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The City of San Francisco

STREETS LITTER RE-AUDIT

2008

PREPARED FOR

The City of San Francisco
San Francisco Environment Department

PREPARED BY

HDR | Brown, Vence & Associates, Inc.

&

MGM Management
A Division Of 1184614 Ontario Inc.
Environmental & Management Service

.

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Executive Summary

The City of San Francisco continues to be known throughout North America for its initiatives to protect the environment. The City has a multitude of waste reduction and waste management programs in place to improve the environment for residents. Such activities as recently moving to “all-plastics” pick ups in the curbside recycling program are examples of how this city achieved a 70% diversion rate by 2007.

In 2007, the City conducted a litter audit. 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 with their proven methodology. MGM Management has conducted over a fourteen major litter audits to major North American municipalities since 2002, and has an accumulated data base of over 56,000 litter observations.

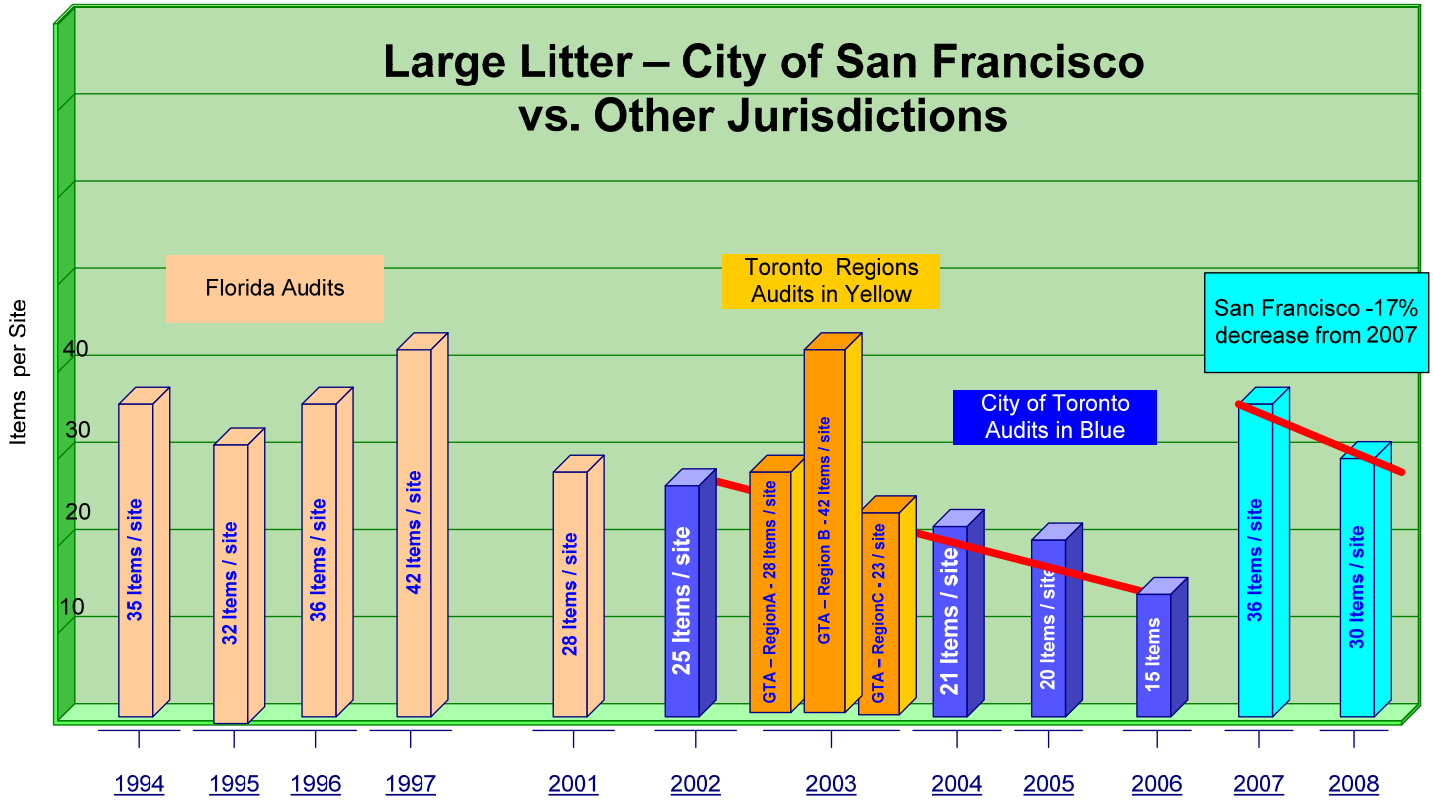
The San Francisco Department of Environment decided that it was necessary to re-audit the 2007 sites in 2008, and to add additional sites to strengthen the litter observations. HDR / BVA Engineering managed and provided trained auditors for the work, while MGM Management provided the audit design, methodology protocols, site selection including new randomly selected sites, data management and data analysis services.

Within this study litter is classified as “large” for those items over 4 square inches in size or as “small” litter for items less than 4 sq. in. 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 in the previous audit (conducted April 9 – 20, 2007).

The 2007 audit observed, an average of 36 items of large litter per site; which decreased 17% to 30 items of large litter per site in 2008 (3,973 / 132 sites). The chart below illustrates how the results in the San Francisco litter audit compare with 2007 and with other jurisdictions.



The largest category of large litter observed, at 664 litter pieces was non-branded paper napkins and paper towels. This is a similar result from the 2007 audit, where napkins were the second most significant category (570 pieces of large litter in 2007). Printed paper materials were the second most significant litter category at 380 items, followed closely by miscellaneous paper, last year's most significant large litter category. Miscellaneous paper was the third most significant category in the 2008 litter audit with 318 items observed.

Again in 2008, all fiber based products and items that were observed contributed 51% of the total large litter observed, as compared to 54% in the 2007 audit. Fiber based litter included paper, paperboard, cardboard, towels, napkins, newspapers, books, flyers, printed materials, and business forms, stationary.

An interesting observation was made in terms of what brands of printed materials are on the ground in San Francisco. MUNI tickets and transfers are a contributor to paper litter on city streets. This observation of transit ticket, receipts and transfers as being a significant contribution to paper litter is consistent with observations made by the consultant in our (other) urban audits. This is an area where action can reduce litter significantly.

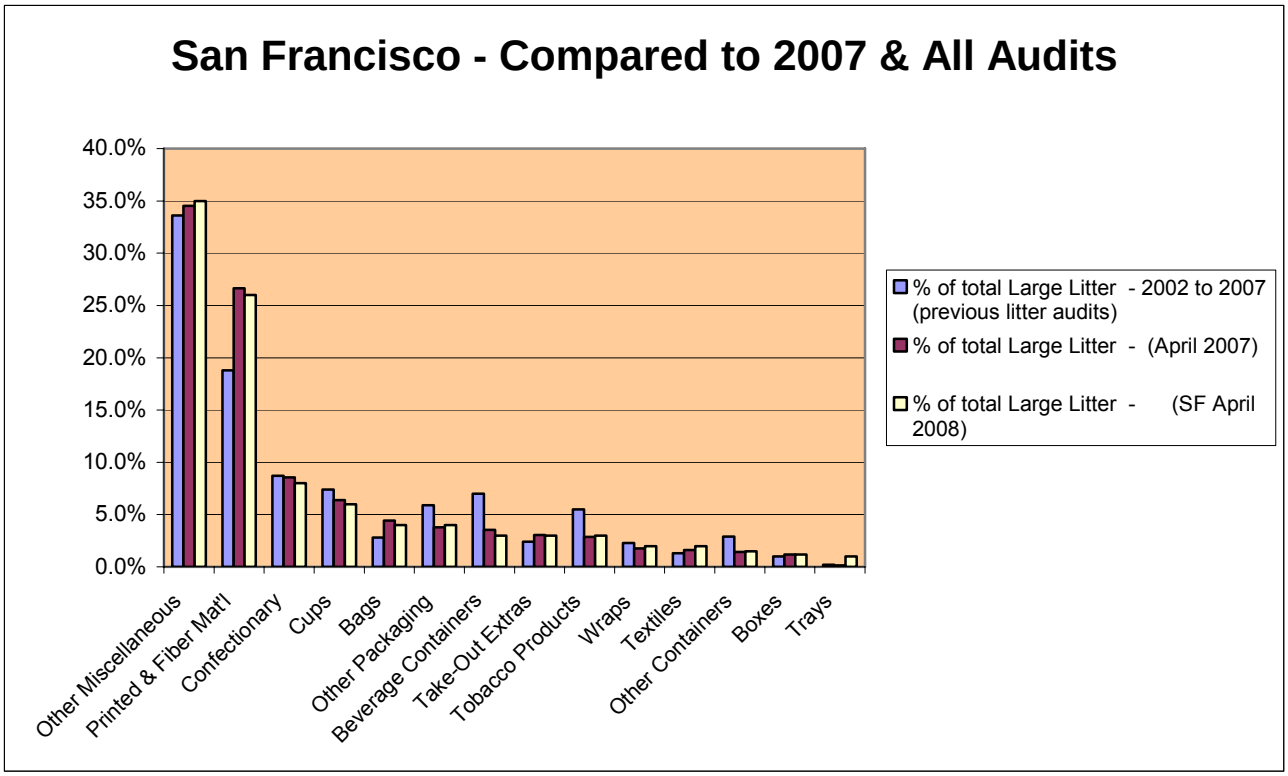
The second most significant material type observed was plastic materials. These included miscellaneous plastic, plastic packaging, wrap, plastic bags-retail and non-retail, hot and cold plastic drink cups, plastic jars, bottles, composites, utensils, zip bags, beverage containers, trays, polystyrene cups, confectionary, sweet and snack food packaging, pouches, plates, retail bags, and carrying rings. The most significant single category of plastic litter was unidentified miscellaneous plastic litter; which is litter that is broken or weathered that auditors cannot identify it with certainly; and is assumed to be plastic. Miscellaneous plastic litter accounted for 186 littered items or 4.7 % (compared to 9% in 2007) of total litter. All large plastic litter in aggregate accounted for 953 items observed (compared to 746 in 2007), or 24 % of total large litter observed (compared to 20% in 2007).

Below we compare litter occurrence in San Francisco versus all previous audits completed by the consultant. This allows a comparison to other jurisdictions where litter audits have been done using the same methodology.

San Francisco 2008 vs. Other Jurisdictions (2002 - 2007)[1.]

	Observations - 2002 to 2006 (other jurisdictions)	% of total Large Litter - 2002 to 2006 (other jurisdictions)	San Francisco Litter Audit (April 2007)	% of total Large Litter - SF April 2007	% of total Large Litter - SF April 2008
Other Miscellaneous	15,428	33.2%	1,316	34.5%	23.6%
Printed & Fiber Mat'l	8,693	18.7%	1,016	26.7%	31.3%
Confectionary	4,094	8.8%	326	8.6%	7.6%
Cups	3,366	7.2%	243	6.4%	6.4%
Bags	1,232	2.7%	169	4.4%	5.9%
Other Packaging	2,862	6.2%	145	3.8%	3.3%
Beverage Containers	3,420	7.4%	135	3.5%	3.0%
Take-Out Extras	1,076	2.3%	116	3.0%	3.8%
Tobacco Products	2,594	5.6%	110	2.9%	3.7%
Wraps	1,109	2.4%	68	1.8%	3.6%
Textiles	608	1.3%	62	1.6%	1.0%
Other Containers	1,472	3.2%	55	1.4%	2.2%
Boxes	448	1.0%	45	1.2%	3.4%
Trays	88	0.2%	6	0.2%	0.1%
	46,490	100%	3,812	100%	100%

1. Aggregated litter data, Litter audits by MGM Management including:
City of Toronto, Canada (2002, 2003, 2004 (2 audits), 2005, 2006
Regional Municipality of Peel, Canada (2003)
Regional Municipality of York, Canada (2003)
Regional Municipality of Durham, Canada (2003)



Again in 2008, observations of the small litter classification during the San Francisco audit showed a relatively low occurrence of small litter on city streets, as compared to audits performed by the consultant in other cities. In the 2008 audit, 2,335 small litter items were observed (compared to 2,393 in 2007) at 132 sites audited. This averages 18 items per site (compared to 23 in 2007) which is comparable with 21 items / site for the City of Toronto, Ontario, Canada; where considerable clean-up activities and litter abatement efforts have been underway for several years. Averages twice as high as the small litter rate observe in San Francisco in 2007 have been recorded by the consultant in other litter audits.

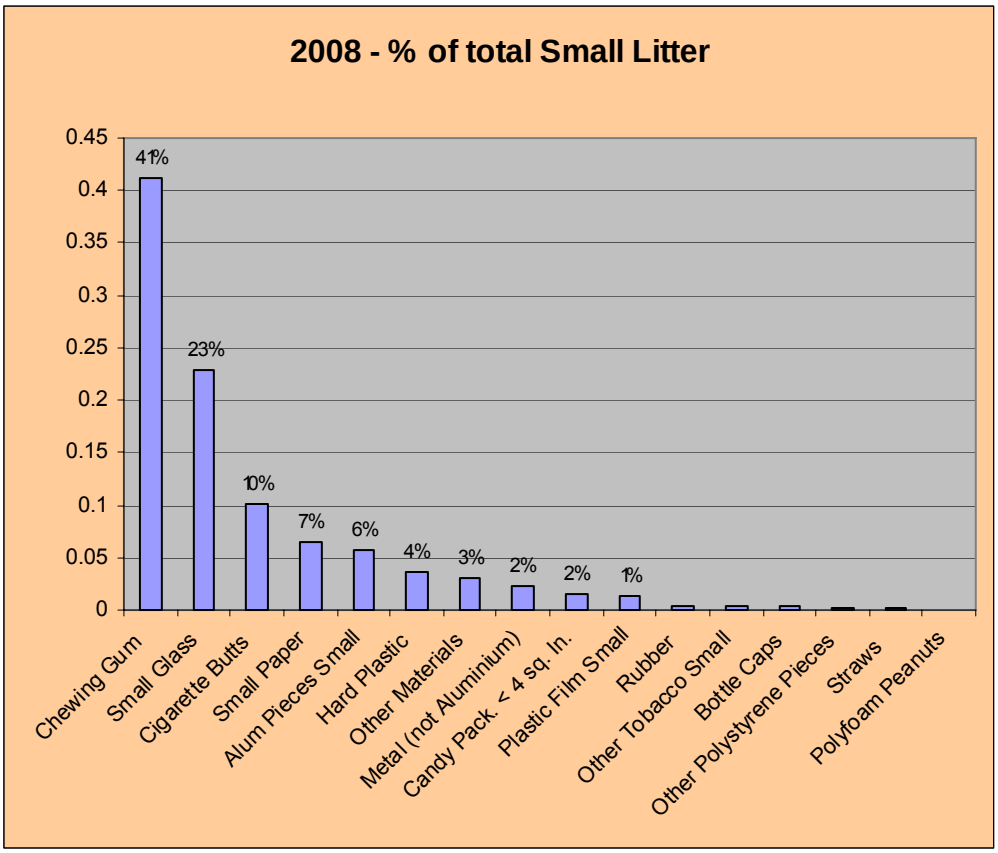
As identified in the 2007 litter audit, gum deposits on San Francisco streets continue to be a significant issue. Gum deposits on sidewalks and roadways cause a sticky and annoying problem for pedestrians. Gum deposits accounted for 39.5% of all the small litter observed during the 2007 audit, and in 2008 a similar observations was noted. In the 2008 litter audit gum deposits were 41% of the small litter observations made (960 gum deposits noted). Glass and paper small litter were also significant contributors to this class of litter.

Small litter is difficult to control, in that it is “manufactured” by a combination of degradation (weather) and man-made activities (vehicle traffic, mowing, etc.).

The small litter results for the 2008 San Francisco audit sites are illustrated below.

Due to the nature of randomly selecting sites and the methodology used for litter auditing of those locations, the consultant is of the opinion that this litter audit is representative of the overall litter occurrence in the City of San Francisco streets, as of April 2008.

2007 San Francisco - Small Litter – by Category



Small Litter Summary

Category	Description	SF 2008 Total Small Litter Items Observed	SF 2008 % of Total Small Litter	SF 2007 Total Small Litter Items Observed	SF 2007 % of Total Small Litter
16	Chewing Gum	960	**41.1%**	946	**39.5%**
8	Small Glass	535	**22.9%**	710	**29.7%**
9	Small Paper	153	6.6%	187	7.8%
1	Cigarette Butts	234	**10.0%**	135	5.6%
15	Other Materials	73	3.1%	97	**4.1%**
11	Hard Plastic	85	3.6%	92	**3.8%**
10	Plastic Film Small	33	1.4%	56	2.3%
2	Other Tobacco Small	9	0.4%	51	2.1%
14	Metal (not Aluminium)	52	2.2%	41	**1.7%**
13	Rubber	10	0.4%	26	**1.1%**
12	Alum Pieces Small	135	**5.8%**	19	0.8%
5	Candy Pack. < 4 sq. In.	36	1.5%	16	0.7%
6	Polyfoam Peanuts	2	0.1%	8	0.3%
7	Other Polystyrene Pieces	6	0.3%	5	0.2%
3	Bottle Caps	8	0.3%	4	0.2%
4	Straws	4	0.2%	0	0.0%
		2,335	100.0%	2,393	100.0%
	Average SF Small Litter Items / site	18		23	

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1.0 Introduction

1.1 Overview

Litter is a problem virtually everywhere where disposable / recyclable packaging is used. People have personal opinions about what litter is – the reality is much different. Whereas there is a general perception that select groups of products make up the majority of litter, field research shows that litter is made up of a broad range of products and materials.

Various researchers describe a clear picture of what litter is comprised of. For example, data show that beverage containers are usually less than 10% (by count) (Daniel Syrek of the Institute for Applied Research), Florida State University at Gainesville, Center for Marine Conservation, and Keep America Beautiful, Keep Florida Beautiful etc. – as well as Beverage Recovery in Canada research in Newfoundland and Ontario, Canada). Beverage container litter includes milk cartons and bottles, pop, beer, liquor, wine, coolers, sips, cups etc.

The purpose of this report is to outline the methodology and results of a litter audit conducted on behalf of the City of San Francisco during April 2008, and to compare these results with the litter audit conducted in San Francisco in April 2007.

This work was conducted by HDR / BVA Engineering Inc.; a San Francisco based full service engineering and environmental management firm. SAIC Engineering of Oakland, CA, assisted in the project management of the work, Chris Hammer of Sustainable Design Resources was the field supervisor for the audit work. MGM Management, a Division of 6528058 Canada Inc. was sub-retained by HDR / BVA Engineering Inc. to assist them in the design, site selection, data management and data analysis for this litter audit.

MGM Management has conducted a number of litter audits including this audit:

- Ontario – conducted under supervision of Dan Syrek, 1990
- Ontario – Toronto area 1994, done by McKenney with Syrek assistance
- City of Toronto, Streets Litter Audit 2002
- Regional Municipality of Peel, Streets Litter Audit 2003
- Regional Municipality of York, Streets Litter Audit 2003
- Regional Municipality of Durham, Streets Litter Audit 2003
- City of Toronto – Streets Litter Audit 2004
- City of Toronto – Parks Litter Audit 2004
- City of Toronto - Streets Litter Audit 2005
- City of Toronto - Streets Litter Audit 2006
- City of San Francisco (USA) - Streets Litter Audit 2007 (April 2007)
- City of Edmonton - Streets Litter Audit 2007 (May –June 2007)
- City of San Francisco (USA) - Streets Litter Audit 2008 (April 2008)

In the USA – over 30 litter count surveys have been done by Syrek, (and reviewed by MGM Management). More recently five excellent surveys have been completed across all of the 29 counties of Florida by the University of Florida. Criticism developed that the Syrek methodology was too complicated and difficult to replicate the results, thus a simpler method was sought. In 1993 the Florida Legislature directed the Florida Center for Solid and Hazardous Waste Management to conduct a state-wide litter count. The Center developed a method for surveying litter that was understandable, simple and statistically valid. MGM Management has been trained in the methods of both the Syrek and by staff of the University of Florida to extract the best of both methodologies and adapt them to our methods.

In the past some local environmental groups have done litter audits of their own design. These methodologies may not be scientific in their development and they often tended to not be reproducible. Measurement techniques need to be unbiased, scientifically rigorous, and reproducible to be defensible. Comparison to other jurisdictions has not usually been possible with local litter audit methods. The methodology used and the data developed from this audit can be reproduced should the City of San Francisco wish to do so, and the results can be compared to other jurisdictions that have used the same approach.

This survey uses a proven and recognized method of identifying litter survey sites and for counting litter.

2.0 City of San Francisco Litter Audit - Methodology

The City of San Francisco litter audit counted “accumulated litter”. This is as compared to “fresh litter” counts, where a site is cleaned, then researchers return after a set time to count the number of pieces of litter that have been deposited. Accumulated litter allows for an examination of the occurrence of litter as it is has developed over time. Fresh litter count surveys are much more labour intensive, and costly to conduct, than accumulated litter counts.

2.1 Site Selection Process

2.1.1 Random Site Selection

In selecting where to conduct a site audit it is important to have an unbiased method of selection. The current methodology does not allow discretion in the field in selecting sites to be audited. Sites are pre-selected using computer techniques. In this way, neither the “dirtiest” nor the “cleanest” locations are picked. The survey teams count litter at sites that are selected in advance of field crews traveling to the location.

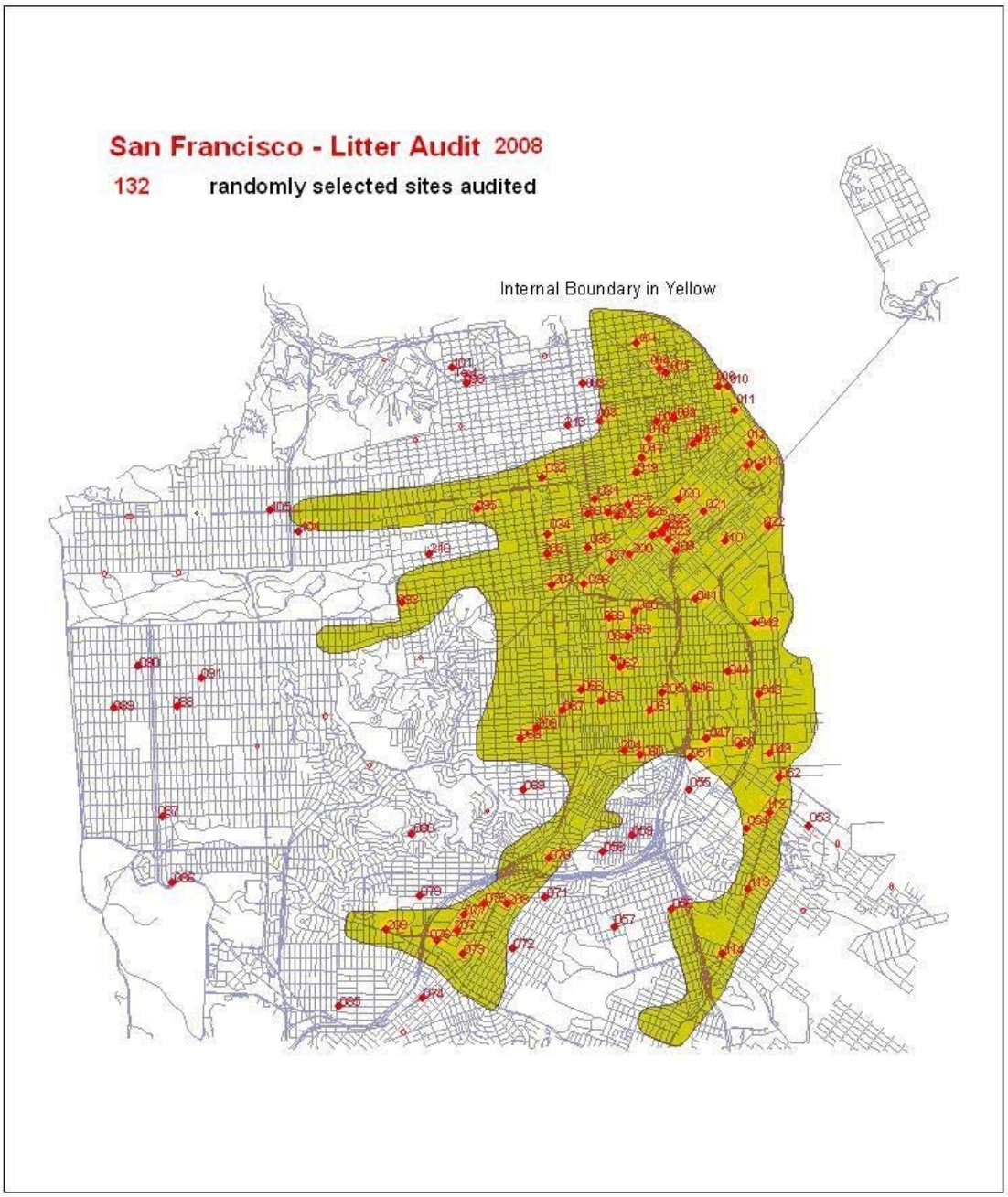
To select sites for the City of San Francisco Litter Audit, a geographical information system (GIS) database for the City of San Francisco was acquired (software used was ArcGIS 9.2 by Environmental Systems Research Institute Inc.). Working with San Francisco Environment, GIS data files were provided. Using ArcGIS 9.2, the consultant had access to 16,256 center-line coordinates for all potential public street locations within the service area of the City of San Francisco. With these data coordinates, the consultant used a computer sample generation program to randomly select potential litter audit sites. These data were then plotted on computer generated maps using ArcGIS 9.2, and detailed locations identified.

The consultant was requested to weight the site selection program to provide 75% of the locations within the internal boundary service areas of the City, while the remaining 25% of sites represented the rest of the City’s geographical area.

The final outcome was 175 randomly selected potential sites. Some of these sites were rejected because they were within ¼ mile of each other, or because they occurred on freeways, railway lines, or ponds. In 2007 a total of 105 randomly selected sites were audited by field surveyors, from the period April 9, 2007 to April 20, 2007. These same 105 sites were re-audited in 2008, plus an additional 27 randomly selected sites were added to the list of sites, to increase the sample size to 132 sites. The 2008 field audit work was completed between April 7 – April 18, 2008.

Figure 1 - 132 Random Sites Were Audited in 2008

Sites were chosen by computer using ArcGIS 9.2 software.



The potential sample sites were then plotted for the entire City of San Francisco on a GIS generated map. Detailed street maps are then used to more accurately locate the sites, using two local map sources, San Francisco; ISBN 1-55368-168-1,MapArt www.mapart.com and also San Francisco & San Mateo Counties; Street Guide, The Thomas Guide, ISBN 01-528-85961-7.

Sites were rejected if they were located:

- on major highways / freeways
- location was on a bridge
- location clearly within a construction area
- on railway / subway rights-of-way
- on hydroelectric power line rights-of-way
- on / within water (ponds, rivers, streams/ lakes)
- access was difficult or impossible
- if located on industrial or private lands

Detailed directions were written by the consultant to direct audit teams to each of the selected sites. Directions were written in a manner that would allow any field team to find each site easily. Field teams were asked to travel to the sites using these directions so that no bias towards whether the site was dirty or clean would be introduced.

For each site further details of the audit site were added to the archival file by the audit team while at location, to allow future audit teams to find the same sites should the City wish to re-audit them in the future.

2.2 Detailed Site Files

The consultant created an individual hard copy site file for each location. These files contain the following:

- discrete site location ID number
- travel directions sheet
- photographic label card (for taking photos on-site)
- Large Litter Site Surveyor Form - (for recording large litter observed)
- Small Litter Item Count form (for recording small litter)

2.3 Conducting a Site Audit

Teams were paired in groups of two. Site auditors were hired by HDR / BVA Engineering Inc. Each team worked independently, reporting their activities to the SAIC Engineering, Project Manager and to the Sustainable Design Resources, field work supervisor. The City was divided into two work sectors, with teams assigned site files accordingly.

