

P41

From: Bick, Robert [mailto:robert.bick@oxfordoutcomes.com]
Sent: September 20, 2012 3:04 PM
To: Heath, Jack
Subject: tobacco product litter

Jack

I thought you might be interested in this.

While careless smoking is a major cause of fire related death and injury, along with major property damage (including homes and forests etc), cigarette consumption results in considerable amounts of litter including cigarette butts and other tobacco-related packaging. Tobacco product litter, particularly cigarette butts, has been shown to be toxic, slow to decompose, costly to manage, and growing in volume—a trend that appears to be exacerbated by the increased prevalence of indoor smoking bans.

Growing concern over TPL has prompted many U.S. states and municipalities to undertake a variety of policy initiatives. The problem stated by one researcher is as follows: "Carried as runoff from streets to drains, to rivers, and ultimately to the ocean and its beaches, cigarette filters are the single most collected item in international beach cleanups each year. They are an environmental blight on streets, sidewalks, and other open areas." Additionally, they are often consumed by fish and waterfowl – which can be poisonous.

I have enclosed a report where the costs of tobacco product litter ("TPL") to the City of San Francisco were estimated. The focus is mainly on direct costs, but the indirect costs associated with environmental impact and tourism—are also discussed. The overall objective was to calculate a cost-per-pack (of cigarettes) that offsets the costs of TPL incurred by the City. TPL is estimated to cost the City \$7,487,916 after applying data from their City's 2009 Streets Litter Audit. Based on a per annum pack consumption of 30.6 million, the City would need to charge a "maximum permissible fee" of \$0.22 per pack to recover the costs of TPL. (in the USA, municipalities have the ability to levy consumption taxes).

The authors suggest a variety of policy options to address the problem, including developing biodegradable filters, increasing fines and penalties for littering butts, monetary deposits on filters, increasing availability of butt receptacles, and expanded public education. The easiest thing to do to address this, I believe, from the perspective of York Region...is to increase fines and penalties. Jack, how often have you been driving ... and see someone tossing a cigarette butt out their window? Doesn't this bother you? You know if I see someone pitch out an apple core or banana peel into a ditch or grassy median...I don't care. It'll disappear/rot in no time. But cigarette butts don't rot.

I think York should start fining smokers who litteras this will help offset clean-up costs associated with TPL.

Here is a related story about TPL resulting from a study executed by the NS department of Environment.
<http://www.cbc.ca/consumer/story/2009/02/10/ns-litter-survey.html?ref=rss>

Bob Bick

I can't see the date for this release...but it is of interest:

For Immediate Release

NEWMARKET – York Region unveiled its Litter Prevent Strategy during a launch at Mazo de la Roche Public School in Newmarket today. Regional Chair and CEO Bill Fisch, Newmarket Mayor Tom Taylor, Aurora

Mayor Tim Jones and York Region District School Board Trustee Lorelea Carruthers joined Grade 4 and 5 classes to help outline a new strategy to combat litter.

"Littering is a completely preventable behaviour that is unfortunately growing in York Region," said Chair Fisch. "To ensure that our communities are kept clean, we have to change people's attitudes, to ensure they understand that littering damages our community and is not socially acceptable."

In 2003, York Region conducted a litter survey at 205 urban and rural locations. The survey found over 8,600 pieces of litter, ranging from cigarette butts to plastic bags and candy wrappers. This amounted to 42 items per site; higher than a similar survey in both the City of Toronto (25 items per site) and Peel Region (22 items per site).

The survey further found that litter was distributed widely across the Region, with significant amounts found in both green areas and along roadways. It also found considerable amounts of very small pieces of litter, making the overall count even higher.

"Preventing littering is not only a matter of cleanliness, it also sends a message about our community values," said Regional Councillor Danny Wheeler, Chair of the Region's Solid Waste Management Committee. "The goals of this Litter Prevention Strategy are to raise awareness that littering tarnishes our communities and to motivate residents to take ownership of this rampant problem."

"This strategy will have significant implications for our community and beyond," said Newmarket Mayor Tom Taylor. "The whole notion of York Region as an attractive place to live, visit and conduct business are elements that will hinge on the success of our efforts."

The Litter Prevention Strategy has two key elements: an educational campaign to change littering behaviours, and a number of community clean-up days to deal with existing litter. Currently, York Region has enlisted the assistance of 46 schools, a number of community agencies and private sector businesses such as Magna, IBM and Tim Horton's to assist with both elements.

