peatlands do exist in the lower latitudes, but they are concentrated around rivers, river deltas, coastal regions, and rain forests. Figure 1 demonstrates the distribution of the world's peatlands.

Peat is sometimes called "organic soil" or "young coal." Although coal was at one time similar in composition to peat, it was physically and chemically transformed after being buried under sedimentary rock and subjected to heat and pressure from movement in the earth's crust. Most lands that produce peat, including Minnesota peatlands, will never experience those special conditions and so will not produce coal.

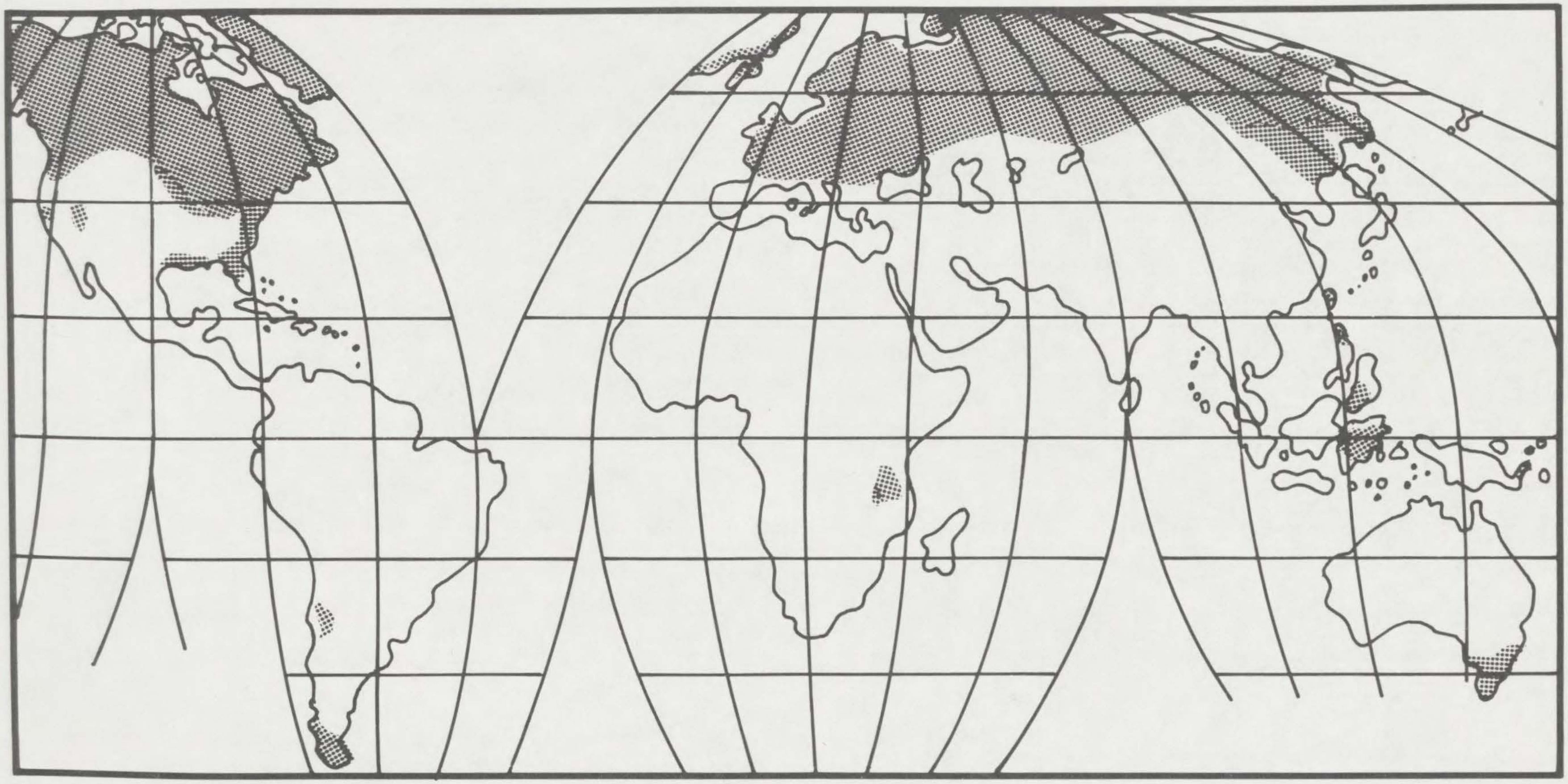
Peatlands are formed in two ways: one process is called "lakefill," in which organic and inorganic materials in the water collect on the bottom of a lake. At the same time, sedges begin to grow around the edge of the lake basin. As these die and decompose, peat fills in the basin until the lake disappears (see Figure 2) (Olson et al. 1979, p.7).

Peatlands can also be formed by a process called "paludification," in which organic material begins to accumulate in the lake areas of a flat, poorly drained surface. The accumulating peat causes the water table to rise, and the peatland spreads ourtward and upward over the landscape (see Figure 3). Peatlands originally formed by lakefill can spread by paludification, if the lake is surrounded by flat, poorly drained land.

Minnesota's peatlands developed in the broad, gradually sloping glacial lake basins and outwash plains formed 10,000 years ago by the retreat of the Wisconsin Ice Sheet. Minnesota's most exten-

Figure 1

World Peatlands



▒ PEATLAND

(Adapted from U.S. Department of Energy. Division of Fossil Fuel Processing. 1979. *Peat Prospectus.* Washington, D.C.: Department of Energy. p. 15.)

Figure 2. Lakefill Process

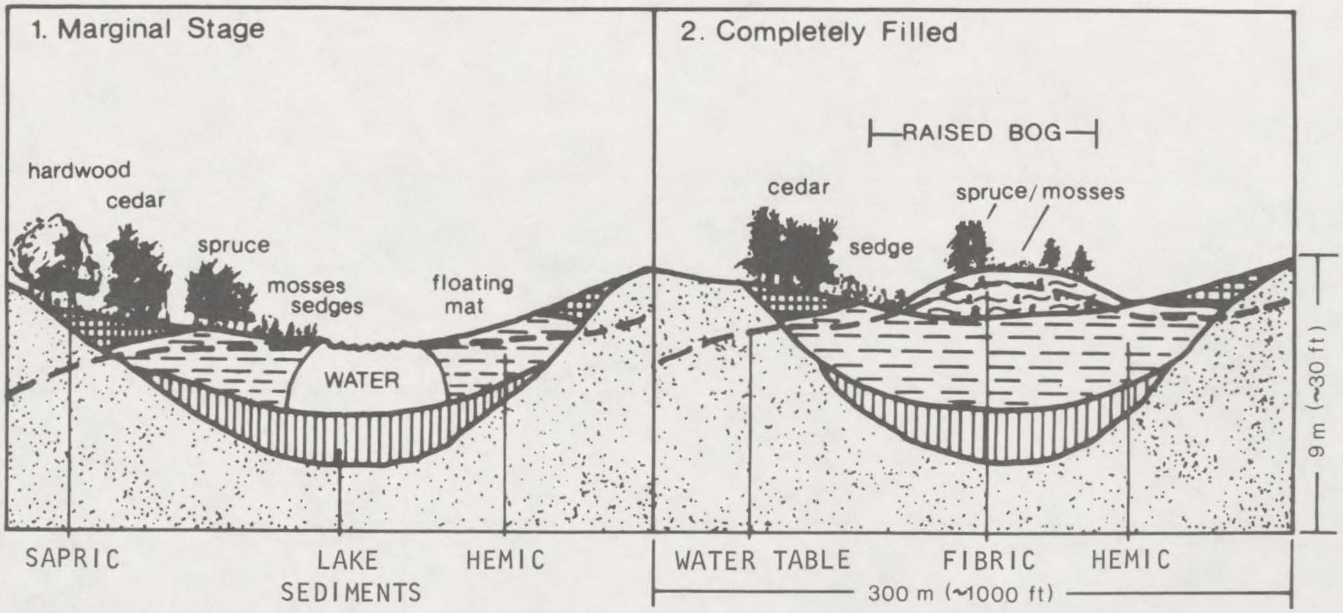
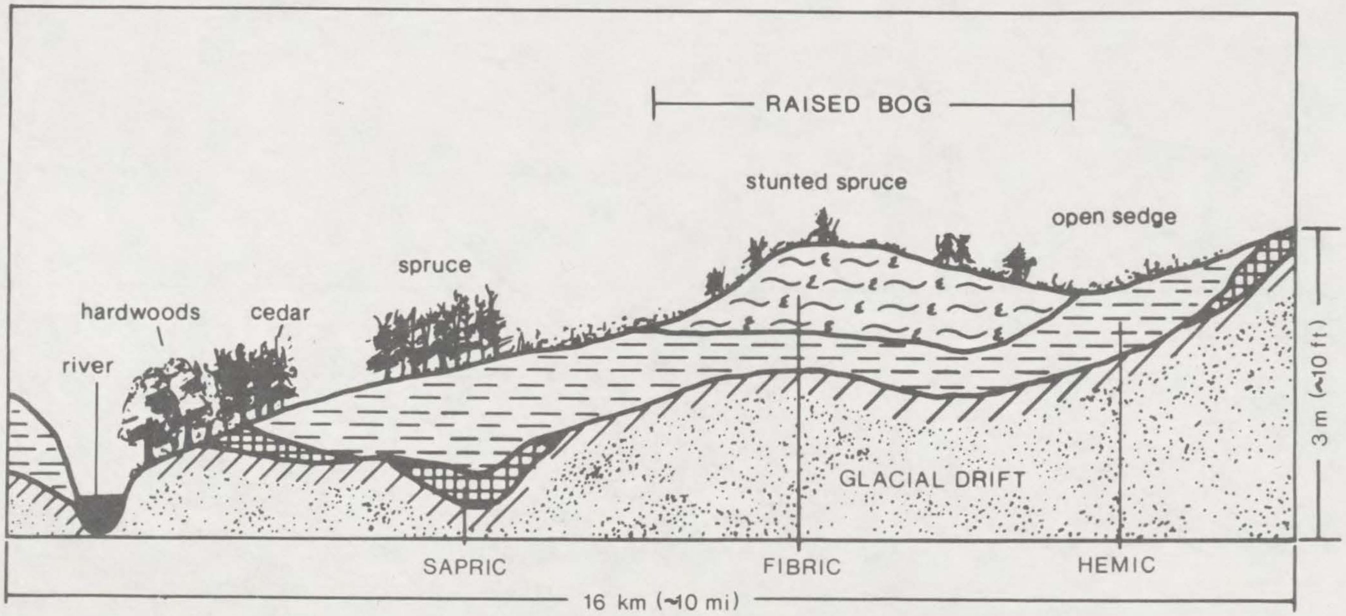


Figure 3. Paludification Process



Lakefill peatland formation in east central Minnesota.

sive peatlands lie in portions of former glacial Lake Agassiz in the counties of Roseau, Lake of the Woods, Beltrami and Koochiching. Major peatlands are also found in southwestern St. Louis and northern Aitkin counties in the abandoned beds of former glacial Lakes Upham and Aitkin. Significant peatlands are also located in northwestern Carlton and southeastern Aitkin counties. Smaller, isolated peatlands are found throughout the rest of Minnesota (Midwest Research Institute December 1976, p. 51). The map in Figure 4, produced by CURA for the University of Minnesota's bioenergy research program, shows the distribution of peatlands and wet mineral soils in Minnesota.

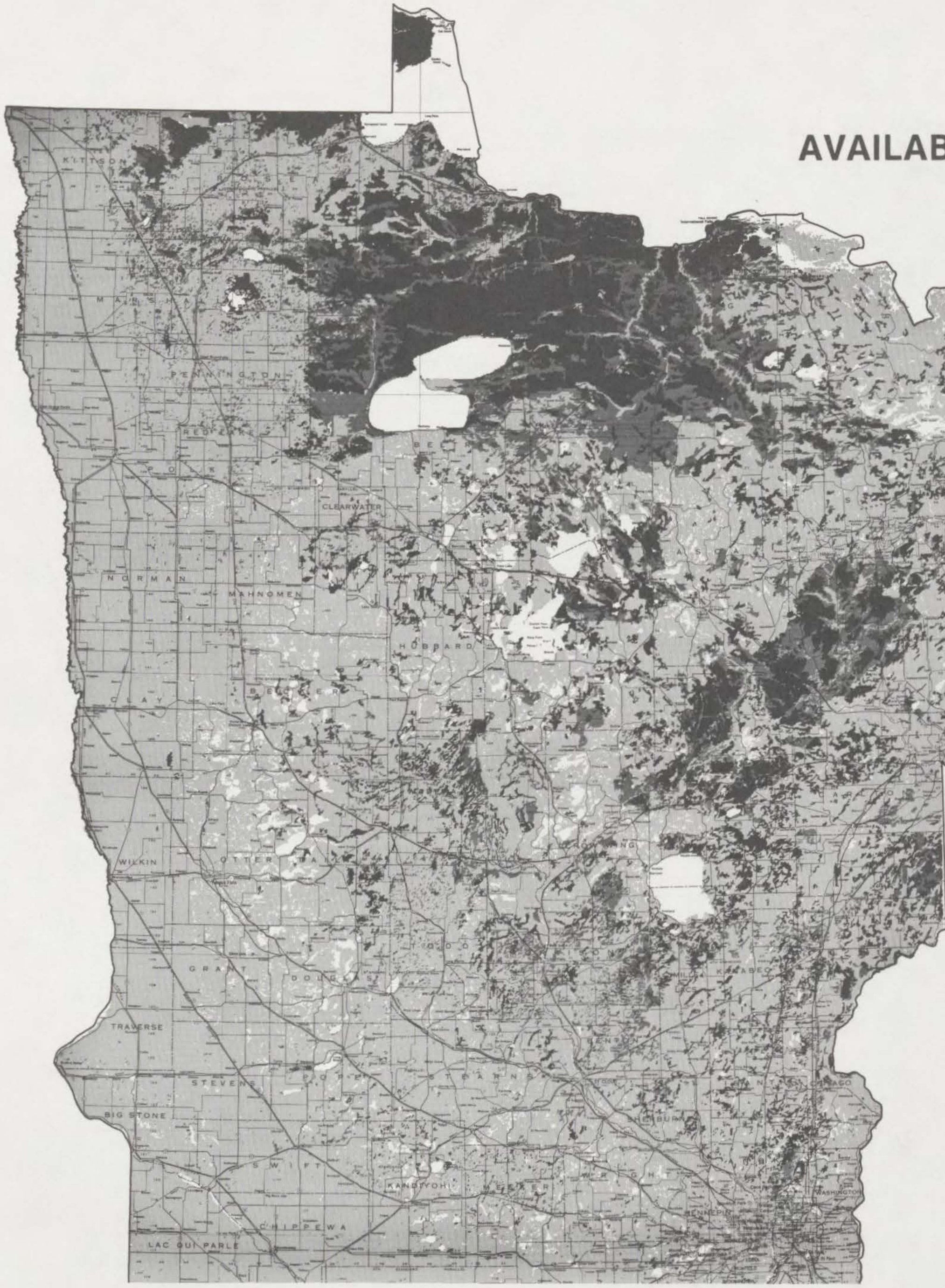
Two basic types of peatland are found in Minnesota. Bogs have a slightly convex surface of vegetation that is dependent on precipitation rather than the ground-water system for its water and nutrient supply. Also called ombrotrophic bogs, their vegetation includes spruce, tamarack, heath shrubs and sphagnum moss.

Minerotrophic fens, on the other hand, are flat peatlands. They are wetter than raised bogs because their water and nutrient supply comes from both precipitation and the groundwater system. Their vegetation consists mainly of sedges, grasses, swamp birch and willow (Midwest Research Institute December 1976, p. 51).

In addition to the bog and fen and transition peatlands containing characteristics of both, other peatlands types are also found in Minnesota. They include the slightly raised islands of sphagnum on which stunted spruce and tamarack grow, as well as

Figure 4

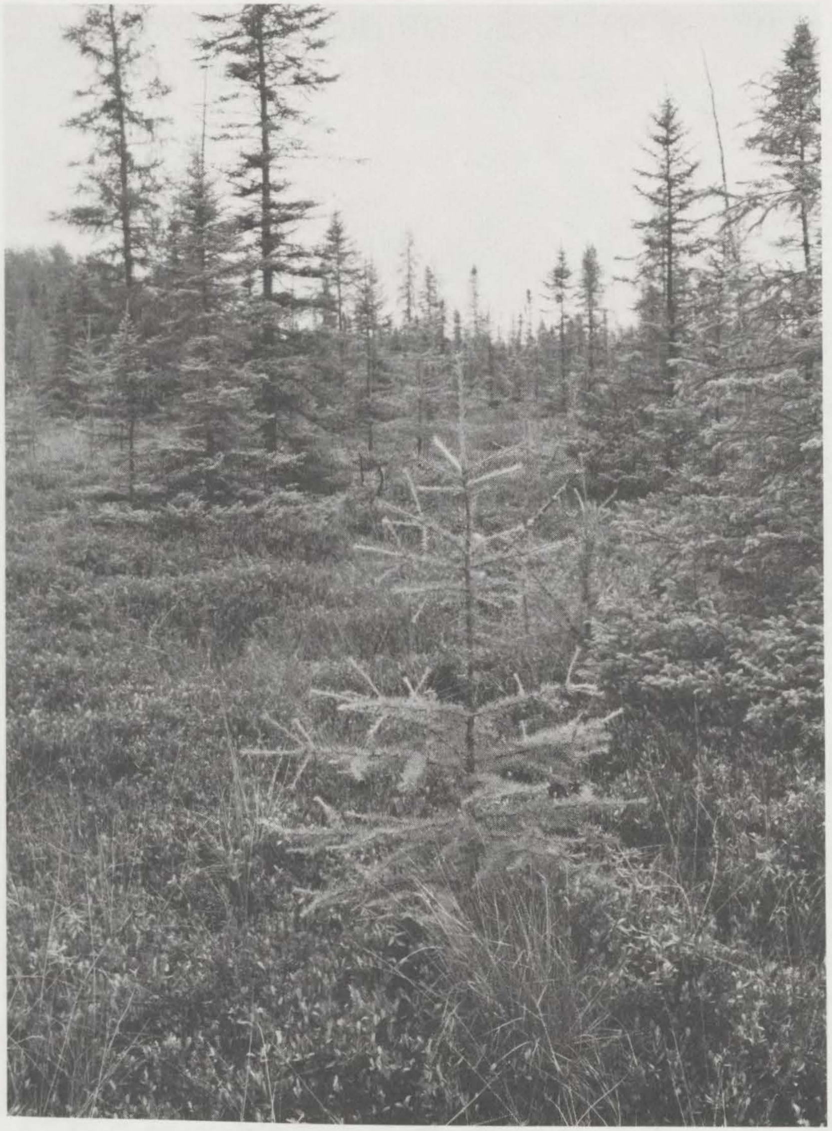
AVAILABLE WETLANDS FOR BIOENERGY PURPOSES
Land Use and Drainage Constraints



LEGEND

A consideration of current land use determined availability. Available wetlands have the following uses: open pasture, marsh or forested. Open pasture lands are excluded in regions of the state where agricultural drainage is common.

- Available peats
- Available poorly drained mineral soils
- Other soils, drained lands and pre-empting land uses
- Water



Vegetation such as black spruce, tamarack and heath shrubs are found on this typical east central Minnesota ombrotrophic bog.

islands, ridges, and peninsulas of mineral soil which support terrestrial vegetation. Some peatlands bear "water-tracks," flat sedge areas that carry surface water from exposed mineral soils downslope toward the headwaters of streams. In some places, these water-tracks are constricted by raised bogs, stunted spruce islands, or upland mineral soil. Where this occurs, the fen develops a series of pools and ridges perpendicular to the direction of the surface-water flow. These are the "patterned fens" of northern Minnesota peatlands (Midwest Research Institute December 1976, p. 51-52).

Peat deposits have formed over thousands of years, collecting at an estimated rate of one to two millimeters per year (U.S. DOE 1979, p. 11). Peat varies in age, degree of decomposition, and appearance. While the development of peat is not regular or its pattern consistent, its characteristic pattern is described below. On the surface of raised bogs is the yellow fibric peat (sphagnum moss), the youngest and least decomposed layer. Its plant constituents are visible in this material. Beneath that is the brown hemic (reed-sedge) peat which, being older, is more decomposed; much of the texture of the original plant material is still discernible in the hemic layer. At the bottom is

Sedges, reeds and stunted spruce are found on this flat <u>minerotrophic fen</u> in north central Minnesota.

the oldest and most decomposed layer, sapric peat. Its plant constituents are decomposed beyond recognition, resulting in a blackish-brown product.

RESOURCES AND RESERVES

It is important to distinguish between acres of peatland resources and commercial reserves. Estimates of peatland resources are based on total acreages of peatland without regard to anticipated constraints on their commercial development. Estimates of commercial reserves, on the other hand, are based on acreages available under a set of known constraints for particular commercial uses. Commercial viability depends not only on estimated surface area, but also on many other factors: the depth and quality of the peat, the size of the peatland, environmental limitations, ownership, transportation networks and necessary public and private service systems needed to support adjacent economic expansion. Thus, while Minnesota's peat resource is presently estimated at 5.9 million acres, its commercial reserves for particular uses is much less and currently unknown.

Table 1 represents a commonly-used estimate of world peat resources. The 408.8 million acres of peatland represent only about one percent of the world's surface, yet large portions of the surface area of some countries, such as Ireland and Sweden,

Table 1: World Peat Resources

Country	Acres (Millions)	Percent of World Total
Soviet Union	228.0	55.8
United States*	52.6	12.9
Finland	35.6	8.7
Canada**	34.0	8.3
East & West Germany	13.1	3.2
Sweden	12.7	3.1
Poland	8.6	2.1
Ireland	7.3	1.8
Great Britain	5.8	1.4
Indonesia	3.3	.8
Norway	2.6	.6
All Others	5.2	1.3
Total	408.8	100.0

*Estimate includes non-permafrost peatlands of Alaska.

**Estimate does not include arctic Canada peatlands.

(Data from U.S. Department of Energy Peat Prospectus July 1979, p. 14) are completely covered by peatlands (U.S. DOE 1979, p. 15). More than 55 percent of the world's peatlands lie within the Soviet Union's borders. The United States ranks second, with almost 13 percent.

Figure 5 and Table 2 identify the distribution of the United States' peatlands. With 27 million acres, Alaska accounts for more than 50 percent of U.S. peatlands. Minnesota ranks second with 5.9 million estimated acres, and Michigan, Florida, Wisconsin and Louisiana also have large amounts of peatlands.

Traditional estimates of peat resources in Minnesota have ranged between 7 and 7.6 million acres. These estimates have been based on county and regional soil surveys, a limited amount of field-work surveying, and other sources.

A recently compiled estimate using data from the Minnesota Soil Atlas has yielded what appears to be the most accurate figures to date. The Center for Urban and Regional Affairs as part of the University of Minnesota's bioenergy research program and using the Minnesota Land Management Information System, has calculated the state's total peat resource at 5.91 million acres, 15 to 22 percent less than was previously estimated (Anderson November 1980, p. 8). Many of the very small peat deposits are not included in this estimate, since the computerized system is based on 40-acre parcels. It is believed, however, that these small deposits would not add a significant amount to the state's total peatlands. Figure 4 represents the distribution of Minnesota's peatlands based on the results

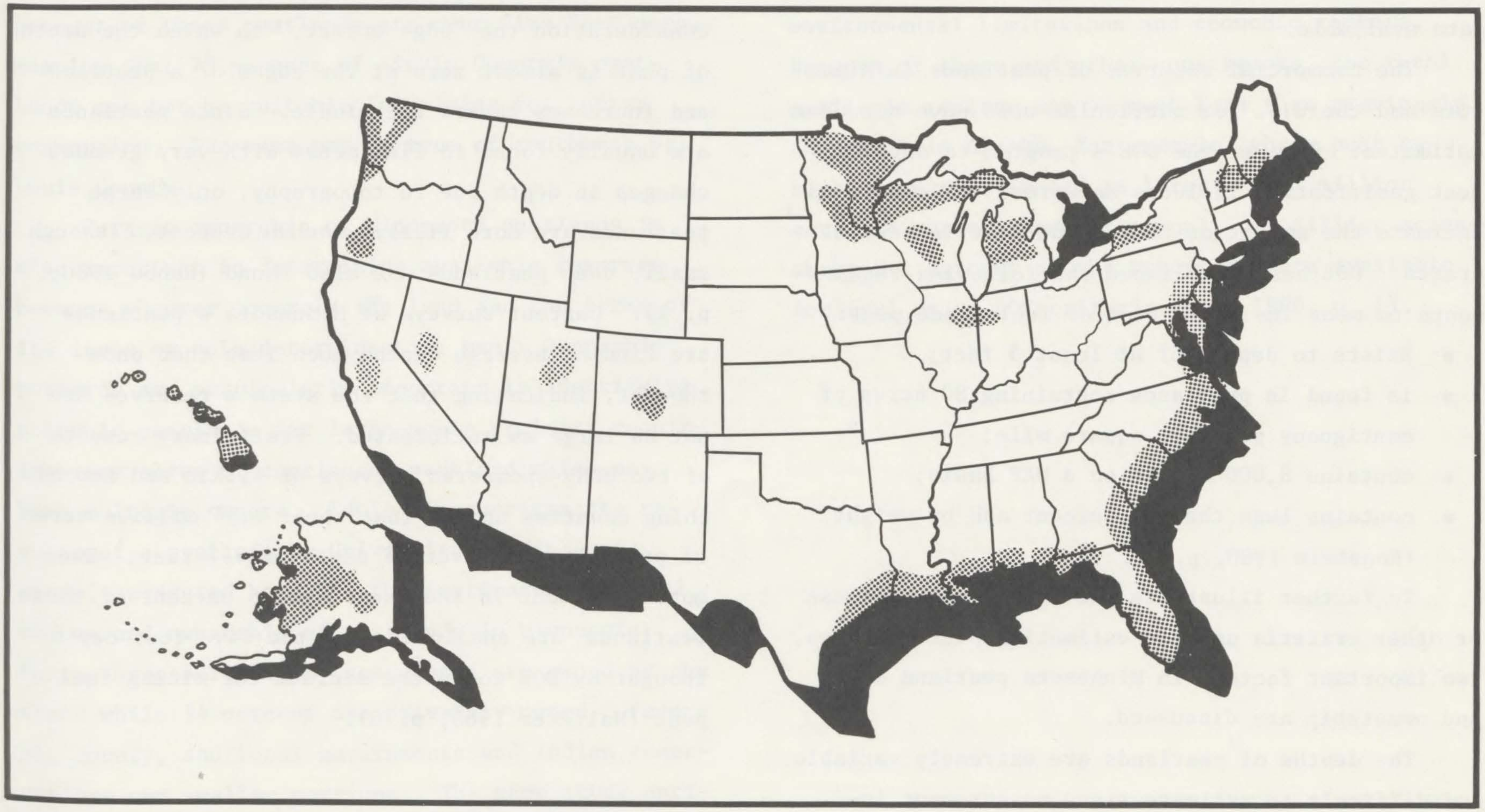
Table 2: U.S. Peat Resources

State	Acres (Millions)	Percent of U.S. Total
Alaska	27.0	52.6
Minnesota	5.9	11.5
Michigan	4.5	8.8
Florida	3.0	5.9
Wisconsin	2.8	5.5
Lousiana	1.8	3.5
North Carolina	1.2	2.3
Maine	.77	1.5
New York	.65	1.3
All Others	3.66	7.1
Total	51.28	100.0

(Data from Punwani, D.V. Peat as an Energy Alternative: An Overview. Paper read at IGT Symposium "Peat as an Energy Alternative," 1-3 December 1980; Anderson, J.P. An inventory of Minnesota's wetlands and their suitability for producing bioenergy crops. November 1980)

Figure 5

Peatlands of the United States



PEATLAND (Adapted from U.S. Department of Energy. Division of Fossil Fuel Processing. 1979. *Peat Prospectus*. Washington, D.C.: December of Energy. p. 13.)

of this computerized study. This map and the associated data are the most up-to-date estimate, derived from what appears to be the best methods and data available.

The commercial reserves of peatlands in Minnesota and the U.S. for particular uses have not been estimated. However the DOE's program to develop peat gasification includes an effort to locate and estimate the amount of fuel-grade peat in several states. DOE has established the following requirements to meet its definition of fuel-grade peat:

- Exists to depths of at least 5 feet;
- is found in peatlands containing 80 acres of contiguous peat per square mile;
- contains 8,000 BTU/lb on a MAF basis;
- contains less than 25 percent ash by weight (Kopstein 1980, p. 3).

To further illustrate the importance of these or other criteria used in estimating peat reserves, two important factors in Minnesota peatland depth and ownership are discussed.

The depths of peatlands are extremely variable and difficult to estimate since measurement involes taking core samples or using ground-penetrating radar scans. Rough estimates have assumed a depth of five to seven feet in determining the volume of peat in a specific peatland but depths can range from less than one foot to over 20 feet. In measuring depth, it is important to take into consideration the "edge effect," in which the depth of peat is almost zero at the edges of a peatland and increases toward the middle. Since peatlands are usually found in flat areas with very gradual changes in depth due to topography, only large peatlands are more likely to be the deepest, although small, deep peatlands are also found (Hobbs 1980, p. 1). Current surveys of Minnesota's peatlands are finding average depths much less than once thought, indicating that the state's reserves are not as large as anticipated. Preliminary results of two MDNR-sponsored surveys of Aitkin and Koochiching counties showed that their 1.14 million acres of peat* have an average depth of 4.7 feet. Even more important is the fact that 65 percent of those peatlands are shallower than the five-foot depth thought by DOE to be the minimum for mining fuel peat (Malterer 1980, p. 6).

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*This is different from an estimated 972,000 acres of peat found in the CURA study. This difference represents 15 percent fewer acres for Koochiching County.

Aitkin County was estimated to have 390,000 acres of peatlands (Malterer 1980, p. 6). Preliminary results of the survey indicate that only 25 percent of these peatlands are over five feet deep, meaning that 75 percent of Aitkin County's peatlands may not be suitable for mining for energy conversion. The same may be true of southwest St. Louis County.

Current ownership of Minnesota peatlands is also important in determining available reserves because whoever controls the land and the terms of its lease or sale determines its use. Ownership patterns are particularly important in identifying suitable peatlands for large-scale projects requiring many acres of contiguous peatland which may have multiple owners. Table 3 summarizes the results of a preliminary University of Minnesota study, conducted by CURA, that estimated the total amount and ownership of peatlands in Minnesota. Forty-three percent of these lands are owned by the state while 34 percent are privately owned. Federal, county, and local governments and Indian reservations own smaller portions. The same study estimated that approximately 35 percent of the peatlands available or suitable for energy development are state owned--not 90 percent as some individuals have claimed (Anderson November 1980, p. 13). This preliminary estimate is based only on land use constraints without regard to peatland characteristics, environmental limitations and economic factors. Because of these and other constraints, the total available reserve may be much less than previously thought. In Alaska, for example, where peat resources were estimated as large as 107 million acres, a survey showed that only 5.5 million acres--about 5.1 percent of the resource--were available for fuel using DOE criteria (Huck 1980, p. 1).

Table 3: Minnesota Peat Resource by County and Ownership

County	Federal	State	County/ Local	Indian	Private	Total
Aitkin	9,000	228,000	81,000	*	127,000	445,000
Carlton	*	30,000	25,000	3,000	40,000	99,000
Itasca	32,000	112,000	56,000	1,000	60,000	261,000
Koochiching	38,000	757,000	60,000	32,000	86,000	972,000
St. Louis	104,000	198,000	250,000	2,000	198,000	751,000
Lake of the Woods	24,000	296,000	*	70,000	36,000	426,000
Beltrami, Clear-water, Hubbard	19,000	411,000	53,000	175,000	124,000	782,000
All Other Counties	237,000	508,000	90,000	7,000	1,331,000	2,174,000
Total	463,000	2,540,000	615,000	290,000	2,002,000	5,910,000
Percent of Total	7.8	43.0	10.4	4.9	33.9	100

*less than 1,000 acres

(Data from Anderson, J.P. An Inventory of Minnesota's wetlands and their suitability for producing bioenergy crops. November 1980)

III. PEATLAND UTILIZATION: MINNESOTA'S OPTIONS

In the United States, most peatlands have been viewed as "wasteland," remote, wild, difficult and expensive to exploit. In part, this is because the fuel, chemicals, food, and timber that peatlands might supply have been produced cheaply enough elsewhere. However, as supplies of certain natural resources, particularly fossil fuels, have diminished and become more expensive, the United States and other countries have taken a new look at development of peatlands.

There are three basic land-use categories for peatlands: a) extraction of nonrenewable resources, b) production of renewable resources, and c) peatland preservation. (See Figure 6).

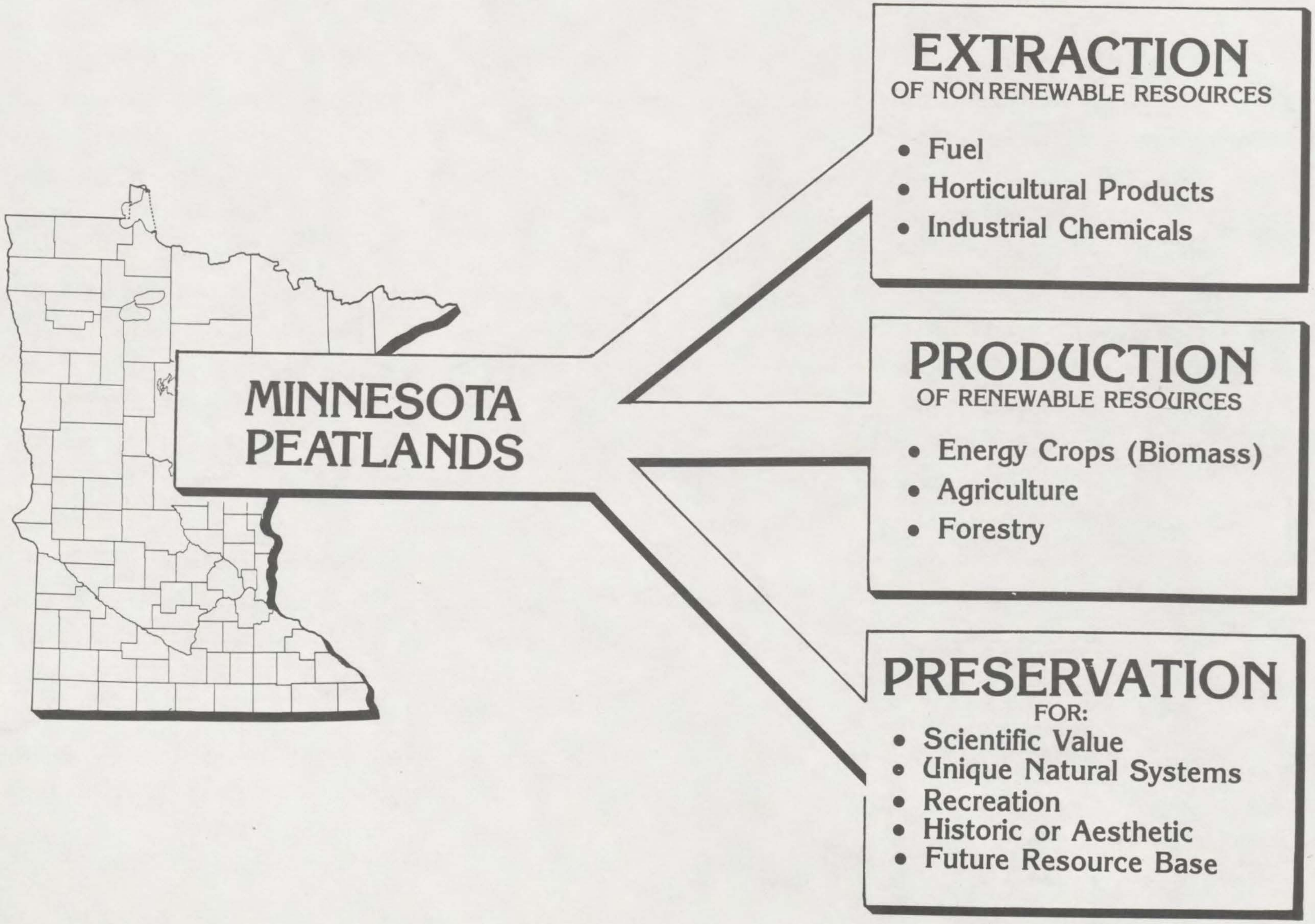
EXTRACTION OF A NONRENEWABLE RESOURCE

Fuel

Peatlands have been a source of fuel for heating and cooking for hundreds of years, dating back at least to Roman times. Peat has been used in Europe and Scandinavia for many years, but was first used on an industrial scale in the Soviet Union in the early 1900s. About 35 years ago Ireland rapidly expanded its use of fuel peat. Then, as energy prices increased, other nations, including Finland, Sweden, Greece, Canada, and the United States, planned or initiated fuel peat development projects (Midwest Research Institute, May 1976, p. 29).

Peat extracted from a peatland can be used as a fuel in a variety of forms. It can be 1) burned directly to produce process heat or electricity with or without steam heat, 2) gasified to produce methane, 3) liquefied to produce alcohol, and 4) briquetted or pelletized to be burned for home or industrial heat. Peat used as a fuel is typically dried to a moisture content of about 50 percent (Tsaros December 1980, p. 2), giving it a heating value of about 4500 BTU's per pound (EKONO October 1977, p. 9). This heating value is substantially less than that of the North Dakota lignite and western subbituminous coal now used in Minnesota. A detailed discussion of these uses of peat for fuel is contained in Chapter IV.

