

KGS  
OF  
72-2

Preliminary Feasibility of Manufacturing Fuel  
for Electric Generating Stations  
from Kansas Cattle Feedlot Wastes

by

Linda A. Flueckinger, Head  
Industrial Minerals Division  
Kansas Geological Survey

Kay Q. Camin, Assoc. Prof.  
Department of Economics  
Wichita State University

-1972-

## TABLE OF CONTENTS

### INTRODUCTION

The Problem of Waste  
Energy Crisis

### ELECTRICAL POWER GENERATION AND POWER STATION FUELS USED IN KANSAS

### KANSAS SUPPLY OF CATTLE MANURE AND POTENTIAL FOR ELECTRICITY GENERATION

Introduction  
State Estimates  
Large Regions  
Fifty Mile Diameter Regions  
Twenty-Five Mile Diameter Regions

### RELATIONSHIP BETWEEN WASTE SUPPLY AND REGIONAL DEMAND FOR POWER

### VALUE OF THE PRODUCTS

### PIPELINE COSTS

### SUGGESTIONS FOR A FUTURE DETAILED FEASIBILITY STUDY

## INTRODUCTION

### The Problem of Waste

The magnitude of the organic solid waste problem is evident in the large amounts generated annually. In the United States there are approximately 3 billion tons<sup>1</sup> produced each year of which 2.5 billion tons is agricultural waste and 2 billion tons is manure.<sup>2</sup>

Kansas ranks fourth in production of cattle and calves and the Kansas portion of total cattle production is increasing (one explanation is that Kansas is part of the Milo Belt, and cattle production in the Milo Belt is increasing while cattle production in the Corn Belt is decreasing); and the demand for beef is increasing. Demand for beef is increasing because the per capita consumption of beef is increasing at the same time population is growing.<sup>3</sup> In short, Kansas is facing and will continue to face the problem of manure disposal.

One million cattle in Kansas feedlots would generate about 12.5 million tons of this manure back to the land at

---

<sup>1</sup>Knapp, E. C. Agricultural Poses Wastes Problems. Environmental Science and Technology, Vol. 4, December 1970, pp. 1098-1100.

<sup>2</sup>Vaughn, R. D. Solid Waste Management--Everybody's Problem. Environmental Science and Technology, Vol. 5, April 1971, p. 293.

<sup>3</sup>Kansas' Investment Opportunities or Where the Economic Action Is, Report 12, September 1969, Agricultural Experiment Station, Kansas State University, Manhattan, Kansas.

rates which provide maximum fertilizer effect and no detrimental nitrogen buildup in the soil. This solution to the animal waste disposal problem probably allows application rates of 20 tons per acre per year--resulting in a land requirement of some 600,000 acres. Economic restrictions on transportation of manure means other uses for manure are needed. The Bureau of Mines has developed a process to convert cattle manure to a low-sulfur oil potentially suitable for use in big power plants.

The purpose of this report is to examine manure production in Kansas from the perspective of potential conversion to fuel oil for use by power plants and also to evaluate the need for synthetic natural gas for similar purposes.

#### Energy Crisis<sup>4</sup>

The situation referred to as the energy crisis pertains more to natural gas than any other of our currently known energy sources.

The demand for natural gas in the United States has grown more rapidly than additions of new proved reserves resulting in a low figure of reserves to production of 15:1. Analysts believe that lack of sufficient exploration and development and projected demands will result in shortages of natural gas as early as the 1970's. The peak demand of 34.8 to 55.7 trillion cubic feet is expected to occur around the year 2000, after

---

<sup>4</sup>Discussion from 1970 Mineral Facts and Problems, U.S. Bureau of Mines, "Natural Gas", Arthur J. Warner, pp. 111-133 and yearly U. S. Bureau of Mines Yearbooks.

which a downturn is expected due to substitution of other fuels such as synthetic gas from coal, oil shale and petroleum liquids.

Utility suppliers and transporters of natural gas find the present exploration and development policies of gas production companies incompatible with their goals of sufficiently supplying future needs of current contract markets and of gaining new markets. Currently electric utilities consume approximately 16% of the total amount of natural gas produced in the United States for generating electric power. This percentage is expected to drop to 10% by the year 2000 due to increased use of nuclear energy. The actual demand for electricity generation in the near future will depend upon the balance achieved between lack of adequate supplies and higher costs of natural gas on the one hand and low natural gas costs relative to coal, fuel oil, deferred deliveries of nuclear energy plants, and the environmental problems they impose on the other.

Kansas ranks fifth in the U.S. with 14.51 trillion cubic feet of natural gas reserves, 5.1% of the United States proved reserves. Natural gas production in Kansas in 1970, 904,467 million cubic feet, represents 4.1% of the total United States production of 21,921,000 million cubic feet. Intrastate consumption consumed 68.3% of Kansas production, interstate shipments 29.9%, storage .6% and transmission losses 1.15%. Kansas production has generally increased annually over the preceding year as shown in the following table:

1967 -	+2.9%
1968 -	-4.2%
1969 -	+5.7%
1970 -	+1.9%

ELECTRICAL POWER GENERATION AND POWER STATION FUELS USED IN  
KANSAS

94% of the fuel used to generate electricity in Kansas in 1969 was natural gas, 5% was coal and remaining 1% oil.<sup>5</sup> Coal burning stations are confined to relatively large stations in the eastern part of the state. Nearly all stations have capabilities of readily changing the fuel type used with changes in supply. This is especially true of natural gas burning units since most receive gas on an interruptible basis. When existing supplies are low, they are shunted to residences and the plants convert to fuel oil for generation.

Kansas is served by seven investor-owned companies, 124 municipal systems and 36 rural cooperatives.<sup>6</sup> Municipal systems generated approximately 17% (2,610,070,946 KWH) of the electricity generated in Kansas in 1970. 56.92% of this was

---

<sup>5</sup>Nielsen, George F., (Ed.) 1971 Keystone Coal Industry Manual, McGraw-Hill, Inc., p. 295.

<sup>6</sup>State of Kansas, Department of Economic Development, Kansas Resources For Industry,

generated in Kansas City, Kansas (1,124,379,386 KWH). The remainder is generated around the state by small local systems with net generation generally much less than 20 million KWH. A summary of these plants is given in Table 1. The location of generating stations with capacities greater than 5 MW are shown in Figure 1.

Approximately 92% of Kansas generation is produced by seven investor-owned companies, an electric cooperative and the previously mentioned Kansas City, Kansas municipal system. These companies, their domains and net generation for 1970 are shown in Figure 2. The generation statistics including plant heat rate (BTU/KWH) are shown in Table 2. The data from Table 2 is summarized in the following Table.

District	No. of Plant	Net Generation % of Total	Oil Used (Bbl)	Gas Used (MCF)
1	1	9.58	0	*
2	4	28.10	177,207	41,213,274
3	6	40.27	54,830	59,101,537,000
4	1	6.33	22,087	*
5	3	10.02	45,642	*
6	5	2.58	37,210	*
7	6	3.08	9,412	287,184,000*
8	1(?)	0	0	0

