

Module 2003 Waste (New Zealand)
Submodule Methane emissions from solid waste disposal sites
Worksheet 6.1A (supplemental)

Total population ¹	MSW generation rate ² (kg/cap/day)	Annual MSW generated (Gg/yr)	Fraction of MSW to SWDs	Total MSW to SWDs (Gg)
4039400	2.07	3045	1.00	3,045

¹ Statistics New Zealand "100 years of population growth"

² Solid Waste Analysis Protocol (2003 results), Ministry for the Environment

Module 2003 Waste (New Zealand)
Submodule Methane emissions from solid waste disposal sites (tier 2)
Worksheet 6.1

Year	Total annual MSW disposed to SWDs (Gg MSW)	Methane generation potential (L ₀)	Methane Generation rate constant (k)	Gross annual methane generation (model output)	Total annual MSW disposed to SWDs with LFG systems (Gg MSW)	Percentage of MSW with LFG systems (%)	Estimated average LFG system collection efficiency (%)	Recovered methane per year (Gg CH ₄)	Net methane generation (Gg CH ₄)	One minus oxidation correction factor	Net methane emissions (Gg CH ₄)
1990	2975	69.55	0.06	115.2	683.0	0.00	0.00	0.00	115.22	0.9	103.70
1991	3067	69.55	0.06	116.5	679.0	0.00	0.00	0.00	116.55	0.9	104.89
1992	3099	69.55	0.06	117.9	729.0	23.53	0.60	20.07	97.81	0.9	88.03
1993	3139	69.55	0.06	119.2	783.0	24.95	0.60	21.60	97.65	0.9	87.88
1994	3183	69.55	0.06	120.6	1019.0	32.02	0.60	28.11	92.54	0.9	83.28
1995	3182	69.55	0.06	122.0	1074.0	33.21	0.60	29.55	92.41	0.9	83.17
1996	3159	68.84	0.06	123.1	1203.0	36.65	0.60	33.03	90.02	0.9	81.02
1997	3136	68.13	0.06	123.9	1608.0	48.47	0.60	44.24	79.70	0.9	71.73
1998	3113	67.42	0.06	124.6	1645.0	49.25	0.60	45.47	79.15	0.9	71.23
1999	3091	66.71	0.06	125.1	1709.0	50.87	0.60	47.52	77.60	0.9	69.84
2000	3068	66.01	0.06	125.5	1700.0	50.32	0.65	51.45	74.01	0.9	66.61
2001	3045	65.30	0.06	125.6	1708.0	50.05	0.65	51.69	73.94	0.9	66.55
2002	3022	64.59	0.06	125.7	1703.0	49.10	0.65	51.26	74.40	0.9	66.96
2003	3045	63.88	0.06	125.6	1631.0	47.70	0.65	50.22	75.42	0.9	67.88

Information in this table based on SCS Wetherill 2002, Solid Waste Analysis Protocol (2003 results) and 2002 Landfill Review and Audit

2003 Calculations of DOC and L₀
New Zealand DOC Estimate Worksheet

Waste category (NZ WAP)	Waste Quantity (tonnes)	Waste composition (% by weight)	Fraction DOC (by weight)
Paper	386,697	13	0.4
Plastic	207,050	7	0
Glass	82,211	3	0
Ferrous Metal	140,063	5	0
Non ferr metal	33,493	1	0
Organic	752,080	25	0.17
Rubble/concrete	496,312	16	0
Timber	380,607	13	0.3
Rubber	39,583	1	0
Nappies/Sanitary	60,897	2	0
Textiles	115,705	4	0
Pot Haz	353,203	12	0
Total	3,044,857	100	

Methane Generation Potential Calculation by Using Waste Type Data in 2003

Methane correction factor (MCF)	Degradable organic carbon (DOC) (GgC/Gg waste)	Fraction of DOC dissimilated (DOC _F)	Fraction by volume of CH ₄	Conversion from C to CH ₄	Methane Generation Potential (L ₀) (GgCH ₄ /Gg waste)	Methane Generation Potential (L ₀) (m ³ CH ₄ /Mg waste)
0.9813	0.1303	0.50	0.50	1.3333	0.0426	63.88

Module 2003 Waste (New Zealand)
Submodule Methane emissions from domestic and commercial wastewater treatment
Worksheet NZ 6.2
Sheet Estimation of emission factor for wastewater handling systems

Wastewater handling system ¹	Fraction of wastewater treated by the handling system ¹ (percent)	Methane conversion factor for the handling system	Product	Maximum methane producing capacity (kg CH ₄ /kg BOD _o)	Emission factor for domestic/commercial wastewater (kg CH ₄ /kg BOD)
Anaerobic pond	1.7	0.65	0.01105	0.375	0.00415
Imhoff tank	0.3	0.55	0.00186	0.375	0.00070
Septic tank	7.4	0.40	0.02974	0.375	0.01115
Oxidation pond	10.7	0.20	0.02131	0.375	0.00799
Facultative aerated pd	1.8	0.10	0.00181	0.375	0.00068
Fully mixed aerated pd	1.6	0	0	0.375	0
Activated sludge	31.2	0	0	0.375	0
Other aerobic plant	12.6	0	0	0.375	0
Milliscreening ²	24.0	0	0	0.375	0
Aerobic ³	8.4	0.10	0.00836	0.375	0.00313
Aggregate MCF					0.0278

