The Industrial Pollution Impacts of NAFTA:

Some Preliminary Results

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Abstract. In this paper, we use a three-country trade model of the North American economy, along with data from the World Bank's Industrial Pollution Projection System (IPPS), to simulate the potential industrial pollution impacts of NAFTA. We find that the most serious industrial pollution impacts occur in the base metals sector. The Mexican petroleum sector is also a significant source of industrial pollution, particularly in the case of air pollution. For specific pollutants in specific countries, the transportation equipment sector is an important source of industrial pollution. Finally, the chemical sector is a significant source of industrial toxin pollution in the United States and Mexico, but not in Canada.

Introduction

The policy debates surrounding the negotiation, passage, and assessment of the North American Free Trade Area (NAFTA) has focused to a great extent on the linkages between trade and the environment.[1] To a large degree, however, this debate has been more speculative than empirical. This is unfortunate because it is well known that *a priori* reasoning alone cannot predict whether trade liberalization will have an overall positive or negative impact on the environment.[2] This paper attempts to provide some empirical evidence in the area of industrial pollution to better inform future debate.

One study that does provide some empirical evidence on NAFTA and the environment was conducted by Grossman and Krueger (1993). These authors combined the output effects of NAFTA as simulated by Brown, Deardorff and Stern (1992) with data from the U.S. Environmental Protection Agency on toxic pollution. With regard to the *direct* impacts of trade liberalization (as opposed to liberalization-induced increases in investment), these authors found that the greatest increases in toxic pollution occur in the U.S. chemicals sector and the Canadian base metals and rubber and plastics products sectors. Other significant trade-induced increases in toxic pollution occurred in the

[1] For a definitive review, see Johnson and Beaulieu (1996).

[2] See Runge (1994), Beghin and Potier (1997), and Beghin, Roland-Holst, and van der Mensbrugghe (1997).

Mexican electrical equipment sector, the U.S. paper products sector, and the Canadian transportation equipment sector.[3]

In this paper, we focus on the industrial pollution impacts of NAFTA. We utilize a three-country, applied equilibrium (AGE) trade model of the North American economy and make use of the World Bank's Industrial Pollution Projection System (IPPS) to generate results for a detailed set of industrial sectors and pollutants. We simulate the liberalization of tariffs and non-tariff barriers (NTBs) that have accompanied NAFTA and provide results for the changes in emissions by industrial sector and pollutant. The results allow us to identify where some of the major environmental impacts of NAFTA might be found.

The Trade Model

We employ a standard applied general equilibrium (AGE) trade model used to simulate the industrial pollution effects of North American trade liberalization in 17 industrial sectors of Canada, the United States, and Mexico.[4] The trade specification follows that of de Melo and Robinson (1989). In each sector of each country, domestic demand is constituted of goods that are differentiated by origin (domestic good, imports from each North American trading partner, and imports from the rest of the world). Also in each sector of each country, domestic production is allocated among differentiated destinations (domestic good, exports to each North American trading partner, and exports to the rest of the world). World prices outside of North America are assumed to remain constant, exchange rates are assumed to be flexible, and trade balances are fixed.

Production in each sector of each country utilizes physical capital and labor. These factors are assumed to be perfectly mobile among the sectors of each country but immobile among countries. Production takes place under constant returns to scale and intermediate goods are utilized in fixed proportions to value added. All markets are perfectly competitive.

The trade-liberalizing experiments we conduct use observed tariff rates for our base year 1991. In addition, we consider very rough estimates of non-tariff barriers using

[3] See also Abler and Pick (1993) for a focus on the Mexican horticultural sector.
[4] Model equations are presented in the Appendix.

UNCTAD data on trade control measures. As is general practice (e.g. Gaston and Trefler, 1994), we use NTB coverage ratios as *ad valorem* equivalents. For this reason, our simulations must be interpreted as merely *suggestive* of the impacts of NAFTA on trade, production, and pollution.[5]

The three-country trade model is calibrated to a 1991 base year data set.[6] The IPPS effluent data are used to create *satellite environmental accounts* to this data set as suggested by Barker (1992), United Nations (1993a,b), and de Haan and Keuning (1996). As is recommended by their compilers, IPPS effluent data are utilized in their per-employee form. Table 1 describes the IPPS pollutants. [7] In the case of air pollution, the IPPS data include particulates, carbon monoxide, sulfur dioxide, nitrogen dioxide, and volatile organic compounds. In the case of industrial bio-accumulative metals and toxins, the data distinguish among transmission to air, water, and land. Finally, in the case of water pollution, the data distinguish between biological oxygen demand and total suspended solids.