\* Data incomplete

Table 1

# Municipally Owned Generating Report for the Year

Part I

City	1970 Production		1970 Sales		1970 Revenue		1970 Expenses		1970 Net		1970 Assets		1970 Liabilities	
	Units	Value	Units	Value	Units	Value	Units	Value	Units	Value	Units	Value	Units	Value
Kansas City	184,713	61,394	184,713	61,394	184,713	61,394	184,713	61,394	184,713	61,394	184,713	61,394	184,713	61,394
Coffeyville	15,118	4,765	15,118	4,765	15,118	4,765	15,118	4,765	15,118	4,765	15,118	4,765	15,118	4,765
Geneseo	16,790	5,100	16,790	5,100	16,790	5,100	16,790	5,100	16,790	5,100	16,790	5,100	16,790	5,100
Winfield	11,403	4,510	11,403	4,510	11,403	4,510	11,403	4,510	11,403	4,510	11,403	4,510	11,403	4,510
Osage	11,016	4,487	11,016	4,487	11,016	4,487	11,016	4,487	11,016	4,487	11,016	4,487	11,016	4,487
McPherson	10,831	4,100	10,831	4,100	10,831	4,100	10,831	4,100	10,831	4,100	10,831	4,100	10,831	4,100
Cheney	10,341	3,730	10,341	3,730	10,341	3,730	10,341	3,730	10,341	3,730	10,341	3,730	10,341	3,730
Wellington	8,012	3,352	8,012	3,352	8,012	3,352	8,012	3,352	8,012	3,352	8,012	3,352	8,012	3,352
Pratt	6,736	3,291	6,736	3,291	6,736	3,291	6,736	3,291	6,736	3,291	6,736	3,291	6,736	3,291
Independence	6,493	2,874	6,493	2,874	6,493	2,874	6,493	2,874	6,493	2,874	6,493	2,874	6,493	2,874
Augusta	5,977	2,890	5,977	2,890	5,977	2,890	5,977	2,890	5,977	2,890	5,977	2,890	5,977	2,890
Goodland	5,711	2,267	5,711	2,267	5,711	2,267	5,711	2,267	5,711	2,267	5,711	2,267	5,711	2,267
Russell	4,711	2,150	4,711	2,150	4,711	2,150	4,711	2,150	4,711	2,150	4,711	2,150	4,711	2,150
Clay Center	4,163	2,123	4,163	2,123	4,163	2,123	4,163	2,123	4,163	2,123	4,163	2,123	4,163	2,123
Colony	4,638	1,895	4,638	1,895	4,638	1,895	4,638	1,895	4,638	1,895	4,638	1,895	4,638	1,895
Larned	4,567	2,194	4,567	2,194	4,567	2,194	4,567	2,194	4,567	2,194	4,567	2,194	4,567	2,194
Osawatomie	4,294	1,981	4,294	1,981	4,294	1,981	4,294	1,981	4,294	1,981	4,294	1,981	4,294	1,981
Belleville	4,121	1,916	4,121	1,916	4,121	1,916	4,121	1,916	4,121	1,916	4,121	1,916	4,121	1,916
Wellington	3,710	2,013	3,710	2,013	3,710	2,013	3,710	2,013	3,710	2,013	3,710	2,013	3,710	2,013
Barton	3,617	1,549	3,617	1,549	3,617	1,549	3,617	1,549	3,617	1,549	3,617	1,549	3,617	1,549
Kingman	3,422	1,604	3,422	1,604	3,422	1,604	3,422	1,604	3,422	1,604	3,422	1,604	3,422	1,604
Wichita	3,293	1,604	3,293	1,604	3,293	1,604	3,293	1,604	3,293	1,604	3,293	1,604	3,293	1,604
Waukegan	3,185	1,106	3,185	1,106	3,185	1,106	3,185	1,106	3,185	1,106	3,185	1,106	3,185	1,106
Carroll	3,189	Report not received	3,189	Report not received	3,189	Report not received	3,189	Report not received	3,189	Report not received	3,189	Report not received	3,189	Report not received
Wellington	3,163	Report not received	3,163	Report not received	3,163	Report not received	3,163	Report not received	3,163	Report not received	3,163	Report not received	3,163	Report not received
Frederick	3,080	1,478	3,080	1,478	3,080	1,478	3,080	1,478	3,080	1,478	3,080	1,478	3,080	1,478
McDonnell	3,063	1,428	3,063	1,428	3,063	1,428	3,063	1,428	3,063	1,428	3,063	1,428	3,063	1,428
Belleville	3,043	1,200	3,043	1,200	3,043	1,200	3,043	1,200	3,043	1,200	3,043	1,200	3,043	1,200
Lindsborg	2,766	1,016	2,766	1,016	2,766	1,016	2,766	1,016	2,766	1,016	2,766	1,016	2,766	1,016
Wageningen	2,739	1,136	2,739	1,136	2,739	1,136	2,739	1,136	2,739	1,136	2,739	1,136	2,739	1,136
Hillsboro	2,730	1,119	2,730	1,119	2,730	1,119	2,730	1,119	2,730	1,119	2,730	1,119	2,730	1,119
Anthony	2,633	1,434	2,633	1,434	2,633	1,434	2,633	1,434	2,633	1,434	2,633	1,434	2,633	1,434
Osage City	2,600	1,290	2,600	1,290	2,600	1,290	2,600	1,290	2,600	1,290	2,600	1,290	2,600	1,290
Glenn	2,591	1,114	2,591	1,114	2,591	1,114	2,591	1,114	2,591	1,114	2,591	1,114	2,591	1,114
Walden	2,520	Report not received	2,520	Report not received	2,520	Report not received	2,520	Report not received	2,520	Report not received	2,520	Report not received	2,520	Report not received
Wesport	2,307	1,084	2,307	1,084	2,307	1,084	2,307	1,084	2,307	1,084	2,307	1,084	2,307	1,084
Ellinwood	2,216	990	2,216	990	2,216	990	2,216	990	2,216	990	2,216	990	2,216	990
Lawrence	2,216	1,042	2,216	1,042	2,216	1,042	2,216	1,042	2,216	1,042	2,216	1,042	2,216	1,042
Stirling	2,211	939	2,211	939	2,211	939	2,211	939	2,211	939	2,211	939	2,211	939
Overland	2,291	Report not received	2,291	Report not received	2,291	Report not received	2,291	Report not received	2,291	Report not received	2,291	Report not received	2,291	Report not received
Osage	2,200	950	2,200	950	2,200	950	2,200	950	2,200	950	2,200	950	2,200	950
Seneca	2,182	951	2,182	951	2,182	951	2,182	951	2,182	951	2,182	951	2,182	951
Horton	2,177	1,085	2,177	1,085	2,177	1,085	2,177	1,085	2,177	1,085	2,177	1,085	2,177	1,085
Ellis	2,137	839	2,137	839	2,137	839	2,137	839	2,137	839	2,137	839	2,137	839
Wellington	2,099	970	2,099	970	2,099	970	2,099	970	2,099	970	2,099	970	2,099	970
Lucas	2,011	769	2,011	769	2,011	769	2,011	769	2,011	769	2,011	769	2,011	769
Hill City	2,011	840	2,011	840	2,011	840	2,011	840	2,011	840	2,011	840	2,011	840
Merick	2,012	998	2,012	998	2,012	998	2,012	998	2,012	998	2,012	998	2,012	998
Osborne	1,980	978	1,980	978	1,980	978	1,980	978	1,980	978	1,980	978	1,980	978
Minneapolis	1,911	909	1,911	909	1,911	909	1,911	909	1,911	909	1,911	909	1,911	909
Greenwood	1,907	930	1,907	930	1,907	930	1,907	930	1,907	930	1,907	930	1,907	930
Wesport	1,899	801	1,899	801	1,899	801	1,899	801	1,899	801	1,899	801	1,899	801
Wesport	1,839	675	1,839	675	1,839	675	1,839	675	1,839	675	1,839	675	1,839	675
Geneseo	1,839	734	1,839	734	1,839	734	1,839	734	1,839	734	1,839	734	1,839	734
Stockton	1,810	943	1,810	943	1,810	943	1,810	943	1,810	943	1,810	943	1,810	943
St. Francis	1,723	900	1,723	900	1,723	900	1,723	900	1,723	900	1,723	900	1,723	900
Chapone	1,729	898	1,729	898	1,729	898	1,729	898	1,729	898	1,729	898	1,729	898
Wellington	1,704	841	1,704	841	1,704	841	1,704	841	1,704	841	1,704	841	1,704	841
Lawrence	1,703	777	1,703	777	1,703	777	1,703	777	1,703	777	1,703	777	1,703	777
Lincoln Center	1,683	998	1,683	998	1,683	998	1,683	998	1,683	998	1,683	998	1,683	998
Lathrop	1,570	630	1,570	630	1,570	630	1,570	630	1,570	630	1,570	630	1,570	630
Dighton	1,560	700	1,560	700	1,560	700	1,560	700	1,560	700	1,560	700	1,560	700
St. Joseph	1,547	807	1,547	807	1,547	807	1,547	807	1,547	807	1,547	807	1,547	807
St. Marys	1,536	882	1,536	882	1,536	882	1,536	882	1,536	882	1,536	882	1,536	882

Part II

# Plants & Distribution Systems Ending December 31, 1970

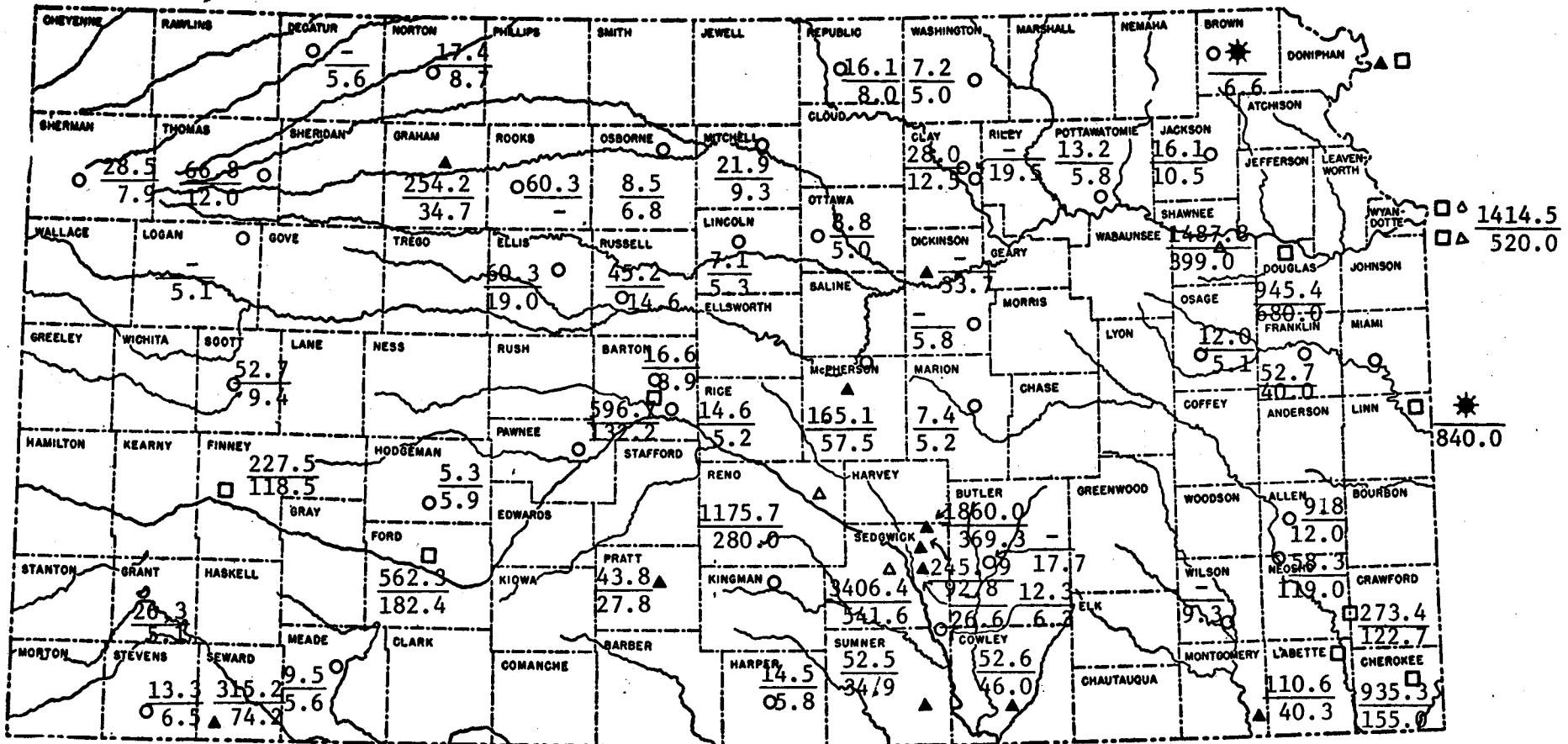
City	Expenditures		Cash Balances		Debt		Assets		Liabilities	
	Capital	Operating	Operating	Debt	Operating	Debt	Operating	Debt	Operating	Debt
Kansas City	84,341,478	83,557,078	870,140	1,985,188	48,512	101,000	951,413	242,390	1,194,263	297,128
Coffeyville	306,633	297,128	225,000	1,111,367	3,527	75,000	1,123,401	673,240	1,800,841	183,184
Geneseo	197,497	183,483	---	---	---	---	---	---	---	---
Winfield	136,944	183,768	244,911	1,383,007	30,632	---	1,413,639	1,872,182	2,500,070	302,463
Osage	106,759	216,000	197,919	1,087,184	87,839	216,000	193,393	513,161	705,354	255,649
McPherson	170,000	399,000	300,000	1,840,149	180,950	132,613	67,338	1,021,633	1,221,608	399,049
Cheney	27,575	121,630	361,261	1,734,943	26,277	30,000	140,000	200,000	110,000	688,000
Wellington	483,437	191,000	171,800	1,409,307	391,749	---	---	489,006	489,006	---
Pratt	80,812	131,882	100,000	801,363	30,632	144,000				