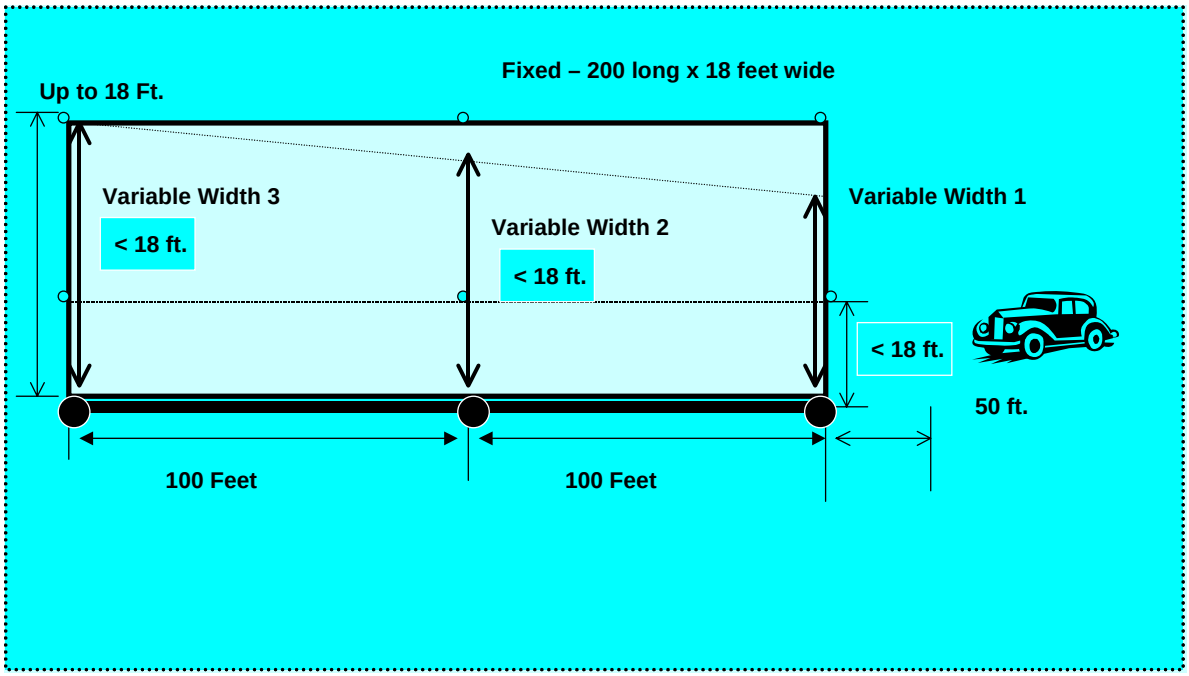
Upon being assigned site files each audit team traveled to their sites. It is of note that the team that audited the downtown areas volunteered to use bicycles as their transportation method. This proved to be a very effective means of doing sites in a congested metropolitan area. By using bicycles, time was saved, and parking costs avoided.

Teams approached their assigned sites from the directions requested and located the site. Upon arriving at a site, the teams safely parked their vehicles. Traffic cones were place on the roadway for traffic control, and team members dressed in fluorescent orange/ yellow traffic vests to increase their visibility. The teams reported their activities throughout the sampling day to the Project Manager by cellular telephone.

Beginning at the front of the parked car (or the start of the site), the team used a measuring device to measure 50 feet ahead of the start of the site. Using street marking paint, a mark was drawn on the pavement ahead to denote the staring point of the audit site. From this point the team measured an additional 100 feet, marking the roadway with another identifier to show the mid-point of the site. A final measurement of an additional 100 feet denoted the end of the audit site. Each site was 200 feet in length.

The width of the site was measured from 1.5 feet inside the curb (from the center of the roadway) towards the outer edge of the site, up to a maximum width of 18 feet. The rule was set to include 1.5 feet into the street since the curb is a normal catchments structure, for which the municipality is responsible for litter clean up. Sites with a width of 18 feet and 200 feet long were designated as a "fixed" site. In many instances a site was less than 18 feet wide. This occurred in commercial areas where storefronts provide less than 18 feet from the roadways (plus 1.5 feet into the road). Sites less than 18 feet in width are designated as "variable" sites.

Figure 2 - Schematic of Litter Audit Site



2.4 Classification of Large Litter

For purposes of classifying litter, and in accordance with the methods used in previous litter surveys conducted by us, large litter was defined to be that which is greater than 4 square inches in size.

2.5 Classification of Small Litter

Small litter were those pieces of debris that were less than 4 square inches in size, within a defined area with an audit site. The small litter audit methodology examines three transacts, or slices, of the site. A frame made of 1/2 inch P.V.C. plastic tubing was constructed to act as a frame. This frame was 1 foot wide and 6 feet long. A surveyor would look for and count small litter in three samples, one at the start of the site, one at the mid-point and one at the end of the site. At each transact section; three flips of the frame are done, thus surveying 18 square feet of the site – repeated three times.

Figure 3 – Small Litter Templates

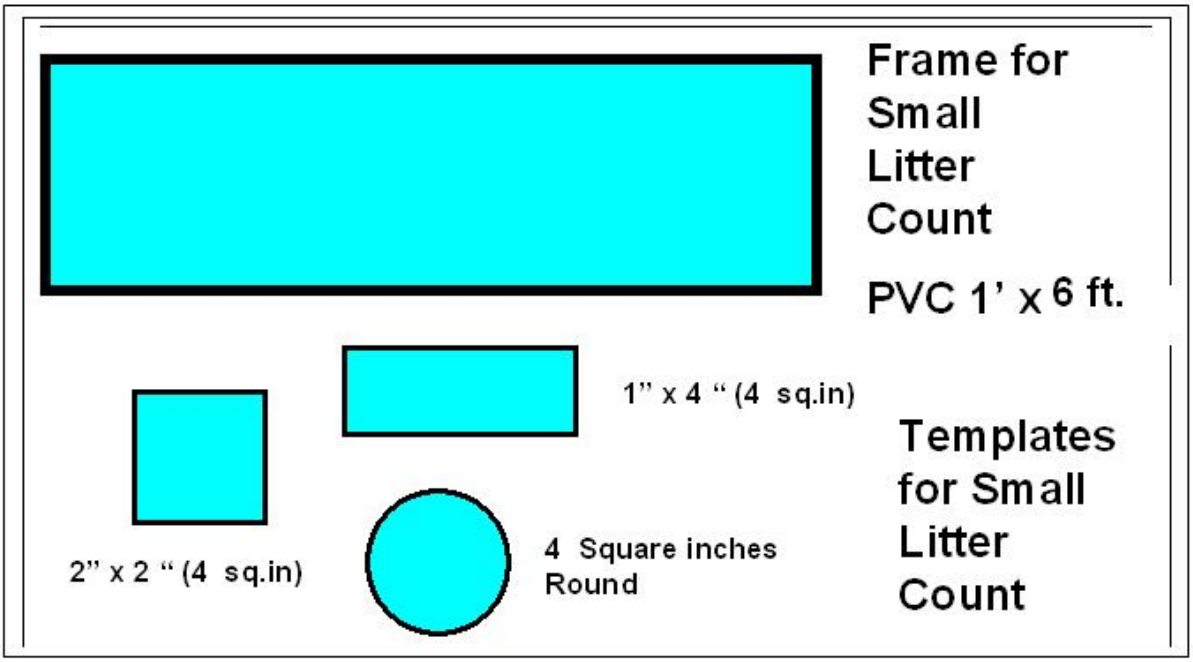


Figure 4 – Site Set-up – Small Litter

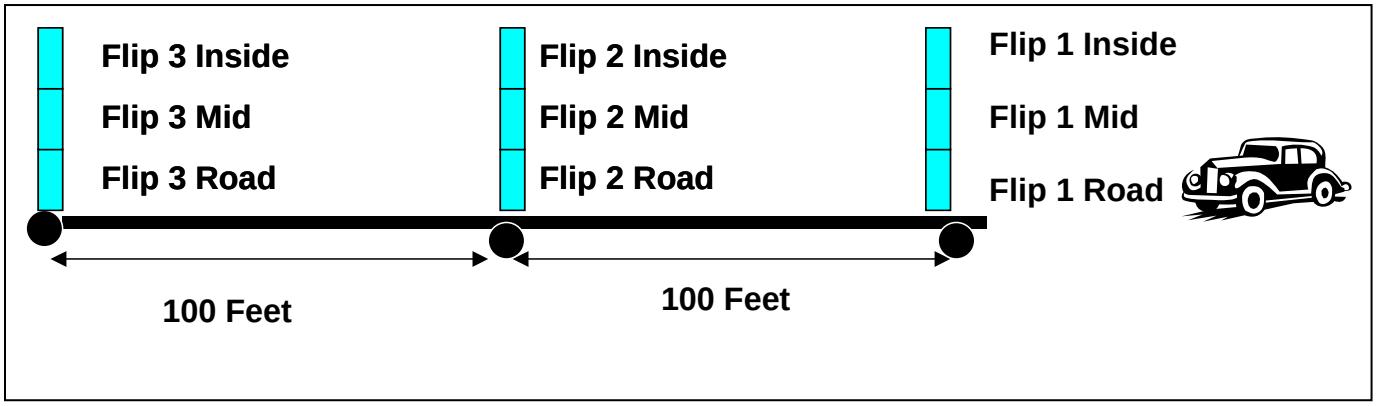


Table 1 - Categories of Small Litter

The categories in the litter counts less than 4 square inches that were examined are:

- cigarette butts/ debris
- other tobacco
- bottle caps
- straws
- candy packaging & wrappers
- polyfoam packing materials
- other polystyrene debris
- glass
- paper
- plastic film
- hard plastic
- aluminium / foil debris
- rubber
- metal (not aluminium)
- other materials
- gum deposits on roadways & sidewalks

Table 2 - Categories of Large Litter

Eighty-four sub-categories of large litter were counted, including:

Major Category	Sub-Category Number	Large Litter	Sub-Category Name	Material
1	1	Beer Cans	Beverage	metal
	2	Beer Bottles (glass)	Beverage	glass
	3	Soft Drink (glass)	Beverage	glass
	4	Soft Drink (cans)	Beverage	metal
	5	Soft Drink (plastic)	Beverage	plastic
	6	Sport Drink (glass)	Beverage	glass
	7	Sport Drink (plastic)	Beverage	plastic
	8	Water (glass)	Beverage	glass
	9	Water (plastic)	Beverage	plastic
	10	Wine/ Liquor (glass)	Beverage	glass
	11	Wine/ Liquor (plastic/other)	Beverage	plastic
	12	Milk/Juice (Plastic)	Beverage	plastic
	13	Milk/Juice (glass)	Beverage	glass
	14	Milk/Juice (Gable Top)	Beverage	paper
2	15	Foil Pouches	Other Packaging	composite
	16	Aseptic (Box)	Other Packaging	composite
	17	Broken Glass Container	Other Packaging	glass
	18	Six pack plastic rings	Other Packaging	plastic
	75	Foil containers	Other Packaging	metal
3	19	Plastic drink cups	Cups	plastic
	20	Paper Cups (cold)	Cups	paper
	21	Paper Cups (Hot)	Cups	paper
	22	Polystyrene cups (foam)	Cups	plastic
	23	Other paper cups	Cups	paper
	24	Cup Lids, Pieces lids	Cups	plastic
4	25	Plastic retail bags	Bags	plastic
	26	Paper retail bags	Bags	paper
	27	Paper bags - fast food	Bags	paper
	28	Plastic bags - not retail	Bags	plastic
	29	Paper bags - not retail	Bags	paper
	30	Zipper bags/ sandwich	Bags	plastic
5	31	Cardboard boxes/ box mat'l	Other Packaging	paper
	32	Paperboard (cereal type)	Other Packaging	paper
	33	Paper Beverage Cases	Other Packaging	paper
	34	Polystyrene clamshells	Other Packaging	plastic
	35	Paper clamshells	Other Packaging	paper
	36	Other Plastic Shells/Boxes	Other Packaging	plastic
6	37	Plastic Jars / Bottles/ Lids	OTHER CNTRS.	plastic
	38	Glass jars/ bottles misc.	OTHER CNTRS.	glass
	39	Cans - steel	OTHER CNTRS.	metal
	40	Cans - aluminum	OTHER CNTRS.	metal
	41	Container lids	OTHER CNTRS.	
	42	Aerosol cans (paint, oils, etc.)	OTHER CNTRS.	metal
7	43	Paper Food Wrap	Food Wraps/ Cntrs	paper
	44	Paper / foil composite wrap	Food Wraps/ Cntrs	composite
	45	Plastic wrap	Food Wraps/ Cntrs	plastic
	54	Condiment package (salt, ketchup, vinegar etc.)	Take-Out Extras	
	55	Utensils	Take-Out Extras	plastic

	56	Name Brand (Fast Food etc.) Towels / Napkins / Serviettes	Take-Out Extras	paper
	57	Paper Fast Food Plates	Take-Out Extras	paper
	58	Poly Fast Food Plates	Take-Out Extras	plastic
	59	Other Plastic FF Plates	Take-Out Extras	plastic
	60	Plates - Other Mat's	Take-Out Extras	
8	46	Polystyrene Trays	Trays	plastic
	47	Paper Trays	Trays	paper
	48	Other Mat'l Trays (what?)	Trays	
9	49	Gum wrappers	Confectionary/Snack	
	50	Candy bar wraps	Confectionary/Snack	
	51	Candy pouches	Confectionary/Snack	
	52	Sweet packaging (describe)	Confectionary/Snack	
	53	Other confectionery (describe)	Confectionary/Snack	
	63	Snack food packaging	Confectionary/Snack	
10	61	Clothing or clothing pieces	Cloth	
	62	Other cloth	Cloth	
11	64	Plastic packaging other	Other Miscellaneous	plastic
	65	Paper packaging other	Paper/ Fibre Mat'l	paper
	66	Plastic / composite other	Other Miscellaneous	
	67	Foil materials / foil pieces	Other Miscellaneous	metal
12	68	No Brand Name Towels / Napkins / Serviettes	Paper/ Fibre Mat'l	paper
	69	Lottery ticket debris	Paper/ Fibre Mat'l	paper
	70	Printed material (newspapers, flyers, books etc.)	Paper/ Fibre Mat'l	paper
	71	Stationary (school, business etc.)	Paper/ Fibre Mat'l	paper
	72	Receipts (business forms, bus transfers, etc.)	Paper/ Fibre Mat'l	paper
13	73	Cigarette / cigar debris (>4")	Tobacco	
	74	Tobacco other (packs, matches, cellophane)	Tobacco	
14	76	Misc. Paper	Other Miscellaneous	paper
	77	Misc. Plastic	Other Miscellaneous	plastic
	78	Misc. Paperboard	Other Miscellaneous	paper
	79	Misc. Cardboard	Other Miscellaneous	paper
	80	Misc. Glass	Other Miscellaneous	glass
	81	Vehicle & Metal Road Debris	Other Miscellaneous	
	82	Construction debris	Other Miscellaneous	
	83	Tire & Rubber debris	Other Miscellaneous	rubber
	84	Home Articles	Other Miscellaneous	

Table 3 - Detailed Descriptions of Large Item Categories

1	Beer Cans		All brands of consumer beer can containers
2	Beer Bottles (glass)		Refillable and non-refillable beer bottles, all sizes
3	Soft Drink (glass)		Soft drinks, carbonated, non-carbonated, flavoured drinks in glass containers
4	Soft Drink (cans)		Soft drinks, carbonated, non-carbonated, flavoured drinks in metal can containers
5	Soft Drink (plastic)		Soft drinks, carbonated, non-carbonated, flavoured drinks in plastic containers, all sizes
6	Sport Drink (glass)		Sport drinks, carbonated or non-carbonated, flavoured drinks in glass containers, all sizes
7	Sport Drink (plastic)		Sport drinks, carbonated or non-carbonated, flavoured drinks in plastic containers, all sizes
8	Water (glass)		Packaged water, carbonated or non-carbonated, flavoured drinks in glass containers, all sizes
9	Water (plastic)		Packaged water, carbonated or non-carbonated, flavoured drinks in plastic containers, all sizes
10	Wine/ Liquor (glass)		Wine & liquor in glass, all sizes
11	Wine/ Liquor (plastic/other)		Wine & liquor in plastic or any other formats, all sizes
12	Milk/Juice (Plastic)		Milk or juice containers, packages in plastic
13	Milk/Juice (glass)		Milk or juice containers, packages in glass
14	Milk/Juice (Gable Top)		Milk or juice containers, packages in gable top paper cartons, all sizes
15	Foil Pouches		All packaged goods in foil packaging, pieces of foil materials
16	Aseptic (Box)		Drink-in-box, juice, fluids, other
17	Broken Glass Container		Glass fragments
18	Six pack plastic rings		Retainer plastic for carrying cans
19	Plastic drink cups		Cups, all sizes, all resin types
20	Paper Cups (cold)		Cups, all sizes, all paper types - cold drinks
21	Paper Cups (Hot)		Cups, all sizes, all paper types - hot drinks
22	Polystyrene cups (foam)		Cups, all sizes, all polystyrene types - hot drinks
23	Other paper cups		Cups, other materials
24	Cup Lids, Pieces lids		Fragments and pieces of cups
25	Plastic retail bags		Whole and pieces of retail plastic bags
26	Paper retail bags		Whole and pieces of retail paper bags

27	Paper bags – fast food		Whole and pieces of fast food outlet paper bags
28	Plastic bags – not retail		Whole and pieces of plastic bags, not retail i.e. dry cleaning
29	Paper bags - not retail		Paper bags & sacs, example leaf bag debris
30	Zipper bags/ sandwich		plastic lunch bags and sacs
31	Cardboard boxes/ box mat'l		All cardboard and box materials
32	Paperboard (cereal type)		Cereal, shoe boxes and pieces etc.
33	Paper Beverage Cases		Paper material outer packaging for beverage products
34	Polystyrene clamshells		Whole and pieces of take-away or other Styrofoam containers
35	Paper clamshells		Whole and pieces of take-away or other paper containers
36	Other Plastic Shells/Boxes		PET, PVC, HDPE , other material shells
37	Plastic Jars / Bottles/ Lids		All jars, bottles etc, plastic, non beverage, example dish detergent bottle
38	Glass jars/ bottles misc.		All jars, bottles not described above, in glass
39	Cans – steel		Food, non-food and other product steel can containers
40	Cans - aluminum		Food, non-food and other product aluminum can containers
41	Container lids		All lids, closures, and pieces > 4 sq. in.
42	Aerosol cans (paint, oils, etc.)		Aerosol cans, tops, lids - all products
43	Paper Food Wrap		Wrap for food, commercial & non-commercial; example meat wrap,
44	Paper / foil composite wrap		Wrap for food or non-food items, commercial & non-commercial; example hamburger paper/ foil composite wrap,
45	Plastic wrap		All plastic wrap types, food, non-food
46	Polystyrene Trays		Trays for take-out, non-take out, microwavable, display etc
47	Paper Trays		Trays for take-out, non-take out, microwavable, display etc
48	Other Mat'l Trays (what?)		Trays for take-out, non-take out, microwavable, display etc
49	Gum wrappers		Packaging used to seal, sell gum products
50	Candy bar wraps		Packaging used to seal, sell candy products
51	Candy pouches		Packaging used to seal, sell candy products - pouch format
52	Sweet packaging (describe)		Packaging used to seal, sell confections (cakes, pies, sweet snack products

53	Other confectionery (describe)		All other packaging for confectionaries
54	Condiment package (salt, ketchup, vinegar etc.)		Pouches, containers, creamers etc
55	Utensils		Forks, knives, chop sticks etc
56	Name Brand (Fast Food etc.) Towels / Napkins / Serviettes		Towels & napkins etc with brand identification identifiable
57	Paper Fast Food Plates		Paper Plates, used to serve fast food
58	Poly Fast Food Plates		Polystyrene Plates, used to serve fast food
59	Other Plastic FF Plates		Other Material Plates, used to serve fast food
60	Plates - Other Materials		Plates for other than fast food applications, i.e. picnic plates used by families
61	Clothing or clothing pieces		All cloth, clothing pieces, and clothing discarded on the site
62	Other cloth		Tarps, industrial fabrics etc
63	Snack food packaging		All snack food (i.e.. Salty snacks, chips)
64	Plastic packaging other		Plastic packaging otherwise not described
65	Paper packaging other		Paper packaging otherwise not described
66	Plastic / composite other		All paper and composite debris not previously described
67	Foil materials / foil pieces		Foils and pieces, aluminum food foils, industrial foils
68	No Brand Name Towels / Napkins / Serviettes		Napkins and towels - no brand identification
69	Lottery ticket debris		Tickets, and gaming items
70	Printed material (newspapers, flyers, books etc.)		All printed material, commercially printed
71	Stationary (school, bus. etc.)		Includes school papers, written items, other printed materials such as business forms
72	Receipts (business forms, bus transfers etc.)		Receipts, business items, invoices, packing slips, bus transfers, commercial tickets (concerts, cinema)

73	Cigarette / cigar debris (>4")		Tobacco items
74	Tobacco other (packs, matches, cellophane)		Packages, wrappers, tobacco foil products, lighters, matchboxes
75	Foil containers		Foil containers (ice cream wraps)
76	Misc. Paper		All other non-described paper material, whole or shredded, unidentifiable as another category
77	Misc. Plastic		All other non-described plastic material, whole or shredded, unidentifiable as another category
78	Misc. Paperboard		All other non-described paperboard material, whole or shredded, unidentifiable as another category
79	Misc. Cardboard		All other non-described cardboard material, whole or shredded, unidentifiable as another category
80	Misc. Glass		All other non-described glass material, whole or broken, unidentifiable as another category
81	Vehicle & Metal Road Debris		Debris associated with transportation, private or commercial
82	Construction debris		Debris associated with construction, private or commercial
83	Tire & Rubber debris		Rubber materials, tire pieces, shock absorbers, sheet rubber or pieces
84	Home Articles		All non-described household items, (i.e.. Lamps, electrical, lawn chairs, etc)

2.6 Survey Counts

After setting up each site, one auditor commenced the large litter survey count, and recorded brands of items observed at the site. The other auditor commenced the small litter survey, using the methodology described above.

Before starting the large litter survey, the field technician first checked his/her tape recorder to ensure it was working properly.

The auditor then dictated the description sections of the Surveyor Site Form (Appendix 1) into the recorder. This information describes the site number, date, digital photos taken, camera used, start time, type of site (residential, industrial, commercial, downtown core), type of roadway, whether road is divided, grass height, evidence of a clean-up, stop sign/ traffic light visible, fast food near-by, convenience store nearby, described the litter catch points (grass mow line, hedge, fence, other), and provided a visual litter rating on a subjective basis. All photographs are part of the archival record for this survey – and are part of the electronic database supplied to the City

The visual litter rating is an "opinion" expressed by the surveyor as to whether the site is dirty (highest rating = 4) or clean (lowest rating = 1).

Once this information is recorded the auditor proceeds to walk the first pass through the site slowly, taping his/ her observations into the tape-recorder as they observe the site. Proceeding back and forth across the site until the surveyor has walked the site up to the mid-point. The surveyor noted that they had reached the mid-point, then continuing on observing litter up to the end of the site boundary, making verbal notations of the litter observed and describing them into the 84 sub-categories of litter. This completed "Pass One". The surveyor then repeated the observations (Pass Two) over the site, using the same procedure, but in the opposite direction. Results of the two passes are used in data analysis.

2.7 Documentation & File Management

At each site the teams were required to make a tape-recorded record of their observations of large litter. At the end of doing the verbal entries into the recorder, a team member then transcribed the verbal observations onto a Large Litter Site Form (Appendix 1). In this way the verbal record was transferred to a written record for the site.

These forms were later transcribed into a database for analysis. Each site's observation forms were transcribed at the site before leaving the location. If a recording problem occurred, the site was redone.

Each form was returned in its file folder to the Project Manager for archival purposes.

2.8 Photographic Record of the Site

At each site location, the litter audit team took digital photographs. One shot was taken at the start of the site, looking towards the end of the site – away from the vehicle. The second shot was taken in the mid-point of the site – looking across the width of the site toward the boundary. And the final photograph was taken at the end of the site – looking back towards the start of the site (towards the vehicle). The purpose of the photographs is to set the scene of the site – not to detail litter on the ground.

In each case the number of photographs at each site was recorded on the Surveyor Site Form. The site-specific digital photographs were downloaded to the database of the survey, as an archival record of the site during the audit period.

Figure 5 - Site Photographs (example photographs)

2.9 Branded Litter Observations

Using the Large Litter Site Form (with 84 sub-categories of large litter) as a guide, data was also gathered for observing Branded Litter. Branded litter is large litter (i.e. over 4 square inches) that has a recognizable brand name affixed. Team auditors verbally identified litter by brand name, which was later transcribed onto the Large Litter Site Form, for data entry and analysis. Where any doubt occurred in the identification of a brand of litter, no entry was made.

2.10 Survey Schedule and Progress

The field audit teams were assembled for training on April 7, 2008. Following an orientation and safety training session field observations began immediately. Fieldwork was conducted between April 7, 2008 – April 18, 2008.

Each two-person audit team were able to complete between 7 – 10 sites per day allowing for breaks, lunch and travel time.

3.0 Large Litter Survey Results

Field observations were dictated into tape recorders, then later transcribed onto Large Litter Site Form (Appendix 1) and Small Item Count Sheets.

Forms were then inputted into a Microsoft Access database for analysis.

3.1 Discussion of Large Litter Results

Litter counted for the City of San Francisco Litter audit, were grouped into 14 broad categories.

- Other (incl. misc. paper)
- Other Packaging (salty snacks etc)
- Cups (hot, cold drinks)
- Tobacco products
- Bags (paper, plastic)
- Food wraps
- Plates

Paper (printed mat's, news)
Confectionary (candy)
Beverage containers
Other Containers (not beverage)
Take out extras (condiments etc)
Cloth / Clothing
Trays

In total, 3,973 pieces of large litter were counted. This is an average of 30 items per site based upon the 132 sites audited. This compares to 3,812 large litter items , averaging 36 items of large litter per site in the 2007 audit, which is 17% lower than the 2007 observations.

The largest category of large litter observed, at 664 litter pieces was non-branded paper napkins and paper towels. This is a similar result from the 2007 audit, where napkins were the second most significant category (570 pieces of large litter in 2007). Printed paper materials were the second most significant litter category at 380 items, followed closely by miscellaneous paper, last year's most significant large litter category was the third most significant category in the 2008 re-audit results at 318 items. .

Again in 2008, all fiber based products and items that were observed contributed 51% of the total large litter observed, as compared to 54% in the 2007 audit. Fiber based litter included paper, paperboard, cardboard, towels, napkins, newspapers, books, flyers, printed materials, and business forms, stationary.

Again in 2008, observations of the small litter classification during the San Francisco audit showed a relatively low occurrence of small litter on city streets, as compared to audits performed by the consultant in other cities. In the 2008 audit, 2,335 small litter items were observed (compared to 2,393 in 2007) at 132 sites audited. This averages 18 items per site (compared to 23 in 2007) which is comparable with 21 items / site for the City of Toronto, Ontario, Canada; where considerable clean-up activities and litter abatement efforts have been underway for several years. Averages twice as high as the small litter rate observe in San Francisco in 2007 have been recorded by the consultant in other litter audits.

As identified in the 2007 litter audit, gum deposits on San Francisco streets continue to be a significant issue. Gum deposits on sidewalks and roadways cause a sticky and annoying problem for pedestrians. Gum deposits accounted for 39.5% of all the small litter observed during the 2007 audit, and in 2008 a similar observations was noted. In the 2008 litter audit gum deposits were 41% of the small litter observations made (960 gum deposits noted). Glass and paper small litter were also significant contributors to this class of litter.

