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Bulk Fuel Distribution Costs For Cooperatives in North Dakota

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PREFACE

Preparation of this report was financed by cooperative research agreement 43-3J31-2-0011 between the Agricultural Cooperative Service (now Rural Business and Cooperative Development Service, Rural Economic and Community Development), USDA, and the North Dakota State University Agricultural Experiment Station. John Dunn, RBCDS/RECD/USDA, served as liaison; and David Cobia was the principal investigator. This report also contributes to NDSU Agricultural Experiment Station project 1383 "Marketing Strategies for Cooperatives."

Several individuals from CENEX-LOL, equipment dealers, construction companies, and other industry contacts provided data for synthetic models and reviewed the survey instrument. The assistance of Alden Sprecher and Larry Fuller was particularly helpful. Fred Boeshaus, Dean Rasmassen, Dennis Vogel, and Roger Warrington, all CENEX-LOL Business Services Managers, provided helpful feedback on relevance and prioritizing concepts and data. Susan Wehri performed the delivery simulations.

ABSTRACT

Economic-engineering cost data and a simulation model were used to analyze the impact of sales density, size of sales area, sales volume, and equipment configuration on costs of bulk fuel delivery by cooperatives. Fixed costs accounted for the majority of delivery costs regardless of sales density or size of sales area, at least for the relevant range of these variables for North Dakota. Increasing the radius of a sales area from 5 to 50 miles increased average costs only $.02 to $.09/gal. Doubling sales by either doubling the size of the sales area or the sales density reduced average total costs by nearly 50%. Thus, cooperatives with excess delivery capacity could achieve significant savings if they consolidate to operate closer to the capacity of delivery equipment.

Small storage facilities (say 50,000 gal.) place little or no restriction on operations because deliveries from bulk fuel terminals are reliable and on a timely basis. Therefore, the economic rationale for building larger storage facilities would include speculation on price changes and as a response to future expectations rather than current operating requirements. The impact of the size of load-out pipes (2" or 3") and delivery trucks (2,000 or 4,000 gal.) is significant in some instances. The larger load-out pipes are most economical for high sales densities. Larger trucks have a comparative advantage in large sales areas with lower sales densities.

Key Words: cooperatives, fuel distribution, delivery costs, market area size

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HIGHLIGHTS

This study was undertaken to create a procedure for evaluating the impact of sales density, size of sales area, sales volume, and storage and delivery equipment configurations on least cost bulk fuel delivery operations for cooperatives. An economic-engineering cost approach was used to analyze these relationships. Benchmark statistics for operating conditions were taken from a survey of 11 selected local North Dakota cooperatives. They were selected to represent operating characteristics throughout the state. Facilities in the western and central regions of the state had larger sales areas and made a greater effort to structure deliveries to reduce miles driven by bulk trucks. For example, managers in these areas of the state indicated that they worked with their patrons to foster an environment where patrons would call in advance, allowing the cooperative to do more structuring of bulk fuel deliveries.

Costs of construction and operation of four sizes of bulk fuel storage facilities were estimated from data provided by industry representatives. Three of the facilities were sized (50,000, 70,000, and 130,000 gal.) to represent bulk fuel facilities operating within the state. The fourth facility (300,000 gal.) was specified as a larger multi-firm facility. Mileage for delivery trucks was estimated based on sales area size and annual sales levels using a computer simulation model. These results were compared to surveyed cooperatives. In most cases, they were operating at less than 50% of equipment capacity.

Annual fixed costs for bulk fuel facilities formed the majority of total costs for bulk fuel storage facilities. Variable delivery costs were generally less than half the level of fixed costs even for facilities with sales areas of 50 miles in radius and high sales volumes. Increasing the radius of the sales area from 5 to 50 miles while holding the level of annual sales constant increased average total costs about $.02/gal. regardless of the level of annual sales or facility size. Increasing the level of annual sales reduced average total costs for bulk fuel facilities until the annual capacity of delivery equipment was reached. Thus, the least cost facility is the smallest facility that can operate at or near capacity of its delivery equipment.

Comparisons of a 70,000 gal. storage facility with different bulk fuel delivery equipment combinations indicated that the least cost equipment complement progressed from one-2,000 to one-4,000 to two-2,000 to two-4,000 gal. bulk trucks. Break-even costs between bulk truck combinations were at or near the delivery capacity of the smaller bulk truck complement.

Size of load-out pipes could be important for co-ops with a small sales area and a high sales density. For example, a 2,000 gal. truck with a 3" load-out pipe could deliver more fuel per day than a 4,000 gal. truck with a 2" load-out pipe. However, the sales densities required for this to occur exceed those characteristic of North Dakota.

Capacities of bulk fuel delivery equipment were compared to county sales densities common to North Dakota. Firms with sales areas with a radius less than 10 to 15 miles in high density areas and 20 to 30 miles in low density areas needed more than 50% market share if they are to approach a least cost bulk fuel facility. Since most of the managers interviewed indicated few stress days (days when orders exceeded deliveries), increases in sales areas, market shares, and consolidation, cooperation, or mergers of local bulk fuel cooperatives could reduce average total costs if changes allowed the firm to operate closer to the capacity of bulk fuel equipment. The highest cost savings of consolidation would occur when two firms could be combined with the equipment, labor, and facilities of a single firm that could operate at or near capacity of the delivery equipment.

Bulk Fuel Distribution Costs for Cooperatives in North Dakota

Bruce L. Dahl, David W. Cobia, and Frank J. Dooley[1]

INTRODUCTION

This study was undertaken to examine cooperative bulk fuel distribution costs and develop a procedure to evaluate the cost effectiveness of facilities in light of sales area size, sales density, and delivery equipment. Alternatively, if existing facilities are present, what is the appropriate size of sales area and/or market share to have given the size of the firms' bulk fuel facility, delivery equipment, and density of sales? Finally, what are the savings associated with consolidation of facilities?

An economic-engineering cost approach was used to analyze the impact of volume, sales density, sales area, size of bulk fuel facility, and delivery equipment complements on costs. This approach was used because average cost data from a survey of bulk fuel distributive cooperatives were not reliable nor applicable to a given situation. Operating conditions for each co-op were unique. Accounting practices and depreciation schedules are so different from firm to firm that direct comparisons are illogical. For these reasons, standardized configurations of equipment and operating conditions and practices were synthesized to represent the sales volume, sales density, sales areas, and operating practices in North Dakota. Baseline information for these models was obtained from CENEX-LOL business service and field representatives and equipment dealers. A survey of selected cooperative bulk fuel distributors provided benchmark statistics for the synthesized models.

The many trends affecting the rural bulk fuel delivery industry since its inception have created an industry out of balance. Changes in the quality of roads and bridges and improvements in trucks have expanded the feasible market area for local cooperatives and increased the reliability of bulk fuel deliveries to local bulk fuel facilities and farmer patrons. Larger farms have led to increasing the size of fuel drops to individual farmers. This has further increased the amount of fuel that individual bulk fuel suppliers can deliver per day. Other trends in farm fuel use are also positioned to alter the bulk fuel industry. Many farmers are adopting larger, more fuel-efficient equipment and/or moving toward no-tillage or reduced tillage production systems that should reduce farm fuel use. Further, additional federal regulation on bulk fuel storage facilities is raising the overhead cost of doing business. Combined, these factors have prompted concerns on what is the appropriate size and structure of bulk fuel facilities.

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BULK FUEL TRADE IN NORTH DAKOTA

Cooperative bulk fuel facilities in North Dakota obtain fuels from terminals and pipelines that traverse the state. Terminals are located at Mandan, Jamestown, Grand Forks, Minot, and Fargo (Figure 1). Shipment of tanker lots from these terminals to local bulk fuel co-ops are timely and do not put capacity constraints on the local co-ops they supply (Fuller). Local co-ops throughout North Dakota tend to have storage facilities that hold from 60,000 to 130,000 gallons of gasoline and diesel. Since delivery of tanker lots can service local bulk fuel storage facilities in a timely manner, larger bulk fuel storage facilities are not required to meet local fuel demands. Although some larger facilities are present, these large facilities do not represent the majority of bulk fuel facilities within the state.

Local fuel supply cooperatives are located in most North Dakota towns. However, in western North Dakota, towns are generally farther apart than in the eastern portion of the state. Therefore, bulk fuel co-ops in the west tend to have larger sales areas. However, the density of sales of petroleum products to farms is correspondingly lower. In 1987, the density of sales of gasoline and diesel purchased by farmers ranged from a low of 884 gallons per square mile in Billings County to a high of 6,425 gal./sq. mile in Walsh County (U.S. Dept. of Commerce). Generally, there was a shift from low sales densities (low numbers of gallons of fuel purchased/sq. mile) of both gasoline and diesel in the western part of North Dakota to higher densities of sales in the eastern part of North Dakota (Figures 2-4). Thus, sales areas for local bulk fuel cooperatives also tended to get larger from eastern to western North Dakota due to lower sales densities.

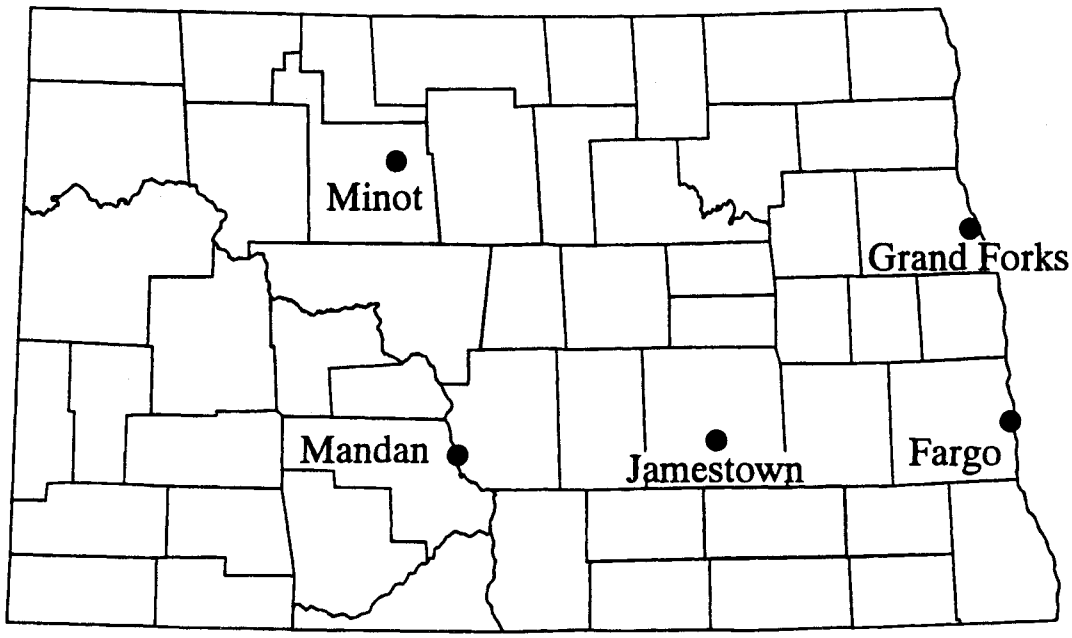

Figure 1. Bulk fuel terminal locations in North Dakota, 1992.

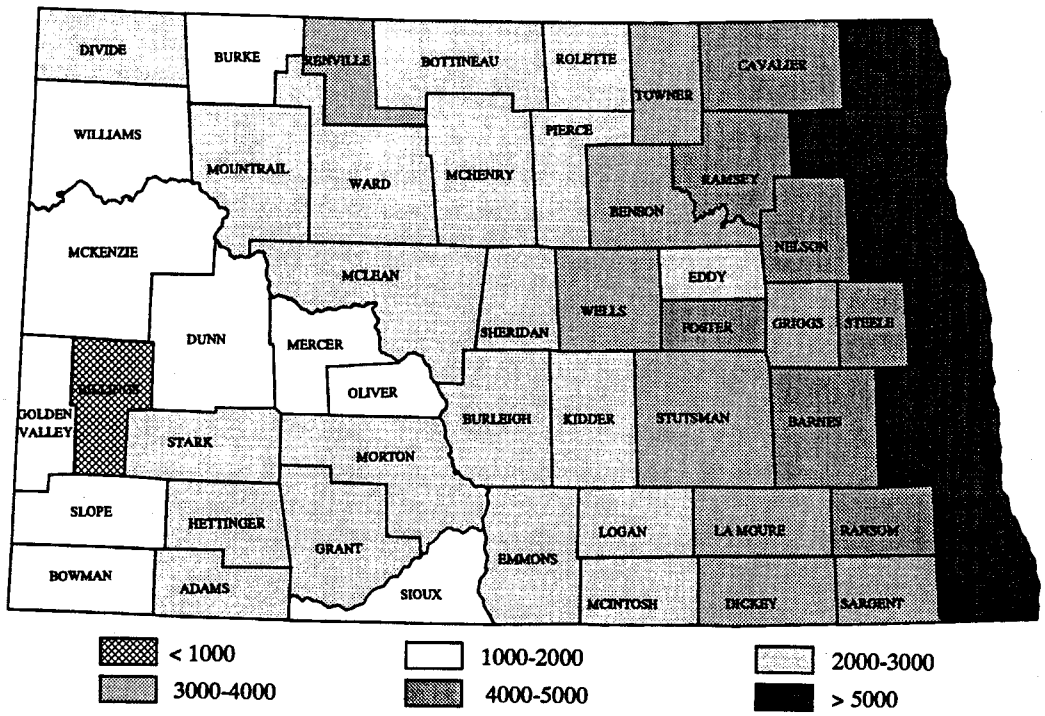

Figure 2. Density of total farm purchases of gas and diesel (gal./sq. mile), North Dakota, 1987.

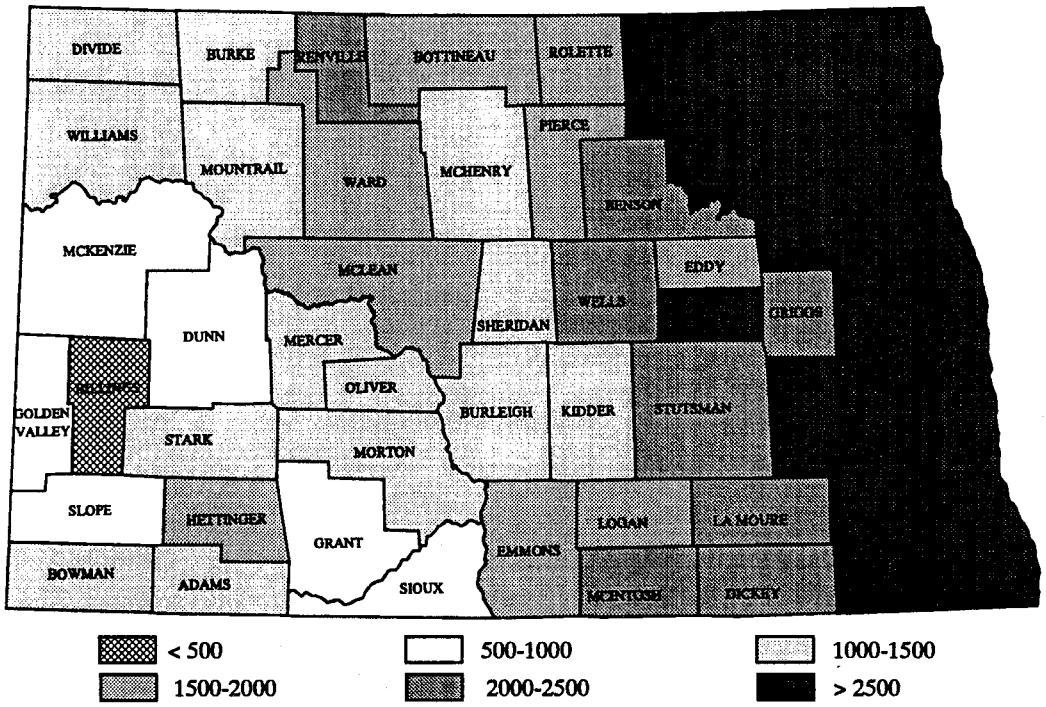

Figure 3. Density of total farm purchases of diesel fuel (gal./sq. mile), North Dakota, 1987.

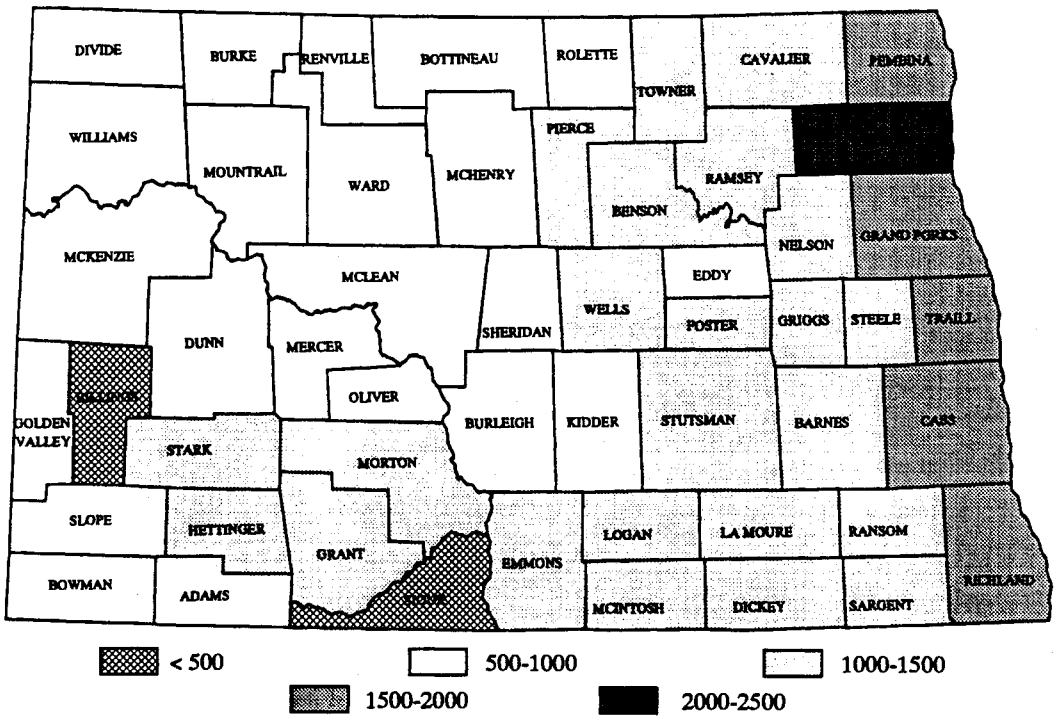

Figure 4. Density of total farm purchases of gasoline (gal./sq. mile), North Dakota, 1987.

GENERAL BUSINESS OPERATING CHARACTERISTICS

A survey of general business and operating characteristics was undertaken to gather information about operating characteristics and expenses for bulk fuel cooperatives. Personal interviews were conducted with 11 local managers and bulk delivery supervisors. Bulk fuel facilities surveyed were selected on the basis of location (east, west, and central North Dakota), size (small, medium, and large storage facilities), and the likelihood of maintaining relatively good records.

Annual bulk fuel sales for the cooperatives surveyed ranged from about 300,000 gal. to more than 1 million gal. The size of individual bulk fuel storage facilities was within the range of 50,000 to 130,000 gal./facility. Total storage for the co-ops were higher in some cases where individual co-ops owned multiple storage facilities. The radius of sales areas was calculated for each firm surveyed, based on the managers' estimates of the size of sales area in each of four directions (north, south, east, and west) from the bulk fuel facility. The average radius of sales area for all firms was 22 miles and ranged from 10 to 43 miles for the 11 local cooperatives surveyed. Co-ops in the central and western regions of the state had larger sales areas than co-ops in the eastern region of the state.

Coordination of bulk truck deliveries by selected co-ops varied across the state. Western and central co-ops were more likely to schedule deliveries to reduce the miles driven by bulk trucks than were co-ops in the eastern region. Co-ops in the western and central regions also were more likely to have "keep full" contracts with local patrons and structure deliveries so that the bulk truck goes out loaded and returns empty (no partial loads). Many of these co-ops had instilled a working environment with patrons which fostered service calls from farmers days in advance of their immediate needs. However, these co-ops would also handle the infrequent emergency out-of-fuel call. This strategy allowed the local co-op to reduce bulk truck miles by structuring deliveries within areas. Furthermore, bulk fuel drivers in the larger sales areas were more likely, if they were in the area and had fuel left, to call farmers or stop in, asking them if they need fuel. Managers in the eastern regions paid less attention to structuring bulk fuel deliveries to reduce bulk truck miles. Most ran on a first-call, first-served basis, leading to more partial loads. Most of the differences in the degree of coordination used to reduce miles driven by the bulk truck was probably reflected in the size of sales areas. Western and central bulk fuel co-ops had sales areas that were larger and had lower sales densities than did the eastern co-ops. Thus, western and central North Dakota co-ops must travel more miles to deliver fuel than the eastern co-ops.

Many local bulk fuel co-ops sell transport loads delivered direct to farmers from the terminals. These loads were typically sold on a margin over their cost. Some local co-op managers in the state are seeing growth in transport loads, especially in areas with higher concentrations of larger farmers. Other local co-op managers are reporting a leveling off or a decrease in the number of transport loads purchased by farmers. Managers listed two issues as important in determining the direction of these conflicting trends. First, some managers indicated that if farm tanks had to comply with the same federal regulations as bulk fuel delivery facilities, direct shipments to farmers would decrease. Second, the trend to larger farms continues to increase the number of farms that can accommodate direct transport load deliveries.

Managers reported increased concern about current and future federal tank regulations and their potential impacts on the bulk fuel delivery industry. Current federal regulations require many of the local bulk fuel co-ops to upgrade their existing facilities to meet codes. These upgrades are many times more expensive than constructing new facilities. Further, the cleanup procedures and costs required for local co-ops to abandon current sites are becoming more complex and expensive.

Operating costs for the surveyed co-ops were collected and classified based on size of the facility and sales area (Tables 1-2). If cost effeciencies were present for size of facility and sales area, they should be observed in the firms with larger storage facilities and smaller sales areas. Total wages (wages and salaries for managers, bookkeepers, and bulk fuel delivery personnel), per gallon increased from an average of $.034/gal. for the 70,000 to 100,000 gal. facilities to $.059/gal. for the largest facilities (>100,000 gal.) (Table 1). This

Table 1. Average storage, gallons delivered, sales area radius, and operating costs/gal. for selected cooperatives, by size of bulk fuel storage facilities, North Dakota, 1992.

Item	Facility size (gal.) 50,000-70,000	70,000-100,000	>100,000
	(- - - - - - - - - - - average* - - - - - - - - - - -)		
Gallons of storage	64,750 (9)	81,333 (3)	136,333 (6)
Bulk gallons delivered	479,650 (9)	857,617 (3)	606,319 (6)
Turnover ratio	7.43 (9)	10.55 (3)	4.81 (6)
Radius of sales area	13 (9)	29 (3)	21 (6)
	(- - - - - - - - - - - - - $ - - - - - - - - - - - -)		
Costs per gallon			
Total wages	.057 (10)	.034 (2)	.059 (4)
Facility maintenance and repairs	.0014 (1)	.0013 (2)	.0030 (5)
Utilities	.0011 (1)	.0003 (1)	.0025 (5)
Bulk truck costs			
Maintenance and repairs	.0203 (1)	.0088 (2)	.0086 (5)
Fuel and oil	.0340 (1)	.0148 (2)	.0152 (5)
Total bulk truck costs	.0543 (1)	.0236 (2)	.0238 (5)

* The number in brackets is the number of observations.

apparent contradictory relationship appeared to be influenced by the level of annual sales and inventory turnover ratio. Firms with higher levels of annual sales or higher inventory turnover ratios had lower costs per gallon for wages.

The 70,000 to 100,000 gal. facilities had the lowest cost per gallon for other selected costs, including utilities and facility repairs and maintenance. Costs per gallon of annual sales were highest for facility repairs and utilities for the largest bulk fuel storage facilities. The lowest cost per gallon for the moderate-sized facilities was probably related to these plants' having the highest storage turnover ratio.

The 70,000 to 100,000 gal. facilities had the lowest cost per gallon for fuel, oil, and total bulk truck costs. Only the repairs and maintenance cost of bulk trucks for the largest facilities was lower than for the 70,000 to 100,000 gal. facilities. Again, these costs appeared to be highly influenced by the level of annual sales. Costs per gallon of annual sales were highest for the smallest facilities for all measures of bulk truck costs. These high

Table 2. Average storage, gallons delivered, sales area radius, and operating costs/gal. delivered for selected bulk fuel cooperatives, by size of sales area, North Dakota, 1992.

Item	Radius of sales area (miles) 10 - 15	16 - 20	21 - 30	>30
	(- - - - - - - - - - - - - - average* - - - - - - - - - - - - - -)			
Gallons of storage	76,500 (3)	167,333 (3)	83,333 (3)	97,500 (2)
Bulk gallons delivered	438,100 (3)	617,667 (3)	793,417 (3)	811,256 (2)
Turnover ratio	6.14 (3)	4.07 (3)	9.29 (3)	8.43 (2)
Radius of sales area	12 (3)	17 (3)	24 (3)	40 (2)
Costs per gallon ($)				
Total wages	.065 (2)	.064 (3)	.048 (1)	.028 (2)
Facility maintenance and repairs	.0035 (2)	.0041 (2)	.0010 (2)	.0008 (2)
Utilities	.0008 (2)	.0027 (2)	.0003 (1)	.0042 (1)
Bulk truck costs ($)				
Maintenance and repairs	.012 (2)	.009 (2)	.011 (2)	.008 (2)
Fuel and oil	.021 (2)	.021 (2)	.018 (2)	.010 (2)
Total bulk truck cost	.033 (2)	.031 (2)	.029 (2)	.018 (2)

* The number in brackets is the number of observations.

bulk truck costs by the smallest facilities were largely a result of low annual bulk fuel sales. However, the smallest bulk fuel facilities also tended to have small bulk trucks with gas engines, which generally have higher operating costs.