Table 1 continued

Part II

City	Customers			Total Meters Installed	System Paid Lead	Month of Peak Load	Total MWh Generated	Total MWh Purchased	Revenue		Expenditures		City	Expenditures Continued			Revenue from Sale of Excess Energy	Cash Balances			Bonds Debt			Estimated Value of Plant and System	
	July	August	September						Charges	Other Income	Capital Improvements	Other Expenditures		Other Expenditures	Other Expenditures	Other Expenditures		Other Expenditures	Other Expenditures	Other Expenditures	Other Expenditures	Other Expenditures	Other Expenditures		Other Expenditures
Abilene	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	none	3,063,600	E	136,723	17,372	153,497	none	120,060	none	none	123,362	15,717	137,717	33,217	none	131,000	none	330,000
Adrian	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	239,200	3,200,000	E	178,112	6,190	184,332	1,308	138,428	none	none	32,000	32,000	none	none	none	none	290,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	2,227,200	3,200,000	E	133,000	2,430	135,430	47,000	35,000	none	none	11,303	11,303	none	none	none	none	200,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	4,347,600	3,200,000	E	85,500	none	85,500	37,900	40,600	none	none	44,318	44,318	none	none	none	none	200,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,750,000	3,200,000	E	5,076,723	4,420	145,311	76,449	42,701	none	none	none	none	none	none	none	none	200,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,393,200	3,200,000	E	2,054,385	E/W	68,482	28,348	none	none	none	4,800	4,800	3,200	3,047	none	31,000	none	130,000
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	5,473,000	3,200,000	E	4,688,000	E	111,612	1,569	113,701	36,228	31,448	19,497	19,497	none	none	none	none	731,384	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	none	4,917,467	E	161,281	1,981	163,262	none	92,994	none	none	104,392	104,392	21,208	none	123,000	none	130,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,703,200	3,665,200	E	90,207	2,911	93,118	40,086	21,963	none	none	none	31,414	none	none	none	none	70,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	4,440,000	3,640,072	E	95,233	22,233	117,466	39,416	83,050	none	none	12,121	12,121	none	none	none	none	210,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,972,000	3,084,000	E/W	123,324	8,932	132,256	none	83,840	none	none	20,382	20,382	none	none	230,000	none	330,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,900,915	3,900,915	E	126,178	19,283	145,361	none	61,333	none	none	100,000	100,000	28,818	none	94,000	none	419,194	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,590,857	3,590,857	E/W	120,393	none	120,632	none	67,783	none	none	7,000	7,000	28,818	none	248,000	none	100,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,278,644	3,278,644	E	111,794	1,760	113,034	none	76,732	none	none	11,650	11,650	39,824	51,474	20,632	none	228,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	4,519,632	4,519,632	E/W	128,137	24,790	152,927	none	96,231	none	none	48,422	48,422	24,161	none	240,000	none	610,830	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,637,319	3,637,319	E	81,324	710	82,034	40,599	17,602	none	none	3,730	3,730	17,117	18,000	none	none	735,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,014,798	3,014,798	E	76,945	27	77,072	none	65,322	none	none	18,984	18,984	30,444	none	none	none	675,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	31,128	31,128	E/W	31,128	31,128	62,256	none	31,128	none	none	12,900	12,900	30,444	none	none	none	100,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,246,000	3,246,000	E	84,500	none	84,500	34,824	23,032	none	none	18,024	18,024	none	none	none	none	100,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,350,018	3,350,018	E	79,926	35,043	114,969	15,139	73,000	none	none	23,000	23,000	48,678	none	none	none	73,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,431,000	3,431,000	E	71,878	1,441	73,319	35,913	11,445	none	none	61,604	61,604	30,984	31,873	none	413,000	29,424	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	81,932	81,932	E/W	81,932	2,851	84,783	none	67,800	none	none	none	none	none	none	none	none	none	40,000
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	30,500	30,500	none	30,500	24,000	54,500	24,000	7,000	none	none	none	none	none	none	none	none	40,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,287,200	3,287,200	E/W	46,413	640	47,053	none	35,640	none	none	8,400	8,400	3,360	6,018	11,999	8,223	none	70,000
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,470,600	1,470,600	E	1,170,721	1,123	37,083	13,608	18,431	none	none	7,200	7,200	39,439	-2,356	none	17,764	none	none
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,642,000	3,642,000	E	63,144	none	63,144	36,100	19,936	none	none	61,436	61,436	7,708	none	16,383	none	100,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,084,000	3,084,000	E	63,909	184	64,053	27,590	19,760	none	none	6,000	6,000	7,737	none	12,223	none	60,000	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,420,000	1,420,000	E	35,112	none	35,112	13,370	7,393	none	none	3,500	3,500	609	none	11,800	none	none	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	43,289	43,289	E	43,289	none	43,289	15,814	21,088	none	none	10,272	10,272	839	4,833	-4,544	none	none	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,941,307	1,941,307	E/W	19,413	none	19,413	25,628	45,808	none	none	2,000	2,000	73,434	none	20,000	none	none	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,740,300	1,740,300	E	1,548,867	none	1,548,867	19,718	19,718	none	none	41,323	41,323	3,720	none	36,000	16,313	24,213	
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	3,114,800	3,114,800	E	47,003	1,044	48,047	33,631	19,203	none	none	1,000	1,000	-1,431	none	16,028	16,028	none	84,500
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	915,600	915,600	E	712,102	1,802	30,447	8,461	19,203	none	none	none	none	none	none	none	none	none	none
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,244,200	1,244,200	E	32,933	1,984	34,939	15,103	13,103	none	none	3,633	3,633	32,688	2,240	none	21,781	21,781	none
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,464,800	1,464,800	E	40,509	none	40,509	15,829	19,884	none	none	4,514	4,514	10,730	8,883	none	17,340	17,340	none
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,780,900	1,780,900	E/W	63,782	none	63,782	23,305	27,032	none	none	Report not received	Report not received	Report not received	Report not received	Report not received	Report not received	Report not received	Report not received
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,044,633	1,044,633	E	28,731	none	28,731	11,449	10,137	none	none	10,000	10,000	31,426	-3,493	none	none	none	63,000
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	8,942,000	8,942,000	E	24,146	6,332	30,478	8,749	none	none	none	none	1,500	1,778	none	1,778	none	none	none
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,033,308	1,033,308	E	23,884	2,854	26,738	12,504	11,936	none	none	none	none	6,400	none	18,000	10,000	none	none
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	26,000	26,000	E	26,000	4,880	30,920	10,100	2,490	none	none	none	none	none	none	943	943	none	none
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	1,217,900	1,044,993	E	35,638	none	35,638	21,338	16,900	none	none	none	none	none	none	none	none	none	none
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	340,600	340,600	E	15,169	none	15,169	5,887	4,800	none	none	Report not received	Report not received	Report not received	Report not received	Report not received	Report not received	Report not received	Report not received
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	371,300	371,300	E	14,551	none	14,551	6,740	6,031	none	none	Report not received	Report not received	Report not received	Report not received	Report not received	Report not received	Report not received	Report not received
Albany	1,416	673	13	690	3,721	2,000	July/Aug. 4,131,600	480,111	480,111	E	19,000	none	19,000	8,406	1,371	none	none	Report not received	Report not received</						

Figure 1: Location of Kansas Electrical Generation Plants with Capacities > 5 Megawatts\*(1970)



