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GRAIN and RAIL IN WESTERN CANADA

THE REPORT OF THE GRAIN HANDLING AND TRANSPORTATION COMMISSION

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The Honourable Otto E. Lang, P.C. M.P.,
Minister of Transport, and Minister
Responsible for the Canadian Wheat Board,
House of Commons,
OTTAWA, Ontario

Sir:

We, the Commissioners of the Grain Handling and Transportation Commission, appointed by Orders-in-Council PC 1975-872 and PC 1975-1067:

> To inquire into the rail needs of communities, the economies of a modernized rail system and the probable conduct of producers and elevator companies in changing circumstances for the purpose of making recommendations concerning the future role of that portion of the rail network identified for further evaluation

Now submit Volume 2 of our Report. The seven reports in this compendium are a part of the research program carried out in the course of our evaluation of the grain transportation and handling systems in Western Canada. They are a part of the input to the conclusions reached, and the recommendations made by this Commission in Volume 1.

ALL OF WHICH IS RESPECTFULLY SUBMITTED:

L.G. Stewart Commissioner	Hon. Emmett M. Hall, Q.C. Chief Commissioner	R. Lehr Commissioner
R. Forbes Commissioner	J.M. McDonough Executive Director	R.H. Cowan Commissioner

GRAIN AND RAIL

IN

WESTERN CANADA

VOLUME II

GRAIN AND RAIL IN WESTERN CANADA

VOLUME II

TO THE READER

The seven reports contained in this volume are a part of the research program carried out by the Grain Handling and Transportation Commission in the course of their evaluation of the transportation and grain handling systems in Western Canada. These reports provide an insight into some of the constraints on the retention and expansion of the secondary agriculture industries in Western Canada, as well as a look at the energy implications of changes in the branch line network and the mini-train as an alternative to conventional branch line operations.

These background papers provided a part of the input to the conclusions reached, and recommendations made by the Commission and referred to in Volume I. It is hoped that these papers will provide the reader with an expanded insight into the complexity and ramifications of some of the issues facing the handling and transportation system in Western Canada at this time.

CHAPTER 1

COST OF HAULING GRAIN BY FARM TRUCKS IN WESTERN CANADA

S.N. Kulshreshtha
W.A. Scott

INTRODUCTION

Any decision involving a reduction in the existing number of grain collection points (elevators) on the prairies, in most likelihood would, yield higher costs of transporting grain between farms and the collection points. Any estimation of such costs requires the knowledge of the level of cost of hauling grain by alternative modes (farm trucks, commercial trucks, etc.) as well as the factors affecting the level of this cost. The present report is designed to provide this type of information for farm trucks for Western Canada.

The study has the following objectives:

1) to estimate the total annual cost of hauling grain between farms and a collection point (usually, but not exclusively, country elevators), and to calculate the average cost of hauling,

2) to investigate the behaviour of total and average costs as size of farm and distance to a collection point increase, and

3) to identify the factors affecting average cost of hauling grain by farm trucks.

Scope of the Study

This study is based on an analysis of 417 farm trucks* in various areas of Saskatchewan. Results reported here are based on a survey of

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* A farm truck in this study was defined as the one with a F-plate and used for hauling grain between a farm and a grain collection point (country elevator, feed mill, seed farm, terminal elevator, neighbors' farms, etc.) during 1971-72 crop year.

farm trucks conducted by Kulshreshtha* during 1972-73 for the Government of Saskatchewan. The present study differs from the original study in two respects: one, all the large (in volume hauled) custom truckers have been deleted from the main analysis; two, levels of cost reported here reflect the economic conditions as they existed in 1974.

Organization of the Study

The remainder of this study is divided into three parts: one, description of sample and brief methodology; two, estimates of annual cost of hauling grain and average cost estimates; and three, analysis of factors affecting average cost of hauling grain by farm trucks. The report concludes with a summary of major findings.

ANALYTICAL FRAMEWORK

Selection of Sample

In the past, a number of studies have been carried out related to the cost of hauling grain. The following reports were reviewed:

1) E.W. Tyrchniewicz, A.H. Butler, and O.P. Tangri, The Cost of Transporting Grain By Farm Truck, Centre for Transportation Studies, The University of Manitoba, Res. Rep. No. 8, July 1971.

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* Results of this survey have been reported in S.N. Kulshreshtha, An Economic Analysis of Farm Truck Ownership, Utilization and Cost of Hauling Grain in Saskatchewan, Dept. of Agric. Econ., University of Saskatchewan, RR: 73-09, August 1973.

2) E.W. Tyrchniewicz, The Cost of Transporting Grain by Farm Truck in the Prairie Provinces, A Study Prepared for the Grains Group, October 1970.

3) S.N. Kulshreshtha, An Economic Analysis of Farm Truck Ownership, Utilization and Cost of Hauling Grain in Saskatchewan, A Study Prepared for Grain Handling and Transportation System Rationalization Office, Regina, August 1973.

4) S.N. Kulshreshtha, Cost of Grain Hauling By Farm Trucks in Saskatchewan, Agricultural Science Bulletin, Extension Division, University of Saskatchewan, March 1974.

5) Canada Grains Council, The Grain Handling and Transportation System in the Brandon Area, Winnipeg, 1974

6) Canada Grains Council, Grain Handling and Transportation, Area 11 Study, Winnipeg, October 1975.

7) E.W. Tyrchniewicz, G.W. Moore and O.P. Tangri, The Cost of Transporting Grain by Custom and Commercial Trucks, Centre for Transportation Studies, University of Manitoba, August 1974.

A summary of sample characteristics for these studies is shown in Appendix A.

Of the studies mentioned above, only two studies (No. 2 and 3 above) were based on an original survey of farm grain trucks*; study No. 7 was for commercial and custom trucks, and the remaining studies used these samples in some modified form.

For purposes of conducting the present study, it was agreed at the outset that no new data generation would be carried out. Such a

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* This excludes study No. 1, because it was a part of the sample for the study No. 2.

decision was made in light of two considerations: (i) the existing studies and their sample information were acceptable, and also accessible to the Commission; and (ii) a new survey of a moderate sample size (say 400 to 500 farmers in the three prairie provinces) required a large financial outlay and time resources.

The choice of a sample was then narrowed down to two sets of samples: one, by Tyrchniewicz for the Grains Groups study, and two, that by Kulshreshtha for Saskatchewan. Tyrchniewicz's sample contained a total of 279 farm trucks, of which 120 were in Manitoba, 101 in Saskatchewan and the remaining 58 in Alberta. Kulshrestha's sample consisted of 430 grain trucks (on 380 farms) including 13 large* cumstom truckers**. Both of these sets of samples had features different from each other. The Tyrchniewicz sample offered the following advantages: The sample had farms from all the three prairie provinces, and therefore lent itself to a type of analysis with provincial disaggregation. The Kulshreshtha sample lacked on this characteristic. However, it had the advantage of being more recent (1971-72 vs. 1968-69 for the previous sample), and having been selected by a random sampling process. Furthermore, if factors affecting cost of hauling grain are

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* The term "large" refers to the fact that these individuals engaged heavily in the practice of custom hauling of grain or other products.

** In this study a custom trucker was a farmer, using a F-plate truck, hauling grain for another farmer for an agreed fee.

similar and if their effect is equal in all the three provinces, a sample based on one province might be considered representative of Western Canada*.

The results based on Tyrchniewicz's sample were examined further to test whether there were significant differences among the three provincial subsamples. A cursory analysis indicated that the three provinces might be significantly different from each other. However, this feature of the sample was outweighted by the consideration that the survey referred to 1967-68 period, and in light of structural changes taking place within the industry the results may be of limited value. Attention was subsequently focused on the Saskatchewan sample. Since it included a number of large custom truckers, and since these trucks were not comparable to average farm trucks (in size, utilization and cost), it was decided to use this sample after deleting the 13 large custom truckers in the Goodsoil - Pierceland area of the sample.

Characteristics of Farm and Grain Trucks in the Sample

As mentioned earlier the sample contained a total of 417 trucks. These trucks were maintained on a total of 370 farms (Table I-1). An average farm in the sample maintained 1.127 trucks. On an average, the sample farm was of 1,053 acres, seeded 461 acres to grain crops, and delivered about 11,100 bushels of grain to various outlets.

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* For more elaboration on this point, see Appendix B.

(Table I-2). Average distance between a farm and the country elevator was 10.75 miles*.

TABLE I-1

DISTRIBUTION OF FARMS BY NUMBER OF TRUCKS

Number of Trucks Per Farm	No. of Farms	No. of Trucks
One	326	326
Two	42	84
Three	1	3
Four	1	4
TOTAL	370	417

TABLE I-2

SELECTED FARM BASED CHARACTERISTICS OF THE SAMPLE

Characteristic	Unit	Value for 1971-72
Size of Farm	Acres	1,053
Area Under Grain	Acres	461
One-way Distance to Elevator	Miles	10.75
Total Bushels Delivered	Bushels	11,099.7

* This average distance is slightly higer than what is considered to be typical distance between a farm and a country elevator. This is because of slightly higher proportion of farms with hauling distance over 30 miles in the sample. This proportion was 13.78 percent as against only 3.1 percent for prairie provinces.

An average truck in the sample was a two-ton, with a gross weight of 19,590 pounds and with a grain box capacity of 208.6 bushels as shown in Table I-3. Average distance between a farm and all the collection points was estimated to be 8.94 miles. This is equivalent to the distance per load when all delivery points' distances are weighted according to share of total grain received. Average output of the grain truck -- as measured by bushel mile* -- was estimated to be 88,022 bushel miles.

TABLE I-3

SELECTED TRUCK BASED CHARACTERISTICS OF THE SAMPLE

Characteristic	Unit	Value for 1971-72
Size of the truck	Tons	2.03
Gross Vehicle Weight	000 lbs.	19.59
Capacity of Grain Box	Bushels	208.6
Age of Truck	Years	15.66
Annual Mileage	Miles	3,226.6
Prop. of Grain Miles to Total	%	33
Annual Bushel-Miles	---	88,022
Weighted distance to all outlets	Miles	8.94

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* Bushel-mile is a measure where one bushel of grain travels a distance of one mile.

Methods of Estimating Cost of Hauling Grain

In this section the method of estimating various items of cost related to hauling grain by farm trucks is described briefly.* Total cost was divided into three parts:

- Total Annual Cost = Annual Common (Fixed) Costs + Annual Common (Variable) Costs + Direct Costs.

Common costs are those costs related to hauling grain which are incurred for trucs as a whole; their share for grain hauling is apportioned using some suitable criterion. Direct costs are those costs which are associated directly with the grain hauling job, and thus, need no apportionment. The criterion chosen to apportion the common costs was the proportion of grain haul miles to annual mileage of the truck.

As mentioned earlier costs in this report reflect the 1974 level. Since the survey data were collected for the 1971-72 crop year, these data were updated using cost indices. These cost indices were derived from Statistics Canada's Farm Input Index**. For the two periods -- 1971-72 and 1974, the value of appropriate indexes were recorded.*** Ratios of the 1974 indices relative to 1971-72 were used to update various cost items. This procedure was followed for all items, except

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* For more detailed description, see Kulshreshtha, 1973, <u>op. cit.</u>, pp.78-90.

** For more details see, Statistics Canada, <u>Price and Price Indexes</u>, (62-202), Ottawa.

*** For 1971-72 average index for the period III quarter (1970) to II quarter (1972) was used, whereas for 1974, average index for the calendar year was used.

fuel cost. For fuel prices, no suitable price index was reported by Statistics Canada. Actual fuel prices during 1971-72 and 1974 were therefore used.* The ratio used for this update of cost levels are shown in Table I-4.

The Common (fixed) costs included the following four items:

1) Depreciation Costs: The method of calculating depreciation in this study was a modification of straight-line and annual revaluation method. Furthermore, adjustment was made for increase in the value of truck over time. The following procedure was used for this adjustment:

- Estimate the up-dated purchased value of the truck in 1971-72 as

$$= \left[\text{Original Purchased Value} + \text{Trade In}\right] \times \frac{\text{Price Index of Truck in 1971-72}}{\text{Price Index of Truck in Year of Purchase}}$$

- Determine the 1971-72 value of the truck. (This value was the same as reported at the time of the survey).

- Calculate Annual depreciation as:

$$= \frac{\text{Value in Step (i) - Value in Step (ii)}}{\text{No. of Years truck was maintained.}}$$

In this calculation, price index for the value of truck is required. Source of data is provided in Appendix C.

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* The actual fuel price during 1971-72 was 25.1 cents per gallon, which increased to 38.8 cents by 1974 -- an increase of 54.58 percent. For more details see, "The Energy Implications of Rationalization of Light Density Traffic Branch Lines", prepared for the Grain Handling and Transportation Commission, by Clayton, Sparks and Associates Ltd., 1976.

TABLE I-4

FACTORS USED FOR UPDATING COST DATA FROM 1971-72 LEVELS TO 1974 LEVELS

No. Statistics Canada Index	Value of Index (1961=100) during		Ratio $\frac{1974}{1971-72}$	Cost Item Updated
	1971-72	1974		
1. Value of Truck	100.9	147.9	1.4658	Depreciation
2. Mortgage Credit	223.1	288.6	1.2936	Interest
3. Building Replacemtn	155.2	211.1	1.3621	Housing
4. Building Repairs	151.9	204.2	1.3443	Housing
5. Motor License and Insurance	151.8	176.3	1.1614	License and Insurance
6. Repairs, Tires and Batteries	138.6	174.5	1.2590	Tires and Batteries, Upkeep and Repairs
7. Monthly Rated Hired Labour	184.7	261.3	1.4747	Labour

Source: Stat. Can., Price and Price Indexes.

2) Interest Costs: This cost was simply calculated by using eight percent rate of interest to owned portion of the value of the truck in 1971-72. For the remainder actual interest rate paid was applied.

3) Housing Costs: This cost included depreciation on the building, repairs to the building, and interest on investment. Rates of depreciation, and of repairs were five percent and two percent of the value of building, whereas a rate of interest equal to eight percent was charged.

4) License and Insurance Costs: Actual license and insurance fees paid were used.

The Common (Variable) Costs included two items of costs:

1) Tires and Batteries Costs: These were the actual levels of costs incurred by farmers during the survey year.

2) Repairs and General Upkeep Costs: The latter category of cost included expenditures incurred on minor tune-up, lubrication, small repairs, changing oil and anti-freeze, and other general related expenses. These costs were used directly from the questionnaires.

Major repairs included items of more lasting in nature. Items such as a new engine, a major overhaul of an engine, or similar expenditures were included in this category of costs. Although such cost expenditures could have been spread out over a number of years, no such attempt was made, since in a large sample it was expected that such expenditures would be averaged out with those trucks with no such cost in that particular year.

These costs included both the labour cost as well as the cost of parts and other supplies. An hourly charge of $2.25 was used to estimate the labour cost in 1971-72.

The direct costs of hauling grain included two items:

1) Fuel Costs: Fuel costs were derived by determining price paid for fuel, and farmers' estimate of average miles per gallon. These figures were used in conjunction with grain haul miles to estimates annual fuel costs.

2) Labour Costs: This cost was divided into two parts:

   - Dead-haul labour costs: which is the time required for loading and unloading of the truck, and waiting at the country elevator.

   - Driving labour cost: this is the time it took a farmer to transport his grain (after loading) from the farm to the country elevator (or to other delivery outlet).

It was further assumed that all trips made to the country elevators were single purpose trips; i.e. grain delivery trip.

This labour input was evaluated by using an hourly wage rate of \$2.25 in 1971-72.

After the calculation of total annual cost of hauling grain, the following cost measures were derived:

- Average cost per bushel: which is the total cost ÷ total bushels delivered during the year.

- Average Cost per Bushel-Mile: which is the total annual cost ÷ total bushel-miles for the truck.

COST OF TRANSPORTING GRAIN BY FARM TRUCKS IN 1974

In this section the cost of hauling grain by farm trucks between a farm and delivery outlet are reported. These estimates were derived using the methodology reported in the previous section. Furthermore, as already noted, the 13 custom truckers were deleted and the subsequent estimates relate to a grain truck not actively involved in custom trucking.*

Total Annual Cost of Hauling Grain

Total annual cost of hauling grain during 1974 was estimated to be $521.38 per truck.** Of this total cost the items of major importance were dead-haul and driving labour, depreciation and repairs and upkeep costs. Common costs (both fixed and variable) accounted for 51.8 per cent of the total, whereas the remaining 48.2 percent were direct costs. (Table I-5). The fixed common costs per grain truck were $179.94 or 34.5 percent of the total grain hauling costs, whereas the variable common costs were $90.39 per grain truck, or 17.3 percent of the total grain hauling cost.

Largest single component of the total cost was dead-haul labour (22.1 percent) followed by depreciation (19.9 percent) and driving labour (17.1 percent). Since labour input is imputed (since most part of this labour is supplied by operator and family members), the out-of-pocket costs of transporting grain are substantially lower than $521.38 per annum.

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* Cost of hauling grain for these 13 custom truckers, along with selected farm and truck based characteristics are presented in Appendix D.

** This implies that if a farm used more than one truck for hauling grain, his cost, on an average, would be a multiple of this number and the number of grain trucks.

TABLE I-5

LEVEL AND DISTRIBUTION OF ANNUAL COST OF HAULING GRAIN BY FARM TRUCKS IN WESTERN CANADA, 1974

Particulars	Amount in $	Percent of Total Cost
Depreciation Cost	103.55	19.9
Housing Cost	9.77	1.9
Interest Costs	51.27	9.8
License & Insurance Cost	15.36	2.9
Common (Fixed) Costs	179.94	34.5
Tires and Batteries Costs	29.43	5.6
Repairs and Upkeep Costs	60.96	11.7
Common (Variable) Costs	90.39	17.3
Fuel Costs	46.62	8.9
Dead-haul Labour Costs	115.36	22.1
Driving Labour Costs	89.07	17.1
Direct Costs	251.05	48.2
Total Cost	521.38	100.0

Average Cost of Hauling Grain

Total annual costs were converted to average (per unit) costs. Two types of unit costs presented are: average cost per bushel, and average cost per bushel-mile. Results are shown in Table I-6. Average common fixed costs were estimated to be 1.827 cents per bushel and 0.204 cents per bushel-mile. Average direct costs were 2.549 cents per bushel and 0.285 cents per bushel-mile. Average total cost (including commong and direct costs) per bushel for 1974 was estimated to be 5.294 cents and that per bushel-mile to be 0.592 cents.

One might wonder whether the average costs shown in Table I-6 are representative of the situation that existed in the prairie provinces during 1974. To test this, estimates of cost using the sample data were weighted by prairie provinces' distribution of permit holders by hauling distance. Results are shown in Table I-7. The average cost per bushel was estimated to be 5.602 cents, whereas that on a per bushel-mile basis to be 0.593 cents. One must note that weighting of various farm situations was done only on the basis of distance to country elevator; no consideration was made to distribution of farms of various sizes within a distance range. Furthermore, in this classification weighted distance to all delivery outlets was not considered, and to the extent the distance to elevator is different from the weighted distance, overall average costs figure may be different. However, based on this crude aggregation, the average costs as reported in Table I-6 are representative of the average conditions in the prairie provinces during 1974.

TABLE I-6

AVERAGE COST OF HAULING GRAIN BY FARM TRUCKS
IN WESTERN CANADA, 1974

Particulars	Per Bushel	Per Bushel-mile
	---------- cents	------------
Average Common (Fixed) Costs	1.827	0.024
Average Common (Variable) Costs	.918	0.103
Average Direct Costs	2.549	0.285
Average Total Cost	5.294	0.592

RELATIONSHIP BETWEEN AVERAGE COSTS, VOLUME OF GRAIN DELIVERED AND DISTANCE TO ELEVATOR

In order to investigate the above interrelationships, the sample of 417 trucks was stratified by two characteristics: one, distance between a farm and country elevator, and two, annual volume of grain delivered by the truck. Nine distance categories and seven volume categories were selected, resulting in a total of 63 cells. However, 21 of such cells had zero frequency, leaving only 52 cells with any grain truck. Characteristics of such trucks, along with information on a total and average costs are summarized in Table I-8. A few tendencies in this table are noteworthy:

TABLE I-7

APPROXIMATE TOTAL ANNUAL COST AND AVERAGE COST FOR PRAIRIE PROVINCES, 1974

Distance Range (miles)	Percent of Total Farmers in Prairie Provinces 1973-75	Average Per Farm Truck		
		Total Cost of Hauling	Bushels Delivered	Bushel-Miles
0-3	11.8	454.16	12,201	71,357
3-6	25.8	452.83	9,913	64,104
6-10	28.8	671.00	11,998	103,769
10-15	19.0	597.99	8,700	113,093
15-20	7.3	559.52	5,732	116,528
20-25	2.9	266.28	1,804	44,248
25-30	1.3	351.58	3,970	114,596
30 +	3.1	444.59	2,784	132,104
Weighted Average		544.21	9,714.4	91,707

Weighted Provincial
Average per Bushel 5.602 cents
Average Cost per Bushel-Mile 0.593 cents

Source: Col. 2, Canada Grains Council, Distribution of Present Delivery Miles among Permit Holders; Col. 3, 4 and 5 based on Saskatchewan sample

TABLE I-8
RELATIONSHIP BETWEEN COST OF HAULING, VOLUME OF GRAIN DELIVERED (PER TRUCK) AND DISTANCE TO ELEVATOR

Distance To Elevator	Characteristics	Unit	Volume Delivered Per Truck Per Annum (Bushels)						
			≤ 3,000	3001-6000	6001-10,000	10,001-15,000	15,001-20,000	20,001-25,000	25,001+
0-3 miles	No. of Trucks	#	12	15	18	18	8	5	7
	Capacity of Grain Box	Bu.	112.5	167.7	188.9	261.3	220.6	282.0	297.1
	Total Bu. Hauled	Bu.	1,781	4,765	7,773	12,631	16,515	22,412	44,245
	Weighted Distance	Miles	3.97	3.31	3.95	5.59	4.21	16.47	4.43
	Common (Fixed) Costs	$	35.29	78.04	106.02	116.31	185.26	884.16	453.63
	Direct Costs	$	92.84	126.73	174.89	189.25	327.72	419.26	492.55
	Total Costs	$	146.26	236.08	315.64	394.93	718.92	1,393.58	961.04
	Av. Cost/Bu.	¢	8.21	4.93	4.06	3.13	4.35	6.22	2.17
	Av. Cost/Bu. Mile	¢	2.068	1.490	1.028	.559	1.034	.377	.490
3.1-6 miles	No. of Trucks	#	21	25	24	28	16	5	5
	Capacity of Grain Box	Bu.	137.4	155.6	198.5	230.3	214.1	280.0	242.0
	Total Bu. Hauled	Bu.	1,899	4,506	7,929	12,391	17,117	23,392	29,728
	Weighted Distance	Miles	4.728	5.013	5.893	6.435	6.802	4.21	9.99
	Common (Fixed) Costs	$	47.22	77.32	150.50	178.63	201.28	424.52	332.66
	Direct Costs	$	69.58	170.76	224.69	263.98	391.96	356.56	402.66
	Total Costs	$	148.24	312.43	445.34	531.03	712.14	828.72	826.76
	Av. Cost/Bu.	¢	7.807	6.933	5.617	4.285	4.160	3.543	2.781
	Av. Cost/Bu. Mile	¢	1.651	1.383	.953	.666	.612	.841	.278

Cont'd

TABLE I-8 (Cont'd)

Distance To Elevator	Characteristics	Unit	Volume Delivered Per Truck Per Annum (Bushels)						
			≤ 3,000	3001-6000	6001-10,000	10,001-15,000	15,001-20,000	20,001-25,000	25,001+
6.1-10 miles	No. of Trucks	#	8	19	23	24	17	12	5
	Capacity of Grain Box	Bu.	150.6	172.4	212.2	224.6	248.8	257.1	320.0
	Total Bu. Hauled	Bu.	1,670	4,526	8,029	12,194	17,861	22,075	30,121
	Weighted Distance	Miles	7.726	8.724	10.122	9.073	7.147	8.796	8.821
	Common (Fixed) Costs	$	48.00	135.87	154.42	224.70	268.16	321.85	784.00
	Direct Costs	$	55.17	167.32	241.96	307.77	445.30	558.12	734.94
	Total Costs	$	140.85	392.63	480.03	665.32	887.97	1,030.17	1,883.2
	Av. Cost/Bu.	¢	8.434	8.675	5.978	5.456	4.971	4.667	6.252
	Av. Cost/Bu. Mile	¢	1.092	.994	.591	.601	.696	.530	.709
10.1-15 miles	No. of Trucks	#	15	6	10	8	6	3	1
	Capacity of Grain Box	Bu.	168.7	254.2	222.0	242.5	259.2	310.0	350.0
	Total Bu. Hauled	Bu.	1,848	4,824	8,375	11,578	16,302	21,812	30,000
	Weighted Distance	Miles	13.12	12.442	11.512	13.205	14.653	12.335	13.00
	Common (Fixed) Costs	$	49.62	116.72	268.44	284.31	320.00	664.67	240.20
	Direct Costs	$	85.41	206.03	317.18	386.94	408.12	534.33	614.10
	Total Costs	$	173.93	352.83	697.32	869.34	938.72	1,322.53	1,048.30
	Av. Cost/Bu.	¢	9.411	7.314	8.326	7.508	5.758	6.063	3.500
	Av. Cost/Bu. Mile	¢	.717	.588	.723	.569	.393	.491	.270

Cont'd

TABLE I-8 (Cont'd)

Distance To Elevator	Characteristics	Unit	Volume Delivered Per Truck Per Annum (Bushels)						
			_ 3,000	3001-6000	6001-10,000	10,001-15,000	15,001-20,000	20,001-25,000	25,001+
15.1-20 miles	No. of Trucks	#	1	2	0	1	0	0	0
	Capacity of Grain Box	Bu.	50	287.5		200.0			
	Total Bu. Hauled	Bu.	950	4,788		12,400			
	Weighted Distance	Miles	16.0	22.482		19.0			
	Common (Fixed) Costs	$	8.20	181.05		263.70			
	Direct Costs	$	108.30	168.50		394.20			
	Total Costs	$	137.00	387.95		1,325.20			
	Av. Cost/Bu.	¢	14.42	8.10		10.70			
	Av. Cost/Bu. Mile	¢	.901	.360		.600			
20.1-25 miles	No. of Trucks	#	4	1	0		0	0	0
	Capacity of Grain Box	Bu.	100.0	200.0					
	Total Bu. Hauled	Bu.	1,057.5	4,790					
	Weighted Distances	Miles	23.99	25.00					
	Common (Fixed) Costs	$	30.35	233.10					
	Direct Costs	$	76.27	317.10					
	Total Costs	$	146.82	744.10					
	Av. Cost/Bu.	¢	13.88	15.50					
	Av. Cost/Bu. Mile	¢	.579	.600					

Cont'd

TABLE I-8 (Cont'd)

Distance To Elevator	Characteristics	Unit	Volume Delivered Per Truck Per Annum (Bushels)						
			_ 3,000	3001-6000	6001-10,000	10,001-15,000	15,001-20,000	20,001-25,000	25,001+
25.1-30 miles	No. of Trucks	#	9	1	2	2	0	0	0
	Capacity of Grain Box	Bu.	205.5	180.0	337.5	280.0			
	Total Bu. Hauled	Bu.	1,383.1	3,660.0	7,615	12,125			
	Weighted Distance	Miles	29.28	28.50	28.27	29.07			
	Common (Fixed) Costs	$	69.17	233.20	160.95	182.00			
	Direct Costs	$	118.71	198.10	356.05	349.45			
	Total Costs	$	230.22	474.50	554.00	633.85			
	Av. Cost/Bu.	¢	16.64	13.00	7.275	5.227			
	Av. Cost/Bu. Mile	¢	.568	.500	.257	.180			
30.1-40 miles	No. of Trucks	#	12	0	1	0	0	0	0
	Capacity of Grain Box	Bu.	155.8		400.0				
	Total Bu. Hauled	Bu.	1,182		7,000.0				
	Weighted Distance	Miles	37.017		38.00				
	Common (Fixed) Costs	$	39.57		50.10				
	Direct Costs	$	82.58		547.10				
	Total Costs	$	146.12		1,002.10				
	Av. Cost/Bu.	¢	12.36		14.30				
	Av. Cost/Bu. Mile	¢	.334		.400				

Cont'd

TABLE I-8 (Cont'd)

Distance To Elevator	Characteristics	Unit	Volume Delivered Per Truck Per Annum (Bushels)						
			– 3,000	3001-6000	6001-10,000	10,001-15,000	15,001-20,000	20,001-25,000	25,001+
40.1-60.1 miles	No. of Trucks	#	13	6	0	0	0	0	1
	Capacity of Grain Box	Bu.	166.1	375.0					450.0
	Total Bu. Hauled	Bu.	1,101.5	4,561					29,000
	Weighted Distance	Miles	48.70	49.00					52.76
	Common (Fixed) Costs	$	105.18	306.08					1,366.40
	Direct Costs	$	135.72	337.38					1,495.20
	Total Costs	$	315.42	791.25					3,067.90
	Av. Cost/Bu.	¢	28.63	17.35					10.600
	Av. Cost/Bu. Mile	¢	.588	.354					.200

1) As either the volume delivered or distance to elevator increased, there was a tendency in the truck size (as measured in terms of capacity of grain box) to increase as well.

2) There was no apparent relationship between volume delivered and distance to all delivery points.

3) As volume delivered increased average cost per bushel-mile declines. A similar tendency was observed for the average cost to decline as weighted distance to all delivery points increased (Figure I-1).

ECONOMETRIC ANALYSIS OF FACTORS AFFECTING AVERAGE COST OF TRANSPORTING GRAIN

The 417 grain trucks were further examined for any regularities that might exist among cost of transporting and various characteristics of the truck (and/or farm). Both the unit costs -- average cost per bushel and average cost per bushel-mile -- were examined. The following variables were hypothesized to affect the level of average cost:

x_1 = Size of truck. This variable was measured in two alternate forms: in tons and in terms of capacity of the grain box;

x_2 = Volume of grain delivered by the truck per annum;

x_3 = Age of the truck;

x_4 = Annual utilization of the truck;

x_5 = One-way distance to delivery point. This variable was measured in two alternate ways: distance to the country elevator and weighted distance to all delivery points;

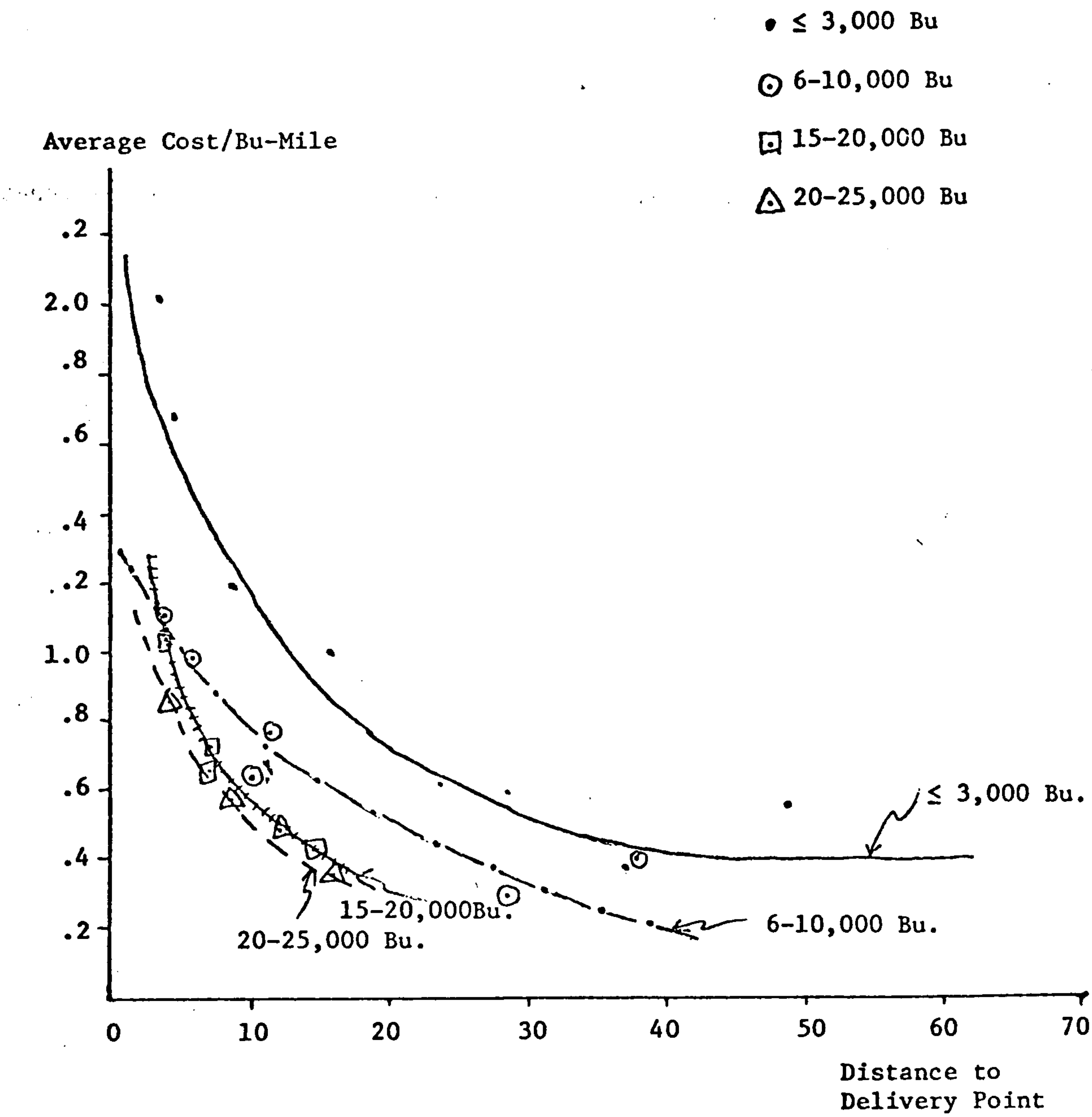

Figure I-1: Relationship among distance to Elevator, Volume of Grain delivered per truck, and Average cost per Bushel-Mile, 1974.

X_6 = Nature of road surface travelled, expressed as proportion (percent) of paved road to total distance;

X_7 = Output of the truck, as measured by annual bushel-miles generated.

The following specifications were hypothesized:

Where Y_1 = Average cost per bushel,

Y_2 = Average cost per bushel-mile.

Average cost per bushel:

$$Y_1 = f(X_1, X_2, X_3, X_5, X_6)$$

$$Y_1 = f(X_1, X_2, X_3, X_4, X_5, X_6)$$

Average cost per bushel-mile:

$$Y_2 = f(X_1, X_2, X_3, X_5, X_7)$$

$$Y_2 = f(X_1, X_2, X_3, X_4, X_5, X_7)$$

The size of the grain truck was expected to exert a downward pressure on average cost because of a more efficient utilization. Similarly the age of the truck and annual utilization of the truck were expected to be negatively related with average cost. One of the explanations for lower average cost for the older truck is the smaller depreciation, which may be partially offset by larger repairs and general maintenance expenditures. Distance travelled variable could be hypothesized to influence average cost both positively as well as negatively. The positive influence of this variable may be as a result of a change in the nature of truck required to adequately perform the hauling function.

It is conceivable that as hauling distance increases, farmers may have to purchase larger and/or newer trucks which would increase the average cost. On the negative influence, it is conceivable that longer distance would result in larger annual utilization and thereby, would reduce average costs.

The nature of the road surfaces travelled (paved vs. unpaved) was hypothesized to have a negative influence. This was based on the fact that on paved road costs of upkeep, tires, and of other repairs are somewhat lower. The output of a truck (bushel-miles) was hypothesized to have negative influence on cost per unit of output since with increased output the fixed costs are better distributed, resulting in a decline in total cost.

Results are shown in Tables I-9 and I-10. Results for the average cost per bushel relationships were expected on a priori basis. Furthermore, all coefficients were found to be statistically significant at one percent or less. The only exception to this was the coefficient for the road surface which was positive, but insignificant. It was subsequently deleted. Based on the goodness of fit criterion equation (5) in Table I-9 was selected. Average cost per bushel increased as one-way distance to elevators increased. However, average cost per bushel exhibited a tendency to decline as a larger truck was used, as truck age increased, as volume delivered increased, and as annual utilization increased. A one percent increase in the volume hauled decreased average cost per bushel by 0.150 percent. Similarly, an increase in the distance to various delivery points by one percent increased average cost by 0.475 percent.

TABLE I-9

REGRESSION COEFFICIENTS FOR FACTORS AFFECTING AVERAGE COST PER BUSHEL, SASKATCHEWAN, 1974

(All Variables in Log Form)

Eq. No.	Intercept	Size of Truck Tons	Capacity of Grain Box (Bu)	Total Bu. Hauled	Age of Truck	Annual Mileage	One Way Distance To Elev.	Weighted Distance to Delivery Point	Paved Miles (Percent of Total)	R^2	$S_{\hat{y}}$
1.	1.559*** (.111)	-.192*** (.047)		-.241*** (.023)	-.094** (.034)		.342*** (.027)		.011 (.011)	.606	.188
2.	2.341*** (.146)	-.308*** (.046)		-.177*** (.024)	-.244*** (.037)	-.271*** (.035)	.452*** (.029)		.009 (.011)	.655	.176
3.	3.095*** (.173)		-.397*** (.051)	-.149*** (.024)	-.265*** (.037)	-.279*** (.034)	.468*** (.029)		.009 (.011)	.668	.173
4.	3.115*** (.180)		-.382*** (.053)	-.182*** (.024)	-.267*** (.038)	-.251*** (.036)		.421*** (.027)		.640	.180
5.	3.110*** (.172)		-.399*** (.050)	-.150*** (.242)	-.267*** (.037)	-.280*** (.035)	.475*** (.028)			.667	.173

Figures in parentheses are standard errors.

*** Significant at 0.1% level.

** Significant at 1% level.

TABLE I-10

REGRESSION COEFFICIENTS FOR FACTORS AFFECTING AVERAGE COST PER BUSHEL-MILE, SASKATCHEWAN, 1974

Eq. No.	Intercept	Size of Truck Tons	Capacity of Truck (Bu.)	Annual Mileage	Age of Truck to Elev.	One Way Distance to Elev.	Weighted Delivery Distance	Bushel-Miles	Annual Bushels Hauled	R^2	$S_{\hat{y}}$
6.	2.357	-.344		-.294	-.249	.333		-.834	.666	.745	.173
	(.142)	(.046)		(.035)	(.037)	(.043)		(.041)	(.045)		
7.	3.191		-.438	-.303	-.272	.342		-.825	.687	.756	.169
	(.169)		(.050)	(.034)	(.036)	(.042)		(.040)	(.044)		
8.	2.382	-.304		-.238	-.243		-.381	-.211		.708	.184
	(.152)	(.049)		(.037)	(.039)		(.027)	(.022)			
9.	3.123		-.389	-.246	-.263		-.393	-.185		.717	.182
	(.182)		(.053)	(.036)	(.039)		(.026)	(.025)			

All variables in log form.

All coefficients significant at 0.1% level.

Figures in parentheses are standard errors.

Results for the average cost per bushel-mile are shown in Table I-10. Based on the criterion of goodness of fit equation (7) could be selected. However, in this equation volume delivered variable had a somewhat questionable sign for the coefficient. It was, therefore,deleted and equation (9) was selected. According to this equation, one percent increase in the output of the truck decreased average cost per bushel-mile by 0.185 percent. Results based on this function are plotted in Figure I-2 and I-3. In Figure I-2 interrelationships among average cost, bushel-miles, and size of truck are shown, whereas those for distance volume delivered are shown in Figures I-3 and I-4. Average cost per bushel per mile declined as either distance, volume of grain delivered, or both increased.

SUMMARY

1. An average farm in the sample was of 1,053 acres, situated approximately 10.75 miles from a country elevator, and delivered approximately 11,099.7 bushels to various collection points. An average of 1.127 grain trucks were maintained per farm.