Costs were classified based on the radius of the sales area (Table 2). Here, all measures of costs per gallon generally decreased as the radius of the sales area increased. This was contrary to what would be expected. However, it is probably related to the larger levels of annual sales obtained by the firms with larger sales areas. Furthermore, firms with larger sales areas were more likely to have diesel trucks which have lower operating costs. Thus, for the co-ops surveyed, the increased costs of delivering to farmers farther from the storage facility were more than offset by the higher annual sales volumes and lower bulk truck operating costs obtained by the firms with the larger sales areas.

INVESTMENT COSTS FOR BULK FUEL FACILITIES AND EQUIPMENT

Investment costs for bulk fuel facilities and delivery equipment were developed for major components of construction and delivery equipment. Four sizes of bulk fuel storage

facilities were selected to represent the range of relevant and potential sizes for bulk fuel distributors in North Dakota. Construction costs for these 4 sizes of bulk fuel storage facilities were developed following current federal regulations for construction of bulk fuel facilities (National Fire Protection Association). Three of the storage facilities (50,000, 70,000, and 130,000 gal.) were selected to represent facilities common to North Dakota. A fourth facility (300,000 gal.) was selected to represent a facility that was larger than normally seen in North Dakota, that could be centrally located and utilized jointly by two or more local co-ops or a large co-op.

Major components required by the four sizes of bulk fuel storage facilities were identified by regional cooperative representatives familiar with bulk fuel storage facility construction (Table 3; Sprecher). Individual facilities except for the 300,000 gal. facility

Table 3. Number and size of selected major components for 4 sizes of bulk fuel storage facilities, North Dakota, 1992.

	Bulk fuel storage facility size (gal.)			
Item	50,000	70,000	130,000	300,000
Tanks (gal./#)				
8,250	6	--	--	--
10,000	--	3	--	--
15,000	--	3	--	--
17,000	--	--	3	--
30,000	--	--	3	10
Pumps #-diameter	2-2"	2-2"	2-3"	4-3"
Diameter of safety equip.	2"	2"	3"	3"
Piping	312' of 2"	312' of 2"	312' of 3"	624' of 3"
Concrete pads & load-out docks (#)	1	1	1	2
Secondary liner (sq. ft)	2679	2679	2679	4416
Fuel meters*	--	--	--	4
Cardtrol system*	--	--	--	1
Land (acres)**	3	3	3	6

* Required if facilities serve more than one co-op.

** Differences in capacity for 50,000 - 130,000 facilities are related to tank height, therefore, no additional land required.

Source: Sprecher.

were specified with 6 storage tanks to allow for the types of product mixes common to North Dakota bulk fuel cooperatives. Tanks were specified as 11 ft. diameter tanks for the three smaller facilities with less than 300,000 gal. storage. Changes in tank capacities for these smaller tanks were achieved by increasing or decreasing the height of the tanks. The 300,000 gal. facility was specified using 10, 12 ft. diameter tanks holding 30,000 gal. each. Tanks larger than 30,000 gal. were not included because they would require custom building on site. This larger facility was assumed to require 6 acres of land. All facilities included safety equipment and construction components for containment of a potential fuel spill (a dike surrounding the facilities and a secondary liner underneath the dike to form a permanent barrier). Safety equipment included relief valves and vents. Costs of major components were obtained from local regional suppliers where available, and regional cooperative representatives (Table 4; Oday Equipment, Inc., Sprecher).

The cost of construction for the 50,000 and 70,000 gal. facilities were within $6,000 of each other at $47,600 and $53,031, respectively. Average construction cost/gal. was $.19 lower for the larger facility. The 130,000 gal. facility cost $73,251 to construct or $20,221 more than the 70,000 gal. facility. Nearly half of the increased construction cost ($9,601) was attributable to the use of 3" rather than 2" piping. Yet, the average cost/gal. for the 130,000 gal. facility was $.20/gal. less than the 70,000 gal. facility. The 300,000 gal. facility cost more than twice the cost of any other facility at $176,515. Higher average construction cost per gallon for the 300,000 gal. facility was linked to the additional meters and a Cardtrol system[2] required to service more than one co-op. If these additional costs for multi-firm operation were not incurred, then the 300,000 gal. facility would have the lowest average construction cost at $0.49/gal. of storage (Table 4).

Labor requirements and delivery equipment typical of the four sizes of bulk fuel storage facilities are in Table 5. Costs for ownership and operation of delivery equipment were gathered for two common sizes of bulk fuel delivery trucks: 2,000 and 4,000 gal. The smaller truck was specified as either an older gas (representing a backup truck), a new gas, or a new diesel truck. The 4,000 gal. truck was specified as a new tandem axle diesel truck (Table 6).

COSTS OF OPERATION

Costs of operation for the facility and delivery trucks were based on estimates of labor and equipment requirements for the different sizes of bulk fuel facilities from state industry representatives and costs of operation from equipment suppliers. Estimates of annual bulk truck miles were established by simulating bulk fuel deliveries with a computer simulation model for different sizes of sales areas (page 17). Costs presented in this section are summarized in Table 7.

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[2] A Cardtrol system is an electronic accounting/billing system that tracks by account. This allows multiple co-ops to track inventories utilized by each co-op.

Table 4. Construction costs for 4 sizes of bulk fuel storage facilities, North Dakota, 1992.

Item	Bulk fuel storage facility size (gal.) 50,000		70,000		130,000	300,000
	(- - - - - - - - - - - - - - - ($) - - - - - - - - - - - - - - -)					
Tanks	15,876		20,250		30,870	62,950
Freight for tanks	1,058	2,115	2,115	3,525		
Safety equipment	7,200[a]		7,200[a]		12,240[b]	20,400[b]
Pumps	2,316[a]		2,316[a]		3,937[b]	7,874[b]
Piping	4,200[a]		4,200[a]		7,140[b]	23,800[b]
Load-out dock	2,450	2,450	2,450	4,900		
Labor	6,000	6,000	6,000	8,000		
Site preparation	500		500		500	1,000
Secondary liner	5,500	5,500	5,500	9,066		
Concrete loading dock	500		500		500	1,000
Electrical wiring	2,000		2,000		2,000	4,000
Subtotal	47,600		53,031		73,252	146,515
Construction cost/gal.	.95		.76		.56	.49
Meters and Cardtrol system	--0--		--0--		--0--	30,000[c]
Total construction cost	47,600		53,031		73,252	176,515
Construction cost/gal.	.95		.76		.56	.59
Depreciation/yr.	2,830		3,120		4,113	9,276
Land: acres	3		3		3	3
Cost (range[d]) $59.82 to $679.32						

[a] 2" piping.
[b] 3" piping.
[c] Required to serve more than one co-op.
[d] Range in cost is to accommodate differences in sales density.
Sources: Oday Equipment, Inc., Sprecher.

Table 5. Labor and bulk fuel truck specifications for 4 sizes of bulk fuel facilities, North Dakota, 1992.

Item	Salary or cost	Number by facility size (gal.) 50,000	70,000	130,000	300,000
Labor	(- - - $ - - -)				
General Manager*	25-40,000	.5	.5	.5	.5
Bookkeeper	14,560	0	1	1	1
Part-time bk. keeper	6,760	0	0	1	
Supervisor/drivers	21,000	.75	1.5	3	6
Trucks (size-gal.-type)**					
2,000-new-gas	53,396	1	1	1	2
2,000-used-gas	27,000	0	1	0	0
2,000-new-diesel	59,396	0	0	0	0
4,000-new-diesel	94,302	0	0	1	2

* $5,000 increments for each larger size.
** Cost of tank and chassis.
Sources: Hall GMC, Oday Equipment, Inc, and Fuller.

Facilities

Depreciation

Annual depreciation for the bulk fuel storage facility was based on the total cost of construction (Table 4), assuming straight-line depreciation and zero salvage value. The facility was expensed over a 20 year period. Bulk trucks were also depreciated using straight-line method over a 5 year period with zero salvage value (Table 7).

Facilities Maintenance and Repair

Repair and maintenance of bulk fuel storage facilities was minimal. Industry representatives indicated that pumps should last the life of the facility. The major cost for repairs and maintenance of storage facilities was cleaning out tanks at $200 per tank (Sprecher). Tanks should be cleaned out at least once every 5 years.

Facility and Liability Insurance

Insurance costs were developed for each facility following typical coverage levels of local co-ops. A local insurance representative who routinely insures cooperative bulk fuel storage facilities supplied a yearly insurance cost for each of the 4 bulk fuel facilities. Costs were estimated for each facility assuming a coverage level for liability equivalent to industry practice ($1 million), delivery equipment contained in each facility, and average levels of inventories representative of local co-op insurance levels (Geistler). Changes in the insurance expense across the 4 facilities largely reflects changes in equipment complements and expected inventory levels.

Table 6. Assumptions and costs for bulk fuel delivery trucks, North Dakota, 1992.

Item	Capacity (gal.) 2,000 (condition/fuel) used/gas	new/gas	new/diesel	4,000 new/diesel
Mpg	5	5	7.5	7.5
Fuel cost ($/gal.)	1.135	1.135	0.9911	0.9911
Lubrication cost (% of fuel cost)	15	15	15	15
Truck costs ($)				
Chassis[1]	12,000	23,396	29,396	49,302
Tank[2]	15,000	30,000	30,000	45,000
Total	27,000	53,396	59,396	94,302
Operating costs/mile ($)				
Fuel and oil	.2622	.2622	.1196	.1196
Maint. & repairs[1]	.0350	.0350	.0350	.0350
Tires[3]	.0307	.0307	.0307	.0599
Total	.3279	.3279	.1853	.2145
Fixed costs per year ($)				
Depreciation	5,400	10,679	11,879	18,860
Insurance[4]	584	584	584	584
License[5]	229	229	229	609
Opportunity cost	1,850	3,658	4,069	6,460
Total	8,063	15,150	16,761	26,513

[1] Hall GMC.
[2] Oday Equipment, Inc.
[3] Brad Ragan Inc.
[4] Gary Geiszler.
[5] Cass County Motor Vehicle Department.

Table 7. Fixed and variable (with respect to volume and distance) costs for facilities and bulk trucks by size of sales area, by size of bulk fuel storage facility, North Dakota, 1992.

Item	Bulk fuel storage facility size (gal.) 50,000	70,000	130,000	300,000
Fixed costs for facilities	(- - - - - - - - - - - - - - - - $ - - - - - - - - - - - - - - - -)			
Depreciation - facility	2,830	3,102	4,113	9,276
Facilities repair & maintenance	240	240	240	400
Insurance: Facility	223	437	671	1,191
Board of directors	1,000	1,000	1,000	1,000
Tank license	450	450	450	750
Labor				
Salaries and wages	28,250	61,060	95,060	167,320
Benefits	10,647	24,444	37,237	65,924
General office expense	807	1,744	2,684	4,717
Opportunity cost				
Land and facility	3,894	4,266	5,652	12,766
Working capital	224	484	744	1,308
Total	48,566	97,227	147,851	264,651
Fixed costs for bulk trucks				
Depreciation - trucks	10,679	16,079	29,540	59,079
Truck licenses	229	458	838	1,676
Insurance - trucks	584	876	1,168	2,336
General office expense	241	476	861	1,723
Opportunity cost: Trucks	3,658	5,507	10,117	20,235
Working capital	69	118	187	374
Total	15,459	23,514	42,711	85,423
Costs per gallon for facilities and delivery trucks that vary with volume				
Office supplies (2% opr. costs)	.000103	.000103	.000054	.000054
Utilities	.000029	.000029	.000036	.000036
Fuel and oil	.004460	.004460	.002032	.002032
Delivery trucks - repair & maintenance	.000597	.000597	.000597	.000597
Opportunity cost - working capital	.000028	.000028	.000014	.000014
Total	.005113	.005113	.002679	.002679
Costs per mile for delivery trucks that vary with distance				
Fuel and oil	.2616	.2616	.1972	.1972
Tires	.0307	.0307	.0599	.0599
Repair & maintenance	.0350	.0350	.0350	.0350
Opportunity cost - working capital	.0018	.0018	.0016	.0016
Total	.3291	.3291	.2937	.2937

Tank License

North Dakota has mandated that commercial tanks must be registered with the state and that annual petroleum release insurance must be purchased from the North Dakota Tank Release Compensation Fund. This coverage costs $75 per year for each aboveground tank and $125 per year for each underground tank (North Dakota Tank Release Compensation Fund; Table 7).

Management and Labor

Labor requirements and wage rates (Table 5) for the 4 bulk fuel facilities were specified following normal industry practices in North Dakota (Fuller). All firms included a general manager. However, surveys with local cooperative managers indicated that managers were typically hired to oversee more enterprises than bulk fuel delivery. These other enterprises might include convenience stores, station stores, fertilizer facilities, and hardware or farm supply sales. For this study, managers were assumed to supply 50% of their time to the operation of the bulk fuel facility. Fuller indicated an average salary for general managers of bulk fuel facilities was $35,000. Salaries of general managers were scaled from $25,000 to $40,000 for the 4 sizes of bulk fuel facilities (Table 7).

Industry representatives indicated that bulk truck drivers were typically hired on salary for the year. If they worked outside the department, their salary was attributed to the other department (Boeshans). Therefore, bulk truck drivers were classified as full-time salaried positions. Bulk drivers' average salary was assumed to be $21,000 per year (Fuller). Workers compensation insurance for employees was specified at $6.15 per $100 of salary up to a maximum of $12,000 (North Dakota Workers Compensation Bureau). Unemployment insurance for employees was specified at $2.80 per $100 in salary up to maximum salary of $12,200 (Job Service of North Dakota). Health insurance coverage for employees varied widely; however, most co-ops provided about $400 per month in health insurance premiums for permanent employees (Hucstra). Part-time employees were not covered. Changes in labor costs across the 4 facilities largely represent changes in the number of bulk truck drivers required with changes in equipment complements (Table 7).

Office Space and General Office Supplies

Office space was generally consolidated with other enterprises. A 20' x 30' office was assumed for each of the bulk fuel facilities with construction costs of $15 / sq.ft. for materials and $15 / sq. ft. for labor (Knox Lumber). Since all the cooperative bulk fuel facilities interviewed shared office space with other enterprises, cost of construction attributable to fuel delivery was assumed to be 50% of total construction cost. A contingent amount (2% of total operating costs) was added to variable costs to represent general office expenses for supplies, utilities, and maintenance.

Land

Land requirements for the three smaller facilities were the same (3 acres) because changes in storage capacity was achieved by changing the height of the tanks. Land values varied widely across the state. Most bulk fuel facilities had land for the storage facility

located near the edge of town. To approximate the value of land for a bulk fuel cooperative's storage facility across the state, a relationship between the value of agricultural land and the density of bulk fuel sales to farmers was estimated by county across North Dakota for 1987. Land value was estimated based on the density of sales using this estimated relationship:

$$\text{Land value} = 49.32 + .105 * \text{density of sales (gallons / sq. mile)} \qquad R^2 = .785$$

This relationship allows land costs in lower sales density areas like western North Dakota to reflect a lower land charge than the higher density areas in the eastern portion of the state (Table 7). Tables and figures (e.g., Appendix Table 1 and Figure 11) reporting fixed costs with changes in sales density incorporated this relationship. Therefore, contrary to normal convention, fixed costs reflected an increase, but this increase was linked to the positive relationship between sales density and land values.

Opportunity Costs

Opportunity costs are costs representing potential income foregone by investing in land, facilities, and working capital used for day-to-day operations rather than investing in the next best alternative. July, 1993, short-term (6.53%) and long-term (6.85%) interest rates from the St. Paul Bank for Co-ops were used to calculate opportunity costs for land and equipment investment, and working capital. Working capital was assumed to equal one month of cash operating expenses. There is an upward bias in the opportunity costs because the initial purchase price, rather than the average book value, was used in the calculation of opportunity costs. This upward bias compensates for inflation.

Utilities

Nearly all utilities for bulk fuel delivery outside of general office expense was electricity for load-out fuel pumps. The size of motors required for the 4 different bulk fuel facilities were 2 horsepower for the plants with 2" load-out pipe and 5 horsepower for the facilities with 3" load-out pipe (Sprecher). A one-to-one relationship between motor horsepower and kilowatts used per hour was appropriate for estimating kilowatt/hour usage for electric motors (Hoffman). This relationship was used to calculate utility cost of operation for the 4 storage facilities. Total annual sales (gallons) were divided by gallons pumped per hour to arrive at total hours of pump use per year. This was multiplied by the average commercial cost for utilities ($0.0648/Kwhr) in North Dakota in 1992 to obtain a yearly cost for utilities (U.S. Dept. of Energy, 1992a).

Bulk Trucks

Costs for bulk truck operation were gathered for a single axle gas truck with a 2,000 gal. bulk fuel tank and a tandem axle diesel truck with a 4,000 gal. bulk fuel tank. Fuel consumption was assumed to be 5 mpg for the truck with the gas engine and 7.5 mpg for the truck with the diesel engine (Hall GMC). Conversations with local bulk fuel managers revealed different accounting practices for pricing fuel for use in bulk delivery trucks. Of those interviewed, more preferred using the same price charged to customers. Therefore,

prices for gas and diesel used by bulk trucks were the average retail prices in 1992. The retail price of unleaded regular including state and federal taxes was $1.135/gal. (U.S. Dept. of Energy, 1992b). Prices reflecting costs for diesel were only available on a regional basis. The retail price of #2 distillates in pad 2[3] including North Dakota state and federal taxes was $.9911/gal. (U.S. Dept. of Energy, 1992b). The cost for lubrication and oil was assumed to be 15% of total costs for both the gas and diesel trucks (Hall GMC). Costs for repairs and maintenance were assumed to be $.035 per mile for both gas and diesel trucks (Hall GMC). Costs for tires were assumed to be $.0307 per mile for 2,000 gal. trucks and $.0599 for 4,000 gal. trucks based on prices for new tires for each truck and a useful tire life of 50,000 miles (Brad Ragan). Truck licenses for North Dakota were $229 for the 2,000 gal. truck and $609 for the 4,000 gal. truck (Cass County Motor Vehicle Department). Annual insurance costs for bulk trucks were $584 per truck (Geistler; Table 7).

Break-even Mileage for 2,000 Gallon Bulk Trucks

An annual break-even mileage can be estimated between a 2,000 gal. gas and diesel truck because the gas truck is cheaper to purchase, but more costly to operate due to a higher cost of fuel and higher fuel consumption than the diesel truck. The annual mileage where costs of operation would be equal for both trucks can be calculated using the following formula:

$$\text{Break-even mileage} = \frac{fd - fg}{vg - vd}$$

where

fd is annual fixed cost of ownership for the diesel truck,
fg is the annual fixed cost of ownership for the gas truck,
vd is the variable cost per mile for the diesel truck, and
vg is the variable cost per mile for the gas truck.

Using fixed costs of $10,679 and $11,879 and variable costs of $.32675 and $.21767 per mile for the gas and diesel trucks, respectively, annual costs of operation for the diesel truck were lower than for the gas truck when annual mileage exceeded 14,769 miles per year (Figure 5). However, when considering changes from a 2,000 gal. truck to a 4,000 gal. truck, the added load capacity of the larger truck must be considered. The larger truck can deliver more fuel before it has to return to the storage facility for refills. This should reduce annual mileage driven for the larger truck and should become increasingly more important as the size of the sales area gets larger. These combined effects are examined at page 17.

[3] Pad 2 represents the region of North Dakota, Minnesota, Wisconsin, Nebraska, South Dakota, Iowa, and Illinois.

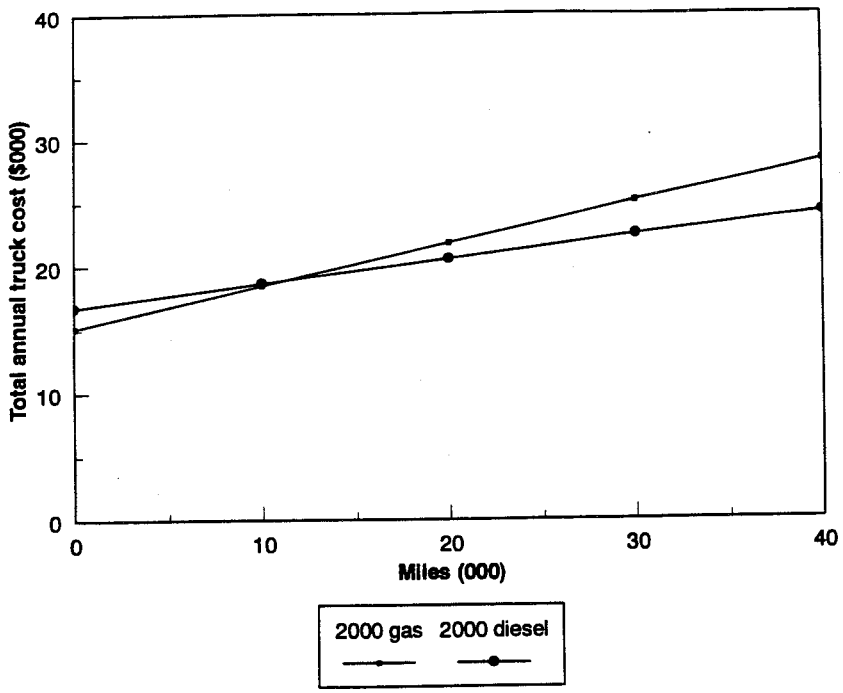


Figure 5. Annual truck costs for 2,000 gallon bulk truck by miles and engine type, 1992.

Simulation of Bulk Fuel Delivery

Costs for bulk truck operation were gathered on a per mile basis. However, annual mileage required to deliver fuel increases with the size of the sales area. To calculate annual mileage, a relationship between miles driven and the size of sales area was needed. Mileage for bulk fuel delivery was estimated by simulating delivery of fuel for 5 sizes of sales areas (5, 12, 20, 35, and 50 mile radius). To aid in computation, a square grid was assumed as a substitute for a circular sales area. The width and length of the grid was assumed to be equal to the diameter of the proposed sales area. In the remainder of this section, one-half of the width of the grid will be referred to as the radius of the sales area.

Locations of bulk fuel deliveries within this grid were established using a random number generator where each location (grid point) within the sales area had an equal chance of being selected. Sizes of fuel drops were also generated at random assuming a normal distribution of drop sizes. Drop sizes for the 2,000 gal. bulk truck were assumed to be normally distributed with 95% of the observations from 200 to 2,000 gal. with a mean of 1,100 gal. Drop sizes for the 4,000 gal. truck were assumed to be normally distributed with 95% of the observations within 200 to 3,000 gal. with a mean of 1,600 gal. These assumptions allowed the larger truck to make larger drops than the smaller truck at specific sites. Drops larger than 2,000 gal. would be represented by multiple loads. However, with the 4,000 gal. truck, drops larger than 2,000 gal. would be possible. Drops larger than 3,000 gal. were not considered because these drop sizes start to approach half tanker and tanker lots delivered directly to the farm.

Deliveries were structured to consolidate them within an area and allow the bulk truck to deliver a full load before returning to the bulk facility. Mileage, gallons delivered, and total hours (driving + loading + unloading times) were estimated for deliveries of bulk fuel throughout the day based on load-out capacities, unloading capacities, average truck speed, and efficiency of loading and unloading (Table 8). Loading and unloading times for bulk trucks were increased by 20% to compensate for the time involved in positioning the truck and hoses at the farm and storage facility. Once hours had accumulated where another delivery could not be made within an 8-hour time frame, the simulation was stopped and gallons delivered, total hours, hours unloading, and miles driven for the day were recorded. Simulations were run 10 times for each sales area, facility load-out pipe size, and truck capacity (2,000 and 4,000 gal.). Means of these 10 simulations were used to represent actual hours and mileage for each size of sales area, truck capacity, and facility load-out pipe size (Table 9). A total of 200 simulations were run.

The results of the simulation indicated that as the radius of the sales area was increased from 5 to 50 miles, gallons delivered per day for a 2,000 gal. bulk truck with a 2" load-out pipe at the storage facility decreased from 9,900 to 3,620 gal. per day (Figure 6). When the radius of the sales area was 50 miles, deliveries per day for all truck sizes approached one truckload per day. As firms moved from 2,000 to 4,000 gal. bulk trucks, gallons delivered per day increased an average of 1,600 gal. for facilities with 2" load-out pipe to an average of 2,000 gal. per day for facilities with 3" load-out pipe. Increased deliveries associated with load-out pipe size were dependant on the size of sales area.

Table 8. Assumptions for simulation of mileage, gallons per day, hours, and unloading hours, bulk fuel delivery, North Dakota, 1992.

Item	Amount
Percent of loads diesel	50 %
Unloading time	
gasoline	45 gal/min
diesel	65 gal/min
average	55 gal/min
Loading time	
2" load-out pipe	100 gal/min
3" load-out pipe	200 gal/min
Average truck speed	45 mph
Loading & unloading efficiency	80 %

Table 9. Simulated daily gallons delivered, hours per day, miles driven, and unloading hours by sales area, truck capacity, and facility load-out pipe size, North Dakota, 1992.