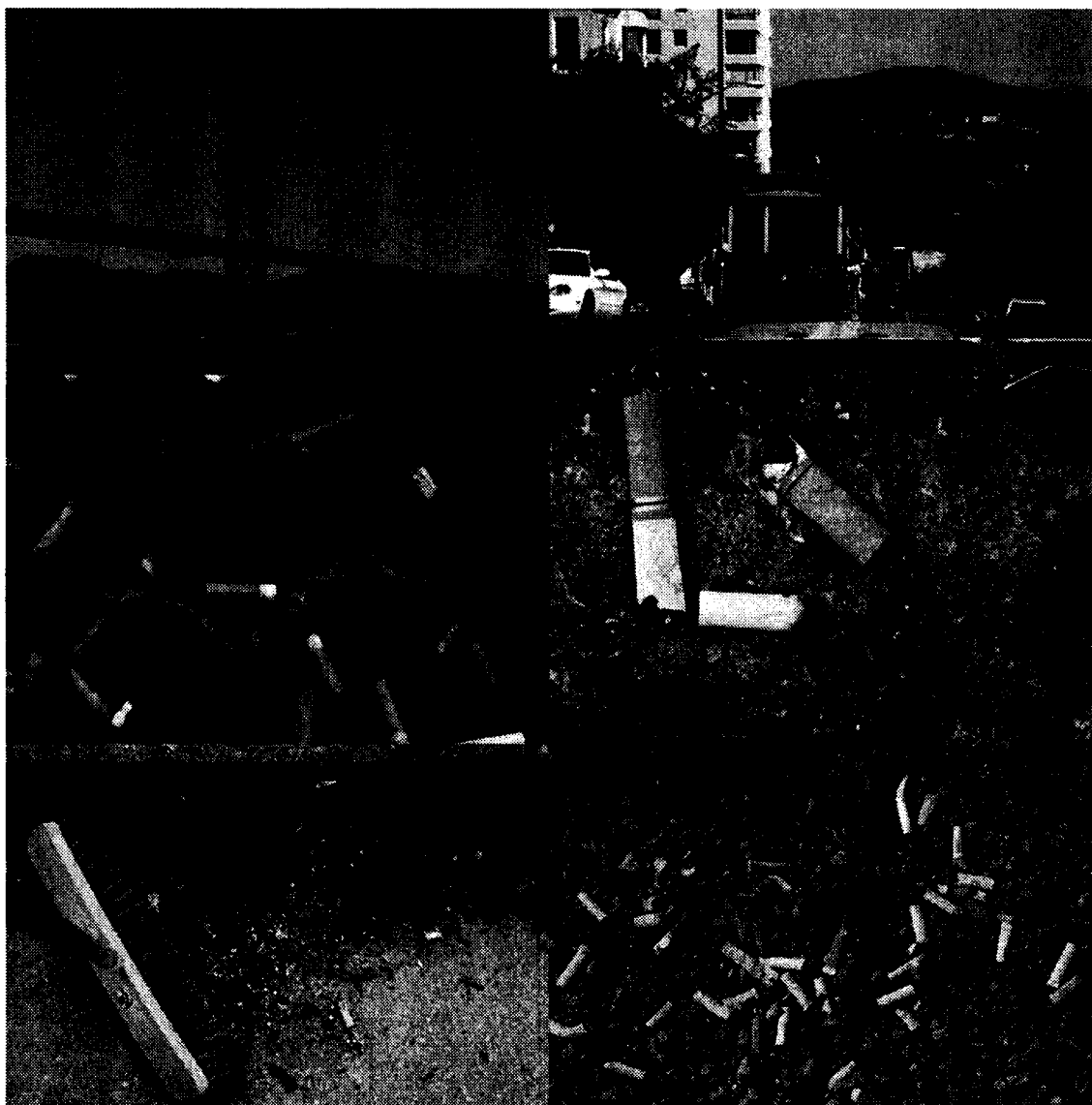
Litter Clean-up events will be taking place throughout the year, with events already scheduled with schools and businesses for October 21st, 23rd and 28th. For more information, please see the attached fact sheets.

For more information on The Regional Municipality of York, the services we offer and links to our nine area municipalities, please visit our Web site at: www.york.ca

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Estimates of the Costs of Tobacco Litter in San Francisco and Calculations of Maximum Permissible Per-Pack Fees



Estimates of the Costs of Tobacco Litter in San Francisco and Calculations of Maximum Permissible Per-Pack Fees

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SUMMARY

More than 360 billion cigarettes were consumed in the U.S. in 2007. Cigarette consumption results in the littering of cigarette butts and other tobacco-related packaging. Tobacco product litter, particularly cigarette butts, has been shown to be toxic, slow to decompose, costly to manage, and growing in volume—a trend that appears to be exacerbated by the increased prevalence of indoor smoking bans. Growing concern over cigarette butt litter has prompted states and municipalities to undertake a variety of policy initiatives. In this report we estimate the costs of tobacco product litter (“TPL”) to the City of San Francisco. We focus mainly on direct costs, but the indirect costs associated with environmental impact and tourism—while not the basis for the fee discussed herein—are also discussed. The overall objective is to calculate a cost-per-pack (of cigarettes) that offsets the costs of TPL incurred by the City. TPL is estimated to cost the City \$7,487,916 after applying data from the City’s 2009 Streets Litter Audit. Based on a per annum pack consumption of 30.6 million, the City would need to charge a “maximum permissible fee” of \$0.22 per pack to recover the costs of TPL.

1. INTRODUCTION

An “externality” occurs whenever the activities of one economic agent affect the activities of another agent in ways that are not taken into account by the operation of the market. When these activities are harmful to one of the economic agents, and the harmed agent is not compensated for the harm, we typically refer to it as a “negative externality.” Litter is considered a “negative externality” in that the market prices for litter-producing products generally do not reflect the costs incurred by third parties for the management and disposal of litter—a direct byproduct of consumption of the product.

