Report on

FIELD INVESTIGATION STUDY

AN ANALYSIS OF COAL BROKERAGES FOR MULTIPLE USERS IN MICHIGAN

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WATER RESOURCES MANAGEMENT PROGRAM

THE UNIVERSITY OF MICHIGAN

August 1, 1982

AN ANALYSIS OF COAL BROKERAGES FOR MULTIPLE USERS IN MICHIGAN

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A practicum submitted in partial fulfillment of the requirement for the degree of Master of Science (Water Resources Management) at the University of Michigan.

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ACKNOWLEDGEMENTS

I would first like to thank my committee, Professor Jonathan Bulkley, and Associate Professor Howard Bunch, for their support and guidance on this project.

I would also like to express my appreciation to Ms. Chris Duncan of the Michigan Department of Natural Resources, Mr. John Ethen of Midwest Energy Resources, Mr. Ron Giaier of Detroit Edison, Mr. Paul Johnson of Johnson Brothers Corporation, and numerous individuals from various agencies and organizations for their input and helpful suggestions.

Finally, special thanks are due Mr. Greg Lang of the Great Lakes Environmental Research Laboratory for his technical assistance in preparing this report, and Ms. Cindy Heenan for her excellent job of typing it.

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I. INTRODUCTION

Coal use by industries and utilities is expected to increase substantially in the United States over the next 20 years, due to rising costs and diminishing supplies of oil and natural gas. Michigan, already a major national user of coal, is actively committed to expanding its own usage level (1).

As the shift to the use of more coal occurs, Michigan will be faced with many challenges. The largest challenge of course, will be to overcome the environmental problems associated with the burning of coal that caused it to fall into disfavor as an industrial and utility fuel during the 1950's and 60's (2).

Another major challenge will be the job of transporting the coal from origin to distination cheaply and efficiently. The transport of coal affects its cost and utility, and increasing fuel prices have created a need for a more efficient distribution system for moving the coal from mine to consumer (3).

To date, government action to promote coal use has taken the form of programs such as tax incentives and direct subsidies to users (4). However, action to encourage coal use and conversion by reducing its delivered cost has received relatively little attention. This is surprising since one of the largest factors that will determine to what extent midwestern industries and utilities use coal will be the total delivered cost of the coal (5). The delivered cost can be defined as the cost of the coal at the mine plus the cost to transport and distribute it (6).

Michigan is far enough away from its sources of coal so that the cost of transportation frequently equals or exceeds the cost of the coal at the mine (7). While the minemouth costs vary little among users, transportation and handling costs vary substantially according to the mode of transport which in turn is dependent on the amount of coal transported.

If potential coal users (espcially small and moderate sized users) are to convert to coal they must be able to purchase it at a low price, relative to oil and natural gas. Most small coal users currently face high fuel costs because their individual coal consumption is too low for them to qualify for volume transportation rates. If the coal demand of an area could be aggregated so that large volumes of coal were moved annually, transportation costs could be kept very low (8).

A major constraint on increasing the use and movement of coal in the Great Lakes states is the lack of an efficient distribution system available to small and moderate sized users (9). One possible solution is the use of transshipment/unloading facilities that can receive coal in large quantities, store it, blend and mix it, and distribute the coal to consumers. Facilities for multiple users could possibly open additional markets for coal in the near future by providing the necessary supporting infrastructure to keep the cost of transporting the coal as low as possible (10).

This paper will examine the feasibility of establishing modern transshipment terminals as local or regional coal distribution centers in Michigan. These facilities, which will be referred to as coal brokerages, are designed to allow multiple users to take advantage of the cost savings associated with high volume shipments of coal, through the aggregation of demand.

The capture of major economies of scale by utilities and other coal users is becoming increasingly important in their attempt to maintain reasonable fuel acquisition costs. Establishing a more efficient coal distribution system would be an important step in this direction.

The practice of consolidating bulk commodity shipping is not new and its application to coal delivery for large buyers has been common for many years (11). Yet, to date, the use of modern coal terminals as brokerages for small and moderate sized users has received relatively little attention. However, rising costs of oil and natural gas, innovations in coal transportation practices (such as the use of unit trains and large lake vessels), and increased use and movement of western coal have all contributed to interest in distributing coal through transshipment facilities. A transshipment facility can be defined as a bulk materials handling terminal designed for the transfer of a commodity from one mode of transport to another for further delivery (12).

In addition to providing access for rail and truck deliveries and docking facilities for vessels, a coal brokerage will also require substantial loading and unloading equipment which is necessary for receiving the high volume shipments, storage, and final distribution of the coal. Ideally, a coal brokerage will allow multiple users to take advantage of these services and obtain their coal at the lowest possible cost (13).

The purpose of this report is not to draw conclusions or predict whether small and moderate sized industries and utilities will use more coal or convert to coal in the future, rather, the focus of this paper is limited strictly to evaluating potential reductions in coal transportation costs, through the use of coal brokerage facilities. This paper also does not address the political/institutional framework regarding ownership and long term operation of a coal brokerage. Recommendations are not made along these lines except as they relate to the role of the coal brokerage.

The next section of this report examines the historical coal use in Michigan. Included is a short discussion of the physical and chemical characteristics of coal. Michigan's energy mix is evaluated and compared with the energy mix for the country as a whole. Coal use by sector is summarized, along with projections of future coal use and movement within the state.

Section III examines the current coal procurement practices, including direct contracting, coal brokering, and coal retailing/marketing. The advantages and disadvantages of each of these options are discussed.

Choices in the coal transportation process including rail, vessel, truck, and pipeline delivery are described in Section IV, along with a review of the current transportation system. Also, the pros and cons of each transport mode are evaluated for small and moderate sized coal users.

Section V evaluates potential brokerage locations in the state of Michigan, including an examination of current coal use and distribution patterns in Michigan. Volume, demand, and transportation issues affecting a brokerage operation are also discussed.

Section VI is a discussion of the physical and capital requirements of a modern coal terminal.

Section VII is the cost feasibility study of the brokerage. Minemouth coal costs, transportation costs, terminal costs, and transshipment charges are examined. In addition, comparisons of present distribution methods are made, taking into account the specific requirements and constraints of individual coal users.

Section VIII which includes the conclusions, recommendations, and areas for further research completes this report.

FOOTNOTES TO SECTION I

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II. COAL USAGE IN MICHIGAN

Michigan is both the seventh most populous state, and the seventh largest user of energy in the nation. Despite being a heavily industrialized state, Michigan consumes less energy per capita than the national average. In 1976, the 9.1 million citizens of Michigan made up 4.3 percent of the U.S. population, but consumed only 3.8 percent of the total U.S. energy consumption. However, Michigan as a state is very energy dependent, importing close to 90 percent of its energy (1).

MICHIGAN'S ENERGY MIX

Of critical importance when evaluating Michigan's energy future is the energy mix, or the types of energy used to accomplish the required end uses. Michigan's energy mix differs from the nation's due to a greater reliance on coal and natural gas and less reliance on petroleum products (2). Table 2-1 shows the patterns of energy consumption in Michigan in the year 1977. Currently, coal serves over 25 percent of Michigan's energy needs. Petroleum accounts for 36 percent, natural gas 30 percent, hydroelectric and nuclear 4.5 percent, and other sources about 4 percent. This compares with the national energy mix of 19 percent coal, 25 percent natural gas, 39 percent petroleum products, 13 percent nuclear, and about 3 percent from other sources (3). Table 2-2 compares Michigan's energy consumption with national energy consumption for the years 1972 through 1977. Of special interest are the coal use statistics that show Michigan consuming over 5 percent of the coal used nationally over the six year period. In addition, as one of the eight Great Lakes states, Michigan is part of the region that used 49 percent of the coal consumed nationally in 1976 (4).

Table 2-1

PATTERNS OF ENERGY CONSUMPTION IN MICHIGAN 1977

Prepared by the Energy Data and Modeling Division
of the Michigan Energy Administration

1977 USES \ FUELS	(L.P.G.) Liquefied Petroleum Gases	Gasoline	Distillate and Diesel Fuel	Jet Fuel	Residual Fuel Oil	Total Petroleum Products	Natural Gas	Coal	Hydro and Nuclear	Other[1]	Electricity	Total (In Trillions of Btus)
	Millions of Gallons						MMCF	1000's Tons	Trillion Btus		Billions of Kwhs	
Residential	243.2 (23.2)	0 (0)	697.1 (96.7)	0 (0)	0 (0)	940.3 (119.9)	333,651 (340.7)	173 (4.4)	0 (0)	0 (0)	21.9 (74.7)	(539.7)
Commercial	27.0 (2.6)	0 (0)	302.8 (42.0)	0 (0)	148.0 (22.2)	477.8 (66.8)	171,015 (174.6)	101 (2.5)	0 (0)	33.9 (33.9)	16.0 (54.6)	(332.4)
Industrial	33.0 (3.1)	73.6 (9.2)	154.4 (21.4)	0 (0)	180.4 (27.0)	441.4 (60.7)	299,276 (305.6)	8,485 (213.6)	0 (0)	79.1 (79.1)	32.5 (110.9)	(769.9)
Transportation	3.0 (0.3)	4,859.6 (607.2)	328.7 (45.6)	218.8 (29.2)	11.6 (1.7)	5,421.7 (684.0)	4,617 (4.7)	0 (0)	0 (0)	0 (0)	0 (0)	(688.7)
Agricultural	48.6 (4.6)	37.7 (4.7)	59.9 (8.3)	0 (0)	0 (0)	146.2 (17.6)	342 (0.3)	0 (0)	0 (0)	0 (0)	.3 (1.0)	(18.9)
Electric Generation	0 (0)	0 (0)	77.1 (10.7)	0 (0)	556.5 (83.3)	633.6 (94.0)	46,174 (47.1)	20,047 (504.6)	128.7 (128.7)	0 (0)	-70.7 (-241.2)	(533.2)
Total	354.8 (33.8)	4,970.9 (621.1)	1,620.0 (224.7)	218.8 (29.2)	896.5 (134.2)	8,061 (1,043.0)	855,075 (873.0)	28,806 (725.1)	128.7 (128.7)	113.0 (113.0)	0 (0)	(2,882.8)

[1] *Includes Asphalt, Road Oil, Feedstocks and Petroleum Coke*
All numbers in brackets are shown in trillions of Btus.

[Reprinted from Michigan Energy and Resource Research Association, 1980]

Table 2-2

MICHIGAN VERSUS NATIONAL ENERGY STA

[Reprinted from Michigan Energy and Resource Resea

NATIONAL ENERGY CONSUMPTION

(Quadrillion Btus)

	1972	1973	1974	1975
Oil	33.779	35.632	33.923	33.222
Natural Gas	23.147	22.959	22.200	20.302
Coal	13.031	12.878	12.768	13.153
Nuclear	.576	.888	1.194	1.805
Hydro	2.831	2.822	3.126	3.116
Other				
TOTAL	73.364	75.179	73.211	71.599

MICHIGAN ENERGY CONSUMPTION

(Quadrillion Btus)

	1972	1973	1974	1975
Oil	1 058	1.089	1.041	1.056
Natural Gas	.896	.933	.943	.916
Coal	.918	.834	.747	.776
Nuclear	.023	.030	.004	.074
Hydro	.017	.009	.011	.010
Other				
TOTAL	2.912	2.896	2.746	2.832

MICHIGAN AS A PERCENTAGE OF NATIONAL ENERGY CONSU

	1972	1973	1974	1975	1976
Oil	3.13	3.05	3.06	3.17	3.24
Natural Gas	3.87	4.06	4.24	4.51	4.55
Coal	7.04	6.47	5.85	5.89	5.37
Nuclear	3.99	3.37	.33	4.09	5.49
Hydro	.60	.31	.35	.32	.42
Other					
TOTAL	3.96	3.85	3.75	3.95	3.95

CHARACTERISTICS OF COAL

Abundant coal reserves exist in several regions of the U.S. The major coal producing regions are the Eastern Region, the Midwest Region and the Western Region. The Eastern Region includes coal produced in Maryland, Pennsylvania, Ohio, Virginia, West Virginia, and eastern Kentucky. The Midwest Region includes coal produced in Indiana, Illinois, and western Kentucky. The Western Region consists primarily of coal produced in Montana, Wyoming and Colorado (5). Other coal producing regions are the Southern Region (Alabama, Tennessee, and Georgia) and western Midwest Region (Iowa, Texas, Missouri, and Oklahoma). These last two regions do not produce any of the coal that is used in the state of Michigan, but do provide some of the coal used in the south and southwest.

Coal can be defined as a sedimentary rock consisting primarily of compounds of carbon, hydrogen, oxygen, sulfur and a large percentage of volatile matter. Most of this volatile matter is water and hydrocarbons. Coal is classifed by proximate analyses (which are empirical tests), to determine the rank or stage of metamorphosis (6). A proximate analysis of coal involves the determination of four constituents. These are: 1) moisture, 2) ash, or the residue from complete combustion, 3) volatile matter, which consists of the gases and vapors driven off when the coal is heated to 960°F for 7 minutes, and, 4) fixed carbon, which is the solid residue that remains after the volatile matter is driven off, minus the ash content (7). In general, sulfur, ash, and moisture are the undesirable constituents of coal. Most of the energy comes from the amount of carbon present when coal is burned.

Coal is formed under pressure for an extensive period of time, possibly up to 400 million years. During formation, coal undergoes a series of alterations as follows: (a) living plants, (b) peat, (c) lignite, (d) sub-bituminous coal, (e) bituminous coal, (f) anthracite. Each step results in an increase in rank. The rank of the coal is the degree of metamorphism, or the progressive alteration from lignite to anthracite (8).

As the rank of coal increases the percentage of fixed carbon increases and the percentages of volatile matter and moisture decrease. Anthracite coal is comprised of 92 percent to 98 percent carbon (9).

Table 2-3 shows the great variation in the composition of coal, by comparing a typical lignite coal with an anthracite coal.

Table 2-3

Coal Analysis (ash-free basis)
[Reprinted from Szabo, 1978]

	Lignite	Anthracite
Fixed Carbon	33%	92%
Volatile matter	26%	5%
Moisture	41%	3%
TOTAL	100%	100%

Figure 2-1 shows the types of coal produced by each region in the U.S.

The bituminous coals of the Eastern and eastern Midwest regions generally have high sulfur levels and low to moderate levels of ash. Bituminous coals from the Southern region are generally low in both ash and sulfur.

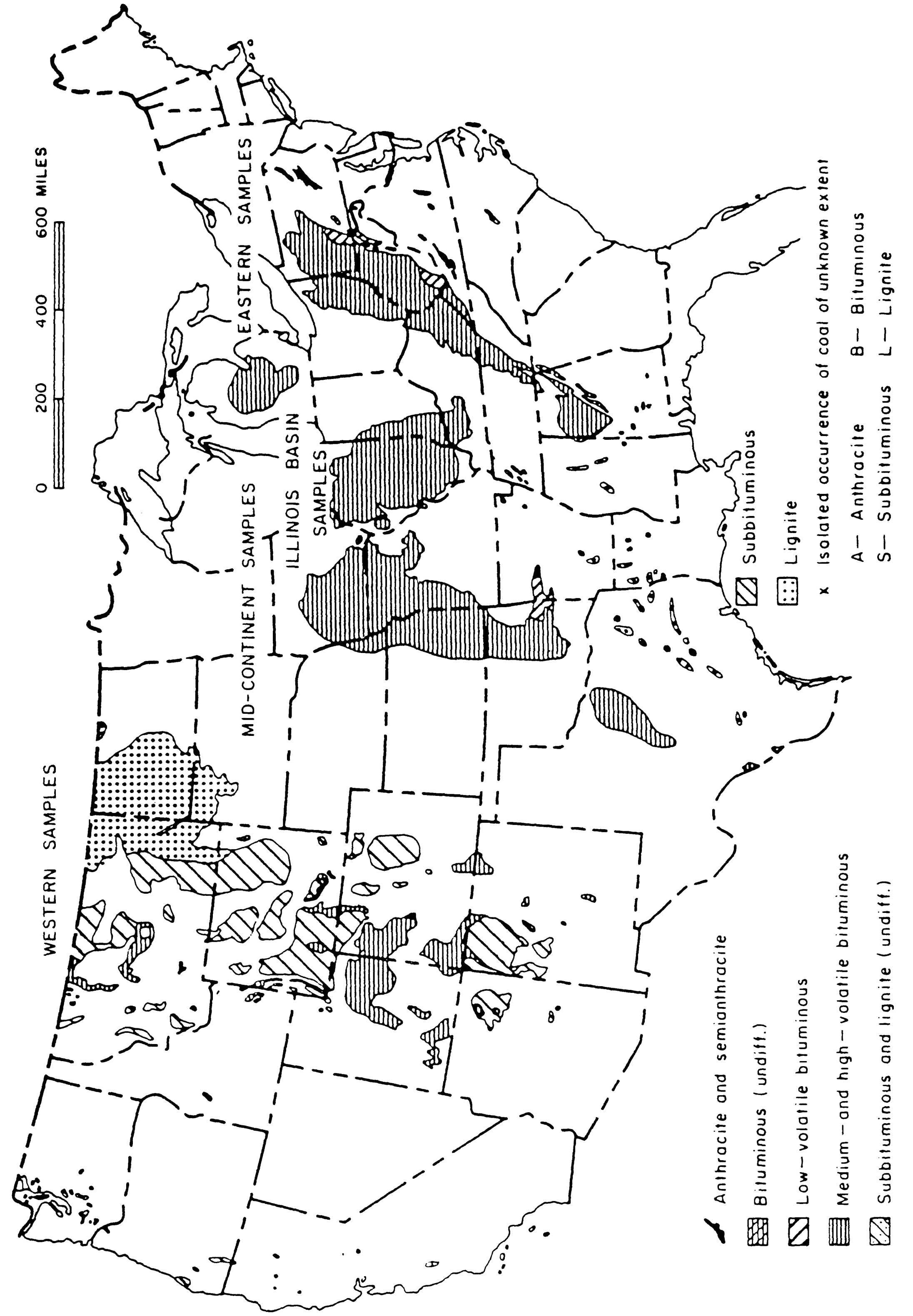

Figure 2-1

COAL FIELDS OF THE UNITED STATES

[Reprinted from Gluskoter et al, 1977]

Subbituminous and lignite coals from the West have a low sulfur content, but have a higher ash and moisture content (10).

UTILIZATION OF COAL

Knowledge of the differences between the types of coal outlined above is important for identification of the potential end use of coal and to provide data for determining the types of burning and handling equipment that will be needed (11).

Coal is used to fire utility and industrial boilers, in conversion to coke for metallurgical processes, in liquefaction, and gasification (12). Not all coal is suitable for all purposes, due to its heterogenous composition. For this reason coal must meet a set of specified requirements determined by each end user.

Energy Content. The main interest in coal is the heat or BTU value. These values typically range between 6,000 and 14,000 BTU per pound, delivered (13). Table 2-4 shows the BTU value range for each type of coal.

Table 2-4

Energy Value of Coal
[Reprinted from the President's Commission on Coal, 1980.]

Type of Coal	BTU/Pound	
	Low	High
Anthracite	13,000	14,000
Bituminous	11,000	13,000
Subbituminous	8,000	10,000
Lignite	6,000	8,000

Ash. Knowing the ash content of coal is important, because ash is a waste product that has to be collected. Also, as the ash content of coal increases the energy value goes down (14). In addition, the ash content is used as an indicator of corrosive and fouling properties of coal (15).

Sulfur. Sulfur content in coal is important due to environmental concerns. The burning of certain coals may present problems if high sulfur emmissions are released into the air. Low sulfur coals contain less than 1 percent sulfur. Medium sulfur coals have between 1.1 and 3 percent sulfur. High sulfur coals are those with greater than 3 percent sulfur.

In general, low sulfur coal is found in the West, and in some portions of the East (West Virginia, Kentucky, Virginia). High sulfur coal is predominantly found in the East and Midwest (16).

Moisture. Moisture is an undersirable constituent of coal, because it lowers the heating value, adds to the shipping weight, and causes freezing problems in the winter (17).

Values of the moisture content in coal may range from 2 percent for a high grade bituminous coal, to 44 percent for a low grade lignite (18). Excess moisture can be removed from coal, but equipment and environmental clean-up costs are often prohibitive (19).

In addition to the properties of coal outlined above, there are others, the significance of which vary on a plant-to-plant basis. Additional factors of importance are: phosphorus content, sodium content, chlorine content, and the size of the coal, which is a commercial description of coal to determine the suitability for certain end uses. Currently, the sizes of bituminous coal are not well standardized but are usually defined by diameter (20). Decisions regarding all of these characteristics will be based primarily on the end use of the coal, and on boiler requirements (21).

UTILITY COAL USE

Seventy percent of the coal used in Michigan is used by utilities to generate electricity; (non-utility production of electricity would raise this percentage). Therefore, the great majority of all coal-receiving facilities in the state use coal for power generation (22). Coal consumption patterns for Michigan over the last two decades show that the use of coal for power generation has increased dramatically on a percentage basis, while all other uses (with the exception of coke making) have experienced a decline (see figure 2-2).

The Detroit Edison Company uses about 42 percent of the coal shipped to Michigan, and generates close to 60 percent of the state's coal produced electricity. The Consumers Power Company generates 30 percent of Michigan's coal produced electricity and uses 21 percent of the coal shipped to the state. The remaining 10 percent of Michigan's coal produced electricity is generated by 11 other firms, which use about 7 percent of the coal shipped to the state (23). All the power plants in Michigan described by operator, location, status, years in operation, fuel, and size, are listed in Appendix A.

Coastal Capacity. Michigan has a higher percentage of electric generating capacity located in its coastal counties than any other Great Lakes state. Michigan's current coastal capacity is 16,051 MWe which is 88 percent of its total capacity (24). Of this, 63 percent is coal facilities or 55 percent of the state's total electric generating capacity. With respect to electric generating facilities planned or under construction from 1980 to 2000, 71 percent (3,491 MWe) of the additional future generating capacity will be located in the coastal zone, and 67 percent of this coastal capacity will be coal fired (25).