Figure 6 ALTERNATIVES FOR UTILIZATION OF PEATLANDS

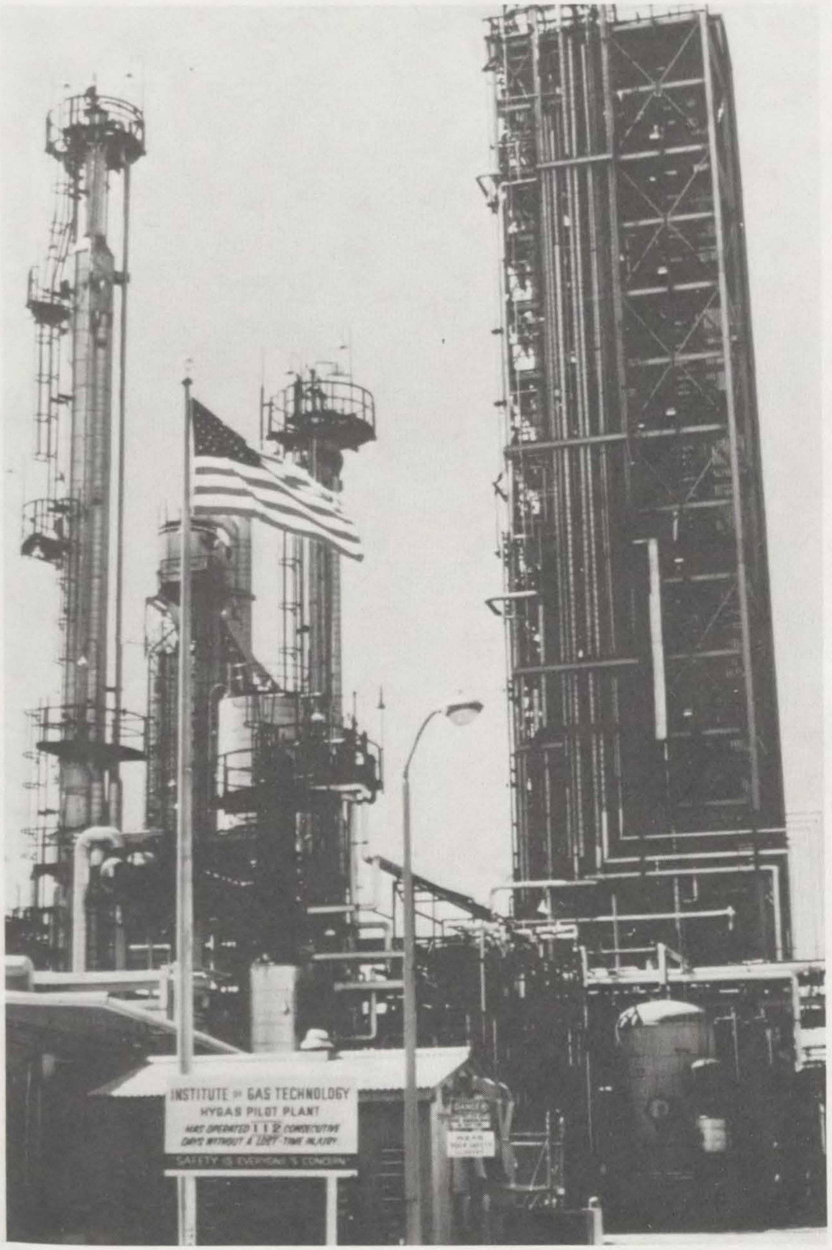


Horticultural Products

Peat can be used as a soil conditioner, as a growing medium for plants and nursery stock, and as an additive to potting soil. Minnesota has an estimated 100,000 acres of sphagnum peat (Anderson November 1980, p. 8) and over one million acres of reed-sedge peat (MnDNR April 1979a, p. 102), both of which have commercial value for horticulture. However, only about 1400 acres of Minnesota's peatlands, representing just .02 percent of the state's total peatland resource, have been developed for these uses. Most of this development is in Aitkin, Itasca, and St. Louis counties (MnDNR April 1979a, p. 101).

A number of conditions affect the viability of extracting peat for horticultural purposes: accessibility, drainage, climate, the depth and quality of the peat, and the availability--depending on ownership--of the peatlands.

To utilize peat for horticulture, the peatland must be prepared for extractive use--cleared of trees and brush and, depending on the mining method, ditched for drainage. The peat is then mach-



Government-owned gasification research facility at the Institute of Gas Technology in Chicago.

Sphagnum moss, used in such horticultural products as soil additives and potting soil.

ine-cut or extracted with the vacuum technique of milled peat and then collected. It can also be mined hydraulically--cut away with a high-pressure hose or dredged--and then transported by a peat slurry pipeline. After the peat is extracted it is dried or dewatered and packaged in bags or bales.

Despite their vast peat resources, the United States and Minnesota are net importers of horticultural peat. Currently, Minnesota contributes only about three percent to U.S. production of horticultural peat (Anderson March 1980, p. 14). Substantial potential exists for increased domestic production, but only if demand increases to a point where it is more economical to supply than to import horticultural peat.

Industrial Chemicals

Peat is a potential source of four types of industrial chemicals: 1) peat bitumens, 2) carbohydrates, 3) humic acids, and 4) peat coke. As the U.S.S.R., Finland, Germany, and other European nations have shown, industrial chemical production could offer a viable alternative for developing peatlands.

Peat bitumens have two by-products: waxes and steroids. Waxes produced from bitumens can be used as waterproofing agents in paints, as lubricants, and as ingredients in household products such as furniture polish. Steroids in the form of pharmaceutical products are used in medicine. Peat is a substitute for other sources of these waxes, such as brown coal and tallow made from animal by-products (Fuchsman 1978, v).

Peat carbohydrates are sources of cultures for yeast used in the production of alcohol and as a high-protein feed for livestock (Fuchsman, Lundberg, and Dreyer 1979, p. 23). Humic acids are used in agriculture as root stimulants, pest controls, and as fertilizer additives. They also are used in the plastic and rubber industries, and in a product that prevents heavy solids from separating in drilling of oil wells.

Peat coke is derived through a process called pyrolysis, in which peat is heated to a point where its organic substances decompose. Two by-products, peat coke and peat tar, are formed. Peat coke is used in the production of activated carbon, which acts as a reducing agent in electric smelting furnaces, as a hardening agent for steel, as a polishing aid, and in the production of alloys for transformer steel. Peat tar is often burned as an energy source for the coking operations. It can also yield pitch, solvents, and grease.

The problems of producing industrial chemicals from peat are similar to those associated with other alternatives involving the extraction of peat--environmental problems related to water and air quality, and the reclamation of mined peatland.

In addition, the development of an industrial chemical industry that uses peat as a raw material must make full use of the peat. Because the different chemicals extracted come from different types of peat, single-product plants would not fully utilize the resource. One solution is to locate complementary industries together, locating more than one process on one site. This may be possible, since chemical plants using a peat feedstock may be of a smaller scale than plants producing fuel from peat. In addition, the chemical products are of higher value per unit and may offer more jobs per acre of peatland.

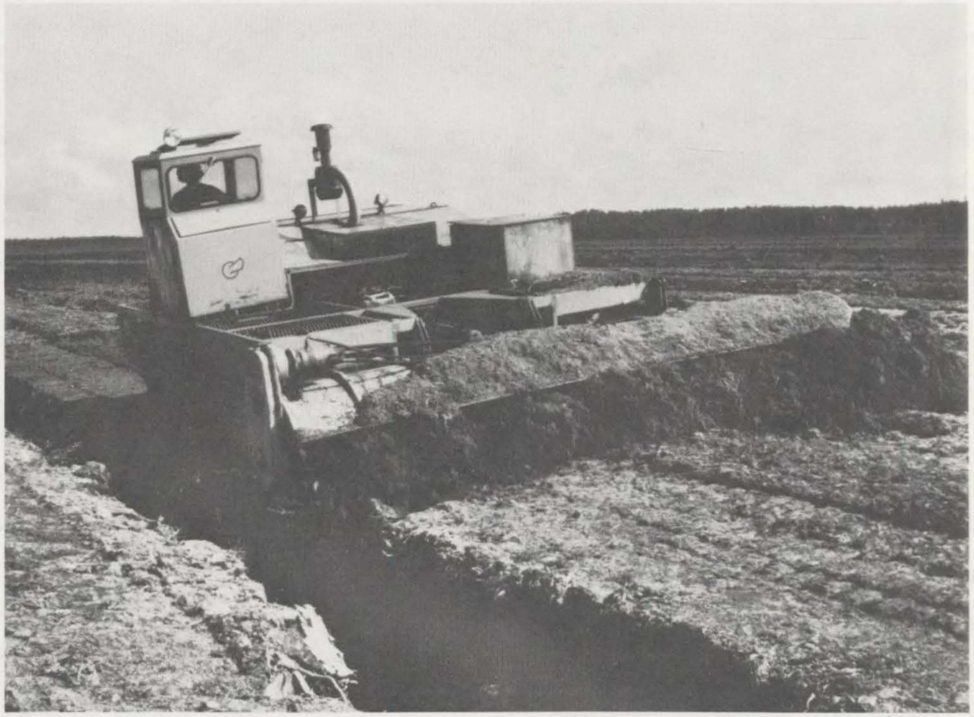
Mining and Dewatering of Peat

Before peat can be mined the peatland must be prepared for the particular mining method to be used. This can involve surveying, draining, clearing, and leveling the peatland, and the entire sequence can take several years.

First, a survey is made to identify the location of peatlands, their depth and size, the natural drainage system, the characteristics of the peat, and the network of services in the peatland area.

Drainage of peatlands is necessary, since they may consist of more than 90 percent water. The spacing, depth, and location of the drainage system varies with the type of mining planned. Milled peat mining requires a more extensive drainage system with more closely spaced ditches than the system used with sod peat mining. Hydraulic mining will require little drainage, since water is an integral part of the harvesting process.

After drainage is sufficient for the peatland surface to support heavy machinery, trees, bushes, and stumps can be removed. (Some clearing might be required prior to drainage.) Bulldozers with low ground pressure might be needed for clearing. In



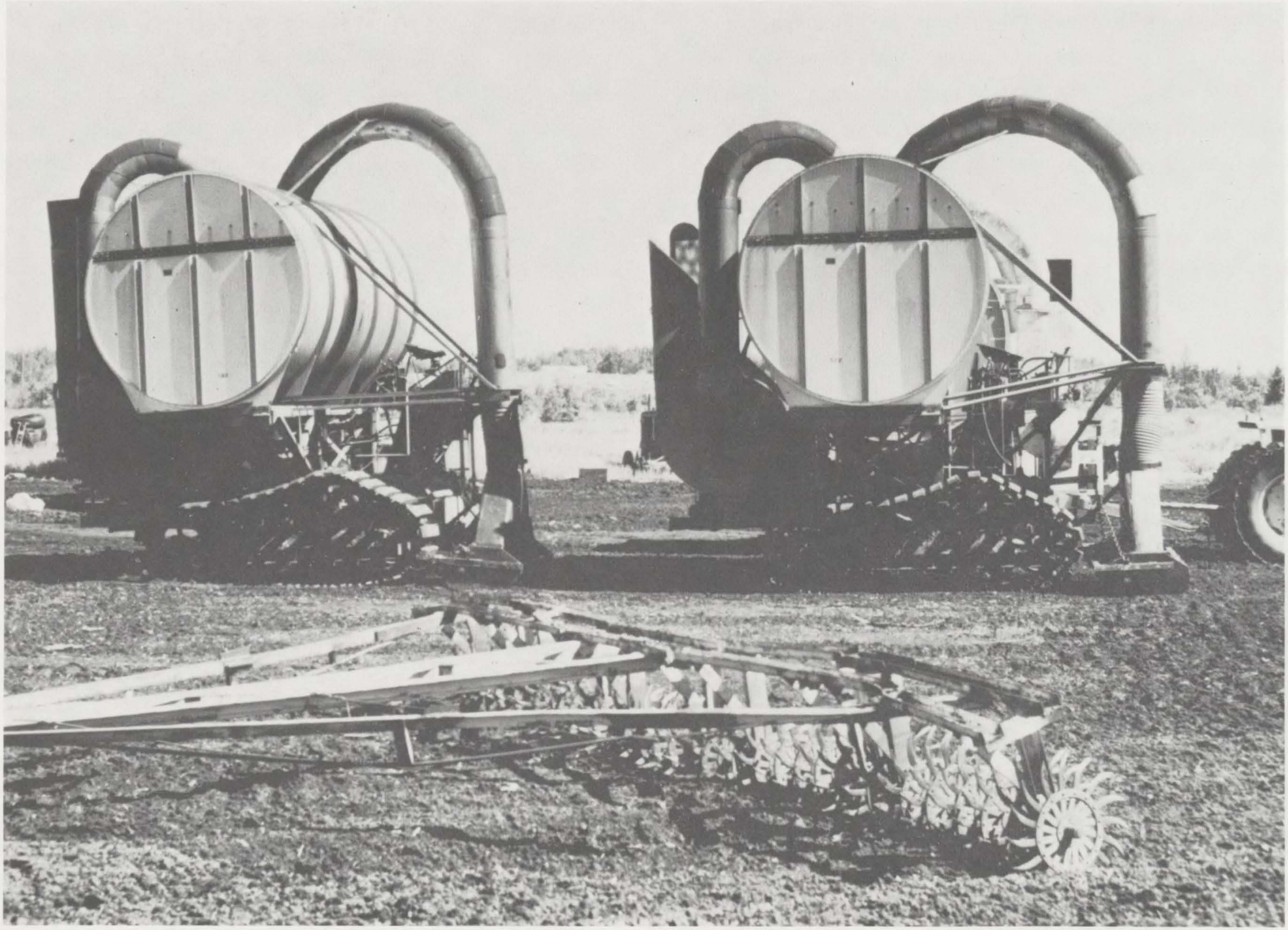
Ditching (left), the first step in the mining process, is necessary to drain the peatland so it can support heavy equipment such as the leveling machine (right), which prepares the surface of the peatland for mining.

Sweden, a "deep macerating" machine has been designed to chop stumps and other underground material and mix it with the top layers of peat (Nämden för Energiproduktionsforsking 1977, p. 96). The final step in the preparation for mining is to level the surface so the mining machinery can operate efficiently and to slope it toward the drainage ditches so that surface water can drain properly (Nämden för Energiproduktionsforsking 1977, p. 96).

Sod peat mining involves extracting peat from a trench in the form of sods and placing the sods on the field for drying.

Sod peat mining is done in Ireland, Finland, the Soviet Union, and Germany. This method produces cylinder-shaped sods approximately 12 to 15 inches in length. First the peatland surface is stripped of overburden, including the sphagnum moss layer. The peat then is cut away from the surface and mixed in a macerator to create uniform, densified sods. These sods are deposited on the ground, where they are cut into 12- to 15-inch pieces. After the sods have dried to a moisture content of 75 to 81 percent, they are collected, turned over and formed into windrows. These windrows are continually turned to accelerate the drying process. Once the moisture content approaches 50 to 55 percent, the sods are collected and stockpiled for storage.

Milled peat mining is presently being used in Ireland, Sweden, Finland and the Soviet Union. After the peatland has been cleared and drained, a thin layer (one-half inch) of peat is milled away. The milled peat, in particles less than one-half inch in diameter, is allowed to dry. To speed up the drying process, the milled peat is turned over with a harrowing device. Depending on the weather, two to five harrow passes are necessary to reduce the moisture content to 45 to 50 percent. When



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this desired moisture content is reached, the milled peat is collected and stockpiled for storage. These stockpiles are often compacted and covered with polyethylene sheets to protect the milled peat from high winds and rainfall.

Hydraulic mining has had limited use in the United States, in Canada, and on a small scale in parts of Europe. In British Columbia, the Western Peat Moss Company uses hydraulic mining. A hovercraft barge, which has a clamshell dredge on a rotating unit with cutter heads, extracts the wet peat (Aspinall and Hudak 1980, p. 7). The peat is deposited in a hopper on the barge. It moves through a conveyor system where pressurized water is used to wash the peat off the stumps and debris. This debris is discharged back into the bog and water is added to the remaining peat material so that a slurry containing no more than five percent solids is formed. This slurry is pumped to a dewatering plant a few miles away or to a settling pond where water is slowly decanted off (Carncross 1980, p. 5).

A harrow (foreground), used in milled peat mining, turns over the peat so it can dry prior to its collection by vacuum machines (background).

Selection of the proper mining type depends on a number of factors, including environmental impacts, costs of mining, and the state of the mining technology.

The environmental impacts associated with each form of mining are not completely understood. Both milled and sod peat mining methods require extensive drainage before the peat can be extracted. Hydraulic mining produces a slurry that is 95 to 98 percent water, and after dewatering the resulting effluent must either be drained off or returned

Hydraulic peat mining in British Columbia, using a clamshell dredge on a hovercraft barge.

to the peatland. Water may be the major environmental problem associated with peat development. Fugitive dust, a problem associated with both the milled and sod peat methods of mining, may be another environmental factor.

Cost estimates are difficult to determine for each type of extraction. The cost of the peat must also include the costs of clearing and draining the peatlands. It has been estimated that this could run between $550 and $1500 per acre (Aspinall and Hudak 1980, p. 12). Milled peat (50 percent moisture) could cost $7.50 per ton (1978 dollars), but this is only a rough estimate. Hydraulic mining has yet to be tried on a large scale, thus the economies of scale are unknown. Equipment has yet to be fully developed for large-scale mining. One cost advantage that hydraulic mining has over sod and milled peat mining is that land preparation (drainage and clearing) is much less extensive. However, the company that manages the British Columbia hydraulic mining operation has estimated that its hydraulic operation costs are three-and-one-half to four times greater than its vacuum-harvested milled peat operation costs (Carncross 1980, p. 6).

The sod and milled peat methods have a proven track record in Europe. Both have been used for large- and small-scale mining in Ireland, Finland and the Soviet Union. Hydraulic mining has had only limited application. It seems apparent that a detailed study of the potential impacts and costs of each mining technique is needed. Smaller-scale trial applications are necessary first, so that an understanding of the impacts and costs is possible.

The dewatering of peat is the most difficult technical problem in using peat as an energy source. Even after the peatland is drained, the moisture content of the peat can exceed 80 percent. Present technologies for direct burning, gasification, and briquetting require peat with a moisture content of 50 percent or less. When sod and milled peat methods are used to mine the peat, it is left to air-dry on the peatland surface. This method of dewatering is both cost- and energy-effective but is dependent on the weather. Weather also affects the number of possible extractions in a year.

Current research efforts suggest that dewatering of peat is possible but can be expensive. Air-dryed peat has a high net energy value (energy content of peat minus energy used to dewater) but further dewatering, requiring some form of energy input, is often necessary.

Mechanical presses are sometimes used. They consume only a small amount of energy--a fraction of the heat content of peat--but they require a substantial initial capital investment. Thermal drying of peat may also be used. Unfortunately, thermal drying results in a lower net energy value, requiring as much as 15 to 34 percent of the energy content of the peat to reduce its moisture content to 50 percent (Nämden för Energiproduktionsforsking 1977, p. 148). One solution to this problem is to take advantage of waste heat generated when peat is converted to another form of energy. Irish briquetting operations separate out the larger pieces of peat and burn these to dry the processed peat (Midwest Research Institute May 1976, p. 53).

Water is held in peat by two physical bonds: an extensive capillary system and natural electrical charges that bind the water to the peat (Nämden för Energiproduktionsforsking 1977, p. 142). The existence of these physical bonds has prompted research in three specific processes to separate water from peat:

1. Wet Carbonization - actually a pre-treatment of the peat prior to dewatering. This process changes the physical properties of the peat so dewatering can be more effective. A Soviet plant in operation since 1938 uses wet carbonization, and the basic technology has been around since the turn of the century (Nämden för Energiproduktionsforsking 1977, p. 143).
2. Wet Oxidation - controlled, pressurized combustion of the peat. The combustion is allowed to continue until the peat has reached the desired moisture content. Results of this process show a recovery of 70 to 80 percent of the peat solids (U.S. DOE 1979, p. 27).
3. Solvent Extraction - slurried peat is combined with a solvent and heated under pressure. As the slurry cools, the peat, water, and solvent can be separated (U.S. DOE 1979, p. 27).

Dewatering of peat has proved to be a difficult problem to solve. Not only are the technical questions not fully answered, but dewatering can cause environmental problems. Other dewatering methods which have not yet been adequately examined include: filtration, centrifuging, sedimentation, solar heat, deep freezing, and vacuum drying (Nämden för Energiproduktionsforsking 1977, p. 148). The technology, costs, and net energy value of each should be examined to determine their feasibility.

RENEWABLE PRODUCTION

Energy Crops

Growing wetland energy crops is a renewable approach to energy production from peatlands. Energy crops collect solar energy through photosynthesis and convert it to plant material or biomass. Biomass can be utilized as fuel through direct burning, gasification, liquefaction, or processing into briquettes and pellets.

Research on energy crops has expanded in recent years as interest in renewable forms of energy has increased. Wetland plants currently being studied for energy crop production on peatlands include alder, willow and other wetland shrubs, cattails, reed-grass, and reed-canary grass.

This renewable source of energy production does not require depletion of the peatland resource and thus extends indefinitely the resource life of the peatlands. A detailed discussion of energy crop production is contained in Chapter IV.

Agricultural Uses

In 1979, an estimated 655,000 acres of Minnesota's peatlands were used for agricultural production. Hay and pasture land represented the most extensive use, approximately 78 percent of peatlands in agricultural production. Row crops,

The energy potential of cattails is being examined in a Minnesota Energy Agency and Department of Natural Resources funded project conducted under the supervision of Dr. Douglas C. Pratt and Ms. Nancy J. Andrews (pictured) of the University of Minnesota's Wetlands Biomass Program.

such as corn and soybeans, and commercial wild rice production accounted for 13 percent and 3 percent, respectively (MnDNR April 1979a, p. 97). Peatlands are also used for commercial crops such as vegetables, grass seed, and cultured sod. A large portion of the peatlands used for agricultural production lies in the southern part of the state. More than half of the peatlands in Faribault, Freeborn, and LeSueur counties are used to produce crops.

The majority of Minnesota's peatlands are in the northern portion of the state. Crops grown on these peatlands must be able to tolerate a shorter growing season and light frosts. This limits the potential for agricultural production of northern Minnesota peatlands. In addition, the need to drain peatlands and fertilize the peat also diminishes the feasibility of agricultural production on some Minnesota peatlands.

However, agricultural production could be used for reclamation of mined peatlands. After extracting a portion of the peat for horticultural or energy production, crops or pasture for livestock might be planted. In Ireland, all harvested peatlands must be reclaimed in such a way that the remaining peat and underlying soil can be utilized in some productive system. Experiments have shown that there is a need for nutrients and lime, but the productivity results have been encouraging. Grass and beef production on reclaimed peatlands is comparable to production levels on good mineral soils. Crops such as onions, carrots, and nursery stock also do well on reclaimed peatlands. The Soviet Union has two million acres of agricultural land on peatlands, much of it the result of reclamation (Midwest Research Institute May 1976, p. 44).

Turnips grown on agricultural peatlands on the Norwegian island of Smöla.

Timber

The approximately 60 percent of Minnesota's peatlands that are forested represent a potentially valuable resource for the state's timber industry. In the seven counties of Aitkin, Beltrami, Carlton, Itasca, Koochiching, Lake of the Woods, and St. Louis, there are over two million acres of marketable timber on peatlands (MnDNR April 1979a, p. 94).

Forest types found on peatlands include tamarack (larch) white cedar, black spruce, and various hardwoods including black ash and elm. Black spruce on peatlands plays an important role in the state's pulpwood industry. In fact, peatlands provided 24 percent of the pulpwood in Minnesota in 1976. Despite the fact that utilization of Minnesota's peatlands for timber has been far below its potential, the commercial value of the timber, if developed, is substantial. For instance, Koochiching County alone harvested $5 million worth of black spruce and tamarack from peatlands in 1976 (MnDNR April 1979a, p. 95).

Recognizing that peatlands are an important timber resource, the MDNR has made several recommendations about utilization of peatland timber. The MDNR suggests more intensive timber production on the state's peatlands. It also recommends planting the valuable black spruce species on peatlands which currently have little or no commercial timber and, in addition, reclaiming mined peatlands through planting black spruce. The MDNR notes that Ireland has successfully planted 20,000 acres of timber as a means of reclaiming mined bogs (MnDNR April 1979a, p. 96).

PRESERVING PEATLANDS

More than 90 percent of Minnesota's peatlands are essentially undisturbed (MnDNR April 1979a, p. 90). Most of this land is remote and largely untouched by human influence. It has natural features rarely found in Minnesota or elsewhere in the nation. Minnesotans have an opportunity to plan for the protection of unusual and interesting portions of this natural landscape before significant development occurs. Five categories of peatlands should be considered for preservation as private development plans and state peatland management policies are formulated: peatlands of 1) scientific value, 2) unique natural systems, 3) recreational value, 4) historical or aesthetic importance, or 5) peatlands important as a resource base for future generations of Minnesotans.

Some of Minnesota's peatlands support rare flora and fauna and others contain important paleontological records. In addition, others must be protected for their value as in-the-field examples of biological, geological, hydrological, or other phenomena important to scientific research or education. These are also peatlands whose disturbance or destruction could jeopardize future scientific inquiry if left unprotected.

Another category of preservation includes peatlands that contain environments essential in some way to the larger biosphere, those that contain plant or animal species requiring protected environments, or peatlands which are in some other way biologically or geologically unique.

The MDNR has identified a number of plant and animal species found on Minnesota's peatlands as being of "special concern," endangered, threatened, or dependent on peatland habitat. See Table 4.

Minnesota's peatlands also contain geological features rarely found in the United States. The most significant peatland in this regard is the so-called "Big Bog" near the Red Lakes in Koochiching, Beltrami, and Lake of the Woods counties. Its huge expanse, about 450 square miles, makes it the largest contiguous peatland in the lower 48 states. The "Big Bog" is part of an even larger peatland that

Tear-drop islands of tamarack and shrubs in the "Big Bog" north of Upper Red Lake.

Table 4: Endangered, Threatened and Dependent Plant, and Animal Species Found in Minnesota's Peatlands.

	ANIMALS	
PLANTS[a]	Threatened[b]	Dependent[c]
western Jacob's ladder	*sandhill crane	cinereus shrew
ram's head lady's slipper	*pine martin	short-tailed shrew
bog-adder's mouth	*fisher	arctic shrew
showy lady's slipper	Canada lynx	star-nosed mole
swamp pink dragon's mouth	*grey wolf	southern bog lemming
lingonberry		northern bog lemming
small-round-leaved orchid		
calypso orchid (fairy slipper)		
twid rush (water bog rush)		
slender-leaved sundew		

* legally protected species

a - officially recognized as endangered or threatened, or located near the geographical limit of their natural range

b - includes birds and mammals of changing and uncertain status

c - primarily dependent on the lowland habitat of Minnesota peatlands

(Data from Minnesota Department of Natural Resources. Minnesota peat program legislative status report. April 1979, p. 21, 46, 47.)

is interconnected throughout the ancient glacial Lake Agassiz.

The "Big Bog" is characterized by large water tracks in which islands of raised vegetation are found (Gorham and Wright, Jr., 1979). These islands, shaped by the water tracks in which they lie, are typically teardrop, horseshoe, or ovoid in shape. By any standard, the "Big Bog," with its distinct islands and water tracks, is impressive, particularly when viewed from the air. According to a

Drainage ditches, constructed on Minnesota's "Big Bog" early in this century, cut through an ovoid island, one of the unusual features of this peatland.

scientist contracted by the MDNR, such large bogs with water tracks represent a delicate adjustment of vegetation to hydrology. This balance is similar to that found in coastal salt marshes (Gorham and Wright, Jr. 1979). Formations like those found in the "Big Bog" cannot be found elsewhere in Minnesota. Although they are rare, similar formations are found in Canada and Alaska.

Some peatlands are valuable for recreation, providing Minnesotans with opportunities to view first-hand unusual biological and geological characteristics. The distance from population centers of most of these areas and their wetland characteristics make public access for recreation difficult. Currently, the peatlands are used for snowmobiling and cross country skiing in the winter. For those interested in experiencing the remote and wild nature of what some have called "Minnesota's last true wilderness," designation of recreational areas on public land might be considered.

Occasionally, lands are protected from development in an effort to maintain them in an undisturbed form for posterity. This is sometimes done because these lands contain unique natural characteristics, as discussed above, or because of their human or natural historical significance or their aesthetic qualities. Such protection might be afforded to portions of Minnesota's peatlands. While their disturbance might not endanger a species or upset a unique geological formation, it may destroy forever an important reference of the state's history (particularly its geological history). Or, development might permanently alter or destroy a beautiful and irreplaceable Minnesota landscape.

Whenever an unexploited finite natural resource is being examined for development, the potential importance of that resource at a future time should be weighed against the advantages of immediate development. Minnesota's peatlands, while extensive, are limited. Used as a fossil fuel, their resource life is likely short-term at best. Thus, it is important to consider preserving some peatlands for use at a future time when the state might face a more critical need. Non-extractive approaches for peatland utilization should be examined in this context.

Some of Minnesota's peatlands have already been identified by the federal government as important natural landmarks. The decision to designate a site is made by the Secretary of the Interior after recommendation by field evaluators and a review by the Board on National Parks, Historic Sites, Buildings and Monuments. After designation, a site can be "registered." A site is considered "registered" when the landowner informally agrees to keep the site in its natural condition. While such a designation has symbolic significance, it does not provide protection to the area, nor does it prevent the landowner from selling, leasing, altering, or in any way developing the land.

The Lake Agassiz Peatlands National Natural Landmark, 22,000 acres in south-central Koochiching County, has been designated and registered as a national landmark. In addition, the Upper Red Lakes Peatland National Natural Landmark, consisting of 138,000 acres in Beltrami County north of Red Lake, has been designated but not registered. Two other peatlands have been examined for designation as national landmarks. One of these, the Lost River Peatlands, 200,000 acres located in southwest Koochiching County, was placed on the "inactive" list in 1975. The other, still being considered, is the North Black River Peatlands, encompassing over 100,000 acres of land in north-central Koochiching County (MnDNR April 1979b, p. 38).

The MDNR is also examining possible peatland sites for preservation with the assistance of the Minnesota Natural Heritage Program. This program, a cooperative effort between the MDNR and The Nature Conservancy, locates natural communities, plants and animal species, and geological features which need protection. A set of specific criteria for preserving Minnesota's peatlands may aid the effort in determining which peatlands should be set aside for the above reasons. The information is sorted into an integrated data management system which is compatible with the Minnesota Land Management Information System (MLMIS), making it possible to examine these considerations along with other MLMIS variables in land use planning.

IV. DEVELOPING PEATLANDS FOR ENERGY: PROGNOSIS FOR THE FUTURE

The Minnesota Energy Agency (MEA) projects that by the end of this decade, increasing demand for energy in Minnesota will begin to outstrip the available supplies of traditional fuels (see Figure 7). According to the MEA, this shortfall will likely result in an economic slowdown, which by 1985 could increase unemployment in Minnesota by 4.7 percentage points. By the year 2000, energy-related unemployment could account for 11 percentage points (MEA 1980, p. 1-3).

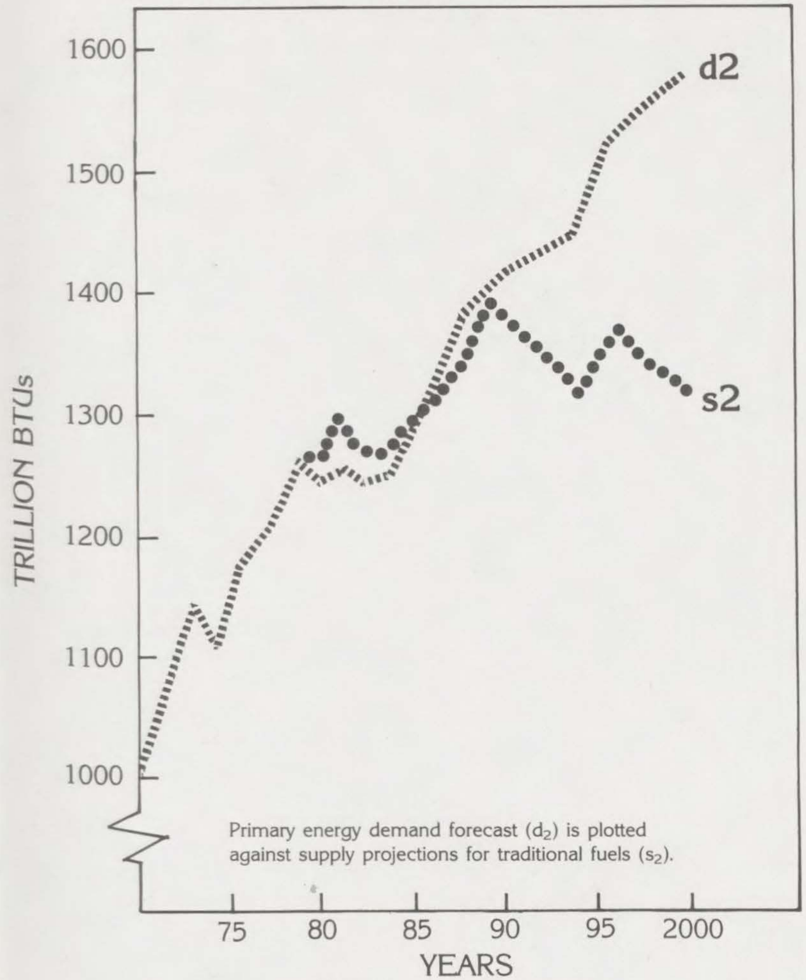
Minnesota, like other energy-dependent states, is at the end of domestic and international pipelines. This means that Minnesota, like those other states, is vulnerable to virtually every change in supply or price of fossil fuels. Growing scarcity and increased production costs have already had an effect on the prices of Minnesota's energy, with the cost of fuel oil rising 88 percent and natural gas 15 percent in 1979 alone. Forecasts for the next 20 years indicate a doubling in the real price of heating oil and increases in natural gas prices of 150 percent (see Figure 8) (MEA 1980, p. 1-3).

While reports of recent months indicate significant new discoveries of natural gas requiring deep drilling (Easterbrook October 1980a and October 1980b), it has yet to be demonstrated how much and at what price that new gas will become available to states like Minnesota. According to the MEA, unless something is done to change our current and projected energy supply and demand, Minnesotans could be paying nine to ten times as much for traditional energy supplies as they do today (MEA 1980, p. 1-3).

Mined peat or harvested energy crops can be converted into specific forms of energy through several approaches. They include 1) direct burning to produce process heat or electricity with or without steam heat, 2) gasification to produce methane, 3) liquefaction to produce alcohol, and 4) briquetting or pelletizing for combustion (see Figure 9).

A number of factors should be considered when comparing the economic feasibility and social desirability of these approaches to the development

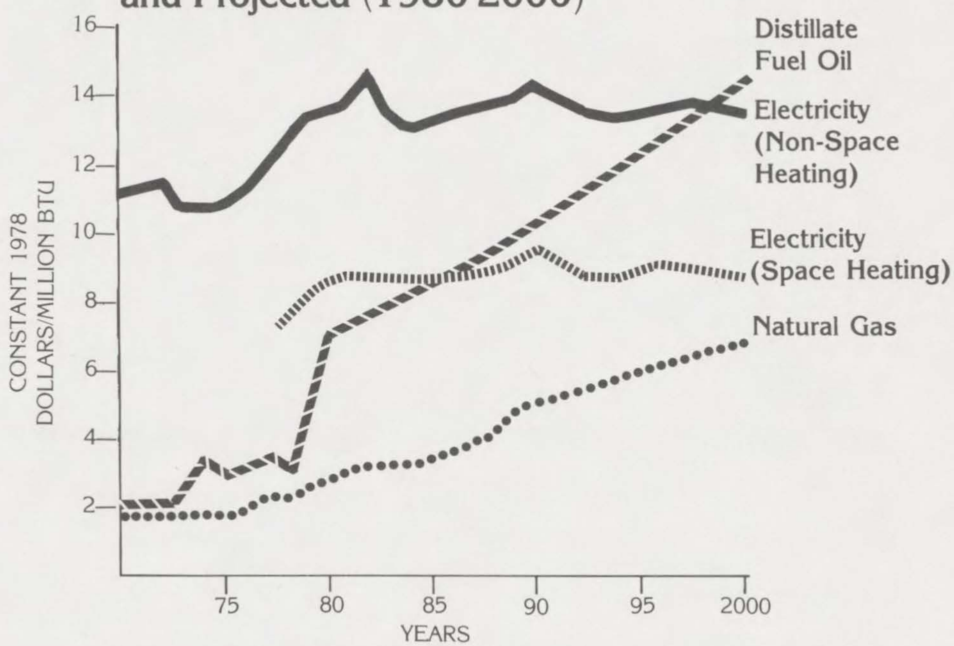
Figure 7
Baseline Primary Energy Supply and Demand in Minnesota to the Year 2000.