Truck/load-out configuration/ Radius of sales area (miles)	Gallons delivered	Total hours/ day	Miles driven	Unloading hours
2000 gallon truck - 2" load-out pipe				
5	9,900	7.54	77.6	3.75
12	7,850	7.53	132.2	2.97
20	6,160	7.44	172.0	2.33
35	4,340	7.41	218.8	1.64
50	3,620	7.84	258.4	1.37
4000 gallon truck - 2" load-out pipe				
5	11,460	7.84	50.0	4.34
12	9,260	7.58	96.4	3.51
20	7,970	7.38	121.6	3.02
35	6,230	7.80	186.6	2.36
50	5,200	7.52	201.2	1.97
2000 gallon truck - 3" load-out pipe				
5	11,730	7.78	95.2	4.44
12	9,010	7.85	157.2	3.41
20	7,010	7.74	196.0	2.66
35	5,120	7.88	234.4	1.94
50	3,830	7.78	265.6	1.45
4000 gallon truck - 3" load-out pipe				
5	13,160	7.74	62.2	4.98
12	11,230	7.81	107.6	4.25
20	9,270	7.86	152.4	3.51
35	7,130	7.80	196.0	2.70
50	6,100	7.90	222.8	2.31

As sales areas increased from a radius of 5 miles to 50 miles, the difference in gallons delivered per day by trucks from facilities with 2" and 3" load-out pipes declined from 1,800 to 200 gal. per day for 2,000 gal. trucks. These results indicated some trade-offs. A 2,000 gal. truck with a 3" load-out pipe at the storage facility in a sales area with a 5 mile radius should be able to deliver more fuel per day than a 4,000 gal. truck with a 2" load-out pipe. This could occur because bulk fuel drivers in a small sales area spend most of their time

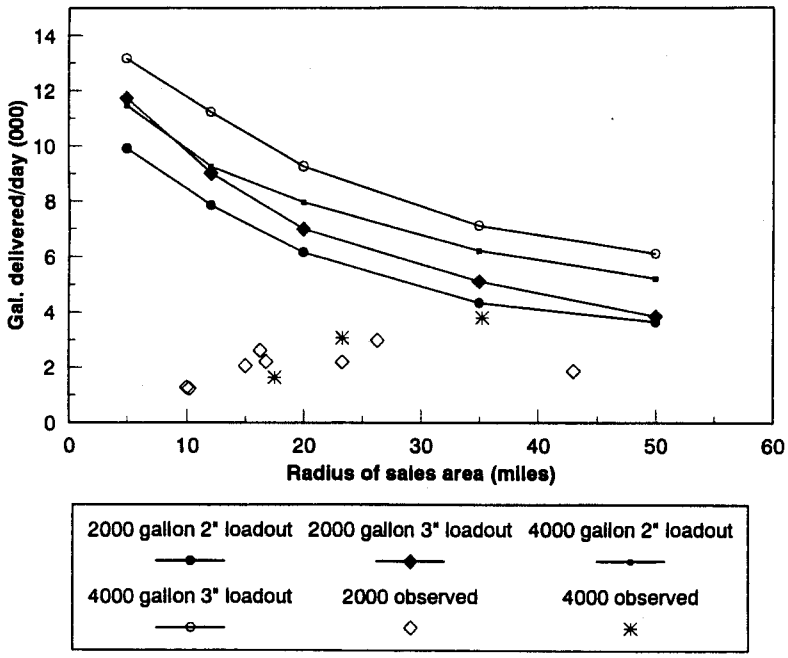


Figure 6. Maximum and observed gallons delivered per day for selected truck and load out pipe sizes, and by radius of sales area.

loading and unloading fuel. The time savings obtained with the larger load-out pipe size more than compensates for the added load capacity of the larger truck. However, when the radius of the sales area was increased beyond 5 miles, time savings obtained with a larger load-out pipe were more than offset by the increase in driving time required by the smaller truck due primarily to its smaller capacity. Thus, the larger truck was able to deliver more fuel per day regardless of load-out pipe size for sales areas larger than 5 miles in radius.

Average daily gallons delivered were calculated for the 11 co-ops surveyed assuming 5.5 days per week and an 8 hour day based on the radius of their sales area. Average gallons delivered per day for both 2,000 and 4,000 gal. bulk trucks indicated a surplus of delivery capacity at all sites (Figure 6). In most cases, the cooperatives surveyed were running at about 50% of capacity or less. This result was not surprising since all of the co-ops surveyed indicated few, if any, stress days.

Delivery Miles and Radius of Sales Area

Functional relationships for miles driven (Table 10) were estimated between simulated results for bulk truck mileage and the radius of sales area for the 4 combinations of truck and facility load-out pipe sizes. The equation for each truck/pipe size configuration was:

Miles driven per gallon = ($b0_{ab}$ + $b1_{ab}$ * radius of sales area (miles)

where

$b0_{ab}$ = intercept coefficient for truck capacity (a) and load-out pipe size (b)

$b1_{ab}$ = slope coefficient for truck capacity (a) and load-out pipe size (b)

Table 10. Regression equations for estimating miles driven per gallon from radius of sales area, by bulk truck capacity and facility load-out pipe size, North Dakota, 1992.

Truck capacity	Load-out pipe	BO_{ab}	$B1_{ab}$	r^2
2000	2"	.000036	.001427	.999
4000	2"	.000708	.00078	.992
2000	3"	.001058	.001339	.997
4000	3"	.001473	.000716	.997

These 4 functional relationships were used in the following analyses to estimate annual mileage for various levels of annual sales and equipment complements. For example, a 2,000 gal. bulk truck with a 2" load-out pipe and a sales area 20 miles in radius would drive 0.0286 miles for every gal. delivered:

0.0286 miles/gal. = (.000036 + .001427 * 20)

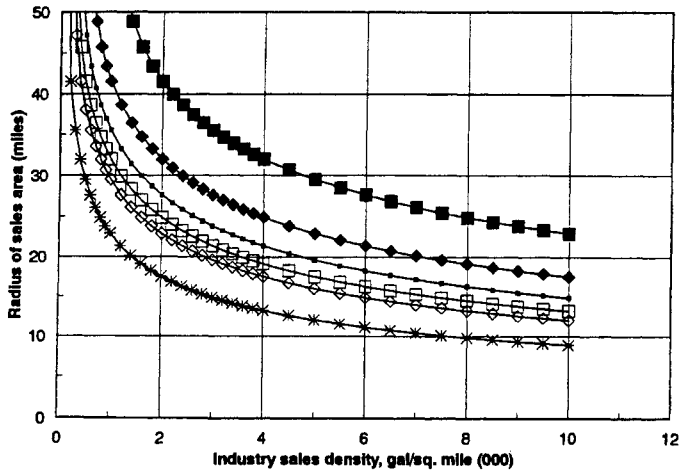
If total annual sales were 800,000 gal., then the estimated annual mileage for this bulk truck was 22,861 miles.

Expanding Sales Area

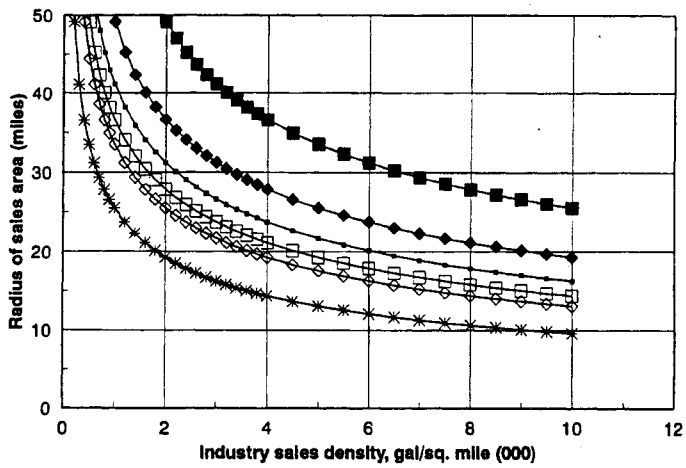
The annual capacity constraints of bulk fuel delivery equipment were examined to determine the physical potential to expand sales areas. Annual delivery capacities for 2 truck and load-out pipe sizes were equated to the maximum amount of sales that could be obtained by a cooperative within a sales area to determine the largest radius of sales area that could be serviced with each equipment complement. Since, in most cases, a single firm cannot be expected to capture 100% of the sales within a given area, the maximum sizes of sales areas were estimated for a range of market shares and sales densities common to counties within North Dakota (Figure 7).

Counties in North Dakota in 1987 had average total bulk fuel sales to farms ranging from 884 to 6,425 gal./sq. mile. A firm located in a sales region where total sales by all firms were 1,000 gal./sq. mile (similar to many counties in western North Dakota) with a 2,000 gal. bulk truck and 30% market share could service a sales area up to a 36 mile radius. Increasing the firm's market share to 50% would reduce the size of the sales area that this firm could service to a 30 mile radius. Moving to a 4,000 gal. truck with 30% market share would allow the firm to service a sales area up to a 42 mile radius. Or increasing the size of the load-out pipe at the storage facility would increase the radius of sales area that could be serviced by about 1 to 2 miles.

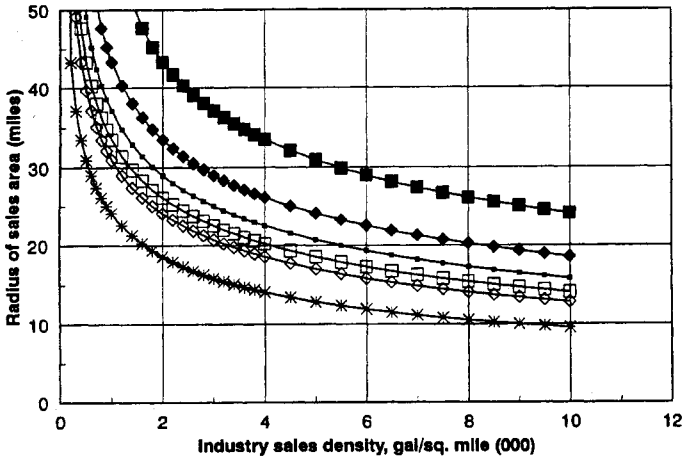
Firms located in an area where total sales by all firms were 2,000 to 3,000 gal./sq. mile (similar to some counties in central North Dakota) with a 30% market share could service a sales



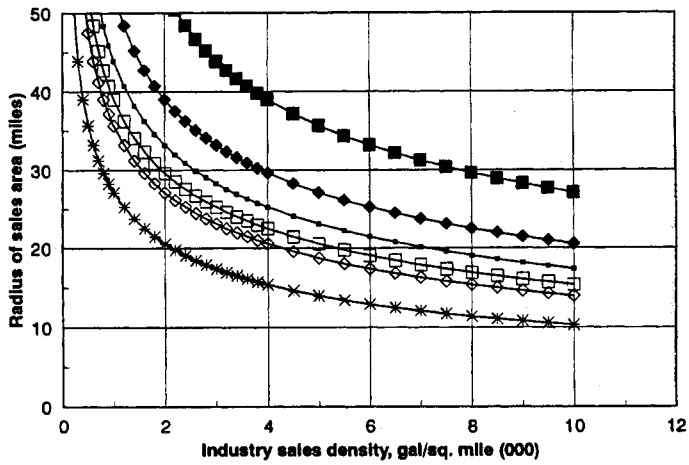
Panel A. 2,000 gal. truck
2-inch load-out pipe



Panel B. 4,000 gal. truck
2-inch load-out pipe



Panel C. 2,000 gal. truck
3-inch load-out pipe



Panel D. 4,000 gal. truck
3-inch load-out pipe

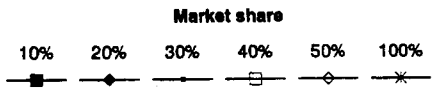


Figure 7. Optimum (truck at capacity) size sales area for specified size of bulk truck, load-out pipe, market share and industry sales density assuming evenly distributed sales throughout the year, North Dakota, 1992. Source: Appendix Tables 1-5.

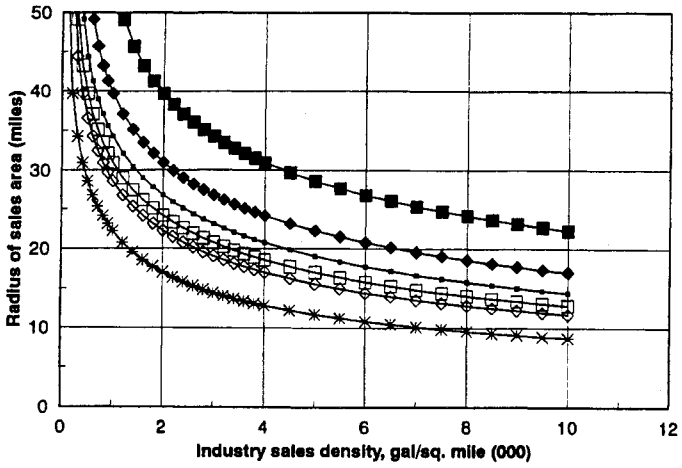
area with a radius of 25 to 28 miles. Increasing the market share up to 50% would reduce the radius of the sales area that could be supplied by about 2 miles. Firms supplying fuel in areas with high densities of sales similar to some eastern counties (5,000 to 6,000 gal./sq. mile) could service sales areas 18 to 20 miles in radius with a 30% market share.

As a firms' market share increased or as the density of total bulk fuel sales increased, the maximum radius of sales area that could be serviced decreased. Furthermore, the change in the radius of sales area required to operate equipment at capacity decreased as the actual level of market share increased. Thus, if firms operating at capacity lose market share, firms with smaller market shares will have to increase the size of their sales area more than firms operating with higher market shares to maintain operations at or near capacity. However, this analysis assumed that sales were evenly distributed throughout the year. Most firms experienced some measure of seasonality of sales due to the seasonal nature of fieldwork. This will reduce the size of the sales area that could be supplied with a given bulk truck. For example, if, on average, bulk trucks were operated at 80% of capacity throughout the year, the radius of the sales area that could be supplied would be reduced by an average of 1.5 to .5 miles for most of the bulk truck complements (Figure 8). However, peaks could be handled by overtime or by pressing backup trucks into service as an alternative to reducing sales area. An indepth analysis of seasonality was beyond the scope of this analysis.

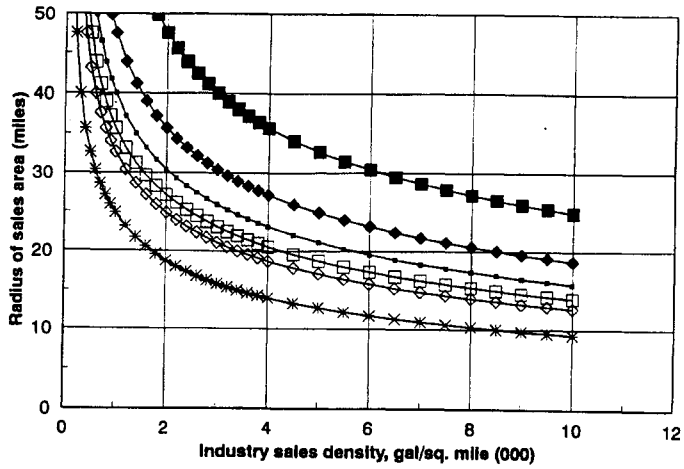
Increasing Market Shares

Capacity constraints of delivery equipment were examined to determine the potential to increase market shares within a given sales area. The physical potential to expand market shares was established by equating annual capacities for various equipment configurations to the total amount of sales that could be obtained within a sales area. Maximum market shares were estimated for various sizes of sales areas and a range of sales densities common to North Dakota (Figure 9).

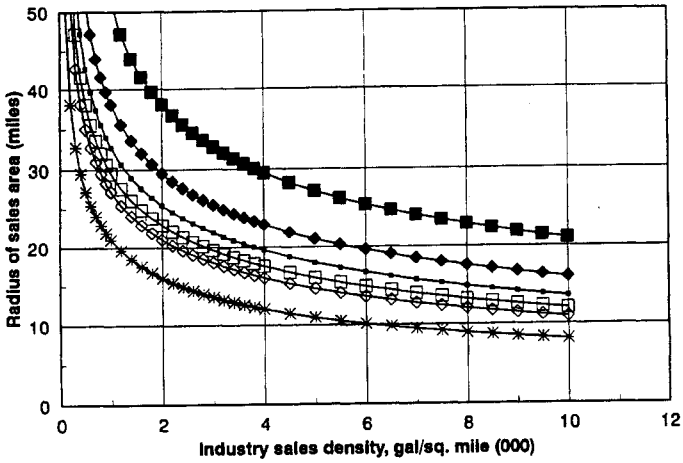
Firms operating in an area with a total sales density of 1,000 gal./sq. mile with a 2,000 gal. bulk truck and a sales area 40 miles in radius could service up to 21% of the market for bulk fuel sales. Movement to a 4,000 gal. truck would increase the maximum market share that could be serviced to 36%. Firms, with sales densities of 2,000 and 3,000 gal./sq. mile (similar to central North Dakota), a 2,000 gal. bulk truck, and a sales area 20 miles in radius could service up to 65 or 48% of the bulk fuel market, respectively. Firms in higher sales density markets, 5,000 to 6,000 gal./sq. mile, with a 20 mile radius sales area could only capture 30 to 25% of the market, respectively. Here again, as radius of the sales area decreased or as truck or load-out pipe sizes increased, the maximum market share that could be serviced increased. This analysis also assumed that sales were evenly distributed throughout the year. Calculations using this unrealistic assumption was made to provide a standard for comparisons. If, for example, the seasonality of sales were to reduce the capacity of the bulk truck to 80%, maximum market shares for the 4 combinations of bulk fuel trucks and load-out pipes were reduced by approximately >1 to 10% within the relevant range of sales densities and market shares (Figure 10).



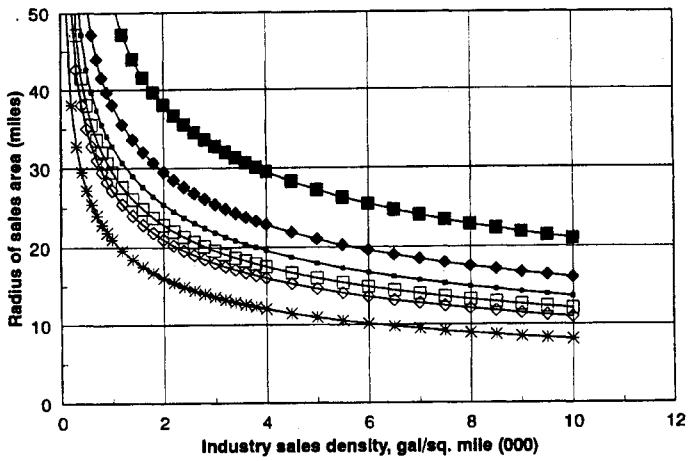
Panel A. 2,000 gal. truck
2-inch load-out pipe



Panel B. 4,000 gal. truck
2-inch load-out pipe



Panel C. 2,000 gal. truck
3-inch load-out pipe



Panel D. 4,000 gal. truck
3-inch load-out pipe

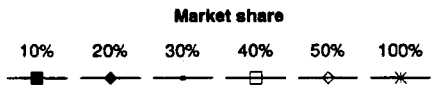
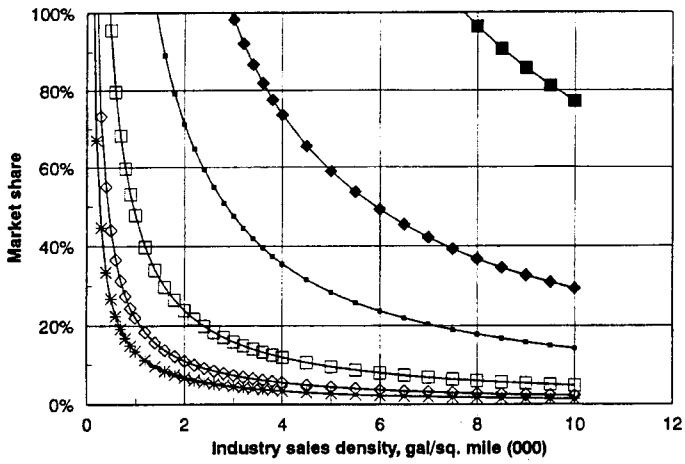
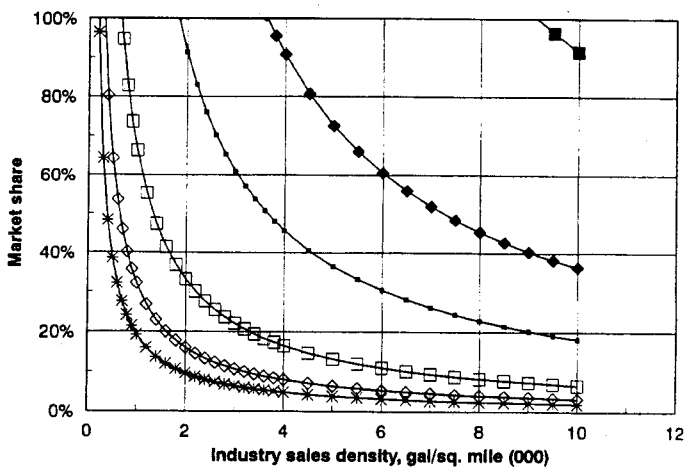


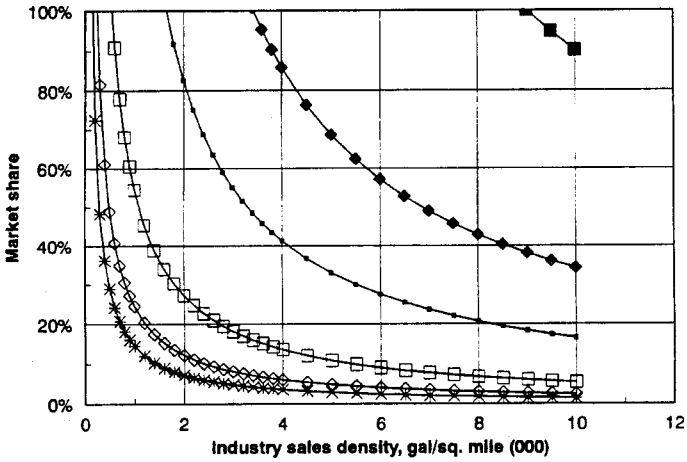
Figure 8. Optimum size sales area for specified size of bulk truck, load-out pipe, market share, and industry sales density and operating at 80% capacity. Source: Appendix Table 1-5.



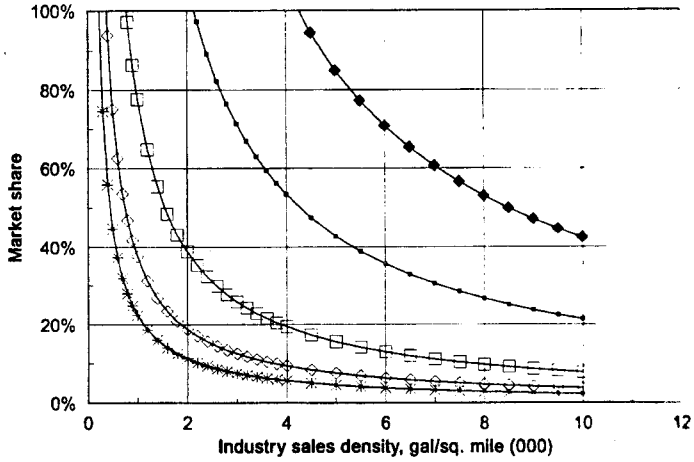
Panel A. 2,000 gal. truck
2-inch load-out pipe



Panel B. 4,000 gal. truck
2-inch load-out pipe



Panel C. 2,000 gal. truck
3-inch load-out pipe



Panel D. 4,000 gal. truck
3-inch load-out pipe

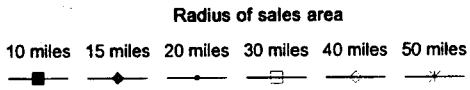
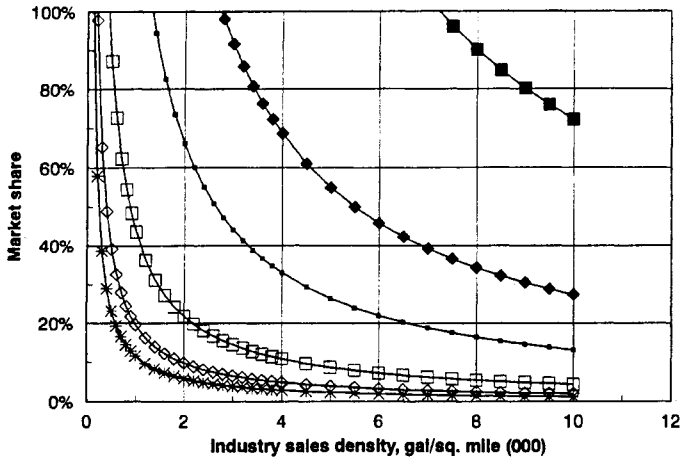
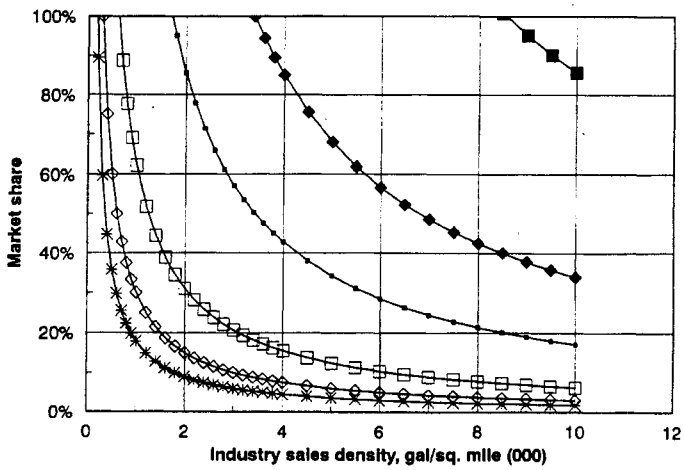


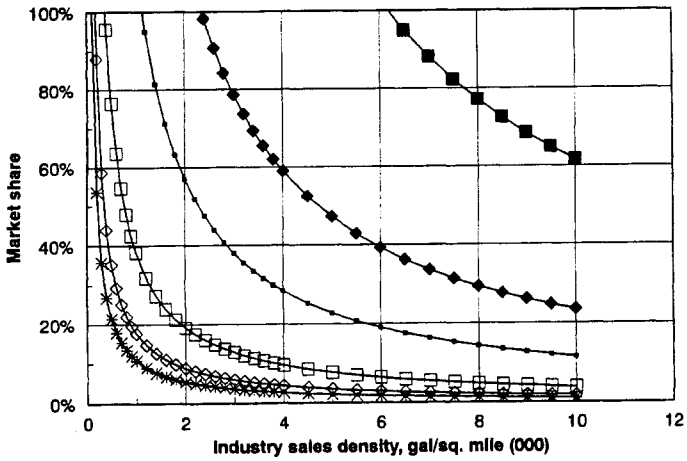
Figure 9. Optimal (truck operating at capacity) market share for specified size of bulk truck and load-out pipe by fuel sales density and sales area size assuming uniform sales throughout the year. Source: Appendix Tables 1-5.