More than 360 billion cigarettes were consumed in the U.S. in 2007.¹ While many cigarette smokers dispose of their cigarette-related litter properly, it is statistically inevitable that others will not, thereby resulting in the littering of cigarette butts and other tobacco-related packaging.² According to an extensive annual worldwide litter audit performed by the Ocean Conservancy, tobacco product litter (“TPL”) comprises 28% of all litter collected from beaches and coastal areas.³ Some estimates put the total weight of tobacco product litter in the U.S. at more than 175 million pounds per year.⁴ TPL has been shown to be toxic, slow to decompose, costly to manage, and growing in volume—a trend that appears to be exacerbated by the increased prevalence of indoor smoking bans.⁵

Growing concern over TPL has prompted states and municipalities to undertake a variety of policy initiatives.⁶ Novotny et al. summarizes the problem as follows: “Carried as runoff from streets to drains, to rivers, and ultimately to the ocean and its beaches, cigarette filters are the single most collected item in international beach cleanups each year. They are an environmental blight on streets, sidewalks, and other open areas.” The authors suggest a variety of policy options to address the problem, including developing biodegradable filters, increasing fines and penalties for littering butts, monetary deposits on filters, increasing availability of butt receptacles, and expanded public education.

In this report we estimate the costs of TPL to the City of San Francisco. We focus mainly on direct costs, but the indirect costs associated with environmental impact and

¹ USDA (2007)

² Novotny and Zhao (1999)

³ Based on the 2009 annual worldwide litter audit; see Ocean Conservancy (2009) The Ocean Conservancy litter audit relies on nearly 400,000 volunteers worldwide to survey litter found at beaches (the majority of which washes onto beaches via storm water outflow). The survey takes place on the same day each year, typically in early September. The 2008 International Coastal Cleanup collected more than 6.8 million pounds of trash in 104 countries and 42 U.S. states.

⁴ See generally www.longwood.edu/cleanva/ciglitterarticle.htm

⁵ For example, see Fueling cigarette litter reduction effort (2005); Atwater (2005); Jeff (2006); Johnson (2006); Moriwaki, Kitajima, and Katahira (2009b)

⁶ Novotny et al. (2009)

tourism—while not the basis for the fee discussed herein—are also discussed. The overall objective is to calculate, using conservative cost calculation methods, a “maximum permissible fee” cost-per-pack (of cigarettes) that offsets some or all of the costs of TPL incurred by the City.

2. METHODOLOGY

The main methodological approach to this study was to combine data from the City of San Francisco Streets Litter Audit (“SLA”) with data from the City pertaining to its direct costs in managing TPL. We use the 2009 SLA to adjust operating cost data provided by the City departments bearing primary responsibility for TPL management, clean-up, and disposal. These departments include Public Works (“DPW”), Recreation and Parks (“RPD”), Port Commission (“PC”), the Municipal Transportation Authority (“MTA”), and the Public Utilities Commission (“PUC”).⁷

The overall objective is to calculate a “maximum permissible fee” per pack (of cigarettes) that offsets some or all the costs of TPL incurred by the City. In order to do so, we supplemented SLA and City cost data with a variety of external sources, including federal government documents (U.S. and non-U.S.); state government documents; city government documents; published literature; unpublished reports; industry trade press; economic data from the U.S. Bureau of Labor Statistics and Economic Census; and smoking prevalence data from the Centers for Disease Control, the U.S. Department of Agriculture, the U.S. Behavioral Risk Factor Survey, the National Health Interview Survey, and the California Health Interview Survey. Most of these sources were used directly and are cited accordingly in the analyses.

We constructed a database containing all of the available data elements, and used the database to conduct a series of simulation models. These models calculated the range of TPL costs to the City, combining those data with estimates of the number of cigarette packs sold in San Francisco. The models take into account the proportion of tobacco products purchased in the City versus carried in from other jurisdictions (due primarily to commuting and tourism). The data are combined to derive an estimated maximum permissible regulatory fee per pack of cigarettes sold in San Francisco. Again, the fee is designed to produce revenues not exceeding the estimated 2009 costs of TPL.

⁷ The main reason for not directly assessing TPL-related costs from the departments was that the departments are not accustomed to tracking cost data for specific types of litter. Instead, the departments typically track the costs of general categories of activity (i.e., street sweeping). Thus, we employ the TPL proportion to adjust activity-based cost estimates.

3. TPL PREVALENCE ESTIMATES

The City conducted SLAs in 2007, 2008 and 2009. Working with HDR / BVA Engineering, a local San Francisco full service firm, the City audited litter on city streets. HDR / BVA in turn contracted MGM Management, a Canadian environmental consulting firm that has expertise in the area of litter audit work to design the audit to conform to their proven methodology. MGM Management has conducted over fourteen major litter audits in major North American municipalities since 2002, and has an accumulated data base of over 56,000 litter observations.⁸

In 2008, the San Francisco Department of Environment re-audited the 2007⁹ sites and to add additional sites to strengthen the litter observations.¹⁰ HDR / BVA Engineering managed and provided trained auditors for the work, while MGM Management provided the audit design, methodology protocols, site selection including new randomly selected sites, data management and data analysis services. MGM classified “large” litter as those items over four square inches in size and “small” litter as items less than four square inches in size. Eighty-four sub-categories of large and sixteen sub-categories for small litter were examined. A total of 3,973 items of large litter were observed by auditors, on San Francisco streets during the April 2008 litter audit. One hundred and thirty two sites (increased from 105 in 2007) were audited April 7-18, 2008. This audit was conducted at approximately the same time of year in 2008 as the 2007 audit (conducted April 9-20, 2007).

