

ECONOMIC IMPLICATIONS AND CONSEQUENCES OF POPULATION GROWTH, LAND USE TRENDS AND URBAN SPRAWL IN SOUTHERN ONTARIO

TABLES

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Prepared for the Environmental Commissioner of Ontario

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LIST OF TABLES

Table 1	Linkages Among Characteristics of Sprawl and Potential Adverse (Negative) Costs and Other Effects With Judgmental Weights on Degree of Linkage
Table 2	Linkages Among Characteristics of Sprawl and Alleged Positive Effects With Judgmental Weights on Degree of Linkage
Table 3	Canadian population by province, 1901 - 2007
Table 4	Ontario GPP by industry, 2006
Table 5	Type of dwelling and population by type of dwelling, Canada (1961 to 2006 Censuses)
Table 6	Value of Building Permits, by Province and Territory
Table 7	Annual Housing Starts, by Province, 2003-2007
Table 8	Total Land Areas and Urban Land Use by Province
Table 9	Total numbers of farms, farm area, land tenure and land in crops, Ontario, 1986 to 2006
Table 10	Estimated Area of Non-agricultural uses of Dependable Agricultural Land, Canada, 1951 - 2001
Table 11	Population, land area, and area-wide population density by size of urban region, America (2000) and Canada (2001)
Table 12	Population densities in the ten largest urban regions in Canada, and America over two succeeding census periods (ordered by the LD2 density measure)
Table 13	Land Use Related Results From Ministry of Municipal Affairs and Housing Municipal Performance Measuring Project
Table 14	New Housing Price Indexes, by Province, 2003-2007
Table 15	Comparing Smart Growth (a.k.a. Managed Growth, Compact Development, Smart Growth, etc.) and Sprawl
Table 16	Costs of Ten Development Patterns at Two Levels of Scale, US <i>Circa</i> 1973
Table 17	Summary of Effects of Trend Versus Planned Development, “New Jersey Impact Assessment” (1)
Table 18	Percent Savings of Compact Growth Over Current or Trend Development
Table 19	Summary of Projected Results Comparing Conventional Development (CD) and Managed Growth (MG) Scenarios, US 2000-2025
Table 20	Emplacement Costs per Housing Unit for Alternative Development Patterns - Prepared for Canadian Mortgage and Housing Corporation, 1996
Table 21	Comparison of per Housing Unit Total Life-Cycle Costs for Conventional and Alternative Development Patterns in Canada Prepared for the Canada Mortgage and Housing Corporation
Table 22	<i>Pro-forma</i> Cost Analyses of “Smart Developments” in GTA Locations
Table 23	Selected Emissions and Sources of Criteria Air Pollutants in Ontario, 1999
Table 24	Air Pollution Related Health Effects Cases and Associated Monetary Values
Table 25	Elements of a Benefit-Cost Evaluation Framework
Table 26	Housing and Travel Cost Trends (\$1996)
Table 27	Housing and Travel As a Proportion of Income
Table 28	Canadian Motor Vehicle Traffic Collision Statistics: 2006 Collisions and Casualties ⁶ 1987-2006

Table 29	Estimates of the Monetary Value of Injuries, Fatalities and Property Damages Due to Road Vehicle Accidents, 1996
Table 30	Consolidated Schedule of Capital Fund Operations, Brampton, 2006
Table 31	Consolidated Schedule of Capital Fund Operations, City of Mississauga, 2006
Table 32	Consolidated Schedule of Capital Fund Financial Activities and Fund Balance, Town of Oakville
Table 33	Consolidated Schedule of Capital Fund Financial Activities and Fund Balance, City of Oshawa, year ended December 31, 2006
Table 34	How Property Tax Increases Attributable to a Park Can Pay the Annual Debt of Acquisition and Development of the Park (1)
Table 35	Participation, Days and Trips of Ontario Participants in Nature-Related Activities in 1996
Table 36	Distribution of Nature-Related Expenditures in 1996
Table 37	Expenditures on Nature-Related Activities by Ontario Participants in 1996, by Type of Activity
Table 38	Economic Implications (Impacts) Associated with Expenditures on Nature-related Activities in Canada, 1996
Table 39	Methods to Estimate Monetary Values Associated with Non-Marketed Natural Resources and Environmental Goods and Services
Table 40	Types of Ecosystem Services
Table 41	Estimated Values for Open Space Services from Stated Preference Studies

Table 1 Linkages Among Characteristics of Sprawl and Potential Adverse (Negative) Costs and Other Effects With Judgmental Weights on Degree of Linkage

Adverse (“negative”) Effects (27)	Low Density	Unlimited Outward Expansion	Land Uses Spatially Segregated	Leapfrog Development	No Central or Regional Ownership or Planning	Dominance of Automobile Transportation	Fragmented Land-Use Governance	Wide Variation in Local Fiscal Capacities	Widespread Commercial Strip Development	Inefficient Processes for Low-Income Housing
PUBLIC-PRIVATE CAPITAL AND OPERATING COSTS										
Higher infrastructure costs	2	2	1	2	1	0	1	0	0	0
Higher public operating costs	2	2	1	2	1	0	1	0	0	0
Higher private residential and non-residential development costs	2	1	0	2	1	0	2	1	1	0
More adverse public fiscal consequences	2	1	1	2	1	0	1	1	0	0
Higher aggregate land costs	2	1	0	2	1	0	1	0	0	0
TRANSPORTATION AND TRAVEL COSTS										
More vehicle miles travelled (VMT)	2	1	2	2	1	2	0	0	2	1
Longer travel times	2	2	1	2	0	-2	0	0	0	1
More automobile trips	2	1	1	2	1	2	1	0	2	1
Higher household transportation spending	2	2	1	2	0	2	0	0	2	1
Less cost-efficient and effective transit	2	2	1	2	0	2	1	0	0	0
Higher pollution and other social costs of travel	2	2	1	2	1	2	1	0	0	0
LAND/ NATURAL HABITAT PRESERVATION										
Loss of agricultural land	1	2	0	2	1	0	0	0	1	0
Reduced farmland productivity	1	2	0	2	0	0	0	0	0	0
Reduced farmland economic viability	0	0	0	1	0	0	0	0	0	0
Loss of sensitive environmental habitats	2	2	0	2	1	0	0	0	1	0

Adverse (“negative”) Effects (27)	Low Density	Unlimited Outward Expansion	Land Uses Spatially Segregated	Leapfrog Development	No Central or Regional Ownership or Planning	Dominance of Automobile Transportation	Fragmented Land-Use Governance	Wide Variation in Local Fiscal Capacities	Widespread Commercial Strip Development	Inefficient Processes for Low-Income Housing
Reduced community and regional open space	1	0	0	0	1	0	1	0	0	0
QUALITY OF LIFE										
Aesthetically displeasing	0	0	0	0	0	0	0	0	2	0
Weakened sense of community	1	1	0	2	0	1	1	1	1	1
Greater stress	0	0	0	0	0	0	0	0	2	0
Higher energy consumption	2	2	0	2	0	1	0	0	1	1
More air pollution	1	0	0	1	0	2	0	0	1	0
Less historical, heritage preservation	0	1	0	0	0	0	0	0	1	1
SOCIAL ISSUES										
Fosters suburban exclusion	1	1	0	0	2	1	2	2	0	2
Fosters spatial mismatch	1	1	0	1	1	1	1	0	1	1
Foster residential segregation	0	1	0	1	1	1	2	1	0	2
Worsens city financial stress	0	0	0	0	1	0	1	2	2	2
Worsens inner-city deterioration	0	1	0	1	1	0	1	2	1	1
LINKAGES										
Sum	35	31	10	37	17	15	18	10	21	15
Ranking	1	3	10	1	6	7	5	9	4	8
Source: Burchell <i>et al.</i> 1998, p. 126. Key: 2 = major linkage, 1 = moderate or minor linkage, 0 = no linkage, -2 = negative linkage										

Table 2 Linkages Among Characteristics of Sprawl and Alleged Positive Effects With Judgmental Weights on Degree of Linkage

Beneficial (“positive”) Effects (14)	Low Density	Unlimited Outward Expansion	Land Uses Spatially Segregated	Leapfrog Development	No Central or Regional Ownership or Planning	Dominance of Automobile Transportation	Fragmented Land-Use Governance	Wide Variation in Local Fiscal Capacities	Widespread Commercial Strip Development	Inefficient Processes for Low-Income Housing
PUBLIC-PRIVATE CAPITAL AND OPERATING COSTS										
Lower public operating costs	2	1	0	2	1	0	0	0	0	0
Lower private residential and non-residential development costs	2	2	0	2	0	0	0	0	0	0
Fosters efficient development (infill) of leapfrogged areas	1	1	0	2	1	0	1	0	0	0
TRANSPORTATION AND TRAVEL COSTS										
Shorter commuting times	2	2	0	2	0	2	0	0	0	0
Less congestion	2	2	1	2	0	1	0	0	1	0
Lower governmental costs for transportation	2	2	0	2	1	2	0	0	0	0
Automobiles are most efficient mode of transportation	2	2	2	2	0	2	0	0	2	0
LAND/ NATURAL HABITAT PRESERVATION										
Enhanced personal and public open space	2	2	0	2	0	1	0	0	0	0
QUALITY OF LIFE										
Preference for low-density living	2	1	0	1	0	2	1	0	0	0
Lower crime rates	2	1	0	1	0	1	0	0	0	0
Reduced costs of public and private goods	2	1	0	1	0	1	0	0	2	0
Fosters greater economic well-being	0	1	1	1	2	0	2	2	0	0
SOCIAL ISSUES										
Fosters localized land use decisions	0	1	0	1	2	0	2	0	0	0
Enhances municipal diversity and choice	0	1	0	1	1	1	2	2	0	1

Beneficial (“positive”) Effects (14)	Low Density	Unlimited Outward Expansion	Land Uses Spatially Segregated	Leapfrog Development	No Central or Regional Ownership or Planning	Dominance of Automobile Transportation	Fragmented Land-Use Governance	Wide Variation in Local Fiscal Capacities	Widespread Commercial Strip Development	Inefficient Processes for Low-Income Housing
LINKAGES										
Sum	21	20.0	4	22	8	13	8	4	5	1
Ranking	2	3	7	1	5	4	5	7	6	8
Source: Burchell <i>et al.</i> 1998. p. 126. Key: 2 = major linkage, 1 = moderate or minor linkage, 0 = no linkage, -2 = negative linkage										