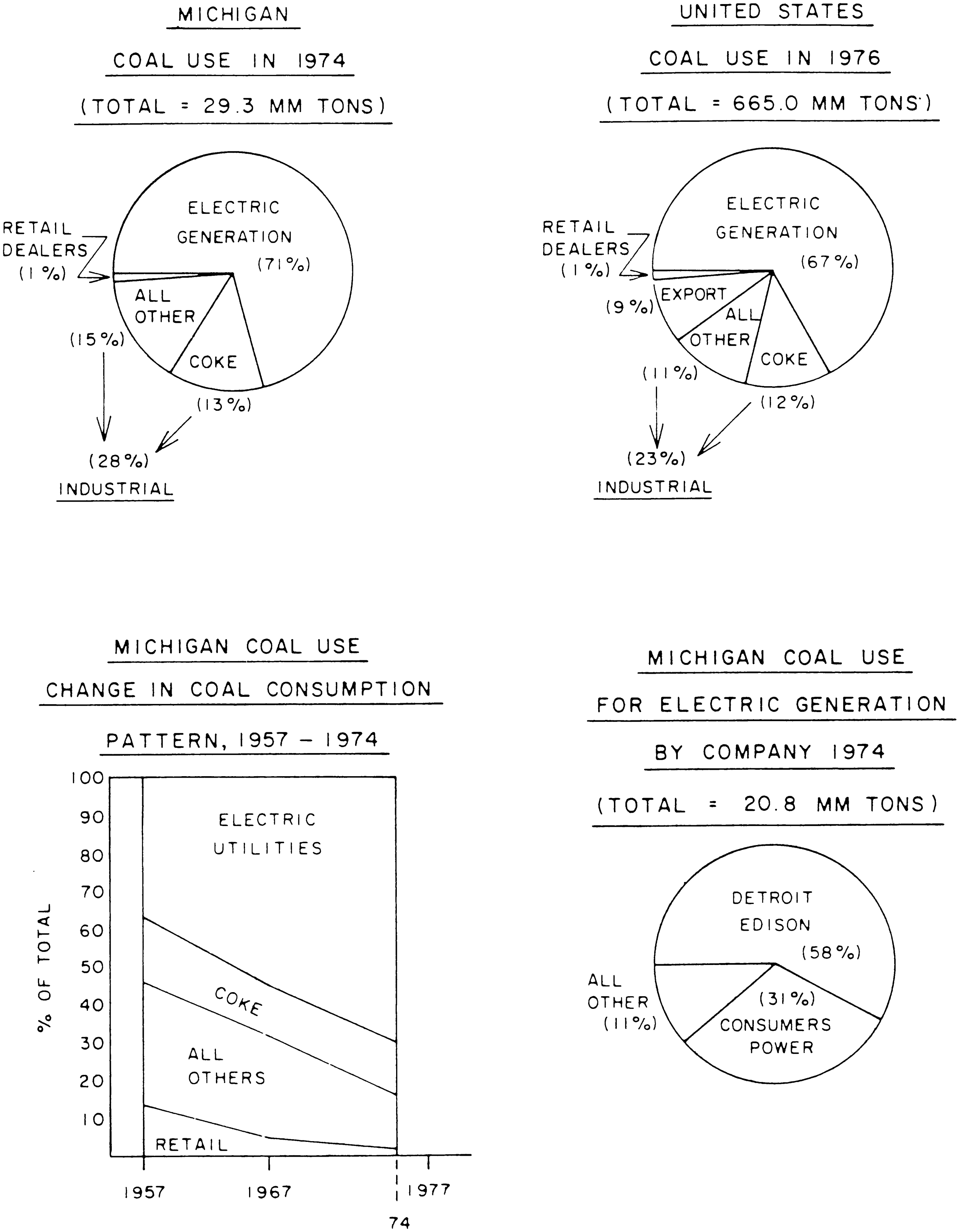

Figure 2-2
COAL USE OVERVIEW

[Reprinted from Michigan Energy and Resource Research Association, 1980]

INDUSTRIAL COAL USE

About 28 percent of the coal shipped to Michigan is used for industrial consumption. Coke production for steel making, which represents the largest single use today outside of electrical generation, amounts to 13 percent of the industrial total. However, the industrial coal market (aside from coke making) has progressively declined over the last two decades (26).

It is inappropriate to treat industry as a single coal using sector when discussing Michigan's energy future. Coal serves the energy needs for many types of industries, and the specific constraints and requirements will be different throughout industry. Therefore, the decisions that are made regarding coal use will be specific to each individual plant (27).

The U.S. Maritime Administration has identified the major coal using industries that will have the greatest effect on the future coal movement and use in the Great Lakes region. Excluding utilities, which are the single largest user, these industries fall into five major groups. These are salt producers, cement and chemical manufacturers, coke manufacturers, paper companies, and steel/iron ore and automotive companies (28).

Salt Producers. Salt companies use coal to produce electric power for their mining operations. Very little growth is projected for this sector in the near future (29).

Cement and Chemical Manufacturers. These companies use coal for power generation in their manufacturing processes. The use of coal in this sector is expected to decline slightly during the 1980's (30).

Coke Manufacturers. Companies that supply coal and coke for manufacturing are expected to increase their coal use during the 1980's. This increase could be in excess of 2 million tons per year (31).

Metallurgical coking coals must be low in ash, low in sulfur, low in phosphorus, and high in fixed carbon. Few coals have been found to have all of these desirable characteristics. Therefore, the standard practice is to blend several coals to make a desirable coke (32).

Paper Companies. This sector uses coal to generate electricity for manufacturing and processing. Demand for coal by these companies is expected to remain stable during the 1980's (33).

Steel/Iron Ore and Automotive Companies. Due to the downturn in the steel and automotive industries, coal requirements for this sector are expected to decline slightly during the 1980's.

The companies described above are all large energy-intensive industries, which are the firms most likely to use large amounts of coal. Smaller less energy-intensive firms are less likely to use or convert to coal because the capital requirements for installing coal-capable boilers are prohibitive. Also, costs of pollution control technology, waste disposal, and land for storage are often more than enough to offset the anticipated increases in the price of oil and natural gas for most small and moderate sized industries (34).

In general, the larger the facility the more likely it will be to use coal (on an individual plant basis). This is because larger firms can afford the capital expenditures for elaborate pollution control, handling, and transportation systems. Thus, only very large industrial plants are considered prime candidates for future coal use (35).

COMMERICAL AND RESIDENTIAL COAL USE

Coal use as a direct fuel for transportation, homes, and small businesses, has shrunk to virtually zero over the past several decades.

Currently, the commercial and residential coal sectors consume about one percent each of the coal shipped to the state of Michigan (36). Coal simply does not compete with oil and natural gas in these markets due to pollution and price characteristics.

FUTURE COAL USE IN MICHIGAN

Current economic conditions give little guidance on how to interpret the extent to which coal use will increase in the future. Projections are hard to make, due to several variables which interact to establish energy demand. To estimate a range of energy demand it is necessary to speculate on the future level of economic growth, consumer actions, rate of population growth, and anticipated levels of energy efficiency and conservation (37).

Nevertheless coal demand is "expected" to increase significantly, but the upward turning point will be sometime after 1985, possibly as late as 1992, since coal production and use is currently demand constrained rather than supply constrained. In view of environmental policies now in effect, and considering the lead times necessary for coal use expansion, coal production and use is likely to remain demand constrained for at least 5 more years and possibly for 10 years (38). After 1992 coal production and use is expected to be supply contrained (39).

The Michigan Energy and Resource Research Association (MERRA) has projected coal use patterns in Michigan through the year 2000, based on national coal production estimates, and individual utility long range planning studies for Michigan. The estimates for expected future coal consumption by sector, in Michigan between now and 2000 are illustrated in Appendix B.

Sixty seven million tons is considered the most probable amount of coal to be used in Michigan in the year 2000. This is over two times the current amount of 32 million tons per year. The effective range is estimated to be between 53 and 80 million tons per year by 2000 (40).

Coal use for generation of electricity is estimated to range between 37 and 47 million tons per year by 2000. This is about 1.8 to 2.1 times the current level of 22.4 million tons per year. Industrial use of coal in Michigan is estimated to range between 10 and 20 million tons per year in 2000. This is 1.1 to 2.2 times the current level of 8.9 million tons per year.

There are a number of assumptions upon which the MERRA projections are based (41). These assumptions are:

1. National coal consumption will range between 1200 and 1800 MM tons by the year 2000. The probability is low of extending much beyond 1800 MM tons.

2. Michigan coal consumption will increase at the same level as national consumption. This implies that Michigan can diversify its industrial base and/or retain its status as a major industrial state.

3. The industrial use of coal will range between doubling and halving its current percent total of coal use by 2000.

4. The synthetic use of coal will be about 10 percent of coal use nationally, and 7 percent of coal use in Michigan by 2000. Due to some major roadblocks in the development of a viable synthetic fuel industry, these estimates are significantly reduced from the projections made by MERRA in 1977.

5. The use of coal for coke will remain steady or increase slightly in absolute terms, but decline percentage wise by the end of the century.

In 1980 the Great Lakes Basin Commission (GLBC) evaluated the MERRA projections for coal use in Michigan. One conclusion was that extrapolation of national trends to Michigan may not always be appropriate. The rationale behind this conclusion is that Michigan currently uses a higher percentage of coal for its overall energy needs than the nation as a whole. Electric generating plants that use coal as their principal fuel in Michigan represent about 61 percent of the state's capacity. Additional coal capable units account for less than 18 percent of Michigan's electric generating capacity. However, other states (e. g. New York) have a much higher coal-capable capacity than Michigan (42). This suggests that Michigan may not have the flexibility or capability to double its coal use for electrical generation. Michigan's current coal fired electric generating capacity is 11,161 MWe. Coal capable generating capacity planned or under construction would increase this capacity by about 50 percent by the year 2000, indicating that Michigan utilities will not double their coal use as the MERRA projections suggest (43). Table 2-6 shows the planned Michigan power plants through 1985.

Michigan industries are also not expected to increase their coal use substantially in the near future. This is due primarily to the recent downturn in the state's economy and Michigan's auto industry producing fewer and smaller cars (44). In addition, few industries now using oil or natural gas for their energy needs are expected to convert to coal in the next 20 years, due primarily to design limitations in industrial boilers (49). In conclusion, Michigan will probably not double its coal use by the year 2000, unless major increases are made in the industrial sectors, or in synthetic fuel development. A more reasonable and practical estimate appears to be a 50 to 75 percent increase in coal use by 2000.

Table 2-6

Planned & Proposed Michigan Power Plants
(CON, PLN & I/P)*
[Reprinted from Great Lakes Basin Commission, 1980)

Operator	City	Plant Name	Status	Year	Fuel	Mega Watts
Coldwater Public Utility	Coldwater	Coldwater 7	PLN	1982	Coal	25
Consumers Power Company	Midland	Midland 1	CON	1985	Nuclear PWR	504
Consumers Power Company	Midland	Midland 2	CON	1984	Nuclear PWR	852
Detroit Edison Company	China Township	Belle River 1	CON	1984	Coal	697
Detroit Edison Company	China Township	Belle River 2	CON	1985	Coal	697
Detroit Edison Company	Newport	Enrico Fermi 2	CON	1982	Nuclear BWR	1154
Grand Haven Board of Light & Power	Grand Haven	JB Sims #3	PLN	1983	Coal	100
Marquette Board of Power & Light	Marquette	Shiras 3	PLN	1983	Coal	43

*PLN - Planned; CON = Under construction; I/P = Indefinetly Postponed

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III. COAL PROCUREMENT PRACTICES

Understanding the current coal procurement practices is important to an evaluation of changes in the coal distribution system. For anyone interested in buying coal there are three primary methods of obtaining it and the specific requirements and constraints of each user will dictate which practice is best.

The three ways of procuring coal are: through coal brokers, coal marketers (retailers and wholesalers), and direct contracts with mines (1). Each of these options has to be evaluated to assess the requirements of a coal brokerage operation.

FUEL REQUIREMENTS

Before coal is purchased, a buyer must establish what type of coal is needed. Normally a user will prepare a list of specifications that include: Btu/ton of coal, sulfur content of the coal, ash content of the coal, moisture content of the coal, size of the coal, mode of receipt (truck, vessel, rail), and frequency of delivery (2).

Once the fuel requirements have been established, the user has to determine the best way to obtain the coal. The factors that determine which procurement option will be most attractive to users are as follows:

Storage capacity. Obviously, some users will be constrained by the amount of land available to store coal.

Capability to accept shipments. Not all users can accept shipments by rail and/or vessel due to lack of access to rail lines or water.

Handling capabilities. Many users lack the equipment needed to load, unload, and store large amounts of coal.

Mixing and blending capabilities. Coal often has to be mixed and blended to meet air pollution and/or boiler requirements. Many users cannot do this themselves. Therefore, the coal has to be prepared before it is delivered (3).

The amount of coal to be purchased (on an annual basis) is another important factor in the selection of a coal procurement option. Under the present coal distribution system, small and moderate sized users contact coal brokers and/or marketers with their list of fuel specifications. The user is then quoted a price that includes the cost of the coal plus any additional services that are needed. A buyer must evaluate not only the price of the coal, but also how close the broker/marketer's bid comes to meeting all the fuel requirements.

COAL BROKERS

Typically, a coal broker buys coal from a mine on behalf of a customer and delivers it (or has it delivered) directly to the final user. A broker can ship the coal to the final destination with the user paying the transportation costs, or the broker can take care of the transportation charges and bill the customer for the services. A coal broker may or may not take title of the coal during a transaction, but usually only arranges the shipments. In the past, brokers worked primarily on a commission basis; currently most brokers are paid a flat salary (4).

The number of small companies distributing coal has been declining for the past several years, and recent trends indicate that the small coal broker is slowly being phased out (5). Historically, brokers have done most of their business with, and obtained most of their coal from mines classified as small producers. A small producer mines less than 500,000 tons per year (6). Recently, many of the smaller mines (particularly in the east) have been closing down or are being bought up by larger producers. This affects the small broker adversely because most of the large mines prefer to conduct business with the larger customers who are willing to enter into long term contractual agreements (7). Also, many smaller mines cannot handle unit trains which makes it impossible for their customers to obtain volume transportation rates. A unit train by definition is a train used for transporting one commodity from origin to destination without interruption (8). It consists of a series of large capacity coal cars and typically hauls 10,000 tons of coal. Such a train is usually comprised of 100, 100-ton cars. The unit train has revolutionized coal transportation by providing virtual non-stop service for both producers and users. Almost all large mines can handle unit trains, making the associated volume rates possible for their buyers (9).

COAL MARKETERS

Marketers are coal companies that serve as both retailer and wholesaler (10). A coal marketer keeps stocks of coal on hand for sale to small utilities, industries, and commercial users. Coal marketers typically maintain and manage one or more stockpiles, own and operate loading and unloading equipment and depending on their size, own railroad cars and lease ships to run their business. Most marketers maintain a large purchasing staff, and operate under annual or term agreements with the majority of their buyers. Many marketers provide services such as coal storage, mixing, and cleaning for their customers (11). For certain types or grades of coal (depending upon the demand) coal marketers will buy coal in volume quantities. Buying coal in large quantities, a coal marketer may be able to pass the associated cost savings on to his customers. In addition, large coal marketers will often act as brokers as a courtesy for certain buyers. For instance, if a coal marketer doesn't have a certain type of coal on hand, he may broker the coal for that user (12).

Many companies distributing coal in the Great Lakes region are located in coastal areas (13). There are a number of reasons why a coastal site is attractive to a company marketing coal. First, vessel delivery of coal is often the most cost effective way of receiving coal for marketers. Also, a coastal site eliminates the need for much of the sophisticated rail loading/unloading equipment normally needed by marketers. If the marketer receives coal exclusively by vessel and distributes the coal by truck, the acreage requirements for the operation are also reduced. In addition, many small coal users may find it cheaper to receive coal by truck from a coal marketer than pay single car rail rates for direct shipments from a mine (14).

DIRECT CONTRACTS

Large coal users (greater than 1,000,000 tons/year) will almost always buy coal on a contract basis from mines. When a utility or other large user contracts directly with a mine for its coal it also has to make arrangements for transportation service with a railroad and if necessary, a vessel company. For these large users, transportation issues are of such importance that they almost always take top priority in the coal procurement process (15).

There are several steps that buyers go through when purchasing coal on a contract basis. These steps are to:

- Secure transportation.
- Evaluate the sources along the route.
- Determine if the sources can provide the necessary services, then make the arrangements; if not,
- Find the next best transportation alternative (16).

There are several reasons why a large coal user will secure the transportation before the coal sources are evaluated. Railroads indirectly dictate when users can get coal. For instance, every afternoon mines have to declare how many cars are needed for the next day. Usually, each mine will not receive its full allotment of cars due to the heavy demand. Therefore, some coal users will have to wait until cars become available to get their coal. Users contracting directly with the mine will usually experience no problems since they are buying large volumes and have entered into a long term agreement with the railroad to provide service. The railroads take care of the contract customers first, then provide service for the smaller users (17).

Most large users have to buy their coal from several suppliers. Frequently this is because a single mine cannot provide all the coal for a large user. More often it is because large users need to blend and mix several types of coal in order to meet air pollution and/or boiler requirements. In some cases a buyer may still obtain unit train rates when purchasing coal from several sources as long as the mines are in the same general area, that is, along the same transportation route (18). In addition, railroads will always give better transportation rates if the sources are located along rail lines that do not require substantial upgrading (19).

For large coal users the advantages of buying coal directly from a mine on a contract basis can be substantial. First of all, the added cost of the middle man (the broker or marketer) can be eliminated by direct contracts. Secondly, the service may be more reliable with their own transportation arrangements. In addition, if enough coal is being shipped, direct contracting is the most cost effective way of procuring coal (20).

ADVANTAGES OF A COAL BROKERAGE OPERATION

In Michigan, present procedures for buying coal seem to work reasonably well. The primary shortcomings have to do with technical and physical weaknesses of the system. Such weaknesses include the inability to store coal in large amounts, the inability to accept delivery from certain transport modes, and the lack of modern loading and unloading equipment to allow users to take advantage of the lowest possible transportation rates (21).

These shortcomings in the present coal distribution system should make the coal brokerage concept appear very attractive to small and moderate sized coal users. Some of the potential advantages of brokering coal through a modern transshipment facility are:

- A coal brokerage would eliminate the need for large capital requirements for coal transloading equipment for individual facilities because buyers would receive their coal by the transport method most convenient to them, probably by truck.
- A coal brokerage would help reduce acreage requirements for storing coal for each user. The brokerage itself would store the majority of the coal allowing the customer to store less.
- The customer would not have to inventory large amounts of coal. Although price agreements would be reached based on annual tonnages, coal would be paid for only as needed.

- For most users a brokerage would mean increased reliability of delivery.
- A coal brokerage should be able to handle more coal on an annual basis than a traditional coal broker or marketer. This should result in substantial cost savings in the delivered price of coal for the customers (22).

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IV. CHOICES IN COAL TRANSPORTATION

Planning changes in the coal distribution process involves the evaluation of tradeoffs of the different modes of coal transportation in light of individual user needs and constraints. In analyzing the transportation requirements for a coal brokerage operation the major factors are the location and interaction of the centers of production and consumption, comparative modal costs of transporting coal, and constraining factors on coal transportation (1).

There are six basic modes of transporting coal in the United States. These are rail, truck, pipeline, conveyor, barge, and vessel. Of these six, vessel, rail, and truck are the primary modes of coal transport in Michigan (2). Selection of transportation modes is made primarily on the basis of cost. However, other factors inherent to each mode influence the selection for a particular origin or destination. For example, the mode of coal transportation is often dictated by physical conditions such as topography, climate, availability of water, navigability of waterways, road conditions, and distance of transport (3).

This section is a short discussion of the major coal transport modes and the historical significance of each mode to the coal distribution system in Michigan. Actual transportation costs and rates will be discussed in Section VII.

RAIL

Rail is the primary method for coal transportation in the United States, especially for long distance hauling. Railroads carry most of the coal that is transported over 100 miles (4).

Rail transport has been the predominant mode of coal delivery to Michigan for over 25 years. In 1975, 31.3 million tons of coal were shipped to the state with rail accounting for 60 percent of this total. By 1979 rail deliveries had dropped to just under 53 percent of the total 32.4 million tons that were shipped. This drop in percentage is due primarily to increased vessel transport of western coal (5).

There are three general types of railway coal movements each with a different rate structure. There are single car shipments, multiple car shipments, and unit trains. Freight rates for unit trains are typically the lowest, single car freight rates are the highest (6).

Single car loading is practiced at the smaller coal mines. For single car loading, empty hopper cars are loaded as needed at the mine site. Crew efficiency and equipment utilization are low since the crew and locomotive units must make more than one trip for only a few cars of coal. Also, coal cars have to be sorted at intermediate terminals because the trains may be hauling different types of coal for multiple consumers (7).

Coal shipped by rail may also be moved by multiple car loading which is practiced at medium to large mines. Freight rates for multiple car shipments are based on a minimum of 10 cars. Determining factors in the rate structure for multiple car delivery will be the length of the shipment, the volume of shipment (in tons or number of cars), and annual volume (8). Although this system is more efficient than single car loading, the cars still have to be sorted at intermediate terminals.

Unit trains are the most efficient method of rail transportation. A unit train by definition is a train used for transporting one commodity from origin to destination without interruption (9). It consists of a series of large capacity coal cars and typically hauls 10,000 tons of coal. Such a train is usually comprised of 100, 100-ton cars. The unit train has revolutionized coal transportation by providing virtual non-stop service for both producers and users.

Determining factors for unit train freight rates are the transportation route (track conditions and terrain), loading and unloading conditions, distance of transport, ownership of rail equipment, and annual volumes moved.

Track Conditions and Terrain. Railroads will always offer the best transportation rates along routes with high quality track and smooth terrain. Freight rates will increase when railroads have to transport coal over rough terrain or on low quality track. In fact, most tracks cannot support unit trains. Therefore, unit train rates are available only to customers having their coal delivered along routes designed to handle unit trains (10).

Loading and Unloading Conditions. Unit train rates are determined at least partially by the capabilities of the mine to load the coal and the user to unload it. The most modern equipment can load or unload a 10,000 ton unit train in less than four hours. Unit train rates will often be negotiated with the agreement that the user can unload the train in a specified amount of time. If this requirement cannot be met, the rates will go up (11).

Distance of Transport. In general, the longer the distance of transport the higher the unit train freight rate.

Annual Volumes. As annual volumes increase, the cost per ton for transporting coal by unit train goes down. There is a minimum volume requirement of approximately 800,000 tons per year to obtain full unit train service (12).

Ownership of Rail Equipment. Unit train transportation rates can be reduced considerably if the coal is delivered with user owned equipment. The equipment requirements include rail cars and frequently, locomotives. Generally, for large coal users, it is cost effective to own rail equipment (13).

PASS THROUGH COAL

Pass through coal can be defined as coal enroute to demand centers outside of a region (or state) but passing through that region (14). The volume of coal that passes through some states such as Minnesota, Illinois, and Ohio is substantial, often millions of tons per year. Michigan on the other hand, has no pass through coal traffic, with the exception of water transport.

If unit train coal deliveries pass through a state to other demand centers high quality unit train trackage has to be constructed through much of the state. With the heavy track already in place, establishing unit train deliveries to demand centers located near the main unit train routes is not a major problem for the railroads (15). Currently, users located away from these routes cannot receive unit train shipments because the existing trackage has not been upgraded to handle the heavy trains. In addition, railroads are not likely to lay new track or upgrade low quality track unless there is a large projected demand for an area (16). Therefore, medium to large coal users located away from the major centers of demand who might otherwise be able to receive unit train shipments, cannot obtain unit train service on their own (17).

WATER TRANSPORT

Water transportation provides the Great Lakes Region with a fuel efficient and low cost mode of bulk transportation. As such, it is receiving significant attention as an alternative to rail for transporting coal to coastal-sited destinations in Michigan (18).