An additional data collection method was added to field work activities during the April 2009 litter audit.¹¹ The San Francisco Department of Environment requested that MGM examine 32 sites to observe *all* small litter and large litter of those sites. These sites were referred to as “Super Sites.” The labor-intensive approach was added to the 2009 audit as a means to over-sample areas known for high litter density, with a secondary goal of increasing overall sample sizes in order to support more robust estimates of litter sub-categories, of which TPL is part.

Table 1 summarizes the results of the April 2009 observations. These count data exclude chewing gum deposits from the denominator, as they are the result of historic accumulations on sidewalks and street curbs, and are generally viewed as uncollectible (and thus not a significant cost-driver). Count data (as opposed to weight or volume data) are appropriate for this analysis because we focus on the costs of manual cleaning, the costs of which vary more by count than by weight or volume.

⁸ See generally <http://www.mgm-management.com/>

⁹ HDR (2007)

¹⁰ HDR (2008)

¹¹ McKenney (2009)

Table 1
Litter Prevalence Reported by 2009 Streets Litter
Audit, City of San Francisco

Litter Category	Count	Percentage
Glass	4,100	37.5%
TPL	2,638	24.6%
Paper	1,819	16.6%
Hard Plastics	720	6.6%
Candy Wrappers	390	3.6%
Plastic Film	328	3.0%
Metal (not aluminum)	263	2.4%
Aluminum	197	1.8%
Other Materials N.E.C.	127	1.2%
Polyfoam pieces	107	1.0%
Bottle Caps	65	0.6%
Rubber	57	0.5%
Straws	55	0.5%
Polyfoam Packing "Peanuts"	16	0.1%
TOTAL	10,927	100.0%

Source: McKenney, M.G. "San Francisco Super Site Data 2009." Osoyoos, BC, Canada: MGM Management & HDR Engineering, 2009. *Notes:* Excludes chewing gum deposits

Pieces of broken glass were a dominant sub-category of litter observed on the 32 Super Sites, making up 38% of all litter observed. Cigarette butts and other small tobacco litter (matches, filters, etc) accounted for 2,683 observations or 24.6% of all litter observed and were the second most predominant sub-category recorded. Paper pieces were third, at 17% of all litter observed at the Super Sites. These three sub-categories of litter accounted for 78.7% of items observed at the Super Sites.

These data are supported by observations made by the City of Toronto, in Super Site audits conducted by MGM in 2004-2006. Toronto observed 98,819 pieces of small litter at 68 sites, with TPL, paper and glass representing 73% of all litter observed. The TPL estimates also bear remarkably close resemblance to the TPL proportions found by the Ocean Conservancy's International Coastal Cleanup ("ICC") data. The 2008 ICC found that TPL comprised 28% of all litter found in the collection effort.¹²

¹² Ocean Conservancy (2009)

4. TPL COST ESTIMATES

Direct Costs. The City departments were asked to report their total operating costs attributable to general litter management, collection, abatement. These reported costs for fiscal year (FY) 2009 are shown in Column 2 of **Table 2**. These cost estimates underestimate the actual costs of TPL mitigation because they *exclude* the costs of mechanical street sweeping (“MSS”). The costs of MSS are incurred at least in part as a result of the mandate, contained in the City’s National Pollution Discharge Elimination System (“NPDES”) permit, that the City sweep its streets and clean out catchment basins in order to address non-litter materials (e.g., silt, sediment and heavy metals). In addition, these cost estimates are exclusive of the costs of collecting and handling TPL and other waste that is properly disposed (i.e., these cost estimates do not include the costs of emptying City trash receptacles). Similarly, we do not include the costs of depositing TPL (legally or illegally disposed of) in the City landfill.

For the same reasons we exclude the PUC’s TPL costs. The PUC assumes primary responsibility for collecting and treating storm and waste water. The overall process is described on the PUC website,¹³ and is generally analogous to wastewater collection processes in other cities.¹⁴ There are two sources of litter that enter the water treatment process: street and sidewalk litter (the portion not collected by DPW mechanical and manual street sweeping); and litter entering the sewage system through residential and commercial indoor drains (toilets, sinks, floor drains, etc.). Both of these introduce TPL into the water collection and treatment process. The main points in the process whereby TPL accumulates are storm water drains/inlets,¹⁵ drainage culverts and piping, intermediate pumping stations, catch basins and storage boxes, and the screens, filters and skimmers located at the main wastewater treatment plant entry points. Hence, like MSS carried out by other departments, a potentially large proportion of the PUC’s TPL costs are inseparable from the activities associated with NPDES compliance. To the extent that the PUC’s TPL mitigation costs are not entirely encompassed in NPDES compliance, our overall TPL cost estimates are understating the true TPL mitigation costs.

¹³ See generally http://sfwater.org/mto_main.cfm (“Bringing Wastewater and Stormwater Together,” “Catch Basins and Storage Boxes,” and “Making Dirty Water Clean Again.”)

¹⁴ For general information on wastewater collection and treatment, refer to Peirce, Weiner, and Vesilind (1998)

¹⁵ Storm water drains and inlets trap TPL in grate coverings, curb hoods, and collection box (especially accumulation in the bottom of the box, in the space between the bottom and the outtake piping).