2. An average grain truck was 2.03 tons, with the capacity of grain box of 208.6 bushel, and was 15.66 years old.

3. On an average, a grain truck was used for 3,226.6 miles, of which 33 percent for hauling grain between farm and a collection point. Weighted distance between the farm and a collection point was 8.94 miles.

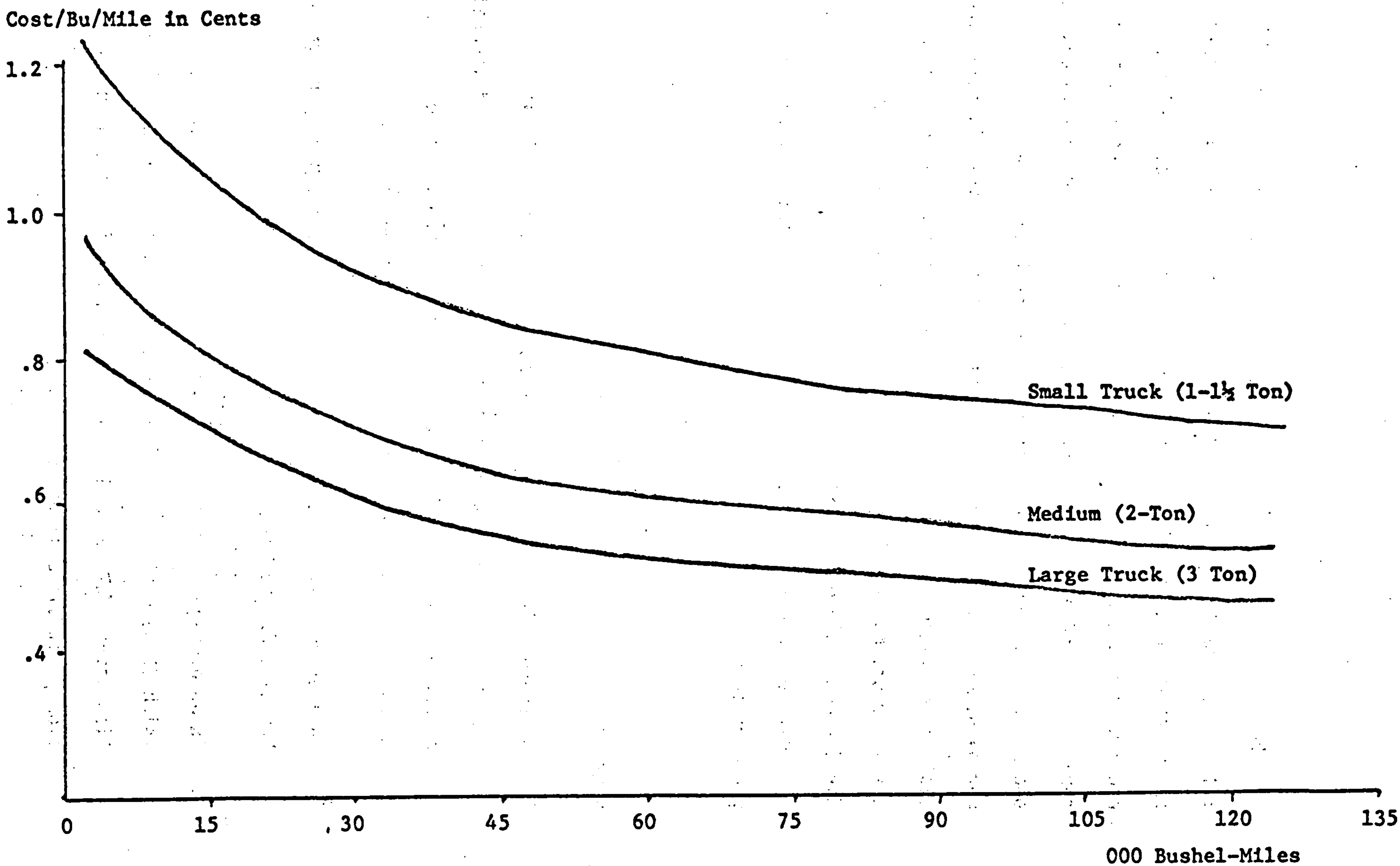

FIGURE I-2: Relationship Between Cost Per Bushel per Mile of Transporting Grain, Bushel-Mile, and Size of Truck, 1974.

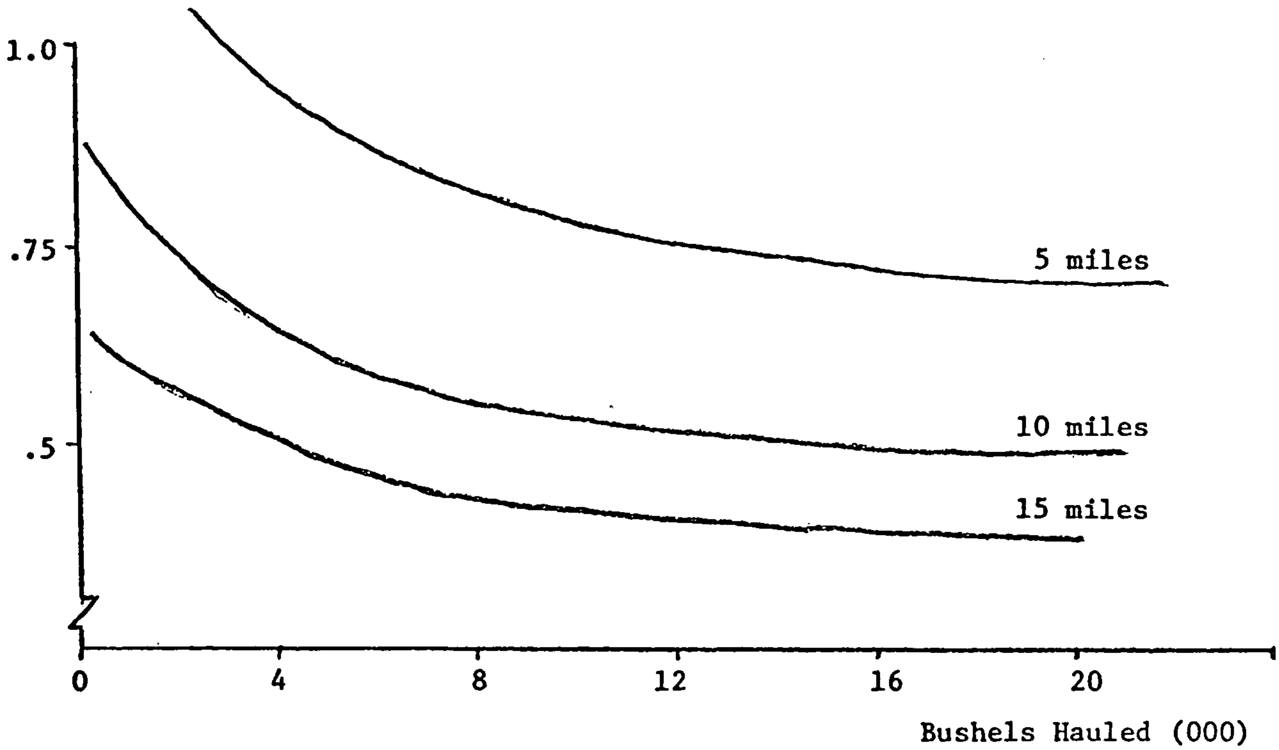

FIGURE I-3: Relationship between Volume Delivered and Average cost for various Distances, 1974.

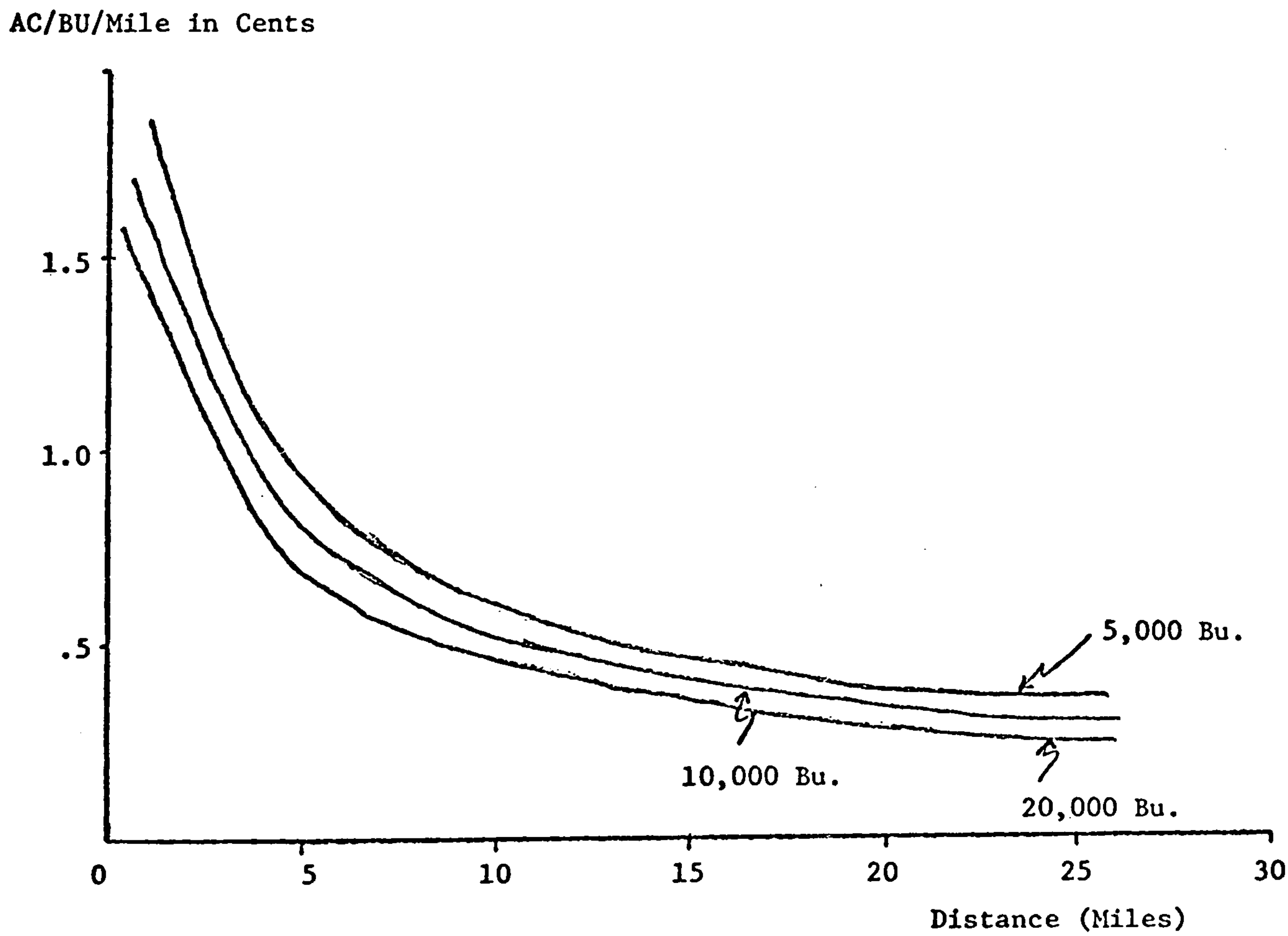

FIGURE I-4: Relationship between Distance to Delivery Point and Average Cost, for Various Volumes Delivered.

4. Total grain transportation cost during 1974 was estimated to be $521.38 per annum.

5. Dead-haul labour and depreciation were the two leading items of expenditure, accounting for 22.1 percent and 19.9 percent of total cost.

6. Average cost of transporting grain was estimated to be 5.294 cents per bushel, and 0.592 cents per bushel per mile. The average cost under existing (1973-74) hauling distance was estimated to be 5.6 and 0.593 cents, per bushel and per bushel-mile, respectively.

7. Trucks were stratified by distance to elevator and annual volume of grain delivered. Based on this analysis there was a tendency in average cost per bushel-mile to decline when either distance or volume increased.

8. Based on regression analysis average cost per bushel per mile declined with an increase in size of truck, its annual utilization, its age and annual bushel-miles.

APPENDIX A

SUMMARY OF SAMPLE CHARACTERISTICS AND FINDINGS OF VARIOUS STUDIES ON COST OF TRANSPORTING GRAIN BY TRUCK

TABLE I-A.1

SUMMARY OF SAMPLE CHARACTERISTICS

Study	Year of Study	Sample Size	Size of Truck: Tons	Size of Truck: Cap. of Grain Box	Annual Mileage	Average Age of Truck	Grain Miles as % of Total	Bushel Miles	Distance to Elevator	Size of Farm	Volume of Grain Delivered
Unit				Bu.	Miles	Years	%		Miles	Acres	Bu.
Tyrchniewicz, Butler, Tangri	1967/8	128	1.8	189	3,778	11.5	13.4	40,620	5.5	852	5,230
Tyrchniewicz (Grains Group)	1967/8	279	2.0	217.5	3,766	10	15.8	61,305	6.9	1,066	6,846
Kulshreshtha	1972/3	404	2.06	214	3,505	15.5	24.2	86,201	11.5	831	11,202
Kulshreshtha* (Ext. Div.)	1972/3	352	2.05	208	2,698	16.3	30.7	81,477	6.4	862	12,447
Canada Grains Council - Brandon Area	1971/2	Same as the Study by Tyrchniewicz, Butler & Tangri									
Canada Grains Council - Area II	1973	133	2.19	217	2,519	15.3	33.3	82,981	5.86	1,243	16,401
Tyrchniewicz, Moore, Tangri**	1967/8	45	2.9	327	9,729	7.5	56.5	874,832	21.8	--	40,701

* This sample included the typical hauling areas only.

** This study deals with movement of grain by commercial and custom trucks.

TABLE I-A.2

SUMMARY OF COST OF TRANSPORTING GRAIN

Study	Year of Study	Total Fixed Costs	Total Variable Costs	Total Cost	Fixed Cost as Percent of Total	Average Cost	
						Per Bu.	Per Bu. Mile
Tyrchniewicz, Butler Tangri	1967/8	$ 57.75	$ 97.52	$155.27	37	2.97¢	.382¢
Tyrchniewicz (Grains Group)	1967/8	$ 91.08	$136.67	$227.75	40	3.27¢	.379¢
Kulshreshtha	1972/3	$151.12	$287.01	$438.13	35	4.22¢	.333¢
Kulshreshtha (Ext. Div.)	1972/3	$140.86	$257.05	$397.91	35.5	3.74¢	.475¢
Canada Gr. Council (Brandon Area)	1971/2	--	--	--	--	3.03¢	.551¢
Canada Gr. Council (Area 11)	1973	--	(Not reported)		--	--	--
Tyrchniewicz, Moore Tangri	1967/8	$475.22	$1,011.90	$1,487.12	32	3.65¢	.170¢

APPENDIX B

REPRESENTATIVENESS OF THE STUDY SAMPLE

FOR WESTERN CANADA

REPRESENTATIVENESS OF THE STUDY SAMPLE FOR WESTERN CANADA

Since this study employs a sample of grain trucks from one province, namely Saskatchewan, one might wonder about its representativeness for the entire prairie region. To the extent that the three provinces have different hauling conditions, different distribution of farm sizes and enterprise combinations, different estimates of cost of transporting grain would result. However, such differences exist even within a region, and between farms.

The merit of the argument that any subregional sample may not be representative of the entire region rests on two premises: one, that different sets of variables influence cost in different subregions, and two, the magnitude of their effects on the cost are different. These premises were examined further using Tyrchniewicz's sample, for Western Canada. For the first premise it was shown that the same set of factors influenced average cost per bushel (or bushel-mile) in the three provinces. For the second premise the following procedure was used. Multiple regression parameters for average cost of hauling grain (as affected by truck and farm characteristics) in the three provinces were examined for homogeneity. A formal test for homogeneity of parameter could not be applied. Alternatively, for the prairie provinces' coefficient (for a given independent variable) a 90 percent confidence interval was estimated. This confidence interval was used to see whether the coefficients for the three provinces (for the same independent variable) were contained within it. For the variables examined, such was not the case. However the differences did not appear to be large. One must also bear in mind that this observation is not based on a formal statistical test, and therefore, this conclusions remains at best, tentative.

APPENDIX C

METHOD OF ESTIMATING THE INDEX
FOR VALUE OF TRUCK
PRIOR TO 1961

METHOD OF ESTIMATING THE INDEX FOR VALUE OF TRUCK PRIOR TO 1961

Statistics Canada has recently constructed an index for the value of truck based 1961. One of the problems of using this index over a period of time is that it was not available prior to 1961. However, during 1961 and 1969 Statistics Canada published two indexes:

1) 1961 based index of value of truck, and
2) 1935-39 based index of price of farm machinery.

Using this data, a regression function was estimated using 1935-39 as the independent variable and 1961 based index as the dependent variable, with the following results:

$$Y = 43.9 + .2117X$$

$$r^2 = .962$$

The coefficient was significant at one percent level of significance. This index was used to estimate the 1961 base index for the 1938-1960 period. Results are shown in Table I-C-1.

TABLE I-C.1

ESTIMATION LEVEL OF INDEX (1961 = 100)
OF VALUE OF FARM TRUCKS IN WESTERN CANADA

Year	1935-39 Index (x)	Estimated 1961 = 100 Index Y = 43.9 + .2117X
1938	103.7	65.8
1939	103.3	65.8
1940*	105.5	66.2
1941*	108.8	66.9
2*	114.1	68.0
3*	117.1	68.7
4*	118.4	68.9
5*	115.2	68.3
1946*	118.8	69.0
7*	126.4	70.6
8*	138.8	73.3
9	158.4	77.4
50*	165.6	78.9
1951*	187.6	83.6
2*	196.2	85.4
3	197.7	85.7
4	199.2	86.1
5	199.9	86.2
1956	209.9	88.3
7	223.5	91.2
8	235.9	93.8
9	247.0	96.2
60	252.8	97.4

Actual (1961 = 100)·Index

1961	100.0	1966	105.0	1971	123.8
2	100.9	7	106.4	2	128.4
3	100.9	8	111.1	3	131.5
4	103.0	9	114.0	4	147.9
5	103.9	70	117.9		

* Average of available monthly indexes; therefore should be considered as an approximate.

APPENDIX D

SELECTED CHARACTERISTICS OF CUSTOM TRUCKERS

TABLE I-D.1

TRUCK BASED CHARACTERISTICS

Characteristics (Average per Truck)	Unit	Value
Size of Truck	Tons	3.038
Capacity of Grain Box	Bu.	387.7
Annual Mileage	Miles	12,433
Annual Bushels Hauled	Bu.	27,558
Distance to Elevator	Miles	36.9
Weighted Delivery Distance	Miles	55.4
Age of Truck	Years	8.85
Bushel-Miles		1,527,575

TABLE I-D.2

DISTRIBUTION OF TOTAL COST OF TRANSPORTING GRAIN FOR A CUSTOM TRUCKER, 1974

Cost Item	Value For 1974	Percent of Total Cost
Depreciation	$ 449.46	14.2
Housing	33.15	1.0
Interest	247.08	7.8
License & Insurance	111.06	3.5
Common (Fixed) Costs	840.77	26.5
Tires & Battery	282.49	8.9
Upkeep & Repairs	369.19	11.6
Common (Variable) Costs	651.70	20.5
Fuel Cost	806.04	25.5
Deadhaul Labour	372.82	11.7
Driving Labour	502.18	15.8
Direct Costs	1,681.04	53.0
Total Cost	3,173.51	100.0

TABLE I-D.3

AVERAGE COST OF TRANSPORTING GRAIN FOR A CUSTOM TRUCKER, 1974

Average Cost Per Bushel	11.51
Average Cost Per Bushel-Mile	.208

CHAPTER 2

ROAD COSTS

W.A. Scott

INTRODUCTION

An estimation of road costs assignable to increased trucking brought about by rail line abandonment is important for purposes of:

1) overall cost analysis of system alternatives;
2) determination of changes in the distribution of costs.

The following considerations are illustrative of the factors which contribute to the complexity of speculative road cost determination and assignment:

1) Routing and amount of grain traffic;
2) Make up of traffic as to vehicle description;
3) Timing and concentration of traffic;
4) Effect of predetermined traffic volume and type on road surface affecting specification and/or maintenance required;
5) Variations in costs of construction and maintenance tasks given different authorities and locations;
6) Future public demand for improved roads.

Provincial and municipal presentations to the Commission have highlighted road costs because of the potential transfer of costs from federal to local authorities in the event of rail line abandonment. No standard format has been used in the compilation of briefs on the subject and it is difficult to relate the content of one presentation to another. In view of the complexity and judgment required in calculating projected road costs, it is essential that the various briefs be summarized and reviewed in the light of research which has been carried out in the area of road impact.

PURPOSE

This chapter will outline the approaches and condense the claims which have been made in presentation to the Commission on the topic.

Discussion will relate the results of various research studies under topical headings dealing with the key objectives and technical problems of analysis.

Conclusions will be drawn with regard to the order of magnitude of future road costs assignable to rationalization and the need for further discussion or analysis.

EXECUTIVE SUMMARY AND CONCLUSIONS

The estimation of potential road cost increases resulting from the impending abandonment of rail lines is complex in that a wide array of assumptions must be made. These assumptions begin with a decision regarding the basic concept of delivery point spacing or location for purposes of projecting traffic routes and volume. Determination of road specifications and life of surfaces and subgrades goes beyond the simple application of engineering strength of material principles. Much input data for use in the engineering analysis is based on somewhat arbitrary selection of factors such as vehicle description (truck size), timing and concentration of traffic and experience factors reflecting typical roadbed performance.

Submissions on the subject of road costs by the Provinces of

Alberta and Saskatchewan have presented total cost estimates to allow for construction and extra maintenance resulting from line by line analysis of road impact which might take place in the event of abandonment. The Province of Manitoba simply related total provincial road mileage to railroad mileage to determine a ratio which was then used to calculate the corresponding number of miles of road which would be affected with abandonment of all category II rail lines.

If one were to accept the blanket abandonment case as "the solution" across the system, the total costs for Saskatchewan would seem low with respect to the Alberta costs, and the total costs for Manitoba would appear high considering the simplistic notion of complete Category II rail line abandonment. When compared with earlier Saskatchewan research, however, the provincial estimates are high and in further testing the Alberta methodology against other research and theory application, the estimates of the Alberta submission would also appear conservative (or high). The Canada Grains Council figures from the Brandon area study are based on more rigorous analysis and they provide costs in cents per bushel based on more realistic methodology than does the recent Manitoba government brief.

Translation of the gross road costs into costs related to the hauling of an average bushel of grain is helpful in relating road impact to the total grain handling and transportation system. The following table summarizes the costs presented by the provincial governments. Estimates from the Canada Grains Council Brandon area study are also shown:

Province	Additional Annual Cost of Road Network	Additional cost of roads in ¢/bu. for grain handled on Category II lines	Additional cost of roads in ¢/bu. for grain handled on all lines
Alberta (1,473 miles of Category II lines)	$2,230,000	4.6	1.1
Saskatchewan (3,470 miles of Category II lines)	4,770,000	3.0	1.1
Manitoba (1,341 miles of Category II lines)	Not Estimated	--	--
Canada Grains Council - Brandon Area	258,000*	3.3	0.9

* 1973 study costs

Given the wide range of assumptions beginning with the definition of the change in delivery point location and spacing, it is not likely productive to re-hash figures submitted. One must recognize the possibility that the most objective estimates would necessarily be submitted with a broad range of totals, the appropriate figure would then be chosen based on selection of dozens of criteria allowed for within the range. When the wide variation in public reaction and demand is combined with the other complexities, it is conceivable that different parties even though they might be quite technically oriented may not be able to agree on even the order of magnitude of road cost assignable to grain haul.

At this point, one might gain perspective by comparing road costs in the order of one cent per bushel which have been submitted by the provinces with the costs of other components of the system. For example, the railways have suggested that the present statutory freight rate of about 12 cents per bushel may be in the order of three and one-half to four times too low. This means that a compensatory rate would be 42 cents to 48 cents per bushel. Even after detailed consideration of all the operating costs, it is conceivable that the marginal error in calculation of this one component will in itself account for funds in excess of total additional highway expenditures.

It would appear that additional highway costs resulting from rail abandonment and "foreseeable" rationalization will not form a significant portion of the total cost of handling and transporting grain. The significance of the projected highway costs to the provinces, however, is illustrated by the fact that the level of annual expenditures required to compensate for their estimated increases account for 2, 6, and 14 percent* of the highways maintenance and construction budgets for Alberta, Saskatchewan and Manitoba respectively.

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* An approximation only -- see appendix for derivation.

DISCUSSION

SUBMISSIONS TO THE COMMISSION

The following summaries paraphrase the main points gleaned from some of the provincial and municipal briefs. Unit construction and maintenance costs as presented have been compiled and are contained in the appendix of this report. Comparison or critique of the submissions will be reserved for other sections of this discussion which draw together the various facets of briefs under topical headings.

Province of Alberta

Three briefs presented by Alberta Transportation Department (October 1975, June 1976 and September 1976) contained summaries of detailed calculations which had been carried out in the estimation of additional costs which would be incurred over a 20-year period in the event of abandonment of Category II rail subdivisions.

It was recognized that larger trucks can haul a quantity of grain with fewer equivalent load units and less resultant damage to roads than if the same quantity of grain were moved by smaller trucks. For example, a two-axle three-ton truck carrying 286 bushels per trip will subject the roadway to about 2.25 times as much stress as will a five-axle semi carrying 964 bushels per trip.

Each "subdivision cost increase" was calculated for two basic assumptions: off-line elevator operation and direct producer haul to on-line elevation points. It was recognized that in the majority of cases the concentration of traffic resulting from commercial hauling to the on-line point from the off-line elevator would result in higher road cost increases than would the more dispersed farm truck traffic flow directly to the on-line point.

The total cost of additional grain haul traffic given abandonment of all red lines in Alberta would be 44.8 million dollars to be spent over a 20-year period. Abandonment of the Furness subdivision, for example, would result in an expenditure of about 1.2 million dollars over a 20-year period considering the road impact of commercial trucking from an off-line elevator at Paradise Valley.

Province of Saskatchewan

This brief recognized the contradiction in the "need" for a hard or oil surfaced road with increased truck traffic. That is, a gravel road will handle more trucks at less cost than an oil surfaced road. Thus, if increased truck traffic results in a need for a hard surface, it may be necessary to go for a higher quality surface to retain the other benefits of hard surface.

The Saskatchewan Department of Highways estimated the impact due to diversion of grain caused by abandonment. No two adjacent lines were assumed to be abandoned simultaneously. Haul was assumed to be in 250-bushel trucks over a 200-day year and costs calculated over a 15-year time frame amounted to 62 million dollars.

There is an admitted problem of determining the road standards required in estimating the impact of additional traffic. The major impact was on oiled or low quality paved roads. Only a minor mileage of gravel roads were estimated to need oiling although it is expected that strong pressure for dust free surfaces would result from only modest increases in truck traffic due to abandonment.

From the standpoint of the public, it would be ideal to overcome the problems created by additional truck traffic by upgrading gravel roads to an asphalt standard and to improve oiled roads to a paved standard. At a cost of about $80 thousand per mile to improve gravel roads and $160 thousand per mile to improve oiled roads, the cost of the above assumed abandonments would be about $500 million.

In the event of large inland terminals replacing the present elevator system, the impact of extra hauling, larger trucks and higher speeds would be disastrous. The brief further states that the upgrading required would cost a total of more than 2.25 billion dollars.

Saskatchewan Municipalities

The Saskatchewan Association of Rural Municipalities projected the costs which might be added to road construction and maintenance in the event of abandonment of the Chelan and Wood Mountain subdivisions.

For example, abandonment of the Chelan subdivision would require movement of four thousand truck loads over four grid roads at one thousand truck loads per year (500 bushels each). It was assumed that this traffic would cause a 25 percent reduction in the road "life" and that yearly maintenance and regravelling costs would increase by 25 to 30 percent. This would result in a yearly cost increase of about $450 per mile per year as follows:

Maintenance cost increase.....	$ 250	x 30% =	$ 75.00
Regravelling cost increase ...	225	x 30% =	67.50
Construction cost increase ...	18000/15	x 25% =	300.00
Total			$442.50

It was estimated that if the road surface were oiled, the required maintenance of $1 thousand per year would increase by 50 percent for an extra $500 per year.

The R.M. of Enfield submission at the Central Butte hearing presented possible cost increases on certain sections of grid road which would receive the largest increase in truck traffic in the event of rail line abandonment. Present maintenance and regravelling appeared as follows:

Grid and main fram access roads:

Maintenance, 1975	$ 235.00/mi.
Gravel - 250 cu.yd. per mile applied every three years at $1.50/yd. and $1.75/yd. to haul ($3.25/yd.)	270.00/mi.
Total Yearly	$ 505.00/mi.

For the sections or road which would require regravelling every two years under increased traffic instead of every three years, the total cost increase would be $90 to $180 per mile per year.

Province of Manitoba

Construction would be required to upgrade many roads to 74 thousand pound capacity in the event of abandonment. Municipalities in the province have indicated costs for minimum standard gravel roads of $2 thousand to $6 thousand per mile to handle the additional grain haul traffic.

The province expresses the opinion that the munipal estimates are conservative and that minimum upgrading costs on municipal roads would be approximately $15 thousand to $20 thousand per mile.

Manitoba recognized a simple ratio of 10.5 miles of road per mile of railway in the province. It was reasoned that this results in a possible 7,600 miles of road being affected in the event of abandonment of 727 miles of railway. An amount of $41.8 million would be required to upgrade 7,600 miles of road if the municipal estimates are assumed correct or $93.7 million if the $15 thousand per mile figure were used.

ROAD IMPACT RESEARCH

The 1971 Grains Group Report outlined several systems which might be derived for the collection of prairie grain. Proposals did not estimate road costs associated with the various schemes although they did create a basis for discussion of potential traffic patterns and perhaps provided the impetus for the generation of various research projects on the topic of road impact.

Some research had been initiated by municipal and provincial governments prior to the Grains Group Report. This can now be combined with more recent studies as a basis for evaluating the claims of local and provincial governments.

Routing and Amount of Grain Traffic

An Assumption regarding spacing of collection points is the most critical element in assessment of road impact. This is illustrated by the relationship developed by Shurson* which showed that traffic varies with the square of the distance between collection points. Surson demonstrated by theoretical shed areas that main links in the road network would be subject to significant increases in traffic volumes in the event of a major change, however, centralization in which spacing of collection points was 20 miles or less would affect only the maintenance cost of rural roads.

Shurson further deduced that centralization in which spacing of collection points was in the order of 20 miles would result in decreasing the number of collection points in Saskatchewan to approximately 520. In 1975 Saskatchewan Pool were represented at about 90 percent of the delivery points in the province (i.e. 715 out of 796). Over the next ten year period, they estimate that this figure would decrease by about 165 to 550** stations. Assuming a similar trend at "non-Sask. Pool" points in the province, the total number of delivery points in the province would, in fact, be reduced to about 600.

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* Shurson, Gordon W. A Study of a Rationalized Grain Handling on the Roads and Highways of Saskatchewan, an unpublished M. Sc. Thesis, Dept. of Civil Engineering, U. of S. Saskatoon, July, 1972.

** Saskatchewan Wheat Pool final submission to the Grain Handling and Transportation Commission at Saskatoon.

As a very rough tie in with the Shurson theory regarding traffic volumes, it might be concluded that the system, in the absence of large scale centralization, would result in overall collection point spacings averaging less than 20 miles, a change not likely to result in significant increases in traffic on major road links.

The analysis by Shurson, referred to above, dealt largely with the increase of traffic on main links and it concluded that the increase in levels of traffic on secondary roads would be relatively insignificant. It was recognized that secondary routes near the extremities of the shed areas would receive significantly more traffic than those routes of similar classification located near the collection point. A study compiled in 1969 by the Saskatchewan Municipal Road Assistance Authority* serves to complement the work by Shurson. This study considered the impact on all roads in the event of abandonment of the Colony subdivision (Rockglen-Killdeer area).

Whereas the Shurson analysis considered theoretical traffic assignment and related this to the provincial road network, the Municipal Road Assistance Authority report was based on actual survey of the detailed road pattern in a smaller area. Information was obtained on the number of grain hauling trips made per year before abandonment (five year average), the routes used and the number of grain hauling trips that would be made and the routes that would be used to haul

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* Clampitt, H.A. and J.J. Kovach, A Study of Effects of Railway Abandonment on Rural Road Needs in the Rockglen-Killdeer area. Municipal Road Assistance Authority, Regina, 1969.

this grain to the new point. The largest projected increase in grain hauling was immediately adjacent to Rock Glen on Highway No. 2 where the resultant average grain haul traffic would have amounted to ten vehicles per day. This figure was small compared with the total traffic consisting of 240 vehicles per day formerly carried by this highway. The total increase in daily traffic on the main grid road from Killdeer to Wood Mountain would have been one vehicle per day average. This figure was also low compared to the volume of 50 to 100 vehicles per day normally carried by this road. These results led to the conclusion that the increase in daily traffic due to railway abandonment would have been relatively insignificant compared to other traffic on the roads. It was stated that other studies which had been carried out by the Municipal Road Assistance Authority verified these results in that grain hauling traffic averaged about three percent of the total traffic on grid roads in the province.

Make-Up of Traffic as to Vehicle Description

Highway use is often expressed in terms of average annual daily traffic (AADT). This is simply a count of the total number of vehicles per year of all descriptions which pass a given point from both directions divided by 365 days. The count of vehicles is usually broken down into total traffic and number of trucks since the effect of the heavier loads is a significant factor in the life of a road. Truck traffic normally represents in the order of 10 percent to 20 percent of total traffic. For example, the Canada Grains Council*

* Canada Grains Council, Brandon Area Study Committee, The Grain Handling and Transportation System in the Brandon Area. Canada Grains Council, 1974.

listed truck traffic over a number of roads in Manitoba ranging from 5 to 14 percent total and Shurson recorded 1971 truck volumes on selected highways in Saskatchewan ranging from 11 to 27 percent of total. A more definitive measure of traffic from the standpoint of road bed and road surface deterioration has been developed based on the actual weight and number of axles which pass over a section of road. The unit derived and in common use is referred to as an equivalent 18 kip (18 thousand pound) axle load and a cross referencing system has been set up which allows for the expression of any vehicle weight and axle combination in terms of ESAL's. One unit or one ESAL (Equivalent Single Axle Load) then is equivalent to one axle loaded to 18 thousand pounds. A single pass with a 750 bushel truck will subject a road to 2.125 ESAL's, whereas, a 200 bushel truck will subject the road to 1.125 ESAL's. A 200 bushel truck must make 3.75 trips in order to move the same quantity of grain as a 750 bushel truck. The 3.75 trips of a 200 bushel truck would subject a roadbed to 4.22 ESAL's or approximately twice the stress of one trip with the 750 bushel truck.

From the above discussion, it is apparent that an assumption of a certain average truck size or mixture of truck sizes must be made in order to provide detailed data required for the assessment of road impact due to increased grain movement over highways in the event of centralization. The most conservative (i.e. resulting in greatest impact) would be to assume that the average truck size remains about the same as present. This is the method which was adopted by the Saskatchewan Municipal Road Assistance Authority in the study of road impact in the Rockglen - Killdeer area. Most studies which have considered centralization beyond the immediate area have reasoned that truck sizes will increase as distance to haul increases. For example, Shurson used farm trucking costs as compared to commercial rates to justify the assumption of 750 bushel trucks in larger area centralization. An internal study by the Saskatchewan Department of Highways* assumed that 25 percent of the grain would move in 250 bushel trucks and the remainder would move in 918 bushel trucks. This latter study also concerned itself with larger area centralization in that it was assumed that the grain collection system would consist of only 42 delivery points in the Province.

It is important to note the number of assumptions which must be made in order to derive a basis for relating the traffic volume increase as a result of centralization to the existing traffic volume. The Canada Grains Council was faced with an interesting situation, for example, in the Brandon Area Study. Information was not available as to the existing truck traffic on a number of roads which would be affected in the area. It was recognized that higher class roads were normally traversed by a larger average truck size. Therefore, a truck size was assumed for each road class; this average truck factor also included a component to represent the return or empty truck.

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* Platta, J.B. The Impact of an Inland Terminal Scheme of Grain Handling Rural Roads and Highways in The Province of Saskatchewan. Planning Branch Department of Highways and Transportation, February, 1973.

In order to calculate the basic equivalent load units, a further assumption was made to the effect that truck traffic on some roads prior to option changes would represent 10 percent of the total vehicle count. A range of normal traffic loading was then calculated for each class of road based on existing total traffic counts. The extremities of these ranges were used as boundaries for the determination of upgrading required when additional grain haul traffic equivalent load units were added to existing traffic load units which had been calculated for a specific section of road.

Additional truck traffic due to grain haul will normally be uni-directional insofar as the heavily loaded movement is concerned. It has been pointed out by Shurson that when comparisons of existing and future traffic are used to assess impact, the effect of uni-directional hauling must be considered. This means that on laned highways either the existing traffic load figures might be considered equal to one-half of total or else the additional traffic figures should be doubled.

Timing and Concentration of Traffic

Oil treatment surfaces are particularly sensitive to heavy axle loads during the spring months of the year when thawing occurs. To a lesser extent,paved roads may experience higher failure rates also due to the thawing of "ice pockets" which have been formed by capillary action in the subgrade during the freezing process. Weight restrictions are, therefore, imposed on a number of roads over the spring months. Restricted roads, inclement weather, timing of farm operations and elevator space tend to combine and have the effect of confining high volumes of grain movement to the months of June and July.

Oil surfaced and gravel roads may sustain different levels of annual traffic depending on the concentration of this traffic. The ideal situation of uniform levels of traffic throughout the year creates the opportunity for maximum use of the roads within acceptable limits of deterioration. This is due to the fact that less frequent loading of the surface over a short period of time decreases the tendency for chuck holes to form and results in more uniform maintenance intervals with respect to the number of vehicles. In order to allow for the effects of high frequency of loading during peak periods, it is appropriate to consider these peaks in relation to normal daily traffic levels for specific roads in assessing impact. The internal study by the Saskatchewan Department of Highways, for example, calculated daily commercial truck traffic on the basis of a 220-day hauling year; a more conservative estimate for farm to elevator haul might be based on a consideration of 40 percent of the grain traffic moving during a two-month period.

The Effect of Additional Traffic Volume and Traffic Make-Up on Road Specifications

Added highway use would normally be assessed in terms of the increase in AADT (average annual daily traffic) with a further check to determine if it was expected that there would be a significant change in traffic composition. For purposes of appraising the effect of increased grain movement, most research is oriented toward assessment of road impact based on load units expressed in terms of equivalent single axle loads (18 thousand pounds) and the change in total traffic receives secondary consideration.

The life of a pavement structure is almost directly proportional to the increase in load units. The effect on an oiled or gravel surface road is much less predictable and is more subject to immediate damage as a result of load increases.

The most practical means of assessing the impact of increased traffic is to compare existing and potential traffic on the route in question with historical data which is available for a number of roads located within the same jurisdiction. Shurson summarized the historical data which was available for a number of roads in Saskatchewan. It was found that Saskatchewan roads have not been considered for upgrading from oil to pavement until total traffic movements reach the equivalent of 35 to 50 ESAL's per day and oiled surface roads carried between 15 and 80 ESAL's per day. Highways carrying less than 35 ESAL's per day could sustain this level of axle loading on an oil surface with normal maintenance. It was concluded that the range of 50 to 60 ESAL's could be used as a guideline and reference point in determining whether or not the estimated increase in axle load repetitions would be significant.

The effect of different levels of centralization on traffic volumes was outlined by Shurson as mentioned in a previous section of this discussion under "Routing and Amount of Traffic", it was found that collection point spacing in the order of 20 miles would not appear to have a significant effect. It was expected, however, that 20 or more ESAL's would be added to 60 percent of the major route mileage for collection point spacing in excess of about 45 miles. Shurson recognized that the major link weakness in the event of development of such a centralized system would be the oil surfaced roads and he stated that the addition of 20 or more ESAL's per day to some existing oil treatment surfaces would probably require the reconstruction of the oil treatment to a heavy duty pavement standard.

