Solid Waste & Recycling

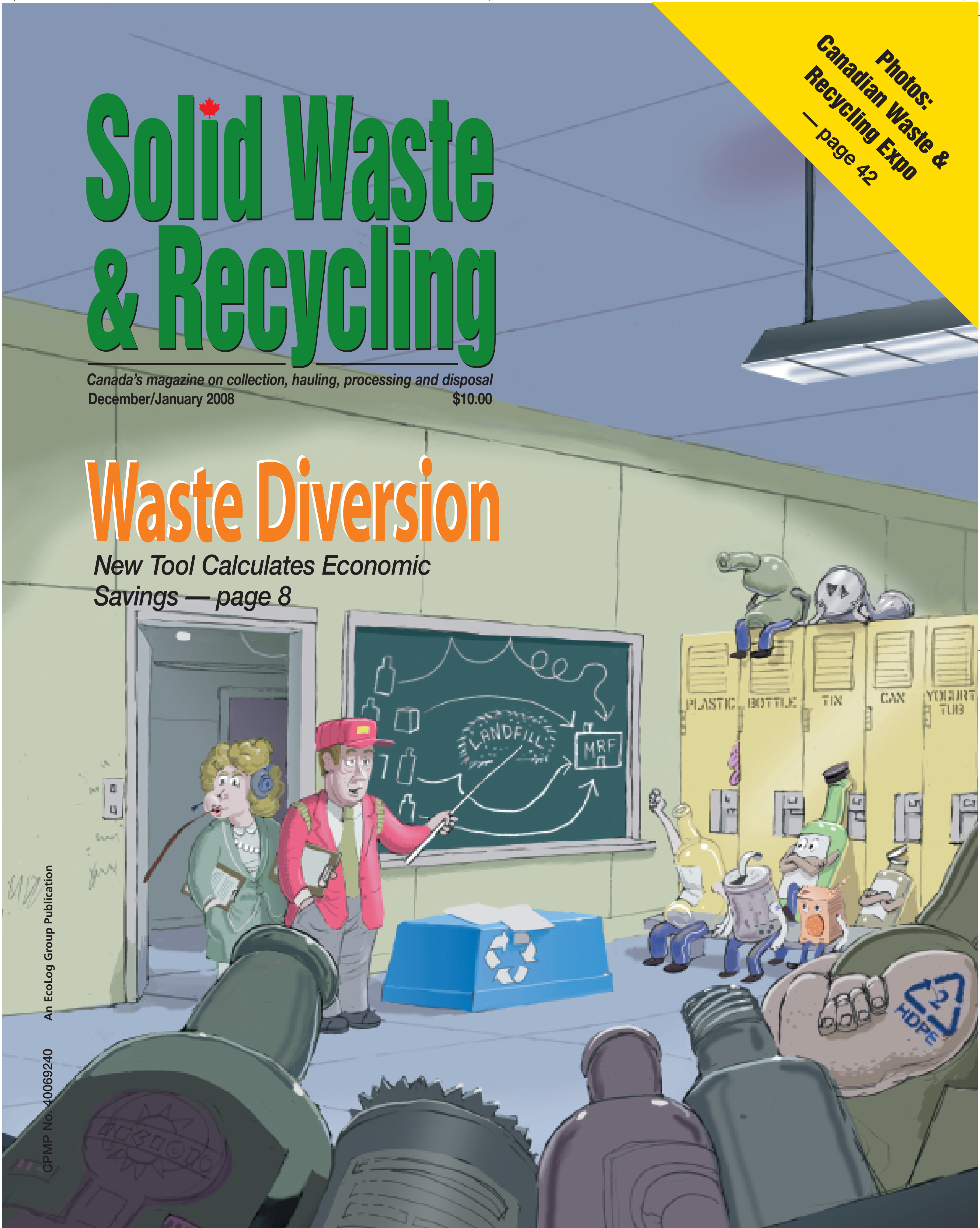
Canada's magazine on collection, hauling, processing and disposal

December/January 2008 $10.00

Photos: Canadian Waste & Recycling Expo — page 42

Waste Diversion

New Tool Calculates Economic Savings — page 8



An EcoLog Group Publication

CPMP No. 40069240

Annual Buyers' Guide — pages 25-40

by Clarissa Morawski

"The results provide the clearest picture of the economic benefits of diversion presented to date."

New model monetizes environmental benefits and reveals new cost savings in waste diversion

The New "Eco-Currency"

As a waste management consultant, rarely do I come across another consultant's report that not only delights and excites, but compels me to promote, disseminate, and speak-out about its findings. Such was the case several months ago when Dr. Jeffery Morris of Sound Resource Management, based in the State of Washington, responded to my request for information on quantifying the benefits of using finished compost.

Morris forwarded me an excel model entitled "Environmental Value of Recycling and Composting" that's the culmination of research projects and peer-reviewed articles going back more than five years, including work for the San Luis Obispo County, California Integrated Waste Management Authority, Seattle Public Utilities, the Washington State Department of Ecology, and the King County, Washington Department of Natural Resources. This model — which I like to call the "Morris Calculator" — could fundamentally shift the way that waste management costs are measured in future.