Table 2
Estimates of Direct Litter Mitigation Cost and TPL Share by Department,
City of San Francisco, 2009

	[1]	[2]	[3]	[4]
Department	Litter Mitigation Activity	Total Litter Cost Estimate (2009)	TPL Share of Litter^a (2009)	TPL Mitigation Costs (2009)
DPW	MC	\$20,290,482	24.6%	\$4,991,459
RPD	MC	\$2,961,675	24.6%	\$728,572
PC	MC	\$1,044,696	24.6%	\$256,995
MTA	MC	\$495,705	24.6%	\$121,943
SUBTOTAL		\$24,792,558		\$6,098,969
Public Education Costs				\$215,000
Administrative Costs ^b				\$1,173,947
TOTAL				\$7,487,916

Source: Data provided directly by the City departments to Paul Ledesma (City Government Zero Waste Coordinator, Department of Environment). *Notes:* DPW = Public Works; RPD = Recreation and Parks; PC = Port Commission; MTA = Municipal Transportation Authority; PUC = Public Utilities Commission; MC = manual litter collection, using a variety of non-mechanized methods; (a) McKenney, M.G. "San Francisco Super Site Data 2009" MGM Management & HDR Engineering, 2009; (b) this estimate sums the totals from Tables 3 and 4.

The estimated total direct cost of TPL to the City is \$6,098,969 per year, based on annualized 2009 data. To this estimate we add two additional costs—public education and administration of the proposed regulatory fee. The rationale for including public education costs is based on the desire on the part of the City to undertake additional efforts to mitigate TPL while recovering the costs imposed by it. The \$215,000 cost estimate is based on the design and production of a multi-media public education effort utilizing five types of communication mediums (cable television, print, internet, billboard, and transit). The administrative cost of the per-pack maximum permissible fee (\$1,173,947) is equal to the sum of the estimated annual costs (**Table 3**) and formation (i.e., “start-up”) costs (**Table 4**), both of which were estimated and reported by the City’s Office of the Treasurer and Tax Collector. As indicated in the last row of Table 2, the result is a total direct cost of TPL to the City of \$7,487,916.

Table 3
Estimates of Annual Costs of Administering TPL Fee

Percent Effort	Code	Description	Annual Cost Estimate
Cashier payment processing, check control and research			
7%	4320	Cashier I	\$4,554
24%	4321	Cashier II	\$16,997
5%	4322	Cashier III	\$3,622
6%	4310	Comm Div Asst Sup	\$6,177
4%	0922	Manager I	\$5,793
Account Services (mailing, customer service, return process, analysis, form printing)			
5%	1654	Principal Accountant	\$6,115
100%	1632	Senior Account Clerk	\$79,084
5%	1824	Principal Administrative Analyst	\$7,362
Auditing			
200%	4222	Sr. Personal Property Auditor	\$250,774
30%	4224	Prin. Personal Property Auditor	\$42,077
10%	0931	Manager III	\$16,764
4%	0933	Manager V	\$7,763
Reconciliation - payment validation			
50%	1630	Account Clerk	\$34,148
Enforcement - collection from non-filers, non-payers, audit billings			
200%	4308	Sr. Collections Officer	\$176,427
10%	4310	Collections Supervisor	\$11,743
20%	4335	Senior Investigator	\$22,124
15%	0922	Manager I	\$21,723
5%	8177	Attorney	\$11,477
Technical & Administrative Support			
20%	1053	Business Analyst	\$25,319
Total Labor ^a			\$750,045
Overhead @ 15.97% per May 2008 Master Fee Schedule			\$119,782
Total Labor			\$869,827
<i>Ongoing Direct Costs</i>			
BTS and Cashiering Systems Maintenance (ongoing)			\$5,000
Form Printing			\$5,000
Postage and Mailing Costs			\$4,000
Supplies			\$1,000
P.O. Box			\$600
<i>Total Maintenance and Supplies</i>			\$15,600
TOTAL			\$885,427

Source: Office of the Treasurer & Tax Collector, City of San Francisco. *Notes:* (a) Salary at these rates until 6/30/09; increase by cost of living thereafter

Table 4
Estimates of TPL Fee Administrative Formation Costs

Position	Number of pay periods	Cost Estimate
<i>Labor Costs:</i> ^a		
Director, Business Tax	2.00	\$14,497
Manager, Policy & Programs	3.00	\$19,344
Budget Director	0.50	\$3,224
Principal Administrative Analyst - BTS	3.00	\$16,427
Principal Accountant	2.00	\$9,092
Account Clerk	2.00	\$5,065
Business Analyst	5.00	\$25,928
Subtotal		\$93,576
Overhead - 15.97% - per fee schedule		\$14,944
Total Labor		\$108,520
<i>Other Direct Costs:</i>		
Programming set up ^b		\$150,000
Cashiering Set up		\$30,000
Subtotal		\$180,000
TOTAL		\$288,520

Source: Office of the Treasurer & Tax Collector, City of San Francisco. Notes: (a) Salary at these rates until 6/30/09; increase by cost of living thereafter; (b) assumes the development of new technology

Indirect Costs. We do not include indirect costs due to the complexities of estimating such costs. Nevertheless, a brief discussion of potential indirect costs suggests that our total cost estimate (based completely on direct costs) is likely *understating* the total costs to the City. Two potentially important indirect costs of TPL are (1) the costs to the City attributable to the toxicity of TPL (particularly cigarette butts) and (2) the costs to the City attributable to TPL's indirect impact on tourism, due to the effects of toxicity on the environment and the effects of litter on the City's image to prospective tourists. As additional scientific evidence on TPL is published and future regulations are promulgated, the City may wish to reconsider the exclusion of specific indirect costs.

