5. RISK ANALYSIS FOR REPRESENTATIVE CORRIDOR

5.1 Introduction

The previous chapter presented a number of different risk measures to allow a comparison of road and rail transport of dangerous goods under similar conditions. It is also useful to determine total risks for a representative corridor, to demonstrate the application of the risk analysis model to a real-life situation, and to allow a comparison based on actual shipments of dangerous goods. This chapter demonstrates the application of the model, focusing on the methods for determining detailed population and property densities for a heavily-used dangerous goods route.

5.2 Detailed Corridor Analysis

The route chosen for the analysis was the Sarnia to Toronto corridor. An analysis of dangerous goods flows identified this corridor as one of the most heavily used in Ontario (Saccomanno, Shortreed and Van Aerde, 1988).

The detailed corridor analysis involved an in-depth examination of the Sarnia to Toronto corridor for land use characteristics. The examination was done by using topographic maps based on aerial photographs which show all land features and buildings (Energy, Mines and Resources Canada, 1986, 1985 and 1984; Pathfinder, 1985, 1983a, 1983b, 1982, 1979 and 1975).

A number of assumptions were made for determining the population at risk given the building detail. It was assumed that: there are 3 people per single family dwelling; there are 2 persons per unit in apartments and townhouses (1000 square feet per apartment and townhouse); apartments are 5 stories high in suburban areas and 10 stories high in urban areas. These assumptions are all classed as population characteristics. It was also assumed that: industrial and office buildings contain 1 person per 250 square feet; commercial buildings contain 1 person per 100 square feet; industrial, office and commercial buildings are 1 story high in suburban areas and 3 stories high in urban areas; schools contain 750 people; hospitals contain 2000 people; motels contain 20 people; major hotels contain 1000 people. These assumptions are categorized as employment characteristics.

Land use characteristics were examined in detail at distances of 100 and 300 meters. These distances were chosen because ranges of 50% and 1% lethality for LPG were of this magnitude (see Chapter 4.4; Purdy et al., 1987), as were immediate danger areas for chlorine spills (Environment Canada, 1984).

Tables 5.1, 5.2 and 5.3 present details of land use, in terms of numbers of people for both population and employment characteristics, for the Sarnia to Toronto corridor for road Route A (freeway), road Route B (non-freeway and freeway), and the rail route. The total population at distances of 0-100 m and 100-300 m are assumed to consist of 50% of the population and 50% of the employment totals. This is a tentative estimate, and could be refined at a later date. The populations calculated from densities previously determined from census data

Table 5.1. Road Route A Link Information - Population Detail.

Link #		Link Length (km)	Link Width 0 - 100 m Pop	Emp	Total	100 - 300 m Pop	Emp	Total	Previous Results (from Census Info) 0 - 100 m Total	100 - 300 m Total
1	Lucasville to Int 7-40	5.5	164	0	82	615	900	758	33	66
2	Int 7-40 to Int 40-402	1.3	16	0	8	9	0	5	30	60
3	Int 40-402 to Int 402-30	18.6	34	0	17	133	0	67	63	126
4	Int 402-30 to Int 402-21	9.3	0	0	0	26	0	13	19	37
5	Int 402-21 to Int 402-7	3.7	0	0	0	9	0	5	7	15
6	Int 402-7 to Int 402-79	6.5	0	0	0	13	0	7	13	26
7	Int 402-79 to Int 402-81	20.3	0	0	0	3	0	2	41	81
8	Int 402-81 to Int 81-2-402	20.5	34	0	17	382	0	191	964	1927
9	Int 81-2-402 to Int 402-4	12.3	72	0	36	215	240	228	57	113
10	Int 402-4 to Int 402-401	5.9	20	0	10	54	0	27	15	31
11	Int 402-401 to Int 401-135	2.6	10	0	5	22	0	11	408	815
12	Int 401-135 to Int 401-126	3.3	3003	453	1728	373	1330	852	1034	2068
13	Int 401-126 to Int 401-74	6.3	0	0	0	10	0	5	20	40
14	Int 401-74 to Int 401-73	7.5	10	0	5	59	0	30	38	75
15	Int 401-73 to Int 401(208)	5.5	0	0	0	35	0	18	12	24
16	Int 401(208) to Int 401-19	10.1	16	0	8	24	0	12	12	24
17	Int 401-19 to Int 401-59	13.2	3	0	2	110	460	285	53	106
18	Int 401-59 to Hwy 401(236)	4.4	80	0	40	65	1290	678	18	35
19	Hwy 401(236) to Int 401-2	1.1	10	0	5	3	0	2	4	9
20	Int 401-2 to Int 401-8	40.4	51	0	26	252	1590	921	154	307
21	Int 401-8 to Int 24-401	4.5	27	360	194	511	60	286	59	117
22	Int 24-401 to Int 6-401	12.9	9	0	5	146	200	173	129	258
23	Int 6-401 to Int 401-25	24.6	21	0	11	130	128	129	182	364
24	Int 401-25 to Hwy 401(328)	12.7	9	0	5	66	780	423	107	213
25	Hwy 401(328) to Int 10-401	9.1	9	0	5	123	725	424	31	62
26	Int 10-401 to Int 403-401	8.2	15	0	8	27	360	194	16	33
27	Int 403-401 to Int 427-401	7.8	3	0	2	141	1730	936	6	12
28	Int 427-401 to Burn.-427	3.6	357	640	499	2652	2380	2516	1735	3470
29	Burn.-427 to Int 5-427	1.9	134	3694	1914	2519	13538	8029	916	1832
30	Int 5-427 to QEW-427	1.8	9	2910	1460	117	3560	1839	868	1735
31	QEW-427 to Isl.-QEW	3.2	109	8040	4075	2529	7440	4985	1542	3085
32	Isl.-QEW to QEW-2	3.4	1165	8470	4818	1317	5040	3179	1639	3278
Total		292.0	5390	24567	14979	12690	41751	27221	10223	20445

Note: Pop - Population
Emp - Employment

Table 5.2. Road Route B Link Information - Population Detail.

Link #		Link Length (km)	Link Width 0 - 100 m Pop	Emp	Total	100 - 300 m Pop	Emp	Total	Previous Results (from Census Info) 0 - 100 m Total	100 - 300 m Total
1	Lucasville to Int 7-40	5.5	84	0	42	225	960	593	33	66
2	Int 7-40 to Int 7-21	18.6	693	290	492	291	210	251	190	379
3	Int 7-21 to Int 7-402	13.3	324	0	162	75	0	38	11	21
4	Int 7-402 to Bend 7-22	2.0	99	0	50	87	0	44	30	60
5	Bend 7-22 to Int 7-79	5.4	129	0	65	24	1500	762	2	4
6	Int 7-79 to Int 7-22	3.7	54	0	27	12	0	6	10	19
7	Int 7-22 to Int 22-81	16.5	270	770	520	57	0	29	43	86
8	Int 22-81 to Int 22-4	29.6	645	1070	858	312	230	271	505	1006
9	Int 22-4 to Int 22-126	5.0	2419	0	1210	2442	40	1241	510	1020
10	Int 22-126 to Int 2-126	5.6	555	5600	3078	3181	18000	10591	825	1651
11	Int 2-126 to Int 2-19	18.1	2537	3470	3004	4223	8740	6482	558	1115
12	Int 2-19 to Int 2-59	19.4	647	180	414	894	1830	1362	217	435
13	Int 2-59 to Int 401-2	8.0	1063	7625	4344	2154	6640	4397	781	1562
14	Int 401-2 to Int 401-8	40.4	51	0	26	252	1590	921	154	307
15	Int 401-8 to Int 24-401	4.5	27	360	194	511	60	286	59	117
16	Int 24-401 to Int 6-401	12.9	9	0	5	146	200	173	129	258
17	Int 6-401 to Int 401-25	24.6	21	0	11	130	128	129	182	364
18	Int 401-25 to Hwy 401(328)	12.7	9	0	5	66	780	423	107	213
19	Hwy 401(328) to Int 10-401	9.1	9	0	5	123	725	424	31	62
20	Int 10-401 to Int 403-401	8.2	15	0	8	27	360	194	16	33
21	Int 403-401 to Int 427-401	7.8	3	0	2	141	1730	936	6	12
22	Int 427-401 to Burn.-427	3.6	357	640	499	2652	2380	2516	1735	3470
23	Burn.-427 to Int 5-427	1.9	134	3694	1914	2519	13538	8029	916	1832
24	Int 5-427 to QEW-427	1.8	9	2910	1460	117	3560	1839	868	1735
25	QEW-427 to Isl.-QEW	3.2	109	8040	4075	2529	7440	4985	1542	3085
26	Isl.-QEW to QEW-2	3.4	1165	8470	4818	1317	5040	3179	1639	3278
Total		284.8	11437	43119	27278	24507	75681	50094	11095	22190

Note: Pop - Population
Emp - Employment

Table 5.3. Rail Link Information - Population Detail.