The internal Saskatchewan Department of Highways' research considered a total of only 42 delivery points in the province. It was found that the major requirement for funds came about as a result of necessary upgrading of oil surfaced roads to pavement. A pavement structure was deemed necessary if total daily 18 kip ESAL's exceeded 25. This study assumed that increases in AADT would have zero effect (i.e. the effect was reduced simply to consideration of increases in ESAL's with no consideration being given to the increase in number of vehicles using the road).

The method of quantifying increases in road loading used by Canada Grains Council in the Brandon study was outlined in an earlier part of this discussion dealing with traffic make-up. The upper "boundary" of traffic which would be acceptable on the lowest class of "oiled road" (6"Asphalt Surface Treatment) was 13,678 ESAL's per year or an average of 38 applications per day. This study also considered factors other than increases in ESAL's. For example, the section of Provincial Road 254 was assumed "too narrow to facilitate commercial trucks of 74 thousand pounds" and there was an allowance of $30 thousand per mile for the upgrading of nine miles of this road to handle a total of 357 trucks per year.

COSTS OF ROAD CONSTRUCTION AND MAINTENANCE ASSIGNABLE TO RAIL ABANDONMENT

Alberta

The Alberta Transportation submissions have been reviewed for purposes of assessing the validity of increased road cost figures. It was determined that the off-line operation of an elevator at Paradise Valley (see Appendix) would not result in a requirement for upgrading the oiled surface section of road on the route to Edgerton since over a critical two month peak period the total increase in load would be about 14 ESAL's.

If it was assumed that the increased traffic reduced the normal resurfacing interval from six to four years application of unit costs presented by Alberta Transportation would increase the average annual expenditure by about $700 per mile, whereas, the Alberta submission indicates that there was an allowance equivalent to about $2,400. per mile for this case in estimating the provincial totals.

This example illustrates that the Alberta Government estimate of extra annual expenditures of $44.8 million over a twenty year period is likely based upon assumptions which make ample allowance for increased road requirement in anticipation of abandonment of all Category II branch lines.

Saskatchewan

The internal report prepared by the Saskatchewan Department of Highways in 1973 claimed to be conservative in that municipal roads were not really subject to capital cost increases under the methodology used. This study which assumed only 42 delivery points in the province estimated that the effect of this level of centralization would result in a requirement of $126 million capital expenditure and about $3 million additional maintenance per year.

The Municipal Authority study for the Rockglen - Killdeer area based on an actual survey concluded that the additional maintenance costs on the roads due to railway abandonment would be practically impossible to measure; however, due to the relatively low increase in average daily traffic, it was suggested that the costs would be relatively insignificant. In this study, analysis of traffic was carried out immediately after a quota was opened. This led to the conclusion that even peak grain hauling traffic would not tax the capacity of the road system either before or after abandonment. Considering the normal timing of grain traffic haul (when weather is good and roads are not soft) and the short periods of peak traffic, it was stated that larger and more costly roads would not likely be necessary or justified as a result of an increase in the number of larger trucks in the event of rail abandonment. It was further noted that all weather roads are required whether or not the railways are abandoned and the planned networks, when constructed, will generally be adequate to carry re-oriented or increased grain traffic if a railway is abandoned.

In view of the lower level of centralization considered in the Saskatchewan government submission, the $62 million figure seems high compared to the 1973 internal report total of $126 million plus $3 million annual maintenance. One would expect, however, that the Saskatchewan total would be much higher than the Alberta figure of $44.8 million considering the geography and the relative number and mileages of Category II branch lines within each province.

Manitoba

The methodology used by the Manitoba government might be generously described as "the broad brush treatment". Ratioing mileages of railroad to miles of roads and highways totals in the provinces would appear to be a very simplistic approach to the assessment of traffic increases and road impact in the event of abandonment.

The 1973 analysis by the Canada Grains Council in the Brandon area is relatively rigorous. The requirement for upgrading and subsequent costs of construction and maintenance were based on movement of grain from off-line elevators in the case of discontinued rail service. It would appear that conservative approaches were used in the assessment of road impact as illustrated by the example previously mentioned where nine miles of Provincial Road #254 were slated for upgrading at a cost of $30 thousand per mile. This resulted in an annual cost of $25,803 or $2,867 per mile for maintenance and construction costs to handle 354 trucks per year.

A total of about $258 thousand per year would be required to cover the maintenance and construction costs assignable to additional grain traffic in the Brandon area according to the above analysis. The rationalization scheme which was assumed in the study encompassed an area which delivered about 28.3 million bushels of grain for rail movement during the study year. The increased road costs therefore resulted in an average of about 0.91 cents per bushel. Due to the complexities of analysis and the wide range of assumptions required to perform calculations, the study did not detail estimates of highway costs which would result from producer haul to on-line elevators, however, it was assumed that this would result in a lower total mileage of collector roads being affected and a total cost of about one-third cent per bushel (or one cent per bushel over the 7.7 million bushels requiring additional trucking) was assigned for this alternative).

INTERPRETATION OF COSTS CLAIMED AND RELATIONSHIP OF ROAD IMPACT TO THE GRAIN HANDLING AND TRANSPORTATION SYSTEM

Estimation of road impact and costs resulting from increases in grain truck traffic as a result of removal of rail service and attendent centralization is very complex. Any approach to cost anaysis for an area necessarily involves the researcher in a series of assumptions. As the boundaries of the geographical area under consideration are widened, several more assumptions must be stacked upon the arbitrary factors chosen in analysis of a smaller area.

Estimates of the Alberta and Saskatchewan government appear to be based on a fairly rigorous analysis in spite of the fact that the choice of methodology might be questioned from many different viewpoints. A number of examples of possible off-line elevator operations have been analysed. These examples (Appendix) provide some insight into road impact in terms of increased loading on major routes. Results would indicate that the Alberta and Saskatchewan government estimates tend to be conservative (i.e. high) as shown for example in the case of earlier discussion with regard to the Furness subdivision example at Paradise Valley.

Public demand must be anticipated in the estimation of road costs but the assessment of that portion attributable to removal of rail service is further complicated by the difficulty of relating cause and effect. For example, there may be many cases where the most practical and lowest cost road specification from the standpoint of the grain haul is not compatible with the requirement of other traffic. Suppose that two points were now connected by a gravel road, since a gravel road might be less costly to maintain than an oiled surface road under higher volumes of truck traffic, the optimum specification might be to stay with a gravel road. As time goes by, the expectations of the public may rise and road standards predictabley could be raised to "dust free" even under conditions of decreasing total traffic. This might necessitate a change to an oiled road which is more subject to costly damage from a relatively low volume of untimely truck traffic. This type of situation is eluded to in the Saskatchewan government statement: "It is expected that strong pressure for dust free surfaces will result from only modest increases in truck traffic due to abandonment". Given the wide range of assumptions beginning with the definition of the change in delivery point location and spacing, it is not likely productive to re-hash figures submitted. One must recognize the possibility that the most objective estimates would necessarily be submitted with a broad range of totals, the appropriate figure would then be chosen based on selection of dozens of criteria allowed for within the range.

Increases in Road Costs Related to Grain Delivered

The provincial estimates have been reviewed and translated into average annual costs as shown in the Appendix. The resultant figures are labelled "1975 constant dollar annual costs" as the provincial government allowances for inflation have been removed. Average annual grain deliveries have been totalled for all Category II branch lines and for all rail lines in Alberta, Saskatchewan and Manitoba. The Saskatchewan government estimate of increased road costs due to line by line abandonment when divided by the grain delivered to these Category II branch lines results in a cost of about three cents per bushel and when divided by all grain delivered in the province, the cost would be about 1.1 cents per bushel. Similarly the results of spreading the Alberta government cost estimate over branch line grain is about 4.6 cents per bushel and over all grain would be about 1.1 cents per bushel.

The Manitoba government estimate of $41.8 million or $93.7 million does not lend itself to similar interpretation as there is not sufficient information in the submission to interpret the figures in terms of total annual costs consisting of amortized construction plus annual maintenance. The Brandon area study, however, involved a detailed analysis of an area collection system which handled about one-quarter of the grain delivered in the province. This detailed calculation resulted in assignable extra road costs of 0.9 cents per bushel for all grain delivered.

It has been illustrated that provincial estimates of increases in road costs due to centralization resulting from rail branch line closure are in the order of three cents per bushel for grain movement affected and amount to about one cent per bushel over all grain delivered. These are average cost figures and should not be interpreted to mean that such figures can be simply applied in the calculation of additional road costs for a micro-rationalization study. Proper assessment of potential road cost increases for purposes of comparing alternatives is still dependent on detailed traffic and road cost estimates in area analysis. The Canada Grains Council Brandon Area Study highway cost increases were estimated in detail; however, it might be argued that even within this area, optimization would be dependent upon a breakdown into finer geographical segments.

Increases in Road Costs Related to Total Highway Expenditures

When viewed in the light of costs of other components of the grain handling and transportation system, one to three cents per bushel to cover additional road costs may not be difficult to justify. In fact, decisions to change and optimize within a well defined collection area may be based on recognition of increased road costs far exceeding the three cents per bushel figure. Resistance to rationalization in cases where the overall economics of change "make sense" may exist chiefly because of potential transfer of costs between jurisdictions. The appendix of this report contains a summary of provincial highway expenditures. The significance of changes in the grain gathering system as viewed by the provincial governments is illustrated by the fact that increases in road costs estimated amount to about 2, 6 and 14 percent*of current highway budgets for Alberta, Saskatchewan and Manitoba respectively.

The Brandon Area Study recognized the potential increase in government revenues which would tend to offset costs. In this analysis, license fees and fuel tax amounted to about one-quarter of a cent per bushel to offset road cost increases of about three and one-third cents per bushel for grain moved by truck in place of rail.

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* The Manitoba figure is based on an approximation in an attempt to relate an expenditure of $93.7 million to existing expenditures -- see Appendix.

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ROAD MAINTENANCE AND CONSTRUCTION COSTS

MANITOBA

ROAD TYPE	Source of Information	Cost of Complete Construction	Next Lower Road Standard	Cost of Upgrading from next lower standard	Nature of Maintenance	Total Annual Maintenance Cost
'75 Gravel 28'	Province of Manitoba	45,000 to 70,000				
'75 Asphalt 28	Province of Manitoba	120,000 to 170,000				
'73 Asphalt	Canada Grains Council				Surface	150 - 570
'73 Gravel	Canada Grains Council				Surface	500 - 680

ROAD MAINTENANCE AND CONSTRUCTION COSTS

ALBERTA

Road Type	Source of Information	Cost of Complete Construction	Next Lower Road Standard	Cost of Upgrading From Next Lower Standard	Nature of Maintenance	Total Annual Maintenance Cost
'75 Gravel 24'	Province of Alberta	40,000				900
'75 Gravel 24'	Province of Alberta		Good road for reconstruction	15,000		
'75 oiled 24'	Province of Alberta	49,000				
'75 Pavement 28' (5" to 12" plant mix)	Province of Alberta		Gravel 28'	90,000 to 214,000		300

ROAD MAINTENANCE AND CONSTRUCTION COSTS

SASKATCHEWAN

Year of Cost & Road Type	Source of Information	Cost of Complete Construction	Next Lower Road Standard	Cost of upgrading from next lower standard ($/mi.)	Nature of Maintenance	Total Annual Maintenance Cost($/yr/mi)
'73 Farm Access Gravel	R.M. of Enfield	$ 5,000				
'74 Farm Access Gravel	R.M. of Enfield	10,000				
'75 Farm Access Gravel	R.M. of Enfield	11,000 to 13,000				
'75 Grid Gravel (24')	R.M. of Enfield				maintenance $235 regravel $270	$ 505.00
'75 Grid Gravel (24')	Saskatchewan Association of R.M.'s	18,000			maintain $250 regravel 225	475.00
'75 Grid Oiled (24')	"					1,000.00 - 1,500
'75 Grid Gravel (24')	Sask. Municipal Road Assistance Authority	13,000				
'75 Grid Asphalt 24' (2"-3" asphalt)	"	28,000				
'75 Gravel 28'	Province of Sask		Earth	$ 27,000		3,700
'75 Oiled 28' (3/4" asphalt)	Province of Sask.		Gravel 24'	14,000		
'75 Asphalt 28' (2" asphalt)	Province of Sask.		Gravel 28'	30,000 to 80,000		3,000
'75 Pavement 28' (4" plant mix)	Province of Sask.		Oiled	60,000 to 160,000		2,600

APPENDIX

ANALYSIS OF ROAD IMPACT IN THE EVENT OF ABANDONMENT OF THE FURNESS SUBDIVISION BASED ON INFORMATION CONTAINED IN THE SUBMISSION TO THE COMMISSION BY ALBERTA TRANSPORTATION DEPARTMENT AT THE REGIONAL HEARING IN STETTLER, ALBERTA June 14, 1976

The following analysis picks up on statements regarding the Furness subdivision and provides some insight into the per mile expenditures used by Alberta Transportation.

In the case of the Furness subdivision, Table 3 lists the total costs at $1,148,000 over a 20 year period for extra road expense due to abandonment and operation of the Paradise Valley elevators as off-line facilities. The "present worth of costs" figure of $806,500 in Table 4 serve no serious purpose but it would be meaningful to calculate a conventional present value for the expenditure of $1,148,000 over 20 years and to also indicate what would be the equivalent average annual amount.

1. Annual costs estimated from figures presented in submissions

Assuming an effective interest rate* of 1.85 percent and equal amounts, the $860,500 "present worth of costs" figure would require the commitment of $51,866 in each year over the 20 year period. The present value of this commitment at the 10 percent discount rate would be $441,564. This equivalent annual expenditure

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* This is approximately equivalent to the Alberta Transportation use of eight percent inflation and a ten percent interest rate. This also checks approximately with the total expenditures figure of table 3 (i.e. $\frac{1,148,000}{20}$ = $57,400 per year).

of $51,866 is now useful in assessing the reasonableness of Alberta Transportation's statements regarding the extra cost of road impact due to abandonment.

2. Projected additional traffic due to "off-track elevator" operation

Paradise Valley Receipts are approximately 600 thousand bushels per year. Assume that for purposes of road impact one must allow for peak traffic volumes thereby 40 percent of the grain moves during the months of June and July, i.e. two months at 120 thousand bushels per month.

To move this on a single shift basis and a five-day week at 900 bushels per trip equals 133 trips.

This works out to about six trips* per day during the peak period.

3. Road Impact

There are several ways of relating this added traffic density to road impact:

a) One might look at the increase in E.S.A.L.'s (Equivalent single axle loads) and compare this increase with normal total E.S.A.L.'s for various road specifications. Each trip with a five-axle-semi loaded to 900 bushels will subject the road to about 2.4 ESAL's. The total increase in ESAL's over the critical peak period will be 2.4 x 6 = 14.4 per day.

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* 52 x 1/12 x 5 = 22 working days per month
133 ÷ 22 is approximately equal to 6.

Historically, Saskatchewan roads have not been considered for upgrading from oil to pavement until total traffic movements reach the equivalent of 35 to 50 ESAL's per day and oiled surface roads currently carry between 15 and 80 ESAL's per day.* Highways carrying less than 35 ESAL's per day could sustain this level of axle loading on an oil surface with normal maintenance. The range of 50 to 60 ESAL's can be used as a guideline and reference point in deciding whether or not the estimated increase in axle load repetitions will be significant. Considering this information, it is unlikely that an increase of 14.4 ESAL's over a peak period would have much effect on the upkeep of an oiled road. It would also be implausible to assess a very significant portion of the cost of upgrading to this additional loading.

b) The additional truck traffic might be compared with total traffic and normal traffic mix relative to road specification.

Saskathcewan Department of Highway criteria requires 500 to 600 units per day to justify upgrading from an oiled surface to pavement.** Truck traffic would normally be

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* A Study of a Rationalized Grain Handling Industry on the Roads and Highways of Saskatchewan, Gordon W. Shurson, Unpublished M.Sc. thesis University of Saskatchewan.

** CP Rail Line Relocation - Poplar River Project, Sask. Power Corp.; a report forwarded to the Commission by W.H. Horner Executive Advisor Grain Handling and Transportation System Rationalization Prov. of Sask.

approximately equal to 10 percent of the total. Therefore truck traffic would be in the range of 50 to 60 units per day at the point of upgrading.

A large five-axle semi could be considered equivalent to about two average trucks for each round trip in grain haul.

It can be seen that on this basis, six trips per day would likely account for a relatively low percentage $\left(\frac{6 \times 2}{60} = 20 \text{ percent}\right)$ of the total contribution of truck traffic toward requirement of an upgrading of the road from oiled surface to pavement.

4. <u>Assessment of annual highway costs attributable to extra grain haul traffic</u>

The route (see circled area on attached map) from Paradise Valley to Edgerton* is made up of about eight miles of gravel and seven miles of oil surface treatment (improved road #897) combined with four miles of heavy duty pavement (highway #41) and seven miles of asphaltic surface course (highway #894).

Road impact and resultant cost might be considered with respect to each section as follows:

a) Additional grain haul from Paradise Valley would have a negligible effect on the life of the heavy duty pavement section;

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* There are approximate mileages and specifications determined from provincial highway maps.

b) The oil surface gravel and asphaltic surface course road sections total 22 miles.

Therefore, the Alberta Transportation submission would indicate that there is an allowance of about $2,400 per mile for yearly expenditure to handle the extra traffic created by hauling from an off-line elevator at Paradise Valley. This is based on the estimate of $51,866 per year cost of step number one above.

Normal maintenance of a surface treated road, the maximum specification likely justified as a future link from Paradise Valley to Edgerton, involves re-oiling every six or seven years. The increase in traffic due to the off-line elevator operation might be projected to decrease the time interval between re-oiling operations. The annual cost of re-oiling considering complete oil and gravel cost as presented in the October 1975 submission by Alberta Transportation would be $8,500 per mile divided by the years of service in the interval.

It would be conservative to estimate that the resurfacing time cycle could go from say six years to four years under the increased traffic. This would increase the average annual expenditure by about $700 per mile which amount to $15,400 for the 22 miles.

The October submission of Alberta Transportation stated that the total annual maintenance cost of a gravel road would be $900 per mile. The R.M. of Enfield submission to the Commission at the Central Butte hearing proposed that if extra traffic should result in a regravelling cycle (250 yards per mile) of every two years, in place of the present three year interval, grid road costs would be increased

$90 to $180 per mile per year.

The above analysis and statement indicate that the allowance of $1,148,000 or yearly $2,400 per mile is excessive for extra expenditure due to road costs associated with grain hauling from an off-line elevator at Paradise Valley. These Alberta Transportation estimates would appear to be three to four times higher than necessary considering an oiled road for the Furness subdivision "off-track elevator" example.

INCREMENTAL ROAD COST ESTIMATES FROM PROVINCIAL GOVERNMENT SUBMISSIONS

Province of Alberta

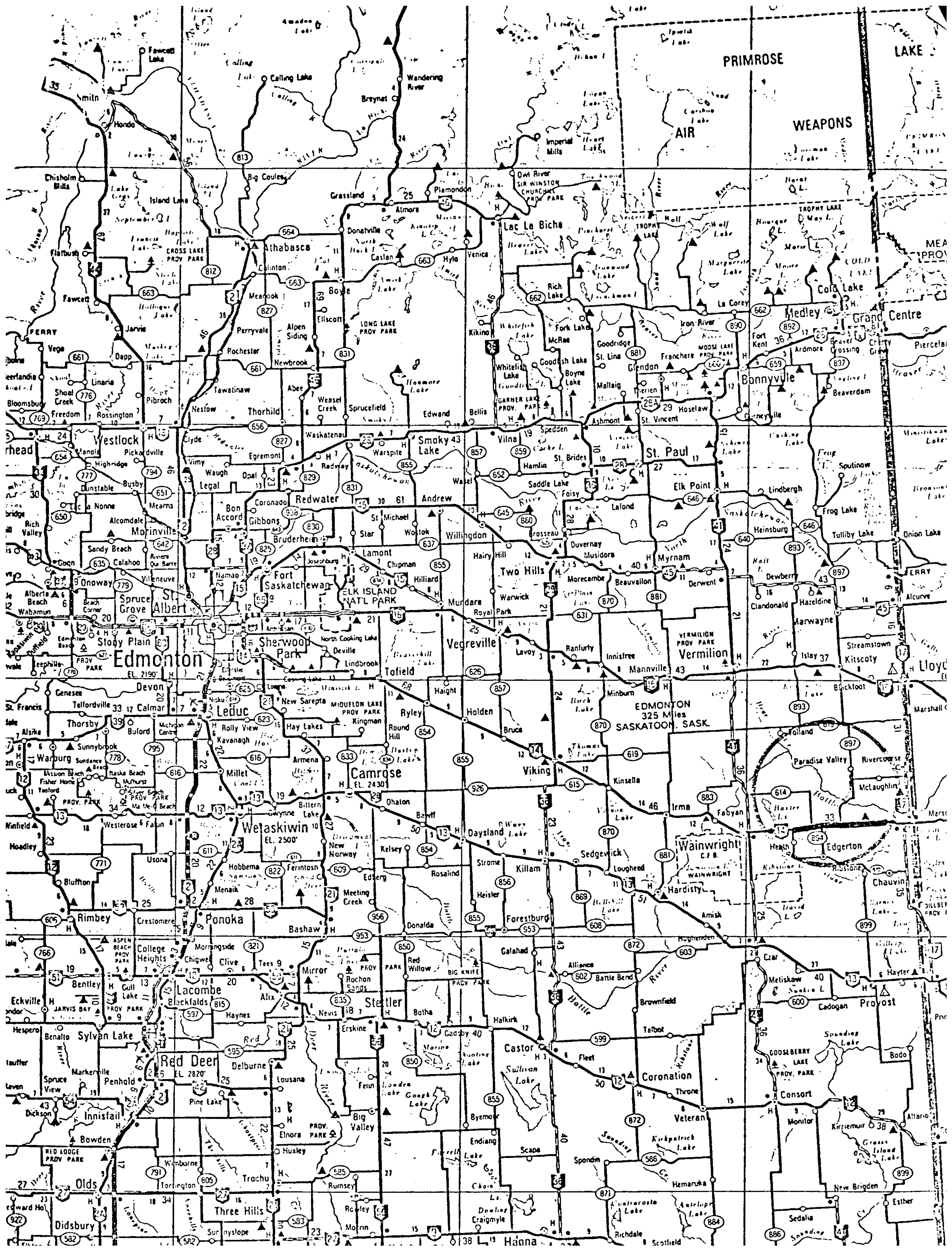
Present worth of costs assuming eight percent inflation and ten percent discount rate

= $37,016,000 to cover a 20 year period
(Note that the effective interest rate is 1.85 percent)

$$\frac{\text{Amount}}{\text{Year}} = \frac{i}{1 - (1 + i)^{-n}} \times \text{P.V.}$$

$$= \frac{.0185}{1 - (1.0185)^{-20}} \times \$37 \times 10^6$$

= $2,230,000 (1975 constant dollar annual cost)


PRIMROSE
LAKE
AIR
WEAPONS
Fawcett Lake
Calling Lake
Wandering River
Breynat
Imperial Mills
Chisholm Mills
Big Coulee
Grassland
Atmore
Plamondon
Owl River
SIR WINSTON CHURCHILL PROV PARK
Lac La Biche
Island Lake
Flatbush
CROSS LAKE PROV PARK
Athabasca
Donatville
Caslan
Hylo
Venice
Colinton
Meanook
Boyle
Fawcett
Jarvie
Perryvale
Pochester
Alpen Siding
Ellscott
LONG LAKE PROV PARK
Kikino
Rich Lake
Fork Lake
McRae
Goodridge
St. Lina
Glendon
Iron River
Franchere
MOOSE LAKE PROV PARK
La Corey
Fort Kent
Ardmore
Medley
Cold Lake
Grand Centre
Pierceland
Beaver Crossing
Bonnyville
Beaverdam
Vega
Dapp
Newbrook
Whitefish Lake
Goodfish Lake
Boyne Lake
Mallaig
Therien
Hoselaw
Linaria
Shoal Creek
Pibroch
Tawatinaw
Abee
Weasel Creek
Sprucefield
Edwand
Bellis
GARNER LAKE PROV. PARK
Ashmont
St. Vincent
Glenreville
Bloomsbury
Freedom
Rossington
Nestow
Thorhild
Spedden
Westlock
Pickardville
Clyde
Egremont
Waskatenau
Warspite
Smoky Lake
Vilna
St. Brides
St. Paul
Sputinow
Highridge
Vimy
Waugh
Legal
Opal
Radway
Hamlin
Saddle Lake
Foisy
Elk Point
Lindbergh
Dunstable
Busby
Mearns
Bon Accord
Coronado
Redwater
Andrew
Lafond
Frog Lake
Rich Valley
Alcomdale
Gibbons
St Michael
Star
Wostok
Willingdon
Brosseau
Duvernay
Musidora
Myrnam
Heinsburg
Tulliby Lake
Onion Lake
Morinville
Bruderheim
Lamont
Hairy Hill
Sandy Beach
Calahoo
Chipman
Two Hills
Morecambe
Beauvallon
Derwent
Dewberry
Onoway
Villeneuve
Namao
Fort Saskatchewan
Hilliard
Alberta Beach
Wabamun
Spruce Grove
St. Albert
ELK ISLAND NAT'L PARK
Mundare
Warwick
Clandonald
Hazeldine
Marwayne
Alcurve
Royal Park
Stony Plain
Sherwood Park
North Cooking Lake
Deville
Lindbrook
Vegreville
Ranfurly
Innisfree
VERMILION PROV PARK
Vermilion
Streamstown
Islay
Kitscoty
Lloyd
Edmonton
EL. 2190'
Devon
Tofield
Lavoy
Mannville
Minburn
Blackfoot
Genesee
Telfordville
Calmar
Leduc
New Sarepta
Haight
Holden
Ryley
Bruce
EDMONTON 325 Miles SASKATOON, SASK.
Marshall
St. Francis
Thorsby
Buford
Rolly View
Kavanagh
Hay Lakes
MIQUELON LAKE PROV PARK
Kingman
Round Hill
Tolland
Warburg
Sunnybrook
Sundance Beach
Armena
Camrose
EL. 2430'
Viking
Kinsella
Paradise Valley
Rivercourse
Millet
Itaska Beach
Fisher Home
Mission Beach
Silver Beach
PROV. PARK
Ma Me O Beach
Gwynne
Bittern Lake
Ohaton
Irma
Fabyan
McLaughlin
Winfield
Westerose
Falun
Wetaskiwin
EL. 2500'
Bawlf
Daysland
Sedgewick
Wainwright
Heath
Edgerton
Hoadley
Usona
Hobbema
Ferintosh
New Norway
Kelsey
Rosalind
Strome
Killam
Lougheed
Hardisty
Ribstone
Chauvin
Bluffton
Samson
Menaik
Edberg
Meeting Creek
Heisler
Forestburg
Amisk
Rimbey
Crestomere
Ponoka
Bashaw
Donalda
Hughenden
ASPEN BEACH PROV PARK
College Heights
Morningside
Chigwell
Clive
Tees
Mirror
PROV PARK
Red Willow
Galahad
Alliance
Battle Bend
Czar
Metiskow
Hayter
Bentley
Gull Lake
Lacombe
Rochon Sands
BIG KNIFE PROV PARK
Eckville
JARVIS BAY PROV PARK
Blackfalds
Haynes
Alix
Nevis
Stettler
Botha
Halkirk
Brownfield
Cadogan
Provost
Hespero
Benalto
Sylvan Lake
Erskine
Gadsby
Castor
Talbot
Red Deer
EL. 2820'
Delburne
Fleet
Coronation
Bodo
Spruce View
Markerville
Penhold
Lousana
Throne
GOOSEBERRY LAKE PROV. PARK
Consort
Dickson
Innisfail
Pine Lake
Fenn
Gough Lake
Byemoor
Veteran
Monitor
Kirriemuir
Altario
Bowden
Elnora
Big Valley
Endiang
RED LODGE PROV PARK
Huxley
Scapa
Spondin
Kirkpatrick Lake
Wimborne
Trochu
Rumsey
Hemaruka
New Brigden
Olds
Torrington
Three Hills
Rowley
Craigmyle
Esther
Didsbury
Sunnyslope
Morrin
Richdale
Sedalia
Hanna
Scotfield

Examples of Increases In Traffic Based On the Assumption Of Off-Line Operation Of Elevators With Commercial Trucking To On-Line Points				
Subdivision	Point of Origin	Destination	Main Road Affected	Additional ESAL's during Peak Period*
Acadia Valley	Acadia Valley	Oyen	19 miles of #41	24
Alida	Alida	Carnduff	18 miles of #318	19
	Storthoaks	Carievale	15 miles of #8	12
	Tilston	Pierson	14 miles of #256 2 miles of #345	10
Fife Lake	Big Beaver & East Poplar	Coronach	12 miles grid & 7 miles #36	19
Furness	Paradise Valley McLaughlin & Rivercourse	Edgerton Lloydminster	22 miles of #897,894 & 7 miles of grid and 22 miles #17	14 17
Inwood	Broad Valley & Fisher Branch	Arborg	13 miles of #16 & 18 miles #68	19
Lyleton	Lyleton	Pierson	3 miles #251 8 miles #256	12
Meskanaw	Alvena	Prudhomme	17 miles grid	14
	Yellow Creek & Meskanaw	Kinistino	23 miles grid	15
	Ethelton	Beatty	5 miles grid & 6 miles #368	5
Riverhurst Central Butte & Main Centre	Main Centre & Gouldtown	Herbert	15 miles grid	12
	Riverhurst, Lawson Central Butte & Mawer	Eyebrow	34 miles #42	55

* Peak loading is based on 40 percent of total grain movement taking place during a two month period.

Province of Saskatchewan

Present worth of costs assuming eight percent inflation and ten percent discount rate

= $62,000,000 to cover a 15 year period
(Note that the effective interest rate is 1.85 percent)

$$\frac{\text{Amount}}{\text{Year}} = \frac{i}{1 - (1 + i)^{-n}} \times \text{P.V.}$$

$$= \frac{.0185}{1 - (1.0185)^{-15}} \times \$62 \times 10^{6}$$

= $4,770,000 (1975 constant dollar annual cost)

Province of Manitoba

The cost of upgrading (construction) for roads of all classes would be $41,846,800 to $93,700,000; note that no figure has been presented for total increase in maintenance cost.

Canada Grains Council Brandon Area Study

For the 181.5 miles of road affected, the total cost of maintenance and construction attributable to increased truck traffic equalled an annual charge of $258 thousand based on amortizing gravel roads over a 40 year period and paved roads over an eight year period. Provincial revenue from truck licensing fee and fuel tax of $19 thousand was deducted to equal 3.09 cents per bushel over 7.7 million bushels to cover extra road costs.

ROAD DATA

Province of Alberta

-- Description of Primary Highways

	Mileage
Four or Six Lane Pavement	394
Two Lane Pavement	5,540
Oil Treatment	901
Gravel	670

-- Current Expenditures (1974-75)

Bridge Construction	$ 15,046,000
Primary Highway Construction	91,284,000
Secondary Road System	20,779,000
Grants, etc.	---
TOTAL	$190,275,000

-- Estimated annual additional costs relative to total 1974-75 construction and maintenance

$$\frac{2,230,000}{112,063,000} = 2.0 \text{ percent}$$

Province of Saskatchewan

-- Description of Roads

	Mileage
Four Lane Pavement	296
Two Lane Pavement	3,664
Oil Treatment (low quality pavement) ..	5,669
Gravel Highways	2,847
Gravel Grid*	16,000
Main Farm Access	17,000
Unimproved	60,000 to 70,000

---

* The proposed "Super Grid" system (1½"asphalt mat on surface) will involve upgrading of 5,000 to 8,500 miles of present grid roads at a cost of about $20,000 per mile for a total of nearly 200 million dollars.

-- Current Expenditures (1974-75)

Bridge Construction	$ 1,000,000
Highway Construction	57,585,000
Maintenance of Highways and Bridge ..	23,175,000
Other	---
TOTAL*	$96,760,000

-- Estimated annual additional costs relative to total 1974-75 construction and maintenance:

$$\frac{4,770,000}{80,760,000} = 5.9 \text{ percent.}$$

Province of Manitoba

-- Description of Roads

	Mileage
Provincial Trunk Highways	4,000
Provincial Roads	7,500
Municipal Roads	36,000

-- Current Expenditures (1974-75)

Highway Construction	$ 50,315,000
Maintenance of Roads	14,500,000
Other	--
TOTAL	$ 85,183,000

-- Estimated annual additional costs relative to total 1974-75 construction and maintenance:

The Province of Manitoba submission did not provide sufficient detail with regard to maintenance costs. A very rough approximation can be made by assuming that total annual costs as envisioned by the Manitoba Government may be in the order of 10 percent of the higher total upgrading figure presented. That is, annual costs due to increased grain haul are:

.10 x 93.7 million dollars = 9.37 million dollars

which is $\frac{9,370,000}{64,815,000}$ = 14.5 percent of the total construction and maintenance expenditure for 1974-75.

* Total yearly expenditures projected by the Department of Highways over the next 20 years will be 120 to 150 million dollars.

Estimated Road Costs Related to Grain Deliveries		
	Ten Year Average Grain Receipts Bushels	
	Category II Lines	All Lines
Alberta	49,000,000	208,000,000
Saskatchewan	157,000,000	438,000,000
Manitoba	45,000,000	117,000,000
	Road Costs -- Cents Per Bushel	
	Category II Lines	All Lines
Alberta $2,230,000 per year	4.6	1.1
Saskatchewan $4,770,000 per year	3.0	1.1
Manitoba Canada Grains Council based on 1973 costs and deliveries $258,000	3.5 (7.7 million bu.)	0.91 (28.3 million bu)

CHAPTER 3

THE ENERGY IMPLICATIONS OF RATIONALIZATION OF LIGHT DENSITY TRAFFIC BRANCH LINES

CLAYTON, SPARKS
& ASSOCIATES LTD.

EXECUTIVE SUMMARY

Background to this Report

The work of the Grain Handling and Transportation Commission is directed towards assessing and recommending to Government the developmental requirements of the prairie grain handling and transportation system. In light of the fact that certain of the developmental options being considered by the Commission envisage decreased rail participation in grain assembly, with an attendant increase in trucking; and in light of the expressed feelings and concerns of many that such adjustments would dictate a necessary, possibly substantial, increase in the energy requirement of the system; the Grain Handling and Transportation Commission commissioned a study on the energy requirements and costs of assembling grain by rail and truck in the prairies. This is the report of the study.

Study Objectives

The Grain Handling and Transportation Commission defined the general study objective as follows:

> "to compare energy costs and consumption in the movements of grain by rail and truck from light-density traffic branch-lines."

Within the context of this general objective, the Commission identified certain specific case-type situations to assess, including:

> "(a determination of) energy costs and consumption in rail movement of grain from elevators located on light-density branch-lines;

> "(a determination of) energy costs and consumption

in commercial truck movement of grain from elevators located on light-density branch-lines; and,

"(a determination of) energy costs and consumption in commercial and farm truck movements of grain from farms to country elevators."

Study Findings

1. Based on the number of gallons of fuel consumed per bushel-mile of haul, rail is approximately 11.9, 9.4, and 4.9 times more energy efficient than the private farm truck, custom farm truck, and commercial grain truck respectively, when operating in grain assembly.

   From the strict energy input standpoint (i.e. a BTU basis as distinct from the above gallonage basis), these ratios are 10.6, 8.5, and 4.9, respectively.

2. Based on total fuel cost (including taxes) measured in cents per bushel-mile of haul, rail is approximately 13.3, 10.8, and 7.3 times as fuel cost effective as is the private farm truck, custom farm truck, and commercial grain truck, respectively, when operating in grain assembly.

3. Regardless of the unit efficiencies of rail, for many branch-lines in the Brandon area, and the retention of private farm truck haul, would produce a net annual increase in fuel required for grain assembly equivalent to the amount of fuel consumed by only one typical commercial highway truck in a year.

4. Pursuit of a positive policy of encouraging shifts in grain haul from small farm trucks to large commercial grain trucks has considerable potential for conserving, and indeed reducing, the energy required of grain transportation, even under circumstances where branch-lines are abandoned.

   To illustrate, abandonment of 270 miles of branch-lines in the Brandon area, if accompanied with wide-scale employment of commercial grain trucks in place of private farm trucks, produces net annual decreases in the amount of fuel required for grain assembly in the area.

5. The government tax revenue implications of changes in fuel consumption effected by limited rationalization are relatively minor.

   However, provincial governments can stand to gain revenue as a result of shifts from private farm truck haulage to commercial truck haulage of grain. In particular, in Saskatchewan under the current farm fuel rebate program, such shifts can realize net total government gains of 12 cents per one thousand bushel-miles of haul.

6. There is an apparent need to develop more substantial empirical rail data respecting fuel consumption in the branch-line setting in the prairies.

   Given the very limited amount of such data made available during the course of this study, and the substantial difference between the average rail fuel consumption rate that has been derived and used in this study vs. the consumption rate suggested by one of the railways, the question of a firm rail consumption rate applicable to grain assembly in the prairies remains somewhat unresolved.

INTRODUCTION

Background to the Study

The work of the Grain Handling and Transportation Commission is directed towards assessing and recommending to Government the developmental requirements of the prairie grain handling and transportation system. In light of the fact that certain of the developmental options being considered by the Commission envisage decreased rail participation in grain assembly, with an attendant increase in trucking; and in light of the expressed feelings and concerns of many* that such adjustments would dictate a necessary, possibly substantial, increase in the energy requirement of the system; the Grain Handling and Transportation Commission has commissioned this study on the energy requirements and costs of moving grain by rail and truck in grain assembly.

The Need for the Study

There are two basic reasons for the study. Firstly, the energy efficiencies of the rail and truck modes, and components of the truck mode,** operating in grain assembly in the prairies, have yet to be specifically investigated. The relatively slow speeds and oft times small size of trains operating in grain assembly; and the relatively small size of truck normally employed in grain haul; suggest that

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* See for example the submissions of the Manitoba and Saskatchewan Governments to the Grain Handling and Transportation Commission - pages 19 and 24 respectively.

** The private farm truck, the custom farm truck, and the commercial grain truck.

indiscriminate use of modal system average transportation energy efficiencies, as presented in the literature,* for assessing energy requirements in grain assembly, is somewhat questionable.

Secondly, energy implications of rationalization are obviously a function of attendant routing implications, as well as unit energy consumption rates. In this regard, it is easily demonstrated that railway grain hauls from certain centres are effected in such a circuitous manner that energy savings can be realized by diverting the grain (through increased truck haul) to centres from which rail routing is more direct.

Study Objectives

The Grain Handling and Transportation Commission has defined the general study objective as follows:

> "to compare energy costs and consumption in the movement of grain by rail and truck from light-density traffic branch-lines."**

Within the context of this general objective, the Commission has also identified certain specific case-type situations to be assessed, including:

> "(a determination of) energy costs and consumption in rail movement of grain from elevators located on light-density branch-lines;
>
> "(a determination of) energy costs and consumption in commercial truck movement of grain from elevators located on light-density branch-lines; and,

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* For example, "Energy - Intensiveness of Transportation", by E. Hirst, Transportation Engineering Journal, February, 1973.

** Study Terms of Reference.

"(a determination of) energy costs and consumption in commercial and farm truck movements of grain from farms to country elevators."*

Study Approach and Scope

The study's general scope has been governed by two prime considerations.

Firstly, each specific branch-line case is unique. For each case, any number of circumstances, conditions, and situations may be effected or affected by branch-line abandonment, or may prevail pre and post abandonment, each of which in their own way contribute to the energy requirements of the associated grain transport activity. The implications of abandonment in one case will not be the same as for another case, either in relative magnitude, or sign.

In recognition of this, the study has been directed at the development of a general methodology and related analytical "tools" which can be used in estimating, or rendering "assessible", the energy implications of any practical branch-line abandonment option. Based on this methodology and its related tools, specifically-defined example abandonment scenarios are then analyzed.