The toxicity and environmental impact of cigarette butts remains a relatively new area of scientific inquiry, but recent evidence strongly suggests that cigarette butts are more toxic than previously believed. Cigarette butts are designed to capture some of the chemicals present in cigarette smoke, which means that the typical used (or smoked) cigarette butt contains some combination of ammonia, formaldehyde, butane, acrylonitrile, toluene, benzene, alkaloid nicotine, and many other chemicals. When burned, many of these chemicals form new compounds.

Many of the chemicals and compounds found in cigarette butts are toxic at even low concentrations. For example, Register (2000) used short-term bioassays (48 hours) to determine how a test organism (the water flea *Daphnia*) reacted to various concentrations of cigarette butts per liter of water. The results indicate that the chemicals released into freshwater environments from cigarette butts were lethal to *Daphnia* at concentrations of 0.125 cigarette butts per liter (one butt per two gallons of water).

In a similar study, Micevska et al. (2006) assessed the acute toxicity of 19 filtered cigarette types to freshwater cladoceran *Ceriodaphnia cf. dubia* and the marine bacterium *Vibrio fischeri* using leachates from artificially smoked cigarette butts.¹⁶ There was a 2.9- and 8-fold difference in toxicity between the least and most toxic cigarette butts to *C. cf. dubia* and *V. fischeri*, respectively. Overall, *C. cf. dubia* was more inherently sensitive than *V. fischeri* by a factor of approximately 15.4, and the interspecies relationship between *C. cf. dubia* and *V. fischeri* was poor ($R^2 = 0.07$). This poor relationship indicates that toxicity data for cigarette butts for one species was a poor predictor of the toxicity of cigarette butts to the other species. Of the 14 organic compounds identified, nicotine and ethylphenol were suspected to be the main causative toxicants. There was a strong relationship between toxicity and tar content and between toxicity and nicotine content for two of the three brands of cigarettes ($R^2 > 0.70$) for *C. cf. dubia* and one brand for *V. fischeri*. However, when the cigarettes were pooled, the relationship was weak ($R^2 < 0.40$) for both test species.

A study conducted in Japan reached similar conclusions. Moriwaki et al. (2009), studying a sample of roadside litter (mostly cigarette butts) collected in the suburban city of Ueda, reported that the elution of arsenic (0.041 mg/L) and nicotine (3.8 mg/L) was ascertained by a dissolution test of cigarette butts, and the loading of heavy metals, such as lead, copper, chromium and cadmium, and polycyclic aromatic hydrocarbons (PAHs) from cigarette butts into the environment was confirmed.¹⁷ The load potentials of heavy metals were 0.02–1.70 mg/km/mo, and that of total-polyaromatic hydrocarbons was 0.032 mg/km/mo. The authors concluded that the roadside litter has a “harmful influence on the environment.”

In a recent unpublished study, Richard Gersberg of San Diego State University evaluated the effects smoked cigarette butts have on marine life.¹⁸ He found that the chemicals from just one filtered cigarette butt had the ability to kill fish living in a one-liter bucket of water. Gersberg's study used three types of cigarette butts: smoked filtered cigarettes without any portion of un-smoked tobacco; smoked filtered cigarettes with a portion of un-smoked tobacco remaining; and clean un-smoked filtered cigarettes. In all cases, about half of the fish were killed with a very low concentration of cigarette butts.

¹⁶ Micevska et al. (2006)

¹⁷ Moriwaki, Kitajima, and Katahira (2009a)

¹⁸ See generally http://newscenter.sdsu.edu/sdsu_newscenter/news.aspx?s=71209

It is difficult to attribute specific costs to the toxicity of cigarette butts. However, toxicity suggests that the balance of marine ecosystems could be disrupted, and such a disruption is likely to have greater economic impacts on cities that support tourism centered on marine life (e.g., marine life viewing; commercial fishing; charter/recreational fishing) and recreational use of coastline and beaches.¹⁹

In addition to the effects of toxicity on marine life and coastal recreation, environmental “cleanliness” plays an important role in the demand for tourism. Urban tourism is to a large extent dependent on “place image”—the process through which individuals perceive the urban environment.²⁰ Individuals typically assign high rankings to destination characteristics likely to be affected by TPL, including “cleanliness and conservation,” “[trash] removal,” and “beach cleanliness,”²¹ and litter itself can have a direct impact of tourism.²² Even small reductions in tourism can result in diminished economic activity and lower tax revenue to cities.²³

5. CIGARETTE SALES

We employed two methods of calculating the volume of cigarette sales in San Francisco. First, we calculated the total dollar value of cigarette sales in San Francisco using the U.S. Census Bureau’s Economic Census. The Economic Census is conducted every five years. In 2002, the latest year for which complete and geographically detailed data is available, there were nearly 25 million business establishments in the U.S. and 7 million of these had paid employees. This accounted for about 97% of business receipts. Data include industry-level information (categorized by the North American Industrial Classification System, or NAICS) on the number of establishments, employment, revenues generated and payroll expenses. It also provides detailed data at a national, state, MSA and county level. Moreover, the data provides detailed information, by industry and state-level geography, on the total value of sales generated from particular product lines, such as frozen food, dairy products, beers and ales and tobacco products.²⁴