Link #		Link Length (km)	Link Width 0 - 100 m Pop	Emp	Total	100 - 300 m Pop	Emp	Total	Previous Results (from Census Info) 0 - 100 m Total	100 - 300 m Total
1	Sarnia	2.7	12	334	173	90	136	113	639	1678
2	Sarnia to Mandaumin	10.3	15	51	33	36	24	30	45	91
3	Mandaumin to Wyoming	9.7	36	0	18	69	750	410	128	256
4	Wyoming to Wanstead	6.3	21	0	11	21	0	11	117	234
5	Wanstead to Watford	13.8	21	0	11	42	0	21	91	182
6	Watford to Strathroy	22.0	30	100	65	177	180	179	400	801
7	Strathroy to CN-CP Int	13.8	30	160	95	63	355	209	265	530
8	CN-CP Int to Komoka	3.2	7	40	24	45	120	83	20	40
9	Komoka to CN-CP Int	6.7	39	40	40	87	160	124	66	131
10	CN-CP Int to Int	2.8	3	0	2	36	20	28	20	40
11	Int to London	6.8	840	2340	1590	2660	8940	5800	2131	4262
12	London	2.5	207	6960	3584	1479	31320	16400	784	1567
13	London to Ingersoll	29.5	922	3540	2231	3830	18670	11250	2230	4460
14	Ingersoll to Woodstock	15.7	734	900	817	2723	4080	3402	1005	2010
15	Woodstock	2.0	25	450	238	125	100	113	436	871
16	Woodstock to Zorra	18.0	685	80	383	1294	20	657	565	1130
17	Zorra to Paris	8.3	136	400	268	509	0	255	40	80
18	Paris	2.8	508	60	284	1292	60	676	391	783
19	Paris to Brantford	13.7	1239	2940	2090	5708	6650	6179	1595	3189
20	Brantford to Lynden	14.5	103	0	52	356	320	338	705	1409
21	Lynden to Copetown	2.7	42	70	56	114	0	57	39	78
22	Copetown to Dundas	9.2	99	40	70	1117	2530	1824	1483	2966
23	Dundas to Hamilton	5.3	111	0	56	669	0	335	2645	5289
24	Hamilton to Burlington	8.4	541	1160	851	1600	980	1290	4192	8383
25	Burlington to Bronte Stn	8.5	129	2180	1155	2335	9540	5938	1100	2200
26	Bronte Stn to Oakville	6.5	12	1700	856	228	6400	3314	714	1427
27	Oakville to CN Junc Metro	21.7	6343	2760	4552	10827	20055	15441	2383	4765
28	CN Junc Metro to Metro	6.4	3527	4920	4224	2380	16840	9610	7895	15790
Total		273.8	16417	31225	23821	39912	128250	84081	32322	64644

Note: Pop - Population
Emp - Employment

(Saccomanno, Shortreed and Van Aerde, 1988) for the Sarnia to Toronto corridor are also presented in these tables. This allows a comparison of the population at risk determined by both methods. Census data tend to be for large land areas, and may underestimate the number of people at risk.

The cumulative totals of population for distances 0 to 100 meters and 100 to 300 meters from the link for the detailed analysis and the census analysis are shown graphically in Figures 5.1, 5.2 and 5.3. Note that relying on the census alone underestimates the population by an average factor of 1.4 for road route A, and 2.4 for road route B. For the rail route, the 100 to 300 meters distance total is underestimated by a factor of 1.3, but for the 0 to 100 meters distance, the census overestimates the population by a factor of 1.4.

Figures 5.1, 5.2 and 5.3 demonstrate the usefulness of determining detailed population and employment characteristics of an area by comparing the population determined by census with that determined by the detailed analysis. Although the detailed results are estimates (for example, buildings are not always identified as being industrial, commercial or residential on the detailed maps, so some assumptions have to made), they can differ by a substantial amount from the census numbers.

5.3 Application and Results

The previous chapter presented a number of risk measures for dangerous goods transport, and compared total risk from the spill with estimated risk from the accident itself for some typical links. This section presents the results of the risk analysis model, giving the risk due to the spill for chlorine and LPG for the Sarnia to Toronto corridor. The estimated risk from the accident is also given, allowing a comparison of total risk for road and rail.

The risk analysis model was run using the detailed population characteristics. A comparison was made with previous risk estimates for LPG (Saccomanno, Shortreed and Van Aerde, 1988), where population densities were determined from census information.

The risk model for LPG gives fatalities for pool fire and fireball events, so the model was run separately for these and combined, assuming a frequency of occurrence of 0.6 for pool fire and 0.4 for fireball (Purdy et al., 1987).

Accident rates are the same as those used previously, including a 20% reduction in rail accident rates (see Chapter 4). For chlorine, a rail tank car was assumed to carry 90 tonnes, and a truck tanker 27 tonnes. For LPG, the amounts carried were assumed to be 63.5 tonnes and 18.1 tonnes for rail and truck respectively.

Figures 5.4 and 5.5 compare cumulative road and rail risks for chlorine, excluding the accident, for the Sarnia to Toronto corridor on a per vehicle and a per tonne basis respectively. For chlorine, risks from the spill itself (in terms of fatalities) were approximately 10 times higher for rail than road. When risks were expressed on a per tonne basis, rail risks

Figure 5.1. Comparison of Detail Information with Census Data - Road Route A.

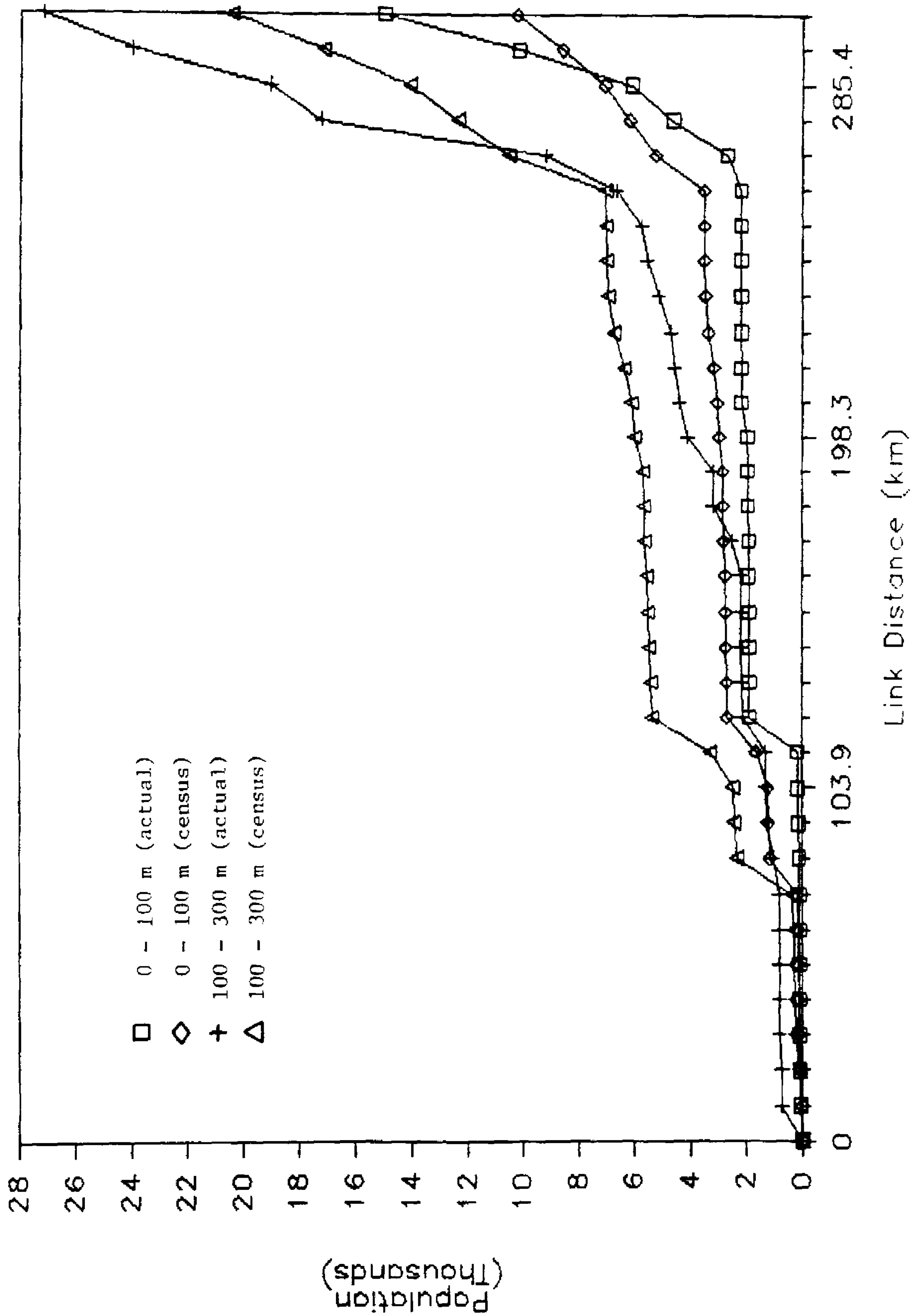


Figure 5.2. Comparison of Detail Information with Census Data - Road Route B.