State Geological Survey of Kansas

- ▲ 250 - 999.9
- ◻ 100 - 249.9
- ▲ 25 - 99.9
- 5 - 24.9
- ★ Station Planned

Megawatts

○ 1970 net generation in million KWH  
capacity in megawatts

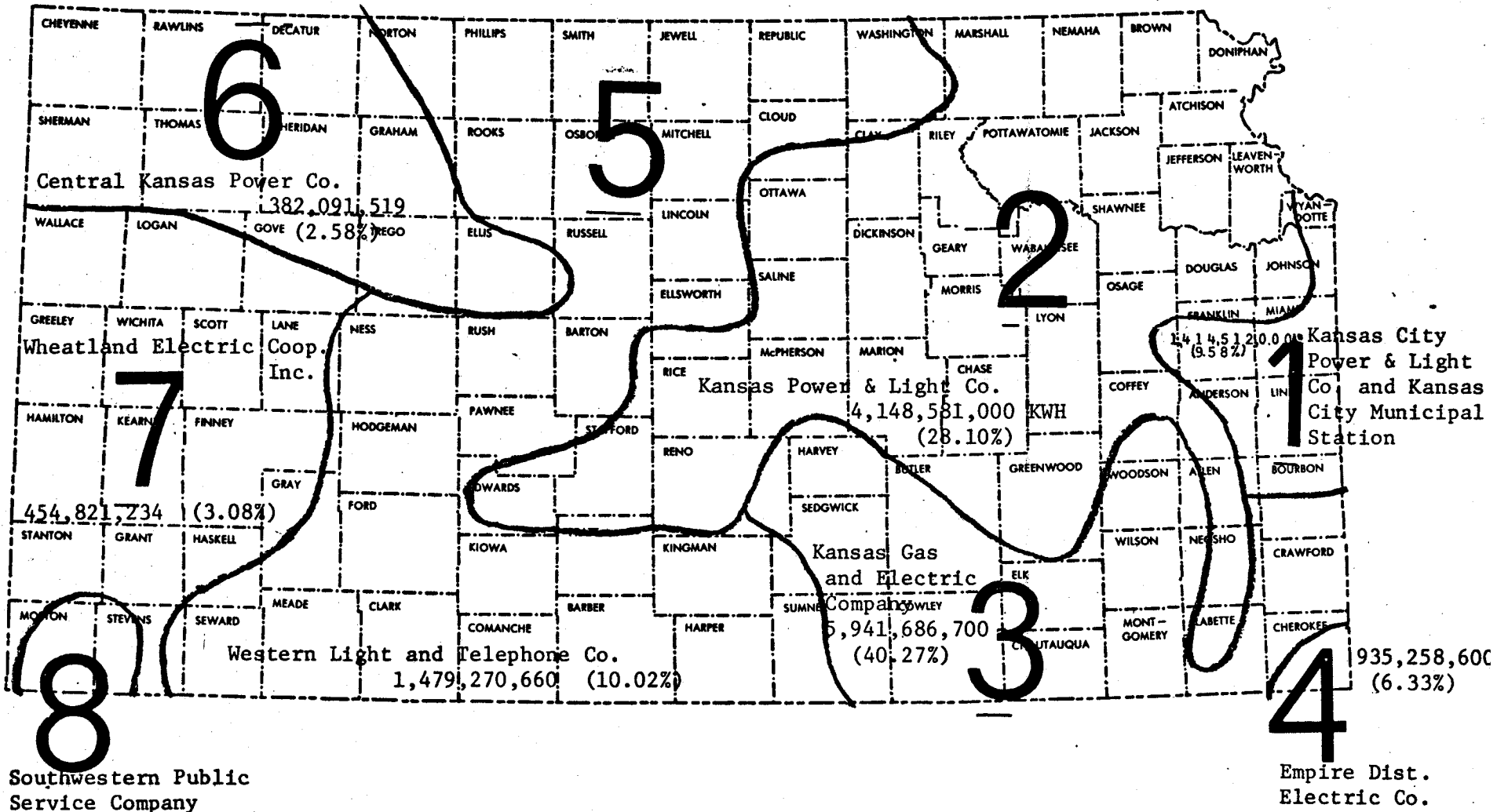
per capita consumption: 4000 - 4900 KWH

total consumption: 5.0 - 14.9 billion KWH

\*Kansas Government Journal, May, 1971. 1971 Keystone Coal Buyers Guide, pp. 318-320.

Electric Power Supply of the State of Kansas, State Corporation Commission, Utilities Div. (1970).

Figure 2: State of Kansas Power Systems with Net Generation in 1970\*



\*State of Kansas, Department of Economic Development, Kansas Resources for Industry.

Table 2: Generation Statistics for Kansas Public and Privately Owned Power Systems

	<u>Plant</u>	<u>Location</u>	<u>Net Generation 1970 in KWH</u>	<u>Plant Heat Rate BTU/net KWH</u>	<u>Type of Plant</u>	<u>Oil and Gas Consummed</u>	
						<u>Oil (bbl)</u>	<u>Gas (MCF)</u>
District 1	Municipal	K.C., Ks.	1,414,512,000*	--	C <sup>+</sup>	0	✓
District 2	Tecumseh	Shawnee Co.	1,487,768,000	11,314	C,O,G	5,411.5	16,656,439
	Lawrence	Douglas Co.	945,387,750	11,054	C,O,G	35,097.0	9,643,874
	Hutchinson	Reno Co.	1,175,667,200	10,925	O,G	117,257.0	14,068,885
	Abilene	Dickinson Co.	33,750(capc)	14,220	O,G	19,442.1	844,076
Subtotal			4,148,581,000	11,117 <sup>x</sup>		177,207.6	41,213,274
District 3		Chatauqua Co.	3,867,700		G,O	2,087	✓
	Gordon Evans	Maize	3,406,421,200	9,810	G,O	17,151	33,589,720,000
	Murry Gill	Wichita	1,860,001,500	10,707	G,O	11,975	19,127,679,000
	Ripley	Wichita	245,923,100	13,678	G,O	11,624	3,162,780,000
	Neosho	Parsons	273,353,200	12,047	C,G,O	11,869	3,126,808,000
	Wichita <sup>†</sup>	Wichita	178,700	--	--	124	27,180,000
Subtotal			5,944,686,700	10,366 <sup>x</sup>		54,830.0	59,101,537,000

\* Purchase less than 1 x 10<sup>6</sup> KWH from K.C., Mo. in emergency situations

† Cold Standby Station

✓ Information incomplete

+ Coal, Oil, Gas

x Weighted Average

Table 2 continued

	<u>Plant</u>	<u>Location</u>	<u>Net Generation 1970 in KWH</u>	<u>Plant Heat Rate BTU/net KWH</u>	<u>Type of Plant</u>	<u>Oil and Gas Consummed</u>	
						<u>Oil (bbl)</u>	<u>Gas (MCF)</u>
District 4	Riverton	Galena	935,258,600	C 11,237 O 12,836 G 18,504	C,O,GG	22,087.57	✓
District 5	Judson Large	Dodge City	562,329,300	11,308	G,O	27,303	✓
	A. Mullergren	Great Bend	596,717,700	10,978	G,O	19,339	✓
	Cimarron River	Liberal	<u>315,202,100</u>	<u>12,521</u>	G	<u>0</u>	✓
Subtotal			1,479,270,660	11,393 <sup>x</sup>		45,642	
District 6		Colby(gas turbine)	7,597,264	16,812	O,G	1,965	✓
		Colby(steam)	59,254,100	16,697	O,G		✓
		Hays	60,341,654	16,811	O,G	4,226	✓
	Ross Beach 1		81,248,000	13,483	O,G	13,853	✓
	Ross Beach 2		<u>172,990,500</u>	<u>12,795</u>	O,G	<u>17,166</u>	✓
Subtotal			382,091,519	14,234 <sup>x</sup>		37,210	

Table 2 continued

	<u>Plant</u>	<u>Location</u>	<u>Net Generation 1970 in KWH</u>	<u>Plant Heat Rate BTU/net KWH</u>	<u>Type of Plant</u>	<u>Oil and Gas Consummed</u>	
						<u>Oil (bbl)</u>	<u>Gas (MCF)</u>
District 7		Stevens Co.	26,329,000	--		3,156	287,184,000
	Jess Taylor	Scott City	52,662,300	--		5,651	✓
	Scott City	Scott Co.	28,520	--		12	✓
	Leoti	Wichita Co.	12,650	--		?	✓
	Syracuse	Hamilton Co.	95,896	--		53	✓
	Garden City	Finney Col	<u>227,502,000</u>	--		<u>540</u>	✓
Subtotal			454,821,234			9,412	
District 8			approx. 0	Electricity purchased from Colo. except for standby basis		approx. 0	
Total			14,759,221,713	10,870 <sup>x</sup>		346,265.17	✓

KANSAS SUPPLY OF CATTLE MANURE AND POTENTIAL FOR ELECTRICITY  
GENERATION

Introduction

Manure production data are based upon estimates of cattle in cattle feedlots whose capacity exceeds 300 animals. All feedlots with a capacity of 300 or more are required to register with the Kansas Animal Health Department. The September 1, 1971 list of registered feedlots and their capacities are the basis of all manure production estimates. It is specifically assumed that feedlots are filled to capacity 365 days per year. The difference between average number of animals in a feedlot and its capacity may greatly affect specific production estimates in a region but without further data from each feedlot with respect to average number of animals, capacity, and projected growth, feedlot capacity will be used as the basis of estimating manure production.

It is assumed that each animal excretes 65 lbs. of manure per day which is 85% water. Bureau of Mines data estimates that one dry ton of manure will yield two barrels of fuel oil. One barrel of fuel oil is used up in the process of converting manure to fuel oil; therefore, one-ton of dry manure is assumed to yield one net barrel of fuel oil.

For calculation of KWH/bbl (potential for fuel generation) that state average heat rate of 10,870 BTU/KWH has been used.

### State Estimates

The location and size class of the feedlots whose capacity is 300 or more are shown in Figure 3.

### Large Regions

Geographic clusters of feedlots were arbitrarily chosen. These clusters and their animal capacities are shown in Figure 4 and Table 3.

The number of animals, manure produced (on wet and dry basis), the fuel oil produced, and the potential kilowatt hours (KWH) of electricity generated are shown in Table 3 for each of the regions and for the state.