Figure 6 – Most Significant Sub-Categories of Litter – 2008

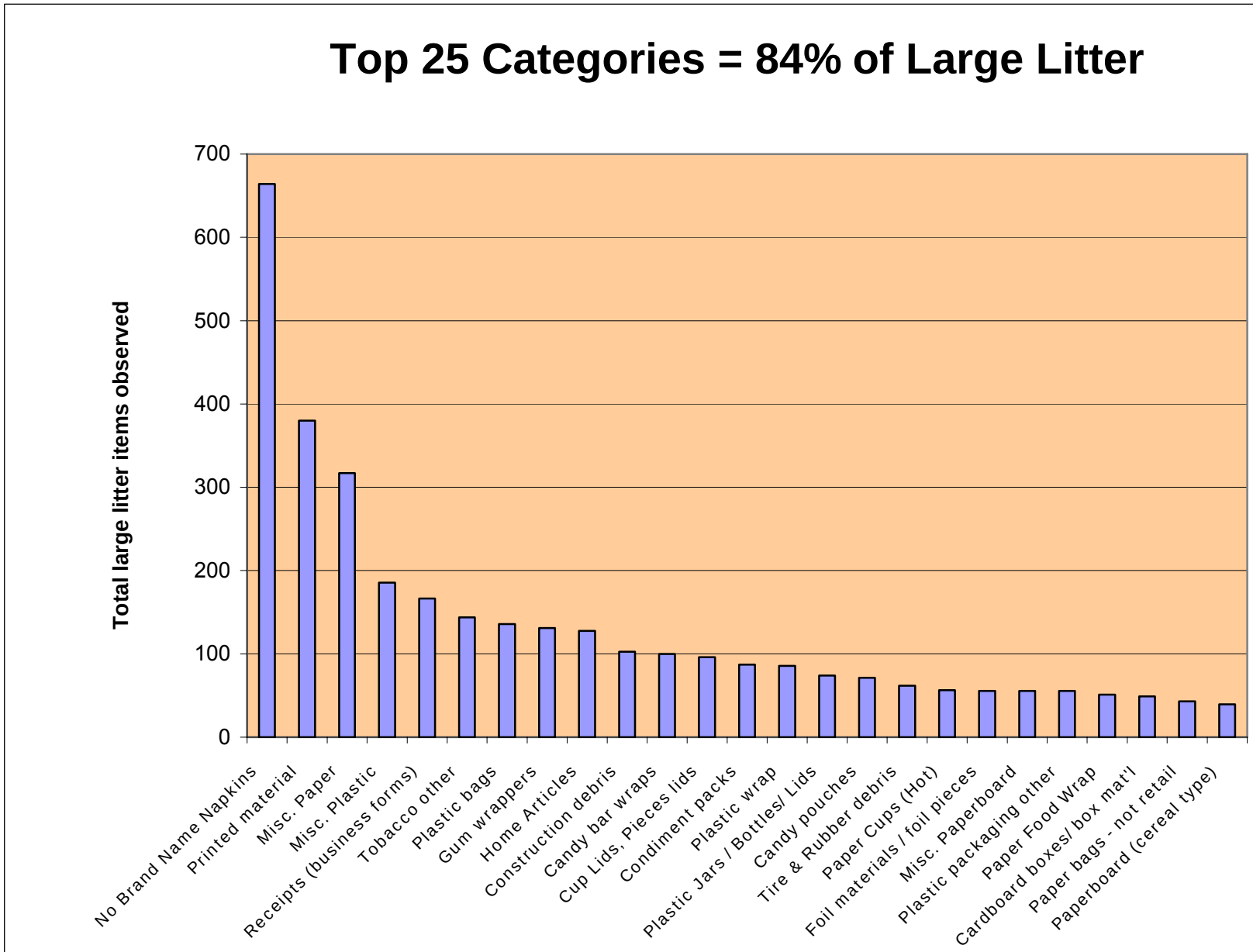


Table 4 - Top Litter Sub-Categories Equal 84% of Litter

Top 25 categories - 84% of Litter	2008	2007
No Brand Name Napkins	664	495
Printed material	380	287
Misc. Paper	317	570
Misc. Plastic	186	342
Receipts (business forms)	167	203
Tobacco other	144	109
Plastic bags	136	72
Gum wrappers	131	32
Home Articles	128	145
Construction debris	103	
Candy bar wraps	100	152
Cup Lids, Pieces lids	96	101
Condiment packs	87	46
Plastic wrap	86	33
Plastic Jars / Bottles/ Lids	74	33
Candy pouches	72	90
Tire & Rubber debris	62	43
Paper Cups (Hot)	57	36
Foil materials / foil pieces	56	105
Misc. Paperboard	56	59
Plastic packaging other	56	
Paper Food Wrap	51	
Cardboard boxes/ box mat'l	49	51
Paper bags - not retail	43	43
Paperboard (cereal type)	40	
Misc. glass		65
Utensils		49
Ploystyrene cups		43
Other cloth		34
	3,336	**3,236**
	% of total Large Litter	% of total Large Litter

Note: Top 10 sub-categories equal 57% pf total large litter.

Table 5 - Summary of All Large Litter Observed (2008)

Large Litter - San Francisco 2008 - All Categories

Large Litter Category	Total Items (averaged)	% of Total large litter
No Brand Name Towels / Napkins / Serviette	664	16.7%
Printed material (newspapers, flyers, books	380	9.6%
Misc. Paper	317	8.0%
Misc. Plastic	185.5	4.7%
Receipts (business forms, bus transfers, etc.	166.5	4.2%
Tobacco other (packs, matches, cellophane)	144	3.6%
Plastic bags - not retail	136	3.4%
Gum wrappers	131	3.3%
Home Articles	127.5	3.2%
Construction debris	102.5	2.6%
Candy bar wraps	100	2.5%
Cup Lids, Pieces lids	96	2.4%
Condiment package (salt, ketchup, vinegar e	87	2.2%
Plastic wrap	85.5	2.2%
Plastic Jars / Bottles/ Lids	74	1.9%
Candy pouches	71.5	1.8%
Tire & Rubber debris	62	1.6%
Paper Cups (Hot)	56.5	1.4%
Foil materials / foil pieces	55.5	1.4%
Misc. Paperboard	55.5	1.4%
Plastic packaging other	55.5	1.4%
Paper Food Wrap	51	1.3%
Cardboard boxes/ box mat'l	49	1.2%
Paper bags - not retail	43	1.1%
Paperboard (cereal type)	39.5	0.99%
Paper Cups (cold)	37	0.93%
Utensils	37	0.93%
Misc. Cardboard	35	0.88%
Vehicle & Metal Road Debris	33	0.83%
Plastic drink cups	31	0.78%
Polystyrene cups (foam)	31	0.78%
Snack food packaging	30	0.76%
Clothing or clothing pieces	26.5	0.67%
Plastic retail bags	25.5	0.64%
Stationary (school, business etc.)	25.5	0.64%
Misc. Glass	18.5	0.47%
Foil containers	17	0.43%
Soft Drink (cans)	17	0.43%
Other Plastic Shells/Boxes	16	0.40%
Sweet packaging (describe)	16	0.40%

Continued…..

Large Litter - San Francisco 2008
- All Categories

...continued

Large Litter Category	Total Items (averaged)	% of Total large litter
Name Brand Towels / Napkins	14.5	0.37%
Paper retail bags	14	0.35%
Milk/Juice (Gable Top)	13.5	0.34%
Paper clamshells	12	0.30%
Wine/ Liquor (plastic/other)	12	0.30%
Water (plastic)	11	0.28%
Zipper bags/ sandwich	10.5	0.26%
Broken Glass Container	10	0.25%
Paper packaging other	10	0.25%
Other cloth	9	0.23%
Plastic / composite other	9	0.23%
Foil Pouches	8.5	0.21%
Paper Beverage Cases	8.5	0.21%
Polystyrene clamshells	7.5	0.19%
Other confectionery (describe)	7	0.18%
Wine/ Liquor (glass)	7	0.18%
Container lids	6.5	0.16%
Lottery ticket debris	6	0.15%
Paper bags - fast food	6	0.15%
Soft Drink (plastic)	6	0.15%
Milk/Juice (Plastic)	5.5	0.14%
Paper / foil composite wrap	4.5	0.11%
Sport Drink (plastic)	4.5	0.11%
Beer Cans	4	0.10%
Other Plastic FF Plates	4	0.10%
Paper Fast Food Plates	4	0.10%
Poly Fast Food Plates	4	0.10%
Glass jars/ bottles misc.	3.5	0.09%
Milk/Juice (glass)	3	0.08%
Beer Bottles (glass)	2.5	0.06%
Other paper cups	2.5	0.06%
Polystyrene Trays	2.5	0.06%
Cans - steel	2	0.05%
Six pack plastic rings	2	0.05%
Aseptic (Box)	1	0.03%
Cigarette / cigar debris (>4")	1	0.03%
Paper Trays	1	0.03%
Soft Drink (glass)	1	0.03%
	3,973	100%
Totl sites audited	132	
Average items per site	30	

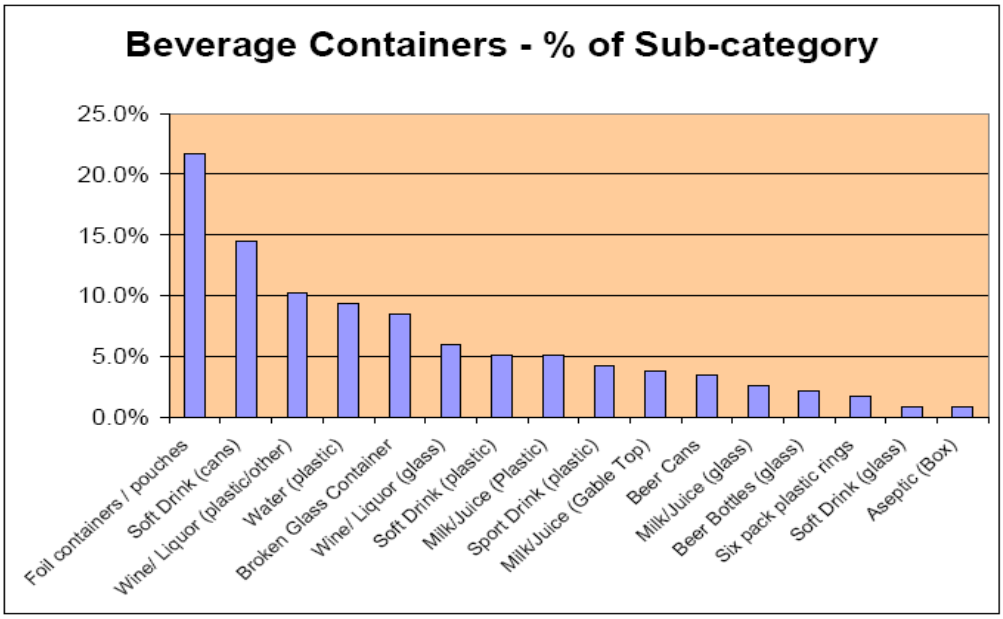
Continued…

3.2 Detailed Analysis by Major Category

3.2.1 Beverage Containers
(Soft drink, beer, wine/liquor, sports, water)

Beverage Containers
(soft drink, beer, wine/liquor, sports, other)

			2008	2007
	Items	% of Sub-category	% of Total Large Litter	% of Total Large Litter
Foil containers / pouches	25.5	21.7%	0.64%	0.46%
Soft Drink (cans)	17	14.5%	0.43%	0.33%
Wine/ Liquor (plastic/other)	12	10.2%	0.30%	0.34%
Water (plastic)	11	9.4%	0.28%	0.25%
Broken Glass Container	10	8.5%	0.25%	0.05%
Wine/ Liquor (glass)	7	6.0%	0.18%	0.09%
Soft Drink (plastic)	6	5.1%	0.15%	0.10%
Milk/Juice (Plastic)	6	5.1%	0.15%	0.18%
Sport Drink (plastic)	5	4.3%	0.13%	0.08%
Milk/Juice (Gable Top)	4.5	3.8%	0.11%	0.10%
Beer Cans	4	3.4%	0.10%	0.16%
Milk/Juice (glass)	3	2.6%	0.08%	0.04%
Beer Bottles (glass)	2.5	2.1%	0.06%	0.77%
Six pack plastic rings	2	1.7%	0.05%	0.00%
Soft Drink (glass)	1	0.9%	0.03%	0.17%
Aseptic (Box)	1	0.9%	0.03%	0.14%
Sport Drink (glass)	0	0.0%	0.00%	0.28%
	117.5	100.0%	2.96%	3.54%



Discussion:

The total beverage category yielded a count of 118, or 3.0 % of the total litter counted. This result is very similar to observations of 3.5% of total litter in 2007. This level of beverage container litter is lower that than the 7.3 % of total litter for beverage containers observed in audits conducted by the consultant in all jurisdictions between 2002-2007 from other jurisdictions. This may partially be explained by the California Redemption Value, placed upon containers in California which provides an incentive for many of these containers to be salvaged for refunds. The data obtained where the contribution of containers was over 7% were in non-deposit – refund jurisdictions.

It is of interest to note that foil pouches and foil beverage containers were the largest subcategory observed as beverage litter. These pouches are extremely popular at the present time and are used by brands such as Capri Sun and Minute Maid. Soft drink containers in aggregate accounted for less than 1 % of total litter (0.73% for all types of soft drink and sport drink containers – compared to 0.96% in 2007). Beer containers accounted for a small amount of total litter, 0.16% compared to 0.92% of total litter in 2007; while wine / liquor containers were observed to be about the same as in 2007 at 0.48% compared to 0.43% of total litter the previous year.

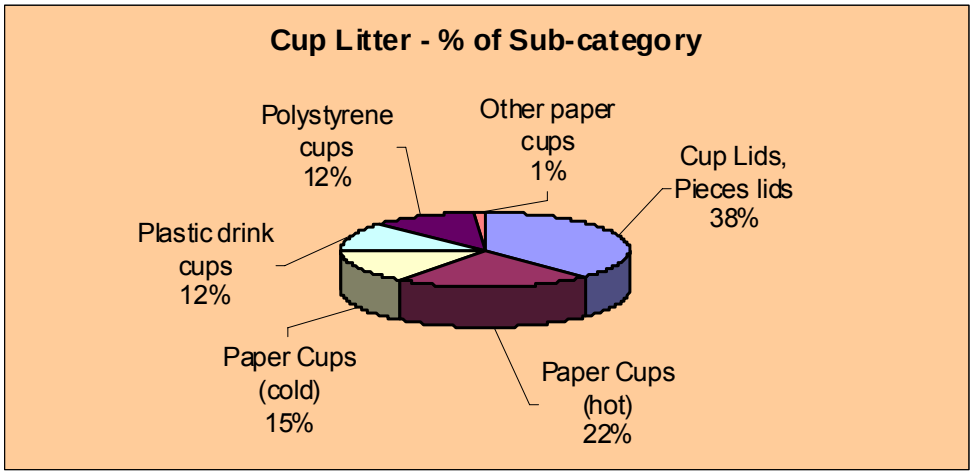
3.2.2 Cups

3.2.2 Cups, lids, pieces of cup debris[1.]

	Items	% of Sub-category	2008 % of Total Large Litter	2007
Cup Lids, Pieces lids	96	37.8%	2.42%	2.64%
Paper Cups (hot)	57	22.2%	1.42%	0.94%
Paper Cups (cold)	37	14.6%	0.93%	0.84%
Plastic drink cups	31	12.2%	0.78%	0.77%
Polystyrene cups	31	12.2%	0.78%	1.13%
Other paper cups	3	1.0%	0.06%	0.04%
	254	100.0%	6.39%	6.36%

Average (2002 - 2007 - 54,000 observations) 7.40%

1. Note: Item counts may not equal whole numbers due to averaging.



Discussion:

Cup litter includes hot and cold drink cups. This is indicative of wastes from a variety of over-the-counter food providers, whereby litter is then deposited on public lands. The category includes, polystyrene cups as well as lids and pieces of lids from hot and cold drink containers.

The sub-category yielded 6.4 % of the total litter in the 2008, San Francisco Litter audit, which is nearly identical to the cup litter observed in 2007, compared to a category average over the consultants 2002 – 2007 audits from other jurisdictions of 7.4% of total litter. San Francisco appears to have an average amount of cup litter. Cup lids and pieces and paper cups make up the majority of the litter in this category, reflecting those retailers that sell their products in this format.

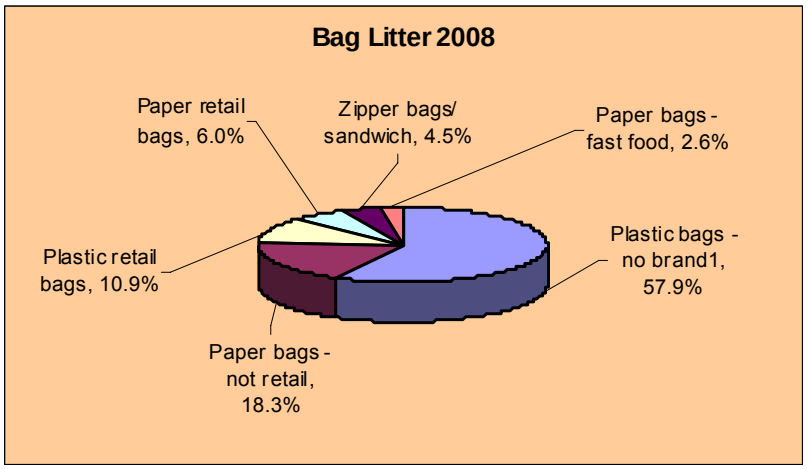
3.2.3 Bags

3.2.3 Bags

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Plastic bags - no brand[1]	136	57.9%	3.42%	1.11%
Paper bags - not retail	43	18.3%	1.08%	1.88%
Plastic retail bags	25.5	10.9%	0.64%	0.60%
Paper retail bags	14	6.0%	0.35%	0.37%
Zipper bags/ sandwich	10.5	4.5%	0.26%	0.31%
Paper bags - fast food	6	2.6%	0.15%	0.18%
	235	100.0%	5.91%	4.45%

Sub-category average (2002 - 2007 - 54,000 observations) 2.80%

1. Note: Plastic bags with no clear brand marking included in this sub-category
2. Item counts may not equal whole numbers due to averaging.



Discussion:

Plastic bags including retail sacks, zipper bags represented 4.3 % of total large litter (172 items out of 3,973). Plastic bags represented 73% of bag litter, as observed in the 2008 litter audit. Plastic bags with or without brand marking on them (i.e. grocery bags) represented 69% of the litter in this category, and 4% of total litter. Paper bags collectively accounted for 24 % of this sub-category, with non-retail paper bags (like lunch bags) representing 18% of the sub-category.

In 2008, as was also observed in 2007, bag litter in San Francisco was higher (5.9% of total litter) than the consultant's category average for bags in all audits conducted between 2002 – 2007 (2.8%) from other combined jurisdictions.

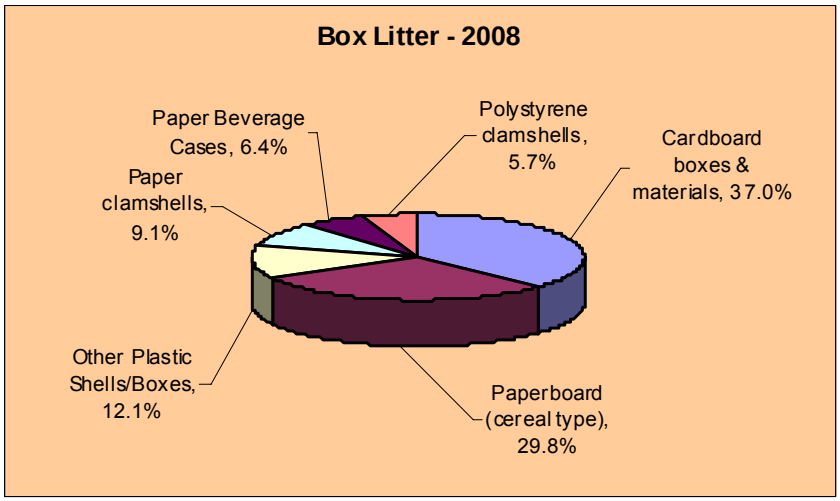
3.2.4 Boxes

3.2.4 Boxes [1.]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Cardboard boxes & materials	49	37.0%	1.23%	0.20%
Paperboard (cereal type)	39.5	29.8%	0.99%	0.30%
Other Plastic Shells/Boxes	16	12.1%	0.40%	0.20%
Paper clamshells	12	9.1%	0.30%	0.00%
Paper Beverage Cases	8.5	6.4%	0.21%	0.00%
Polystyrene clamshells	7.5	5.7%	0.19%	0.50%
	132.5	100.0%	3.34%	1.20%

Sub-category average (2002 - 2007 - 54,000 observations) 2.80%

1. Item counts may not equal whole numbers due to averaging.



Discussion:

The amount of large litter in the boxes sub-category which was observed in 2008 was considerably more than noted in the 2007 audit.

The amount of cardboard box pieces was higher than in 2007 (49 items in 2008 vs. 7 in 2007). San Francisco box litter was similar to all jurisdictions audited by the consultant average for this sub-category in audits between 2002 – 2007 from other jurisdictions3.3% vs. 2.8% all previous audits).

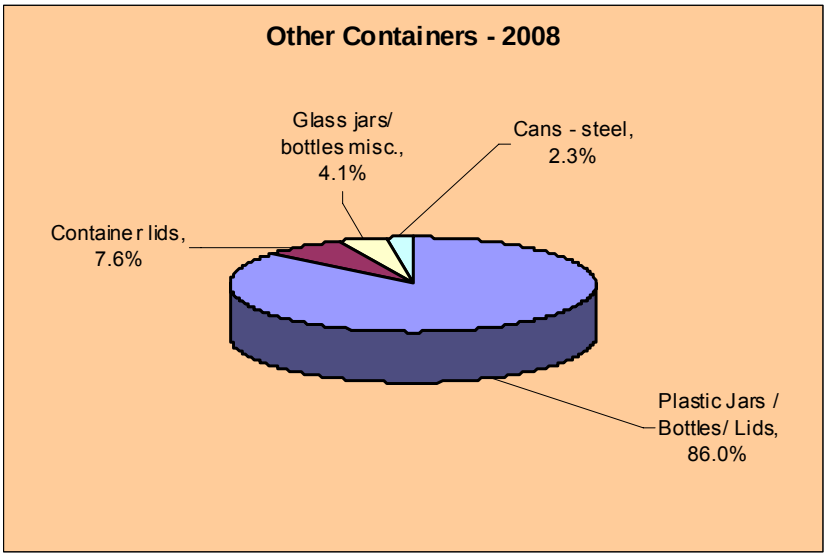
3.2.5 Other Containers (non-beverage)

3.2.5 Other Containers [1]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Plastic Jars / Bottles/ Lids	74	86.0%	1.86%	0.87%
Container lids	6.5	7.6%	0.16%	0.08%
Glass jars/ bottles misc.	3.5	4.1%	0.09%	0.05%
Cans - steel	2	2.3%	0.05%	0.13%
Aerosol cans	0	0.0%	0.00%	0.14%
cans - Aluminum	0	0.0%	0.00%	0.16%
	86	100.0%	2.16%	1.43%

Sub-category average (2002 - 2007 - 54,000 observations) 1.40%

1. Item counts may not equal whole numbers due to averaging.



Discussion:

Containers other than beverage containers accounted for a relatively small proportion of total litter in the 2008 San Francisco litter audit, but interesting enough there was slightly more of this sub-category of large litter observed than in 2007. In 2007, Other Containers accounted for 1.4% of total litter, whereas in 2008 this sub-category represented 2.2%.

Plastic jars, bottles and lids which did not fit another specific sub-category were 74% of the litter in this sub-category. The proportion of Other Container litter observed during the 2008 San Francisco litter audit was slightly higher than the consultant's observations of this sub-category (1.4% of total litter), in all previous audits performed between 2002 – 2007 in other jurisdictions (54,000 observations).

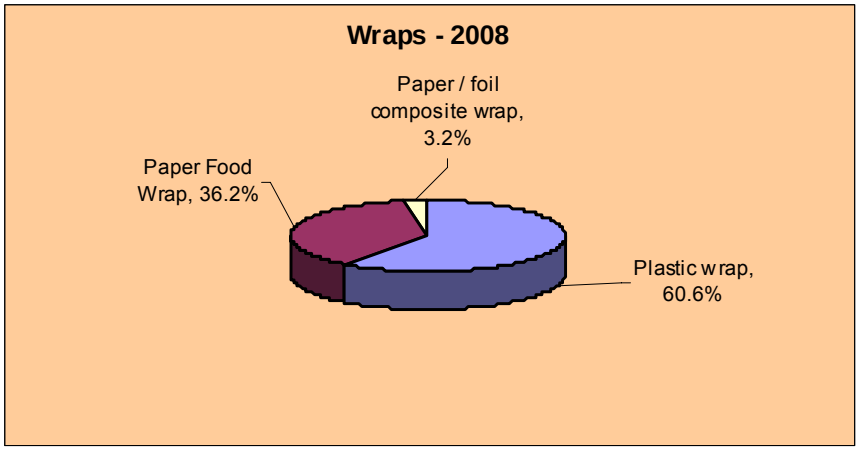
3.2.6 Wraps

3.2.6 Wraps[1.]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Plastic wrap	85.5	60.6%	2.15%	0.67%
Paper Food Wrap	51	36.2%	1.28%	0.85%
Paper / foil composite wrap	4.5	3.2%	0.11%	0.26%
	141	100.0%	3.55%	1.78%

Sub-category average (2002 - 2007 - 54,000 observations) 2.30%

1. Item counts may not equal whole numbers due to averaging.



Discussion:

Within this category are items which are used to wrap food for consumption off premises, mainly from fast food outlets. About 40% more food wrap materials were observed in the 2008 litter audit as compared to 2007. The majority of food wrap materials in 2008 were plastic food wrap litter, accounting for 85% of the wrapper materials, compared to 58% in 2007.

This is in contrast to the findings in 2007, where paper food wraps dominated the wrap litter observed, at 48 % of the sub-category. In 2007, plastic food wrap materials were 58% of the wrap sub-category.

The proportion of wrap litter observed during the 2008 San Francisco litter audit was higher than the average found in aggregated litter observations in audits performed between 2002 – 2007 in other jurisdictions (3.55% wraps in San Francisco vs. 2.3% wraps in 54,000 observations).

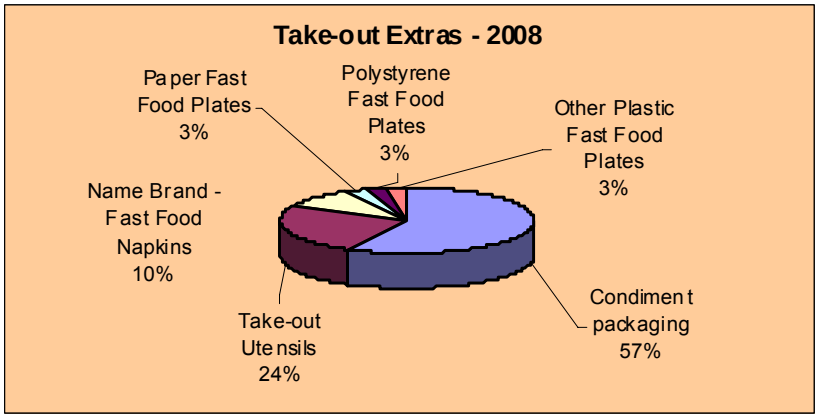
3.2.7 Take Out Extras

3.2.7 Take-Out Extras [1.& 2.]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Condiment packaging	87	57.8%	2.19%	1.21%
Take-out Utensils	37	24.6%	0.93%	1.29%
Name Brand - Fast Food Napkins	14.5	9.6%	0.36%	0.38%
Paper Fast Food Plates	4	2.7%	0.10%	0.09%
Polystyrene Fast Food Plates	4	2.7%	0.10%	0.08%
Other Plastic Fast Food Plates	4	2.7%	0.10%	
	150.5	100.0%	3.79%	3.04%

Sub-category average (2002 - 2007 - 54,000 observations) 2.40%

1. Item counts may not equal whole numbers due to averaging.
2. Take-out extras include: condiment packaging (eg. Salt, pepper, sugar, soya,mustard, relish, mayo, spoons, forks, plates, other fast food items



Discussion:

The sub-category of Take-out Food Extras includes condiment packages (ketchup, vinegar, salt, pepper, etc.) and utensils used by patrons of fast food establishments, as well as name brand napkins and fast food plates. Non-branded napkins are not included in this sub-category, since they may or may not be attributable to fast food outlet customers, and are therefore included in with paper litter.