Table 3 Canadian population by province, 1901 - 2007

Province/Territory	Total population (thousands)											Percent Change (%)		
	1901	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001	2007	1901 to 1951	1951 to 2007
Newfoundland and Labrador	...	...	...	...	...	361.4	457.9	530.9	574.8	579.5	522.0	506.3	...	40
Prince Edward Island	103.3	93.7	88.6	88.0	95.0	98.4	104.6	112.6	123.7	130.3	136.7	138.6	(5)	41
Nova Scotia	459.6	492.3	523.8	512.8	578.0	642.6	737.0	797.3	854.6	915.1	932.4	934.1	40	45
New Brunswick	331.1	351.9	387.9	408.2	457.4	515.7	597.9	642.5	706.3	745.5	749.9	749.8	56	45
Quebec	1648.9	2,005.8	2,360.5	2,874.7	3,331.9	4,055.7	5,259.2	6,137.3	6,547.7	7,064.6	7,397.0	7,700.8	146	90
Ontario	2,182.9	2,527.3	2,933.7	3,431.7	3,787.7	4,597.5	6,236.1	7,849.0	8,811.3	10,428.1	11,897.6	12,803.9	111	178
Manitoba	255.2	461.4	610.1	700.1	729.7	776.5	921.7	998.9	1,036.4	1,109.6	1,151.3	1,186.7	204	53
Saskatchewan	91.3	492.4	757.5	921.8	896.0	831.7	925.2	932.0	975.9	1,002.7	1,000.1	996.9	811	20
Alberta	73.0	374.3	588.5	731.6	796.2	939.5	1,332.0	1,665.7	2,294.2	2,592.6	3,056.7	3,474.0	1,187	270
British Columbia	178.7	392.5	524.6	694.3	817.8	1,165.2	1,629.1	2,240.5	2,823.9	3,373.5	4,078.4	4,380.3	552	276
Yukon Territory	27.2	8.5	4.1	4.2	5.0	9.1	14.6	19.0	23.9	28.9	30.1	31.0	(67)	241
Northwest Territories	20.1 ¹	6.5 ¹	8.1 ¹	9.3 ¹	12.01	16.0	23.0 ¹	36.4 ¹	47.6 ¹	38.7	40.8	42.6	(20)	166
Nunavut	...	...	...	...	...	...	...	...	...	22.2	28.1	31.1	...	...
Canada	5,371.3	7,206.6	8,787.8	10,376.7	11,506.7	14,009.4	18,238.3	21,962.0	24,820.4	28,031.4	31,021.3	32,976	161	135

Notes:
... not applicable
Figures may not add up to totals due to rounding.
1. Includes Nunavut.

Sources:
Statistics Canada, 2004, *Human Activity and the Environment - Annual Statistics 2004*. October 2004.
Statistics Canada, 1983, *Historical Statistics of Canada, Second Edition*, F.H. Leacy (ed.), Catalogue no. 11-516-XPE, Ottawa.
Statistics Canada, CANSIM, tables 051-0001 and 051-0024.

Table 4 Ontario GPP by industry, 2006

Industry	\$1997 mil	% Total
Primary (agriculture, mining, petrol, etc.)	7568	1.7%
Manufacturing	84763	18.8%
Construction	23380	5.2%
Utilities	10,213	2.3%
Goods Producing Industries	125,823	27.9%
Transportation & Warehousing	17,665	3.9%
Information & Culture (incl. telecoms)	18850	4.2%
Wholesale Trade	34558	7.7%
Retail Trade	25851	5.7%
Finance, Insurance, Real Estate, & Leasing	101,881	22.6%
Professional & Administrative Services	36,144	8.0%
Education	19,244	4.3%
Health Care & Social Services	24,285	5.4%
Arts, Entertainment & Recreation	3,892	0.9%
Accommodation & Food	8,779	1.9%
Public Administration	22,920	5.1%
Other Services	10,547	2.3%
Services Producing Industries	323,883	71.9%
Total	450,540	100.0%

Source: Ontario Ministry of Finance, Ontario Economic Accounts, Q2 2007, October 2007
GPP = Gross Provincial Product

Table 5 Type of dwelling and population by type of dwelling, Canada (1961 to 2006 Censuses)

Year	Population	Occupied private dwellings	Collective dwellings	Collective dwellings as a % of occupied private dwellings	Population in collective dwellings	Population in collective dwellings as a % of total population	Average number persons per private household
% Chg 1961-2006	73.3%	173.0%	24.2%		10.4%		-35.9%
2006	31,612,895	12,435,520	27,915	0.22%	533,930	1.69%	2.5
2001	30,007,095	11,562,975	25,755	0.22%	479,520	1.60%	2.6
1996	28,846,760	10,820,050	22,615	0.21%	449,000	1.56%	2.6
1991	27,296,859	10,018,267	21,020	0.21%	446,885	1.64%	2.7
1986	25,309,331	8,991,672	19,800	0.22%	434,370	1.72%	2.8
1981	24,343,181	8,281,531	17,370	0.21%	405,735	1.67%	2.9
1976	22,992,604	7,166,095	16,445	0.23%	384,530	1.67%	3.1
1971(1)	21,568,311	6,034,508	17,585	0.29%	392,695	1.82%	3.5
1966	20,014,880	5,180,473	18,236	0.35%	463,266	2.31%	3.7
1961(1)	18,238,247	4,554,493	22,475	0.49%	483,718	2.65%	3.9

Source:
 Statistics Canada, 2006 Census of Population
 Collective dwellings refer to institutions such as boarding schools, prisons, hospitals, nursing homes, etc.

Table 6 Value of Building Permits, by Province and Territory

Jurisdiction	2003	2004	2005	2006	2007	% Change 2003-2007	% of Canada 2007
All permits \$ millions							
Canada	50,772.00	55,578.6	60,750.70	66,265.80	74,379.70	46.5%	100.0%
Newfoundland and Labrador	421	501.2	494.1	538.4	660.1	56.8%	0.9%
Prince Edward Island	178.1	223.8	244	207	163.8	-8.0%	0.2%
Nova Scotia	1,014.10	1,125.80	1,188.00	1,291.40	1,288.90	27.1%	1.7%
New Brunswick	696.3	797.3	829	933.3	965.2	38.6%	1.3%
Quebec	10,090.90	11,629.60	11,288.00	11,878.30	12,973.40	28.6%	17.4%
Ontario	23,235.20	23,905.30	24,129.60	23,292.20	26,710.40	15.0%	35.9%
Manitoba	1,065.00	1,150.40	1,128.50	1,378.80	1,480.10	39.0%	2.0%
Saskatchewan	772.6	770	905.7	1,138.60	1,646.40	113.1%	2.2%
Alberta	6,667.20	7,327.10	10,201.70	13,875.70	15,729.70	135.9%	21.1%
British Columbia	6,394.20	7,938.70	10,182.90	11,541.50	12,544.70	96.2%	16.9%
Yukon Territory	52.6	75.9	77.3	95.6	79.6	51.3%	0.1%
Northwest Territories	86.2	105.3	68.7	37.7	74	-14.2%	0.1%
Nunavut	98.6	28.1	13.2	57.4	63.5	-35.6%	0.1%

Source: Statistics Canada, CANSIM, tables (for fee) 026-0003 and 026-0008, and Catalogue no 64-001-X.
Last modified: 2008-03-06.

Table 7 Annual Housing Starts, by Province, 2003-2007

Jurisdiction	2003	2004	2005	2006	2007	% Change 2003-07
Number of Starts						
Canada	218426	233431	225,481	227,395	228343	4.5%
Newfoundland and Labrador	2692	2,870	2,498	2,234	2,649	-1.6%
Prince Edward Island	814	919	862	738	750	-7.9%
New Brunswick	4489	3,947	3,959	4,085	4,242	-5.5%
Nova Scotia	5096	4,717	4,775	4,896	4,750	-6.8%
Quebec	50289	58,448	50,910	47,877	48,553	-3.5%
Ontario	85180	85,114	78,795	73417	68123	-20.0%
Manitoba	4206	4,440	4,731	5028	5,738	36.4%
Saskatchewan	3315	3,781	3,437	3715	6,007	81.2%
Alberta	36171	36,270	40,847	48962	48,336	33.6%
British Columbia	26174	32,925	34,667	36443	39,195	49.7%

Sources: Statistics Canada, CANS, table (for fee) 027-0008, Canada Mortgage and Housing Corporation (CMHC). Last modified: 2008-01-28.

Table 8 Total Land Areas and Urban Land Use by Province

Province	Total Land Areas	1971	1981	1991	1996	Percent Change, 1971-1996	1996 Urban Area as a % of Total Land Areas
	square kilometres						
Newfoundland	373,872	455	479	622	825	81	0.2
Prince Edward Island	5,660	56	76	96	136	144	2.4
Nova Scotia	53,338	541	600	763	948	75	1.8
New Brunswick	71,450	618	599	869	1,078	74	1.5
Quebec	1,365,128	4,255	4,400	5,711	6,830	61	0.5
Ontario	917,741	5,545	6,019	7,593	9,017	63	1.0
Manitoba	553,556	695	749	977	1,126	62	0.2
Saskatchewan	591,670	752	884	1,131	1,312	74	0.2
Alberta	642,317	1,424	2,080	2,667	3,302	132	0.5
British Columbia	925,186	1,564	2,129	2,673	3,471	122	0.4
Yukon	474,391	N/A	N/A	N/A	N/A		
Northwest Territories	1,183,085	N/A	N/A	N/A	N/A		
Nunavut	1,936,113	N/A	N/A	N/A	N/A		
Total Canada	9,093,507	15,905	18,015	23,103	28,045	76	0.3

Notes:

N/A = Data not available.

Figures may not add up to totals due to rounding.

Source:

Total Land Areas: Natural Resources Canada, GeoAccess Division at <http://www40.statcan.gc.ca/l01/cst01/phys01-eng.htm>.

Urban Land Areas: Statistics Canada, Environment Accounts and Statistics Division, *Econnections - Linking the Environment and the Economy - Indicators and Detailed Statistics 2000*, p. 10.

Land and freshwater area, by province and territory				
	Total area	Land	Freshwater	% of total area
	km ²			
Canada	9984670	9093507	891,163	100
Newfoundland and Labrador	405212	373872	31,340	4.1
Prince Edward Island	5660	5,660	0	0.1
Nova Scotia	55284	53338	1,946	0.6
New Brunswick	72,908	71,450	1,458	0.7
Quebec	1,542,056	1,365,128	176,928	15.4
Ontario	1,076,395	917,741	158,654	10.8
Manitoba	647,797	553,556	94,241	6.5
Saskatchewan	651,036	591670	59,366	6.5
Alberta	661,848	642,317	19,531	6.6
British Columbia	944,735	925,186	19,549	9.5
Yukon	482,443	474391	8,052	4.8
Northwest Territories	1,346,106	1,183,085	163,021	13.5
Nunavut	2,093,190	1936113	157,077	21
<u>Source: Natural Resources Canada, GeoAccess Division.</u>				
<u>http://www40.statcan.gc.ca/l01/cst01/phys01-eng.htm</u>				
Last modified: 2005-02-01.				