(Adapted from Minnesota Energy Agency. 1980. *Draft 1980 Energy Policy and Conservation Biennial Report.* St. Paul: Minnesota Energy Agency. p. 1-2)

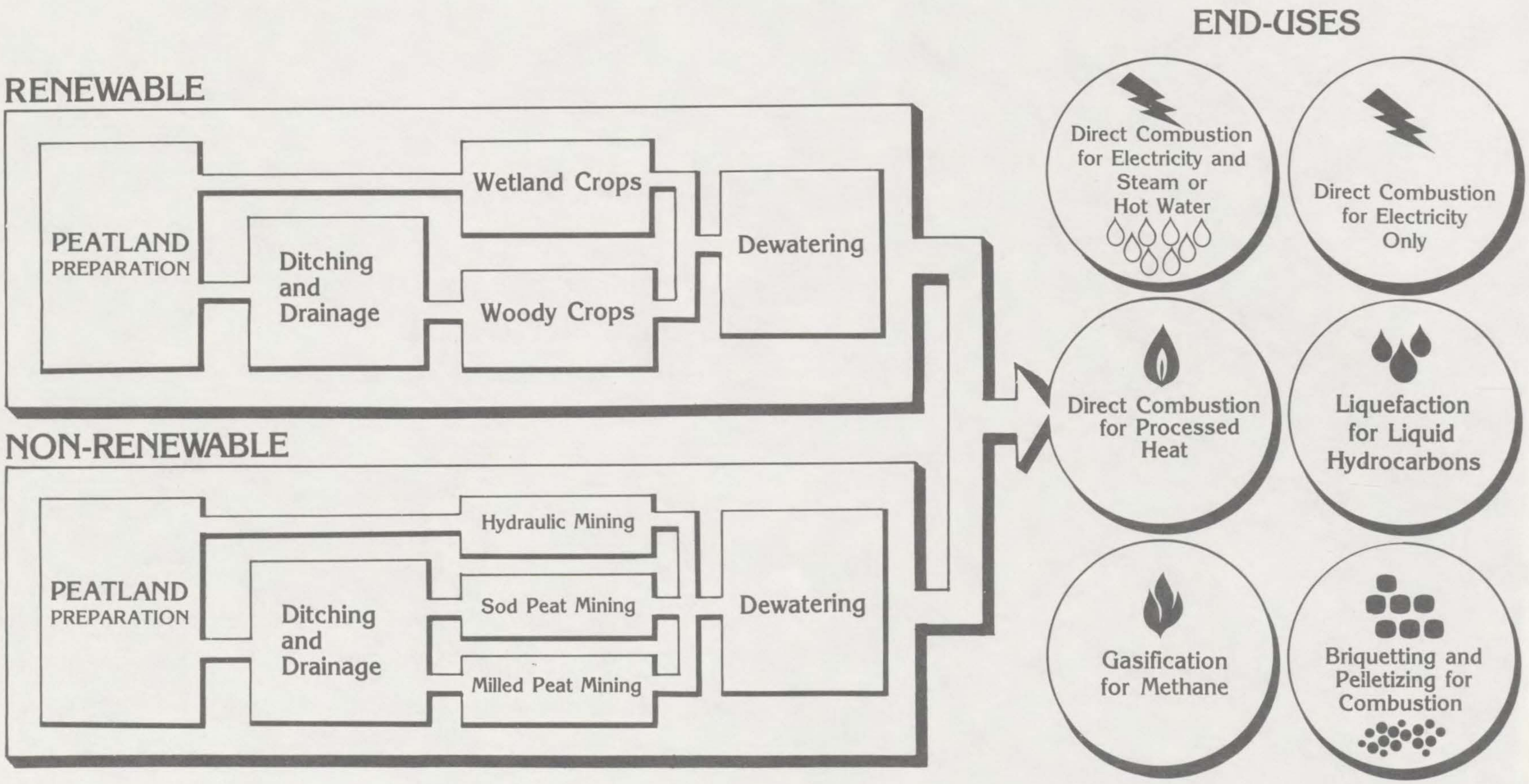
of Minnesota's peatlands for energy. First, the quality and quantity of the energy demanded and its value in the market should be identified. The cost of each development approach is also a major concern. Components of total cost include private and public production costs, environmental costs,

Figure 8
Residential Energy Prices, Actual (1970-1979) and Projected (1980-2000)



(Adapted from Minnesota Energy Agency. 1980. *Draft 1980 Energy Policy and Conservation Biennial Report.* St. Paul: Minnesota Energy Agency. p. 1-2)

Figure 9 PEATLAND UTILIZATION FOR ENERGY



and user costs. The energy efficiency of each development approach is also of key concern and needs to be determined by considering all energy inputs associated with all aspects of the approach. Finally, the long- and short-term energy supply stability is an important factor when evaluating the desirability of any of these development approaches.

Direct Combustion of Peat

Direct combustion of peat to produce process heat or electricity with or without steam heat is the most conventional method of utilizing peat as a source of energy. While the United States has not used its peat for direct combustion, European countries have burned peat to produce electricity since 1922. Before then peat was burned for heating and cooking. In some regions of Europe, peat is used in much the same way we have depended on oil, coal, or natural gas for electricity and heating.

The Soviets, with their large peat resource, built the first electric generating plant using sod peat. In 1931, the first district heating plant successfully utilized milled peat as a fuel (Midwest Research Institute May 1976, p. 31). Russia's peat consumption for power plants has grown to 80 million tons a year. A total of 76 plants, with a combined capacity of 4000 megawatts (roughly equal to half of Minnesota's total generating capacity in 1978) are peat fired. The largest of these plants has an output capacity of 730 megawatts, which is significantly larger than the typical power plant in Minnesota.

Peat is an important source of energy in Finland as well. As early as the late 1940s, sod peat was burned in boilers to heat individual buildings, offsetting the costs of imported oil and coal. In the late 1950s, Finland recognized the need to include district heating in its overall energy plan. Realizing that the cost of electricity to the individual consumer could be reduced and a more efficient energy source provided, Finland made long range plans to construct six district heating plants. When finished, these plants will have an output of 300 megawatts of electric power and 600 megawatts equivalence of district heating (Midwest Research Institute May 1976, p. 38).

In Ireland, an estimated 30 percent of the energy supply comes from peat, mostly in the form of electricity. The Irish Electrical Supply Board presently operates seven peat-fired electric plants with a combined output of 400 megawatts and has plans for an additional 200 megawatts in the next few years. Irish officials claim that the technical problems of direct combustion have been overcome. With the high costs of imported oil, the cost per megawatt of peat-generated electricity in Ireland is cheaper than the cost of oil-fired electricity (Midwest Research Institute May 1976, p.35).

The United States is far behind the European countries. First Colony Farms in North Carolina have started to examine the feasibility of large power plants generating over 100 megawatts. In Minnesota, United Power Association is interested in studying the feasibility of a 100 megawatt "peat and biomass integrated gasification combined cycle" power plant. This plant would gasify peat into a low-BTU gas to burn in an adjoining power plant.

Peat is transformed into electricity or process heat through direct combustion. This process heat is used either in a district heating system or in some industrial process such as taconite plants. Figure 10 demonstrates the general principles of direct combustion for electricity and district heating. After it is harvested and dewatered, the peat is processed into briquettes or pellets, or it is pulverized. The fuel is then either stored or transported to the plant site, where it can be further dried so that the BTU or heat content is increased. Then the fuel enters the boiler, where it is burned and turned into steam.

The heat produced by combustion creates steam in pipes which pass through the chamber. This steam is then passed through a turbine to create electricity. In a plant that produces only electricity, the steam is then condensed in a cooling tower. A more efficient system is one in which this "waste steam" is used to heat water, which is then transferred into a district heating system. If only electricity is produced, over 60 percent of the heat content of the fuel is lost, but when a district heating system is added it is possible that only 20 percent of the heat content is lost (Midwest Research Institute May 1976, p. 37).

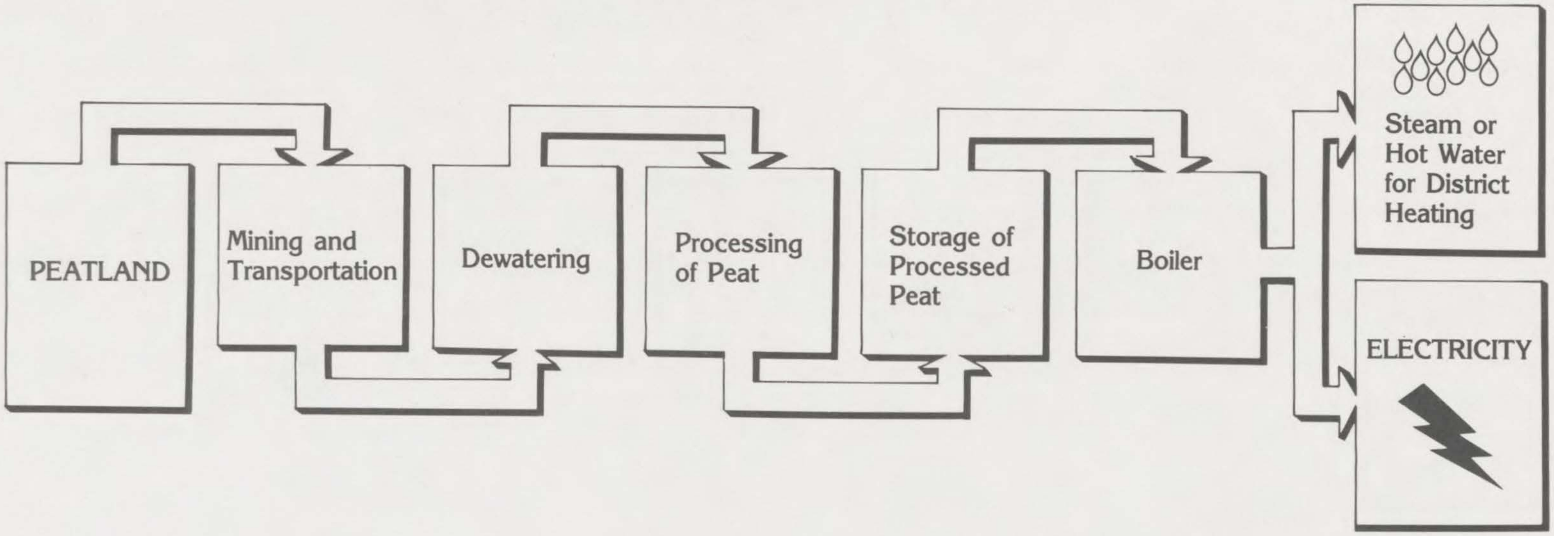
Because district heating requires that the plant be located near a population or industrial center, there is a trade-off between the cost of transporting the peat from the peatland to the plant and the savings derived from the district heating system. Because of these transportation costs, peat combustion provides primarily a local source of energy.

Gasification

Gasification is another means of utilizing Minnesota's peatlands for energy. It is thought that the advanced technologies used to convert coal and lignite to synthetic natural gas (SNG) are applicable to peat gasification.

In the United States, peat gasification has received financial and political support through Congressional action that has promoted the develop-

Figure 10 **DIRECT COMBUSTION**

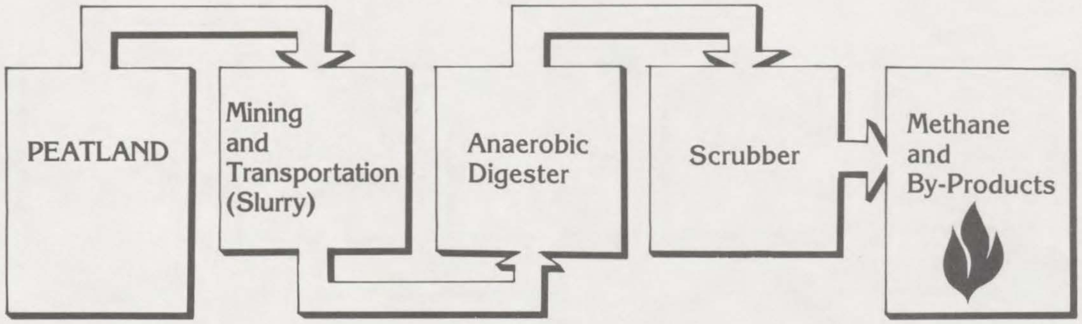


ment of synthetic fuels as substitutes for traditional fossil fuels, particularly imported oil. These efforts, culminating in the passage in 1980 of the Energy Security Act, authorized billions of dollars for research and development of synthetic fuels. While this effort has been geared primarily to coal and shale technologies, peat gasification research has been funded as well.

Minnesota Gas Company (Minnegasco) and Northern Natural Gas have indicated a strong interest in producing pipeline-quality synthetic natural gas from Minnesota peat. According to Minnegasco, as natural gas prices increase and Minnesotans begin to rely on expensive gas from Alaska, the still-developing technology of peat gasification will likely become economically feasible or even advantageous.

Peat can be converted into SNG in the form of methane through one of two basic processes: biogasification and hydrogasification. In biogasification, anaerobic fermentation converts organic matter to methane. Usually used for gasification of municipal and feedlot wastes and agricultural and forest residues, biogasification can also be

Figure 11
BIOGASIFICATION PROCESS



used for peat.

Microorganisms in the peat mixture act as catalysts for the fermentation process that produces methane and carbon dioxide. This raw gas is scrubbed to remove the carbon dioxide and hydrogen sulfide, along with trace acid gasses, from the methane. The remaining slurry, containing inorganic wastes, residual microorganisms, and undigestible peat components, can be utilized for animal feed, soil conditioners or, after stabilization, for land disposal (see Figure 11).

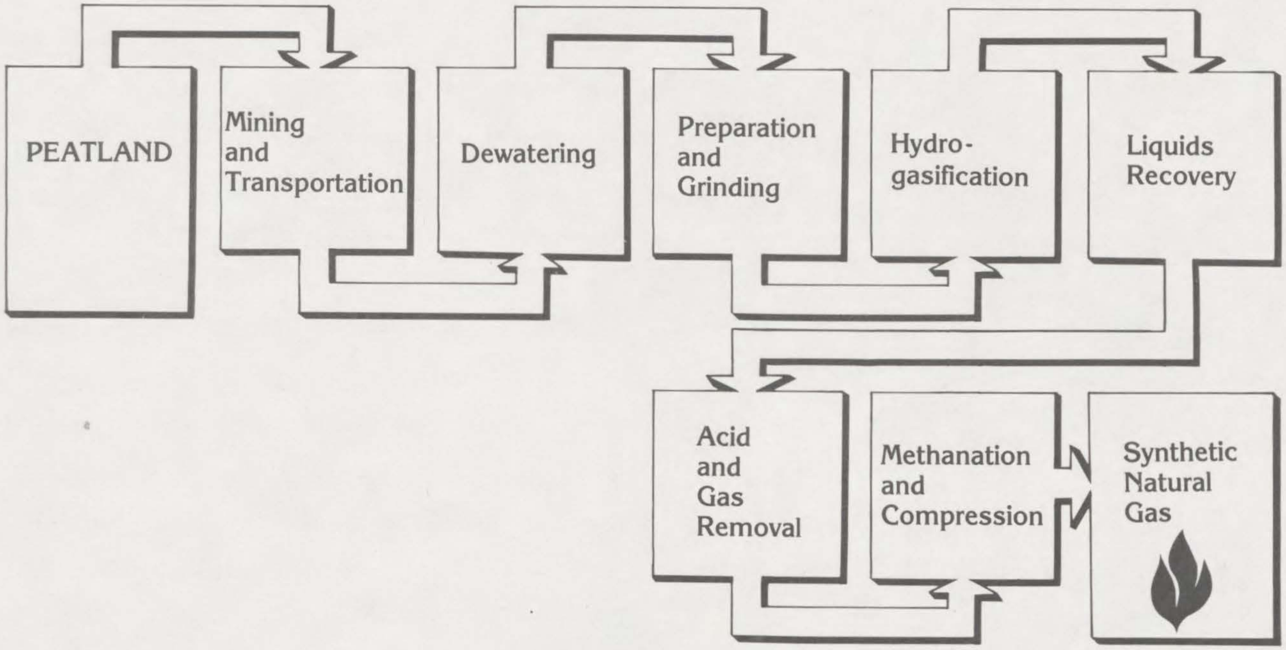
One advantage of the biogasification process is that it apparently does not require dewatered peat and thereby eliminates some significant costs. However, peat biogasification is a concept still only at the bench level of development and its prospects are as yet uncertain.

Peat can also be converted to gas through a hydrogasification process similar to that used for coal and lignite. Despite the fact that peat hydrogasification is still limited to laboratory-scale operation, its research and development is further advanced than that of biogasification. For this reason, it seems likely that hydrogasification will be the process used by Minnegasco and others in Minnesota. Simply stated, in hydrogasification peat is combined with steam and air or oxygen under high pressure and temperature to make synthetic natural gas. If air is used, medium-BTU fuel gas is formed. If oxygen is used, high-BTU gas is produced (see Figure 12).

According to the Institute of Gas Technology (IGT), gasification breaks peat down into the following products (in percentages): SNG, 52.4; fuel liquids, 8.4; benzene, 3.8; ammonia, 2.3; sulfur, 0.1; losses, 33.0 (Rader 1979, p. 296).

There are several technical advantages of peat over coal gasification. Because of the greater amount of volatile material in peat, it can produce three times more hydrocarbon gases than can lignite or subbituminous coal; thus peat requires less catalytic methanation after it is gasified (Punwani March 1980a, p. 129). In addition, because peat is so volatile, the gasification vessels can be small-

Figure 12
IGT HYDROGAS PROCESS



er and require lower pressures and temperatures than coal gasifiers (U.S. DOE 1979, p. 31).

Liquefaction of Peat For Liquid Hydrocarbons

The production of liquid fuels from peat has received little attention in the United States despite the fact that the nation's primary energy-supply problem is finding liquid fuel to replace imported oil. It is possible to generate liquid hydrocarbons, in the form of methanol or ethanol, from peat or biomass. Methanol is a toxic liquid sometimes referred to as wood alcohol. It is produced by a heating process. In contrast, ethanol, or grain alcohol, is produced by a fermentation process. Ethanol is the alcohol in wine, beer and distilled liquors.

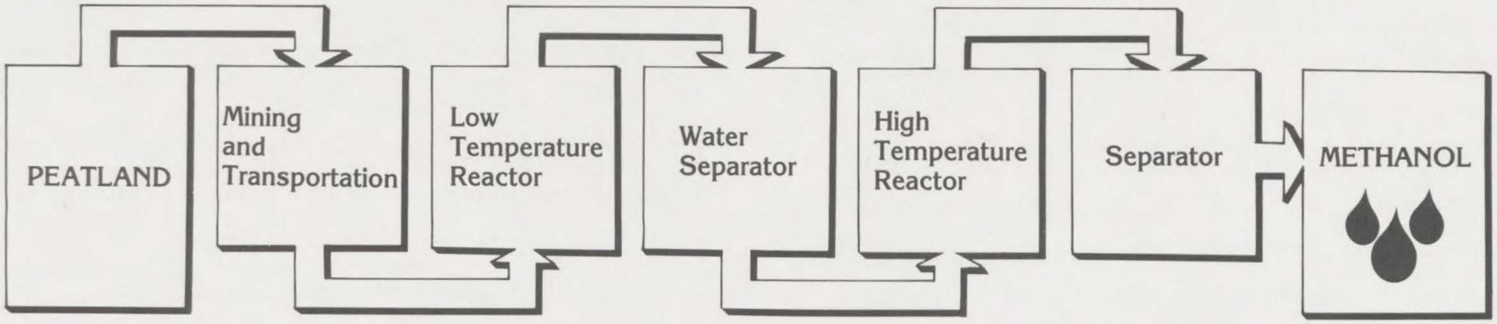
Ethanol production in the United States has received public attention for its role in the synfuels program. Gasohol, a mixture of gasoline and ethanol alcohol, is presently being produced in a number of locations throughout the Midwest. It is usually produced from a grain feedstock such as corn. Other biomass materials such as those that could grow on peatlands could also be used, but they must be dewatered before ethanol can be made.

In contrast, methanol has received much less attention than ethanol. Methanol can be produced from material with a higher moisture content. For this reason peat, with a moisture content between 85 and 95 percent (compared to a rough average of 50 percent for biomass if converted to liquid fuel), would most likely be converted to methanol. One problem is that a significant amount of energy is needed to heat the peat or other feedstock for the conversion process. This can make the process less desirable because the energy efficiency can be lower.

For a number of years, peat has been considered as a feedstock for conversion to liquid fuels. Early research was done in Sweden, the Soviet Union and Finland. Recently West Germany and Canada have been added to the list of interested countries (Björnbom, Björnbom, Granath, Hornell, and Karlsson 1980, p. 1). Canadian interest in using peat as a feedstock for the production of "organic fuels" began in 1938 (Chornet December 1980, p. 2).

Recognizing the potential advantages of synthetic liquid fuels over other alternative energy forms using peat, both Finland and the Soviet Union are developing liquefaction facilities. The largest is a Soviet plant with a capacity of 2,750 tons per day of methanol (Solantausta and Asplund 1980, p. 2).

Figure 13
LIQUEFACTION



There are two general methods for producing methanol from peat. The first involves gasification of the peat (see the section on peat gasification), then converting the gas to a liquid. After the peat is blended and dried to a moisture content of about 50 percent, the feedstock is gasified to produce a synthetic gas. Through a compression process the gas is then formed into a liquid methanol (Solantausta and Asplund 1980, p. 26).

The second process for converting peat to a liquid fuel is also a two-step procedure. (See Figure 13.) After it has been mined, wet peat is placed in a reactor unit where the temperature is increased until water begins to separate from the peat material. The water then is decanted off in a separator and the remaining mixture is combined with a solvent and placed in another reactor. Higher temperatures in this reactor complete the liquefaction and the solvent is then removed (Björnbom et al. 1980, p. 1-2). Estimates of the efficiency of producing methanol vary between 50 and 70 percent, depending on which processes are used (Chornet and Roy 1980, p. 6; Ikan et al. 1980, p. 3).

The advantage of a liquid fuel is its versatility. No only can it be used to heat and generate electricity in boilers, it can also be adapted for use in the transportation network. In addition, higher energy efficiency in conversion is possible than when peat is burned directly. Liquefaction also eliminates the energy-intensive dewatering stage, adding to the efficiency of the system. Finally, the liquefaction process appears to decrease the amount of sulfur, nitrogen, and oxygen in the liquid product when compared to the original amounts in the raw peat (Ikan et al. 1980, p. 5). This means that burning peat in liquid form may reduce the potential for adverse air quality impacts.

Briquetting

Briquetting produces a concentrated piece of peat in the form of a briquette or pellet. It can serve as an effective energy source for home heating as well as a feedstock for burning in small industrial boilers (see direct combustion section). While gasification and direct combustion technologies serve concentrated population or industrial centers, an advantage of briquettes is that they can be transferred and stored for use in sparsely populated rural regions.

Briquettes are produced from peat in Ireland, Russia, Finland, and Sweden. The Irish briquetting industry, which began in 1935, has an annual output of 350,000 tons. Ireland's three briquetting plants require 850,000 tons of raw peat per year. The Soviets have plants that range in capacity from 30,000 tons a year to 200,000 tons a year (Midwest Research Institute May 1976, p. 32). So far, interest in briquetting within the United States has been limited.

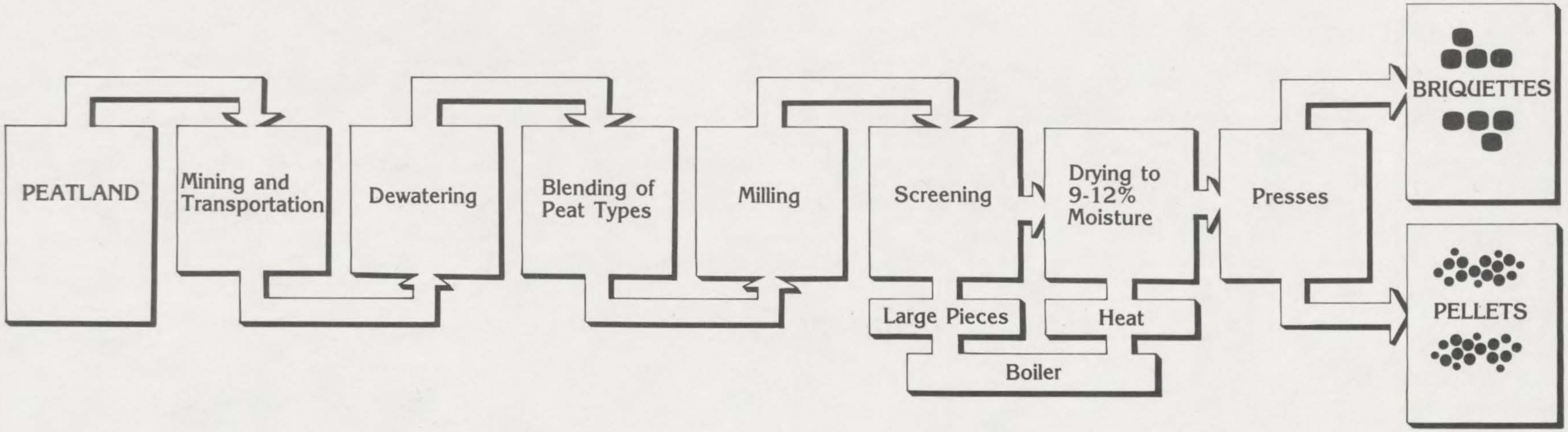
Briquetting involves pressing milled peat into briquettes of varying sizes without a binding agent. Figure 14 summarizes this process. The peat is mined and dewatered at the bog. It is then transferred to a briquetting plant, where it is first blended into a homogeneous product. This blending process is necessary to assure that the feedstock has consistent density, moisture, and fiber content (Namden for Energiproduktionsforsking 1977, p. 154).

The next step is to mill the blended peat, which reduces the peat to small particles 10 millimeters in size. Larger pieces of peat are segregated as the milled peat is passed through a screen and fed into a boiler to produce heat for the drying process.

After it is dried, the peat is in powder form, with a moisture content ranging from 9 to 12 percent. This powder is then compressed into uniform-sized

Figure 14

BRIQUETTING/PELLETIZING



briquettes or pellets with a healing value of 7,200 BTU/lb. The briquettes are sold either to individuals for home heating or to commercial interests as fuel for industrial boilers.

Briquettes can be composed exclusively of peat or they can be a combination of peat, bark powder, wood chips, and biomass (Nämden för Energiproduktionsforsking 1977, p. 158). The result, as long as the feedstock is blended, is a concentrated product that can offer constant thermal properties.

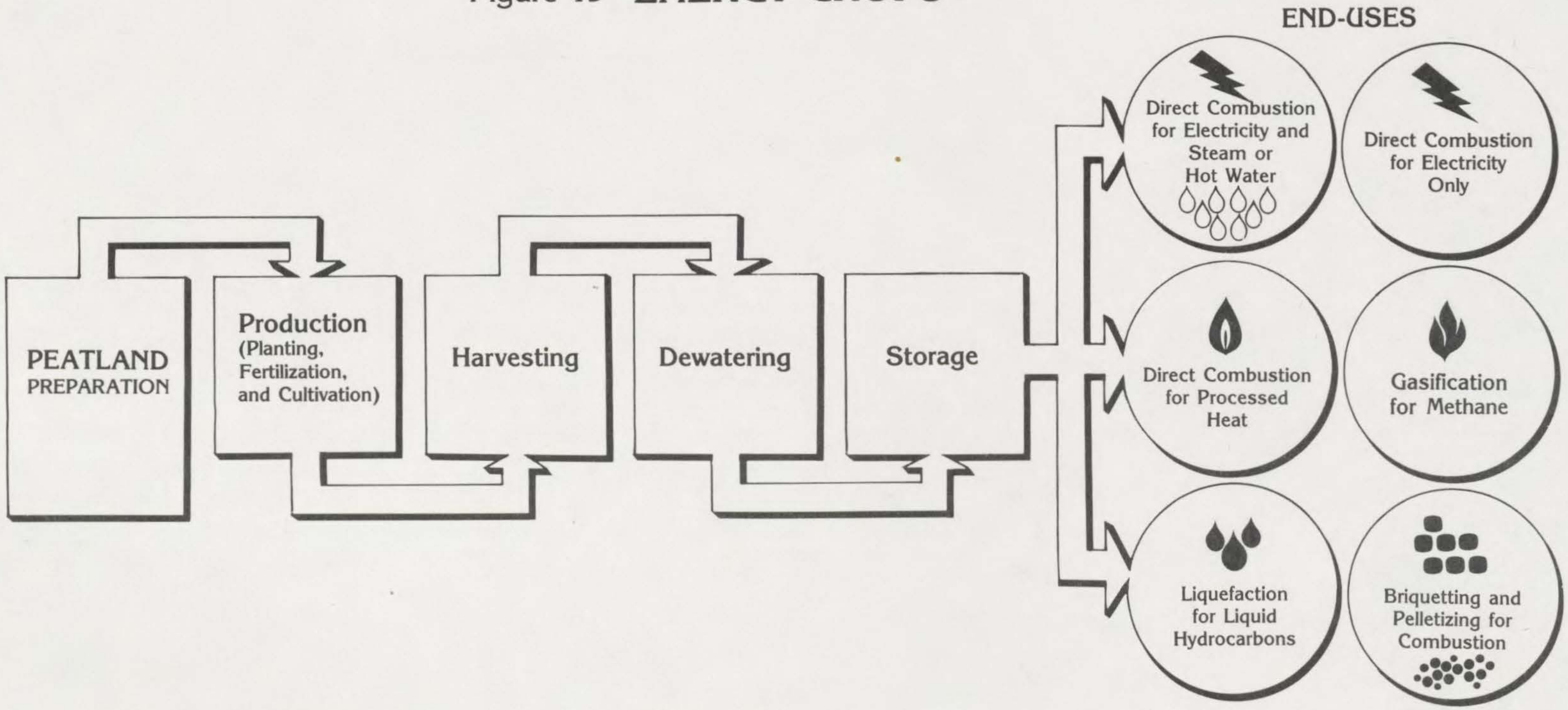
Growing Energy Crops for Biomass Production

The production of biomass is the only renewable approach for energy development of Minnesota's peatlands. If peat, a finite resource, is used as a fossil fuel, it can provide only a relatively short-term solution to the state's long-term energy problem. Other processes of converting peat--gasification, direct combustion, and briquetting--have one common characteristic: once the peat is consumed, the resource is gone. Biomass production is one possible means of greatly increasing the life of the resource.

Figure 15 demonstrates the general procedure that is followed to produce energy from biomass. Biomass is plant material formed through photosynthesis. Biomass not only includes live material associated with timber, grains, or forage crops, but also indirectly produced material such as animal and municipal wastes. The components of biomass that can ultimately be converted to a usable energy source are chemically similar to traditional fossil fuels (MEA 1980, p. 4-31).

While the present plans of Minnegasco, Northern Natural Gas, and DOE do not include production of biomass for use as a feedstock for gasification, biomass or a biomass-peat combination for gasification appear technically possible. Like peat, biomass can also be burned directly to produce heat and electricity, briquetted or pelletized, or

Figure 15 **ENERGY CROPS**



converted to liquid fuels.

Energy crops are grown primarily for their energy content. The traditional biomass resources have been grains, sugar crops, forage crops, wood, and crop residuals (Tyner 1980, p. 3). But using grains, sugar crops, and forage crops as a source of energy will conflict with the use of prime agricultural land for food production. Energy crops, on the other hand, can be grown on marginal land presently not used for agricultural production. In Minnesota, this land includes peatlands and wet mineral soils that are not drained due to their remoteness or low productivity. The energy crops associated with these wet soils include cattails, reeds, alder, and willows. Timber--other than alder and willow--has been mentioned as a possible energy crop but may require extensive drainage if grown on peatlands. Present stands of timber or peatlands like black spruce can supply a source of biomass energy, but their growth rates may be too slow to be economically feasible.

In experiments done by the University of Minnesota, the cattail has proved to be a likely energy crop. It satisfies criteria set for yield and growing conditions (Pratt and Andrews April 1980, p. 2). Cattail yields of 17.8 tons/acre are possible in natural stands. The cattail can be propagated either by seeds or by planting the rhizome (the cattail's root structure). Planting by seed is much cheaper, but yield estimates are higher when the rhizome is planted. Cattails can also be grown in a monoculture setting in large stands, creating more efficient harvesting conditions. Other potential energy crops include the reed phragmites and certain willows that grow on partially drained peatlands.

An important consideration in determining the feasibility of an energy crop is the amount of energy consumed when the crop is converted to an end-use product. The MEA has identified fertilizing, harvesting and planting, resistance to disease, and drying as important factors to examine when judging the energy requirements of a crop (MEA 1980, p. 4-40). In addition, storage and transportation are also critical factors for maximizing the net yield of an energy crop.

Minnesota offers a large acreage of wetlands (peat and wet mineral soils) that could be used for growing energy crops. A significant portion of the estimated 5.9 million acres of peatlands in Minnesota (Anderson November 1980, p. 9), could be available for energy crops after the ownership and social and economic constraints have been taken into account. Although its technical feasibility has not been demonstrated, energy crops might also be used to reclaim mined peatlands.

The MEA believes that large-scale biomass production could significantly contribute to Minnesota's annual energy supply. The MEA has estimated that there are potentially 5.5 million acres of wetlands of which 65 percent are peatlands that could be used for growing energy crops. They estimate that these lands could provide 1.29 quads of energy, an amount approximately equal to the estimate of total energy used in Minnesota in 1980 (MEA 1980, p. 4-41). It should be noted, however, that environmental, economic, and social constraints may reduce these estimates.

EVALUATING ALTERNATIVES: WHAT ARE THE FACTORS?

Quality and Quantity of Energy

The first step in evaluating options for developing Minnesota's peatlands for energy is to determine what quality and quantity of energy is desired. Quality of energy is measured in two ways: 1) the form of energy (such as electricity, natural gas, or petroleum products), and 2) the consumer's ability to convert this form of energy into an end-use that is compatible with the consumer's needs. The quantity of energy is derived from matching the supply of energy to a level that meets the demand of specific types of fuels. Also important is the projected market value of the fuel produced and the profitability of its production.

According to the MEA, Minnesota's demand for energy will outstrip its supply in the near future if present consumption patterns continue (MEA 1980, p. 1-3). Because the state and the nation now depend largely on unstable foreign sources, petroleum products will be in shortest supply. Traditionally, Canada has supplied a large portion of the crude petroleum processed by Minnesota refineries, but this is expected to decline drastically over the next few years. The transportation sector depends almost exclusively on petroleum, and shortages could create serious problems. Possible discoveries of large amounts of natural gas and the large reserves of western coal make these two sources of energy more stable. The quantity of new fuel types and their dependability are important factors in evaluating development options.

The efficiency of converting a fuel source into a usable end product is a measure of quality.

Electricity has the highest efficiency, since it is easily converted into energy for a number of uses. Other fuel sources such as coal are not so easily converted. Distribution is another consideration of quality; while electricity is available to almost every household, natural gas is not, particularly in rural areas.

Since no cost estimates for mining, dewatering, and specific conversion of Minnesota's peat and biomass exist, and since peat and biomass from peatlands are not currently used for energy in Minnesota, their market value as reflected by price is unknown. Peat and biomass must compete with traditional sources of fuel in order for projects to be profitable for their developers.

Energy Efficiency

Rising energy prices in the past few years have increased the importance of examining an option's overall energy efficiency. By comparing the net energy value--the total energy content of the resource minus the energy necessary for producing energy from it--of various options, the most efficient method of producing can be determined. This net energy contribution should be an important factor in assessing the desirability of a specific project.

A study done in conjunction with this report has examined the energy inputs associated with various options of utilizing peatlands. Land preparation, mining, transportation, dewatering, and conversion methods were all evaluated in relation to the amount of energy required to manufacture an end-use energy product. Although the figures are preliminary, the conclusions will aid in making decision about the efficiencies of various options. The following discussion is based on the assumptions and calculations of that study, reported in "Peatland Energy Options: A System Analysis," by Roger G. Aiken.

Table 5 compares the three types of mining--milled peat, sod peat, and hydraulic mining--in terms of the percentage of the available peat resource required for different stages in preparing the peat for conversion. Land preparation, extraction, and processing use relatively little energy. Only sod peat mining uses more than one percent of the total resource in these three stages of utilization.

The location of the conversion facility (i.e. gasification of liquefaction plant) is important in determining the efficiency of an option. Hydraulic mining requires almost three percent of the resource's energy content for transportation, while sod and milled peat require less than one percent. The closer the plant is to the developed peatland, the less energy is used for transporting.

Table 5: Percent of Available Peat Resource for Feedstock Fuel for Sod, Milled, and Hydraulic Extraction Processes

	Extraction Process		
	Sod Peat	Densified Milled Peat	Hydraulic
Land preparation	(a)	(a)	(a)
Extraction	.9	.2	.2
Processing (i.e., densification, crushing, and loading)	.5	.3	(b)
Transportation	.6	.8	2.9
Dewatering	(c)	(c)	8.9-12.0
Losses (i.e., dust or colloidal)	1.0	4.0	20.0

(a) Negligible

(b) Not necessary for this extraction process.

(c) Drying is done naturally in the field and does not require additional dewatering.

(Aiken, Roger G. Estimation of energy inputs and needs for peat and peatland biomass development. 1981.)

An advantage of sod and milled peat mining is that they require no energy for dewatering. The extracted peat is dried naturally in the field by the sun. Hydraulic mining, on the other hand, must be dewatered by mechanical and/or thermal processes. This requires between 8.9 and 12.0 percent of the energy content of the peat. In milled peat mining, 4.0 percent of the peat is lost as dust when the peat is being mined, processed, and transported. In sod peat mining, that loss is one percent. In hydraulic mining, as much as 20 to 30 percent of the peat is lost as colloidal particles during dewatering and transportation. These particles remain in the slurry used for transportation and may be returned to the peatland.

Of the three peat mining methods and their associated transportation requirements, hydraulic mining was found to require five to ten times the energy input of sod and milled peat mining. This is reflected in the first line of Table 6. This table demonstrates the net energy contribution of each possible conversion option under varying production processes. In addition to the three mining methods discussed above, two energy crops are included--one high and one low in nitrogen requirement for fertilizer. Production of nitrogen fertil-

Table 6: Energy Content in Fuel or Feedstock as a Percentage of Total Input Energy (Feedstock Resource + All Other Energy Inputs).[1]

Conversion Process Feedstock or Available End-Use Fuel to Consumers	Extraction Process Sod Peat 35% Moisture	Densified Milled Peat 50% Moisture	Hydraulic Peat[2]	Energy Crop High N	(Cattail) Low N
Feedstock delivered to conversion plant site	97.0	94.8	69.1	70.7	75.5
Gasification (SNG + by-products)	65.0	63.5	46.3	45.7	48.9
Gasification (SNG only)	49.1	48.0	35.0	35.8	38.3
Electricity only	24.2	21.8	16.5	16.5	17.6
Cogeneration (electricity and hot water)	58.3	52.7	39.7	40.0	42.6
District heat only (hot water)	58.9	53.4	40.7	40.9	43.6
Briquettes	85.4	78.1	59.1	60.7	64.6

[1] In comparing the different conversion options it is important to note that these figures only relate to the first law of thermodynamics, or the actual energy content of the fuel. The quality of energy which takes account of the second law of thermodynamics was discussed in a prior section.