In the 2008 litter audit Take-out Extra's, such as condiment packaging and utensils continued to be the main large litter components in this sub-category, together accounting for 81% of Take-out Extra litter. In 2007 and again in 2008 the proportion of take-out extras litter observed during the San Francisco litter audit was greater than the average found in aggregated litter observations performed between 2002 – 2007 in other jurisdictions. (3.04% 2007; 3.79% in 2008 vs. 2.38% take-out extra litter found in 54,000 observations). It is also noted that this sub-category increased by 25% in its contribution of total litter (from 3.04% in 2007 to 3.79% in 2008)

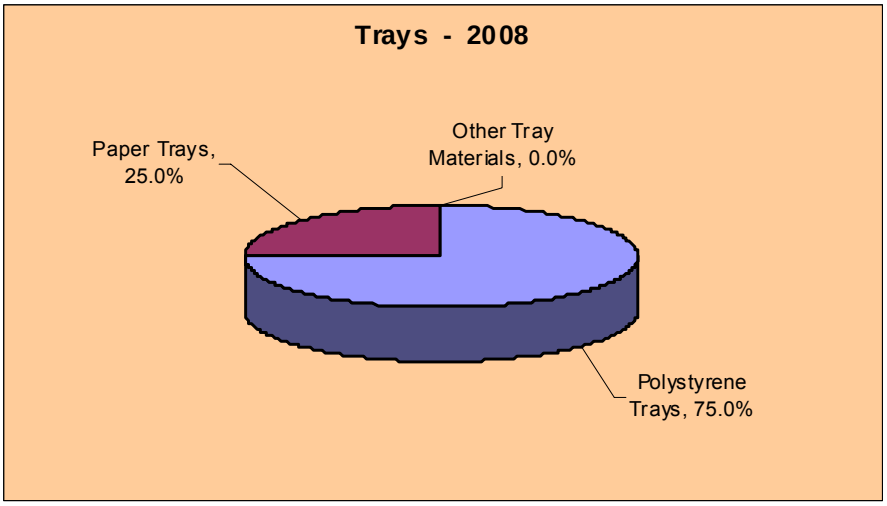
3.2.8 Trays

3.2.8 Trays [1.]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Polystyrene Trays	3	75.0%	0.08%	0.03%
Paper Trays	1	25.0%	0.03%	0.12%
Other Tray Materials	0	0.0%	0.00%	0.00%
	4	100.0%	0.10%	0.15%

Sub-category average (2002 - 2007 - 54,000 observations) 0.20%

1. Item counts may not equal whole numbers due to averaging.



Discussion:

Trays represented a very small category of large litter well less than 1% (0.15% of total litter in 2007 and 0.10% in 2008). Tray litter observed during the San Francisco litter audit was less than the average found in aggregated litter observations in audits performed between 2002 – 2007 in aggregated data for all jurisdictions. (0.10% wraps in San Francisco vs. 0.20 % take-out extra litter found in 54,000 observations).

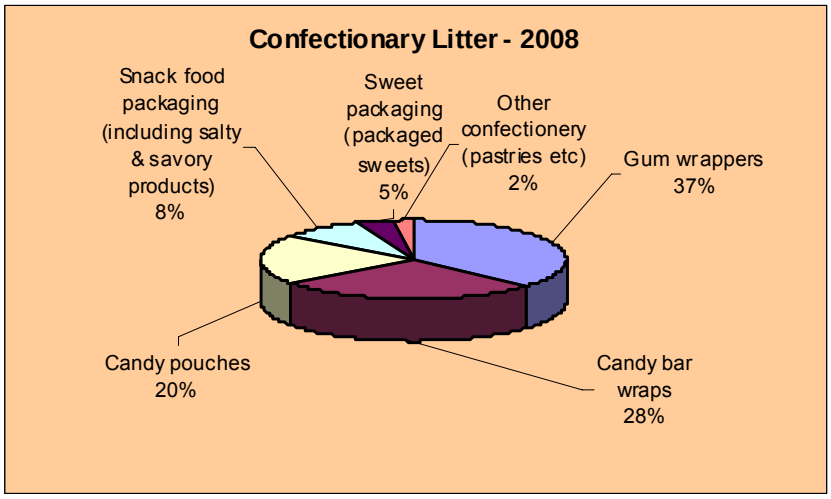
3.2.9 Confectionary

3.2.9 Confectionary[1.]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Gum wrappers	131	36.8%	3.30%	0.84%
Candy bar wraps	100	28.1%	2.52%	3.99%
Candy pouches	71.5	20.1%	1.80%	0.49%
Snack food packaging (including salty & savory products)	30	8.4%	0.76%	2.37%
Sweet packaging (packaged sweets)	16	4.5%	0.40%	0.81%
Other confectionery (pastries etc)	7	2.0%	0.18%	0.07%
	355.5	100.0%	7.61%	8.57%

Contribution of total large litter - 2007	8.57%
Sub-category average (2002 - 2007 - 54,000 observations)	8.70%

1. Item counts may not equal whole numbers due to averaging.



Discussion:

Confectionary products include candy bar wraps, candy pouches, including other sweet and snack food packaging. Confectionary packaging litter continued to be a significant component of the litter observed in this audit, at 7.6% of the total large litter observed, compared to 8.6% in 2007.

The most significant contributors were gum wrappers, candy bar wrappers and candy pouches, which collectively accounted for 85% of the confectionary litter observed in 2008. Confectionary litter observed during the 2008 San Francisco litter audit was slightly less than the average found in aggregated litter observations in audits performed between 2002 – 2007 in other jurisdictions (7.6 % of total litter in San Francisco vs. 8.7% observed in 54,000 observations).

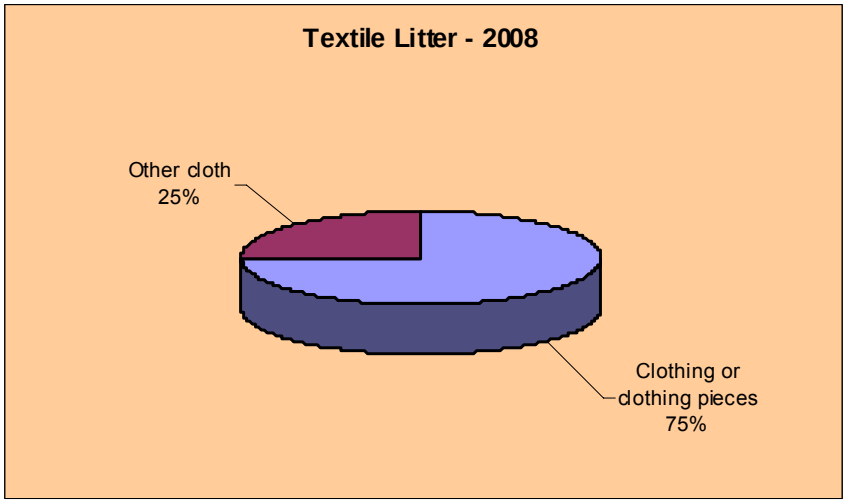
3.2.10 Textiles

3.2.10 Textiles[1.]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Clothing or clothing pieces	27	75.0%	0.68%	0.74%
Other cloth	9	25.0%	0.23%	0.89%
	36	100.0%	0.91%	1.63%

Contribution of total large litter - 2007	1.63%
Sub-category average (2002 - 2007 - 54,000 observations)	1.30%

1. Item counts may not equal whole numbers due to averaging.



Discussion

In the 2008 litter audit only 36 textile items were observed, compared to a total 62 items of textile items in 2007. The 2008 audit yielded a similar result for textile materials confirming that they are a relatively small contributor to total large litter in the City. The textile litter observed during the San Francisco litter audit was close to the average found in aggregated litter observations in audits performed between 2002 – 2007 in other jurisdictions (0.91 % of total litter in San Francisco vs. 1.3% observed 54,000 combined litter observations).

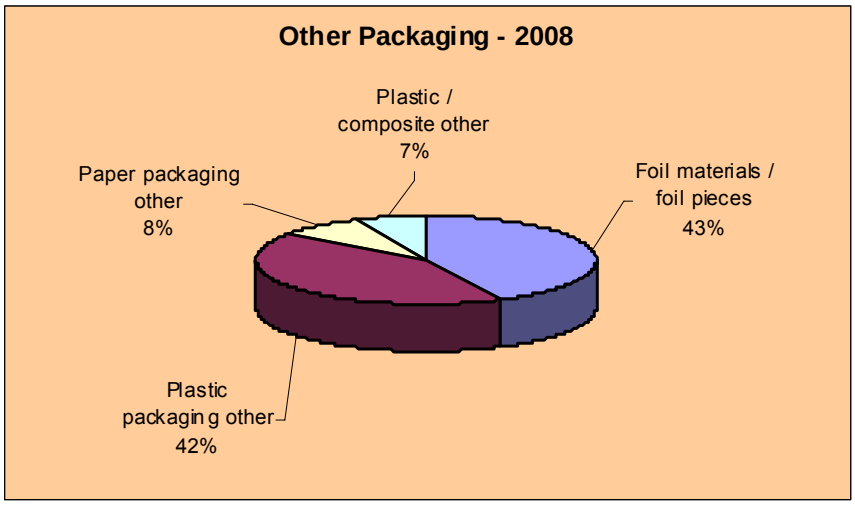
3.2.11 Other Packaging

3.2.11 Other Packaging[1.]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Foil materials / foil pieces	56	42.7%	1.41%	2.74%
Plastic packaging other	55.5	42.4%	1.40%	0.72%
Paper packaging other	10.5	8.0%	0.26%	0.27%
Plastic / composite other	9	6.9%	0.23%	0.07%
	131	100.0%	3.30%	3.80%

Sub-category average (2002 - 2007 - 54,000 observations) 5.90%

1. Item counts may not equal whole numbers due to averaging.



Discussion

This sub-category includes packaging that did not fit into other packaging sub-categories, but which were still identifiable as large litter. In the San Francisco litter audit this is a relatively significant contributor of total large litter in the City. In the 2008 litter audit, as in the 2007 study, “other packaging” large litter was less than the average found in aggregated litter observations in audits performed between 2002 – 2007 in other jurisdictions (2008 – 3.3% and 2007 - 3.8 % of total litter in San Francisco vs. 5.9% observed in 54,000 observations). In the 2008 litter audit, foil materials and pieces and plastic packaging make up 85% of this segment as observed in San Francisco.

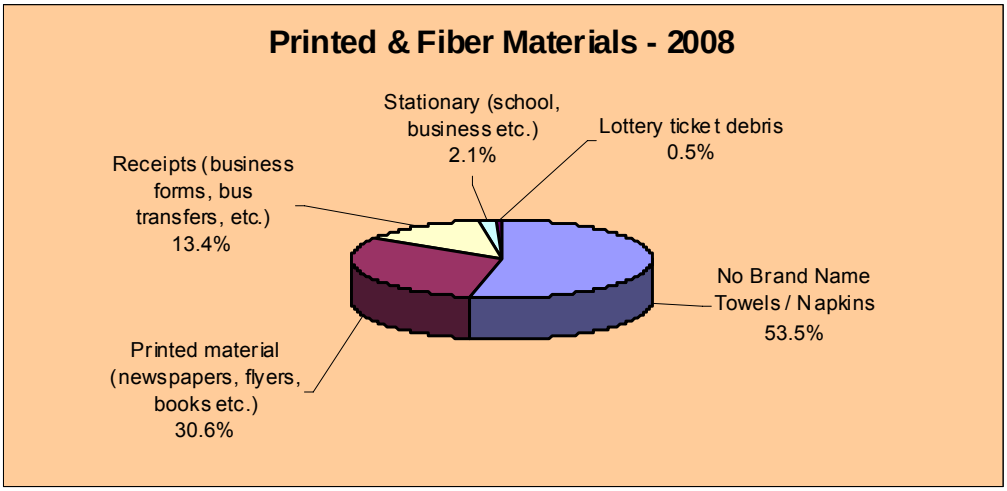
3.2.12 Printed & Fibre Materials

3.2.12 Printed and Fiber Materials [1]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
No Brand Name Towels / Napkins	664	53.5%	16.71%	13.00%
Printed material (newspapers, flyers, books etc.)	380	30.6%	9.56%	7.50%
Receipts (business forms, bus transfers, etc.)	166.5	13.4%	4.19%	5.30%
Stationary (school, business etc.)	25.5	2.1%	0.64%	0.10%
Lottery ticket debris	6	0.5%	0.15%	0.80%
	1242	100.0%	31.26%	26.70%

Sub-category average (2002 - 2007 - 54,000 observations) 18.80%

1. Item counts may not equal whole numbers due to averaging.



Discussion

This sub-category continues to be a significant contributor to large litter in San Francisco. As observed in the 2007, and again in 2008, the largest proportion of this sub-category, (49% in 2007, and 54% in 2008) was napkins or pieces of napkins which could not be directly attributed to the fast food sub-category, because no brand markings were visible. It is likely that a significant proportion of this napkin litter originates from fast food service outlets.

Printed materials including newspaper and flyer litter, printed MUNI tickets and other business receipts are also large contributors to overall large litter in the City. This sub-category is a higher level of proportional litter, compared to the average found in aggregated litter observations in audits performed between 2002 – 2007 in other (31 % of total litter in San Francisco vs. 18.8% observed in 54,000 previous litter audit observations).

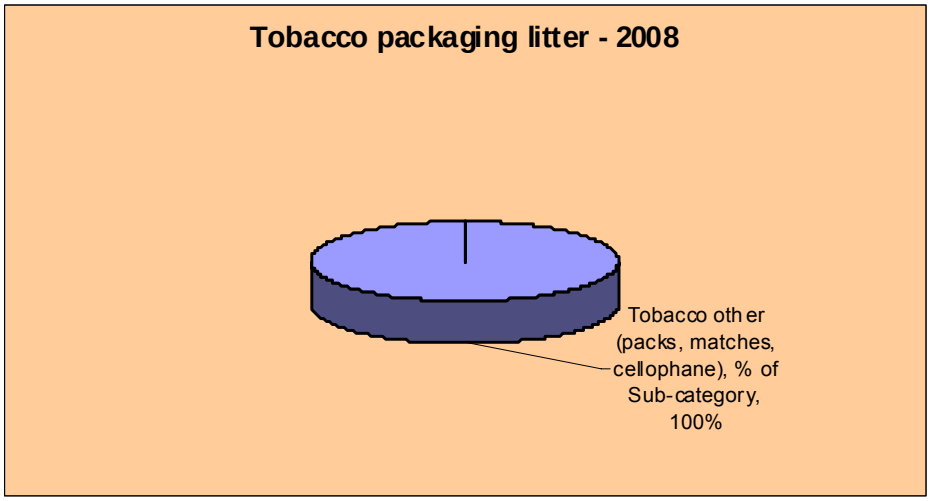
3.2.13 Tobacco

3.2.12 Printed and Fiber Materials [1. & 2.]

	Items	% of Sub-category	2008 % of Total Large Litter	2007 % of Total Large Litter
Tobacco other (packs, matches, cellophane)	145	100.0%	3.65%	2.89%
	145	100.0%	3.65%	2.89%

Sub-category average (2002 - 2007 - 54,000 observations) 5.50%

1. Item counts may not equal whole numbers due to averaging.
2. Large litter in the tobacco sub-category does not include cigarette butts - which are < 4 sq.in and are included in the analysis on small litter that follows in this report



Discussion

The amount of large tobacco litter observed on San Francisco streets contributed 3.65% of total large litter. In 2008, as in the 2007 litter audit, this a significantly lower level of tobacco litter compared to the average found in aggregated litter observations in audits performed between 2002 – 2007 in all jurisdictions (3.65 % of total litter in San Francisco vs. 5.5% observed in 54,000 observations). Tobacco packaging litter remains a significant sub-category of large litter on City streets.

3.2.14 Other Miscellaneous

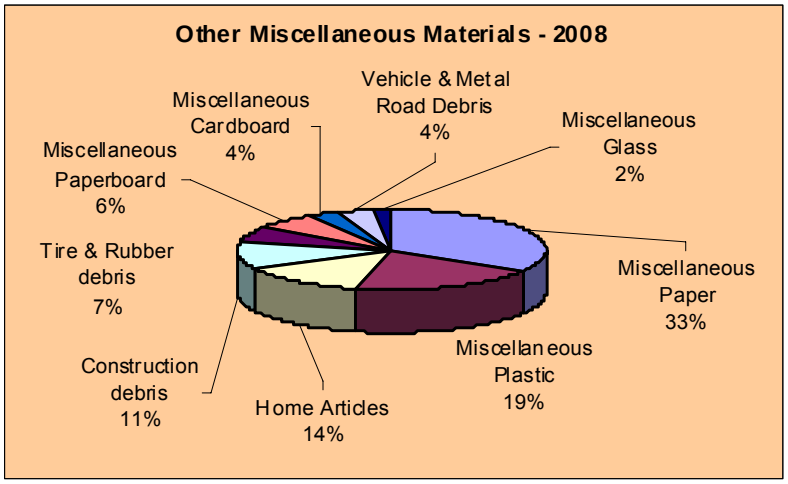
This sub-category is normally the largest sub-category grouping because it includes various miscellaneous material types which cannot be grouped in other categories. The sub-category includes miscellaneous paper, miscellaneous plastic, miscellaneous cardboard, miscellaneous paperboard, miscellaneous glass, vehicle & road debris, tire and rubber debris, construction debris, and home articles.

3.2.13 Other Miscellaneous Materials[1]

			2008	2007
	Items	% of Sub-category	% of Total Large Litter	% of Total Large Litter
Miscellaneous Paper	317	33.8%	7.98%	15.00%
Miscellaneous Plastic	185.5	19.8%	4.67%	9.00%
Home Articles	127.5	13.6%	3.21%	3.80%
Construction debris	102.5	10.9%	2.58%	0.80%
Tire & Rubber debris	62	6.6%	1.56%	0.20%
Miscellaneous Paperboard	55.5	5.9%	1.40%	1.60%
Miscellaneous Cardboard	35	3.7%	0.88%	1.30%
Vehicle & Metal Road Debris	33	3.5%	0.83%	1.10%
Miscellaneous Glass	18.5	2.0%	0.47%	1.70%
	936.5	100.0%	23.57%	34.50%

Sub-category average (2002 - 2007 - 54,000 observations) 33.60%

1. Item counts may not equal whole numbers due to averaging.



Discussion:

This sub-category yields the largest segment of litter observed in the City of San Francisco Litter Audit since it is a sub-category that encompasses much of the unspecific litter observed. In total 937 pieces of large litter fell into this general category, compared to 1,316 items which were observed on fewer sites (105) in 2007.

Miscellaneous materials are those that cannot be identified other than by the material type or likely origin of the litter (i.e. home articles, vehicle debris). I the 2008 study, miscellaneous paper materials accounted for the largest proportion of this sub-category, at 317 large litter items in this sub-category (33%) or a significant 8% of total large litter counted. Miscellaneous plastic materials accounted for 185 of the sub-category and 5% of all the large litter counted.

These categories consisted of bits of stationary, newspapers, flyers, and often included shredded paper from lawn mowing. This material derives from a plethora of sources, that once weathered or when grass is mowed is shredded into indistinguishable large litter pieces.

Similar to observations made in the 2007 litter audit, in 2008 miscellaneous paper and miscellaneous plastic again represent two material categories that warrant discussion. Because of the nature of paper or plastic litter, it is often not possible for litter auditors to determine what the paper or plastic litter was as an original product or packaging component. This is because both types of these materials degrade due to weathering, and often lost their distinguishing features that would allow more positive identification to be included in another sub-category. If litter auditors could not positively categorize a piece of paper or plastics litter as belonging to a specific sub-category (i.e. confectionary), then they classified that item of litter as miscellaneous paper or plastic. These two sub-categories are significant for planners of litter abatement programs, since in aggregate they represent between 13% (2008) and 24% (2007) of total large litter on San Francisco streets. Effective efforts to reduce paper litter and plastic litter would reduce total litter substantially. We attribute the difference in this sub-category's observations from 2007 to 2008, as being random sampling differences that could occur from sites being generally cleaner in 2008 than in 2007, or the use of different auditors in each of the two audit studies. Proportionally, Other Miscellaneous large litter remains a significant sub-category of interest in both 2007 and again in 2008.

The miscellaneous litter observed in the 2008 litter audit was observed to be lower than aggregated litter observations from all audits performed between 2002 – (24 % of total litter in San Francisco 2008 vs. 34% in 2007 and 33.6% from 54,000 observations).

4.0 Small Litter Survey Results

4.1 Discussion of Small Litter Results

The categories examined in the litter counts of items less than 4 square inches in size are:

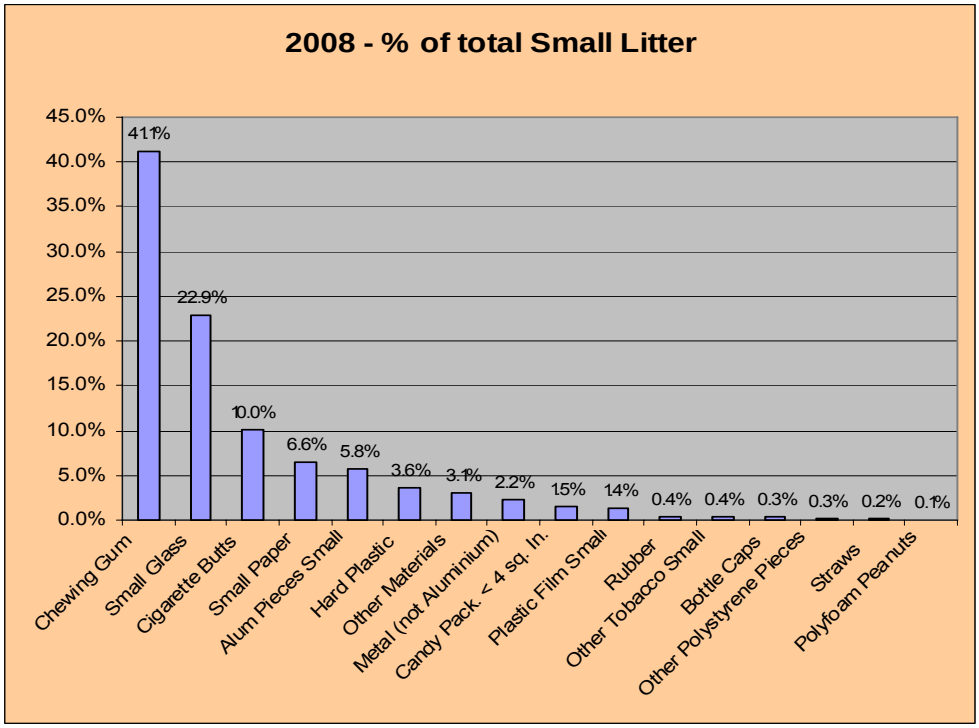
- cigarette butts/ debris
- other tobacco
- bottle caps
- straws
- candy packaging
- polyfoam packing materials
- other polystyrene debris
- glass
- paper
- plastic film
- hard plastic
- aluminum / foil debris
- rubber
- metal (not aluminum)
- other materials
- chewing gum

The small litter methodology requires researchers to count small litter that fall within three slices within a given site (transacts) – three 6 square foot segments of a site (3 x 1 foot by 6 feet). Accordingly, the small litter counts may or may not have recorded some of the small litter existing on a site, depending on whether the placement of the transact frames encompass the small litter or not. However, the benefit of this method is its rigor. Every site was handled in the same way. Thus, this was a fair and objective examination of small litter as observed.

Small litter is difficult to control, because it is "manufactured" by a combination of degradation (weather) and man-made activities (vehicle traffic, mowing, etc.).

Observations of small litter during the San Francisco litter audit showed a relatively low occurrence of small litter on city streets, as compared other to audits performed by the consultant in other jurisdictions. In the 2008 audit in San Francisco, 2,335 items of small litter (compared to 2,393 in 2007) items were observed in 132 sites audited. This average of 18 items per site compared with 23 items / site observed on San Francisco streets in 2007; a reduction of 21%. Averages twice as high as the small litter rate observed in San Francisco in 2007 and 2008, have been recorded by the consultant in audits conducted in other jurisdictions. A note of caution however is required in considering small litter audit results. The methodology specifies that only a very small area within a site is actually measured for small litter items. For a fixed site (18 ft x 200 ft = 3,600 sq. ft.) less than 1% of the entire site is audited for small litter items. The small litter audit results should be considered as an indication of "relative" types of small litter on local streets.

As observed in 2007, it is of note that gum deposits on San Francisco streets continue to be the most significant small litter item observed. This is consistent with other audits performed by the consultant where gum deposits are usually the largest proportion of small litter observed. The other top small litter proportions (i.e. paper, glass, cigarette butts) observed in the San Francisco audit are also consistent with previous audit observations from other jurisdictions.



Small Litter Summary

Description	SF 2008 Total Small Litter Items Observed	SF 2008 % of Total Small Litter	SF 2007 Total Small Litter Items Observed	SF 2007 % of Total Small Litter
Chewing Gum	960	**41.1%**	946	**39.5%**
Small Glass	535	**22.9%**	710	**29.7%**
Small Paper	153	6.6%	187	7.8%
Cigarette Butts	234	**10.0%**	135	5.6%
Other Materials	73	3.1%	97	**4.1%**
Hard Plastic	85	3.6%	92	**3.8%**
Plastic Film Small	33	1.4%	56	2.3%
Other Tobacco Small	9	0.4%	51	2.1%
Metal (not Aluminium)	52	2.2%	41	**1.7%**
Rubber	10	0.4%	26	**1.1%**
Alum Pieces Small	135	**5.8%**	19	0.8%
Candy Pack. < 4 sq. In.	36	1.5%	16	0.7%
Polyfoam Peanuts	2	0.1%	8	0.3%
Other Polystyrene Pieces	6	0.3%	5	0.2%
Bottle Caps	8	0.3%	4	0.2%
Straws	4	0.2%	0	0.0%
	2,335	100.0%	2,393	100.0%

Average SF Small Litter Items / site 18 23

Notes:

APPENDIX 1 – Large Litter Audit Form

Large Litter Site Form
CHECK TAPE RECORDER IS WORKING

Site ID Number: _____ Date:_____ Photos Taken: ___ Y/N

Start Time: _____ Finished Time: _____ Tape #: _____

Surveyor's Name: _____ FIXED or VARIABLE _____ F / V (circle one)

If variable:

Width 1 :Beginning: _____ ft. (up to 18ft.)
Width 2: Middle: _____ ft. (up to 18ft.)
Width 3: End _____ ft. (up to 18ft.) **Always 200 feet long**

Road type: Major highway ☐ Paved Rural Road ☐Unpaved Rural Road ☐ Major City Street ☐

Minor City Street ☐ Laneway Other ☐ _____ (describe)
Lanes: 2, 4, 6, other (explain)
_____

Is roadway / highway divided: _____ Y / N

Area Attribute:

Built up / urban area ☐ Is the area Residential ☐ Industrial ☐ Parkland

☐ Rural setting ☐

Grass Height: a. < 3 inches: ☐ b. 3" – 6": ☐ c. over 6 ": ☐ (Check one)

Catch point: fence ☐ hedge ☐ curb ☐ mower line ☐ tree line ☐ other ☐
_____ details

Visual rating of site: (1 = cleanest ; 4 = dirtiest) _____

Is there a Fast food store within 1 KM? _____ Y/N

Convenience store within 1 KM _____ Y/N

Traffic light / stop sign or major intersection within sight? _____ Y/N

Evidence of Litter Clean up? _____ Y/N
Cleanup details _____

_____ (text)

Additional comments : _____

CAT #	CATEGORY	Pass 1	Total	Pass 2	Total	BRAND NAMES OBSERVED
	MISCELLANEOUS LITTER					
76	Misc. Paper (unidentifiable paper)					
77	Misc. Plastic (unidentifiable plastic)					
78	Misc. Paperboard (unidentifiable paperboard)					
79	Misc. Cardboard (unidentifiable cardboard)					
80	Misc. Glass (unidentifiable glass)					
	CONTAINERS					
1	Beer Cans					
2	Beer Bottles (glass)					
3	Soft Drink (glass)					
4	Soft Drink (cans)					
5	Soft Drink (plastic)					
6	Sport Drink (glass)					
7	Sport Drink (plastic)					
8	Water (glass)					
9	Water (plastic)					
10	Wine/ Liquor (glass)					
11	Wine/ Liquor (plastic/other)					
12	Milk/Juice (Plastic)					
13	Milk/Juice (glass)					
14	Milk/Juice (Gable Top)					
15	Foil Pouches					
16	Aseptic (Box)					
17	Broken Glass Container					
18	Six pack plastic rings					
	CUPS					
19	Plastic drink cups					
20	Paper Cups (cold)					
21	Paper Cups (Hot)					
22	Polystyrene cups (foam)					
23	Other paper cups					
24	Cup Lids, Pieces lids					
	BAGS					
25	Plastic retail bags					
26	Paper retail bags					
27	Paper bags – fast food					
28	Plastic bags – not retail					
29	Paper bags - not retail					
30	Zipper bags/ sandwich					
	Boxes					
31	Cardboard boxes/ box mat'l					
32	Paperboard (cereal type)					
33	Paper Beverage Cases					
34	Polystyrene clamshells					
35	Paper clamshells					
36	Other Plastic Shells/Boxes					
	Other Containers & Packaging					
37	Plastic Jars / Bottles/ Lids					
38	Glass jars/ bottles misc.					
39	Cans – steel					
40	Cans – aluminium (not beverage)					
41	Container lids					
42	Aerosol cans (paint, oils, etc.)					
64	Plastic packaging other					
65	Paper packaging other					
66	Plastic / composite other					
67	Foil materials / foil pieces					
75	Foil containers					

	WRAPS & TRAYS					
43	Paper Food Wrap					
44	Paper / Foil composite wrap					
45	Plastic wrap					
46	Polystyrene Trays					
47	Paper Trays					
48	Other Mat'l Trays					
	CANDY & GUM & SNACKS					
49	Gum wrappers					
50	Candy bar wraps					
51	Candy pouches					
52	Sweet packaging (describe)					
53	Other confectionery (describe)					
63	Snack food packaging (chips / peanuts etc)					
	FAST FOOD ITEMS					
54	Condiment package (salt, ketchup, vinegar etc.)					
55	Utensils					
56	Name Brand (Fast Food etc.) Towels / Napkins / Serviettes					
57	Paper Fast Food Plates					
58	Poly Fast Food Plates					
59	Other Plastic Fast Food Plates					
60	Plates - Other Materials					
68	No Brand Name Towels / Napkins / Serviettes					
	HOUSHOLD ARTICLES					
61	Clothing or clothing pieces					
62	Other cloth					

81	Vehicle & Metal Road Debris					
82	Construction debris					
83	Tire & Rubber debris					
84	Home Articles					
	PRINTED MATERIALS					
69	Lottery ticket debris					
70	Printed material (newspapers, flyers, books etc.)					
71	Stationary(school, bus. etc.)					
72	Receipts (business forms , bus transfers etc.)					
	TOBACCO PRODUCTS					
73	Cigarette / cigar debris (>4")					
74	Tobacco other (packs, matches, cellophane)					

APPENDIX 2 – Site Locations & Driving Directions

2008 Litter Audit - Site Locations & Driving Directions

Site Id	Map Source	Map Insert	Main Map	Site_name	Site_type	Directions	Additional Comments
		Co-ordinate	Co-ordinate				
1	MapArt	B-82	A-10	FRANCISCO	Street	Travel North on Sansome St. turn west on Chestnut St.; turn north onto Mason then left onto Francisco St - site is on the north side just west of Mason St.	
2	MapArt	B-84	A-11	THE EMBARCADERO	Street	Travel north on Sansome St. to the Emvarcadero. Site is on The Embarcadero just north of Chesnut St. opposite Pier 31	
3	MapArt	C-81	B-9	UNION	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel N on Sansome to Broadway then turn left onto Broadway - proceed to Columbus turn right onto Columbus - continue to Union St turn Left onto Union - proceed past Larkin - site is on Union just west of Larkin St.	
4	MapArt	C-83	B-11	FILBERT	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel N on Sansome to Broadway and turn west to Stockton St. Turn north on Stockton St. to Filbert St. Site is south side of Filbert St. in Washington Sq. Pk.	
5	MapArt	D-83	B-11	JASPER	Place	Commencing at HDR's Offices (Sansome/ Bush) - travel N on Sansome to Broadway and turn west to Stockton St. Turn north on Stockton St. to Union St.; turn right on Union (east) Jasper Place - is halfway down the block. Site is on Jasper Place north of Union St.	
6	MapArt	C-85	B-11	DAVIS	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel North on Sansome St - to Vallejo St - turn right and proceed to Davis St - turn right onto Davis - site is immediately after turning onto Davis.	
7	MapArt	D-81	B-10	WASHINGTON	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel North on Sansome St to California - turn left (west) continue on California until Larkin - turn right (N) onto Larkin - to Washington St - turn right on Washington . Site is on Washington east of Larkin in front of Spring Valley School.	
8	MapArt	D-83	B-11	POWELL	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel N on Sansome St to California and turn left onto California - proceed to Powell St and turn right -(N) - proceed past Clay St - site is on Powell just N of Clay.	
9	MapArt	D-83	B-11	GRANT	Street	Commencing at HDR's Offices (Sansome/Bush) - travel N on Sansome - turn left onto Sacramento St - proceed to Grant St. Site on Grant St. north of Clay St.	
10	MapArt	C-85	B-12	THE EMBARCADERO	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel North on Sansome St to Broadway - turn Right travel East to The Embarcadero -- - Site is south of Broadway	
11	MapArt	D-85	B-12	DRUM	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel N to Jackson St. and turn right (east) and proceed to Drum St. Turn right (south) onto Drum St. site is immediately south of Jackson on the west side of street..	