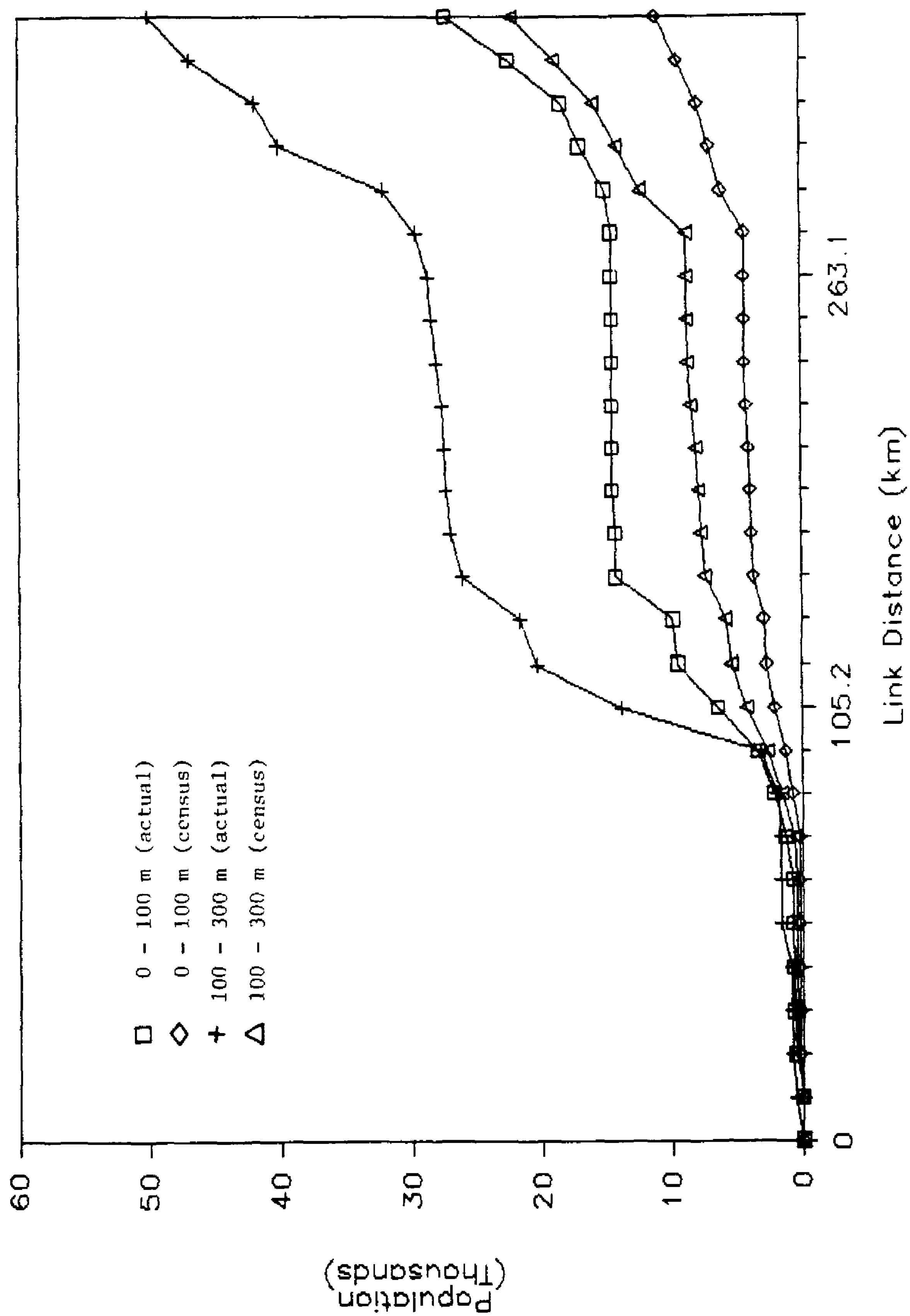


Figure 5.3. Comparison of Detail Information with Census Data - Rail Route.

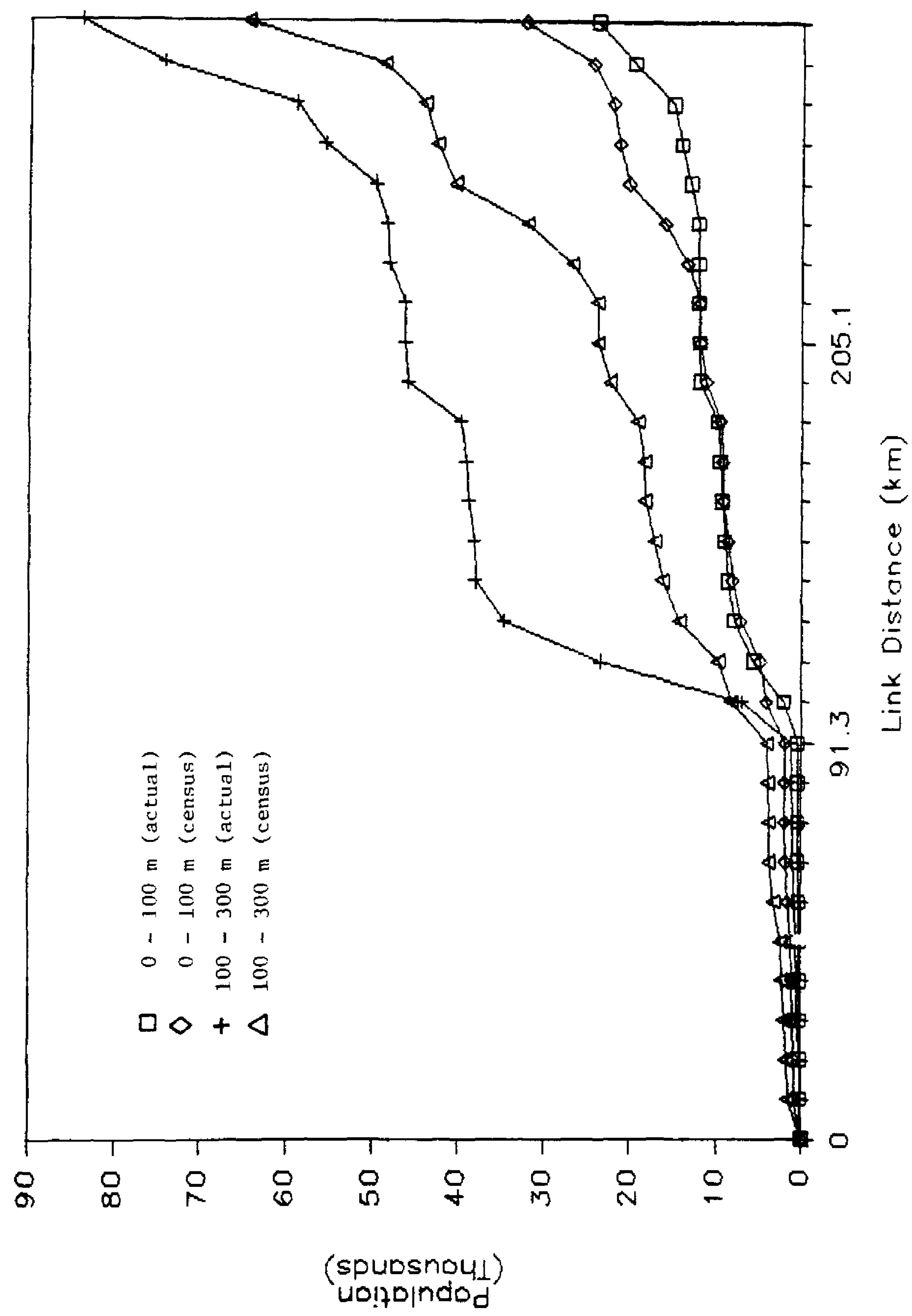


Figure 5.4. Chlorine Road and Rail Risks - Fatalities per Vehicle (Excluding Accident).

