

A photograph of a beach scene. In the upper right, the lower legs and feet of a person in dark clothing are visible, walking away from the camera. Their shadow is cast long and dark on the sand. Several footprints are visible in the sand. In the center, a large, clear plastic bottle lies on its side, partially filled with water. The bottle is the size of a large soda bottle. In the background, another smaller plastic bottle lies on the sand near the water's edge. The overall lighting is bright, suggesting a sunny day.

The  
toxic  
footprint

of  
bottled  
water

# The toxic footprint of PET-bottled water in British Columbia



A REPORT PREPARED FOR TOXIC FREE CANADA

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**toxic free!**  
C a n a d a

## The toxic footprint of PET-bottled water in British Columbia


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<b>Calories / Calories 0</b>	
<b>Fat / Lipides 0 g</b>	<b>0 %</b>
<b>Sodium / Sodium 0 mg</b>	<b>0 %</b>
<b>Carbohydrate / Glucides 0 g</b>	<b>0 %</b>
<b>Protein / Protéines 0 g</b>	
<b>Calcium / Calcium 0 %</b>	
Not a significant source of saturated fat, trans fat, cholesterol, fibre, sugars, vitamin A, vitamin C or iron.	
Source négligeable de lipides saturés, lipides trans, cholestérol, fibres, sucres, vitamine A, vitamine C et fer.	
<small>ANALYSIS ANALYSE - PPM          Ingredients: Spring Water, Dioxide of Carbon          Ingrédients: eau de source, dioxyde de carbone          Bottled by / Embouteillé par          Nestlé Waters of Canada          Nestlé Waters of Canada          100% RECYCLED PET BOTTLES (100% PET EN FLAKES)          Made in Canada / Fabriqué au Canada          100% PET EN FLAKES          Made in Canada / Fabriqué au Canada</small>	

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## Introduction

In 1989, consumers in North America witnessed a small product innovation that would have profound consequences around the world — the advent of the 500 ml water bottle made of polyethylene terephthalate, or PET as it would quickly become known. In the two decades since that event, that bottle has multiplied a trillion-fold and become almost a permanent fixture in the hands of millions of people world-wide.

While the single-use water bottle was the innovation in 1989, that PET beverage container today could as easily be filled with a variety of drinks, from fruit beverages, and carbonated soft drinks to sports drinks and various other specialty beverages. Globally, water and beverage bottlers have fuelled a huge PET plastic industry, with the market for PET resin estimated at 15 million tonnes in 2007 (Octal on track, 2008). Glass and even aluminum containers are increasingly being pushed aside in favour of PET bottles shaped in dozens of different ways.

But that industry and the bottles it has created are leaving an enormous environmental footprint, including environmental releases of toxic substances and massive waste as millions of unrecycled bottles pile up in landfills and float on ocean tides.

This report focuses on that footprint as it relates to the use of bottled water in British Columbia. In targeting PET water bottles we are not suggesting they are the only source of the problem. In fact the issues outlined in this report apply equally to PET soft drink, fruit beverage and sports drink bottles, which in some cases are more numerous than water bottles. But in taking steps to reduce the impact of PET plastic, limiting the use of single-serve bottled water is a place for B.C. consumers to start. Water is the one beverage that is available readily through the tap, at a tiny fraction of the cost of bottled water. Ensuring that there is ready access to clean drinking water and that all residents can enjoy that access without having to purchase bottled water is good public policy and an important part of good environmental stewardship.

This report is produced as part of Toxic Free Canada's Getting Off The Bottle campaign, which is aimed at encouraging B.C. consumers to reduce their use of bottled water by 20 per cent over the next two years.

## Water: the shift to plastic

Single-serve bottled water, once only a product for elite health spas, has now become a multi-million dollar industry in Canada. Canadians drank 66 litres of bottled water per capita in 2006 (Agriculture and Agri-food Canada), more than twice the 28 litres each person consumed just eight years earlier. Imports of bottled water, especially from France, tripled over the period from 1996-2006 (Agriculture and Agri-food Canada).

In British Columbia, which is the focus of this report, bottled water sales have followed the same upward trend, as sales of plastic-bottled beverages rose 67 per cent between 2003 and 2007, with much of that increase coming from bottled water. Over the same period, beverage sales also shifted significantly away from carbonated soft drinks to bottled water (Encorp Pacific, Beverage Marketing Corporation).

Although the bottled water category includes the 18.5 litre cooler bottles for home and office delivery, it is the single-use bottle that is increasingly the focus of attention. Made from PET plastic, the bottles have become a familiar sight everywhere — in the refrigerator cases of retail stores, gas stations, restaurants and school vending machines as well as warehouse club stores and home maintenance outlets. Unfortunately, they have become just as familiar a sight in trash cans and municipal landfills and even in the world's oceans where they contribute to a growing new continent of waste.

Once the contents of a single-use water bottle have been drained, the container doesn't feel like much — a bit of clear plastic that weighs barely more than a first-class letter. But put millions, or even thousands of them together and they create a massive footprint in British Columbia and around the world. From the petroleum used to fabricate and transport the bottles, through the greenhouse gases created, to the toxic pollutants released during manufacturing, and the plastic waste accumulating in landfills, the health and environmental effects of bottled water linger long after the water has been consumed.

## The bottled water trend

Two generations ago, only a couple of imported bottled water products were on retail shelves and restaurant tables. But in the 1980s, a number of U.S. and Canadian bottlers moved into the field, linking their product to a growing fitness trend and offering bottled water as an alternative to carbonated soft drinks. That continues to be a trend, with market leader Nestlé calling itself a “healthy hydration company... (whose) products can help people lead healthier lives” (Nestlé Waters Yearbook 2007).

During the 1990s and into 2000-01, several widely publicized incidents of contaminated water in both the U.S. and Canada pushed sales even higher. Although water crises such as contaminated municipal water in Walkerton, Ontario in 2000 did not themselves undermine confidence in tap water (EnviroNics, Walkerton 2000), the bottled water industry was very successful in creating an image of safety and convenience for its product and in promoting its taste against chlorine-treated municipal water (Agriculture and Agri-food Canada).

An analysis carried out by Statistics Canada in 2008 found that nearly 30 per cent of Canadians chose bottled water as their main source of drinking water (Against the Flow 2008).