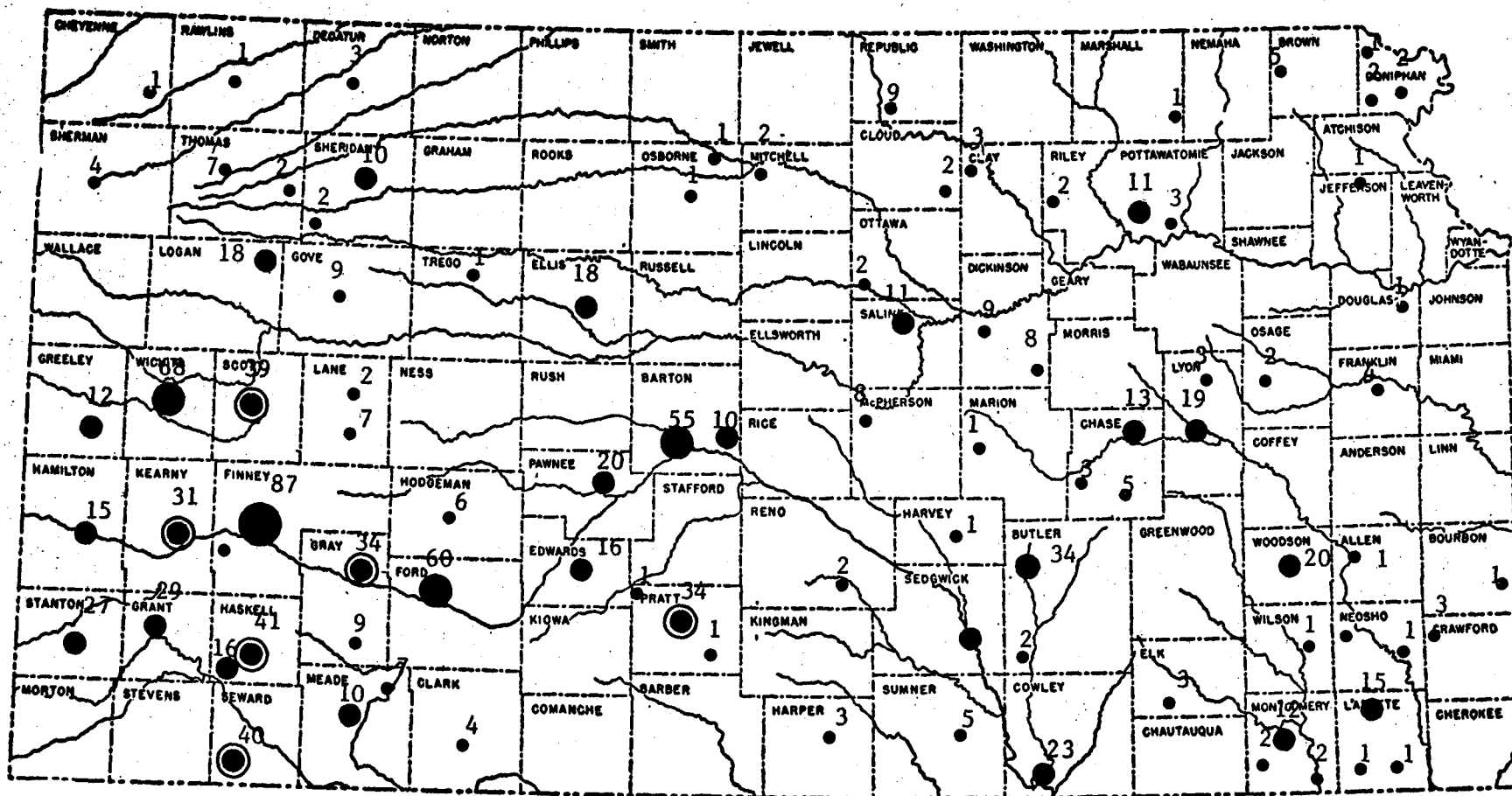
### Fifty Mile Diameter Regions

Smaller regions are designated in Figure 5. For each of these regions estimates were made of manure production, fuel oil, and potential electricity generated. See Table 4.

### Twenty-Five Mile Diameter Regions

Smaller regions are designated in Figure 6. For each of these regions estimates were made of manure production, fuel oil, and potential electricity generated. See Table 5.

Figure 3: Feedlot Capacity\*  
in Thousands of Animals, September 1971

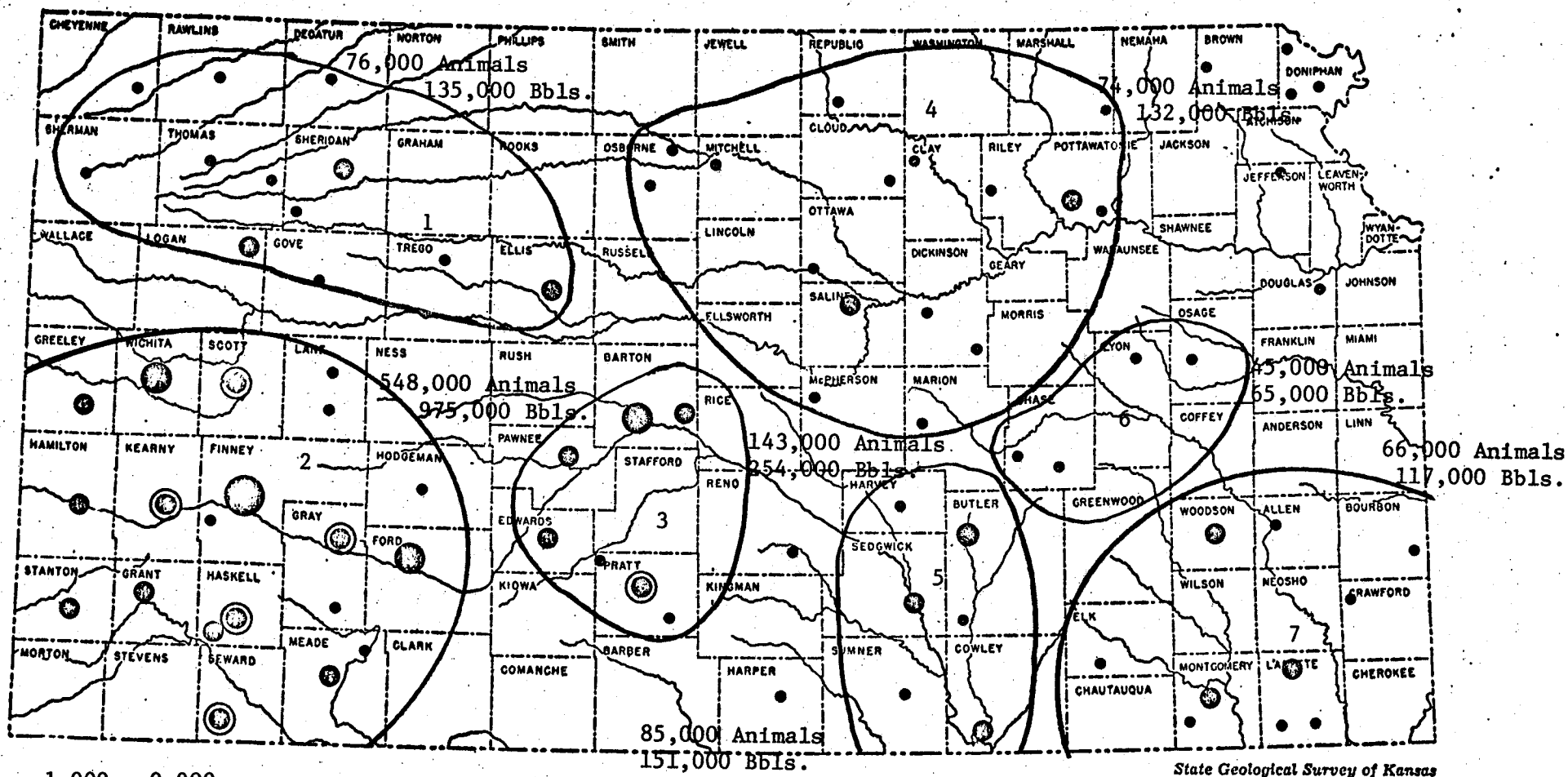


State Geological Survey of Kansas

- 1,000 - 9,000
- 10,000 - 29,000
- 30,000 - 49,000
- ⊙ 50,000 - 69,000
- 70,000+

\*Kansas Animal Health Department, Animal Health Division, State Office Bldg., Topeka, Ks. 66612

Figure 4: Feedlot Capacity for Large Regions\*  
in Thousands of Animals, September 1971



- 1,000 - 9,000
- 10,000 - 29,000
- 30,000 - 49,000
- 50,000 - 59,000
- 70,000+

\*Kansas Animal Health Department, Animal Health Division, State Office Bldg., Topeka, Ks. 66612