Water delivery of coal in Michigan has increased in recent years due to the movement of more western coal. In 1975, water delivery accounted for about 40 percent of the total amount of coal shipped to Michigan. In 1979, water delivery accounted for 47 percent of the total amount of coal that was shipped to the state (19). Table 4-1 shows the tonnages moved into Michigan during the years 1975-1979 by rail, vessel, and truck.

Coastal-sited users find vessel delivery an attractive way to receive coal. Sixty six percent of all facilities in the coastal zone in Michigan receive coal exclusively by vessel. Another 19 percent of all coastal-sited facilities in the state receive coal by both vessel and rail (20).

The determining factors for vessel transportation rates on the Great Lakes are the size of the ship, the age of the ship, miles travelled, loading and unloading time, and whether or not there is a backhaul.

Size of Ship. Economies of scale in vessel transport dictate the use of the largest ships possible to haul coal (21). The term "largest" does not necessarily mean the longest vessel or the broadest vessel, but refers to the measure of the ship's productivity. This is expressed as the ship's capacity in deadweight tons (22).

As the deadweight of a ship is increased, the potential annual gross revenue potential will go up in proportion to deadweight. All the costs associated with building and operating a larger ship will also increase,

Table 4-1

Shipments of bituminous, subbituminous, and lignite coal to Michigan 1975-1979.
(In Thousand Short Tons)
[Reprinted from Great Lakes Basin Commission, 1980]

1979	Electric Utilities	Coke Plants	Other Industrials	Retial Sales	Total
All-rail	13,879	674	2,381	30	16,963
Water	10,167	3,352	1,863	4	15,385
Truck	2	-	33	1	36
Total 1/	24,047	4,026	4,276	35	32,385
1978					
All-rail	13,664	829	1,826	40	16,360
Water	7,527	2,099	1,485	34	11,143
Truck	1	-	104	-	105
Total 1/	21,192	2,928	3,415	74	27,608
1977					
All-rail	13,438	728	2,256	159	16,581
Water	7,721	3,301	1,191	-	12,213
Truck	6	-	-	1	7
Total 1/	21,165	4,029	3,447	160	28,801
1976					
All-rail	14,558	922	2,214	224	17,918
Water	6,639	3,571	1,653	24	11,887
Truck	-	-	-	-	-
Total 1/	21,197	4,493	3,867	248	29,805
1975					
All-rail	15,523	755	2,201	262	18,741
Water	6,279	4,588	1,682	-	12,549
Total 1/	21,802	5,343	3,883	262	31,290

but not in proportion to the increase in deadweight. Figure 4-1 shows that only port expenses increase almost proportionally to deadweight, because port expenses are by the ton. Maintenance and repair costs, fuel costs, and crew expenses increase at a much lower rate, and overhead costs are virtually fixed. In essence, the larger the ship the less the costs are likely to be on a per ton basis, and these savings can be passed along to the consumer (23). However, larger ships have deeper drafts, and many of the smaller ports do not have the deep draft facilities to handle a very large vessel. Most of the vessels that currently haul coal on the Great Lakes are in the 600 ft to 700 ft class. At present, only two large vessels were designed exclusively to carry coal on the Great Lakes. These are the St. Clair (770 ft), and the Belle River (1000 ft). These vessels are committed solely to western coal transportation through contractual agreement between Detroit Edison and the American Steamship Co., which owns and operates the vessels (24).

Age of Ship. There are currently 78 registered U.S. vessels that carry ore and grain during all or part of the Great Lakes shipping season. Only 19 of these were built in the last 20 years (25). Under free market conditions, the best ship for any given trade is the one that can provide service to a customer at the lowest possible price, while allowing the owner to make a reasonable profit (26). Due to the longevity of ships on the Great Lakes, and depending on market conditions, it is often advantageous for a shipper to bring out an older vessel, as opposed to building a new one, to transport bulk commodities. This is due primarily to the large (often prohibitive) capital investment required to build a ship. In making the decision to use an older vessel, capital costs will not be considered, but other costs such

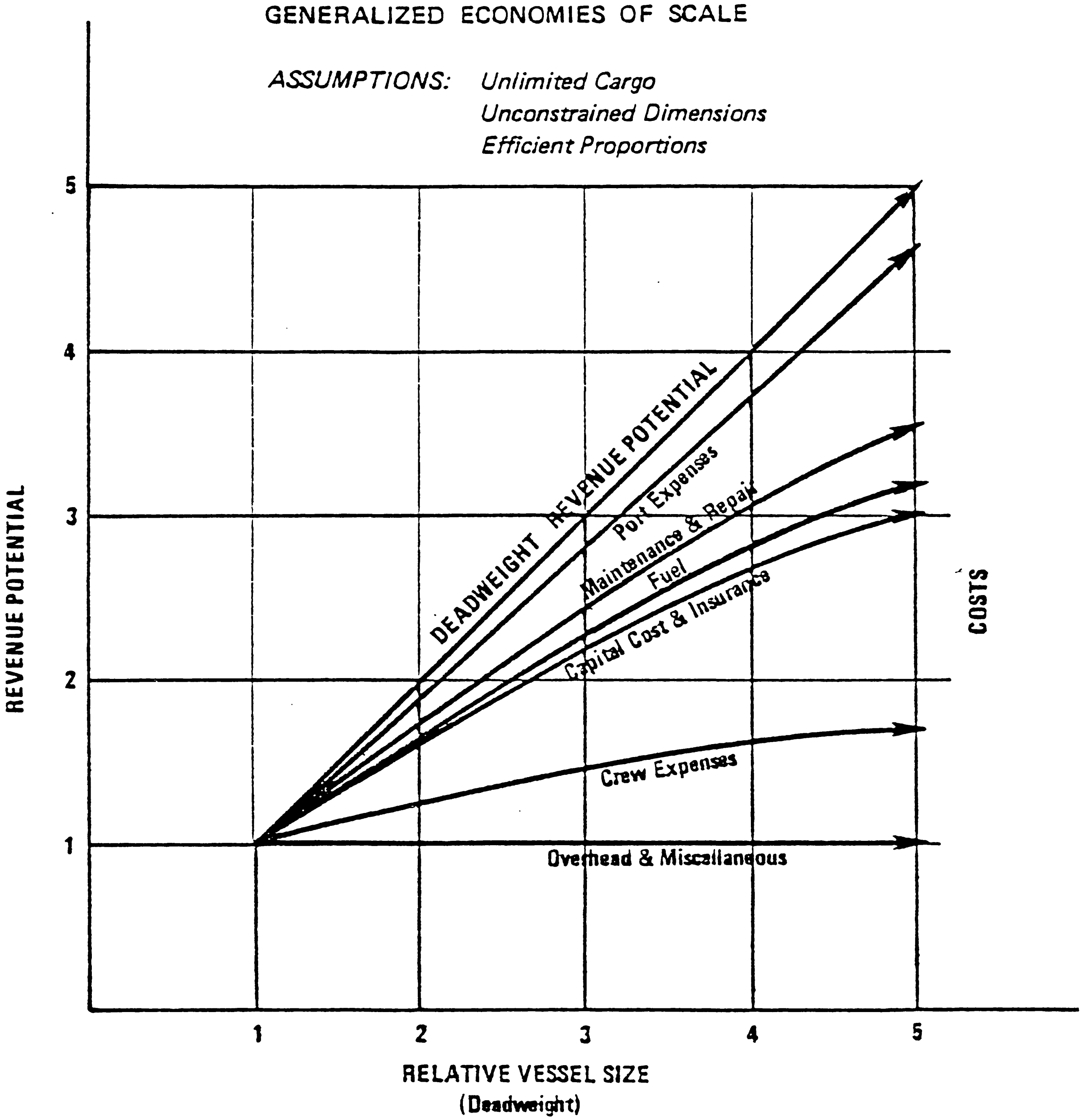

Figure 4-1

[Reprinted from Great Lakes Basin Commission, 1978] as operating expenses and inspection costs for the older vessels may be important (27).

Miles Travelled. On a per mile basis, vessel delivery of coal is the most cost effective way to transport coal in Michigan. However, vessel transport is only competitive for relatively long distance hauls, and would probably not be used as a transport mode for local distribution (28).

Loading and Unloading Time. Charges will be assessed for the detention of a vessel beyond the time allowed for loading and unloading. This is called a demurrage and will contribute to an increase in the price of coal (or any commodity) delivered by vessel (29).

Demurrage charges can be significant with regard to waterborne coal transportation, and a demurrage policy is frequently negotiated in the contract between buyer and shipper. A shipper may offer a low freight rate if the buyer is willing to take the risk of demurrage. On the other hand, the shipper may take the risk of demurrage, but will charge the customer a higher freight rate. Demurrage charges can range anywhere from 800 dollars per hour to 1500 dollars per hour (30).

Backhauls. Cost savings can be realized in coal delivered by vessel if there is a guaranteed backhaul. With a backhaul the primary expense is the time it takes to load and unload the commodity. Cost savings result, because a backhaul eliminates the need for ships to make the return trip in ballast. Scheduling of the ships often presents a problem, but if a backhaul can be arranged, both customers benefit (31).

TRUCK

Trucks are used mainly for initial or final shipments of coal over short distances. They comprise a very small part of the long haul market.

Small mine operators use trucks because of the relatively low capital investment and their great flexibility. The increasing number of strip mines, the increasing cost of railroad transport, the shortage of rail coal cars, and the availability of public roads make the use of trucks attractive for many small operators (32).

Such users find truck delivery attractive because of its flexibility and its reliability. Also, truck delivery eliminates the need for sophisticated loading and unloading equipment, and reduces acreage requirements for coal storage. In fact, coal delivery by truck may be cheaper than rail delivery for many small and moderate sized users (33).

Trucking coal is cost effective only over relatively short hauls. Trucks almost never haul coal over 200 miles, and the average highway shipment of coal is only about 50 miles. This compares with an average haul of 300 miles by train, and 480 miles by vessel (34). At present, coal transportation by truck is limited in Michigan. The only significant truck transport of coal in the state occurs at Traverse City where the municipal utility receiving docks are located several miles from the generating plant. Here, coal is delivered to the docks by barge and then trucked to the plant (35). Also, trucks are used for local distribution of coal to small users in the eastern portion of Michigan's Upper Peninsula where coal is being brokered from Sault Ste. Marie (36).

CONVEYOR SYSTEMS

Conveyer systems are used throughout the country at mines, power plants, industrial sites, and transshipment/unloading facilities. Conveyors are used only at facilities where the life and size of the operation will support the large capital investment (37). They are used primarily in short haul situations, moving coal to and from storage areas, cleaning and blending areas, and loading and unloading areas. Conveyors are an important component of a coal brokerage operation, and will be discussed in more detail in Section VI.

One of the main advantages of an overland conveyer is that it can be built over difficult terrain with low cost for earthwork. A conveyer system may also be feasible in some areas where construction of a road or railbed could cause environmental damage. Conveyors have other advantages as well. They are easy to operate, generally reliable, and relatively maintenance free (38).

Distance may limit application of using conveyors for coal transportation. Of the six major transport modes, conveyors serve the shortest distance origin-destinations (usually under 20 miles). Currently, conveyor systems are not cost competitive with other transport modes for long hauls (39).

SLURRY PIPELINES

By definition a coal slurry pipeline is a mixture of coal and water that is transported through a pipeline. Transport is of a single substance (coal) from a single point (40). The first commercial coal pipeline in this country was built 26 years ago in Ohio and operated successfully for 6 years from 1957 to 1963. The pipeline was closed following a reduction in rail rates, making the pipeline economically impractical. Currently, a pipeline is carrying coal 273 miles from the Black Mesa Mine in Arizona to the Mohave generating station in Nevada. This pipeline has been operational since 1971 and transports 4.8 million tons of coal annually (41).

In certain situations, slurry pipelines may offer some advantages over other modes of transport. Pipelines may provide the most direct route of transport especially in areas of rugged terrain. Also, slurry pipelines may be desirable where high volume transportation is required and the railroad network is such that the origin-destination cannot be served by unit train.

There are some disadvantages to slurry pipelines as well. The major constraints associated with building and operating a coal slurry pipeline are:

- They require high initial capital outlay.
- Changes in coal transportation patterns could make operating and proposed pipelines obsolete.
- There is a problem of acquiring water rights to transport the coal. This is especially critical in the arid west where water is scarce.
- There is a problem of obtaining eminent domain for slurry pipelines (42).

There are presently seven pipeline systems that are planned or under study in the U.S. Six of these proposed pipelines originate from the west, and one from eastern Kentucky. None of them include Michigan. Slurry pipelines are a proven technology but are not currently a widespread means of transporting coal. Although they may play an important role in the movement of coal in the future, pipelines are not considered an important transport mode for a brokerage operation, because they do not offer the necessary flexibility. This is due to the fact that currently, planned pipelines will transport only one type of coal from source to final destination. A brokerage operation for small and moderate sized users will need to handle at least 4 and possibly up to 10 different types of coal for its customers

(43). Presently, pipelines are most attractive to large generating stations which use millions of tons of one type of coal per year.

This section has addressed the major transport modes as they relate to a potential brokerage operation. It has not addressed the selection of coal transport modes by the amount and type of coal preparation needed before shipment to the final user. Coal must always undergo some preparation, such as crushing or cleaning, before it can be delivered to a customer. The extent of the preparation depends on the quality of coal as mined, the quality desired by the consumer, and to some extent, the mode of transport (44). For example, coal delivered by slurry pipeline has to undergo more extensive preparation than coal delivered by rail.

There will usually be an add-on cost for coal cleaning ranging from 3 to 8 dollars per ton (45). The extent of cleaning depends primarily on the quality of the coal and the desired use. Coal cleaning can occur before the coal is transported or at the facility site of the user. Although coal cleaning is an important issue, it is assumed for this study that a brokerage will only be involved in the receipt, storage, and distribution of the coal, and not in the cleaning process.

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V. BROKERAGE LOCATION ANALYSIS FOR MICHIGAN

For a study of the potential implications of distributing coal through a brokerage in Michigan, examining current distribution patterns is valuable and of great assistance in helping to predict the type and location of a brokerage operation.

In 1979, total coal use in the state of Michigan was slightly over 32 million tons. The great majority of the coal use in the state occurs in the southern half of the lower peninsula. Southeastern Michigan alone accounts for over 40 percent of the total coal used (1). Figure 5-1 is a map of the state of Michigan broken down into Planning and Development Regions. These regions will be useful in the following discussion of coal use and distribution. The areas of heaviest coal use are Region 1 (which includes most of southeastern Michigan), Region 7, Region 12, and Region 14. These four regions combined account for about 75 percent of the coal used in Michigan (2).

In 1980, the Great Lakes Basin Commission (GLBC) conducted a coal facility review for the state of Michigan. Coal companies, dock operators, and port managers were contacted and questioned regarding coal use, capacity of existing facilities, origin and transportation connections of the coal moving to the facilities, known or perceived future coal demands, and anticipated facility changes needed to handle future coal deliveries. The results of this facility review were subsequently broken down into several separate categories including origin data, transport mode data, current throughput data (including the number of individual receipts for each region), end use data, and projected changes in coal related activities at these facilities, including future expansion possibilities (3).

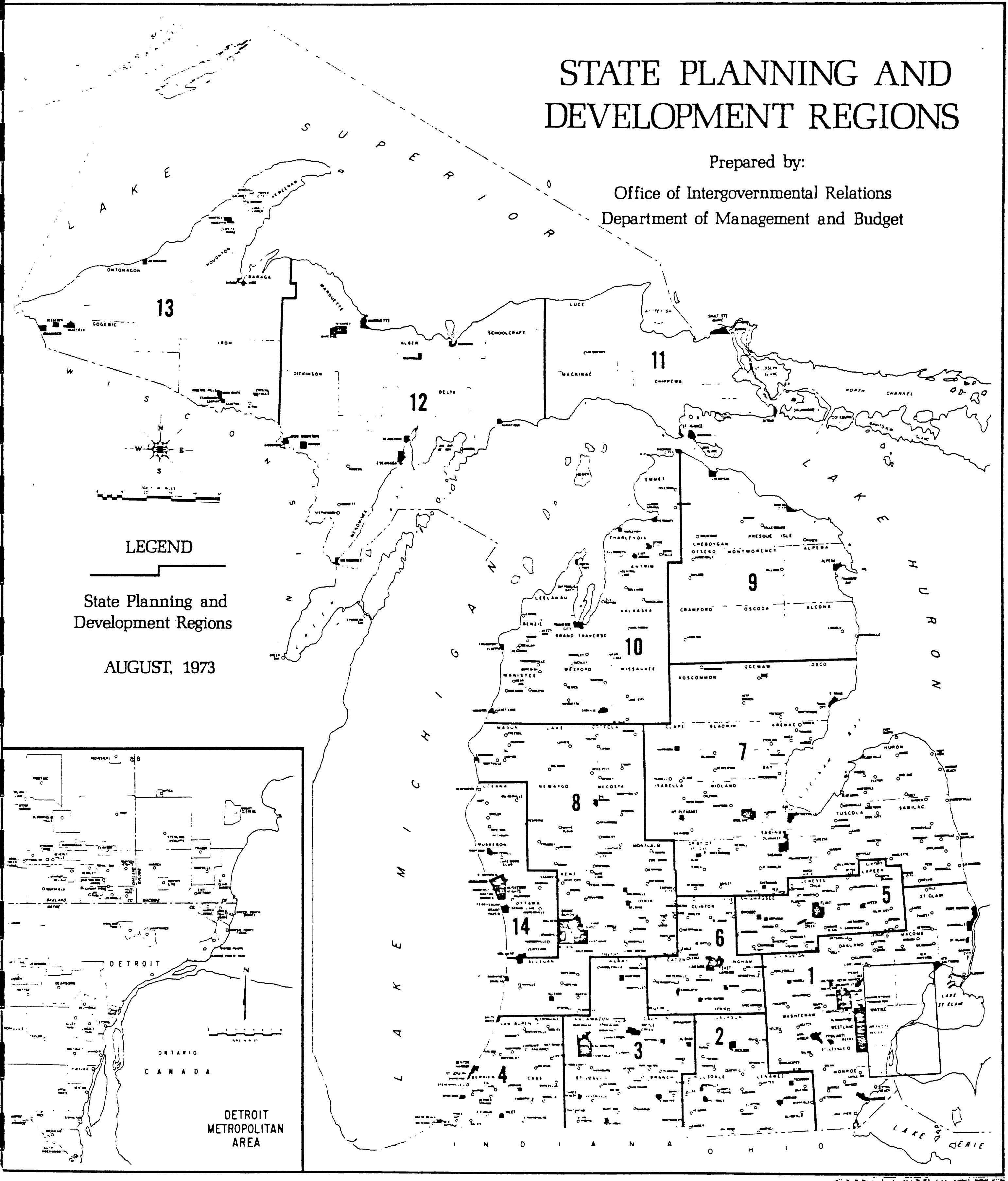
STATE PLANNING AND DEVELOPMENT REGIONS
Prepared by:
Office of Intergovernmental Relations
Department of Management and Budget
LEGEND
State Planning and Development Regions
AUGUST, 1973
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
WISCONSIN
INDIANA
OHIO
LAKE ERIE
NORTH CHANNEL
13
12
11
10
9
8
7
6
5
4
3
2
1
14
DETROIT
ONTARIO
CANADA
DETROIT METROPOLITAN AREA

Figure 5-1

ORIGIN DATA

For discussion purposes, the coal producing areas of the country can be grouped into three major regions. Thus, coal is classified as eastern coal, midwestern coal, or western coal as a result of where it is mined. Eastern coal usually refers to coal from Pennsylvania, Virginia, West Virginia, Ohio and eastern Kentucky. The Midwestern Region refers to coal from Illinois, Indiana, and western Kentucky. Western coal is primarily from Montana and Wyoming (4).

Eastern Kentucky provides almost 38 percent of the coal used in Michigan. Other major sources of coal for the state include Ohio, West Virginia, Virginia, Illinois, Pennsylvania, Wyoming and Montana. Use of western coal in Michigan rose from under 4 percent in 1973 to over 12 percent in 1979 (5).

The number of individual facilities served strictly by coal from the Eastern and Midwestern regions of the United States far outweigh the number of facilities receiving western coal. Currently, no facilities receive western coal exclusively, and although the number of facilities receiving coal from the Western region is small, the annual tonnages used by these facilities is high. Presently, only very large generating stations using millions of tons of coal per year are using western coal (6).

TRANSPORT MODE DATA

Due to the fact that the largest regions of coal use and demand in Michigan are located within the coastal zone, almost half the coal delivered to the state occurs via lake vessel. Sixty seven percent of all coastal zone facilities using coal rely exclusively on vessel transport. Another 14 percent employ only rail, and 19 percent use both rail and water to obtain their coal (7). An important observation can be made with regard to the difference in the utilization of rail and water transport between the southern half of the lower peninsula and the rest of the state. The GLBC survey shows that the facilities in the southern half of the state receive coal by both rail and vessel, whereas utilities and industries in the northern part of the state rely exclusively on water transport for their coal delivery.

COAL END USE DATA

The great majority of coal used in Michigan is for the generation of electricity (8). Over 70 percent of the coal shipped to the state is used by utilities, and the number of annual receipts by the utility sector is over six times the number of annual receipts by the industrial sector (9). Non-utility production of electricity raises the 70 percent total substantially. Data collected by the GLBC concerning the end use of coal shows that the great majority of the receiving facilities in the state do indeed use their coal in power generation (10).

THROUGHPUT DATA

Table 5-1 shows the 1979 throughput for the 8 regions surveyed in the GLBC study. The information is categorized into utility throughput and industrial throughput. The total figure represents only coastal coal, and does not take into account coal delivered to users outside of the coastal zone. Indications are that the majority of the non-coastal coal (about 9,800,000 tons in 1979), was delivered to users in regions 1, 7, and 14. Non-coastal users receiving coal in regions not included in the GLBC Coastal Facility Review are located in Battle Creek and Kalamazoo (Region 3), Flint

Table 5-1

1979 Coal Throughput
[Reprinted from Great Lakes Basin Commission, 1980]

Region	Utilities (tons)	Industry (tons)
Region 1	8,740,000	302,000
Region 7	2,175,000	15,000
Region 9	---	87,000
Region 10	130,000	263,406
Region 11	---	150,000
Region 12	2,940,000	2,303,111
Region 13	2,275,149	---
Region 14	3,090,000	11,000
TOTAL	19,350,149	3,305,517
COMBINED TOTAL	22,480,666	

(Region 5), and Lansing (Region 6). These regions combined probably use no more than 15 percent of the coal shipped to the state (11).

BROKERAGE SITING CRITERIA

Now that the background information regarding coal use and distribution has been presented, the potential locations of a coal brokerage operation can be evaluated. The GLBC coal survey data are useful in assessing the regions of coal use in the state that can be considered potential candidates for a coal brokerage operation. A short description of the criteria used to predict which regions will be most able to support a brokerage operation follows. Only facility siting criteria for the terminal is included. The physical and capital requirements of the operation are discussed in Sections VI and VII.