Despite those statistics, community opposition to water extractions in Ontario as well as increasing environmental awareness of the waste generated by PET plastic bottles has put the industry on the defensive. Companies have responded by intensive efforts to “green” the image of both their product and their corporate brand. Still, Nestlé acknowledged that “perceived environmental issues” were factors in the decline in bottled water sales it reported in 2008 (Bloomberg).

Examined in detail, those “environmental issues” are much more than “perceived.” As this report will show, they are substantive and Canadians who are concerned about toxic pollutants, climate change and landfill waste have good reason to look critically at bottled water.

## Toxic beginning — PET manufacturing

*Polyethylene terephthalate (PET) resin manufacturing utilizes toxic materials and releases at least two carcinogens into the environment.*



Single-use water bottles, in the 300 ml to 1.5 litre size, are made from polyethylene terephthalate (PET), a kind of plastic that, like most others, is manufactured using petroleum as the feedstock. Some larger water containers, in the 4-litre size and up, are made from low density polyethylene or polyvinyl chloride, while the 18.5-litre cooler jugs are made from polycarbonate. But they are not the focus of this report.

PET is typically made by reacting ethylene glycol with terephthalic acid in the presence of a catalyst to form pellets of plastic resin. Those pellets are then heated to a molten liquid, which is injected into preforms and mechanically blown into the various bottle shapes. The bottles are then cooled and either shipped to bottlers or in some cases, filled on site.

The manufacturing process itself involves a number of chemical constituents that are potentially hazardous to workers in the plant, including antimony trioxide, which is used as a catalyst in making the PET polymer, and ethylene glycol. Antimony trioxide is listed as a possible human carcinogen by the International Agency for Research on Cancer while ethylene glycol is a kidney toxicant (IARC, Cruzan et al 2004).

According to a lifecycle analysis prepared for the plastics industry by Franklin Associates, PET manufacturing releases dozens of air- and waterborne substances, many of which are listed carcinogens or reproductive toxins. They include the carcinogens ethylene oxide, benzene, methylene chloride, ethylbenzene and the reproductive toxicant toluene. Most are in small amounts below reporting thresholds for pollutant inventories, although the report notes that the “effects of the various emissions on humans and on the environment are not fully known” (Franklin Associates).

Industry Canada lists only one manufacturer, Invista, that produces PET resin in Canada (Industry Canada), with plants in Millhaven and Maitland, Ontario. At Bath, Ontario, site of Invista Canada’s Millhaven PET plastics manufacturing facility, the National Pollutants Release Inventory (NPRI) has reported significant environmental releases of several listed air contaminants, including acetaldehyde, 1,4-dioxane and ethylene glycol. In 2007, the plant released 6.7 tonnes of acetaldehyde and 0.58 tonnes of 1,4-dioxane into the atmosphere (NPRI

2007 facility report). IARC lists both acetaldehyde and 1,4-dioxane as Group 2—possible human carcinogens (IARC). However, the Millhaven plant was closed in April, 2009 and is not expected to re-open. The company has not stated whether it will produce PET resin at its other facilities or whether PET for Canadian bottling operations will be sourced outside the country. Other plant reductions have also taken place, but the overall North American capacity for PET resin increased in 2008 as other plants increased production (Bank of America).

## Bottled water: healthy hydration?

*Bottled water can potentially contain toxic ingredients, the byproducts of PET plastic manufacturing.*



**B**ottled water is marketed as an important component of healthy living and often presented as a clean, pure drink in contrast to municipal water. Bottling companies advertise their reverse osmosis filtration to emphasize the image of purity. But the plastic itself can change the content.

Unlike polycarbonate plastic — which is used for the large home and office water cooler reservoirs — PET plastic does not leach the chemical bisphenol-A, which was declared toxic by the federal government in 2008. But a study conducted at the University of Heidelberg in 2007 found that PET plastic bottles leach the metal antimony into the water they contain as the bottles stand (Shotyk et al, 2006). Antimony trioxide is used as a catalyst in manufacturing PET plastic and antimony leaches into the water when the bottle is filled. Levels also tend to rise the longer the water remains in the bottle (Shotyk 2006, Westerhoff 2008).

Although antimony is most toxic when dusts are inhaled at high concentrations, ingestion of antimony can cause a variety of gastrointestinal symptoms, including vomiting and diarrhea. The levels that were found in the studies cited are below World Health Organization standards for drinking water but little is known about the health effects that might result from drinking water that has been stored for months at a time.

Several studies done in Europe have also detected low levels of synthetic compounds known as phthalates (also known as ortho-phthalates) in spring water bottled in PET plastic. Among the phthalates detected were dibutyl phthalate (DBP) and di-ethyl hexyl phthalate (DEHP), (Bosnir 2007, Biscardi 2003, Signorile 2007, Kohler 2003). Both substances are listed as reproductive toxicants that can affect the developing fetus, especially the male fetus (Borch et al, Ema et al). The National Association for PET Container Resources (NAPCOR), which represents the North American PET manufacturing industry, has stated that ortho-phthalates are not used in the manufacture of PET (NAPCOR news release), so their presence in the water remains unexplained. The phthalates detected are below levels known to be harmful to health but they nonetheless contribute to overall exposure since phthalates are also present in many consumer and personal care products.

## Water sources: bottling up the spring

**B**ottled water sold in PET containers comes in two distinct types — remineralized (or demineralized) water, which is drawn from municipal water sources, and spring water, which is drawn at source from streams or groundwater aquifers.

Re-mineralized water is essentially tap water that is treated with reverse osmosis filtration to remove any impurities. Because minerals are also stripped out in the treatment process, some mineral content is added to make the water more consistent in taste. Both Coca-Cola's Dasani and Pepsico's Aquafina are made from municipal water.

Most waters sold in B.C., such as Nestlé Pure Life and Montclair, Whistler water, and many house brands as well as imported waters, are spring waters.