TABLE 3

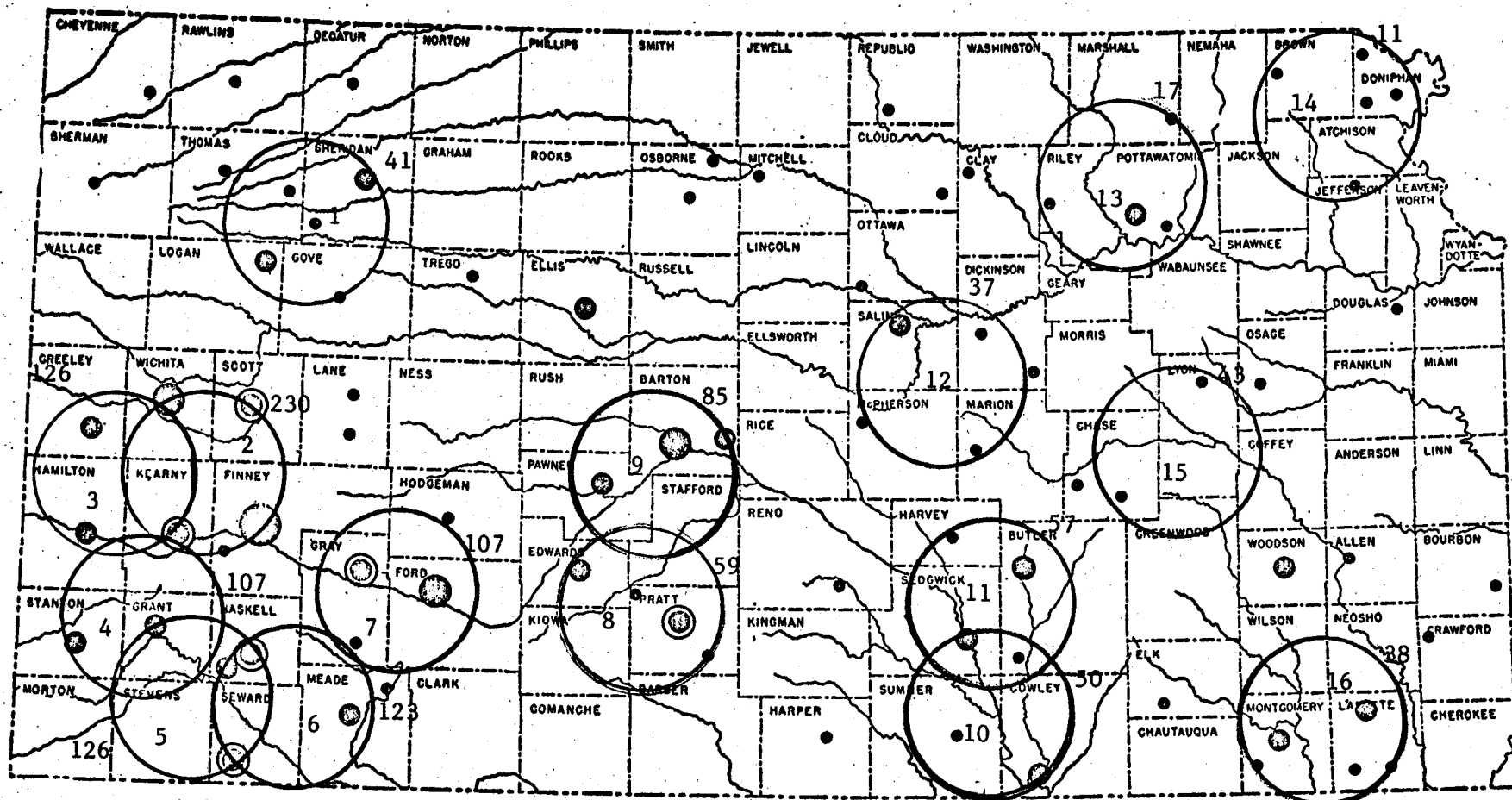
ANNUAL KANSAS CATTLE MANURE PRODUCTION AND TRANSPORTATION  
ESTIMATED FUEL OIL YIELDS AND POTENTIAL ELECTRIC POWER GENERATION BY SELECTED AREAS, 1971

Region	Cattle Feedlot Capacity	Annual Raw Manure Production	Annual Manure Production	Net Production of Fuel Oil	Potential Electric Power Generation
	Thousands of Animals	Thousands of Tons*	Thousands of Dry Tons**	Thousands of Barrels	Thousands of Kilowatt Hours
1	76	901	135	135	49,815
2	548	6,500	975	975	470,925
3	143	1,696	254	254	122,682
4	74	877	132	132	57,816
5	85	1,008	151	151	66,138
6	45	433	65	65	31,395
7	66	782	117	117	56,511
Kansas	1,058	12,505	1,875	1,875	825,625

\* Assumed to be 65 lbs/animal/day containing 85% water.

\*\*Assumed to be 15% of 65 lbs/animal/day or 9.75 lbs/animal/day.

Figure 5: Feedlot Capacity for Selected 50 Mile Diameter Areas\*  
in Thousands of Animals, September 1971

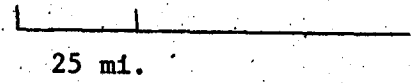


State Geological Survey of Kansas

- 1,000 - 9,000
- 10,000 - 29,000
- 30,000 - 49,000
- 50,000 - 69,000
- 70,000+

Mean Size: 79,000 Animals  
Radius of Circle: 25 miles

38 - Thousands of Animals  
1 - No. of Region



\*Kansas Animal Health Department, Animal Health Division, State Office Bldg., Topeka, Ks. 66612

TABLE 4

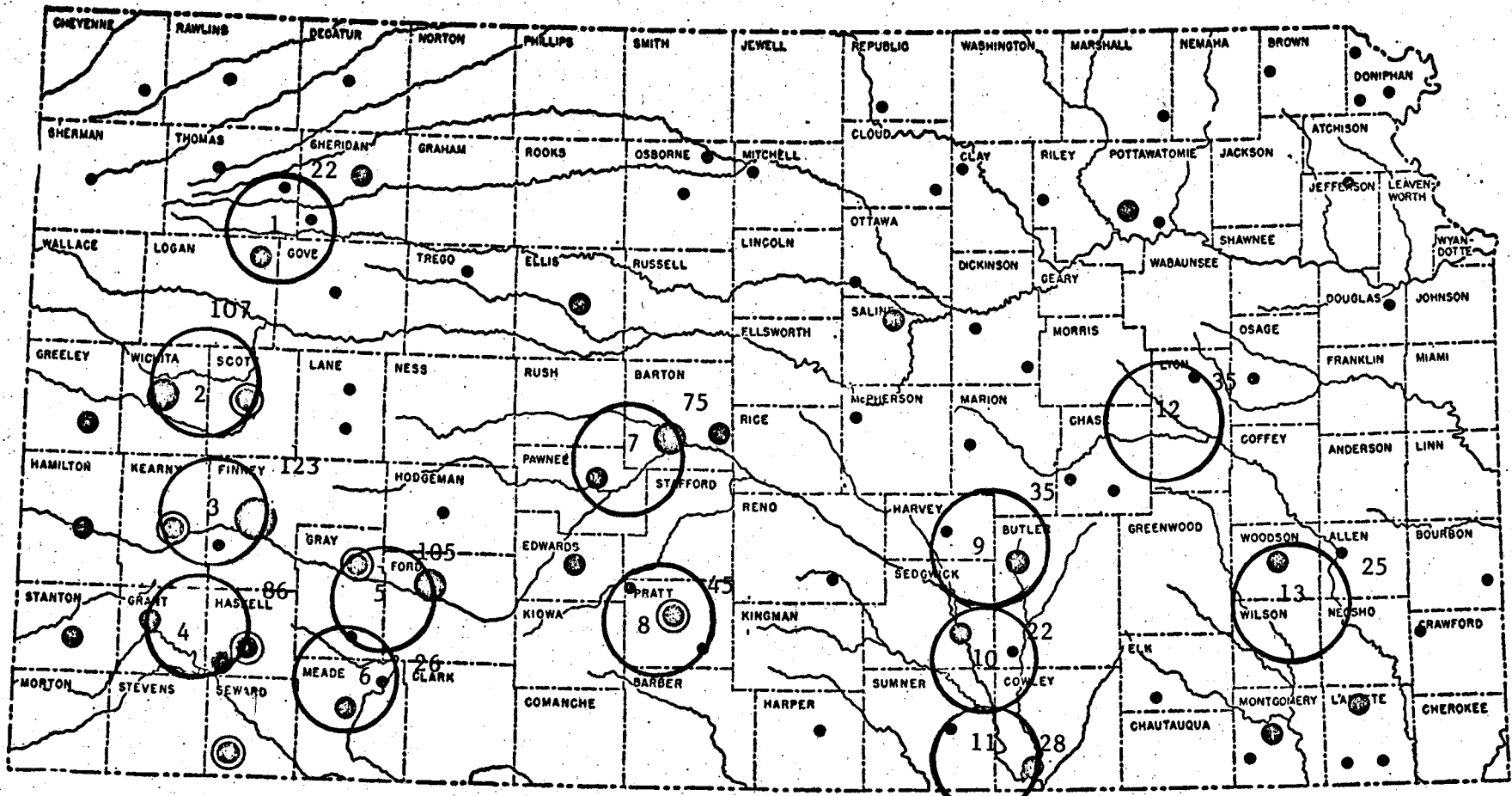
ANNUAL KANSAS CATTLE MANURE PRODUCTION AND TRANSPORTATION  
ESTIMATED FUEL OIL YIELDS AND POTENTIAL ELECTRIC POWER GENERATION BY SELECTED AREAS, 1971

Region diameter of which is 50 miles	Cattle Feedlot Capacity	Annual Raw Manure Production	Annual Manure Production	Net Production of Fuel Oil	Potential Electric Power Generation
	Thousands of Animals	Thousands of Tons*	Thousands of Dry Tons**	Thousands of Barrels	Thousands of Kilowatt Hours
1	41	486	73	73	30,937
2	230	593	89	89	41,029
3	126	1,494	224	224	103,264
4	107	1,267	190	190	87,590
5	126	1,494	224	224	103,264
6	123	1,459	219	219	100,959
7	107	1,267	190	190	87,590
8	59	299	45	45	20,745
9	85	968	145	145	68,440
10	50	593	84	84	42,588
11	57	676	105	105	53,235
12	37	438	66	66	31,152
13	17	201	30	30	14,160
14	11	130	20	20	9,440
15	43	510	77	77	36,344
16	38	450	66	66	33,462

\*Assumed to be 65 lbs/animal/day containing 85% water.

\*\*Assumed to be 15% of 65 lbs/animal/day or 9.75 lbs/animal/day.