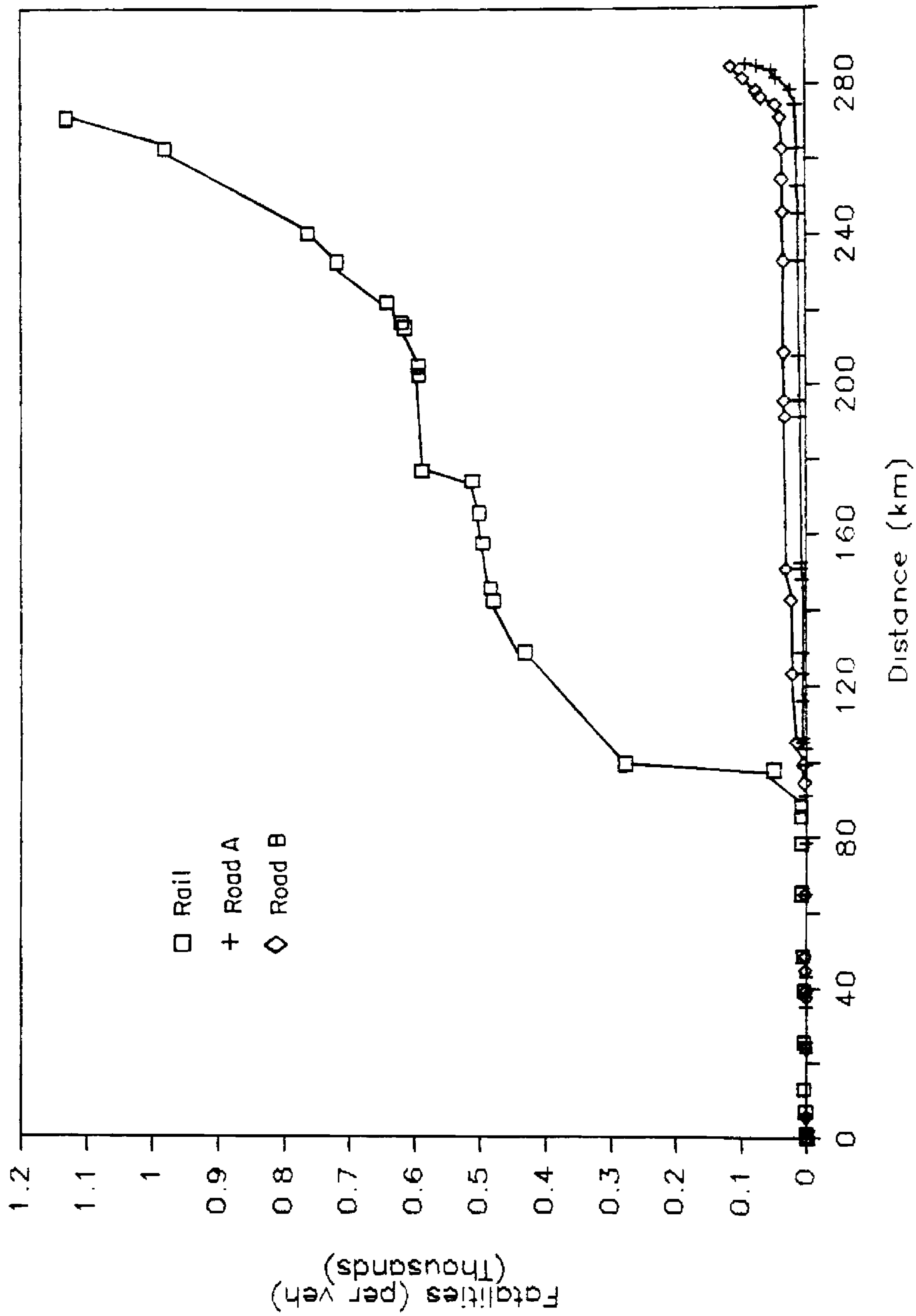
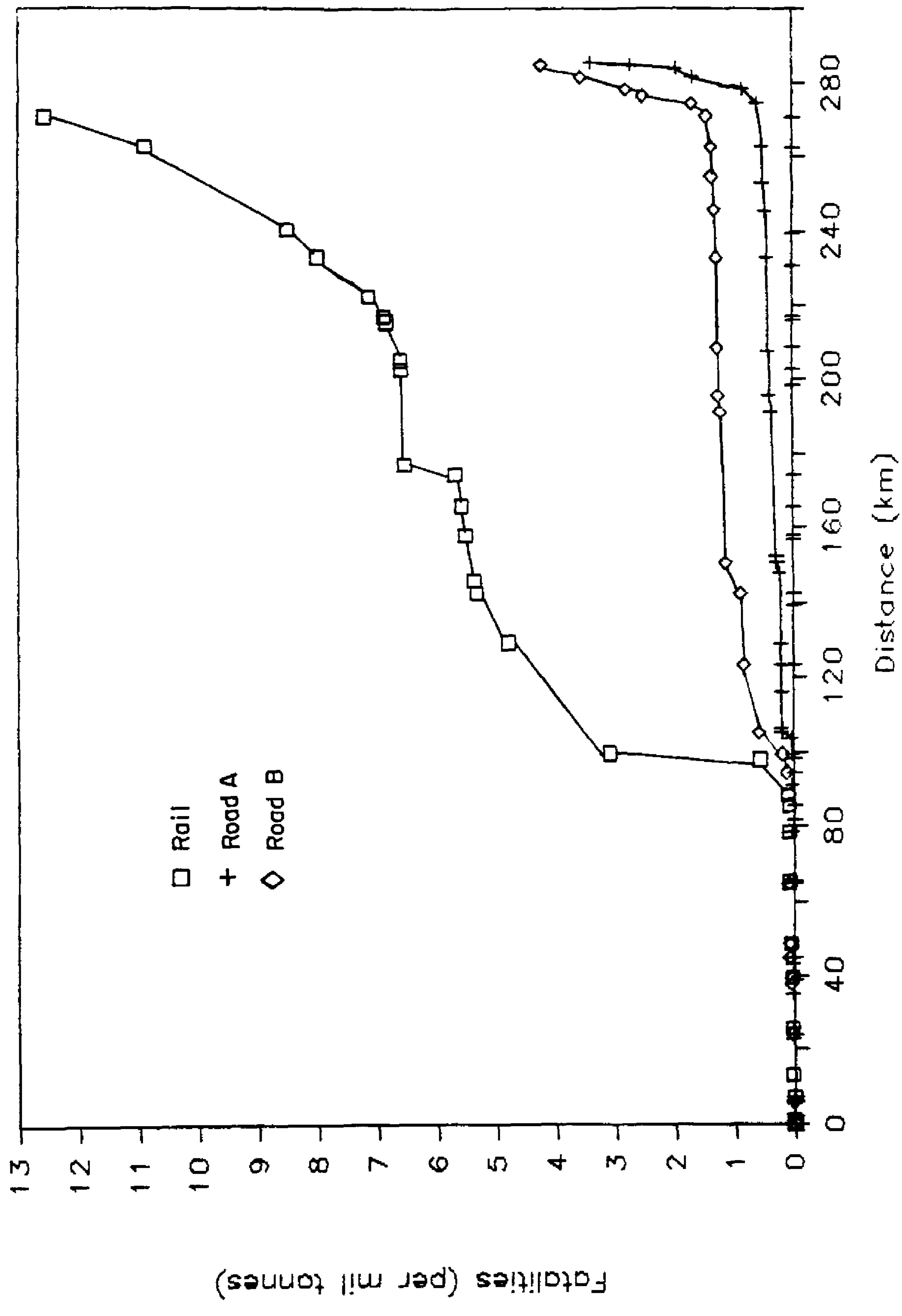


Figure 5.5. Chlorine Road and Rail Risks - Fatalities per Tonne (Excluding Accident).



were about three times as high as those for road.

Figures 5.6 and 5.7 give road and rail risks for LPG, excluding the accident, per vehicle and per tonne respectively. Figure 5.7 also presents previous results for LPG using census information. As previously discussed, the population information (and hence risk) is underestimated in most cases by considering the census data only.

Risks for LPG (excluding the accident) were approximately 6 times lower for rail than for road on a per vehicle basis, and approximately 22 times lower than road on a per tonne basis. Previous results (based on census information for population densities) show rail 4.5 times higher than road on a per tonne basis. Thus, it is important to consider detailed land use information in order to get a more accurate estimate of the population at risk from a dangerous goods spill.

A complete comparison of road and rail risks in terms of fatalities must include a presentation of fatalities due to the accident itself. These fatalities have been previously estimated for the Sarnia to Toronto corridor (Saccomanno, Shortreed and Van Aerde, 1988). Table 5.4 gives a summary of risks from the dangerous good and from the accident, and the resulting total risk, for chlorine and LPG. This table indicates that rail risk is 2 times greater than road risk for chlorine, and road risk is 5 times greater than rail risk for LPG on a per tonne basis. These results should be treated with caution since, as illustrated in Table 4.18, the estimated damage areas, especially for chlorine, vary widely. Further work is required to refine these estimates.