Demand. A brokerage operation should be located in an area with sufficient demand to justify the large capital requirements necessary to build and operate a modern coal terminal. In addition, a brokerage should be located in an area where demand is likely to increase. As annual throughput increases, a coal terminal will become more cost effective, which helps to keep the cost per ton of coal as low as possible for the end user (12). Table 5-2 shows the areas in Michigan where demand is likely to increase in the near future. The numbers indicate the percentage of facilities surveyed that expect to increase their coal use.

With the exception of projected increases in coal use in Region 10, these figures indicate that the areas anticipating major increases in coal use are the regions already consuming the largest amounts of coal (Regions 1, 7, 12, and 14).

Table 5-2

Percentage of Facilities Indicating Expected Increase in Coal Usage (Through 1985)
[Reprinted from Great Lakes Basin Commission, 1980.]

Region	Percent Anticipating Increase	Number of Responses
1	20%	20
7	50%	8
9	0%	4
10	40%	5
11	0%	4
12	37.5%	8
14	75%	4

Multiple Users. A brokerage operation should be located in an area with multiple users to take advantage of the centralized high volume, low cost shipments of coal. Multiple users would not be required for all types of brokerage operations. For instance, a brokerage could handle coal for a low btu gasification plant (13). However, in this analysis the multiple users are a necessity for the brokerage operation. Only Region 13 does not contain several users from both the industrial and utility sectors and therefore, cannot satisfy the multiple user requirement.

Annual Throughput. A modern coal terminal will have a minimum throughput requirement, below which the establishment of a coal brokerage operation becomes much less feasible. In general, a minimum annual volume necessary to obtain unit train coal service is 800,000 to 1,000,000 tons (14).

This figure usually represents the delivery of one type of coal to final destination. However, a coal brokerage designed for multiple users may have to move several types of coal to meet the needs of its customers (15).

In theory, the brokerage should move 800,000 tons of each type of coal to obtain full unit train service. In practice, this requirement may not be absolutely necessary because all volume rail rates are negotiable (16). However, a brokerage should be able to handle substantially more than the 800,000 ton/year minimum requirement. This does not mean that it is infeasible to establish a coal brokerage operation if annual throughput is less than 800,000 tons/year, but it does make the operation appear much less attractive from an economic standpoint (17).

Transportation Requirements. The availability of transportation alternatives will, to a large degree, dictate the type of coal brokerage operation to be established. Ideally, a brokerage operation should handle several transportation modes, and be located along major transportation corridors, both rail and water (18). Because the majority of coal shipped to Michigan is used in the coastal zone, and coastal regions project the largest increases in coal demand, these areas appear to be the most logical locations for a brokerage operation (19). Regions 1, 7, and 14 are all located along Michigan's coast and can take advantage of both rail and water delivery of coal. However, Regions 9, 10, 11, 12, and 13 currently receive all of their coal by water, and Regions 2, 3, 5, and 6, because of their inland locations, receive all of their coal by rail.

SURVEY RESULTS

The GLBC survey data indicate that regions 1, 7, 12, and 14 are the prime candidates for a brokerage operation in Michigan. This does not mean that a brokerage operation could not be located elsewhere in the state, it only means that these regions best meet the criteria outlined above.

Regions 1, 7, 12, and 14 all use well over 2,000,000 tons of coal per year and could meet the minimum volume requirements for a brokerage. Region 13 also uses over 2,000,000 tons/year, but the coal delivered to Region 13 is used by only one customer. Hence, Region 13 would not be a viable location for a coal brokerage designed to serve multiple users.

Regions 1, 7, 12, and 14 are all predicting an increase in coal use in the near future. Region 10 is also predicting an increase in coal use, but the amount of coal currently being used in Region 10 is too low (less than 400,000 tons/year) to support a brokerage operation. Regions 9, 11, and 13 are predicting no growth in coal demand in the near future (through 1985), and thus, are not considered prime candidates for a brokerage operation (20).

Survey data are not available for Regions 2, 3, 4, 5, and 6. However, indications are that current demand in these regions is insufficient to support a modern coal brokerage.

Regions 1, 7, and 14 use a transportation mix, and can take advantage of both unit train and low cost vessel transport of coal. Table 5-3 shows the unit train coal routes within the state of Michigan. Regions 1, 7, and 14 are all located along one or more of these unit train routes. Region 12 receives no coal by rail, but relies exclusively on water transport for its deliveries. This region is of interest because it receives eastern coal from Lake Erie ports far cheaper than other coastal regions in the state. Backhauls of iron ore from Marquette to the lower lakes help to reduce the delivered price of coal to Region 12 (21).

TABLE 5-3

Coal Unit Train Routes Within Michigan
[Reprinted from Great Lakes Basin Commission, 1980]

Region 1

Monroe (Detroit-Edison): 12 trains/wk
Conrial via Toledo, Monroe

Trenton (Detroit-Edison Channel Plant): 4 trains/wk
D&TSL via Toledo

River Rouge (Detroit-Edison): 1 train/wk
Conrail via Toledo

Connor Creek (Detriot-Edison): 1 train/wk
Conrail via Toledo

Erie (Detriot-Edison): 80 trains/yr
D&TSL via Toledo

Region 6

Lansing (Board of Power & Light): 1 train/wk
GTW via Toledo - D&T ShoreLine, Detroit, Durand, Lansing

Region 7

Essexville (Consumers Power, Karn & Weadock Plants):
4 trains/wk - equally split C&O and GTW
C&O via Toledo, Plymouth, Flint, Saginaw
GTW via Toledo - D&T ShoreLine, Detroit, Durand, Saginaw

Midland (Dow): 2 trains/wk
GTW via Toledo - D&T ShoreLine, Detroit, Durand, Saginaw, Bay City

Region 14

West Olive (Consumers Power, Campbell Plant): 4 trains/wk
C&O via Toledo, Plymouth, Lansing, Grand Rapids, Holland

FOOTNOTES TO SECTION V

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VI. REQUIREMENTS OF A COAL BROKERAGE

This chapter examines the physical and financial requirements of a brokerage operation. The costs of transshipping coal can be broken down into two major categories--capital costs and operating costs. Capital costs include the costs for storage space, rail spurs, car dumpers, conveyors, and mobile equipment. Operating costs include labor, maintenance and supplies, fuel costs, and general administration and overhead. Only the capital costs of the facility will be described in this section. The operating costs of a brokerage will be discussed in Chapter 7.

PHYSICAL COMPONENTS

The operation of a coal brokerage centers around a modern transshipment facility. This facility is necessary for three main functions: receiving high volume shipments of coal, storing large amounts of coal, and distributing the coal to the end user (1). These functions are discussed briefly as they relate to the physical and capital requirements of a coal brokerage.

Rail Unloading Equipment. A substantial investment in high speed unloading equipment is required to receive coal by unit train shipments (2). Construction of a rail spur is required to connect the main rail line to the terminal. This spur line has to be of high quality to handle the heaviest unit trains. The rail spur will end at the unloading facilities located along a loop track. This loop track has to be of sufficient length to hold an entire unit train which is up to 1.5 miles long (3).

Trains moving along the loop track at low speeds are precisely positioned and emptied with a rotary car dump. The design of this dumping system allows one entire rail car plus a portion of the track to be coupled and rotated 180 degrees. The coal is dumped into a hopper below the track where underground conveyors move the coal to the storage areas. The rotary car dump is enclosed in a building (called a dumper shed) which helps to contain most of the dust generated from the dumping. The rotary car dump system is the most expensive, but is also the fastest way of unloading trains. This design can unload a 110 car unit train in 3 to 4 hours which enables the user to obtain the lowest possible unit train rates (4).

Vessel Unloading Requirements. The primary physical components necessary to unload vessels include the construction of a slip and dock, and dockside conveying equipment to move the coal into storage (5). Additional equipment will be required if vessels that are not self-unloading are to be handled. However, of the 78 U.S. vessels registered to haul ore and grain on the Great Lakes, 58 are self-unloaders (6). For this study it is assumed that a brokerage will be handling only self-unloading vessels.

Conveyor Systems. A series of conveyors are used to transport coal within a transshipment/unloading facility. These conveyors are usually enclosed and are used to move coal from unloading areas to storage areas, or directly to loading areas. The major capital expenditures of a modern conveyor system are the supports and overland components including idlers, foundations and structures, belting, and drives (7). Requirements for conveyor components are influenced by the width of the system which varies with the speed of the belt.

Conveyors have proved to be exceptional coal handling systems. Generally, they are long wearing, and if belt idlers are spaced properly, friction drag can be reduced to a minimum (8). Belt wear is the most important maintenance issue and occurs primarily at transfer points. Belts will last longer if transfer points can be kept to a minimum (9).

Coal Storage. Stockpiles will be an important part of a brokerage operation. Generally, a transshipment facility (in this case a brokerage) will maintain a 90 to 120 day supply and will have the potential to store anywhere from 1/4 to 1/3 of its maximum annual throughput capacity (10).

Conical storage piles are the most common for facilities storing moderate amounts of coal (less than 100,000 tons). For storage of larger amounts of coal, a wedge shaped pile, fed with a traveling stacker that runs parallel to the pile, is the preferred design. As the pile is built to its maximum height, the radial stacker moves automatically across the top, discharging the coal from the leading edge of the pile. A wedge shaped design allows for the storage of different types of coal in different sections of the pile permitting individual loading, or simultaneous loading as a blended coal (11).

Coal Storage Equipment. Coal storage equipment is required primarily for two operations, reclaiming and grooming.

Reclaiming refers to the physical moving of the stockpile to reduce the amount of dead space, plus readying the coal for loading onto conveyor belts. Grooming refers to the compacting of the coal pile to help reduce the risk of spontaneous combustion (12). The equipment necessary for the reclaiming and grooming operations include, bulldozers, front end loaders, scrapers, rotary plow feeders, and conveyors.

Bulldozers, front end loaders, and scrapers are large vehicles used in both the reclaiming and grooming processes, to physically move the coal (13).

A rotary plow feeder is a large piece of machinery that moves horizontally along the top of a reclaim tunnel, sweeping coal onto a conveyor belt.

The rotary plow feeder is used to reclaim coal for loading onto ships, trucks, or unit trains (14).

Truck Loading. Not all large transshipment facilities are able to load trucks, but a terminal designed to broker coal for multiple users should certainly handle this transport mode. The necessary components for the truck loading operation of a brokerage facility are; a large platform scale to weigh the coal, a surge bin under which trucks are positioned for loading, and additional conveying equipment to bring the coal to the bin. The additional capital requirements for adding truck loading capability to a multimodal facility would be less than 1 million dollars (15).

CAPITAL REQUIREMENTS

Coal terminals can be constructed in various sizes to meet the needs of the operator. Throughput capacity ranges anywhere from a million tons per year for a very small facility to over 18 million tons per year at a large facility like the Superior Midwest Energy Terminal at Superior, Wisconsin. Decisions regarding terminal size will be based on a number of site specific issues including local or regional coal demand, land availability, and the availability of capital.

The terminal to be evaluated in this study has a throughput capacity of 2 million tons per year. It is a multimodal facility designed to handle vessels, trains, and trucks. This terminal might typically receive two unit trains per week plus one vessel per week. With a rotary car dump system, the train unloading rate is approximately 3500 tons per hour, and the vessel unloading rate (self-unloaders) is approximately 10,000 tons per hour (16). Truck loading can be done at a rate of 500 tons per hour, or approximately 17 trucks with 30 ton payloads per hour (17).

The capital requirements for a 2 million ton per year multimodal facility are listed in Table 6-1. Many of the estimates were taken from Fruin et al. (1979) (18). The data were updated with the assistance of Mr. John Ethen of Midwest Energy Resources Co., Superior, Wisconsin, and Mr. Paul Johnson of Johnson Brothers Corporation, Litchfield, Minnesota.

Although terminals of this small size do exist, they are rarely built, because of the large capital investment. The smallest terminals commonly built have an annual throughput capacity in the 5 to 6 million tons per year range (19). The primary reason for constructing a larger terminal is that the additional investment needed to add the extra throughput capacity is not much greater than the capital invested in a 1 to 2 million ton per year facility (20). Upwards of 85 percent of the capital required to build a 5 million ton per year facility is also required to build a 2 million ton per year terminal (21). For comparison, the capital requirements of a 5 million ton per year facility are listed in Appendix C. It shows a total capital requirement of 21 million compared to 18.5 million for a 2 million ton per year faciity.

Throughput capacity of a coal terminal is determined to a large degree by the capabilities of the rotary car dump system to unload trains (22). To a lesser degree it is determined by storage capacity and by the amount of reclaim and handling equipment. A modern rotary car dump system operated 24 hours a day, 365 days a year can unload 6 million tons of coal annually (23). Therefore, additional throughput capacity (up to 6 million tons per year) is almost always built into a coal terminal unless there is restricted demand in an area and best estimates indicate that demand will not increase. Lack of storage space may also dictate building a smaller facility (24).

Table 6-1

Capital Requirements for a 2,000,000
Ton-Per-Year Multimodal Coal Terminal.
[Reprinted from Fruin et al., 1979; (updated data)]

Equipment Needed	Approximate Cost (millions of dollars)
1. Parallel or loop track for 110 car unit train	1.0
2. Rotary car dumper	3.0
3. Dumper shed	.75
4. Ground storage (approximately 500,000 tons)	1.0
5. Conveyor system to put coal in storage piles	2.5
6. Sprays and dusthoods on conveyors to minimize dust generation	.75
7. Equipment for storage and reclaim	2.5
8. Dock for vessels	4.0
9. Loaders and scrapers	.75
10. Truck load out	.75
TOTAL EQUIPMENT	17.00
11. Contingency and Working Capital	1.50
TOTAL CAPITAL	18.50

Due to the current low demand in the non-utility sectors of the study areas, the 2 million ton per year facility will be used in this report.

FOOTNOTES TO SECTION VI

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VII. BROKERAGE FEASIBILITY ANALYSIS

This chapter examines the feasibility of brokering coal for small and moderate sized users in Michigan. The first section is a discussion of the minemouth costs of coal. Then, the rail rates, vessel rates, and truck rates for transporting coal are evaluated. Total terminal costs are subsequently listed and compared at various levels of annual throughput. The last part of this chapter evaluates the potential cost savings of brokering coal from four sites (Detroit, Bay City, Muskegon, and Marquette).

MINEMOUTH PRICES OF COAL

Before the potential cost savings of distributing coal through a brokerage can be determined, the costs of coal at the minemouth have to be examined.

The free on board (F.O.B.) mine price is the price paid for coal measured in dollars per short ton at the mine site (1). This price does not include transportation costs, which will be discussed separately.

There are two primary minemouth rate structures, the contract rate and the spot rate. The contract price of coal at a mine is usually dependent on some minimum annual volume. The terms of each contract will be different, based on such factors as the size of the mine, age of the mine, ability of the mine to handle unit trains, and the type of mining (2). The spot rate is the current market rate that an occasional user would be expected to pay. This is usually (but not necessarily) higher than an average contract rate (3).

Although small or moderate sized coal users are not excluded from obtaining a good contract rate from a mine, they tend to pay more than the larger coal users. This is because small users have less buying power, and do not have the financial resources available to obtain the best contract rates (4). Larger coal users can support purchasing staffs to buy coal, which allows them to obtain the lowest possible contract rates. Most large utilities and industries using over 200,000 tons of coal per year buy coal under contract (5).

The F.O.B. minemouth costs of coal used in this study were obtained from the Energy Information Administration, of the U.S. Department of Energy. Average minemouth costs from four coal producing regions are used, as a brokerage will need to receive several different coals to meet the needs of its customers. The selected regions are Ohio #8 (eastern Ohio), Pittsburgh (southern Pennsylvania), Big Sandy (eastern Kentucky), and the Powder River Basin (Montana and Wyoming). These four regions were selected because they are all important coal producers for Michigan industries and utilities.

Table 7-1 lists the average prices of coal for the selected regions for calendar year 1980.

The average contract price is the F.O.B. mine price representing only mines that had an annual production of 10,000 short tons or more (6).

The data do not indicate how much of this coal was sold at the spot rate, or what the average spot rate was. A good estimate for determining how much small users are likely to pay for coal at the mine is to add 10 percent to the average contract price (7).

Therefore, the average spot rate in Table 7-1 assumes a 10 percent increase over the average contract price. This spot rate is approximately what the smaller users would be expected to pay per ton at the minemouth.

Table 7-1

Average Prices of Coal for Selected Regions (1980)

Region	Tonnage Produced	Average Contract Price per Ton ($/ton)	Estimated Average "Spot" Price ($/ton)*
Ohio #8 (E. Ohio)	17,935,451	26.17	28.79
Pittsburgh (S. Penn.)	93,124,956	29.26	32.19
Big Sandy (E. Ky.)	95,590,437	33.48	36.83
Power River Basin (Mont. and Wyo.)	71,943,161	8.27	9.10

*Estimated at 10 percent over average contract price.

[Source: U.S. Department of Energy]

Larger users would probably pay the average contract price for coal at the mine (8).

RAILROAD FREIGHT RATES FOR COAL

Railroads were contacted early in this study regarding rail freight rates. Information was often difficult to obtain due to the multitude of rates established by each carrier. A crucial step in obtaining this information was the selection of the specific origins and destinations which enabled the railroads to manage the requests for data more easily.

Single car rates are fairly easy to obtain, because these are the standard rates which any coal user can obtain. Many carriers have a coal manual or a coal rate sheet with all of the single car rates listed for each origin-destination.

Volume rates on the other hand are more difficult to obtain, because these rates are always negotiated between the user and carrier and are dependent on a number of factors such as ownership of rail equipment, loading and unloading capabilities, and annual volumes (9).

In addition, most railroads do not like to quote volume rates until the coal is contracted. Therefore, the volume rates listed in this study represent one rate that might apply to larger coal users, but not necessarily the actual rate that may be obtained through negotiation. As mentioned earlier, the origins of the coals examined in this study are eastern Ohio (Ohio #8), eastern Kentucky (Big Sandy), Pittsburgh, and the Powder River Basin of Montana. The destinations of interest are Detroit, Bay City (Essexville), Muskegon, and Marquette.

Railroads are required by the Interstate Commerce Commission (ICC) to publish their rates or tariffs (10). The ICC reviews rates and may reject rates that it considers unreasonable. However, the ICC cannot set rates. Thus, the railroads have the freedom to set rates within fairly wide limits as long as their minimum revenue needs are met (11). Competition from other railroads and other transportation modes have generally provided practical upper limits to the rail rate structure (12).

Single Car Rates. Single car freight rates are subject to general increases implemented by the rail industry. These increases generally occur four times per year, and are a percentage increase based on institutional and operating factors of the rail industry as a whole (13). These percentage increases apply across the board regardless of the origin, destination, or carrier. Table 7-2 shows the all rail single car rates from the Eastern origins (Ohio #8, E. Kentucky, and Pittsburgh), to the areas of interest. These figures were taken from published tariffs supplied by the railroads serving the requested origin-destinations.

Table 7-2

All Rail Single Car Freight Rates

Origin	Destination	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Detroit	16.81	271	0.062
Ohio #8	Essexville	19.20	377	0.051
Ohio #8	Muskegon	19.20	454	0.042
E. Kentucky	Detroit	20.42	444	0.046
E. Kentucky	Essexville	22.87	519	0.044
E. Kentucky	Muskegon	22.87	604	0.038
Pittsburgh	Detroit	18.62	369	0.050
Pittsburgh	Essexville	21.03	475	0.044
Pittsburgh	Muskegon	21.03	552	0.038

[Source: Bessemer and Lake Erie, Chessie System, Consolidated Rail, and Norfolk and Western supplied tariffs)

Table 7-3 shows the published lake cargo single car rail rates from the Ohio #8, E. Kentucky, and Pittsburgh origins, as well as the western coal from Montana. Lake cargo rates represent the transportation costs from the origin to the point of transshipment. Superior, Wisconsin is the transshipment point for the Montana coal. The coals from the eastern origins are transshipped at Conneaut, Sandusky, or Toledo, Ohio.

Multiple Car Volume Rates. Multiple car volume rates are subject to the same general rate increases as single car rates. Depending on the origin, destination, and type of shipment, multiple car rates can offer savings of up to 20 percent over the single car freight rate. There are two primary volume shipment rates that are established by the railroads to serve moderate to large coal users. These are discussed briefly.

Trainload Volume Rates. A trainload is a shipment of coal usually delivered in volumes of 5000 to 7000 tons on a single day from not more than two origins. Trainload rates are usually dependent on a certain annual volume requirement, often several million tons per year. Other trainload rates may be established with an annual volume requirement of only a few hundred thousand tons per year. Generally, if a customer uses 500,000 tons of coal (from the same general origin) on an annual basis, a trainload rate can be negotiated (14). A typical trainload rate offers savings of 6 percent to 13 percent over the single car rate (15).

Single Car Annual Volume Rates. These rates are established based on the customer receiving a certain minimum annual volume, usually several million tons per year. Single car annual volume rates allow large users to take advantage of the cost savings associated with rate reductions that normally would be unavailable. Single car annual volume rates may apply when

Table 7-3

Lake Cargo[†] Single Car Rates

Origin	Final Destination	Transshipment Point	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Detroit	Sandusky	12.58	135	0.093
Ohio #8	Bay City	Sandusky	11.98	135	0.089
Ohio #8	Muskegon	Sandusky	11.98	135	0.089
Ohio #8	Detroit	Conneaut	12.45	136	0.092
Ohio #8	Essexville	Conneaut	11.80	136	0.087
Ohio #8	Muskegon	Conneaut	11.80	136	0.087
Ohio #8	Marquette	Conneaut	11.80	136	0.087
Ohio #8	Detroit	Toledo	13.24	212	0.062
Ohio #8	Essexville	Toledo	12.69	212	0.060
Ohio #8	Muskegon	Toledo	12.69	212	0.060
Ohio #8	Marquette	Toledo	12.69	212	0.060
E. Kentucky	Detroit	Toledo	15.17	362	0.042
E. Kentucky	Essexville	Toledo	14.62	362	0.040
E. Kentucky	Muskegon	Toledo	14.62	362	0.040
E. Kentucky	Marquette	Toledo	14.62	362	0.040
E. Kentucky	Detroit	Sandusky	13.73	342	0.040
E. Kentucky	Essexville	Sandusky	13.16	342	0.038
E. Kentucky	Muskegon	Sandusky	13.16	342	0.038
E. Kentucky	Marquette	Sandusky	13.16	342	0.038
Montana	Detroit	Superior	24.74	814	0.030
Montana	Essexville	Superior	24.74	814	0.030
Montana	Muskegon	Superior	24.74	814	0.030
Montana	Marquette	Superior	24.74	814	0.030
Pittsburgh	Detroit	Conneaut	12.58	148	0.085
Pittsburgh	Essexville	Conneaut	12.00	148	0.081
Pittsburgh	Muskegon	Conneaut	12.00	148	0.081
Pittsburgh	Marquette	Conneaut	12.00	148	0.081
Pittsburgh	Detroit	Sandusky	13.01	191	0.068
Pittsburgh	Essexville	Sandusky	12.41	191	0.065
Pittsburgh	Muskegon	Sandusky	12.41	191	0.065
Pittsburgh	Marquette	Sandusky	12.41	191	0.065

[†]Lake Cargo rates are rail rates from the origin to a point of transshipment. The coal is delivered to the user by vessel.