Secondly, while detailed analysis of the study is carried out within a framework of existing technology, regulations, and fuel prices the study has also identified and commented on the possible effects of foreseeable developments in these areas, which could conceivably

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* Study Terms of Reference

and substantially alter the relative energy requirements and costs of the rail and truck modes operating in grain assembly in the future.

Accordingly, three* study elements were defined:

> Study Element 1: Develop a generalized methodology for estimating energy requirements/costs for the collection and movement of grain by rail and truck, to permit the assessment of the energy implications of light-density traffic branch-line rationalization.
>
> Study Element 2: Identify specific branch-line cases to be assessed, and analyze the energy requirement/cost implications of abandonment, utilizing the methodology developed in Element 1.
>
> Study Element 3: Identify and generally assess the implications of foreseeable technological developments, changes in vehicle weight and dimension regulations, and changes in the relative prices of fuels, on the relative levels of energy requirements/costs associated with the movement of grain by rail and by truck.

Study Boundaries

Clarification on the scope of the study can be achieved through a brief comment on what the study does not attempt to do, nor claim to be.

Firstly, it is not a theoretical treatise on "work" and "energy". Nonetheless, the basic theoretical concepts and issues involved in

---

* At the commencement of the study, we had also contemplated assessing the energy implications which would be associated with effecting institutional changes in the rail system, such as joint-running rights, branch-line tradeoffs, or traffic interchange, for specific cases of circuitous rail routing. The limitations of the rail fuel consumption data made available to this study precluded any substantial effort in this regard, and the report accordingly does not deal with this consideration further. Given the availability of better rail data, analysis in this regard could be usefully pursued.

the determination of energy requirements of transportation generally and their relevance to the determination of modal energy "efficiencies", have been reviewed and are discussed in Attachment A.*

Secondly, it is not a detailed study on the effects of the wide range of factors which affect the fuel requirements of rail and truck. Basically, the study is limited to the development and employment of "representative", or "average", fuel utilization rates by each mode, as functions of relevant and measurable determinants related thereto.

Thirdly, the study does not consider the so-called "full energy circle". For example, the energy implications of more highway construction in place of less rail maintenance (a likely effect of branch-line abandonment), are not considered.

Fourthly, the study does not investigate the energy implications of changes to the system generally, but only to limited sub-systems (i.e. specific lines/areas). In the same vein, the energy implications of trucking grain to export terminals is beyond the scope of the study. Nonetheless, portions of the data base presented in the report could be employed in such analyses.

Lastly, while realizing that the initial farm to elevator traffic allocations are important determinants of energy requirements, this

---

* "Some Transportation Energy Considerations", P.B. Hertz, University of Saskatchewan, 1975. Another excellent reference in this regard in "Railroads and the Environment - Estimation of Fuel Consumption in Rail Transportation", Hopkins, U.S. Department of Transportation.

study does not re-develop a method of traffic allocation. In the specific cases examined, the farm to elevator traffic allocation calculations carried out in other studies is accepted, at face value.

THE ANALYTICAL METHODOLOGY FOR ESTIMATING THE ENERGY IMPLICATIONS OF BRANCH-LINE RATIONALIZATION

The purpose of this section is to develop and describe the basic methodology and analytical tools required to estimate the energy implications of branch-line rationalization (Study Element 1).

Problem Conceptualization

Figure III-1 illustrates a stylized general example of a before and after abandonment situation, wherein grain produced at farm (F) is required to be transported to terminal (T).* In the before and after cases respectively, the grain is transported by truck to primary elevators B (on the branch-line to be closed) and A (on a line remaining open). From the elevators, the grain is moved by Rail to T.

The fuel implications of this adjustment can be represented

---

* This example illustrates the most general of situations, except for the one wherein the effect of abandonment would be such as to re-direct the grain produced at F to an alternate terminal (T'). Given a closed system (i.e. grain requirements at T and T'do not change as a result of abandonment), such an effect would in turn require a redirection of an equivalent amount of grain from another producing area (F'), in the "before" case destined to T', to T in the "after" case.

by the following general equation:

$$\begin{array}{c}\text{Change in}\\\text{Fuel}\\\text{Consumption}\end{array} = \left[\begin{array}{l}\text{Difference in}\\\text{fuel required}\\\text{to truck}\\\text{grain from F}\\\text{to A vs. from}\\\text{F to B}\end{array} + \begin{array}{l}\text{Difference in}\\\text{fuel required}\\\text{to position}\\\text{empty trucks}\\\text{at F for haul}\\\text{to A vs. to B}\end{array}\right] + \left[\begin{array}{l}\text{Difference in}\\\text{fuel required}\\\text{to rail grain}\\\text{from A to T}\\\text{vs. from B}\\\text{to T}\end{array} + \begin{array}{l}\text{Difference in}\\\text{fuel required}\\\text{to position}\\\text{empty rail}\\\text{cars at A}\\\text{vs. at B for}\\\text{haul to T}\end{array}\right]$$

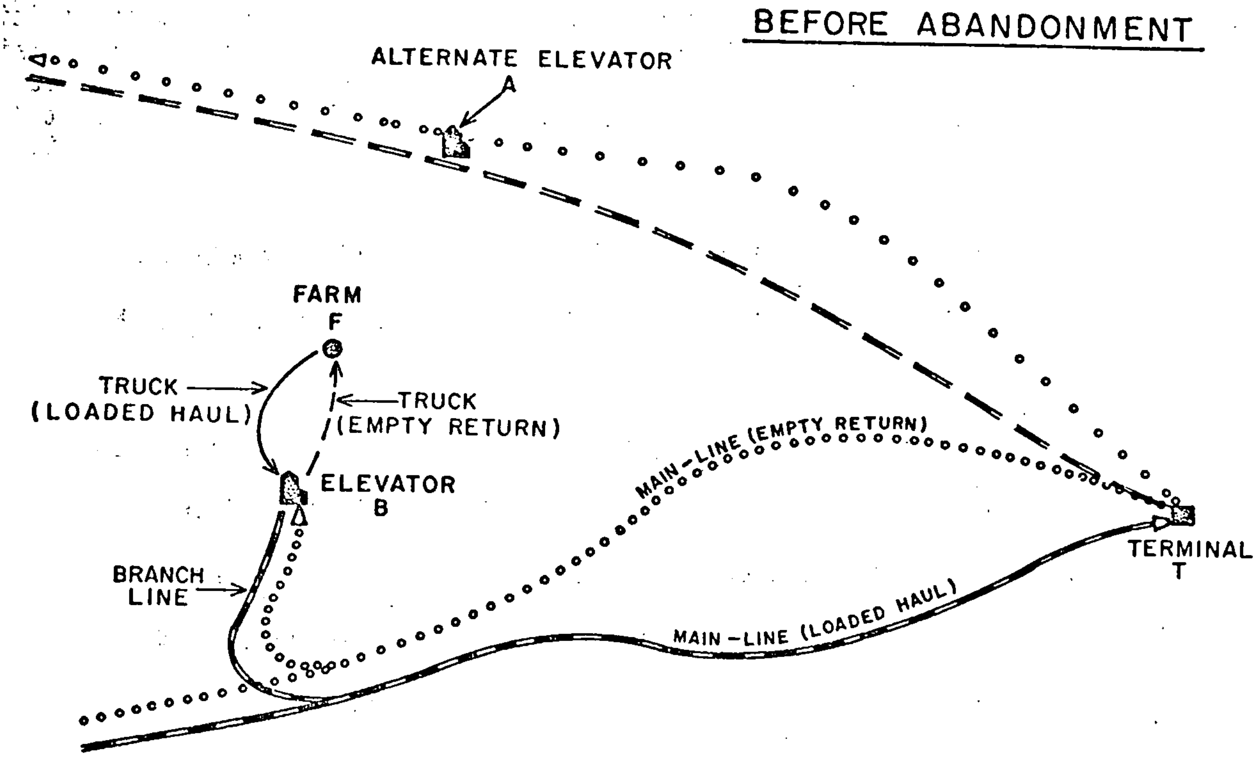
The full effect of a branch-line closure is the summation of change relating to all the grain traffic originally handled on the line in question.

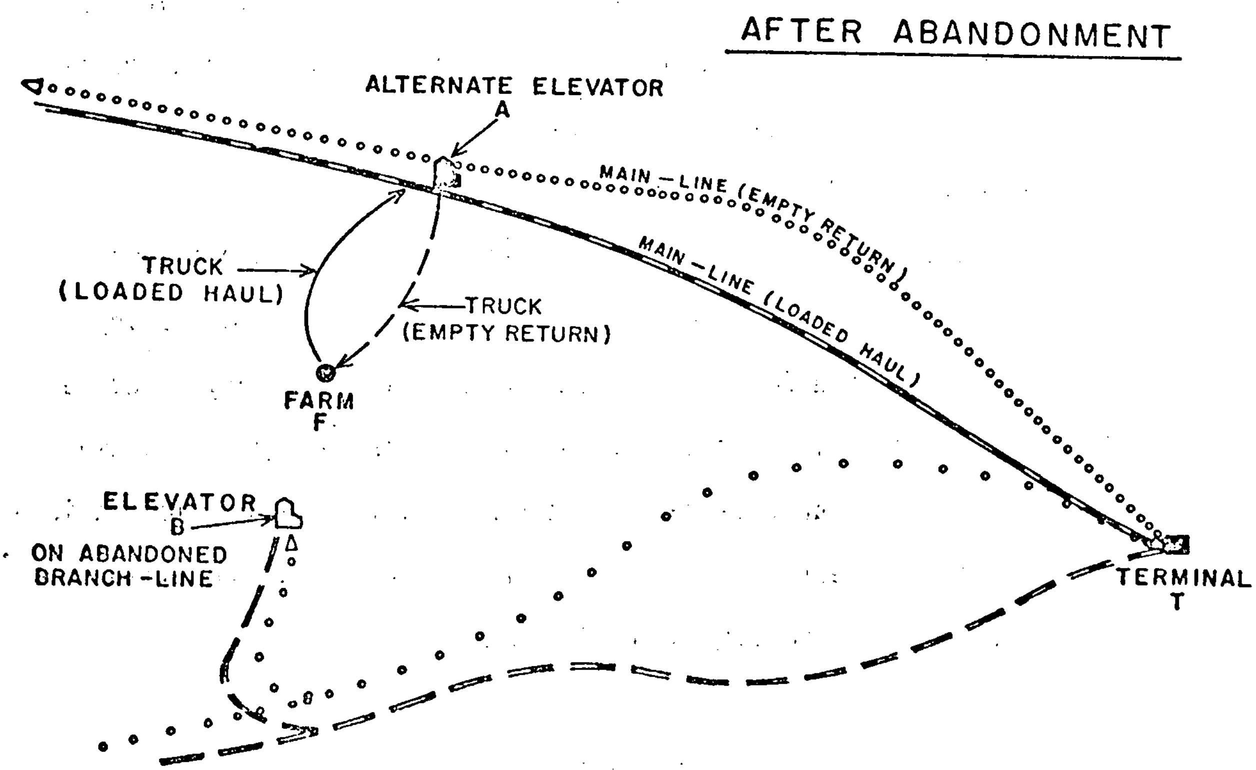
In many cases, the overall effect of abandonment is often less complicated than is the case for the situation illustrated in Figure III-1. For instance, the routing of empty and loaded grain-carrying vehicles is normally common. Further, the loaded and empty rail cars may, in the before and after cases, find themselves at a common rail point somewhere between the primary elevators and the destination terminal. In such a case, where external effects are small or non-existent, the effect of abandonment on fuel requirements need only be assessed between F and the common point, since there is no change beyond the common point.

From the above, it is generally observed that to estimate the energy implications of branch-line rationalization, it is necessary to account for: the effects of rationalization on the energy requirements of both the rail and truck modes, in both the empty and loaded directions of grain haul; between the common points beyond which rationalization has no effect. This sets the framework for the requirements of the analytical methodology, and its "tools".

FIGURE III-1

STYLIZED EXAMPLE OF A "BEFORE" AND "AFTER" BRANCH-LINE ABANDONMENT SITUATION





A Theoretical Review

The need to expend energy in transportation is derived from the requirement in moving products between places to overcome various forms in resistance to motion present on our planet. There are of course several sources of energy available for such purposes, including wind, the horse, coal, the sun, nuclear power, and oil. In recent years, the oil derivatives, gasoline and diesel fuel, have become in effect the sole sources of energy employed in the transportation of grain in Western Canada.

The movement of grain is effected by placing the grain in containers (i.e. truck boxes, rail box-cars) which are attached to "prime movers" (i.e. trucks, train engines), and which transform the potential energy of fuel into mechanical energy capable of performing the work required to overcome the resistances to motion associated with desired movements. It is the extent of these resistances to motion, the potential heat energy of fuels, and the rate at which prime movers transform the heat energy of fuel into useful work output (i.e. thermal efficiency), which together determine the fuel requirements of particular transport movements. In order to develop an understanding of the energy requirements of transport systems, and the relative energy efficiencies of one mode of transport to another, it is useful to briefly consider these three basic concepts: resistance to motion; the stored energy in fuel; and thermal efficiency.

1) Resistance to Motion

There are many forces which act to resist motion of land-borne wheeled-vehicles, including the rolling resistance of wheels, bearing resistance, aerodynamic drag, coriolis loading,* steering resistance, turning resistance, grade resistance, acceleration resistance, chassis friction resistance, and braking resistance. The sum of these resistances, normally expressed in pounds of force per ton (pounds per ton), equals the total resistance which must be overcome to move the vehicle.

Attachement A presents a detailed discussion respecting each of these resistance forces, both from a general theoretical standpoint and a modal-specific standpoint. As is shown, these forces vary significantly between modes, and indeed within each mode, depending on vehicle size, operating speed, load, and many other factors. Given similar or the same fuel types for different modes (in the sense of Btu rating), and relatively similar thermal efficiencies between modes, it is this single factor, resistance, which determines and accounts for, more than anything else, the differences in energy efficiencies between transport modes.

2) The Heat Energy of Fuels

The sources of energy for the truck and rail modes operating in grain assembly are gasoline and diesel fuel. These fuels contain stored heat energy, normally measured in British thermal units (Btu's). A Btu is equivalent to 778 foot pound of energy. In operational terms, given a 100 percent thermal efficient machine, one Btu could be converted to a one pound force acting through 778 feet. Diesel oil and gasoline have average Btu ratings of about 166,500 and 149,200 Btus per gallon respectively. The concentration of heat energy in gasoline is approximately 15 percent less than that in diesel fuel. On a gallonage comparative basis, the inherent differences in the heat energy of fuels, given other things equal, favour those transport modes which utilize higher rated fuels.

3) Thermal Efficiency

Overall thermal efficiency is the ratio of useful work output removed from a system (in this case, a vehicle overcoming

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* Derived from the inertial force caused by the earth's rotation.

travel resistance), divided by the total work-heat equivalent supplied to the system (in this case, via fuel):

$$\text{Thermal Efficiency} = \frac{\text{Ft.Lb. Work Output}}{\text{Btu Fuel Input} \times 778} \times 100\%$$

The laws of thermodynamics state that 100 percent thermal efficiencies are impossible, or in other words, that output must always be less than input. (The thermal efficiencies of engines onto themselves depend on a wide range of factors, including size, type, design, load and speed, and can vary from 0, when an engine is idling, to as high as 50 percent for laboratory research Stirling engines).

The typical railroad diesel-electric locomotive operates with an overall thermal efficiency of about 25 percent, while diesel trucks generally obtain a 20 percent thermal efficiency. Gasoline-powered trucks commonly achieve in the range of 16 percent thermal efficiency, with automobiles in the region of ten percent thermal efficiency at the speed at which they achieve their highest mile per gallon performance.*

Again, given other things equal, different modes experience an energy advantage, one to another, simply from the standpoint of their relative abilities to convert the heat energy of fuel into useful work output required to overcome resistance to motion.

As has been stated, it is the combination of the above factors which determine the actual fuel requirements of any particular transport movement. Further, it is these factors which account for inherent differences in fuel requirements between modes and strongly influence the relative transportation energy efficiencies of one mode, or mode element (i.e. private farm truck vs. commercial grain truck) to the next.

Transport Energy Efficiency

Transportation energy efficiency may be defined in various ways, but probably the most commonly employed definition is the division

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* Hertz, ibid.

of net ton-miles of movement by Btu fuel input (or gallons of fuel input, by fuel type):

$$\text{Transportation Energy Efficient } \mu = \frac{\text{Net Ton-miles transported}}{\text{Btu fuel input}}$$

Transportation energy efficiency defined in this way is always much less than one. Accordingly, its inverse is usually quoted in the literature. The greater the value of the inverse, the lower the transportation energy efficiency.

For the purposes of this study, the definition of transportation energy efficiency, and accordingly its inverse, has been modified in a manner which takes specific account of the commodity under study (grain), and the requirement to consider both the empty and loaded direction of haul (as discussed previously - Problem Conceptualization). Specifically, the definition is: the number of gallons of fuel consumed (by fuel type) in both the empty and loaded directions of haul, in effecting a movement of one thousand "typical" bushels (by weight) over a distance of one mile. (The "typical" bushel is discussed in Section 4, and weighs 55 pounds).

A specific example will illustrate the operational meaning of this definition. Assume that grain is hauled in a gasoline-fueled farm truck which operates in the loaded direction at 20 thousand pounds gross vehicle weight (hereafter referred to as g.v.w.) with an 11 thousand pound carrying capacity. The average weight of the grain hauled is 55 pounds per bushel. Therefore, given no volume constraint, the average load per run is 200 bushels (i.e. 11 thousand pounds ÷ 55 pounds per bushel). Assume further that the truck experiences an average fuel performance rate of 10 miles per gallon, under conditions where for every mile it travels loaded (i.e. at 20 thousand pounds g.v.w.) it travels a return mile empty (i.e. at 9 thousand pounds g.v.w.). Given that the truck is operated in grain haul in a manner where empty miles equal loaded miles, then the inverse transportation energy efficiency for this truck is calculated as follows:

> For 200 bushels to be moved one mile, the truck travels two miles, consuming 0.1 gallons (gasoline) per mile
>
> Therefore:

$$\frac{1}{\mu} = \frac{0.2 \text{ gallons (gasoline)}}{200 \text{ bushel-miles}} = \frac{1.0 \text{ gallons (gasoline)}}{1{,}000 \text{ bushel-miles}}$$

The following two sections respectively develop measures of inverse transportation energy efficiency* for the truck and rail modes operating in grain assembly.

Inverse Transportation Energy Efficiencies for Trucks Operating in Grain Assembly

Three trucking alternatives are available for the farm to elevator element of grain assembly - the private farm truck, the custom farm truck, and the commercial grain truck. Given these alternatives, and the vehicle weight and dimension and "use" regulations in the prairies, grain can be and is transported from farm to elevator in gasoline and diesel-powered trucks ranging in size

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* The term "inverse transportation energy efficiency" is used throughout this report. For the purpose herein, it is simply a measure of the fuel consumption rate of transport modes operating in grain assembly.

from small half-tons to 82 thousand pound g.v.w. combination units. Clearly, because of this wide assortment of trucks used in grain assembly, wide variations in the transportation energy efficiencies of trucked-grain are experienced, when comparing one situation to the next.

The purpose of this section is to develop a schedule of inverse transportation energy efficiency measures over the full range of trucks employed in grain assembly, under the three trucking alternatives. This schedule will serve as a general tool for assessment of the energy implications of specific rationalization options, wherein vehicle characteristics (i.e. size, fuel type) may vary from one specific case to the next.

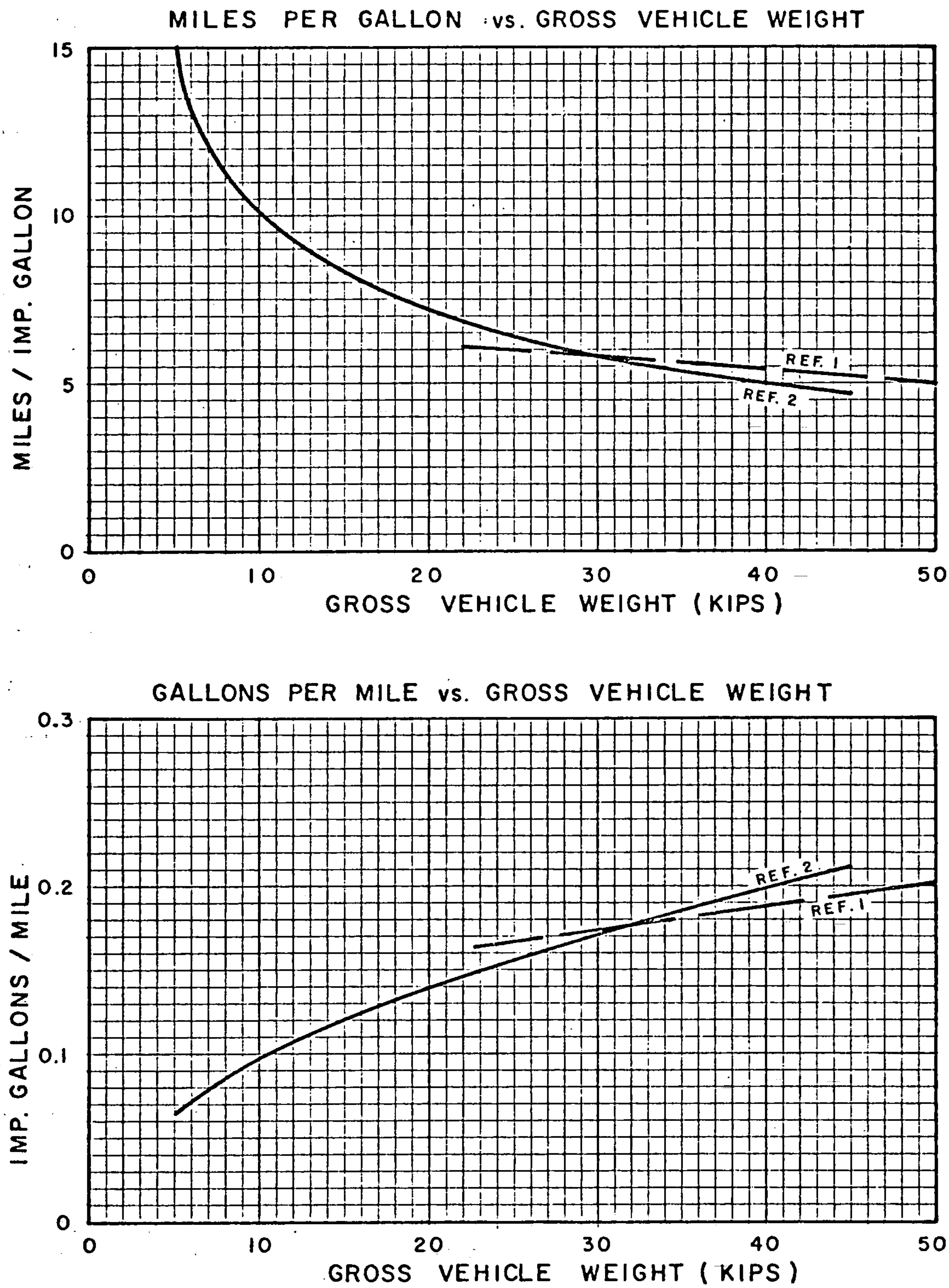
The basic determinants used in the calculation of this schedule are: gross vehicle weight under load; the ratio of tare weight (and therefore, payload) to loaded g.v.w.; operating speed; the ratio of empty to loaded miles per grain haul; average fuel consumption by vehicular weight at normal operating speeds; the weight of a "typical" bushel; and vehicle type (by fuel consumed).

-- Gasoline-Fueled Trucks

Figure III-2 illustrates several empirically developed relationship of gross average miles per gallon, and its inverse, gallons per mile, for different levels of loaded g.v.w., for two and three-axle gas-powered trucks ranging in weight from a g.v.w. of 7,500 pounds to a g.v.w. of 45 thousand pounds.

FIGURE III-2

CONSUMPTION RATES FOR GASOLINE - FUELED TRUCKS



SOURCE:

REF. 1 H.R.B. BULLETIN 301 — FIG. 47
REF. 2 W.H.I. RESEARCH SUMMARY SERIES NO. 1-74

Trucks in this size range account for the very great majority of both private and custom farm trucks employed in grain assembly in the prairies. Only in very isolated instances are five-axle units employed by farmers in private or custom haul, and such units are nearly solely diesel-fueled.

As developed from various sources, Figure III-3 illustrates the range of the relationship between tare, gross and net weights for the range of gas-powered private farm and custom farm trucks operating in grain assembly. As shown, the range of payloads, at fixed g.v.w. (or fixed tare), is wide, primarily resulting from variations in both vehicle design and operating practice.

Based on our assessment of the adequacy of the information sources which have been utilized to construct Figure III-3, we have estimated the average relationship of loaded gross weight to payload for g.v.w.'s between 10 thousand and 30 thousand pounds for farm truck hauling of grain, as:

Payload (kips) = 0.755 (g.v.w. - 4.20)
Where: g.v.w. is expressed in kips (i.e. thousands of pounds)

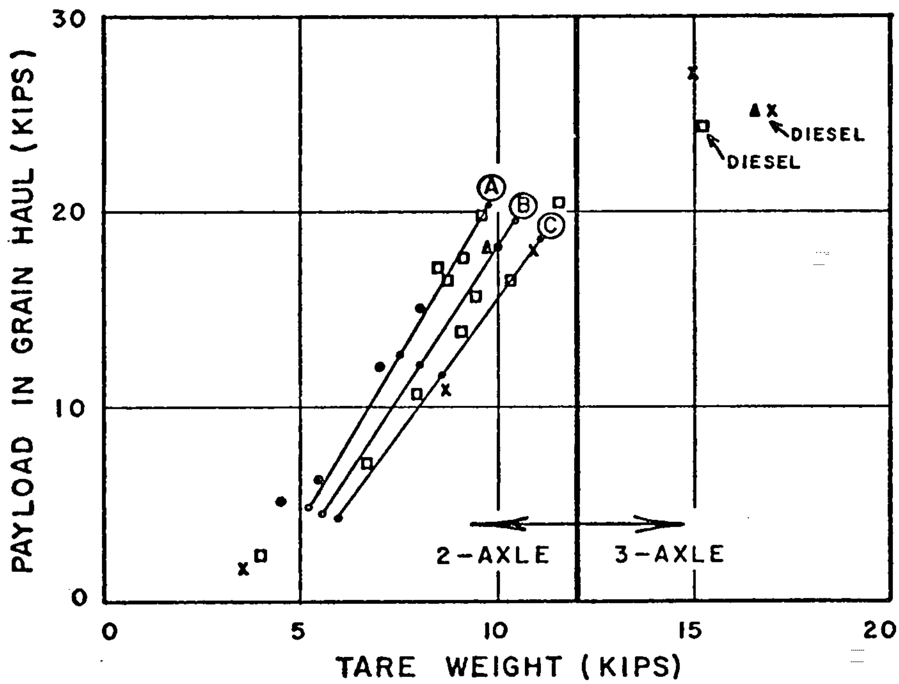
Because of the obvious limitations to this type of estimate, and to examine the sensitivity of calculated energy efficiency measures to error in this estimate, the following possible variations in this average relationship are also considered in the derivations which follows:

Payload (kips) = .775 (g.v.w. - 3.90) High Estimate
Payload (kips) = .735 (g.v.w. - 4.50) Low Estimate
Where: g.v.w. is expressed in kips

Each of these three curves has been superimposed on Figure III-3.

FIGURE III-3

RELATIONSHIP OF PAYLOAD, TARE WEIGHT, AND LOADED GROSS VEHICLE WEIGHT FOR SMALL TRUCKS



SOURCE:
- • DISCUSSIONS WITH COMMERCIAL TRUCKERS
- x DISCUSSIONS WITH TRUCK SALES OUTLETS
- ◻ ACTUAL OBSERVED GRAIN DELIVERIES
- ▲ H.R.B. BULLETIN 301 — FIGURE 15

NOTE: UNLESS OTHERWISE INDICATED, THE PLOTTED POINTS REFER TO GASOLINE-FUELED TRUCKS

LEGEND:

(A) PAYLOAD = .775 (G.V.W. − 3.90) IN KIPS

(B) PAYLOAD = .755 (G.V.W. − 4.20) IN KIPS

(C) PAYLOAD = .735 (G.V.W. − 4.50) IN KIPS

• FOR G.V.W.'s BETWEEN 10 000 AND 30 000 lbs.

NOTE: THESE CURVES HAVE NO STATISTICAL SIGNIFICANCE, BUT REPRESENT OUR ESTIMATES OF THE LIKELY RANGE OF THE RELATIONSHIP SHOWN.

Utilizing these relationships, and assuming that private and custom farm trucks operating in grain assembly produce one empty return mile for every loaded mile of haul, Figure III-4 has been developed from Figure III-2 to illustrate the fuel requirements of this size range of truck per average running-mile (i.e. half the miles are operated in a loaded state, and half are operated in an empty state) for different levels of g.v.w. in the loaded direction.* For comparative purposes, the frequency distributions of reported fuel mileage performance vs. licensed g.v.w. obtained in a survey respecting farm trucking**, along with the "means" of the illustrated distributions, are also shown in Figure III-4. While the distribution in the survey data is wide, the means compare favourably with the derived average-mile relationship. (It is to be noted that running speeds of farm trucks operating in grain haul average in the order of 30 miles per hour).***

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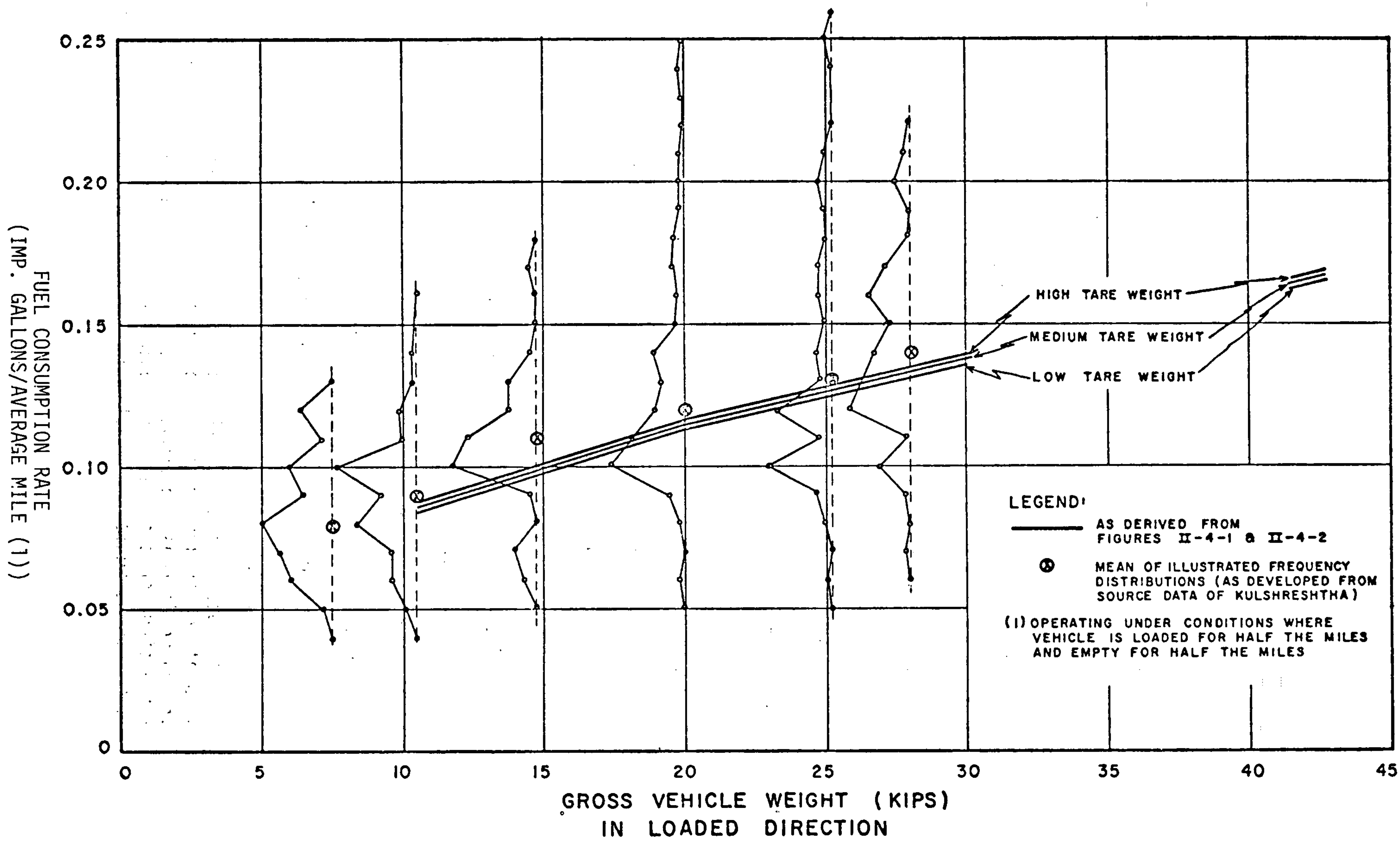
* The fuel consumption schedule of Reference 1 has been employed. This derivation inherently assumes that the consumption schedule applies for the same vehicle in both its empty and loaded state. Clearly, this is questionable from a theoretical standpoint, but any error which might be introduced as a result of the assumption is considered to be well within the bounds of acceptability for the purpose at hand.

** Kulshreshtha, S.N. - "An Economic Analysis of Farm Truck Ownership, Utilization, and Cost of Handling Grain in Saskatchewan"- source data.

*** This is a reasonable average of the data developed by Tyrchniewicz ("The Cost of Transporting Grain by Farm Trucks in the Prairie Provinces" -- Table III-3) and Kulshreshtha (ibid) as derived from Tables III-15 and III-30 for areas B, C, and D.

FIGURE III-4 FUEL CONSUMPTION SCHEDULE GASOLINE-FUELED TRUCKS



Again for comparative purposes, Figure III-5 illustrates calculated consumption schedules for farm trucks, as a function of g.v.w. per tare, speed, and vehicular horsepower. These calculations have been made utilizing the resistance equations discussed in Attachment A, and details are presented in Attachment B. (The plotted curves apply to a situation wherein the truck is empty for half the miles, loaded for half the miles, on gravel half the time, and on pavement half the time). It can be seen that there is a good comparison between the calculated consumption schedule at 35 miles per hour and the data presented in Figure III-4.*

Based on the above, we have concluded that the average mile consumption schedule derived from Reference 1, and illustrated in III-4, is an adequate approximation of the average consumption schedule experienced by private and custom farm trucks operating in grain assembly in the prairies. Recognizing the limitations of this approximation, the derivation of transportation energy efficiencies for private and custom farm trucks will consider the effects of a ± 5 percent error in the chosen consumption schedule.

Figure III-6 presents schedules of inverse transportation

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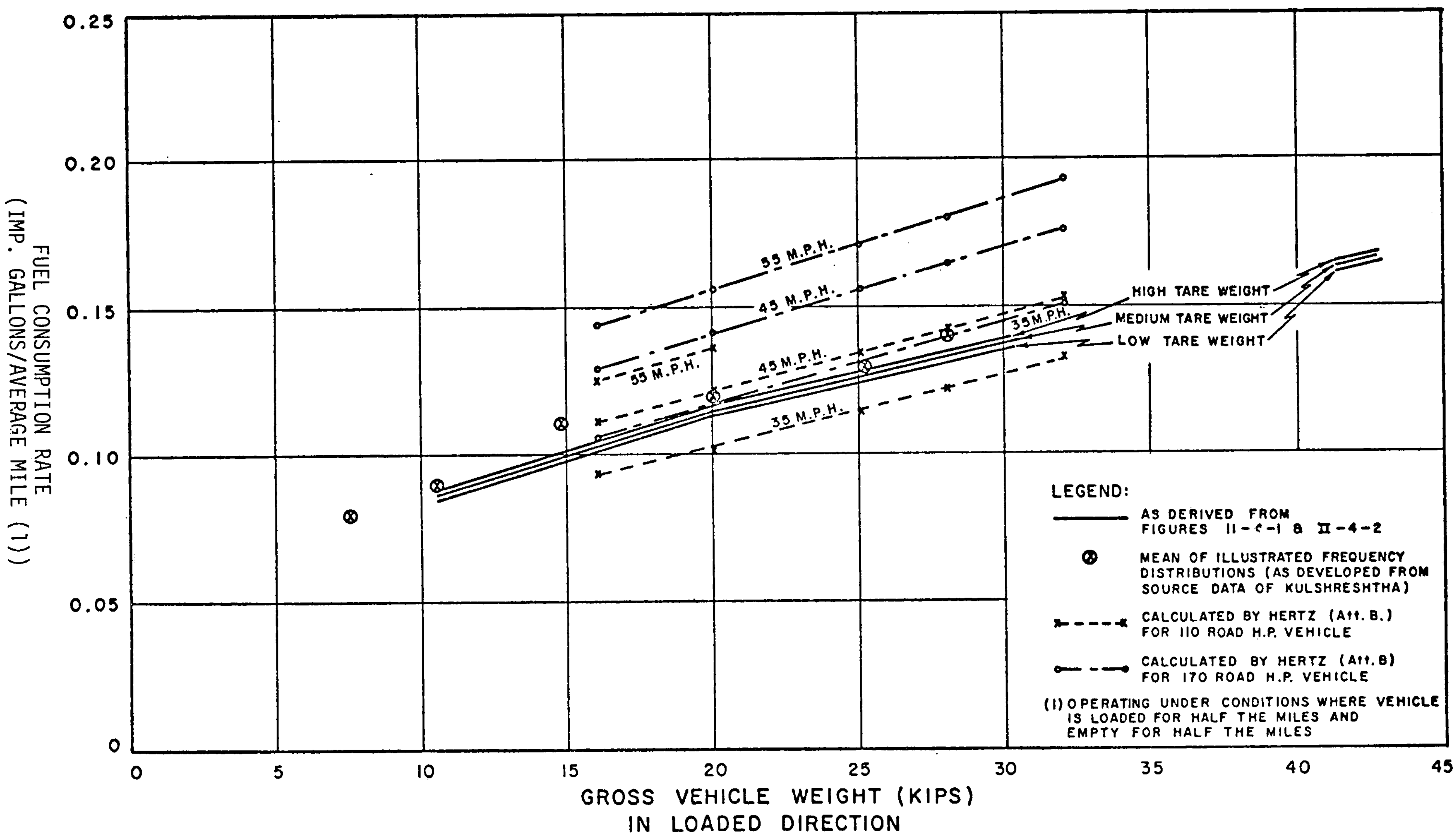
* Note that these calculated consumption schedules do not account for idling or low temperature effects. These effects would of course increase consumption for the average year-round operation. Accounting for these effects would tend to bring a calculated consumption rate schedule at 30 miles per hour in line with the derived schedule.

FIGURE III-5 CALCULATED FUEL CONSUMPTION SCHEDULE
GASOLINE - FUELED TRUCKS



energy efficiencies as developed from the fuel consumption schedules shown in Figure III-4, and the relationships of payload to gross weight described earlier. Payload has been converted to "typical" bushels, using an average weight of 55 pounds per bushel.*'**.