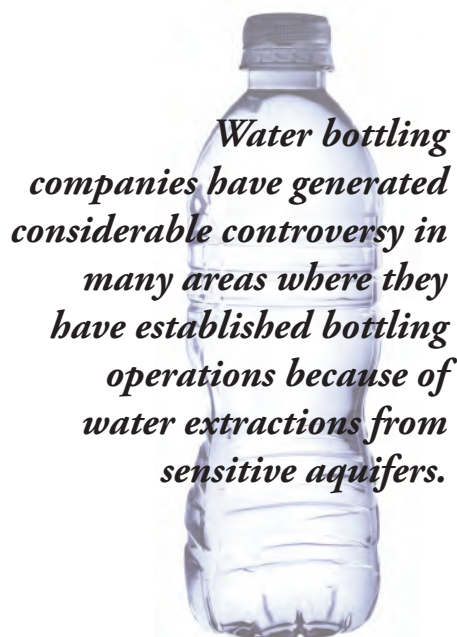
Water bottling companies have generated considerable controversy in many areas where they have established bottling operations because of water extractions from sensitive aquifers. A number of communities in New York and Maine as well as Ontario, have been the focus of campaigns aimed at blocking spring water bottling operations that would have extracted millions of litres of groundwater in areas where water resources are already heavily utilized for drinking water, agriculture and other uses. In Guelph, Ontario, community watershed activists intervened with Ontario's Ministry of Environment in 2008, pointing out that Nestlé's permit to withdraw 3.6 million litres per day for its Aberfoyle bottling plant was causing a reversal of groundwater flow in Mill Creek, one of the streams in the watershed. The effect was confirmed in studies, prompting the Ontario MOE to make increased environmental monitoring a condition of Nestlé's licence renewal, which was limited to two years instead of the requested five (Wellington Water Watchers 2008).

In the U.S., organizations working for the protection of fish habitat have also warned that groundwater extraction depletes spring waters that are vital in providing flows for local streams on which both trout and salmon populations depend (Tapped Out 2008).

(In both Canada and the U.S. the water extraction for bottling operations has raised even more fundamental issues, including public-private water rights ownership and the potential commodification of water under the provisions of the North American Free Trade Agreement. But those issues are beyond the scope of this report.)

In B.C., the level of water extractions for bottling operations has not raised the same level of controversy, largely because most operations are in water-rich areas such as Hope and Whistler, and the extractions represent a small fraction of the groundwater resource. But future water licences and bottling operations could potentially affect areas where water resources are more heavily used.

In addition, efforts by some companies to seek out pristine sources for bottled water pose an environmental risk by opening road access and siting bottling facilities in remote areas. Some



recent examples include currently pending applications to the Integrated Land Management Bureau for bottling operations in remote creeks in the Bute Inlet area of coastal B.C. In some cases, the creeks have no names on area maps and are only known by their local names.

## A growing flood of PET bottles

*In B.C., an estimated 126-164 million bottles of water in PET plastic beverage containers were sold in 2007.*



The rise in per capita consumption of bottled water over the last decade only tells part of the story. An increasing proportion of that consumption is coming from single-use PET water bottles, which are occupying a more prominent place in Canadian consumers' regular purchases. In B.C., a total of 478 million plastic (mainly PET) bottled beverages were sold in 2007, almost double the number sold just five years earlier in 2002 (Encorp). A significant proportion of those were water bottles, whose sales have increased rapidly while bottled soft drink sales have declined (Agriculture and Agri-food Canada).

British Columbia is one of six Canadian provinces with a deposit return system for beverage containers (except for milk containers). The province has contracted with a recycler, Encorp Pacific, to coordinate beverage container collection and recycling. Encorp provides annual reports available to the public that track the numbers and kinds of containers collected and the average recycling percentages for the various container types. Those reports make it possible to determine the number of beverage containers of the major types sold in British Columbia, to see how many were recycled and how many were unredeemed and discarded into the environment.

Encorp's reports track the major beverage container types, including aluminum cans, plastic bottles, glass bottles, polycoat containers and a few others. Since a number of beverages, including pop, fruit and sports beverages as well as water are bottled in plastic, it's not possible to determine an exact number of PET water bottles directly from the Encorp data. However, there are additional data available from beverage marketing sources that can help make an estimate as accurate as possible. In this report, we have used those data to estimate a range of percentages that represent the proportion of water bottles in the PET-bottled segment.

The plastic bottle category in Encorp's annual statistics includes some beverages bottled in another plastic, known as high density polyethylene (HDPE). Encorp reports (Encorp, pers. comm.) that HDPE bottles constituted only two per cent of the plastic bottles collected in 2007. Therefore that percentage is deducted from the total numbers of plastic bottles sold or recycled to determine the remaining portion, which is made up of PET plastic bottles.

Statistics on retail and vending machine sales of PET-bottled beverages are not available through public sources. Beverage companies can purchase compiled sales data from such statistical marketing firms as AC Nielson or the Beverage Marketing Corporation (BMC). The BMC sells marketing data on numerous different beverages and countries, with a single report typically selling for \$5,500. However, according to limited sample data that is available, carbonated soft drinks (known in the industry as CSDs) accounted for 14.3 per cent of overall beverage sales in Canada in 2007 by volume, while bottled water accounted for 10 per cent of

total volume and various fruit, sports and specialty beverages accounted for another 11 per cent (BMC Multiple Beverage Canada). The total beverage market by volume includes top-selling beverages such as coffee, tea and milk, which make up the bulk of beverage sales. However, the focus here is on the PET-bottled beverage sector and those beverages — CSDs and water, as well as fruit, sports and specialty beverages — that are sold in PET plastic bottles. For example, a 10 per cent share of the total beverage market is much larger when it is calculated in terms of the smaller PET-bottled segment. Those shares for bottled water, CSDs and juice beverages would be re-calculated, as follows:

Beverage type	Share
Carbonated soft drinks	41%
Bottled water	29%
Fruit, sports drinks	30%

Based on that calculation, bottled water would represent 29 per cent of the PET bottled beverage sector. But there are additional factors that could affect that estimate.

The bottled water category includes home and office cooler delivery and retail bulk sales in the 4-litre to 18.5 litre-jug size. CSDs also include a comparable bulk sales component in the form of fountain sales (to fast food restaurants and convenience stores that serve from a pressurized fountain system into a cup). While CSD and water markets are similar in modes of delivery, the percentage of bottled water share in the home and office delivery is greater than the comparable fountain sales component for CSDs. Because of that, the estimated percentage of water bottles in the PET bottle sector could potentially be lower. Accordingly, we have adjusted the figure of 29 per cent downward to 27 per cent. That represents the low end of the range.