5.4 Conclusions

This chapter emphasizes the importance of accurately determining the population at risk from a spill of a dangerous good, to compare different modes of transport. Results are shown to be widely different when land use maps are used rather than census information, to determine population densities, especially in the case of the road routes from Sarnia to Toronto. This chapter also confirms the results of Chapter 4, which discusses the importance of including an estimate of people at risk from the dangerous goods accident itself as well as the people at risk from the spill. Total risk for rail transport is shown to be lower than road risk for some dangerous goods, when the fatalities due to the accident are included. Thus, a comprehensive comparison of the risk of road and rail must include consideration of the accident.

Figure 5.6. LPG Road and Rail Risks - Fatalities per Vehicle (Excluding Accident).

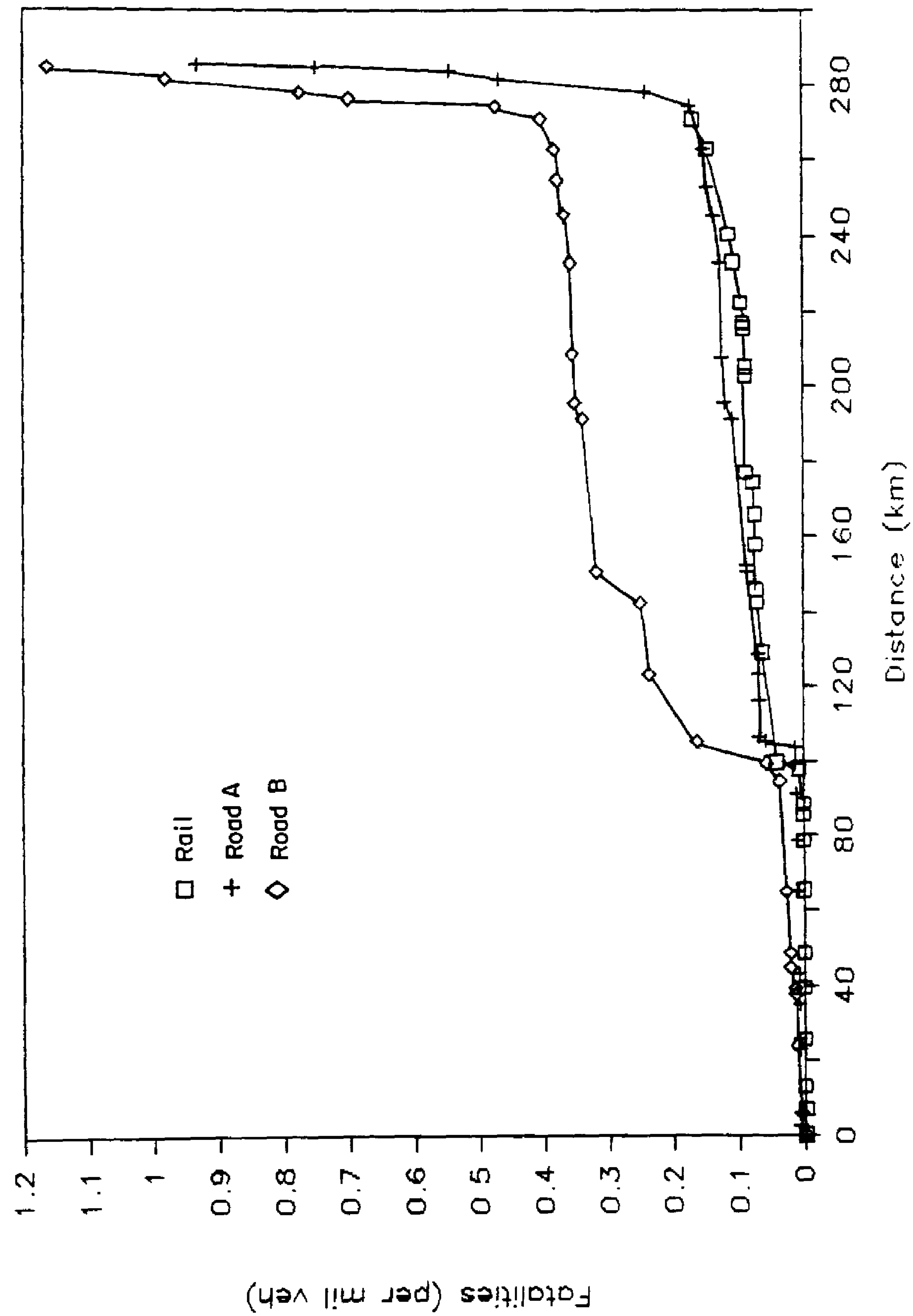


Figure 5.7. LPG Road and Rail Risks - Fatalities per Tonne (Excluding Accident).

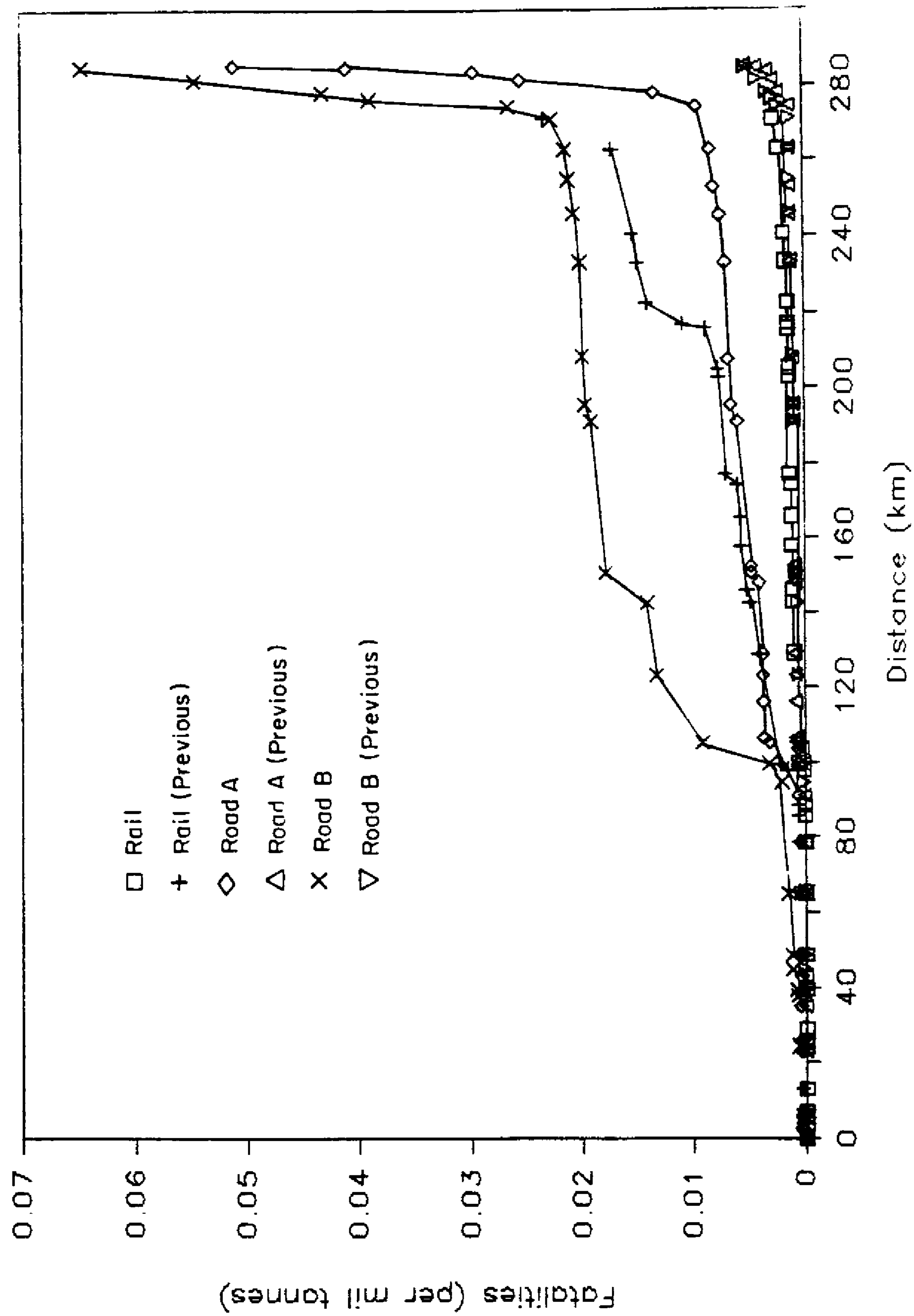


Table 5.4. Comparison of Total Fatalities from Sarnia to Toronto by Road and Rail.