[Source: Bessemer and Lake Erie, Burlington Northern, Chessie System, Consolidated Rail, and Norfolk and Western supplied tariffs] small mines cannot service unit trains. This allows the user to do business with any size shipper (16).

These rates, which represent a cost reduction of 3 percent to 5 percent over the single car rate, are not designed to provide cost savings for small and moderate sized users (17).

Table 7-4 lists the all rail volume rates to the study areas from the Ohio #8, E. Kentucky, and Pittsburgh origins. Some of the volume rates are estimated using a percentage reduction from the single car rate. It is assumed that an average trainload rate will represent a cost savings of 10 percent over the single car rate, and this number is used in the approximations. The estimated trainload volume rates are listed in Table 7-5. Table 7-6 shows the lake cargo volume rates from the four origins to the transshipment points.

Estimations regarding lake cargo rail rates from the Lake Erie Ports to Marquette were also made, and are displayed in Table 7-7. Although these rates do not come from published tariffs, it is generally assumed that the lake cargo rate to Marquette will be the same as the lake cargo rates to Essexville and Muskegon (18).

Unit Train Rates. Unit train rates are also subject to the same general rate increases implemented for single car freight rates by the rail industry (19). Generally, unit train rates (using carrier equipment) are from 60 percent to 70 percent of the single car rate. Table 7-8 lists the published all rail unit train rates. Some very good unit train rates will offer a 50 percent savings over single car rates. A poor unit train rate may represent savings of only 20 percent. Because of the difficulty in obtaining specific tariffs, some of the unit train rates listed in this report are estimations based on a percentage reduction from the single car rate.

Table 7-4

All Rail Volume Freight Rates

Origin	Destination	Type of Shipment	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Detroit	single car (annual vol)	16.42	271	0.061
Ohio #8	Detroit	trainload	15.67	271	0.058
E. Kentucky	Essexville	trainload	16.36	519	0.032
E. Kentucky	Muskegon	trainload	16.36	604	0.027
Pittsburgh	Detroit	single car (annual vol)	18.22	369	0.049
Pittsburgh	Detroit	trainload	17.47	369	0.047

[Source: Bessemer and Lake Erie, Chessie System, and Norfolk and Western supplied tariffs]

Table 7-5

Estimated All Rail Trainload Freight Rates
(Assuming a 10% rate reduction from single car rates.)

Origin	Destination	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Essexville	17.28	377	0.046
Onio # 8	Muskegon	17.28	454	0.038
E. Kentucky	Detroit	18.38	444	0.041
Pittsburgh	Essexville	18.93	475	0.040
Pittsburgh	Muskegon	18.93	552	0.034

[Source: Estimated from tariffs supplied by Bessemer and Lake Erie, Chessie System, and Norfolk and Western Railroad Companies.]

Table 7-6

Lake Cargo† Volume Rail Rates

Origin	Final Destination	Transshipment Point	Type of Shipment	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Detroit	Sandusky	single car (annual vol)	12.91	135	0.096
Ohio #8	Detroit	Sandusky	trainload	11.92	135	0.088
Ohio #8	Essexville	Sandusky	trainload	10.46	135	0.077
Ohio #8	Muskegon	Sandusky	trainload	10.46	135	0.077
Ohio #8	Detroit	Conneaut	trainload	11.65	136	0.086
Ohio #8	Essexville	Conneaut	trainload	10.31	136	0.076
Ohio #8	Muskegon	Conneaut	trainload	10.31	136	0.076
E. Kentucky	Essexville	Toledo	trainload	12.05	362	0.033
E. Kentucky	Muskegon	Toledo	trainload	12.05	362	0.033
E. Kentucky	Detroit	Toledo	trainload	13.70	362	0.038
Pittsburgh	Detroit	Sandusky	single car (annual vol)	12.63	191	0.066
Pittsburgh	Detroit	Sandusky	trainload	12.35	191	0.065
Pittsburgh	Essexville	Sandusky	trainload	10.76	191	0.056
Pittsburgh	Muskegon	Sandusky	trainload	10.76	191	0.056
Pittsburgh	Detroit	Conneaut	trainload	12.13	148	0.082
Pittsburgh	Essexville	Conneaut	trainload	10.48	148	0.071
Pittsburgh	Muskegon	Conneaut	trainload	10.48	148	0.071
Montana	Detroit	Superior	trainload	22.18	814	0.027
Montana	Essexville	Superior	trainload	22.18	814	0.027
Montana	Muskegon	Superior	trainload	22.18	814	0.027
Montana	Marquette	Superior	trainload	22.18	814	0.027

†Lake Cargo rates are rail rates from the origin to a point of transshipment. The coal is delivered to the user by vessel.

[Source: Bessemer and Lake Erie, Burlington Northern, Chessie System, Consolidated Rail, and Norfolk and Western supplied tariffs]

Table 7-7

Estimated Lake Cargo† Trainload Rail Rates to Marquette*

Origin	Final Destination	Transshipment Point	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Marquette	Sandusky	10.46	135	0.077
Ohio #8	Marquette	Conneaut	10.31	136	0.076
E. Kentucky	Marquette	Toledo	12.05	362	0.033
Pittsburgh	Marquette	Sandusky	10.76	191	0.056
Pittsburgh	Marquette	Conneaut	10.48	148	0.071

*The lake cargo rail rates to Marquette are generally the same as the lake cargo rail rates to Essexville and Muskegon.

†Lake Cargo rates are rail rates from the origin to a point of transshipment. The coal is delivered to the user by vessel.

[Source: Estimated from tariffs supplied by Bessemer and Lake Erie, Chessie System, and Norfolk and Western Railroad Companies.]

Table 7-8

All Rail Unit Train Freight Rates

Origin	Destination	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Essexville	11.49	377	0.030
Ohio #8	Muskegon	11.49	454	0.025
E. Kentucky	Essexville	14.90	519	0.029
E. Kentucky	Muskegon	14.90	604	0.025

[Source: Chessie System and Norfolk and Western supplied tariffs]

In general, unit train service will offer a cost savings of about 35 percent over the single car rate, and this figure was used in the calculations (20).

Table 7-9 shows the estimated all rail unit train rates for the origin-destinations of interest.

Table 7-10 shows the lake cargo unit train rates from the four origins to the transshipment points. Again, due to lack of published data, some estimations of lake cargo unit train rates were made based on a percentage reduction from the single car lake cargo rates. These estimates are included in Table 7-11.

Contract Rates. Public Law 96-448 (The 1980 Staggers Railroad Act) which went into effect October 14, 1980 enables the railroads to establish long term contract rates, which they were prevented from doing before this time (21). For contract rates, an escalation formula based on railroad cost indicies is applied to any rate increase. The operating costs of the railroad are, overwhelmingly, the most important factors in determining rate increases for contract rates (22). Although the ICC still reviews contracts, the actual rates are negotiated between the railroad and the customers and will vary with each situation.

DISCUSSION OF RAILROAD FREIGHT RATES

In most cases, the rail freight rates presented in Tables 7-2 through 7-11, are from published tariffs supplied by the railroads. In several cases however, these rates are based on percentage reduction estimates from related tariffs. These estimations were made for comparison of potential volume rate savings over the single car rates. In practice this may be misleading because the rate structures for many volume movements from certain origins to destinations do not actually exist.

Table 7-9

Estimated All Rail Unit Train Freight Rates
(Assuming a 35% rate reduction from single car rates.)

Origin	Destination	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Detroit	10.93	271	0.040
E. Kentucky	Detroit	13.27	444	0.030
Pittsburgh	Detroit	12.10	369	0.033
Pittsburgh	Essexville	13.67	475	0.029
Pittsburgh	Muskegon	13.67	522	0.025

[Source: Estimated from tariffs supplied by Bessemer and Lake Erie, Chessie System, and Norfolk and Western Railroad Companies.]

Table 7-10

Large Cargo† Unit Train Rail Rates

Origin	Final Destination	Transshipment Point	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Detroit	Sandusky	6.27	135	0.046
Ohio #8	Essexville	Sandusky	6.27	135	0.046
Ohio # 8	Muskegon	Sandusky	6.27	135	0.046
E. Kentucky	Detroit	Toledo	12.70	362	0.035
Montana	Detroit	Superior	13.32	814	0.016
Montana	Essexville	Superior	13.32	814	0.016
Montana	Muskegon	Superior	13.32	814	0.016
Montana	Marquette	Superior	13.32	814	0.016

†Lake Cargo rates are rail rates from the origin to a point of transshipment. The coal is delivered to the user by vessel.

[Source: Burlington Northern, Chessie System, and Norfolk and Western supplied tariffs]

Table 7-11

Estimated Lake Cargo† Unit Train Rates
(Assuming a 35% rate reduction from single car rates)

Origin	Final Destination	Transshipment Point	Rate ($/ton)	Mileage	Rate ($/ton mile)
Ohio #8	Marquette*	Sandusky	6.27	135	0.046
E. Kentucky	Essexville	Toledo	9.51	362	0.026
E. Kentucky	Muskegon	Toledo	9.51	362	0.026
E. Kentucky	Marquette	Toledo	9.51	362	0.026
Pittsburgh	Detroit	Sandusky	8.46	191	0.044
Pittsburgh	Essexville	Sandusky	8.07	191	0.042
Pittsburgh	Muskegon	Sandusky	8.07	191	0.042
Pittsburgh	Marquette	Sandusky	8.07	191	0.042

*The lake cargo unit train rate to Marquette is assumed to be the same as the lake cargo rate to Essexville and Muskegon.

†Lake Cargo rates are rail rates from the origin to a point of transshipment. The coal is delivered to the user by vessel.

[Source: Estimated from tariffs supplied by Bessemer and Lake Erie, Chessie System, and Norfolk and Western Railroad Companies.]

For instance, individual railroads establish volume rates to certain destinations only as the need arises. If a railroad does not have any customers receiving coal by unit train in a certain area they will not publish a unit train rate. In addition, all volume transportation rates are negotiated between the shipper and the customer, so that prices may vary slightly depending on the specific conditions. Generally, railroads do not quote rates until the coal has been contracted. The published volume rates are therefore rates that are extant, but not necessarily the same rate that would be obtained by a user contracting a large amount of coal.

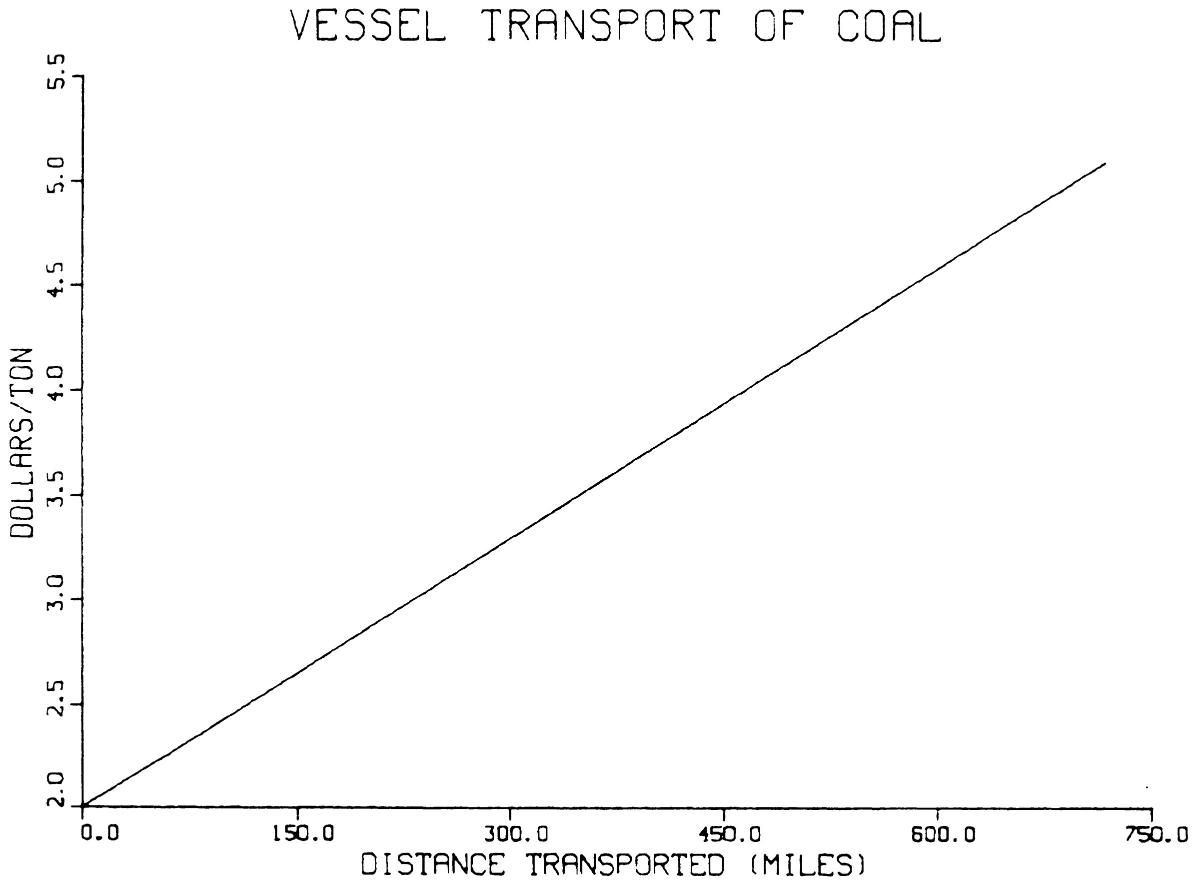
VESSEL RATES FOR COAL

Unlike the railroads, vessel operators are not required by law to publish their rates for hauling coal. Therefore, actual transportation costs for vessels cannot be determined from existing tariffs the way they can for rail (23).

Vessel companies often enter into long term contractual agreements with large coal users. This arrangement allows the vessel company to determine equipment and operating requirements more accurately, and allows the user to keep transportation costs low (24). A customer wishing to purchase a boat load of coal will buy it at the "spot" rate which is dependent on the origins and destinations to be served, the availability of vessels, and the possibility of a backhaul (25).

Figure 7-1 shows the approximate costs of transporting coal by lake vessel.

It should be stressed that the numbers used are not from published tariffs but are estimations based on the best available data supplied primarily by the American Steamship Company (26). The assumptions for this



[Source: Appendix D]

Figure 7-1

APPROXIMATE COST OF TRANSPORTING COAL BY VESSEL graph are that the coal will be delivered in 670 ft to 730 ft class vessels. There is a cost of 2 dollars at the origin (0 miles travelled) and increases occur at a rate of 43 cents per hundred miles travelled.

This curve is a good representation of the costs of coal movement anywhere on the lakes except western coal being shipped to Monroe (which is higher due to Monroe Harbor's limited draft) and coal moving from Lake Erie ports to Marquette (which is less due to the frequency of backhauls). Table 7-12 shows the distances between the ports of interest, in statute miles.

TRANSSHIPMENT POINTS

Although western coal used in Michigan is transshipped only at Superior, Wisconsin, eastern coal is transshipped at several Lake Erie ports. Generally, the rail rate structures ensure that no single Lake Erie port will be more economically attractive than the others. For instance, Michigan rail rates to Conneaut are slightly lower than the rail rates to Sandusky, which are lower than the rail rates to Toledo. Also, the transshipping charge is the same for all the Lake Erie ports; $1.27/ton. Hence, for the most part, the delivered price of the coal will be about the same no matter from which Lake Erie port it was transshipped.

However, depending on the rate established, or the origin of the coal, it is sometimes advantageous to transship from one Lake Erie port over another. It should be pointed out that there are other factors besides price, such as which railroads carry coal to the desired port, reliability of service, harbor congestion, and obtaining the desired grade of coal.

For the purpose of this study it is assumed that Ohio #8 coal is transshipped at Sandusky, E. Kentucky coal is transshipped at Toledo, and Pittsburgh coal is transshipped at Sandusky. The selection of these ports was based primarily on the availability of published rail tariffs.

Table 7-12

Distances Between Ports (statute miles)

Conneaut	TO	Detroit	164 miles
		Bay City	388 miles
		Muskegon	697 miles
		Marquette	655 miles
Sandusky	TO	Detroit	72 miles
		Bay City	296 miles
		Muskegon	605 miles
		Marquette	563 miles
Toledo	TO	Detroit	54 miles
		Bay City	278 miles
		Muskegon	587 miles
		Marquette	545 miles
Superior	TO	Detroit	724 miles
		Bay City	625 miles
		Muskegon	707 miles
		Marquette	260 miles

[Source: National Oceanic and Atmospheric Administration]

TRUCK RATES

The truck transportation rates for coal were obtained from published tariffs supplied by the Michigan Public Service Commission (MPSC). These rates can apply anywhere in Michigan, provided that the carrier has the authority to haul coal (27).

Table 7-13 shows the rates for hauling coal on a mileage basis. A mileage or distance rate applies only to a specific commodity, in this case coal, and involves a minimum shipment weight. For the purposes of this analysis, that minimum shipment weight is 30 tons (column 2).

COAL TRANSSHIPMENT COSTS

In order to assess the feasibility of a brokerage operation, the total terminal costs, or the transshipping costs have to be determined. Table 7-14 lists the estimated annual operating costs of a 2 million ton per year multimodal coal transshipment facility. These figures are based primarily on estimates provided by Mr. John Ethen of Midwest Energy Resources Co., Superior, Wisconsin and Mr. Paul Johnson of Johnson Brothers Corporation, Litchfield, Minnesota. Some of the data originally appeared in Fruin et al. (1979) (28).

The annual fixed costs for a 2 million ton-per-year facility which include interest and amortization, taxes, insurance, and administration and overhead are approximately $4,069,000. The interest and amortization payments were calculated assuming a 25 year economic life and a 16 percent rate of interest. Sixteen percent is the interest rate at which a terminal could be financed assuming 100 percent coverage (29). Sixteen percent is also the interst rate of BAA rated investment bonds, which are the lowest grade investment bonds. A BAA investment grade is considered the most

Table 7-13

The following rates apply on COAL and/or COKE, in dump vehicles.
Truckload Minimum Weights are in tons of 2,000 Pounds.
RATES IN CENTS PER TON OF 2,000 POUNDS

MILEAGE	COLUMNS		MILEAGE	COLUMNS	
	1	2		1	2
	MINIMUM TONS			MINIMUM TONS	
(Inclusive)	10	30	(Inclusive)	10	30
1-5	268	111	56-60	681	453
6-10	299	141	61-65	718	484
11-15	330	172	66-70	757	515
16-20	368	205	71-75	794	544
21-25	407	237	76-80	832	756
26-30	447	266	81-85	869	606
31-35	486	299	86-90	910	636
36-40	527	330	91-95	946	667
41-45	564	360	96-100	984	696
46-50	603	392	100-105	1023	727
51-55	624	424	106-110	1060	758

Column 1: For distances in excess of 110 miles, the rate will be the applicable 110 mile rate, plus six (6) cents per ton for each mile in excess of the first 110 miles.

Column 2: For distances in excess of 110 miles, the rate will be the applicable 110 mile rate, plus five (5) cents per ton for each mile in excess of the first 110 miles.

[Source: Michigan Public Service Commission]

Table 7-14

Estimated Annual Operating Costs of a 2 Million ton-per-year Multimodal Coal Transloading Facility.

Cost Components		Approximate Annual Cost
Capital Costs (includes equipment, material, contract services, and labor)	$17,000,000*	
Contingencies and Working Capital	1,500,000*	
Annual Fixed Costs		
Interest and amortization (assuming a 25 year economic life and a 16% interest rate)		$ 3,034,000
Taxes		350,000
Insurance		35,000
Administration and overhead		650,000
		4,069,000
Annual Variable Costs		
Labor		541,000
Fuel		390,000
Maintenance and Supplies		1,500,000
TOTAL ANNUAL COSTS (Before Federal Taxes)		$ 6,500,000

*These figures were obtained from Table 6-1.

[Source: Table 6-1 and Fruin et al. (28)]

likely rating for the financing of a coal terminal (30). The description of a BAA bond rating is "bonds regarded as having adequate capacity to pay principal and interest, but certain protective elements may be lacking in the event of adverse economic conditions which could lead to a weakened capacity for payment" (31). This payment is 3,034,000 annually.

The annual variable costs for this facility which include labor, fuel, and maintenance and supplies are estimated to be $2,431,000. The total terminal costs are approximately 6.5 million dollars annually.

The total terminal costs as a function of annual throughput are listed in Table 7-15. It is evident that as throughput capacity increases, the cost per ton of transshipping coal drops significantly. Figure 7-2 represents this relationship graphically.

Once the coal transshipment costs of a brokerage have been determined, comparisons can be made regarding the potential cost savings for users interested in receiving brokered coal. Although brokerage facilities are evaluated at four specific sites in the State of Michigan, there are some general assumptions that are made relative to the brokerage operation. These are:

- There are four different coals delivered to the brokerage. The origins are; eastern Ohio, eastern Kentucky, Pennsylvania, and Montana.

- The brokerage can (with the exception of Marquette) receive coal by both rail and water. The decisions regarding the mode of receipt are based entirely on costs.

- The prices quoted are the average of the four coals.

- The brokerage receives equal tonnages of each type of coal. For instance, if the annual throughput of the brokerage is 2,000,000 tons/year, 500,000 tons of each coal are delivered.

- All local distribution is by truck. There is a minimum shipment weight of 30 tons, and costs are based on a haul of 36-40 miles. For these distances the trucking charge is $3.30/ton (see Table 7-13).

Table 7-15

Total Terminal Costs
(2 Million Tons Annual Throughput Capacity)

Total Terminal Costs	Annual Throughput (Tons)	Cost ($/ton)
$6,500,000	500,000	13.0
6,500,000	1,000,000	6.5
6,500,000	1,200,000	5.42
6,500,000	1,400,000	4.64
6,500,000	1,600,000	4.06
6,500,000	1,800,000	3.61
6,500,000	2,000,000	2.60

- A transshipment charge of $1.27 is incurred at all the ports. This is the actual charge at the Lake Erie ports and an estimated charge at Superior.

- Unit train rates are available at 750,000 tons per year throughput. This is the most critical assumption, because the break even point for all of the brokerage locations will be dependent on when the full unit train rates become available. With the four different coals being delivered, full unit train rates will probably not be available at a total annual throughput of 750,000 tons. However, to examine the effect of terminal costs on the total delivered cost of the brokered coal, unit train rates are assumed to be available with a throughput of 750,000 tons per year.