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
12	MapArt	E-86	C-12	HOWARD	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel east on Bush Street which turns into 1st St. and turn left (east) onto Mission St. turn right (south onto Spear St. and then right onto Howard St.. Site on Howard St. betwee Spear St and Main St. on right side of street.	Site very clean.
13	MapArt	F-86	C-12	FREMONT	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel east on Bush Street which turns into 1st St. Continue on 1st St. and turn left onto Fulsome St. then left onto Fremont St. Site is immediately north of Folsom St.	
14	MapArt	E-84	C-11	PETRARCH	Place	Commencing at HDR's Offices (Sansome/ Bush) - travel north 1/2 block to Pine St. and turn left. Petrarch Place is an alleyway 3/4 of the way down the block. (Site is entire alleyway)	
15	MapArt	E-84	C-11	MONTGOMERY	Street	North on Sansome St from HDR offices, to Pine St turn left on Pine - proceed to Montgomery turn left onto Montgomery - site is on Montgomery at Bush St.	
16	MapArt	E-83	C-10	MASON	St.	From HRD office - N on Pine St. Turn left onto Pine St. proceed west on Pine to Mason St. - turn Right on Mason. Site is on Mason south of California.	
17	MapArt	E-82	C-10	TAYLOR	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel north on Sansome and turn left onto Pine St. Proceed to Mason St. turn left (south) to Sutter St. and turn right onto Sutter (west) then right (north) onto Taylor St. Site is between Sutter and Bush on the right side of the street.	
18	MapArt	E-81	C-10	BUSH	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel north on Sansome and turn left onto Pine St. Continue on Pine St. to Polk St. and turn left (south) onto Polk St. then left (east) onto Bush St. Site is between Polk and Larkin Streets on right hand side of street .	
19	MapArt	F-83	C-11	GEARY	Boulevard	Commencing at HDR's Offices (Sansome/ Bush) - travel SW onto Market St to Geary St. - turn right onto Geary St.; walk two blocks …. Site is on Geary in front of Union Square. Measure where people can walk.	Very windy day with high pedestrian traffic.
20	MapArt	G-84	D-11	MISSION	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St proceed to 4th and turn right onto Mission. Site is on Mission between 4th & 5th Streets on right hand side of street.	
21	MapArt	G-85	D-11	04 TH	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St - turn left onto 4th St….. Site is on 4th St. immediately south of FolsomSt.	
22	MapArt	H-86	D-12	KING	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St turn left onto 2nd St. continue to King St. and turn right (sw) Site is on King adjacent to 2nd and King transit station.	
23	MapArt	H-83	D-11	RUSS	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St - turn left (S) onto 6th St. proceed to Minna St. turn right onto Minna St and then turn left onto Russ St - Site on Russ St. just before Folsom St.	
24	MapArt	H-83	D-11	RUSS	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 6th St turn left onto 6th St.- proceed to Minna St - turn right on Minna and proceed to Russ St - Turn left onto Russ St. Site is immediate at Russ and Minna on Russ St.	
25	MapArt	H-83	D-10	HOWARD	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 6th St turn left onto 6th St.- proceed to Minna St - turn right on Minna continue to 8th St. turn left (south) onto Howard St. and turn left (northeast). Site on Howard just befor 7th St on rightfhand side of street	

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
26	MapArt	G-83	D-10	STEVENSON	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 6th St - turn left onto 6th St - then left (west) onto Mission St. and turn right on 7th St. and then right onto Stevenson St. Site is on Stevenson between 7th and 6th St. on righthand side.	
27	MapArt	G-82	D-10	LEAVENWORTH	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St and turn right onto McAllister St then right onto Leavenworth. Site is between Golden Gate Ave and Turk St.on right side of street.	
28	MapArt	G-82	D-10	MCALLISTER	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St and turn right onto McAllister St. Site is immediately after Levenworth adjacent to Hastings College.	
29	MapArt	G-82	D-10	LARKIN	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St and turn right onto McAllister St. Turn right onto Larkin St. Site is between McCallister and Golden Gate Ave. on right hand side of street.	
30	MapArt	G-81	D-10	GOLDEN GATE	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St and turn right onto McAllister St. Proceed to Van Ness Ave. and turn right (north) the proceed to Golden Gate Ave. Site is on Golden Gate Ave. between of Van Ness and Polk St. on the right hand side of street.	
31	MapArt	F-81	D-10	ELLIS	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St turn right onto Ellis St. and proceed west to Polk Stf. site is on Ellis St. between Polk St. and Van Ness St. on right hand side.	
32	MapArt	F-80	C-9	POST	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Geary St - turn right onto Geary and proceed westbound - turn onto Laguna St - then immediately onto Post St - site is on Post just west of Laguna St.	
33	MapArt	H-80	D-9	FULTON	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Ellis St. - turn right onto Elllis proceed to Gough St. - Turn left onto Gough St. - continue to Fulton turn right. Site is at on Fulton just west of Laguna and east of Webster St. in front of the Buchanan St. Mall.	
34	MapArt	H-81	D-9	FULTON	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Van Ness - turn right go N to Grove St. Turn left and then right (north) onto Franklin then left onto Fulton St. Site is on right hand side of Fulton between Franklin St. and Gough St.	
35	MapArt	H-81	D-10	FELL	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St turn right onto Franklin St. then turn right onto Fell St. Site is on north side of Fell St. between Franklin and Van Ness Ave. on right side of street.	
36	MapArt	J-82	G-12	MISSION	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St. thne turn left onto 10th street then right onto Mission St. 'Site is on Mission St between between 10th street and 11th street.	
37	MapArt	H-82	D-10	MARKET	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St. Site is on Market St. immediately after Hayes St. on right hand side.	
38	MapArt	J-81	E-9	MCCOPPIN	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Valencia St - turn left onto Valencia - proceed to McCoppin turn left again onto McCoppin - Site is on McCoppin just west of Jessie St.	
39	MapArt	K-82	E-10	15TH	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St turn left onto South Van Ness Ave. and proceed to 14th St. turn left (east) and then turn right (south) onto Fulsom St. and turn right (west) onto 15th St. Site is on 15 St. between Folsom and Shotwell Streets.	
40	MapArt	K-83	E-10	TREAT	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 10th St - turn left (SE) into 10 th St. - Turn right onto Harrison St. (S) amd turn left onto Alameda St. and turn left onto Treat St. Site is on Treat Street immediately after Alameda on left side of street.	

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
41	MapArt	K-85	E-11	DE HARO	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St. - proceed to King St. and turn right (SW) then turn left onto 6 th St. thne right on Berry St. and continue to De Haro St. . Site is at corner of Berry and De Harro on left side..	
42	MapArt	K-86	E-12	16TH	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St - turn left (SE) onto 4th St. then turn Right (SW) onto Third St - continue towards Missions Rock Terminal to 16th St - turn Right onto 16 St. Site is on 16th St. between 3rd St. & 6th St. on right hand side.	
43	MapArt		F-12	INDIANA	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St. - proceed to Third St ; Turn right (south) onto Third St. - then turn right onto 23rd St. turn right again onto Indiana St.. Site is on Indiana between Tubbs St. and 22nd St.	
44	MapArt		F-12	19TH	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St. - proceed to Third St ; Turn right (south) onto Third St. - then turn right onto 19th St. Site is on 19th St. between Conneticut St. and Arkansas St.	
45	MapArt		G-12	ARKANSAS	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St. - proceed to Third St ; Turn right (south) onto Third St. then left (west) onto 20th St. then left (south) onto Arkansas St. Site is on Arkansas St. just north of 23rd St. at the south end of the Potrero Hill Rec. Centre property.	
46	MapArt		F-11	22ND	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St. - proceed to Third St ; Turn right (south) onto Third St. then left (west) onto 20th St. and then turn left (south) onto Rhode Island St. Site is in green space on corner of 22nd St. and Kansas St. on the NW corner.	
47	MapArt		G-11	26TH	Street	From HDR's Offices - travel SW on Market St to 4th St. - proceed to Third St ; Turn right (south) onto Third St. - turn right (W) onto Cesar Chavez then right onto 26th St. Site is immediately after Da Haro on right side of street.	
48	MapArt		F-12	MARIPOSA	Street	From HDR's Offices - travel SW on Market St to 4th St. - proceed to Third St ; Turn right (south) onto Third St. turn right onto Mariposa St. 'Site is on the north side of Mariposa St. at corner of Minnesota St.	
49	MapArt		G-12	MARIN	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St. - proceed to Third St ; Turn right (south) onto Third St. - continue to Marin St. Site is on Marin immediately west of 3rd. St. just after Tennessee.	
50	MapArt		G-12	CESAR CHAVEZ	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St. - proceed to Third St ; Turn right (south) onto Third St. then right onto Cesar Chavez St. Site is on Cesar Chavez St. between Mississippi and Missouri St.	Lots more litter inside hedges but could not count/see all.

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
51	MapArt		G-11	MARIN	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St. proceed to Third St ; Turn right (south) onto Third St. - then turn right onto Cesar Chavez St.. then left onto 26th .St. then left onto Marin St. Site on south side of Marin.	
52	MapArt		H-13	03 ST	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 4th St. - proceed to Third St ; Turn right (south) onto Third St. - Site is on 3rd St. just south of Cargo Way on right side of street.	
53	MapArt		H-13	EVANS	Avenue	Commencing from HDR's offices, proceed SW on Market St.and turn left onto 4th St - then right onto 3rd St. and proceed to Evans Ave. and turn left. Site is after Mendell St. opposite the Postal Service Mail Facility.	
54	MapArt		H-12	PHELPS	Street	Commencing from HDR's offices, proceed SW on Market St. to 4th St - turn left and proceed to 3rd St. and turn right (S) turn right on Phelps St. Site is on east side of Phelps south of La Salle Ave. to McKinnon. (near SFO Community College)	More litter seen on west side of street.
55	MapArt		H-11	MCKINNON	Avenue	Commencing from HDR's offices, proceed SW on Market St. to 4th St - then turn right onto 3rd St. (S) then turn right onto Phelps St. then right onto Oakdale Ave. then turn right onto Toland St. then left onto McKinnon Ave. Site is between Toland and Loomis St. on north (right) side of street.	
56	MapArt		K-11	BACON	Street	Commencing from HDR's offices, proceed SW on Market St. to Van Ness proceed to Mission St. - turn right and proceed on Mission to Silver Ave. proceed on Silver to University St. - turn right (S) proceed to Bacon St. - Site is on Bacon just past Goettingen St - between Goettingen St & Brussels St. on same side as school playground.	Site was only 137 feet long due to construction zone.
57	MapArt		K-10	BACON	Street	Commencing from HDR's offices, proceed SW on Market St. to Van Ness proceed to Mission St. - turn right and proceed on Mission and turn left onto Silver Ave. then right onto University St (S) proceed to Bacon St. - turn right - site is on Bacon between Princton St. & Cambridge St.	No small litter found on site.
58	MapArt		J-10	CRESCENT	Avenue	Commencing from HDR's offices, proceed SW on Market St. to Van Ness proceed to Mission St. - turn right and proceed on Mission to Crescent Ave. turn left (east). Site is on south side of Crescent Ave. east of Agnon Way beginning at west end of St. Mary's Pk.	Employee who cuts the grass does not see it as his responsibility to pick up trash.
59	MapArt		J-10	PRENTISS	Street	From HRD's offices travel SW on Market St. - turn left onto 10 St and then right onto Mission St. heading South - proceed on Mission until turning left onto Cortland Ave - proceed along Cortland to Banks - turn right - go S on Banks to Tomkins turn left then turn left again onto Prentiss. Site is on Prentiss N of Tomkins Ave.	
60	MapArt		G-10	CESAR CHAVEZ	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to South Van Ness Ave. turn left (south) onto proceed to Cesar Chaves St. and turn left and proceed for one block. Site is immediately east of Shotwell St. on south side of Cesar Chavez.	St. Anthony - Church/School provides and award to the school kids who police the area.

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
61	MapArt		G-10	23RD	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to South Van Ness Ave turn left (east) to 23rd St and turn left. Site is between Harrison St. and Alabama St.	
62	MapArt		F-10	FOLSOM	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to South Van Ness Ave turn left (south) then turn left onto 20th St. (E) and left onto Folsom St. (north). Site is on east side of Folsom St. in front of John J. O'Connell High School of Technology.	Picture #4 - Large TV chest dumped on site.
63	MapArt		F-10	TREAT	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to South Van Ness and turn left (S) then turn left onto 17th St. then right onto Treat Ave. Site is on west side of Treat Ave. between 17th St and 18th St.	Neighbor says he keeps watch on this site. Locals say ther are no garbage cans on this street. The sidewalk is visually three times more filthy.
64	MapArt		F-10	SHOTWELL	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to South Van Ness Ave. turn left and proceed South to 18th St - turn left and then right onto Shotwell St. Site is on right (west) side of Shotwell between 19th St and 18th St.	Most of site area near construction zone. New construction site is on SW corner of 18th and Shotwell where there are larger items piled up against the construction fence.
65	MapArt		G-10	22ND	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to South Van Ness Ave. turn left then turn right onto 22nd. St. Site is on the norths side of 22nd St. between Capp and Mission.	
66	MapArt		F-9	21ST	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to South Van Ness Ave. turn left then turn right onto 21st St. Site is on nouth side of 21St just west of Valencia St	Upsloping area. Extra photos taken of trash in apt. cellar way. Apt. faces onto Valencia>
67	MapArt		G-9	QUANE	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Delores St - turn Left and proceed South to 22nd St - turn left onto 22nd St - proceed to Quane St - Site is on Quane St just S of 22nd St.	
68	MapArt		G-8	NOE	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St. - turn right onto 15th St. proceed 100 yards to Noe St. and turn left (S) onto Noe St. Site is on West side of Noe between Jersey St. & & 24th St.	
69	MapArt		H-8	NOE	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Delores - turn left and travel South on Delores to 29th St. turn right (West) and proceed to Noe turn left (South) on Noe. Site is on Noe between Day and 30th St across from Kate Kennedy school.	Resident says he picks up cigarette butts, pop cans, candy wrappers and fast food bags everyday.
70	MapArt		J-9	MISSION	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St then left onto South Van Ness St. then turn left onto 4th St ; Turn Right onto Cesar Chavez then left onto Mission St. Site is on Mission St. just south of Bosworth St..	

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
71	MapArt		K-9	SILVER	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St then left onto South Van Ness St. then turn left onto 4th St ; Turn Right onto Cesar Chavez then left onto Mission St. Proceed to Silver St. and turn left (east) Site is between Edenborough and Napels St.	WTS & lots of gun on sidewalk, pedestrian tells us this neighborhood needs a sidewalk cleaner.
72	MapArt		K-8	PERSIA	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St then left onto South Van Ness St. then turn left onto 4th St ; Turn Right onto Cesar Chavez then left onto Mission St. Proceed to Persia Ave. and turn left (southeast) Site is between Madrid and Edenborough St.	
73	MapArt		K-8	CAYUGA	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Guererro St. - turn left onto Guererro St - proceed south to Cesar Chavez turn left proceed to Mission St - - turn left onto Mission proceed to Ocean Ave. turn right and then turn left onto Cayuga Ave. Site is on Cayuga Ave. in green space south of Onondaga Ave. across from Balboa High School and starts 4 car lengths below Junior Terrace along the school wire fence side of Cayuga.	
74	MapArt		L-7	ALEMANY	Boulevard	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Guererro St. - turn left onto Guererro St - proceed south to Cesar Chavez turn left proceed to Mission St - - turn Right onto Mission proceed to Ocean Ave. turn right proceed to Alemany Ave turn left onto Alemany. Site is on Alemany Ave just past Naglee.	
75	MapArt	E-80	C-9	OCTAVIA	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel N on Sansome - turn left (west) onto California - proceed to Franklin St.- proceed N on Franklin then left (west) onto Sutter St then right onto Octavia St. . Site is on Octavia North of Sacremento St in Lafayette Pk.	
76	MapArt		K7	SAN JOSE	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 10 th St - turn left (S) and proceed to Mission St turn right onto Mission- proceed on Mission to Ocean Ave - turn right onto Ocean Ave then right onto San Jose Ave. Site is in front of Balboa Park (actually in front of park on San Jose)	Homemade container on site for storing doggy bags.
77	MapArt		K-8	DELANO	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St turn left onto Guererro St. and proceed south on Guererro St. which becomes San Jose Ave. Turn left onto Santa Ysabel Ave. then turn Right onto Delano Ave. Site is on Delano between Santa Ynez Ave and San Juan Ave.	No large litter on site.
78	MapArt		K-8	SANTA ROSA	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St turn left onto Guererro St.. and proceed south on Guererro St. which becomes San Jose Ave. Turn left onto Santa Rosa Ave. Site is on Santa Rosa starting at number 239 Santa Rosa Ave.	No small litter on site.
79	MapArt		K-7	JUDSON	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St turn left onto Guererro St. and proceed south on Guererro St. which becomes San Jose Ave. Turn right onto Joost Ave.then turn left onto Foerester St. and then left onto Judson Ave. Site is on Judson east of Foerester	
80	MapArt		J-7	MOLIMO	Drive	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St turn left onto Guererro St. and proceed south on Guererro St. which becomes San Jose Ave. Turn right onto Joost Ave. then turn right onto Foerester and left onto Palmos Dr. then right on Molimo Dr. Site is on Molimo Dr. just after Myra Way on right side.	

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
81	MapArt		G-7	TWIN PEAKS	Boulevard	Travel SW on Market St. Continue on Market past 17th St. towards Diamond Heights Park. Turn right (north) on Twin Peaks. Site is on Twin Peaks 50 yards past Panorama on right side of road.	
82	MapArt		H-6	WOODSIDE	Avenue	Travel Sw on Market St. continuing past 17th Ave. Turn onto Woodside Ave. Park on Woodside near Balceta.	
85	MapArt		L-6	BROAD	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Guererro St. - turn left onto Guererro St which becomes San Jose Ave. then turn right onto Broad St. Site is on Broad St. between Capitol St. and Orizaba Ave.	
86	MapArt		K-3	GELLERT	Drive	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to Guererro St. which becomes San Jose Ave. then turn right onto Ocean Ave.then turn left onto Eucalyptus Ave. then left onto Middlefield Dr. then right onto Merced Blvd. then right onto Gellert Dr. Site is on Gellert Dr. on left side in green space.	
87	MapArt		H-3	VICENTE	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St untill it becomes Portola Dr. then turn right onto Vicente St. Site is on Vicente just west of 35 Ave.	
88	MapArt		G-3	NORIEGA	Street	From HRD's offices travel N on Sansome St to Geary St - turn left onto Geary and proceed (quite a long way) past Masonic St and towards the Univ. of San Francisco - Continue to Stanyan turn left (S) on Stanyan and proceed past Golden Gate park then turn right (W) onto Frederick St. which turns into Lincoln Way then proceed on Lincoln Way to 32 Ave - turn left onto 32 Ave and proceed to Noriega St - turn right on Noriega - Site is immediately after turn on Noriega.	
89	MapArt		G-2	NORIEGA	Street	From HRD's offices travel N on Sansome St to Geary St - turn left onto Geary and proceed (quite a long way) past Masonic St and towards the Univ. of San Francisco - Continue to Stanyan turn left (S) on Stanyan and proceed past Golden Gate park then turn right (W) onto Frederick St. which turns into Lincoln Way then proceed on Lincoln Way to 32 Ave - turn left onto 32 Ave and proceed to Noriega St - turn right on Noriega. Site is near the end of Noriega. just west of 44th Ave across from Union 76 Gas Station and next to Noriega Child Development Centre.	Site is big dumping ground for home applicances.
90	MapArt		F-3	KIRKHAM	Street	From HRD's offices travel N on Sansome St to Geary St - turn left onto Geary and proceed (quite a long way) past Masonic St and towards the Univ. of San Francisco - Continue to Stanyan turn left (S) on Stanyan to Frederick St. which becom Lincoln Way then proceed on Lincoln Way to Sunset Blvd - turn left (S) onto Sunset Blvd. to Kirkham turn right onto Kirkham - Site on south side of Kirkham St. between 38th and 39th Ave.starting next to house #1501 38th Ave.	Extremely windy day.

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
91	MapArt		F-3	LAWTON	Street	From HRD's offices travel N on Sansome St to Geary St - turn left onto Geary and proceed (quite a long way) past Masonic St and towards the Univ. of San Francisco - Continue to Stanyan turn left (S) on Stanyan and proceed past Golden Gate park then turn right onto Frederick St. which becomes Lincoln Waythen turn left onto 29th Ave. turn right onto Lawton St . Site is bewtween 29th Ave and 30th Ave. on the north side of the street.	
93	MapArt		E-7	WALLER	Street	From HRD's offices travel N on Sansome St to Geary St - turn left onto Geary and proceed (quite a long way) past Masonic St and towards the Univ. of San Francisco - Continue to Stanyan turn left (S) on Stanyan then left onto Waller St. Site is on Waller St. on the north side of the street.Waller St just east of Stanayan St.	Extremely windy day.
94	MapArt		E-8	CASTRO	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St then turn right (north) onto Castro St. Site is on the east side of Castro St. north of 14th St.	
95	MapArt		D-8	ELLIS	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St then turn right (west) onto Geary Blvd. then left (south) onto Divisadero St then turn right onto Ellis. Site is on Ellis St. immediately west of Divisadero St. on N side of street.	Photo #4 is of vacant lot behind gas station and east of 2034 Ellis. Most trash is near street.
96	MapArt		C-8	DIVISADERO	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St then turn right (west) onto Geary Blvd. then right onto Divisadero St. Site is on Divisadero between Sacramento St. and Clay St. on right side .	Very clean and tidy with no small litter.
97	MapArt	A-82	A-10	BEACH	Street	From HRD's offices travel N on Sansome St. turning left onto Broadway St. then left (NW) onto Columbus Ave and then right (N) onto Jones St. then right (east) onto Beach St. .Site is on the south side of Beach St. between Jones St. and Taylor St.	
98	MapArt		B-8	DIVISADERO	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St then turn right (west) onto Geary Blvd. then right onto Divisadero St. Site is betweeen Greenwich St and Lombard St. on right side.	
99	MapArt	A-83	A-10	THE EMBARCADERO	Boulevard	From HRD's offices travel N on Sansome St. then turn left onto The Embarcadero. 'Site is on the south side of The Embarcadero just after Beach St. in the park opposite the Pier 41 Blue & Gold Fleet Terminal	No large litter found on site.
101	MapArt		D-6	STANYAN	Boulevard	From HRD's offices travel SW onMarket St and turn right (west) onto Geary St - turn left (south) onto Stanyan Blvd. Site is on East side of Stanyan Blvd. between Anza St. and Turk St.	Very clean site.
102	MapArt		D-6	6TH	Avenue	From HRD's offices travel SW onMarket St and turn right (west) onto Geary St - turn left (south) onto Stanyan Blvd then turn right onto Balboa St. then left (south) onto 6th 'ave. The site is in front of Frank Mccoppin south of Balboa and north of Cabrillo.	School custodian says the place is constantly getting dumped on. She cleans the sidewalk everyday.