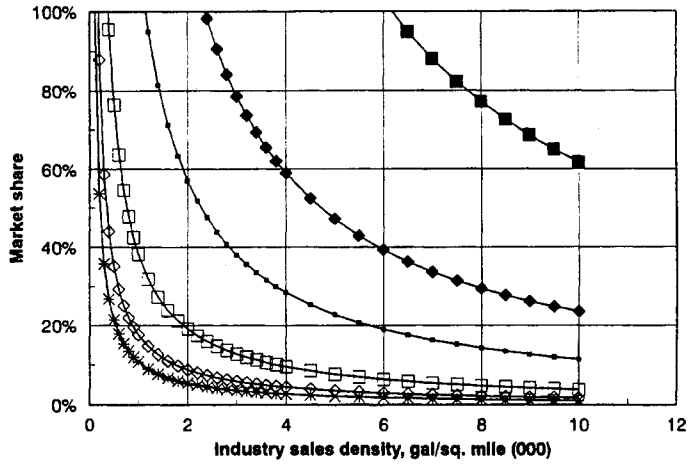
Panel A. 2,000 gal. truck
2-inch load-out pipe



Panel B. 4,000 gal. truck
2-inch load-out pipe



Panel C. 2,000 gal. truck
3-inch load-out pipe



Panel D. 4,000 gal. truck
3-inch load-out pipe

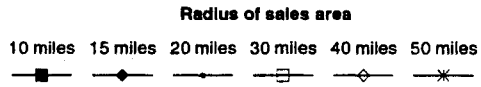


Figure 10. Optimal market share for specified size of bulk truck and load-out pipe by fuel sales density and sales area size and operating at 80% capacity, North Dakota, 1992.

Since most of the bulk fuel managers had few stress days and average daily gallons delivered for these co-ops were running at 50% of capacity or less, strategies to increase annual sales could be achieved at most local bulk fuel cooperatives. These strategies could include increasing market share and/or increasing the size of the sales area. Firms currently operating can increase market share or the size of sales area through either competitive means (pursuing competitive pricing strategies or promoting quality of service, quality of products, and/or timeliness of deliveries) or restructuring strategies (acquisition of competitors, consolidation, joint ventures, and cooperative agreements).

Firms with a sales area radius less than 10 to 15 miles and in high density markets (5,000 to 6,000 gal./sq. mile) and 20 to 30 miles in low density areas of North Dakota (>1,000 gal./sq. mile) will have a hard time achieving capacity of their delivery equipment. These firms would have to obtain market shares of 50 to 100% to approach the capacity of their delivery equipment. Therefore, to increase sales, they may want to focus on increasing the size of their sales area.

If farmer-owned bulk fuel cooperatives have overlapping trade areas and neither is operating at or near capacity of its delivery equipment, a single firm may be able to service the trade area that both cooperatives supply. In this type of situation, acquisition by one of the remaining cooperatives, mergers which consolidate facilities and equipment, pairing relationships, or joint ventures between cooperatives may be considered. The potential to do this will depend on the degree that sales areas overlap, the size of sales areas involved, total sales and market shares for each of the individual cooperatives, facilities and delivery equipment complements in the resulting firm(s), and the cost savings or efficiencies that can be achieved by increasing sales levels. However, operating equipment at or near annual capacity in a firm with highly seasonal sales may incur additional costs, such as overtime, offsetting to some extent these gains.

COST ANALYSIS

Costs of operation for bulk fuel cooperatives were analyzed to determine the importance of fixed and variable costs and to identify the impact of varying facility size, trade area size, sales density, annual sales volume, and delivery equipment complement on costs of bulk fuel delivery. This analysis examined costs for delivery of bulk fuel in two ways. First, costs were compared for 4 sizes of bulk fuel facilities with specific equipment complements. Second, costs of each facility size were compared with a variety of delivery equipment configurations.

In the first section, total annual fixed and variable costs were reported for 4 sizes of facilities, then by sales area size, next by facility size, and finally by increasing annual sales assuming a constant sales density.

The second section examined costs for a 70,000 gal. facility with 4 delivery equipment combinations. In this section, per unit costs were examined for a 70,000 gal. facility with 2" and 3" load-out pipes and one-2,000; two-2,000; one-4,000; or two-4,000 gal. bulk trucks

assuming a fixed sales density. Finally, average total costs for each equipment complement were examined in combination with sales area size and density. Costs were not reported beyond the physical capacity of the delivery equipment.

Total Annual Costs

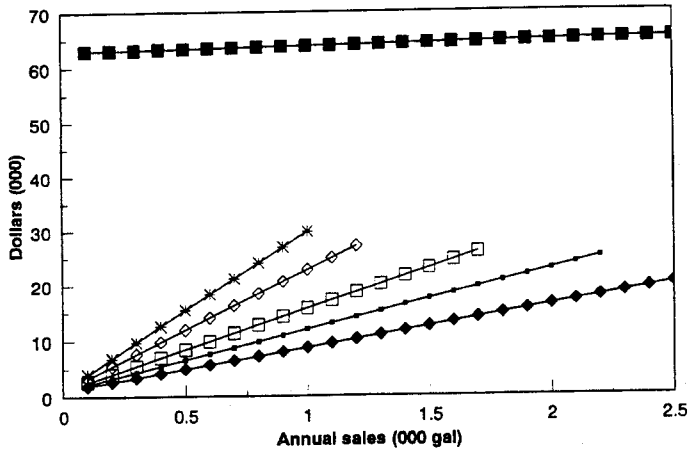
Annual costs were estimated for the 4 sizes of bulk fuel facilities for sales areas with a radius of 5, 12, 20, 35, and 50 miles (Appendix Tables 1-5 respectively)across a range of annual sales volumes and associated sales densities. Annual volumes were increased until distribution equipment capacity was reached. Therefore, many of the costs reported in these tables are for sales densities in excess of those reported for North Dakota. Costs were calculated using cost estimates from Table 7 and the functional relationships for estimating annual mileage (Table 10). Variable costs were split between those that vary with the volume of sales [costs for utilities at the bulk fuel storage facility and costs for unloading fuel (truck running time)] and those that vary with the radius of the sales area (cost of driving to and from farms).

Total variable costs were overshadowed by the fixed costs of operation for facilities and bulk trucks regardless of the size of the facility (Figure 11). Therefore, average costs were volume sensitive. Furthermore, variable costs associated with distances were an even smaller share of total costs. As a result, economies achieved by increased volume as a direct result of increasing market size overshadowed minor increases in distribution costs. For example, a 70,000 gal. facility with 1,000,000 gal. in annual sales had fixed costs of $119,338. Variable costs, depending on the size of the sales area, ranged from $9,784 to $31,309 for a 5 and 50 mile radius sales area, respectively. As the radius of sales areas increased, assuming a correspondingly lower sales density, total variable costs increased more rapidly, and the capacity of the delivery equipment was reached at lower annual sales volumes. Since, in this case, the larger facilities were specified with more delivery equipment with larger capacities, they reached the capacity of their delivery equipment at higher levels of annual fuel sales.

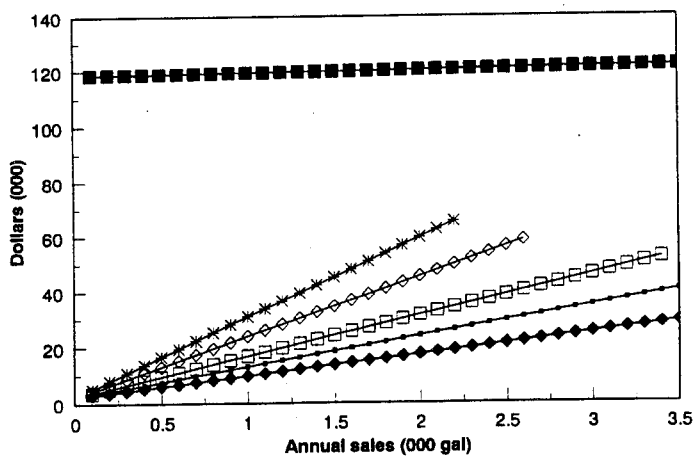
Variable costs as a proportion of fixed costs declined as the size of facility increased. In the case of the 70,000 gal. facility with 1 million gal. in annual sales, the variable costs for the 50 mile radius sales area were about 1/4 the level of fixed costs. The variable costs for the 50,000, 70,000, 130,000, and 300,000 gal. facilities were generally less than 50, 40, 30, and 20% of fixed costs, respectively. Thus, fixed costs dominated the cost of bulk fuel delivery.

Average Total Costs

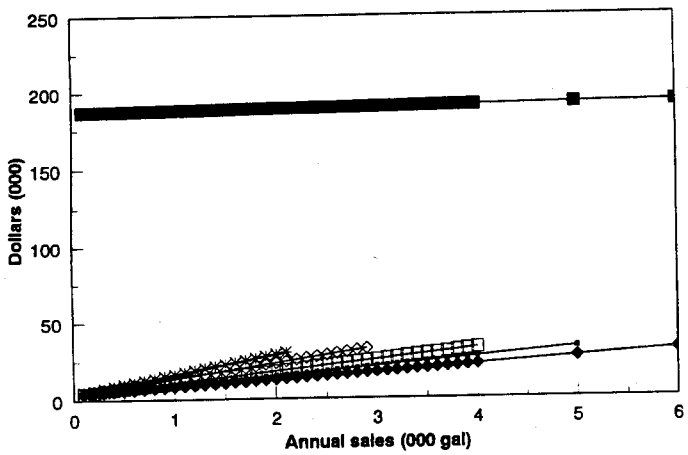
Comparisons of average total delivery costs were made to highlight the effect of size of sales area, size of facility, and annual sales volume on delivery costs (Figure 12). Average total costs did not appear to increase significantly as size of sales area is increased, while maintaining constant total sales. Again, variable costs directly attributable to distance was a small portion of total costs. For example, a firm with a 70,000 gal. facility and 1



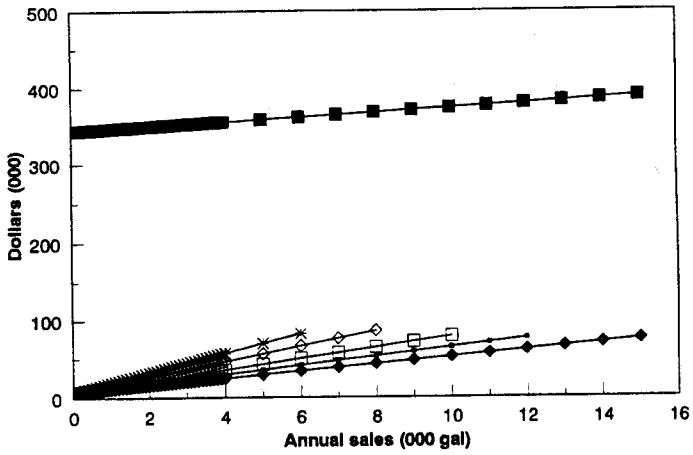
Panel A. 50,000 gal. facility



Panel B. 70,000 gal. facility



Panel C. 130,000 gal. truck



Panel D. 300,000 gal. truck

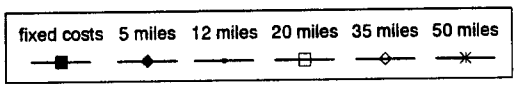
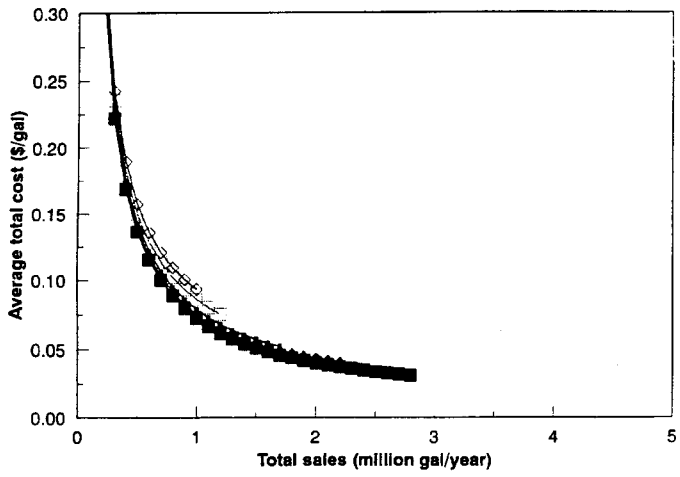
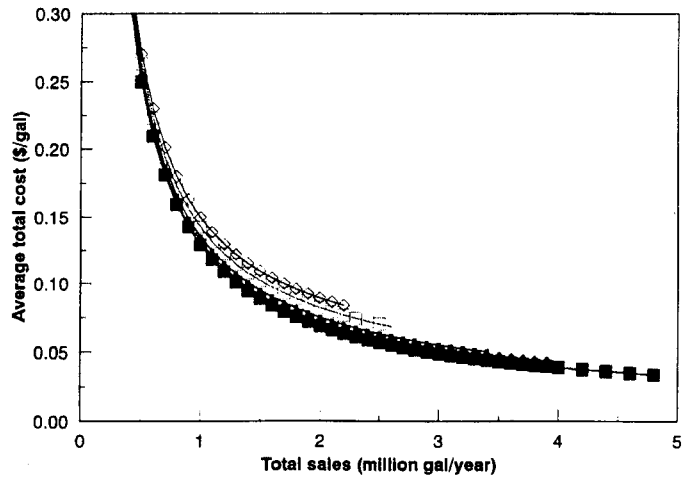


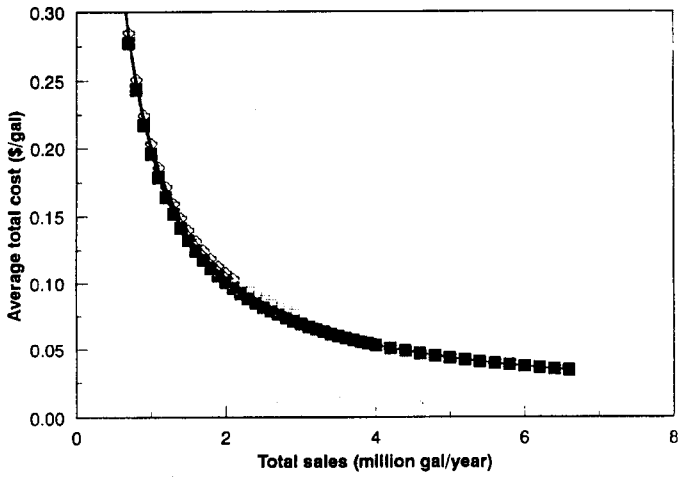
Figure 11. Fixed and variable costs for specified radii of sales area and facility size, North Dakota, 1992. Changes in fixed costs reflect assumed positive relationship between facility land cost and sales density. Source: Appendix Tables 23-26.



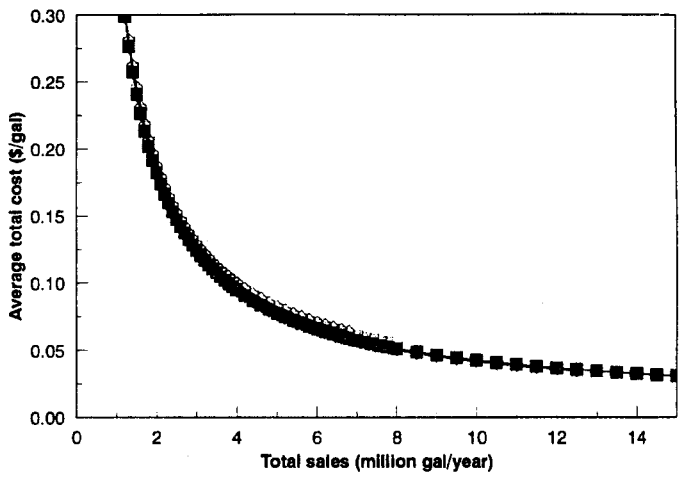
Panel A. 50,000 gal. facility



Panel B. 70,000 gal. facility



Panel C. 130,000 gal. truck



Panel D. 300,000 gal. truck

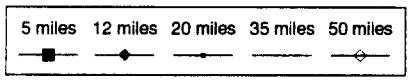


Figure 12. Average total cost for specified size of bulk storage facility, by radius of sales are, North Dakota, 1992.

million gal. of annual sales would have an average total cost of $.129, $.132, $.135, $.143, or $.150/gal. delivered for sales areas of 5, 12, 20, 35, and 50 miles in radius, respectively (Figure 13; Appendix Tables 1-5). Thus, by increasing the radius of the sales area from 5 to 50 miles (which results in a trade area that is 100 times larger), average total costs increased by $.021/gal. This difference in average total costs between sales areas of 5 and 50 miles held for all 4 facilities and sales volumes examined (Figure 14). Therefore, the effects of extending the size of a firm's sales area on average costs were minimal. The effect of increasing the size of sales area is largely reflected in a reduction in the maximum amount of sales that can be physically delivered.

Average total costs were examined to determine the effect of facility size on costs for a range of sales area sizes (radius of 5, 12, 20, 35, and 50 miles; Figure 15). The lowest average cost facility for each size of sales area was the smallest facility where annual sales did not exceed the yearly capacity of the bulk fuel delivery equipment. For example, a firm with 1 million gal. of annual sales in a 20 mile radius sales area would have average total costs per gallon of $.078, $.135, $.197, or $.356 for a 50,000, 70,000, 130,000, or 300,000 gal. facility, respectively (Appendix Table 3).

These findings indicated that the least cost facility for any level of annual sales was the smallest facility that will allow for adequate liquidity of fuel supplies. Small storage facilities, e.g. 50,000 gal., placed little or no restriction on operations. Obtaining fuel from terminal suppliers was not a problem (Fuller). Deliveries from terminals were reliable and could be obtained on a timely basis.

Many bulk fuel cooperatives in North Dakota have storage facilities larger than 50,000 gal. These firms must be considering other factors when determining how much storage to build. Fuller indicated that most firms sold their fuel on margins over cost; however, a few firms also sold on price appreciation of fuel inventories. Therefore, some firms may view price appreciation as an appropriate rationale for increasing storage capacity. Furthermore, storage facilities have a useful life of 20 to 30 years. Firms deciding on how large a storage facility to construct must consider the availability of fuels many years in advance. Thus, the decision on how large a facility to construct was a response to the assessment of the potential risk by the firms' manager and board at the time the facility was constructed. Therefore, an explanation for the large sizes for storage facilities is that firms perception of the availability of fuels may have changed, especially for firms constructing facilities during times when availability of fuels may be limited, like the late 1970s. Firms expecting a situation of high liquidity of supplies would move toward constructing smaller storage facilities, and firms expecting fuel deliveries to become less reliable would move toward constructing larger facilities.

Constant Sales Density

The impact of alternative equipment and facility configurations on average total costs were evaluated assuming a constant sales density (Figure 16). This scenario assumed that changes in annual sales would require corresponding changes in the size of an individual

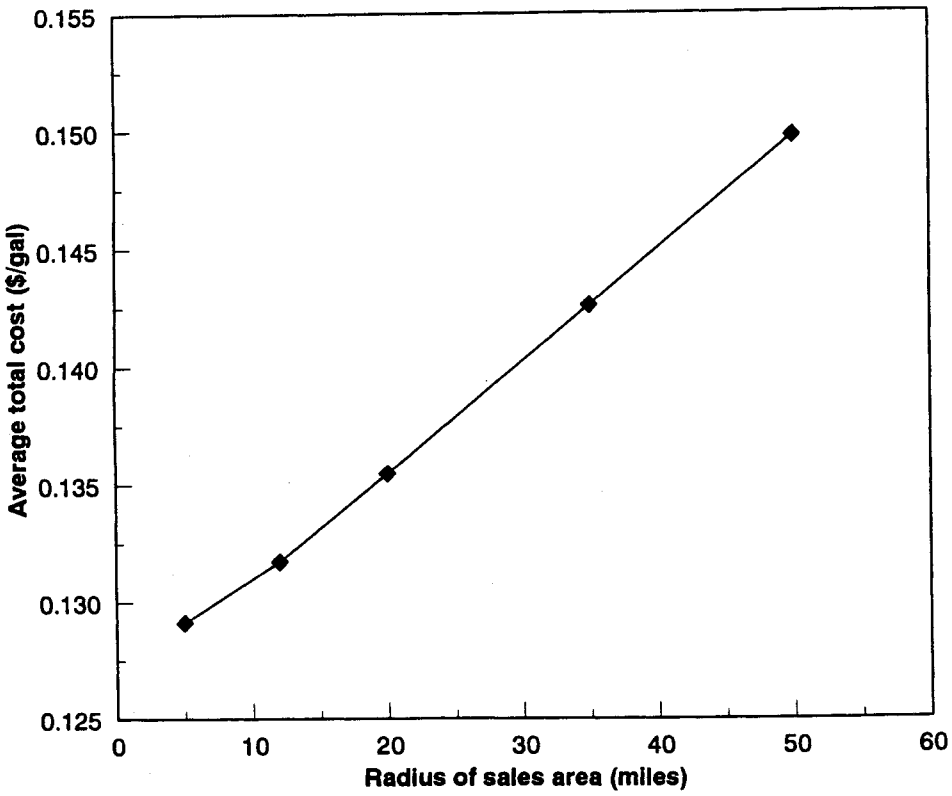


Figure 13. Average total costs for a 70,000 gallon facility with annual sales of 1,000,000 gallons by size of sale are, North Dakota, 1992. Source: Appendix tables 1-6.

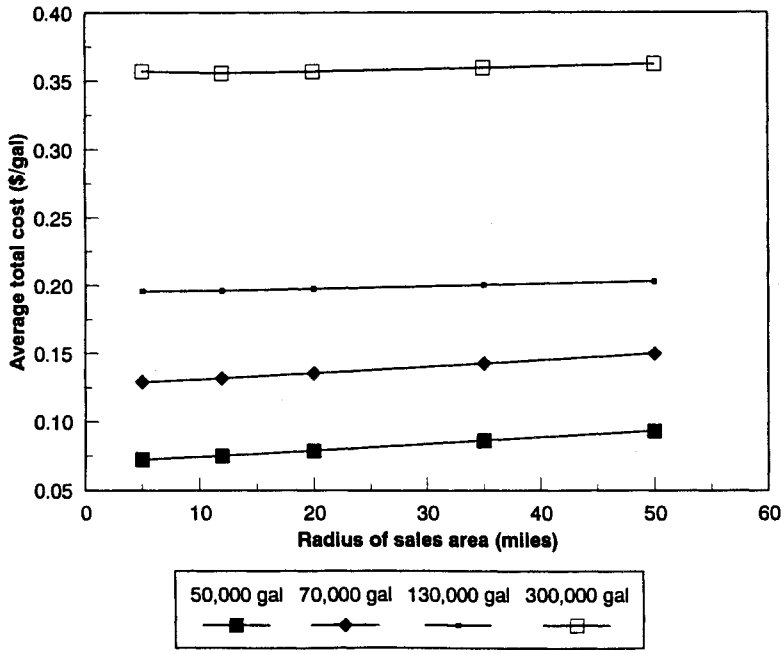
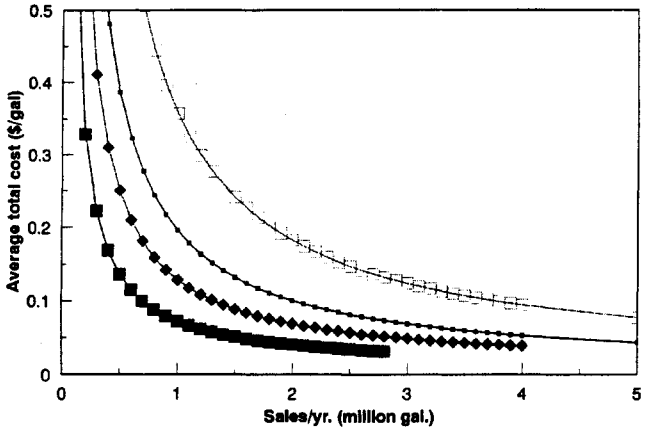
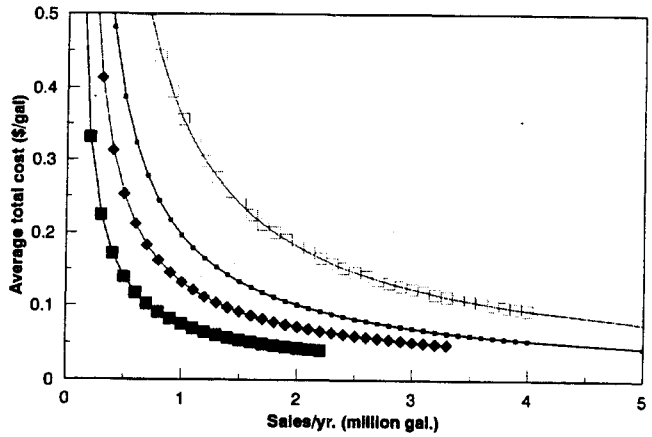


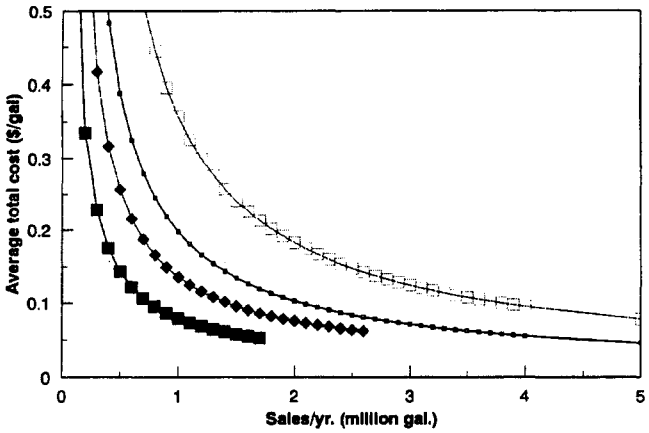
Figure 14. Average total costs for annual sales of 1,000,000 gallons by size of facility and sales are, North Dakota, 1992. Source: Appendix tables 1-6.