COMPARATIVE COSTS OF BROKERING COAL

The following is a discussion of the feasibility and potential benefit of locating a coal brokerage at each of the previously mentioned sites. The cost advantages of receiving brokered coal will be examined by evaluating the brokerage cost curves. Comparisons will be made between the cost of brokering coal and the cost of coal delivered at the single car rate, at various annual throughputs.

REGION 1 (DETROIT)

For the Detroit area the cost of coal delivered at the single car rate for a typical user is $49.01/ton. This number was obtained by taking the average of the four coals, delivered by both rail and vessel. Table 7-16 shows the delivered costs of the single car shipments to Detroit from the four origins.

The best possible delivered price of coal to a brokerage in the Detroit area averages $38.00/ton for the four coals. This is accomplished through unit train deliveries from E. Kentucky and vessel deliveries from the other three sources. Table 7-17 lists the delivered costs of the unit train shipments from the four origins.

Figure 7-3 shows the cost curves for the brokerage operation and the average user. The straight line represents the single car rate that the

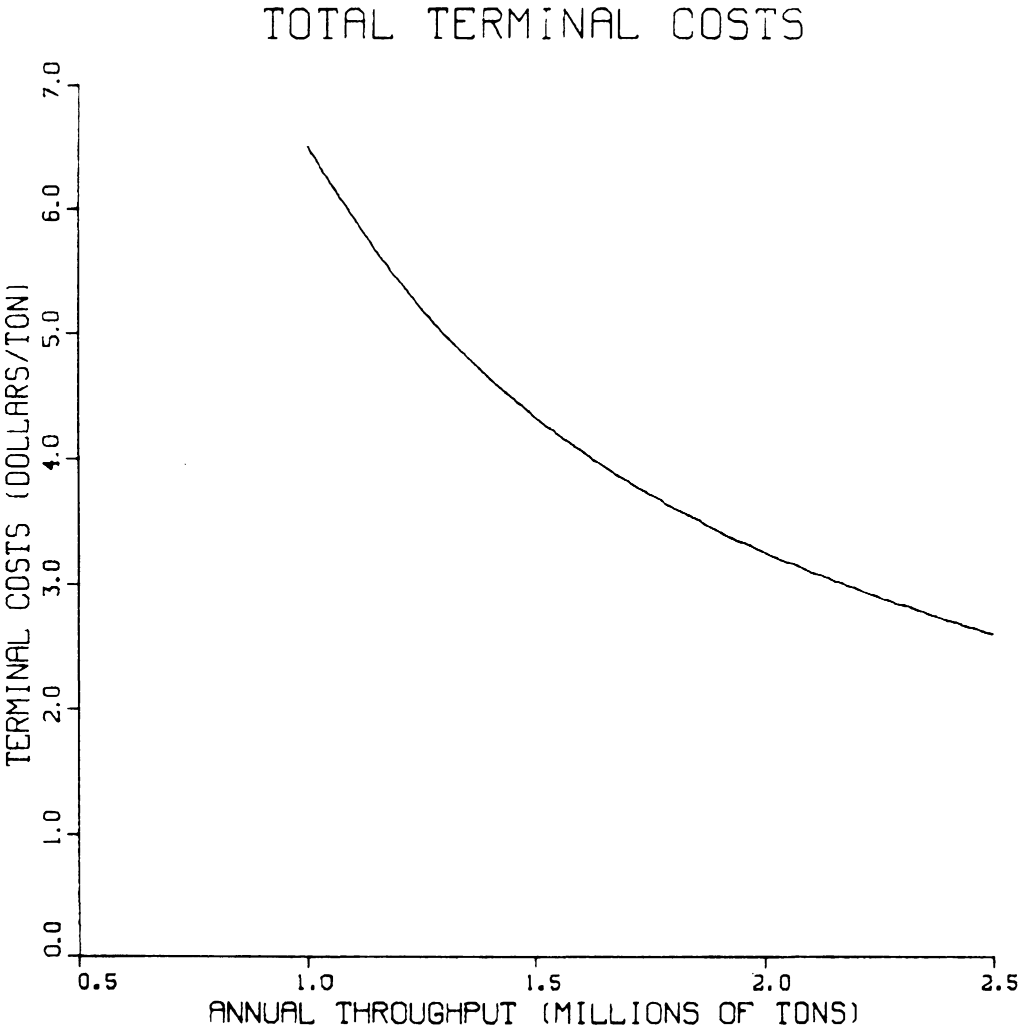

TOTAL TERMINAL COSTS
TERMINAL COSTS (DOLLARS/TON)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
0.5
1.0
1.5
2.0
2.5
ANNUAL THROUGHPUT (MILLIONS OF TONS)

Figure 7-2

Table 7-16

Delivered Cost of Coal to Detroit
(Single Car Rate)

Origin	Type of Delivery	Transshipment Point	Transportation Cost ($/ton)	Minemouth Cost ($/ton)	Total Delivered Cost ($/ton)
Ohio #8	All Rail	---	16.81	28.79	45.6
Ohio #8	Vessel	Sandusky	16.15	28.79	44.49
E. Kentucky	All Rail	---	20.42	36.83	57.25
E. Kentucky	Vessel	Toledo	18.67	36.83	55.50
Pittsburgh	All Rail	---	18.62	32.19	50.81
Pittsburgh	Vessel	Sandusky	16.59	32.19	48.78
Montana	Vessel	Superior	31.12	9.10	40.22

$\mu = 49.01$

Table 7-17

Delivered Cost of Coal to Detroit
(Unit Train Rate)

Origin	Type of Delivery	Transshipment Point	Transportation Cost ($/ton)	Minemouth Cost ($/ton)	Total Delivered Cost ($/ton)
Ohio #8	Vessel	Sandusky	9.85	26.17	36.02
E. Kentucky	All Rail	---	13.27	33.48	46.75
Pittsburgh	Vessel	Sandusky	12.03	29.26	41.29
Montana	Vessel	Sandusky	19.70	8.27	27.97

$\mu = 38.00$

average user would be paying. Terminal costs are very prohibitive at low levels of throughput for the brokerage. As throughput increases these costs drop. For Detroit, the cutoff (break even) point appears to be at an annual throughput of about 840,000 tons, if unit train rates are available. Assuming that the brokerage can obtain unit train rates at this annual volume, coal can be distributed to users within a radius of 40 miles, at a price equal to the single car rate. Users located closer than 36 miles to the terminal would be able to obtain the coal for less. Also, if annual throughput was greater than 840,000 tons, the delivered cost of the coal would drop below the single car rate.

REGION 7 (BAY CITY (ESSEXVILLE))

For the average user in the Bay City-Essexville area the delivered price of coal would be $50.15/ton. This, again, is the average of four coals delivered by both rail and vessel, at the single car rate.

Table 7-18 lists the delivered single car rates to Bay City (Essexville).

The best delivered unit train rate to a brokerage in the Bay City (Essexville) region averages $38.47/ton for the four coals. This average is obtained by receiving all of the coal by lake vessel.

Table 7-19 lists the cost of coal delivered at the unit train rate.

The cost curve of the brokerage and the average single car rates are represented in Figure 7-4. It appears that the break even point for a brokerage distributing coal within a 40 mile radius in the Bay City-Essexville Region is approximately 780,000 tons (annual throughput), provided full unit train rates are available at this level. If annual volumes

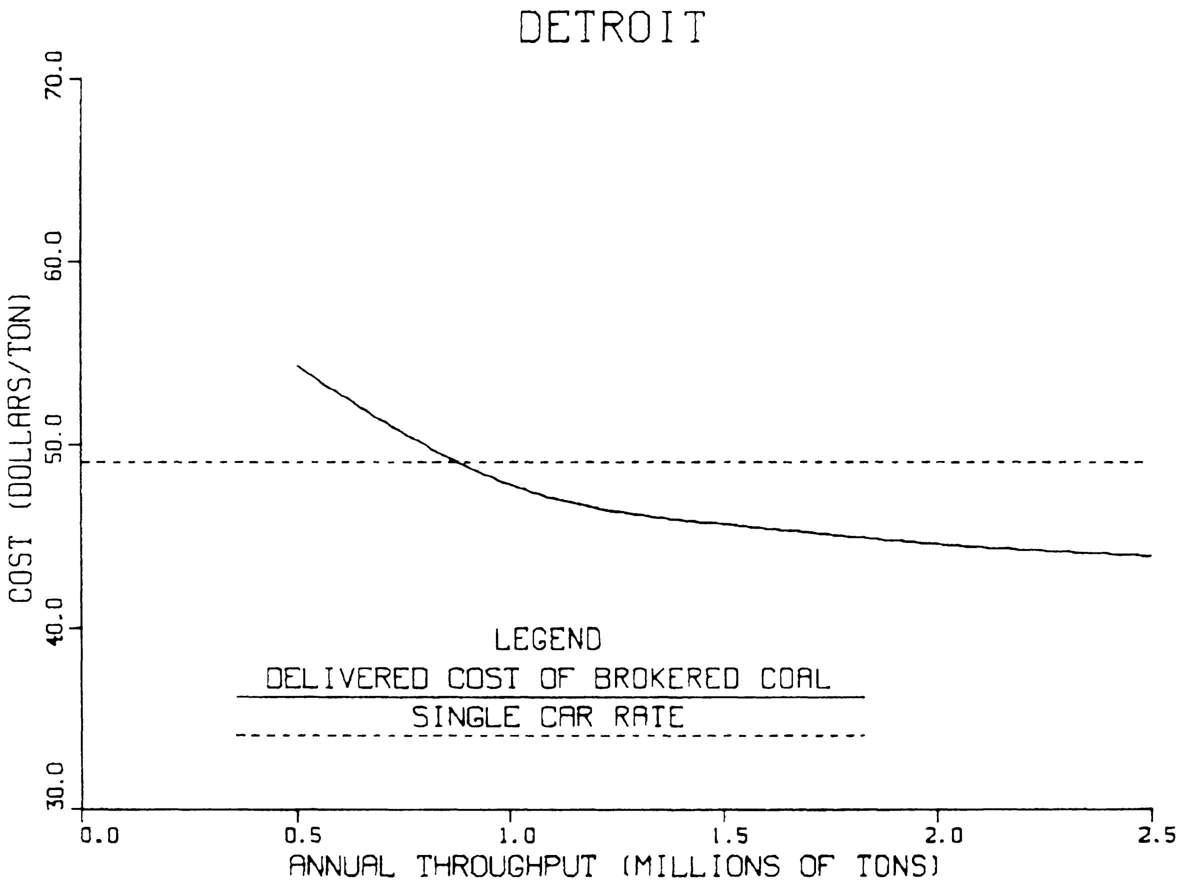


Figure 7-3

COMPARATIVE COSTS OF BROKERING COAL

Table 7-18

Delivered Cost of Coal to Essexville (Bay City)
(Single Car Rate)

Origin	Type of Delivery	Transshipment Point	Transportation Cost ($/ton)	Minemouth Cost ($/ton)	Total Delivered Cost ($/ton
Ohio #8	All Rail	---	19.20	28.79	47.99
Ohio #8	Vessel	Sandusky	16.52	28.79	45.31
E. Kentucky	All Rail	---	22.87	36.83	59.70
E. Kentucky	Vessel	Toledo	19.08	36.83	55.91
Pittsburgh	All Rail	---	21.03	32.19	53.22
Pittsburgh	Vessel	Sandusky	16.95	32.19	49.14
Montana	Vessel	Superior	30.70	9.10	39.8

μ = 50.15

Table 7-19

Delivered Cost of Coal to Essexville (Bay City)
(Unit Train Rate)

Origin	Type of Delivery	Transshipment Point	Transportation Cost ($/ton)	Minemouth Cost ($/ton)	Total Delivered Cost ($/ton
Ohio #8	Vessel	Sandusky	10.81	26.17	36.98
E. Kentucky	Vessel	Toledo	13.97	33.48	47.45
Pittsburgh	Vessel	Sandusky	12.62	29.26	41.88
Montana	Vessel	Superior	19.28	8.27	27.55

$\mu = 38.47$

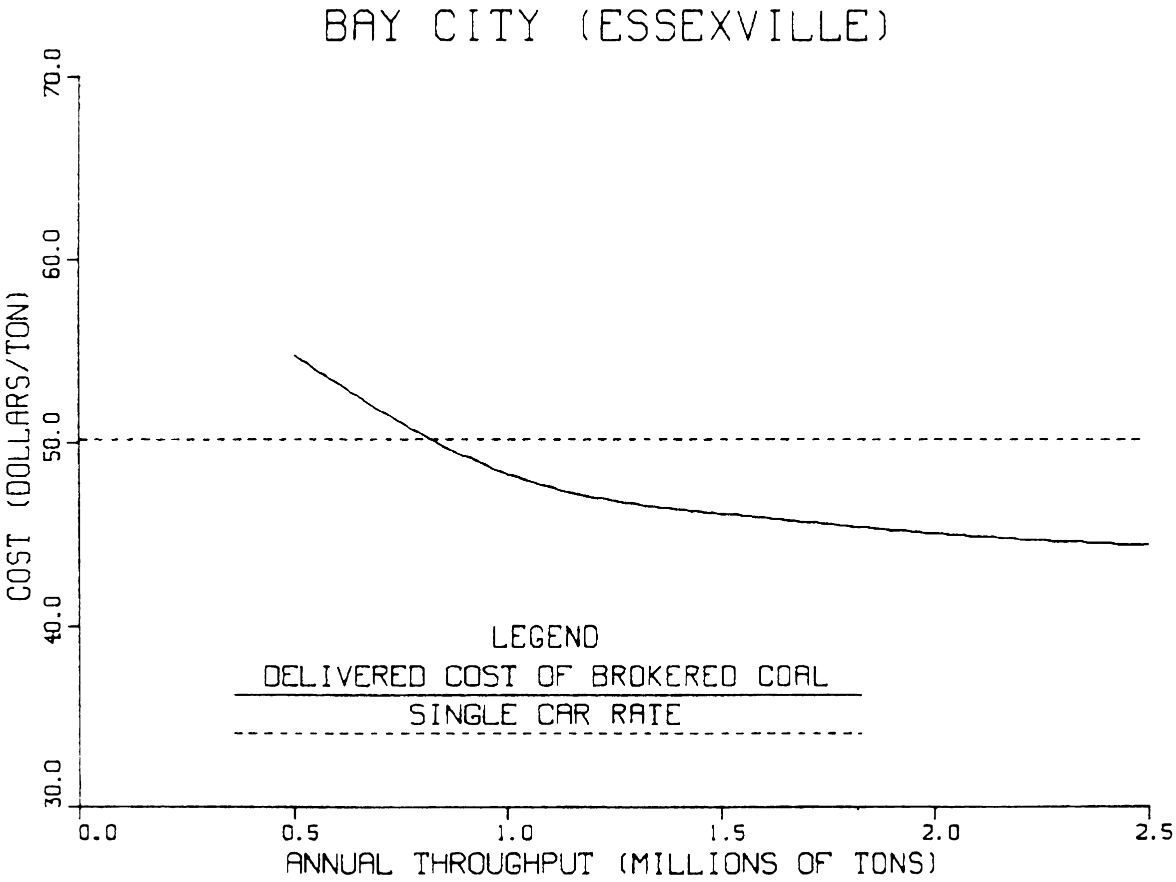


Figure 7-4

COMPARATIVE COSTS OF BROKERING COAL

over 780,000 tons per year can be moved, the coal distribution costs will be even less.

REGION 14 (MUSKEGON)

The average delivered single car rate for a small to moderate sized coal user purchasing coal in the Muskegon area is $50.77/ton. This is the average of four coals delivered by both vessel and rail. The prices of coal delivered at the single car rate to Muskegon are listed in Table 7-20.

The lowest delivered unit train rate achievable by a brokerage in the Muskegon area averages $39.22/ton for the four coals. This average rate is accomplished through all rail deliveries from Ohio #8, E. Kentucky, and Pittsburgh, and vessel delivery of Montana coal from Superior, Wisconsin. The delivered unit train rates for the four coals to the brokerage are listed in Table 7-21.

Figure 7-5 shows the cost curve of the brokerage versus the single car rate obtained by the average user. For a brokerage operation in Muskegon, it appears that the break even point would require an annual throughput of about 790,000 tons, assuming that the coal is distributed within a radius of 40 miles, and full unit train rates are available. At an annual throughput level of less than 790,000 tons the delivered cost of brokered coal would be higher than the single car rate. However, if more than 790,000 tons per year can be distributed or if the user is located less than 36 miles from the brokerage, the delivered cost of the coal will be less.

REGION 12 (MARQUETTE)

A brokerage facility in Marquette would be different than a brokerage at the three other sites due to the fact that the region receives no rail

Table 7-20

Delivered Cost of Coal to Muskegon
(Single Car Rate)

Origin	Type of Delivery	Transshipment Point	Transportation Cost ($/ton)	Minemouth Cost ($/ton)	Total Delivered Cost ($/ton
Ohio #8	All Rail	---	19.20	28.79	47.99
Ohio #8	Vessel	Sandusky	17.85	28.79	46.64
E. Kentucky	All Rail	---	22.87	36.83	59.70
E. Kentucky	Vessel	Toledo	20.41	36.83	57.24
Pittsburgh	All Rail	---	21.03	32.19	53.22
Pittsburgh	Vessel	Sandusky	18.28	32.19	50.47
Montana	Vessel	Superior	31.05	9.10	50.15

μ = 50.77

Table 7-21

Delivered Cost of Coal to Muskegon
(Unit Train Rate)

Origin	Type of Delivery	Transshipment Point	Transportation Cost ($/ton)	Minemouth Cost ($/ton)	Total Delivered Cost ($/ton
Ohio #8	All rail	---	11.49	26.17	37.66
E. Kentucky	All rail	---	14.90	33.48	48.38
Pittsburgh	All rail	---	13.67	29.26	42.93
Montana	All rail	Superior	19.63	8.27	27.90

$\mu = 39.22$

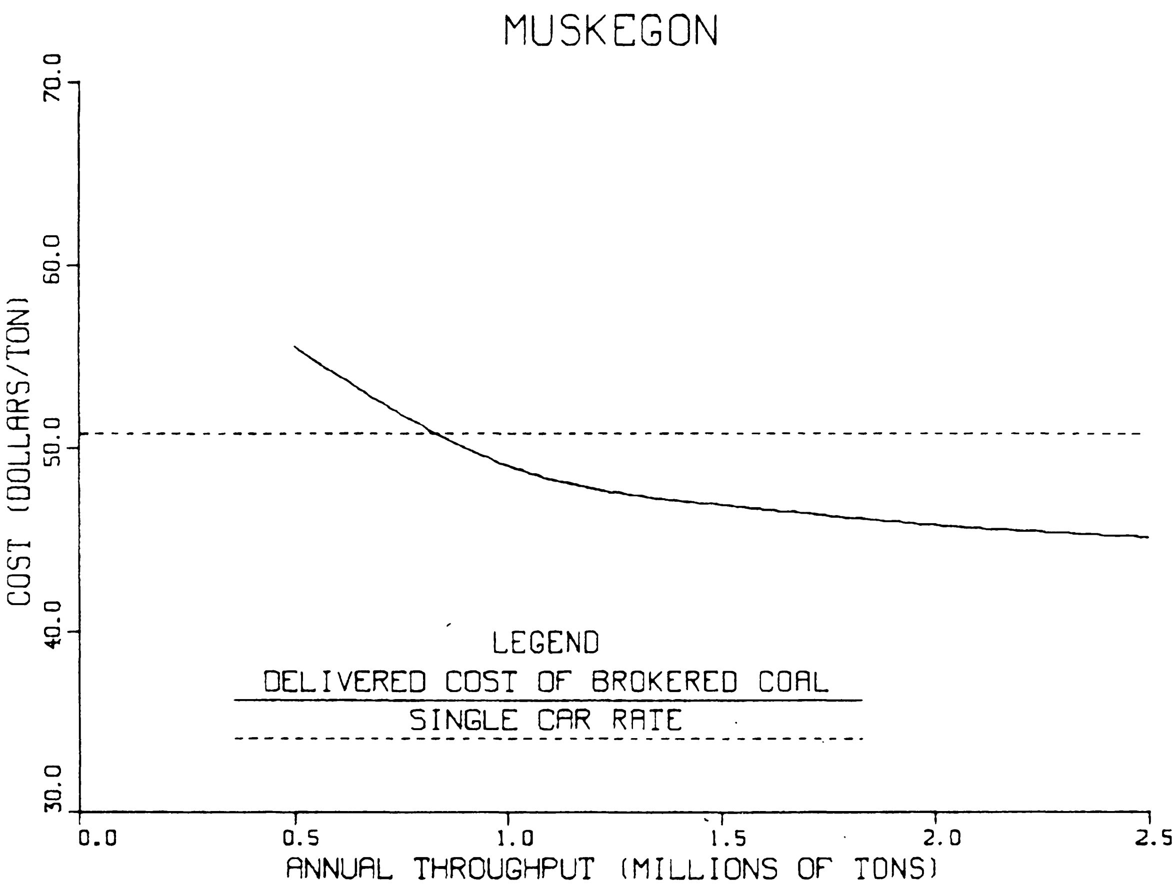


Figure 7-5

COMPARATIVE COSTS OF BROKERING COAL

shipments of coal (32). Therefore, a Region 12 brokerage facility would be designed as a vessel to truck transloading terminal.

A facility that does not handle rail shipments has different physical and capital requirements than a multimodal facility. Table 7-22 lists the capital requirements of a 2 million ton-per-year vessel-to-truck coal terminal. Equipment costs are reduced substantially because there is no need for a rail loop track, a rotary car dump system, or a dumper shed (33). Also the capital investments toward reclaim, storage, and conveying equipment are reduced. Overall, equipment requirements are about 1/3 less than for a multimodal facility.

The estimated operating costs of a 2 million ton-per-year vessel to truck facility are listed in Table 7-23. All of the costs are lower than those of a multimodal facility. Labor is reduced because the number of required personnel is only 19 as opposed to 26 for a small multimodal facility (34). Maintenance and supplies are less because there is substantially less equipment needed. Fuel requirements are reduced because a vessel-to-truck facility probably will not have to be staffed 24 hours a day as does a multimodal facility, due primarily to increased flexibility in scheduling deliveries from vessels over rail.

Some of the data for Tables 7-22 and 7-23 originally appeared in Fruin et al. (1979) (36). The figures were updated with the assistance of Mr. Paul Johnson of Johnson Brothers Corporation, Litchfield, MN, and Professor J. E. Fruin of the University of Minnesota.