How it works

The calculator compiles a series of well-known US EPA data on the environmental impacts of various waste management options (including composting, landfill and waste-to-energy (WTE) along with product life cycle data from Carnegie Mellon University's Economic Input-Output Life Cycle Assessment model.

(For those who wish to consult the sources, they are: US EPA's *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, 3rd Edition, September 2006; Research Triangle Institute's *Municipal Solid Waste Life-Cycle Database*, prepared for the Atmospheric Protection Branch, National Risk Management Research Laboratory, US EPA; and, Carnegie Mellon University Green Design Institute's *Economic Input-Output Life Cycle Assessment* model available on the Internet at **www.eiolca.net**)

The impacts measured affect climate change expressed as CO_2 equivalents; human health expressed as particulates, toluene equivalents (toxics); and benzene equivalents (carcinogens); eutrophication expressed as nitrogen equivalents; acidification expressed as sulfur dioxide equivalents; and ecosystem toxicity expressed as herbicide 2,4-D equivalents.

As provided by the US EPA data, each waste management option can be tailored to its specific profile and assigned its relative pollution amounts. For example, the eCO_2 output of a landfill without energy recovery is substantially higher than one with energy recovery. Or, electricity from WTE that replaces coal-fired power will have a greater impact on reducing greenhouse gases (GHGs) compared with a natural gas replacement. Similarly, recycling includes the avoided GHG emissions and pollution because secondary feedstock is used instead of virgin materials for re-manufacturing, thus avoiding all the pollution associated with primary resource extraction activities.

Table 1: Value of Environmental Impact Category Emissions Reductions Per Ton ($US)

Climate Change	Human Health – Particulates	Human Health — Toxics	Human Health- Carcinogens	Eutrophica-tion	Acidification	Ecosystems Toxicity
eCO_2	ePM2.5	eToluene	eBenzene	eN	eSO_2	e2,4-D
$36	$10,000	$118	$3,030	$4	$661	$3,280

(The methodology for aggregating pollutant emissions into these environmental impact categories is explained in the documentation for US EPA's TRACI [Tool for the Reduction and Assessment of Chemical and other environmental Impacts] model.)

But this data on recycling is nothing new to us. Life-cycle assessments (LCAs) have been widely available since the mid 1990s, and are used regularly when measuring waste management impacts — especially GHG emissions given that climate change is top of mind today. Even Canada has its own version of the net GHG impact of waste management offered to us by Environment Canada and National Resources Canada (*Determination of the Impacts of Waste Management Activities on Greenhouse Gas Emissions*).

So what's new?

While the life-cycle data on recycling is informative, it's difficult for lay-people, and more importantly, decision-makers to understand what the pollution profile actually means in terms of the real impact on human health and the environment. This is where the "Morris calculator" comes in.

Morris attaches a monetary value to each pollutant, based on either the estimated real financial costs to society in terms of environmental degradation and human health impact, or the actual market value of the pollutant's emissions established through trading schemes such as auctions for US EPA's sulfur dioxide emissions permits under the *Clean Air Act* provisions for controlling acid rain.

According to Morris, monetization provides a method for evaluating trade-offs between the seven types of environmental impacts, and is a standard approach within the field of environmental economics. Morris admits that monetization is "controversial" but he states that it allows us to compare environmental benefits to the financial costs for recycling and composting.

One example of monetization assigns a value to a short ton of CO_2. Carbon dioxide emission reduction credits are traded throughout the world today at varying prices. In countries with regulated schemes, the prices usually run well over $100 per ton, while in the unregulated market of North America, the price of a ton of CO_2 is anywhere from $1 to $4 per ton. The recently completed Stern review on the economics of climate change estimated the environmental cost of a metric ton of CO_2

"Morris attaches a monetary value to each pollutant, based on either the estimated real financial costs to society in terms of environmental degradation and human health impact, or the actual market value of the pollutant's emissions."

Table 2: Estimated Upstream and Use Phase Emissions Reductions per Ton Composted

(pounds of emissions reductions per ton composted)

	Climate Change	Human Health – Particulates	Human Health – Toxics	Human Health – Carcinogens	Eutrophica-tion	Acidification	Ecosystems Toxicity
	(eCO2)	ePM2.5	eToluene	eBenzene	eN	eSO2	e2,4-D
Avoided Pesticide Production	54.02	0.09	112.42	0.06		0.45	0.89
Avoided Pesticide Use			27.77	0.00			1.74
Avoided Fertilizer Production	1018.31	0.41	146.82	0.25		1.86	2.28
Avoided Fertilizer Use					5.36		
Total	**1072.33**	**0.51**	**287.00**	**0.31**	**5.36**	**2.31**	**4.92**

emissions at $85. Other studies have estimated this environmental cost at upwards of $100 per tonne. In his calculator Morris assigns a value of $36 per short ton, a conservative estimate based on the range of benefits and market valuations for CO_2 emissions reductions. This is also the GHG offset valuation used by Seattle City Light.