[2] For gasification, moisture content can be for 50 percent while electricity, cogeneration district heating and briquetting requires drying to a moisture content of 35 percent. The first three rows of this hydraulic mining column reflect a 50 percent moisture content while the remaining rows represent a moisture content of 35 percent.

(Aiken, Roger G. Estimation of energy inputs and needs for peat and peatland biomass development. 1981.)

izer in the form of anhydrous ammonia consumes a significant amount of natural gas. The actual amounts of fertilizer required will depend on the nitrogen content of organic peat used as a growing medium for the energy crops. Of the five approaches to peatland utilization for energy, sod peat mining, with a net energy value of 97 percent, offers the highest preconversion energy efficiency. Hydraulic mining has the lowest preconversion net energy value of 69.1 percent.

Gasification (SNG and by-products), cogeneration, and district heating all have relatively the same net energy value. For example, an equivalent of 97 percent of the peat resource is available as a feedstock for the gasification conversion process after the extraction, processing, and transportation requirements for sod peat mining. The gasification process uses another 33 percent of the energy content of the resource. This results in a net energy value of 65 percent.

Th combination of sod peat mining and briquetting has the highest net energy value--over 85 percent. Both the high and the low nitrogen biomass production processes offer net energy values for briquetting of 60.7 and 64.6 percent, respectively. These two have net energy values similar to that of hydraulic mining. They may be more desirable, however, since they offer renewable approaches that will lengthen the life span of the resource indefinitely. Overall, the differences in net energy values may be misleading for heating and other household uses because electricity is available to almost every household, while new equipment that could burn briquettes is expensive to install and few households have them. It may be possible that present equipment like wood stoves can be adapted for burning briquettes which would decrease the costs significantly.

When examining the energy efficiency of these various approaches to peatland development, energy conservation strategies designed to reduce overall energy demand should also be considered. Capital investments in energy conservation at levels similar to those associated with energy supply expansion through peatland development may yield a net energy contribution as high or higher than peatland development. Where this is the case conservation efforts may be cheaper in the long run while at the same time conserving of finite fossil fuel resources.

Total Cost

The total cost of developing peatlands will be greater than the price tag placed on the energy produced from such development. Under present market systems, prices are usually only associated with the construction and operating costs that the producer bears. The costs that are borne by society as a whole are often omitted. To realistically assess the relative desirability of various approaches to peatland development, these other costs should be considered.

The total cost of a resource can be described with the following equation:

Total Cost = PC + EC + UC

PC - the private and public production costs associated with the construction and operation of a peatland development project.

EC - the environmental costs that are a result of the development project.

UC - the user costs: the sacrifices that must be made for the use of the peatland resource.

Development will also result in benefits to an area. Both benefits and costs must be weighed to determine the total cost of development.

Production costs of peatland development include not only the actual construction and operation costs, but also the expenditures that must be made to supply public services such as hospitals, sewer systems, and other services required by the increased population that results from the development project. These costs can be paid either by area taxpayers--who pay for additional public services financed through government--or by customers--who pay production costs passed on to them in the form of higher energy prices. In the long run, the benefits of greater public and private infrastructures--increased economic activity--may outweigh the cost of developing them.

If the plant must import a significant percentage of its work force, the expense of moving these individuals and their families becomes a factor in determining production costs. In addition, the costs of reclamation should be an integral part of the operational phase. Reclamation should not be a "one shot" task but an ongoing process until the land is returned to its original state or is able to produce a product beneficial to society. If the reclaimed land is able to produce a product with a higher value than the original peatland, this may be an added benefit of the development project.

Environmental costs are those associated with environmental impacts of a project and efforts to prevent or minimize them. While it is difficult to determine these costs, they must be considered when realistically assessing development alternatives. All parties involved or affected by the development--the developers and the residents of the surrounding area--should be thought about when the consideration of these costs take place.

User costs can be divided into two components. The first is the cost of giving up the peatland for other uses. Wildlife habitats, recreation, timber production, and agricultural production are all alternative ways to use peatlands and the cost of sacrificing those uses to development must be considered.

The second user cost is the sacrifice future generations must make as a result of the present generation's exploitation of the resource. Since future generations are not here to protect their resource base, those responsible for the present must consider what those generations are being denied. Retaining a resource is beneficial in three ways: 1) the resource increases in economic value, benefitting future generations as well as the present one, 2) because production costs increase as readily accessible resources are consumed, foregoing current consumption of the resource can minimize production costs in the future, 3) future generations are able to enjoy the value of the resource's environmental character (Howe 1979, p. 78). Including the cost to future generations is not an unusual practice; it has been estimated that the price of OPEC petroleum may include the cost of decreasing the resource stock.

Unfortunately, industry does not usually assume the responsibility of considering these costs, and they are often omitted when determining the desirability of a specific project. Thus, government has traditionally taken the lead in determining what these costs are and who is responsible for them.

Stability of the Supply

With Minnesota partially dependent on foreign sources of energy (i.e., OPEC and Canada), questions of supply stability are never far from the top of the list of energy issues. Both long- and short-term physical and social questions are involved in dealing with the peatland's potential for supplying a portion of the state's energy supply.

The long-term stability of a resource base such as peat depends not only on what approach is applied but on how well that approach is managed. If a peatland's ability to produce energy crops is damaged through mismanagement, the resource base is no longer renewable. Long-term stability is also important for maintaining a stable regional economy. A renewable approach assures a region that the jobs and income generated by a development project will continue. Since nonrenewable approaches limit the resource's life, economic stability is also in jeopardy.

Short-term stability deals with supply shortages or economic slowdowns due to seasonal or unexpected events. These problems may be solved in a week or less, or they may take months or even years. One proposal for utilizing the peatlands for energy in Minnesota is a 250 million cubic feet per day gasification plant. If completed, this project could supply approximately 21 percent of the estimated amount of natural gas used in Minnesota in 1979 (MEA 1980, p. 2-26). Since this is a significant percentage of the state's consumption, one plant shutdown because of strikes or extended mechanical problems could affect the state's supply of natural gas. While the lost supply could be temporarily replaced by natural gas from storage facilities or from other distributors, the stability over an extended period must be questioned. Planning for several smaller gasification plants generating the same amount of natural gas could prevent that supply problem.

Another short-term stability problem is associated with the mining of peat. It appears that peat can only be mined during the months of June, July, August, and September, with production peaking sometime in July and August. Mining peat requires drained land and unfrozen peat. Spring flooding also can limit the mining period. In the northern regions of Minnesota, the first and last frosts of the season occur during the first weeks of September and the first week in June. In hydraulic mining, a slurry method is used to transport the peat to the conversion facility. This slurry may be as much as 97 percent water and temperatures must be high enough so that the slurry does not freeze (Conklin 1978, p. 3-2). The short harvesting season of northern climates means that, under current levels of technology, all of a conversion plant's feedstock must be collected over the summer months. Chronic seasonal unemployment may be created, causing economic hardships for those relying on peat mining as their major source of income.

Conclusions

While all of the energy approaches discussed in this chapter appear to be technically possible, their relative economic feasibility and social desirability have not been demonstrated. Based on examination of these alternatives, several general observations are noted:

- The quality and quantity of energy which could be produced from peatlands has not been identified. Nor has the market value of this energy been established. Thus, the profitability of any of these approaches has yet to be demonstrated. Those private efforts now underway have been heavily subsidized through public expenditures and for that reason do not necessarily indicate that peatland development for energy will be profitable.
- At present there is no reason to believe it is not technically feasible to utilize either peat or biomass to produce energy through direct burning, gasification, liquefaction, or briquetting or pelletizing for combustion. However, economic factors will probably determine the forms of energy which can practically be produced and used.
- Current industry and government proposals for deriving energy from the state's peatlands are geared almost exclusively to large-scale peat gasification. To a much lesser degree, gasification of energy crops is also being considered. This focus on gasification is somewhat puzzling in light of the fact that the major energy-supply problems for the country and the state are related to decreasing supply and increasing prices of liquid fuels. Moreover, Minnesota has given little attention to the direct combustion and briquetting approaches, despite the fact that these have been traditional uses of peat elsewhere in the world.
- The total cost associated with each approach has not been identified.
- Estimates of the energy efficiencies of the various approaches have been summarized in this chapter. The net-energy values of the approaches that involve peat extraction depend in part on the particular mining method used, with sod peat mining offering the highest preconversion energy efficiency. Hydraulic mining has a significantly lower net energy value. Gasification, cogeneration, and district heating all have similar net energy values, while briquetting is significantly more energy efficient.
- Growing energy crops, using peatlands as a renewable resource, provides significantly longer-term supply stability than all extractive approaches.

V. THE IMPACTS OF PEATLAND DEVELOPMENT

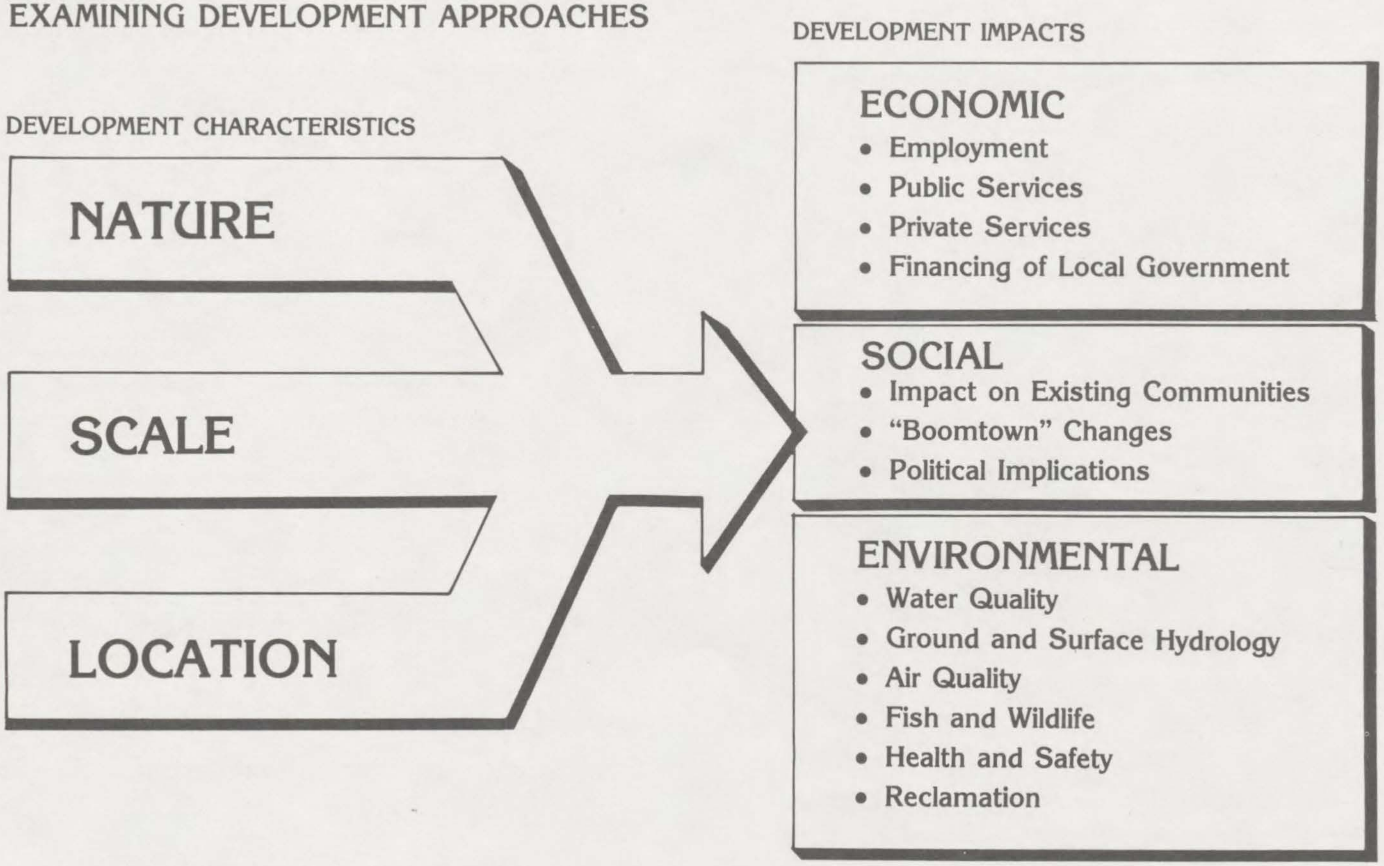
Industry, government, and citizens share responsibility for the wise use of Minnesota's peatlands for energy. While Minnesota's energy situation and economic condition could be improved through the development of its peatlands, the degree to which those potential benefits are realized will depend on how and where energy development occurs. Because most of the peatlands in the state are still undisturbed, Minnesotans have the chance to plan carefully for their use, and to consider not only all possible energy options but their potential implications as well.

In this chapter, three categories of impact--economic, social, and environmental--are examined. The first part of the chapter identifies issues associated with economic development and discusses how they relate to the region's labor force, the stock of private and public services, and the ability of the region's governmental units to offset possible negative impacts. The second portion presents a case study that illustrates the possible impacts of a specific development project currently being considered for Minnesota and compares the capacity of two regions of the state to accommodate such a project and its economic impacts. Social impacts dealing with the effects of boomtown growth and changing lifestyles due to development are discussed in the third portion of the chapter. The fourth part summarizes the possible environmental impacts that are possible when peatlands are developed. The manner in which Minnesota is affected will depend on the nature and scale of specific projects and their locations within the state. Figure 16 provides a framework for examining these interlocking factors. These factors and how they relate to the possible economic, social and environmental impacts are discussed in the final section of this chapter.

ECONOMIC EFFECTS

Development of Minnesota's peatland for energy is being considered in part because it could provide economic development to northern Minnesota's troubled economy, particularly on the Iron Range. There is no question that if exploitation of this largely undeveloped resource becomes economically

Figure 16
EXAMINING DEVELOPMENT APPROACHES



feasible, it could generate new jobs and income, create new industry, and expand the range of goods and services. However, realizing these potential benefits will depend on how and where development occurs. This section contains a discussion of the potential economic impacts associated with development. The degree to which these are negative or positive depends on the specific nature and scale of energy projects and their particular locations in the state.

Planned economic development of a region follows one of two approaches. The first approach is to maintain the status quo by attempting to minimize changes to both the economic and social systems of the region. The second is to introduce economic expansion by either broadening the economic base of the region or by altering it so it becomes more diversified. Each approach requires matching the needs of a development project to what a particular site can supply. Table 7 summarizes the important factors in this matching process. The nature and scale of a project determine its needs, and the private and public sectors of the region must be capable of meeting those needs. If the matching process is unbalanced--if a project is inappropriate for the site--there can be adverse impacts that burden the region's residents and its governmental units.

Employment

Increased employment and income are beneficial for a region's economy. Economic development through a new industrial project can enhance a region's economy in two ways: by maintaining existing employment and income levels or by promoting economic expansion--more jobs and income--in the region. Depending on the specific nature, scale, and

Table 7: Economic Development Relationship Between the Nature and Scale of a Project and Its Location.

Nature and Scale Determines	Location Determines
Required number of employees	Available labor force
Additional population due to development project	Stock of housing Municipal services Educational system Transportation system
Disposable income generated by development project	Increased expenditures and jobs in retail trade entertainment and other industries
Tax revenue generated by development project	Increased public expenditures to provide required services

the particular location of a project, development of Minnesota's peatlands could benefit regional economies either by preventing decline or promoting expansion.

The development of the peatlands in these regions would represent a growth in the industrial base. Economic theory divides industries into two groups, basic and nonbasic. Basic industries account for a larger share of a region's employment than in the nation as a whole. They are not dependent on the region's economy and usually serve outside markets. As external demand causes increased production in the basic industries, income earned by their employees increases. This additional income is spent for goods and services produced by the nonbasic industries, such as retail trade and government, which are dependent on the economic activity generated by the basic industries. An example of this basic-nonbasic relationship can be found by examining the taconite and iron ore industries in northeastern Minnesota. Towns such as Gilbert and Aurora, that supply the service or nonbasic industries, may not have even existed if not for the basic iron ore or taconite industries.

A large-scale peatland operation would constitute a basic industry. Construction and operation of such a project in an unpopulated area would result in an increase in nonbasic industries as well. The employees of the plant and their families would demand such services as food stores, health care, and services supplied by various government agencies. Present communities would be expanded and new towns might be created.

The addition of the basic industry and the associated nonbasic industries may do much to bolster a region's economy and maintain employment and income levels. The region's ability to supply the work force needed to operate a development project depends on the amount of local labor available. Factors that determine the amount of available labor include the unemployment rate, the region's population, competing employment opportunities, the distance of the project site from the region's communities, and the wage rate (Wieland, Leistritz, and Murdock 1979, p. 61). In addition, the scale of the development project is important. If a small project is planned, most regions will have little problem supplying the needed work force. A large-scale project, in contrast, may require many more times the workers than a region can supply, and outside labor will have to be brought in.

A possible population gain resulting from large-scale development over a relatively short period of time could create the situation referred to as the "Gillette Syndrome." In Gillette, Wyoming, the local labor force in the sparsely populated region was too small to supply the workers required for large-scale coal development. A huge influx of workers and their families occurred over a short period of time, bringing many economic, social, and land-use problems to the small Wyoming town. In more populated areas, the employment requirements for a project this size might be supplied by the local labor force, and the adverse impacts of development would be minimized.

Economic development can be used to maintain the status quo in an area such as northern Minnesota or a development project can play a larger role by locating in areas of depressed economic activity. Chronic unemployment and low regional income, characteristics of depressed economic activity, can be alleviated by matching a development project to a specific region.

An example of an earlier, successful matching process can be found in this state. For many years, northeastern Minnesota has been plagued by cyclical economic activity. In the 1960s, as the sources for higher grade iron ore began to dry up, the mines began to close and the region experienced high unemployment. The ill effects were felt more widely than on the Iron Range; the decreased economic activity also hurt other portions of the state because the iron ore industry provided a large portion of Minnesota's gross state product. The increased unemployment and welfare payments placed burdens on many governmental units. When the taconite industry developed, in the 1960s, the export income of the region's mining industries grew and a level of near-full employment and increased economic activity returned. In this example, research led to the development of a new industry that utilized the region's resources. A peat industry could play a similar role.

Development of the peatlands must be undertaken carefully to avoid a short term boom. Extraction of the peat resource would offer only a short term opportunity for exploiting the peatlands and longer term jobs would be questionable. A biomass development (or a peat extraction/biomass combination) has a better chance of supplying jobs for a much longer period since a renewable resource is utilized.

The local labor force is an important part of economic development. If a region's labor force is large enough (the metropolitan area, for example), even the construction of a large-scale project may not have a significant impact. The opposite is true in an area without a large labor force. Thus, matching a project's scale with a region's ability to supply the required labor in the specified industries is an important factor in directing peatland development.

The number of workers available for specific industries is also important in siting a project for economic development reasons. Training employees for the operational phase of the project should be undertaken to make the best use of local labor. However, the construction phase requires certain trades that cannot be taught in a short period of time. Sufficient lead time would be needed to train construction workers from the region's labor force so that as many local workers as possib]e could be used.

Some jobs associated with peatland development for energy will be seasonal because of limitations due to climate (see previous discussion on energy stability). Technical problems resulting from seasonal climatic variation may affect the economic stability of the region. During the winter months, layoffs of mining or energy crop harvesting workers may cause unemployment problems. Other jobs or income for these seasonal employees must be found. Loss of income will place a burden on the workers and their families as well as on the surrounding businesses and governmental units. A work force characterized by a large turnover each season may mean a loss of both time and productivity compared to a work force that remains constant over a longer period of time.

Public Services

New development can greatly increase the demand for services provided by local government. The degree to which these public services can be supplied when they are needed depends on the rate at which development occurs and whether sufficient planning and preparation have taken place. The scale and location of development are important factors in determining the amount of public services required to satisfy the demand of the new population. Table 8 lists a summary of these services and the percentage of total expenditure by counties, cities, and townships for those services.

General government expenses are greater in larger districts as are the tax bases to pay for them. Smaller cities and townships have very few services to supply and do not need many employees. In contrast, counties and larger cities assume a much greater responsibility and must hire a larger number of employees. Smaller cities, as they grow in population, will sometimes require a wholly new set of services, thereby adding new employees in jobs where previously no service was supplied.

Public safety comprises the largest share of operating expenses for many cities. In sparsely populated areas, law enforcement is usually pro-

Table 8: Public Services Provided by Local Governmental Units.

	Percent of Expenditures for Services		
	Counties	Cities	Townships
1. General Government Elected officials, office workers, tax collectors, administrative personnel	13.6	8.4	14.5
2. Public Safety Law enforcement, fire, ambulance	8.8	19.8	7.4[a]
3. Health Hospitals and nursing homes, public health, civil defense	5.3	1.4	-
4. Transportation Street and highway, intra- and inter-city bus service	21.9	17.4	65.4[b]
5. Education Capital costs, operating costs	*	*	*
6. Sanitation Sewer, water, waste disposal	-	15.0	2.8[c]
7. Libraries	1.5	1.6	-
8. Parks, Recreation, and Conservation	3.1	10.9	-
9. Insurance and Interest Payments	-	6.4	1.1
10. Welfare	40.6	-	-
11. Other	5.2	19.1	8.8

*Funding is through a special tax for school districts and from state funding.

(Carlson, A.H. Report of the State Auditor of Minnesota on the Revenues, Expenditures, and Debt of the Local Governments in Minnesota, April 1980, pp. 22, 50, 58.)

[a - just for fire protection; b - road and bridge expenditures; c - just for sewer and water] vided by the county. The sheriff's department must cover a large area, and as population increases the job becomes more difficult. Cities provide their own law enforcement. Demand created by a population increase can be distributed in an orderly fashion--and most likely met at a lower cost--over a large, concentrated population.

Fire departments serve in much the same way that law enforcement agencies do. Larger cities supply the surrounding area with services. In return, the smaller cities and the rural townships pay for the services through intergovernmental payments. The more dispersed a population is, the less efficient the fire service is. As in the case of law enforcement, a large population gain could be easily absorbed into a large present population, and fewer purchases of new fire fighting equipment would be necessary.

The level of hospital and ambulance service usually depends on the size of the population. For example, more hospital beds and a greater diversification of health services are needed as the population increases. Additions to present facilities can often be less expensive than building new ones. For this reason, development in areas where there is a larger, established population with an existing health care system is of smaller financial consequence than the same development in a sparsely populated area.

The transportation network is an important factor in determining the total cost of a development project. Construction costs for new or upgraded roads are substantial. According to 1977 figures, upgrading a two-lane gravel road to a two-lane paved road costs $70,000 per mile. To widen a two-land highway requires an investment of $160,000 per mile (Waldum 1979, p. 20). Because an expanded population requires new residential streets and upgraded highways, a large burden is put on the local governments. State and federal aid for construction of new roads helps decrease the burden, but the increased costs can still place considerable stress on local government budgets.

Education is administered through special administrative districts. Revenue for individual school districts comes from a combination of property taxes, a state revenue-sharing program, and a series of special state and federal grants. Rapid and significant population increases resulting from a large-scale development project could have devastating effects on individual school districts. A dramatic example occurred recently in

North Dakota during construction of a large-scale military project in North Dakota that put great financial strain on the educational system. One district attempted to raise the tax mill rate for education, but the increase was voted down by the public. This school district did not have funds to pay its staff and almost shut down for financial reasons (Boe 1975, p. 148).

Before residential development in a concentrated area can take place, planning and construction of a sanitation system is necessary. This means that construction of a sewer and water system and provision for waste disposal is necessary. Costs for such systems can be a great burden on smaller communities. An even greater problem arises when cities and towns construct sewer and water facilities in anticipation of a new development only to learn that the project for which they were preparing is cancelled. This happened in North Dakota when an American Natural Resource coal gasification plant ran into financial difficulties. One small community, Hazen, sacrificed essential public services to construct a new sewer system. These unnecessary sacrifices can result in cutbacks for health care and education systems (Paul 1980, p. 46).

Parks, recreational facilities, and libraries provide services that usually must be expanded to meet the demands of increased population. This is particularly costly for areas with few, if any, of these services, such as rural areas. Provision of these services can be delayed while other "essential" services are made available, but not without diminishing the local quality of life.

Insurance costs for governments increase as governmental units build roads and add other capital items to their inventory. As a community adds to its supply of facilities, it must sell more bonds to pay for them. Interest payments will increase in relation to the amount of bonds withstanding. While welfare costs make up a significant portion of a county's budget, the initial impact from a development project will be minimal. But as an industrial facility approaches the end of its operational life, welfare costs to the county could increase when people are laid off for extended periods of time.

Private Services

Just as new development can add to the demand for public services, the supply of private services in a region must also increase. Privately supplied services include housing, construction, transportation, communications, utilities, retail and wholesale trade, and entertainment.

In most communities, there is little difficulty in matching the stock of housing with the demand. If development does not occur in an orderly fashion, however, this matching process becomes difficult. A large-scale peatland development project could cause adverse impacts on a region's housing stock. Factors determining the extent of these impacts include:

- size of incoming population;
- demographic characteristics of incoming population (i.e., married or single, and number of children);
- the region's supply of housing;
- distance and location of surrounding larger communities that could possibly supply housing; and
- the region's ability to supply temporary housing.

Any significant change that results in demand for a large increase in housing causes problems not only for the new residents but also for the original residents. These problems include:

- increased cost of housing;
- increased housing values and property taxes;
- inadequate zoning requirements; and
- competition for construction materials and workers, resulting in shortages and increased costs.

Renters of either multiple or single family dwellings may experience the greatest problems. The new workers often have larger incomes than do the original residents. This is most evident if the project is located in a rural area with little prior industrial development. During construction of the Anti-Ballistic Missile project in North Dakota, competition for housing resulted in enormous increases in rental prices. Dwellings that previously rented for $50 suddenly rented for $200-$250 a month (Boe 1975, p. 147). For the project's workers this might not be a problem, but for others --such as those living on low or fixed incomes--it can be an enormous burden. Important goods and services that were previously purchased must now be foregone to pay for the housing price increases.

To minimize these problems, substantial lead time is important for planning and constructing residential housing. Protecting present residents should be an important element in the planning process. Another critical component is a detailed inventory of the region's housing stock and the requirements of the incoming population. Such an inventory will directly aid the matching process and will help to minimize the possible adverse housing impacts. Federal housing programs and the possibility of temporary housing may lessen the impact.

Actually measuring private services can be very time consuming because it requires an inventory for the entire region. It is also difficult to arrive at a consistent definition for all the services being inventoried. Therefore, an alternative method, measuring the total amount of retail trade, may be used. Use of this measurement rests on the assumption that total retail sales measure the amount of private services available to the residents of a region. Larger retail sales mean that not only are more customers buying the city's or region's products, but also that those customers may have a greater selection of services. Communities differ in the types of services they offer. Hamlets have few if any services, while communities the size of Hibbing or Bemidji offer complete shopping areas. Cities such as Minneapolis or Duluth are wholesale as well as retail centers.

Increased population due to a development project creates problems when attempts are made to meet demand for private services. Competition for local labor, which is already intense from the construction of the basic industry, can cause shortages in the operation of private services (e.g., retail clerks and mechanics) and in the construction of facilities for such services. Housing construction and the project itself compete for construction workers. Professionals must be encouraged to locate in less-developed regions, but many professionals and businessmen may not wish to take the risk of locating when development may last for a relatively short period of time.

The expansion of private services may promote economic growth in a region, but there are other factors such as inter-industry linkages, that must be taken into consideration. A region's linkages promote further growth as the region's demand for goods and services increases. These linkages are a measure of the amount of interdependence among a region's industries. The greater the interdependence, the more income remains inside a region as demand increases. This results in a region's relying less on other regions for the production of goods and services demanded by its residents.

Financing Local Government

Of all the sectors of a region's economy, local governmental units may face the most difficulty in dealing with construction and operation of a peatlands development project. The difficulties that arise are related to the location and scale of the plant and the size of the governmental units. If the project is small and employs only a few people, the responsibilities of the governmental units are accordingly small. On the other hand, a project employing 2,000 workers or more may drastically change the local government unit's customary guidelines and priorities. A project's location determines the governmental units affected, and the size of the units (township, city, county) determines the extent of the impact. For example, since a larger community has more facilities than a smaller one, the negative impacts of a large development project will most likely be less severe.

Insufficient lead time causes many of the problems local governments have in dealing with the influx of a large number of people. These problems include: widespread and unplanned development, stretching the capacity of existing services, and insufficient financing for building the required public services. This last problem is further intensified by the fact that tax revenues generated from peatland development may lag behind the need for public services. For this reason, many local governments must often cut back on services to long-time residents so that more money can be directed to planning and constructing new services.

Finding capital for construction of public services is the first step after the needs have been identified. For smaller communities, the amount that must be spent on these new services may be far above what the community has spent previously. For larger communities, the size of the expenditure is just one of many factors in the decision to build more public services.

Under present regulations, financing for services is the responsibility of the local community, which must borrow the required capital through the bond market. There are two general types of bonds available to local governments for financing of public services: revenue bonds secured by revenues from a particular service, and general obligation bonds levied against the tax base of the community. The money received from the bonds is then paid back over a long period of time. There is, however, a state law governing bonding limits for communities, based on the total valuation of property within a community's boundaries. Once a limit is reached, the community must apply to the state legislature for an exemption or it must explore other means of financing. Two significant problems associated with this bonding limit are that the limit is not based on the valuation of new property but only on the existing stock, and that financing of future services and facilities must also be included in this bonding limit. If the community has already borrowed to its capacity, another alternative must be found.

Except for selling bonds, other means of financing for new services are limited. Special assessments to build new services are often used in established communities. An assessment is placed on the homeowner or business, and the service is paid for over a specific period of time. Unfortunately, "up front" money is required to pay for construction costs, and this is usually supplied by selling bonds. Another financing method is the sale of any securities that a community holds; but few communities are able to utilize this form of financing because of the lack of securities to sell. A community can also use short-term borrowing as a way of raising capital, but this is generally much more expensive than long-term borrowing (bonds) in terms of interest charges and must be paid back in a much shorter period. Finally, a community can increase the taxes of its residents and commercial businesses. This type of funding could run into serious opposition from taxpayers, since they would be paying for services for the incoming population, not just for themselves.

Because there may be a number of financing possibilities available, a detailed examination of these for each community is needed. Capital requirements, the past bonding record, the general financial condition, the tax base, and a number of other factors must be examined before a decision can be made about what financing alternatives are best. It is likely that even a combination of the above alternatives cannot fully finance the construction and operation of new services. At that point, a community must look to outside sources for financial aid. The federal government, through programs from such sources as the Farmers Home Administration, the Department of Housing and Urban Development, the Economic Development Association, and the Small Business Administration, can help communities to provide services (Stadig 1975, p. 150). Congress has also enacted the Energy Impact Area Development Assistance Program. Although this program is directed at coal and uranium development, it could possibly aid communities experiencing adverse impacts from peatland development projects.

Another source of aid is community impact funds such as those used in Montana and North Dakota. Their role is to help communities meet the costs from the impact of a development project. Such funds are financed with severance taxes on the extracted resources.

A severance tax on peat could help finance a community impact fund, although it would do little to help in the project's initial stages since funding would not be available until after the peat had been extracted. A solution to this problem would be for the fund to have the power to borrow from capital markets. Administratively, this fund could be a unit of an overall peatlands development agency patterned after the Iron Range Resources and Rehabilitation Board. Another method of taxation would have to be developed if the peatlands were used for growing biomass, since the severance tax cannot be applied to a non-extractive resource.

Local governmental units must prepare for other problems that could result from peatland development. There is, first, the possibility that thriving communities could become ghost towns once the resource base has been depleted. New industry must be planned to prevent such a boom-bust cycle. The taconite industry's Northeastern Minnesota Economic Protection Fund could be a model. Another possible problem--one that would require cooperation between local government--is that adverse impacts may occur in one community while another receives the tax revenues from the project. For example, if a project were developed in southwest Koochiching County, areas of Beltrami and Itasca counties would feel the effects from development. A transfer of tax revenues by a regional unit such as a regional development commission could aid those communities experiencing adverse impacts.

CASE STUDY: TWO NORTHERN MINNESOTA SITES

Because of the possible positive and negative impacts from peatland development, an example of a large-scale 250 million cubic foot gasification plant is used to illustrate these impacts in two study areas, each with different regional characteristics. This analysis is based on a current project proposal that would mine, on a large scale, 314,000 acres of land containing 200,000 acres of peat in north-central Minnesota. The project is the most specific and seriously considered proposal in Minnesota at this time. This analysis examines many of the factors of economic development discussed in the previous section and demonstrates the importance of matching a specific development project to a particular region. When that matching process is carried out, not only are potential impacts identified but adverse impacts can be diminished or avoided. Many of those impacts have occurred as the result of previous large-scale development, particularly in the Minnesota taconite industry and in the coal and lignite developments of Wyoming, Montana, and North Dakota.

The first study area is located in southwest Koochiching County near the town of Margie (see Figure 17). The hypothetical plant is centrally located in an "eligible region" identified as meeting the necessary resource and accessibility requirements for large-scale mining and gasification (Ertec Atlantic, Inc. November 18, 1980, Attachment 6-8).

A site-selection process was used by Ertec Atlantic, formally Fugro Inc., a consultant to Minnesota Gas Company, to select eligible regions for large-scale peatland development. This process utilized the "Delphi" technique involving a panel of experts from various backgrounds. First, areas unable to support large-scale development because of environmental, engineering, or resource factors are eliminated and areas "eligible" for development are selected. Next, issues are identified and weighed by the panel. The weighed issues are then evaluated for each eligible region and a "preferred" site is chosen according to the evaluation (Ertec November 3, 1980, p. 6-7).