However, there are more compelling reasons to adjust the percentage upwards. The overall market shares for beverages bottled in PET (outlined above) assumes they are all bottled in PET. In fact, a significant portion of the total volume of CSDs is delivered in aluminum cans, while water is not. Therefore the overall share of CSDs in the plastic bottle stream should be adjusted to account for that. Similarly, a large portion of the overall juice beverage volume is delivered in polycoat (tetrapak and gable top) juice boxes and some in glass bottles. There is also a small portion of the water bottle category— made up exclusively of sparkling waters — sold in glass. All those factors necessitate some adjustment in relative market shares.

There are no statistics available on specific PET-bottle versus aluminum can market shares, so we can only estimate the total percentage. Since water is only sold in PET (except for sparkling waters sold in glass), while CSDs and fruit beverages are spread among other container types, we have reduced the fruit beverage percentage by 1 per cent and the CSD percentage by 5 per cent and added those to the total percentage of water bottles to estimate the high end of the range of PET bottles. On that basis, the percentage of water bottles in the PET-bottled beverage sector could be as high as 35 per cent.

***Therefore, we estimate that bottled water constitutes from 27 to 35 per cent of all PET-bottled beverages sold in B.C.***

According to Encorp Pacific's annual report for 2007 (the most recent available), British Columbians bought 477,943,398 beverages packaged in plastic bottles in 2007. Subtracting the two per cent that were made from HDPE, it leaves 468,384,530 PET-bottle beverages sold in B.C.

*Based on that total, we estimate that between 126.5 and 164 million PET water bottles were sold in B.C. in 2007.*

Two additional figures help put that number into perspective and suggest, if anything, that it may be conservative.

Figures presented to the U.S. mayors in May 2008 showed that U.S. consumption of 16-ounce PET bottled water was 65 bottles per capita in 2007 (Rosenberg 2008). At the same time, overall U.S. per capita consumption of bottled water was 100 litres per year — roughly one-third more than Canadian consumption. Calculating the Canadian consumption as a percentage of the U.S. and using that percentage to estimate the per capita consumption of the equivalent size Canadian bottle (500 ml), it follows that per capita consumption in Canada would be 43 bottles. Multiplied by the population of B.C. — 4.4 million — consumption in B.C. would equal 188,760,00 bottles, significantly more than we have estimated here.

Similarly, figures from a 2006 food industry trade report, Spin On the Bottle, put overall bottled water volume consumption (in containers under 18 litres) at 1,664,732,719 litres for the 52 weeks ending June 10, 2006. British Columbia's population-based share of that would be 244,049,982 litres, which is again higher than our figure, even when various-sized containers are taken into account. In addition, sales continued to rise in 2007 and would make the 2007 year-end figure even higher.

## Measuring the footprint

*Producing the bottles of water sold in B.C. and transporting them to market used between 49,440 and 64,005 barrels of oil. The 64,005 barrels would be enough to fuel a fleet of 12,268 Ford Explorer SUVs driving from Vancouver to St. John's, Newfoundland.*



Producing PET plastic bottles and transporting the filled water bottles to market is an energy-intensive business. Most of the energy is embodied in the PET plastic itself, which is derived from petroleum. But transport costs can also add a significant portion and vary widely, depending on the distance to market from bottling plants. For some imported brands, which are bottled at source and then shipped to North American markets, the energy cost can be as much as 2000 times the energy cost of producing tap water (Gleick et al 2009). But even where there are only average distances from bottling plant to market, bottled water involves a significant consumption of energy.

Most of that energy comes in the form of petroleum, which is the feedstock for both the PET plastic itself as well as the fuel used to transport the filled bottles. As a material for beverage containers, PET represents a technology that is dependent on fossil fuels, with all the implications that dependence has for global climate change. Not only is PET dependent on

petroleum as the feedstock for the resin, but its manufacture is also heavily dependent on fossil fuel-generated energy.

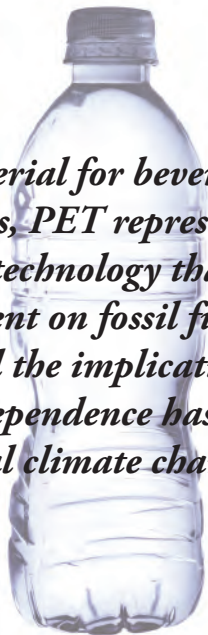
The plastics industry recently released a lifecycle analysis of PET plastic used in water bottles that assessed energy use and greenhouse gas emissions. The analysis was prepared by Franklin Associates, one of the world's leading firms in lifecycle studies, whose clients include leading corporations and the U.S. Environmental Protection Agency. Franklin Associates' analysis found that it required 21,370 megajoules of energy to produce 10,000 bottles from cradle to fabrication. That figure was based on an average bottle weight of 20.3 grams, which represented an average of various bottles size and weights. Since that study was conducted in 2006, some companies in the water bottling industry have undertaken further "lightweighting" of bottles, in some cases producing a 500-ml bottle that weighs as little as 12.5 grams. If those bottles go into general production across the industry, the overall energy use could potentially be reduced by as much as 30 per cent (Gleick et al 2009).

However, the analysis in British Columbia is based on numbers of bottles, rather than volume of water. The bottles sold throughout the province come in an array of sizes and weights, and include two major brands commonly sold in the 591-ml size as well as some in the 1-litre and 1.5 litre size that are more than twice the 20.3-gram average. As a result, the composite average used in the lifecycle analysis possibly underestimates the amount of PET resin used to manufacture the bottles sold in B.C. Therefore the energy use and emissions indicated by the industry lifecycle analysis should be seen, in the context of B.C., as a minimum amount. The actual energy use and emissions could actually be higher.

A more recent study by the U.S.-based Pacific Institute (Gleick et al 2009), estimated cradle to fabrication figure of 4 megajoules per 38 gram PET bottle. That yields a similar calculation to the Franklin Associates report for an equivalent amount of PET — 21,368 MJ.