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* In the prairies, the distribution of bushel deliveries of grain by type is:

	Density lbs./bushel	Kulshreshtha (Ibid) Table 8	Trimac (Exhibit 11)	Brandon Study (p. 17)
Wheat	60	66%	65%	
Barley	48	20%	20%	
Oats	34	2%	7%	
Rye	56		3%	
Rape	50		3%	
Flax	50	11%	3%	
Other	(50)	1%		
Weighted Average Bushel Density		55.9#/bushel	55.2#/bushel	53#/bushel

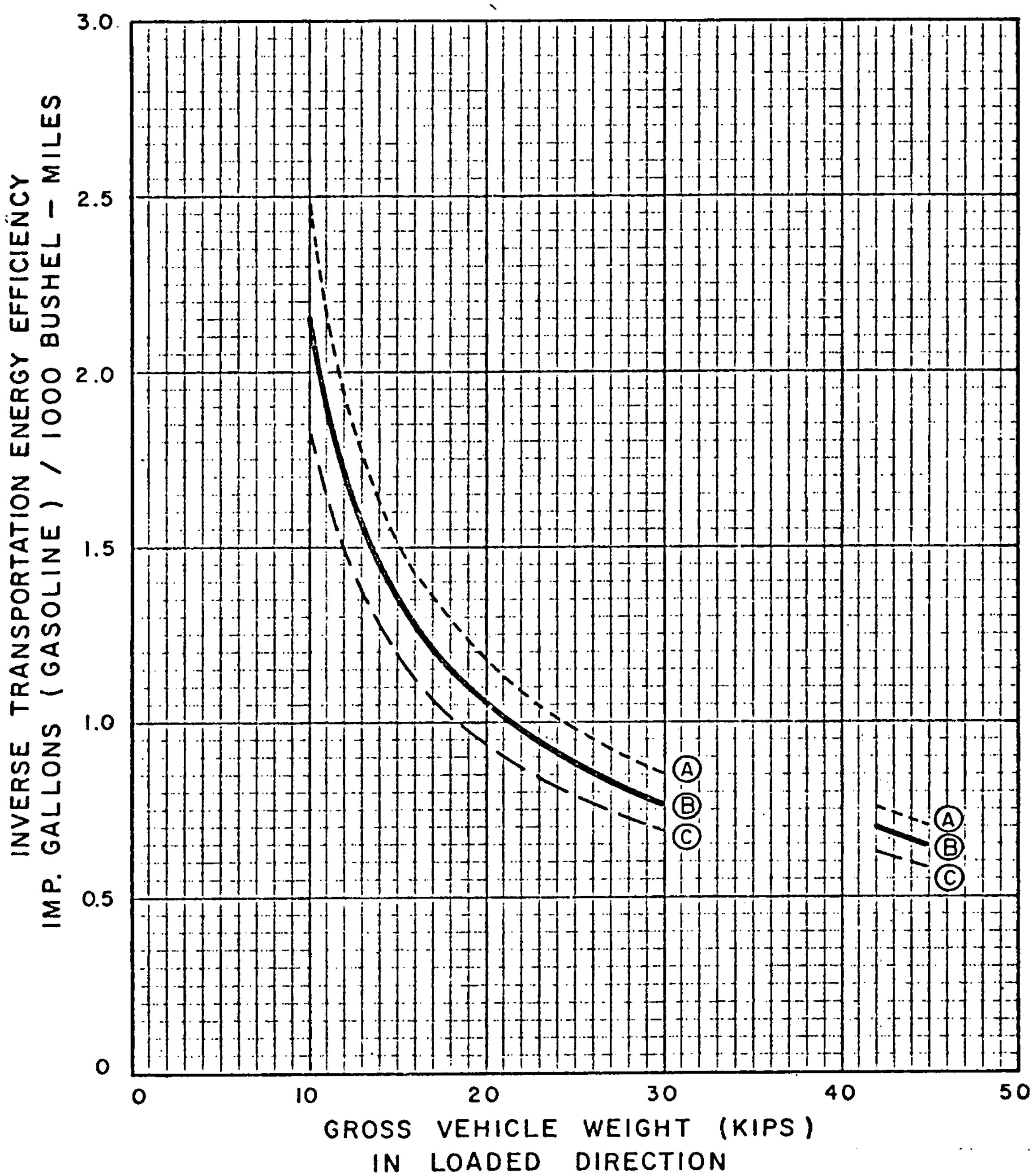
Trimac -- "Evaluation of Commercial Carriage of Grain for the Grains Group".
Brandon Study -- Canada Grains Council.

** An example calculation of the inverse transportation energy efficiency for a loaded g.v.w. of 20,000 lbs. follows:

From Figure III-4 and a ±5% Sensivity Check Fuel Consumed/Return-mile Trip		From Figure III-3 Payload/Return Trip	Inverse Transportation Energy Efficiency Gallons/1000 bushel-miles
High	0.246 gallons	Low 11,390 lbs. (207.1 bushels)	1.19
Medium	0.230 gallons	Medium 11,930 lbs. (216.9 bushels)	1.06
Low	0.214 gallons	High 12,475 lbs. (226.8 bushels)	0.94

FIGURE III-6

SCHEDULE OF INVERSE TRANSPORTATION ENERGY EFFICIENCY FOR PRIVATE AND CUSTOM FARM TRUCKS GASOLINE – FUELED



LEGEND:

Ⓐ – COMBINATION OF "*HIGH*" CONSUMPTION AND "*LOW*" PAYLOAD

Ⓑ – COMBINATION OF "*MEDIUM*" CONSUMPTION AND "*MEDIUM*" PAYLOAD

Ⓒ – COMBINATION OF "*LOW*" CONSUMPTION AND "*HIGH*" PAYLOAD

It can be seen that energy efficiency increases substantially as truck size increases. For the same ten thousand "typical" bushels hauled ten miles, a 12 thousand pounds g.v.w. (loaded) truck would require 170 gallons of gasoline, while a 28 thousand pounds g.v.w. (loaded) truck would require 81 gallons of gasoline.

-- Diesel-Fueled Trucks

For the purposes of this study, the commercial grain truck is considered to be a five-axle hopper-bottom semi, which operates effectively at the maximum g.v.w. and axle weights permitted within the weight and dimension regulations of each province. These regulations vary between provinces, and as well vary within provinces from one road to the next. Accordingly, the weight constraints on a commercial grain truck operation are dependent on the road (and the province) on and in which the truck operates.

Over the allowable range of g.v.w.'s at which five-axle units may operate in the prairies (i.e. 74 thousand pounds to 82 thousand pounds), the tare weight of a unit will not change. In other words, exactly the same vehicle can and does operate at both these limits. As is the case with smaller trucks, the tare weights of commercial grain trucks vary, from an apparent absolute high of 32 thousand pounds to an apparent absolute low of 24 thousand pounds.* The normal tare weight for these units,

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* 32 thousand pounds - discussion with carriers
24 thousand pounds - Trimac - "Evaluation of Commercial Carriage of Grain for the Grains Group".

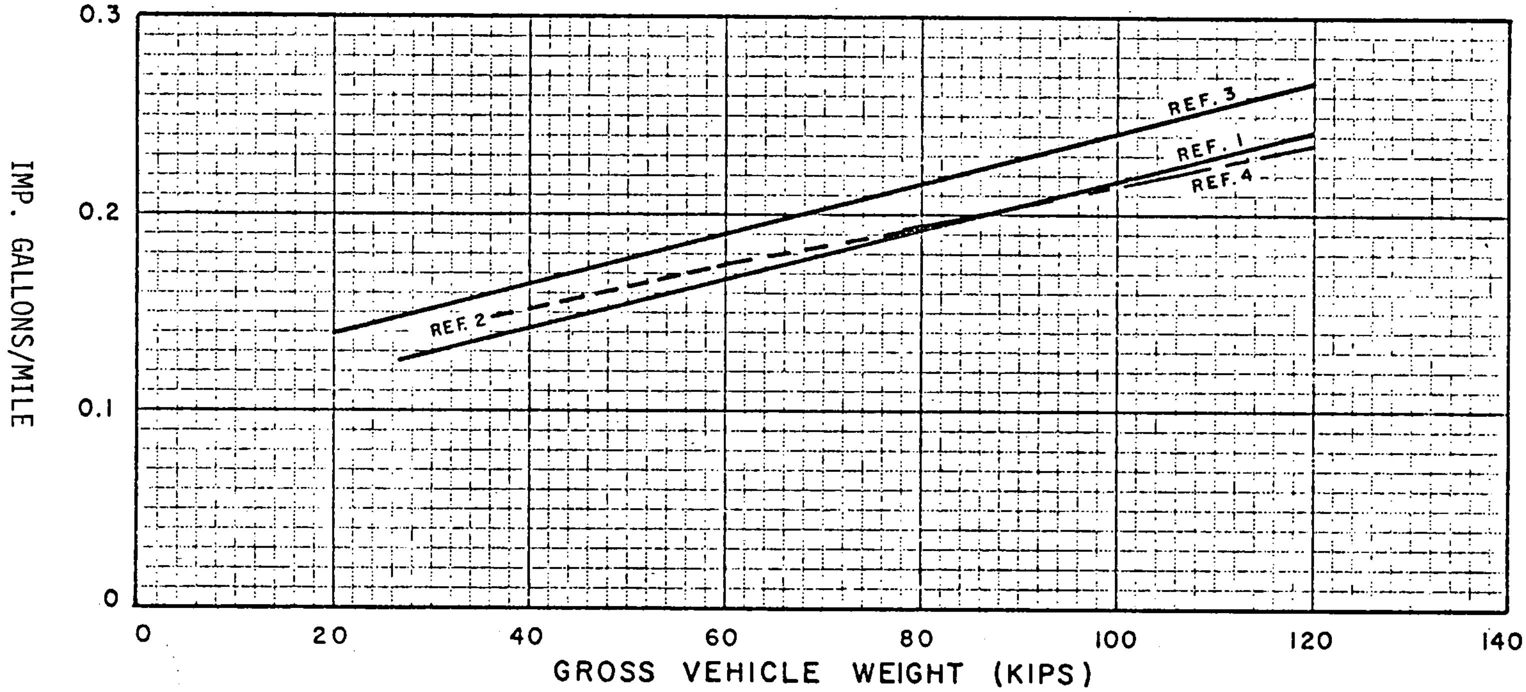
however, based on discussions with carriers, discussions with weigh scale operators, and an assessment of average loads (by weight) experienced in the Canadian Wheat Board/Saskatchewan Trucking Association haul to inland terminals in 1975, is 26,500 pounds.

A number of references respecting fuel consumption rates for diesel-powered trucks of the size used in grain haul have been examined. (Figure III-7 illustrates these consumption rates). In comparison to the results of discussion with commercial grain truckers, it would appear that this material suggests better fuel performance than is experienced in practise in the prairies. Accordingly, we have chosen to hold with the results of these discussions as being more representative of the situation in the prairies. On a year-round, half empty, half loaded basis of operation, including idling, therefore, average fuel performance for 74 thousand pounds and 82 thousand pounds loaded operations are 5.15 and 5.10 miles per gallon respectively.* At the outside, these average consumption rates can reasonably be expected to be within ± 0.20 miles per gallon of the actual rate.

---

* For costing purposes, the Saskatchewan Trucking Association normally employs a 5.00 m.p.g. fuel performance rate for commercial grain trucking. Preliminary results of the R.T.A.C. fuel tax study have determined the following average consumption rates in the prairies: Manitoba, 4.99 m.p.g.; Saskatchewan, 4.90 m.p.g.; Alberta, 5.60 m.p.g. A Trimac study entitled "Operating Costs of Trucks in Canada" (1973) has utilized average fuel performance rates of 5.5 m.p.g. for Alberta and Saskatchewan.

FIGURE III-7 CONSUMPTION RATES FOR DIESEL - FUELED TRUCKS



SOURCE:

REF. 1 H.R.B. BULLETIN 301 - FIGURE 47
REF. 2 W.H.I. RESEARCH SUMMARY SERIES NO. 1-74
REF. 3 W.H.I. RESEARCH COMMITEE REPORT NO. 2 - FIGURE 58 (AT. 46 M.P.H.)
REF. 4 W.H.I. RESEARCH SUMMARY SERIES NO. 1-74 - FIGURE 1 (AVERAGE)

Based on the above, Table III-1,develops the range of inverse transportation energy efficiencies for commercial trucks, at loaded g.v.w.'s of 74 thousand pounds and 82 thousand pounds.* Again, on a gallonage equivalency basis alone, there are substantial energy savings realized in hauling grain by commercial truck in comparison to a farm truck. For the same ten thousand "typical" bushels hauled ten miles, a 20 thousand pound g.v.w. (loaded) truck would consume 106 gallons of gasoline, while a 74 thousand pounds g.v.w. (loaded) commercial truck would consume 45 gallons of diesel fuel.

TABLE III-1

Calculations of Inverse Transportation Energy Efficiency for Commercial Trucks

G.V.W. loaded direction (lbs.)	Diesel Fuel consumed per return-mile trip (gallons)			Payload per trip lbs./bushel	Inverse Transportation Energy Efficiency Imp. gallons (diesel)/ 1,000 bushel-miles		
	High	Medium	Low		High	Medium	Low
74,000	.404	.388	.374	47,500/863.6	0.47	0.45	0.43
75,000	.404	.388	.374	48,500/881.8	0.46	0.44	0.42
82,000	.408	.392	.378	55,500/1009.1	0.40	0.39	0.37

* For this purpose, we have assumed that commercial grain trucking incurs one empty mile of movement for every loaded mile of haul. Some commercial grain truckers, indeed, report loaded to empty mile ratios which are greater than one.

Inverse Transportation Energy Efficiencies for Rail Operating In Grain Assembly

Transportation energy efficiencies for the rail mode operating in grain assembly can and do vary widely, from one specific line and run to the next. Train consist, speed, ambient temperature, thermal efficiency, grades, curvature, switching, idling, dead-heading, rolling stock design, stops and starts, wind, and other factors, contribute to the fuel requirements of a branch-line run, and variations in these factors create substnatial variations in calculated transportation energy efficiencies between lines, and on the same line between runs. Nonetheless, because of the relatively low absolute level of inverse transportation energy efficiency for rail vs. truck (and in particular, for rail vs. the small farm truck), the significance of these variations, as will be illustrated, is relatively unimportant from the standpoint of modal comparisons of energy efficiency in grain haul.

From the outset, it had been agreed that this study would concern itself only with representative or typical fuel consumption rates, to be provided by the railways, for use in the calculation of rail transportation energy efficiency. In this regard, major sources of available, measured fuel consumption data were not provided.* However, a limited number of specific fuel consumption measurements were

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* Available data not provided included Canadian National Railway's fuel consumption tables developed for costing purposes, and the results of a large number of fuel consumption tests recently conducted by CP Rail.

undertaken by the railways for this study, and the results of some of these were provided.*

Because of the shortage of empirical consumption data, it has been necessary to test the reasonableness of the limited amount provided from the theoretical standpoint, wherein fuel requirements over a range of branch-line situations and operations have been estimated using the resistance equations discussed in Attachment A. These fuel requirements were then converted into measures of transport energy efficiency, and compared with their equivalents derived from the empirical data provided.

Attachment C details the calculation of fuel consumption and inverse transportation efficiencies for a reasonably typical range of branch-line situations and operations. The sensitivity of fuel consumption to certain of the influencing factors is illustrated in these calculations, demonstrating the kind of variation which can occur from one specific fuel measurement to the next.

The basic assumptions used in the calculations are:

1) branch-line originating grain is transported in standard 60 ton box-cars with tare weights of 22 ton "normal" loaded weights of 79 ton, and payloads of 57 ton.**

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* Attachment D presents the results of the specific tests carried our during the course of the study, and reported to us. This data is illustrated in Figure III-8.

** These weights were derived from an assessment of the consist information provided by the railways for a number of branch-line and main-line runs, and general equipments lists. Herein, we have not considered the hopper cars because of their relatively limited employment on light density traffic branch-lines.

2) for each loaded mile travelled by a box-car, the car travels one mile in an empty state.

3) for each mile travelled by a locomotive pulling loaded cars, it travels one mile pulling empty cars.

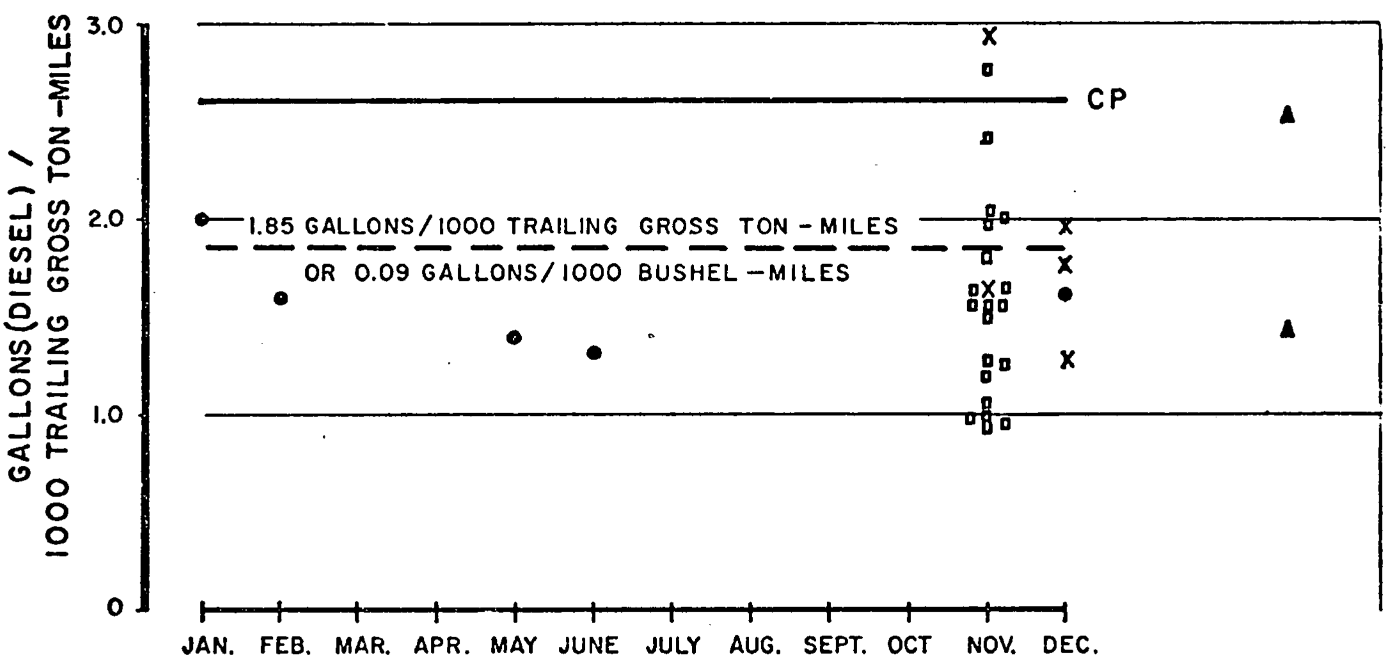
4) the payload of 57 tons is equivalent to 2,070 "typical" bushels (i.e. 55 lbs/bushel).

These calculations suggest that a normal range of inverse transportation energy efficiencies for branch-line operation is from 0.07 to 0.12 gallons of diesel per one thousand bushel miles. Clearly, as can be seen from the calculations, it is totally in order to expect inverse efficiency levels beyond this range on specific runs and lines (i.e. with lower temperatures, greater grade effects, dead-heading operation, higher side winds, and so on). Nonetheless, we believe that the normal branch-line operation for most lines when considered year-round would fall within the calculated range.

For comparative purposes, Figure III-8 illustrates a number of measured consumption rates provided by the railways, including system averages, and a limited number of spot tests. These rates have been developed on the basis of trailing gross ton-miles (i.e. exclusive of the weight of engines). For most of the points plotted, fuel consumed in associated idling and switching has been included in the rate calculation. Based on the Canadian National data, an average experienced consumption rate in the prairie region is about 1.70 gallons per one thousand trailing gross ton-miles, ranging from 1.30

FIGURE III-8

FUEL CONSUMPTION RATES EXPERIENCED BY RAIL IN PRAIRIE OPERATION



LEGEND:

- ● CN PRAIRIE REGION SYSTEM AVERAGES (UN-OFFICIAL)
- X SPOT TESTS (TWO-WAY HAUL) - CN
- ◻ SPOT TESTS (ONE-WAY HAUL) - CN
- ▲ CALCULATED VALUS FOR SPECIFIC SCENARIOS (SEE TEXT AND ATTACHMENT C)
- CP CONSUMPTION RATE APPLIED IN CP's "ON-LINE" SUBSIDY CALCULATIONS FOR C.T.C. (1974) (UN-CONFIRMED)

to 2.10 gallons through the year.* This range and average is considered applicable to cases wherein trains operate on the lines more or less year round, in such a manner as to run basically a train-load (say 20 to 50) of empty 60 ton box-cars "out" a line, returning with approximately the same number of cars loaded. The weight of locomotives would be excluded from the gross ton-mile determination, and consumption would include fuel for idling and switching, both along the run and at both ends of it.

Using the typical bushel load per car of 2,070 bushels, tare car weights of 22 ton, and loaded car weights of 79 tons, for every 101 tons of gross ton-mile haul (i.e. 22 tons empty for one mile, and 79 tons loaded for one mile), 2,070 bushels are moved one mile. Converting the consumption rates discussed above, the average inverse transportation energy efficiency for rail operating in grain assembly is 0.083 gallons of diesel per one thousand bushel miles, normally falling in a range from 0.063 to 0.103 gallons per one thousand bushel miles.

As a further comparison, from Hopkins**, an average consumption

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* In comparison, the study of "Artic Oil and Gas by Rail", 1974, presents data indicating consumption rates of 0.97 to 1.20 gallons per one thousand trailing gross ton-miles, for relatively high speed unit trains hauling oil and LNG.

** Hopkins, "Railroads and the Environment - Estimation of Fuel Consumption in Rail Transportation", 1975. From Figure
return trip consumption for a 20 car train, averaging payloads of 57 ton per car (or 2,070 typical bushels per car) and average speeds of 15 miles per hour, is 0.02 pounds diesel per net ton-mile. Diesel fuel weights 8.5 pounds per imperial gallon. Therefore, the converted consumption rate is:

$$\frac{.02 \times 1 \times 20 \times 57}{20 \times 8.5 \times 2.07} \; \frac{\text{gallons}}{1{,}000 \text{ bushels-mi.}} = 0.06 \text{ gallons per } 1{,}000 \text{ bushel-miles.}$$

rate of 0.06 gallons per one thousand bushel-miles (assuming no grade effect, and no associated idling and switching) for branch-line operation is derived. Allowing for a grade, idling, and switching effect of 30 percent, this would increase to 0.08 gallons per one thousand bushel-miles.

Based on these various figures, we have concluded that an inverse transportation energy efficiency rate of 0.09 gallons per one thousand bushel-miles can be considered an appropriate rail rate to utilize in modal comparisons, and the analysis of specific case situations.

A Modal Comparison of Inverse Transportation Energy Efficiencies for Private and Custom Farm Trucks, Commercial Trucks, and Rail, Operating in Grain Assembly in the Branch-Line Setting

Utilizing the transportation energy efficiency schedules and rates developed in previous sections, this section develops an overall comparison of modal energy efficiencies of grain collection in the prairies.

Towards this end, it is firstly necessary to establish the point on the small truck schedule (Figure III-6) which approximates the average inverse energy efficiency rate for private farm truck haul. Because of the shape of the schedule, the consumption rate at the average g.v.w. operating level will not necessarily account for the effect on average consumption of the distribution in vehicle size and the distribution of grain haul activity by vehicle size.

To illustrate, from the standpoint of distribution of vehicle size, if one thousand bushels are moved one mile by each of a ten thousand pounds and 30 thousand pounds gross vehicle weight loaded truck, the average inverse energy efficiency rate is greater than if the two thousand bushels were moved one mile by a 20 thousand pound loaded truck. Conteracting this size distribution effect, however, is the generally observed fact that as activity level (i.e. bushel-miles) of farm trucking increases, so does vehicle size. Kulshreshtha* estimated that average grain box size increased by 2.08 bushels per extra mile of grain haul (where volume remains constant), and by 0.5 bushels per 100 extra bushels of haul (where distance remains constant).** Tyrchniewicz*** and the Area 11 Study**** also conclusively show that as bushel-miles of haul increases, so does truck size.

Accordingly, for purposes of establishing a method of estimating average inverse energy efficiency for the private farm trucking component of grain haul in the prairies, an analysis was undertaken to establish the weighted average loaded g.v.w. figure to employ in the determination of average inverse energy efficiency. In this regard, utilizing Table 13 from Kushreshthna*****, Table III-2 has been constructed to estimate the bushel-mile activity for each cell in the

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* ibid. p. 49

** ibid. p. 49

*** ibid. p. 24

**** Canada Grains Council Study of Rationalization in the Rosetown Area - Chapter on Farm Truck Costs.

***** ibid.

matrix of "bushels delivered" vs. "average one-way hual distance".* Table III-3 shows the calculated values of the average g.v.w. relevant to the haul requirements of each cell. Table III-4 details the calculations of the average inverse energy efficiency, and the corresponding weighted g.v.w. load, over the complete activity range.

The derived average inverse energy efficiency of this analysis, of 1.065 gallons per one thousand bushel-miles, is, from Figure III-6, associated with a loaded g.v.w. of 19.900 pounds. Comparing this with the observed average (licensed) g.v.w. determined by Kulshreshtna** of 19,940 pounds, the two are considered, for all intents and purposes, equal. Further, using data developed by both Tyrchniewicz and Kulshreshtha,*** this weighted g.v.w. of 19,940 pounds is approximately

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* For this purpose "average bushels" is simply the mean of the bushel groupings shown in Table 13, and "average distance" has been approximated by the equations: avg. distance = low of grouping + 2/3 grouping size. (Note that this approximation is relatively crude, holding substantially true only when "low end of grouping" is 0 or greater than 3/4 of "high end of grouping" for a circular collection area served by radia roads. Nonetheless, for the purpose at hand, it is felt that any error introduced as a result of employing this assumption is within the scope of accuracy of the analysis generally).

** ibid. - Table 6

*** ibid. - Tyrchniewicz (Table 1)

Avg. Box Capacity (Western Canada)= 217.5 bushels

$$\text{Payload} = \frac{217.5 \times 55}{1{,}000} = 11.96 \text{ kips}$$

$$\text{g.v.w.} = \frac{11.96}{.755} + 4.20 = 20{,}040 \text{ pounds}$$

- Kulshreshtha (Table 6)

Avg. Box Capacity (All Areas) = 214 bushels

$$\text{g.v.s.} = \frac{214 \times 55}{.755 \times 1{,}000} + 4.20 = 19{,}790 \text{ pounds.}$$

TABLE III-2

Estimation of Bushel-Mile Activity
By
Delivered Quantity vs. Haul Distance
(1,000 bushel-miles[3]/% Total Activity[4])

Avg. Bushels Delivered(1) \ Avg. Haul Distances (2)	4	9.3	17.6	27.6	37.6	42
2,000	272/0.8	484/1.4	669/2.0	883/2.6	827/2.4	1,344/3.9
6,000	1,200/3.5	1,450/4.3	950/2.8	496/1.5	676/2.0	1,008/2.9
10,000	1,040/3.0	3,255/9.5	1,408/4.1	552/1.6	nil	x
14,000	1,680/4.9	2,473/7.2	1,478/4.3	386/1.1	nil	x
18,000	1,152/3.4	2,511/7.3	950/2.8	nil	x	x
21,000	1,512/4.4	4,101/12.0	1,478/4.3	x	x	x

where: x -- involved custom trucking only

(1) average of grouping. For example, for grouping 8,001 - 12,000 bushels, average equals ten thousand bushels.

(2) estimated on the basis of: lower range of grouping + 2/3 of grouping size. For example, for group range 11 - 20.9 miles, average haul distance is assumed equal to 11.0 + 2/3(9.9) = 17.6 miles.

(3) bushel-miles calculated as follows, for example cell (2,000 bushels x 4 miles):

4 miles/truck x 2,000 bushels x 34 trucks = 272,000 bushel-miles

where: "34 trucks" is derived from Julshreshtha (Table 13) for this cell.

(4) Percent of total activity for each cell is calculated by:

--activity in cell ÷ total activity x 100%.

TABLE III-3
Estimation of Truck Size
(in g.v.w.) for each "mileage per delivery" cell
in Table III-2

Average utilized box capacity[1] (bushels) per loaded g.v.w.[2] (kips)

Avg. Bushels Delivered \ Avg. Haul Distance	4	9.3	17.6	27.6	37.6	42
2,000	137/14.0	127/13.2	157/15.5	157/15.5	150/15.0	181/17.1
6,000	154/15.1	163/16.0	240/21.9	252/22.8	306/26.7	363/31.0
10,000	195/18.5	214/20.0	210/19.5	217/24.1	--	--
14,000	223/20.5	215/20.0	213/20.0	294/26.0	--	--
18,000	186/17.5	241/22.0	245/22.2	--	--	--
21,000	256/23.0	252/22.5	294/26.0	--	--	--

(1) Average utilized box capacity has been calculated using the box capacity figures quoted in Kulshreshtha - Table 13, and the average box capacity load factor for the prairies of 91.8 percent determined by Tyrchniewicz, (ibid. p. 11).

ex. calculation for cell (ten thousand bushels by 17.6 miles)

avg. box capacity = 229 bushels
avg. bushel load = 229 x .918 = 210 bushels.

(2) Loaded g.v.w. is derived from avg. bushel load, as follows:

payload = average bushel load x typical bushel weight

$$\text{g.v.w. (loaded)} = \frac{\text{payload}}{.755} + 4.2 \text{ (in kips)}$$

- From Figure III-3

$\therefore$ For cell (14,000 bushels x 9.3 miles)

$$\text{g.v.w. (loaded)} = \frac{234 \times .918 \times 55}{.755 \times 1{,}000} + 4.2 = 20.0 \text{ kips.}$$

TABLE III-4

Estimation of Weighted Average Inverse Transportation Energy Efficiency
for Grain Haul by Farm Truck accounting for
Effects of Bushel-Mile Activity Level on Truck Size
(from Tables III-2 and III-3)

(Percentage of total activity)(inverse energy efficiency for attendant g.v.w.)
"cell" contribution per one thousand bushel-miles

Avg. Bushels Delivered \ Avg. Haul Distances						
2,000	(0.8)(1.46) .01168	(1.4)(1.55) .02170	(2.0)(1.30) .02600	(2.6)(1.30) .03380	(2.4)(1.35) .03240	(3.9)(1.20) .04680
6,000	(3.5)(1.33) .04655	(4.3)(1.28) .05504	(2.8)(0.99) .02772	(1.5)(0.96) .01440	(2.0)(0.85) .01700	(2.9)(0.76) .02204
10,000	(3.0)(1.13) .03390	(9.5)(1.06) .10070	(4.1)(1.08) .04428	(1.6)(0.90) .01440	--	--
14,000	(4.9)(1.04) .05096	(7.2)(1.06) .07632	(4.3)(1.06) .04558	(1.1)(0.86) .00946	--	--
18,000	(3.4)(1.17) .03978	(7.3)(0.98) .07154	(2.8)(0.98) .02744	--	--	--
21,000	(4.4)(0.95) .04180	(12.0)(0.97) .11640	(4.3)(0.86) .03698	--	--	--

Example Calculation: For cell (18,000 bushels x 9.3 miles)
activity level = 7.3% of total (from Table III-2)
average loaded g.v.w. = 22.0 kips (from Table III-3)
corresponding 1/u = 0.98 gallons per 1,000 bushel-miles (from Figure
cell contribution = 0.073 x 0.98 = 0.07154 gallons

For 1,000 bushel-miles, weighted average inverse energy efficiency is:
contribution of each cell = 1.06467 gallons per 1,000 bushel-miles

From Figure III-6: the g.v.w. corresponding to the weighted average inverse energy efficiency of 1.065 gallons per 1,000 bushel-miles is 19,900 pounds.

equal to the average g.v.w. derived from the developed relationship of payload and g.v.w. (i.e. payload = .755 gross vehicle weight - 4.20)), where payload equals average box capacity (in bushels) multiplied by the weight of a typical bushel (i.e. 55 pounds), divided by one thousand (i.e. to convert pounds to kips). Accordingly, we have concluded that the following methods are acceptable for approximating the weighted g.v.w. (accounting for activity distribution by vehicle size) to employ in estimating average inverse transportation energy efficiency for private farm truck haul:

$$\text{Weighted Average g.v.w.} = \text{average licensed g.v.w.}$$

$$\text{or} \quad = \frac{\text{Avg. box capacity x 55}}{.755 \text{ x } 1{,}000} + 4.20 \text{ (in kips)}$$

It is to be noted that in certain instances, observed data respecting average (licensed) g.v.w. and average box capacity, and more particularly, average bushel load, appear to be inconsistent* to a degree which necessitates judgment in choosing the method to employ in determining weighted average g.v.w.

In summary, for the private farm truck haul situation throughout the prairies, and using Tyrchniewicz's reported box capacity of 217.5 bushels, Kulshreshtha's reported average box capacity of 214 bushels and average g.v.w. of 19,940 pounds, we estimate that the weighted average (loaded) g.v.w. to be employed in the determination of average inverse transportation energy efficiency for private farm

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* In particular, the Tyrchniewicz data (Table 1) for Manitoba suggests an unreasonably low g.v.w., given the average bushel load.

trucked-grain is 19,920 pounds.* From Figure III-6, therefore, the average inverse transportation energy efficiency for private farm trucked-grain across the prairies is 1.07 gallons of gasoline per one thousand bushel-miles.

Custom-trucked grain is normally transported, as would be expected, in larger trucks than those used in private farm haul. Table III-5 presents the various shources of information available respecting their sizes. Given the shape of the inverse energy efficiency schedule over this size range of custom farm trucks, we have concluded that it is unnecessary to weight the size for purposes of determination of average inverse energy efficiency. Instead, from Table III-5, based on an approximate average box capacity in the prairies of 335 bushels, assumed loaded to 91 percent,** we estimate that an average loaded g.v.w. of 26,400 pounds*** is a reasonable basis to use in the approximation of average inverse energy efficiency for this element of farm-trucked grain. Based on this, from Figure III-6, the average inverse energy efficiency for custom farm-trucked grain (across the prairies) is 0.85 gallons of gasoline per one thousand bushel-miles, with a possible range from 0.77 to 0.94 gallons.

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* The simple average of 19,940, 20,040, and 19,790.

** Tyrchniewicz, Moore, Tangri - "The Cost of Transporting Grain by Custom and Commercial Truck" - 1974, p. 23.

*** $\frac{335 \times .91 \times 55}{.755 \times 1{,}000} + 4.2$ (in kips).

TABLE III-5

Custom Farm Truck Sizes in the Prairies

Source	Box Size (Bushels)	Comment
Kulshreshtha*	283	Average for areas B,C, & D
Kulshreshtha	410	Average for area A
Kulshreshtha	346	Average for all areas
Tyrchniewicz, Moore & Tangri**	327	However, average load equals 296 bushels, or 91 percent of capacity

* ibid. - Table 22

** "The Cost of Transporting Grain by Custom and Commercial Truck", Tyrchniewicz et al., 1974, p. 23.

For commercially-trucked grain, assuming a 75 thousand pounds loaded operation* from Table III-2 the average inverse transportation energy efficiency is 0.44 gallons of diesel per one thousand bushel-miles, with a possible range from 0.42 to 0.46.

For the rail mode, utilizing the data previously developed and presented, average inverse transportation energy efficiency is 0.09 gallons of diesel per one thousand bushel-miles.

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* This is one thousand pounds greater than normal weight limits but within normal tolerance policy respecting weight control. Discussions with weigh scale operators, and analysis of the S.T.A./ Canadian Wheat Board elevator to terminal haul, suggest that the 75 thousand pounds loaded state is normal.

FIGURE III-9

A MODAL COMPARISON OF INVERSE TRANSPORTATION ENERGY EFFICIENCY IN GRAIN ASSEMBLY ESTIMATED PRAIRIE AVERAGES

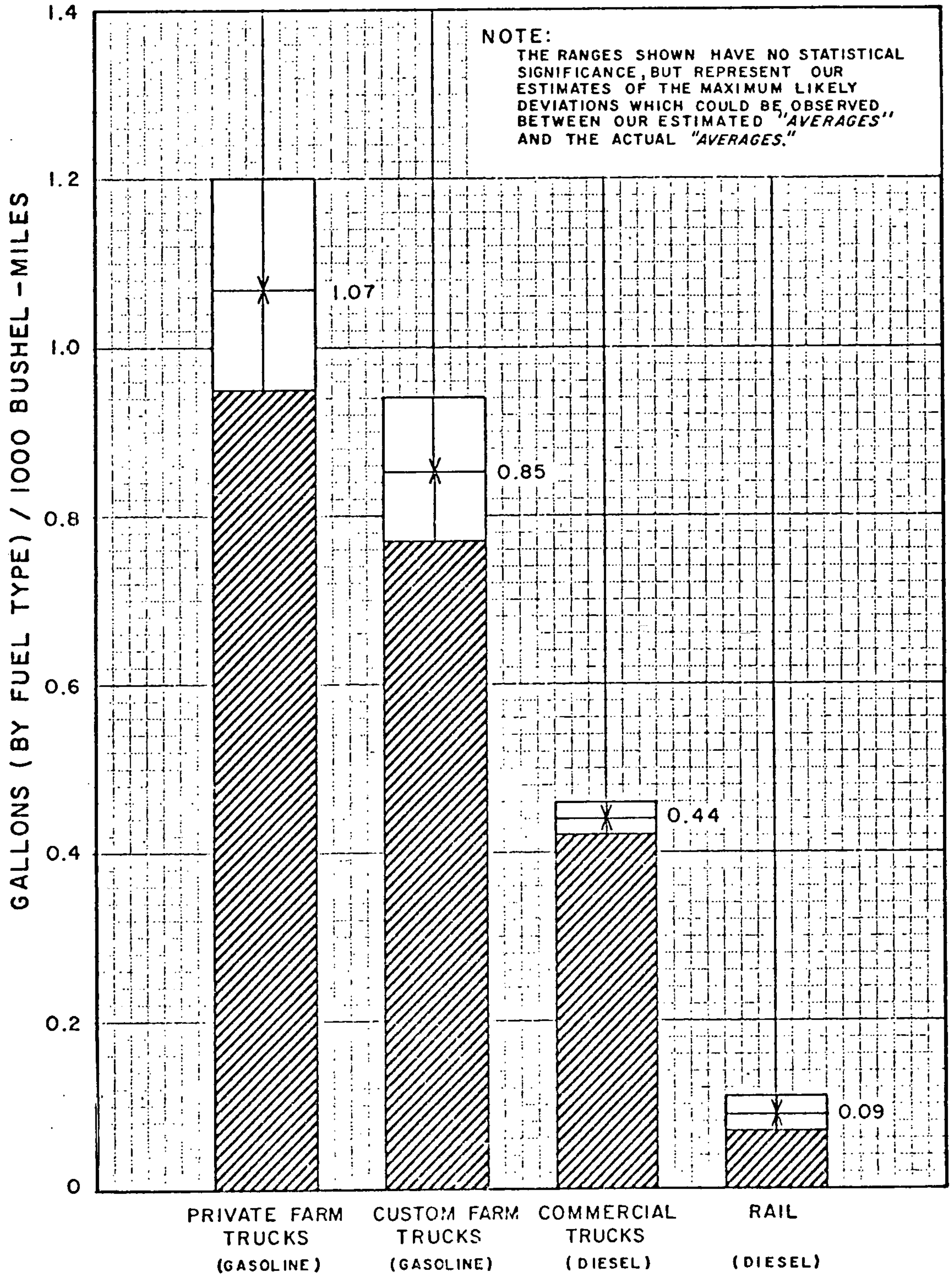

Figure III-9 illustrates these comparative rates for each mode. On a gallonage equivalency basis, the ratios of average truck inverse transportation energy efficiencies versus average rail efficiencies are:

Private farm truck vs. rail	11.9:1
Custom farm truck vs. rail	9.4:1
Commercial truck vs. rail	4.9:1

On a Btu equivalency basis*, these ratios become:

Private farm truck vs. rail	10.6:1
Custom farm truck vs. rail	8.5:1
Commercial truck vs. rail	4.9:1

FUEL COSTS AND GRAIN TRANSPORTATION IN WESTERN CANADA

The purpose of this section is to develop and present the basic data requirements and methodology for determining unit fuel prices applicable to grain haul in the prairies. The determination of the cost effects of adjustments in the grain transport system result from the application of these developed unit prices to estimated changes in consumption quantities.

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* Conversion Basis:

1 gallon gasoline = 149,200 Btu
1 gallon diesel = 166,500 Btu

Fuel Cost Factors

For the consumer, the price of gasoline and diesel fuel is made up of two components: the economic cost of the fuel, and the federal and provincial taxes added to fuel at points of production and sale.