Simulation Results

For the purposes of this paper, we focus on a simulation exercise closest to that considered by Brown, Deardorff and Stern (1992) and, therefore, by Grossman and Krueger (1993).[8] We consider the removal of both tariffs as measured by their observed values and NTBs as measured by coverage ratios. We assume that each North American trading partner maintains its existing protection with respect to the rest of the world. Additionally, as is standard practice in most trade policy models, we assume that total labor supply is fixed in each country. The results of these simulations for each industrial

[5] The NTB measures are discussed in Roland-Holst, Reinert, and Shiells (1994).

[6] The base year data set is in the form of a social accounting matrix (SAM) described in a document available from the corresponding author and (for Spanish speakers) in Reinert, Ricaurte, and Roland-Holst (1998). The calibration of the model also requires a set of behavior parameters described in Reinert and Roland-Holst (1998), and these behavioral parameters can be varied to conduct sensitivity analyses.

[7] On the IPPS, see Hettige, Lucas and Wheeler (1992) and the references therein. See also the web-site listed in our data sources at the end of the paper.

[8] As with all AGE simulations, the results are not forecasts. Rather they simulate a *counterfactual* economy, namely, North America in 1991 with the NAFTA trade liberalization agreements fully in place.

sector and IPPS pollutant are presented in Tables 2 through 5. For comparison purposes, estimated base-level emissions are presented in Tables 6 through 9.

Table 2 presents the changes in industrial *air pollution* caused by trade liberalization in North America for each industrial sector of the model. The evidence presented in this table suggests that the industrial air pollution generated as a result of NAFTA will be concentrated in a few particular sectors. These are petroleum, base metals, and transportation equipment. For particulates, carbon monoxide, sulfur dioxide, and nitrogen dioxide, the greatest increases occur in the U.S. base metals sector and in the Mexican petroleum sector.[9] In the case of volatile organic compounds, however, the transportation equipment sectors of Canada and the United States are large sources. In terms of total air pollution emissions, the greatest increases are of carbon monoxide and sulfur dioxide in the United States and sulfur dioxide in Mexico. Significant reductions in air pollution occur in the Canadian and Mexican paper sectors and in the Canadian chemicals sector.

Table 3 addresses industrial *bio-accumulative metals pollution*. Here, the petroleum sector plays a less important role than base metals and transportation equipment. The largest emissions are to land, and these occur in the Canadian and U.S. base metals and transportation equipment sectors and in the Mexican base metals sector. In terms of total emissions, the United States leads both Canada and Mexico, primarily as a result of changes in its base metals sector. Again the Canadian chemicals sector registers improvement in emissions, although these are slight.

Table 4 presents the changes in industrial *toxin pollution*. Here, transmission to air is important along with transmission to land. This is especially the case for the transportation equipment sector in Canada. The base metals sector is also important for the transmission of toxins to land in this country.[10] In the United States and Mexico, the chemical sector appears as significant sources of toxins. Importantly, this is *not* the case

[9] Pollution associated with the petroleum sector in Mexico has been a significant part of the debate over NAFTA and the environment. See Commission for Environmental Cooperation (1996).

[10] Qualitatively, these results for Canada agree with those of Grossman and Krueger (1993).

for Canada where this is a *reduction* of toxin emissions in the chemical sector.[11] This reflects the comparative advantage of the U.S. and Mexican chemical sectors over their Canadian counterpart. The U.S. base metals and transportation equipment sectors and the Mexican petroleum sector are also significant sources of toxins, [12] and in terms of total emissions, the U.S. leads with toxic emissions to land and air.

Finally, Table 5 presents the simulation results for *water pollution*. The base metals sector is again a crucial source of effluents. This is particularly the case for total suspended solids in all three countries. In the case of biological oxygen demand, there is actually an overall decrease in Canada due to the contraction of the paper products sector. The Mexican petroleum sector is a significant source of total suspended solids, but this is an order of magnitude less than in its base metals sector. By far, the greatest concern with regard to water pollution as a result of NAFTA trade liberalization is the increase in total suspended solids from the base metals sector of the United States.

Conclusions

The most serious industrial pollution impacts of NAFTA occur in the base metals sector. In terms of magnitude, the greatest impacts are in the United States and Canada, and this is the case for most of the pollutants considered. As alleged in the debate over NAFTA and the environment, however, the Mexican petroleum sector is a significant source of industrial pollution, particularly in the case of air pollution. For specific industrial pollutants in specific countries, the transportation equipment sector is also an important source of industrial pollution. This is the case for both volatile organic compounds and toxins released into the air in Canada and the United States. Finally, as suggested by Grossman and Krueger's (1993) results, the chemical sector is a significant source of industrial toxin pollution in the United States and Mexico, but not in Canada.