Table 9 Total numbers of farms, farm area, land tenure and land in crops, Ontario, 1986 to 2006

Farms and Farm Areas	1986	1991	1996	2001	2006	% Change 1986-2006
Total number of farms	72,713	68,633	67,520	59,728	57,211	-21.3%
Total farm area						
Area in hectares ¹	5,646,582	5,451,379	5,616,860	5,466,233	5,386,453	-4.6%
Farms reporting	72,713	68,633	67,520	59,728	57,211	
Average area in hectares per farm reporting	78	79	83	92	94	20.5%
Total area owned						
Area in hectares ¹	4,229,662	4,001,527	3,951,596	3,793,190	3,597,531	-14.9%
Farms reporting	68,469	65,328	64,354	57,156	55,179	
Average area in hectares per farm reporting	62	61	61	66	65	4.8%
Total area rented or leased from others²						
Area in hectares ¹	1,416,920	1,449,852	1,665,264	1,673,043	1,788,922	26.3%
Farms reporting	24487	22,427	24,191	22,055	21,508	
Average area in hectares per farm reporting	58	65	69	76	83	43.1%
Land in crops (excluding Christmas trees)						
Area in hectares ¹	3,457,966	3411667	3,544,927	3,656,705	3,660,941	5.9%
Farms reporting	65,943	61,353	59,269	53,799	50,169	
Average area in hectares per farm reporting	52	56	60	68	73	40.4%
<p>1. Conversion factor: 1 hectare equals 2.47105413 acres. 2. Total area rented or leased from others includes land; leased from governments, rented or leased from others and crop-shared from others. Source: Statistics Canada, censuses of agriculture. Last modified: 2007-05-16.</p>						

Table 10 Estimated Area of Non-agricultural uses of Dependable Agricultural Land, Canada, 1951 - 2001

Year	Urban and rural built-up ¹	Transportation and utilities ²	Protected areas and campgrounds	Other ³	Total
1951	11,400	7,400	1,000	200	20,000
1961	12,600	7,400	1,100	300	21,400
1971	14,300	8,200	1,300	500	24,300
1981	18,000	9,800	1,500	1,100	30,400
1991	21,100	10,600	2,100	1,700	35,500
2001	23,200	11,700	3,400	2,100	40,400

Notes:

Figures are rounded to the nearest 100.

1/ Includes inventoried human settlements with populations above 1000, settlements with a population under 1000, and rural farmsteads/housing lots.

2/ Includes roads, railways, airports and utility transmission lines.

3/ Includes lumberyards, sewage treatment facilities, dumps, Federal Real Property, cemeteries, pits, quarries, auto-wreckers and golf courses.

Source: Statistics Canada, Environment Accounts and Statistics Division

Table 11 Population, land area, and area-wide population density by size of urban region, America (2000) and Canada (2001)

	Population (000s)	Land area (km²)	Persons per km²
USA, 2000	281,422	9,161,927	31
4,000,000 persons or more	92,846	283,181	328
<i>New York--Northern New Jersey--Long Island, NY--NJ--CT, CMSA</i>	21,200	27,065	783
<i>Los Angeles--Riverside--Orange County, CA, CMSA</i>	16,374	87,944	186
<i>Chicago--Gary--Kenosha, IL--IN--WI, CMSA</i>	9,158	17,941	510
<i>Washington--Baltimore, DC--MD--VA--WV, CMSA</i>	7,608	24,803	307
<i>San Francisco--Oakland--San Jose, CA, CMSA</i>	7,039	19,083	369
<i>Philadelphia--Wilmington--Atlantic City, PA--NJ--DE--MD, CMSA</i>	6,188	15,372	403
<i>Boston--Worcester--Lawrence, MA--NH--ME--CT, CMSA</i>	5,819	14,574	399
<i>Detroit--Ann Arbor--Flint, MI, CMSA</i>	5,456	17,004	321
<i>Dallas--Fort Worth, TX, CMSA</i>	5,222	23,579	221
<i>Houston--Galveston--Brazoria, TX, CMSA</i>	4,670	19,956	234
<i>Atlanta, GA, MSA</i>	4,112	15,861	259
1,000,000 to 3,999,999 persons	68,672	486,166	141
100,000 to 999,999 persons	62,758	977,622	64
Rural or small urban (under 100,000 persons)	57,145	7,414,958	8
Canada, 2001	30,007	9,012,112	3
4,000,000 persons or more	4,683	5,903	793
<i>Toronto</i>	4,683	5,903	793
1,000,000-3,999,999	6,477	12,244	529
100,000-999,999	8,988	73,485	122
Rural or small urban (under 100,000 persons)	9,859	8,920,481	1

Source ICPSR series 3194. *Census of Population and Housing, 2000 [United States]: Summary File 1, States*. Calculations based on aggregation from SUMLEV 091 (block group) by the author.
 Statistics Canada. 2001 Geosuite CD-ROM. Calculations by the author.

From Miron, 2003, p 28.

Table 12 Population densities in the ten largest urban regions in Canada, and America over two succeeding census periods (ordered by the LD2 density measure)

Urban Region	Previous Census (1995-96)					Latest Census (2000-01)				
	Population (000s)	Land Area (sq km)	AD	LD ₂	S ₂	Population (000s)	Land Area (sq km)	AD	LD ₂	S ₂
New York CMSA	18,087	20,192	896	6,787	7,192	21,200	27,065	783	6,855	7,552
Toronto CMA	4,264	11,707	364	3,635	2,243	4,683	5,903	793	3,681	2,274
Montreal CMA	3,327	7,990	416	3,634	2,715	3,426	4,047	847	3,632	2,776
Los Angeles CMSA	14,532	87,972	165	3,012	2,252	16,374	87,944	186	3,200	2,323
Chicago CMSA	8,066	14,553	554	2,904	2,506	9,158	17,941	510	2,892	2,583
San Francisco CMSA	6,253	19,084	328	2,602	2,246	7,039	19,083	369	2,872	2,365
Vancouver CMA	1,832	5,630	325	2,638	1,536	1,987	2,879	690	2,826	1,684
Hamilton CMA	624	2,718	230	2,266	1,372	662	1,372	483	2,246	1,382
Philadelphia CMSA	5,899	13,845	426	2,498	2,609	6,188	15,372	403	2,231	2,394
Winnipeg CMA	667	8,165	82	2,157	1,198	671	4,151	162	2,123	1,176
Calgary CMA	822	10,203	81	2,030	948	951	5,083	187	2,032	951
Ottawa - Hull CMA	1,010	11,347	89	1,845	1,223	1,064	5,318	200	1,908	1,271
Boston CMSA	4,172	8,043	519	2,087	2,146	5,819	14,574	399	1,840	2,038
Quebec CMA	672	6,292	107	1,775	1,299	683	3,154	216	1,747	1,339
Washington MSA	3,924	10,274	382	1,880	1,604	7,608	24,803	307	1,733	1,517
Edmonton CMA	863	19,047	45	1,605	857	938	9,419	100	1,672	918
London CMA	399	4,191	95	1,686	817	432	2,333	185	1,635	850
Detroit CMSA	4,665	13,405	348	1,614	1,098	5,456	17,004	321	1,404	994
Houston CMSA	3,711	18,408	202	1,216	782	4,670	19,956	234	1,397	940
Dallas CMSA	3,885	18,046	215	1,186	700	5,222	23,579	221	1,333	831

Notes AD is area-wide density (persons per square kilometre). LD₂ is weighted average local density measured at 2 km. radius. S₂ is the weighted standard deviation of local density within 2 km. radius.

Sources U.S. data calculated from 2000 Census of Population and Housing Summary File 1 using summary level 091 block groups and 1990 Census STF3a using summary level 090 block groups. Canadian data calculated from the 2001 Census Geosuite database and the 1996 Census GEOREF database. Calculations by the author. Miron, 2003, p. 31.

**Table 13 Land Use Related Results From Ministry of Municipal Affairs and Housing
Municipal Performance Measuring Project**

Number of hectares of land originally designated for agricultural purposes which was re-designated for other uses during the reporting year										
Municipal Groupings	2001	2002	2003	2004	2005	2006	Total Ha 2001-2006	Total Redesignated Land as a % of Total Settlement Area 2001-2006		
Top 10 Municipalities	1,355	417	848	-2,162	3,435	4,836	8729	2.5%		
Other Municipalities above 100,000 Population	2412	4,642	1,132	-1,578	6,180	4,848	17636	8.2%		
Average Annual % of land designated for agricultural purposes which was not re-designated for other uses during the reporting year										
Groups of Municipalities	2001	2002	2003	2004	2005	2006				
Top 10 Municipalities	99.5	99.8	99.8	100.2	98.4	99.2				
All Municipalities above 100,000 Population	98.8	99.0	99.8	99.7	99.2	91.0				
Hectares of land in the settlement area as of December 31 of the reporting year										
Groups of Municipalities							Population Densities (1)			
				2004	2005	2006	2004		2006	
							Per ha.	Per km2	Per ha.	Per km2
Top 10 Municipalities										
Number of Municipalities in Sample				7	9	9				
Hectares of land				280,753	351,586	353,019	18	1,800	21	2,100
Other Municipalities above 100,000 Pop.										
No. Municipalities in Sample				14	15	16				
Hectares of land				211,161		213,858	14	1,400	14	1,400
Source: Ontario Ministry of Municipal Affairs and Housing (2004) Municipal Performance Measurement Project										
(1) 1 km2 = 100 hectares										

Table 14 New Housing Price Indexes, by Province, 2003-2007

Jurisdiction	2003	2004	2005	2006	2007	% Changes					Avg Annual
						2003	2004	2005	2006	2007	% Change
1997=100											
Canada	116.7	123.2	129.4	142.0	153.0	5.6%	5.0%	9.7%	7.7%		7.0%
House only	123.0	131.1	137.6	151.7	162.9	6.6%	5.0%	10.2%	7.4%		7.3%
Land only	105.0	108.0	113.4	122.9	133.6	2.9%	5.0%	8.4%	8.7%		6.2%
St. John's (N.L.)	112.5	118.6	125.2	129.8	136.3	5.4%	5.6%	3.7%	5.0%		4.9%
Charlottetown (P.E.I.)	105.5	109.4	114.0	116.5	118.0	3.7%	4.2%	2.2%	1.3%		2.8%
Halifax (N.S.)	119.1	121.6	125.0	130.4	138.0	2.1%	2.8%	4.3%	5.8%		3.8%
Saint John, Moncton, and Fredericton (N.B.)	102.9	105.0	109.2	112.9	113.9	2.0%	4.0%	3.4%	0.9%		2.6%
Québec (Que.)	121.9	129.3	134.9	141.9	147.6	6.1%	4.3%	5.2%	4.0%		4.9%
Montréal (Que.)	126.8	135.0	141.8	147.7	154.1	6.5%	5.0%	4.2%	4.3%		5.0%
Ottawa–Gatineau (Ont./Que.)	138.3	147.4	154.2	158.9	161.7	6.6%	4.6%	3.0%	1.8%		4.0%
Toronto and Oshawa (Ont.)	119.5	126.6	132.3	137.3	141.0	5.9%	4.5%	3.8%	2.7%		4.2%
Hamilton (Ont.)	120.9	127.4	134.6	142.0	148.4	5.4%	5.7%	5.5%	4.5%		5.3%
St. Catharines–Niagara (Ont.)	120.5	128.8	137.8	144.2	150.1	6.9%	7.0%	4.6%	4.1%		5.7%
London (Ont.)	115.0	120.4	126.3	132.8	137.6	4.7%	4.9%	5.1%	3.6%		4.6%
Kitchener (Ont.)	119.8	125.1	131.4	136.8	138.8	4.4%	5.0%	4.1%	1.5%		3.8%
Windsor (Ont.)	102.1	102.5	105.5	105.4	103.2	0.4%	2.9%	-0.1%	-2.1%		0.3%
Greater Sudbury & Thunder Bay	96.4	98.3	100.0	101.7	106.1	2.0%	1.7%	1.7%	4.3%		2.4%
Average for Ontario											3.8%
Winnipeg (Man.)	114.1	121.6	132.0	144.5	161.5	6.6%	8.6%	9.5%	11.8%		9.1%
Regina (Sask.)	124.9	133.7	142.2	154.5	188.8	7.0%	6.4%	8.6%	22.2%		11.1%
Saskatoon (Sask.)	113.6	119.8	126.5	138.0	191.5	5.5%	5.6%	9.1%	38.8%		14.7%
Calgary (Alta.)	130.9	138.2	147.8	212.2	246.6	5.6%	6.9%	43.6%	16.2%		18.1%
Edmonton (Alta.)	124.0	129.3	137.7	177.5	234.4	4.3%	6.5%	28.9%	32.1%		17.9%
Vancouver (B.C.)	96.2	101.0	105.4	112.7	120.7	5.0%	4.4%	6.9%	7.1%		5.8%
Victoria (B.C.)	96.2	105.0	113.3	117.7	118.2	9.1%	7.9%	3.9%	0.4%		5.3%

Sources: Statistics Canada, CANSIM, table (for fee) 327-0005 and Catalogue no 62-007- X. Last modified: 2008-03-11.