The determinants of these two price components are, of course, different with the economic cost being basically a function of supply and demand (as influenced by tax policy), and the tax component being a function of public policy respecting user fees, cost transfers, and general revenue needs. For grain transport in the prairies, the experienced or financial cost of fuels to users varies by fuel type, mode and user type within the trucking mode, as will be shown. Accordingly, it is both useful and necessary to distinguish between these two price components in order that the differences between the relative changes in consumption levels and fuel costs resulting from rationalization may be understood as to their reason and significance.

Fuel Pricing: Method and Make-Up

a) Methodology

Petroleum refiners post selling prices of product, referred to as posted tank wagon prices, at various locations where they have bulk storage stations with product available for sale. These posted tank wagon prices include, in addition to crude oil and refining costs and profit: transportation charges from the refinery to the bulk plant and from the bulk plant to the purchaser; bulk dealer mark-up; and applicable federal taxes. Posted tank wagon prices exclude applicable provincial taxes. All major refiners post tank wagon prices for three categories of sale: product destined to service station dealers; product destined to farm purchasers and home heating customers; and product destined directly to commercial consumers.

Posted tank wagon prices are considered to be "target prices". Many factors, such as sale volume, delivery distance, and customer storage facilities, can and do affect final delivered price - often for commercial users in a manner which renders delivered price something less than posted price. In determining final price, these factors are normally accounted for through discounts and contractual agreements negotiated between purchaser and selling agent. The relevance and size of discounts to various purchasers will be discussed later.

b) Historic Trends in Posted Tank Wagon Prices in the Prairies

A record of historic farm and commercial posted tank wagon prices for gasoline and diesel fuel at Edmonton, Calgary, Regina, and Winnipeg is presented in Table III-6. As shown, there has been a steady decrease in the posted price differentials between gasoline and diesel, from about 3.5 cents per gallon in 1967 to 2.4 cents per gallon in 1975.

TABLE III-6

Example Historic Posted Tankwagon Prices in the Prairies*

(cents/gallon)

	Edmonton/Calgary		Regina/Saskatoon		Winnipeg		Federal Sales Tax Included	
	Commercial	Farm	Commercial	Farm	Commercial	Farm	Gasoline	Diesel
Dec. 1967:								
Gasoline	22.5	21.5	23.4	22.4	23.4	22.4	2.1	1.6
Diesel	19.0	18.0	19.8	18.8	20.0	19.0		
Nov. 1969:								
Gasoline	23.2	22.2	24.1	23.1	24.1	23.1	2.1	1.6
Diesel	19.7	18.7	20.5	19.5	20.7	19.7		
Dec. 1970:								
Gasoline	24.2	23.2	25.1	24.1	25.1	24.1	2.1	1.6
Diesel	20.7	19.7	21.5	20.5	21.7	20.7		
Sept. 1971:								
Gasoline	25.2	24.2	26.1	25.1	26.1	25.1	2.5	2.4
Diesel	21.7	20.7	22.5	21.5	22.7	21.7		
June 1972:								
Diesel	22.7	21.7	23.5	22.5	23.7	22.7	2.5	2.4
Dec. 1973:								
Gasoline	29.0	28.0	29.9	28.9	29.9	28.9	2.7	2.7
Diesel	26.5	25.5	27.3	26.3	27.5	26.5		
Aug. 1974:								
Gasoline	38.9	37.9	39.8	38.8	39.8	38.8	3.3	3.1
Diesel	36.4	35.4	37.2	36.2	37.4	36.4		
Aug. 1975:								
Gasoline	46.5	45.5	47.4	46.4	42.0**	40.8	3.9	3.7
Diesel	44.0	43.0	44.8	43.8	39.6**	38.6		
Sept. 1975:								
Gasoline	46.6	45.5	47.5	46.4	41.9**	40.8**	3.9	3.7
	44.2	43.2	45.0	44.0	39.6**	38.6**		

* includes F.S.T.

** Price freeze in effect in Manitoba

c) <u>Historic Trends in Federal and Provincial Fuel Taxes</u>

Table III-7 summarizes historic data on Federal and Provincial taxes for gasoline and diesel fuel. It is to be noted that the general pattern of increasing provincial fuel tax rates was changed in 1974, with the prime objective of dampening the impact of rapid increases in world energy prices.

Federal sales taxes payable on motive fuels are constant across Canada. The present level of these taxes is: premium gasoline - 4.4 cents per gallon; regular and low-lead gasoline - 3.9 cents per gallon; and diesel oil - 3.7 cents per gallon. These taxes do not apply when fuel is used in a manufacturing process. In addition to these federal sales taxes, the Federal Government has recently instituted a ten cent per gallon excise tax on gasoline, refundable when used by a vehicle employed in business activity.

Provincial fuel taxes are comprised of two separate parts. A general fuel oil tax of three cents per gallon in Alberta, four cents per gallon in Saskatchewan, and five cents per gallon in Manitoba, is levied on all fuels (gasoline, diesel oil, fuel oil, etc.) except those used in vehicles properly registered as farm trucks. This general fuel oil tax is applicable to railway locomotive fuel purchases. In addition, a product tax is levied to create the overall provincial taxes indicated in Table III-7. Farm trucks are again exempt from this product tax as are railway locomotives. In Saskatchewan, under current tax regulations, fuel used in farm vehicles (F-plated) as well as being exempt from provincial fuel taxes, is subject to a seven cent per gallon rebate grant. R-plated farm vehicles (i.e. normally but not always more than 2-axles) are subject to the provincial tax and do not receive the rebate.

TABLE III-7

Historic Federal and Provincial Gasoline and Diesel Taxes in the Prairies (cents/gallon)

	Federal Sales Tax		Provincial General Fuel and Product Taxes					
			Manitoba		Saskatchewan		Alberta	
	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
1967	2.1	1.6	17.0	20.0	15.0	20.0	12.0	17.0
1968	2.1	1.6	17.0	20.0	15.0	20.0	12.0	17.0
1969	2.1	1.6	17.0	20.0	17.0	21.0	15.0	17.0
1970	2.1	1.6	17.0	20.0	19.0	21.0	15.0	17.0
1971	2.5	2.4	17.0	20.0	19.0	21.0	15.0	17.0
1972	2.5	2.4	17.0	20.0	19.0	21.0	15.0	17.0
1973	2.7	2.7	17.0	20.0	19.0	21.0	15.0	17.0
1974	3.3	3.1	15.0	18.0	12.0	16.0	10.0	12.0
1975	3.9	3.7	18.0	21.0	12.0	16.0	10.0	12.0

NOTES:

1) Farm vehicles are exempt from provincial fuel taxes. In Saskatchewan, fuel taxes are payable for R-plated farm trucks.

2) Farmers in Saskatchewan receive rebates of seven cents per gallon of gasoline and diesel.

3) Railway locomotives pay general fuel taxes at the following rates: Manitoba - 5 cents per gallon on diesel and gasoline; Saskatchewan - four cents per gallon on diesel and gasoline; Alberta - three cents per gallon on diesel and gasoline.

4) In Manitoba, in addition to the five cents per gallon general tax, the railways pay the product tax of 13 cents per gallon on gasoline, off-road use.

d) Trends in Gasoline and Diesel Production and Transportation on the Prairies

In recent years, there have been major adjustments in the location of petroleum refinery capacity in the prairies. Table III-8 destails operating capacities for individual refineries in the prairie region and summarizes refining capacity by province. At the end of 1975, Manitoba had only one refinery. Industry capacity had decreased by 36 percent over the past eight years. In Saskatchewan, industry capacity has decreased 53 percent over the same time period. In Alberta, refining capacity has increased by 88.4 percent between 1967 and 1975.

The prairie regions' total refining capacity was 322 thousand BPCD at the end of 1975, or 52.1 percent greater than in 1967. Alberta's share of total capacity has increased in eight years from 45.1 to 80.7 percent. These changes in capacity location will have pronounced effects on the source of diesel and gasoline supply for Saskatchewan and Manitoba, as well as on the determinants of price level and structure.

Complementing these adjustments in refining capacity location was the commencement, in 1972, of the transportation of refined petroleum products via the Interprovincial Pipeline Ltd. system running east from Edmonton. This system is now being used to transport refined products from Edmonton to Winnipeg (Gretna station), and is expected to soon be moving products as far east as the Lakehead.

TABLE III-8

Refinery Capacity in the Prairie Provinces
(Design Crude Oil Capacity - Barrels per Calendar Day)

Province and Refinery Owner	Location	1967	1970	1975	1975(3)
Manitoba					
Gulf Oil Canada Ltd.(1)	Brandon	3,600	--	--	--
Imperial Oil Limited(2)	E. St. Paul	20,200	20,200	22,000	
Shell Canada Ltd.	St. Boniface	20,000	26,500	28,000	28,000
TOTAL MANITOBA		43,800	46,700	50,000	28,000
Saskatchewan					
Consumers Co-op	Regina	20,800	21,500	25,000	25,000
Gulf Oil Canada Ltd.(1)	Moose Jaw	13,500	13,500	9,300	9,300
Gulf Oil Canada Ltd.(1)	Saskatoon	7,450	7,450	--	--
Husky Oil Canada Ltd.	Moose Jaw	3,300	3,500	--	--
Imperial Oil Ltd.	Regina	27,400	28,800	31,300	--
TOTAL SASKATCHEWAN		72,450	74,750	65,600	34,300
Alberta					
Gulf Oil Canada Ltd.(1)	Calgary	9,000	9,000	8,700	8,700
Gulf Oil Canada Ltd.(1)	Edmonton	12,600	12,600	74,500	74,500
Husky Oil Canada Ltd.	Lloydminster	5,200	6,500	10,500	10,500
Imperial Oil Limited	Calgary	17,500	18,200	21,100	--
Imperial Oil Limited	Edmonton	32,000	33,000	39,000	140,000
Shell Canada Ltd.	Bowden	4,100	5,000	5,000	5,000
Texaco Canada Ltd.	Edmonton	15,000	18,000	21,000	21,000
		95,400	102,300	179,800	259,700
TOTAL PRAIRIES		211,650	223,750	295,400	322,000
Alberta as % of Prairies		45.1%	45.7%	60.9%	80.7%

SOURCE: Canadian Petroleum Magaxine Refining Issues July 1967, 1970, and 1975.

(1) Formerly British American Oil Co. Ltd.

(2) Now considered part of Winnipeg

(3) Reflects changes expected by the end of 1975 when Imperial Oils 140,000 barrel per day refinery comes on stream in Edmonton, Alberta

The growth of Edmonton as the major refining centre on the prairies, and the use of the Interprovincial Pipeline system for the transportation of refined product, leads to the general observation that the pricing of refined product out of Edmonton will be the fundamental base of energy fuel cost determination in the prairies.

Estimating Gasoline and Diesel Prices, by Mode and Location

a) Methodology

Oil companies post prices for the three classes of fuel trade discussed earlier at most of the population centres in the three prairie provinces. These posted prices are affected by many factors, and as a result, can lead to as many as thirty different price zones in a province. For the purposes of this study, it is considered unnecessary to attempt to fully describe the resulting detailed posted price schedules. Instead, a generalized method has been developed for calculating applicable fuel prices for a greatly reduced number of regional locations, utilizing previously developed energy costs and tax data. The method consists of: (i) the simple multiplication of the "Edmonton refining centre" energy cost by a transportation/competition factor to obtain a regional energy price at another location; (ii) a deduction from this factored price to account for trade discounts, where applicable, and (iii) the addition of applicable Federal and Provincial taxes to determine buyers' prices.

b) Fuel Cost Factors by Geographical Location

An analysis of posted prices has been carried out for a substantial number of centres in each of the three prairie provinces, in relation to comparable prices in Edmonton. These prices were related to the price at Edmonton in order to calculate a regional energy cost differential. The developed factors are presented in Table III-9. To establish the energy price at any of the indicated locations, the appropriate factor is applied to the Edmonton energy price.

The variations in energy prices, independent of taxes, over the prairie region is not extreme, with the maximum (Hudson Bay, Saskatchewan) being about 12 percent greater than the present Edmonton price. For locations not specifically indicated in Table III-9, a reasonable estimate can be obtained by applying the closest regional factor.

c) Relevant Considerations Respecting the Specific Determination of Farm Fuel Prices

The posted prices for farm customers include the cost of delivery from the bulk station to the farmer's storage facility. Discounts from these prices are rare. Farmers purchasing fuel at service stations effect increases in their fuel costs, because of the service station mark-up of six to ten cents per gallon. Mark-ups may be somewhat less at service stations which do not sell products identified by the brands and trademarks of the major oil companies.

TABLE III-9

Prairie Region Energy Cost Factors in Relation To Posted Tankwagon Prices at Edmonton

Alberta		Saskatchewan		Manitoba	
Edmonton-Calgary	1.00	Biggar	1.03	Brandon	1.06
Athabasca	1.06	Estevan	1.09	Dauphin	1.09
Banff	1.04	Hudson Bay	1.12	Erickson	1.08
Drumheller	1.05	Kindersley	1.10	Gretna	1.06
Ft. McMurray	1.10	Lloydminster	1.08	Killarney	1.07
Grande Prairie	1.06	Maple Creek	1.10	Melita	1.09
Jasper	1.09	Meadow Lake	1.10	Minnedosa	1.06
Lethbridge	1.07	Melfort	1.07	Portage La Prairie	1.05
Medicine Hat	1.08	North Battleford	1.08	Russel	1.10
Red Deer	1.04	Oxbow	1.07	Steinback	1.04
Spirit River	1.05	Prince Albert	1.09	Swan River	1.09
St. Paul	1.07	Regina - Moose Jaw - Saskatoon	1.02	Virden	1.08
Valleyview	1.08	Swift Current	1.09	Winnipeg	1.02
Wainwright	1.07	Weyburn	1.07		
		Yorkton	1.09		

As previously indicated, farmers at present do not pay provincial fuel taxes in the three prairie provinces. Farmers in Saskatchewan do get a grant from the Government of seven cents per gallon of gasoline or diesel*. However, they do not receive the rebate, and must pay provincial fuel tax on fuel consumed by R-plated farm vehicles.

d) Relevant Considerations Respecting the Specific Determination of Commercial Truckers' Fuel Prices

Larger trucking firms usually purchase diesel oil and gasoline at a negotiated contract price which fluctuates as the bulk dealers price fluctuates. If truckers have their own bulk tanks, or if they fill their trucks from the bulk dealers tanks, they usually receive discounts of two to three cents per gallon off the commercial customers price.

This discount, however, is available only for large quantity purchases. Small firms (i.e. one or two trucks) usually deal with a service station rather than a bulk dealer. Purchases by these companies will usually be at a discount of up to three cents from the retain price, but of course will include the service station mark-up for labor, storage, profit, etc. ranging from six cents to ten cents per gallon.

Very large fuel customers may obtain discounts of three to five cents per gallon of gasoline or diesel oil purchased. However,

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* In 1975, this rebate was available to a maximum of $200 per farmer. It is anticipated that some adjustment in this rebate program will be forthcoming shortly.

these firms invariably have their own large storage facilities capable of receiving large quantities per delivery.

Trucking firms whose units cover geographic areas which extend beyond the limits of the fuel-carrying capacity of their units must, of course, often purchase fuel at service stations. Frequently, however, they are able to obtain some discounts on these purchases, through volume-buying arrangements with the dealer's company.

e) Relevant Considerations Respecting the Specific Determination of Railway Fuel Prices

Railway fuel purchases are made in basically three ways: at refineries or pipeline terminals, wherefrom product is transported by rail to railway storage facilities; from bulk dealers, who deliver the product to railway storage facilities; and from bulk dealers, who deliver the product directly to locomotives on line.

CP Rail utilizes diesel oil in their locomotives, while CN has shifted to the use of Great Canadian Oil Sands tar sands semi-refined synthetic crude oil. Canadian National Railway has not provided detailed information on the cost of this synthetic crude, but has advised that because of its special nature, its price is higher than that of most synthetic crude, and is not significantly lower than diesel oil prices (after discount)*.

Although no official information has been provided to this effect, it is understood that railway diesel fuel purchases are currently made at a discount of about ten cents per gallon from posted price, or about 30.5 cents per gallon at Edmonton. Comparing this with the synthetic crude price of 24.6 cents per gallon, and accepting the Canadian National Railway's comment that its particular synthetic crude is priced at a premium, there would appear to be some question as to Canadian National Railway's suggestion that the price differential between diesel and synthetic crude is only minor. However, for lack of more concrete price information, we are obliged to accept the proposition that both railways experience similar unit fuel prices as derived from posted diesel prices.

The railways purchase diesel oil on annual contracts at specified prices, subject to change on 30 days' notice. The diesel oil is purchased usually at the refinery, with subsequent transportation and storage being supplied by the railways at a cost ranging from one cent to two cents per gallon. This cost can vary considerably because of distance, and the number of inventory returns per year. Because of this additional storage

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* Cost data at Edmonton:

Crude Oil $8.00/barrel = 22.9 cents per gallon
Synthetic Crude $8.60/barrel = 24.6 cents per gallon
Diesel (Posted - excluding F.S.T.) $14.17 barrel = 40.5 cents per gallon.

cost, a net discount from posted prices of 8.5 cents per gallon from regional prices appears reasonable for railway diesel used out of main rail line storage depots.

The railways purchase diesel oil for a substantial number of locations from bulk plants, delivering the diesel fuel into the locomotive's tanks. The amount purchased at these bulk plants ranges from about 13 thousand gallons per year to one million gallons per year, with the average being about 100 thousand gallons per year. Discounts off posted price range from three to six and one-half cents per gallon, and average about five cents per gallon. The bulk plant dealer applies a surcharge when delivery orders do not exceed a certain minimum or are made outside of normal business hours. Thse surcharges vary, some being levied on an hourly basis with others being levied on a gallonage basis. A discount of four cents per gallon from posted prices appears appropriate for bulk plant purchases of locomotive diesel.

Example Specific Price Determinations - By Mode and Location

For purposes of illustrating the methodology for estimating fuel prices, Table III-10 details the calculation of unit fuel prices applicable to specific situations (i.e. buyer and area).

A Modal Comparison of Inverse Transportation Fuel Cost Efficiencies for Grain Assembly in the Prairies

Variations in fuel costs between consuming modes and locations of purchase dictate that the conversion of modal consumption rates to

TABLE III-10
Example Fuel Price Determinations in the Prairies
(By Purchaser and Location)
(cents/gallon)

Determination of Energy Costs in 1975

Fuel Type	diesel	gasoline	diesel
Fuel Purchaser	railway	farmer	commercial trucker
Location	Carlton, Sask.	Brandon, Man.	Rockglen, Sask.
Edmonton Energy Price	40.5	41.6	40.5
Multiply by regional transport cost factor	1.08	1.06	1.07
Regional Energy Price	43.7	44.1	43.3
Less Discounts	10.0	0.0	3.0
Energy Cost to Buyer	33.7	44.1	40.3
ADD TAXES:			
Federal Sales Tax	3.7	3.9	3.7
Provincial Tax	4.0	0.0	16.0
TOTAL ENERGY PRICE	41.4	48.0	60.0

* Date of above calculations - December 30th, 1975.

modal fuel cost rates will create modal comparative ratios of fuel cost efficiency which differ from the comparable ratios of consumption efficiency as presented in the section on 'A modal comparison of inverse transportation energy efficiency'.

Figure III-10 illustrates the results of such a conversion for one particular case, utilizing the prairie average consumption rates developed in the aforementioned section, and modal fuel prices at

Saskatoon. From a total energy cost standpoint (including taxes/ rebates), private farm trucks, custom farm trucks, commercial trucks, and rail expend 42.1 cents, 33.4 cents, 25.5 cents, and 3.5 cents of fuel per one thousand bushel-miles of haul, respectively*. (It is to be noted from Figure III-10 that, at present in Saskatchewan, an average one thousand bushels being moved one mile by a private farm truck effect a direct total government cost of 3.3 cents. The same one thousand bushels moved one mile by commercial truck generate a direct total government revenue of 8.7 cents. The net government gain to be realized per one thousand bushel-miles of haul tranferred from private farm truck to commercial truck is, therefore, 12 cents).

Utilizing these total cost figures, the fuel cost efficiency ratios, comparing one mode to the next at Saskatoon, are:

private farm truck vs. rail	12.0:1
custom farm truck vs. rail	9.9:1
commercial truck vs. rail	7.3:1

The comparable ratios as developed for Brandon, Manitoba and

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* For example - for the private farm truck:

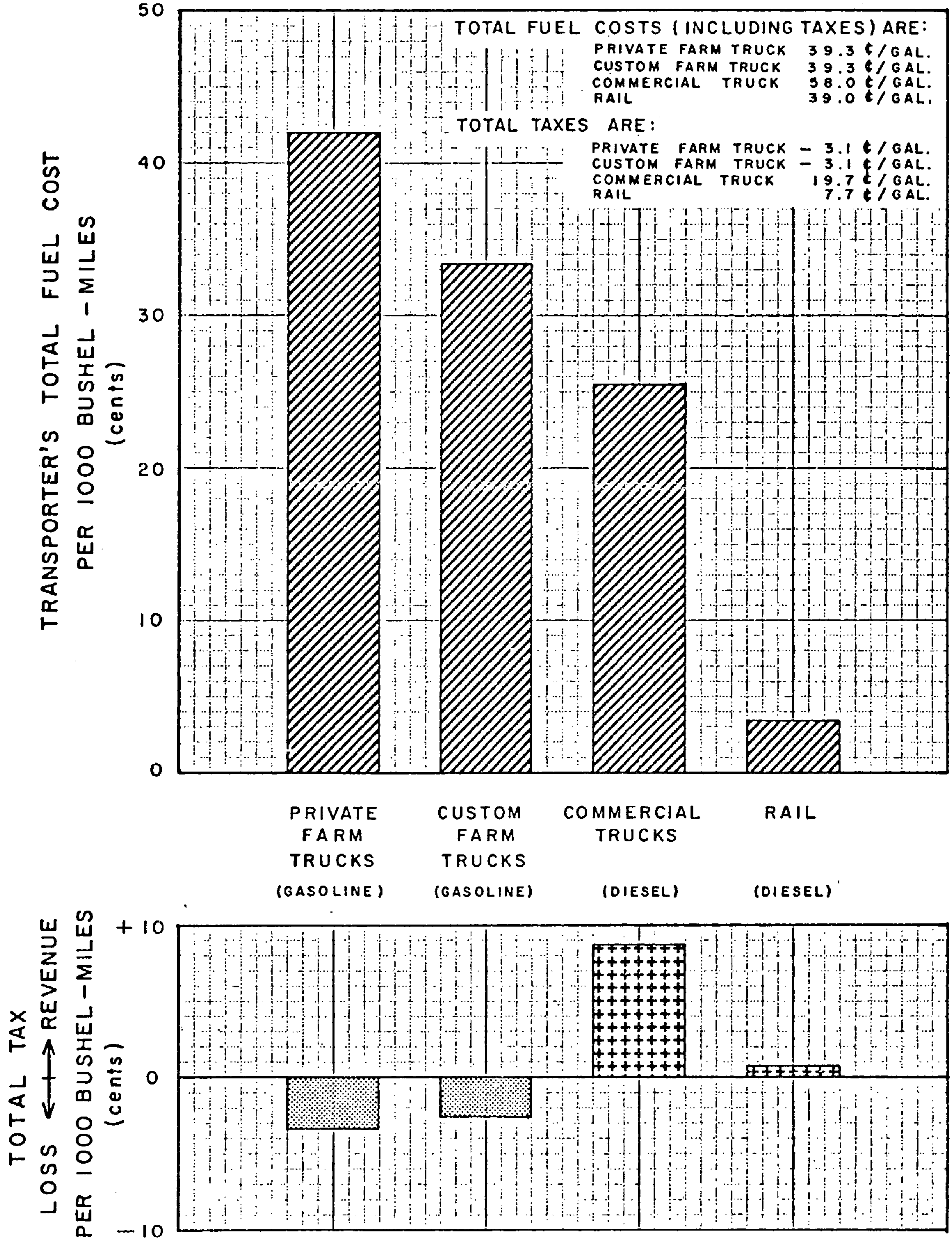
consumption = 1.07 gallons (gasoline) per 1,000 bushel-miles

price of gasoline (including F.S.T. and provincial rebate
= 39.3 cents per gallon

inverse transportation fuel cost efficiency = 1.07 x 39.3
= 42.1 cents per 1,000 bushel-miles.

FIGURE III-10

A MODAL COMPARISON OF TRANSPORTER'S TOTAL FUEL COSTS PER 1000 BUSHEL-MILES AND TOTAL TAX REVENUE (LOSS) PER 1000 BUSHEL-MILES AT SASKATOON - DEC. '75



Red Deer, Alberta, are:*

	Brandon	Red Deer
private farm truck vs. rail	15.2:1	12.8:1
custom farm truck vs. rail	11.0:1	11.5:1
commercial truck vs. rail	7.7:1	6.9:1

Over the prairies, it can be seen that the major difference between the ratios of modal fuel consumption efficiencies and modal fuel cost efficiencies is experienced by the commercial trucker, which enjoys neither the bulk purchasing power of the railways, nor the preferential tax treatment of the farmer (or custom farm trucker). In effect, while the commercial truck is 2.4 times as efficient as the private farm truck from the fuel consumption standpoint, while operating in grain assembly, it is only 1.8 times as efficient from the fuel cost standpoint. While fuel taxes account for less than 10 percent of fuel cost for farmers and railways, they account for one-third of the commercial truckers' fuel cost. The commercial trucker, of course, if the only road mode which contributes direct tax to provincial governments for road construction and maintenance (if it is assumed that the "general" provincial fuel taxes are not ear-marked for road expenditures).

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* In calculating these ratios, all consumption rates are the same as those discussed earlier herein except for private farm trucks which are estimated to be 1.17 and 0.95 gallons of gasoline per one thousand bushel-miles in Manitoba and Alberta respectively (equivalent to 17,800 and 22,450 pounds loaded direction g.v.w. respectively).

ASSESSMENT OF THE ENERGY IMPLICATIONS OF SPECIFIC BRANCH-LINE RATIONALIZATION

The comparative modal energy efficiencies developed in the third section do not, of course, onto themselves explain the energy implications of branch-line rationalization. In this regard, there are three other factors to account for:

(i) variations in the average size of farm trucks between areas;

(ii) variations in the mix of commercial, custom and private farm haul between specific cases; and

(iii) variations in the extent of rail and truck circuitousness between specific cases.

Specific Case Analysis

This section addresses the analysis of specific cases, wherein the before and after "scenarios" are defined, and the effects of the change are estimated. In each case, it has been assumed that the grain quantities are measured in typical bushels (as discussed previously), and the transportation equipment (i.e. trucks and railcars) is the same as that which has been used to develop the inverse transportation energy efficiency schedules and rates presented in the section on full costs and transportation in Western Canada. It has been further assumed that changes in producer haul distances are not accompanied with immediate adjustments in average vehicle size. Over time, of course, such adjustments could be expected to occur.

The following sections present detailed descriptions of each of the cases which have been analyzed, and the results of these analyses.

CASE 1A: Rationalization in the Brandon Area

1. Scenario (Equivalent to Alternative System No. 3 in the Canada Grains Council Study of the Brandon Area)

   a) General Statement

      This scenario assumes the removal of 270 miles of light traffic density rail lines and the closure of the elevators at the 25 delivery points on those lines. The producers re-direct their grain to the nearest elevators on the remaining basic rail network, using private farm trucks. Figure III-11 illustrates the before and after conditions of this scenario.

   b) Traffic Allocation Data Source

      Allocations of grain, and changes in truck mileage, are taken directly from the Brandon Area Study. (This study deals with grain deliveries in crop year '71-'72).

   c) Other Considerations

      The weighted average private farm truck size to be employed in determining average inverse transportation energy efficiency has been determined as follows:

$$\text{wt. avg. g.v.w.*} = \frac{\text{avg. box capacity} \times 55}{.755 \times 1{,}000} + 4.20 = 17.81 \text{ kips}$$

where avg. box capacity = 186.8 bushels**

2. Calculations

   a) General

      It is assumed that all grain in the area is destined for the Lakehead, in both the pre and post abandonment states. While there are traffic shifts from one rail network to the other, it is assumed that these shifts are reconciled at Portage La Prairie, in such a manner as to render the effects of the change nil between Portage and the Lakehead.

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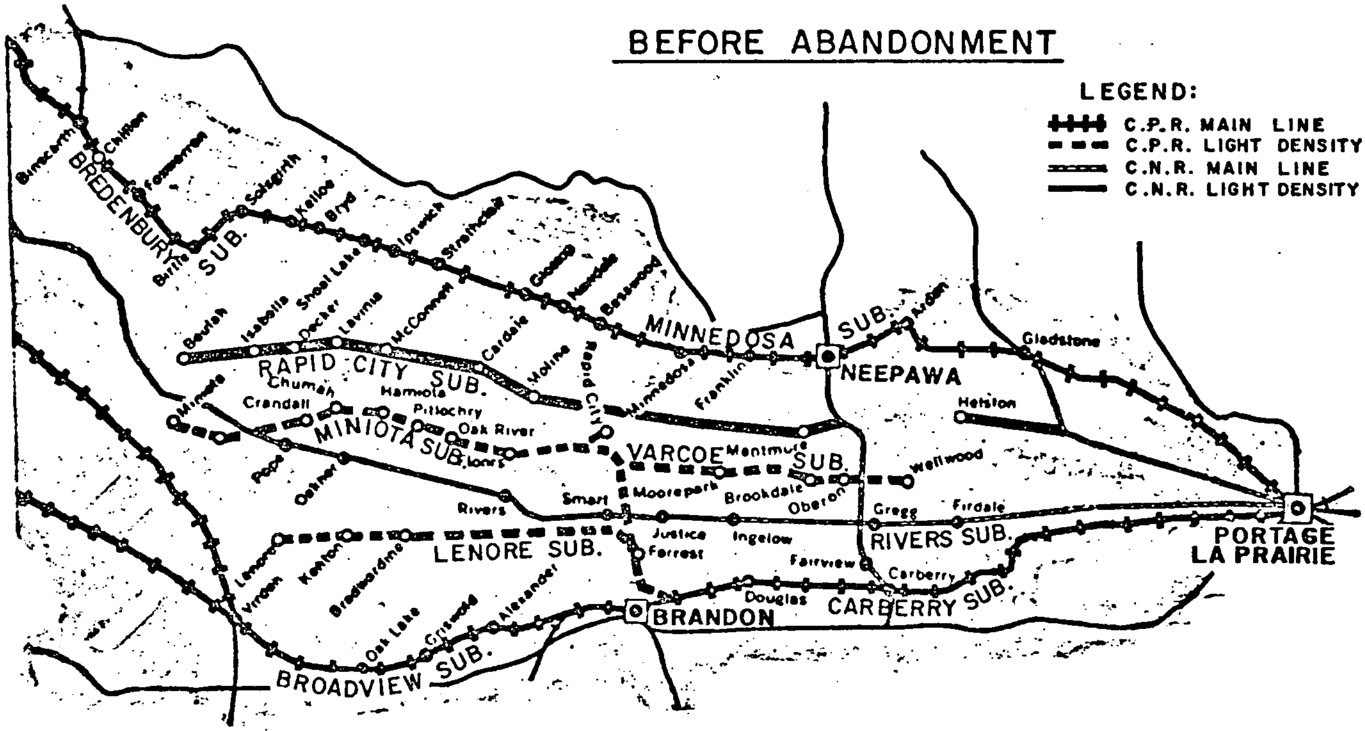
* See Section re: "A Modal Comparison of Inverse Transportation Energy Efficiencies...."

** Tyrchniewicz - ibid - Table 1 (Manitoba)

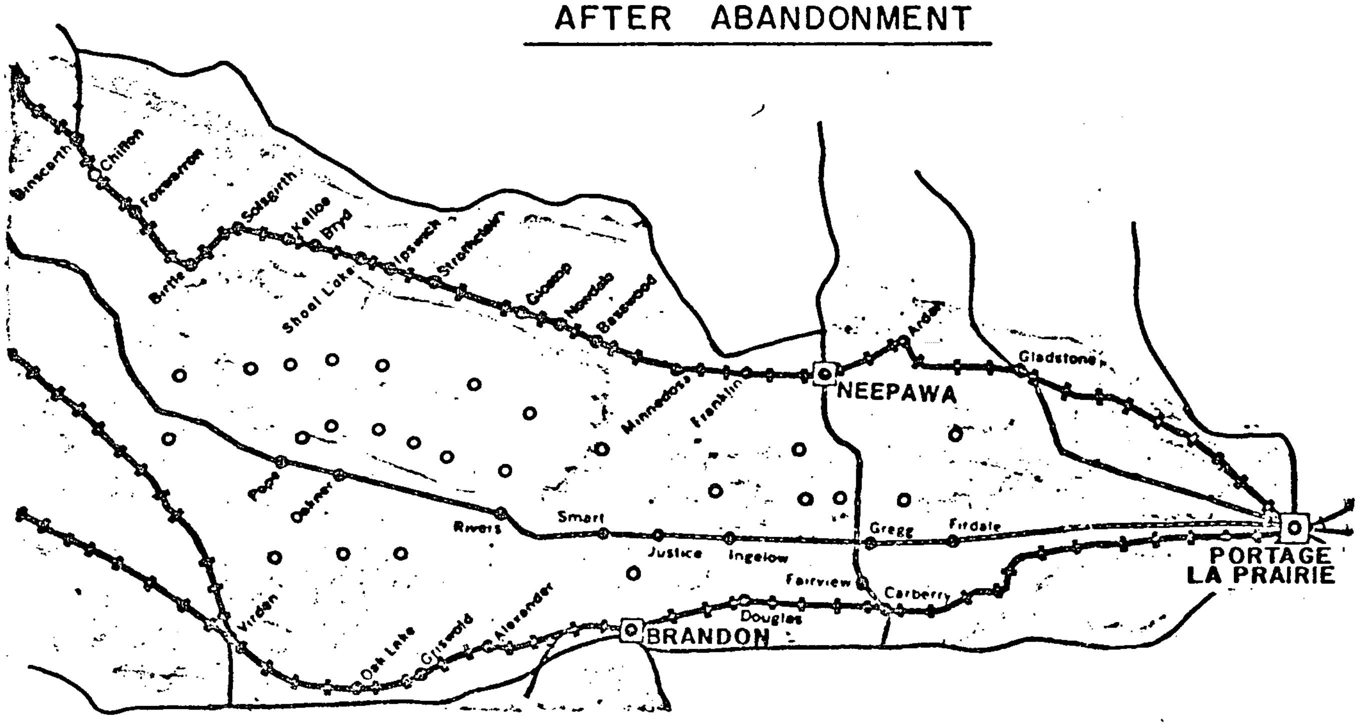
FIGURE III-11

RATIONALIZATION IN THE BRANDON AREA SCENARIO CASES IA AND IB

BEFORE ABANDONMENT



AFTER ABANDONMENT



ROUTING ASSUMPTION:

ALL AFFECTED GRAIN IS MOVED TO PORTAGE FROM THE RECEIVING ELEVATORS, AND THEN RECONCILED BETWEEN RAIL SYSTEMS PRIOR TO FURTHERANCE.

b) Bushel-Mile Implications for Rail

Tables III-11 and III-12 present detailed calculations of the changes in bushel-mile haulings experienced by the railways, between the pre and post abandonment states. The net rail effect (with reconciliation at Portage) is 147947 - 1000 bushel-miles DECREASE.

c) Bushel-Mile Implications for Truck

A shift in deliveries from elevators on the abandoned lines to elevators on the basic network increases haul distance for associated grains 4.2 miles (see Brandon Area Study, p. 18). The net truck effect is, therefore, 32201 - 1000 bushel-miles INCREASE (i.e. 7667 x 4.2).

3. Results - Estimated Fuel Consumption/Cost Implications

Table III-13 summarizes the estimated fuel consumption per cost implications of the defined scenario. The overall fuel requirement associated with grain assembly in the area would increase by about 25 thousand gallons per year. This increase in fuel consumption would add about 0.16 cents to the cost of delivery of each bushel produced in the area. The provincial Government would experience a small revenue loss (i.e. less than $1,000 per year), while the Federal Government would experience a small revenue gain (i.e. less than $1,000 per year).

CASE 1B: Rationalization in the Brandon Area

1. Scenario (Equivalent to CASE 1A, except that upon abandonment all grain originating with affected producers is shifted into commercial trucks for movement from farm to closest alternate elevator).

2. Calculations

a) General and Bushel-Mile Implications for Rail
See CASE 1A

b) Bushel-Mile Implications for Truck

Upon abandonment, affected producers cease trucking in farm vehicles. Pre-abandonment, their average haul distance is 4.9 miles (see Brandon Study, p. 13), with an average

TABLE III-11

Calculation of Bushel-Mile Losses for Rail Experienced For Scenario Case 1A

Delivery Points Experiencing Receipt Losses	Rail System	Rail Subdivision	Decreased Handling '000 bus.*	Rail Miles to Portage	1,000 Bushel-Miles
Beulah	CN	R. City	310	137.0	42,470
Bradwardine	CP	Lenore	327	115.9	37,899
Brookdale	CP	Varcoe	521	114.3	59,550
Cardale	CN	R. City	445	105.1	46,769
Chumah	CP	Miniota	63	133.3	8,398
Crandall	CP	Miniota	389	137.7	53,565
Decker	CN	R. City	356	125.8	44,785
Floors	CP	Miniota	204	114.8	23,419
Forrest	CP	Miniota	286	88.5	25,311
Golden Stream	CN	Gladstone	65	31.6	2,054
Hamiota	CP	Miniota	500	128.9	64,450
Helston	CN	Neepawa	261	38.3	9,996
Isabella	CN	R. City	384	129.9	49,882
Kenton	CP	Lenore	410	122.5	50,225
Lavinia	CN	R. City	237	120.8	28,630
Lenore	CP	Lenore	440	129.4	56,936
McConnell	CN	R. City	388	114.5	44,426
Mentmore	CN	R. City	263	68.3	17,963
Moline	CN	R. City	235	97.9	23,007
Moorepark	CP	Varcoe	296	104.2	30,843
Oak River	CP	Miniota	467	120.8	56,414
Oberon	CP	Varcoe	165	117.7	19,421
Rapid City	CP	R. City Spur	471	109.2	51,433
Wellwood	CP	Varcoe	184	124.5	22,908
TOTAL			7,667		870,754

* as derived from Table 5.1, Brandon Study, ibid.

TABLE III-12

Calculation of Bushel-Mile Gains for Rail Experienced For Scenario Case 1A

Delivery Points Experiencing Receipt Increases	Rail System	Rail Subdivision	Increased Handlings '000 bus.*	Rail Miles to Portage	1,000 Bushel-Miles
Alexander	CP	Broadview	13	93.2	1,212
Arden	CP	Minnedosa	36	50.9	1,832
Basswood	CP	Bredenbury	161	87.9	14,152
Brandon	CP	Broadview	6	77.5	465
Bryd	CP	Brendenbury	183	118.1	21,612
Birtle	CP	Bredenbury	188	137.1	25,775
Douglas	CP	Carberry	13	66.2	861
Firdale	CN	Rivers	154	36.5	5,621
Franklin	CP	Minnedosa	117	69.6	8,143
Gladstone	CP	Minnedosa	73	34.4	2,511
Glossop	CP	Bredenbury	191	100.7	19,234
Gregg	CN	Rivers	90	45.3	4,077
Griswold	CP	Broadview	67	102.3	6,854
Harte	CN	Rivers	285	52.5	14,963
Ingelow	CN	Rivers	429	58.9	25,268
Justice	CN	Rivers	295	67.4	19,883
Kelloe	CP	Bredenbury	140	122.5	17,150
McAuley	CP	Neudorf	10	161.1	1,611
Miniota	CN	Rivers	398	124.6	49,591
Minnedosa	CP	Minnedosa	26	77.9	2,025
Neepawa	CP	Minnedosa	112	60.3	6,754
Newdale	CP	Bredenbury	161	96.2	15,488
Oak Lake	CP	Broadview	127	109.5	13,907
Oakner	CN	Rivers	1,395	104.1	145,220
Petrel Junction	CN	Rivers	99	49.4	4,891
Pope	CN	Rivers	1,091	110.5	120,556
Rivers	CN	Rivers	521	87.9	45,796
Shoal Lake	CP	Bredenbury	175	114.3	20,003
Smart Siding (knox)	CN	Rivers	510	74.9	38,199
Solsqirth	CP	Bredenbury	128	129.1	16,525
Strathclair	CP	Bredenbury	331	105.5	34,921
Virden	CP	Broadview	142	124.7	17,707
TOTAL			7,667		722,807

* as derived from Table 5.9, Brandon Study, ibid.