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
103	MapArt		E-4	FULTON	Street	From HRD's offices travel SW onMarket St and turn right (west) onto Geary St - turn left (south) onto 27th Ave. and then right (west) onto Fulton St. 'Site is on Fulton Street starting at 27th and heading west toward 28th Avenue on the south side of the street in front of the Golden Gate Park	
104	MapArt		D-5	12TH	Avenue	From HRD's offices travel N on Sansome St to Geary St - turn left onto Geary and proceed (quite a long way) past Masonic Ave. and towards the Univ. of San Francisco - Continue past Stnayan Blvd.and turn left (south) onto12th Ave. Site is on west side of 12 th Ave just south of of Anza St. Between Anza St. and Balboa St.	Street was repaved 3 days prior to litter audit.
105	MapArt		D-5	GEARY	Boulevard	From HRD's offices left onto Bush St then right onto Market Stravel SW on Market St. turn right (west) onto Geary Blvd. Site is on the north side of Geary between 16th Ave. and 17th Ave.	
106	MapArt		D-3	CLEMENT	Street	From HRD's offices left onto Bush St then right onto Market Stravel SW on Market St. turn right (west) onto Geary Blvd. then right (north) onto 36th Ave. and then left (west) onto Clement St. Site is on Clement, east of 36th Ave.	Very clean site.
107	MapArt		D-2	POINT LOBOS	Street	From HRD's offices left onto Bush St then right onto Market Stravel SW on Market St. turn right (west) onto Geary Blvd. and then turn right (west) onto Point Lobos Ave. Site is on Point Lobos between 45th and 46th Ave.	Very windy day.
108	MapArt		E-2	FULTON	Street	From HRD's offices travel SW onMarket St and turn right (west) onto Geary St - turn left (south) onto 27th Ave. and then right (west) onto Fulton St. Site is on Fulton just west of 40th Ave in green space area	
109	MapArt	H-84	D-11	SHERMAN	Street	SW on Market St to 6th St.; S on 6th St. to Harrison St.; turn right (north) on 7th St. then right on Cleveland St. then right (SE) onto Sherman St. Site on left side of Sherman St in front of Bessie Carmichael School just North of Harrison St.	
110	MapArt	H-85	D-12	BRANNAN	Street	SW on Market Street, S on 4th Street, go under the I80. Brannan is the 3rd street past I80. Site on Brannan between 4th and 5th Streets.	
111	MapArt	F-86	C-12	BEALE	Street	From Market Street turn south on Beale. Site is between Beale and Folsom.	
112	MapArt		H-12	3RD	Street	SW on Market; turn S onto 4th Street and proceed to 3rd St; turn right (south) onto 3rd St. proceed past Evans St. Site on West side of 3rd St. just south of Galvez Ave.	
113	MapArt		J-12	3RD	Street	From Market Street turn S onto 4th St; proceed to 3rd St. and turn right (south) onto 3rd St. and proceed south past Cesar Chavez St and Evans Ave. Site is on 3rd St. just North of Underwood. Site should be done on east side of 3rd if possible.	
114	MapArt		K-12	3RD	Street	From Market Street turn S onto 4th St; proceed to 3rd St. and turn right (south) onto 3rd St. and proceed south past Cesar Chavez St and Evans Ave. 'Site is on 3rd St. between Hollister and Ingerson on the west side.	

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
200	MapArt	H-82	D-10	9TH	Street	Proceeding SW on Market Street then turn left (SE) onto 8th St. then turn right (northwest) onto 9th St. Site is on left side (west) between Atoma and Minna St.	
201	MapArt	H-83	D-10	7TH	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St to 7th St - turn left(SE) onto 6th St then turnf right (SW) onto Harrison St. then right (NW) onto 7th St. Site is on east side of 7th St.just before Howard St.	
202	MapArt	H-80	D-9	BUCHANAN	Street	Travel SW on Market Street then right (north) onto Van Ness Ave. then left (west) onto Hayes St. and then south onto Buchanan St. Site is on Buchanan St. just North of Fell St	
203	MapArt	J-80	E-9	BUCHANAN	Street	Travel Sw on Market St. then turn right (west) onto Hermann St. then turn right onto Buchanan St. Site is on the west side between Hermann and Waller St.	
204	MapArt		G-10	FOLSOM	Street	Travel SW on Market St. and then left (SE) onto 4th St. then turn right (SW) onto Howard St. then turn left (east) onto 22nd St. then turn right (south) onto Folsom St. Site is on west side of Folsom St. between 22nd and 23rd St.	Very windy. Lots of things blowing around. More garbage in knooks & crannies.
205	MapArt		F-11	HAMPSHIRE	Street	Travel SW on Market St. turn left (SE) onto 10th St. and proceed under Hwy. 101 and 10th becomes Potrero Ave. Continue south and turn right (west) on 22nd St. then right (north) onto Hampshire St. 'Site is on right (east) side of Hampshire St - between 22nd St. and 21st St.	Very clean street.
206	MapArt		G-9	24TH	Street	Travel SW on Market St. then turn left (south) onto Church St. and then right (west) onto 24th St. Site is on south side of 24th St. east of Sanchez St.	Veryf clean site.
207	MapArt		K-8	MEDA	Avenue	From HRD office - travel SW on Market St to Van Ness - turn left onto Van Ness to Mission - turn right onto Mission and proceed past Hwy 280 to Onondaga Ave turn right on Onondaga Ave proceed to Oteso Ave turn right and proceed to Meda (which is just past Ocean Ave.) and turn left onto Meda. Site starts at 2 Meda and goes across Ostago along Meda and dead ends at Ocean.	
208	MapArt		K-8	COTTER	Street	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St. then turn left onto South Van Ness and then right onto Mission St. continue past Silver Ave. and turn right (NW) onto Cotter St. Site on Cotter 50 feet from Misson on public library side.	The further away form Mission Stl. The cleaner it gets.
209	MapArt		K-6	OCEAN	Avenue	Commencing at HDR's Offices (Sansome/ Bush) - travel SW on Market St. then turn left onto South Van Ness and then right onto Mission St. then right onto Ocean Ave. Site is on Ocean between Phelan & Plymouth in green space on right (north) side of street.	Used green space on Ocean & Phelan (corner space) because actual green space on Ocean was fenced off.
210	MapArt		D-7	ASHBURY	Street	Proceed SW on Market and turn right (west) onto Geary St. which turns into Geary Blvd. and then turn left (south) onto Masonic Ave. and then turn right (west) onto Grove St. and then right onto Ashbury St. Site is on west side of Ashbury St. just south of Fulton St	

Site Id	Map Source	Map Insert Co-ordinate	Main Map Co-ordinate	Site_name	Site_type	Directions	Additional Comments
211	MapArt		F-7	STANYAN	Street	Proceed SW on Market and turn right (west) onto Geary St. which turns into Geary Blvd. then turn left onto Stanyan Blvd. which turns into Stanyan St. 'Site is on the west side of Stanyan St. at 17th St, near the interior green belt area.	Resident stated "It's messy on Tuesdays after they pick up the garbage."
212	MapArt		C-7	PRESIDIO	Avenue	From HRD's offices travel N on Sansome St to Geary St - turn left onto Geary and proceed west to Presidio Ave - turn right (N) - site is on Presidio across the street from Fire Dept Museum.	
213	MapArt	E-81	B-9	FRANKLIN	Street	Travel North on Sansome St. and turn left (west) onto California St. and then turn right (north) onto Frankling St. Site is on Franklin - St. just north of Washington St.on right side.	
301	MapArt		A-8	CERVANTES	Boulevard	Travel north on Sansome St. then turn left (west) onto Broadway then turn right (NW) onto Columbus Ave. and then turn left (west) onto Bay St. and continue until Bay St. becomes Cervantes. Site is on Cervantes St. just past Beach St.	
302	MapArt		F-6	PARNASSUS	Avenue	Travel west on Market St. to 17th St.; then proceed west on 17th St. to Stanyan St.; turn right onto Stanyan St. and proceed north to Parnassus Ave. Site is on Paranassus Av e. in front of the University of California San Francisco Medical Centre.	
303	MapArt		F-9	CHURCH	Street	Proceed west on Market St. then turn south onto Church St. Site is on the west side of Church St. between 18th Street and Hancock St.	NW side of Mission Park near Mission High School - mostly bigger stuff on hillside.
304	MapArt		F-5	LAWTON	Street	Travel west on Market St. to 17th St.; then proceed west on 17th St. to Stanyan St.; turn right onto Stanyan St. and proceed north to Parnassus Ave. Turn left (west) onto Parnassus Ave. to 12th Ave. and turn left (south) to Lawton St. Site is on the north side of Lawton in front of the Alice Fong Yu school.	
305	MapArt	J-86	E-12	CHANNEL	Street	Travel east on Market St. and turn leftt (south) onto 4th St. crossing over the China Basin Channel. Take the first right after the Channel which is Channel St. Site is on the south side of Channel St. in front of Giants Parking Lot B.	Ball park site.
306	MapArt		H-4	22ND	Avenue	Proceed west on Market St. until it turns into Portola Dr. Continue southwest on Portola Dr. to Vicente St. Turn right onto Vincente St. and proceed west to 22nd Ave. Turn right (north) onto 22nd Ave. Site is on 22nd Ave. north of Rivera St. in front of the Abraham Lincoln School.	
307	MapArt		K-5	19TH	Avenue	Proceed west on Market St. until it turns into Portola Dr. Continue southwest on Portola Dr. to Sloat Blvd. Turn right onto Sloat Blvd. and proceed west to 19th Ave. Turn left (south) onto 19th Ave. Site is on the west side of 19th Ave. adjacent to the San Francisco University Subway Station.	Spoke with custodian who said they clean up every morning Monday - Friday.
308	MapArt		J-14	INNES	Avenue	Travel east on Market St. to 4th St.and turn right onto 3rd St. and proceed south on 3rd. St. to Evans Ave. Turn left onto 3rd St. which turns into Hunter Point Blvd. and then into Innes Ave. Site is on Innes Ave. just before Donahue St.	Major housing development being built jus to the southeast.

132 Number of sites

APPENDIX 3 – Site Rankings

2008 Ranking	Site Id	2007 Ranking	Site_name	2008 Total Items / Site		
1	305	Not done	CHANNEL	372		Above average
2	73	3	CAYUGA	179		Above average
3	39	12	15TH	125		Above average
4	64	6	SHOTWELL	122		Above average
5	204	24	FOLSOM	97		Above average
6	79	37	JUDSON	95		Above average
7	48	Not done	MARIPOSA	81		Above average
7	49	25	MARIN	81		Above average
8	88	21	NORIEGA	80		Above average
9	66	79	21ST	73		Above average
10	53	13	EVANS	71		Above average
11	62	53	FOLSOM	70		Above average
12	58	55	CRESCENT	69		Above average
13	50	31	CESAR CHAVEZ	67		Above average
14	209	43	OCEAN	66		Above average
15	70	32	MISSION	65		Above average
16	82	Not done	WOODSIDE	64		Above average
16	102	Not done	6TH	64		Above average
17	89	78	NORIEGA	61		Above average
18	110	85	BRANNAN	58		Above average
19	63	62	TREAT	57		Above average
20	303	Not done	CHURCH	56		Above average
21	208	41	COTTER	54		Above average
22	105	49	GEARY	49		Above average
23	86	104	GELLERT	46		Above average
25	95	17	ELLIS	45		Above average
25	40	62	TREAT	45		Above average
26	41	88	DE HARO	44		Above average
27	51	45	MARIN	43		Above average
28	65	33	22ND	42		Above average
29	46	91	22ND	41		Above average
30	107	Not done	POINT LOBOS	40		Above average

2008 Ranking	Site Id	2007 Ranking	Site_name	2008 Total Items / Site		
31	91	20	LAWTON	39		Above average
32	205	70	HAMPSHIRE	38		Above average
32	307	90	19TH	38		Above average
33	3	Not done	UNION	37		Above average
34	44	90	19TH	36		Above average
35	114	4	3RD	35		Above average
36	68	100	NOE	32		Above average
37	1	34	FRANCISCO	31		Above average
37	6	64	DAVIS	31		Above average
37	67	16	QUANE	31		Above average
38	71	10	SILVER	30		**Average**
38	16	Not done	MASON	30		**Average**
39	306	Not done	22ND	29		Below average
39	308	Not done	INNES	29		Below average
40	207	44	MEDA	28		Below average
40	61	66	23RD	28		Below average
41	13	2	FREMONT	27		Below average
42	21	9	04 TH	27		Below average
42	60	65	CESAR CHAVEZ	27		Below average
43	103	84	FULTON	26		Below average
43	7	38	WASHINGTON	26		Below average
44	43	23	INDIANA	25		Below average
45	108	84	FULTON	24		Below average
45	304	20	LAWTON	24		Below average
45	25	54	HOWARD	24		Below average
46	56	74	BACON	23		Below average
46	93	27	WALLER	23		Below average
46	112	61	3RD	23		Below average
47	42	102	16TH	22		Below average
48	69	35	NOE	22		Below average
49	302	Not done	PARNASSUS	21		Below average
50	111	8	BEALE	20		Below average
51	72	14	PERSIA	19		Below average
52	78	67	SANTA ROSA	18		Below average
52	17	86	TAYLOR	18		Below average
52	109	63	SHERMAN	18		Below average
52	37	Not done	MARKET	18		Below average
53	81	Not done	TWIN PEAKS	17		Below average
53	211	58	STANYAN	17		Below average
54	35	28	FELL	16		Below average
55	80	98	MOLIMO	15		Below average
56	54	1	PHELPS	14		Below average
56	57	93	BACON	14		Below average
57	87	36	VICENTE	13		Below average
57	10	7	THE EMBARCADERO	13		Below average
57	29	71	LARKIN	13		Below average
57	98	89	DIVISADERO	13		Below average
58	76	5	SAN JOSE	12		Below average
58	27	30	LEAVENWORTH	12		Below average
58	45	Not done	ARKANSAS	12		Below average
59	34	84	FULTON	11		Below average
59	104	48	12TH	11		Below average
60	55	29	MCKINNON	10		Below average
60	97	Not done	BEACH	10		Below average

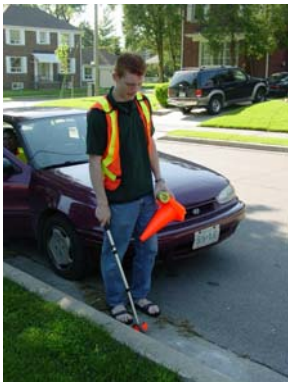
2008 Ranking	Site Id	2007 Ranking	Site_name	2008 Total Items / Site		
60	33	84	FULTON	10		Below average
60	15	96	MONTGOMERY	10		Below average
61	14	77	PETRARCH	9		Below average
61	38	Not done	MCCOPPIN	9		Below average
61	85	51	BROAD	9		Below average
61	96	89	DIVISADERO	9		Below average
62	8	68	POWELL	8		Below average
62	74	50	ALEMANY	8		Below average
62	106	Not done	CLEMENT	8		Below average
62	202	60	BUCHANAN	8		Below average
62	19	99	GEARY	8		Below average
63	22	59	KING	7		Below average
63	94	Not done	CASTRO	7		Below average
63	18	Not done	BUSH	7		Below average
63	24	47	RUSS	7		Below average
63	30	22	GOLDEN GATE	7		Below average
63	75	94	OCTAVIA	7		Below average
63	200	52	9TH	7		Below average
64	12	81	HOWARD	6		Below average
64	36	76	MISSION	6		Below average
64	26	11	STEVENSON	6		Below average
65	52	61	03 ST	5		Below average
65	59	106	PRENTISS	5		Below average
65	90	75	KIRKHAM	5		Below average
65	23	80	RUSS	5		Below average
66	31	40	ELLIS	4		Below average
66	301	Not done	CERVANTES	4		Below average
66	4	46	FILBERT	4		Below average
66	5	105	JASPER	4		Below average
67	9	56	GRANT	3		Below average
67	20	76	MISSION	3		Below average
67	47	57	26TH	3		Below average
67	203	73	BUCHANAN	3		Below average
67	206	26	24TH	3		Below average
67	210	19	ASHBURY	3		Below average
68	32	72	POST	2		Below average
68	101	58	STANYAN	2		Below average
68	113	61	3RD	2		Below average
68	212	Not done	PRESIDIO	2		Below average
68	213	95	FRANKLIN	2		Below average
69	2	Not done	THE EMBARCADERO	1		Below average
69	11	103	DRUM	1		Below average
69	28	87	MCALLISTER	1		Below average
69	201	92	7TH	1		Below average

3,973

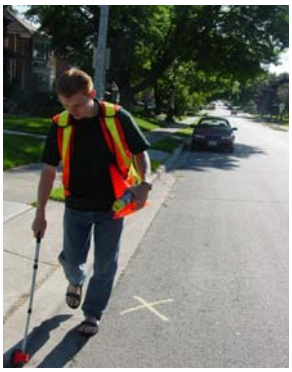
APPENDIX 4 - Photos - Setting up a Site

Large Litter Audits

- Team Arrives at the site, Measures 50ft. ahead of car, sets up site



- Marks starting point – mid-point and end of site



- Takes photos of site

- Then walks site – describing the large litter – and dictating into a tape recorder

Photos - Small Litter – Set up and Counting

- While team member is completing large litter count – small litter frame is used to examine small litter

- Small litter is examined at close range In order to see, count and describe

- Three “flips” counted at each site

APPENDIX 5 - Branded Litter Survey
(2008)

PREPARED FOR

San Francisco Environmental Services

PREPARED BY MGM Management
www.mgm-management.com
July 2008

Appendix 5 - Branded Litter Survey

1.0 Methodology – Branded Litter

Using the Surveyor Site Form (with 84 categories of large litter) as a guide, data observing the names of manufacturers and brand owners of littered materials were recorded. Branded litter is described as any large litter (i.e. over 4 square inches) that has a recognizable brand name affixed. Where doubt occurred in the brand of the item – no entry was made.

Auditors identified litter by brand name, which was later transcribed onto Site Survey Forms, for data entry and analysis.

2.0 Branded Litter Results

2.1 Beverage Branded Litter

Beer cans represent an insignificant contribution to large litter in the City of San Francisco. Only a few beer containers (4 cans in total) of any brand were observed during the audit. We deem this sample to be too small to be statistically valid for commenting on the distribution of beer container litter on San Francisco streets.

Only 1 brand of beer cans observed:

Cans

- Steel Reserve

Beer Bottles

- The 3 beer bottles observed were too weathered to be indentified.

2.2 Soft Drink Cans - Branded Litter

Soft drink containers were also a relatively small contributor to large litter on San Francisco streets. Only a few soft drink beverage containers were brand identified by auditors (10 containers in total). We deem this sample to be too small to be statistically valid for commenting on the distribution of soft container brands on San Francisco streets; however we report the observations below.

Brands of soft drinks observed:

Coca-Cola	3	30%
7-UP	1	10%
Honey Bee	1	10%
Hong Van	1	10%
Mist	1	10%
Pepsi	1	10%
Red Bull	1	10%
Vernors	1	10%
	10	100%

2.3 Bottled Water - Branded Litter

Only 11 plastic water bottles were observed by litter auditors in 2008.

Discussion: Bottled water has continued to be a growth packaged beverage for people on the go. Sales of bottled water have been reported growing at over 10% per year in various trade magazines.

Five brands of water bottles observed as litter on San Francisco streets in the 2007 litter audit; these were:

VOSS
Kirkland
Arrowhead
Crystal Geyser
Alhambra

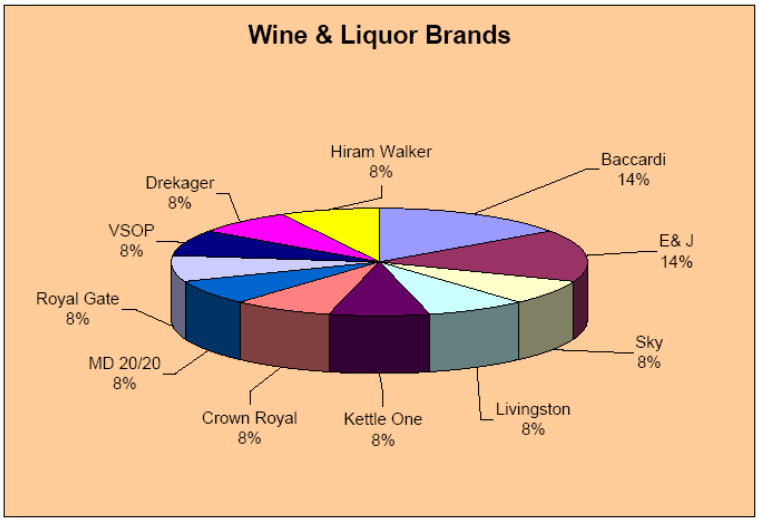
2.4 Sport Drinks - Branded Litter

Discussion: Sport drinks were not a significant component of total large litter on San Francisco streets. Only 5 sports drink containers were observed in the 2007 audit. Two brand names were observed, 2 were Gatorade and 1 Western family brand.

2.5 Wine & Liquor - Branded Litter

Similar to the observations noted in the 2007 litter audit, wine & liquor large litter was not a significant component of total large litter on San Francisco streets. Thirteen branded containers in the wine & liquor category were observed in the 2008 San Francisco litter audit.

	Items	% of Group
Baccardi	2	15%
E& J	2	15%
Sky	1	8%
Livingston	1	8%
Kettle One	1	8%
Crown Royal	1	8%
MD 20/20	1	8%
Royal Gate	1	8%
VSOP	1	8%
Drekager	1	8%
Hiram Walker	1	8%
	13	100%

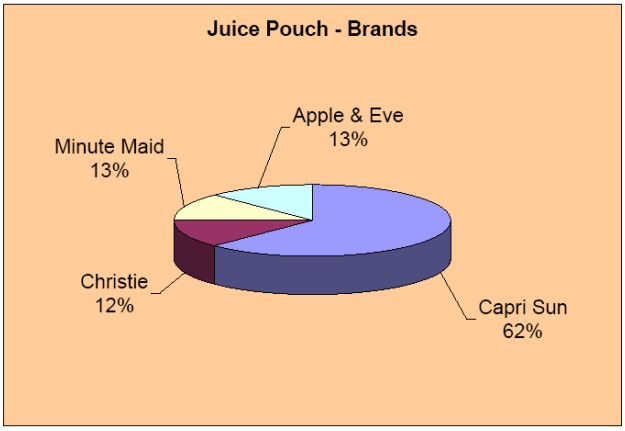


2.6 Milk & Juice - Branded Litter

Discussion: Only eight large litter items were observed within the milk and juice products subcategory. These were identified as Orangina, Starbucks and Kerns's , all of these items were glass containers.

2.7 Foil Pouch Drinks - Branded Litter

	Items	% of Group
Capri Sun	5	63%
Christie	1	13%
Minute Maid	1	13%
Apple & Eve	1	13%
	8	100%



Discussion: 26 pouch containers, with juice drink products were observed for this sub-category of large litter, of which 8 were positively identified by brands, Fice of those pouch items were Capri Sun, which accounted for 63% of the identified brands.

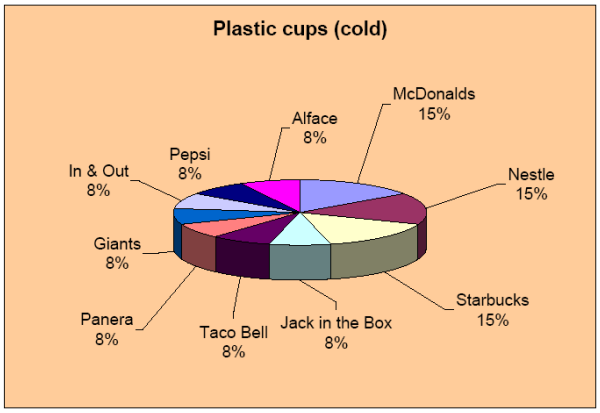
3.0 Cups, Lids and Cup Debris Branded Litter

This category encompasses all cold and hot drink cup litter, including lids.

In general sites near a coffee shop, fast-food outlet or other over-the-counter drink outlet were highest in their occurrence of cup debris.

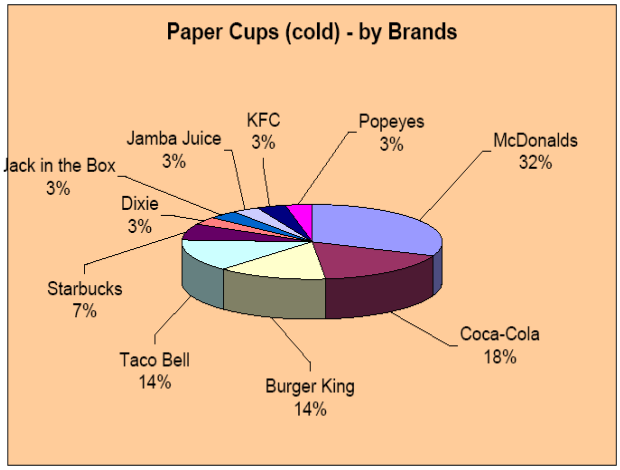
Presentation of the brand observations for this subcategory appears below.

	Items	% of Group
McDonalds	2	15%
Nestle	2	15%
Starbucks	2	15%
Jack in the Box	1	8%
Taco Bell	1	8%
Panera	1	8%
Giants	1	8%
In & Out	1	8%
Pepsi	1	8%
Alface	1	8%
	13	100%



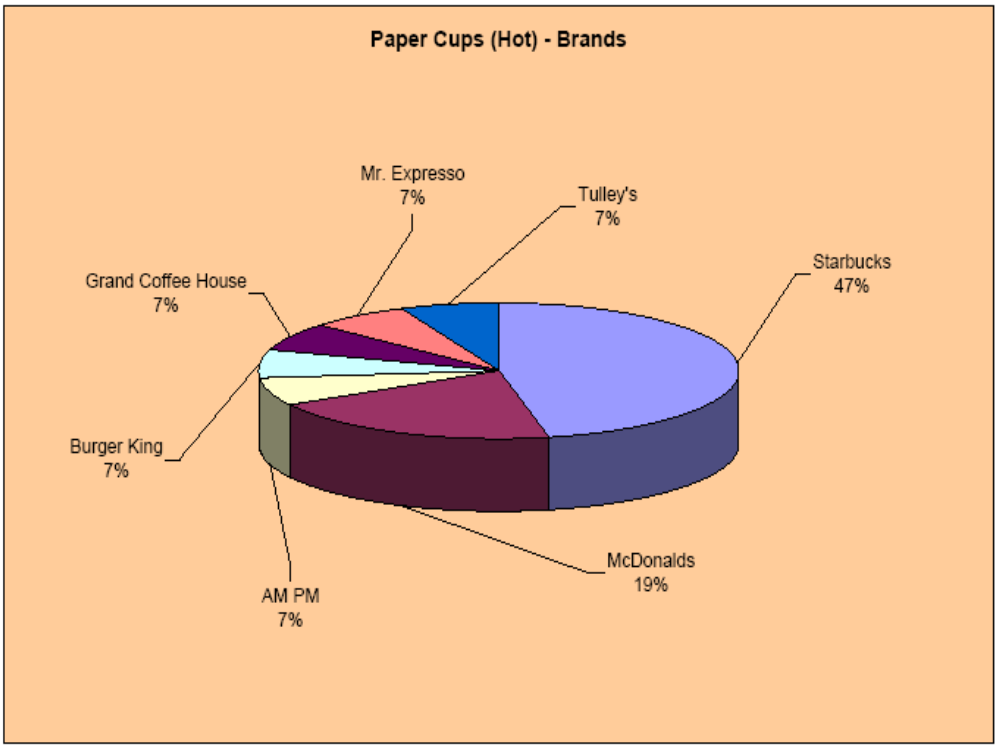
McDonalds, Starbucks and Nestle plastic drink cups represented 45% of the cups observed in this sub-category.

	Items	% of Group
McDonalds	9	31%
Coca-Cola	5	17%
Burger King	4	14%
Taco Bell	4	14%
Starbucks	2	7%
Dixie	1	3%
Jack in the Box	1	3%
Jamba Juice	1	3%
KFC	1	3%
Popeyes	1	3%
	29	100%



The 2008 San Francisco Litter audit also examined the brands of hot drink paper cups, normally associated with coffee shops. These brand results appear below.

	Items	% of Group
Starbucks	7	47%
McDonalds	3	20%
AM PM	1	7%
Burger King	1	7%
Grand Coffee House	1	7%
Mr. Expresso	1	7%
Tulleys	1	7%
	15	100%



In total 57 hot drink paper cups were observed in the 2008 litter audit. Of these, 15 were positively identified by brand. Starbucks and McDonalds accounted for 66% of the branded hot cup litter identified.

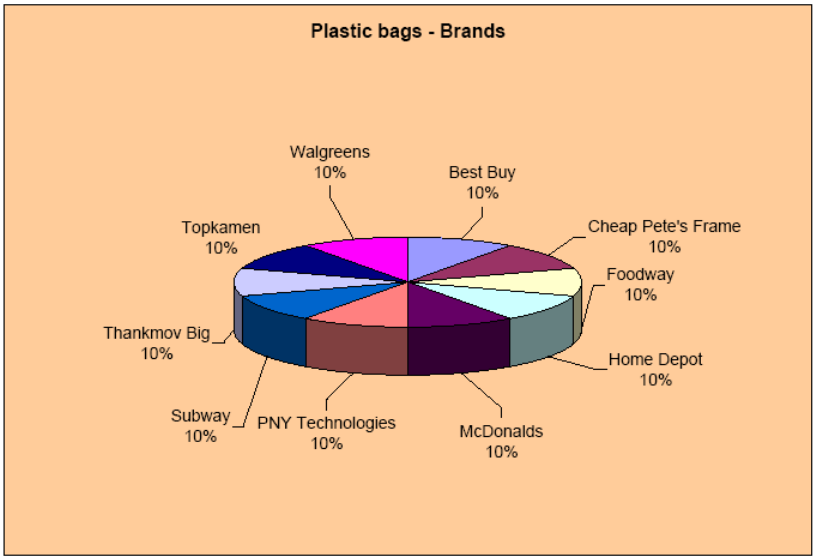
4.0 Bag Branded Litter

4.1 Plastic & Paper Retail and Paper Bags from Fast Food

In the 2008 San Francisco Litter Audit, field teams observed 26 items in the plastic retail bag sub-category. There were ten brands of plastic retail bags observed.