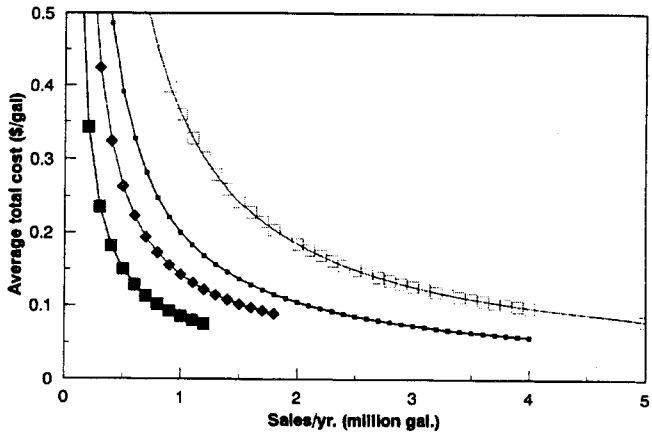
Panel A. 5-mile sales area radius



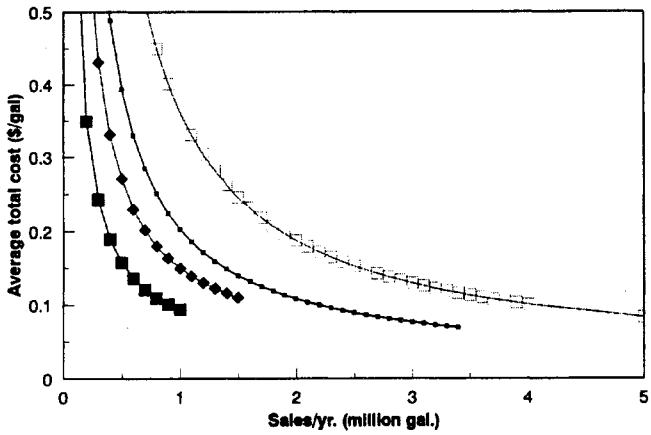
Panel B. 12-mile sales area radius



Panel C. 20-mile sales area radius



Panel D. 35-mile sales area radius



Panel E. 50-mile sales area radius

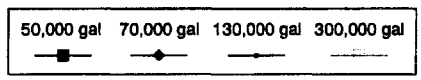
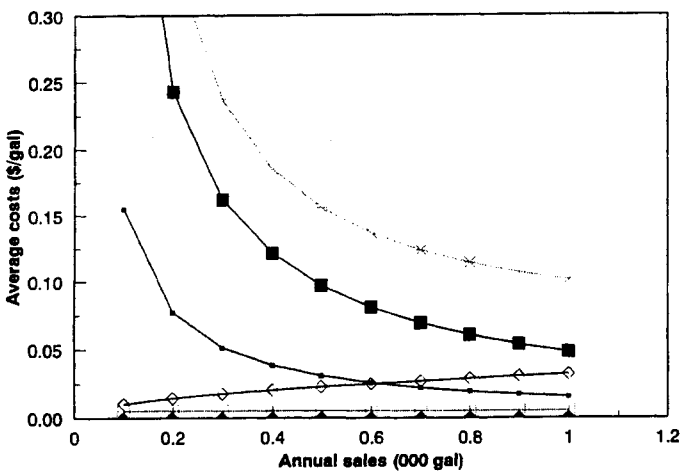
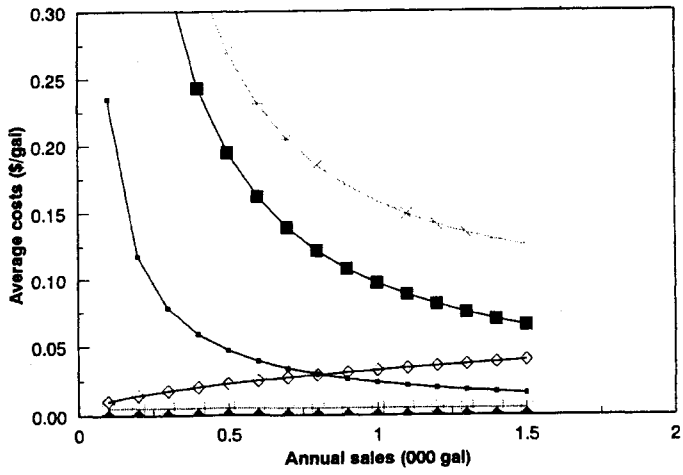


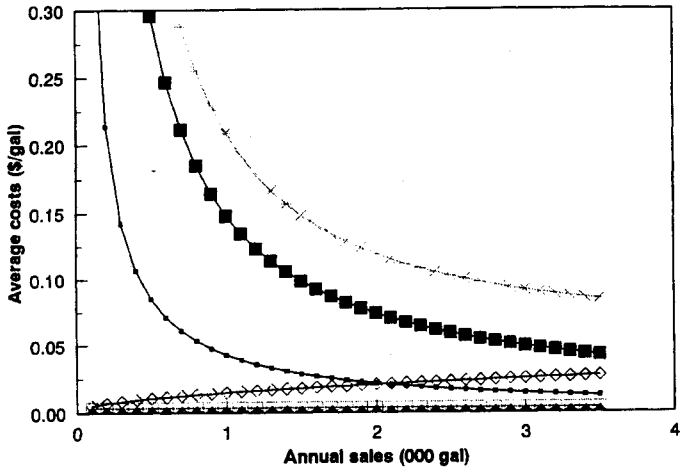
Figure 15. Average total cost by total sales for specified size of bulk fuel facilities and sales area radius, North Dakota, 1992.



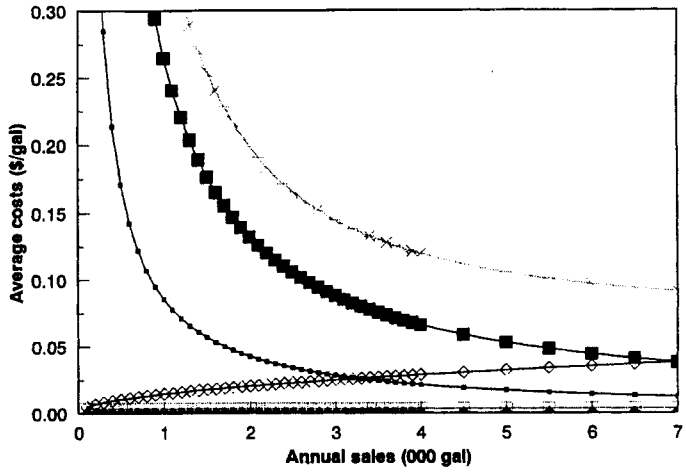
Panel A. 50,000 gal. facility



Panel B. 70,000 gal. facility



Panel C. 130,000 gal. truck



Panel D. 300,000 gal. truck

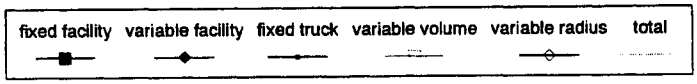


Figure 16. Average costs for specified size of bulk fuel facility with a constant sales density of 100 gal./sq. mile North Dakota, 1992. Increased volume is achieved by increasing the radius of the sales area. Source: Appendix Tables 1-5.

firm's sales area. In essence, this analysis examined how average costs vary for an existing firm as it increasd its sales area, while maintaining market share.

The potential for an optimal or least cost volume at less than full capacity is greatest for low density scenarios. Here, costs directly related to distribution will be at their greatest proportionate share, compared to all other costs. Sales densities for individual cooperatives surveyed ranged from 92 to 1,200 gal./sq. mile. Therefore, a sales density of only 100 gal./sq. mile was used to highlight the potential impact of low sales densities.

Average costs were estimated for selected categories of costs (fixed facility, fixed equipment, variable costs associated with volume of sales, and variable costs associated with the size of the sales area). Average variable costs for facilities and costs that vary by volume remained constant at minimal levels. This indicated that variable costs incurred by increasing sales volumes had a limited impact on the overall cost structure of bulk fuel storage facilities. Furthermore, average variable costs for costs that vary with the size of the sales area (mileage costs for distance to and from farms) increased as the sales area increased. However, even with the low sales densities common to firms in North Dakota, delivery costs did not overwhelm fixed costs before the capacity of delivery equipment was reached. Because fixed costs for facilities and equipment are such a high proportion of total costs, firms with the smallest total fixed costs will be the least cost facility provided seasonal peaks are met within the relevant North Dakota sales densities.

Substantially higher sales densities than those currently in North Dakota are required to achieve potential in-plant economies of size. To examine this situation, average total costs were evaluated at 80% capacity to account for peak periods for delivery equipment for each facility size. Sales densities were allowed to increase to any level to reach maximum storage facility capacity. Differences in capacity between the 50,000 gal. and the 130,000 gal. facility were accounted for by differences in sales density. This comparison yielded a measure of long-run economies of size.

Economies of size became more pronounced as the market area radius was increased. For example, at a sales area of 5 miles, average total costs for a 50,000 gal. facility and a 130,000 gal. facility operating at 80% of capacity of their delivery equipment would have costs of about $0.035/gal. Increasing the size of the sales area to 35 miles in radius increased average costs at 80% of capacity to $0.086 and $0.08 for the 50,000 and 130,000 gal. facilities, respectively (Figures 12 and 15). Thus, there appears to be economies to size for larger facilities with larger sales areas. However, given the range of sales densities common to North Dakota, economies of size were unrealistic.

For example, a 50,000 gal. facility operating at 80% of capacity with a sales density of 3,000 gal./sq. mile would have sales of almost 2 million gal. per year within a sales area of 14 miles in radius at an average total cost of $0.049/gal. (Figure 16). However, a 130,000 gal. facility required 4 million gal. in sales and a 20 mile radius sales area to obtain average total costs of $0.056. If the sales density were reduced to 100 gal./sq. mile, then the 50,000

gal. facility would require 800,000 gal. of annual sales within a 50 mile radius sales area to achieve average total costs of $.113/gal. The 130,000 gal. facility would require almost 3 million gal. in annual sales within a 90 mile radius sales area to operate at 80% capacity. Average total costs for the 130,000 gal. facility would be about $0.098/gal. However, the relationship used to estimate bulk truck mileage only used sales areas up to 50 miles in radius. Extension of mileage estimates and their effect on costs beyond 50 miles are suspect. Furthermore, sales areas of 100 miles in radius would cover almost 1/2 of the state. Thus, if there were economies to size, they would be hard to realize within North Dakota.

Distribution Equipment Configurations

The impact of different equipment configurations on average total costs was examined for a 70,000 gal. facility assuming a constant sales density. The 70,000 gal. facility is one of the more common sizes of facilities within North Dakota and should provide insight into the effect of equipment complements on average costs as they relate to size of sales area, sales density, and total annual sales. This section examined costs per gallon on a daily basis for the four equipment complements as the size of sales area was increased assuming a constant market share. Then, the effect of sales density on average total costs was examined for each equipment complement. Finally, break-even levels of sales were calculated for equipment complements.

Average total costs for the one-2,000 and one-4,000 gal. trucks and for the two-2,000 and two-4,000 gal. trucks were generally within $.02 to $.03/gal. of each other for each of the load-out pipe sizes and daily sales volumes over 1,000 gal./day (Figure 17; Appendix Table 6). For example, a 70,000 gal. facility with 2" load-out pipe, sales density of 300 gal./sq. mile, and daily sales of 2,092 gal. would have an average total cost of $.134 and $.144 for one-2,000 and one-4,000 gal. bulk trucks, respectively. Moving to an equipment complement with two-2,000 or two-4,000 gal. bulk trucks increased average total costs to $.1636 and $.1928, respectively. The lowest cost equipment complement for all sales densities examined progresses from one-2,000 gal. truck, to one-4,000 gal. truck, to two-2,000 gal. trucks to two-4,000 gal. trucks as total daily sales increase. The lowest average total cost equipment complement switches from one complement to the next when the smaller equipment complement is at or near capacity (Figure 17).

Increasing the size of the bulk truck from 2,000 to 4,000 gal. increased the delivery potential of the bulk truck for a sales area of 5 to 50 miles in radius by just over 1,500 gal. per day (Table 9 and Figure 6). The change to the larger bulk truck resulted in larger percentage increases in capacity for the larger sales areas (44% for a 50 mile radius versus 16% for a 5 mile radius). Impacts on costs were not as dramatic. For facilities with low sales volumes and low sales densities, costs would increase by up to 15%. However, costs decreased by up to 6% for firms with higher sales densities and sales volumes operating near the capacity of the 2,000 gal. bulk truck. Therefore, increasing the delivery capacity of bulk trucks should be more cost effective for firms with larger sales areas and larger sales volumes.

Increasing the load-out pipe size from 2" to 3" for a 70,000 gal. facility with a 300 gal./sq. mile sales density and 2,092 gal./day daily sales increased average total costs for a

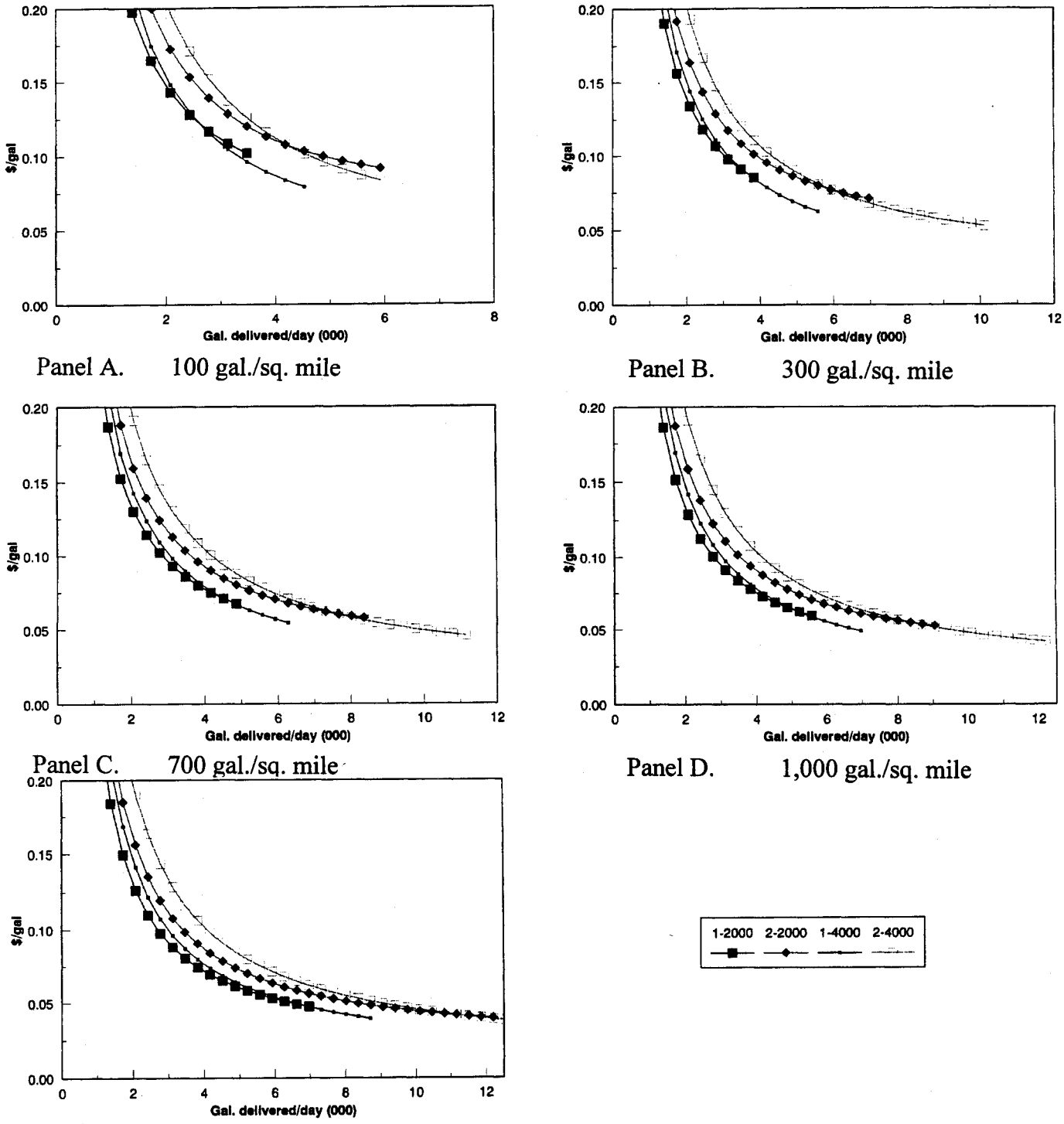


Figure 17. Average total cost for a 70,000 gallon bulk fuel facility at specified sales densities with 4 delivery equipment configurations (# of trucks/capacity), a 2 inch load out pipe, and a constant sales density, North Dakota, 1992. Increases in sales are achieved by increasing the size of the sales area.

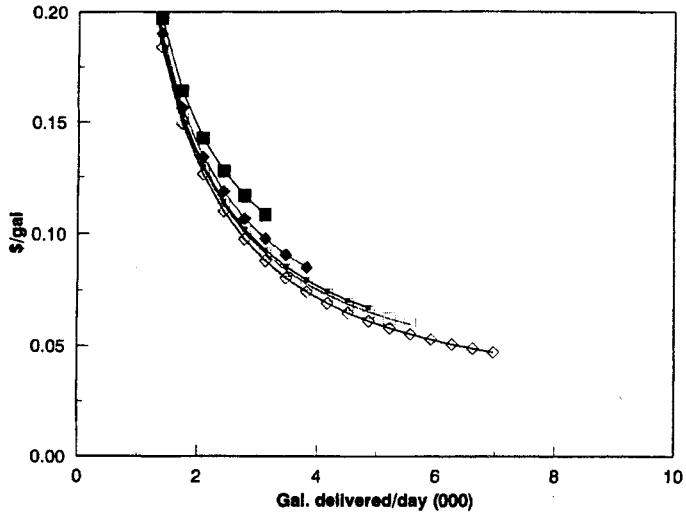
2,000 gal. bulk truck from $.1340 to $.1347 or from $.1442 to $.1450 for a 4,000 gal. truck (Appendix Table 6). Therefore, doubling the capacity of the load-out pipe by increasing its diameter from 2" to 3" increased average total costs by 0.5%. The change in average total costs with a change in load-out pipe size held at less than 1% for all the equipment complements, sales densities, and sales volumes examined. Therefore, increasing the load-out pipe size at the storage facility increased the daily capacity of a 2,000 gal. bulk truck for sales areas with a radius of 5 to 50 miles by 1,800 to 210 gal./day (19 to 6%), respectively (Table 9). This increase in capacity increased average total costs by less than 1%. Thus, firms constructing facilities with small or moderate-sized sales areas may gain a limited increase in delivery capacity more cost effectively by increasing the size of the load-out pipe at the facility from 2" to 3". However, as the size of sales area, annual sales, and additional capacity required increase, increasing the size of the bulk truck(s) would become the more cost effective alternative for increasing delivery capacity.

Average total costs were examined to determine the effect on costs of increasing sales volume by increasing sales area for each of the 4 equipment complements and sales densities (Figure 18). Average total costs for each equipment complement varied by less than $.03/gal. across the range of firm sales densities except for the 2,000 gal. truck in low firm sales densities (100 gal./sq. mile). In these low firm density sales areas, the 2,000 gal. truck had average total costs that were $.02 to $.04/gal. higher than those in higher sales densities. However, the 4,000 gal. truck still maintained costs within $.02 of those obtained with higher firm sales densities, which, in the case of the low densities of sales, were less than the 2,000 gal. truck. This indicated inefficiencies for the 2,000 gal. bulk truck for firms with low sales densities and with high daily sales. Sales density did not have much impact on costs except for the 2,000 gal. trucks in areas where firm sales densities were low (100 gal./sq. mile).

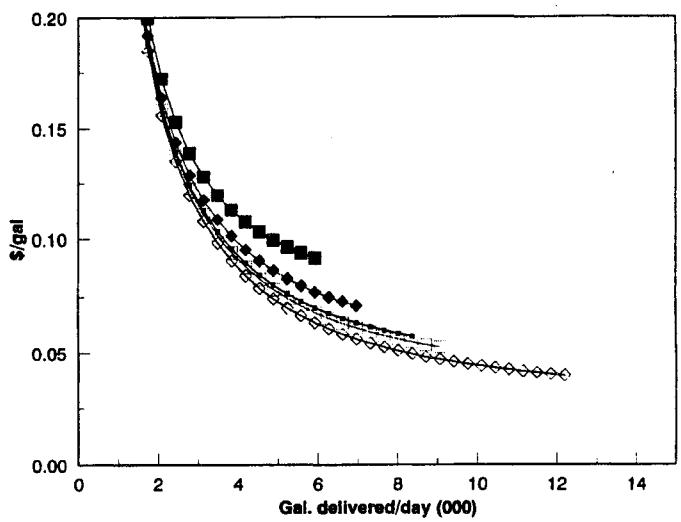
Break-even levels of annual sales were calculated between delivery costs for a 2,000 gal. truck and a 4,000 gal. truck for 2 and 3 in. load-out pipe sizes and specified radius of sales area (Table 11). Break-even sales volumes for the smaller sales areas exceeded the yearly capacity of the 2,000 gal. truck to deliver fuel. Thus, the capacity of the 2,000 gal. truck to deliver fuel determined when to upgrade to a 4,000 gal. truck for small sales areas. When sales areas had radii of 20, 35, and 50 miles, the break-even annual sales between a 2,000 and a 4,000 gal. truck were about 1.6, 1.0, and .8 million gal./year respectively. These results were close to annual capacities for the 2,000 gal. truck for these radii of sales areas. This indicated that, for the most part, the lowest average total cost delivery system was one that had the smallest truck or trucks operating at or near capacity.

Combined Analysis of Density, Area, and Equipment

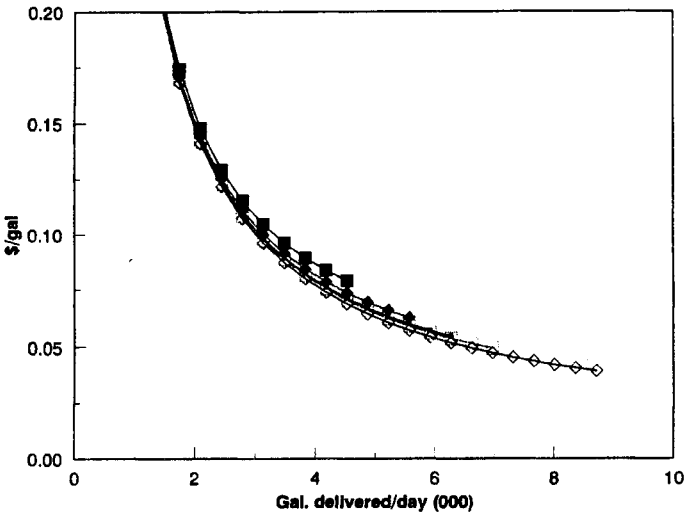
In this section, the effects of sales volume, size of sales area, density of sales, and equipment complement were analyzed collectively. Average total costs were calculated for a range of sales densities and sales areas for the 70,000 gal. facility by equipment complement (Table 12). Firm sales densities ranged from 100 to 6,400 gal./sq. mile. This represented the potential range of sales densities in North Dakota. Sales densities were scaled so that



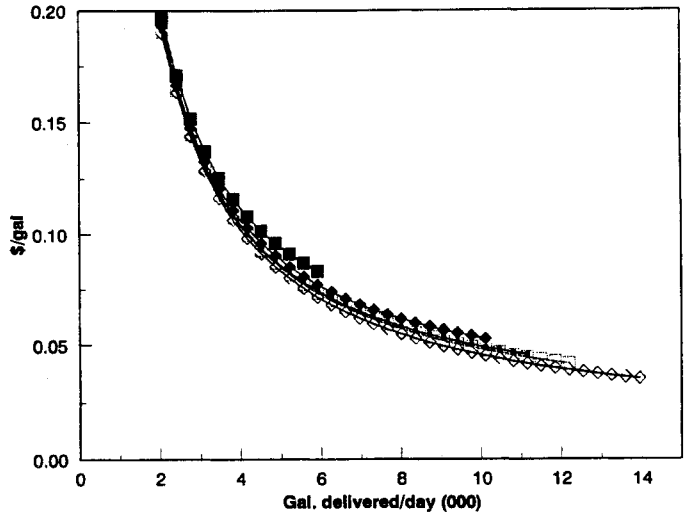
Panel A. One, 2,000 gal. truck.



Panel B. Two, 2,000 gal. trucks.



Panel C. One, 4,000 gal. truck.



Panel D. Two, 4,000 gal. trucks.

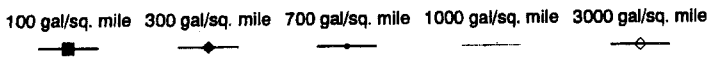


Figure 18. Average total delivery cost for 70,000 gallon facility with specified number and size of delivery truck and sales densities, North Dakota, 1992.

Table 11. Break-even volumes between 2,000 and 4,000 gal. trucks by load-out pipe size and radius of sales area, 70,000 gal. facility, North Dakota, 1992.

Radius	Load-out pipe size		
	2"	3"	2" to 3"
	(- - - Annual break-even gallons - - -)		
5	a	a	a
12	a	a	a
20	1,617,990	1,640,519	a
35	1,061,723	1,087,540	1,124,021
50	790,089	813,372	828,626
	(- - - Daily break-even gallons - - -)		
5	a	a	a
12	a	a	a
20	5,642	5,720	a
35	3,702	3,792	3,919
50	2,755	2,836	2,889

a Break-even gallons exceed yearly or daily capacity of 2,000 gallon bulk truck.

each increment in density represented a doubling of the previous sales area. Sales areas ranged from 5 to 50 miles. Similarly, 4 increments in the size of the sales area from 12.5 to 50 miles in radius represented a doubling of the size of sales area. The 5 mile sales area was not related in scale to the other sales areas, but was included to show costs for small sales areas with high sales densities. For example, the 70,000 gal. facility with one-2,000 gal. bulk truck supplying a sales area with a 12.5 mile radius with a firm sales density of 400 gal./sq. mile would have average total costs of $0.2346/gal.

Two sets of ratios were given for comparison. First, the density ratio used the average cost at 100 gal./sq. mile as the denominator. This ratio reflected the proportional change in average total costs as the sales density increased. In general, as the sales density doubled, the average total cost for a 70,000 gal. facility with any equipment complement was reduced by almost 50 percent because fixed costs were such a major portion of total costs. For example, a 70,000 gal. facility with one 2,000 gal. bulk truck in a 12.5 mile sales area, doubling the sales density from 100 gal./sq. mile reduced costs to 51, 26, 14, 7, and 4% of the costs for a sales density of 100 gal./sq. mile, respectively, for each doubling of sales density. Each doubling of sales density reduced average total costs by almost 50 percent.