TABLE III-13

Estimated Energy Implications

Scenario Case 1A

Applicable Inverse Efficiency Rate	0.09 gallons/1,000 bushel-miles	1.17 gallons/1,000 bushel-miles
Estimated Bushel-Mile Change/Year	-147,900 1,000 bushel-miles	+32,200 1,000 bushel-miles
Total Fuel Quantity Effect/Year	- 13,300 gallons	+37,700 gallons
Fuel Type	diesel	gasoline
Applicable Unit Price	41.6 cents/gallons	48.0 cents/gallon
Total User Cost Effect per Year	- $5,530	+ $18,100
Fuel Tax Effect Per Year	Fed. Gov't Loss $490 Prov. Gov't Loss $660	Fed. Gov't Gain $1,470 Prov. Gov't-no change

inverse transportation energy efficiency rate of 1.17 gallons (gasoline) per one thousand bushel-miles. Post-abandonment, commercial trucks operating at 74 thousand pounds g.v.w. carry out all haul in the area, over an average distance of 9.1 miles (i.e. 4.2 + 4.9).

3. Results - Estimated Fuel Consumption per Cost Implications

Table III-14 summarizes the estimated fuel consumption per cost implications of the defined scenario. The overall fuel requirement associated with grain assembly in the area would decrease by about 26 thousand gallons per year. This decrease in fuel consumption would reduce the cost of delivery of each bushel produced in the area by about 0.08 cents. The provincial Government would experience a revenue gain of about $6 thousand per year, while the federal Government would experience a small revenue loss (less than $1 thousand).

CASE 2A: Rationalization in the Carlton Area

1. Scenario

a) General Statement

This scenario assumes closure of Canadian National's Carlton Sub, and all elevators on the line. The producers re-direct their grain deliveries to the nearest elevators on the remaining basic rail network, using private farm trucks. Figure III-12 illustrates the before and after conditions of this scenario.

b) Traffic Allocation Data Source

Allocations of grain, and changes in truck mileage, are taken directly from Prairie Regional Study No. 10*. The data respecting the 1969-70 crop year presented in Study No. 10 is used in this particular analysis.

c) Other Considerations

The weighted average private farm truck size to be employed in determining the applicable average inverse transportation energy efficiency rate has been determined as follows:

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* Agriculture Canada, The Rosthern Region of Saskatchewan, 1972

TABLE III-14

Estimated Energy Implications

Scenario Case 1B

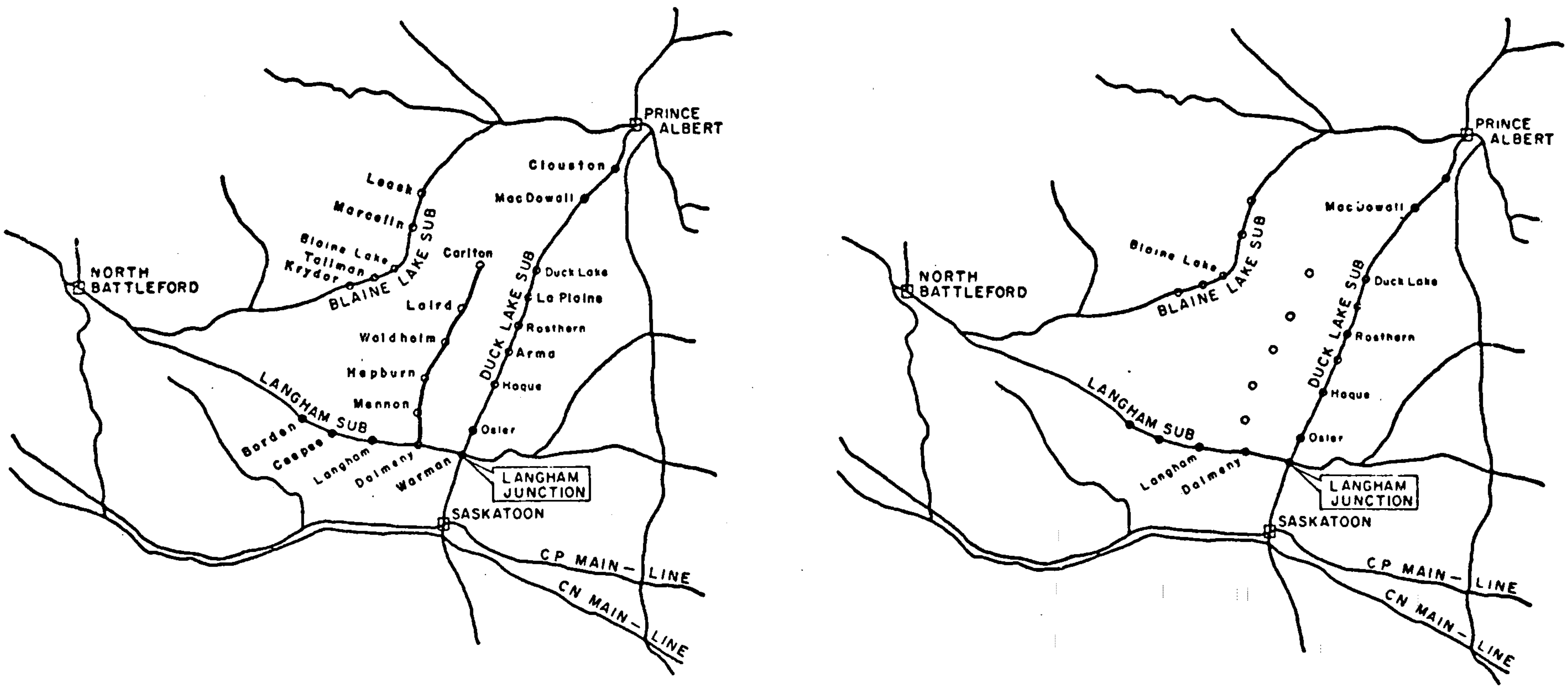
	MODE		
	Rail	Private Farm Truck	Commercial Truck
Applicable Inverse Efficiency Rate	0.09 gallons/1,000 bushel-miles	1.17 gallons/1,000 bushel-miles	0.45 gallons/1,000 bushel-miles
Estimated Bushel-Mile Change/Year	-147,900 1,000 bushel-miles	- 37,600* 1,000 bushel-miles	+ 69,800** 1,000 bushel-miles
Total Fuel Quantity Effect/Year	- 13,300 gallons	- 44,000 gallons	+ 31,400 gallons
Fuel Type	Diesel	gasoline	diesel
Applicable Unit Price	41.6 cents/gallon	48.0 cents/gallon	64.6 cents/gallon
Total User Cost Effect/Year	- $5,530	- $21,120	+ $20,280
Fuel Tax Effect/Year	Fed. Gov't Loss $490 Prov. Gov't Loss $660	Fed. Gov't Loss $1,720 Prov. Gov't Loss-no change	Fed. Gov't Gain $1,160 Prov. Gov't Gain $6,590

* 7,667 x 4.9

** 7,667 x 9.1

FIGURE III-12 RATIONALIZATION IN THE CARLTON AREA SCENARIO CASES 2A AND 2B

BEFORE ABANDONMENT | AFTER ABANDONMENT



ROUTING ASSUMPTION:

ALL AFFECTED GRAIN IS MOVED DIRECTLY TO LANGHAM JCT. FROM THE RECEIVING ELEVATORS, PRIOR TO FURTHERANCE, BOTH BEFORE AND AFTER ABANDONMENT.

$$\text{wt. avg. g.v.w.} = \frac{\text{avg. box capacity x 55}}{.755 \times 1{,}000} + 4.20 = 19.8 \text{ kips}$$

where avg. box capacity = 214 bushels *.

This compares favourably with the average licensed g.v.w. of 19,940 pounds.

2. Calculations

a) General

It is assumed that all affected grain is moved directly to Langhan Junction from the receiving elevators, prior to furtherance, both before and after abandonment. Note that all diverted traffic remains on the Canadian National system. Grain diverted to the Blaine Lake Sub is assumed to be routed from Blaine Lake to Prince Albert to Langham Junction, for furtherance.

b) Bushel-Mile Implications for Rail

Table III-15 presents detailed calculations of the changes in bushel-mile haulings experienced by Canadian National between the pre and post abandonment states. The net rail effect is 2,720 - 1,000 bushel-miles DECREASE. It is to be noted from this Table that the relatively small amount of grain diverted to the Blaine Lake Sub (i.e. about one percent of the affected handlings) produces a bushel-mile impact of +12969, or nearly 27 percent of the total increased bushel-mile haulings from points experiencing increased handlings. This illustrates the possible significance of circuitous routing to fuel requirements. (In this particular instance, however, the magnitude of the numbers involved is relatively small, rendering the issue un-important).

c) Bushel-Mile Implications for Truck

A diversion of deliveries from elevators on the abandoned lines to elevators on the basic network increases haul

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* Kulshreshtha - ibid - Table 6 (Saskatchewan - All Areas)

TABLE III-15

Calculation of Bushel-Mile Changes Experienced by Rail for Scenario Case 2A

Delivery Points Experiencing Receipt Losses	Rail System	Rail Subdivision	Decreased Handlings '000 bus.*	Rail Miles to Langham Jct.	1,000 Bushel-Miles
Carlton	CN	Carlton	399	44.9	17,915
Laird	CN	Carlton	348	36.9	12,841
Waldheim	CN	Carlton	406	29.9	12,139
Hepburn	CN	Carlton	298	22.5	6,705
Mennon	CN	Carlton	108	15.7	1,696
TOTAL			1,559		51,296

* as derived from Table 4.2, Regional Study No. 10, ibid.

Delivery Points Experiencing Receipt Gains	Rail System	Rail Subdivision	Increased Handlings '000 bus.*	Rail Miles to Langham Jct.	1,000 Bushel-Miles
Osler	CN	Duck Lake	17	4.2	71
Langham	CN	Langham	57	16.8	958
Dalmeny	CN	Langham	272	8.9	2,421
Blaine Lake	CN	Blaine Lake	97	133.7	12,969
MacDowall	CN	Duck Lake	17	55.2	938
Rosthern	CN	Duck Lake	559	26.4	14,758
Duck Lake	CN	Duck Lake	362	37.9	13,720
Hague	CN	Duck Lake	178	15.4	2,741
TOTAL			1,559		48,576

* as derived from Table 4.2, Regional Study No. 10, ibid.

distances for associated grains as follows:

Diverted from Mennon	- Increase = 4.82 miles	
Diverted from Carlton	- Increase = 4.75 miles	
Diverted from Hepburn	- Increase = 7.50 miles	*
Diverted from Laird	- Increase = 9.69 miles	
Diverted from Waldheim	- Increase = 9.38 miles	

Grain quantities diverted from each of the abandoned delivery points are:

From Mennon	107,576 bushels	
From Carlton	399,477 bushels	
From Hepburn	298,256 bushels	**
From Laird	348,267 bushels	
From Waldheim	406,001 bushels	

Based on these figures, the net truck effect is an increase in haulage of 11835 - 1000 bushel-miles.

3. <u>Results - Estimated Fuel Consumption Per Cost Implications</u>

Table III-16 summarizes the estimated fuel consumption per cost implications of the defined scenario. The overall fuel requirement associated with grain assembly in the area would <u>increase</u> by about 12,400 gallons per year. This increase in consumption would add about 0.33 cents to the cost of delivery of each bushel produced in the area. The provincial Government would experience a small revenue loss (less than $1,000 per year), while the federal Government would experience a small revenue gain (less than $1,000 per year).

<u>CASE 2B: Rationalization in the Carlton Area</u>

1. <u>Scenario</u>

a) General Statement

This scenario assumes closure of Canadian National's Carlton Sub. All elevators remain open on the abandoned line, with producers continuing to haul to the elevators

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* From Table 4.6 in Regional Study No. 10

** From Table 4.2 in Regional Study No. 10

in the same manner as in the pre-abandonment case. Grain is hauled from these elevators to the closest alternates in commercial grain trucks operating at 74 thousand pounds g.v.w.

b) Traffic Allocation Data Source

The Commercial trucks are assumed to divert grain as follows:

From Carlton to Duck Lake ...... 14 miles
From Laird to Rosthern .... 13 miles
From Waldheim to Rosthern ..... 15 miles
From Hepburn to Hague .... 12 miles
From Mennon to Dalmeny .... 7 miles

2. Calculations

a) Bushel-Miles Implications for Rail

Table III-17 presents detailed calculations of the changes in bushel-mile haulings experienced by Canadian National between the pre and post abandonment states. The net rail effect is 10718 - 1000 bushel-miles DECREASE.

b) Bushel-Mile Implications for Truck

There is no change in private farm truck haul. Increased haulage by commercial truck is 20542 - 1000 bushel-miles.

3. Results - Estimated Fuel Consumption per Cost Implications

Table III-18 summarizes the estimated fuel consumption per cost implications of the defined scenario. The overall fuel requirement associated with grain assembly in the area would increase by about 8,300 gallons per year. This increase in consumption would add about 0.33 cents to the cost of delivery of each bushel produced in the area. The provincial Government would experience a revenue gain of about $1,400 per year, and the federal Government would experience a small revenue gain (less than $1,000 per year).

TABLE III-16

Estimated Energy Implications
Scenario Case 2A

	Mode	
	Rail	Private Farm Truck
Applicable Inverse Efficiency Rate	0.09 gallons/1,000 bushel-miles	1.07 gallons/1,000 bushel-miles
Estimated Bushel-Mile Change/Year	- 2,700 1,000 bushel-miles	+ 11,800 1,000 bushel-miles
Total Fuel Quantity Effect/Year	-250 gallons	+ 12,600 gallons
Fuel Type	diesel	gasoline
Applicable Unit Price	41.4 cents/gallon	41.8 cents/gallon
Total User Cost Effect/Year	- $100	+ $5,270
Fuel Tax Effect/Year	Fed. Gov't Loss $10 Prov.Gov't Loss $10	Fed. Gov't Gain $490 Prov.Gov't Loss $880

TABLE III-18

Estimated Energy Implications
Scenario Case 2B

	Mode	
	Rail	Commercial Truck
Applicable Inverse Efficiency Rate	0.09 gallons/1,000 bushel-miles	0.45 gallons/1,000 bushel-miles
Estimated Bushel-Mile Change/Year	- 10,718 1,000 bushel-miles	+ 20,542 1,000 bushel-miles
Total Fuel Quantity Effect/Year	- 950 gallons	+ 9,250 gallons
Fuel Type	diesel	diesel
Applicable Unit Price	41.4 cents/gallon	60.4 cents/gallon
Total User Cost Effect/Year	-$390	+ $5,590
Fuel Tax Effect/Year	Fed. Gov't Loss $30 Prov.Gov't Loss $40	Fed. Gov't Gain $340 Prov.Gov't Gain $1,480

TABLE III-17

Calculation of Bushel-Mile Gains* Experienced By Rail
for
Schenario Case 2B

Delivery Points Experiencing Receipt Gains	Rail System	Rail Subdivision	Increased Handlings '000 bus.	Rail Miles to Langham Jct.	1,000 Bushel Miles
Duck Lake	CN	Duck Lake	399	37.9	15,122
Rosthern	CN	Duck Lake	754	26.4	19,906
Haugue	CN	Duck Lake	298	15.4	4,589
Dalmeny	CN	Langham	108	8.9	961
TOTAL			1,559		40,578

* Losses are same as for Case 2A

General Comments

From the results of the analysis of these specific rationalization scenarios, several observations can be drawn:

Firstly: For many of the branch-lines, the effects of abandonment on fuel consumption requirements of the railways will be relatively minor.

To illustrate, abandonment of 270 miles of track in the Brandon area would decrease fuel consumption associated with related rail grain assembly by about 13 thousand gallons per year, or one-half of the quantity of fuel consumed by a typical five-axle commercial highway truck in a year. Abandonment of the Carlton Sub would reduce railway fuel requirements by a quantity of fuel which is less than that consumed by one typical automobile in a year.

There are two basic reasons for this. Firstly, the unit inverse energy efficiency rate for rail is relatively small. Accordingly, large changes in bushel-mile haul must be experienced to effect significant quantity adjustments. Secondly, for many of the specific branch-line cases, traffic would be re-directed from the abandoned line to effectively paralleling lines, tending to minimize changes in bushel-mile rail haul. Of course, isolated cases of highly circuitous rail routing would not fall into this pattern.

Secondly: Given abandonment and the continued extensive employment of small private farm trucks, consumption could increase substantially but would not necessarily do so.

In the case of the Brandon area, where current haul distances are short, extensive abandonment produced a net fuel increase equivalent to the amount of fuel consumed by one typical commercial highway truck in a year. In areas where the proximity to alternative rail lines is less, greater effects of course would be observed.

Thirdly: Given abandonment, the increases in fuel requirements which would be experienced by attendant increases in private farm truck haul could often be more than offset by shifting grain haul to large commercial trucks.

An objective of energy conservation in grain assembly could be oft times better served by encouraging shifts from the small private farm trucks to large trucks, in place of continued encouragement of the extensive employment of small private farm trucks. As was illustrated for the Brandon area, fairly extensive branch-line abandonment, if accompanied with wide-scale employment of large trucks, can produce overall fuel savings.

Fourthly: The government revenue implications of changes in fuel consumption effected by rationalization are relatively minor. Nontheless, it is interesting to note that provincial governments in particular can stand to gain revenue as a result of shifts from private farm truck haulage to commercial truck haulage of grain. As illustrated for the Brandon area, this gain in provincial revenue can occur even under circumstances wherein overall fuel consumption decreases.

As an overall general comment, it is reasonable to observe that the magnitude of the energy implications of many of the rationalization options, particularly when accompanied with increases in the employment of large trucks in the place of small trucks, would be very minor, and indeed so small as to be effectively immeasurable and unpredictable. If energy conservation onto itself is to be viewed as an important argument favouring the retention of branch-lines, then in the same simplistic way, one should also argue, more strongly, for a significant shift from small private farm truck haul to large commercial truck haul of grain in the initial farm to elevator move. The first position only constrains <u>growth</u> in consumption, while the second position could effect <u>decreases</u> in consumption.

CONSIDERATION FOR THE FUTURE

This section addresses a number of general matters of relevance to fuel requirements and costs of grain assembly in the foreseeable future. Its purposes are to identify possible changes in regulation, technology, and fuel prices which could significantly alter the relative energy efficiency of one mode to the next while operating in grain assembly, and to generally comment on the implications of the changes.

Possible Developments in Regulation

a) Vehicle Weight and Dimension Regulations

In late 1974, the three prairie provinces entered a joint agreement with the Federal Government to upgrade the major highway network in the prairies (referred to as the primary highway system) to permit the operation of larger trucks than had theretofore been permitted. As a result of this developmental agreement, on designated highways, trucks are permitted to operate at gross vehicle weights up to 110 thousand pounds with 35 thousand pound tandem axles. Previous to the agreement, weight limits in the prairies were generally restricted to 74 thousand pound g.v.w., with 32 thousand pounds tandems. The effects of these increases have yet to be felt in the trucking of grain, exept in isolated circumstances, basically because of limitation in scope of the designated network.

If, as has been generally discussed, the scope of the network was to be increased, or more particularly, applied province and region wide, substantial improvements in the energy efficiency of commercially trucked grain could be realized. To illustrate, given that road haul could generally take place at 110 thousand pound g.v.w., the inverse transportation energy efficiency for grain haul on these large trucks would be 0.35 gallons per one thousand bushel-miles,* or about one-fifth improved over the 74 thousand pound vehicle consumption requirement.

Increases in allowable truck lengths, unless accompanied with increased weight allowances, would not improve the energy efficiency of grain haul by large trucks (in that such trucks are nearly always "weighted-out", and not "bulked-out").

b) Speed Limit Decrease

There is currently substantial discussion about the possible decrease of speed limits across Canada to a maximum of 55 miles per hour. For the most part, such a decrease would effect no change in the fuel requirements of private farm trucks operating in grain assembly, in that most farm trucks in such operation average speeds substantially less than this proposed maximum. Such an adjustment, however, could alter somewhat the average consumption rates for large trucks. To illustrate, the average speed of semi-trailer truck units operating on primary highways in Saskatchewan is about 60 miles per hour.** For that portion of their activity on such

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* Assuming:
fuel performance = 4.0 m.p.g.
tare weight = 32 thousand pounds
payload = 110,000 - 32,000 = 78,000 lbs. or 1,418 typical bushels

$$\text{inverse efficiency} = \frac{0.5 \text{ gallons}}{1{,}418 \text{ bushel-miles}} = 0.35 \text{ gallons per one thousand bushel-miles.}$$

** See "Speeds on Saskatchewan Highways", published by the Saskatchewan Department of Highways.

roads, one may expect a reduction inoperating speed of commercial trucks by about five miles per hour to the proposed 55 miles per hour limit. Such an adjustment could be expected to improve fuel performance, and the inverse transportation energy efficiency rate by seven percent.**

Technological Developments

a) Railways

Probably the most important technological development in rail transport, which can produce foreseeable and significant improvements in rail fuel consumption associated with grain assembly, is the relatively recent introduction of high payload hopper cars, with roller bearings. In this regard, improvements would be derived primarily from the reduced resistance force per ton which must be overcome to move these units, relative to the old box-cars. Of course, there are branch-lines which are incapable of supporting the maximum loaded weight of these units, and in such instances no particular improvement is possible. Nonetheless, it is in order to expect that average inverse transportation energy efficiency of grain haul has improved, and will continue to improve, as more of these units are introduced into the system. (No firm data on the probable improvement in fuel efficiency resulting from the use of this equipment has been

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* R.R. Mayes: see footnote * next page

provided during this study).

b) Trucks

Mayes* briefly discusses a number of equipment developments designed to improve fuel performance in large trucks. There is, of course, much literature respecting detailed developmental possibilities in this regard, although it appears generally fair to observe that in the foreseeable future, there will be no large scale introduction of technological innovation which will substantially alter average energy efficiency of the truck mode operating in grain assembly**. This is particularly true for the private farm truck component of grain haul, for which there is a large physical plant already in existance that, regardless of technological development, would require substantial time to replace and modernize.

Fuel Price Developments

In the short term, no significant alternations are expected in the relative costs of fuel when comparing one mode operating in grain assembly to the next. This, of course, does not suggest that the absolute magnitude of fuel prices will not change. In this regard,

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* R.R. Mayes, "Energy and Trucking: An Examination of the Roles of Reason and Rhetoric in Modal Fuel Efficiency Studies", presented at the RTAC Conference in Calgary, September 1975.

** Discussions with commercial grain truckers in Saskatchewan indicate that there is always fairly wide-scale employment of light-weight grain-hoppers, and that accordingly payloads are about maximized.

obviously as prices increase, there are overall cost advantages to be reaped by encouraging, as possible, greater use of the more energy efficient modes, or mode elements.

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"Measurement of Rail Transportation Fuel Consumption" - a study sponsored by the U.S. F.R.A. under the direction of J. Hopkins.

CHAPTER 4

THE IMPACT OF BRANCH LINE ABANDONMENT ON THE FISCAL VIABILITY OF LOCAL GOVERNMENTS

D.A. Neil

INTRODUCTION

An interesting aspect of Western Canadian history is the relationship between its railways and its settlement pattern. Since the rail network largely preceded the settlement of the area, the location of settlements, its organizations and institutions were greatly influenced and dependent upon the railways. It may be the awareness of this interrelationship that causes much of the opposition to rail line abandonment.

One group of institutions which were directly related to the rail network were the municipal governments of incorporated villages and towns and to a lesser extent, rural municipalities and school units.

One of the concerns of briefs put forward to the Grain Handling and Transportation Commission at the local hearings is the impact of rail line abandonment on the fiscal viability of local governments.

Purpose of the Study

The general purpose of this study is to determine the importance of local tax revenues derived from right-of-way properties.* The study attempts to determine:

1) the amount of tax assessment that incorporated communities and rural municipalities derive from right-of-way properties; and

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* Includes both railway and non railway properties.

2) the impact that the loss of right-of-way assessment would have on incorporated communities and rural municipalities with respect to:

   a) loss of tax assessment and levies;

   b) distributional effect of loss of right-of-way assessment;

   c) change required in municipal mill rates and school mill rates to maintain the present tax revenues.

Scope of Study and Assumptions

In assuming the effects of rail line abandonment, two levels of government are studied. These two levels of government are the local level and the school division. The local level includes both incorporated communities and rural municipalities. Taxpayers are subject to taxation from both these levels of government. The local level of government establishes the municipal mill rate based on the assessment within its administrative boundary. Similarly the school division establishes the school mill rate based on the assessment within its boundary. In general, a school division contains several incorporated communities and several rural municipalities (or portions of rural municipalities). As a result there are several tax jurisdictions or tax zones within a school district. A tax zone is defined as a separate geographic area with the same local government and school division jurisdictions. For example, a rural municipality may fall within two or more school divisions, thus, taxpayers in the same rural municipality but in different school divisions could face different mill rates (See figure IV-1).

Assumptions

In order to arrive at the findings in this study, several important assumptions were made. Firstly, it was assumed that when a rail line was closed, all tax assessment on the right-of-way would be lost including non-railway right-of-way assessment (i.e. grain elevators, bulk fuel dealers, etc.). Secondly, it was assumed that the assessed value of the right-of-way properties after abandonment would be zero since improvements would be removed or torn down and the right-of-way would have no alternative use. Thirdly, it was assumed there would be no increase or reduction in expenditures by either of the levels of government affected. As a result it was assumed that there would be no new expenditures on the road system which may be required because of longer grain hauling distances brought on by the loss of elevator service. Finally, it was assumed that there would be no assistance from any higher level of government to compensate for loss of tax revenues.

Data Collection

The tax assessment data collected were obtained from the Provincial Department of Municipal Affairs and incorporated communities tax assessment roles for 1975. Data for school district were collected from the Provincial Department of Education.

Study Area

-- Elrose Area

The rail lines studies in this area were:

1) the CP Rail McMorran Subdivision;

2) the CP Rail Matador Subidivision;

3) the CP Rail Kerrobert Subdivision*;

4) the Canadian National Elrose Subdivision**;

5) the Canadian National White Bear Subdivision;

6) the Canadian National Conquest Subdivision***.

The area encompasses eleven rural municipalities which fall within the boundaries of four school districts. Three towns and eleven villages are included in the study area.

Importance of Tax Assessment Derived from Right-of-Way Properties

Tax assessment of right-of-way properties would seem to be relatively more important to incorporated communities than to municipalities. The proportion of tax assessment of right-of-way properties to total tax assessment are shown in Table IV-1. Right-of-way properties in municipalities make up a very small proportion of the total tax assessment in the study area. They are in all cases less than five percent of the total. The proportion of the tax base relating to right-of-way properties usually diminishes as a community grows larger. This is readily apparent in a comparison of the proportion of tax assessment of small and large communities. For example in the Elrose area, the

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* Includes only that portion of the Kerrobert Subdivision from Milden to Conquest. This portion of the Kerrobert Subdivision is part of the basic network.

** Includes only that portion of the Elrose Subdivision from Tichfield to Glidden.

*** Includes only that portion of the Conquest Subdivision from Conquest to Beechy.

TABLE IV-1 PROPERTY TAX ASSESSMENT FOR MUNICIPALITIES AND INCORPORATED COMMUNITIES, 1975

ELROSE AREA

	Railway Right-of-way Tax Assessment	Non Railway Right-of-way Tax Assessment	Total Right-of-way Tax Assessment	Total Tax Assessment	Percent of Total Tax Assessment Derived From R.O.W. Properties
MUNICIPALITIES	$	$	$	$	
225 Canaan	9,050	NIL	9,050	1,661,510	0.54%
226 Victory	6,820	45,360	52,180	2,965,670	1.76%
228 Lacadena	49,190	305,870	355,060	7,379,780	4.81%
255 Coteau	27,660	55,370	83,030	2,003,000	4.15%
256 King George	NIL	NIL	NIL	1,851,290	0.00%
257 Monet	64,710	211,800	276,510	6,488,660	4.26%
259 Snipe Lake	54,080	257,350	311,430	9,051,080	3.44%
260 Newcombe	22,840	28,940	51,780	3,810,640	1.36%
285 Fertile Valley	51,450	90,140	141,590	3,766,164	3.76%
286 Milden	26,100	30,380	56,480	4,293,760	1.32%
287 St. Andrews	46,360	94,390	140,750	4,929,450	2.86%
INCORPORATED COMMUNITIES					
Elrose	15,000	110,700	125,700	1,085,940	11.58%
Eston	30,750	236,120	266,870	2,551,670	10.46%
Kyle	8,140	84,150	92,290	985,530	9.36%
Beechy	7,270	152,620	159,890	638,660	25.04%
Birsay	4,250	44,780	49,030	171,110	28.65%
Bounty	3,820	7,040	10,860	86,780	12.51%
Conquest	13,250	59,230	72,480	361,040	20.08%
Dinsmore	11,470	162,280	173,750	826,510	21.02%
Lucky Lake	9,630	91,080	100,710	594,180	16.95%
Macrorie	7,090	39,610	46,700	173,930	26.85%
Madison	5,130	74,610	79,740	155,190	51.38%
Milden	6,680	106,410	113,090	469,880	24.07%
Plato	3,660	46,920	50,580	121,290	41.70%
Wiseton	5,630	79,050	84,680	310,095	27.31%

proportion of tax assessment of right-of-way properties at Madison (population 58) is 51.38 percent of the total assessment, while at Eston (population 1,418) right-of-way assessment represents only 10.46 percent of the total assessment. This relationship reflects the greater economic activity at larger centres. In general, the proportion of right-of-way assessment diminishes as the total assessment of the taxing authority increases.

DISTRIBUTIONAL EFFECTS

Impact of Loss of Right-Of-Way Assessment

A significant aspect in studying the importance of local tax revenues derived from right-of-way properties is the distributional effects that loss of right-of-way assessment will cause. Most studies in the past have just considered the loss of assessment by local governments and have ignored the distributional effects.

A distributional effect could be defined as a change in mill rates which is not proportionate to the change in the taxing authorities' loss of assessment. In all cases, there will be a distributional effect between incorporated communities and rural municipal districts. In Saskatchewan, there will be an additional distributional effect within some rural municipalities in those cases where taxpayers in the same municipality experience different total mill rate increases because their municipality falls within different school divisions. The school divisions will have to adjust their school mill rates differently depending on the loss of assessment within their boundaries, whereas the change in the municipal mill rate will be constant throughout the municipality.

THE ELROSE AREA

Alternative 1

The description of the railway subdivisions in the area have previously been discussed. For purposes of Alternative 1, it was assumed that the Elrose, White Bear, Matador, McMorran and Conquest Subdivisions would be closed. Table IV-2 shows the amount of right-of-way assessment that would be lost. As stated earlier, it was assumed for purposes of this study that in the event of closure of a rail line, all other right-of-way assessments would be lost. The largest projected loss of assessment occurs in the R.M. of Lacadena. This loss is $355,060 and represents 4.8 percent of the total assessment and a loss of $30,713 of tax levy*. In Alternative 1, all but three municipalities, Fertile Valley, Milden and St.Andrews lose 100 percent of their right-of-way assessment. The largest loss of tax levy also occurs in the municipality of Lacadena. The largest percentage loss of assessment in communities occurs at Madison, $79,740 or 51.4 percent of the total assessment

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* Loss of tax levy is the loss of assessment times the total mill rate. See Table IV-4 for the loss of tax levies.

TABLE IV-2 - LOSS OF TAXABLE ASSESSMENT BY TAXING AUTHORITY AND PROJECTED SCHOOL AND MUNICIPAL MILL RATES

ALTERNATIVE 1	TOTAL TAX ASSESSMENT	ESTON-ELROSE SCHOOL UNIT TAXAB ASSESSMENT	ESTON-ELROSE SCHOOL UNIT LOSS OF TAXABLE ASSESSMENT	ESTON-ELROSE SCHOOL UNIT PROJECTED TAXABLE ASSESSMENT	OUTLOOK SCHOOL UNIT TAXABLE ASSESSMENT	OUTLOOK SCHOOL UNIT LOSS OF TAXABLE ASSESSMENT	OUTLOOK SCHOOL UNIT PROJECTED TAXABLE ASSESSMENT	ROSETOWN SCHOOL UNIT TAXABLE ASSESSMENT	ROSETOWN SCHOOL UNIT LOSS OF TAXABLE ASSESSMENT	ROSETOWN SCHOOL UNIT PROJECTED TAXABLE ASSESSMENT	PROJECTED TOTAL TAX ASSESSMENT	PRESENT MUNICIPAL MILL RATE	PROJECTED MUNICIPAL MILL RATE
MUNICIPALITIES													
225 Canaan	1,661,510	-	-	-	1,661,510	9,050	1,652,460	-	-	-	1,652,460	52.5	52.8
226 Victory	2,965,670	201,720	-	201,720	2,524,450	52,180	2,472,270	-	-	-	2,913,490	44.2	45.0
228 Lacadena	7,379,780	7,379,780	355,060	7,024,720	-	-	-	-	-	-	7,024,720	40.5	42.5
255 Coteau	2,003,000	-	-	-	2,003,000	83,030	1,919,970	-	-	-	1,919,970	45.0	46.9
256 King George	1,851,290	1,581,020	-	1,581,020	270,270	-	270,270	-	-	-	1,851,020	40.0	40.0
257 Monet	6,488,660	6,373,110	276,510	6,096,600	-	-	-	115,550	-	115,550	6,212,150	31.9	33.3
259 Snipe Lake	9,051,080	9,051,080	311,430	8,739,650	-	-	-	-	-	-	8,739,650	41.0	42.5
260 Newcombe	3,810,640	1,005,434	5,600	999,834	-	-	-	-	-	-	3,758,860	43.5	44.1
285 Fertile Valley	3,766,164	709,326	11,260	698,066	2,735,594	121,430	2,614,164	316,094	-	316,094	3,633,474	37.2	38.6
286 Milden	4,293,760	1,310,130	29,590	1,280,540	-	-	-	2,983,630	15,880	2,967,750	4,248,290	39.5	39.9
287 St. Andrews	4,929,450	134,360	-	134,360	-	-	-	4,795,090	84,090	4,711,000	4,845,360	38.0	38.7
288 Pleasant Valley	-	-	-	-	-	-	-	2,413,835	-	2,413,835	N.A.	N.A.	N.A.
Other R.M's	-	-	-	-	5,938,261	4,000	5,934,261	14,547,350	-	14,547,350	-	-	-
Sub-Total	-	27,745,960	989,450	26,756,510	15,133,085	279,770	14,853,315	25,171,549	99,970	25,071,579	-	-	-
INCORPORATED COMMUNITIES													
Elrose	1,085,940	1,085,940	125,700	960,240	-	-	-	-	-	-	960,240	36.0	40.7
Eston	2,551,670	2,551,670	266,870	2,284,800	-	-	-	-	-	-	2,284,800	49.0	54.7
Kyle	985,530	985,530	92,290	893,240	-	-	-	-	-	-	893,240	39.0	43.0
Beechy	638,660	-	-	-	638,660	159,890	478,770	-	-	-	478,770	47.0	62.7
Birsay	171,110	-	-	-	171,110	49,030	122,080	-	-	-	122,080	43.0	60.3
Bounty	86,780	-	-	-	86,780	-	86,780	-	-	-	86,780	30.0	30.0
Conquest	361,040	-	-	-	361,040	8,240	352,800	-	-	-	352,800	34.2	35.0
Dinsmore	826,510	826,510	173,750	652,760	-	-	-	-	-	-	652,760	38.0	48.1
Lucky Lake	594,180	-	-	-	594,180	100,710	493,470	-	-	-	493,470	43.0	51.8
Macrorie	173,930	-	-	-	173,930	46,700	127,230	-	-	-	127,230	30.0	41.0
Madison	155,190	155,190	79,740	75,450	-	-	-	-	-	-	75,450	28.0	57.6
Milden	469,880	-	-	-	-	-	-	469,880	-	469,880	469,880	32.0	32.0
Plato	121,290	121,290	50,580	70,710	-	-	-	-	-	-	70,710	30.0	51.4
Wiseton	310,095	84,680	225,415	-	-	-	-	-	-	-	225,415	42.0	57.8
Others	-	-	-	-	4,442,400	-	4,442,400	7,845,280	-	7,845,280	-	-	-
Sub-Total	-	6,036,225	873,610	5,162,615	6,468,100	364,570	6,103,530	8,315,160	-	8,315,160	-	-	-
TOTAL	-	33,782,185	1,863,060	31,919,125	21,601,185	634,260	70,966,925	33,486,709	99,970	33,386,739	-	-	-
Present School Mill Rate		46.0			39.0			45.0					
Projected School Mill Rate		48.7			40.2			45.1					

and $5,901 in loss of tax levy, while the largest absolute loss is at Eston where the loss of assessment is $266,870 or 10.5 percent of the total assessment and $25,353 in loss of tax levy (at 1975 mill rate).

Table IV-2 also presents the total assessments and loss of assessment brought about by the removal of rail lines, for each municipality, community and school unit in the study area. Present school and municipal mill rates are also shown.

The change in the municipal portion of the total mill rate is proportionate to the change in total assessment in the municipality or incorporated community. The change in total assessment is the difference between the total assessment and the projected total assessment. (Projected Mill Rate = Present Total Assessment/Projected Total Assessment x Present Mill Rate). The projected municipal mill rate for each municipality and community is calculated by dividing the present total assessment of a municipality or community by the projected total assessment and multiplying that figure by the present municipal mill rate (Table IV-3).

The change in the school portion of the total mill rate is proportionate to the change in assessment in the school unit. Incorporated communities always lie within one school unit, however, several of the municipalities lie within more than one school unit. Thus, when calculating the projected total mill rates, different parts of a municipality will have different total mill rates depending upon which school unit they lie within. Table IV-2 shows that loss in taxable assessment of each school unit brought about by the loss of assessment of municipalities and communities within each school unit. The projected school mill rate for each school unit and therefore for each community and portion of a municipality in that school unit is calculated by dividing the present total assessment of the school unit by the projected total assessment and multiplying that figure by the present school mill rate. (Table IV-3).

Figure IV-1 shows the increase in mill rate for each tax zone in the study area. The largest increase in the total mill rate in a rural municipality was in Lacadena which increased 4.7 mills or 5.4 percent. The municipality of Lacadena is in the Eston-Elrose school unit. The largest increase in the total mill rate of a community was at Madison where the projected mill rate rose 32.3 mills or 43.6 percent.

Some of the more interesting distributional effects upon the mill rate in Alternative 1 are as follows:

1) R.M. of King George, No. 225. There are no railways running through the municipality and therefore no loss of assessment. Thus the municipal portion of the total mill rate does not change. However, part of 225 King George is in the Eston-Elrose school unit while the remainder is in the Outlook school unit. For the taxpayers of King George living in the Eston-Elrose school unit, their mill rate would increase by 2.7 mills and for those in the Outlook school unit there would be a 1.2 mill increase.

2) Village of Milden. Milden does not lose any tax assessment, thus its municipal portion of the total mill rate does not change. Milden is in the Rosetown school unit and because of the loss of assessment in the school unit, the school portion of the total mill rate is increased by 0.1 mills.

TABLE IV-3

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITIES AND INCORPORATED COMMUNITIES BY SCHOOL UNITS, BASIS 1975.