It is hoped that the results of this paper will contribute to the ongoing discussions of the impacts of NAFTA on the environment in general and to the work of the Commission for Environmental Cooperation (CEC) in particular.

[11] Grossman and Krueger (1993) show a decrease in toxin pollution from the Mexican chemicals sector in their trade-liberalization alone case, but an increase in the trade and investment liberalization case.

Appendix: Trade Model Equations

This appendix presents the equation structure for a simple, multi-region applied general equilibrium model of trade policy. The equations of the model are presented first, and these are followed by a description of the variables and parameters. The equation that determines each variable is given in parentheses after its definition. To simplify the model, all markets are perfectly competitive, there are constant returns to scale in production, quota rents accrue to domestic importers, and supplies of labor and physical capital are fixed in each region.

Consumer Behavior (LES)

$$P_{ij}^{Q} C_{ij} = P_{ij}^{Q} \mu_{ij} + s_{ij}\left(Y_j - \sum_h P_{hj}^{Q} \mu_{hj}\right) \qquad \forall i, j \tag{1}$$

Cost Equations and Production (CES with Leontief Intermediates)

$$V_{ij} = \left(\frac{X_{ij}}{a_{ij}}\right)\left[b_{ij}^{f_{ij}} w_j^{\left(1-f_{ij}\right)} + \left(1-b_{ij}^{f_{ij}}\right) r_j^{\left(1-f_{ij}\right)}\right]^{\frac{1}{\left(1-f_{ij}\right)}} \qquad \forall i, j \tag{2}$$

$$T_{ij} = V_{ij} + \sum_h P_{hj}^{Q} io_{hij} X_{ij} \qquad \forall i, j \tag{3}$$

Factor Markets (CES Demands and Full Employment)

$$L_{ij} = V_{ij}^{f_{ij}} X_{ij}^{\left(1-f_{ij}\right)} b_{ij}^{f_{ij}} w_j^{-f_{ij}} a_{ij}^{\left(f_{ij}-1\right)} \qquad \forall i, j \tag{4}$$

$$K_{ij} = V_{ij}^{f_{ij}} X_{ij}^{\left(1-f_{ij}\right)} \left(1-b_{ij}\right)^{f_{ij}} r_j^{-f_{ij}} a_{ij}^{\left(f_{ij}-1\right)} \qquad \forall i, j \tag{5}$$

$$\sum_i L_{ij} = L_j \qquad \forall j \tag{6}$$

$$\sum_i K_{ij} = K_j \qquad \forall j \tag{7}$$

[12] Here, our results are in contradiction to those of Grossman and Krueger (1993). This is most likely due to the different way we model NTBs compared to Brown, Deardorff and Stern (1992).

Commodity Demands, Supplies, and Allocation of Traded Goods (CES and CET)

$$Q_{ij} = \alpha_{ij}\left[\sum_k \beta_{ijk} D_{ijk}^{\frac{(\sigma_{ij}-1)}{\sigma_{ij}}}\right]^{\frac{\sigma_{ij}}{(\sigma_{ij}-1)}} \qquad \forall i, j \tag{8}$$

$$\left(\frac{D_{ijk}}{D_{ijj}}\right) = \left[\left(\frac{\beta_{ijk}}{\beta_{ijj}}\right)\left(\frac{P_{ijj}}{P_{ijk}}\right)\right]^{\sigma_{ij}} \qquad \forall i, j, k, j \neq k \tag{9}$$

$$X_{ij} = \gamma_{ij}\left[\sum_k \delta_{ijk} S_{ijk}^{\frac{(\tau_{ij}+1)}{\tau_{ij}}}\right]^{\frac{\tau_{ij}}{(\tau_{ij}+1)}} \qquad \forall i, j \tag{10}$$

$$\left(\frac{S_{ijk}}{S_{ijj}}\right) = \left[\left(\frac{\delta_{ijk}}{\delta_{ijj}}\right)\left(\frac{P_{ijj}}{P_{ijk}}\right)\right]^{\tau_{ij}} \qquad \forall i, j, k, j \neq k \tag{11}$$

Commodity Prices

$$P_{ij}^{Q} Q_{ij} = \sum_k P_{ijk} D_{ijk} \qquad \forall i, j \tag{12}$$

$$P_{ij}^{X} X_{ij} = \sum_k P_{ijk} S_{ijk} \qquad \forall i, j \tag{13}$$

$$P_{ijj} = \frac{T_{ij}}{X_{ij}} \qquad \forall i, j \tag{14}$$

$$P_{ijk} = (1 + t_{ijk})(1 + \rho_{ijk}) e_j PW_{ijk} \qquad \forall i, j, k, j \neq k \tag{15}$$