Table 15 Comparing Smart Growth (a.k.a. Managed Growth, Compact Development, Smart Growth, etc.) and Sprawl

Characteristic	Smart Growth	Sprawl
Land Use Density	Higher density, clustered	Lower density, dispersed
Growth Pattern	Infill and brownfield development	Unrestricted urban periphery (greenfield) expansion
Development Location	Commercial & institutional activities are concentrated into centres and downtowns	Commercial & institutional activities are dispersed
Land Use Mix	Mixed land use; residential, commercial, institutional uses occupy same neighbourhoods, streets and buildings	Homogeneous land uses; residential, commercial, retail, institution are separated in different locations.
Scale	Smaller buildings, residences, blocks and roads; more pedestrian spaces and walkways; public transit focus of transportation design and infrastructure	Larger buildings, homes, wider roads, large campuses for government buildings and office complexes, large highways are focus of transportation design and construction.
Transportation	Priority given to pedestrian, cycling, transit besides automobiles; more automobile-free transportation rights of way.	Exclusive automobile centred transportation design and infrastructure.
Street Design	Grid patterns with right-angle intersections. Alley-ways between properties. Urban streets designed to accommodate a variety of transport modes and activities. Inter-urban highways built to avoid environmentally sensitive lands and wetlands.	Curving crescents, cul-de-sacs, dead-ends in subdivisions. Highways and main streets designed to maximize motor vehicle volume and speed; low priority for pedestrians and non-motor vehicle transport modes. Inter-urban highways built as a straight line between two locations through any and all environments.
Planning Process	Planned and coordinated among jurisdictions and stakeholders.	Little or no long term planning; some coordination among jurisdictions and stakeholders. Use of eminent domain to build highways.
Public Space	Expand public realm with plazas, parks, street centred shopping and restaurants, off street parking, etc.	Private realm dominates with fenced yards, gated communities, waterfront access controlled by private associations, indoor shopping malls, accessible mainly by automobile.

Source: Litman, 2007

Table 16 Costs of Ten Development Patterns at Two Levels of Scale, US Circa 1973

Cost Categories	Hypothetical Development Patterns at Community Level (10,000 units)					Hypothetical Development Patterns at Neighbourhood Level (1,000 units)				
	Low-density Sprawl	Low-density Planned	Sprawl Mix	Planned Mix	High-density Planned	Single-family Conventional	Single-family Clustered	Townhouse Clustered	Walk-up Apartments	High-rise Apartments
INFRASTRUCTURE	Capital Costs per Unit, 1973 US\$									
Recreation, Schools, Public Facilities	\$6,468	\$6,461	\$6,453	\$7,456	\$6,466	\$5,574	\$5,628	\$4,812	\$4,790	\$1,869
Roads Streets	\$3,797	\$3,377	\$3,235	\$2,708	\$2,286	\$3,080	\$2,661	\$2,111	\$1,464	\$801
Utilities	\$6,197	\$4,744	\$3,868	\$2,323	\$2,243	\$5,483	\$3,649	\$2,369	\$1,579	\$958
Infrastructure Subtotal	\$16,462	\$14,582	\$13,556	\$12,487	\$10,995	\$14,137	\$11,938	\$9,292	\$7,833	\$3,628
Construction Cost per Unit / Other (1)	\$34,994	\$34,398	\$23,728	\$23,266	\$17,711	\$34,774	\$34,320	\$17,967	\$13,449	\$17,088
Total Infrastructure	\$51,456	\$48,980	\$37,284	\$35,753	\$28,706	\$48,911	\$46,258	\$27,259	\$21,282	\$20,716
Public Proportion (%) (2)	19%	12%	24%	16%	18%	15%	15%	20%	25%	13%
Public Infrastructure Costs	\$9,777	\$5,878	\$8,948	\$5,720	\$5,167	\$7,337	\$6,939	\$5,452	\$5,321	\$2,693
OPERATING COSTS	Annual Non-residential Operating and Maintenance Costs per Unit in year 10									
Total Operating Costs	\$2,111	\$2,067	\$1,965	\$1,937	\$1,873	\$1,721	\$1,720	\$1,388	\$1,319	\$548
Public Proportion (%) (2)	57%	51%	61%	55%	55%	67%	67%	72%	74%	57%
Public Costs	\$1,203	\$1,054	\$1,199	\$1,065	\$1,030	\$1,153	\$1,152	\$999	\$976	\$312
LAND	Land Required for 10,000 units									
Total	NA	NA	NA	NA	NA	5,000	4,000	3,000	2,000	1,000
Already Developed	4,590	4,113	2,780	3,040	2,173	NA	NA	NA	NA	NA
Vacant	1,410	1,887	3,220	2,960	3,827	NA	NA	NA	NA	NA
ENVIRONMENTAL CONSEQUENCES										
Non-auto air pollution (tons/year)	1,420	1,420	1,034	1,034	809	1,420	1,420	951	728	644
Sewage Effluent (billion litres/yr) (3)	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Water Use (million litres/yr)	4,428	4,164	3,444	3,444	2,877	4,561	4,008	3,456	2,763	2,419
Non-auto Energy Use (billion BTUs/yr)	2,355	2,355	1,750	1,750	1,400	2,398	2,398	1,595	1,232	1,056
<p>Source: Burchell <i>et al.</i> (1998), p 14. Derived from earlier work by Real Estate Research Corporation (RERC). (1974) <i>The Costs of Sprawl: Environmental and Economic Costs of Alternative Residential Development Patterns at the Urban Fringe: (Volume I: Detailed Cost Analysis; Volume II: Literature Review and Bibliography)</i>. Washington, DC: U.S. Government Printing Office.</p> <p>Notes: NA = Not Applicable.</p> <p>(1) Includes other project expenses such as land dedications.</p> <p>(2) Rationale for these proportions were not provided in the reference.</p> <p>(3) It appears that sewage effluents also include storm water runoff.</p>										

Table 17 Summary of Effects of Trend Versus Planned Development, “New Jersey Impact Assessment” (1)

Growth/Development Effects	Current or Trend Development	Planned Development	Trend vrs Planned Development	
			Difference	% Change (2)
Population Growth (persons)	520,012	520,012		
Household Growth (households)	431,000	431,000		
Employment Growth (persons)	653,600	653,600		
Infrastructure				
Roads (US\$ millions)	\$2,924	\$2,225	\$699	23.9%
Utilities - water (US\$ millions)	\$634	\$550	\$8	13.2%
Utilities - sewer (US\$ millions)	\$6,790	\$6,313	\$477	7.0%
Total Utilities (US\$ millions)	\$7,424	\$6,863	\$561	7.6%
Schools (US\$ millions)	\$5,296	\$5,123	\$173	3.3%
Total Infrastructure (US\$ millions)	\$15,644	\$14,211	\$1,433	9.2%
Land Consumption				
All Lands (acres)	292,079	117,607	174,471	59.7%
Fruit Lands (acres)	36,482	6,139	30,343	83.2%
Agricultural Lands (acres)	108,000	66,000	42,000	38.9%
House Prices				
Median Price per Unit (1990 US\$)	\$172,567	\$162,162	\$10,495	6.1%
Housing Index (3)	118	126	8	6.7%
<p>Source: Burchell, Robert W. 1992a. <i>Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan, Report II: Research Findings</i>. Trenton: New Jersey Office of State Planning. Burchell, Robert W. 1992b. <i>Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan, Report III: Supplemental AIPLAN Assessment</i>. Trenton: New Jersey Office of State Planning.</p> <p>Notes: (1) Trend Development refers to Urban Sprawl type development (2) % savings over Trend Development. (3) Higher Index value implies more affordable.</p>				

Table 18 Percent Savings of Compact Growth Over Current or Trend Development

Types of Effects	Lexington, KY & Delaware Estuary	Michigan	South Carolina	New Jersey
Public-Private Capital and Operating Costs				
Roads (local)	14.8 - 19.7	12.4%	12%	26%
Utilities	6.7 - 8.2	13.7%	13%	8%
Housing Costs	2.5 - 8.4	6.8%	7%	6%
Cost-Revenue change	6.90%	3.5%	5%	2%
Land/Natural Habitat Preservation				
Developable Land	20.5 - 24.2	15.5%	15%	6%
Agricultural Land	18 - 29	17.4%	18%	39%
Frail (Sensitive) Land	20 - 27	20.9%	22%	17%
Sources: Burchell, 1992-1997 cited in Burchell <i>et al.</i> (1998) Current or Trend Development = Sprawl Development				

Table 19 Summary of Projected Results Comparing Conventional Development (CD) and Managed Growth (MG) Scenarios, US 2000-2025

Region	Total Public Service Costs				Property Development Costs per Unit				Savings in Road Construction		Water and Sewer Infrastructure			
	Revenues - Costs		CD - MG		Residential Savings		Non-residential Savings		Lane-miles Required	Total Costs (\$Bil)	Total Expenditures (\$Mil)			
	CD (\$ Mil)	MG (\$ Mil)	\$ Mil	% Chg	\$/unit	% Reduction	\$/unit	% Reduction			CD	MG	CD-MG Savings	% Saving
Northeast	\$1,841	\$3,676	\$1,835	99.7%	\$18,089	7.3%	\$1,428	1.7%	6,809	\$6.20	\$16,015	\$14,751	\$1,264	7.89%
Midwest	(\$3,562)	(\$2,001)	\$1,561	-43.8%	\$9,470	6.3%	\$854	1.2%	17,550	\$8.61	\$30,393	\$28,839	\$1,554	5.11%
South	(\$19,532)	(\$18,531)	\$1,001	-5.1%	\$11,737	8.4%	\$912	1.3%	78,989	\$38.92	\$84,573	\$79,026	\$5,547	6.56%
West	(\$22,535)	(\$22,728)	(\$192)	0.9%	\$14,954	7.6%	\$576	0.7%	84,957	\$55.98	\$58,786	\$54,544	\$4,242	7.22%
Total	(\$43,788)	(\$39,583)	\$4,205	-9.6%	\$13,003	7.8%	\$865	1.1%	188,305	\$109.70	\$189,767	\$177,160	\$12,607	6.64%

Source: Burchell and Mukherji, 2003.
 Estimates are differences in growth forecasts of specific costs and other consequences using integrated multiple equation models for each cost or consequence category.