Figure 17
Location of Study Areas

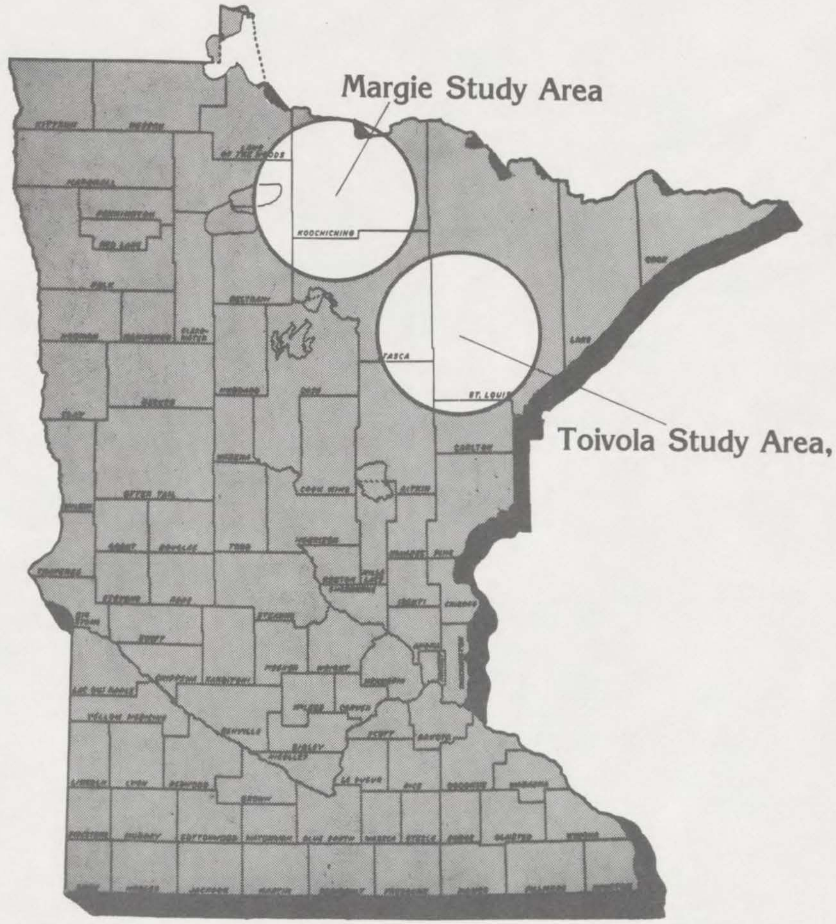
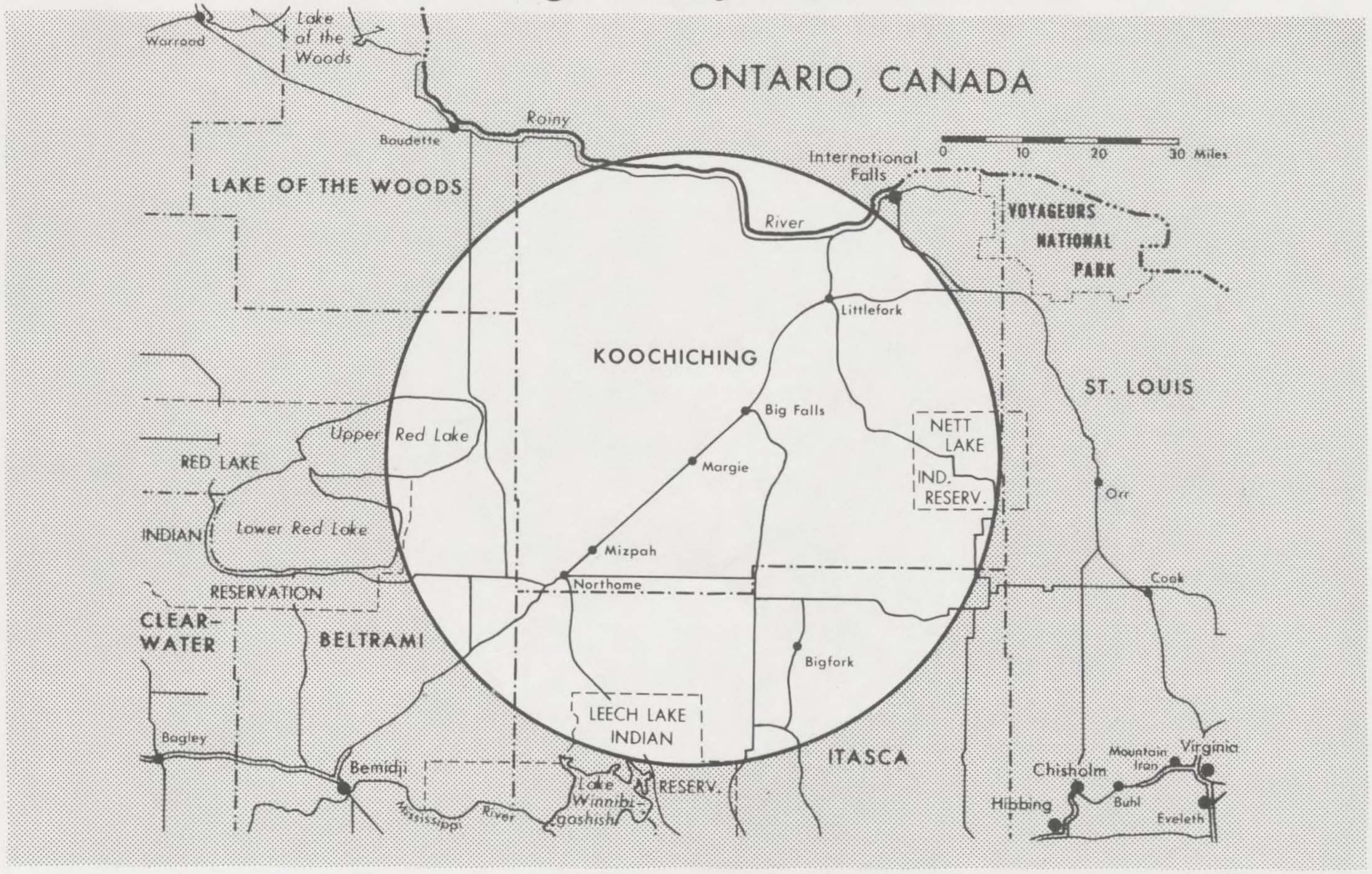


Figure 18

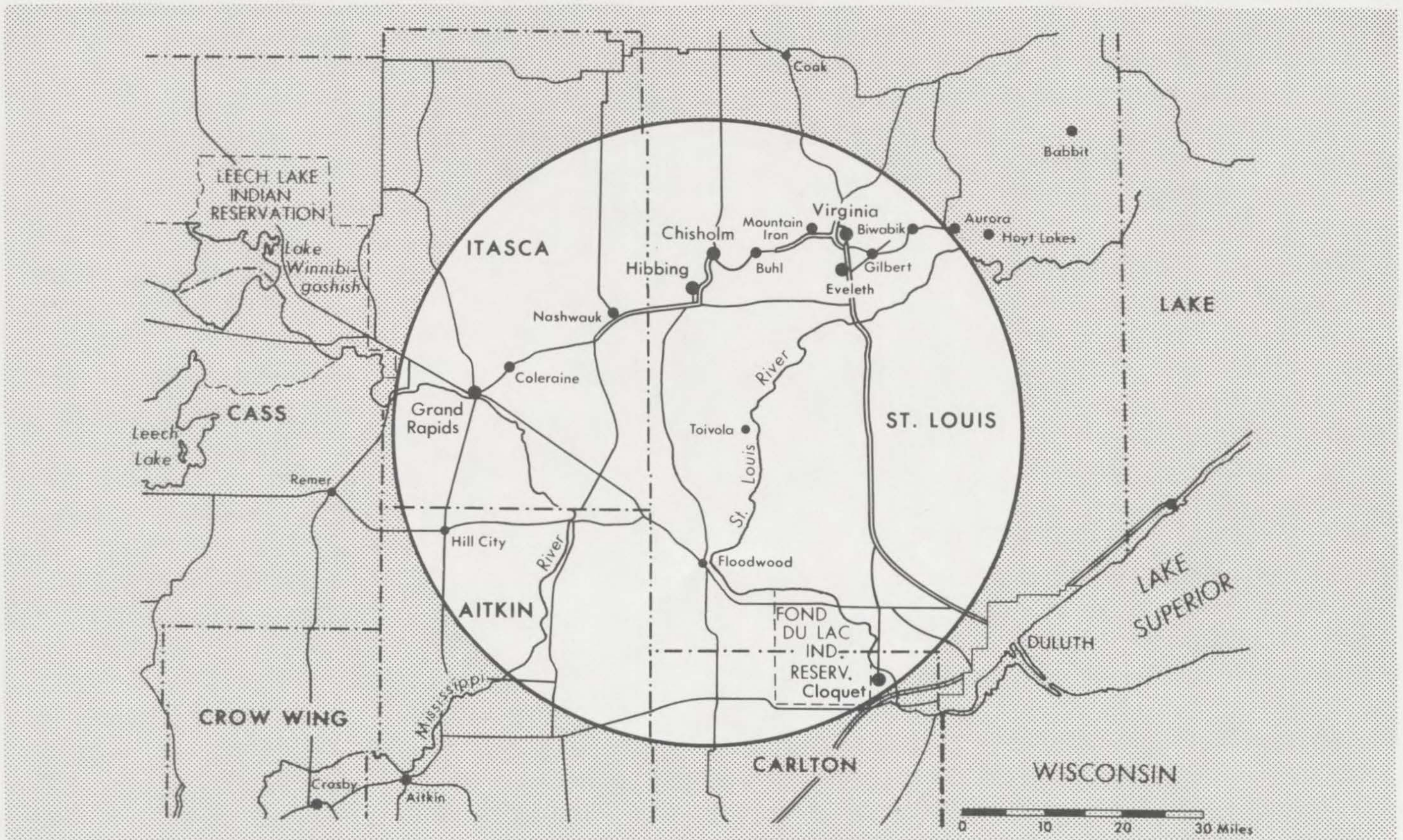
Margie Study Area,



The second study area is in southwest St. Louis County near the town of Toivola (see Figure 17), an area which was classified as "eligible" for a large-scale development project by the Ertec Atlantic study and which also has drawn "unofficial" interest from Northern Natural Gas Company. It is located south of the Iron Range communities of Hibbing, Chisholm, and Virginia.

Surrounding each site is a development area with a 40-mile radius centered at a possible loca-

Figure 19
Toivola Study Area



tion of a plant (see Figures 18 and 19). A 40-mile radius represents an area of potential impact over a longer time span. It is based on a study examining the characteristics of the labor force associated with North Dakota lignite development. That study assumed that a representative commuting region should have boundaries confined to 40 miles from the development site (Wieland, Leistritz, and Murdock 1979, p. 58). Actual commuting distances within the development area can be longer than 40 miles, depending on the extent and location of the roads. The same study surveyed construction and operational workers and found that the average commuting distances were 33.6 and 21.9 miles respectively. Other studies have shown that as a project moves into the operational phase, workers tend to move their residences closer to their place of employment (Leholm 1975, p. 136).

Population Characteristics

Population figures from 1977 indicate substantial population differences between the two development areas. Table 9 summarizes the 1970 and 1977 population data. The Margie study area has a population of 20,433 people. It is predominantly rural; only 18 percent of its people reside in incorporated villages or cities. The rest are spread through the sparsely populated regions of north-central Minnesota. In contrast, the Toivola study area has a population of 133,133, 57 percent of which live in incorporated villages or cities. A significant portion of the population of this second site is concentrated in a band of communities that runs from Grand Rapids to Virginia. Tables 10 and 11 summarize the population of the communities that surround the two study areas and the distance to the possible plant site. It is evident that a much larger number of people live within driving distance to the Toivola plant site than the Margie plant site.

Each area is affected by an outside population center. Duluth lies just beyond the Toivola study area's boundary. The population of this city and surrounding area is in excess of 100,000. It is possible that construction workers could commute from Duluth to the plant site. The Margie study area lies between two major cities in north-central Minnesota--Bemidji and International Falls, with 1977 populations of 11,490 and 8,842 respectively, and are within 20 miles of the study-area boundaries. Although these two cities could not contribute the workers and services that Duluth could, they still could have an impact on the population and employment patterns at the plant site.

Since the entire 1977 population of the Margie study area was only 20,433, mostly scattered in sparsely populated rural areas, a doubling of the population due to the construction and operation of a peat conversion facility could create the need for extensive additions to the present stock of public and private services. This would add a considerable burden to present and future residents of the area.

Table 9: Population for the Margie and Toivola Study Areas, 1970 and 1977.

Margie Study Area	Incorporated Villages/Cities 1970	1977	Rural 1970	1977	Total 1970	1977	Percent Change
Beltrami	903	1,079	1,890	2,431	2,793	3,510	25.67
Itasca	677	810	4,463	5,517	5,140	6,327	23.09
Koochiching	1,827	1,791	6,446	6,678	8,273	8,469	2.37
Lake of the Woods	0	0	2,036	2,176	2,036	2,127	4.47
Total S.W. Koochiching Development Area	3,407	3,680	14,835	16,802	18,242	20,433	12.01
Toivola Study Area							
Aitkin	606	836	2,447	2,987	3,053	3,823	25.22
Carlton	9,012	11,741	4,768	2,230	13,780	13,971	1.39
Itasca	13,468	15,487	23,175	27,749	36,643	43,236	17.99
St. Louis	47,809	48,129	19,798	23,974	67,607	72,103	6.65
Total S.W. St. Louis Development Area	70,895	76,193	50,188	56,940	121,083	133,133	9.95

(Adapted from U.S. Department of Commerce. Bureau of the Census. Current Population Reports: Population Estimates and Projections. "1977 Population Estimates for Counties, Incorporated Places, and Minor Civil Divisions in Minnesota." Series P-25, No. 836. November, 1979)

A more suitable site is the Toivola study area. Its larger population could mean that many of the impacts of large-scale development could be accommodated. A possible gain in population due to increased employment in both the peat industry (the basic industry) and the industries that serve it

Table 10: Road Mileage to Plant Site and Population of Surrounding Communities: Toivola Study Area.

City	Mileage	1977 Population
Floodwood	20	639
Hibbing	23	16,209
Chisholm	28	6,036
Grand Rapids	34	9,400
Eveleth	39	4,635
Virginia	40	11,487
Cloquet	53	11,445
Duluth	55	100,578

(Adapted from Minnesota Department of Transportation. Minnesota 1977-78 Official Transportation Map. May 1977; U.S. Department of Commerce. Bureau of the Census. Current Population Reports: Population Estimates and Projections. "1977 Population Estimates for Counties, Incorporated Places, and Minor Civil Divisions in Minnesota." Series P-25, No. 836. November 1979.)

(the nonbasic industries) would represent a much smaller increase in population. The pressure generated by a population gain of this magnitude would not be as great because local labor could be hired and the existing public and private infra-

Table 11: Road Mileage to Plant Site and Population of Surrounding Communities: Margie Study Area.

City	Mileage	1977 Population
Big Falls	9	527
Mizpah	15	124
Northome	20	335
Little Fork	28	805
Blackduck	33	777
International Falls	48	5,884
Big Fork	50	473
Bemidji	68	11,490
Grand Rapids	82	9,400

(Adapted from Minnesota Department of Transportation. Minnesota 1977-78 Official Transportation Map. May 1977; U.S. Department of Commerce. Bureau of the Census. Current Population Reports: Population Estimates and Projections. "1977 Population Estimates for Counties, Incorporated Places, and Minor Civil Divisions in Minnesota." Series P-25, No. 836. November 1979.)

structure could be used.

Employment

In examining these two study areas, it is important to note the difference in the structure and size of the economy and labor force. These differ-

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ences can aid in directing development where it might help the most.

The labor requirements for a large-scale development project are demonstrated in Table 12. The example used is a 250 million cubic foot per day gasification plant. It has been estimated that a plant this size would require 2,700 construction workers and an additional 5,500 employees of service (nonbasic) industries. If little or no local labor is available, a population growth of 16,569

Representative communities in the two study areas: Northome (left), in the Margie study area, with a 1977 population of 335; and a portion of Hibbing (right), in the Toivola study area, with a 1977 population of 16,209.

could occur as the plant is being built.

During the operational phase, an increase in population to 22,114 could be expected. Family size varies between the construction and operational phase because many of the construction workers are nonlocal and their families do not accompany them. In addition, operational phase workers are more likely to be married than those in the construction phase (Wieland, 1979, p. 60). The indirect impact of family size is less since the typical industries often employ the second member of a family in jobs such as retail clerks.

Since planning must take into account the expected population gains over time, the pattern of these employment gains is important. Figure 20 demonstrates a possible sequence for the project discussed above. It is assumed that very few services and little local labor are available in the region prior to development. Until the third and fourth years, the increased population during construction outstrips the public and private services provided by the nonbasic industries. As a result, the people in the area must live with inadequate services during that time. As operation of the plant begins in the fourth year, permanent employees replace the construction workers. Obviously, many construction

Table 12: Potential Employment and Population Changes Due to Construction and Operation of a Large-Scale SNG Plant (250 m. cu.ft./day capacity).

	Construction	Operation*
Direct Impact		
Employment[1]	2,700	2,380
Family Size[2]	2.47	3.47
Population (derived from direct employment)	6,669	8,092
Indirect Impact		
Employment[1]	5,500	7,790
Family Size[1]	1.8	1.8
Population	9,900	14,022
Total Impact		
Employment	8,200	10,170
Population	16,569	22,114

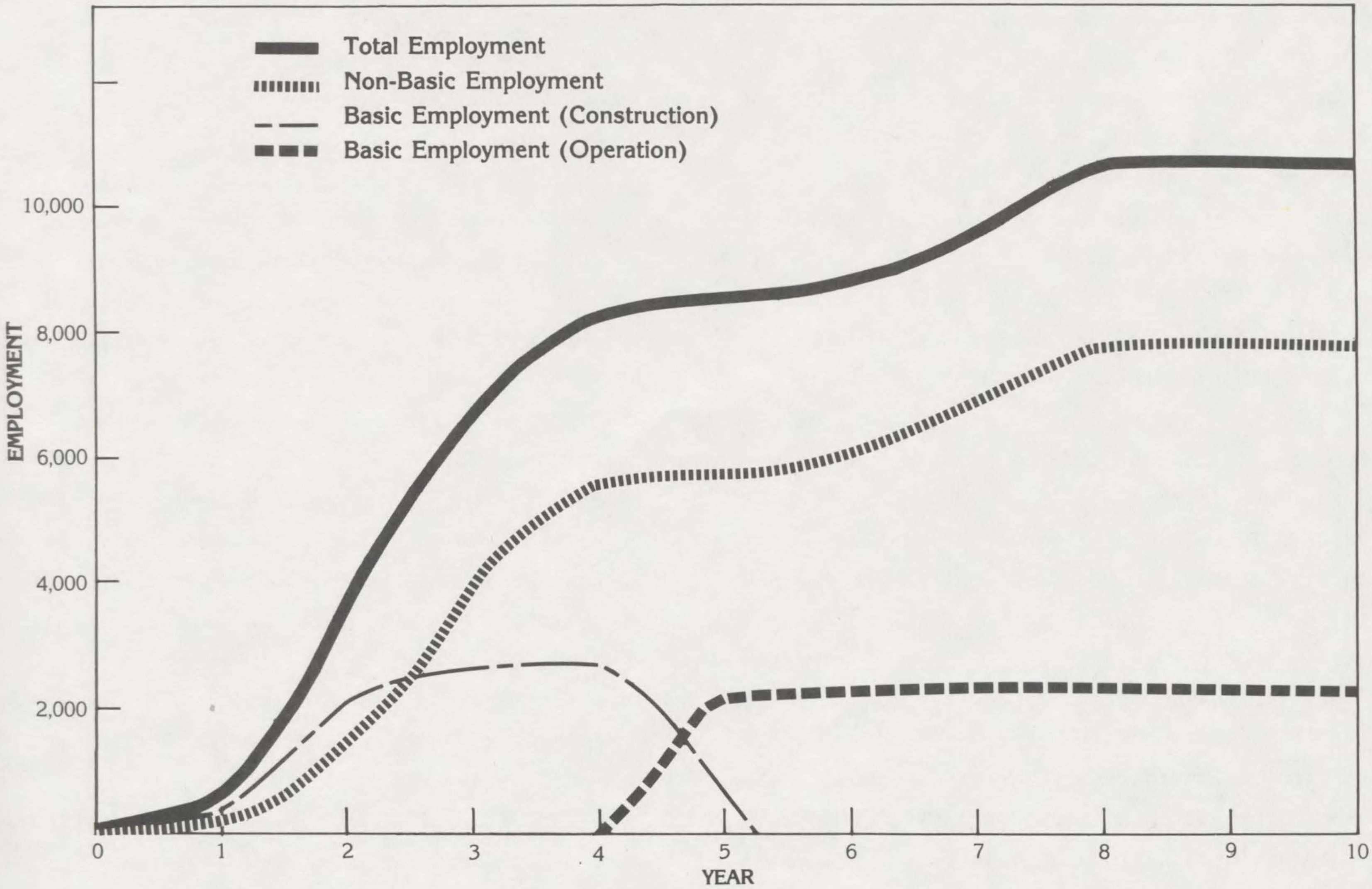
*Includes both employment at the gasification plant and for the mining of the peat.

[1]Meagher, Maki, and Laulainen, Economic Effects of Minnesota Peatland Development. February 1979.

[2]Wieland, Leistritz, and Murdock, Characteristics and Residential Patterns of Energy-Related Work Forces in the Northern Great Plains. July 1979.

Figure 20

Potential Employment Increase Due to Construction of 250 million cu. ft./day Gasification Plant.



workers will decide to remain as permanent employees, but this does little to change the actual pattern of employment. Nonbasic employment continues to grow, reflecting the greater need for services during the operational phase. Since the family of the operational phase employee is larger and more permanent, more public services, such as educational facilities, are required. The nonbasic employment does not reach a maximum until the eighth year because of the time it takes to construct these facilities.

The ability of a region to absorb the population increases due to the development project is partially demonstrated by examining each region's population. An addition of over 22,000 in the population of the Margie study area would mean a twofold increase in that area's residents. In contrast, the Toivola's area would only increase by 15 percent. The actual amount of impact will depend on the area's stock of services and how much local labor can be employed.

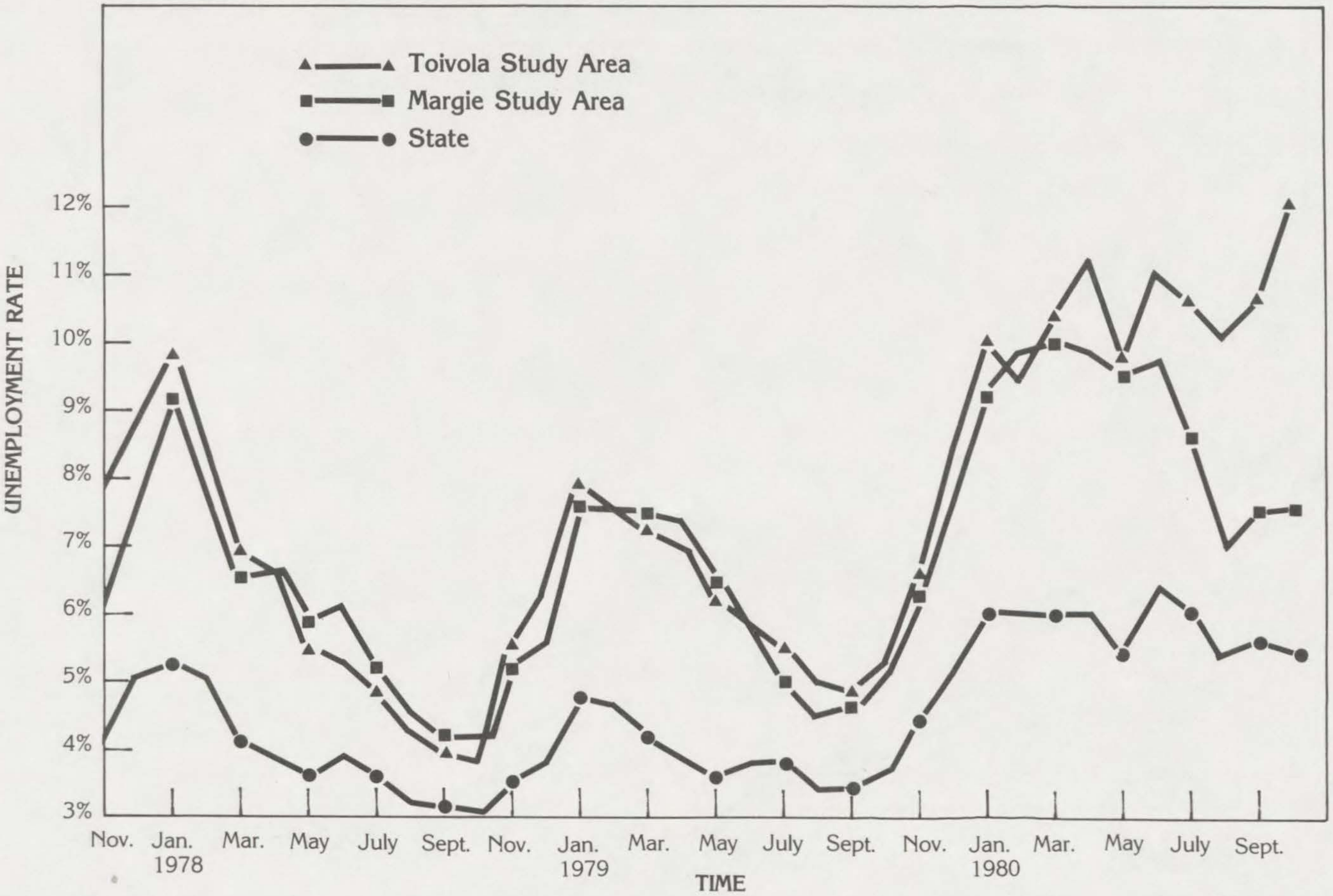
One key goal in economic development is to utilize the existing unemployed and underemployed in a region. The Toivola study area encompasses portions of the Iron Range. Presently, national and international actions have decreased the economic activity on the Iron Range. Stagnating demand for products such as automobiles and large appliances, combined with increased competition from foreign ore sources, has significantly reduced the level of exports from this crucial northeastern Minnesota basic industry. This is not the first time that the level of this region's exports has decreased.

This cyclical pattern of economic activity can be seen in the employment data of the past few years. Figure 21 demonstrates the unemployment rate for the last three years, while Figure 22 represents the total number of employed on a monthly basis for the same period. Since employment data is reported on the county level, two assumptions had to be made: 1) that the Margie study area primarily draws workers from three counties, Koochiching, Beltrami, and Lake of the Woods; 2) that the Toivola study area employs people residing in Carlton, Itasca, and St. Louis (excluding Duluth) counties.

Both areas show approximately the same rate of unemployment, one that is significantly higher than the rate statewide. Only for the period from June 1980 to October 1980 was there a significant difference between the two unemployment rates. During

Figure 21

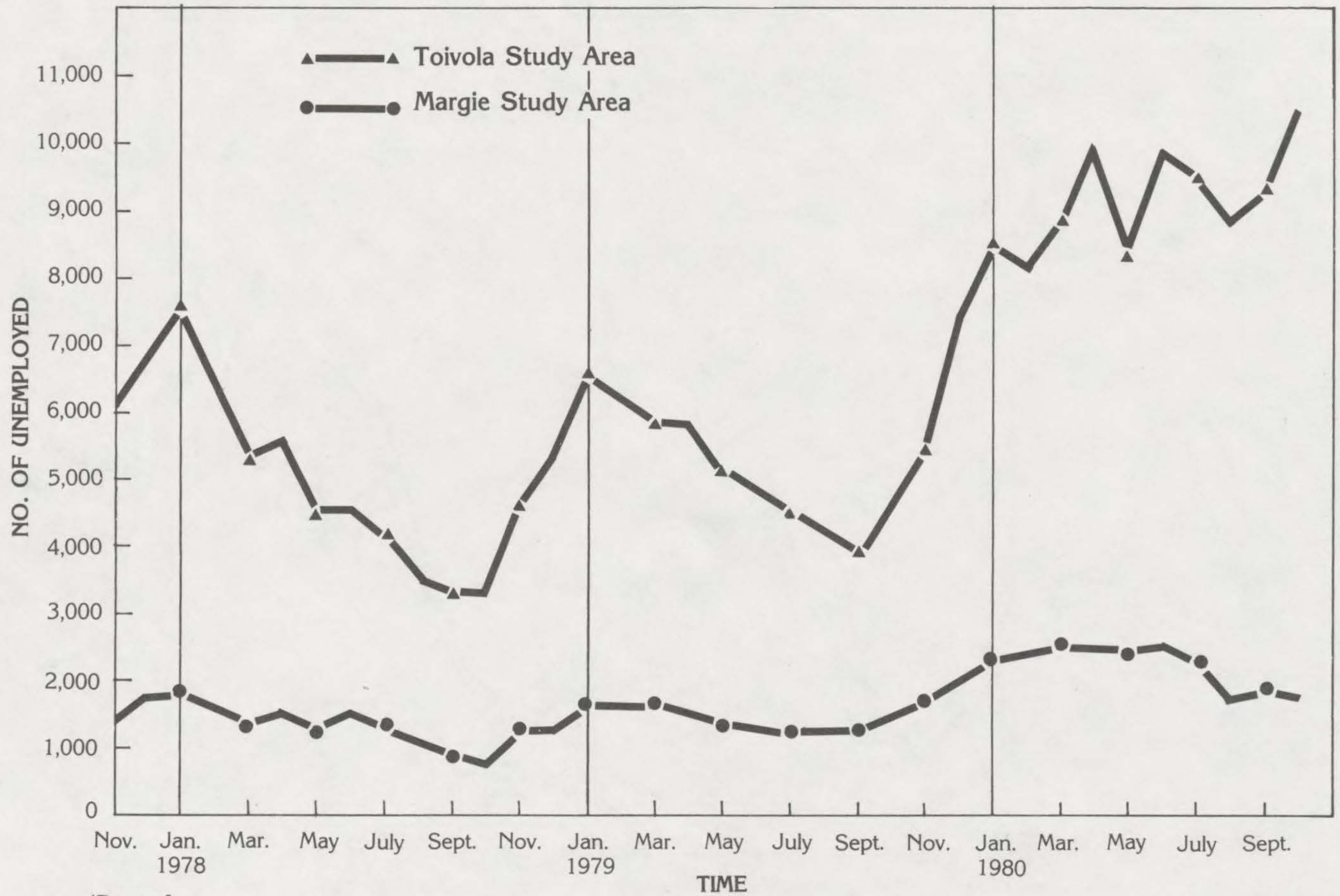
Unemployment Rate for: Toivola Study Area, Margie Study Area, and State of Minnesota, November 1977-October 1980.



(Data from
Minnesota Department of Economic Security. 1979-1980. *Northeastern Minnesota Labor and Market Review*. Duluth: Minnesota Department of Economic Security, Regional Labor Market Information Center. III, 1 - IV, 12.)

Figure 22

Number of Unemployed for Toivola Study Area and Margie Study Area, November 1977-October 1980.



(Data from
Minnesota Department of Economic Security. 1979-1980. *Northeastern Minnesota Labor and Market Review.* Duluth: Minnesota Department of Economic Security, Regional Labor Market Information Center. III, 1 - IV, 12.)

that period, the demand for steel products remained stagnant while other portions of the economy generally improved.

Even more important is the number of unemployed. While the unemployment rates are similar between the two regions, the number of unemployed is much greater for the Toivola study area. For example, in February 1980, when the two unemployment figures were almost the same, the Margie study area had 2,400 laborers out of work while the Toivola study area had over 8,000 unemployed workers. At no time during this three-year period did the Toivola study area have fewer than 3,000 laborers out of work.

A peat development project could do much to provide jobs for the unemployed. When as many local workers as possible are hired, the adverse impacts from development can be decreased and the economic activity of the region improved. But the choice of location is important. In contrast to the Toivola site, construction of the large scale gasification project in the Margie study area would likely lead to many of the adverse impacts associated with the "Gillette Syndrome" described earlier. The smaller number of available laborers, often fewer than 2,000, would mean that many construction and operational-phase workers would have to move into the region.

Employment in specific trades is also important. Table 13 details the construction and trade industries. The estimated 2,700 construction workers required for a gasification plant are almost three times more than the number of construction-industry workers now living in the Margie study area. In addition, a significant number of construction workers will also be needed to build housing and various services to meet the needs of a growing region.

The retail trade employment figures are included to demonstrate the extent of nonbasic or service industries for each region. The Toivola study area has almost three times the number of employees in retail trade than does the Margie area. Because retail trade is typical of all nonbasic industries, there is little doubt that the supply of services is much larger in the Toivola study area.

Public Services

The cost of providing new public services is increasing. If it is possible, development should be directed toward regions with an established network of these services, thereby lessening chances of overloading a region's stock of services. The capacity of each system should also be examined. It is apparent that there are large differences between the two study areas' ability to provide services to an increased population. These differences appear in the following services: public safety, health care, transportation, education, and sanitation (sewer systems).

Table 13: 1978 Employment by County for the Construction and Retail Trade Industries. (Annual Average not Seasonally Adjusted.)

County	Construction	Trade	Total
Beltrami	759	2,727	8,650
Koochiching	149	1,099	5,253
Lake of the Woods	92	241	1,153
Total for above counties	1,000	4,979	14,144
- - - -	- - -	- - -	- - -
Carlton	335	1,900	8,932
Itasca	748	2,885	12,677
St. Louis (excluding Duluth)	2,912	7,684	37,797
Total for above counties	3,995	12,469	59,406

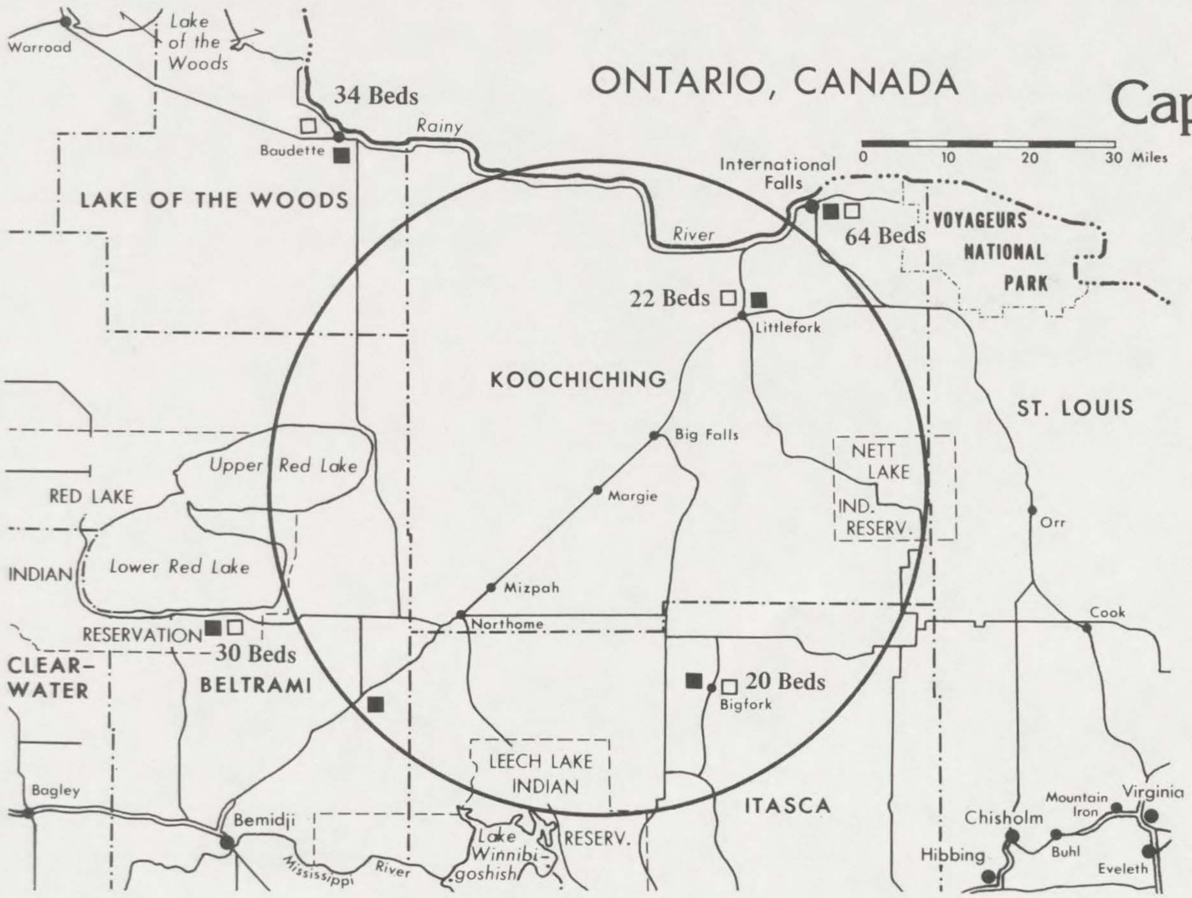
(Compiled from: Minnesota Department of Economic Security. Minnesota Employment & Wages by County. First Quarter 1977 - Fourth Quarter 1979.)

Because of its dispersed population, the Margie study area could require new fire and polic departments. Protection of public safety in the Toivola study area may be adequate since the population is larger and new residents could be distributed throughout areas with existing departments.

Figures 23 and 24 demonstrate the distribution of health care facilities (hospitals and ambulances) for the two study areas. The Margie study area has only 42 beds in two hospitals. The closest hospital to the study area's center is 28 miles away in Little Fork. In contrast, 553 beds in five hospitals are available in the Toivola study area, with the closest hospital 23 miles away in Hibbing. If the study area boundaries are extended 15 more miles, these hospital bed totals increase by 128 for the Margie area and 1,094 for the Toivola area. The Duluth area, which is adjacent to the Toivola study area, offers health care facilities that are supplied at very few locations in the state. Residents in the Margie study area would have a much greater distance to travel to receive these special services.

Figure 23

Location and Capacity of Hospitals and Ambulance Service for Margie Study Area.



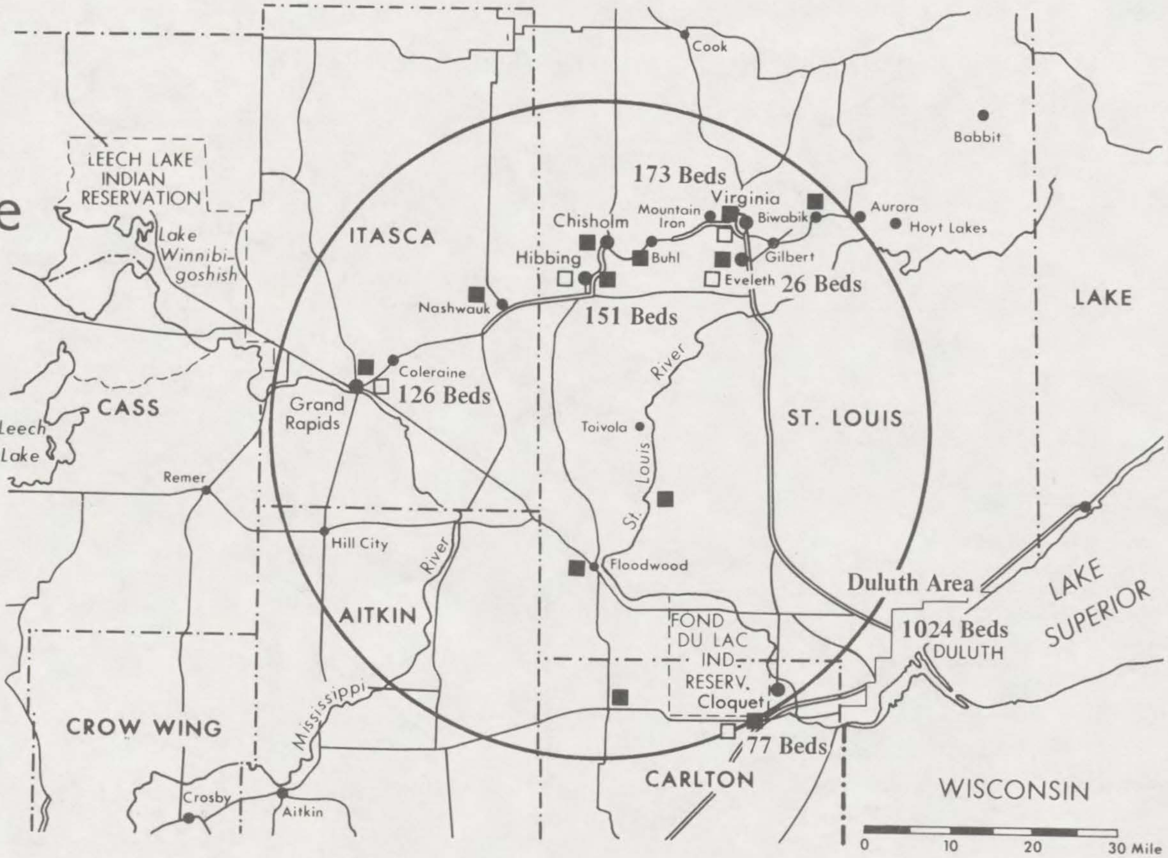
Legend
Hospitals □
Ambulance Service ■

(Data from Minnesota Department of Health. 1979. *Directory of Licensed and Certified Health Care Facilities, 1979.* St. Paul: State of Minnesota.)

A population gain due to a large development project in the Margie study area would most likely require new or expanded health facilities if the problems of inadequate services are to be avoided. In contrast, the capacity of the present facilities in the Toivola study area may be large enough so that few if any new facilities would be needed. A much greater initial capital expenditure for health care

Figure 24

Location and Capacity of Hospitals and Ambulance Service for Toivola Study Area.



Legend
□ Hospitals
■ Ambulance Service

(Data from
Minnesota Department of Health. 1979.
Directory of Licenses and Certified Health Care Facilities, 1979.
St. Paul: State of Minnesota.)

in the Margie area will be required.

The Margie study area has fewer roads to accommodate increased traffic from economic expansion than the Toivola area. In addition, since a much greater amount of the Margie area is peat, special techniques for road construction could be necessary, increasing the costs per mile. To handle development of the scale discussed here, it would probably be necessary to increase the capacity of the road network in that area, as well as to upgrade it.