Commodity Market Equilibrium

$$Q_{ij} = C_{ij} + \sum_h io_{ihj} X_{hj} \qquad \forall i, j \tag{16}$$

$$D_{ijk} = S_{ijk} \qquad \forall i, j, k \tag{17}$$

Income and Revenue

$$RT_j = \sum_i \sum_k t_{ijk} e_j PW_{ijk} D_{ijk} \qquad \forall j \tag{18}$$

$$RQ_j = \sum_i \sum_k \boldsymbol{r}_{ijk} e_j PW_{ijk} D_{ijk} \qquad \forall j \tag{19}$$

$$Y_j = w_j L_j + r_j K_j + RT_j + RQ_j \qquad \forall j \tag{20}$$

Foreign Balance

$$\sum_{k \neq j} \sum_i PW_{ijk} S_{ijk} = \sum_{k \neq j} \sum_i PW_{ijk} D_{ijk} \qquad \forall j \tag{21}$$

Sets and Indices

$h, i \in I$ sectors

$j, k \in J$ regions

Quantity Variables

C_{ij} = final demand for composite consumption good i in region j (1)

D_{ijk} = demand for good i in region j from source region k (8, 9)

K_{ij} = input of physical capital in sector i of region j (5)

L_{ij} = input of labor in sector i of region j (4)

Q_{ij} = demand for composite consumption good i in region j (16)

S_{ijk} = supply of good i from region j to region k (10, 11)

X_{ij} = output of sector i in region j (14)

Price Variables

e_j = exchange rate for region j (21)

P_{ijk} = domestic price of good i in region j demanded from region k (15, 17)

P_{ij}^{Q} = domestic purchaser price of composite consumption good i in region j (12)

P_{ij}^{X} = domestic producer price of composite good *i* in region *j* (13)

PW_{ijk} = world price of good *i* demanded in region *j* from region *k* (17)

r_j = rental rate on physical capital in region *j* (7)

w_j = wage rate in region *j* (6)

Nominal Variables

RQ_j = quota rents in region *j* (19)

RT_j = tariff revenue in region *j* (18)

T_{ij} = total costs in sector *i* of region *j* (3)

V_{ij} = value added in sector *i* in region *j* (2)

Y_j = income in region *j* (20)

Parameters

a_{ij} = intercept parameter in CES production function in sector *i* of region *j*

b_{ij} = share parameter in CES production function in sector *i* of region *j*

io_{hij} = input of good *h* needed per unit of sector *i* output in region *j*

K_j = total physical capital stock in region *j*

L_j = total labor force in region *j*

s_{ij} = consumption share for composite good *i* in region *j*

t_{ijk} = ad valorem tariff on imports of good *i* into region *j* from region *k*

$\boldsymbol{a}_{ij}$ = intercept parameter in CES product aggregation function for sector *i* of region *j*

β_{ijk} = share parameter in CES product aggregation function for product *i* in region *j* from source region *k*

δ_{ij} = share parameter in CET allocation function for sector *i* in region *j*

γ_{ij} = intercept parameter in CET allocation function for sector *i* in region *j*

μ_{ij} = subsistence minimum for composite consumption good *i* in region *j*

ϕ_{ij} = elasticity of substitution between labor and capital in sector *i* of region *j*

τ_{ijk} = ad valorem equivalent quota on imorts of good *i* into region *j* from region *k*

σ_{ij} = elasticity of substitution among sources of product *i* in region *j*

θ_{ij} = elasticity of transformation among destinations for sector *i* of region *j*

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Table 1. The IPPS Pollutants

Name	Symbol	Description
Particulates	PT	Fine airborne particles that can damage respiratory systems.
Carbon Monoxide	CO	A poisonous gas that inhibits the ability of blood to carry oxygen.
Sulfur Dioxide	SO2	A gas that can contribute to respiratory disease and acid rain.
Nitrogen Dioxide	NO2	A gas that contributes to both respiratory disease and to the formation of acid rain and ozone.
Volatile Organic Compounds	VOC	A class of chemicals associated with skin reactions, nervous system effects, sick-building syndrome, and multiple chemical sensitivity. Many are also suspected carcinogens.
Bio-accumulative Metals	MetAir, MetWat, MetLand	Metals, including mercury, lead, arsenic, chromium, nickel, copper, zinc, and cadmium. They contribute to mental and physical birth defects.
Toxic Pollutants	ToxAir, ToxWat, ToxLand	A class of chemicals that can damage internal organs and neurological functions, cause reproductive problems and birth defects. Many are also suspected carcinogens.
Biological Oxygen Demand	BOD	Organic water pollutants that remove dissolved oxygen. They can damage aquatic species and promote the growth of algae and pathogens.
Total Suspended Solids	TSS	Non-organic, non-toxic particles that can damage aquatic ecosystems and promote the growth of pathogens.