As another concrete example, reducing sulfur dioxide equivalent emissions by one ton is valued at $661 based on a rolling average of spot prices for SO_2 emissions permits in EPA's annual acid rain allowance auction. Morris assigns a value to each group of pollutants and references their source.

Table 1 shows the calculator's valuation for the public health and ecological benefits from reducing emissions for each impact category. Valuation of reductions in emissions of pollutants that cause the other five types of environmental harm, besides climate change and acidification, are based on scientific studies on the health and ecological costs of these environmental impacts. For example, the human health costs of toxics is based on a Harvard University Center for Risk Analysis study on the health costs of mercury emissions, while the cost to ecosystems of ecologically toxic emissions is based on an Ohio State University Integrated Pest Management Program study on putting an environmental price to pesticide use. The relative human toxicity of mercury compared with toluene provides the basis for the human toxicity cost of $118 per ton of toluene equivalents that is shown in Table 1.

Monetizing the benefits of compost

The other major innovation is that the Morris calculator takes the final step of monetizing the value of using the finished compost after composting. According to Morris, compost produced from yard debris, food scraps and compostable paper and cardboard can substantially reduce the use of pesticides and synthetic fertilizers on lawns and gardens. Based on peer-reviewed research published in *The International Journal of Life Cycle Assessment* (InJLCA) Morris conservatively estimates that compost use on lawns and gardens is associated with a 50 per cent reduction in pesticide and synthetic fertilizer use.

Once again, Morris relies on existing life cycle data from the Carnegie-Mellon Economic Input-Output Life Cycle assessment (EIOLCA) tool, supplemented in this instance with data from the peer-reviewed research in InJLCA, to inventory the pollution generated from synthetic nutrients and a pesticide approach to lawn and garden care. (*See table 2.*) What's not accounted for, however, is the exposure of chemicals to persons or wildlife at the time of pesticide application, as well as the impacts from disposal of pesticides in the garbage.

The final calculation to assess the economic value of the environmental cost or benefit of composting organics subtracts the avoided environmental cost/benefit of diversion from the default disposal method (landfill or WTE), and adds on the benefits shown in Table 2 derived from using finished compost.

Quick analysis for Ontario's diversion

Plugging Ontario's municipal curbside collection diversion figures from 2006 into the Morris calculator provides a quick analysis of the economic cost/benefit.

The results show that in Ontario for 2006 curbside recycling and composting, the environmental benefit was worth over US $235 million. On average, the curbside diversion benefit was $161.28 per tonne, with an average composting and recycling benefit of $38.78 and $231.52 per tonne respectively.

Dr. Morris' calculator brings together years of reliable life-cycle analysis data and applies it to real-life diversion scenarios. The results provide the clearest picture of the economic benefits of diversion presented to date. Morris' tool enables all of us — businesses, consultants, bureaucrats, media, and decision-makers — to better understand full-

Applying the "Morris Calculator" — Environmental Value of Recycling and Composting to Ontario

Ontario Municipal Curbside Materials Diverted	2006 tonnes (WDO datacall)	Environmental value per short ton (US$)	Total curbside environmental value 2006 (US$)
Leaf, yard & bulky yard waste	334,893	$ 24.45	$ 9,006,947
Household organics	196,178	$ 53.70	$ 11,588,234
Printed Paper	498,845	$ 138.79	$ 76,158,167
Paper-based packaging	198,874	$ 410.14	$ 89,722,801
Aluminum cans	11,629	$1,450.30	$ 18,552,093
Steel Cans	34,754	$ 59.75	$ 2,284,207
Glass containers	139,654	$ 47.66	$ 7,321,501
PET	27,205	$ 572.21	$ 17,123,670
HDPE container	15,272	$ 195.38	$ 3,282,228
TOTAL	**1,457,304**		**$ 235,039,847**

Basic Assumptions for Quick Analysis:

- Recycling and composting replaces landfilling with energy recovery.
- Recyclable materials are being diverted through traditional recycling end-markets.
- Material is being collected via curbside collection (excludes depots);
- Collection (hauling) impacts from diversion and disposal are equal; and
- Compost from organics is suitable for compost end-market.

cost accounting associated with waste management practices. One can only hope that this will lead to more environmentally-sound decisions around the treatment of waste in the future.

	TOTAL Environmental Value
Per tonne recycled	$ 231.52
Per tonne composted	$ 38.78
Per tonne diverted (total)	$ 161.28

Dr. Morris' model is currently being used for a full-cost assessment study for Region-wide composting versus landfill or WTE for the Region of Niagara. The results will be presented in a future issue of *Solid Waste & Recycling* magazine.

Clarissa Morawski is principal of CM Consulting in Peterborough, Ontario and is a contributing editor of this publication. Contact Clarissa at morawski@ca.inter.net