Throughout this report we have used the Franklin Associates figure of 21,370 MJ per 10,000 bottles to calculate the energy costs of producing PET. The original study adjusted that figure to take into account a combustion credit for PET plastic that had been incinerated to produce energy. But since there is no incineration of PET plastic in British Columbia for energy use, we have not included that credit.

There is also energy needed to treat the water that is being bottled, as well as to fill, label and seal the bottles. The Pacific Institute report calculated those costs across a range of 0.0001–0.02 megajoules (MJ) per 38g bottle for water treatment and 0.01 MJ for filling, sealing and labelling. We have taken an average from those figures of 0.02 MJ per 38g bottle and re-calculated the amount to take into account the smaller bottle size used in the Franklin Associates study outlined above. Based on 10,000 20.3g bottles, the additional energy cost for water treatment, filling, sealing and labelling equals 107 MJ (Gleick et al 2009).



***As a material for beverage containers, PET represents a technology that is dependent on fossil fuels, with all the implications that dependence has for global climate change.***

To convert megajoules to barrels of oil, we have used the standard figure one barrel of oil = 6,100 MJ (6.1 GJ) provided by the National Energy Board.

## Transport costs

Energy use and costs for transporting bottled water can be a significant portion of the overall energy consumption for bottled water, especially where markets are long distances from bottling plants. For example, the continent's leading supplier of bottled water, Nestlé, has two bottling plants in Canada, in Hope and Guelph. Transport energy use and costs for markets in the Prairies and Atlantic Canada would be substantially higher than markets in British Columbia's Lower Mainland and southern Ontario. Imported spring waters, bottled under such well known labels as Evian and Volvic from France, Gerolsteiner from Germany, Eternal from New Zealand and Fiji Water from Fiji, bring an enormous energy footprint, since the water is shipped in bottles from source and shipped by container ship to Canadian ports. For water from European sources, the bottles are offloaded in Montreal and shipped by rail across Canada.

To determine transport costs, we have estimated market shares, based on the brands sold in British Columbia, the relative distance from company bottling plants to the key destination of Vancouver and the average weights of the various brand label products. The market shares have been derived from a number of sources, including market leader Nestlé's marketing reports, Beverage Marketing Corporation data and Agriculture and Agri-food Canada reports.

The following table is based on total sales in British Columbia, estimated market shares, and distance from the closest brand bottling plant. In the case of international brands of bottled water, which are bottled at source, the figures are based on shipment by container vessel to Vancouver (Fiji) or Montreal (European bottled waters), followed by rail shipment from Montreal to Vancouver.

Company	Share	# of bottles	Distance
Nestlé	37%	46,791,615–60,659,127	150 km (Hope)
Dasani	14%	17,704,935–22,952,102	30 km (Coquitlam)
Aquafina	16%	20,234,212–26,230,974	27 km (Delta)
Others, local	28%	35,409,870–45,904,204	14 km (Richmond, Bby)
Int'l, France	4.5%	5,690,872–7,377,461	5343 sea; 4903 rail
Int'l, Fiji	0.5%	632,319–819,719	9446 sea

Once relative shares and distances were determined, the total freight weight in each share was determined, together with the distance required to deliver that freight to the main market in Vancouver. The results were calculated for both the lowest percentage estimate of water bottles (27%) and the highest (35%). The resulting calculation was expressed in tonne-kilometres and was based on the following:

- The weight per filled bottle in each brand category: filled bottles were individually weighed on scales that had been calibrated as audited by Measurement Canada. Nestlé bottles were 520g, Dasani and Aquafina bottles were based the weight of the 591 ml bottle, the most

common and the mid-range in each company's range of bottle sizes (Dasani 610g, Aquafina 628g); Other local waters were based on an average of three different brand 500 ml bottles, including one sport top (avg. 626g); and international brands were based on two 500 ml bottles and one 1-litre bottle from three leading imported brands (avg. 702g).

- Distances for Canadian-bottled waters were calculated from the nearest bottling plant to Vancouver.

Distances for imported waters were not calculated individually for all ports, but rather for one European port and one port in Fiji. Since France is the source of most European imported waters, LeHavre was chosen as the European port. Suva, the main port in Fiji from which Fiji water is shipped, was chosen as the southern Pacific port, although the share here also includes some waters bottled in New Zealand, which is even more distant from Vancouver.

Bottled water transport: energy use		
Company	Tonne-km	Energy (MJ)
Nestlé	3,649,745–4,731,412	8,430,911–10,929,561
Dasani	324,000–420,023	2,449,440–3,175,374
Aquafina	343,091–444,772	2,593,768–3,362,476
Local, other	310,332–402,304	2,346,110–3,041,418
Int'l, France	21,345,243–27,671,277 (sea)	7,897,740–10,238,372
Int'l, France	19,587,446–25,392,527 (rail)	4,309,238–5,586,356
Int'l, Fiji	4,192,965–5,435,632 (sea)	1,551,397–2,011,184
Total		29,578,604–38,344,741
Barrels of oil		4,849–6,286 barrels

The shipping methods depended on the bottled water source and the distance travelled. Local waters bottled in Hope and Calgary were assumed to have been shipped by heavy duty diesel transport truck, while water bottled in closer proximity to Vancouver was assumed to have been shipped in medium-sized trucks. Waters from Fiji were assumed to have been shipped by container vessel to the port of Vancouver while those from France were assumed to have come by container ship to Montreal and then by rail from Montreal to Vancouver.

Energy intensity figures for each shipping mode, expressed in megajoules per tonne-kilometre, were taken from the Natural Resources Canada Data handbook 2006 (rail, truck) and the U.S. Department of Energy 2007 (sea), which provide the following figures:

Rail	0.22 megajoules/tonne-km
Truck, heavy	2.31 MJ/tonne-km
Truck, medium	7.56 MJ/tonne-km
Marine	0.37 MJ/tonne-km

Total energy use was then calculated and expressed in barrels of oil, based on the National Energy Board equivalent figure of 6100 MJ per barrel.

Using the energy use figure determined by the lifecycle analysis, the bottles sold in B.C. required between 44,303 and 57,431 barrels of oil for fabrication.

Treating the water and then filling, labelling and sealing the bottles required between 210 and 288 barrels of oil.