Table 20 Emplacement Costs per Housing Unit for Alternative Development Patterns - Prepared for Canadian Mortgage and Housing Corporation, 1996

Service Cost Components	Conventional Development	Alternative Development Plan	Differences	% Savings Under the Alternative Development Plan
Garbage collection and disposal	\$0	\$0	\$0	0%
School facilities and transportation	\$10,034	\$10,033	(\$1)	0%
Roads incl. utilities and service connections	\$5,272	\$3,311	(\$1,961)	-37%
Stormwater management	\$3,491	\$2,210	(\$1,281)	-37%
Sanitary sewers	\$1,885	\$1,191	(\$694)	-37%
Water distribution	\$1,758	\$1,258	(\$500)	-28%
Transit	\$1,059	\$881	(\$178)	-17%
Works and Parks Department	\$417	\$358	(\$59)	-14%
Police	\$362	\$313	(\$49)	-14%
Fire protection	\$348	\$301	(\$47)	-14%
Electric services	\$1,992	\$1,731	(\$261)	-13%
Parkland	\$3,591	\$3,368	(\$223)	-6%
Libraries	\$522	\$489	(\$33)	-6%
Recreational facilities	\$3,335	\$3,183	(\$152)	-5%
Sidewalks and street lighting	\$498	\$636	\$138	28%
Total	\$34,564	\$29,263	(\$5,301)	-15%
Source: Canadian Mortgage and Housing Corporation (1996) <i>Infrastructure Costs Associated with Conventional and Alternative Development Patterns.</i>				

Table 21 Comparison of per Housing Unit Total Life-Cycle Costs for Conventional and Alternative Development Patterns in Canada Prepared for the Canada Mortgage and Housing Corporation

Service Cost Components	Conventional Development	Alternative Development Plan	Differences	% Savings Under Alternative Development Plan
Garbage collection and disposal	\$2,453	\$2,301	(\$152)	0%
School facilities and transportation	\$56,804	\$56,799	(\$5)	0%
Sanitary sewers	\$2,652	\$1,677	(\$975)	-37%
Stormwater management	\$4,105	\$2,606	(\$1,499)	-37%
Water distribution	\$3,534	\$2,446	(\$1,088)	-31%
Roads incl. utilities and service connections	\$10,446	\$7,392	(\$3,054)	-29%
Transit	\$9,104	\$7,774	(\$1,330)	-15%
Police	\$7,466	\$6,450	(\$1,016)	-14%
Fire protection	\$5,204	\$4,496	(\$708)	-14%
Works and Parks Department	\$772	\$663	(\$109)	-14%
Parkland	\$4,735	\$4,325	(\$410)	-9%
Electric services	\$6,270	\$5,893	(\$377)	-6%
Libraries	\$2,934	\$2,752	(\$182)	-6%
Recreational facilities	\$7,794	\$7,434	(\$360)	-5%
Sidewalks and street lighting	\$936	\$1,225	\$289	31%
Total	\$125,209	\$114,233	(\$10,976)	-9%

Source: Canadian Mortgage and Housing Corporation (1996) *Infrastructure Costs Associated with Conventional and Alternative Development Patterns*

Table 22 Pro-forma Cost Analyses of “Smart Developments” in GTA Locations

Project (1)	Total Cost \$ mil	Res Unit Price or Face Rent per Sqr Ft	# Res. Units; Sqr Feet of Commercial area	% of Total Project Cost (2)						
				Land	Hard Construction	Parking	Development Charges	Building Permits	Gov't Influenced Costs	Other
Vaughan, Residential (1 a)	\$3.0	\$231,800	150	3.4%	63.0%	12.0%	5.9%	0.4%	6.5%	
Vaughan, Commercial (1 b)	\$44.0	\$21.98	240,000	2.4%	57.3%	13.8%	2.3%	0.6%	2.9%	
Hurontario St., Residential (2 a)	\$8.8	\$225,555	44	13.0%	56.0%	8.2%	6.1%	0.6%	7.6%	0.6% (3)
Hurontario St., Commercial (2 b)	\$4.2	\$20.65	100,000	4.2%	55.0%	12.0%	2.2%	0.6%	4.1%	
Whitby GO Area, Residential (3 a)	\$20.7	\$220,823	50	2.3%	55.0%	16.0%	1.5%	-	2.0%	
Whitby GO Area, Commercial (3 b)	\$9.9	\$20.69	120,000	7.2%	61.0%	12.7%	3.2%	0.2%	3.8%	
St. Catharines, Residential (4 a)	\$8.4	\$187,365	50	3.7%	63.0%	15.0%	1.1%	0.3%	1.7%	
St. Catharines, Commercial (4 b)	\$8.0	\$16.04	60,000	3.2%	52.5%	18.0%	1.4%	0.3%	2.0%	
Averages for Residential Projects	\$10.2	\$216,386		5.6%	59.3%	12.8%	3.7%	0.3%	4.5%	
Averages for Commercial Projects	\$16.5	\$19.84		4.3%	56.5%	14.1%	2.3%	0.4%	3.2%	

Source: Royal LePage Advisors, Appendix B: Smart Growth Development Types - *Pro forma* Financial Analysis, in Blais (2003)

Notes:

- (1) Project Descriptions - NB all projects include basement parking which is not common in these locations.
 - 1. Vaughan Corporate Centre Hwy 7. a) High-rise residential apartments; b) High-rise office building.
 - 2. Hurontario St, Mississauga. a) Mid-rise stacked townhouses and row houses; b) 3-6 storey office bldg.
 - 3. Whitby GO Station area. a) Mid-rise, 4-6 storey residential; b) 8-story mid-high density office bldg.
 - 4. Downtown St. Catharines. a) Single story residential town houses; b) 4-story medium commercial-office building.
- (2) These percentages to not add up to 100% because the profit margin and certain cost items are not displayed such as leasing and financing cost for commercial buildings and sales and marketing costs for residential developments.
- (3) Parkland dedication. Other projects included this cost item as well but either did not provide the per cent value they are included in “government influenced costs.”

Table 23 Selected Emissions and Sources of Criteria Air Pollutants in Ontario, 1999

Source Sector	SO ₂		NO _x		VOC		CO		Total PM		PM ₁₀		PM _{2.5}	
	Kt	%	Kt	%	Kt	%	Kt	%	Kt	%	Kt	%	Kt	%
Area Sources														
Total Vehicles	10.6	1.8	183.6	0.4	139.1	20.1	1,439.1	60.8	10.9	5.3	10.8	8.8	9.1	10.7
Residential	4.2	0.7	16.5	3.0	83.5	12.1	154.2	6.5	22.4	11.0	21.9	17.8	21.9	25.8
Commercial (1)	1.8	0.3	9.1	1.7	0.4	0.1	1.9	0.1	1.0	0.1	1.0	0.8	1.0	1.1
Industrial (1)	7.6	1.3	10.0	1.8	0.4	0.1	6.8	0.3	5.9	2.9	5.3	4.3	4.4	5.2
Misc. Processes (2) (4)	0.0	0.0	0.0	0.0	5.8	0.8	1.1	0.0	57.5	28.1	14.6	11.9	4.5	5.3
Subtotal Area Sources (3)	44.9	8.0	383.8	70.0	571.5	83.0	2,243.9	95.0	114.4	56.0	68.2	56.0	53.2	63.0
Stationary Industrial Sources														
Subtotal Stationary Industrial Sources (3)	535.0	92.0	165.6	30.0	120.0	17.0	121.9	5.0	90.4	44.0	54.6	44.0	31.6	37.0
Ontario Total	579.9	100	549.4	100	691.4	100	2,365.8	100	204.8	100	122.8	100	84.8	100
Pollutants as a % of combined total Ontario emissions (5)	13.2 %		12.5 %		15.7 %		53.9%		4.7%					

Source: Ontario Ministry of the Environment (2003) *Fast Reference Emissions Document*. Table A23.

Notes :

Kt = kilotonne = 1000 tonnes.

PM = particulate matter; PM₁₀ = particulate matter ≤ 10 microns in diameter; PM_{2.5} = particulate matter ≤ 2.5 microns in diameter.

[1] Emissions estimated from Statistics Canada information and adjusted for emissions already accounted for under point sources.

[2] Includes industrial processes that are not accounted for under point sources (e.g. mining, quarrying, stone processing, fertilizer application, grain handling, etc.)

[3] Components may not add up to totals due to rounding.

[4] Zero values represent no emissions or emissions less than 50 tonnes per year.

[5] Sum of all emissions (excluding PM₁₀ and PM_{2.5}) = 4,391.3 kilotonnes.

NB Emission data are a combination of reported and projected emission estimates. These estimates may be revised with updated source/sector information or emission estimation methodologies.

NB Since 2003, the collection, management and reporting of air pollutant emission data (including GHG emissions) from all provinces, including Ontario, are carried out by Environment Canada. Emissions data for Ontario can now be obtained from an Environment Canada website,

<http://www.ec.gc.ca/default.asp?lang=En&n=499D6B13-1>. GHG emissions can be obtained from

http://www.ec.gc.ca/pdb/ghg/onlineData/docs/t4n5_all_b.xls. The most recent emissions data for Ontario, disaggregated by sector, are available for 2005 and 2006. Emissions data by sector and over time for earlier years are available only for Canada for years between 1985 and 2006 at the above noted web site.

Table 24 Air Pollution Related Health Effects Cases and Associated Monetary Values

	Ontario Sources	Transboundary Sources	Totals	%
Attributable Air Pollution-Related Mortalities and Morbidity Cases per year				% from Ontario
Premature mortalities	3,130	2,751	4,881	44.0%
Hospital admissions	6,541	11,939	18,480	35.0%
Emergency room visits	7,950	13,925	21,874	36.0%
Minor Illnesses	2,119,608	2,682,437	4,802,045	44.0%
Aggregate Monetary Values of Air Pollution-Related Mortalities and Morbidities by Region (\$ million per year)				% of Total
Northeast Ontario	\$43	\$87	\$130	2.0%
Central Ontario	\$34	\$84	\$118	1.8%
Southeast Ontario	\$262	\$493	\$755	11.5%
South Central Ontario	\$2,166	\$1,992	\$4,159	63.1%
Southwest Ontario	\$361	\$1,067	\$1,428	21.7%
Total	\$2,866	\$3,723	\$6,590	100.0%
Source: DSS Management Consultants (2005).				
NB The authors caution that these estimates are conservative and understate the actual occurrence and values of these consequences.				

Table 25 **Elements of a Benefit-Cost Evaluation Framework**

Evaluation criteria, are factors and consequences considered in a particular analysis?