Total terminal costs as a function of annual throughput are listed in Table 7-24. At low levels of throughput the total terminal costs for distributing coal are quite high. As annual throughput increases the

Table 7-22

Capital Requirements for a 2 million ton-per-year vessel to truck coal terminal. [Source: Fruin et al. 1979; (updated data)]

Equipment Needed	Approximate Cost (millions of dollars)
1. Equipment for storage and reclaim	2.0
2. Dock for vessels	4.0
3. Ground storage (approximately 500,000 tons)	1.0
4. Conveyor system to put coal in storage piles	2.0
5. Sprays and dusthoods on conveyors to minimize dust generation	.75
6. Loaders and scrapers	.75
7. Truck load out	.75
TOTAL EQUIPMENT	11.25
8. Contingency and Working Capital	1.25
TOTAL CAPITAL	12.50

Table 7-23

Estimated Operating Cost of a 2 Million ton-per-year
Vessel-to-Truck Transshipment Facility

Cost Components		Approximate Annual Cost
Capital Cost (includes equipment, material, contract services, and labor)	$11,250,000	
Contingencies and Working Capital	1,250,000	
Annual Fixed Costs		
Interest and amortization (assuming a 25 year economic life and a 16% interest rate)		$ 2,275,000
Taxes		300,000
Insurance		25,000
Administration and overhead		500,000
		3,100,000
Annual Variable Costs		
Labor		400,000
Fuel		300,000
Maintenance and Supplies		1,100,000
TOTAL ANNUAL COSTS (Before Federal Taxes)		$ 4,900,000

[Source: Table 7-22 and Fruin et al. (28)]

Table 7-24

Total Terminal Costs
(2 Million Tons Annual Throughput Capacity)

Total Terminal Costs	Annual Throughput (Tons)	Cost ($/ton)
$4,900,000	500,000	9.8
4,900,000	1,000,000	4.9
4,900,000	1,200,000	4.08
4,900,000	1,400,000	3.5
4,900,000	1,600,000	3.06
4,900,000	1,800,000	2.72
4,900,000	2,000,000	2.45

terminal costs drop significantly. Figure 7-6 represents this relationship graphically.

Region 12 was included as a potential brokerage site, because coal from the Lake Erie Ports is often transported as a backhaul to Marquette.* As a backhaul the transportation costs are less by about $1.00/ton than they would be otherwise (37).

When backhauls can be arranged, both parties benefit. However, the scheduling of ships often presents a problem, to the extent that backhauls do not occur as frequently as they could (38). For the purposes of this analysis, the assumption is that a brokerage facility will be able to receive backhaul rate reductions 100 percent of the time. Also, it is assumed that an average user buying an occasional boat load of coal will not be able to obtain the backhaul rate reduction. This may or may not be true, but a brokerage receiving a large number of ships on an annual basis, will probably have greater scheduling flexibility to take advantage of backhaul rate reductions more frequently.

Table 7-25 lists the delivered single car rates to Marquette. The average of the four coals (all delivered by lake vessel) is $48.00/ton. This is what the average coal user purchasing coal at the single car rate would be expected to pay.

The lowest delivered lake cargo unit train rate to a brokerage in Marquette averages $38.18/ton for the four coals. This includes the backhaul rate reductions from the delivered price of the eastern coals.

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*The primary bulk commodity movement is iron ore shipped from the Lake Superior Ports to the lower lakes.

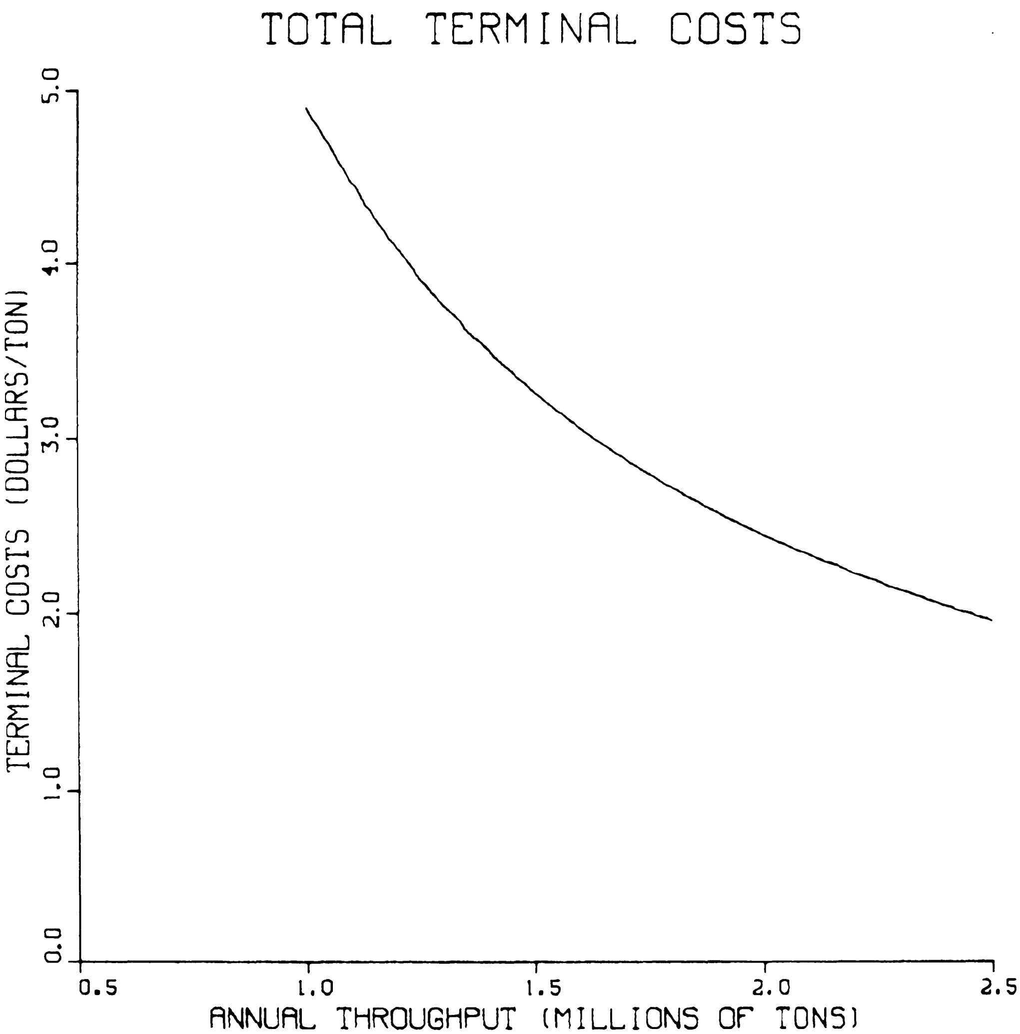
TOTAL TERMINAL COSTS
TERMINAL COSTS (DOLLARS/TON)
0.0
1.0
2.0
3.0
4.0
5.0
0.5
1.0
1.5
2.0
2.5
ANNUAL THROUGHPUT (MILLIONS OF TONS)

Figure 7-6

Table 7-25

Delivered Cost of Coal to Marquette
(Single Car Rate)

Origin	Type of Delivery	Transshipment Point	Transportation Cost ($/ton)	Minemouth Cost ($/ton)	Total Delivered Cost ($/ton
Ohio #8	Vessel	Sandusky	17.67	28.79	46.46
E. Kentucky	Vessel	Toledo	20.23	36.83	57.06
Pittsburgh	Vessel	Sandusky	18.10	32.19	50.29
Montana	Vessel	Superior	29.10	9.10	38.2

$\mu = 48.00$

Table 7-26 lists the delivered unit train rates to Marquette from the Ohio #8, E. Kentucky, Pittsburgh and Montana sources.

Figure 7-7 shows the cost curve for the Marquette brokerage, and the single car rate obtained by the average user.

Because the capital requirements of the vessel to truck facility are less than for the multimodal facilities, terminal costs are less prohibitive at low levels of throughput for the Marquette terminal. The data indicate that the break even point, where the cost of brokered coal is the same as the single car rate, is at an annual throughput of approximately 750,000 tons. This assumes that unit train rates are available at this level of throughput, and that the coal is being distributed to users located 36 - 40 miles from the facility. Users located closer to the facility would receive their coal for even less. In addition, if annual throughput is increased, greater cost savings can result.

SUMMARY

Table 7-27 displays the minimum throughput requirements for the four brokerages. Of the four brokerage sites the Marquette terminal appears to be the most attractive. Brokered coal can be distributed at the single car rate with an annual throughput of 750,000 tons.

The Detroit brokerage appears to be the least attractive. Here, the brokerage has to handle 840,000 tons on an annual basis to meet the single car rate. The Bay City and Muskegon terminals need 780,000 and 790,000 tons of throughput respectively to break even (meet the single car rate).

Decisions regarding the feasibility of a brokerage cannot be made on comparative minimum throughput requirements alone. For instance, a Detroit brokerage may be feasible because it is located near the area of heaviest

Table 7-26

Delivered Cost of Coal to Marquette
(Unit Train Rate)

Origin	Type of Delivery	Transshipment Point	Transportation Cost ($/ton)	Minemouth Cost ($/ton)	Total Delivered Cost ($/ton
Ohio #8	Vessel	Sandusky	10.96	26.17	37.13
E. Kentucky	Vessel	Toledo	14.12	33.48	47.6
Pittsburgh	Vessel	Sandusky	12.76	29.26	42.02
Montana	Vessel	Superior	17.71	8.27	25.98

$\mu = 38.17$

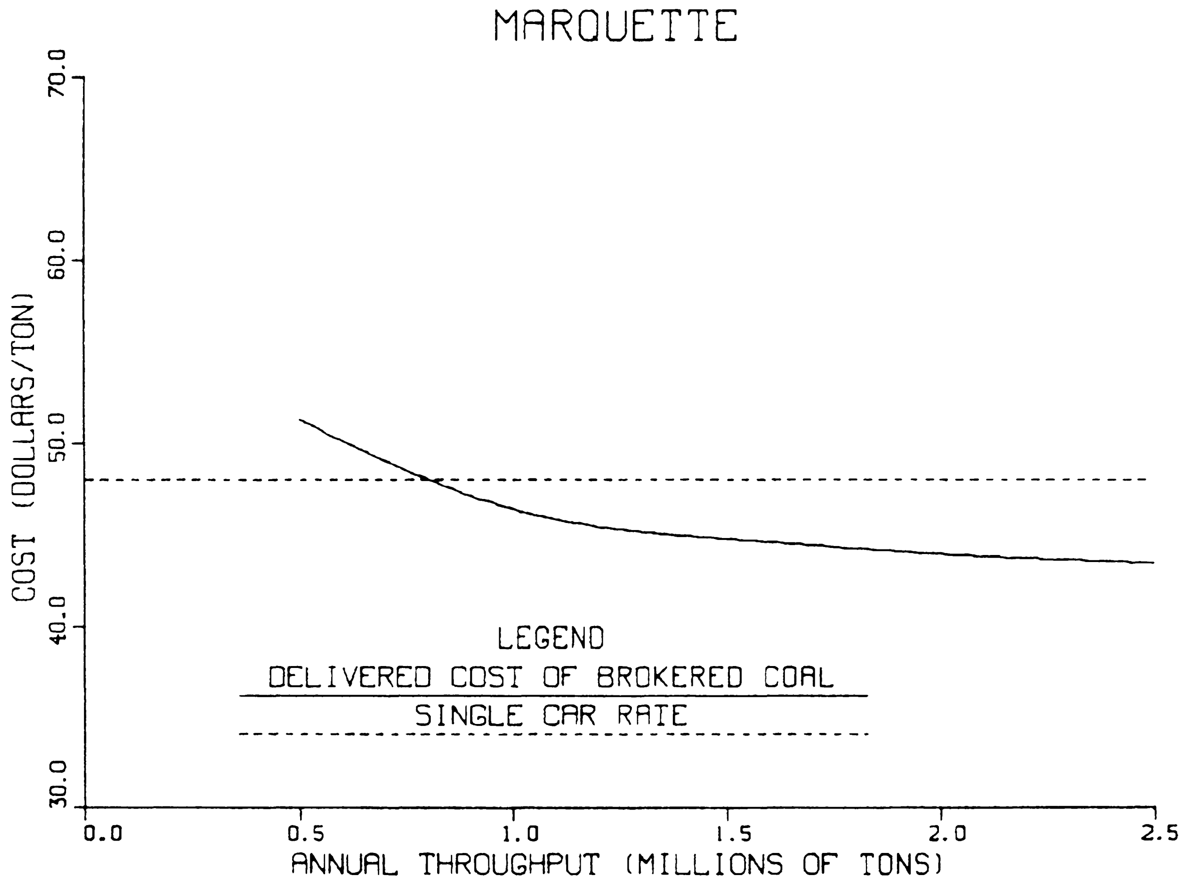

Figure 7-7

COMPARATIVE COSTS OF BROKERING COAL

Table 7-27

Brokerage Throughput Requirements

Brokerage Location	Delivered single car rate to be met ($/ton)	Minimum annual throughput requirement (tons)
Region 1 Detroit	49.01	840,000
Region 7 Bay City (Essexville)	50.15	780,000
Region 14 Muskegon	50.77	790,000
Region 12 Marquette	48.00	750,000

demand, and may be able to meet the additional throughput requirement. Marquette may not be the most desired location for a brokerage because of the shortcomings of the transportation system. For instance, vessels can only deliver the coal to a Marquette brokerage 8-9 months out of the year.

A Muskegon brokerage may be able to reduce distribution costs by handling midwest coals from Illinois or Indiana. These coals would be transshipped at Chicago and could be delivered more cheaply than the eastern coals from the Lake Erie Ports (39).

However, there are two major issues that must be addressed before an adequate assessment of brokerage feasibility can be made. One question that has to be answered is what level of annual throughput do unit train rates become available? The minimum throughput requirement for the four brokerage sites is 750,000 tons per year assuming unit train rates are available at this level. However, it appears that unit trains will not be available at this level of throughput and may not be obtainable until annual throughput is well over 1 million tons. The minimum level of throughput that a brokerage would have to handle to be feasible, would be the annual volume at which unit train rates became available. Without unit train transportation rates the establishment of a coal brokerage makes little sense (40).

The second question deserving consideration with regard to the successful establishment of a coal brokerage is whether there is sufficient demand (excluding large utility and industrial users) to support a coal distribution center. Both of these issues will be discussed in more detail in the final chapter.

FOOTNOTES TO SECTION VII

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VIII. SUMMARY AND CONCLUSIONS

As relative supplies of oil and natural gas decline, coal will become increasingly important as a source of energy for the state of Michigan. A primary constraint on increasing the use and movement of coal is the lack of an efficient distribution system to serve small and moderate sized users.

One of the major problems of supplying coal to small and moderate sized users is the lack of a supporting infrastructure for the distribution of the coal. Once the infrastructure is in place, potential smaller volume customers (such as industrial/institutional users) can use the distribution network to take advantage of unit train and large vessel transportation rates (1).

A major prerequisite for unit train service is that high volumes of coal are needed to make the operation both practical and economical. Many existing or potential coal users are too small to benefit from the cost savings associated with unit train service.

A coal brokerage, as described in this study, is a distribution center designed to allow small and moderate sized users to take advantage of the cost savings associated with high volume shipments of coal through the aggregation of demand. A coal brokerage requires equipment to unload unit trains and vessels (if coastal-sited), maintain and manage a stockpile, and transfer coal from the storage areas onto other transport modes for local distribution.

Four potential multiple user brokerage sites were evaluated for the state of Michigan. These were; Detroit, Bay City (Essexville), Muskegon, and Marquette. The minimum annual throughput requirements (excluding profit) needed to meet an average single car freight rate (the standard rate paid by smaller coal users), ranged from 750,000 tons for the Marquette brokerage to 840,000 tons for the Detroit brokerage.

Indications are that with enough annual throughput, coal brokerage facilities can provide cost savings for small and moderate sized coal users in Michigan.

However, excluding large utility and industrial users there appears to be insufficient demand to meet the minimum throughput requirements in all the study areas, with the possible exception of Region 1 (southeastern Michigan).

In Region 1 (Detroit), the Detroit Edison Company users over 10.8 million tons of coal per year (2). Excluding Detroit Edison, and large industrial users, the coal demand in Region 1 may still be sufficient to meet the minimum throughput requirement of 840,000 tons on an annual basis, provided that unit train transportation rates are available at this level of annual throughput. The fact that unit train rates are probably not available at 840,000 tons total throughput makes this brokerage appear marginally feasible (3).

In Region 7, the Consumers Power Company uses over 2 million tons of coal per year, and the Dow Chemical Company uses over 500,000 tons annually. Demand from other users will not be enough to support the minimum annual throughput requirement of 780,000 tons.

The Consumers Power Company also uses over 3 million tons per year in Region 14 (4), which leaves little additional demand in the area to support a brokerage operation.

In Region 12, the Upper Peninsula Generating Station in Marquette uses almost 3 million tons of coal, and the Lake Superior and Ishpeming Railroad

Company purchases over 2 million tons annually. Demand by other users in this region cannot support a brokerage.

The implication of these data for Michigan are quite clear. Most of the coal purchased in the state is being used by extremely large power plants which already have the infrastructure to receive high volume, low cost shipments of coal.

With the exception of Region 1, demand from smaller users appears to be insufficient to support the high capital investment, and the minimum annual throughput requirements of a coal brokerage operation. In addition, it is doubtful that full unit train rates will be available to a brokerage handling 4 or more coals with an annual throughput under 2 million tons (6). Without the cost savings available from unit train transportation there is little point in pursuing the concept of a regional coal distribution center (7).

ROLE OF A COAL BROKERAGE

Although the capital investment of a modern coal terminal may be prohibitive, a brokerage facility could be very attractive if it is built concurrently with some other operation. One possibility would be to establish a brokerage in conjunction with a large electric generating station, which would be the primary user. Upon initial investigation, the idea of using the coal handling facilities of power plants is attractive because utilities use large amounts of coal, have a staff experienced in purchasing and handling operations, and have the supporting infrastructure to handle high volume shipments (8). However, the potential for using existing power plant terminals as coal distribution centers is limited, due primarily to lack of space and little additional throughput capacity (9).

There are other problems associated with using coal-fired power plants as regional coal distribution centers, such as:

- Articles of corporation of some utilities would prevent them from engaging in activities other than selling electricity.
- Railroads may be unwilling to deliver coal to a central point which will serve multiple customers.
- The location of a utility may be distant from smaller industrial and institutional users.
- The operation would not be permanent because it could easily be terminated if the utility/operator finds the business unprofitable, impractical, or otherwise undesirable. This point is perhaps the most serious weakness (10).

At a new generating station, many of the aforementioned drawbacks could be avoided by having an independent coal broker receive all of the coal at the plant site. There are various options available to carry out the concept. These are:

- The utility owns and operates the coal handling equipment and leases it to the broker/operator.
- The broker owns all of the equipment. This will reduce the utility's initial capital outlay.
- The coal handling equipment and facilities are jointly owned by the utility and the broker (11).

Especially at smaller power plants, it is possible for a coal broker, rather than the utility, to operate all aspects of the regional coal distribution center. The concept is attractive because it permits the coal handling for a region to be done in a centralized place. The benefits of possible reduced air and water pollution are added to lower coal costs for industrial/institutional users, and perhaps even lower coal costs for the participating utility (12).

Also, it is recommended that the possibility of adding additional throughput capacity to a proposed power plant coal transshipment facility be looked into as part of the energy facility siting process.

Another possibility for a coal brokerage would be a combination facility handling different commodities. For instance, a coal unit train facility and a grain unit train facility could be built along the same loop track. Trucks could haul coal out to the small users, and bring grain into the facility (13). Some of the larger companies involved with grain production, such as the Pillsbury Corporation, have expressed an interest in this type of facility (14).

However, there are some drawbacks to this alternative, such as:

- Major grain producing regions and major coal use areas are not always located in close proximity to one another.
- Increased truck traffic would cause congestion problems at the terminal site (15).

Although demand increases are expected in all four of the study areas, it is unlikely that potential economic savings from improved coal distribution would be enough incentive to encourage much additional coal use and conversion (16). There are several reasons for this:

- Costs of conversion to coal from natural gas or oil are often prohibitive for small and moderate sized industries and utilities. This is due to the large capital investment required for coal capable boilers (17).

- Costs of pollution control technologies are high for small industries, often 200 to 300 percent of the cost of the boiler itself. In other words, there are economies of scale involved with coal conversion, making it more attractive for large energy intensive firms to convert to coal, because they can more easily afford the capital investments (18).
- There are air quality constraints. That is, many sites are located in non-attainment areas for burning coal, prohibiting them from converting.

Although the delivered price of coal is an important consideration for potential industrial/utility coal users, actual fuel choices are based on factors that go well beyond the relative cost of the coal. Any expansion in the use of coal involves difficult technical, regulatory and logistical decisions. In addition, widespread conversion to coal will take a long time, and will involve the development of new technologies and institutional frameworks.

With the possible exception of a Region 1 coal brokerage (which could prove to be feasible under certain circumstances) brokerage facilities appear to be only marginally feasible as a means of distributing coal to small and moderate sized users. This is due mainly to high terminal costs at low levels of throughput and a general lack of demand. However, coal demand is expected to increase in both the utility and industrial sectors in the near future, and evaluated strictly in terms of potential cost reductions in the delivered price of coal, brokerage facilities do indeed offer savings in coal distribution costs. This is important because if coal cannot be delivered cheaply and conveniently in the future it will not be used, especially by small and moderate sized coal users.

Also, it must be remembered that coal transportation and delivery issues pale in comparison to the major environmental problems associated with the burning of coal (19). Air pollution control costs are still the major reason why small and moderate sized users are reluctant to convert to coal as their primary fuel source (20). Therefore, major advances in air pollution control technology may be needed to make a large scale brokerage concept appear more attractive in the future.

FOOTNOTES TO SECTION VIII

(1) Minnesota Energy Agency. 1978. The Minnesota Coal Study, p. 66.

(2) Great Lakes Basin Commission. 1980. Coastal Effects of Coal Transshipment in Michigan: An Evaluation Strategy, pp. C-9 - C-10.

(3) Great Lakes Basin Commission. 1980. Coastal Effects of Coal Transshipment in Michigan: An Evaluation Strategy, p. C-11.

(4) Great Lakes Basin Commission. 1980. Coastal Effects of Coal Transshipment in Michigan: An Evaluation Strategy, pp. C-14 - C-15.

(5) Great Lakes Basin Commission. 1980. Coastal Effects of Coal Transshipment in Michigan: An Evaluation Strategy, p. C-7.

(6) Ethen, J. A., Midwest Energy Resources, Co. December 3, 1981. Personal communication.

(7) Minnesota State Planning Agency. 1978. Coal Terminals in Minnesota, p. 25.

(8) Knorr, Rita, and Wilkie, Kurt. 1979. An Analysis of a Coal Brokerage for a Midwest Site. Argonne National Laboratory, p. 8.

(9) Giaier, R., Detroit Edison Co. July 9, 1981. Personal communication.

(10) Knorr, Rita, and Wilkie, Kurt. 1979. An Analysis of a Coal Brokerage for a Midwest Site. Argonne National Laboratory, p. 8.

(11) Minnesota Energy Agency. 1978. The Minnesota Coal Study, p. 66.

(12) Minnesota State Planning Agency. 1978. Coal Terminals in Minnesota, p. 27.

(13) Johnson, P. W., Johnson Brothers Corporation. January 18, 1982. Personal communication.

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(15) Minnesota State Planning Agency. 1978. Coal Terminals in Minnesota, p. 27.