Transporting the bottles sold in B.C. in 2007 to market required between 4,849 and 6,286 barrels of oil more.

Manufacturing the bottles, filling them and transporting them to markets required between 49,440 and 64,005 barrels of oil. The 64,005 barrels would be enough to fuel a huge fleet of SUVs, made up of 12,268 Ford Explorers, travelling from Vancouver to St. Johns, Newfoundland.<sup>1</sup>

The energy content of one 20.3g PET bottle (manufacturing alone) is 2.13 MJ — the equivalent of 11 per cent of the volume of a 500-ml bottle in oil (Franklin Associates 2007). If the energy inputs needed to fill the bottle and transport it to market are included, that percentage rises to between 16 and 28 per cent, depending on the distance travelled (Gleick et al 2009).

## Greenhouse gases

*Manufacturing a 20.3g PET plastic water bottle generates almost four times the bottle's weight in greenhouse gases. Producing PET bottles of water sold in BC in 2007 and transporting them to market generated between 12,922,578 and 16,766,604 kg of greenhouse gases (CO<sub>2</sub>e). That's the amount that would be generated in heating the average Canadian home for the next 2,177 years.*



The manufacturing of PET plastic and the transport of bottled water results in considerable greenhouse gases that contribute to global warming, including methane, nitrous oxide, and carbon dioxide. The gases are measured in relationship to the warming potential of CO<sub>2</sub> and expressed as CO<sub>2</sub> equivalents or CO<sub>2</sub>e in determining greenhouse gas emissions. The lifecycle analysis conducted by Franklin Associates provides a figure of 961 kg of CO<sub>2</sub>e per 10,000 bottles for the cradle to fabrication phase of PET. Each individual 20.3-gram bottle generates 96 g of greenhouse gases — almost four times the weight of the bottle.

That figure does not include the emissions from water treatment or from bottle filling, labelling and sealing operations. For that number, we have taken the 107 MJ/10,000 bottles provided by Gleick et al and calculated the greenhouse gas emissions based on using hydro-

<sup>1</sup> Based on a 4,590-mi. one-way trip at 19 miles per gallon highway (EPA rating) and conversion of oil, rated at 6.1 GJ/barrel to gasoline, rated at 0.13176 GJ/gallon ([onlineconversion.com/energy.htm](http://onlineconversion.com/energy.htm)).

generated electricity — the main source of electricity in B.C. — as the energy source for the treating, filling and sealing operations.

Canadian research (Dones et al 2006) pegs greenhouse gas production from hydro dams at 34 g CO<sub>2</sub>e/kWh for one specific hydroelectric power dam, Le Grande Complex, which is virtually the same as the average of the range of measurements (10-60 g CO<sub>2</sub>e/kWh) derived from estimating. We have used the 34g CO<sub>2</sub>e/kWh figure and converted it to megajoules, using Natural Resources Canada equivalency figure of 3.6 MJ/kWh.

The calculation per 10,000 bottles would be:

$$(107\text{MJ}/10,000\text{bottles} \div 3.6\text{MJ}/\text{kWh}) \times 34 \text{ CO}_2\text{e}/\text{kWh} = 1.02 \text{ kg CO}_2\text{e}/10,000 \text{ bottles}$$

## Transport emissions

The transport figures used to calculate the greenhouse gas emissions generated by freight shipment of bottled waters were taken from the 2007 Transportation Research Board Special Report, The Environmental Footprint of Surface Transportation, prepared by John Lawson of Lawson Economic Research. That report establishes greenhouse gas emission intensity for various shipping methods, expressed in grams CO<sub>2</sub> equivalent (CO<sub>2</sub>e) per tonne-km, as follows:

Marine	10g/tonne-km
Rail	17g/tonne-km
Truck (heavy)	30g/tonne-km
Truck (medium)	60g/tonne-km

Using the tonne-km for each market share outlined above, the emissions for transporting the bottled water sold in B.C. is as follows:

Company	Tonne-km	CO <sub>2</sub> e kg
Nestlé	3,649,745–4,731,412	109,492–156,137
Dasani	324,000–420,023	19,440–25,201
Aquafina	343,091–444,772	20,585–26,686
Local, other	310,332–402,304	18,620–24,138
Int'l, France	21,345,243–27,671,277 (sea)	213,452–276,712
Int'l, France	19,587,446–25,392,527 (rail)	332,987–431,673
Int'l, Fiji	4,192,965–5,435,632 (sea)	41,930–54,356
Total		756,506–994,903

Manufacturing the bottles sold in B.C. in 2007 generated between 12,153,173 and 15,754,979 kg of CO<sub>2</sub>e. Treating the water and filling the bottles generated between 12,899 and 16,722 kg. Transporting them generated between 756,506 and 994,903 kg for a total of between 12,922,578 and 16,766,604 kg of greenhouse gases (CO<sub>2</sub>e).

At the top end of that range, the greenhouse gases generated by the PET water bottles sold in BC — manufacturing the PET bottles, filling them and transporting them to market — are equivalent to the GHG generated in heating the typical Canadian home for the next 2,177 years (CMHC-Ten Steps to a Cooler Planet).

## A rising tide of plastic waste

*Encorp Pacific annual recycling reports show that 130,485,768 plastic bottles ended up in B.C. landfills in 2007 alone. Of those between 34.5 million and 44.8 million were discarded water bottles. The 44.8 million bottles would be enough to fill 21,833 full-size pickup trucks.*



Like most plastics, PET is highly resistant to biodegradation in the environment and PET bottles thrown in the landfills will typically last for centuries. (Park, DFO 2006). In that lengthy process, the plastic is often broken up into small pellets that can be ingested by birds and other wildlife where it is toxic and for some birds, lethal. In many B.C. landfills, where waste burial is a standard procedure, the PET is not exposed to sunlight and the biodegradation process takes even longer.

An increasing amount of bottle waste is also accumulating in the ocean, from bottles that are discarded on beaches as well as from commercial shipping and recreational boaters. On a global scale, that waste is contributing to the emergence of a virtual continent of waste in the North Pacific, known as the Eastern Garbage Patch. Massive amounts trash, much of its plastic waste from the west coast of North America and the east coast of Japan, have been deposited by ocean currents into an area known as the North Pacific Gyre (Moore et al) where it is accumulating.