	Previous Risk due to DG (Census)	Risk due to DG (Detail)	Risk due to Accident	Total Risk
	Estimated Fatalities per Million Tonnes from Sarnia to Toronto			
ROAD (Route A)				
LPG	0.0052	0.052	0.34	0.392
Chlorine	-	3.38	0.34	3.72
RAIL				
LPG	0.023	0.003	0.04	0.043
Chlorine	-	12.6	0.04	12.64

6. PERCEPTION OF ROAD AND RAIL SAFETY

6.1 Introduction

In the earlier study of road and rail safety (Saccomanno, Shortreed and Van Aerde, 1988), it was found that there was a relationship between the severity of dangerous goods incidents and the number of newspaper articles per incident. For example, for more severe incidents there were more articles. The previous work did not have enough data to determine if there was any bias in reporting between road and rail.

The first objective of this chapter was to use the methodology developed previously and expand the data base to include all of Canada (previous study was for Ontario only), and to extend the time frame to incorporate the period from August 1987 to June 1988. For this period, -data were available from both computer-based newspaper files and from Transport Canada's file of incidents involving dangerous goods that are required to be reported according to the Transportation of Dangerous Goods Act (Transport Canada, 1988). Finally, the data base was expanded by surveying newspaper articles from the Montreal Gazette as well as the Globe and Mail and Toronto Star.

The second objective was to use the expanded data base to determine if there was any indication of bias in the reporting of incidents on road versus rail mode. The hypothesis was that the newspaper industry is an accurate representation of the public perception of dangerous goods incidents. This hypothesis had been strengthened by the earlier findings of a linear relationship between the number of news articles and the severity of the incident.

6.2 Methodology

The computer data bases for the Globe and Mail, the Toronto Star and the Montreal Gazette were searched for any articles that had the following key words:

1. road or rail (or any word such as railway, truck, etc.)
2. dangerous, hazardous, fuel, chemical, etc.
3. accident, derailment, overturn, etc.

The incident data base was obtained from Transport Canada as a computer file. It covered the period from January 1986 to June 1988. It contained 1448 entries, of which 344 or 28.5% were for rail and 863 or 71.5% were for road mode.

The newspaper articles were reviewed and those related to dangerous goods incidents are listed in Table 6.1. The table is organized according to the incident data as found in the Transport Canada data base. For the time period, 17 incidents out of the 1207 in the incident data base also had at least one article in either the Globe and Mail, the Toronto Star or the Montreal Gazette. In addition, Table 6.1 lists 13 additional incidents, which appear to be dangerous goods accident/incidents but were not in the incident data base.

Table 6.1 Dangerous Goods Incidents Newspaper Articles.

GLOBE # articles	GLOBE tot words	STAR # articles	STAR tot words	GAZETTE # articles	GAZETTE tot words	REPORTED	DATE	LOCATION		DG CLASS	MODE	INJURIES	DEATHS	EVACUATED	CAUSENOTE	SPILL	POPULATION	cell
2	633	3	1002	1	317		19870812	HAMILTON	ON	31	1	2	1	300	COLLISION/OT	HIGH	HIGH	9
1	83	1	427				19870708	HUNTSVILLE	ON	31	1			300	OVERTURN	HIGH	LOW	7
1	193	1	157				19870803	STILL RIVER	ON	31	1	3			COLLISION	HIGH	LOW	7
1	64	2	553				19870326	PRESCOTT	ON	32	1		1		COLLISION/OT	MEDIUM	HIGH	6
1	53						19870415	TOPPING	ON	51	1	1			OVERTURN	HIGH	HIGH	7
1	121	1	178				19860811	NORTH YORK	ON	61	21				FL/PUNCTURE	LOW	HIGH	3
		2	459				19870714	ABERFOYLE	ON	80	1				TANK FAILURE	MEDIUM	MEDIUM	5
1	66						19870221	BARRIE	ON	80	1				PKG FAILURE	LOW	HIGH	3
		1	63				19860722	TORONTO	ON	92	21	2			IMP LOADING	LOW	HIGH	3
				1	94		19880511	BARRIE	ON	80	1			30		LOW	MEDIUM	2
				1	605		19880317	POINTE-CLAIRE	PQ	80	1					LOW	HIGH	3
				1	43		19880114	MANNING PARK	BC	51	1					LOW	LOW	1
				1	324		19871105	TORONTO	ON	70	1					MEDIUM	HIGH	6
				1	29		19860726	HUBBARDS	NS	31	1	2	1			LOW	LOW	1
				1	37		19860419	AIRDRIE	AB	24	1	6				MEDIUM	MEDIUM	5
				1	270		19860212	PARRY SOUND	ON	80	2					HIGH	MEDIUM	8
1	1402						19860215	BERNIERES	PQ	31	2	42			COLLISION	LOW	LOW	1
		1	118			N	19870523	SMITH FALLS		3	2				DERAILMENT	LOW	HIGH	3
								DG: resin solutions										
		2	556			N	19870406	ORILLIA		2	2				DERAILMENT	HIGH	HIGH	9
								DG: ethylene oxide										
		1	292			N	19861019	Toronto										
								Six trucks										
								flamable/corrosive		3/8	21				SABOTAGE	HIGH	HIGH	9
		1	76			N	19860805	ETOBICOKE		8	22				DRUM LEAKAGE	LOW	HIGH	3
1	76					N	19880315	HWY 401	ON	3	1				OVERTURN	LOW	LOW	1
=	==						=	=====	==	3	1				OVERTURN	LOW	LOW	1
		1	338			N	19871126	ETOBICOKE 401	ON	3	1				COLLISION	MEDIUM	HIGH	6
				2	488	N	19880510	LITTON	PQ	3	2				DERAILMENT	HIGH	LOW	7
				1	602	N	19870914	MONTREAL	PQ	?	1				ACCIDENT	LOW	HIGH	3
								(antifreeze)										
				1	388	N	19861001	MONTREAL	PQ	3	1/3				?	LOW	HIGH	3
								(Dorval airport)										
				1	115	N	19860729	LAVAL	PQ	?	1				LEAK	LOW	HIGH	3
								(transformer liq.)										
				1	130	N	19860712	MONTREAL (?)	PQ	?	1				?	LOW	HIGH	3
				1	273	N	19860309	SPRINGVILLE	AL	6	1	18		1500	OVERTURN	HIGH	HIGH	9

Each incident was classified by:

1. dangerous goods class (see Table 6.2)
2. mode 1,21 - road, road terminal
   2,22 - rail, rail terminal
3. damages in terms of number of persons injured, killed or evacuated
4. the cause of the incident
5. spill level Low - < 80 kg or 80 liters
   Medium - 80 to 800 kg or liters
   High - > 800 kg or liters
6. population density in vicinity of the spill
   Low - < 100 persons per square kilometer
   Medium - 100- 1000 persons " "
   High - > 1000 persons per " "
7. severity cell (see Figure 6.3)

The severity of an incident is a function of the class of dangerous good involved, the quantity spilled and the population exposed. Earlier, it had been suggested that the damages be included in the severity rating but this was not possible because of the limited data available.

For dangerous goods classes with adequate data, i.e., class 3 (flammable liquids) and class 8 (corrosive substances), the newspaper articles were compared to the severity of the incident separately for road and rail incidents.

6.3 Preliminary Analysis

The frequency of incidents, by class and mode, in the Transport Canada file are illustrated in Figure 6.1 and Figure 6.2. The predominance of class 3 and class 8 incidents is evident. There are more road incidents than rail incidents in each class, with the exception of class 2 (compressd gases).

Figure 6.3 illustrates the severity cell and mode for those incidents which appeared in newspaper articles for class 3 and class 8 only. Of the 30 newspaper articles listed in Table 6.1, 13 were in class 3, and 7 were in class 8, for a total of 20 or 67% of all incidents reported in the newspapers.

The 30 incidents reported represent 17 in the Transport Canada data base or 1.4% of all incidents, plus 13 additional incidents or .76 additional incidents per reported incident.

The number of road and rail incidents reported in newpaper articles was 22 1/2 for road (one incident was a combination of road and air modes) and 6 for rail (as indicated in Table 6.1, the mode of some incidents was not known). In percentage terms, the newspaper articles were 79% road and 21% rail. This can be compared to the distribution of incidents in the Transport Canada data base of 71.5% road and 28.5% rail. Thus, slightly more road incidents were reported than rail incidents.

If the comparison of mode reports is limited only to those in the Transport Canada data base, then 88% of the newspaper articles pertain to road incidents and 12% to rail. Again, there appears to be more reporting of road incidents than rail incidents.

Table 6.2. Dangerous Goods Classes and Subdivisions.