Modelling techniques, predict how a policy change or program will affect travel behaviour and land use patterns, and measure the incremental benefits and costs that result.

A Base Case (also called *do-nothing case*), are conditions that would occur without the proposed policy or program.

Reference units, such as costs per lane-mile, vehicle-mile, passenger-mile, incremental peak-period trip, etc.

Base year and discount rate, which indicate how costs are adjusted to reflect the time value of money.

Perspective and scope, such as the geographic range of effects to consider.

Dealing with uncertainty, such as whether sensitivity analysis or statistical tests will be used.

How results are presented, so that the results of different evaluations are easy to compare.

A with-and-without test, which displays the conditions that would occur with or without a particular policy or project. For example, the consequences of a roadway widening are the incremental changes that would occur if the project were implemented.

Defining the base case, conditions that would otherwise occur if the proposed policy or project were **not** implemented.

Table 26 Housing and Travel Cost Trends (\$1996)

Regional Municipality	Average Travel Costs			Average Housing Costs			Average Travel + Housing Costs		
	1986	1991	1996	1986	1991	1996	1986	1991	1996
Toronto	7,900	8,300	7,000	9,000	10,400	10,100	16,900	18,700	17,100
Durham	10,800	12,000	10,400	9,900	12,600	12,000	20,700	24,600	22,400
York	13,400	15,400	13,700	11,700	14,100	13,600	25,100	29,500	27,300
Peel	12,000	13,000	11,000	10,800	13,000	12,800	22,800	26,000	23,800
Halton	12,700	13,600	12,000	10,500	12,600	12,300	23,200	26,200	24,300
Hamilton	7,600	9,200	8,300	7,700	9,000	8,800	15,300	18,200	17,100
GTA Total	9,300	10,300	9,000	9,400	11,300	11,000	18,700	21,600	20,000

Source: Miller, et al. (2004) *Travel and Housing Costs in the Greater Toronto Area (GTA): 1986-1996*.

Table 27 Housing and Travel As a Proportion of Income

Regional Municipality	Average (Travel Costs)/ Income			Average (Housing Costs)/ Income			Average (Travel + Housing Costs)/ Income		
	1986	1991	1996	1986	1991	1996	1986	1991	1996
Toronto	14.2%	14.2%	13.0%	16.2%	17.8%	18.8%	30.3%	32.0%	31.8%
Durham	18.3%	19.0%	16.6%	16.8%	19.9%	19.1%	35.1%	38.9%	35.7%
York	18.8%	19.8%	18.4%	16.4%	18.2%	18.3%	35.3%	38.0%	36.7%
Peel	18.7%	19.2%	16.8%	16.8%	19.2%	19.6%	35.6%	38.4%	36.4%
Halton	19.3%	18.6%	16.4%	16.0%	17.2%	16.8%	35.3%	35.7%	33.2%
Hamilton	16.2%	18.3%	16.9%	16.4%	17.9%	17.9%	32.6%	36.1%	34.8%
GTA Total	16.1%	16.6%	15.2%	16.3%	18.3%	18.6%	32.4%	34.9%	33.8%
% Growth 1986-96		-5.4%			14.4%			4.6%	

Source: Miller, et al. (2004) *Travel and Housing Costs in the Greater Toronto Area (GTA): 1986-1996*.

Table 28 Canadian Motor Vehicle Traffic Collision Statistics: 2006 Collisions and Casualties⁶ 1987-2006

Year	COLLISIONS		VICTIMS			% Changes	
	Fatal ¹	Personal Injury	Fatalities ³	Serious Injuries	Injuries ⁵ (Total)	Fatalities From 1987	Total Injuries From 1987
1987	3,729	193,237	4,283	28,000	280,605		
1988	3,610	190,094	4,154	28,031	278,820	-3.0%	-0.6%
1989	3,651	192,595	4,238	27,422	284,937	-1.1%	1.5%
1990	3,445	178,515	3,963	25,183	262,680	-7.5%	-6.4%
1991	3,228	170,693	3,690	26,035	249,217	-13.8%	-11.2%
1992	3,073	169,640	3,501	25,521	249,823	-18.3%	-11.0%
1993	3,121	168,106	3,615	23,902	247,593	-15.6%	-11.8%
1994	2,869	166,780	3,263	22,830	245,110	-23.8%	-12.6%
1995	2,854	164,190	3,351	21,494	241,935	-21.8%	-13.8%
1996	2,679	153,966	3,062	18,737	227,320	-28.5%	-19.0%
1997	2,617	147,538	3,033	17,294	217,403	-29.2%	-22.5%
1998	2,576	145,612	2,911	16,409	213,304	-32.0%	-24.0%
1999	2,635	148,660	2,984	16,186	218,437	-30.3%	-22.2%
2000	2,569	153,273	2,927	15,579	222,830	-31.7%	-20.6%
2001*	2,432	148,961	2,776	15,282	216,441	-35.2%	-22.9%
2002	2,594	153,850	2,932	15,906	222,706	-31.5%	-20.6%
2003	2,486	150,474	2,768	15,104	216,089	-35.4%	-23.0%
2004	2,430	145,256	2,722	15,605	206,232	-36.4%	-26.5%
2005	2,558	145,604	2,905	15,812	204,751	-32.2%	-27.0%
2006	2,604	144,756	2,889	15,281	199,337	-32.5%	-29.0%

Source: Transport Canada @ <http://www.tc.gc.ca/roadsafety/tp/tp3322/2006/page1.htm>

Notes:

- ¹ "Fatal collisions" include all reportable motor vehicle crashes which resulted in at least one fatality, where death occurred within 30 days of collision, except in Quebec (8 days).
- ² "Personal Injury" collisions include all reportable motor vehicle crashes which resulted in at least one injury but not death within the timeframes set out in "Fatal collisions".
- ³ "Fatalities" include all those who died as a result of involvement in a reportable traffic collision within 30 days of its occurrence, except in Quebec (8 days).
- ⁴ "Serious Injuries" include persons admitted to hospital for treatment or observation. Serious injuries for British Columbia were estimated from 1987 to 2003 and for January, February and March 2004.
- ⁵ "Total Injuries" include minimal, minor, moderate, serious and unspecified severities.
- ⁶ Collisions and casualties were revised for the period 1996 to 2005 based on submissions by one of the jurisdictions.
- * Data for Nunavut are not reported for 2001 except for fatalities.

Table 29 Estimates of the Monetary Value of Injuries, Fatalities and Property Damages Due to Road Vehicle Accidents, 1996

Severity	Number of Occurrences	Compensation Cost per Occurrence	Total Compensation Cost (\$ Billion)
Fatalities	3,294	\$15,600,000	\$5.1
Injuries	230,885	\$28,000	\$6.5
Property Damages	670,000	\$5,600	\$3.8
Total			\$15.4

Source: Road Safety and Motor Vehicle Regulation, Transportation Safety Board, Transport Canada. <http://www.tc.gc.ca/roadsafety/tp2436/rs200403/menu.htm>

Table 30 Consolidated Schedule of Capital Fund Operations, Brampton, 2006

	2006 Budget \$	2006 Actual \$	2005 Actual \$
REVENUES			
Grants:			
Government of Canada	3,041,000	–	587,772
Province of Ontario	4,761,000	2,337,822	2,942,561
Donations	–	179,117	8,733
Total Grants	7,802,000	2,516,939	3,539,066
Investment Income	–	295,569	187,522
Development levies	122,080,809	92,358,084	88,751,566
Total Revenues	129,882,809	95,170,592	92,478,154
EXPENDITURES			
General Government	13,939,531	10,792,450	18,916,788
Protection to persons and property	3,705,931	3,268,530	2,499,374
Transportation services	70,193,762	80,031,765	52,349,282
Health Services (cemeteries)	–	113,834	725,082
Social & Family services	–	–	39,981
Recreation and cultural services	66,541,776	68,058,269	65,798,951
Planning and development	1,425,597	365,268	961,945
Total Expenditures	155,806,597	162,630,116	141,291,403
Development levies as a % of Total Expenditures	78.4%	56.8%	62.8%
NET		(67,459,524)	(48,813,249)
FINANCING AND TRANSFERS			
Transfers from Revenue Fund		3,314,863	4,493,665
Transfers from Reserve Funds		61,229,318	49,666,988
Net transfers		64,544,181	54,160,653
CHANGE IN CAPITAL FUND BALANCE		(2,915,343)	5,347,404
Opening Capital Fund Balance		240,249,473	234,902,069
CLOSING CAPITAL FUND BALANCE		237,334,130	240,249,473

Source: The Corporation of the City of Brampton, Ontario, Canada, Annual Report 2006

Table 31 Consolidated Schedule of Capital Fund Operations, City of Mississauga, 2006

Items	2006 Budget (\$000)	2006 Actual (\$000)	2005 Actual (\$000)
Revenues			
Development Contributions Applied	\$52,295	\$61,226	\$31,979
Specific Grants	\$17,473	\$17,473	\$4,460
Other	\$6,017	\$4,970	\$4,705
Total Revenues	\$75,785	\$83,669	\$41,144
Expenditures			
Transportation	\$90,055	\$76,270	\$82,045
Other Categories (General Government, Protection, Environment, Social & Family, Recreation & Culture)	\$46,593	\$52,344	\$54,676
Total Expenditures	\$136,648	\$128,614	\$136,721
Development Contributions as % of Total Expenditures	38.3%	47.6%	23.4%
Net Expenditures	(\$60,863)	(\$44,945)	(\$95,577)
Transfers from Reserve Funds (1)	\$96,707	\$80,904	\$72,649
Changes in Capital Fund Balance	\$35,844	\$35,959	(\$22,928)
Opening Capital Fund Balance	\$71,826	\$71,826	\$94,754
Closing Capital Fund Balance	\$107,670	\$107,785	\$71,826
Source: Financial Report of the City of Mississauga, 2006 (1) Revenues to Reserve Funds include "Contributions from developers for specific works". Revenues from developers were \$41,658 and \$38,228 in 2006 and 2005 respectively.			

Table 32 Consolidated Schedule of Capital Fund Financial Activities and Fund Balance, Town of Oakville

Year ended December 31, 2006

(tabular columns in thousands of dollars)

Schedule 2

	2006 BUDGET	2006 ACTUAL	2005 ACTUAL
Revenues			
Provincial Grants	\$ 825	\$ 3,276	\$ 941
Gas Tax Funding	-	724	-
Developer charges earned	24,106	12,859	14,818
Upper tier recoveries	-	1,015	2,523
Other revenue and recoveries	3,523	6,949	2,487
TOTAL REVENUES	28,454	24,823	20,769
Expenditures			
General government	10,743	8,495	4,435
Protection to persons and property	1,344	1,553	2,432
Transportation services	31,449	25,637	18,049
Environmental services	-	613	1,011
Health services	48	53	130
Recreation and cultural services	15,355	16,193	17,629
Planning and development	1,180	389	949
TOTAL EXPENDITURES	60,119	52,933	44,635
NET EXPENDITURES	(31,665)	(28,110)	(23,866)
Financing and Transfers			
Proceeds from long-term debt	10,007	4,782	3,584
Transfer from Operating Fund	9,761	10,216	8,583
Transfer from Reserve and Reserve Funds	11,897	11,055	9,507
NET FINANCING AND TRANSFERS	31,665	26,053	21,674
CHANGE IN CAPITAL FUND BALANCE	-	(2,057)	(2,192)
CAPITAL FUND BALANCE, BEGINNING OF YEAR	-	6,847	9,039
CAPITAL FUND BALANCE, END OF YEAR	\$ -	\$ 4,790	\$ 6,847

Source: Annual Financial Report for the Town of Oakville, 2006.