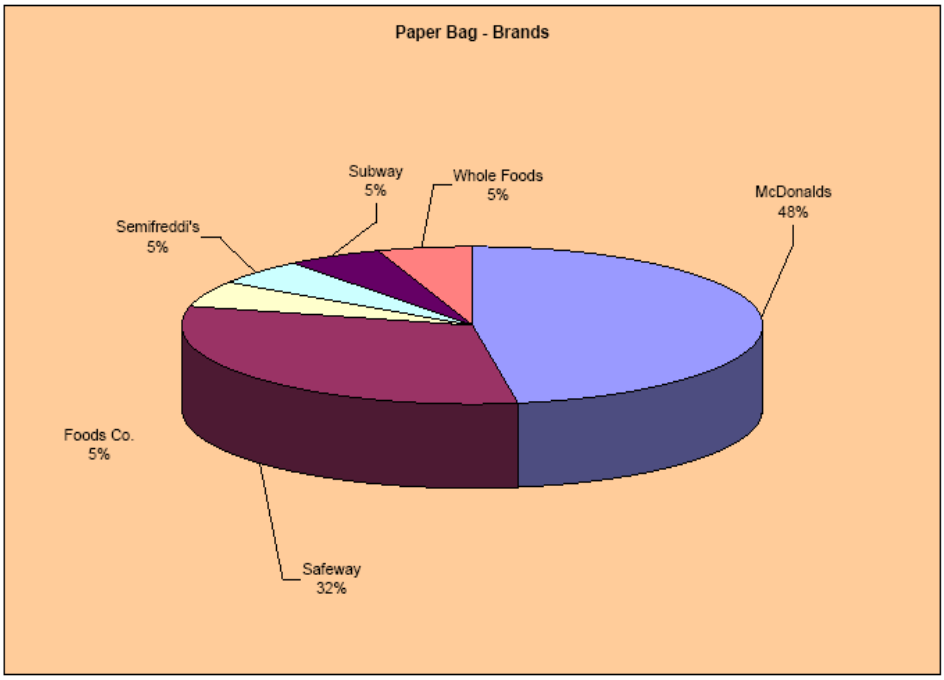
Plastic Bags - by Brand

	Items	% of Group
Best Buy	1	10%
Cheap Pete's Frame	1	10%
Foodway	1	10%
Home Depot	1	10%
McDonalds	1	10%
PNY Technologies	1	10%
Subway	1	10%
Thankmov Big	1	10%
Topkamen	1	10%
Walgreens	1	10%
	10	100%



Paper Bags - by Brand

	Items	% of Group
McDonalds	9	47%
Safeway	6	32%
Foods Co.	1	5%
Semifreddi's	1	5%
Subway	1	5%
Whole Foods	1	5%
	19	100%



In the paper bags sub-category, McDonalds and Safeway branded litter represented 79% of the brands observed.

5.0 Boxes, Cardboard Boxes, Other Containers, Food Wrap

The boxes sub-category of litter, contributed 3.34% of total large litter observed. Most of the large litter observed in this sub-category was not identifiable by brand. The brands that were observed were:

Paper clamshells with brands observed from Popeye's, Jack in a Box, McDonalds, Kari Out, and Burger King. Of 8 identified brands observed in this sub-category of paper clamshells, McDonalds represented 3 or 37%.

Other cardboard and paper board box materials identified were: Bud Light, Pepsi, SFD Tomatoes, Krispy Kreme, and Ankyo Development Ltd.

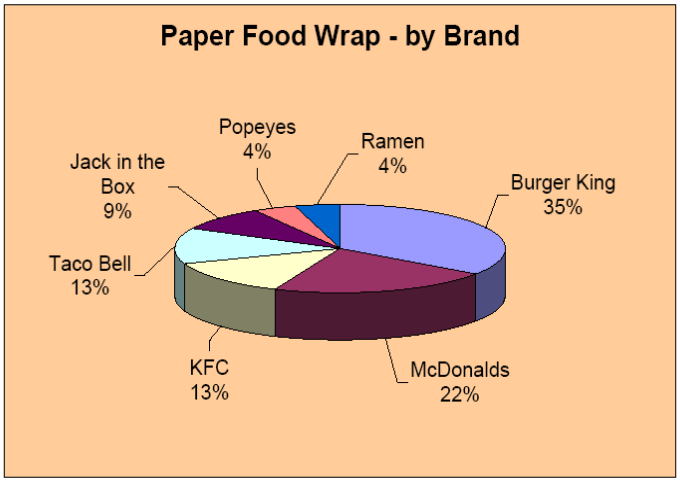
6.0 Fast Food Litter Brands Identified

6.1 Food Wraps - Brands

Brands observed in the wraps sub-category were 1.25% of total large litter and are illustrated below in terms of the brands observed.

Paper Food Wrap - by Brand

	Items	% of Group
Burger King	8	35%
McDonalds	5	22%
KFC	3	13%
Taco Bell	3	13%
Jack in the Box	2	9%
Popeyes	1	4%
Ramen	1	4%
	23	100%



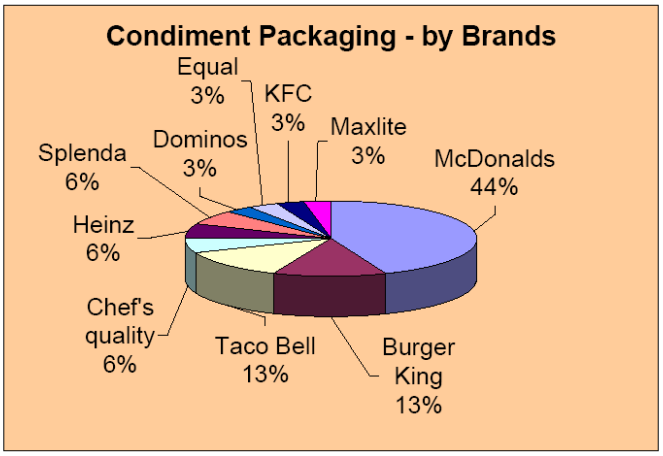
The litter audit teams observed other food wrap materials, such as plastic wraps, and plastic/composite foil wraps; however positive brand identifications could not be made.

6.2 Take-Out Extra Branded Litter

Take-out extras constitute a relatively significant contribution of large litter observed on San Francisco streets, with 150 items (3.79% of total large litter observed). Forty-four per cent of the take out litter observed were condiment packages, like salt, vinegar, ketchup packages etc. The brand observations for these items are illustrated below. Note that utensils do not normally carry any brand information therefore the data presented below represents only condiment packaging.

Take-Out Extras - Condiment Packaging

	Items	% of Group
McDonalds	14	44%
Burger King	4	13%
Taco Bell	4	13%
Chef's quality	2	6%
Heinz	2	6%
Splenda	2	6%
Dominos	1	3%
Equal	1	3%
KFC	1	3%
Maxlite	1	3%
	32	100%



7.0 Confectionary Branded Litter

Confectionary products comprised 7.61 % of total large litter in the San Francisco audit which is a significant amount of large litter. Below we illustrate the brands of products observed in this sub-category.

7.1 Brands of Gum Wrap Litter

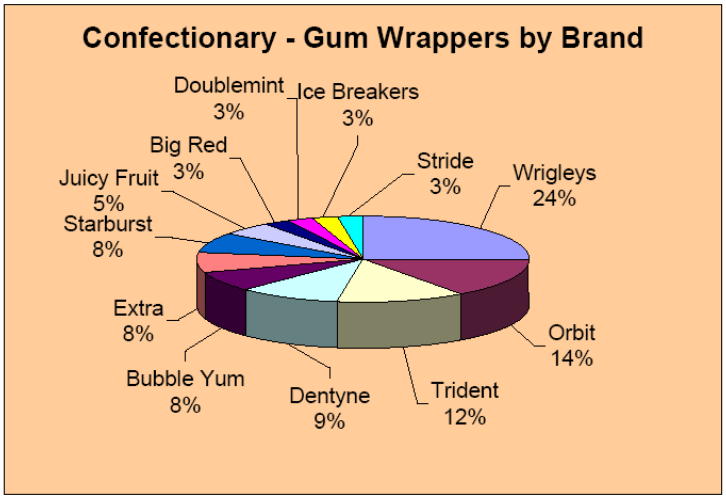
Gum litter appears to be a significant issue in San Francisco. Gum packaging litters the streets, and there are high occurrences of gum deposits on sidewalks and streets throughout the city. It should be noted that gum deposits on city streets was the largest sub-category of small litter observed in the 2008 litter audit.

In total 131 large litter items we observed as gum wrappers, of which 40 items were identifiable by brand.

Three brands make up over 63% of branded gum litter observed (Wrigley's, Trident, Dentyne, and Orbit). Attributing Juicy Fruit (5%) and Doublemint to Wrigley's, who own these brands, this company's brands accounted for 32% of gum wrapper litter on city streets.

Gum Wrappers - by Brand

	Items	% of Group
Wrigleys	10	25%
Orbit	6	15%
Trident	5	13%
Dentyne	4	10%
Bubble Yum	3	8%
Extra	3	8%
Starburst	3	8%
Juicy Fruit	2	5%
Big Red	1	3%
Doublemint	1	3%
Ice Breakers	1	3%
Stride	1	3%
	40	100%



7.2 Brands of Candy Wrap Litter

In the 2008 San Francisco litter audit 100 candy wraps were observed, which represent a significant contribution to total large litter at 2.52%. Of the 100 candy wraps observed, 43 were identifiable by brand. The brand identity of these candy wraps is illustrated below.

Candy Wrappers - by Brand

	Items	% of Group		Items	% of Group
Kit Kat	4	9.3%	Grandma's Cookies	1	2.3%
Hersheys	3	7.0%	Gummy Worms	1	2.3%
Snickers	3	7.0%	Kuds	1	2.3%
Blue Bunny	2	4.7%	Maya	1	2.3%
Cadbury	2	4.7%	Nature Valley	1	2.3%
Fruit by the Foot	2	4.7%	Nestle	1	2.3%
Halls	2	4.7%	Quaker Oats	1	2.3%
Mentos	2	4.7%	Reeses	1	2.3%
Twizzler	2	4.7%	Ricola	1	2.3%
Anne Candy	1	2.3%	Ricolino	1	2.3%
Baskin Robins	1	2.3%	Sperfari	1	2.3%
Cliff	1	2.3%	Starbursts	1	2.3%
Crunch	1	2.3%	Toblerone	1	2.3%
Ferrara Pan	1	2.3%	TWIX	1	2.3%
Ghirardelli	1	2.3%	York	1	2.3%
				43	100.0%

7.3 Brands of Candy Pouch Litter

In the 2007 litter audit, only eight brand observations were made for candy punch litter. However, in 2008, auditors were able to identify 23 candy pouch litter items as illustrated in the table below.

Candy Pouches - by Brand

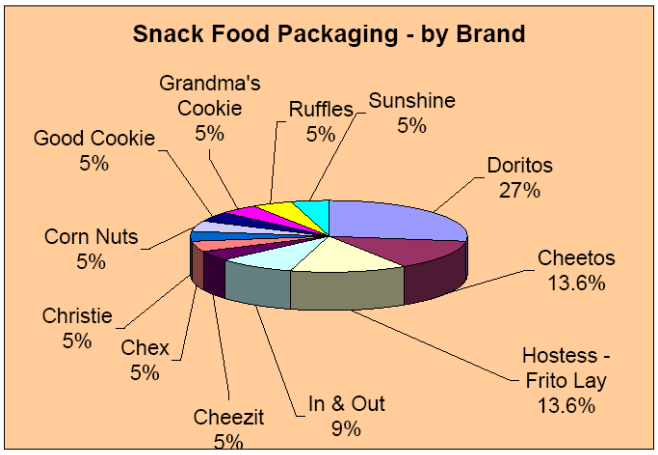
	Items	% of Group
Ricola	6	26.1%
M & M's	3	13.0%
Boston Baked Beans	2	8.7%
Fruit by the Foot	1	4.3%
Jelly Belly	1	4.3%
Lifesavers	1	4.3%
Mentos	1	4.3%
Pop Tart	1	4.3%
Redvines	1	4.3%
Reeses	1	4.3%
Sathers	1	4.3%
Starbursts	1	4.3%
Tootsie Roll	1	4.3%
Twizzler	1	4.3%
Werthers	1	4.3%
	23	100.0%

7.4 Brands of Snack Food (savoury & salted snacks) Litter

In the 2008 litter audit, 30 large items were observed in the snack food category, of which 22 were identifiable by brand.

Snack Food Packaging - by Brand

	Items	% of Group
Doritos	6	27.3 %
Cheetos	3	13.6 %
Hostess - Frito Lay	3	13.6 %
In & Out	2	9%
Cheezit	1	5%
Chex	1	5%
Christie	1	5%
Corn Nuts	1	5%
Good Cookie	1	5%
Grandma's Cookie	1	5%
Ruffles	1	5%
Sunshine	1	5%
	22	100.0 %



Doritos, Cheetos and Hostess-Frito Lay brand products account for 54% of the large litter identifiable in this sub-category.

8.0 Branded Printed Materials

In the sub-category of branded litter, printed material represents about 14.6% of the total large litter observed, and as such is a significant sub-category.

Printed materials of various types of newspapers and advertisements were a significant contributor to large litter, contributing 9.6 % of total large litter observed. Many of the pieces of large litter counted could not be positively identified as to the brand name of the producer of the printed material, due mostly to weathering of the litter, or shredding where lawn mowing activities may take place.

The printed materials that could be identified by brands are illustrated below.

8.1 Newspapers, Advertisements

Printed Materials - by Brand

	Items	% of Group		Items	% of Group
Wells Fargo	6	16.2%	Mervyns	1	2.7%
Boxing Boot Camp Ad	4	10.8%	Mensajero	1	2.7%
Examiner	2	5.4%	Memorex	1	2.7%
Welches	1	2.7%	Lucky Coupons	1	2.7%
Visa Gift Card	1	2.7%	Guardian	1	2.7%
Verison Wireless	1	2.7%	Greico	1	2.7%
Valley Yellow Pages	1	2.7%	Fed-Ex	1	2.7%
Spicy Bite	1	2.7%	El Santode Israel	1	2.7%
San Francisco Chronicle	1	2.7%	Dole	1	2.7%
Ralph Lauren	1	2.7%	Cow Palace	1	2.7%
Raley's	1	2.7%	Chevy's	1	2.7%
Pronto Pizza	1	2.7%	Bed Bath & Beyond	1	2.7%
New Ganges Restaurant	1	2.7%	Artisan Home Resor	1	2.7%
Neno Japanese Restaurant	1	2.7%			
Mr. Dao Tree Service	1	2.7%		37	100.0%

8.2 Business Forms (MUNI Tickets, business receipts etc)

Business forms, tickets, transfers and receipt litter continue to be of significance as a sub-category of large litter on San Francisco streets. Business forms as a sub-category represent 4.2 % of total large litter (5.3% in 2007).

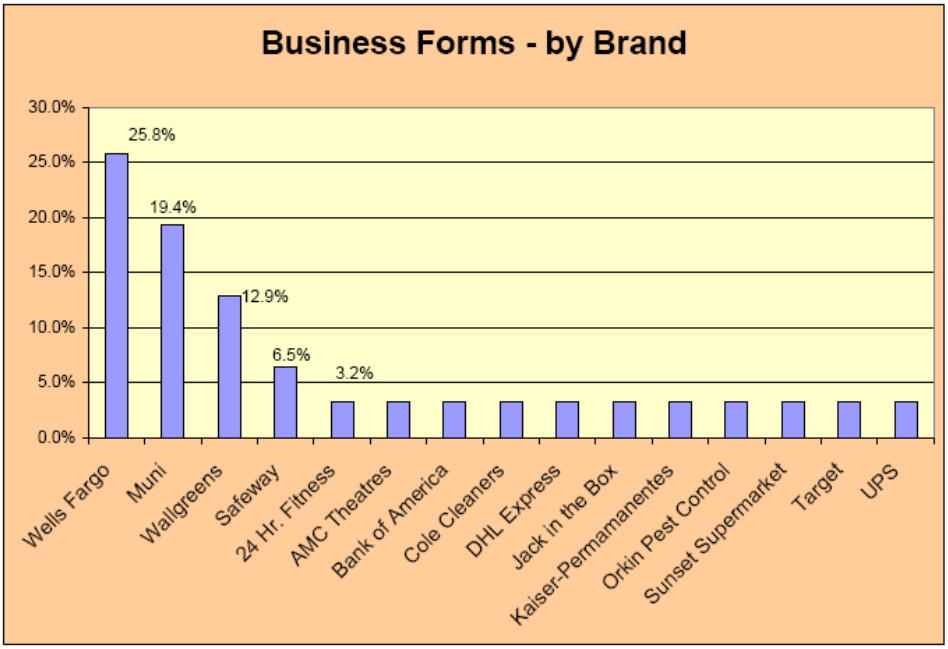
Much of the large litter observed in this sub-category was weathered to the point of not being able to make positive brand identification, or the business form did not have a brand name printed on it. Cash register receipts, courier forms, and transit tickets are examples of litter in this sub-category.

Wells Fargo receipts and printed forms accounted for 26% of the branded business forms observed, followed by MUNI tickets and transfers (19%). Transit ticket litter has been observed by the consultant at similar levels of total litter in other municipalities. This is an on-going issue for large municipalities, but one that may be reduced with a targeted effort.

See data details on the next page.

Business forms & Receipts - by Brand

	Items	% of Group
Wells Fargo	8	25.8%
Muni	6	19.4%
Wallgreens	4	12.9%
Safeway	2	6.5%
24 Hr. Fitness	1	3.2%
AMC Theatres	1	3.2%
Bank of America	1	3.2%
Cole Cleaners	1	3.2%
DHL Express	1	3.2%
Jack in the Box	1	3.2%
Kaiser-Permamanentes	1	3.2%
Orkin Pest Control	1	3.2%
Sunset Supermarket	1	3.2%
Target	1	3.2%
UPS	1	3.2%
	31	100.0%



9.0 Tobacco Litter

Tobacco packaging accounted for 145 large litter items (or 3.6% of total large litter). Of these observed items 78 were identified by brands, as illustrated below.

Marlboro, Parliament, Newport and Camel brands make up 74% of tobacco litter brands observed on San Francisco streets.

Tobacco Packaging - by Brand

	Items	% of Group
Marlboro	41	52.6 %
Parliament	7	9.0%
Newport	6	7.7%
Camel	3	3.8%
American Spirit	2	2.6%
Asian	2	2.6%
Chesterfield	2	2.6%
Kool	2	2.6%
Maverick	2	2.6%
Shuang xi	2	2.6%
Benson & Hedges	1	1.3%
Big Shot	1	1.3%
Chinese	1	1.3%
Midnight Special	1	1.3%
Royal Blue	1	1.3%
SSS	1	1.3%
USA Gold	1	1.3%
Winston	1	1.3%
Wvyesher	1	1.3%
	78	100.0 %

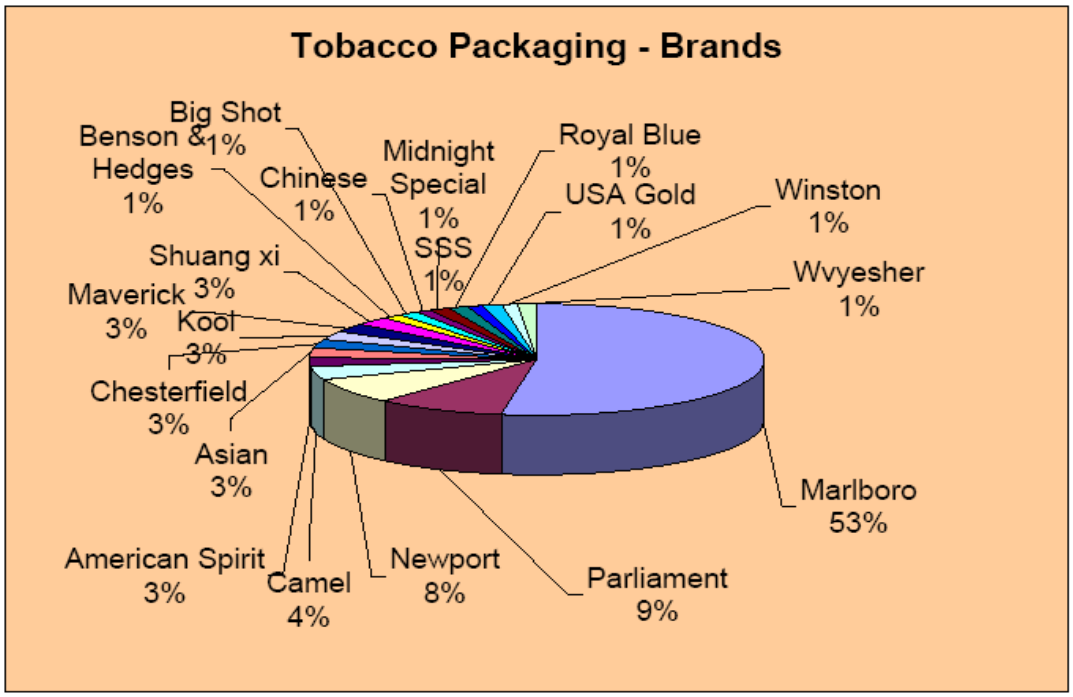

Tobacco Packaging - Brands
Big Shot 1%
Benson & Hedges 1%
Chinese 1%
Midnight Special 1%
SSS 1%
Royal Blue 1%
USA Gold 1%
Winston 1%
Wvyesher 1%
Shuang xi 3%
Maverick 3%
Kool 3%
Chesterfield 3%
Asian 3%
American Spirit 3%
Camel 4%
Newport 8%
Parliament 9%
Marlboro 53%

Table 6 - All Branded Litter – by Category

All Branded Litter - Alphabetically by Category

Beverage

Brand name	Items Identified	% of Total Litter
7-UP	1	0.025%
Adam & Eve	1	0.025%
Alhambra	1	0.025%
Amp Energy	1	0.025%
Apple & Eve	1	0.025%
Arrowhead	1	0.025%
Baccardi	2	0.050%
Berkley Farms	1	0.025%
Capri Sun	5	0.126%
Christie	1	0.025%
Coca-Cola	5	0.126%
Corona	1	0.025%
Crown Royal	1	0.025%
Crystal Geyser	1	0.025%
Drekager	1	0.025%
E&J	2	0.050%
Gatoraid	2	0.050%
Hiram Walker	1	0.025%
Honey Bee	1	0.025%
Hong Van	1	0.025%
Kern's	1	0.025%
Kettle One	1	0.025%
Kirkland	1	0.025%
Livingston	1	0.025%
MD 20/20	1	0.025%
Minute Maid	1	0.025%
Mist	1	0.025%
Orangina	1	0.025%
Pepsi	1	0.025%
Red Bull	1	0.025%
Redline	1	0.025%
Royal Gate	1	0.025%
Sky	1	0.025%
Starbucks	3	0.076%
Steel Reserve	1	0.025%
V8	1	0.025%
Vernors	1	0.025%
VOSS	1	0.025%
VSOP	1	0.025%
Western Family	1	0.025%

Cups

Brand name	Items Identified	% of Total Litter
7-Eleven	4	0.101%
Alface	1	0.025%
AM PM	1	0.025%
Ben & Jerry's	1	0.025%
Burger King	5	0.126%
Coca-Cola	5	0.126%
Dixie	1	0.025%
Giants	1	0.025%
In & Out	1	0.025%
It's a Grand C	1	0.025%
Jack in the Bc	3	0.076%
Jamba Juice	1	0.025%
KFC	1	0.025%
McDonalds	19	0.478%
Mr. Expresso	1	0.025%
Nestle	2	0.050%
Panera	1	0.025%
Pepsi	1	0.025%
Popeyes	1	0.025%
Shell	4	0.101%
Starbucks	14	0.352%
Suncup	1	0.025%
Taco Bell	5	0.126%
Tulley's	1	0.025%

Plastic & Paper Bags

Brand name	Items Identified	% of Total Litter
Best Buy	1	0.025%
Cheap Pete's Frame	1	0.025%
Foods Co.	2	0.050%
Foodway	1	0.025%
Home Depot	1	0.025%
McDonalds	9	0.227%
PNY Technologies	1	0.025%
Safeway	7	0.176%
Semifreddi's	1	0.025%
Subway	2	0.050%
Thankmov Big	1	0.025%
Topkamen	5	0.126%
Walgreens	1	0.025%
Whole Foods	1	0.025%
Ziplock	2	0.050%

Boxes & Clamshells

Brand name	Items Identified	% of Total Litter
360 °	1	0.025%
Ankyo Development Ltd.	1	0.025%
Big Daddy	1	0.025%
Briton	1	0.025%
Bud Light	1	0.025%
Burger King	2	0.050%
Jack in the Box	1	0.025%
Kari Out	1	0.025%
Krispy Kreme	1	0.025%
McDonalds	4	0.101%
Pepsi	1	0.025%
Popeyes	1	0.025%
SFD Tomatoes	1	0.025%
Starbucks	1	0.025%

Other Containers

Brand name	Items Identified	% of Total Litter
Beauty Rush	1	0.025%
Blue Bunny	1	0.025%
Evian	1	0.025%
Gatoraid	1	0.025%
Gvayaki	1	0.025%
Nature's Garden	1	0.025%
Pepsi	2	0.050%
Pringles	2	0.050%
Starbucks	2	0.050%
Tropicana	1	0.025%
Welch's	1	0.025%
Yoplait	2	0.050%

Paper & Plastic Food Wrap

Brand name	Items Identified	% of Total Litter
Boukham	1	0.025%
Burger King	2	0.050%
Drumstick	1	0.025%
Jack in the Box	1	0.025%
KFC	1	0.025%
Kraft	1	0.025%
McDonalds	7	0.176%
Pocky	1	0.025%
Popeyes	1	0.025%
Ramen	1	0.025%
Ritz	2	0.050%
Slim Jims	2	0.050%
Taco Bell	1	0.025%

All Branded Litter - Alphabetically by Category

3

Confectionary

Brand name	Items Identified	% of Total Litter	Brand name	Items Identified	% of Total Litter
Anne Candy	1	0.025%	Klondike Bar	1	0.025%
Baskin Robins	1	0.025%	Kuds	1	0.025%
Big Red	1	0.025%	Lays	1	0.025%
Blue Bunny	2	0.050%	Lifesavers	1	0.025%
Boston Baked Beans	3	0.076%	M & M's	3	0.076%
Bubble Tape	1	0.025%	Maya	1	0.025%
Bubble Yum	3	0.076%	Mentos	3	0.076%
Cadbury	2	0.050%	Nature Valley	1	0.025%
Cheetos	3	0.076%	Nestle	1	0.025%
Cheezit	1	0.025%	Orbit	8	0.201%
Chex	1	0.025%	Oreos	1	0.025%
Christie	1	0.025%	Pop Tart	1	0.025%
Cliff	1	0.025%	Popcicle	1	0.025%
Corn Nuts	1	0.025%	Quaker Oats	1	0.025%
Crunch	1	0.025%	Redvines	2	0.050%
Cup Cakes	1	0.025%	Reeses	2	0.050%
Dentyne	4	0.101%	Ricola	7	0.176%
Doritos	6	0.151%	Ricolino	1	0.025%
Doublemint	1	0.025%	Ruffles	1	0.025%
Extra	3	0.076%	Sathers	1	0.025%
Fatboy	1	0.025%	Skyflake	1	0.025%
Ferrara Pan	1	0.025%	Snickers	3	0.076%
Ferro Rocher	1	0.025%	Sperfari	1	0.025%
Hostess - 'Frito Lay	4	0.101%	Splenda	1	0.025%
Fruit by the Foot	3	0.076%	Starburst	5	0.126%
Ghirardelli	1	0.025%	Stride	1	0.025%
Good Cookie	1	0.025%	Sunshine	1	0.025%
Grandma's Cookie	2	0.050%	Toblerone	1	0.025%
Gummy Worms	1	0.025%	Tootsie Pop	3	0.076%
Halls	3	0.076%	Trident	6	0.151%
Hersheys	3	0.076%	Trident	1	0.025%
Ice Breakers	1	0.025%	TWIX	1	0.025%
In & Out	2	0.050%	Twizzler	3	0.076%
Jelly Belly	1	0.025%	Werthers	1	0.025%
Juicy Fruit	2	0.050%	Wrigleys	9	0.227%
Kit Kat	4	0.101%	York	1	0.025%