The difference between the two study areas' educational systems is demonstrated by Table 14, which summarizes pupil enrollment. The Margie area has an enrollment of 6,405 pupils, almost half of which lie within the International Falls district. The Toivola area had 28,419 pupils enrolled in the 1978-1979 school year. Figures 25 and 26 demonstrate the distribution of school facilities for each study area.

A 250 million cubic feet a day plant could mean an increase of 2,210 students by the time the operational phase is reached.* This would mean a 35 percent increase in enrollment for the Margie study area. In 1975, the three districts within the Margie study area had the capacity for approximately 11 percent more students (Arrowhead Regional Development Commission 1975, p.11). Not only would new schools have to be built to accommodate a 35 percent increase, but 140 new staff would have to be hired. In the Toivola study area, the increase would be only 8 percent of current enrollment--assuming that local labor was not available. Similarly, the added cost would be

*This was determined by assuming an increase of 11,057 in population (see Employment Section). The state average percentage of public school pupils in relationship to the state's population is approximately 20 percent.

Table 14: Development Area Educational System. Total Number of Students and Staff, 1978-1979 School Year.*

1978 - 1979 Average Daily Attendance	Margie Study Area	Toivola Study Area
kindergarten	407	1,930
Grades 1-6	2,753	11,785
Grades 7-12	3,245	14,704
Total	6,405	28,419
Total Staff**	416	1,681
Pupil/Staff Ratio	15.4	16.91

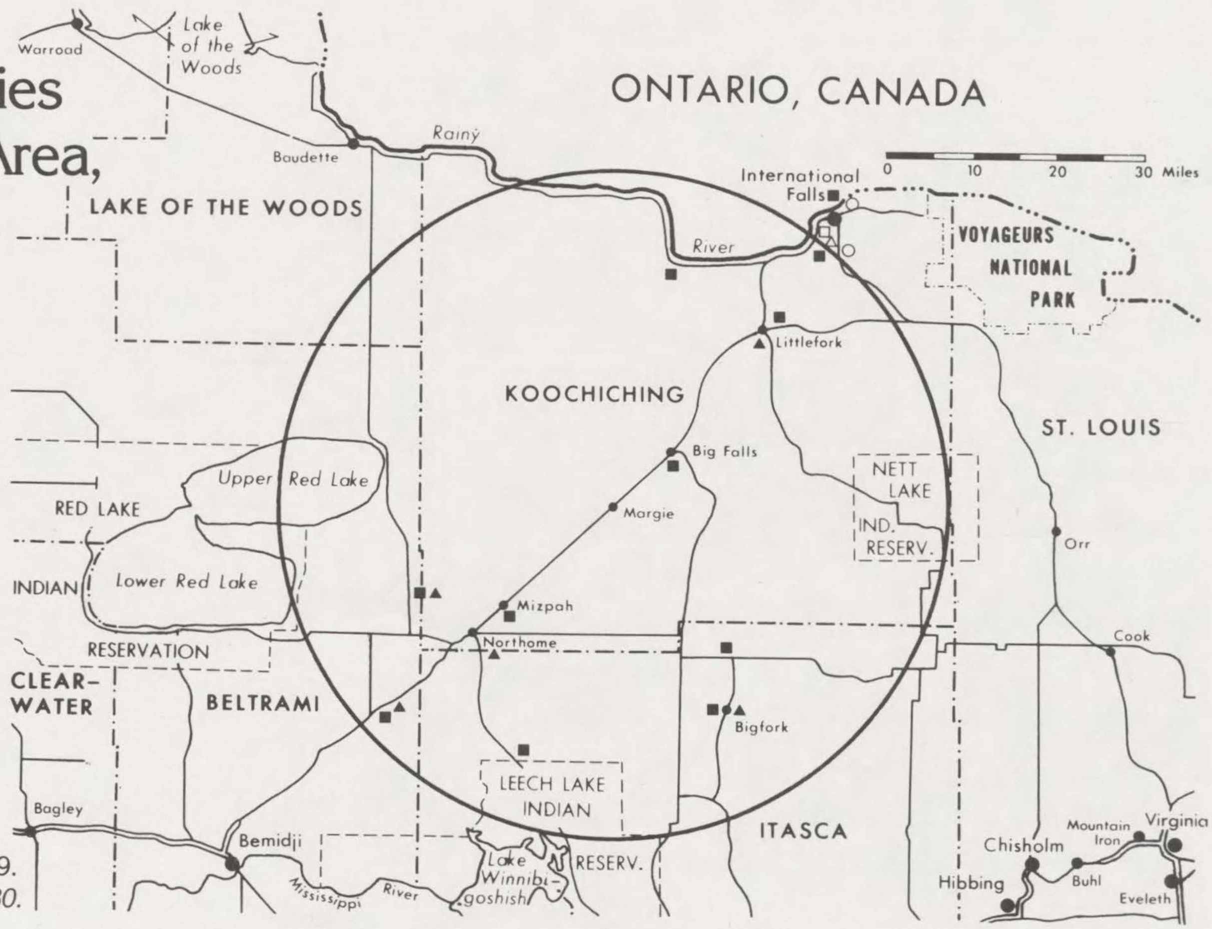
*These figures are approximations since boundaries of school districts do not completely conform to study area boundaries. Only school districts whose facilities and a large portion of total enrollment lie within the study area are included.

**Staff includes administrators, classroom teachers, and other professional personnel.

(Adapted from Minnesota Department of Education, sde. "School District Profiles, 1978-1979." July 1980)

Figure 25

Location of Educational Facilities for Margie Study Area, 1978-1979.



Legend
- ■ Elementary
- ▲ Grades 7-12
- □ Grades 7-9
- △ Grades 9-12 or 10-12
- ○ Private

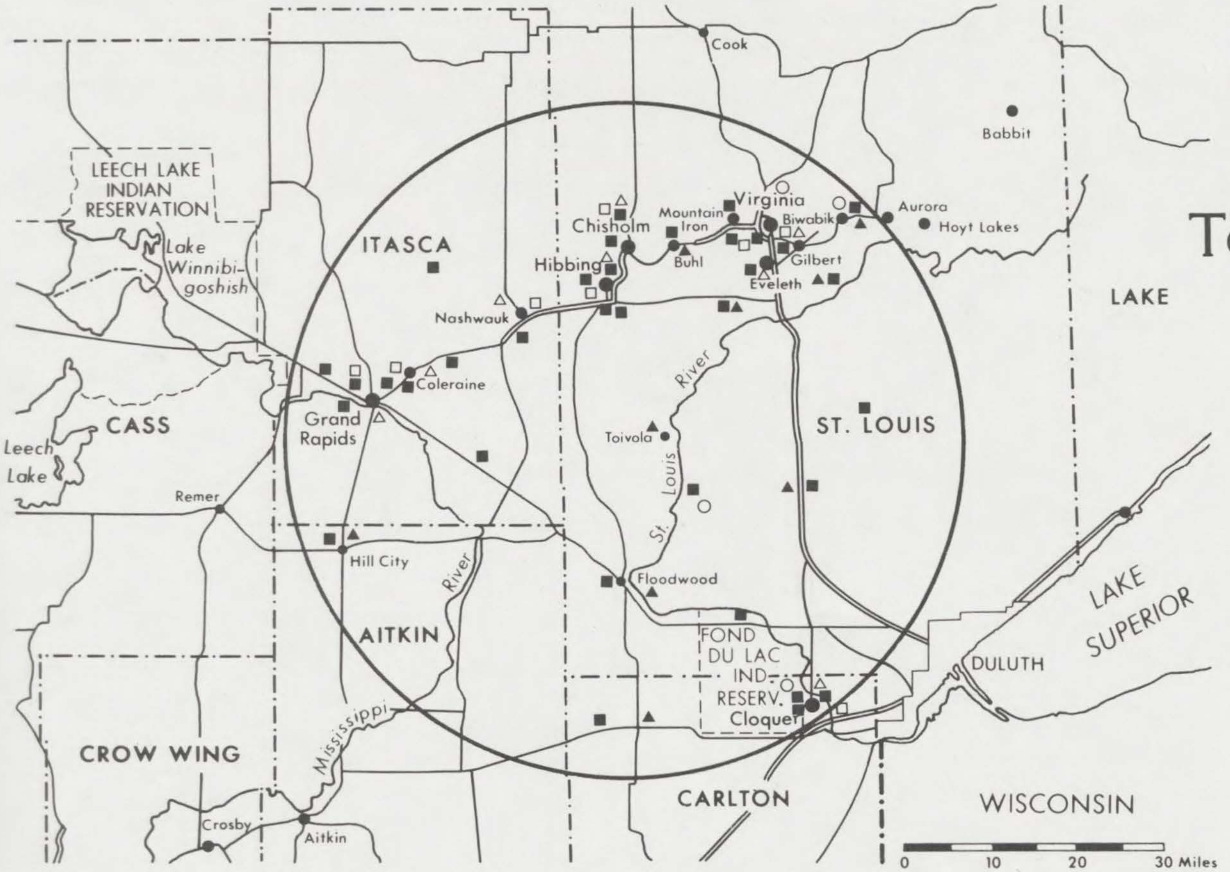
(Data from Minnesota Department of Education. 1979. *Minnesota Educational Directory 1979-80.* St. Paul: State of Minnesota.)

much less for the Toivola study area. These figures illustrate the importance of examining individual school districts, their facilities, and their capacity to absorb new students.

Development of peatlands in northern Minnesota could put similar strains on <u>sanitation facilities</u>.

Figure 26

Location of Educational Facilities for Toivola Study Area, 1978-1979.



Legend
Elementary ■
Grades 7-12 ▲
Grades 7-9 □
Grades 9-12 or 10-12 △
Private ○

(Data from Minnesota Department of Education. 1979. *Minnesota Educational Directory 1979-80.* St. Paul: State of Minnesota.)

Soil conditions in the Margie study area are rated as "severe" for development. This means that construction of sewer and water systems would have to overcome difficult engineering problems, adding further to the costs of development (Arrowhead Regional Development Commission 1975, p.11). These same conditions could also lead to problems in finding sites for solid waste disposal.

Figures 27 and 28 show the cities and regions with existing sewer systems. While an examination of the capacity of each system is required to reassess the impacts of large-scale development, one can see that the Toivola study area has a much more extensive sewer system. This study area could possibly absorb the population expenditures for new or expanded sewer and water facilities.

The public services discussed in this section and the costs associated with them must be included in estimates of the total cost of a development project. The difference between two locations of the project as demonstrated by the Margie and Toivola sites could mean millions of dollars. This money would not only have to be paid by the new population but also by the original residents.

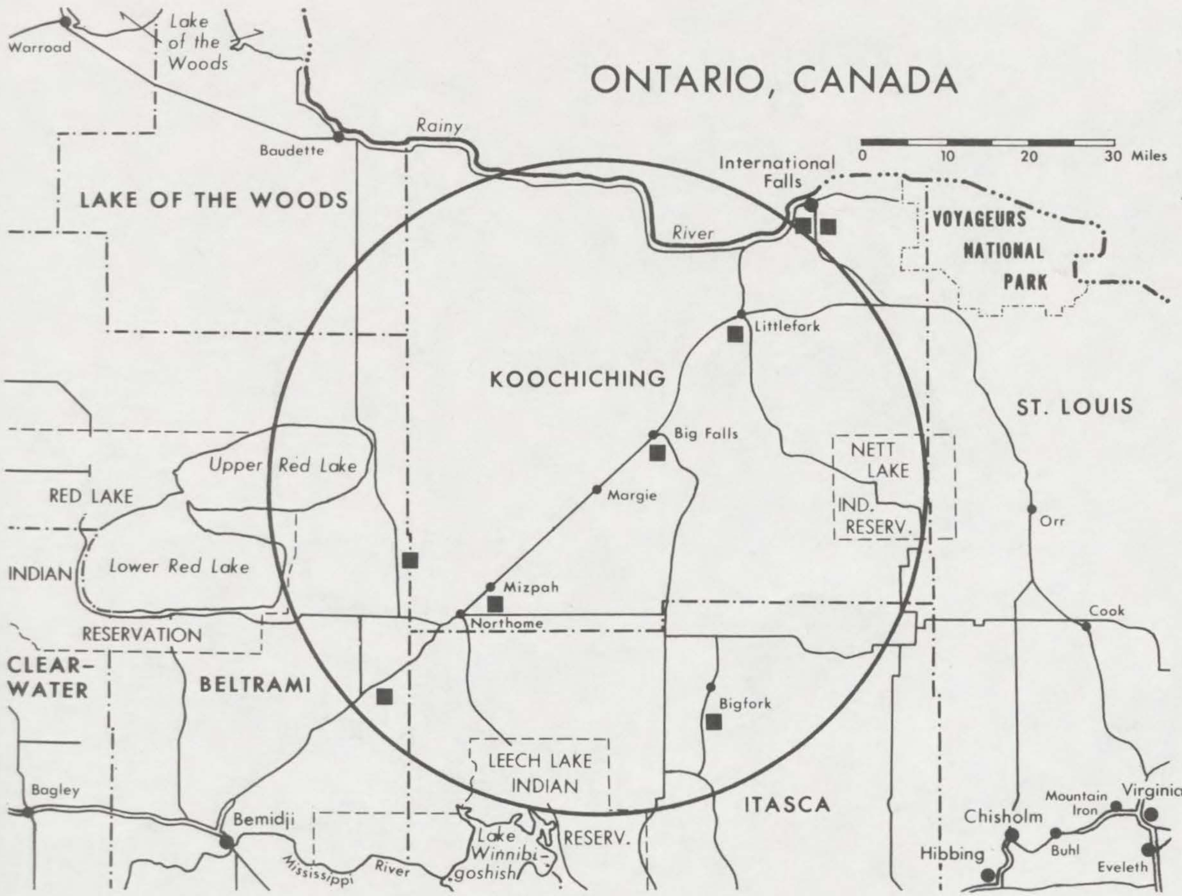
Private Services

Both study areas could experience housing problems. The Toivola study area has recently gone through a construction boom caused by the development of taconite plants. Because of their earlier experience, governmental units and the public as a whole may be able to react more efficiently to increased demand for housing. And because more local labor could be utilized in this study area, the possible adverse housing impacts would be less. The Margie study area is primarily rural and offers far fewer housing alternatives. This would mean considerable commuting from cities such as International Falls until substantial housing could be built near the project site. Another possible problem is the amount of land available for residential construction. Since much of the region's land area is peatlands, and suitable housing sites more difficult to find, housing construction costs may be higher.

As mentioned earlier, total retail sales are a measure of the amount and extent of available services a region has. Tables 15 and 16 demonstrate the differences in retail sales between the two study areas. While the Margie study area has no significant city or trade center within its boundaries, the Toivola study area has seven cities. Only Bemidji, which accounts for 90 percent of Beltrami County's retail trade, and International Falls, which represents 75 percent of Koochiching County's sales, have adequate supplies of services for a larger population in or near the Margie study area. Cities such as Hibbing, Chisholm, Virginia, Eveleth, and Grand Rapids, all in the Toivola study area, have significant amounts of retail trade that

Figure 27

Distribution of Sewer Systems for Margie Study Area, 1979.

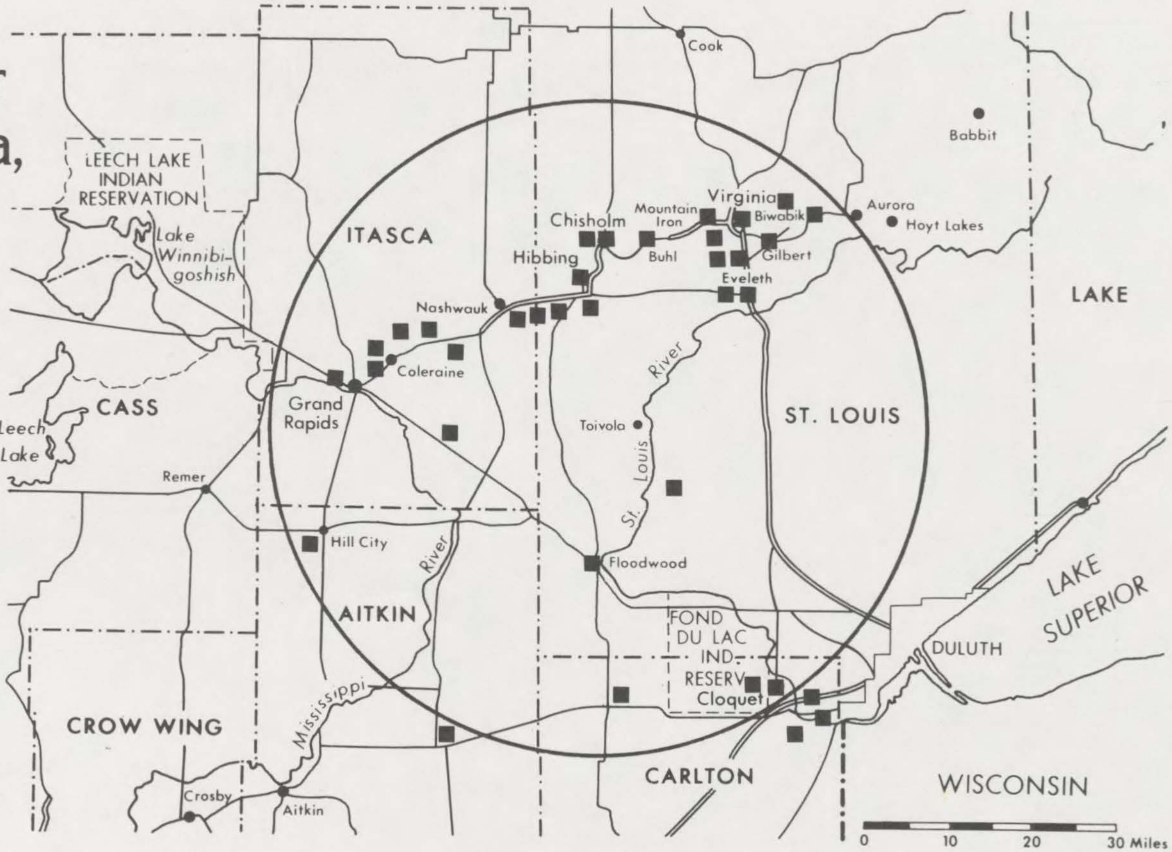


(Data from Minnesota Pollution Control Agency. Division of Water Quality, Facilities Section. 1979. *Wastewater Disposal Facilities Inventory State of Minnesota.* St. Paul: Minnesota Pollution Control Agency.)

may adequately supply the required services of a larger population. While increased demand for private services may help the Toivola region, its positive or negative impact on the Margie study area will depend on whether private service development occurs in an orderly manner.

Figure 28

Distribution of Sewer Systems for Toivola Study Area, 1979.



(Data from
Minnesota Pollution Control Agency.
Division of Water Quality,
Facilities Division. 1979.
Wastewater Disposal Facilities Inventory State of Minnesota. St. Paul:
Minnesota Pollution Control Agency.)

Economic studies of northern Minnesota have shown that peatland development will result in increased economic activity due to the inter-industry linkages (Maki, Laulainen, and Meagher 1978, p.88). The Toivola area, with a larger economic base in the Iron Range communities likely has a greater degree of inter-industry activity than does the Margie area. This means that as demand for goods and services

Table 15: Retail Trade for Counties and Specific Cities in the Margie Study Area, 1977.

Counties and Specific Cities	Retail Sales City/Area	Retail Sales County
Beltrami (1978)		$104,008,000
Bemidji	$90,539,000	
County Excluding Bemidji	13,469,000	
Koochiching		58,162,000
International Falls	42,894	
County Excluding Bemidji	15,268	
Lake of the Woods		6,519,000

(Minnesota Department of Economic Security. Northeastern Minnesota Labor Market Review. 1979-1980; Minnesota Department of Economic Development. 1978 Retail Sales by Type, by Quarter: State, Regions, Counties and Cities. 1979.)

increases, the Toivola study area's economy could grow at an even greater rate as its industries react to the demand.

Table 16: Retail Trade for Counties and Specific Cities in the Toivola Study Area, 1977.

Counties and Specific Cities	Retail Sales City/Area	Retail Sales County
Carlton		$89,860,000
Cloquet	$51,084,000	
County Excluding Cloquet	38,776,000	
Itasca		130,190,000
Grand Rapids	93,252,000	
County Excluding Grand Rapids	36,938,000	
St. Louis		782,653,000
Chisholm	15,001,000	
Duluth	403,490,000	
Eveleth	21,830,000	
Gilbert	3,507,000	
Hibbing	90,080,000	
Virginia	105,304,000	
County Excluding Above Cities	143,441,000	

(Minnesota Department of Economic Security. Northeastern Minnesota Labor Market Review. 1979-1980; Minnesota Department of Economic Development. 1978 Retail Sales by Type by Quarter: State, Regions, Counties and Cities. 1979.)

Government Financing

Differences in problems of local government financing due to development impacts in the Margie and Toivola study areas are hard to distinguish. A much more detailed study of the individual units of government is required. It is evident, however, that the more urbanized Toivola site could absorb the possible impacts of peatlands development. This site has experienced the boomtown effects from the iron ore and taconite industries and may already be geared to handle these problems. Governmental units such as the IRRRB demonstrate the cooperation that already exists between the local communities and counties. Since local-government financing involves a complex network of funding alternatives, cooperation between the different units of local government will do much to eliminate many possible problems in this complex network.

SOCIAL EFFECTS

Related to and as important as the economic ramifications of peatland development are its social implications. While new development can bring many economic and social benefits to an area, it can also fundamentally alter the nature of communities by disrupting traditional settlement patterns, changing the nature of commerce, and transforming personal lifestyles. The historical continuity of a community, which evolved through a series of incremental changes over many years, can be radically altered in just a few years.

The degree to which peatland development results in beneficial social impacts depends on the specific nature and scale of a project, its location, and the rate of development. To avoid major disruption of existing communities and their residents, the nature and scale of a project should be compatible with the social and economic systems and historical development patterns of the area in which it is proposed.

Residents may welcome a change in the nature of their community and may desire the expanded economic and social opportunities which can accompany major development. However, it is important that economic growth and social change occur in an orderly manner. Thus, the rate of development (in part a function of the project's scale) should be gradual enough to allow communities to identify and ameliorate detrimental impacts and anticipate the subsequently altered character of their communities.

The Special Problems of "Boomtown" Growth

One detrimental kind of energy development is rapid-growth or "boomtown" development, which occurs when a community experiences faster than average economic and population growth. Although it results in increased employment opportunities, an expanded tax base, and increased social and cultural diversity, boomtown growth severely strains existing community institutions. One major problem associated with boomtown energy development is the inflation due to increased demand for services by incoming personnel and their families. This demand exceeds the capacity of existing local systems. Problems associated with stress caused by rapid change also increase as this very nature of a community is altered (Davenport, III, and Davenport 1980, p. 43).

Depending on its specific nature, scale, location and rate, development of Minnesota's peatlands for energy could result in disruptive social impacts, including boomtown effects. For example, one proposal is for construction of a large-scale (250 million cubic feet a day) peat gasification plant in north-central Minnesota. Locations for the project are currently being examined in the Margie study area (see previous section; Economic Effects of Peatland Development), a sparsely populated area of Minnesota. The current economic bases of communities in the Margie area are agriculture, forestry, and tourism. This area is near the Red Lake Indian Reservation, which has a tribal community of 4,200 people economically and socially dependent on fishing, hunting, agriculture, wild rice production, and forestry. These communities could be greatly affected by the economic and social impact of such a project.

It was estimated in the previous section (Economic Effects of Peatland Development) that this project could directly or indirectly cause a population increase of over 16,000 people during construction, assuming that no local people would be employed. Even if it is assumed that people from local communities substituted for 50 percent of the increased population, the 8,000 additional people would still result in a 41 percent increase in the population of the area (1977 population figures). After the construction period and during the operation of the plant, the population would increase by 22,000 people, again assuming that no local people were employed. If 50 percent of that potential increase could be replaced by existing populations, the 11,000 additional people would still result in a long-term population increase of 54 percent.

The impacts of these sudden and significant increases will be amplified in the small towns near the development site. For example, the largest of the six towns in the Margie study area is Little Fork, with a population of 805. The smallest is Mizpa with only 124 people. While some of the population influx might be absorbed by International Falls (population 8,842), which lies just outside the study area, it is likely that the detrimental social impacts on these small towns would be significant.

While the gasification proposal is the largest thus far suggested for Minnesota, other large-scale peat utilization schemes for energy are also likely to be proposed. Thus boomtown effects on existing communities are a major concern.

Recent studies of boomtowns caused by energy development in western states document the detrimental social implications of rapid-growth development. Statistics gathered in boomtowns indicate dramatic increases in crime, alcoholism, suicide, family and child behavior problems, employee turnover, and declines in worker productivity (Freudenburg February 1980, p. 1-4). One such boomtown is Craig, Colorado. Its 5,000 population doubled in two years as a result of construction of a coal-fired power plant. Statistics gathered from Craig over those two years reflect a pattern found in other boomtowns:

- Overall crime rate rose 300-450 percent (depending on computation method).
- Crimes against persons went up 900 percent.
- Crimes against property rose 222 percent.
- "Family disturbances" increased by 352 percent.
- "Child behavior problems" rose 1,000 percent.
- Alcohol-related complaints rose 550 percent.
- Other drug-related reports went up 1,400 percent (Adapted from Lantz and McKeown 1979, p. 45, and Freudenburg 1980, p. 1-4).

Researchers have interpreted these statistics as a reflection of both sudden growth in community population and of the characteristics of incoming residents. But the statistics apparently also reflect significant changes in the viewpoint and behavior of original residents. It appears, for example, that an increased number of crimes are not committed only by the new residents, but also among the original residents following changes in the community (Freudenburg 1980, p. 6-7). Thus, the social problems of boomtowns may not be primarily--or even in part--brought on because of the character of incoming residents, as has sometimes been suggested. Rather, these problems may be due to the changes in the community resulting from rapid growth.

Even so, the typical reaction of original and incoming residents to emerging social problems is a divided community. Referred to by boomtown researchers as "bifurcation," this phenomenon is characterized by social dichotomies such as "old-timer vs. newcomer," "rural vs. urban," or "rancher vs. hardhat" (Davenport, III and Davenport 1980, p. 43-4).

The alienation and fragmentation in boomtowns may be related to an important change observed in one study:

> ...each individual person becomes a smaller part of a larger whole. So the transition begins--the community moves toward a larger and more diverse population, the longtimers know a smaller percentage of their neighbors, there is a differentiation of interests and association, and more and more transactions between people become formal and contractual rather than personal and face-to-face (Cortese and Jones 1979, p. 10).

Researchers have examined some of the effects of rapid growth on the well-being of particular boomtown residents. The following analysis draws heavily on a major paper by Freudenburg (1980) which summarizes the observations of a number of boomtown researchers. In general, newcomers tend to experience the benefits of rapid growth to a greater degree than do original residents. Construction workers--usually from outside the community--benefit from the employment and personal income available due to development. They have freely chosen to become part of the community with its new boomtown character. Their wives, however, do not fare as well, sharing in the negative consequences experienced by local women in general:

> A construction worker's wife is generally not able to make friends or to gain a sense of personal worth from work, for her family may not stay in a community long enough to make it worth her while to search for a job. The wife generally reports that she does not have as much influence or free choice as her husband in deciding whether or not to move to a new community, and she may also be bothered more than her husband by inadequacies of housing, recreational, and educational opportunities, or by problems of isolation which result from living in a "fringe" trailer settlement (Freudenburg 1980, p. 21).

Newcomers likely to remain in the community after construction--highly skilled managers and supervisors--tend to seek establishment in the community. They often benefit by eventually becoming the leaders of the newly developed community, guiding its transformation (Freudenburg 1980, p. 22-24).

How does new development affect original residents whose livelihood is derived from current land uses? Studies of western boomtowns indicate that farmers and ranchers who do not expect to sell their own land for development experience undesirable effects of rapid growth development, in part because their once central role in the community diminishes.

> When compared with the ranchers in the three non-boom communities, the boomtown ranchers were significantly more likely to say that their community had grown "worse" in the three or four years before the survey, to say that the recent rate of change had been "too fast," and to assess the quality of their own lives in a very negative way: They were significantly less happy, significantly more likely to describe their lives as "disappointing" (rather than "rewarding"), and as "discouraging" (rather than "hopeful"), and they were even more likely to have experienced a number of stress-related physical illnesses (Freudenburg 1980, p. 36).

It has been speculated that the original residents who are elderly are likely to suffer the most from rapid-growth development. However, the elderly may be the best equipped to insulate themselves from the changes in their communities. This is because they are often "set in their ways," an attitude which gives their lives continuity despite the radical changes going on in their community. This attitude is reinforced by insulation provided through association with a large network of friends. In addition, the elderly often support economic growth in principle, believing it will assure the continued existence and "progress" of their community (Freudenburg 1980, p. 39-41).

Even so, it seems likely that those elderly people who cannot or will not insulate themselves could be alienated by changes in the appearance and operation of the community, the destruction of local landmarks, and the disappearance of the preboom community's way of life. In addition, those elderly who live on fixed incomes may have a hard time adjusting to changing housing, food and other costs.

The youth of original residents do not have insulating mechanisms to protect their sense of well-being. One study, which compared the attitudes of boomtown students with other students of the same age living in the same region, indicated negative impacts:

> When compared to their peers in the three other western Colorado communities, the students in the boomtown show a pattern of consistently negative evaluations--of their communities, their schools, their peers, and even themselves. They feel worse about the energy growth, the government, their teachers,

> and their lives in general. They describe a social situation which few people would find desirable; they are significantly more likely to speak of fear, threats, and criminal victimization; and many of them appear to have responded to the changes in their lives by developing a virtual sheath of cynicism, attempting to manage their malaise by discounting or devaluing much of the world which surrounds them (Freudenburg 1980, p. 42).

Educational institutions undergo major changes as a result of boomtown growth. In addition to overcrowding, two other problems have been observed. The stability of school programs is often upset as a result of the transiency of many of the children, particularly those of construction workers. This can be damaging to the learning process for all students and it can create problems for teachers who must conduct an educational program while continually gaining or losing students in their classrooms. In addition, conflicts in values and lifestyles between local and incoming students can create friction in boomtown schools. On the other hand, new demands placed on schools by incoming residents, some of whom are professionally trained, can result in improved educational programs after a period of initial disruption (Cortese and Jones 1979, p. 9).

Rapid development can also radically change the nature of commerce in existing communities in ways disruptive to community traditions. Rapid growth is often accompanied by a high turnover in business ownership. As the community and its business clientele change, some local business people often decide to sell their businesses to take advantage of handsome offers made by incoming entrepreneurs. In addition, although many existing businesses may benefit from expanded markets, the smaller businesses may find it difficult to compete with new enterprises, especially national chains which often move into boomtown communities in response to the sudden increase in consumer dollars. With their large volumes, they can often sell goods and services at lower prices than smaller existing businesses (Freudenburg 1980, p. 30; Cortese and Jones 1979, p. 8).

While these new businesses may offer lower prices and a greater variety of goods and services, there are social disadvantages to the changes. "In particular, many business owners have found that growth requires them to change their ways of doing business--using new advertising techniques, discontinuing specialized services, learning that they 'can't afford the time' to chat with customers and so on" (Freudenburg 1980, p. 29). These are important social aspects of commerce that contribute to the quality of life in communities.

Research into the social implications of rapid growth development in energy communities is not exhaustive. Much has yet to be learned about the reasons for increased crime and other problems associated with boomtowns. Those studies which have been completed provide some sense of the disruption that rapid growth can promote.

Various methods for coping with boomtown effects have been examined. These include community planning (Jirovec 1979; Bleiker 1980), "needs assessment" (Olson 1980; Hawkins 1980), improvement of mental health programs (Weisz 1980), grass-roots organizing to mobilize citizens to prepare for the impacts of boomtown growth (Warner 1979; Jirovec 1979), and job training programs for local residents to reduce the need for imported workers (Davenport, III and Davenport 1980, p. 47). However, these measures assume large-scale energy development will occur.

Freudenburg argues that "an ounce of prevention may be worth far more than a pound of mitigative measures," and that "it is only when we stick with large, centralized installations that we even need to worry about boomtowns...in fact, the only way to get a boomtown is to do everything wrong" (Freudenburg 1979, p. 58). He suggests that projects should be modified in several ways in order to minimize their boomtown effects. These include reducing the size of facilities, using construction technology which limits peak construction employment and thus minimizes the boom, increasing the duration of the construction period, and siting projects in densely populated areas that include several communities (Freudenburg 1979, p. 58-60).

The problems of boomtown growth are especially obvious. But disruptive change in communities can also occur over longer periods of time as a result of any new development not compatible with established community life. These changes--though more slowly manifest--can alienate original residents who have witnessed the replacement of their traditional way of life and their old community with something new and quite different. In this regard, the boomtown can be thought of as the most extreme form of community alteration at the most extreme rate.

While the detrimental social impacts of new development may be less pronounced when they occur at a more accommodating rate, these same kinds of impacts can still be of great concern to original residents. Peatland development that will result in significant changes in communities should be examined for its social impacts even if the rate of development is more gradual than that which characterizes boomtowns.

Political Implications

Among the possible social effects of peatland development are political changes resulting directly or indirectly from major development. A detailed examination of political change is beyond the scope of this report. However, a number of implications are identified in the following discussion. New development can alter existing relationships between local, state, and federal governments as well as shift their particular responsibilities. This can have significant effects on the local political process. Depending on the nature of the development, the state and federal governments can become directly involved, primarily through regulation of what have been local political and governmental affairs. As a result, local governments at municipal and county levels may play a diminished role.

The involvement of state and federal jurisdictions may or may not enhance the influence of local citizens on development policy and other local matters. To some, these new government influences are just what is needed to "shake up" complacent or unresponsive local government officials. On the other hand, the shift of government control and political power from local to state and federal jurisdictions may not be welcomed by local citizens and public officials. It may be viewed as an inappropriate centralization of authority over decisions which belong to local government.

A political process based on local government, in which citizens have direct influence over policy, can suddenly be altered to include these distant, less well understood, and less locally accountable jurisdictions. State and federal regulatory functions are typically performed by bureaucratic agencies that may use formal political processes primarily to generate legitimacy for decisions rather than to invite citizen participation. Thus, government accountability to local citizens is further eroded.

In addition, the regulatory and planning functions which remain the responsibility of local government become more complex and time consuming as the demand for government services increases. These functions, once performed by local elected officials or volunteer citizen committees, are delegated--perhaps out of necessity--to professional government staff or hired consultants. In this way local government operations change in character and become less accountable.

It has been thought that as citizen influence diminishes locally it increases at state and federal levels. However, given the nature of the regulating agencies at those levels, it is possible that when citizen influence erodes at the local level, it declines overall.

Another possible political implication of significant development is the creation of a "company town" atmosphere. The politics and government of growing communities can be heavily influenced by new developers, both particular companies and individual company leaders. New industries may become the major employers in the community as well as its largest local taxpayers. Because of this dependence, new industries can become influential and even dominate the political forces in a community, thus overwhelming the influence of the citizenry.

ENVIRONMENTAL EFFECTS

As is the case with economic and social impacts, the specific nature and scale of the technologies used for producing energy and the particular peatlands selected will determine the character and extent of the environmental effects of development. Study of these potential impacts has only recently begun in the United States. As a result, many uncertainties remain about the nature and extent of environmental impacts. In particular, the impact of various methods of peat mining on ground and surface hydrology are not well understood and to a large degree require analysis of specific sites. In addition, little information exists about any of the impacts of energy-crop production on peatlands, some of which will also be site-specific.

However, studies have recently begun under the auspices of natural resource departments and other agencies in various states considering peatland development. Of these studies, those being conducted by the Minnesota Department of Natural Resources since 1975 are probably the most extensive. The United States Department of Energy, as part of its peat gasification development effort, began a generic environmental analysis in 1979. In addition, environmental impact will be considered in Minnegasco's current feasibility study of large-scale gasification. The 19-month study, being funded by DOE and the Gas Research Institute, is expected to be completed in mid-1982.

Available information indicates that peatland development could affect the environment in several ways. Peatland development for energy could result in significant land disturbance and affect water quality, peatland hydrology, air quality, and fish and wildlife habitat. In addition, several health and safety issues are of concern.

These environmental impacts can be managed in several ways. Development sites can be selected so that impacts will be contained in or confined to narrow geographic areas. This can also reduce the total impact in any one location. For example, containment is of particular concern when disturbance of ground and surface hydrology could effect watersheds that span many miles and may cross international boundries.

Impacts can also be mitigated or prevented through the adoption of particular energy production technologies, pollution control devices, or management practices which will minimize or avoid impacts. Impacts can be further prevented through the careful selection of particular technologies and sites whose development will not generate as many impacts as development of other technologies and sites.

Impacts of Land Preparation, Mining, and Dewatering

Land disturbance is one of the impacts associated with the clearing and mining of peat for energy. This is because peat is a surface mineral, and its extraction affects wildlife, forecloses other land uses, and affects the efficacy of reclamation. While there is some variation between mining methods, all methods require disturbing large acreages relative to the amount of energy produced from their peat. For example, it has been estimated that a 250 million cubic feet a day SNG plant would require approximately 28,500 tons of dry peat a day. Since a peatland can yield 200 tons of dry peat per acre foot, such a plant would require 142.5 acre feet per day (Aspinall and Hudak 1980, p. 2).

These kinds of volumes are required not only because of the scale of this project, but because peat, which is 80-90 percent water, contains fewer Btu's of energy per pound than other fuels. Land-area requirements are also large because peat is found in mineable sites at depths of only 5 to 20 feet. It has been estimated that an 800 megawatt power plant would require peat extracted (apparently with hydraulic methods) from 6,900 acres of Minnesota peatland per year. That same plant would require surface mining of only 50 acres of western coal and 85 acres of eastern coal (Walters, King, and Richardson 1980, p. 6).

Significant differences in land requirements exist between dry and wet mining approaches. The hydraulic method excavates to the full depth of the peat, while the milled method removes only the very top of the surface with each excavation pass. These differences mean that to remove the same amount of peat, hydraulic mining disturbs one acre while the milled peat method disturbs ten (Aiken 1981).