(http://www.oakville.ca/Media_Files/General/AR06FinancialStatements.pdf)

Table 33 Consolidated Schedule of Capital Fund Financial Activities and Fund Balance, City of Oshawa, year ended December 31, 2006

	2006	2005
	\$	\$
REVENUE		
Contributions from developers - earned	2,900,824	10,776,726
Federal Gas Tax Revenue	1,355,703	1,355,703
Government grants	444,932	876,542
Donations	18,290	15,000
Other	2,229,096	1,665,039
Total Revenue	6,948,845	14,689,010
EXPENDITURES		
General government	1,614,373	3,329,574
Protection to persons and property	4,930,444	1,646,704
Transportation services	8,089,749	8,346,967
Environmental services	6,665,369	4,581,435
Health Services	92,288	650
Social and family services	169,484	586,398
Recreation and cultural services	57,412,648	49,547,640
Planning and development services	4,912,976	702,675
Total Expenditures	83,887,331	68,742,043
Contributions from developers as a % of Total Expenditures	3.5%	15.7%
NET EXPENDITURES	(76,938,486)	(54,053,033)
FINANCING AND TRANSFERS:		
Financing - debenture proceeds	21,680,000	33,000,000
Financing - OPUC Note proceeds	-	23,064,000
Current fund	11,007,856	6,358,924
Reserves and reserve funds	4,698,366	5,955,082
Total Transfers	37,386,222	68,378,006
CHANGE IN CAPITAL FUND BALANCE	(39,552,264)	14,324,973
CAPITAL FUND BALANCE, Beginning of Year	37,808,235	23,483,262
CAPITAL FUND BALANCE, End of Year	(1,744,029)	37,808,235

Source: City of Oshawa, 2006 Annual Report

Table 34 How Property Tax Increases Attributable to a Park Can Pay the Annual Debt of Acquisition and Development of the Park (1)

Zone (2)	Property Values (3)	Incremental Value Attributed to Park	Total Property Taxes at 2% of Property Value	Incremental Property Taxes Attributed to the Park	Aggregate Property Tax Increments for 70 Lots
Outside Park Influence	\$2,000	\$0	\$40	\$0	\$0
Zone A	\$240,000	\$40,000	\$4,800	\$800	\$56,000
Zone B	\$220,000	\$20,000	\$4,400	\$400	\$28,000
Zone C	\$210,000	\$10,000	\$4,200	\$200	\$14,000
Totals					\$98,000

Source: Crompton, 2001.

Notes:

(1) Hypothetical 50-acre natural area park with appealing topography and vegetation. Cost of acquiring and developing park (including fencing, trails, planting, landscaping is \$20,000/acre = \$1,000,000. Annual debt charges for 20-year general obligation bond at 5% are about \$90,000 which is less than the \$98,000 in aggregate tax increments.

(2) Zone A = Adjacent to Park; Zone B = 1 block away from Park; Zone C = 2 blocks away from park.

(3) All values are denominated in US\$.

Table 35 Participation, Days and Trips of Ontario Participants in Nature-Related Activities in 1996

Indicators	Outdoor Activities in Natural Areas	Residential Wildlife-Related Activities	Wildlife Viewing (1)	Recreational Fishing (1)	Hunting (1)	Indirect Nature-related Activities	Grand Totals (1) (million)
Participation							7,600,000
Number of Participants	3,878,000	3,822,000	1,561,000	1,536,000	314,000	6,599,000	
Participation Rate	43.4%	42.8%	17.5%	17.2%	3.5%	73.9%	
Days							634,400,000
Number of Days	58,525,000	553,975,000	25,869,000	27,432,000	5,413,000	n/a	
Average Number Days per Participant	15.1	145.0	16.6	17.9	17.3		
Trips							66,300,000
Total Trips	46,910,000	n/a	17,989,000	20,117,000	4,123,000	n/a	
Average Number Trips per Participant	12.1	N/a	11.5	13.1	13.1	n/a	
<p>Source: DuWors <i>et al.</i>(1999) <i>The Importance of Nature to Canadians: Survey Highlights</i>. Ottawa: Environment Canada, p. 32</p> <p>n/a = not available.</p> <p>(1) Estimates include wildlife viewing, fishing and hunting as main and secondary activities combined, as described in Chapters 2 and 3 of DuWors <i>et al.</i> As a result, grand totals of participants, days and trips are less than the sum for the individual activities.</p>							

Table 36 Distribution of Nature-Related Expenditures in 1996

Expenditure Category	Canada		Ontario	
	\$ Billion	%	\$ Million	%
Accommodation	\$1.4	12.7%	\$598.8	14.0%
Transportation	\$2.6	23.6%	\$991.7	23.2%
Food	\$2.0	18.2%	\$756.4	17.7%
Equipment	\$3.1	28.2%	\$1,136.1	26.5%
Other Items	\$0.6	5.8%	\$218.9	5.1%
Costs for other nature-related activities (1)	\$1.2	10.9%	\$581.5	13.6%
Total	\$11.0	100.0%	\$4,283.4	100.0%

Source: Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians (2000) *The Importance of Nature to Canadians: The Economic Significance of Nature-Related Activities*. Ottawa: Environment Canada, p. 12.

Notes:

(1) including expenditures on maintaining, restoring or purchasing land for conservation, nature-related organizations and residential wildlife-related activities. Data on these activities were not broken down by expenditure category.

Table 37 Expenditures on Nature-Related Activities by Ontario Participants in 1996, by Type of Activity

Expenditure Category	Outdoor Activities in Natural Areas		Wildlife Viewing (1)		Recreational Fishing (1)		Hunting (1)		Other Nature-Related Activities (2)	Total Expenditures (3)	
	\$ Million	%	\$ Million	%	\$ Million	%	\$ Million	%	\$ Million	\$ Million	%
Accommodation	\$489.7	17.2%	\$28.1	6.8%	\$67.8	8.9%	\$13.2	6.6%		\$598.8	14.0%
Transportation	\$757.4	26.6%	\$58.7	4.3%	\$130.6	7.1%	\$45.0	22.4%		\$991.7	23.2%
Food	\$606.3	21.3%	\$36.2	8.8%	\$85.6	1.2%	\$28.4	14.2%		\$756.4	17.7%
Equipment	\$843.3	29.6%	\$287.9 (4)	0.1%	\$398.2	2.2%	\$64.1	32.0%		\$1,136.1	26.5%
Other Items	\$154.3	5.4%			\$80.1	0.5%	\$49.8	24.8%		\$218.9	5.1%
Costs incurred for other nature-related activities									\$581.5	\$581.5	13.6%
Total	\$2,851.0	100.0%	\$410.9		\$762.2		\$200.6		\$581.5	\$4,283.4	
Average yearly expenditure (4)	\$735.0		\$263.0		\$496.0		\$639.0				
Average daily expenditure (4)	\$49.0		\$16.0		\$25.0		\$37.0				

Source: Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians (2000) *The Importance of Nature to Canadians: The Economic Significance of Nature-Related Activities*. Ottawa: Environment Canada, p. 36.

Notes:

(1) Expenditures for wildlife viewing, recreational fishing and hunting are for main and secondary activities combined as explained in Section 2.1 of the above-noted report. Due to the manner in which the secondary expenditures were calculated, there are duplications and these values cannot be summed.

(2) Costs for other nature-related activities include expenditures on maintaining, restoring or purchasing land for conservation, nature-related organizations and residential wildlife-related activities. Data on these activities were not broken down by expenditure category.

(3) These values taken from DuWors *et al.*, 1999, p. 32.

(4) Average per person per year.

Table 38 Economic Implications (Impacts) Associated with Expenditures on Nature-related Activities in Canada, 1996

Economic Implication Indicators	Canada (\$ Billion)	Ontario (\$ Billion)
Gross business production	\$16.3	\$7.08
Gross domestic product	\$11.4	\$4.50
Government revenue from taxes	\$5.1	\$1.46
Personal Income	\$5.5	\$2.45
Number of jobs sustained (persons)	201,400	77,890
<p>Source: Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians (2000) <i>The Importance of Nature to Canadians: The Economic Significance of Nature-Related Activities</i>. Ottawa: Environment Canada, pp. 13, 27.</p>		

Table 39 Methods to Estimate Monetary Values Associated with Non-Marketed Natural Resources and Environmental Goods and Services