The ratio of the average total cost for each equipment combination to the average total cost for a 2,000 gal. truck with a sales area of 12.5 miles was calculated as the size of the

Table 12. Average total costs, density ratios, and sales area size ratios for 70,000 gallon facility with specified equipment configurations, bulk fuel distribution, North Dakota, 1992.

Sales density (gal./sq. mile)	Radius of sales area (miles) 5(# truck size) 1-2000	5(# truck size) 2-2000	5(# truck size) 1-4000	5(# truck size) 2-4000	12.5(#-truck size) 1-2000	12.5(#-truck size) 2-2000	12.5(#-truck size) 1-4000	12.5(#-truck size) 2-4000	17.7(#-truck size) 1-2000	17.7(#-truck size) 2-2000	17.7(#-truck size) 1-4000	17.7(#-truck size) 2-4000
	(- Average total cost, $/gal -)											
100	5.5867	7.8470	7.0344	10.7457	0.9040	1.2656	1.1308	1.7246	0.4590	0.6393	0.5680	0.8642
200	2.7977	3.9279	3.5199	5.3756	0.4577	0.6386	0.5685	0.8654	0.2364	0.3266	0.2876	0.4356
400	1.4032	1.9683	1.7627	2.6905	0.2346	0.3250	0.2873	0.4358	0.1251	0.1702	0.1473	0.2214
800	0.7060	0.9885	0.8840	1.3480	0.1231	0.1683	0.1467	0.2210	0.0695	0.0920	0.0772	0.1142
1600	0.3574	0.4986	0.4447	0.6767	0.0673	0.0899	0.0764	0.1136	0.0417	0.0530	0.0422	0.0607
3200	0.1831	0.2537	0.2251	0.3411	0.0394	0.0507	0.0413	0.0599		0.0334		0.0339
6400	0.0959	0.1312	0.1153	0.1732		0.0311		0.0330				
	(- Sales Density ratios, 100=1 -)											
100	1	1	1	1	1	1	1	1	1	1	1	1
200	0.5008	0.5006	0.5004	0.5003	0.5064	0.5045	0.5027	0.5018	0.5151	0.5108	0.5063	0.5041
400	0.2512	0.2508	0.2506	0.2504	0.2595	0.2568	0.2541	0.2527	0.2727	0.2663	0.2594	0.2562
800	0.1264	0.1260	0.1257	0.1254	0.1361	0.1329	0.1298	0.1281	0.1514	0.1440	0.1360	0.1322
1600	0.0640	0.0635	0.0632	0.0630	0.0744	0.0710	0.0676	0.0658	0.0908	0.0828	0.0742	0.0702
3200	0.0328	0.0323	0.0320	0.0317	0.0436	0.0400	0.0365	0.0347		0.0523		0.0392
6400	0.0172	0.0167	0.0164	0.0161		0.0246		0.0191				
	(- - - - - - - - - - - - - - - - - Sales area size/equip. configuration ratios, 12.5 miles & one-2,000 truck = 1 - - - - - - - - - - - - - - - -)											
100	6.1802	8.6806	7.7817	11.8872	1	1.4001	1.2509	1.9078	0.5077	0.7073	0.6284	0.9560
200	6.1122	8.5812	7.6899	11.7439	1	1.3950	1.2419	1.8906	0.5165	0.7135	0.6282	0.9517
400	5.9811	8.3896	7.5131	11.4677	1	1.3854	1.2246	1.8574	0.5334	0.7256	0.6280	0.9436
800	5.7372	8.0333	7.1842	10.9542	1	1.3674	1.1924	1.7956	0.5648	0.7480	0.6276	0.9284
1600	5.3121	7.4120	6.6107	10.0586	1	1.3360	1.1363	1.6879	0.6196	0.7871	0.6269	0.9020
3200	4.6479	6.4414	5.7149	8.6596	1	1.2870	1.0485	1.5197		0.8483		0.8608
Mean	5.6618	7.9230	7.0824	10.7952	1	1.3618	1.1824	1.7765	0.5484	0.7550	0.6278	0.9238

cont'd.

Table 12. (cont'd.)

Sales density (gal./sq. mile)	Radius of sales area (miles) 25(# truck size) 1-2000	25(# truck size) 2-2000	25(# truck size) 1-4000	25(# truck size) 2-4000	35.5(#-truck size) 1-2000	35.5(#-truck size) 2-2000	35.5(#-truck size) 1-4000	35.5(#-truck size) 2-4000	50(#-truck size) 1-2000	50(#-truck size) 2-2000	50(#-truck size) 1-4000	50(#-truck size) 2-4000	Mean
	(- Average total cost, $/gal -)												
100	0.2404	0.3308	0.2897	0.4382	0.1328	0.1777	0.1501	0.2237	0.0847	0.1073	0.0838	0.1209	
200	0.1288	0.1740	0.1491	0.2233	0.0775	0.0999	0.0803	0.1172		0.0682	0.0487	0.0672	
400	0.0730	0.0956	0.0788	0.1159		0.0610	0.0455	0.0639				0.0404	
800		0.0564	0.0437	0.0622				0.0373					
1600				0.0354									
	(- Density ratios (specified to 100) -)												
100	1	1	1	1	1	1	1	1	1	1	1	1	1
200	0.5359	0.5261	0.5147	0.5097	0.5834	0.5624	0.5354	0.5237		0.6349	0.5806	0.5559	0.5323
400	0.3038	0.2891	0.2721	0.2646		0.3436	0.3031	0.2856				0.3338	0.2796
800		0.1706	0.1508	0.1421				0.1666					0.1434
1600				0.0808									0.0753
3200													0.0411
6400													0.0219
	(- - - - - - - - - - - - Sales area size/equip. configuration ratios (specified to 12.5 mile/1-2000) -)												
100	0.2659	0.3659	0.3205	0.4847	0.1469	0.1965	0.1660	0.2474	0.0937	0.1187	0.0927	0.1338	
200	0.2814	0.3802	0.3258	0.4879	0.1693	0.2183	0.1755	0.2559		0.1489	0.1063	0.1468	
400	0.3113	0.4076	0.3360	0.4942		0.2602	0.1939	0.2723				0.1720	
800		0.4587	0.3550	0.5058				0.3027					
1600				0.5261									
Mean	0.2862	0.4031	0.3343	0.4997	0.1581	0.2250	0.1785	0.2696	0.0937	0.1338	0.0995	0.1509	

sales area changed. Increases in the size of the sales area from 12.5 miles to 50 miles again resulted in about a 50 percent reduction in average total costs for each doubling of sales area. For example, a 70,000 gal. facility with one-2,000 gal. bulk truck and a sales density of 200 gal./sq. mile would have average total costs of $0.4577, $0.2364, $0.1288, and $0.0775 for sales areas of 12.5, 17.7, 25, and 35.5 miles in radius, respectively. This reduced average total costs to 52, 28, and 17% of the costs for the 12.5 mile sales area by doubling the size of sales area to 17.7, 25, and 35.5 miles in radius, respectively.

Changes in equipment complements and sales areas can also be examined. For example, a 70,000 gal. facility with a sales density of 1,600 gal./sq. mile and a sales area with a 12.5 mile radius would have average total costs of $0.0673, $0.0899, $0.0764, and $0.1136/gal. for one-2,000, two-2,000, one-4,000, and two-4,000 gal. bulk trucks, respectively. Therefore, adding a second 2,000 gal. bulk truck increased costs by 34%. Moving to one or two 4,000 gal. bulk trucks increased costs by 14 and 69%. Doubling the size of the sales area to 17.7 miles in radius and changing the equipment complement to two-2,000, one-4,000, or two-4,000 gal. bulk trucks reduced costs to 79, 63, and 90% of the costs of one-2,000 gal. bulk truck with a 12.5 mile radius. Therefore, doubling sales by doubling the size of sales area and adding a second 2,000 gal. truck will reduce costs by 21%. Similarly, switching to either one or two 4,000 gal. bulk trucks would reduce costs by 37 and 10%, respectively.

The results obtained in this section indicated that increasing annual sales through increased market share (sales density) or sales area size provided about equal reductions in average total costs. Since fixed costs were the major factor influencing average total costs for a bulk fuel facility, any strategy that increased annual sales up to the capacity of delivery equipment will lower costs. Firms looking to operate at least cost should strive to operate at or near the capacity of their delivery equipment.

As firms approach the limit of the delivery equipment, other factors that affect the size of facility and delivery equipment should be considered. For instance, the degree that fuel deliveries are seasonal can impact decisions on equipment complements. Firms experiencing more seasonal sales need to be able to respond to peak demand times. More seasonal sales require firms to increase delivery capacity of equipment either through extending the hours per day that trucks run, purchasing higher capacity trucks, putting backup trucks into service, or reducing service to patrons. As sales become more evenly distributed throughout the year, the need to move to larger delivery equipment to meet stress days is lessened.

SAVINGS FROM CONSOLIDATION

Bulk fuel cooperatives surveyed indicated few stress days. Most of the firms surveyed reported annual sales levels that represented 50% or less of the calculated annual delivery capacity of their bulk trucks. Therefore, consolidation or cooperation of firms could substantially reduce the cost of fuel delivery if it allowed the resulting firm(s) to operate

closer to equipment capacity. For example, 2 firms with 70,000 gal. of storage, trade areas of 20 miles in radius that overlap, and total annual sales of 700,000 gal. per year each would incur average costs of operation of about $.187/gal. (Appendix Table 3). For comparison, if the trade areas totally overlap, a single firm with 70,000 gal. of storage could service this trade area with costs of operation of about $.101/gal. Thus, a single firm would save about $.086/gal., a 46% reduction. This would amount to an annual savings of $120,400 over the costs of the 2 firms operated separately. Alternatively, if the same 2 firms are located so that they had adjoining sales areas, a combined firm with a 35 mile radius sales area (more than twice the area of a 20 mile radius sales area) would incur average total costs of $.108/gal., a savings of 42% ($.079/gal.) or $110,600 per year. Similar savings occurred for other sizes of facilities and sales areas when a single firm can be operated closer to capacity. Therefore, depending on the firms involved, two bulk fuel cooperatives with excess capacity could be replaced by a single firm at a significant savings to farmer patrons.

Since fixed costs dominated costs for bulk fuel delivery, cost savings for firms considering consolidation were greatest if fixed costs for facilities, equipment, and salaries were lowered to that of a single firm. Consolidation of the two cooperatives with 70,000 gal. facilities and overlapping sales areas would reduce annual costs of operation by $120,400 if they reduced the size and number of storage facilities, bulk delivery equipment, and labor to that of a single firm. Savings in annual costs of operation by laying off the manager and bookkeeper for one of the firms would amount to $41,622 or about $.03/gal. A reduction in the number of bulk trucks and drivers to that of a single firm would reduce annual costs of operation by $23,514 and $43,882, or $0.017 and $0.031/gal. respectively. Eliminating one of the bulk storage facilities would reduce annual costs of operation by $8,665 or $0.006/gal. The remainder of the savings representing about $0.002/gal. would come from eliminating of multiple licenses, insurances, and some general office expenses. Therefore, most of the savings in annual costs of operation from consolidation would be due to reductions in management, bookkeepers, bulk trucks, and drivers.

Boeshans indicated that in previous consolidations, generally office space, bulk trucks, bulk truck drivers, and the storage facilities were retained. However, in some cases, storage facilities were either removed or allowed to remain idle. In most cases, the major effect of previous consolidations was a loss of the general manager and bookkeeper positions for one of the firms. Thus, firms that have consolidated in the past have taken advantage of one of the areas where significant savings in costs could be achieved.

Future consolidations and/or joint ventures may be influenced by changes in federal tank regulations which will increase costs for maintaining bulk fuel storage. The effect of these changes in regulations may be to promote more pairing ventures between cooperatives in the future which could include a centrally located storage facility for use by multiple cooperatives (Boeshans). This type of pairing would require the addition of one set of meters to monitor how much fuel each cooperative uses. Costs for 2 sets of meters and a Cardtrol system in the largest facility were $30,000. Costs for a single set of meters would be about $10,000.

If two firms with 70,000 gal. of bulk storage form a pairing relationship with a centrally located 70,000 gal. facility, investment costs for the storage facilities would be reduced from $53,051 to $31,526 per firm. For each cooperative, annual fixed operating costs for tank licenses, depreciation, facility insurance, facility repairs and maintenance, and opportunity costs for land and facilities would be about half as much. This translated into a reduction in annual operating costs of less than $5,000 per firm. If both firms had annual sales of 500,000 gal., each firm would have average total costs that were $0.01/gal. lower. Thus, unless existing facilities require updating to meet federal codes or unless annual sales volumes for both facilities are extremely low, pairing relationships will have a limited impact on average total costs for the firms involved.

Consolidation of 2 firms would also involve other costs and considerations. When firms consolidate, they could sell excess equipment and storage facilities. Income obtained from sales of office space, bulk fuel trucks, and land will depend on the demand for these items and could range from minimal amounts up to replacement value of the item(s). Firms can also decide to eliminate storage facilities, which can provide income if the tanks are in good condition. Sales of tanks in good condition should recover about 40% of the cost of the tank on average. However, if tanks are old, the only alternative may be to scrap the facility. In such a case, it typically costs from $5,000 to $6,000 to scrap a 6 tank bulk fuel storage facility (Sprecher).

Eliminating storage facilities would also involve site cleanup costs. Minimum cleanup costs incurred at any site would amount to at least $5,000. Of this cost, $3,000 would be required for a site inspection, and a minimum of $2,000 would be needed for land farming of contaminated soils. Maximum costs of cleanup depend on the degree of contamination and may be unlimited in time and/or cost, particularly if contamination gets into groundwater. However, North Dakota has mandated that all commercial tanks obtain coverage from the North Dakota Tank Release Compensation Fund. This fund insures site cleanup for tanks registered in North Dakota. The fund covers 90% of the reasonable cost of cleanup from $5,000 to $155,000 and 100% from $155,000 to $1 million. Tank owners will not be liable for more than $20,000 out-of-pocket expense for any one release. Therefore, firm liability for site cleanup costs after the facility is removed should be limited to about $20,000.

SUMMARY AND CONCLUSIONS

This study was undertaken to create a procedure for evaluating the least cost combination of bulk fuel storage facility and delivery equipment to have in relation to sales area size, density of sales, and level of annual sales. An economic engineering cost approach was used to analyze these relationships. Benchmark statistics for operating conditions were taken from a survey of 11 local North Dakota cooperatives. They were selected to be representative of operating characteristics throughout the state. Facilities in the western and central regions of the state had larger sales areas made greater effort to structure deliveries to reduce miles driven by the bulk truck. For example, managers in these areas of the state

indicated that they worked with their patrons to foster an environment where patrons would call in advance, allowing the cooperative to do more structuring of bulk fuel deliveries.

Costs of construction and operation of 4 sizes of bulk fuel storage facilities were estimated from data provided by industry representatives. Three of the facilities were sized (50,000, 70,000 and 130,000 gal.) to be representative of bulk fuel facilities operating within the state. The fourth facility (300,000 gal.) was specified as a larger multi-firm facility. Operating costs for bulk fuel deliveries were estimated by calculating costs per mile for bulk truck operation. Mileage was then estimated based on sales area size and annual sales levels using a computer simulation model. These results were compared to surveyed cooperatives. In most cases, cooperatives were operating at less than 50% of estimated capacity.

Annual fixed costs for bulk fuel facilities accounted for the majority of total costs for bulk fuel storage facilities. Variable delivery costs were generally less than half the level of fixed costs even for facilities with sales area of 50 miles in radius and high sales volumes. Increasing the radius of a sales area from 5 to 50 miles while holding the level of annual sales constant increased average total costs about $.02/gal. regardless of the level of annual sales or size of facility. Increasing the level of annual sales reduced average total costs for bulk fuel facilities until the annual capacity of delivery equipment was exceeded.

Doubling annual sales by either doubling the size of the sales area or doubling the density of sales within a sales area reduced average total costs by almost 50 percent. However, as the size of sales area increased, doubling the density of sales reduced average total costs more than increasing the size of sales area. Since delivery costs were a small portion of total delivery costs especially for firms with small sales areas, it is not surprising that firms with small sales areas did not stress extensive scheduling of bulk fuel deliveries. However, in larger sales areas, it becomes more important to control delivery costs as they form higher proportions of total costs. Thus, the least cost facility was the smallest facility that could provide liquidity of supplies and operate at or near capacity of their delivery equipment.

Comparisons of a 70,000 gal. storage facility with different bulk fuel delivery equipment combinations indicated that least cost bulk fuel equipment complements progressed from one-2,000 to one-4,000 to two-2,000 to two-4,000 gal. bulk trucks. Break-even costs among equipment complements were at or near the capacity of the smaller equipment complement. Bulk fuel cooperatives should switch from a 2,000 gal. gas truck to a 2,000 gal. diesel truck when annual mileage exceeds 14,769 miles per year.

Since densities of bulk fuel sales within counties of North Dakota range from an average of 884 to 6,425 gal./sq. mile, firms will have a hard time obtaining the required levels of annual sales to approach a least cost bulk fuel facility when their sales areas have a radius of less than 10-15 miles. If farmer-owned bulk fuel cooperatives are not operating at or near capacity of delivery equipment, increasing market share or size of sales area through competitive means, such as increasing competitive pricing strategies, promoting service,

quality of product, or timeliness of deliveries are important methods of reducing costs. However, since the bulk fuel market is of a limited size, not all local cooperatives will be able to increase market shares or sales areas through competitive strategies. When farmer-owned bulk fuel cooperatives have overlapping sales areas and neither of the co-ops involved is running at or near capacity of its delivery equipment, consolidation or cooperation between cooperatives may be a more appropriate strategy to reduce costs if combinations of cooperatives allow the facilities involved to operate closer to the capacity of delivery equipment.

The most cost savings will be obtained when consolidation of two facilities results in a firm with facilities, labor, and equipment of a single firm that is operating close to capacity of the delivery equipment. The majority of cost savings from consolidation will come from reductions in management, bookkeeping staff, bulk delivery trucks, and drivers. However, other aspects relating to environment regulations, equipment replacement, and impacts on local communities may also influence local decisions on whether to cooperate, consolidate, or merge.

Increasing the size of the load-out pipe from 2" to 3" for a 70,000 gal. facility doubled the capacity of the load-out pipe and increased the daily capacity of a 2,000 gal. bulk truck by 1,800 gal./day for a 5 mile radius, but only 200 gal./day for a 50 mile radius sales area. This increase in daily delivery capacity increased average total costs by less than 1%. Increasing the size of the bulk truck from 2,000 to 4,000 gal. would similarly increase daily delivery capacities by 16 to 30% for sales areas from 5 to 50 miles in radius, respectively. Average total costs would increase by up to 15% for low sales volumes and low sales densities or decrease by up to 6% at or near the capacity of the smaller bulk truck. Therefore, firms with small to modest sales areas and lower sales volumes constructing facilities can opt to add delivery capacity by increasing the load-out pipe size to 3" with a minimal effect on average total costs. However, firms with larger sales areas and larger sales volumes needing additional capacity should opt for increasing the size of the bulk truck which will actually reduce costs at annual sales levels approaching or exceeding the capacity of a 2,000 gal. bulk truck.

Finally, the need for further study was identified in a number of areas. More reliable estimates of closing costs, particularly environmental cleanup, for facilities need to be gathered. Costs of compliance for environmental regulations for on-farm bulk fuel storage tanks should be examined as they relate to bulk fuel delivery. Capacity constraints for bulk fuel delivery need to be examined in relation to the seasonality of sales, size of fuel drops, and distribution of sales within sales areas.

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Appendix Table 1. Fixed and variable costs related to volume and radius of sales area for specified sizes of bulk fuel facilities for a 5-mile radius sales area, North Dakota, 1992.*

Sales		50,000 gallon facility					70,000 gallon facility				
			Variable costs related to:					Variable costs related to:			
Volume	Density	Fixed**	Volume	Sales area	Total	Total per gal.	Fixed**	Volume	Sales area	Total	Total per gal.
(gal./yr.)	(gal./sq. mile)	($)									
100,000	1,273	63,004	1,634	236	64,874	0.649	118,510	2,700	236	121,445	1.214
200,000	2,546	63,096	2,159	471	65,727	0.329	118,602	3,225	471	122,298	0.611
300,000	3,820	63,188	2,684	707	66,580	0.222	118,694	3,750	707	123,151	0.411
400,000	5,093	63,280	3,210	943	67,432	0.169	118,786	4,276	943	124,004	0.310
500,000	6,366	63,372	3,735	1,178	68,285	0.137	118,878	4,801	1,178	124,857	0.250
600,000	7,639	63,464	4,260	1,414	69,138	0.115	118,970	5,326	1,414	125,710	0.210
700,000	8,913	63,556	4,785	1,650	69,991	0.100	119,062	5,851	1,650	126,563	0.181
800,000	10,186	63,648	5,311	1,885	70,844	0.089	119,154	6,377	1,885	127,416	0.159
900,000	11,459	63,740	5,836	2,121	71,697	0.080	119,246	6,902	2,121	128,269	0.143
1,000,000	12,732	63,832	6,361	2,357	72,550	0.073	119,338	7,427	2,357	129,121	0.129
1,100,000	14,006	63,924	6,886	2,592	73,403	0.067	119,430	7,952	2,592	129,974	0.118
1,200,000	15,279	64,016	7,412	2,828	74,256	0.062	119,522	8,478	2,828	130,827	0.109
1,300,000	16,552	64,108	7,937	3,064	75,108	0.058	119,614	9,003	3,064	131,680	0.101
1,400,000	17,825	64,200	8,462	3,299	75,961	0.054	119,706	9,528	3,299	132,533	0.095
1,500,000	19,099	64,292	8,987	3,535	76,814	0.051	119,798	10,053	3,535	133,386	0.089
1,600,000	20,372	64,384	9,512	3,771	77,667	0.049	119,890	10,579	3,771	134,239	0.084
1,700,000	21,645	64,476	10,038	4,006	78,520	0.046	119,982	11,104	4,006	135,092	0.079
1,800,000	22,918	64,568	10,563	4,242	79,373	0.044	120,074	11,629	4,242	135,945	0.076
1,900,000	24,192	64,660	11,088	4,478	80,226	0.042	120,166	12,154	4,478	136,798	0.072
2,000,000	25,465	64,752	11,613	4,713	81,079	0.041	120,258	12,679	4,713	137,650	0.069
2,100,000	26,738	64,844	12,139	4,949	81,932	0.039	120,350	13,205	4,949	138,503	0.066
2,200,000	28,011	64,936	12,664	5,185	82,785	0.038	120,442	13,730	5,185	139,356	0.063
2,300,000	29,285	65,028	13,189	5,420	83,637	0.036	120,534	14,255	5,420	140,209	0.061
2,400,000	30,558	65,120	13,714	5,656	84,490	0.035	120,626	14,780	5,656	141,062	0.059
2,500,000	31,831	65,212	14,240	5,892	85,343	0.034	120,718	15,306	5,892	141,915	0.057
2,600,000	33,104	65,304	14,765	6,127	86,196	0.033	120,809	15,831	6,127	142,768	0.055
2,700,000	34,377	65,396	15,290	6,363	87,049	0.032	120,901	16,356	6,363	143,621	0.053
2,800,000	35,651	65,488	15,815	6,599	87,902	0.031	120,993	16,881	6,599	144,474	0.052
2,900,000	36,924						121,085	17,407	6,834	145,326	0.050
3,000,000	38,197						121,177	17,932	7,070	146,179	0.049
3,100,000	39,470						121,269	18,457	7,306	147,032	0.047
3,200,000	40,744						121,361	18,982	7,541	147,885	0.046
3,300,000	42,017						121,453	19,508	7,777	148,738	0.045
3,400,000	43,290						121,545	20,033	8,013	149,591	0.044
3,500,000	44,563						121,637	20,558	8,248	150,444	0.043
3,600,000	45,837						121,729	21,083	8,484	151,297	0.042
3,700,000	47,110						121,821	21,609	8,720	152,150	0.041
3,800,000	48,383						121,913	22,134	8,955	153,002	0.040
3,900,000	49,656						122,005	22,659	9,191	153,855	0.039
4,000,000	50,930						122,097	23,184	9,427	154,708	0.039

(cont'd)

Appendix Table 1. Cont'd.