Further peatland disturbance will occur during the construction and stabilization of roads. Because peatlands cannot support heavy equipment except when they are frozen, special construction arrangements, including ditching, will be required (Lofton 1980, p. 5).

The substantial requirements for peat mining and the disturbance associated with it should be considered when selecting a mining method and determining the scale of mining and processing operations.

Air quality impacts are also associated with peat mining. The major problem is the fugitive dust emitted during extraction and handling. This is especially a problem with milled and sod peat mining, in which the peat is air-dried on the peatland. Fugitive dust consists of soil particles and peat fibers stirred into the air by wind and equipment operating on exposed peat surfaces. Factors that influence the amoung of dust include local weather conditions, the moisture content of peat, and the mining and dewatering methods (Ertugrul and Sober 1980, p. 7).

Fugitive dust emissions can carry 20 to 30 miles downwind of a mining operation (MnDNR April 1979a, p. 68). These effects can be diminished by covering storage piles, using watersprays and the construction of windbreaks (Ertigrul and Sober 1980, p. 7). However, the effectiveness of windbreaks for large scale mining, which requires expansive land area, has not been demonstrated (Walters, King, and Richardson 1980, p. 7).

To a lesser degree, air quality is affected by exhaust emissions from vehicles and machinery used during excavation and handling. These emissions include sulfer dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), hydrocarbons (HC), and particulates (Ertugrul and Sober 1980, p. 7). The degree to which these are a problem depends on the number of vehicles and other machinery and pollution control devices on the equipment.

Water impacts associated with land preparation, mining, and dewatering are perhaps the major environmental concerns of peatland development. Ditching and the clearing of the land, excavation, drainage of the peatland and peat dewatering all affect water quality and surface and groundwater hydrology.

These impacts have been extensively examined for the Minnesota Department of Natural Resources (MDNR) as part of their Peat Program. This section relies heavily on their work (MnDNR April 1979a; Clausen and Brooks 1980; Clausen 1980; Crawford 1978).

Several water quality impacts have been identified in the MDNR studies. Potentially harmful constituents found in natural peatlands could be released into nearby lakes, rivers, and streams during development. "Based upon the literature, discharge waters from natural peatlands have the potential of exceeding the toxic limits for fish for the constituents pH, zinc, and dissolved oxygen; exceeding drinking water standards for iron and color; and exceeding the MPCA fisheries and recreation standards for pH, color, and dissolved oxygen" (Clausen and Brooks 1980, p. ix). The herbicide DDT and its breakdown form DDD have been found in Canadian peatlands (Clausen and Brooks 1980, p. viii). In addition, mining, with or without drainage, could result in impacts from the "apparent tendency of peat to absorb such heavy metals as copper, nickel, and mercury...Such heavy metals could be released into the ecosystem if peatlands were disturbed" (MnDNR April 1979a, p. 12).

Other impacts relate to development-induced changes in the water quality of the peatlands themselves.

- Drainage and mining of bogs may increase pH, calcium, magnesium, bicarbonate, sulfate, and humic and fulvic acids and decrease chloride and nitrate concentrations in discharge waters.
- Drainage and mining of fens may increase pH, magnesium, sulfate, nitrate, and humic and fulvic acids and decrease calcium and bicarbonate concentrations in discharge waters.
- With the increased age of drainage and mining operations, pH, iron, calcium, magnesium, bicarbonate, and humic and fulvic acid concentrations increased due to increased aeration (Clausen and Brooks 1980, p. x).

Other water quality impacts are associated with peat dewatering and with the disposal of water after peat has been removed from slurries used in some forms of hydraulic mining. The constituents outlined above are likely to be also found in this waste water and could deteriorate waters into which they are disposed.

It is important to note the large volumes of water that could be affected. It has been estimated, for example, that the peat required each day to fuel a 250 million cubic feet a day gasification plant would contain 43 million gallons of water (Aspinall and Hudak 1980, p. 2). Much of this water -- perhaps even 50 percent of it -- would have to be disposed after the peat is dewatered.

Much has yet to be learned about the groundwater systems of peatlands and the hydrology impacts of development. However, some significant impacts have been identified by the MDNR (MnDNR April 1979a; Clausen and Brooks 1980; Clausen 1980). When peatlands are drained, groundwater collection and flow are affected. Peat subsidence (sinking) increases, causing the peat to become more dense and to lose some of its porosity, permeability, water content, and capacity for holding water. Drainage generally reduces evapotranspiration, especially during the summer and in dry years. It lowers the groundwater table and modifies the pattern of flow so that water moves toward the ditch. It also increases the storage capacity of the peatland.

Drainage also affects peatland runoff. According to MDNR, the effects of drainage on runoff vary with the spacing, age, and type of drainage ditching used; peat or peatland type; vegetation type; and climate. Drainage has been found to increase runoff overall and to distribute flow more evenly throughout the year. Apparently it also delays runoff by increasing the storage capacity of the peat (Clausen and Brooks 1980, p. vii).

Possible techniques for mitigating those water impacts have been identified (Ertugrul and Sober 1980, p. 11-13). These include:

- Buffer zones to control or limit subsurface interchange of mining area water and surrounding environs.
- Control of pH in affected waters through natural or artificial methods.
- Control of vertical and horizontal movement of surface and sub-surface water within mining areas and between these areas and surrounding environs using layers of relatively impermeable hemic and sapric peats or impermeable in situ clays.

- Control of the ratios of buffer zones, ponding waters (for dewatering and slurry effluent), agriculture zones, and wildlife areas to produce a hydrologic response during and following peat extraction comparable to the pre-mining hydrologic response of the system.

All of the impacts associated with land preparation, mining, and dewatering outlined in this section also affect the fish and wildlife habitats of peatlands. Disturbing peatlands through development will annihilate immobile species and drive mobile species out of the area. Wildlife populations will be displaced not only on, but near areas that are disturbed or destroyed. Wildlife will also be affected by the presence of human populations, which can interfere with mating, nesting, rearing and migration. In addition, changes in these habitats and removal of particular species can alter the prey-predator relationships of carnivores and herbivores both on and off development sites. Wildlife can also absorb toxic materials in the terrestrial biota caused by changes in air and water environments. These toxic materials can be transmitted through the food chain to higher organisms (King et al. 1980, p. 3: 45).

In addition, the drainage and ponding required by mining generates physical and chemical changes that affect aquatic and estuarine ecosystems. These can affect fisheries positively or negatively, depending on the particular situation and species:

> Potential beneficial effects...would occur if, for example, low flows are supplemented with good quality water; increased habitat is created by formation of additional drainages and lakes; or small increases in micronutrients are discharged from drained areas. The opposite situation would occur if water quality or other stresses are placed on the system that adversely impact the fishery resource. A few common examples of these conditions are discharges of poorer quality water, reduction of dissolved oxygen levels, removal of habitat, severe sedimentation, salinity changes, and temperature stresses (King et al. 1980, p. 3: 39).

The magnitude of impacts on fish and wildlife will depend on the particular method and scale of mining, its water and air quality impacts, and the extent to land which is disturbed. Because peat lands vary in their importance as fish and wildlife habitats, the significance of projected impacts on fish and wildlife will depend on the location of development.

Impact of Growing Energy Crops on Peatlands

Unfortunately, there is little information available about the environmental impacts of growing energy crops on peatlands. However, a few general observations can be made.

Land disturbance through peatland preparation and energy crop production and harvesting could have a major impact. It has been estimated that to produce a given amount of energy through production of cattails would require ten times the land area used to produce that same amount of energy from peat extracted with the milled peat method, and one hundred times the land area used to produce energy using hydraulic mining of peat (Aiken 1981). However, unlike extractive approaches, the land disturbed by energy-crop production can be used indefinitely because the peat is not removed. Peatlands hold more energy potential if they are used to grow energy crops than if they are mined for their peat, but more land is disturbed at any one time to produce that energy.

Air quality impacts of energy crop production and harvesting are likely to be less severe than those associated with peat extraction. They are primarily related to air pollutants emitted from production and harvesting equipment. Fugitive peat dust is not a major problem, because the peatland is largely left intact. However, peat dust and crop residues, stirred by wind, tillage, and harvesting, could create local air quality problems.

Water impacts of energy crop production could also be significantly less severe than those associated with peat extraction. It has been suggested that full-scale drainage, like that associated with peat extraction, would not be necessary, thus avoiding major changes in water quality and hydrology (Minnesota Water Planning Board 1980, p. 17).

However, major drainage can probably be avoided only if wetland energy crops such as cattails are used. Even then, some drainage may be required to regulate water level. Production of woody crops, such as willows, may require drainage of the type used in agricultural or forest production. In addition, water quality might be affected by use of fertilizers and pesticides, depending on the degree and type of use necessary.

Thus it is possible that water quality impacts like those associated with agricultural and forest production on peatlands could occur when growing energy crops. According to the MDNR agricultural and forest production on peatlands can generate the impacts listed below. Could these then also occur as a result of energy crop production?

- Agricultural activities which include: drainage, cultivation, and fertilization appear to increase nitrogen, phosphorus, and potassium concentrations in discharge and soil solution waters.

- Cultivation and fertilization appear to increase the specific conductivity of soil solution and discharge waters.
- Agricultural practices modify the relative amounts of various forms of nitrogen in discharge waters.
- Forest drainage is likely to increase pH, calcium, sodium, potassium, manganese, and possibly conductivity; and decrease organic carbon and acidity and possibly iron, ammonium, and phosphate with the magnitude of change being greater if the ditch intercepts mineral soil.
- Forest drainage is likely to increase suspended sediment immediately after drainage followed by a reduction over time with periodic rises during rain storms.
- Fertilization with NPK (nitrogen, phosphorus, and potassium) of drained forested peatlands increases phosphorus and decreases iron in peatland waters. Fertilization with NPK and lime ($Ca\ Co_3$) increases pH and calcium and reduces iron in drainage waters, and reduces ammonium and nitrate in the peat (Clausen January, 1980, p. ix).

Fish and wildlife might also be affected by energy crop production on peatlands. The impacts on their habitats could be significant, replacing ecosystems of diverse plant and animal species with large expanses of monocultural plant communities. Impacts might include displacement of species, interference with wildlife activities, and the effects on fish and wildlife resulting from changes in soil, air and water quality.

Impact of Processing and Utilization of Peat

Little information is available regarding the impact of processing crops to produce energy. For this reason, the following discussion focuses exclusively on peat processing. Because peat and biomass are both composed of plant material, it may be that some of the impacts discussed below are pertinent to biomass processing as well.

After peat is extracted and dewatered, it can be processed or used directly as fuel. Consultants for DOE have identified several air quality impacts associated with processing and utilization of peat as a fuel (King et al. 1980, p. 3:29 - 3:36). The following chemical species are produced:

- Carbon monoxide (CO), from direct combustion of sod peat, peat briquettes, or peat-fuel and peat synfuels plants. Carbon monoxide results from incomplete combustion. It is not easily collected in scrubbers and can be controlled only by improving the combustion process.
- Nitrogen oxides (NO_x), particularly nitric oxide (NO), from direct combustion of peat fuel and peat synfuels plants. In the atmosphere, nitric oxides are transformed to nitrogen dioxide (NO_2), a catalyst in the formation of photochemical air pollutants.
- Sulfur oxides (SO_x), from direct combustion of peat-fuel and peat synfuels plants. While peat is relatively low in sulfur content, combustion and processing to synfuels could aggravate the problem of acid rain.
- Particulates, from direct combustion of sod peat, peat briquettes, or peat-fuel and peat synfuels plants. These include particulate sulfate, heavy metals and polynuclear hydrocarbons.
- Non-methane hydrocarbons, from direct combustion of sod peat, peat briquettes, or peat-fuel and peat synfuels plants. The result of incomplete combustion, these compounds can react in the atmosphere to produce photochemical oxidants. In addition, polynuclear aromatic hydrocarbons are often carcinogenic.
- Metals, from direct combustion of sod peat, peat briquettes, or peat-fuel and peat synfuels plants. Accumulated in peat, these metals can be emitted as suspended particles or gaseous molecules.
- Reduced sulfur compounds, from peat synfuels plants.
- Nitrogen compounds, in the form of ammonia and hydrogen cyanide, from peat synfuels plants.
- Halgen compounds, such as hydrogen chlorine and hydrochloric acids, from peat synfuels plants.
- Water vapor, from facilities using direct combustion of sod peat, peat briquettes, and peat-fuel and peat synfuels plants. Vapor significantly reduces visibility and promotes increased chemical activity of other pollutants. For example, water vapor forms acid mists when combined with sulfur oxides. Water vapor can occur as icefog during winter in northern peatlands, such as those in Minnesota.
- Carbon dioxide is produced by combustion of peat in any form, including the production and

use of synfuels. Production and consumption of synfuels produces more CO_2 per useful Btu than does direct burning of peat (King et al, 1980, p. 3:36). Within the past decade, scientific consensus has formed that if fossil fuel combustion rates continue as currently projected by energy conventional forecasts, which ignore the resulting CO_2 buildup in the atmosphere, will result in significant changes in climate and sea levels. These changes could begin within a few decades. As now projected, the changes would have a serious, adverse, impact on, for example, agricultural productivity and other human activities. In summarizing these impacts, and the scientific evidence supporting them, the President's Council on Environmental Quality concluded in a 1981 report:

> The analysis presented in this report of the potential risks from even moderate increases in the burning of fossil fuels over the coming decades underscores the vital need to incorporate the CO_2 issue into the development of U.S. and global energy policy and to accelerate the use of renewable energy sources and energy conservation techniques (Council on Environmental Quality 1981, p. 56).

The production and use of biomass as an energy source produces no net increase in atmospheric CO_2 and hence does not contribute to increasing the risks from CO_2 induced climate change (Council on Environmental Quality 1981; Woodwell et al. 1979; World Meteorological Organization/U.N. Environmental Program/International Council of Scientific Unions 1980).

According to the DOE consultants, some of these emissions may exceed federal and perhaps state limits during combustion of all forms of peat. However, peat synfuels plants will have greater difficulty staying within these limits than will direct combustion approaches. In fact, synfuels plants may exceed allowable limits for particulates, non-methane hydrocarbons, photochemical oxidants, metals, reduced sulfur compounds, nitrogen compounds, and halogen compounds (King et al. 1980, p. 3: 27 - 3: 36).

Other impacts resulting from peat processing and combustion for energy include the accumulation of solid wastes and waste water similar to that associated with the operation of other fossil-fuel fired boilers and related equipment (Walters, King, and Richardson 1980, p. 8). Because of the large volumes of peat to be processed or burned directly, disposal of ash could be a significant problem. This ash may contain heavy metals, making disposal more difficult.

Similarly, waste water treatment facilities will be necessary for some peat facilities. For example, peat gasification plants will produce noxious by-products such as phenol, benzene (a carcinogen), and polynuclear aromatics (e.g. benzopyren). While much of these products can be removed through treatment, significant amounts will escape unavoidably and enter the environment (Crawford 1978, p. 17).

Health and Safety

Several health and safety hazards are associated with producing energy from peatlands. A major problem is the exposure of workers to dust from peat mining and handling processes. Experience in Europe suggests that this problem can be mitigated by using pressurized cabins on equipment or by placing these cabins above the level of dust clouds, or by providing face masks for workers (Conklin 1978, p. 4-1).

It is also important to protect workers from hazards related to the presence of high-temperature and high-pressure equipment in peat gasification and liquefaction plants (Walters, King, and Richardson 1980, p. 8). Exposure of workers to the hazardous substances associated with peat processing, such as metal carbonyls, trace elements, and organic carcinogens can also be a problem (King et al. 1980, p. A: 68 - A: 70).

Two other major concerns are dust explosions due to spontaneous combustion or accidental ignition of peat, as well as fires on peatlands and in peat stockpiles.

Reclamation

If Minnesota's peatlands are mined for energy it will be necessary to reclaim them for some long-term beneficial use. Most current information regarding peatland reclamation comes from experience in Europe and the Soviet Union, and is based only on relatively small scale projects (MnDNR April 1979a, p. 127). The MDNR, in anticipation of its requirement that all state-owned peatlands leased for development be reclaimed, has initiated studies for reclaiming mined peatlands with agricultural and forest production.

There are several possible approaches to reclaiming mined peatlands. Returning these lands to agricultural production is the primary approach used in the Soviet Union and is used in Ireland as well. Conversion of these lands to livestock pasture is also used. Forest production is the major reclaimed use of peatlands in Finland, an approach which can also provide wildlife habitat at the same time that commercial activity is being conducted. Wildlife habitat can also be provided by transforming mined peatlands into open water for aquatic species and migratory waterfowl. Ireland has considered reclaiming these lands for recreation by creating artificial lakes for waterskiing, sailing, canoeing, fishing and hunting (Midwest Research Institute May 1976, p. 43-46).

Recently, interest has developed in reclaiming peatlands by growing energy crops on them. In fact, this approach has been suggested by the MEA so these lands can continue to contribute to Minnesota's energy supply (MEA 1980, p. 4-45).

Peatland mined for horticultural products in northeastern Minnesota prior to reclamation.

If mined peatlands are to be reclaimed, enough peat must be left at the base of the mined area to enable growth of agricultural products, and energy crops, or for forest production. In Finland, Germany, and the Soviet Union, developers are required to leave 18 inches for this purpose (Midwest Research Institute May 1976, p. 44).

It is also essential that an adequate drainage system be developed after peat mining. Mined peatlands are often left in an overdrained condition requiring back-filling to provide sufficient moisture for crop production (Midwest Research Institute May 1976, p. 46). Most reclaimed peatlands will also need leveling and some should be cambered between ditches to allow surface runoff of rainwater (Midwest Research Institute May 1976, p. 46).

If crop production is selected as the reclamation approach, the mined peatland will require the following:

- An initial fertilizer treatment is needed to correct for phosphorus and potassium deficiencies.
- Lime is needed on peats if pH is below 5.0.

- Application of proper minor elements such as copper, manganese, and boron is needed for certain vegetable and grass crops.
- Preparation of a desirable seed bed by disking and rototilling is necessary.
- Use of proper weed control chemicals for specific crops is required (Midwest Research Institute May 1976, p. 46).

When selecting the method, scale and location of peat mining, it is wise to consider the desired reclaimed use of the land and the feasibility of possible reclamation approaches. Reclamation should be viewed as a necessary part of any mining scheme.

Conclusions

Development of Minnesota's peatlands for energy could improve the state's economic and energy situations. However, development plans and state policies must reflect careful consideration of the economic, social, and environmental effects of peatland development.

How they occur in a particular situation depends on the nature and scale of a specific project and its particular location in the state.

The nature of a project is defined by the energy technologies and related activities associated with it. The types of economic, social, and environmental impacts likely to occur depend, in large measure, on the nature of the project.

The appropriate scale of a project is defined not in terms of any absolute size, but by the ability of a particular project to provide economic and social benefits and minimal detrimental impacts in a specific location.

A project's location provides the context in which development will occur. The suitability of any location will depend on the nature and scale of a project as well as the characteristics of the site. Some locations will be inadequate for large-scale projects because they could not absorb the economic, social, and environmental changes that development will bring. In such locations, consideration of smaller-scale projects is more appropriate.

Table 17 outlines the economic, social, and environmental impacts related to the nature and scale of a project. The degree to which these impacts are positive or negative depends in part on the characteristics of the particular areas where a project is located.

Anticipating the potential economic, social,

Table 17: The Economic, Social and Environmental Impacts Related to the Nature and Scale of a Development Project.

ECONOMIC IMPACTS

Jobs and Workers

- number of new jobs created
- specific skills required of the labor force
- mix of local and imported workers

Economic Stability

- long- and short-term stability of economic activity in the region
- number of jobs which are seasonal or temporary

Public and Private Services

- commercial and industrial networks needed to provide goods and services to the development project
- public services demanded by the development project
- public and private services demanded by development-induced population growth
- time required to make services available to the population.
- ability of government to assume the costs of providing public services

Local Economies

- range of goods and services available
- degree to which commercial enterprises are locally owned and operated
- changes in cost of living

SOCIAL IMPACTS

Jobs and Workers

- stability of employment in affected communities
- variety of skills, education and background of workers
- mix of local and imported workers living in surrounding communities

Communities

- rate of economic and social change in affected communities
- ultimate size and character of affected communities after development occurs
- ability of affected communities to absorb changes in size and character
- mix of new and original residents
- diversity of religious practices
- range of social opportunities
- degree to which traditional life-styles are disrupted
- changes in local politics and government

ENVIRONMENTAL IMPACTS

Land

- character and extent of land disturbance

Water

- potential changes in the quality of ground and surface waters
- degree to which such changes can be geographically contained

Air

- character and extent of air pollution
- degree to which pollutants can be geographically contained and technically mitigated or prevented

Wildlife

- potential alterations to native fish and wildlife habitats

Workers

- potential hazards to the health and safety of the labor force

Reclamation

- method of reclaiming mined land and the degree to which it can be restored to a usable state following peat extraction and environmental implications associated with the nature and scale of a project is essential in choosing a geographic area which can best accommodate those impacts. Such anticipation also makes it possible to minimize or prevent detrimental impacts. When a project is sited in an area that cannot accommodate such development, the following detrimental impacts can occur:

1. Development which is rapid and nonorderly and therefore disruptive to existing social and economic systems.
2. Reliance on imported rather than the local work force.
3. Excessive demands or burdens on existing service networks.
4. Budget shortfalls in local governments due to increased expenditures for public services.
5. Increases in the cost of living due to rising demand for goods and services.
6. Inadequate supply and increased prices of housing.
7. Disruption or displacement of local commerce.
8. Environmental impacts which cannot be contained, mitigated, or prevented.

VI. LEGAL AND REGULATORY FRAMEWORK FOR PEATLAND DEVELOPMENT

Despite extensive public ownership, Minnesota's peatlands have been largely ignored by the state's lawmakers and planners. Now that interest in developing the peatlands for energy and other uses is increasing, policy-makers will have to decide what alternatives for development or preserving peat are best for the state. The decision will not be easy, since the alternatives are diverse and in some cases mutually exclusive.

Since the state has very little experience with peatlands development, peat is not specifically cited in most Minnesota laws governing mineral extraction or land use. Nevertheless, a panoply of federal, state, and local laws and regulations have general applicability to any peatland development. Because peat is not a mineral nor a traditional energy source in this country, and because peat extraction is not quite like any other surface use such as agriculture or forestry, peat's status in this regulatory framework is often unclear.

Whatever the ultimate content of Minnesota's policy on peatland development (what use, if any; when; what scale; where), it is extremely important that the process of decision-making be carefully considered. Who decides, and how and when the decisions are made can be as important in our system of government as the ultimate decision itself. The optimum process will allow all affected persons to participate and all relevant considerations to be weighed.

The first section of this chapter briefly summarizes existing laws and regulations related to various aspects of peatland development. Relevant laws fall into three categories:

1. Laws which clearly apply to any peatland development.
2. Laws which may apply. In many cases, these are laws that give government agencies discretion over their regulatory actions. In other cases, statutory language is vague.
3. Laws which appear to be relevant but are written so as to exclude application to peatland development.

The second section of this chapter summarizes options for improving the overall decision making framework for peatlands. Three administrative options are described and evaluated.

EXISTING LEGAL AND REGULATORY FRAMEWORK

Research and Development Funding

Although the state of Minnesota and private industry have invested modestly in peatland research and development, funding and direction for basic research and development of peat as an energy source have been generally left to the federal government. The Department of Energy (DOE) has taken the lead in evaluating the possibilities of large scale peat gasification. The Peat Development Program, undertaken under the Alternative Fuels legislation, is administered through the Office of Resource Application in DOE. Most of the federal work on Minnesota peatland development has been in conjunction with, or oriented toward, the large-scale gasification plans of industry. Minnegasco and others in the gas industry (Northern Natural Gas and the Institute of Gas Technology) have also contributed to these studies.

Two new federal programs may eventually be used for peatland development. The 1980 Energy Security Act created the U.S. Synfuels Corporation, which can provide various types of financial assistance to projects converting peat to any solid, liquid, or gas that can be substituted for petroleum or natural gas. It appears that research and development are not eligible for funding by the corporation, but land, mines, conversion facilities, transportation systems, and power plants are eligible.

The Biomass Energy and Alcohol Fuels portion of the Act provides similar types of funding for projects converting renewable organic matter--wood, cattails, willows, or other crops grown on peatlands--to energy mostly for alcohol. DOE will administer the Act for aquatic plants, presumably including peat-related crops, while the United States Department of Agriculture (USDA) will administer the Act for non-aquatic plants.

Up to $88 billion may ultimately be appropriated until the Energy Security Act is phased out over the period 1992-1997.

One related law which may be of significance is the National Environmental Policy Act which requires federal government agencies to "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources" (42 USC §4332(E) 1976). Since there are many alternative uses of peatlands to be explored, DOE may be required to study them in addition to the current focus on large scale gasification.

DOE research funding priorities are not put before the public for hearings or comment, and there is very little that citizens can do to influence them.

The state's role in peatland research and development has consisted of two large studies. The first, the Minnesota Peat Program, is scheduled for presentation to the legislature in 1981. The study covers environmental, social, economic, and technical aspects of peatland development.

In addition, the 1980 session of the Legislature appropriated $225,000 to the Minnesota Energy Agency (MEA) for the Wetlands Biomass Project, to be performed at the University of Minnesota. These studies will focus in part on the feasibility of growing cattails on peatlands and other wetlands for subsequent conversion to energy.

The Iron Range Resources and Rehabilitation Board and the Arrowhead and Headwaters Regional Development Commissions have also been involved to greater or lesser degrees in other studies.

The federal government's commitment to synfuels has caused peatland research and development to focus on large-scale gasification instead of small-scale, renewable uses. To the extent that these alternative uses are not developed and explored, they will tend to be eclipsed by the momentum that large-scale gasification now has. There appears to be virtually no opportunity for citizens to affect the manner in which federal research dollars are spent on peat.

Peatland Development Policy

Neither the federal government nor Minnesota has adopted a specific peatland policy or plan. The state's peat policy to date has been merely to maintain ownership over large areas of peatlands and to lease small acreages for horticultural extraction. The state has not indicated what role, if any, peatlands will play in its overall energy conservation policies. Although the MEA is now advocating use of Minnesota's peatlands for renewable energy crops, no one knows whether that policy will be ultimately adopted. The Energy Security Act, enacted by the federal government, could provide funds for peatland development, since the goals of the act include replacing petroleum and natural gas with other energy sources, including peat. However, it is not clear whether the funds appropriated under the act will go to peatland development. Although local governments could influence a general peatland development policy through their land use and taxation powers, no local governments have elected to use their powers toward this end.

No unit of government has developed a comprehensive peatland development policy, nor sought public participation in the development of such a policy. Because of federal funding of research and development in the area of large-scale gasification, that option appears to be, de facto, the federal peat policy. Because peatland development can substantially affect Minnesota's long-term interests in the areas of energy, environment, agriculture, and economic development, it is imperative that a comprehensive development policy be adopted in a way that involves all affected interests, including the general public.

Land Use and Transfers

The land use and land transfer system in Minnesota is critical to decision-making in peatland use. In this system, private landowners and numerous levels of government play a variety of roles.

Conveyance of Privately Owned Lands. A private landowner may convey land or rights to land in a number of ways. First, he or she may sell the land outright. A conveyance of "fee simple title" without limitation will divest the landowner of any residuary interest in the property. In order to convey "fee simple title" without limitation, the landowner must have absolute title to the property, and the land cannot be encumbered by liens or other restrictions.

A landowner also may convey land subject to limitations on title. Such limitations may exist because the land has special significance as a habitat for wildlife, a historic site, a recreation or drainage area, or some other special use. Such restrictions could affect peatland development, but it is not known precisely how much of the privately owned land in the peatland regions is subject to such limitations.

In Minnesota, a landowner may convey the mineral rights beneath the surface of his or her property. Although the law is unclear, peat is generally considered by state agencies as a surface resource. Therefore, at least as far as state government is concerned, someone who owns only the mineral rights to property would not have the right to mine the peat there. According to MDNR officials, recent leases of state lands have specifically mentioned how peat will be considered in order to avoid confusion over its status under the laws.

A landowner can lease his or her peatland for development. Fee title to the property stays with the landowner, and full interest in the property will revert to the owner at the end of the lease. During the term of the lease, a lessee will be able to mine or otherwise use peatland located on the property. If the typical mineral lease is used as a model, the lease will often include a flat annual per acre rental plus royalties based upon the value of the product.

Conveyance of Publicly Owned Peatlands. Several government units own peatlands in Minnesota. The federal government owns approximately 460,000 acres, managed primarily as national forests, national wildlife refuges, and by the Bureau of Land Management. The state owns approximately 2,540,000 acres; all are managed by the MDNR. Indian reservations in the state own approximately 290,000 acres, managed by the various tribal councils. Counties administer 615,000 acres, most of which is tax forfeited land. Other local government units own insignificant amounts.

Conveyance of lands owned by each of these public owners is subject to procedures unique to that government unit. With some restrictions, each of the various public owners is permitted to sell the properties, and each may lease property for peatland development. As a general rule, the more "intense" the present use of the land, the more difficult it is to convey the property. Thus, for example, peatlands now part of national or state forests require more complicated conveyance procedures--sometimes including legislation--than do county owned or administered tax forfeited lands or federally owned lands that do not have recreational or other significance.

In addition to outright sales or leases of publicly owned lands, transfers are possible. For example, Minnesota law allows the state to trade land it owns for land owned by federal or local government units. In addition, state lands can be transferred between uses (for example, from recreational purposes to unrestricted use).

Because of the complexities involved in conveying publicly owned lands, it is not useful here to consider every form of conveyance in detail. It is useful, however, to discuss conveyances of state owned lands more completely, since the state owns most publicly owned peatlands in Minnesota, and state law does contain some specific provisions relating to the conveyance of peatlands.

Minnesota Statutes, Section 92.461, first enacted in 1935, prohibits the sale of any state lands "which are chiefly valuable by reason of deposits of peat in commercial quantities." This section also states that before *any* state land is offered for sale, the Commissioner of Natural Resources shall evaluate the land to see whether it falls within this category. According to department personnel, peat exists in "commercial quantities" only if it extends to a depth of at least four feet.

Minnesota Statutes, Section 92.50, provides the terms under which the state may lease its lands for purposes of removing sand, gravel, peat, and other surface products. Generally, the leases may not extend for more than 10 years, except that peatland leases may extend for up to 25 years if approved by the state's Executive Council (the Governor and other statewide elected officials). State law permits the leases to contain conditions defining exactly how the peat resource will be developed.

There are other provisions for the sale and lease of state lands, including forest lands, but it is unclear how these provisions relate to those which specifically govern the conveyance of peatlands. Presumably, under general rules of statutory construction, the laws relating specifically to peat will supercede general statutes affecting conveyances of state owned lands.

State law also contains provisions relating to leasing of tax forfeited peatlands. Under Section 282.04, a county auditor may, with the approval of the county board and the Commissioner of Natural Resources, lease peatlands for up to 25 years. Before these leases can be effective, however, a public hearing must be held.

Land Use Planning and Zoning. Local government units can exert control over private peatland development through their land use planning and zoning powers. (Note: whether local zoning ordinances can control the use of state or federally owned lands is unclear. The statutes are not specific, but it is presumed that the state, within limits of reasonableness, is able to determine uses for its own lands.)

Minnesota Statutes, Sections 394.21 through 394.37, give county boards a wide range of discretion in controlling the use of lands within the county. For example, a county's comprehensive plan and resulting zoning ordinance may establish controls in a number of areas that are relevant to peatland development. According to the statutes, these areas include agriculture, forestry, soil conservation, water supply conservation, surface water drainage and removal, conservation of shorelands, wetlands preservation, open space, protection of groundwater, protection of "slope, soils, unconsolidated materials or bedrock from potentially damaging development," preservation of woodlands and wildlife habitat, reclamation of non-metal mining lands, and erosion and sediment controls. In addition, a zoning ordinance may cover the location of transportation routes and industrial and processing facilities.

Where countywide zoning is not in effect, a town board may ask the residents of the township to approve a referendum granting zoning powers to the board. If the referendum is approved, the board can write a comprehensive plan and then prescribe zoning regulations affecting the location and extent of industry, agriculture, and other land uses within the township.

<u>Other Forms of Land Use Control</u>. Various state and local government agencies have control over the siting of improvements or facilities that will affect peatland development. Such facilities include power line corridors, roadway and railway construction corridors, and waste dumps.

The current peatland ownership structure is complex. Varying laws relating to conveyances and permissible uses will apply depending on the type of ownership. Because of this situation, it will be difficult to implement a development policy affecting all of our state's peatland resources.

Because state government owns so much of the state's peatlands, and because decisions about their use are significant land use decisions, a mechanism must be developed to insure that peatland development meshes with land use policies. The task will not be easy, since federal, state, and local government units are all involved in land use decisions, and since peatlands cover such a large total acreage.

Although the state owns so much of the land, it may have difficulty ensuring that it is developed wisely because of ambiguities about such things as the legal status of peat as a mineral and the variety of conveyance and use restrictions. These issues should be resolved as soon as possible in a way that will facilitate the implementation of a comprehensive peatland development policy.

Until a comprehensive peatland development policy is adopted, the state should retain its prohibition on selling peatlands and should continue its policy of leasing them only for restricted uses and for limited periods of time. Executive Council approval (or approval of a coordinating structure) should be required for all peatland leases of major size or duration. The Legislature should review maximum allowable lease periods to assure that leases for nonextractive uses are long enough to allow fair return on investments.

The Legislature should determine whether to treat peatland development as a mineral or a surface use. The authors of this study believe that development of peatlands should be designated a surface use. This would allow peatland conveyance to be consistent, whether the peatland was to be mined or where the peatland is used for biomass production. Transfer of mineral rights, whether on private or public lands, would not constitute rights to the peat.

Peatland leases should include specific conditions for reclamation, environmental protection, taxes and royalties, so that a lease can be revoked if the conditions are not met by the lessee.

Certificates of Need and Site Selection

MEA requires public hearings on energy supply and demand before it will issue a certificate of need for the following, 1) a new fuel conversion facility with a peak capacity of 25 tons per hour, 2) a new gas pipeline of at least 200 pounds per square inch of pressure and length greater than 50 miles within Minnesota, 3) a peat-fired power plant producing 50 megawatts or more of electricity, or 4) an expansion of a pilot fuel conversion plant. (Smaller scale peat energy facilities or biomass operations would not require certificates of need.) Criteria to be considered include:

- forecasts of energy demand;
- ability of existing facilities to meet that demand;
- the effects of conservation or promotional practices by the applicant company;
- the effect of the proposed facility in making efficient use of resources;
- the appropriateness of the size, type, and timing of the facility;
- costs, compared to alternatives;
- effects on natural and socioeconomic environments, compared to alternatives;
- expected reliability;

- evidence of benefits to society, compatible with protection of environment, economy, human health;
- evidence that the proposed facility can meet relevant policies and regulations of state, federal, and local governments.

The certificate of need process requires proposers to list anticipated sites for the project if they are known. It is possible that certificate of need proceedings would not consider any particular site. Thus, a proposed project might be evaluated without regard to specific local effects and without notification of a specific local community.

After the MEA completes the certificate of need process, the Minnesota Environmental Quality Board (MEQB) begins the process of identifying a specific site. The MEQB would select sites for peat-fired power plants and resultant large transmission lines, but not for energy conversion facilities and gas pipelines.

Because the state owns large portions of the peatlands, it could presumably have significant power in determining project sites: the MDNR and the Executive Council could decide precisely which state owned lands to lease for what type of use.

The existing state process for determining the need for major energy facilities is a good one. The broad consideration of alternatives, conservation, economic feasibility, and local effects is important in assuring that major facilities be built only if they are needed.

Water Conservation and Drainage

Usable peat is most often found in marsh lands, bogs, or other wetland areas. All of the means for extracting peat from these areas involve relocation of water. In traditional extraction techniques, excess water is drained from the bog. The newer hydraulic mining process uses water as a transport medium. Whichever technique is adopted, peat extraction will involve relocating excess water, at least temporarily.

Minnesota law contains a variety of regulations relating to water conservation and drainage. If peatlands include "public waters," that is, waters "which serve a material beneficial public purpose," they will be subject to an array of water-planning and regulatory provisions under Chapter 105 of Minnesota Statutes. The public waters category includes waters which have a substantial impact upon agriculture, underground water strata, wildlife habitat, and areas designated as "scientific and natural." If the "public waters" designation applies, then the peatlands will be subject to the jurisdiction of the Commissioner of Natural Resources, the Water Planning Board, local government units, other state agencies and "special districts."

If the waters in the peatland areas are not "public waters," then relocation of those waters may call into play an entirely different regulatory system. If the peatland can be defined as a "water basin," then the laws relating to drainage systems in Chapter 106 of Minnesota Statutes will apply. To be defined as a water basin, an area must be "an enclosed natural depression with definable banks capable of containing water which may be partly filled with waters of the state and which is discernible on aerial photographs." Many of the peatlands in the state fall technically within this definition.

If Chapter 106 applies, then drainage of the peatlands will be subject to the public notice and hearing requirements for the construction of "county ditches" and "judicial ditches" in the state. These proceedings allow any landowners who may be adversely affected by the drainage to file for compensation for any damages incurred.

On its face, the law relating to drainage does not appear to have been written with peatlands in mind. However, a narrow reading of the law suggests that these laws may in fact apply to many possible uses of peatlands.

Under Minnesota Statutes, Section 111.03, a district court judge may order the creation of a "drainage and conservancy district" for the prevention of fires "in areas of agricultural lands or in peat areas subject to destruction and damage by fire." These districts are created pursuant to petitions that may be filed by individuals or appropriate local government officials. Once a district is created, the district board must approve any alterations in the water for drainage or other purposes. In addition, the court may order the construction of dams, levees, and other devices in order to preserve the water supply.