Figure 6: Feedlot Capacity for Selected 25 Mile Diameter Areas\*  
in Thousands of Animals, September 1971

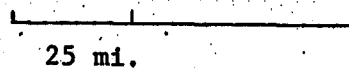


State Geological Survey of Kansas

- 1,000 - 9,000
- 10,000 - 29,000
- 30,000 - 49,000
- 50,000 - 69,000
- 70,000+

Mean Size: 56,000 Animals  
Radius of Circle: 12.5 miles

35 - Thousands of Animals  
9 - No. of Region



\*Kansas Animal Health Department, Animal Health Division, State Office Bldg., Topeka, Ks. 66612

TABLE 5

ANNUAL KANSAS CATTLE MANURE PRODUCTION AND TRANSPORTATION  
ESTIMATED FUEL OIL YIELDS AND POTENTIAL ELECTRIC POWER GENERATION BY SELECTED AREAS, 1971

Region diameter of which is 25 miles	Cattle Feedlot Capacity	Annual Raw Manure Production	Annual Manure Production	Minimum ton miles of Transportation within Specified Area		Net Production of Fuel Oil	Potential Electric Power Generation
	Thousands of Animals	Thousands of Tons*	Thousands of Dry Tons**	Thousands of Wet-Ton Miles/Year	Thousands of Dry-Ton Miles/Year	Thousands of Barrels	Thousands Kilowatt Hours
1	22	260	39	854	128	39	14,444
2	107	1,269	190	9,252	1,387	190	87,771
3	123	1,459	218	9,537	1,430	218	100,895
4	86	1,020	153	9,774	1,466	153	70,544
5	105	1,245	186	3,131	469	186	86,130
6	26	308	46	9,015	1,352	46	21,327
7	75	889	133	4,745	711	133	62,989
8	45	533	80	3,416	512	80	37,393
9	35	415	62	1,186	177	62	31,574
10	22	260	39	379	56	39	19,847
11	28	332	49	189	28	49	25,260
12	35	415	62	3,036	455	62	30,516
13	25	296	44	949	142	44	22,553

\*Assumed to be 65 lbs/animal/day containing 85% water.

\*\*Assumed to be 15% of 65 lbs/animal/day or 9.75 lb/animal/day.

RELATIONSHIP BETWEEN WASTE SUPPLY AND REGIONAL DEMAND FOR  
POWER

If it is economically feasible to carry out the technology for converting cattle feedlot waste to oil or gas on a large scale, the product might be dumped into preexisting pipelines or consumed locally by power plants or for other uses. Assuming that the product will be consumed regionally, the following Table shows the relationship between power plant fuel demand and potential yield for the broad power regions:

District	Potential Oil Production bbl/yr	Oil Used for Power Generation 1970 (Demand)	<u>%Potential Oil Demand</u>	Gas Used Power Gen- eration 1970
1		small		
2	197,000	177,207	+111%	41,213,274
3	151,000	54,830	+275%	59,101,537,000
4	117,000	22,087	+530%	*
5	254,000	45,642	+556%	*
6	138,700	37,210	+373%	*
7	975,000	9,412	+10,359%	0

Since the potential supply far outdistances the demand, some other regional market would have to exist for the product or it would have to be marketed over broader areas. The production of synthetic gas would be more attractive at present because of greater demand.

## VALUE OF THE PRODUCTS

If all cattle feedlot waste could be converted to electric power, it would amount to 11% of the net generation for 1970 if converted to gas and 5.5% if converted to oil. Using an average value of \$.017 per KWH,<sup>7</sup> the potential annual value of this electric power is \$28,575,419. The total potential annual value of the manufactured fuel oil on a statewide basis is \$15,742,000; fuel oil for power stations is currently valued at \$4.25-\$4.30/bbl.<sup>8</sup> The value of potential oil production and electric power generated broken down for the large regions and the 50 and 25 mile diameter areas are shown in Tables 6, 7 and 8.

## PIPELINE COSTS

Pipeline costs were calculated for the 25 mile diameter area with largest number of animals; region 3 with a 123,000 cattle capacity (Table 5). In the calculations it was assumed that waste from the smaller 5,000 and 31,000 animal capacity feedlots would be pumped eastward to the larger 87,000 capacity feedlot. The following calculations were

---

<sup>7</sup>Calculated from ratios of Kansas Power and Light Company's, 1970 electric power earnings and 1970 net generation.

<sup>8</sup>Personal Communication, Mr. Derrick Miller, Kansas Power and Light Company, Business Manager, Topeka, Kansas.

Table 6: Value of Potential Fuel Oil and Electric Power  
for Large Regions

Region	Potential Production of Fuel Oil (Thousands of Bbls.)	Market Value	Potential Production of Electricity (Thousands of KWH)	Market Value
1	135	\$ 573,750	49,815	\$ 846,855
2	975	4,143,750	470,925	8,005,725
3	254	1,079,500	122,682	2,085,594
4	132	561,000	57,816	982,872
5	151	641,750	66,138	1,124,346
6	65	276,250	31,395	533,715
7	117	497,250	56,511	960,687
C Kansas	1,875	7,968,750	825,625	14,035,625

Table 7: Value of Potential Fuel Oil and Electric Power  
For 50 Mile Diameter Areas

Region	Potential Production of Fuel Oil (Thousands of Bbls.)	Market Value	Potential Production of Electricity (Thousands of KWH)	Market Value
1	73	\$ 310,250	30,937	\$ 525,929
2	89	378,250	41,029	697,493
3	224	952,000	103,264	1,755,488
4	190	807,500	87,590	1,489,030
5	224	952,000	103,264	1,755,488
6	219	930,750	100,959	1,716,303
7	190	807,500	87,590	1,489,030
8	45	191,250	20,745	352,665
9	145	616,250	68,440	1,163,480
10	84	357,000	42,588	723,996
11	105	446,250	53,235	904,995
12	66	280,500	31,152	529,584
13	30	127,500	14,160	240,702
14	20	85,000	9,440	150,480
15	77	327,250	36,344	617,848
16	66	280,500	33,462	568,854

Table 8: Value of Potential Fuel Oil and Electric Power  
For 25 Mile Diameter Areas

Region	Potential Production of Fuel Oil (Thousands of Bbls.)	Market Value	Potential Production of Electricity (Thousands of KWH)	Market Value
1	39	\$ 165,750	14,444	\$ 245,548
2	190	807,500	87,771	1,492,107
3	218	926,500	100,895	1,715,215
4	153	650,250	70,544	1,199,248
5	186	790,500	86,130	1,464,210
6	46	195,500	21,327	362,559
7	133	565,250	62,989	1,070,813
8	80	340,000	37,393	635,681
9	62	263,500	31,574	536,758
10	39	165,750	19,847	337,399
11	49	208,250	25,260	429,420
12	62	263,500	30,516	518,772
13	44	187,000	22,553	383,401

Made in order to use estimating graphs for pump cost, pipe diameter, and pipe cost:<sup>9, 10</sup>

- 1) gal/min (q) =  $\left[ \frac{\text{no. of cattle}}{\text{at source}} \right] \left[ \frac{\text{dry waste/cow}}{\text{min.}} \right] \left[ \frac{100}{8.35} \right]$
- 2) lb/min (q') = q [ 8.35 lbs/gal ] [ 60 min/hr. ]
- 3) Pick pipe diameter--p. 79.
- 4) Calculate pipe cost = pipe cost (p. 88) x 1.5.
- 5) Pick pump cost--p. 55.
6. Total Cost = [ pump cost ] + [ pipeline cost ]  $\left[ \frac{\text{pipeline}}{\text{distance}} \right] \left[ \frac{\text{economic index} = \frac{132}{90}}{\text{index}} \right]$

The term 100 in equation (1) represents conversion to a 1% slurry; 50 was used to convert to a 2% slurry. A density of 62.4 lbs/cubic foot was used for the slurry. Friction losses, topographic effects, provision for burial and other detailed aspects of pipeline transmission were not included. The economic index was adopted from <sup>a</sup>table in order to bring the cost tables to a 1971 base.<sup>11</sup> The following tables give the results of the calculations using a 1% and a 2% slurry for region 3 (Table <sup>9</sup>5).

The potential value of electricity from cattle waste for region 3 (Table 6) is \$1,715,215 and the potential value

<sup>9</sup> Arias, Robert S. and Newton, Robert D., 1955, Chemical Engineering Cost Estimation: McGraw-Hill Book Co., Inc., New York, pp. 55, 79, 88.

<sup>10</sup> Method of calculating pipeline costs worked on by Dale Laurance.

<sup>11</sup> Chemical Engineering, Economic Indicators, October 18, 1971, p. 192.

Table 9: Pipeline Costs for Region 3

	Feedlot Capacity	q (gal/min)	q' (lbs/hr)	Pipe Diameter	Cost/ft.x1.5	Total Distance	Pump Cost	Economic Index	Total Cost
Region 3-1% Slurry	5,000	407	203,907	5"	\$ 1.50	12 mi.	\$ 700	1.47	\$140,737
	31,000	<u>2,525</u>	<u>1,265,025</u>	18"	18.00	<u>20 mi.</u>	<u>5,000</u>	1.47	<u>2,801,526</u>
Total		2,932	1,468,932			32 mi.	5,700		\$2,942,263
Region 3-2% Slurry	5,000	204	102,204	5"	\$1.50	12 mi.	\$ 500	1.47	\$ 140,444
	31,000	<u>1,262</u>	<u>632,262</u>	10"	6.25	<u>20 mi.</u>	<u>2,000</u>	1.47	<u>973,140</u>
Total		1,466	734,466			32 mi.	2,500		\$1,113,584

of fuel oil is \$926,500. compared to pipeline cost estimates of \$2,942,263 and \$1,113,584. respectively for 1% and 2% slurries.