Technique/Methods	Advantages	Disadvantages
<p>Market Prices. Use prevailing prices to value products bought and sold in local markets.</p>	<p>Market prices reflect the private WTP for wetland products, services and benefits that can be traded (e.g., fish, timber, fire wood, recreation). These values can be used to construct financial accounts to compare alternative wetland uses from the perspective of individuals or companies concerned with private profit and losses. Price data are relatively easy to obtain.</p>	<p>Market imperfections such as monopoly power or externalities can distort market prices which will not accurately reflect the economic value of goods or services to society as a whole. Seasonal variations and other effects on prices need to be considered when market prices are used in economic analysis.</p>
<p>Shadow Prices. Market prices are adjusted for government transfer payments, market imperfections and policy distortions. May also incorporate distribution weights where equality concerns are made explicit. Shadow prices may also be estimated for non-marketed goods.</p>	<p>Shadow prices reflect the true economic value or opportunity cost to society as a whole for commodities that are traded in domestic or international markets (e.g., fish, fire wood, peat).</p>	<p>Derivation of shadow prices is complex and may require substantial data. Sometimes, such values are not accepted by decision-makers.</p>
<p>Hedonic Price Estimates. Values of environmental amenities (such as a vista or an ecosystem) derived from property or labour markets. The basic assumption is that the observed property values or wage rates reflect WTP and WTAC values associated with different combinations of attributes or characteristics and that it is possible to isolate values of certain key attributes or characteristics by means of statistical techniques.</p>	<p>Hedonic price methods have the potential for valuing certain wetland functions such as storm water flood protection or groundwater recharges based on differential land values, assuming that the wetland functions are fully reflected in land prices.</p>	<p>There are often so many characteristics and attributes about different lands and properties that values for individual attributes cannot be estimated. Estimation procedures are complex and data intensive. The approach may also be limited where markets are distorted, choices are constrained by income and data about environmental conditions are not available.</p>
<p>Stated Preference Methods Contingent Valuation - Ask individuals what they would be willing to pay to gain specified environmental or non-marketed activities and services, using systematic questionnaires. Choice Modeling - Respondents choose their preferred option from a set of options.</p>	<p>Can be applied to obtain estimates for any type of non-marketed good or services. Questionnaires can be designed to adjust for information deficiencies and other sources of bias and error. Generates monetary value estimates. There is wide experience with this method. May rank options or choose monetary values</p>	<p>Potential for bias and error but latest methods and procedures have eliminated most. Design of questionnaires and analysis of data often complex and require specialized expertise. Results considered “soft” by some stakeholders, especially regulated industry.</p>
<p>Travel Cost Method. The travel cost approach derives WTP values for environmental benefits at specific recreational locations based on data on travel distances, costs of travel and entrance fees for sites if available.</p>	<p>Widely used to estimate WTP values of recreational sites including public parks and wildlife reserves in developed countries. Could be used in Rwanda to estimate WTP for ecotourism to tropical wetlands.</p>	<p>Data intensive; restrictive assumptions about consumer behaviour (e.g., multi-functional trips) and results are highly sensitive to statistical methods used to specify the demand relationship.</p>
<p>Production Function Method. Can be applied to estimate WTP values of non-marketed resources or ecological functions in terms of changes in economic activity by Modelling the physical contribution of the resource or function to economic output.</p>	<p>Used to estimate monetary values of wetlands and reef destruction, deforestation and water pollution, etc., on productive activities such as fishing, hunting and farming.</p>	<p>Requires information of ‘dose-response’ relationships between resources or function being valued and associated economic output. Application of the approach is most straightforward in the case of single use systems but becomes more complicated with multiple use systems. Problems may arise from multi-specification of the ecological-economic relationship or double counting.</p>
<p>Related Good Method. Infers WTP values from information about relationships between non-marketed goods and services and marketed goods and services that are either substitutes or complements. The following specific empirical estimation methods are categorized under the “related good method”: - <i>barter exchange approach</i> relies on actual exchange of non-marketed goods. - <i>direct substitute approach</i> assumes that a marketed good can be substituted for a non-marketed good. - <i>indirect substitute approach</i> also relies on substitute goods, but if the latter is not exchanged in</p>	<p>These approaches may provide rough estimates of WTP values, subject to data constraints and the degree of similarity or substitutability between related goods.. There may be more data available for these approaches</p>	<p>The <i>barter exchange approach</i> requires information on the rate of exchange between two goods. The <i>direct substitute approach</i> requires information on the degree of substitution between two goods. The <i>indirect substitute approach</i> requires information on the degree of substitution and on the contribution of the substitute good to economic output. Estimates are often only partial values of non-marketed environmental attributes and benefits.</p>

Technique / Methods	Advantages	Disadvantages
<p>the market, values are inferred from changes in economic output (i.e., the direct substitute approach combined with the production function approach).</p> <p>Constructed Market Techniques. Generates estimates of WTP values by directly asking consumers and local people their preferences about non-marketed goods and services. Variations of this approach include: - <i>Simulated market (SM)</i> constructs an experimental market in which money actually changes hands. <i>Contingent valuation method (CVM)</i> constructs a hypothetical market to elicit respondents' willingness to pay. <i>Contingent ranking (CR)</i> ranks ordinal preferences for non-marketed environmental amenities and services.</p>	<p>Provides estimates from respondents of their "Hicksian welfare measure." Provides best theoretical measure of WTP. <i>SM</i> involves a controlled experimental setting permits close study of factors that determine preferences. <i>CVM</i> is the only method that can measure <i>option</i>, <i>existence</i> and <i>legacy</i> values and provide theoretically appropriate estimates of total WTP for non-marketed ecosystem goods and services. <i>CR</i> provides estimates of ordinal rankings of respondents' preferences among non-marketed goods and services which can be useful for prioritizing policies and programs.</p>	<p>Practical limitations of constructed market techniques may detract from theoretical advantages, leading to poor estimates of true willingness to pay. <i>SM</i>: sophisticated design and implementation may limit application in developing countries. <i>CVM</i>: results sensitive to numerous sources of bias in survey design and implementation. <i>CR</i>: does not elicit willingness to pay directly, hence lacks theoretical advantages of other approaches.</p>
<p>Cost-Based Valuation Techniques. Based on assumption that the cost of maintaining an environmental benefit is a reasonable estimate of the value of relevant products and services. Variants include: <i>Indirect opportunity cost (IOC)</i> method uses wages foregone by labour in production of non-marketed goods. <i>Restoration cost (RSC)</i> valuation based on costs of restoring ecosystem goods or services. <i>Replacement cost (RPC)</i> method applies the costs of human-made substitutes for environmental goods or services. <i>Relocation cost (RLC)</i> assumes that the costs of relocating threatened communities represent WTAC values. <i>Preventive expenditure (PE)</i> includes expenditures incurred to avoid or prevent damage or degradation of environmental benefits are presumed to represent WTP values.</p>	<p>The Cost-Base Valuation techniques are often easier to estimate than to estimate the quantities and values of relevant non-marketed products, services and benefits themselves. Approaches are less data- and resource-intensive. <i>IOC</i> is useful in evaluating subsistence benefits where harvesting and collecting time is a major input. <i>RSC</i> is potentially useful when valuing particular environmental functions. <i>RPC</i> can be useful in estimating indirect use benefits when ecological data are not available for estimating damage functions. <i>RLC</i> is only useful in valuing environmental amenities in the face of mass dislocation such as a dam project or the establishment of protected areas. <i>PE</i> can be useful in estimating indirect use benefits with prevention technologies.</p>	<p>Expenditures may not reflect full WTP values by affected parties. <i>IOC</i> may underestimate benefits significantly if there is substantial producer or consumer surplus. <i>RSC</i> involves diminishing returns and difficulties associated with restoring ecosystems to their original conditions. A questionable method. <i>RPC</i> is difficult to ensure that net costs of replacements do not exceed the values associated with the original functions. May overstate willingness to pay if only physical indicators of benefits are available. <i>RLC</i> in practice, benefits provided by the new location are unlikely to match those of the original location. <i>PE</i> may mismatch benefits of investment in prevention with the original level of benefits may lead to spurious estimates of willingness to pay.</p>
<p>Sources : Based on Annex 3 in partial draft report by Kabenga, Musabe and Musahara, "Economic Analysis of Natural Resource Use in Rwanda Land and Water Resource Use in Rugezi Wetlands"; IED (1994)</p>		

Table 40 **Types of Ecosystem Services**

Ecosystem Service	Ecosystem Function	Examples of Services
Atmospheric stabilization	Stabilization of atmospheric chemical composition	CO ₂ /O ₂ balance, stratospheric ozone, SO ₂ levels
Climate stabilization	Regulation of global temperature, precipitation and other climate processes affected by land use	Greenhouse gas production, cloud formation
Disturbance avoidance	Integrity of ecosystem responses to environmental fluctuations	Storm protection, flood control, drought recovery and how vegetation structure helps control environmental variability
Water stabilization	Stabilization of hydrological flows	Supply water for agriculture use (irrigation), industrial use or transportation
Water supply	Storage and retention of water	Water storage by watersheds, reservoirs and aquifers
Erosion control & sediment retention	Retention of soil within an ecosystem	Prevention of soil loss by wind, runoff, other processes, storage of silt in lakes, wetlands, drainage
Soil formation	Soil formation process	Weathering of rock and accumulation of organic material
Nutrient cycling	Storage, internal cycling, processing and acquisition of nutrients	Nitrogen fixation, nitrogen/phosphorus, etc. nutrient cycles
Waste treatment	Recovery of mobile nutrients and removal or breakdown of excess nutrients and compounds	Waste treatment, pollution control, detoxification
Pollination	Movement of floral pollinators	Providing pollinators for plants
Biological control	Regulation of pest populations	Predator control of prey species
Habitat	Habitat for resident and transient populations	Nurseries, habitat for migratory species, regional habitats for locally harvested species, wintering grounds
Raw materials	Natural resource primary production	Lumber, fuels, fodder, crops, fisheries
Genetic resources	Sources of unique biological materials and products	Medicine, products for materials, science, genes for plant resistance and crop pests, ornamental species
Recreation	Provides opportunities for recreation	Eco-Tourism, sportfishing, swimming, boating, etc.
Cultural	Opportunities for non-commercial uses	Aesthetic, artistic, education, spiritual, scientific, aboriginal sites

Sources: Olewiler, 2004. Adapted from Sauer, Amanda (2002) The Values of Conservation Easements discussion paper. World Resources Institute, presented by West Hill Foundation for Nature, December 1, 2002 and Costanza, R. *et al.* (1997). "The Value of the World's Ecosystem Services and Natural Capital" *Nature*. Vol. 387, pp 253-260.

Table 41 Estimated Values for Open Space Services from Stated Preference Studies

Type of Open Space	Average WTP (US\$ 2000)	Measure of Value Aggregated Over Households (US\$ 2000)
Urban		
Undeveloped land parcel of 5.5 acres Morey <i>et al.</i> 1998 (CV) (1995\$)	\$264/household (one-time payment)	\$1.5 million for all households within a 1-mile radius
Farm Land		
Preserve farmland from development in South Carolina Bergstrom <i>et al.</i> 1985 (CV) (1982\$)	\$9-\$16/household/year (1)	\$23-\$61/acre
Preserve farmland from development in Alaska Beasley <i>et al.</i> 1998 (CV) (1984\$)	\$126-239/household/yr (2)	\$830/acre
Preserve farmland from development in Alaska Beasley <i>et al.</i> 1998 (CV) (1984\$)	\$62-\$109/household/year (1)	\$123/acre 6%-16% of value of farmland
Preserve western ranch land from development in Colorado Rosenberger and Walsh 1997 (CV) (1993\$)	\$86-\$144/household/year (1)	
Preserve farmland from development in Suffolk County, New York, Johnston <i>et al.</i> 2001 (contingent choice) (3) (1995\$)	\$40-\$162/household/acre/year (1)	\$1,355/acre/year
Wetlands		
Value of improvements in ecological and water quality benefits (nonrecreational benefits) Lant and Roberts 1990 (CV) (1987\$)	\$56-\$71/year for improvements in wetlands	Recreational and ecological values said to be as high as market value of crop land.
Value of storm water retention Stevens <i>et al.</i> 1995 (CV) (1993\$)	\$92/acre/year	
Meta-analysis of value of wetlands Woodward and Wui (2001) (1990\$)		\$1,205/acre average across all studies \$1,597/acre for bird watching
Value of adjacency to water-based services Earnhart 2001 (contingent choice and revealed preference) (1996\$)	\$15,400/house (5.8% of house value in 1996)	
Value of adjacency to land-based services Earnhart 2001a (1996\$)	\$18,700/house (7.2% of house value in 1996)	
Value of adjacency to restored marsh (compared with degraded marsh) Earnhart 2001a (1996\$)	\$7,340 per house 2.7% of median house price in 1996	
Source: McConnell, Virginia and Walls, Margaret (2005) <i>The Value of Open Space: Evidence from Studies of Nonmarket Benefits</i> . Washington D. C.:Resources for the Future, January 2005 www.rff.org .		
Notes:		
CV = Contingent Valuation Survey Method		
(1) per thousand acres for increments of 25% additional land preserved.		
(2) per thousand acres for an increment of 50% additional land preserved.		
(3) these results tended to be sensitive to estimated model specification.		