Two types of data were collected for both San Francisco County and the state of California. The first type of data collected measures the dollar value of total industry-level

¹⁹ See generally Ocean Conservancy (2009)

²⁰ Selby (2004); and BBC News (2004)

²¹ See, for example, Kozak et al. (2004)

²² See, for example, Smith (1987)

²³ Jie, Madsen, and Jensen-Butler (2007); Lundie, Dwyer, and Forsyth (2007); Poling (2006); Tyrrell and Johnston (2006)

²⁴ Further details on the 2002 Economic Census, and NAICS classification, can be found at the following web site: <http://www.census.gov/econ/census02/>.

sales for selected NAICS codes.²⁵ This data is available for both the state of California and for San Francisco County.²⁶ Data pertaining to sales for product line 20150 (cigarettes) is not available at the county level.²⁷ Hence, we collected this product line data for California and utilize it to estimate product line 20150 sales for San Francisco County (see below). Finally, we collect data from the US Census on population and population aged 18 and older for both California and San Francisco County that we also utilize to estimate product-line 20150 sales for San Francisco County.

Using the California data, we calculate for each NAICS code the share of total sales that is attributable to sales of product-line 20150. These shares are then applied, with one modification, to the San Francisco County total sales figures to obtain an estimate of San Francisco County product-line 20150 sales. The modification was made to these shares to reflect differing demographic profiles between San Francisco County and the state of California. For instance, the proportion of the population aged 18 and older (a primary smoking and tobacco-using demographic) is somewhat larger in San Francisco County than in the state. Hence, one might then conclude that sales of tobacco products are likely higher in San Francisco County than in state of California. We constructed an index to account for this demographic difference and then apply that index to the above-calculated sales shares.²⁸ These adjusted shares are then applied to the San Francisco County total sales figures to arrive at the sales data shown in Column 1 of **Table 5**.

²⁵ These selected industries were deemed the main vendors of tobacco products in the San Francisco area.

²⁶ This data was extracted from Census at the following web site on May 1, 2009:
http://factfinder.census.gov/servlet/FindEconDatasetsServlet?ds_name=EC0200A1&_lang=en

²⁷ In addition, these data are not available at the MSA or other sub-state level.

²⁸ This index was constructed in the following manner. First, the share of population aged 18 and older was calculated for both San Francisco County and for California. Then, the San Francisco County share is divided by the California share. Such indexes are often referred to as Location Quotients (LQs). The LQ value turned out to be 1.15. This value indicates that the proportion of those individuals aged 18 and over is about 15 percent larger in San Francisco County than in the state of California. It was this LQ that was applied to each of California's product-line sales shares by NAICS code.

Table 5
Estimates of Total Cigarette Sales and Retail Channel Shares, San Francisco, 2009

	[1]	[2]	[3]	[4]	[5]
Retail Channel	2002 San Francisco Cigarette Sales^a	2002 San Francisco Cigarette Sales Estimate^b	2002 San Francisco Cigarette Sales Channel Shares	2007 San Francisco Cigarette Sales Estimate^c	2009 San Francisco Cigarette Sales Estimate^d
Food & beverage stores	\$32,690,486	\$33,580,182	28.45%	\$30,188,583	\$35,797,622
Beer, wine, & liquor stores	\$10,040,885	\$10,930,580	9.26%	\$9,826,592	\$11,652,373
Pharmacies & drug stores	\$5,338,172	NA	NA	NA	NA
General merchandise stores	\$23,779,998	\$24,669,693	20.90%	\$22,178,054	\$26,298,736
Gasoline stations	\$14,082,541	\$14,972,237	12.68%	\$13,460,041	\$15,960,916
Other retailers N.E.C.	\$15,750,354	\$16,640,050	14.10%	\$14,959,405	\$17,738,862
Limited-service dining / bars	\$16,355,307	\$17,245,002	14.61%	\$15,503,257	\$18,383,762
TOTAL	\$118,037,744	\$118,037,744	100.00%	\$106,115,932	\$125,832,272

Sources and Notes: See text. (a) Product code 20150; (b) Distributes NAICS 44611 (pharmacies and drug stores) to other retail channels following the passage of legislation banning the sales of tobacco products in pharmacies and drug stores; (c) Reduced by changes in smoking rate, calculated by comparing 2005 and 2007 results from the California Health Interview Survey (relevant survey question regarding whether respondent has smoked at least 100 times); (d) 2002 data are increased by general economy-wide price inflation between 2002 and 2009, as measured by the Consumer Price Index (CPI).

In order to calculate per-pack fees, we used the following methodology to derive total packs sold in San Francisco. First, we retrieved data on cigarette packs sold per capita in California.²⁹ The CDC reported a California “packs per capita” of 31.8.³⁰ To verify, we used the 2007 California Health Interview Survey (CHIS) data (subsampled to San Francisco) on smoking prevalence and (for regular smokers) the number of cigarettes per day are typically smoked. These data show remarkably similar results, suggesting that 31.8 packs per capita was an appropriate estimate for the state and for San Francisco. An additional verification consisted of dividing the sales data from Table 5 (column 5) by the average price for a pack of cigarettes in California (\$4.10).³¹ Taking this result and converting to packs further supports the 31.8 packs per capita estimate.