- 1 SCS Wetherill 2002
2 Milliscreening or no treatment
3 Methane from sludge

Module 2003 Waste (New Zealand)
Submodule Methane emissions from domestic and commercial wastewater and sludge treatment
Worksheet NZ 6.2
Sheet Estimation of methane emissions from domestic/commercial wastewater and sludge

	Total organic product ¹ (kg BOD/yr)	Emission factor (kg CH ₄ /kg BOD)	CH ₄ emissions without recovery/ flaring (kg CH ₄ /yr)	CH ₄ recovered and/or flared ² (kg CH ₄ /yr)	Net CH ₄ emissions (Gg CH ₄ /yr)
Wastewater	143,033,614	0.0278	3,976,137	0	4.0
Sludge ²					0.0
Total					4.0

- 1 SCS Wetherill 2002
2 Almost all CH₄ generated from aerobic sludge handling is collected therefore does not contribute to methane emissions, thus emissions from sludge have not been estimated; after methane recovery net emissions of methane from sludge are zero.

Module 2003 Waste (New Zealand)
Submodule Indirect nitrous oxide emissions from human sewage
Worksheet 6.4 (adapted)

Per capita wastewater N (kg/person/year) ¹	Total Population ²	Emission factor (EF ₆) (kg N ₂ O-N/kg sewage-N produced)	Total N ₂ O emissions (Gg)
4.75	4,039,400	0.01	0.30

- ¹ SCS Wetherill 2002
² Statistics New Zealand.

Module 2003 Waste (New Zealand)
 Submodule Methane emissions from industrial wastewater and sludge handling
 Worksheet NZ 6.3 (modified)

	Total industrial output (tonne product/year)	Degradable organic component (kg COD/tonne product)	Total industrial organic wastewater (kg COD/yr)	Proportion of industry using anaerobic treatment (without CH ₄ collection)	Proportion of incoming COD degraded anaerobically in anaerobic plant	Maximum CH ₄ producing capacity (kg CH ₄ /kg COD)	Emission factor (kg CH ₄ /kg incoming COD)	CH ₄ emissions (Gg/year)
	TOW _{ind}					B ₀		
Meat industry								
beef	600,000	50	30,000,000	43%	55%	0.25	0.059	1.77
sheep/lambs	545,000	50	27,250,000	33%	55%	0.25	0.045	1.24
pigs	48,338	50	2,416,900	40%	55%	0.25	0.055	0.13
venison	27,081	50	1,354,050	40%	55%	0.25	0.055	0.07
goats	1,285	50	64,250	40%	55%	0.25	0.055	0.00
poultry	111,000	123	13,653,000	20%	55%	0.25	0.028	0.38
Leather and skins	85,000	180	15,300,000	0%	70%	0.25	0.000	0.00
Pulp and paper			56,889,552	100%	2%	0.25	0.005	0.28
Wool scouring	183,000	22	4,026,000	9%	29%	0.25	0.007	0.03
Wine ¹								0.02
Beverages				0%			0	
Dairy processing	1,714,363	5.8	9,943,305	0%			0	
Food processing				0%			0	
Metals and minerals				0%			0	
Petrochemical				0%			0	
Plastics				0%			0	
Textiles				0%			0	
Iron and steel				0%			0	
Non-ferrous metals				0%			0	
Fertiliser				0%			0	
Total								3.93

1 Emissions estimate for wine from Savage 1997. All other data from SCS Wetherill 2002

Module 2003 Waste (New Zealand)
 Submodule Nitrous oxide emissions from industrial wastewater handling
 Worksheet (adapted from 6.3 and 6.4)

	Total industrial organic wastewater (kg COD/yr)	Ratio of N to COD in wastewater	Total Nitrogen in wastewater (kg N/yr)	Emission factor (EF ₀) (kg N ₂ O-N/kg wastewater-N)	N ₂ O emissions (Gg/year)
	TOW _{ind}				
Meat industry					
beef	30,000,000	0.08	2,400,000	0.02	0.075
sheep/lambs	27,250,000	0.08	2,180,000	0.02	0.069
pigs	2,416,900	0.08	193,352	0.02	0.006
venison	1,354,050	0.08	108,324	0.02	0.003
goats	64,250	0.08	5,140	0.02	0.000
poultry	13,653,000	0.08	1,092,240	0.02	0.034
Leather & skins	15,300,000	0.08	1,224,000	0.02	0.038
Pulp and paper	56,889,552	0.0038	216,180	0.00	
Wool scouring	4,026,000	0.018	72,468	0.01	0.001
Wine					
Beverages					
Dairy processing	9,943,305	0.018	178,979	0.0025	0.001
Food processing					
Metals & mins					
Petrochemical					
Plastics					
Textiles					
Iron and steel					
Non-ferrous					
Fertiliser					
Total					0.23