Recycling of PET plastic bottles can in theory address some of the issues related to PET bottle use, including waste generation, energy use and greenhouse gas emissions. To be effective, recycling programs must achieve a high level of used container collection, find markets for recycled PET resin and eventually at least, achieve a closed loop system whereby much of the virgin PET resin currently used to make beverage containers is replaced with recycled PET.

Currently markets are widely available for recycled PET, which is used to manufacture polyester carpet fibre, textiles and synthetic fleece jackets, vests and outerwear linings. There has been some movement to include recycled PET in PET containers, but the percentage of recycled material is usually limited to 25 per cent (Beverage Daily.com) and so far there has been little application in PET beverage containers. Certainly no bottler in Canada currently uses recycled PET in its beverage containers.

## Recycling or downcycling?

A key issue with PET is what happens to a PET plastic bottle after it has served its purpose as a beverage container. Even if it is recovered by a recycler, it is not truly recycled but rather “downcycled” into one-time use products. The term was coined by authors William McDonough and Michael Braungart in their book *Cradle to Cradle* to indicate products that

were recycled into different products that are not recycled themselves. A PET plastic beverage container isn't recycled into another bottle, but rather into different products that are usually discarded after use. As a result, virgin PET is needed each time to manufacture a new bottle and every additional bottle that is sold requires all the inputs necessary to manufacture virgin PET resin.

In the U.S. and Europe, beverage collection and recycling programs are still collecting fewer than 50 per cent of the containers sold. Nestlé, the world's leading producer of bottled water, acknowledged in its 2007 report that the PET plastic recycling was still only 37 per cent in Europe and 20 per cent in the U.S. (Nestlé Yearbook 2007).

Those low recovery rates come despite advertising efforts by the beverage and water bottling industry. Over the last year, they have been vigorously promoting recycling as part of a marketing program to promote increased sales of bottled water while avoiding the negative image of increased PET waste.

In British Columbia, recycling rates for beverage containers are significantly higher than elsewhere on the continent, mainly because of the well-established refundable bottle deposit system and a network of bottle return depots, both administered by Encorp Pacific. The recovery rate for plastic beverage containers — mainly PET but also including HDPE and some polyvinyl chloride (PVC) containers — peaked in 2003 at 80.5 per cent and declined for two years before it began to rise again. In 2007, 72.7 percent of plastic bottles were recycled. At the time this report was completed, figures for the full 12 months of 2008 were not yet available from Encorp. But statistics for the first quarter of 2008 showed the recovery rate for containers under one litre reaching 76 per cent, indicating that the trend is continuing upward but has yet to reach the level achieved in 2003.

Even with incremental improvement in the recycling rate, however, more bottles have been ending up in the landfill each year as rapidly increasing sales of PET-bottled beverages outstrip the recovery rate.

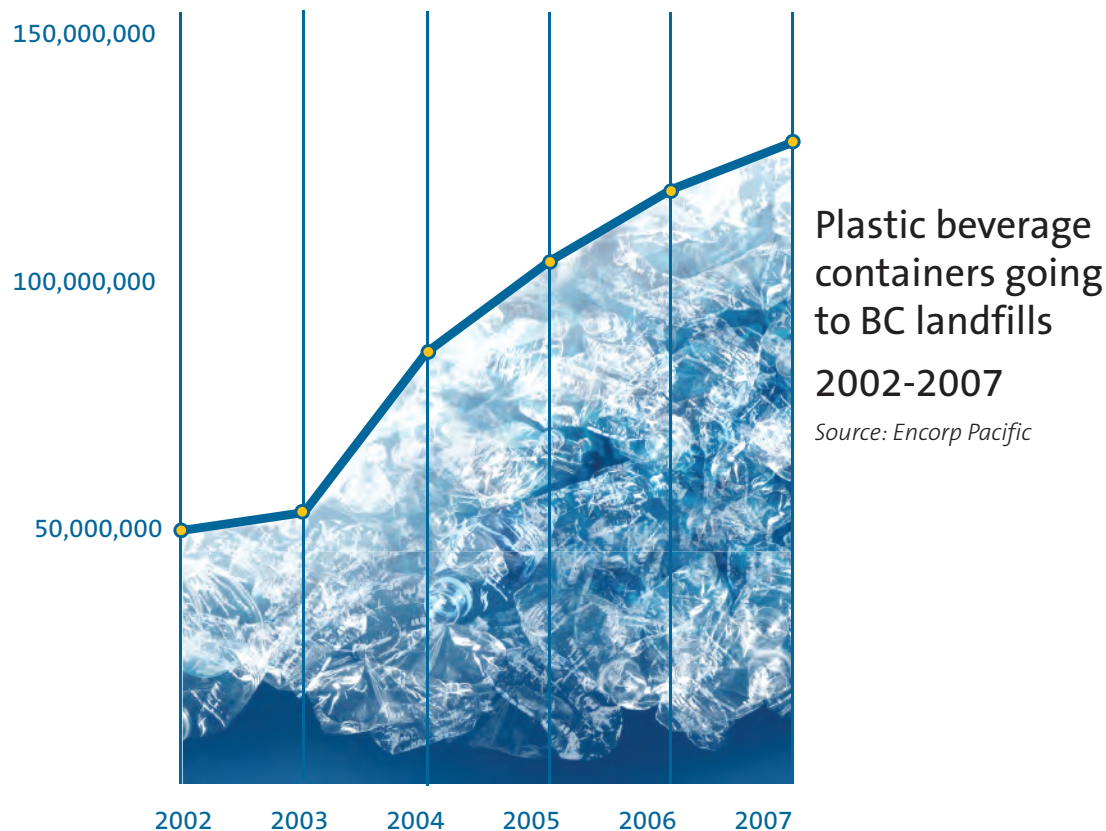
As the graph on the following page demonstrates, the numbers of unredeemed plastic beverage containers has been rising every year since 2002. In 2007, 130,485,768 unredeemed plastic bottles ended up as landfill or environmental waste, a 247 per cent increase over 2002.