Source: World Bank Industrial Pollution Projection System

Table 2. Effects of NAFTA on Industrial Air Pollution (thousands of pounds)

	Can	Can	Can	Can	Can	US	US	US	US	US	Mex	Mex	Mex	Mex	Mex
Sector	**PT**	**CO**	**SO2**	**NO2**	**VOC**	**PT**	**CO**	**SO2**	**NO2**	**VOC**	**PT**	**CO**	**SO2**	**NO2**	**VOC**
Petrol	4,384	14,077	27,710	16,248	12,220	1,067	3,426	6,743	3,954	2,974	15,322	49,196	96,840	56,783	42,705
Foodpr	325	97	354	355	92	2,782	828	3,035	3,042	791	341	101	372	372	97
Bever	25	20	383	244	414	-37	-30	-570	-363	-616	39	31	598	381	646
Tobac	2	10	123	74	24	-4	-19	-239	-145	-48	0	2	19	12	4
Textl	-55	-48	-261	-343	-157	180	158	857	1,126	515	351	309	1,674	2,199	1,007
Cloth	0	0	3	1	1	0	0	-3	-1	-1	0	0	1	0	0
Leath	11	1	20	5	35	140	18	254	64	442	8	1	14	3	24
Paper	-1,821	-10,609	-9,323	-5,141	-2,044	33	192	169	93	37	-197	-1,149	-1,009	-557	-221
Chem.	-293	-2,630	-1,552	-1,516	-1,279	1,276	11,472	6,770	6,614	5,581	845	7,598	4,484	4,381	3,696
Rubber	99	37	856	294	1,123	137	51	1,188	408	1,559	11	4	94	32	124
Nmtmn	-476	-119	-688	-541	-64	-111	-28	-160	-126	-15	1,892	475	2,735	2,150	253
Bsmetl	5,016	30,825	40,248	5,759	2,543	12,374	76,052	99,301	14,209	6,275	1,344	8,261	10,786	1,543	682
Wdmetl	637	1,159	253	493	1,325	2,920	5,314	1,162	2,261	6,077	763	1,388	304	591	1,588
Nelcmc	1	9	9	4	10	71	518	479	215	545	25	184	170	76	193
Elcmc	33	168	305	150	204	-10	-53	-96	-47	-64	36	185	337	166	226
Trnseq	3,266	5,561	7,908	4,109	29,531	3,531	6,013	8,550	4,443	31,930	294	500	711	370	2,656
Othmn	2	1	3	3	18	1	0	2	1	9	3	1	6	6	37
Total	11,156	38,558	66,352	20,199	43,997	24,349	103,913	127,442	35,750	55,991	21,076	67,088	118,136	68,509	53,716

Sectors are: petroleum; food processing; beverages; tobacco; textiles; clothing; leather; paper; chemicals; rubber; non-metalic mineral products; base metals; wood and metal products; non-electrical machinery; electrical machinery; transportation equipment; and other manufactures.
Pollutants are: PT- particulates; CO- carbon monoxide; SO2- sulfur dioxide; NO2- nitrogen dioxide; VOC- volatile organic compounds.

Table 3. Effects of NAFTA on Industrial Bio-accumulative Metals Pollution (thousands of pounds)

	Can	Can	Can	US	US	US	Mex	Mex	Mex
Sector	**MetAir**	**MetWat**	**MetLand**	**MetAir**	**MetWat**	**MetLand**	**MetAir**	**MetWat**	**MetLand**
Petrol	8	3	84	2	1	20	30	12	292
Foodpr	0	0	1	0	0	5	0	0	1
Bever	0	0	3	0	0	-5	0	0	5
Tobac	0	0	0	0	0	0	0	0	0
Textl	0	0	-6	1	0	21	3	0	41
Cloth	0	0	0	0	0	0	0	0	0
Leath	0	0	12	0	0	151	0	0	8
Paper	-2	-3	-9	0	0	0	0	0	-1
Chem	-3	-3	-99	13	12	432	8	8	286
Rubber	2	0	95	2	1	132	0	0	10
Nmtmn	-1	0	-8	0	0	-2	4	0	31
Bsmetl	261	19	7,482	644	47	18,459	70	5	2,005
Wdmetl	2	0	53	9	2	243	2	0	63
Nelcmc	0	0	2	5	0	94	2	0	33
Elcmc	2	0	68	-1	0	-22	2	0	76
Trnseq	93	2	1,142	101	2	1,234	8	0	103
Othmn	0	0	3	0	0	1	0	0	6
Total	362	19	8,821	776	65	20,765	130	26	2,960

Sectors are: petroleum; food processing; beverages; tobacco; textiles; clothing; leather; paper; chemicals; rubber; non-metalic mineral products; base metals; wood and metal products; non-electrical machinery; electrical machinery; transportation equipment; and other manufactures.
Pollutants are: Metals to air, water, and land.