The federal government also plays a role in water drainage and conservation. The U.S. Army Corps of Engineers has permit authority for filling and dredging on federal lands and in navigable waters. The Corps may take the lead on a federal environmental impact statement, if a proposed development is large enough and close to public waters. More generally, the International Joint Commission, consisting of U.S. and Canadian representatives, has some jurisdiction over water use and discharge in basins draining into the Great Lakes.

Although peatland development will inevitably displace significant amounts of both surface and sub-surface waters, laws relating to water usage and transfer are confusing and unclear in their application to peatlands. These laws do not appear to have been written with the unique characteristics of peatland development in mind.

Mining and Reclamation

It appears that neither federal nor state mining and reclamation regulations apply to peat mining. The federal Surface Mining Control Act refers explicitly only to "coal" and "lignite." No official interpretation of peat's standing under the Act has been made. An internal staff memo prepared by the Office of Surface Mining, which administers the Act, has concluded, however, that peat and peatlands do not fall under the Act. The chairman of that staff committee submitted a minority position that peatland development for energy uses should be covered by the Act because it will pose major environmental issues as a result of its mining methods and the location of peat deposits. To date, no one has submitted a formal request to the Director of the Office of Surface Mining for a definitive interpretation. It is possible that at a later date the Act may be interpreted to include peat.

If the Act did apply to peat and peatlands, it would require permits for peat mining (which could, by agreement, be administered by the state) and adherence to performance guarantees that land will be restored to original contours and a better land use. The mining company would be required to contribute to a reclamation fund at so much per ton extracted. Areas could be designated as unsuitable for surface mining, either by a state planning process or by a citizen petition.

It is quite clear that the state mineland reclamation law would not apply to peatland development, since the law refers only to "metallic minerals." This law is the only source of MDNR authority over mining, other than the authority to place conditions on leases of state land. If changed by legislation to include peat mining, the reclamation law would allow the state to adopt rules covering permits to mine peat, reclaiming peatlands, and disposal of peat mining waste. The law also would spell out the liability of the mining company. Public hearings would be held on the proposed rules relating to peat mining and perhaps on each mining permit considered.

Apparently, no federal or state laws directly regulate peat mining or peatlands reclamation. Because experience with reclamation of coal and taconite mineland may not apply to peatlands reclamation, research will be needed to design appropriate regulations.

Environmental Regulation and Studies

Over the past decade, an impressive array of structures and laws for controlling environmental degradation have evolved. Both the United States and Minnesota have enacted environmental protection acts. Laws designed to protect air and water quality authorize the federal government to set basic guidelines and the state government to administer and possibly strengthen the law. Many federal and state agencies have potential roles in guarding against harmful environmental effects of peatland development.

Air quality. The U.S. Environmental Protection Agency (EPA) develops standards for implementing the Clean Air Act and its amendments, but the Minnesota Pollution Control Agency (MPCA) administers the law. Five sections are important to peatland development.

1. National Ambient Air Quality Standards have been set for five major pollutants (total suspended particulates, sulpher dioxide, oxides of nitrogen, carbon monoxide, and ozone). The MPCA administers this law by granting permits to stationary sources. Minnesota's standards are generally more strict than federal standards. Air quality regulations may be reviewed at both the state and national levels in 1981.
2. Areas in which the levels of one of the primary five pollutants are already greater than those allowed by standards are designated Non-Attainment Areas. No new emissions of the pollutant are allowed in these areas unless pollution from existing sources is reduced. Several peatland areas in the state are within non-attainment areas.
3. New Source Performance Standards, which are stricter than National Ambient Air Quality Standards, apply to newly constructed fuel-fired facilities. The MPCA conducts pre-construction reviews. Under its own authority, MPCA can also assess total air quality impacts of mining operations (MPCA Rules APC 1, 5, 6, 8).

4. Hazardous Air Pollutant Standards have been established for certain heavy metals. Peat tends to absorb such materials, and processing or burning peat may release them into the air.

5. Prevention of Significant Deterioration requires areas in the state to be classified according to how much additional air pollution will be allowed. Class 1 areas are allowed almost no additional air pollution. Voyageurs National Park and the Boundary Waters Canoe Wilderness Area are currently Class 1 areas. Indian reservations, such as Red Lake, may designate their lands Class 1, by a decision of their governing body. In Class 2 areas, some degradation of air quality is allowed, such as that which would accompany moderate, well-controlled growth. Most peatlands are in Class 2 areas. In Class 3 areas, large scale development is allowed if secondary standards are met. It is unclear whether wind-blown mining dust or fugitive dust from soil are exempt from the requirements for prevention of significant deterioration. If they are exempt, dust from peat mining would be excluded from regulation.

Water quality. The Federal Water Pollution Control Act (Public Law 92-500) is also administered by the MPCA under federal guidelines. The MPCA administers the National Pollutant Discharge Elimination System by granting permits for the treatment of waste water discharges, with specific conditions attached. Effluent guidelines are set on a case-by-case basis. The United States has set a "no pollution discharge" goal for 1985, meaning all water discharges will have to be cleaned up by then. In addition, the federal Act sets effluent standards for certain kinds of new facilities. It is possible that such facilities include those which convert peat into energy. In the case of toxic pollutants, the Act specifies the type of anti-pollution devices that must be used. Again, the state may adopt stricter requirements than those set by the federal EPA. In addition, MPCA requires permits for the construction and operation of closed system waste treatment facilities, including tailings basins. Peat mining methods that use drainage or hydraulic transportation would probably fall under this requirement.

Also, MPCA has authority over all non-point source runoff (general runoff not traceable to one specific source). Noise, disposal of solid waste, storage and disposal of liquids, solid wastes, and residual materials (i.e., scrubber sludge) are also regulated by MPCA.

Both the air and water laws provide opportunities for public comment. Public hearings are optional.

Environmental studies. The National Environmental Policy Act (Public Law 91-190) requires that an environmental impact statement (EIS) be prepared for "major federal actions significantly affecting the quality of the human environment." Because it is likely that federal subsidies will be sought for peatland energy projects, proposals will almost surely require a federal EIS. DOE is beginning studies that will gather data which could be used in preparing an environmental impact assessment for peatland development. Each proposed peatland development project would be subjected to the assessment in order to decide whether an EIS is warranted. The purpose of EIS is to provide information to the public and decision-makers about the possible effects of a development project, and to give full consideration to alternatives to the proposed action. An EIS does not require changes in proposed developments; it merely provides information.

It is likely that a state EIS will also be required for peatland development in Minnesota. The state is currently rewriting its regulations of the state EIS process, which applies to private as well as public activities. Under legislation passed in 1980, the MEQB will adopt rules which will specify in advance what kinds of proposals will require an EIS and those that will require an environmental assessment worksheet, which may or may not show the need for a full-scale EIS. Public hearings on these rules are scheduled for March 1981. Under the proposed rules, the agency responsible for conducting the study will also be specified in advance. Proposed rules would require an EIS for the following facilities or activities that might be associated with peatland development:

- electrical power plants greater than 50 megawatts;
- fuel-conversion facilities for converting peat or biomass to gaseous, liquid, or solid fuels, if greater than 350,000 dry tons per year are processed;
- peat mining on more than 320 acres;
- stationary sources of air pollution emitting more than 100 tons per year of any one pollutant.

Environmental assessment worksheets would be required for:

- conversion of more than 640 acres of peatlands (to biomass, agriculture, etc.);
- electrical power plants of 1-50 megawatts;
- conversion of peat and biomass to fuel where more than 5,000 dry tons/year are processed;
- gas pipelines greater than 200 pounds per square inch and greater than 50 miles long;
- stationary sources of air pollution emitting 25-100 tons of a pollutant per year;
- alteration of wetlands, stream diversion, or water impoundment.

Other requirements may also apply.

Under the proposed rules, financial transactions, legislative actions, and agency rulemaking are exempt from the EIS process. If both a federal and a state EIS were required for a project, the federal EIS would be prepared first and would serve as the draft statement for the state EIS. Provision is also made in the proposed rules for a generic EIS which would cover new types of activities prior to development of site-specific proposals. Peatland development is specifically identified in the comments to the rules as an activity where a generic approach might be appropriate.

<u>Other environmental laws</u>.

1. The National Historical Preservation Act requires that federally financed, permitted, or assisted projects cannot adversely affect important historic or cultural sites unless no alternative exists.
2. In administering the Endangered Species Act, the U.S. Fish and Wildlife Service identifies endangered species and critical habitats and reviews projects in which the federal government is involved. It also administers and enforces the Executive Orders on floodplains and wetlands (Executive Orders 11988 and 11990).
3. The Fish and Wildlife Coordination Act; Wildlife and Scenic Rivers Act; Coastal Zone Management Act; and the Marine Protection, Research and Sanctuaries Act are federal laws which may apply to specific peatlands in the state.

The Minnesota Environmental Coordination Procedures Act provides a mechanism for coordinating the diverse and numerous permits which may be required for a development proposal. A person proposing a project may apply to the environmental permits coordination unit of the MEQB for all necessary state permits. If the proposal complies with all local laws and regulations, then MEQB staff contacts appropriate state agencies, holds all necessary public hearings, and requires each agency to make a final decision on the permits.

The purpose of the Act is not only to coordinate procedures and make sure that a development complies with state laws, but also to give citizens an opportunity to present their views on a proposal as a whole.

Local governments also have the power to control environmental effects of peatland development. Counties, municipalities, and townships may use their zoning laws to encourage and discourage different uses of peatlands. Performance standards or conditions may be applied to rezoning actions or conditional-use permits.

The Red Lake Indian Reservation is a special case. Since it is a sovereign nation within Minnesota, the tribe's governing council has full jurisdiction over its lands. In addition, the council may be able to influence development outside the reservation borders if the development would disrupt the reservation's natural resources or its economy.

If properly and conscientiously applied, existing laws and regulations should provide adequate protection against environmental degradation caused by peatland development. Any problems are likely to be caused by the difficulty of coordinating the various authorities involved.

Taxation

State and local governments in Minnesota have yet to decide how they will tax the revenues derived from peat development. The tax system selected--and whether it tends to favor non-extractive as opposed to extractive uses--may have a significant effect on the type of development that ultimately occurs. Several types of taxes now in use in Minnesota are potentially applicable to the various options for peatland development.

Production taxes. This system of taxation assesses a flat amount per ton of resources removed. Typically, a production tax is used in lieu of property taxes (since the "value of the use of the land" will be known only after the chief resource of the land--the mineral--is removed).

The Minnesota production tax on minerals is a "severance" tax. The general theory underlying severance taxation is that the extraction of minerals or other products from the land is a one-time event. Once these products are extracted, the people of the state will forever be denied any benefit from these products. Therefore, severance tax supporters argue that it is appropriate to place a tax on the gross amount of resource mined.

Occupation taxes. Occupation taxes are based on a mining company's earnings after production expenses are deducted or credited. Occupation taxes, because they are based on net earnings, are often used in lieu of income taxes.

Although Minnesota has production taxes and occupation taxes for iron ore, taconite and copper-nickel, no similar taxes have been placed on peat. Peatlands and the earnings from their development are therefore currently subject to forms of taxation used for non-mining activities in the state.

Property taxation. Peatlands, whether or not they are in the process of being developed, are now subject to property taxation. State law, however, does not specify which property tax classification applies to peatlands. The Department of Revenue staff has indicated that it is likely they are classified Class "4b," undeveloped nonagricultural lands.

If full-scale extractive development of the peatlands occurs, and if no production tax is substituted for the property tax, state policymakers will need to assign a tax classification to peatlands. Peatlands could be classified as undeveloped nonagricultural lands, as agricultural lands, or as "mineral interests." Alternatively, the Legislature could establish separate classifcations for peat and/or the peatlands themselves. (This latter approach was adopted for iron ore and derivatives. Class 1 property is the iron ore; the iron-bearing lands themselves are classified according to their "surface" characteristics.) A separate peatland classification system also may be needed if non-extractive development--e.g. agricultural development--occurs.

Property taxes on any peat processing facility are also at issue. Since the facility may possibly be processing peat brought from peatlands which lie outside the jurisdiction of the taxing authority where the facility is located, it may be appropriate to consider a property tax system which also benefits those units of local government that have jurisdiction over the peatlands.

Income taxation. As noted above, income taxes on mining companies are commonly eliminated when occupation taxes are levied on the companies. This has happened in the case of Minnesota's taconite industry. (The income tax has been retained for copper-nickel mining although state officials are studying whether it should be dropped.) Even if peat extraction is exempted from the income tax, earnings from non-extractive uses could be subject to the income tax. Also, rental and royalty income derived from private peatlands could be taxed as income or, as is done with taconite and other minerals, could be taxed under a separate rate structure which encourages development.

Miscellaneous taxation provisions. As noted above, there are no production, occupation, or severance taxes for mined peat, nor have lands where peat is being mined been given a specific property tax classification. However, peat is mentioned specifically in two Minnesota tax laws.

One of these laws specifically prohibits private citizens from removing peat, standing timber, and other minerals from lands on which property taxes are owed. If there is peat on such land, the Commissioner of Finance or the county auditor is empowered to mine the peat, sell it, and apply the proceeds to the payment of the taxes. It is unknown whether this option has ever been used, nor is it clear how this provision would relate to other regulatory laws affecting the peat. (Relevant sections of law are Minnesota Statutes, Section 272.38-272.40.)

The second law prohibits mining of peat from property which has been forfeited for nonpayment of taxes until the new owner has made full payment for the land. (See Sections 282.321-282.35.)

Tax revenue distribution issues. If a production or occupation tax, or some combination of the two, is imposed on the extraction of peat, then a formula will be needed for distribution of the tax revenues. Since the revenues will be in lieu of property taxes, the local governments in the area will lose revenues and would presumably seek reimbursement from the new tax collections.

For example, more than 90 percent of the revenues from the taconite taxes are returned to local governments. Most goes to school districts; lesser amounts go to counties and municipalities. Some portions go to two separate economic development funds, and a small portion of the taconite tax is deposited in the state's general fund since it is assumed that all the citizens of the state have legitimate claim to benefits derived from removal of one of the state's natural resources. Although the precise distribution formula may need to be modified, the general concept of revenue distribution used for the taconite tax with beneficiaries including local government units, schools, and state as a whole, and economic development funds--could also be used for distribution of peatland tax revenues.

Because peat can either be used in place or extracted, it is difficult to simply adopt in toto one of the existing tax systems for minerals or agricultural land. What is needed is a system that can reflect the peatlands unique characteristics as both an in-place growing medium and as a source of raw material for energy and other uses. However, adopting a "flexible" system may raise a whole series of new issues for Minnesota.

First, valuation of the resource will be difficult. Many of the contemplated extractive uses--especially gasification--are still experimental, and it is impossible to know the efficiency of the process and the ultimate value of its product. Also, the value of an energy resource is highly volatile in this period of unstable energy supplies and prices. Therefore, the system must not only be flexible in order to recognize a range of possible uses, but it must be easily adjustable to market and supply conditions.

Second, both extractive and non-extractive uses of the resource may occur on the same land. For example, research indicates that it may be possible to extract a portion of the peat in an area and use the remainder as a growing medium for cattails or other energy crops. Thus, any taxation system must recognize possibilities for dual use.

Finally, it is imperative that a taxing system reimburse local governments for costs associated with peatland development. If property taxes on peatlands are replaced by forms of mineral taxation, the Legislature should adopt a peatland tax distribution system that properly compensates the government units for lost property tax revenues and any increased services required because of the development. Also, special provisions should be made for protecting local economies against the "boom and bust" cycle that often accompanies mineral development.

Social and Economic Development

A number of governmental agencies are interested in the social and economic impact of peatland development. They include:

Federal and interstate development agencies. In recent years, the federal government has established a number of agencies to help economically depressed areas of the country. One of these is the Upper Great Lakes Regional Commission, which serves the northern portions of Minnesota, Wisconsin, and Michigan. The agency distributes federal money for a variety of research and development projects. It has helped analyse and resolve problems created by the iron ore and taconite industry in northern Minnesota, and, presumably, would help resolve similar problems relating to peatland development. Future funding for the Commission is uncertain, however.

Other federal agencies which may have an interest in the social and economic issues connected with peatland development include the Economic Development Administration in the Department of Commerce, the Department of Housing and Urban Development, and the Department of Energy. The Departments of Interior, Agriculture, and the Bureau of Indian Affairs may also have a role in planning peatland development. Finally, the Department of Transportation and the Interstate Commerce Commission may be involved in regulating the development of new transportation facilities and franchises needed to distribute the peatlands' products to locations outside Minnesota.

State development agencies. The state Department of Economic Development and the regional development commissions could participate in peatland development.

As the agency having general responsibility for promoting business development in Minnesota, the Minnesota Department of Economic Development could help attract peat processors, distributors, and necessary supporting industries to the state. In addition, DED has experience in locating and obtaining financing for the types of businesses (food, clothing, and auto repair, for example), that will be needed to serve any increased population resulting from peatland development.

The Arrowhead and Headwaters Regional Development Commissions have jurisdiction over the areas of heaviest peatland concentration. Charged by state law with promoting economic development and comprehensive planning, the RDCs work with both private businesses and local government units. RDCs can help local governments plan for expansion related to peatland development, and they also can provide financing assistance for businesses moving into the area.

Mineral area development programs. In 1941, the Iron Range Resources and Rehabilitation Board (IRRRB) was created to help reduce unemployment and "economic distress" on the Iron Range in Minnesota. The Board, consisting of 10 legislators and the state Commissioner of Natural Resources, annually receives a portion of the taconite production tax. The money is deposited in the "taconite area environmental protection fund" and is used for the following purposes:

- to study the environmental impacts of taconite mining and processing;
- to reclaim minelands;
- to enhance local economic development projects through the construction of public works; and
- to monitor health problems among mining employees.

The IRRRB will clearly be involved if peatland development occurs near taconite mining areas, primarily St. Louis, Itasca, Aitkin, and Cass counties. The vast peatlands in Koochiching, Beltrami, and Lake of the Woods counties are not within the Board's funding area.

In 1977, the Legislature created the "Northeast Minnesota Economic Protection Fund," also consisting of proceeds from the taconite production tax. The fund will be used after the year 2002 to redevelop local economies that have been depressed by depletion of the taconite ore. Within the past year, various government officials have suggested that this fund should be made available now to aid the development of the peatlands so that an industry is fully developed by the time of taconite depletion.

Other state and sub-state agencies. A substantial number of localized public and quasi-public developmental organizations may become involved in peatland development. These organizations include area redevelopment authorities and federal- and state-chartered community development corporations.

A broad array of other public agencies could help local communities cope with the impact of peatland development. For example, the Minnesota Housing Finance Agency (MHFA) is charged with meeting the housing needs of low- and moderate-income people in Minnesota. If there is a need for extensive new housing development, MHFA is a likely source of assistance. Assistance also could be provided by the Minnesota Department of Transportation, the Energy Agency, the Agriculture Department, the Department of Natural Resources, and the Department of Labor and Industry.

At the local level, major peatland development will have a significant effect on local service agencies. Housing, social services, transportation, and education systems at the local level will be immediately affected by an influx of people working on peat-related activities.

A substantial number of federal, state, regional, and local government agencies could concern themselves with social and economic issues related to peatland development. In most cases it is left to the discretion of the agency to decide the extent to which it will become involved.

GENERAL OPTIONS FOR ADMINISTRATIVE STRUCTURE

This section covers in more general terms options available for instituting a decision-making process for peatlands. The first option is to retain the current system, by changing the existing regulatory framework to apply to peatland development. The second option, to coordinate regulatory activities, would allow simultaneous implementation of various recommendations made in the first part and would also allow for some meshing of the various agencies' efforts. The third option, to create a wholly new public-private structure, would go even further in giving Minnesota the power to guide and control any development of its peatlands.

Option #1: Retain the Current System

It is possible to control peatland development through existing laws and rules once the few regulatory gaps are filled and ambiguities are clarified. Relying on the current system, however, is a piecemeal approach because regulatory control is dispersed among many governmental units.

It is impossible to implement a comprehensive and rational policy on peatland development with the current system. For example, while energy planning occurs at DOE, MEA, and the Public Utilities Commission, decisions about protecting resources are being made at MDNR, MEQB, and MPCA. Agricultural promotion decisions are being made at the federal and state agricultural departments, land use decisions are being made by a host of public and private landowners and local government units, and economic assistance decisions are being made by a number of federal, state, and regional development agencies. Various other agencies are simultaneously making decisions about water drainage, transportation, energy facility siting, and energy research funding.

Another disadvantage of the current system is that the number of governmental units involved will deter all but the most determined of citizens and citizen groups from participating in the regulatory and development processes. By the same token, a developer interested in small-scale peatland development may become discouraged once he or she is apprised of the bureaucratic hurdles to be cleared.

Option #2: Continue Emphasis on Private Initiative; Coordinate State Regulation

If the Legislature desires to continue in its current role of being a regulator and lessor (rather than being an initiator and participant in peatland development), then the focus of change should be on *the state regulatory process*. Improvements in this process will reduce the problems identified with Option #1 above while continuing the dominant role for the private sector in peatland development.

In order to improve the state regulatory process, a more formal coordinative structure may be needed. Three options appear to exist. First, a procedure for coordinating permits could be established. An existing state agency such as the MDNR or the MEA could be designated to coordinate activities between agencies and to help peatland developers and citizens deal with the various agencies having regulatory jurisdiction. Secondly, a new interagency task group could be established--e.g. a Peatland Development Board consisting of representatives of all state agencies with peatland-related responsibilities. (Note: There now exists an informal peat advisory task force consisting of agency representatives.) Finally, a wholly new agency could be created, and all existing state regulatory functions relating to peatlands could be transferred to it.

At the same time, coordination could be attempted among state agencies involved in economic development. This could be done through the interagency group identified above. The state Department of Economic Development could be charged with coordinating all peatland-related activities of the various state and regional agencies concerned with economic development. A third approach might be the creation of an agency analogous to the IRRRB to perform similar functions in respect to peatland development. (Note: This idea would be especially appropriate if a new tax distribution system were to be created to benefit peatland areas.) Finally, a public/private community development corporation could be founded to coordinate the delivery of not only public assistance, but private development dollars as well.

There might be an opportunity for coordination at the local level also. Since most major peatlands cross over township--and occasionally county--boundaries, it will be extremely beneficial to have a mechanism for coordinating local inter-governmental responses to peatland development issues. Such a technique will be useful for zoning, water drainage or roadway construction problems caused by peatland development. One method to accomplish this coordination might be the creation of regional peatland development boards consisting of representatives from each affected county in the regions. (Note: So-called "special districts" have been used in Minnesota to deal with topics of inter-jurisdictional interest--e.g., soil and water conservation and hospitals. Perhaps this model could apply to the peatlands as well.)

Increasing coordination among government agencies, as outlined above, should simplify somewhat the peatland decision-making process. Problems will remain, however. Coordinating activities within each governmental level will not necessarily resolve the need to mesh policies and programs between levels of government. For example, an energy policy devised at the state level could easily be countered by local government units that become convinced that the state policy does not properly accommodate the interest of their residents. Similarly, a county zoning board's efforts to encourage renewable uses of the peatlands could be blunted by a state decision to lease its peatlands for a major gasification facility. In addition, coordination does not necessarily give citizens more opportunity for input into the decision-making process.

Option #3: Create a New Public-Private Structure

A third option would be to create a wholly new structure that would meld together the various private and public interests in peatland development. Such a structure could take a variety of forms. It could be a "public corporation" governed by representatives from both the private and public sectors. Such a corporation would be chartered by legislative enactment and would therefore have close ties and accountability to the public. The public corporation would have as its prime purpose the representation of the public interest and the implementation of the state peatland development policy.

In Minnesota there is no precedent for a public corporation with statewide jurisdiction. Precedent is provided, however, by other states, the federal government and many regional entities. Although the Minnesota Constitution specifically prohibits the creation by the Legislature of "private corporations," the model envisioned here for a public corporation would not violate that restriction. Peatland development by a public corporation has successfully been practiced in Ireland, Sweden and Finland. The Bord ma Mona, a peatland development public corporation in Ireland has taken the responsibility for peat extraction, conversion to energy and reclamation efforts.

A variation of the public corporation discussed above would be the creation of several smaller corporations, each having jurisdiction over a particular peatland area. Other alternatives for public-private structures might be local or community development corporations. These entities now provide the opportunity for joint public-private participation in a large number of areas, throughout the state.

Whatever the precise structure, the goal would be the creation of one or more entities that would combine the best features of public agencies and private businesses. Ideally, this structure would serve more than a passive role in peatland development; it would actively represent the public interest and serve as a participant and initiator of sound development activities.

The range of potential jurisdiction for the public-private cooperation on corporations is broad. The entity could be given title to peatlands now under public ownership, and it could be given the power of eminent domain over private peatlands. Or the public owners may simply designate the corporation as the lessee for specific development purposes.

The entity could also be given broad energy policy jurisdiction. For example, it could be charged with determining permissible energy uses of the peatlands; it could be responsible for coordinating peat research; it could be given the authority to determine appropriate facilities for conversion of peat or biomass to energy; and it could even be granted the power to construct and operate those facilities. Alternatively, it could be given the power to contract with private entities for the performance of any or all of these functions.

If the Legislature desired, it could allow the entity to supersede local land use and drainage powers. It could coordinate the various economic development programs that apply to communities affected by peatland development. Finally, it could monitor and enforce laws governing peat mining and reclamation.

Financing for the corporation could come from any number of sources. Private investors would be encouraged to invest and share in the profits. Public support could come from:

- dedication of a portion of the taxes on the peatlands or their products to the corporation,
- proceeds from a levy on property in the area,
- biennial general fund appropriations,
- proceeds from the conveyance of peatlands, or
- proceeds from the sale of general obligation or revenue bonds.

Income from the sale of peatland products would be shared by the participating public and private investors.

If the public corporation vehicle is used, the Minnesota Legislature would need to specify the composition of the corporation's board of directors. The board could include representatives from the public at large; residents of the affected areas of the state; state agencies having responsibilities in the areas of energy, environment, agriculture and economic development; private sector developers and investors; organized labor; affected local government units; tribal representatives and federal agency representatives.

It will be imperative to make the public corporation's board of directors accountable to the public and the Legislature. Several techniques are available to accomplish this. First, the directors could be elected at large from the state as a whole, or as representatives from specific affected regions. Second, they could be appointed for specified terms of office by elected officials (e.g., the Legislature, the Governor, local county boards). As a final option, members initially could be appointed, but their replacements would be selected by the remaining board members. (This would be similar to the typical, self-perpetuating corporate board having staggered terms of office for its members.)

The creation of a new public-private entity has several advantages over the other options discussed in this chapter. Such an entity, whether it be a single, larger public corporation or several smaller corporations, can be the focal point for input from a broad sector of individuals and entities interested in peatland development. It would allow the state to be more than a responder to private initiatives; it would serve as an initiator and participant in development activities. Finally, it would ensure that control over one of Minnesota's few indigenous energy sources will be retained by the people of Minnesota.

A public-private entity also has disadvantages. First, consolidating powers over peatland development may unduly limit the rights of citizens who now have power through local government units to control, if not stop, types of investment which they believe to be undesirable. Also, merely establishing such an entity may create a strong pro-development momentum that may be difficult to restrain.

Finally, and more generally, bigness does not always lead to better decisions. The mere size of the corporation--if one statewide corporation is used--together with the powers it may be given, suggests that the public interest may not necessarily be served. If a number of local peatland development corporations are used, then the opposite problem may emerge--the lack of a cohesive and coordinated policy for peatland development. Also, wholly private entities could prove more efficient and economical in peat development, and may therefore--if properly monitored--do the best job of meeting the public interest.

VII. RECOMMENDATIONS OF THE CURA PEAT POLICY PANEL

Based on its examination of the energy, economic, social, legal, and environmental issues included in its full report, the CURA Peat Policy Panel has formulated recommendations regarding development of Minnesota peatlands. These are directed to all interested in the future of the state's peatlands, including industry, government, and citizens.

PREMISES UNDERLYING THE RECOMMENDATIONS

1. Regions of Minnesota, particularly the Iron Range, are in need of local economic development and may benefit from peatland development.
2. The degree to which economic development is beneficial to citizens depends on the nature and scale of development as evaluated in the context of specific locations.
3. Unless current patterns of energy availability and use are altered, Minnesota and the rest of the nation can expect near- and long-term shortages of traditional fossil fuels accompanied by increasing prices associated with scarcity, decreasing accessibility, and changes in government regulation.
4. Portions of Minnesota's peatlands contain important and in some cases rare biological, geological, aesthetic, or other characteristics which could be disturbed or destroyed by development.
5. Many questions regarding the availability, utilization methods, and the potential economic, social, and environmental effects of peatland development are still unanswered. The recommendations offered in this report are based on research findings currently available.

RECOMMENDATIONS OF THE PANEL

Development of Minnesota's peatlands for energy could improve the state's economic and energy situations. However, development plans and state policies must reflect careful consideration of the energy, economic, social, and environmental implications of peatland development. With this in mind the following recommendations are made.

1. A comprehensive state policy for peatlands should be established. Minnesota needs a coordinated and comprehensive policy for its peatlands. The Legislature should design a policy and establish appropriate institutions broad enough to encompass both public and private developmental interests. The policy should recognize that developing this resource is desirable but that it should occur only if it can be demonstrated that a) there will be positive economic, energy, and social results and b) any detrimental economic, social, and environmental impacts can be prevented or minimized. The Legislature should solicit broad public input by conducting public hearings throughout the state during this process of policy formulation.

2. Certain peatlands should be preserved. Before significant development commitments are made, appropriate governmental agencies, with the participation of citizen groups, should identify the type, size, and location of peatland areas to be preserved in their natural state. Such lands could be preserved for their scientific value, unique natural systems, recreational value, historical or aesthetic importance, or their value as a future resource.

3. An administrative structure should be created. Because so many interests and factors are involved in potential peatland development, it is imperative that a structure be created to coordinate and interrelate these interests and factors. Because the state is the single largest landowner of peatlands and because various state and local agencies have jurisdiction over decisions affecting peatland development, we recommend that the Legislature establish either a new structure that would bring together the public and private interests in peatland development or a new state coordinating body to oversee development. Because the current regulatory and developmental framework is too fragmented to permit implementation of a rational and comprehensive development policy, the following are proposed:

   a. If the Legislature desires the state to be an initiator of and participant in peatland development, then the Legislature should create one or more public corporations to consist of governmental, citizen, labor, and private industry representation. This corporation could have jurisdiction in some or all areas of peatland development including energy utilization and planning, land use, resource utilization and processing, and regional economic and social development.

b. If the state elects to remain as a regulator and "lessor," then the existing regulatory and developmental framework needs modification. Specifically, the Legislature should establish a coordinating structure to ensure that the interests of affected state and local agencies are represented in the decision-making process.

c. Whatever structural model is ultimately selected for regulating and developing peatlands, it is necessary that the existing regulatory processes regarding water, drainage, and other environmental controls be clarified and coordinated.

d. Because of the wide-ranging impact of peatland development on our state's energy, economic, social, and environmental conditions, it is imperative that opportunities for input from private development and citizens be provided regardless of the structural model chosen. This input must be obtained before and at frequent points throughout the process. It is not sufficient simply to allow citizens to testify at permit hearings. The citizens of the state must be fully informed about the issues relating to peatlands before development decisions are made.

4. Energy proposals should be carefully evaluated. The following factors should be considered in determining the desirability of specific proposals:

   a. The quality of energy to be produced compared with the quality demanded.

   b. The quantity of energy produced compared with the quantity demanded, and its value in the market.

   c. Total cost, accounting for all private and public production, environmental and user costs.

d. Energy efficiency and the net energy contribution of the proposed development.

e. Stability of the energy supply to be provided.

In this regard, the process of Certification of Need should be used to compare the proposed project's costs and benefits with those of other available alternatives. The existing process should be improved with a review of the criteria for certification. Some categories might be expanded to include smaller peat-related projects. Proponents of projects should demonstrate in detail that their total cost, capital requirements and net energy contribution are competitive with those associated with general energy conservation strategies.

5. A well defined development policy should be adopted. The specific nature and scale of development should be matched with appropriate locations. The goals of such a policy should be:

a. Development at a rate which assures orderly economic growth and desired social change.

b. Development with beneficial long-term economic and social effects. Detrimental economic and social impacts can be prevented or minimized by locating development in areas capable of providing public and private services for whatever population growth may occur.

c. Energy for use within the area as well as for export.

d. Enhanced possibilities for containing, mitigating, and preventing detrimental environmental impacts.

Certificate of Need proposals should be specific to particular sites so that specific impacts can be considered and citizens from the proposed development area can be involved.

6. Development should occur on a suitable scale. Development of Minnesota's peatlands for energy should occur on a scale which is economically and technically feasible but small enough to:

a. Promote and protect local economic activity and ensure the greatest possible level of locally owned and operated businesses associated with new development.

b. Minimize the detrimental economic and social impacts often associated with large-scale development, including the disruption of the economic and social systems of existing communities.

c. Contain, mitigate, or prevent detrimental environmental impacts by narrowing the geographic area of impact and by reducing the overall impact in any one location.

d. Promote multiple uses of Minnesota's peatlands so that the resource can be made available to diverse energy and other development interests; and to provide the state with management flexibility over peatlands owned by or under its jurisdiction.

7. Production of wetland energy crops should be emphasized. The economic feasibility of producing energy from peatlands in Minnesota, including energy crop production approaches, has not been demonstrated. However, we believe that utilization of Minnesota's peatlands for energy crop production is the most prudent approach for the following reasons:

   a. As a renewable energy approach, it offers the longest-term use of Minnesota's peatlands for energy and, thereby, enhances the long-term economic stability of the area.

   b. This approach is potentially as versatile as extractive approaches because energy crops can be used as a feed stock for direct-burning, liquefaction, gasification, and briquetting.

   c. This approach preserves Minnesota's finite, nonrenewable peat resource for future generations to use at a time when the state might face a more critical need for the products which can be produced from peat.

8. Conditions for extracting peat should be clearly defined. In situations where small-scale production of energy crops is clearly not technically or economically feasible, small-scale approaches which require peat extraction--despite their nonrenewable use of the resource--should be encouraged if all of the following can be demonstrated:

   a. Such development will be of clear benefit in providing local economic activity and local employment.

b. Such development will provide a locally available and usable source of energy.

c. Detrimental economic, social, and environmental impacts of such development can be prevented or minimized.

d. Reclamation of the mined peatland to a usable form is possible and will be guaranteed through arrangements with the peatland developer. Potential uses of mined peatlands should be evaluated from economic, social, and environmental standpoints, and a planned optimum mix of end-uses for the region should be projected as a guide to policy and regulation.

Because peat mining is currently not covered by state laws, the state must adopt a peatlands mining and reclamation law and the administrative rules necessary to implement the law.

9. Peatlands slated to become inaccessible should be considered for mining. Those peatlands slated to become inaccessible due to other kinds of development--such as those lands scheduled to become taconite tailings dumps--should be considered for mining. Appropriate state agencies should begin immediately to determine the exact location and acreage of such peatlands.

10. Research and development efforts should be broadened. In keeping with the preceding recommendations, current research and development efforts--now almost exclusively geared to large-scale peat mining, dewatering, and gasification--should be broadened to include research and development in the following areas:

   a. Economic, social and environmental effects of peatland development.
   b. Small-scale energy crop production.
   c. Small-scale peat extraction.
   d. Small-scale dewatering and conversion of energy crops and peat.
   e. Methods to contain, mitigate, and prevent detrimental environmental impact.
   f. Reclamation.

In order not to rely primarily on federally funded research and development projects, state agencies should expand their work in those research areas that are not currently of interest to the federal government.

11. Demonstration projects should be started.

Among other research and development efforts, the state should begin demonstration projects as soon as possible that are consistent with the policies developed in this report. These projects should be funded by industry and government and could be located on peatlands slated to become inaccessible as described in Recommendation 9. Such projects should include examination of the technical and economic feasibility of:

a. Land preparation for energy crop production and peat extraction.
b. Small-scale approaches for energy crop production--both to produce energy on unmined peatlands and as a technique for reclaiming mined peatlands.
c. Small-scale approaches for peat mining.
d. Small-scale approaches to energy crop and peat utilization.
e. Dewatering and conversion of energy crops and peat.
f. Reclamation approaches.

12. Sufficient lead time is required. Lead time should be required to prepared for potential development impacts. This lead time will allow a sufficient period of time for private and public service providers to prepare for the development project by either expanding or adjusting their supply of services. Leases for peatland development should not be approved until plans for preventing or minimizing the potential impacts have been formulated. Requirements in the lease agreement should include that the developer aid state and local government in the formulation and implementation of plans to prevent or minimize potentially adverse impacts.

13. Peat revenue policy should be established. Because peat is not subject to special treatment under our tax laws, it is doubtful that revenues from our current system of taxes, rents, and royalties will compensate for the costs attendant to peatland development. Therefore, state revenue laws should be written to:

a. Establish a tax that recognizes the unique results and costs attendant to both extractive and nonextractive uses.
b. Tax extractive and nonrenewable uses in ways generally comparable to mineral taxation (with consideration given to both production and occupation taxes).

c. Tax nonextractive and renewable uses in ways generally comparable to agricultural land taxation.

d. To the extent permitted by the constitution, establish a preference by the use of favorable tax rates to encourage the utilization of peat to solve Minnesota's energy needs.

e. That tax revenues, rents, and royalties be distributed in ways designed to compensate fairly the government units absorbing the costs of peatland development.

14. A peatland leasing policy should be established. As the primary landowner of peatlands, the state's ability to lease peatlands will be a primary means of controlling the nature, scale, and location of development.

a. For purpose of legal title to lands, peat should be statutorily established as a surface use rather than as a mineral right. This will recognize that peat is a surface resource and will be consistent with Minnesota Department of Natural Resources' current administrative treatment of its status.

b. The state should make full use of its authority to place conditions on a lease in order to ensure that environmental, financial, and other obligations are met by developers.

c. The maximum number of years currently allowed for leases may be too short for non-extractive uses, and should be reviewed.

d. The creation of any new decision-making structure to manage and regulate Minnesota's peatlands would include appropriate changes in existing leasing authority. However, if the existing structure is retained, Executive Council approval and legislative consultation should be required for all leases which are major in size or duration.

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