Sales		130,000 gallon facility					300,000 gallon facility				
			Variable costs related to:			Total		Variable costs related to:			Total
Volume	Density	Fixed**	Volume	Sales area	Total	per gal.	Fixed**	Volume	Sales area	Total	per gal.
(gal./yr.)	(gal./sq. mile)	($)									
100,000	1,273	186,948	3,758	127	190,833	1.908	343,604	6,545	127	350,277	3.503
200,000	2,546	187,040	4,091	254	191,384	0.957	343,911	6,878	254	351,043	1.755
300,000	3,820	187,132	4,423	381	191,936	0.640	344,218	7,211	381	351,809	1.173
400,000	5,093	187,224	4,756	508	192,488	0.481	344,524	7,544	508	352,576	0.881
500,000	6,366	187,316	5,089	634	193,039	0.386	344,831	7,877	634	353,342	0.707
600,000	7,639	187,408	5,422	761	193,591	0.323	345,137	8,210	761	354,108	0.590
700,000	8,913	187,500	5,755	888	194,143	0.277	345,444	8,542	888	354,875	0.507
800,000	10,186	187,592	6,088	1,015	194,694	0.243	345,751	8,875	1,015	355,641	0.445
900,000	11,459	187,684	6,420	1,142	195,246	0.217	346,057	9,208	1,142	356,407	0.396
1,000,000	12,732	187,776	6,753	1,269	195,798	0.196	346,364	9,541	1,269	357,174	0.357
1,100,000	14,006	187,868	7,086	1,396	196,350	0.178	346,671	9,874	1,396	357,940	0.325
1,200,000	15,279	187,960	7,419	1,523	196,901	0.164	346,977	10,207	1,523	358,706	0.299
1,300,000	16,552	188,052	7,752	1,649	197,453	0.152	347,284	10,539	1,649	359,473	0.277
1,400,000	17,825	188,144	8,085	1,776	198,005	0.141	347,590	10,872	1,776	360,239	0.257
1,500,000	19,099	188,236	8,417	1,903	198,556	0.132	347,897	11,205	1,903	361,005	0.241
1,600,000	20,372	188,328	8,750	2,030	199,108	0.124	348,204	11,538	2,030	361,772	0.226
1,700,000	21,645	188,420	9,083	2,157	199,660	0.117	348,510	11,871	2,157	362,538	0.213
1,800,000	22,918	188,512	9,416	2,284	200,212	0.111	348,817	12,204	2,284	363,304	0.202
1,900,000	24,192	188,604	9,749	2,411	200,763	0.106	349,123	12,536	2,411	364,071	0.192
2,000,000	25,465	188,696	10,082	2,538	201,315	0.101	349,430	12,869	2,538	364,837	0.182
2,100,000	26,738	188,788	10,414	2,665	201,867	0.096	349,737	13,202	2,665	365,603	0.174
2,200,000	28,011	188,880	10,747	2,791	202,418	0.092	350,043	13,535	2,791	366,370	0.167
2,300,000	29,285	188,972	11,080	2,918	202,970	0.088	350,350	13,868	2,918	367,136	0.160
2,400,000	30,558	189,064	11,413	3,045	203,522	0.085	350,657	14,201	3,045	367,902	0.153
2,500,000	31,831	189,156	11,746	3,172	204,073	0.082	350,963	14,534	3,172	368,669	0.147
2,600,000	33,104	189,248	12,079	3,299	204,625	0.079	351,270	14,866	3,299	369,435	0.142
2,700,000	34,377	189,340	12,411	3,426	205,177	0.076	351,576	15,199	3,426	370,201	0.137
2,800,000	35,651	189,432	12,744	3,553	205,729	0.073	351,883	15,532	3,553	370,968	0.132
2,900,000	36,924	189,524	13,077	3,680	206,280	0.071	352,190	15,865	3,680	371,734	0.128
3,000,000	38,197	189,616	13,410	3,807	206,832	0.069	352,496	16,198	3,807	372,500	0.124
3,100,000	39,470	189,708	13,743	3,933	207,384	0.067	352,803	16,531	3,933	373,267	0.120
3,200,000	40,744	189,800	14,076	4,060	207,935	0.065	353,109	16,863	4,060	374,033	0.117
3,300,000	42,017	189,891	14,408	4,187	208,487	0.063	353,416	17,196	4,187	374,799	0.114
3,400,000	43,290	189,983	14,741	4,314	209,039	0.061	353,723	17,529	4,314	375,566	0.110
3,500,000	44,563	190,075	15,074	4,441	209,590	0.060	354,029	17,862	4,441	376,332	0.108
3,600,000	45,837	190,167	15,407	4,568	210,142	0.058	354,336	18,195	4,568	377,098	0.105
3,700,000	47,110	190,259	15,740	4,695	210,694	0.057	354,643	18,528	4,695	377,865	0.102
3,800,000	48,383	190,351	16,073	4,822	211,246	0.056	354,949	18,860	4,822	378,631	0.100
3,900,000	49,656	190,443	16,405	4,948	211,797	0.054	355,256	19,193	4,948	379,397	0.097
4,000,000	50,930	190,535	16,738	5,075	212,349	0.053	355,562	19,526	5,075	380,164	0.095
5,000,000	63,662	191,455	20,067	6,344	217,866	0.044	358,629	22,854	6,344	387,827	0.078
6,000,000	76,394	192,375	23,395	7,613	223,383	0.037	361,695	26,183	7,613	395,490	0.066
7,000,000	89,127	193,295	26,723	8,882	228,900	0.033	364,761	29,511	8,882	403,154	0.058
8,000,000	101,859						367,827	32,839	10,151	410,817	0.051
9,000,000	114,592						370,893	36,168	11,420	418,481	0.046
10,000,00	127,324						373,959	39,496	12,688	426,144	0.043
11,000,00	140,056						377,026	42,824	13,957	433,807	0.039
12,000,00	152,789						380,092	46,153	15,226	441,471	0.037
13,000,00	165,521						383,158	49,481	16,495	449,134	0.035
14,000,00	178,254						386,224	52,809	17,764	456,797	0.033
15,000,00	190,986						389,290	56,138	19,033	464,461	0.031

* Costs not reported when annual sales exceed equipment capacity. ** Changes in fixed costs reflect assumed positive relationship between facility land values and sales density.

Appendix Table 2. Fixed and variable costs related to volume and radius of sales area for specified sizes of bulk fuel facilities for a 12-mile radius sales area, North Dakota, 1992.

Sales		50,000 gallon facility					70,000 gallon facility				
			Variable costs related to:			Total		Variable costs related to:			Total
Volume	Density	Fixed**	Volume	Sales area	Total	per gal.	Fixed**	Volume	Sales area	Total	per gal.
(gal./yr.)	(gal./sq. mile)	($)									
100,000	1,273	62,928	1,640	564	65,133	0.651	118,434	2,706	564	121,704	1.217
200,000	2,546	62,944	2,172	1,128	66,244	0.331	118,450	3,238	1,128	122,816	0.614
300,000	3,820	62,960	2,704	1,692	67,356	0.225	118,466	3,770	1,692	123,928	0.413
400,000	5,093	62,976	3,236	2,256	68,468	0.171	118,482	4,302	2,256	125,039	0.313
500,000	6,366	62,992	3,768	2,820	69,579	0.139	118,498	4,834	2,820	126,151	0.252
600,000	7,639	63,008	4,299	3,384	70,691	0.118	118,514	5,366	3,384	127,263	0.212
700,000	8,913	63,024	4,831	3,948	71,803	0.103	118,530	5,897	3,948	128,375	0.183
800,000	10,186	63,040	5,363	4,511	72,915	0.091	118,546	6,429	4,511	129,486	0.162
900,000	11,459	63,056	5,895	5,075	74,026	0.082	118,562	6,961	5,075	130,598	0.145
1,000,000	12,732	63,072	6,427	5,639	75,138	0.075	118,578	7,493	5,639	131,710	0.132
1,100,000	14,006	63,088	6,958	6,203	76,250	0.069	118,594	8,025	6,203	132,821	0.121
1,200,000	15,279	63,104	7,490	6,767	77,361	0.064	118,610	8,556	6,767	133,933	0.112
1,300,000	16,552	63,120	8,022	7,331	78,473	0.060	118,625	9,088	7,331	135,045	0.104
1,400,000	17,825	63,136	8,554	7,895	79,585	0.057	118,641	9,620	7,895	136,157	0.097
1,500,000	19,099	63,152	9,086	8,459	80,697	0.054	118,657	10,152	8,459	137,268	0.092
1,600,000	20,372	63,168	9,618	9,023	81,808	0.051	118,673	10,684	9,023	138,380	0.086
1,700,000	21,645	63,184	10,149	9,587	82,920	0.049	118,689	11,215	9,587	139,492	0.082
1,800,000	22,918	63,200	10,681	10,151	84,032	0.047	118,705	11,747	10,151	140,603	0.078
1,900,000	24,192	63,216	11,213	10,715	85,143	0.045	118,721	12,279	10,715	141,715	0.075
2,000,000	25,465	63,232	11,745	11,279	86,255	0.043	118,737	12,811	11,279	142,827	0.071
2,100,000	26,738	63,248	12,277	11,843	87,367	0.042	118,753	13,343	11,843	143,939	0.069
2,200,000	28,011	63,264	12,808	12,407	88,479	0.040	118,769	13,874	12,407	145,050	0.066
2,300,000	29,285						118,785	14,406	12,971	146,162	0.064
2,400,000	30,558						118,801	14,938	13,534	147,274	0.061
2,500,000	31,831						118,817	15,470	14,098	148,385	0.059
2,600,000	33,104						118,833	16,002	14,662	149,497	0.057
2,700,000	34,377						118,849	16,533	15,226	150,609	0.056
2,800,000	35,651						118,865	17,065	15,790	151,720	0.054
2,900,000	36,924						118,881	17,597	16,354	152,832	0.053
3,000,000	38,197						118,897	18,129	16,918	153,944	0.051
3,100,000	39,470						118,913	18,661	17,482	155,056	0.050
3,200,000	40,744						118,929	19,192	18,046	156,167	0.049
3,300,000	42,017						118,945	19,724	18,610	157,279	0.048

cont'd.

Appendix Table 2. Cont'd.

Sales		130,000 gallon facility					300,000 gallon facility				
			Variable costs related to:					Variable costs related to:			
Volume	Density	Fixed**	Volume	Sales area	Total	Total per gal.	Fixed**	Volume	Sales area	Total	Total per gal.
(gal./yr.)	(gal./sq. mile)	($)									
100,000	1,273	186,872	3,760	253	190,885	1.909	343,351	6,548	253	350,152	3.502
200,000	2,546	186,888	4,096	505	191,489	0.957	343,404	6,883	505	350,793	1.754
300,000	3,820	186,904	4,431	758	192,093	0.640	343,457	7,219	758	351,434	1.171
400,000	5,093	186,920	4,766	1,011	192,697	0.482	343,511	7,554	1,011	352,076	0.880
500,000	6,366	186,936	5,102	1,264	193,301	0.387	343,564	7,889	1,264	352,717	0.705
600,000	7,639	186,952	5,437	1,516	193,905	0.323	343,617	8,225	1,516	353,358	0.589
700,000	8,913	186,968	5,772	1,769	194,509	0.278	343,670	8,560	1,769	354,000	0.506
800,000	10,186	186,984	6,108	2,022	195,113	0.244	343,724	8,895	2,022	354,641	0.443
900,000	11,459	187,000	6,443	2,275	195,717	0.217	343,777	9,231	2,275	355,282	0.395
1,000,000	12,732	187,016	6,778	2,527	196,322	0.196	343,830	9,566	2,527	355,924	0.356
1,100,000	14,006	187,032	7,114	2,780	196,926	0.179	343,883	9,902	2,780	356,565	0.324
1,200,000	15,279	187,048	7,449	3,033	197,530	0.165	343,937	10,237	3,033	357,206	0.298
1,300,000	16,552	187,064	7,784	3,286	198,134	0.152	343,990	10,572	3,286	357,848	0.275
1,400,000	17,825	187,080	8,120	3,538	198,738	0.142	344,043	10,908	3,538	358,489	0.256
1,500,000	19,099	187,096	8,455	3,791	199,342	0.133	344,096	11,243	3,791	359,130	0.239
1,600,000	20,372	187,112	8,790	4,044	199,946	0.125	344,149	11,578	4,044	359,772	0.225
1,700,000	21,645	187,127	9,126	4,297	200,550	0.118	344,203	11,914	4,297	360,413	0.212
1,800,000	22,918	187,143	9,461	4,549	201,154	0.112	344,256	12,249	4,549	361,054	0.201
1,900,000	24,192	187,159	9,797	4,802	201,758	0.106	344,309	12,584	4,802	361,696	0.190
2,000,000	25,465	187,175	10,132	5,055	202,362	0.101	344,362	12,920	5,055	362,337	0.181
2,100,000	26,738	187,191	10,467	5,308	202,966	0.097	344,416	13,255	5,308	362,978	0.173
2,200,000	28,011	187,207	10,803	5,560	203,570	0.093	344,469	13,590	5,560	363,620	0.165
2,300,000	29,285	187,223	11,138	5,813	204,174	0.089	344,522	13,926	5,813	364,261	0.158
2,400,000	30,558	187,239	11,473	6,066	204,778	0.085	344,575	14,261	6,066	364,902	0.152
2,500,000	31,831	187,255	11,809	6,319	205,383	0.082	344,629	14,596	6,319	365,544	0.146
2,600,000	33,104	187,271	12,144	6,571	205,987	0.079	344,682	14,932	6,571	366,185	0.141
2,700,000	34,377	187,287	12,479	6,824	206,591	0.077	344,735	15,267	6,824	366,826	0.136
2,800,000	35,651	187,303	12,815	7,077	207,195	0.074	344,788	15,602	7,077	367,468	0.131
2,900,000	36,924	187,319	13,150	7,330	207,799	0.072	344,841	15,938	7,330	368,109	0.127
3,000,000	38,197	187,335	13,485	7,582	208,403	0.069	344,895	16,273	7,582	368,750	0.123
3,100,000	39,470	187,351	13,821	7,835	209,007	0.067	344,948	16,609	7,835	369,392	0.119
3,200,000	40,744	187,367	14,156	8,088	209,611	0.066	345,001	16,944	8,088	370,033	0.116
3,300,000	42,017	187,383	14,491	8,341	210,215	0.064	345,054	17,279	8,341	370,674	0.112
3,400,000	43,290	187,399	14,827	8,593	210,819	0.062	345,108	17,615	8,593	371,316	0.109
3,500,000	44,563	187,415	15,162	8,846	211,423	0.060	345,161	17,950	8,846	371,957	0.106
3,600,000	45,837	187,431	15,498	9,099	212,027	0.059	345,214	18,285	9,099	372,598	0.103
3,700,000	47,110	187,447	15,833	9,352	212,631	0.057	345,267	18,621	9,352	373,240	0.101
3,800,000	48,383	187,463	16,168	9,604	213,235	0.056	345,321	18,956	9,604	373,881	0.098
3,900,000	49,656	187,479	16,504	9,857	213,839	0.055	345,374	19,291	9,857	374,522	0.096
4,000,000	50,930	187,495	16,839	10,110	214,444	0.054	345,427	19,627	10,110	375,164	0.094
5,000,000	63,662	187,654	20,192	12,637	220,484	0.044	345,959	22,980	12,637	381,577	0.076
6,000,000	76,394	187,814	23,546	15,165	226,525	0.038	346,492	26,334	15,165	387,990	0.065
7,000,000	89,127						347,024	29,687	17,692	394,403	0.056
8,000,000	101,859						347,556	33,041	20,220	400,817	0.050
9,000,000	114,592						348,089	36,394	22,747	407,230	0.045
10,000,000	127,324						348,621	39,748	25,275	413,643	0.041
11,000,000	140,056						349,153	43,101	27,802	420,057	0.038
12,000,000	152,789						349,686	46,455	30,330	426,470	0.036

* Costs not reported when annual sales exceed equipment capacity.

** Changes in fixed costs reflect assumed positive relationship between facility land values and sales density.

Appendix Table 3. Fixed and variable costs related to volume and radius of sales area for specified sizes of bulk fuel facilities for a 20 mile radius sales area, North Dakota, 1992.

Sales		50,000 gallon facility					70,000 gallon facility				
			Variable costs related to:					Variable costs related to:			
Volume	Density	Fixed**	Volume	Sales area	Total	Total per gal.	Fixed**	Volume	Sales area	Total	Total per gal.
(gal./yr.)	(gal./sq. mile)	($)									
100,000	1,273	62,918	1,648	939	65,505	0.655	118,424	2,714	939	122,077	1.221
200,000	2,546	62,924	2,187	1,878	66,989	0.335	118,429	3,253	1,878	123,561	0.618
300,000	3,820	62,930	2,727	2,817	68,473	0.228	118,435	3,793	2,817	125,045	0.417
400,000	5,093	62,935	3,266	3,756	69,958	0.175	118,441	4,332	3,756	126,529	0.316
500,000	6,366	62,941	3,805	4,696	71,442	0.143	118,447	4,871	4,696	128,013	0.256
600,000	7,639	62,947	4,344	5,635	72,926	0.122	118,452	5,411	5,635	129,498	0.216
700,000	8,913	62,952	4,884	6,574	74,410	0.106	118,458	5,950	6,574	130,982	0.187
800,000	10,186	62,958	5,423	7,513	75,894	0.095	118,464	6,489	7,513	132,466	0.166
900,000	11,459	62,964	5,962	8,452	77,378	0.086	118,470	7,028	8,452	133,950	0.149
1,000,000	12,732	62,970	6,502	9,391	78,862	0.079	118,475	7,568	9,391	135,434	0.135
1,100,000	14,006	62,975	7,041	10,330	80,347	0.073	118,481	8,107	10,330	136,918	0.124
1,200,000	15,279	62,981	7,580	11,269	81,831	0.068	118,487	8,646	11,269	138,402	0.115
1,300,000	16,552	62,987	8,120	12,208	83,315	0.064	118,493	9,186	12,208	139,887	0.108
1,400,000	17,825	62,993	8,659	13,147	84,799	0.061	118,498	9,725	13,147	141,371	0.101
1,500,000	19,099	62,998	9,198	14,087	86,283	0.058	118,504	10,264	14,087	142,855	0.095
1,600,000	20,372	63,004	9,738	15,026	87,767	0.055	118,510	10,804	15,026	144,339	0.090
1,700,000	21,645	63,010	10,277	15,965	89,252	0.053	118,516	11,343	15,965	145,823	0.086
1,800,000	22,918						118,521	11,882	16,904	147,307	0.082
1,900,000	24,192						118,527	12,422	17,843	148,792	0.078
2,000,000	25,465						118,533	12,961	18,782	150,276	0.075
2,100,000	26,738						118,539	13,500	19,721	151,760	0.072
2,200,000	28,011						118,544	14,039	20,660	153,244	0.070
2,300,000	29,285						118,550	14,579	21,599	154,728	0.067
2,400,000	30,558						118,556	15,118	22,538	156,212	0.065
2,500,000	31,831						118,562	15,657	23,478	157,697	0.063
2,600,000	33,104						118,567	16,197	24,417	159,181	0.061

(cont'd)

Appendix Table 3. Cont'd.

Sales		130,000 gallon facility					300,000 gallon facility				
			Variable costs related to:					Variable costs related to:			
Volume	Density	Fixed**	Volume	Sales area	Total	Total per gal.	Fixed**	Volume	Sales area	Total	Total per gal.
(gal./yr.)	(gal./sq. mile)	(					$				)
100,000	1,273	186,862	3,763	397	191,021	1.910	343,317	6,551	397	350,264	3.503
200,000	2,546	186,867	4,101	793	191,762	0.959	343,336	6,889	793	351,018	1.755
300,000	3,820	186,873	4,440	1,190	192,503	0.642	343,355	7,227	1,190	351,772	1.173
400,000	5,093	186,879	4,778	1,586	193,243	0.483	343,374	7,566	1,586	352,526	0.881
500,000	6,366	186,885	5,116	1,983	193,984	0.388	343,394	7,904	1,983	353,280	0.707
600,000	7,639	186,890	5,454	2,380	194,724	0.325	343,413	8,242	2,380	354,034	0.590
700,000	8,913	186,896	5,792	2,776	195,465	0.279	343,432	8,580	2,776	354,788	0.507
800,000	10,186	186,902	6,131	3,173	196,205	0.245	343,451	8,918	3,173	355,542	0.444
900,000	11,459	186,908	6,469	3,569	196,946	0.219	343,470	9,257	3,569	356,296	0.396
1,000,000	12,732	186,913	6,807	3,966	197,686	0.198	343,489	9,595	3,966	357,050	0.357
1,100,000	14,006	186,919	7,145	4,362	198,427	0.180	343,509	9,933	4,362	357,804	0.325
1,200,000	15,279	186,925	7,484	4,759	199,168	0.166	343,528	10,271	4,759	358,558	0.299
1,300,000	16,552	186,931	7,822	5,156	199,908	0.154	343,547	10,610	5,156	359,312	0.276
1,400,000	17,825	186,936	8,160	5,552	200,649	0.143	343,566	10,948	5,552	360,066	0.257
1,500,000	19,099	186,942	8,498	5,949	201,389	0.134	343,585	11,286	5,949	360,820	0.241
1,600,000	20,372	186,948	8,837	6,345	202,130	0.126	343,604	11,624	6,345	361,574	0.226
1,700,000	21,645	186,954	9,175	6,742	202,870	0.119	343,623	11,963	6,742	362,328	0.213
1,800,000	22,918	186,959	9,513	7,139	203,611	0.113	343,643	12,301	7,139	363,082	0.202
1,900,000	24,192	186,965	9,851	7,535	204,352	0.108	343,662	12,639	7,535	363,836	0.191
2,000,000	25,465	186,971	10,189	7,932	205,092	0.103	343,681	12,977	7,932	364,590	0.182
2,100,000	26,738	186,977	10,528	8,328	205,833	0.098	343,700	13,315	8,328	365,344	0.174
2,200,000	28,011	186,982	10,866	8,725	206,573	0.094	343,719	13,654	8,725	366,098	0.166
2,300,000	29,285	186,988	11,204	9,122	207,314	0.090	343,738	13,992	9,122	366,852	0.160
2,400,000	30,558	186,994	11,542	9,518	208,054	0.087	343,758	14,330	9,518	367,606	0.153
2,500,000	31,831	187,000	11,881	9,915	208,795	0.084	343,777	14,668	9,915	368,360	0.147
2,600,000	33,104	187,005	12,219	10,311	209,536	0.081	343,796	15,007	10,311	369,114	0.142
2,700,000	34,377	187,011	12,557	10,708	210,276	0.078	343,815	15,345	10,708	369,868	0.137
2,800,000	35,651	187,017	12,895	11,104	211,017	0.075	343,834	15,683	11,104	370,622	0.132
2,900,000	36,924	187,023	13,233	11,501	211,757	0.073	343,853	16,021	11,501	371,376	0.128
3,000,000	38,197	187,028	13,572	11,898	212,498	0.071	343,873	16,359	11,898	372,130	0.124
3,100,000	39,470	187,034	13,910	12,294	213,238	0.069	343,892	16,698	12,294	372,884	0.120
3,200,000	40,744	187,040	14,248	12,691	213,979	0.067	343,911	17,036	12,691	373,638	0.117
3,300,000	42,017	187,046	14,586	13,087	214,720	0.065	343,930	17,374	13,087	374,392	0.113
3,400,000	43,290	187,051	14,925	13,484	215,460	0.063	343,949	17,712	13,484	375,146	0.110
3,500,000	44,563	187,057	15,263	13,881	216,201	0.062	343,968	18,051	13,881	375,900	0.107
3,600,000	45,837	187,063	15,601	14,277	216,941	0.060	343,988	18,389	14,277	376,654	0.105
3,700,000	47,110	187,069	15,939	14,674	217,682	0.059	344,007	18,727	14,674	377,408	0.102
3,800,000	48,383	187,074	16,278	15,070	218,422	0.057	344,026	19,065	15,070	378,162	0.100
3,900,000	49,656	187,080	16,616	15,467	219,163	0.056	344,045	19,404	15,467	378,916	0.097
4,000,000	50,930	187,086	16,954	15,864	219,903	0.055	344,064	19,742	15,864	379,670	0.095
5,000,000	63,662	187,143	20,336	19,829	227,309	0.045	344,256	23,124	19,829	387,209	0.077
6,000,000	76,394						344,448	26,506	23,795	394,749	0.066
7,000,000	89,127						344,639	29,889	27,761	402,289	0.057
8,000,000	101,859						344,831	33,271	31,727	409,829	0.051
9,000,000	114,592						345,022	36,653	35,693	417,369	0.046
10,000,000	127,324						345,214	40,035	39,659	424,908	0.042

* Costs not reported when annual sales exceed equipment capacity.

** Changes in fixed costs reflect assumed positive relationship between facility land values and sales density.

Appendix Table 4. Fixed and variable costs related to volume and radius of sales area for specified sizes of bulk fuel facilities for a 35 mile radius sales area, North Dakota, 1992.

Sales		50,000 gallon facility					70,000 gallon facility				
			Variable costs related to:					Variable costs related to:			
Volume	Density	Fixed**	Volume	Sales area	Total	Total per gal.	Fixed**	Volume	Sales area	Total	Total per gal.
(gal./yr.)	(gal./sq. mile)	(				$					)
100,000	1,273	62,914	1,662	1,643	66,219	0.662	118,420	2,728	1,643	122,790	1.228
200,000	2,546	62,916	2,215	3,285	68,416	0.342	118,422	3,281	3,285	124,988	0.625
300,000	3,820	62,918	2,769	4,928	70,614	0.235	118,424	3,835	4,928	127,186	0.424
400,000	5,093	62,920	3,322	6,570	72,812	0.182	118,425	4,388	6,570	129,384	0.323
500,000	6,366	62,922	3,876	8,213	75,010	0.150	118,427	4,942	8,213	131,582	0.263
600,000	7,639	62,924	4,429	9,855	77,208	0.129	118,429	5,495	9,855	133,779	0.223
700,000	8,913	62,925	4,982	11,498	79,405	0.113	118,431	6,048	11,498	135,977	0.194
800,000	10,186	62,927	5,536	13,140	81,603	0.102	118,433	6,602	13,140	138,175	0.173
900,000	11,459	62,929	6,089	14,783	83,801	0.093	118,435	7,155	14,783	140,373	0.156
1,000,000	12,732	62,931	6,642	16,425	85,999	0.086	118,437	7,708	16,425	142,570	0.143
1,100,000	14,006	62,933	7,196	18,068	88,197	0.080	118,439	8,262	18,068	144,768	0.132
1,200,000	15,279	62,935	7,749	19,710	90,394	0.075	118,440	8,815	19,710	146,966	0.122
1,300,000	16,552						118,442	9,369	21,353	149,164	0.115
1,400,000	17,825						118,444	9,922	22,996	151,362	0.108
1,500,000	19,099						118,446	10,475	24,638	153,559	0.102
1,600,000	20,372						118,448	11,029	26,281	155,757	0.097
1,700,000	21,645						118,450	11,582	27,923	157,955	0.093
1,800,000	22,918						118,452	12,135	29,566	160,153	0.089

(cont'd)

Appendix Table 4. Cont'd.