Table 4. Effects of NAFTA on Industrial Toxin Pollution (thousands of pounds)

	Can	Can	Can	US	US	US	Mex	Mex	Mex
Sector	**ToxAir**	**ToxWat**	**ToxLand**	**ToxAir**	**ToxWat**	**ToxLand**	**ToxAir**	**ToxWat**	**ToxLand**
Petrol	1,140	80	4,334	277	20	1,055	3,984	280	15,147
Foodpr	14	4	54	122	34	467	15	4	57
Bever	15	2	11	-22	-3	-17	23	3	18
Tobac	26	0	3	-51	0	-5	4	0	0
Textl	-106	-20	-63	349	65	208	682	126	406
Cloth	1	0	1	-1	0	-1	0	0	0
Leath	46	2	89	589	20	1,125	32	1	60
Paper	-1,906	-437	-726	35	8	13	-206	-47	-79
Chem	-967	-287	-2,230	4,217	1,253	9,729	2,793	830	6,443
Rubber	899	2	331	1,247	3	459	99	0	36
Nmtmn	-28	-1	-37	-6	0	-9	110	3	145
Bsmetl	2,867	305	9,479	7,072	752	23,388	768	82	2,540
Wdmetl	364	8	189	1,669	37	867	436	10	227
Nelcmc	6	0	4	348	9	230	124	3	82
Elcmc	284	3	284	-90	-1	-90	315	3	315
Trnseq	15,861	61	6,843	17,149	66	7,399	1,427	5	615
Othmn	31	0	15	15	0	7	62	1	29
Total	18,549	-277	18,581	32,920	2,261	44,826	10,668	1,304	26,044

Sectors are: petroleum; food processing; beverages; tobacco; textiles; clothing; leather; paper; chemicals; rubber; non-metalic mineral products; base metals; wood and metal products; non-electrical machinery; electrical machinery; transportation equipment; and other manufactures.
Pollutants are: Toxins to air, water, and land.

Table 5. Effects of NAFTA on Industrial Water Pollution (thousands of pounds)

	Can	Can	US	US	Mex	Mex
Sector	**BOD**	**TSS**	**BOD**	**TSS**	**BOD**	**TSS**
Petrol	271	1,335	66	325	948	4,664
Foodpr	483	120	4,136	1,032	506	126
Bever	164	297	-245	-441	257	463
Tobac	0	0	0	0	0	0
Textl	0	0	0	0	0	0
Cloth	0	0	0	0	0	0
Leath	8	17	104	216	6	12
Paper	-5,004	-16,838	91	305	-542	-1,823
Chem	-365	-1,224	1,594	5,341	1,056	3,537
Rubber	170	466	236	647	19	51
Nmtmn	-1	-13	0	-3	6	51
Bsmetl	2,245	152,998	5,540	377,481	602	41,003
Wdmetl	18	140	81	642	21	168
Nelcmc	0	1	2	38	1	13
Elcmc	12	17	-4	-5	13	19
Trnseq	14	102	15	110	1	9
Othmn	0	414	0	204	0	825
Total	-1,986	137,832	11,615	385,891	2,893	49,120

Sectors are: petroleum; food processing; beverages; tobacco; textiles; clothing; leather; paper; chemicals; rubber; non-metalic mineral products; base metals; wood and metal products; non-electrical machinery; electrical machinery; transportation equipment; and other manufactures.
Pollutants are: BOD- biological oxygen demand; and TSS- total suspended solids.