²⁹ Based on data gathered by Centers for Disease Control (Behavioral Risk Factor Survey), U.S. Department of Agriculture, the U.S. National Health Interview Study (NHIS), the California Health Interview Survey, and the California Board of Equalization.

³⁰ CDC State Tobacco Activities Tracking and Evaluation (STATE) System, 2008 Tobacco Control Highlights: California

³¹ California pre-tax retail cigarette pack price was \$4.10 in 2009 (based on pack prices from *Campaign for Tobacco Free Kids*—www.tobaccofreekids.org). Dividing the total cigarette revenue based on the Economic Census (\$125,832,272) by an average pre-tax price per pack (\$4.10) = 30,690,798 packs sold. Thus, using data sourced completely differently, we arrive at the same pack estimate of 30.6 million.

Second, in order to convert the packs-per-capita data point into a measure of packs purchased in San Francisco per annum, we adjusted San Francisco population data for influx of daytime commuters³² and daytime and nighttime visitors and tourists.³³ These adjustments are shown on **Table 6**. The result is an estimate of 30.6 million cigarette packs purchased in San Francisco in 2008.³⁴ We assume that number purchased is roughly the same in 2009, based on the countervailing effects of continually declining smoking rates and increasing population.

Table 6
Cigarette Packs Purchased in San Francisco, 2008-09

Measure	Estimate
Total Resident Population (2008) ^a	808,976
Total Commuter Population (2008) ^b	175,548
Total Daytime Population (2008)	984,524
Daily Tourist Population (2008) ^c	131,722
Daily (24-hr) Total Population (2008)	1,116,246
Cigarette Packs per Capita in CA (2007) ^d	31.8
Cigarette Packs Consumed in SF (2008-2009)	30,611,026

Sources and Notes: (a) U.S. Bureau of the Census, Current Population Estimates; (b) Census 2000 PHC-T-40. Estimated Daytime Population and Employment-Residence Ratios: 2000 (trended to 2008); (c) San Francisco Visitor Bureau "2008 Visitor Volume & Spending" ("Visitors in San Francisco on an Average Day"); (d) CDC State Tobacco Activities Tracking and Evaluation (STATE) System, 2008 Tobacco Control Highlights: California (and verified using the California Health Interview Survey, 2005/07).

6. MAXIMUM PERMISSIBLE PER-PACK FEE

The calculation of a maximum permissible per-pack fee requires one final adjustment. We assume that the commuter and tourist visitors to San Francisco purchase 50% of their cigarettes *outside* of San Francisco. This results in an 11.2% reduction in the litter mitigation costs (assuming the City does not seek to recover the costs of cigarette butts *not* sold by San Francisco vendors). This adjustment is shown on **Table 7**. The result is a total "recoverable" TPL cost of \$6,649,270 after adjusting for "in-migration" of TPL.

³² Source: Census 2000 PHC-T-40. Estimated Daytime Population and Employment-Residence Ratios: 2000

³³ Source: San Francisco Visitor Bureau "2008 Visitor Volume & Spending" ("Visitors in San Francisco on an Average Day")

³⁴ In terms of cigarettes purchased in San Francisco, 30.6 million packs converts to 612,220,520 individual cigarettes.

When divided by the estimate of total packs consumed by San Franciscans, the result is a maximum permissible per-pack fee of \$0.22.³⁵

Table 7
Calculation of Per-Pack Maximum Permissible Fee

Measure	Estimate
Cigarette Packs Purchased in SF (2008)	30,611,026
Total Litter Mitigation Costs (2009) ^a	\$7,487,916
Total Litter Mitigation Costs Adjusted for In-migration (2009) ^b	\$6,649,270
Total Litter Mitigation Costs per Pack (2009)	\$0.22

Sources and Notes: (a) from Table 2 Column [4]; (b) assumes commuter and tourist visitors to San Francisco purchase 50% of their cigarettes outside of San Francisco, resulting in an 11.2% reduction in mitigation costs associated with TPL purchased within the boundaries of the City.

7. CONCLUSIONS

In this report we estimate the costs of tobacco product litter (“TPL”) to the City of San Francisco. We focus mainly on direct costs, but indirect costs associated with environmental impact and tourism are also discussed. The overall objective is to calculate a cost-per-pack (of cigarettes) that offsets the costs of TPL incurred by the City. TPL is estimated to cost the City \$7,487,916, after applying adjustments from the City’s 2009 Streets Litter Audit. Based on a per annum pack consumption of 30.6 million, the City would need to charge a fee of \$0.22 per pack to recover the costs of TPL.

³⁵ Were this fee to be implemented, it is likely that the higher price will result in slightly lower consumption. Reviews of studies of the “price elasticity of demand” for cigarettes suggest that a 10% increase in price will reduce overall cigarette consumption by approximately 3%. But the price effects will also reduce TPL, all else equal, thus the net price effect on the per-pack fee necessary for 100% cost offset is likely to be negligible. These effects should be evaluated in after the first full year of implementation. For a discussion of cigarette elasticity estimates, refer to U.S. Department of Health and Human Services (2000)

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