We have used the same percentages outlined in the section detailing PET water bottles sales to determine how many of the unredeemed PET beverage containers were water bottles. We first deducted two per cent from the total to account for HDPE containers and then took 27 or 35 per cent of the remaining amount. We estimate that between 34.5 and 44.8 million PET water bottles were not recovered in 2007 and ended up in landfills or other environmental waste. The 44.8 million bottles would be enough to fill 21,833 full-size pickup trucks.

According to Encorp's annual report, two-thirds of the unredeemed beverage containers went



***A PET plastic beverage container isn't recycled into another bottle, but rather into different products that are usually discarded after use.***



to Metro Vancouver’s landfill. Based on that, between 23 and 30 million PET water bottles went to Metro Vancouver landfills in 2007.

## Conclusion

Whether measured by energy use, greenhouse emissions or the volume of plastic waste, PET plastic beverage bottles are creating an enormous environmental footprint in British Columbia — and that footprint will grow as long as water bottles sales continue to increase. The claim made by Nestlé Waters, in a Globe and Mail advertisement in October, 2008, that bottled water “is the most environmentally responsible consumer product in the world” simply cannot be supported by the facts. Even more untenable is the claim by the International Water Bottling Industry that “when it comes to environmental stewardship...the bottled water industry is part of the solution”(Some Facts 2006). Bottled water is anything but a solution to two of the key environmental issues currently confronting British Columbians — global warming and growing waste.

As this report has emphasized, reversing the upward trend in PET bottle use in this province is critical to controlling the environment impact of PET plastic. Reducing the use of PET-bottled water and replacing it wherever possible with tap water is an important first step.

It is, of course, only the first step. Clearly, if municipal water is to be seen by the public as the first choice for water, clean, safe drinking water must be a basic right for all residents, with

all governments committed to developing and maintaining infrastructure to support that right. There must be greater public access, including public water fountains in parks, schools and municipal facilities, with bottle refilling capabilities. There should be legislation at the federal and provincial government levels to protect our public water resource, ensuring safe sources of drinking water for all Canadians and adequate stream flows to sustain fish.

In recycling, both provincial and municipal governments should be working with industry to develop effective plastic container recycling programs that boost recovery rates to near 100 per cent, and to ensure that all PET and other recyclable plastics are captured. One immediate initiative, for example, would be to extend the direct deposit system to PET clamshell packages — used widely for small fruits, tomatoes and bulk cheeses — to ensure that the millions of such packages are recycled, not landfilled.

## Getting Off The Bottle Campaign

**I**n conjunction with the release of this report, Toxic Free Canada is launching its Getting Off the Bottle campaign, which is aimed at reducing bottled water use by 20 per cent in B.C. The campaign will focus on reducing the use of PET-bottled water and encourage the use of the alternative, tap water. It follows Toxic Free Canada's well-established model of toxics use reduction, which is based on creating public awareness about the human health effects, waste and environmental impact associated with use of a toxic substance and encouraging its replacement with a safer, environmentally-preferable alternative. In this case, tap water is the environmentally-preferable — and readily available — alternative.

The following are some of the elements of the Getting Off the Bottle campaign:

- Encouraging all British Columbians, individuals as well as clubs, sports teams and workplaces, to reduce their bottled water use by at least 20 per cent;
- Promoting the use of tap water and reusable water bottles as the first choice for portable drinking water;
- Working with student and Scout groups to promote bottled water reduction programs and tap water use at the school level;
- Supporting civic initiatives to promote tap water use in schools, parks recreation centres and other public venues through the installation and retrofitting of drinking fountains, including bottle refilling stations;
- Promoting infrastructure development that will ensure systematic upgrades of municipal water systems throughout the province.

In the Metro Vancouver region and in much of B.C., municipal water quality is already considered among the best in the world, as the award given to Clearbrook, B.C. for the “world's best municipal water” attests (Berkeley Springs Award 2009). In Metro Vancouver, the quality will be even more assured in the fall of 2009, when the first of two new, state-of-the art filtration plants comes on line. The plant will use ultraviolet disinfection, which will allow a reduction in the use of chlorine for disinfection, while filtration will eliminate the turbidity that has occasionally affected the region's water supply following storms and heavy rainfall.

Reducing bottled water use and replacing it with tap water can also yield a considerable cost saving. For example, a 500-ml bottle of premium water, imported from Fiji, sells for \$1.49, or

\$2.98 a litre — 3,750 times the cost of municipal water delivered to the tap in the Metro Vancouver region<sup>2</sup>. Even using the Canadian Association of Bottled Water Association's stated cost of \$0.36 a litre, bottled water still comes in at 450 times the cost of Metro Vancouver tap water.

Elsewhere, this report has recognized that bottled water is not the only source of PET plastic bottles. While tap water provides the obvious alternative to bottled water, other PET-bottled beverages such as soft drinks and fruit beverages will still be available. Simply removing access to bottled water may not be appropriate in all circumstances, especially if it simply results in consumers choosing another beverage that is also bottled in PET plastic. Developing an array of alternatives, including water refilling stations, drinking fountains and even compostable serving cups in theatres and other venues, will be critical to success. Focussing on a reduction in bottle use provides greater receptivity to public education about the environmental footprint of all PET-bottled beverages and ultimately, can lead to action and lasting results based on that education.

In June, 2008, the U.S. conference of mayors called on civic administrations throughout the U.S. to phase out the use of bottled water in city government buildings and at civic functions. Just nine months later, in March 2009, the Federation of Canadian Municipalities passed a similar motion, urging municipal governments across the country to phase out the sale and purchase of bottled water on municipal property. A number of Canadian cities and towns, including Vancouver and Toronto, have already adopted policies aimed at eliminating city use of bottled water.

A reduction campaign will complement some of the initiatives already begun by municipal councils, parks boards and university student societies to ban the use of bottled water in their facilities and encourage the use of municipal water exclusively. It will similarly complement Metro Vancouver's Tap Water Pledge, which is also promoting a 20 per cent reduction in bottled water use throughout the region.

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<sup>2</sup> Water from the Metro Vancouver system is delivered to regional municipalities at a cost of \$0.80 per 1,000 litres. Peter Cech, Communications specialist, Metro Vancouver Corporate Relations Department, personal communication, April 7, 2009.

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