Table 6. 1991 Estimated Base Levels of Industrial Air Pollution (thousands of pounds)

	Can	Can	Can	Can	Can	US	US	US	US	US	Mex	Mex	Mex	Mex	Mex
Sector	**PT**	**CO**	**SO2**	**NO2**	**VOC**	**PT**	**CO**	**SO2**	**NO2**	**VOC**	**PT**	**CO**	**SO2**	**NO2**	**VOC**
Petrol	103,945	333,744	656,969	385,220	289,713	1,111,409	3,568,484	7,024,484	4,118,871	3,097,688	189,263	607,682	1,196,209	701,408	527,510
Foodpr	48,243	14,351	52,634	52,759	13,710	318,667	94,796	347,671	348,493	90,558	129,617	38,558	141,415	141,749	36,834
Bever	1,705	1,377	26,221	16,695	28,342	13,690	11,055	210,503	134,028	227,529	6,066	4,898	93,269	59,385	100,813
Tobac	61	256	3,242	1,962	645	852	3,594	45,596	27,593	9,069	99	418	5,304	3,210	1,055
Textl	1,502	1,321	7,163	9,409	4,307	17,607	15,478	83,951	110,274	50,481	4,399	3,867	20,974	27,550	12,612
Cloth	9	21	202	76	51	85	192	1,825	687	456	8	18	166	62	41
Leath	367	48	666	167	1,159	2,593	341	4,712	1,178	8,193	2,264	298	4,115	1,029	7,154
Paper	53,670	312,633	274,722	151,488	60,222	454,619	2,648,228	2,327,094	1,283,212	510,122	25,978	151,327	132,977	73,326	29,150
Chem.	28,058	252,279	148,870	145,448	122,733	281,119	2,527,650	1,491,567	1,457,283	1,229,692	54,009	485,620	286,564	279,978	236,252
Rubber	1,218	457	10,582	3,635	13,889	14,897	5,591	129,397	44,452	169,833	1,000	375	8,686	2,984	11,401
Nmtmn	34,815	8,746	50,343	39,565	4,661	367,819	92,407	531,874	418,008	49,243	99,717	25,052	144,193	113,324	13,350
Bsmetl	69,283	425,809	555,978	79,558	35,134	477,490	2,934,602	3,831,708	548,297	242,140	57,376	352,625	460,422	65,884	29,096
Wdmetl	44,343	80,697	17,641	34,345	92,287	335,018	609,684	133,284	259,487	697,249	12,615	22,957	5,019	9,771	26,254
Nelcmc	679	4,966	4,592	2,063	5,221	9,763	71,365	65,991	29,643	75,032	702	5,130	4,743	2,131	5,393
Elcmc	1,060	5,410	9,841	4,838	6,585	21,645	110,505	201,019	98,825	134,507	1,150	5,870	10,677	5,249	7,144
Trnseq	4,766	8,115	11,539	5,996	43,092	41,693	70,993	100,952	52,457	376,985	5,081	8,652	12,303	6,393	45,942
Othmn	139	59	269	251	1,534	1,826	780	3,535	3,301	20,164	114	49	221	206	1,260
Total	393,863	1,450,291	1,831,476	933,475	723,283	3,470,792	12,765,745	16,535,164	8,936,091	6,988,943	589,458	1,713,395	2,527,258	1,493,639	1,091,262

Sectors are: petroleum; food processing; beverages; tobacco; textiles; clothing; leather; paper; chemicals; rubber; non-metalic mineral products; base metals; wood and metal products; non-electrical machinery; electrical machinery; transportation equipment; and other manufactures.
Pollutants are: PT- particulates; CO- carbon monoxide; SO2- sulfur dioxide; NO2- nitrogen dioxide; VOC- volatile organic compounds.

Table 7. 1991 Estimated Base Levels of Industrial Bio-accumulative Metals Pollution (thousands of pounds)

	Can	Can	Can	US	US	US	Mex	Mex	Mex
Sector	**MetAir**	**MetWat**	**MetLand**	**MetAir**	**MetWat**	**MetLand**	**MetAir**	**MetWat**	**MetLand**
Petrol	201	79	1,983	2,152	850	21,207	366	145	3,611
Foodpr	1	6	84	4	40	554	2	16	225
Bever	1	0	221	5	1	1,771	2	0	785
Tobac	0	0	0	0	0	0	0	0	0
Textl	11	1	175	129	7	2,056	32	2	514
Cloth	0	0	5	1	0	49	0	0	4
Leath	1	0	397	4	3	2,804	3	2	2,449
Paper	65	86	278	554	727	2,351	32	42	134
Chem	278	266	9,491	2,781	2,662	95,089	534	511	18,269
Rubber	22	5	1,176	271	62	14,385	18	4	966
Nmtmn	71	1	577	747	11	6,098	202	3	1,653
Bsmetl	3,604	262	103,352	24,836	1,804	712,286	2,984	217	85,589
Wdmetl	137	27	3,683	1,032	206	27,829	39	8	1,048
Nelcmc	46	1	903	664	17	12,980	48	1	933
Elcmc	70	6	2,206	1,420	121	45,069	75	6	2,394
Trnseq	136	3	1,666	1,190	23	14,573	145	3	1,776
Othmn	16	1	242	207	13	3,179	13	1	199
Total	4,658	744	126,440	35,998	6,547	962,280	4,497	961	120,549

Sectors are: petroleum; food processing; beverages; tobacco; textiles; clothing; leather; paper; chemicals; rubber; non-metalic mineral products; base metals; wood and metal products; non-electrical machinery; electrical machinery; transportation equipment; and other manufactures.
Pollutants are: Metals to air, water, and land.