Class 1 - Explosives
- 1.1 Explosive
- 1.2 Explosive
- 1.3 Explosive
- 1.4 Explosive
- 1.5 Blasting Agent

Class 2 - Gases (Compressed)
- 2.1 Flammable Gas
- 2.2 Nonflammable Gas
- 2.3 Poison Gas

Class 3 - Flammable Liquids
- 3.1 Flammable Liquid
- 3.2 Flammable Liquid
- 3.3 Flammable Liquid

Class 4 - Flammable Solids; Spontaneous Combustibles
- 4.1 Flammable Solid
- 4.2 Spontaneous Combustible
- 4.3 Dangerous when Wet

Class 5 - Oxidizing Substances
- 5.1 Oxidizing Substance
- 5.2 Organic Peroxides

Class 6 - Poisonous Substances
- 6.1 Poisonous Substances
- 6.2 Infectious Substances

Class 7 - Radioactive Materials

Class 8 - Corrosive Substances

Class 9 - Miscellaneous Dangerous Goods

Figure 6.1 Dangerous Goods Class Distribution.

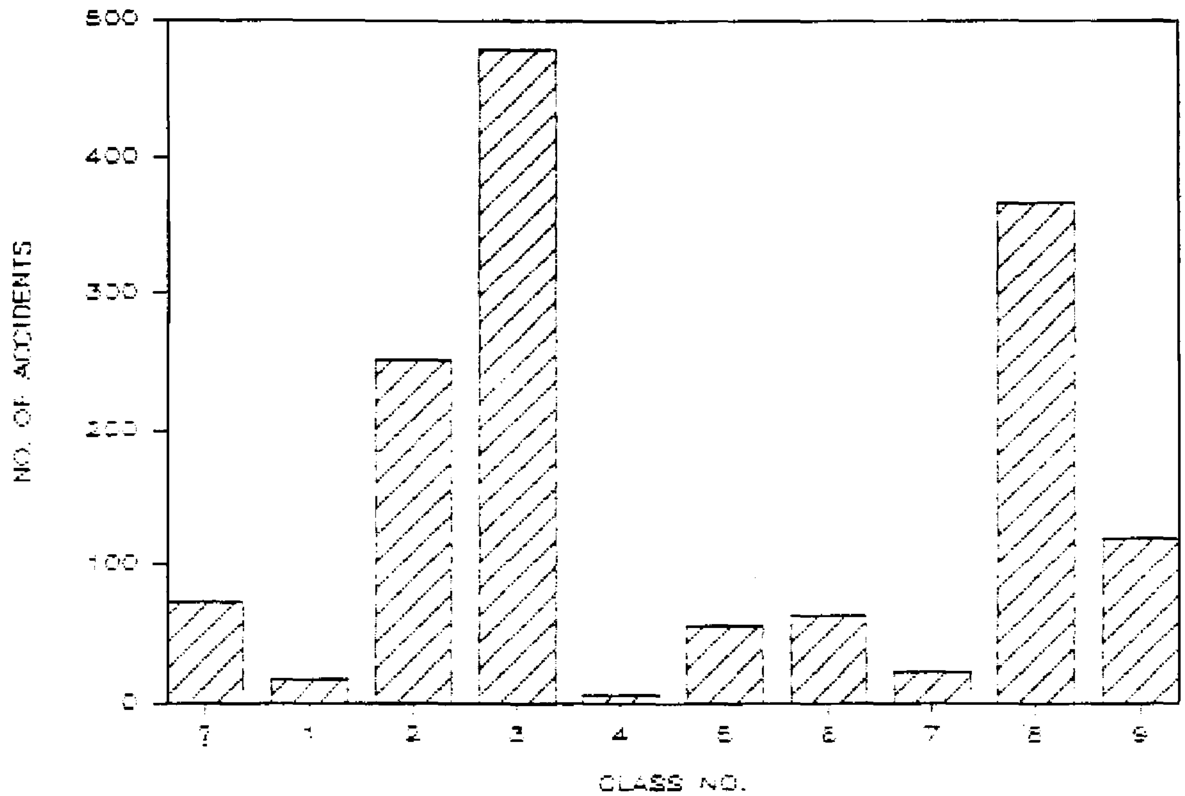


Figure 6.2 Dangerous Goods Accidents by Class and Mode.

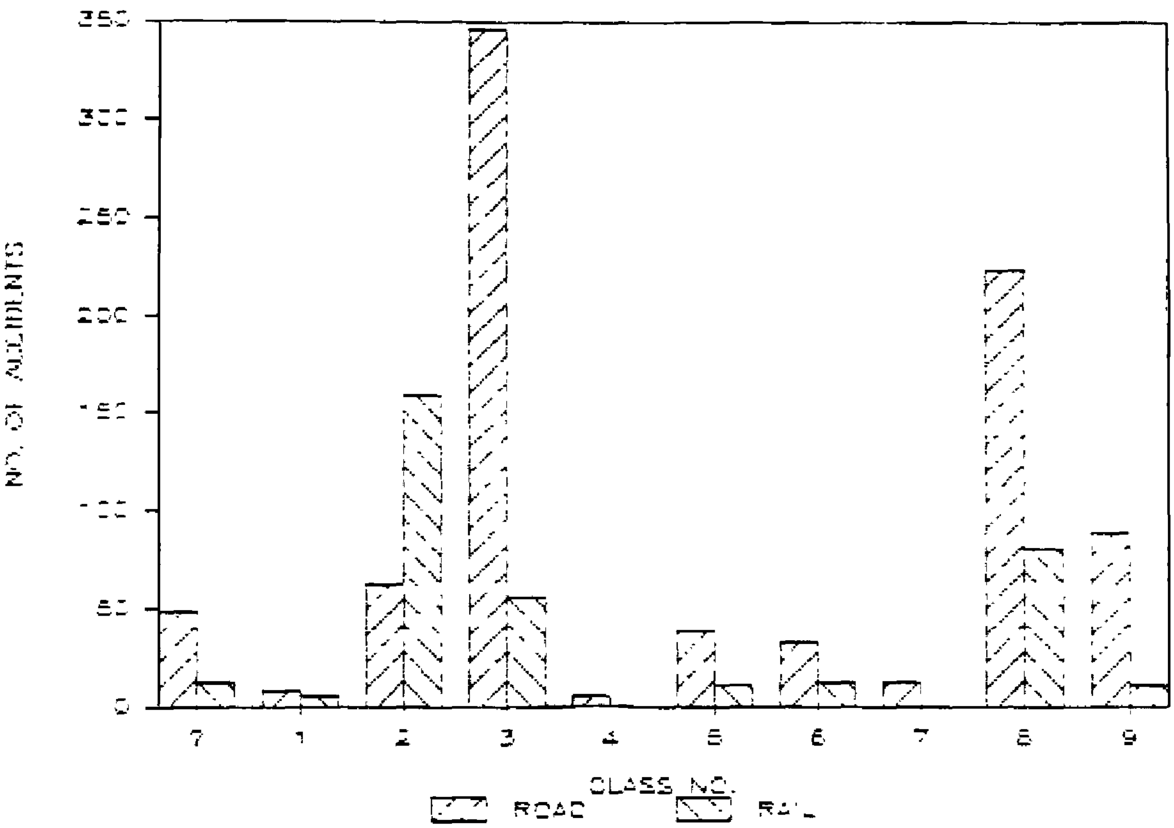


Figure 6.3. Newspaper Articles by Severity Cell for Dangerous Goods Incidents from January 1986 to June 1988.

Class 3 - Flammable Liquids

		POPULATION DENSITY		
		LOW	MEDIUM	HIGH
	LOW	3/1 1	2	1/1 3
SPILL	MED	4	5	2/0 6
	HIGH	2/1 7	8	2/0 9

Class 8 - Corrosive Substances

		POPULATION DENSITY		
		LOW	MEDIUM	HIGH
	LOW	1	1/0 2	2/1 3
SPILL	MED	4	1/0 5	6
	HIGH	7	0/1 8	1/0 9

Legend: Road Articles/Rail Articles
Severity Class

The damages by mode for class 3 (flammable liquids) were compared based on the data in Table 6.1. For road, there were 0.33 deaths per reported incident, 0.8 injuries and 67 persons evacuated per incident reported. For rail, 21 persons were injured per incident (one rail incident involved 42 injuries) with no deaths or evacuations. The data are very limited and few conclusions can be drawn. It is not possible to determine if the deaths were due to the accident or to the dangerous good. However, it appears that road incidents have more damages than rail incidents.

6.4 Severity versus Reporting

The data in Table 6.1 and Figure 6.3 are presented in Figures 6.4 and 6.5 to illustrate the reporting characteristics versus severity by road and rail modes.

Figure 6.4 shows the number of articles per incident versus the severity of the incident. As found previously, the more severe the incident, the more articles found in the three newspapers surveyed. While the number of data points are limited, the plots of road and rail incidents indicate no difference in number of articles.