(16) Fruin, J. E., Levins, R. A., and Wilson, D. 1980. "Distribution Cost Reduction as an Incentive for Coal Conversion." American Journal of Agricultural Economics, Vol. 62, No. 1, pp. 118-123.

(17) Taylor, C. R., Chessie System Railroad. October 13, 1981. Personal communication.

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APPENDIX A

Michigan Power Plants
(OPR & STN)*
[Reprinted from Great Lakes Basin Commission, 1980]

Operator	City	Plant Name	Status	Year	Fuel	Mega Watts
Coldwater Bd. Public Utility	Coldwater	Coldwater 4-6	OPR	1940	Coal	11
Consumers Power Company	Muskegon	BC Cobb 1-5	OPR	1948	Coal	510
Comsumers Power Company	Comstock	BE Morrow 1-4	OPR	1939	Oil	186
Consumers Power Company	Charlevoix	Big Rock Point 2	OPR	1963	Nuclear BWR	72
Consumers Power Company	Essexville	DE Karn 1 & 2	OPR	1959	Coal	530
Consumers Power Company	Essexville	DE Karn 3	OPR	1975	Oil	605
Consumers Power Company	Essexville	DE Karn 4	OPR	1977	Oil	612
Consumers Power Company	Essexville	JC Weadock 1-8	OPR	1940	Oil Coal	615
Consumers Power Company	West Olive	J.C. Campbell 1 & 2	OPR	1962	Coal	652
Consumers Power Company	West Olive	J.C. Campbell 3	OPR	1981	Coal	800

*OPR = Operating status; STN = Standby status

Operator	City	Plant Name	Status	Year	Fuel	Mega Watts
Consumers Power Company	Erie	J.R. Whiting 1-3	OPR	1952	Coal	325
Consumers Power Company	Covert	Palisades 1	OPR	1971	Nuclear BWR	668
Detroit Edison Company	Detroit	Conners Creek	OPR	1934	Oil Gas Coal	450
Detroit Edison Company	Detroit	Delray	OPR	1929	Oil Gas	375
Detroit Edison Compnay	Newport	Enrico Fermi 1	OPR	1960	Oil	150
Detroit Edison Company	Avoca	Greenwood 1	OPR	1979	Oil	800
Detroit Edison Company	Harbor Beach	Harbor Beach	OPR	1968	Coal Oil	121
Detroit Edison Company	Marysville	Marysville	OPR	1942	Coal Gas	200
Detroit Edison Company	Monroe	Monroe	OPR	1971	Coal Oil	3150
Detroit Edison Company	Riverview	Pennwall	OPR	1926	Coal Oil	37
Detroit Edison Company	Port Huron	Port Huron	OPR	1938	Coal	7

*OPR = Operating status; STN = Standby status

Operator	City	Plant Naame	Status	Year	Fuel	Mega Watts
Detroit Edison Company	River Rouge	River Rouge	OPR	1955	Coal Oil Gas	842
Detroit Edison Company	Belle River	St. Clair	OPR	1953	Coal Oil Gas	1620
Detroit Edison Company	Trenton	Trenton Channel	OPR	1949	Coal Gas Oil	738
Detroit Public Lighting	Detroit	Mistersky 1-6	OPR	1927	Coal Oil	175
Detroit Public Lighting	Detroit	Mistersky 7	OPR	1979	Oil	60
Dow Chemical	Ludington	Ludington 2 & 13	OPR	1944	Coal	14
Ford Motor Company	Wayne	Power House One 1-7	OPR	1931	Coal Gas	345
Gladstone Light Utility	Gladstone	Gladstone 1 & 2	OPR	1955	Coal	6
Grand Haven Board of Light and Power	Grand Haven	JB Sims 1 & 2	OPR	1961	Coal Oil	20
Holland Board of Public Works	Holland	James DeYoung 306	OPR	1951	Coal Gas Oil	83
Huron Cement		Alpena 3-7	OPR	1920	Coal	43

*OPR = Operating status; STN = Standby status

Operator	City	Plant Name	Status	Year	Fuel	Mega Watts
Indiana & Michigan Electric Power	Bridgman	DC Cook 1	OPR	1975	Nuclear PWR	1054
Indiana & Michigan Electric Company	Bridgman	DC Cook 2	OPR	1978	Nuclear PWR	1054
Lansing Board of Water & Light	Lansing	Eckert 1-3	OPR	1954	Coal	175
Lansing Board of Water & Light	Lansing	Eckert 4-6	OPR	1954	Coal	175
Lansing Board of Water & Light	Lansing	Erickson 1	OPR	1973	Coal	160
Lansing Board of Water & Light	Lansing	Ottawa Street 1-5	OPR	1979	Coal	82
Marquette Board of Light and Power	Marquette	Shiras 1 & 2	OPR	1967	Coal Gas	36
Michigan State University	East Lansing	Shaw Lane 1	STN	1958	Coal Gas	6
Northern Michigan Electric Coop.	Boyne City	Advance 1-3	OPR	1967	Coal	26
Traverse City Light and Power	Traverse City	Bayside 1-4	OPR	1949	Coal Gas	33
University of Michigan	Ann Arbor	University of Michigan	OPR	1930	Gas	27

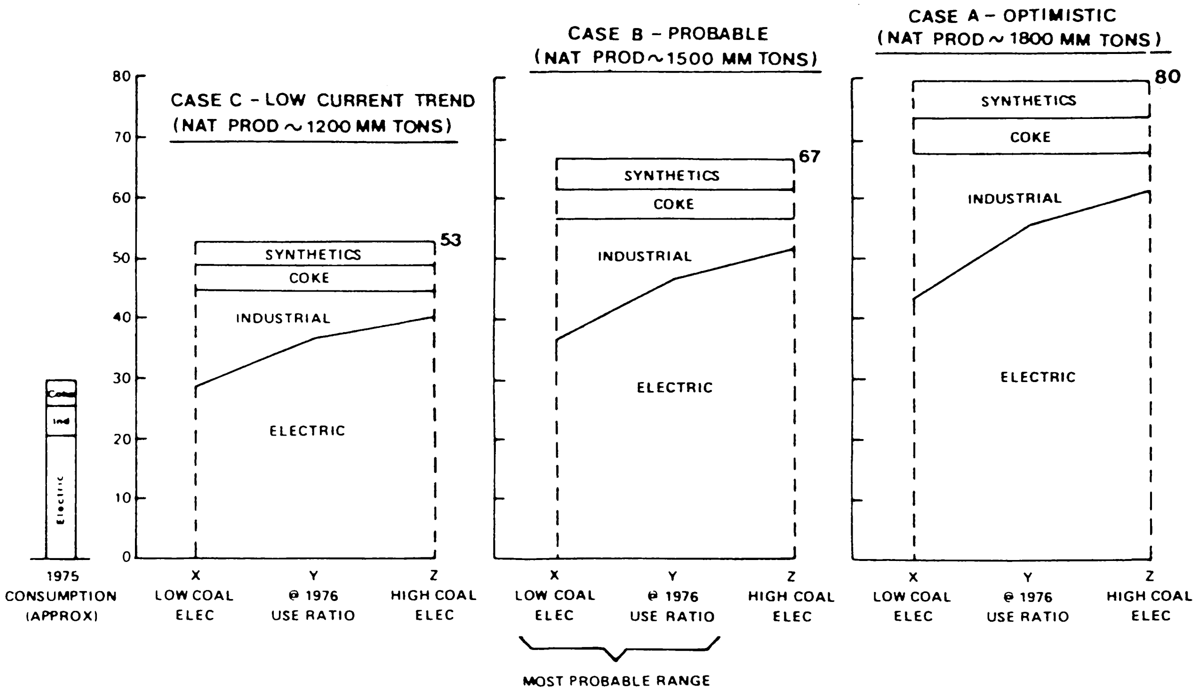
*OPR = Operating status; STN = Standby status

Operator	City	Plant Name	Status	Year	Fuel	Mega Watts
Upper Peninsula Generating Company	Marquette	Presque Isle 1-4	OPR	1955	Coal	175
Upper Peninsula Generating Company	Marquette	Presque Isle 5 & 6	OPR	1974	Coal	160
Upper Peninsula Generating Company	Marquette	Presque Isle 7-9	OPR	1978	Coal	240
Upper Peninsula Power Company	Escanaba	Escanaba 1 & 2	OPR	1957	Coal	29
Upper Peninsula Power Company	Lanse	JH Warden 1	OPR	1959	Coal	18
White Pine Copper Company		White Pine 1-4	OPR	1953	--	58
Wolverine Electric Coop.	Dorr	Van Dyke 6	OPR	1968	Oil Gas	21
Wyandotte Dept. Municipal Service	Wyandotte	Wyandotte 2-5 & 7	OPR	1939	Gas Oil	50

*OPR = Operating status; STN = Standby status

APPENDIX B

MICHIGAN—POTENTIAL COAL CONSUMPTION @ 2000 AD



SUMMARY - MICHIGAN POTENTIAL COAL CONSUMPTION @ 2000 AD (MM TONS/YR)

	PRODUCTION US	PRODUCTION MICH	USE SECTORS	LOW COAL ELEC X	@ 1976 RATIO Y	HIGH COAL ELEC Z	~1975 Consumption
CASE A OPTIMISTIC	1800	80	ELECTRIC	44	56	62	21
			INDUSTRIAL	24	12	6	4
			COKE	6	6	6	4
			SYNTHETICS	6	6	6	0
CASE B PROBABLE	1500	67	ELECTRIC	37	47	52	21
			INDUSTRIAL	20	10	5	4
			COKE	5	5	5	4
			SYNTHETICS	5	5	5	0
CASE C CURRENT TREND	1200	53	ELECTRIC	29	37	41	21
			INDUSTRIAL	16	8	4	4
			COKE	4	4	4	4
			SYNTHETICS	4	4	4	0

LEGEND

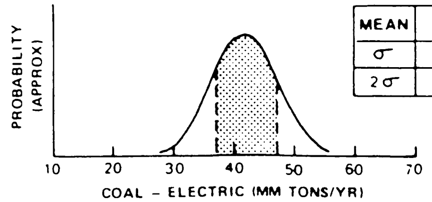
37 / 20 (shaded) = HIGH PROBABILITY RANGE

MICHIGAN 2000 AD
COAL - ELECTRIC (MM TONS/YR)

	X	Y	Z
CASE A	44	56	62
CASE B	37	47	52
CASE C	29	37	41

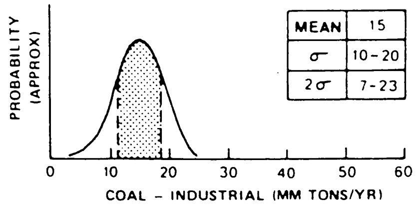
MICHIGAN 2000 AD
COAL - INDUSTRIAL (MM TONS/YR)

	X	Y	Z
CASE A	24	12	6
CASE B	20	10	5
CASE C	16	8	4



STATISTICS

MEAN	42
σ	37 - 47
2σ	32 - 52

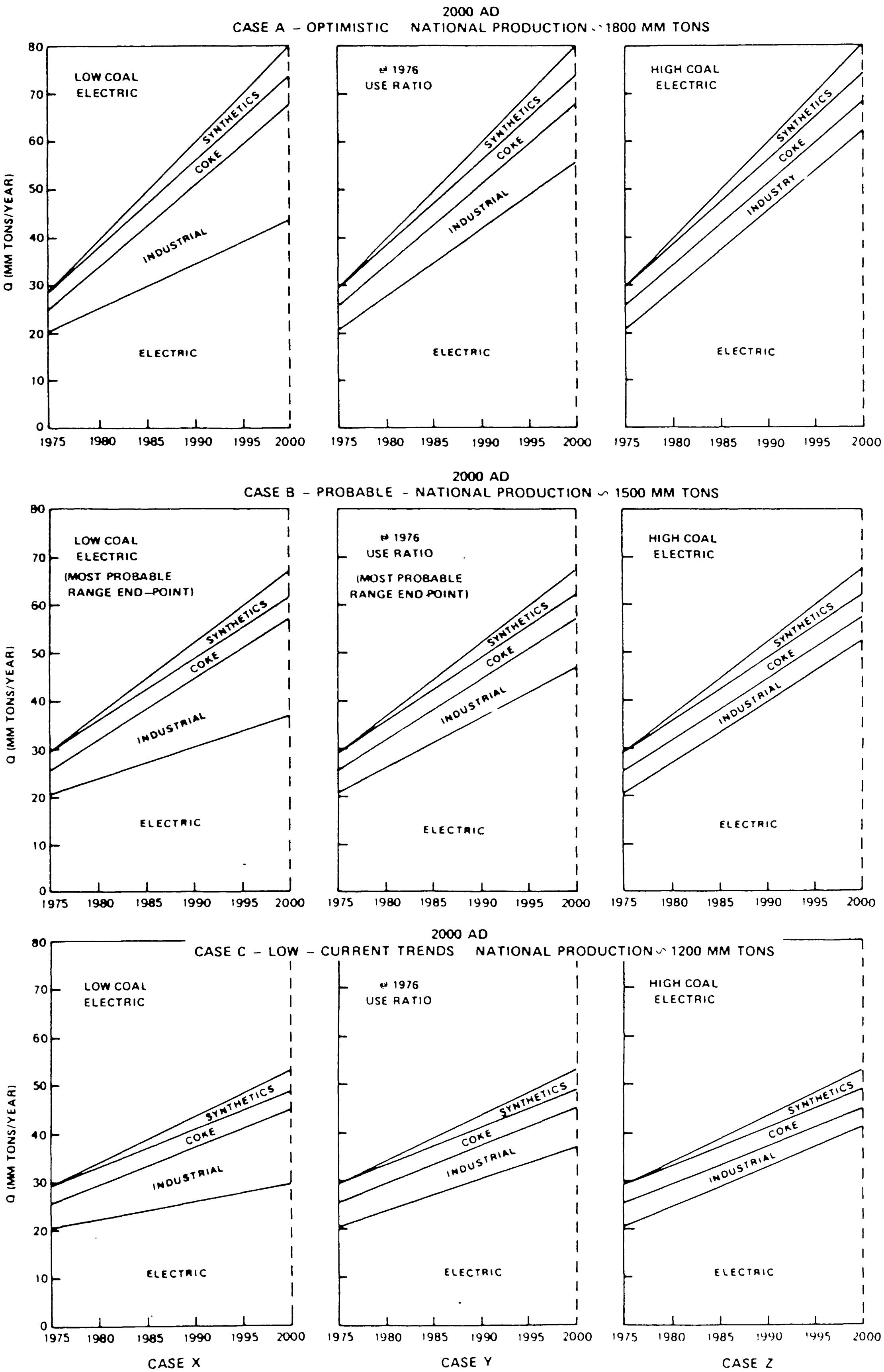


STATISTICS

MEAN	15
σ	10 - 20
2σ	7 - 23

[Reprinted from Michigan Energy Resource and Research Association, 1980]

MICHIGAN—POTENTIAL COAL CONSUMPTION 1975 - 2000 AD



[Reprinted from Michigan Energy Resource and Research Association, 1980]

APPENDIX C

Capital Requirements for a 5 Million
Ton-Per-Year Multimodal Coal Terminal.
[Reprinted from Fruin et al., 1979; (updated data)]

Equipment Needed	Approximate Cost (millions of dollars)
1. Parallel or loop track for 110 car unit train	1.0
2. Rotary car dumper	3.0
3. Dumper shed	.75
4. Ground storage (approximately 1,000,000 tons)	2.0
5. Conveyor system to put coal in storage piles	3.0
6. Sprays and dusthoods on conveyors to minimize dust generation	1.0
7. Equipment for storage and reclaim	3.0
8. Dock for vessels	4.0
9. Loaders and scrapers	.75
10. Truck load out	.75
TOTAL EQUIPMENT	19.25
11. Contingency and Working Capital	1.75
TOTAL CAPITAL	21.00

APPENDIX D

CALCULATIONS FOR DETERMINING TOTAL COST OF COAL DELIVERED BY VESSEL

Equation (supplied by American Steamship Co., 1981)

$$Y = [2.00 + X/100(.43)] + Z$$

Where: Y = lake cargo freight rate;

X = miles travelled by water (statute);

Z = transshipping charge.

Delivered Lake Cargo Single Car Rates to Detroit

Origin	Transshipment Pt.	Calculation	Total/ton
Ohio #8	Sandusky	12.58 + [2.00 + 72/100(.43)] + 1.27	$16.15
E. Kentucky	Toledo	15.17 + [2.00 + 54/100(.43)] + 1.27	18.67
Pittsburgh	Sandusky	13.01 + [2.00 + 72/100(.43)] + 1.27	16.59
Montana	Superior	24.74 + [2.00 + 724/100(.43)] + 1.27	31.12

Delivered Lake Cargo Unit Train Rates to Detroit

Origin	Transshipment Pt.	Calculation	Total/ton
Ohio #8	Sandusky	6.27 + [2.00 + 72/100(.43)] + 1.27	$ 9.85
E. Kentucky	Toledo	12.70 + [2.00 + 54/100(.43)] + 1.27	16.20
Pittsburgh	Sandusky	8.46 + [2.00 + 72/100(.43)] + 1.27	12.03
Montana	Superior	13.32 + [2.00 + 724/100(.43)] + 1.27	19.70

$$Y = [2.00 + X/100(.43)] + Z$$

Delivered Lake Cargo Single Car Rates to Bay City (Essexville)

Origin	Transshipment Pt.	Calculation	Total/ton
Ohio #8	Sandusky	11.98 + [2.00 + 296/100(.43)] + 1.27	$16.52
E. Kentucky	Toledo	14.62 + [2.00 + 278/100(.43)] + 1.27	19.08
Pittsburgh	Sandusky	12.41 + [2.00 + 296/100(.43)] + 1.27	16.95
Montana	Superior	24.74 + [2.00 + 625/100(.43)] + 1.27	30.70

Delivered Lake Cargo Unit Train Rates to Bay City (Essexville)

Origin	Transshipment Pt.	Calculation	Total/ton
Ohio #8	Sandusky	6.27 + [2.00 + 296/100(.43)] + 1.27	$10.81
E. Kentucky	Toledo	9.51 + [2.00 + 278/100(.43)] + 1.27	13.97
Pittsburgh	Sandusky	8.07 + [2.00 + 296/100(.43)] + 1.27	12.61
Montana	Superior	13.32 + [2.00 + 625/100(.43)] + 1.27	19.28

Delivered Lake Cargo Single Car Rates to Muskegon

Origin	Transshipment Pt.	Calculation	Total/ton
Ohio #8	Sandusky	11.98 + [2.00 + 605/100(.43)] + 1.27	$17.85
E. Kentucky	Toledo	14.62 + [2.00 + 587/100(.43)] + 1.27	20.41
Pittsburgh	Sandusky	12.41 + [2.00 + 605/100(.43)] + 1.27	18.28
Montana	Superior	24.74 + [2.00 + 707/100(.43)] + 1.27	31.05

$$Y = [2.00 + X/100(.43)] + Z$$

Delivered Lake Cargo Single Unit Train Rates to Muskegon

Origin	Transshipment Pt.	Calculation	Total/ton
Ohio #8	Sandusky	6.27 + [2.00 + 605/100(.43)] + 1.27	$12.14
E. Kentucky	Toledo	9.51 + [2.00 + 587/100(.43)] + 1.27	15.30
Pittsburgh	Sandusky	8.07 + [2.00 + 605/100(.43)] + 1.27	13.94
Montana	Superior	13.32 + [2.00 + 707/100(.43)] + 1.27	19.63

Delivered Lake Cargo Single Car Rates to Marquette

Origin	Transshipment Pt.	Calculation	Total/ton
Ohio #8	Sandusky	11.98 + [2.00 + 563/100(.43)] + 1.27	$17.67
E. Kentucky	Toledo	14.62 + [2.00 + 545/100(.43)] + 1.27	20.23
Pittsburgh	Sandusky	12.41 + [2.00 + 563/100(.43)] + 1.27	18.10
Montana	Superior	24.74 + [2.00 + 260/100(.43)] + 1.27	29.13

Delivered Lake Cargo Unit Train Rates to Marquette*

Origin	Transshipment Pt.	Calculation	Total/ton
Ohio #8	Sandusky	6.27 + [2.00 + 563/100(.43)] + 1.27	$11.96
E. Kentucky	Toledo	9.51 + [2.00 + 545/100(.43)] + 1.27	15.12
Pittsburgh	Sandusky	8.07 + [2.00 + 563/100(.43)] + 1.27	13.76
Montana	Superior	13.32 + [2.00 + 260/100(.43)] + 1.27	17.71

*For calculating backhaul rate reduction, subtract $1/ton from delivered cost.

AIIM SCANNER TEST CHART # 2

Spectra
4 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
6 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
8 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
10 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789

Times Roman
4 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
6 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
8 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
10 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789

Century Schoolbook Bold
4 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
6 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
8 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
10 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789

News Gothic Bold Reversed
4 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
6 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
8 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
10 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789

Bodoni Italic
4 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
6 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
8 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789
10 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:",./?$0123456789

Greek and Math Symbols
4 PT ΑΒΓΔΕΞΘΗΙΚΛΜΝΟΠΦΡΣΤΥΩΧΨΖαβγδεξθηικλμνοπφρστυωχψζ≧∓",./≦±=≠°><⋫⋪⋗⋖≡
6 PT ΑΒΓΔΕΞΘΗΙΚΛΜΝΟΠΦΡΣΤΥΩΧΨΖαβγδεξθηικλμνοπφρστυωχψζ≧∓",./≦±=≠°><⋫⋪⋗⋖≡
8 PT ΑΒΓΔΕΞΘΗΙΚΛΜΝΟΠΦΡΣΤΥΩΧΨΖαβγδεξθηικλμνοπφρστυωχψζ≧∓",./≦±=≠°><⋫⋪⋗⋖≡
10 PT ΑΒΓΔΕΞΘΗΙΚΛΜΝΟΠΦΡΣΤΥΩΧΨΖαβγδεξθηικλμνοπφρστυωχψζ≧∓",./≦±=≠°><⋫⋪⋗⋖≡

White

Black

Isolated Characters

e	m	1	2	3	a
4	5	6	7	o	•
8	9	0	h	I	B

0123456
A4 Page 6543210

MESH HALFTONE WEDGES

65

85

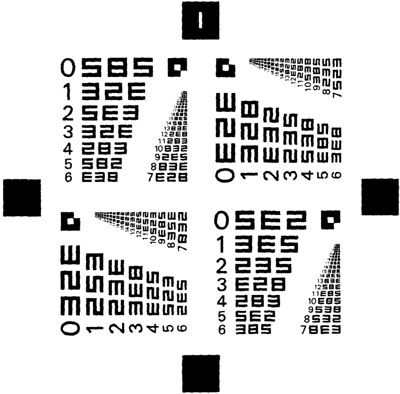
100

110

133

150

RIT ALPHANUMERIC RESOLUTION TEST OBJECT, RT-1-71



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