	ESTON - ELROSE SCHOOL UNIT			OUTLOOK SCHOOL UNIT			ROSETOWN SCHOOL UNIT		
ALTERNATIVE 1	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %
MUNICIPALITIES									
225 CANAAN									
school	-	-	-	39.0	40.2	3.1	-	-	-
municipal	-	-	-	52.5	52.8	0.6	-	-	-
TOTAL	-	-	-	91.5	93.0	1.6	-	-	-
226 VICTORY									
school	46.0	48.7	5.9	39.0	40.2	3.1	-	-	-
municipal	44.2	45.0	1.8	44.2	45.0	1.8	-	-	-
TOTAL	90.2	93.7	3.9	83.2	85.2	2.4	-	-	-
228 LACADENA									
school	46.0	48.7	5.9	-	-	-	-	-	-
municipal	40.5	42.5	4.9	-	-	-	-	-	-
TOTAL	86.5	91.2	5.4	-	-	-	-	-	-
255 COTEAU									
school	-	-	-	39.0	40.2	3.1	-	-	-
municipal	-	-	-	45.0	46.9	4.2	-	-	-
TOTAL	-	-	-	84.0	87.1	3.7	-	-	-
256 KING GEORGE									
school	46.0	48.7	5.9	39.0	40.2	3.1	-	-	-
municipal	40.0	40.0	0.0	40.0	40.0	0.0	-	-	-
TOTAL	86.0	88.7	3.1	79.0	80.2	1.5	-	-	-
257 MONET									
school	46.0	48.7	5.9	-	-	-	45.0	45.1	0.2
municipal	31.9	33.3	4.4	-	-	-	31.9	33.3	4.4
TOTAL	77.9	82.0	5.3	-	-	-	76.9	78.4	2.0

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITIES AND INCORPORATED COMMUNITIES BY SHCOOL UNITS, BASIS 1975.

	ESTON - ELROSE SCHOOL UNIT			OUTLOOK SCHOOL UNIT			ROSETOWN SCHOOL UNIT		
	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %
MUNICIPALITIES									
259 SNIPE LAKE									
school	46.0	48.7	5.9	-	-	-	-	-	-
municipal	41.0	42.5	3.7	-	-	-	-	-	-
TOTAL	87.0	91.2	4.8	-	-	-	-	-	-
260 NEWCOMBE									
school	46.0	48.7	5.9	-	-	-	-	-	-
municipal	43.5	44.1	1.4	-	-	-	-	-	-
TOTAL	89.5	92.8	3.7	-	-	-	-	-	-
285 FERTILE VALLEY									
school	46.0	48.7	5.9	39.0	40.2	3.1	45.0	45.1	0.2
municipal	37.2	38.6	4.0	37.2	38.6	4.0	37.2	38.6	4.0
TOTAL	83.2	87.3	4.9	76.2	78.8	3.4	82.2	83.7	1.8
286 MILDEN									
school	46.0	48.7	5.9	-	-	-	45.0	45.1	0.2
municipal	39.5	39.9	1.0	-	-	-	39.5	39.9	1.0
TOTAL	85.5	88.6	3.6	-	-	-	84.5	85.0	0.6
287 ST. ANDREWS									
school	46.0	48.7	5.9	-	-	-	45.0	45.1	0.2
municipal	38.0	38.7	1.8	-	-	-	38.0	38.7	1.8
TOTAL	84.0	87.4	4.0	-	-	-	83.0	83.8	1.0
288 PLEASANT VALLEY[1]									
school	-	-	-	-	-	-	45.0	45.1	0.2
municipal	-	-	-	-	-	-	-	-	0.0
TOTAL	-	-	-	-	-	-	45.0	45.1	0.2

1 The municipality of Pleasant Valley is representative of those municipalities within the Rosetown School Unit where the municipal mill rate is unaffected.

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITIES AND INCORPORATED COMMUNITIES BY SCHOOL UNITS, BASIS 1975.

	ESTON - ELROSE SCHOOL UNIT			OUTLOOK SCHOOL UNIT			ROSETOWN SCHOOL UNIT		
	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %
INCORPORATED COMMUNITIES									
ELROSE									
school	46.0	48.7	5.9	-	-	-	-	-	-
municipal	36.0	40.7	13.1	-	-	-	-	-	-
TOTAL	82.0	89.4	9.0	-	-	-	-	-	-
ESTON									
school	46.0	48.7	5.9	-	-	-	-	-	-
municipal	49.0	54.7	11.6	-	-	-	-	-	-
TOTAL	95.0	103.4	8.8	-	-	-	-	-	-
KYLE									
school	46.0	48.7	5.9	-	-	-	-	-	-
municipal	39.0	43.0	10.3	-	-	-	-	-	-
TOTAL	85.0	91.7	7.9	-	-	-	-	-	-
BEECHY									
school	-	-	-	39.0	40.2	3.1	-	-	-
municipal	-	-	-	47.0	62.7	33.4	-	-	-
TOTAL	-	-	-	86.0	102.9	19.7	-	-	-
BIRSAY									
school	-	-	-	39.0	40.2	3.1	-	-	-
municipal	-	-	-	43.0	60.3	40.2	-	-	-
TOTAL	-	-	-	82.0	100.5	22.6	-	-	-
BOUNTY									
school	-	-	-	39.0	40.2	3.1	-	-	-
municipal	-	-	-	30.0	30.0	0.0	-	-	-
TOTAL	-	-	-	69.0	70.2	1.7	-	-	-

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITIES AND INCORPORATED COMMUNITIES BY SCHOOL UNITS, BASIS 1975.

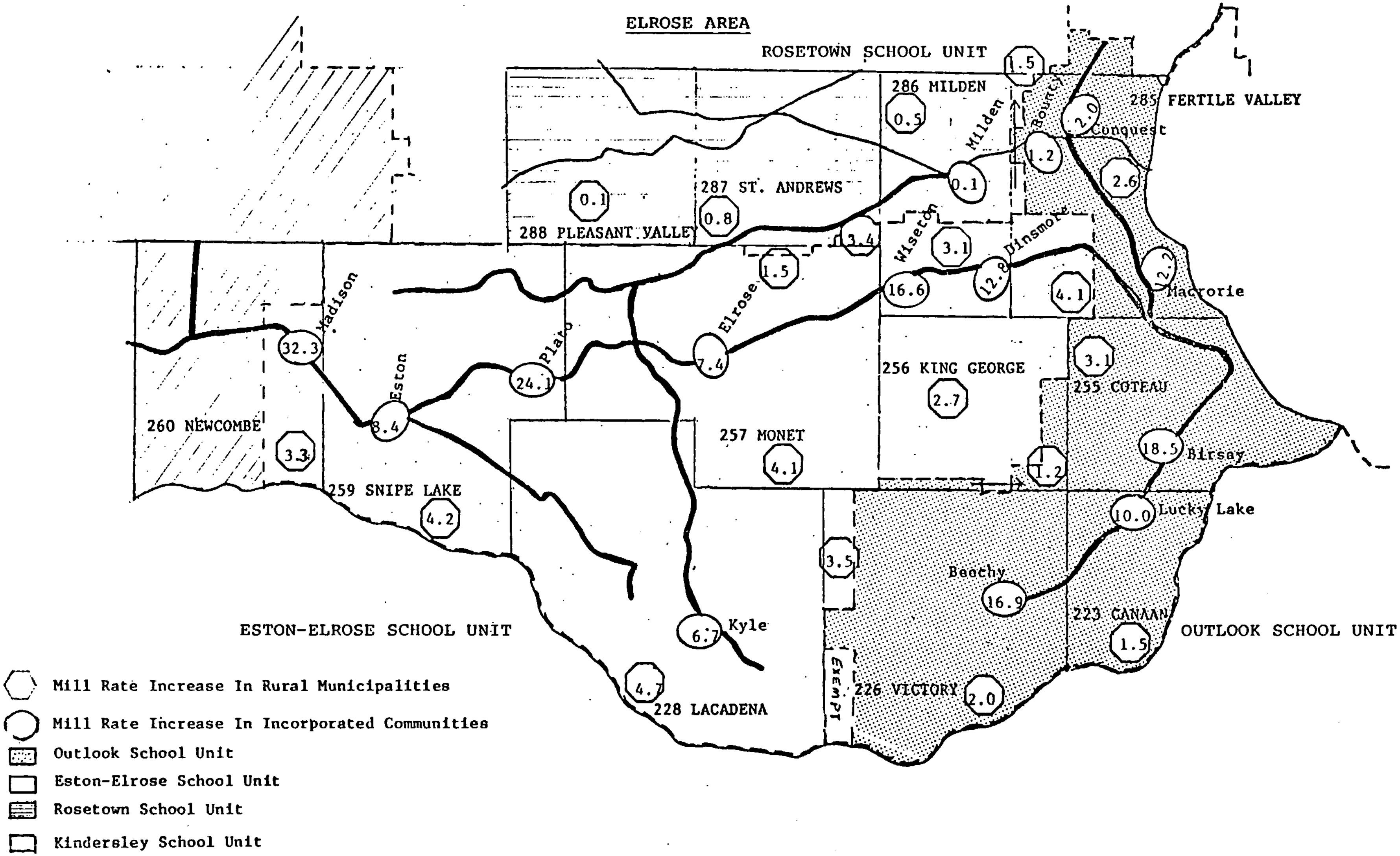
	ESTON - ELROSE SCHOOL UNIT			OUTLOOK SCHOOL UNIT			ROSETOWN SCHOOL UNIT		
	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %
INCORPORATED COMMUNITIES									
CONQUEST									
school	-	-	-	39.0	40.2	3.1	-	-	-
municipal	-	-	-	34.2	35.0	2.3	-	-	-
TOTAL	-	-	-	73.2	75.2	2.7	-	-	-
DINSMORE									
school	46.0	48.7	5.9	-	-	-	-	-	-
municipal	38.0	48.1	26.6	-	-	-	-	-	-
TOTAL	84.0	96.8	15.2	-	-	-	-	-	-
LUCKY LAKE									
school	-	-	-	39.0	40.2	3.1	-	-	-
municipal	-	-	-	43.0	51.8	20.4	-	-	-
TOTAL	-	-	-	82.0	92.0	12.2	-	-	-
MACRORIE									
school	-	-	-	39.0	40.2	3.1	-	-	-
municipal	-	-	-	30.0	41.0	36.7	-	-	-
TOTAL	-	-	-	69.0	81.2	17.7	-	-	-
MADISON									
school	46.0	48.7	5.9	-	-	-	-	-	-
municipal	28.0	57.6	105.7	-	-	-	-	-	-
TOTAL	74.0	106.3	43.6	-	-	-	-	-	-
MILDEN									
school	-	-	-	-	-	-	45.0	45.1	0.2
municipal	-	-	-	-	-	-	32.0	32.0	0.0
TOTAL	-	-	-	-	-	-	77.0	77.1	0.1

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITIES AND INCORPORATED COMMUNITIES BY SCHOOL UNITS, BASIS 1975.

	ESTON - ELROSE SCHOOL UNIT			OUTLOOK SCHOOL UNIT			ROSETOWN SCHOOL UNIT		
	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE
INCORPORATED COMMUNITIES			%			%			%
PLATO									
school	46.0	48.7	5.9	-	-	-	-	-	-
municipal	30.0	51.4	71.3	-	-	-	-	-	-
TOTAL	76.0	100.1	31.7	-	-	-	-	-	-
WISETON									
school	46.0	46.8	5.9	-	-	-	-	-	-
municipal	42.0	57.8	37.6	-	-	-	-	-	-
TOTAL	88.0	104.6	18.9	-	-	-	-	-	-

FIGURE IV-1 ALTERNATIVE 1

ELROSE AREA



3) R.M. of Fertile Valley, No. 285. The municipality of Fertile Valley is in three school units. The mill rates for those taxpayers in:

   a) the Rosetown school unit increased by 1.5 mills;

   b) the Outlook school unit increased by 2.6 mills;

   c) the Eston-Elrose school unit increased by 4.1 mills.

4) Madison. The village of Madison's school mill rate increased by 5.9 percent while the municipal rate increased by 105.7 percent. Had the burden of loss of assessment not been distributed amongst other taxpayers in the school unit, the projected mill rate would have been much higher (approximately 152.2 mills) than the 106.3 mills suggested here.

5) R.M. of Pleasant Valley, No. 288. The municipality of Pleasant Valley is representative of those municipalities (outside the study area) where the municipal mill rate is unaffected but the school mill rate increases (0.1 mills).

Table IV-4 shows a comparison of right-of-way tax levy lost by municipalities and communities and the increase in tax levy on the remaining assessment. The right-of-way tax levy lost is calculated by multiplying the loss of assessment by the present mill rate, while the increase in tax levy on the remaining assessment is calculated by multiplying the projected total assessment by the projected increase in mill rate. This table illustrates the distributional effects once more as it shows that any one group of taxpayers can either pay more or less than the actual tax levy lost in their tax zone. For example, in the municipality of Lacadena, the right-of-way levy lost is $30,713 and the increase in tax levy on the remaining assessment is $33,016. These taxpayers must not only make up the loss of tax levy in their own

TABLE IV-4

A COMPARISON OF RIGHT-OF-WAY TAX LEVY LOST AND THE INCREASE IN TAX LEVY ON REMAINING ASSESSMENT, BASIS 1975

ALTERNATIVE 1	ESTON-ELROSE SCHOOL UNIT		OUTLOOK SCHOOL UNIT		ROSETOWN SCHOOL UNIT	
	RIGHT-OF-WAY TAX LEVY LOST	INCREASE IN TAX LEVY ON REMAINING ASSESSMENT	RIGHT-OF-WAY TAX LEVY LOST	INCREASE IN TAX LEVY ON REMAINING ASSESSMENT	RIGHT-OF-WAY TAX LEVY LOST	INCREASE IN TAX LEVY ON REMAINING ASSESSMENT
MUNICIPALITIES			$			
225 Canaan	-	-	828	2,479	-	-
226 Victory	-	706	4,341	4,945	-	-
228 Lacadena	30,713	33,016	-	-	-	-
255 Coteau	-	-	6,975	5,952	-	-
256 King George	-	4,269	-	324	-	-
257 Monet	21,540	24,996	-	-	-	173
259 Snipe Lake	27,094	36,707	-	-	-	-
260 Newcombe	501	3,299	-	-	-	-
285 Fertile Valley	937	2,862	9,253	7,113	-	474
286 Milden	2,530	3,970	-	-	1,342	1,484
287 St. Andrews	-	457	-	-	6,979	3,769
288 Pleasant Valley	-	-	-	-	-	241
INCORPORATED COMMUNITIES						
Elrose	10,307	7,106	-	-	-	-
Eston	25,353	19,192	-	-	-	-
Kyle	7,845	5,985	-	-	-	-
Beechy	-	-	13,751	8,091	-	-
Birsay	-	-	4,020	2,258	-	-
Bounty	-	-	-	104	-	-
Conquest	-	-	603	706	-	-
Dinsmore	14,595	8,355	-	-	-	-
Lucky Lake	-	-	8,258	4,935	-	-
Macrorie	-	-	3,222	1,552	-	-
Madison	5,901	2,437	-	-	-	-
Milden	-	-	-	-	-	47
Plato	3,844	1,704	-	-	-	-
Wiseton	7,452	3,742	-	-	-	-

tax zone but are also responsible for $697 ($33,713 - $33,016) of increased tax levies attributable to lost assessment in other tax zones. This is due to the averaging effect of mill rates which apply equally to all zones within a jurisdiction.

Alternative II

For purposes of Alternative II, it was assumed that the McMorran and Matador subdivisions are closed and an eight-mile link is constructed between White Bear and Kyle. The largest projected loss of assessment and tax levy would once again occur in the R.M. of Lacadena. This loss is $145,260 and represents 2.0 percent of the total assessment and a loss of $12,565 of tax levy. None of the incorporated communities would experience any loss of assessment under this alternative. It should be noted that the additional eight miles of rail line constructed was assumed to be assessed at $800 per mile ($6,400) and was included in the figure "loss of taxable assessment" in Table IV-5 ($151,660 - $6,400 = $145,260).

Figure IV-2 shows the increase in mill rate for each tax zone in the study area under Alternative II. The largest increase in total mill rate in a rural municipality was in Lacadena which increased 1.2 miles or 1.4 percent.

Other distributional effects of Alternative II are as follows:

1) There was no change in the school mill rate or municipal mill rate for any tax zone in the Outlook School District.

2) While there were no changes in the municipal mill rates in the incorporated communities, those communities

TABLE IV-5 : LOSS OF TAXABLE ASSESSMENT BY TAXING AUTHORITY AND PROJECTED SCHOOL AND MUNICIPAL MILL RATES

		ESTON-ELROSE SCHOOL UNIT			OUTLOOK SCHOOL UNIT			ROSETOWN SCHOOL UNIT					
ALTERNATIVE 2	TOTAL TAX ASSESSMENT	TAXABLE ASSESSMENT	LOSS OF TAXABLE ASSESSMENT	PROJECTED TAXABLE ASSESSMENT	TAXABLE ASSESSMENT	LOSS OF TAXABLE ASSESSMENT	PROJECTED TAXABLE ASSESSMENT	TAXABLE ASSESSMENT	LOSS OF TAXABLE ASSESSMENT	PROJECTED TAXABLE ASSESSMENT	PROJECTED TOTAL TAX ASSESSMENT	PRESENT MUNICIPAL MILL RATE	PROJECTED MUNICIPAL MILL RATE
MUNICIPALITIES													
225 Canaan	1,661,510	-	-	-	1,661,510	-	1,661,510	-	-	-	1,661,510	52.5	52.5
226 Victory	2,965,670	201,720	-	201,720	2,524,450	-	2,524,450	-	-	-	2,965,670	44.2	44.2
228 Lacadena	7,379,780	7,379,780	145,260	7,234,520	-	-	-	-	-	-	7,234,520	40.5	41.3
255 Coteau	2,003,000	-	-	-	2,003,000	-	2,003,000	-	-	-	2,003,000	45.0	45.0
256 King George	1,851,290	1,581,020	-	1,581,020	270,270	-	270,270	-	-	-	1,851,020	40.0	40.0
257 Monet	6,488,660	6,373,110	64,160	6,308,950	-	-	-	115,550	-	115,550	6,424,500	31.9	32.2
259 Snipe Lake	9,051,080	9,051,080	68,610	8,982,470	-	-	-	-	-	-	8,982,470	41.0	41.4
260 Newcombe	3,810,640	1,005,434	-	1,005,434	-	-	-	-	-	-	3,810,640	43.5	43.5
285 Fertile Valley	3,766,164	709,326	-	709,326	2,735,594	-	2,735,594	316,094		316,094	3,766,164	37.2	37.2
286 Milden	4,293,760	1,310,130	-	1,310,130	-	-	-	2,983,630	15,880	2,967,750	4,277,880	39.5	39.6
287 St. Andrews	4,929,450	134,360	-	134,360	-	-	-	4,795,090	84,090	4,711,000	4,845,360	38.0	38.7
288 Pleasant Valley	-	-	-	-	-	-	-	2,413,835	-	2,413,835	N.A.	N.A.	N.A.
Other R.M's	-	-	-	-	5,938,261	-	5,938,261	14,547,350	-	14,547,350	-	-	-
Sub-total	-	27,745,960	278,030	27,467,930	15,133,085	-	25,133,085	25,171,549	99,970	25,071,579	-	-	-
INCORPORATED COMMUNITIES													
Elrose	1,085,940	1,085,940	-	1,085,940	-	-	-	-	-	-	1,085,940	36.0	36.0
Eston	2,551,670	2,551,670	-	2,551,670	-	-	-	-	-	-	2,551,670	49.0	49.0
Kyle	985,530	985,530	-	985,530	-	-	-	-	-	-	985,530	39.0	39.0
Beechy	638,660	-	-	-	638,660	-	638,660	-	-	-	638,660	47.0	47.0
Birsay	171,110	-	-	-	171,110	-	171,110	-	-	-	171,110	43.0	43.0
Bounty	86,780	-	-	-	86,780	-	86,780	-	-	-	86,780	30.0	30.0
Conquest	361,040	-	-	-	361,040	-	361,040	-	-	-	361,040	34.2	34.2
Dinsmore	826,510	826,510	-	826,510	-	-	-	-	-	-	826,510	38.0	38.0
Lucky Lake	594,180	-	-	-	594,180	-	594,180	-	-	-	594,180	43.0	43.0
Macrorie	173,930	-	-	-	173,930	-	173,930	-	-	-	173,930	30.0	30.0
Madison	155,190	155,190	-	155,190	-	-	-	-	-	-	155,190	28.0	28.0
Milden	469,880	-	-	-	-	-	-	469,880	-	469,880	469,880	32.0	32.0
Plato	121,290	121,290	-	121,290	-	-	-	-	-	-	121,290	30.0	30.0
Wiseton	310,095	84,680	-	84,680	-	-	-	-	-	-	310,095	42.0	42.0
Others	-	-	-	-	4,442,400	-	4,442,400	7,845,280	-	7,845,280	-	-	-
Sub-Total	-	6,036,225	-	6,036,225	6,468,100	-	6,468,100	8,315,160	-	8,315,160	-	-	-
TOTAL	-	33,782,185	278,030	33,507,155	21,601,185		21,601,185	33,486,709	99,970	33,386,739	-	-	-
Present School Mill Rate		46.0			39.0		45.0						
Projected School Mill Rate		46.4			39.0		45.1						

FIGURE IV-2 ALTERNATIVE II

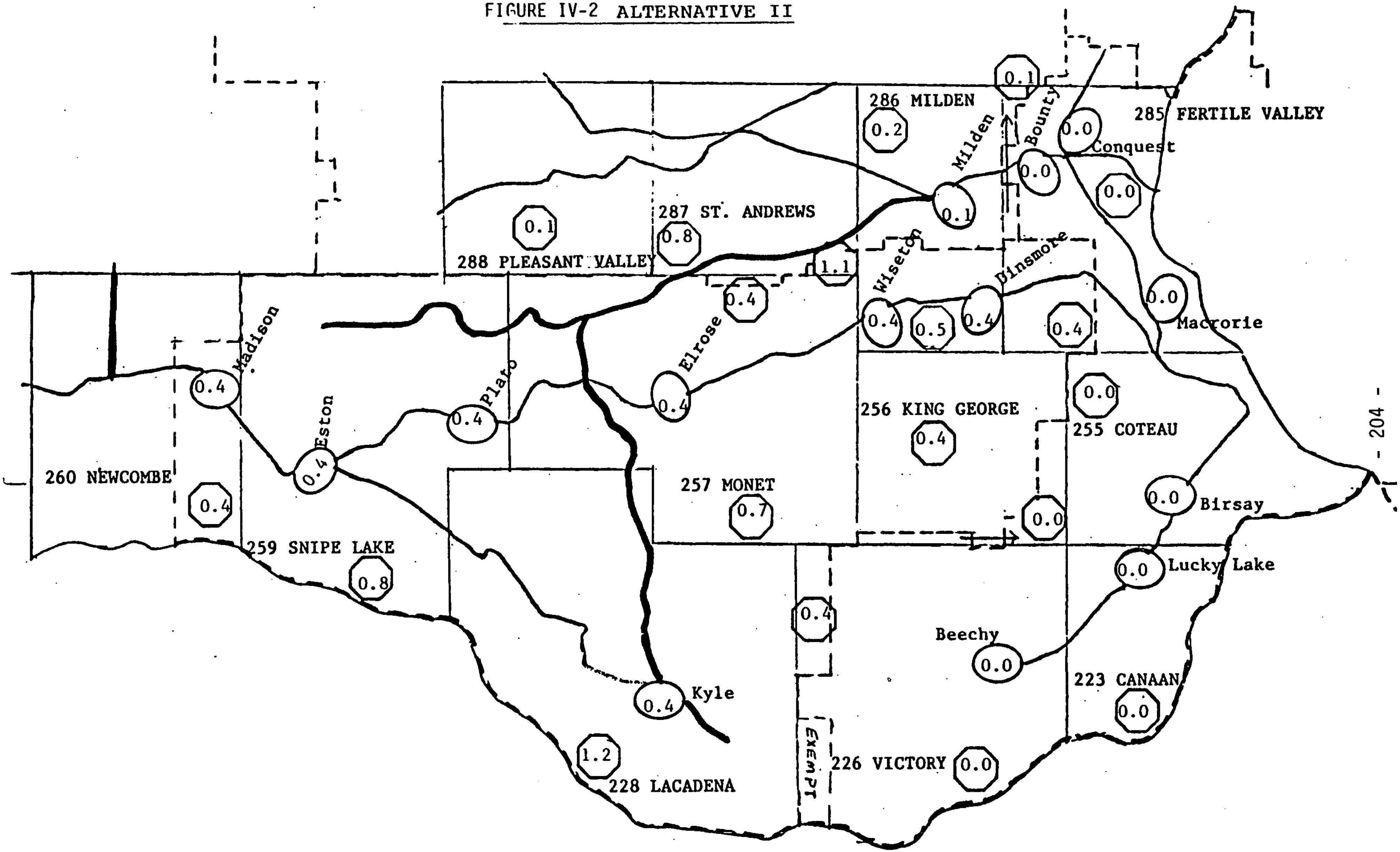


TABLE IV-6

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITES AND INCORPORATED COMMUNITIES BY SCHOOL UNITS, BASIS 1975.

	ESTON - ELROSE SCHOOL UNIT			OUTLOOK SCHOOL UNIT			ROSETOWN SCHOOL UNIT		
ALTERNATIVE 2	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %
MUNICIPALITIES									
225 CANAAN									
school	-	-	-	39.0	39.0	0.0	-	-	-
municipal	-	-	-	52.5	52.5	0.0	-	-	-
TOTAL	-	-	-	91.5	91.5	0.0	-	-	-
226 VICTORY									
school	46.0	46.4	0.9	39.0	39.0	0.0	-	-	-
municipal	44.2	44.2	0.0	44.2	44.2	0.0	-	-	-
TOTAL	90.2	90.6	0.4	83.2	83.2	0.0	-	-	-
228 LACADENA									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	40.5	41.3	2.0	-	-	-	-	-	-
TOTAL	86.5	87.7	1.4	-	-	-	-	-	-
255 COTEAU									
school	-	-	-	39.0	39.0	0.0	-	-	-
municipal	-	-	-	45.0	45.0	0.0	-	-	-
TOTAL	-	-	-	84.0	84.0	0.0	-	-	-
256 KING GEORGE									
school	46.0	46.4	0.9	39.0	39.0	0.0	-	-	-
municipal	40.0	40.0	0.0	40.0	40.0	0.0	-	-	-
TOTAL	86.0	86.4	0.5	79.0	79.0	0.0	-	-	-
257 MONET									
school	46.0	46.4	0.9	-	-	-	45.0	45.1	0.2
municipal	31.9	32.2	0.9	-	-	-	31.9	32.2	0.9
TOTAL	77.9	78.6	0.9	-	-	-	76.9	77.3	0.5

TABLE IV-6 cont'd

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITIES AND INCORPORATED COMMUNITIES BY SCHOOL UNITS, BASIS 1975.

ALTERNATIVE 2	ESTON - ELROSE SCHOOL UNIT			OUTLOOK SCHOOL UNIT			ROSETOWN SCHOOL UNIT		
	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %
MUNICIPALITIES									
259 SNIPE LAKE									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	41.0	41.4	1.0	-	-	-	-	-	-
TOTAL	87.0	87.8	0.9	-	-	-	-	-	-
260 NEWCOMBE									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	43.5	43.5	0.0	-	-	-	-	-	-
TOTAL	89.5	89.9	0.4	-	-	-	-	-	-
285 FERTILE VALLEY									
school	46.0	46.4	0.9	39.0	39.0	0.0	45.0	45.1	0.2
municipal	37.2	37.2	0.0	37.2	37.2	0.0	37.2	37.2	0.0
TOTAL	83.2	83.6	0.5	76.2	76.2	0.0	82.2	82.3	0.1
286 MILDEN									
school	46.0	46.4	0.9	-	-	-	45.0	45.1	0.2
municipal	39.5	39.6	0.3	-	-	-	39.5	39.6	0.3
TOTAL	85.5	86.0	0.6	-	-	-	84.5	84.7	0.2
287 ST. ANDREWS									
school	46.0	46.4	0.9	-	-	-	45.0	45.1	0.2
municipal	38.0	38.7	1.8	-	-	-	38.0	38.7	1.8
TOTAL	84.0	85.1	1.3	-	-	-	83.0	83.8	1.0
288 PLEASANT VALLEY[1]									
school	-	-	-	-	-	-	45.0	45.1	0.2
municipal	-	-	-	-	-	-	-	-	0.0
TOTAL	-	-	-	-	-	-	45.0	45.1	0.2

1 The municipality of Pleasant Valley is representative of those municipalities within the Rosetown School Unit whre the municipal mill rate is unaffected.

TABLE IV-6 (cont'd)

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITIES AND INCORPORATED COMMUNITIES BY SCHOOL UNITS, BASIS 1975.

	ESTON - ELROSE SCHOOL UNIT			OUTLOOK SCHOOL UNIT			ROSETOWN SCHOOL UNIT		
ALTERNATIVE 2	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %
INCORPORATED COMMUNITIES									
ELROSE									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	36.0	36.0	0.0	-	-	-	-	-	-
TOTAL	82.0	82.4	0.5	-	-	-	-	-	-
ESTON									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	49.0	49.0	0.0	-	-	-	-	-	-
TOTAL	95.0	95.4	0.4	-	-	-	-	-	-
KYLE									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	39.0	39.0	0.0	-	-	-	-	-	-
TOTAL	85.0	85.4	0.5	-	-	-	-	-	-
BEECHY									
school	-	-	-	39.0	39.0	0.0	-	-	-
municipal	-	-	-	47.0	47.0	0.0	-	-	-
TOTAL	-	-	-	86.0	86.0	0.0	-	-	-
BIRSAY									
school	-	-	-	39.0	39.0	0.0	-	-	-
municipal	-	-	-	43.0	43.0	0.0	-	-	-
TOTAL	-	-	-	82.0	82.0	0.0	-	-	-
BOUNTY									
school	-	-	-	39.0	39.0	0.0	-	-	-
municipal	-	-	-	30.0	30.0	0.0	-	-	-
TOTAL	-	-	-	69.0	69.0	0.0	-	-	-

TABLE IV-6 (cont'd)

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITIES AND INCORPORATED COMMUNITIES BY SCHOOL UNITS, BASIS 1975.

ALTERNATIVE 2	ESTON - ELROSE SCHOOL UNIT PRESENT MILL RATE	ESTON - ELROSE SCHOOL UNIT NEW MILL RATE	ESTON - ELROSE SCHOOL UNIT PERCENTAGE CHANGE %	OUTLOOK SCHOOL UNIT PRESENT MILL RATE	OUTLOOK SCHOOL UNIT NEW MILL RATE	OUTLOOK SCHOOL UNIT PERCENTAGE CHANGE %	ROSETOWN SCHOOL UNIT PRESENT MILL RATE	ROSETOWN SCHOOL UNIT NEW MILL RATE	ROSETOWN SCHOOL UNIT PERCENTAGE CHANGE %
INCORPORATED COMMUNITIES									
CONQUEST									
school	-	-	-	39.0	39.0	0.0	-	-	-
municipal	-	-	-	34.2	34.2	0.0	-	-	-
TOTAL	-	-	-	73.2	73.2	0.0	-	-	-
DINSMORE									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	38.0	38.0	0.0	-	-	-	-	-	-
TOTAL	84.0	84.4	0.5	-	-	-	-	-	-
LUCKY LAKE									
school	-	-	-	39.0	39.0	0.0	-	-	-
municipal	-	-	-	43.0	43.0	0.0	-	-	-
TOTAL	-	-	-	82.0	82.0	0.0	-	-	-
MACRORIE									
school	-	-	-	39.0	39.0	0.0	-	-	-
municipal	-	-	-	30.0	30.0	0.0	-	-	-
TOTAL	-	-	-	69.0	69.0	0.0	-	-	-
MADISON									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	28.0	28.0	0.0	-	-	-	-	-	-
TOTAL	74.0	74.4	0.5	-	-	-	-	-	-
MILDEN									
school	-	-	-	-	-	-	45.0	45.1	0.2
municipal	-	-	-	-	-	-	32.0	32.0	0.0
TOTAL	-	-	-	-	-	-	77.0	77.1	0.1

TABLE IV-6 (cont'd)

PRESENT AND PROJECTED MILL RATES OF MUNICIPALITIES AND INCORPORATED COMMUNITIES BY SCHOOL UNITS, BASIS 1975.

ALTERNATIVE 2	ESTON - ELROSE SCHOOL UNIT PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	OUTLOOK SCHOOL UNIT PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %	ROSETOWN SCHOOL UNIT PRESENT MILL RATE	NEW MILL RATE	PERCENTAGE CHANGE %
INCORPORATED COMMUNITIES									
PLATO									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	30.0	30.0	0.0	-	-	-	-	-	-
TOTAL	76.0	76.4	0.5	-	-	-	-	-	-
WISETON									
school	46.0	46.4	0.9	-	-	-	-	-	-
municipal	42.0	42.0	0.0	-	-	-	-	-	-
TOTAL	88.0	88.4	0.5	-	-	-	-	-	-

in the Eston-Elrose School District would experience an increase of 0.4 mills due to the increase in the school portion of the total mill rate.

3) Milden. The village of Milden is on a protected line and does not have an increase in municipal mill rate yet its total projected mill rate would increase by 0.1 mills as a result of the change in school mill rate in the Rosetown School District.

Table IV-7 shows the right-of-way tax levy lost and the increase in tax levy on remaining assessment for municipalities and communities under Alternative II. As stated before, none of the incorporated communities experienced a loss of assessment, however, those communities in the Eston-Elrose and Rosetown School Districts will have an increase in the tax levy due to the increase of the school mill rates. These communities will now contribute a larger proportion of the total school tax levy to the school district than before abandonment.

TABLE IV-7

A COMPARISON OF RIGHT-OF-WAY TAX LEVY LOST AND THE INCREASE IN TAX LEVY ON REMAINING ASSESSMENT, BASIS 1975

	ESTON-ELROSE SCHOOL UNIT		OUTLOOK SCHOOL UNIT		ROSETOWN SCHOOL UNIT	
ALTERNATIVE II	RIGHT-OF-WAY TAX LEVY LOST	INCREASE IN TAX LEVY ON REMAINING ASSESSMENT	RIGHT-OF-WAY TAX LEVY LOST	INCREASE IN TAX LEVY ON REMAINING ASSESSMENT	RIGHT-OF-WAY TAX LEVY LOST	INCREASE IN TAX LEVY ON REMAINING ASSESSMENT
MUNICIPALITIES	$	$	$	$	$	$
225 Canaan	-	-	-	-	-	-
226 Victory	-	81	-	-	-	-
228 Lacadena	12,565	8,681	-	-	-	-
255 Coteau	-	-	-	-	-	-
256 King George	-	632	-	-	-	-
257 Monet	4,998	4,416	-	-	-	46
259 Snipe Lake	5,969	7,186	-	-	-	-
260 Newcombe	-	402	-	-	-	-
285 Fertile Valley	-	284	-	-	-	32
286 Milden	-	655	-	-	1,358	594
287 St. Andrews	-	148	-	-	7,063	3,769
288 Pleasant Valley	-	-	-	-	-	241
INCORPORATED COMMUNITIES						
Elrose	-	434	-	-	-	-
Eston	-	1,021	-	-	-	-
Kyle	-	394	-	-	-	-
Beechy	-	-	-	-	-	-
Birsay	-	-	-	-	-	-
Bounty	-	-	-	-	-	-
Conquest	-	-	-	-	-	-
Dinsmore	-	331	-	-	-	-
Lucky Lake	-	-	-	-	-	-
Macrorie	-	-	-	-	-	-
Madison	-	62	-	-	-	-
Milden	-	-	-	-	-	47
Plato	-	49	-	-	-	-
Wiscton	-	34	-	-	-	-

A P P E N D I X

APPENDIX

Additional Effects

One of the effects of rail service discontinuance is to increase the average haul of producer in the delivery of grains. Since the assessment of arable land for tax purposes recognizes the distance to market as a determinant of land productivity, it is important that this element be included in the measurement of impact of rail service discontinuance.

This element has two effects of interest. First, the decreased assessment of arable land results in a lower rate of taxation (cost of production) to producers. Second, the decreased assessment reduces the tax base of rural municipalities and school district. From a system's view these effects cancel each other in total but have a distributional effect between the elements of the system.

From the producer's point of view, the reduced taxes partially offset the increased transportation costs involved in delivering grain increased distances. If this approach is taken, then it is valid to attribute a cost of rail service discontinuance to rural municipalities equal to lost tax revenues.

The purpose of this appendix is to explore:

1) the magnitude of tax savings by producers as compared to increased trucking costs, and

2) the magnitude of revenues lost by rural municipalities.

Impact on Producers

The increase in trucking costs experienced by producers is equal to the increase in bushel-miles required to deliver grain involved in the abandonment of a branch line multiplied by the cost of transporting grain in cents per bushel-mile. The related decrease in tax, on the other hand, is determined by multiplying the original assessment by discount factor times the current mill rate. Since the discount factor varies with the miles to market and the land assessment varies with the yield of arable land, it is likely that the increase in trucking costs and the decrease in taxes are closely related. The following hypothetical example will serve to demonstrate the relationship discussed above.

Assumptions

R.M. with 210 thousand acres
200 thousand acres arable

Land Assessment	=	\$4,700,000
Total Assessment	=	\$5,000,000
Trucking costs	=	5 cents per bushel-mile
Average yield	=	15 bushels per acre
Total production	=	3,000,000 bushels
Current mill rate	=	80 mills
Original average trucking distance	=	5 miles

Adjustments for accessibility to markets (See Table IV-A.1)

TABLE IV-A.1

TABLE OF DISCOUNTS TO MARKET

Discounts for Accessibility to Market

Miles	Adjusted Percent	Miles	Adjusted Percent	Miles	Adjusted Percent
1	0	21	11	41	14
2	1	22	11	42	14
3	2	23	11	43	15
4	3	24	12	44	15
5	4	25	12	45	15
6	5	26	12	46	15
7	6	27	12	47	15
8	6	28	12	48	15
9	7	29	13	49	15
10	7	30	13	50	15
11	8	31	13	51	15
12	8	32	13	52	15
13	9	33	13	53	16
14	9	34	13	54	16
15	9	35	14	55	16
16	10	36	14	56	16
17	10	37	14	57	16
18	10	38	14	58	16
19	11	39	14	59	16
20	11	40	14	60	16

The additional trucking costs and reduced taxes for the total Rural Municipality are as follows:

TABLE IV-A.2

RELATIONSHIP BETWEEN INCREASED TRUCKING COSTS AND DECREASED LAND TAXES

Additional Miles	Additional Bushel-Miles (000,000's)	Additional Trucking Costs ($)	Discount Factor (%)	Reduced Taxes	Taxes as % of Trucking Cost
1	3	15,000	1	3,760	25.07
5	15	75,000	3	11,280	15.04
10	30	150,000	5	18,800	12.53
15	45	225,000	7	26,320	11.70
20	60	300,000	8	30,080	10.27
25	75	375,000	9	33,840	9.02

The above table shows that the reduced taxes significantly reduce the impact of trucking costs. In addition it indicates that the reduction in taxes is a more important element in smaller increases in trucking distances. The exact relationship between additional trucking costs and reduced property taxes will vary between rural municipalities but it is likely in the range of one-fifth to one-third of additional trucking costs for moderate increases in distance.

Impact on Rural Municipalities and School Districts

The direct effect of rail line abandonment on rural municipalities and school districts will be to lose the taxes paid by the railways and rail dependent facilities such as elevators. Indirectly, these tax authorities lose taxes because of downward adjusted assessment. Table IV-A.3 suggests the magnitude of these losses.

TABLE IV-A.3

EFFECT ON R.M. REVENUE OF TRUCKING DISTANCE ADJUSTMENT OF ASSESSMENT

Additional Miles	Original Assessment	Loss of Assessment (Distance adj.)	Percentage Loss (%)	Lost Revenue ($)
1	5,000,000	47,000	.94	3,760
5	5,000,000	141,000	2.8	11,280
10	5,000,000	235,000	4.7	18,800
15	5,000,000	329,000	6.6	26,320
20	5,000,000	376,000	7.5	30,080
25	5,000,000	423,000	8.5	33,840

The above table indicates that the downward adjustment of land assessment has a significant effect on rural municipality and school district revenues when increased trucking distances are moderate to high. The size of this lost revenue is probably greater than the direct loss from railways and rail related taxpayers.