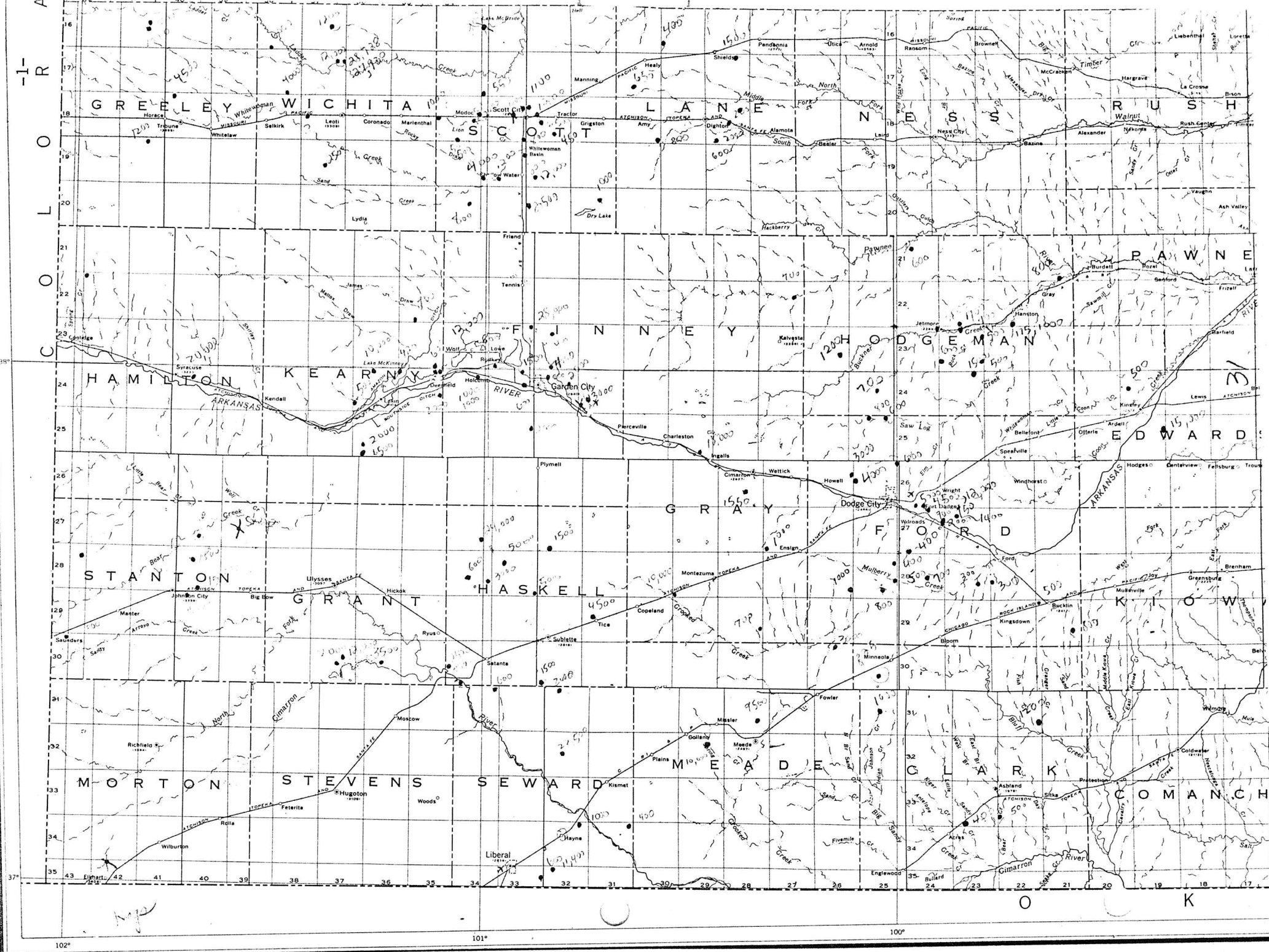
#### SUGGESTIONS FOR A FUTURE DETAILED FEASIBILITY STUDY

The following are suggested for consideration when more information is available:

- 1) Work out the economics of scale in processing manure. What is the average cost per barrel of oil of different size plants?
- 2) What are the costs of putting oil into existing pipelines for shipment to electric generating plants?
- 3) Solve the critical problem of how far slurries can be pumped for processing, including the refined costs of transporting the slurry and return water.
- 4) Consider the distribution of small feedlots with less than 1000 animals to determine whether they may also be included for consideration.
- 5) What is the optimal spacial arrangement of feedlots, converting plant and power plant?
- 6) What are the possible mechanical methods of conveyance of animal waste and how do the costs compare with pipeline transportation costs?
- 7) Construct a graph of pumping cost as a function of size of feedlot.

**Appendix A**

**Animal Miles Between Feedlots and a Central Locality  
In 17 Southwestern Kansas Counties**



102° 101° 100°

## Animal Miles Between Feedlots and Central Plant

County	No. of Animals in Feedlots	No. of Miles to Plant	No. of Animal Miles
<u>Scott</u>	7,050	33±4	232,650
	17,800	27±6	480,600
	4,300	21±10	90,300
	<u>14,050</u>	<u>42±4</u>	<u>590,100</u>
Subtotal	45,200	123	1,393,650
	300	61 not included in tabulation	
<u>Wichita</u>	69,858	66±4	4,610,628
	8,500	62±6	527,000
	<u>6,000</u>	<u>76-</u>	<u>456,000</u>
Subtotal	84,358	204	5,593,628
<u>Greeley</u>	3,200	96±2	307,200
	<u>5,700</u>	<u>81±4</u>	<u>461,700</u>
Subtotal	8,900	177	768,900
<u>Lane</u>	5,400	67±4	361,800
	1,050	61±2	64,050
	<u>1,500</u>	<u>69±2</u>	<u>103,500</u>
Subtotal	7,950	197	529,350
<u>Hamilton</u>	20,000	54±3	1,080,000
	<u>1,000</u>	<u>79±3</u>	<u>79,000</u>
Subtotal	21,000	133	1,159,000
<u>Finney</u>	60,500	4±2	242,000
	<u>7,000</u>	<u>11±2</u>	<u>77,000</u>
Subtotal	67,500	15	319,000

## Animal Miles continued

County	No. of Animals in Feedlots	No. of Miles to Plant	No. of Animal Miles
<u>Kearny</u>	20,000	15±3	300,000
	11,820	20±6	336,400
	<u>8,500</u>	<u>44±3</u>	<u>374,000</u>
Subtotal	40,520	79	1,010,400
<u>Hodgeman</u>	6,675	59±6	393,825
	800	88±2	70,000
	2,000	68±3	13,600
	600	64±3	38,400
	<u>1,900</u>	<u>56±7</u>	<u>106,400</u>
Subtotal	11,975	335	622,625
<u>Haskell</u>	34,100	23±4	1,125,300
	11,000	36±7	396,000
	<u>9,900</u>	<u>47±2</u>	<u>465,300</u>
Subtotal	55,000	116	1,986,600
<u>Grant</u>	17,500	70±3	1,225,000
<u>Stanton</u>	30,300	85±6	2,575,500
	<u>1,200</u>	<u>98±6</u>	<u>117,600</u>
Subtotal	31,500	183	2,693,100
<u>Gray</u>	19,550	52±6	1,016,600
	10,000	65±4	650,000
	<u>700</u>	<u>67±3</u>	<u>46,900</u>
Subtotal	30,250	367	1,713,500
<u>Ford</u>	30,250	63±5	1,905,750
	7,600	46±3	349,600
	3,800	62±6	235,600
	600	70±4	42,000
	<u>300</u>	<u>84±5</u>	<u>25,200</u>
Subtotal	42,450	325	2,558,150

Animal Miles continued

County	No. of Animals in Feedlots	No. of Miles to Plant	No. of Animal Miles
<u>Seward</u>	13,000	76±6	988,000
	400	86±5	34,400
	<u>25,100</u>	<u>48±6</u>	<u>1,204,800</u>
Subtotal	38,500	210	2,227,200
<u>Mead</u>	19,500	74±6	1,443,000
	<u>3,825</u>	<u>68±6</u>	<u>204,000</u>
Subtotal	23,329	142	1,647,000
<u>Clark</u>	1,825	68±8	124,100
	980	98±8	96,040
	<u>1,200</u>	<u>75±6</u>	<u>90,000</u>
Subtotal	4,005	241	310,140
<u>Edwards</u>	15,500	93±6	1,441,500
Total	545,433	2,827	27,198,743

Assumptions in Calculating Mileage and Number of Animal Miles

1. All feedlots were utilized, with an exception, regardless of size and distance from the plant.
2. Mileage was calculated using roads shown on the official Kansas road map.
3. The central plant is placed 4 miles north of Garden City. The largest numbers of animals are present here and there is an abundant water supply.

Average Number of Miles of Transport /Animal/ton

$$\frac{545,433 \text{ animals}}{27,198,743 \text{ animals miles}} = 49.87 \text{ miles/animal}$$

The elimination of smaller feedlots at longer distances would reduce this figure.

Transportation Costs

I. Mr. Vernon Ball - Ball Trucking Co., Garden City, Kansas.

Rate: \$1.00/ton for ten mile haul

.05/ton for each mile beyond 10 miles

Loading Costs: \$ .25/ton

Maximim Haul: Generally 30 miles, possibly 50 or 60 if demand from farmers is great.

Moisture Content: 70 - 80% - January

< 10% - July

Cost to Farmer: If manure is supplied - \$1.75/ton

II. Mr. Judd Lackey - Jarboe-Lackey Feedlot, Parsons, Kansas.

Rate: \$10.00-12.00/hr. 5 or 6 18-ton tandem dump trucks can be filled in one hour or possibly 8 per hour if they line up continually under loader. This works out to be \$ .10-.15 to \$1.00/ton depending on moisture content.

Loading Costs: \$20.00/hr. whether equipment is owned or leased.

Moisture Content: Same as Ball Trucking Co.

Therefore the cost of transportation for the average number of miles of transport/animal/ton would be the following:

10 miles = \$1.00  
40 miles @\$ .05/mi = \$2.00  
\$3.00 per animal/ton

On a large scale hauling basis this figure might drop to \$ .05/ton for every mile.