Figure 6.5 shows the number of words per article versus the severity of the incident. Again, the general trend is for more severe incidents to have more words per article. Although the data are limited, there seems to be no difference in the number of words per article between road and rail. The consideration of damage level as a factor should be included in the severity rating (for example, the rail incident involved 42 injuries), but due to lack of data this has not yet been done.

6.5 Non-Incidents

The newspaper articles were reviewed to identify articles (including letters, editorials, etc.) which concerned the movement of dangerous goods but were not specific to a particular incident. Twenty-eight articles were found in the three papers over the time period sampled -- 16 for rail and 12 for road. Of the rail articles, 9 concerned the Toronto Area Rail Task Force. For the road mode, 4 concerned the transportation of radioactive heavy water. Other than these two "issues" the articles were of general interest about the movement of dangerous goods, emergency response plans, etc.

Compared to the newspaper articles related to incidents and the number of incidents by mode, the rail mode is overrepresented in general articles about dangerous goods. The sample size is not large and the inclusion or exclusion of articles related to "issue" items is a moot point. However, there is an indication that a higher perception exists for rail movements of dangerous goods than road.

Figure 6.4. Newspaper Articles vs. Severity (Class 3 and Class 8).

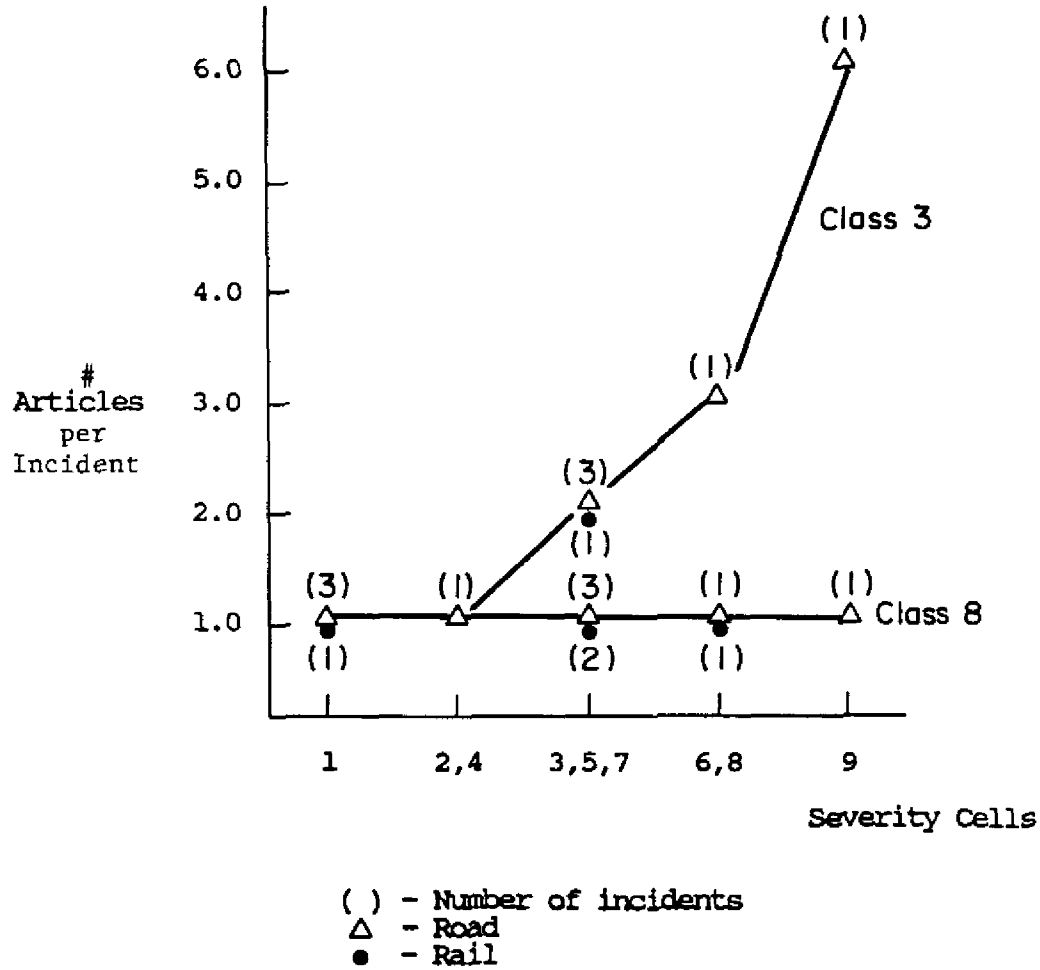
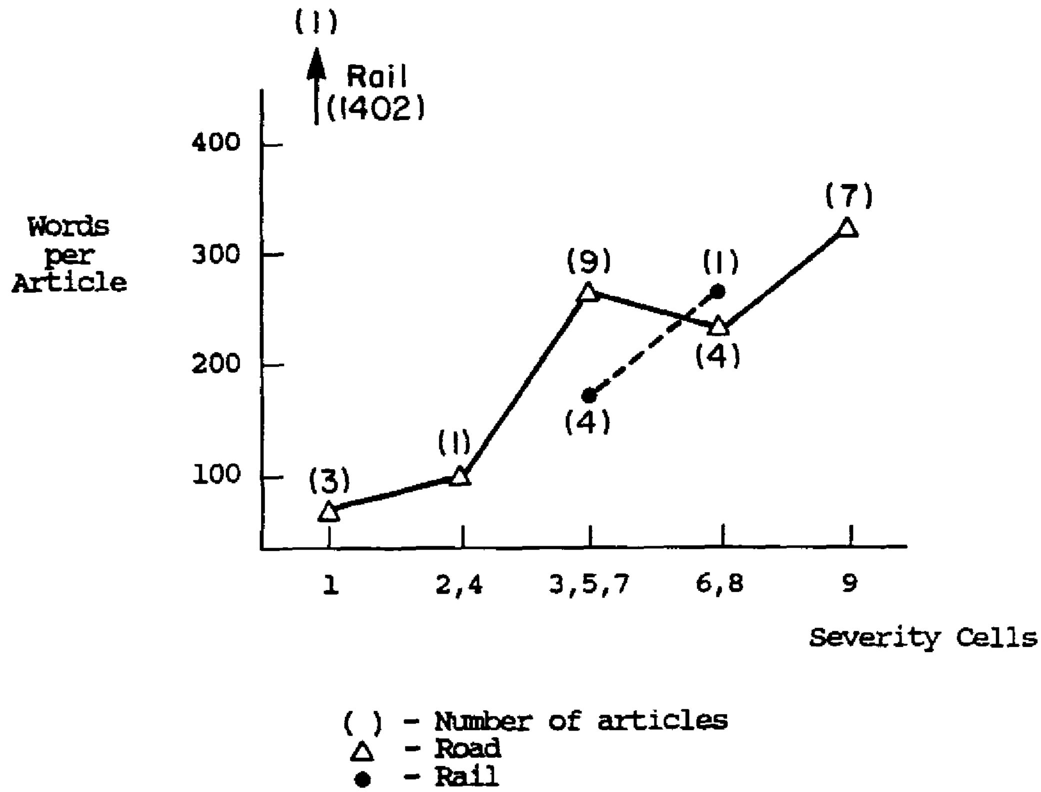


Figure 6.5. Words per Article vs. Severity (Class 3 and Class 8).



6.6 Discussion and Conclusions

The larger data set of articles representing all of Canada for a period of almost two years for three major newspapers is still not large enough for a definitive analysis. Nevertheless, it was possible to identify a number of trends and to indicate the nature of the relative perception of rail and road dangerous goods incidents. The data also confirmed the earlier results which indicated that newspaper articles were an accurate reflection of the severity or potential severity of incidents.

The underlying hypothesis is that newspaper articles are a reflection of the interests and concerns of the general public and are a measure of public perception. Thus, comparisons of the actual number of incidents with the perception of these incidents will indicate any perceptual biases that may exist.

The conclusions are:

1. Only about 1% of all incidents reported to Transport Canada are reported in the major newspapers.

2. The newspaper articles, both in number and length, accurately reflect the severity or potential severity of an incident.

3. There is no difference in the perception of road and rail incidents as measured by the number of articles or the length of articles per incident, once the severity of the incident has been controlled.

4. There is some indication that there is posssibly more attention by the public to rail movements of dangerous goods than for road movements based on an analysis of articles which do not relate to specific incidents.

5. There are apparently a significant number of incidents which are not reported to Transport Canada and further investigation of these unreported incidents is suggested.

6. Newspaper content analysis seems to be both a useful method for evaluating public perceptions and also an efficient method given the availability of computer data files for newspapers.