Table 8. 1991 Estimated Base Levels of Industrial Toxin Pollution (thousands of pounds)

	Can	Can	Can	US	US	US	Mex	Mex	Mex
Sector	**ToxAir**	**ToxWat**	**ToxLand**	**ToxAir**	**ToxWat**	**ToxLand**	**ToxAir**	**ToxWat**	**ToxLand**
Petrol	27,031	1,901	102,761	289,020	20,329	1,098,744	49,218	3,462	187,107
Foodpr	2,110	594	8,098	13,936	3,925	53,489	5,669	1,597	21,757
Bever	1,010	150	785	8,108	1,201	6,305	3,592	532	2,794
Tobac	696	5	69	9,795	67	971	1,139	8	113
Textl	2,918	540	1,736	34,198	6,326	20,349	8,544	1,580	5,084
Cloth	81	0	31	735	0	277	67	0	25
Leath	1,545	53	2,950	10,929	376	20,864	9,543	329	18,219
Paper	56,159	12,865	21,405	475,704	108,972	181,315	27,183	6,227	10,361
Chem	92,731	27,548	213,945	929,097	276,014	2,143,566	178,501	53,029	411,828
Rubber	11,116	27	4,093	135,926	334	50,043	9,124	22	3,359
Nmtmn	2,031	57	2,676	21,452	603	28,274	5,816	164	7,665
Bsmetl	39,598	4,208	130,946	272,904	28,998	902,456	32,792	3,484	108,440
Wdmetl	25,354	557	13,168	191,559	4,212	99,484	7,213	159	3,746
Nelcmc	3,335	83	2,207	47,929	1,196	31,719	3,445	86	2,280
Elcmc	9,181	95	9,181	187,540	1,946	187,540	9,961	103	9,961
Trnseq	23,144	89	9,986	202,476	778	87,358	24,675	95	10,646
Othmn	2,609	22	1,214	34,303	285	15,959	2,144	18	997
Total	300,650	48,794	525,250	2,865,609	455,563	4,928,712	378,627	70,894	804,383

Sectors are: petroleum; food processing; beverages; tobacco; textiles; clothing; leather; paper; chemicals; rubber; non-metalic mineral products; base metals; wood and metal products; non-electrical machinery; electrical machinery; transportation equipment; and other manufactures.
Pollutants are: Toxins to air, water, and land.

Table 9. 1991 Estimated Base Levels of Industrial Water Pollution (thousands of pounds)

	Can	Can	US	US	Mex	Mex
Sector	**BOD**	**TSS**	**BOD**	**TSS**	**BOD**	**TSS**
Petrol	6,429	31,644	68,740	338,343	11,706	57,617
Foodpr	71,723	17,901	473,763	118,243	192,703	48,095
Bever	11,260	20,306	90,393	163,019	40,051	72,230
Tobac	4	5	55	67	6	8
Textl	0	0	0	0	0	0
Cloth	0	0	0	0	0	0
Leath	272	566	1,923	4,001	1,680	3,494
Paper	147,473	496,180	1,249,198	4,202,995	71,383	240,171
Chem	35,046	117,452	351,139	1,176,778	67,462	226,086
Rubber	2,103	5,763	25,715	70,471	1,726	4,731
Nmtmn	105	944	1,112	9,969	302	2,703
Bsmetl	31,016	2,113,480	213,755	14,565,745	25,685	1,750,237
Wdmetl	1,235	9,753	9,330	73,684	351	2,774
Nelcmc	17	364	244	5,232	18	376
Elcmc	382	545	7,812	11,131	415	591
Trnseq	20	149	175	1,302	21	159
Othmn	3	34,463	36	453,135	2	28,322
Total	307,088	2,849,513	2,493,391	21,194,116	413,510	2,437,594

Sectors are: petroleum; food processing; beverages; tobacco; textiles; clothing; leather; paper; chemicals; rubber; non-metalic mineral products; base metals; wood and metal products; non-electrical machinery; electrical machinery; transportation equipment; and other manufactures.
Pollutants are: BOD- biological oxygen demand; and TSS- total suspended solids.