Sales		130,000 gallon facility					300,000 gallon facility				
			Variable costs related to:			Total		Variable costs related to:			Total
Volume	Density	Fixed**	Volume	Sales area	Total	per gal.	Fixed**	Volume	Sales area	Total	per gal.
(gal./yr.)	(gal./sq. mile)	($)									
100,000	1,273	186,858	3,768	666	191,293	1.913	343,304	6,556	666	350,527	3.505
200,000	2,546	186,860	4,112	1,333	192,304	0.962	343,310	6,900	1,333	351,543	1.758
300,000	3,820	186,862	4,456	1,999	193,316	0.644	343,316	7,244	1,999	352,559	1.175
400,000	5,093	186,863	4,799	2,665	194,328	0.486	343,323	7,587	2,665	353,575	0.884
500,000	6,366	186,865	5,143	3,331	195,340	0.391	343,329	7,931	3,331	354,591	0.709
600,000	7,639	186,867	5,487	3,998	196,352	0.327	343,335	8,274	3,998	355,607	0.593
700,000	8,913	186,869	5,830	4,664	197,363	0.282	343,342	8,618	4,664	356,624	0.509
800,000	10,186	186,871	6,174	5,330	198,375	0.248	343,348	8,962	5,330	357,640	0.447
900,000	11,459	186,873	6,517	5,997	199,387	0.222	343,354	9,305	5,997	358,656	0.399
1,000,000	12,732	186,875	6,861	6,663	200,399	0.200	343,360	9,649	6,663	359,672	0.360
1,100,000	14,006	186,877	7,205	7,329	201,411	0.183	343,367	9,992	7,329	360,688	0.328
1,200,000	15,279	186,879	7,548	7,996	202,422	0.169	343,373	10,336	7,996	361,704	0.301
1,300,000	16,552	186,880	7,892	8,662	203,434	0.156	343,379	10,680	8,662	362,721	0.279
1,400,000	17,825	186,882	8,236	9,328	204,446	0.146	343,385	11,023	9,328	363,737	0.260
1,500,000	19,099	186,884	8,579	9,994	205,458	0.137	343,392	11,367	9,994	364,753	0.243
1,600,000	20,372	186,886	8,923	10,661	206,470	0.129	343,398	11,711	10,661	365,769	0.229
1,700,000	21,645	186,888	9,266	11,327	207,481	0.122	343,404	12,054	11,327	366,785	0.216
1,800,000	22,918	186,890	9,610	11,993	208,493	0.116	343,410	12,398	11,993	367,801	0.204
1,900,000	24,192	186,892	9,954	12,660	209,505	0.110	343,417	12,741	12,660	368,818	0.194
2,000,000	25,465	186,894	10,297	13,326	210,517	0.105	343,423	13,085	13,326	369,834	0.185
2,100,000	26,738	186,895	10,641	13,992	211,528	0.101	343,429	13,429	13,992	370,850	0.177
2,200,000	28,011	186,897	10,985	14,658	212,540	0.097	343,435	13,772	14,658	371,866	0.169
2,300,000	29,285	186,899	11,328	15,325	213,552	0.093	343,442	14,116	15,325	372,882	0.162
2,400,000	30,558	186,901	11,672	15,991	214,564	0.089	343,448	14,460	15,991	373,898	0.156
2,500,000	31,831	186,903	12,015	16,657	215,576	0.086	343,454	14,803	16,657	374,915	0.150
2,600,000	33,104	186,905	12,359	17,324	216,587	0.083	343,460	15,147	17,324	375,931	0.145
2,700,000	34,377	186,907	12,703	17,990	217,599	0.081	343,467	15,490	17,990	376,947	0.140
2,800,000	35,651	186,909	13,046	18,656	218,611	0.078	343,473	15,834	18,656	377,963	0.135
2,900,000	36,924	186,910	13,390	19,322	219,623	0.076	343,479	16,178	19,322	378,979	0.131
3,000,000	38,197	186,912	13,734	19,989	220,635	0.074	343,485	16,521	19,989	379,996	0.127
3,100,000	39,470	186,914	14,077	20,655	221,646	0.071	343,492	16,865	20,655	381,012	0.123
3,200,000	40,744	186,916	14,421	21,321	222,658	0.070	343,498	17,209	21,321	382,028	0.119
3,300,000	42,017	186,918	14,764	21,988	223,670	0.068	343,504	17,552	21,988	383,044	0.116
3,400,000	43,290	186,920	15,108	22,654	224,682	0.066	343,510	17,896	22,654	384,060	0.113
3,500,000	44,563	186,922	15,452	23,320	225,694	0.064	343,517	18,239	23,320	385,076	0.110
3,600,000	45,837	186,924	15,795	23,987	226,705	0.063	343,523	18,583	23,987	386,093	0.107
3,700,000	47,110	186,925	16,139	24,653	227,717	0.062	343,529	18,927	24,653	387,109	0.105
3,800,000	48,383	186,927	16,483	25,319	228,729	0.060	343,536	19,270	25,319	388,125	0.102
3,900,000	49,656	186,929	16,826	25,985	229,741	0.059	343,542	19,614	25,985	389,141	0.100
4,000,000	50,930	186,931	17,170	26,652	230,752	0.058	343,548	19,958	26,652	390,157	0.098
5,000,000	63,662						343,611	23,394	33,315	400,319	0.080
6,000,000	76,394						343,673	26,830	39,978	410,481	0.068
7,000,000	89,127						343,736	30,266	46,640	420,642	0.060
8,000,000	101,859						343,798	33,702	53,303	430,804	0.054

* Costs not reported when annual sales exceed equipment capacity.

** Changes in fixed costs reflect assumed positive relationship between facility land values and sales density.

Appendix Table 5. Fixed and variable costs related to volume and radius of sales area for specified sizes of bulk fuel facilities for a 50 mile radius sales area, North Dakota, 1992.

Sales		50,000 gallon facility					70,000 gallon facility				
			Variable costs related to:					Variable costs related to:			
Volume	Density	Fixed**	Volume	Sales area	Total	Total per gal.	Fixed**	Volume	Sales area	Total	Total per gal.
(gal./yr.)	(gal./sq. mile)	($)									
100,000	1,273	62,913	1,676	2,346	66,935	0.669	118,419	2,742	2,346	123,507	1.235
200,000	2,546	62,914	2,244	4,692	69,850	0.349	118,420	3,310	4,692	126,421	0.632
300,000	3,820	62,915	2,811	7,038	72,764	0.243	118,421	3,877	7,038	129,336	0.431
400,000	5,093	62,916	3,378	9,384	75,678	0.189	118,422	4,444	9,384	132,250	0.331
500,000	6,366	62,917	3,946	11,730	78,593	0.157	118,422	5,012	11,730	135,164	0.270
600,000	7,639	62,918	4,513	14,076	81,507	0.136	118,423	5,579	14,076	138,079	0.230
700,000	8,913	62,919	5,081	16,422	84,421	0.121	118,424	6,147	16,422	140,993	0.201
800,000	10,186	62,920	5,648	18,768	87,336	0.109	118,425	6,714	18,768	143,907	0.180
900,000	11,459	62,921	6,216	21,114	90,250	0.100	118,426	7,282	21,114	146,822	0.163
1,000,000	12,732	62,921	6,783	23,460	93,164	0.093	118,427	7,849	23,460	149,736	0.150
1,100,000	14,006						118,428	8,417	25,806	152,650	0.139
1,200,000	15,279						118,429	8,984	28,152	155,565	0.130
1,300,000	16,552						118,430	9,551	30,498	158,479	0.122
1,400,000	17,825						118,431	10,119	32,844	161,393	0.115
1,500,000	19,099						118,432	10,686	35,190	164,308	0.110

(cont'd)

Appendix Table 5. Cont'd.

Sales		130,000 gallon facility					300,000 gallon facility				
			Variable costs related to:			Total		Variable costs related to:			Total
Volume	Density	Fixed**	Volume	Sales area	Total	per gal.	Fixed**	Volume	Sales area	Total	per gal.
(gal./yr.)	(gal./sq. mile)	($)									
100,000	1,273	186,857	3,774	936	191,567	1.916	343,301	6,562	936	350,798	3.508
200,000	2,546	186,858	4,123	1,872	192,853	0.964	343,304	6,911	1,872	352,087	1.760
300,000	3,820	186,859	4,472	2,808	194,139	0.647	343,307	7,260	2,808	353,375	1.178
400,000	5,093	186,860	4,821	3,744	195,425	0.489	343,310	7,609	3,744	354,663	0.887
500,000	6,366	186,861	5,170	4,680	196,711	0.393	343,313	7,958	4,680	355,951	0.712
600,000	7,639	186,862	5,519	5,616	197,996	0.330	343,316	8,307	5,616	357,239	0.595
700,000	8,913	186,862	5,868	6,552	199,282	0.285	343,319	8,656	6,552	358,527	0.512
800,000	10,186	186,863	6,217	7,488	200,568	0.251	343,322	9,005	7,488	359,815	0.450
900,000	11,459	186,864	6,566	8,424	201,854	0.224	343,325	9,354	8,424	361,103	0.401
1,000,000	12,732	186,865	6,915	9,360	203,140	0.203	343,328	9,703	9,360	362,391	0.362
1,100,000	14,006	186,866	7,264	10,296	204,426	0.186	343,331	10,052	10,296	363,679	0.331
1,200,000	15,279	186,867	7,613	11,232	205,712	0.171	343,335	10,401	11,232	364,967	0.304
1,300,000	16,552	186,868	7,962	12,168	206,998	0.159	343,338	10,750	12,168	366,255	0.282
1,400,000	17,825	186,869	8,311	13,104	208,284	0.149	343,341	11,099	13,104	367,543	0.263
1,500,000	19,099	186,870	8,660	14,040	209,570	0.140	343,344	11,448	14,040	368,832	0.246
1,600,000	20,372	186,871	9,009	14,976	210,856	0.132	343,347	11,797	14,976	370,120	0.231
1,700,000	21,645	186,872	9,358	15,912	212,142	0.125	343,350	12,146	15,912	371,408	0.218
1,800,000	22,918	186,873	9,707	16,848	213,428	0.119	343,353	12,495	16,848	372,696	0.207
1,900,000	24,192	186,873	10,056	17,784	214,714	0.113	343,356	12,844	17,784	373,984	0.197
2,000,000	25,465	186,874	10,405	18,720	215,999	0.108	343,359	13,193	18,720	375,272	0.188
2,100,000	26,738	186,875	10,754	19,656	217,285	0.103	343,362	13,542	19,656	376,560	0.179
2,200,000	28,011	186,876	11,103	20,592	218,571	0.099	343,365	13,891	20,592	377,848	0.172
2,300,000	29,285	186,877	11,452	21,528	219,857	0.096	343,368	14,240	21,528	379,136	0.165
2,400,000	30,558	186,878	11,801	22,464	221,143	0.092	343,371	14,589	22,464	380,424	0.159
2,500,000	31,831	186,879	12,150	23,400	222,429	0.089	343,374	14,938	23,400	381,712	0.153
2,600,000	33,104	186,880	12,499	24,336	223,715	0.086	343,377	15,287	24,336	383,000	0.147
2,700,000	34,377	186,881	12,848	25,272	225,001	0.083	343,381	15,636	25,272	384,288	0.142
2,800,000	35,651	186,882	13,197	26,208	226,287	0.081	343,384	15,985	26,208	385,577	0.138
2,900,000	36,924	186,883	13,546	27,144	227,573	0.078	343,387	16,334	27,144	386,865	0.133
3,000,000	38,197	186,884	13,895	28,080	228,859	0.076	343,390	16,683	28,080	388,153	0.129
3,100,000	39,470	186,885	14,244	29,016	230,145	0.074	343,393	17,032	29,016	389,441	0.126
3,200,000	40,744	186,885	14,593	29,952	231,431	0.072	343,396	17,381	29,952	390,729	0.122
3,300,000	42,017	186,886	14,942	30,888	232,717	0.071	343,399	17,730	30,888	392,017	0.119
3,400,000	43,290	186,887	15,291	31,824	234,003	0.069	343,402	18,079	31,824	393,305	0.116
3,500,000	44,563						343,405	18,428	32,760	394,593	0.113
3,600,000	45,837						343,408	18,777	33,696	395,881	0.110
3,700,000	47,110						343,411	19,126	34,632	397,169	0.107
3,800,000	48,383						343,414	19,475	35,568	398,457	0.105
3,900,000	49,656						343,417	19,824	36,504	399,745	0.102
4,000,000	50,930						343,420	20,173	37,440	401,033	0.100
5,000,000	63,662						343,451	23,663	46,800	413,914	0.083
6,000,000	76,394						343,482	27,154	56,160	426,795	0.071

* Costs not reported when annual sales exceed equipment capacity

** Changes in fixed costs reflect assumed positive relationship between facility land values and sales density.

Appendix Table 6. Average total cost* ($/gal.) for 70,000 gallon facility by equipment compliment and load-out pipe size, by specified sales density, North Dakota, 1992.

Sales volume	2" load out pipe Number-size of trucks				3" load out pipe Number-size of trucks			
(gal./day)	1-2000	2-2000	1-4000	2-4000	1-2000	2-2000	1-4000	2-4000
	(- 100 gal./sq. mile -)							
349	0.7136	0.8911	0.8208	1.1123	0.7199	0.8974	0.8271	1.1186
697	0.3672	0.4560	0.4154	0.5612	0.3701	0.4588	0.4184	0.5641
1,046	0.2532	0.3124	0.2809	0.3781	0.2549	0.3141	0.2827	0.3799
1,395	0.1972	0.2416	0.2141	0.2869	0.1982	0.2426	0.2153	0.2881
1,743	0.1642	0.1997	0.1742	0.2325	0.1648	0.2003	0.1750	0.2333
2,092	0.1426	0.1722	0.1479	0.1964	0.1430	0.1726	0.1484	0.1970
2,441	0.1276	0.1530	0.1292	0.1708	0.1278	0.1531	0.1295	0.1712
2,790	0.1166	0.1388	0.1153	0.1517	0.1166	0.1388	0.1155	0.1519
3,138	0.1084	0.1281	0.1046	0.1370	0.1082	0.1279	0.1047	0.1371
3,487	0.1019	0.1197	0.0962	0.1253	0.1017	0.1194	0.0961	0.1252
3,836		0.1130	0.0893	0.1158		0.1126	0.0892	0.1157
4,184		0.1076	0.0837	0.1080		0.1071	0.0834	0.1077
4,533		0.1032	0.0790	0.1014		0.1026	0.0786	0.1011
4,882		0.0995		0.0958		0.0988	0.0746	0.0954
5,230		0.0964		0.0910		0.0957	0.0711	0.0906
5,579		0.0938		0.0868		0.0930		0.0863
5,928		0.0916		0.0832		0.0908		0.0827

cont'd.

Appendix Table 6. Cont'd.

Sales volume	2" load out pipe Number-size of trucks				3" load out pipe Number-size of trucks			
gal./day	1-2000	2-2000	1-4000	2-4000	1-2000	2-2000	1-4000	2-4000
	(- 300 gal./sq. mile -)							
349	0.7102	0.8877	0.8194	1.1109	0.7166	0.8942	0.8259	1.1174
697	0.3623	0.4510	0.4134	0.5591	0.3653	0.4541	0.4165	0.5622
1,046	0.2472	0.3063	0.2784	0.3755	0.2491	0.3082	0.2803	0.3775
1,395	0.1901	0.2345	0.2111	0.2840	0.1914	0.2358	0.2125	0.2853
1,743	0.1563	0.1918	0.1709	0.2292	0.1572	0.1927	0.1719	0.2302
2,092	0.1340	0.1636	0.1442	0.1928	0.1347	0.1642	0.1450	0.1936
2,441	0.1183	0.1436	0.1252	0.1669	0.1187	0.1441	0.1258	0.1675
2,790	0.1066	0.1288	0.1111	0.1475	0.1070	0.1292	0.1115	0.1480
3,138	0.0978	0.1175	0.1001	0.1325	0.0980	0.1177	0.1005	0.1328
3,487	0.0908	0.1085	0.0914	0.1206	0.0909	0.1086	0.0917	0.1208
3,836	0.0851	0.1013	0.0843	0.1108	0.0852	0.1013	0.0845	0.1110
4,184		0.0953	0.0785	0.1028	0.0805	0.0953	0.0786	0.1028
4,533		0.0904	0.0735	0.0960	0.0766	0.0903	0.0736	0.0960
4,882		0.0862	0.0693	0.0902		0.0861	0.0693	0.0901
5,230		0.0827	0.0657	0.0852		0.0825	0.0657	0.0851
5,579		0.0797	0.0626	0.0808		0.0794	0.0625	0.0807
5,928		0.0770		0.0770		0.0767	0.0597	0.0769
6,276		0.0747		0.0737		0.0744		0.0735
6,625		0.0727		0.0707		0.0723		0.0704
6,974		0.0710		0.0680		0.0705		0.0677
7,323				0.0656		0.0689		0.0653
7,671				0.0634		0.0675		0.0631
8,020				0.0614		0.0663		0.0611
8,369				0.0597				0.0593
8,717				0.0580				0.0576
9,066				0.0565				0.0561
9,415				0.0551				0.0547
9,763				0.0539				0.0534
10,112				0.0527				0.0522
10,461								0.0511
10,809								0.0501
11,158								0.0492
11,507								0.0483

cont'd.

Appendix Table 6. Cont'd.

Sales volume	2" load out pipe Number-size of trucks				3" load out pipe Number-size of trucks			
gal./day	1-2000	2-2000	1-4000	2-4000	1-2000	2-2000	1-4000	2-4000
	(- 700 gal./sq. mile -)							
349	0.7088	0.8864	0.8190	1.1105	0.7153	0.8928	0.8255	1.1170
697	0.3601	0.4488	0.4125	0.5582	0.3632	0.4520	0.4157	0.5614
1,046	0.2444	0.3035	0.2772	0.3744	0.2464	0.3055	0.2793	0.3764
1,395	0.1869	0.2312	0.2097	0.2826	0.1883	0.2327	0.2112	0.2841
1,743	0.1526	0.1881	0.1694	0.2276	0.1537	0.1892	0.1705	0.2288
2,092	0.1299	0.1595	0.1425	0.1911	0.1308	0.1603	0.1434	0.1920
2,441	0.1139	0.1392	0.1234	0.1650	0.1145	0.1399	0.1241	0.1657
2,790	0.1020	0.1241	0.1091	0.1455	0.1025	0.1247	0.1097	0.1461
3,138	0.0928	0.1125	0.0980	0.1304	0.0932	0.1129	0.0985	0.1309
3,487	0.0855	0.1033	0.0892	0.1183	0.0858	0.1036	0.0896	0.1187
3,836	0.0796	0.0958	0.0820	0.1085	0.0799	0.0960	0.0823	0.1088
4,184	0.0748	0.0896	0.0760	0.1003	0.0750	0.0898	0.0763	0.1006
4,533	0.0708	0.0844	0.0710	0.0934	0.0709	0.0845	0.0712	0.0936
4,882	0.0673	0.0800	0.0667	0.0875	0.0674	0.0801	0.0669	0.0877
5,230		0.0763	0.0630	0.0824	0.0644	0.0763	0.0631	0.0825
5,579		0.0730	0.0598	0.0780	0.0619	0.0730	0.0599	0.0781
5,928		0.0702	0.0570	0.0741	0.0596	0.0701	0.0570	0.0741
6,276		0.0677	0.0545	0.0707		0.0676	0.0545	0.0707
6,625		0.0655		0.0676		0.0653	0.0522	0.0675
6,974		0.0635		0.0648		0.0634	0.0502	0.0648
7,323		0.0618		0.0623		0.0616	0.0484	0.0623
7,671		0.0602		0.0601		0.0600		0.0600
8,020		0.0588		0.0580		0.0586		0.0579
8,369		0.0576		0.0562		0.0573		0.0560
8,717				0.0545		0.0561		0.0543
9,066				0.0529		0.0551		0.0527
9,415				0.0515		0.0541		0.0513
9,763				0.0501				0.0499
10,112				0.0489				0.0487
10,461				0.0477				0.0475
10,809				0.0467				0.0464
11,158				0.0457				0.0454
11,507								0.0445
11,856								0.0436
12,204								0.0428
12,553								0.0420

cont'd.

Appendix Table 6. Cont'd.

Sales volume	2" load out pipe Number-size of trucks				3" load out pipe Number-size of trucks			
gal./day	1-2000	2-2000	1-4000	2-4000	1-2000	2-2000	1-4000	2-4000
	(- 1,000 gal./sq. mile -)							
349	0.7085	0.8861	0.8190	1.1105	0.7150	0.8926	0.8255	1.1170
697	0.3594	0.4482	0.4123	0.5580	0.3626	0.4514	0.4155	0.5612
1,046	0.2435	0.3027	0.2769	0.3741	0.2456	0.3047	0.2790	0.3762
1,395	0.1859	0.2303	0.2094	0.2822	0.1873	0.2317	0.2109	0.2837
1,743	0.1515	0.1870	0.1689	0.2272	0.1526	0.1881	0.1701	0.2284
2,092	0.1287	0.1583	0.1420	0.1906	0.1296	0.1592	0.1429	0.1915
2,441	0.1125	0.1379	0.1228	0.1645	0.1132	0.1386	0.1236	0.1652
2,790	0.1005	0.1227	0.1085	0.1449	0.1011	0.1233	0.1091	0.1456
3,138	0.0912	0.1110	0.0974	0.1298	0.0917	0.1114	0.0979	0.1303
3,487	0.0839	0.1016	0.0885	0.1177	0.0843	0.1020	0.0889	0.1181
3,836	0.0779	0.0941	0.0813	0.1078	0.0782	0.0944	0.0816	0.1081
4,184	0.0730	0.0878	0.0753	0.0996	0.0732	0.0880	0.0756	0.0999
4,533	0.0689	0.0826	0.0702	0.0926	0.0691	0.0827	0.0705	0.0929
4,882	0.0654	0.0781	0.0659	0.0867	0.0655	0.0782	0.0661	0.0869
5,230	0.0624	0.0743	0.0622	0.0816	0.0625	0.0743	0.0623	0.0818
5,579	0.0598	0.0709	0.0589	0.0771	0.0599	0.0710	0.0590	0.0773
5,928		0.0680	0.0561	0.0732	0.0576	0.0680	0.0562	0.0733
6,276		0.0655	0.0535	0.0697	0.0556	0.0655	0.0536	0.0698
6,625		0.0632	0.0513	0.0666		0.0632	0.0513	0.0667
6,974		0.0612	0.0493	0.0638		0.0611	0.0493	0.0639
7,323		0.0594		0.0613		0.0593	0.0474	0.0613
7,671		0.0578		0.0591		0.0577	0.0458	0.0590
8,020		0.0564		0.0570		0.0562		0.0569
8,369		0.0550		0.0551		0.0549		0.0550
8,717		0.0538		0.0534		0.0536		0.0533
9,066		0.0528		0.0518		0.0525		0.0517
9,415				0.0503		0.0515		0.0502
9,763				0.0490		0.0506		0.0488
10,112				0.0477		0.0497		0.0476
10,461				0.0465		0.0490		0.0464
10,809				0.0455				0.0453
11,158				0.0444				0.0442
11,507				0.0435				0.0433
11,856				0.0426				0.0424
12,204				0.0418				0.0415
12,553								0.0407
12,902								0.0400
13,250								0.0393
13,599								0.0386

cont'd.

Appendix Table 6. Cont'd.

Sales volume	2" load out pipe Number-size of trucks				3" load out pipe Number-size of trucks			
gal./day	1-2000	2-2000	1-4000	2-4000	1-2000	2-2000	1-4000	2-4000
	(- 3,000 gal./sq. mile -)							
349	0.7089	0.8864	0.8200	1.1115	0.7154	0.8929	0.8265	1.1180
697	0.3586	0.4473	0.4123	0.5581	0.3618	0.4506	0.4156	0.5613
1,046	0.2421	0.3013	0.2766	0.3737	0.2442	0.3034	0.2787	0.3759
1,395	0.1840	0.2284	0.2088	0.2816	0.1855	0.2299	0.2103	0.2832
1,743	0.1493	0.1848	0.1681	0.2264	0.1505	0.1860	0.1694	0.2277
2,092	0.1262	0.1558	0.1411	0.1897	0.1272	0.1568	0.1421	0.1907
2,441	0.1098	0.1352	0.1218	0.1634	0.1106	0.1360	0.1226	0.1643
2,790	0.0975	0.1197	0.1073	0.1438	0.0982	0.1204	0.1080	0.1445
3,138	0.0881	0.1078	0.0961	0.1285	0.0886	0.1083	0.0967	0.1291
3,487	0.0805	0.0983	0.0871	0.1163	0.0810	0.0987	0.0877	0.1168
3,836	0.0744	0.0905	0.0798	0.1063	0.0748	0.0909	0.0803	0.1068
4,184	0.0693	0.0841	0.0737	0.0980	0.0696	0.0844	0.0742	0.0984
4,533	0.0650	0.0786	0.0686	0.0910	0.0653	0.0790	0.0690	0.0914
4,882	0.0613	0.0740	0.0642	0.0850	0.0616	0.0743	0.0645	0.0854
5,230	0.0582	0.0700	0.0604	0.0798	0.0584	0.0703	0.0607	0.0801
5,579	0.0555	0.0666	0.0571	0.0753	0.0557	0.0668	0.0573	0.0756
5,928	0.0531	0.0635	0.0542	0.0713	0.0532	0.0637	0.0544	0.0715
6,276	0.0510	0.0608	0.0516	0.0678	0.0511	0.0610	0.0518	0.0680
6,625	0.0491	0.0584	0.0493	0.0646	0.0492	0.0585	0.0495	0.0648
6,974	0.0474	0.0563	0.0472	0.0618	0.0475	0.0564	0.0474	0.0619
7,323		0.0544	0.0453	0.0592	0.0460	0.0544	0.0455	0.0593
7,671		0.0526	0.0436	0.0569	0.0446	0.0527	0.0438	0.0570
8,020		0.0510	0.0421	0.0548	0.0434	0.0511	0.0422	0.0549
8,369		0.0496	0.0407	0.0528		0.0496	0.0408	0.0529
8,717		0.0483	0.0394	0.0511		0.0483	0.0395	0.0511
9,066		0.0471		0.0494		0.0471	0.0383	0.0495
9,415		0.0460		0.0479		0.0460	0.0371	0.0479
9,763		0.0450		0.0465		0.0449	0.0361	0.0465
10,112		0.0440		0.0452		0.0440		0.0452
10,461		0.0432		0.0440		0.0431		0.0440
10,809		0.0424		0.0429		0.0423		0.0428
11,158		0.0416		0.0418		0.0415		0.0418
11,507		0.0409		0.0408		0.0408		0.0408
11,856		0.0403		0.0399		0.0401		0.0398
12,204		0.0397		0.0390		0.0395		0.0389
12,553				0.0382		0.0389		0.0381
12,902				0.0374		0.0384		0.0373
13,250				0.0367		0.0379		0.0366
13,599				0.0360		0.0374		0.0359
13,948				0.0353		0.0370		0.0352
15,691								0.0324

Average total cost not reported if annual sales exceeds capacity of bulk fuel delivery equipment

LIST OF TABLES

LIST OF FIGURES