Take-Out Extras

Brand name	Items Identified	% of Total Litter
7-Eleven	2	0.050%
Burger King	4	0.101%
Chef's quality	2	0.050%
Crazy Sushi	1	0.025%
Dixie	1	0.025%
Dominos	1	0.025%
Equal	1	0.025%
Heinz	2	0.050%
Hunan Chef	1	0.025%
KFC	2	0.050%
MAXLITE	1	0.025%
McDonalds	14	0.352%
Menu Wild Pepper	2	0.050%
Popeyes	3	0.076%
Splenda	2	0.050%
Starbucks	2	0.050%
Taco Bell	4	0.101%
Walgreens	1	0.025%

Other Packaging

Brand name	Items Identified	% of Total Litter
Anew	1	0.025%
Chapstick	1	0.025%
Christie	1	0.025%
Crest	2	0.050%
Scotch Bright	1	0.025%
Slim Jim	3	0.076%
Tazo	1	0.025%
The Absorber	1	0.025%
Tic Tak	1	0.025%
Top Ramen	1	0.025%
Trojan	1	0.025%
Yoplait	1	0.025%

Printed Materials

Brand name	Items Identified	% of Total Litter	Brand name	Items Identified	% of Total Litter
24 Hr. Fitness	1		Mr. Dao Tree Service	1	
AMC Theatres	1		MUNI	6	
Artisan Home Resorts	1		Neno Japanese Restaurant	1	
Bank of America	1		New Ganges Restaurant	1	
Bed Bath & Beyond	1		Orkin Pest Control	1	
Bic	1		Pronto Pizza	1	
Boxing Boot Camp Ad	4		Raley's	1	
Chevy's	1		Ralph Lauren	1	
Cole Cleaners	1		Red Hot Cherries	1	
Cow Palace	1		Safeway	2	
DHL Express	1		San Francisco Chronicle	1	
Dole	1		Spicy Bite	1	
El Santode Israel	1		Sunset Supermarket	1	
Fed-Ex	1		Target	1	
Greico	1		The Examiner	2	
Guardian	1		Tic Tac Toe	1	
Jack in the Box	1		UPS	1	
Kaiser-Permamanentes	1		Valley Yellow Pages	1	
Lucky Coupons	1		Verison Wireless	1	
Memorex	1		Visa Gift Card	1	
Mensajero	1		Wallgreens	4	
Mervyns	1		Welches	1	
			Wells Fargo	14	

Tobacco Packaging

Brand name	Items Identified	% of Total Litter
Marlboro	41	1.032%
Parliament	7	0.176%
Newport	6	0.151%
Camel	3	0.076%
American Spirit	2	0.050%
Asian	2	0.050%
Chesterfield	2	0.050%
Kool	2	0.050%
Maverick	2	0.050%
Shuang xi	2	0.050%
Benson & Hedges	1	0.025%
Big Shot	1	0.025%
Chinese	1	0.025%
Midnight Special	1	0.025%
Royal Blue	1	0.025%
SSS	1	0.025%
USA Gold	1	0.025%
Winston	1	0.025%
Wvyesher	1	0.025%

Other Miscellaneous

Brand name	Items Identified	% of Total Litter
Advil	1	0.025%
AVON	1	0.025%
Benadryl	1	0.025%
Boss	1	0.025%
CAT	1	0.025%
Citi Bank Group	1	0.025%
Crayola	1	0.025%
Disney Princess	1	0.025%
Double Bubble Football	1	0.025%
Ice Breakers	1	0.025%
Johnson's	1	0.025%
Kleenex	1	0.025%
Kodak	1	0.025%
MD 20/20	1	0.025%
National Choice	2	0.050%
North Beach Pizza	1	0.025%
OB	1	0.025%
Old Navy	1	0.025%
Pilsner Vrgvell	1	0.025%
Proti Anytime	1	0.025%
Ready Post	1	0.025%
Starbucks	1	0.025%
Starz Bar	1	0.025%
Sunny D	1	0.025%
Thrift Lodge	1	0.025%
Trojan	1	0.025%
Universal Choice	1	0.025%
Windex	1	0.025%

Table 7 - 2008 – All Branded Litter - Alphabetical

All Branded Litter - Alphabetically

Brand Name	Items	% of total large litter
24 Hr. Fitness	1	0.025%
360 °	1	0.025%
7-Eleven	6	0.151%
7-UP	1	0.025%
Adam & Eve	1	0.025%
Advil	1	0.025%
Alface	1	0.025%
Alhambra	1	0.025%
AM PM	1	0.025%
AMC Theatres	1	0.025%
American Spirit	2	0.050%
Amp Energy	1	0.025%
Anew	1	0.025%
Ankyo Development Ltd.	1	0.025%
Anne Candy	1	0.025%
Apple & Eve	1	0.025%
Arrowhead	1	0.025%
Artisan Home Resorts	1	0.025%
Asian	2	0.050%
AVON	1	0.025%
Baccardi	2	0.050%
Bank of America	1	0.025%
Baskin Robins	1	0.025%
Beauty Rush	1	0.025%
Bed Bath & Beyond	1	0.025%
Ben & Jerry's	1	0.025%
Benadryl	1	0.025%
Benson & Hedges	1	0.025%
Berkley Farms	1	0.025%
Best Buy	1	0.025%
Bic	1	0.025%
Big Daddy	1	0.025%
Big Red	1	0.025%
Big Shot	1	0.025%
Blue Bunny	3	0.076%
Boss	1	0.025%
Boston Baked Beans	3	0.076%
Boukham	1	0.025%
Boxing Boot Camp Ad	4	0.101%
Briton	1	0.025%
Bubble Tape	1	0.025%
Bubble Yum	3	0.076%
Bud Light	1	0.025%
Burger King	13	0.327%
Cadbury	2	0.050%
Camel	3	0.076%
Capri Sun	5	0.126%
CAT	1	0.025%
Chapstick	1	0.025%
Cheap Pete's Frame	1	0.025%
Cheetos	3	0.076%
Cheezit	1	0.025%
Chef's quality	2	0.050%
Chesterfield	2	0.050%
Chevy's	1	0.025%
Chex	1	0.025%
Chinese	2	0.050%
Christie	1	0.025%
Christie	1	0.025%
Citi Bank Group	1	0.025%
Cliff	1	0.025%
Coca-Cola	10	0.252%
Cole Cleaners	1	0.025%
Corn Nuts	1	0.025%
Corona	1	0.025%
Cow Palace	1	0.025%
Crayola	1	0.025%
Crazy Sushi	1	0.025%
Crest	2	0.050%
Crown Royal	1	0.025%
Crunch	1	0.025%
Crystal Geyser	1	0.025%
Cup Cakes	1	0.025%
Dentyne	4	0.101%
DHL Express	1	0.025%
Disney Princess	1	0.025%

All Branded Litter - Alphabetically

Brand Name	Items	% of total large litter
Dixie	2	0.050%
Dole	1	0.025%
Dominos	1	0.025%
Doritos	6	0.151%
Double Bubble Football	1	0.025%
Doublemint	1	0.025%
Drekager	1	0.025%
Drumstick	1	0.025%
E&J	2	0.050%
El Santode Israel	1	0.025%
Equal	1	0.025%
Evian	1	0.025%
Extra	3	0.076%
Fatboy	1	0.025%
Fed-Ex	1	0.025%
Ferrara Pan	1	0.025%
Ferro Rocher	1	0.025%
Foods Co.	2	0.050%
Foodway	1	0.025%
Fruit by the Foot	3	0.076%
Gatoraid	3	0.076%
Ghirardelli	1	0.025%
Giants	1	0.025%
Good Cookie	1	0.025%
Grandma's Cookie	2	0.050%
Greico	1	0.025%
Guardian	1	0.025%
Gummy Worms	1	0.025%
Gvayaki	1	0.025%
Halls	3	0.076%
Heinz	2	0.050%
Hersheys	3	0.076%
Hiram Walker	1	0.025%
Home Depot	1	0.025%
Honey Bee	1	0.025%
Hong Van	1	0.025%
Hostess - 'Frito Lay	4	0.101%
Hunan Chef	1	0.025%
Ice Breakers	2	0.050%
In & Out	3	0.076%
It’s a Grand Coffee House	1	0.025%

Brand Name	Items	% of total large litter
Jack in the Box	6	0.151%
Jamba Juice	1	0.025%
Jelly Belly	1	0.025%
Johnson's	1	0.025%
Juicy Fruit	2	0.050%
Kaiser-Permamanentes	1	0.025%
Kari Out	1	0.025%
Kern's	1	0.025%
Kettle One	1	0.025%
KFC	4	0.101%
Kirkland	1	0.025%
Kit Kat	4	0.101%
Kleenex	1	0.025%
Klondike Bar	1	0.025%
Kodak	1	0.025%
Kool	2	0.050%
Kraft	1	0.025%
Krispy Kreme	1	0.025%
Kuds	1	0.025%
Lays	1	0.025%
Lifesavers	1	0.025%
Livingston	1	0.025%
Lucky Coupons	1	0.025%
M & M's	3	0.076%
Marlboro	41	1.032%
Maverick	2	0.050%
MAXLITE	1	0.025%
Maya	1	0.025%
McDonalds	53	1.334%
MD 20/20	2	0.050%
Memorex	1	0.025%
Mensajero	1	0.025%
Mentos	3	0.076%
Menu Wild Pepper	2	0.050%
Mervyns	1	0.025%
Midnight Special	1	0.025%
Minute Maid	1	0.025%
Mist	1	0.025%
Mr. Dao Tree Service	1	0.025%
Mr. Expresso	1	0.025%

All Branded Litter - Alphabetically

Brand Name	Items	% of total large litter
MUNI	6	0.151%
National Choice	2	0.050%
Nature Valley	1	0.025%
Nature's Garden	1	0.025%
Neno Japanese Restauran	1	0.025%
Nestle	3	0.076%
New Ganges Restaurant	1	0.025%
Newport	6	0.151%
North Beach Pizza	1	0.025%
OB	1	0.025%
Old Navy	1	0.025%
Orangina	1	0.025%
Orbit	8	0.201%
Oreos	1	0.025%
Orkin Pest Control	1	0.025%
Panera	1	0.025%
Parliament	7	0.176%
Pepsi	5	0.126%
Pilsner Vrgvell	1	0.025%
PNY Technologies	1	0.025%
Pocky	1	0.025%
Pop Tart	1	0.025%
Popcycle	1	0.025%
Popeyes	6	0.151%
Pringles	2	0.050%
Pronto Pizza	1	0.025%
Proti Anytime	1	0.025%
Quaker Oats	1	0.025%
Raley's	1	0.025%
Ralph Lauren	1	0.025%
Ramen	1	0.025%
Ready Post	1	0.025%
Red Bull	1	0.025%
Red Hot Cherries	1	0.025%
Redline	1	0.025%
Redvines	2	0.050%
Reeses	2	0.050%
Ricola	7	0.176%
Ricolino	1	0.025%
Ritz	2	0.050%
Royal Blue	1	0.025%
Royal Gate	1	0.025%
Ruffles	1	0.025%
Safeway	9	0.227%
San Francisco Chronicle	1	0.025%
Sathers	1	0.025%
Scotch Bright	1	0.025%
Semifreddi's	1	0.025%
SFD Tomatoes	1	0.025%
Shell	4	0.101%
Shuang xi	2	0.050%
Sky	1	0.025%
Skyflake	1	0.025%
Slim Jim	5	0.126%
Snickers	3	0.076%
Sperfari	1	0.025%
Spicy Bite	1	0.025%
Splenda	3	0.076%
SSS	1	0.025%
Starbucks	23	0.579%
Starburst	5	0.126%
Starz Bar	1	0.025%
Steel Reserve	1	0.025%
Stride	1	0.025%
Subway	2	0.050%
Suncup	1	0.025%
Sunny D	1	0.025%
Sunset Supermarket	1	0.025%
Sunshine	1	0.025%
Taco Bell	10	0.252%
Target	1	0.025%
Tazo	1	0.025%
Thankmov Big	1	0.025%
The Absorber	1	0.025%
The Examiner	2	0.050%
Thrift Lodge	1	0.025%
Tic Tac Toe	1	0.025%
Tic Tak	1	0.025%
Toblerone	1	0.025%
Tootsie Pop	3	0.076%
Top Ramen	1	0.025%
Topkamen	5	0.126%
Trident	7	0.176%
Trojan	2	0.050%
Tropicana	1	0.025%
Tulley's	1	0.025%
TWIX	1	0.025%
Twizzler	3	0.076%
Universal Choice	1	0.025%
UPS	1	0.025%
USA Gold	1	0.025%
V8	1	0.025%
Valley Yellow Pages	1	0.025%
Verison Wireless	1	0.025%
Vernors	1	0.025%
Visa Gift Card	1	0.025%
VOSS	1	0.025%
VSOP	1	0.025%
Walgreens	8	0.201%
Welches	2	0.050%
Wells Fargo	14	0.352%
Werthers	1	0.025%
Western Family	1	0.025%
Whole Foods	1	0.025%
Windex	1	0.025%
Winston	1	0.025%
Wrigleys	9	0.227%
Wvyesher	1	0.025%
Yoplait	3	0.076%
York	1	0.025%
Ziplock	2	0.050%

Table 8 - 2008 –Branded Litter – Found in 2007 & 2008

All Branded Litter - Alphabetically

Brand Name	2008 Items	2008 % of total large litter	Brand Name	2007 Items	2007 % of total large litter
24 Hr. Fitness	1	0.025%			
360 °	1	0.025%			
7-Eleven	6	0.151%	7 Eleven	3	0.08%
7-UP	1	0.025%			
Adam & Eve	1	0.025%			
Advil	1	0.025%			
Alface	1	0.025%			
Alhambra	1	0.025%	Alhambra	2	0.05%
AM PM	1	0.025%			
AMC Theatres	1	0.025%			
American Spirit	2	0.050%			
Amp Energy	1	0.025%			
Anew	1	0.025%			
Ankyo Development Ltd.	1	0.025%			
Anne Candy	1	0.025%			
Apple & Eve	1	0.025%			
Arrowhead	1	0.025%			
Artisan Home Resorts	1	0.025%			
Asian	2	0.050%			
AVON	1	0.025%			
Baccardi	2	0.050%			
Bank of America	1	0.025%			
Baskin Robins	1	0.025%	Baskin Robbins	1	0.03%
Beauty Rush	1	0.025%			
Bed Bath & Beyond	1	0.025%	d Bath & Beyond	1	0.03%
Ben & Jerry's	1	0.025%			
Benadryl	1	0.025%	Benadryl	1	0.03%
Benson & Hedges	1	0.025%			
Berkley Farms	1	0.025%			
Best Buy	1	0.025%	Best Buy	1	0.03%
Bic	1	0.025%			
Big Daddy	1	0.025%			
Big Red	1	0.025%			
Big Shot	1	0.025%			
Blue Bunny	3	0.076%			
Boss	1	0.025%			
Boston Baked Beans	3	0.076%			
Boukham	1	0.025%			
Boxing Boot Camp Ad	4	0.101%			
Briton	1	0.025%			
Bubble Tape	1	0.025%			
Bubble Yum	3	0.076%			
Bud Light	1	0.025%			
Burger King	13	0.327%	Burger King	20	0.52%
Cadbury	2	0.050%			
Camel	3	0.076%	Camel	6	0.16%

Brand Name	2008 Items	2008 % of total large litter	Brand Name	2007 Items	2007 % of total large litter
Capri Sun	5	0.126%			
CAT	1	0.025%			
Chapstick	1	0.025%			
Cheap Pete's Frame	1	0.025%			
Cheetos	3	0.076%			
Cheezit	1	0.025%			
Chef's quality	2	0.050%			
Chesterfield	2	0.050%			
Chevy's	1	0.025%			
Chex	1	0.025%			
Chinese	2	0.050%			
Christie	1	0.025%			
Christie	1	0.025%			
Citi Bank Group	1	0.025%			
Cliff	1	0.025%			
Coca-Cola	10	0.252%	Coca-Cola	3	0.08%
Cole Cleaners	1	0.025%			
Corn Nuts	1	0.025%			
Corona	1	0.025%	Corona	1	0.03%
Cow Palace	1	0.025%			
Crayola	1	0.025%			
Crazy Sushi	1	0.025%			
Crest	2	0.050%			
Crown Royal	1	0.025%			
Crunch	1	0.025%			
Crystal Geyser	1	0.025%	Crystal Geyser	3	0.08%
Cup Cakes	1	0.025%			
Dentyne	4	0.101%	Dentyne	3	0.08%
DHL Express	1	0.025%			
Disney Princess	1	0.025%			
Dixie	2	0.050%			
Dole	1	0.025%			
Dominos	1	0.025%			
Doritos	6	0.151%			
Double Bubble Footb	1	0.025%			
Doublemint	1	0.025%			
Drekager	1	0.025%			
Drumstick	1	0.025%	Drumstick	1	0.03%
E&J	2	0.050%	E & J	1	0.03%
El Santode Israel	1	0.025%			
Equal	1	0.025%			
Evian	1	0.025%			
Extra	3	0.076%			
Fatboy	1	0.025%			
Fed-Ex	1	0.025%	Fed Ex	10	0.26%

Table 8 - 2008 –Branded Litter – Found in 2007 & 2008

(cont'd)

Brand Name	Items	2008 % of total large litter	Brand Name	Items	2007 % of total large litter
Ferrara Pan	1	0.025%			
Ferro Rocher	1	0.025%			
Foods Co.	2	0.050%			
Foodway	1	0.025%			
Fruit by the Foot	3	0.076%			
Gatoraid	3	0.076%			
Ghirardelli	1	0.025%			
Giants	1	0.025%			
Good Cookie	1	0.025%	Good Cookie	1	0.03%
Grandma's Cookie	2	0.050%			
Greico	1	0.025%			
Guardian	1	0.025%	SF Guardian	1	0.03%
Gummy Worms	1	0.025%			
Gvayaki	1	0.025%			
Halls	3	0.076%			
Heinz	2	0.050%			
Hersheys	3	0.076%	Hersheys	7	0.18%
Hiram Walker	1	0.025%			
Home Depot	1	0.025%	Home Depot	1	0.03%
Honey Bee	1	0.025%			
Hong Van	1	0.025%			
Hostess - 'Frito Lay	4	0.101%			
Hunan Chef	1	0.025%			
Ice Breakers	2	0.050%			
In & Out	3	0.076%	In & Out Burger	1	0.03%
It's a Grand Coffee House	1	0.025%			
Jack in the Box	6	0.151%			
Jamba Juice	1	0.025%			
Jelly Belly	1	0.025%	Jelly Belly	2	0.05%
Johnson's	1	0.025%			
Juicy Fruit	2	0.050%			
Kaiser-Permamanentes	1	0.025%			
Kari Out	1	0.025%			
Kern's	1	0.025%			
Kettle One	1	0.025%			
KFC	4	0.101%	KFC	2	0.05%
Kirkland	1	0.025%	Kirkland	1	0.03%
Kit Kat	4	0.101%	Kit-Kat	2	0.05%
Kleenex	1	0.025%	Kleenex	1	0.03%
Klondike Bar	1	0.025%	Klondike	1	0.03%
Kodak	1	0.025%			
Kool	2	0.050%			
Kraft	1	0.025%			
Krispy Kreme	1	0.025%			
Kuds	1	0.025%			
Lays	1	0.025%			
Lifesavers	1	0.025%	Lifesaver	1	0.03%
Livingston	1	0.025%			
Lucky Coupons	1	0.025%			
M & M's	3	0.076%	M & M's	4	0.10%

Brand Name	Items	2008 % of total large litter	Brand Name	Items	2007 % of total large litter
Marlboro	41	1.032%	Marlboro	23	0.60%
Maverick	2	0.050%			
MAXLITE	1	0.025%			
Maya	1	0.025%			
McDonalds	53	1.334%			
MD 20/20	2	0.050%			
Memorex	1	0.025%			
Mensajero	1	0.025%			
Mentos	3	0.076%			
Menu Wild Pepper	2	0.050%			
Mervins	1	0.025%	Mervins	1	0.03%
Midnight Special	1	0.025%			
Minute Maid	1	0.025%			
Mist	1	0.025%			
Mr. Dao Tree Service	1	0.025%			
Mr. Expresso	1	0.025%			
MUNI	6	0.151%	NI ticket/transfer	25	0.66%
National Choice	2	0.050%			
Nature Valley	1	0.025%	Nature Valley	3	0.08%
Nature's Garden	1	0.025%			
Neno Japanese Rest	1	0.025%			
Nestle	3	0.076%	Nestle	4	0.10%
New Ganges Restaur	1	0.025%			
Newport	6	0.151%	Newport	7	0.18%
North Beach Pizza	1	0.025%			
OB	1	0.025%			
Old Navy	1	0.025%			
Orangina	1	0.025%			
Orbit	8	0.201%	Orbit	5	0.13%
Oreos	1	0.025%			
Orkin Pest Control	1	0.025%			
Panera	1	0.025%			
Parliament	7	0.176%	Parliament	5	0.13%
Pepsi	5	0.126%	Pepsi	5	0.13%
Pilsner Vrgvell	1	0.025%			
PNY Technologies	1	0.025%			
Pocky	1	0.025%			
Pop Tart	1	0.025%			
Popcycle	1	0.025%			
Popeyes	6	0.151%			
Pringles	2	0.050%			
Pronto Pizza	1	0.025%			
Proti Anytime	1	0.025%			
Quaker Oats	1	0.025%			
Raley's	1	0.025%			
Ralph Lauren	1	0.025%			
Ramen	1	0.025%			
Ready Post	1	0.025%			
Red Bull	1	0.025%			
Red Hot Cherries	1	0.025%			
Redline	1	0.025%			
Redvines	2	0.050%			

Table 8 - 2008 –Branded Litter – Found in 2007 & 2008

(cont'd)

Brand Name	Items	2008 % of total large litter	Brand Name	Items	2007 % of total large litter
Reeses	2	0.050%	Reeses	4	0.10%
Ricola	7	0.176%	Ricola	1	0.03%
Ricolino	1	0.025%			
Ritz	2	0.050%			
Royal Blue	1	0.025%			
Royal Gate	1	0.025%			
Ruffles	1	0.025%			
Safeway	9	0.227%	Safeway	10	0.26%
San Francisco Chronicle	1	0.025%			
Sathers	1	0.025%			
Scotch Bright	1	0.025%			
Semifreddi's	1	0.025%			
SFD Tomatoes	1	0.025%			
Shell	4	0.101%			
Shuang xi	2	0.050%			
Sky	1	0.025%			
Skyflake	1	0.025%			
Slim Jim	5	0.126%			
Snickers	3	0.076%	Snickers	7	0.18%
Sperfari	1	0.025%			
Spicy Bite	1	0.025%			
Splenda	3	0.076%			
SSS	1	0.025%			
Starbucks	23	0.579%	Starbucks	17	0.45%
Starburst	5	0.126%	Starburst	2	0.05%
Starz Bar	1	0.025%			
Steel Reserve	1	0.025%			
Stride	1	0.025%			
Subway	2	0.050%	Subway	2	0.05%
Suncup	1	0.025%			
Sunny D	1	0.025%	Sunny D	1	0.03%
Sunset Supermarket	1	0.025%			
Sunshine	1	0.025%			
Taco Bell	10	0.252%	Taco Bell	2	0.05%
Target	1	0.025%	Target	1	0.03%
Tazo	1	0.025%			
Thankmov Big	1	0.025%			

Brand Name	Items	2008 % of total large litter	Brand Name	Items	2007 % of total large litter
The Absorber	1	0.025%			
The Examiner	2	0.050%			
Thrift Lodge	1	0.025%			
Tic Tac Toe	1	0.025%			
Tic Tak	1	0.025%			
Toblerone	1	0.025%			
Tootsie Roll	3	0.076%	Tootsie Roll	8	0.21%
Top Ramen	1	0.025%			
Topkamen	5	0.126%			
Trident	7	0.176%	Trident	9	0.24%
Trojan	2	0.050%			
Tropicana	1	0.025%			
Tulley's	1	0.025%	Tulley's	1	0.03%
TWIX	1	0.025%	Twix	3	0.08%
Twizzler	3	0.076%			
Universal Choice	1	0.025%			
UPS	1	0.025%			
USA Gold	1	0.025%	USA Gold	1	0.03%
V8	1	0.025%			
Valley Yellow Pages	1	0.025%			
Verison Wireless	1	0.025%			
Vernors	1	0.025%			
Visa Gift Card	1	0.025%			
VOSS	1	0.025%			
VSOP	1	0.025%			
Walgreens	8	0.201%	Walgreens	7	0.18%
Welches	2	0.050%	Welchers	1	0.03%
Wells Fargo	14	0.352%	Wells Fargo	1	0.03%
Werthers	1	0.025%	Werthers	4	0.10%
Western Family	1	0.025%	White Rabbit	1	0.03%
Whole Foods	1	0.025%	Whole Foods	1	0.03%
Windex	1	0.025%			
Winston	1	0.025%			
Wrigleys	9	0.227%	Wrigleys	2	0.05%
Wvyesher	1	0.025%			
Yoplait	3	0.076%			
York	1	0.025%			
Ziplock	2	0.050%			

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Synthetic polymers in the marine environment: A rapidly increasing, long-term threat

Charles James Moore *

Algalita Marine Research Foundation, 148 N. Marina Drive, Long Beach, CA 90803, USA

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ABSTRACT

Synthetic polymers, commonly known as plastics, have been entering the marine environment in quantities paralleling their level of production over the last half century. However, in the last two decades of the 20th Century, the deposition rate accelerated past the rate of production, and plastics are now one of the most common and persistent pollutants in ocean waters and beaches worldwide. Thirty years ago the prevailing attitude of the plastic industry was that "plastic litter is a very small proportion of all litter and causes no harm to the environment except as an eyesore" [Derraik, J.G.B., 2002. The pollution of the marine environment by plastic debris: a review. Mar. Pollut. Bull. 44(9), 842–852]. Between 1960 and 2000, the world production of plastic resins increased 25-fold, while recovery of the material remained below 5%. Between 1970 and 2003, plastics became the fastest growing segment of the US municipal waste stream, increasing nine-fold, and marine litter is now 60–80% plastic, reaching 90–95% in some areas. While undoubtedly still an eyesore, plastic debris today is having significant harmful effects on marine biota. Albatross, fulmars, shearwaters and petrels mistake floating plastics for food, and many individuals of these species are affected; in fact, 44% of all seabird species are known to ingest plastic. Sea turtles ingest plastic bags, fishing line and other plastics, as do 26 species of cetaceans. In all, 267 species of marine organisms worldwide are known to have been affected by plastic debris, a number that will increase as smaller organisms are assessed. The number of fish, birds, and mammals that succumb each year to derelict fishing nets and lines in which they become entangled cannot be reliably known; but estimates are in the millions. We divide marine plastic debris into two categories: macro, >5 mm and micro, <5 mm. While macro-debris may sometimes be traced to its origin by object identification or markings, micro-debris, consisting of particles of two main varieties, (1) fragments broken from larger objects, and (2) resin pellets and powders, the basic thermoplastic industry feedstocks, are difficult to trace. Ingestion of plastic micro-debris by filter feeders at the base of the food web is known to occur, but has not been quantified. Ingestion of degraded plastic pellets and fragments raises toxicity concerns, since plastics are known to adsorb hydrophobic pollutants. The potential bioavailability of compounds added to plastics at the time of manufacture, as well as those adsorbed from the environment are complex issues that merit more widespread investigation. The physiological effects of any bioavailable compounds desorbed from plastics by marine biota are being directly investigated, since it was found 20 years ago that the mass of ingested plastic in Great Shearwaters was positively correlated with PCBs in their fat and eggs. Colonization of plastic marine debris by sessile organisms provides a vector for transport of alien species in the ocean environment and may threaten marine biodiversity. There is also potential danger to marine ecosystems from the accumulation of plastic debris on the sea floor. The accumulation of such debris can inhibit gas exchange between the overlying waters and the pore waters of the sediments, and disrupt or smother inhabitants of the benthos. The extent of this problem and its effects have recently begun to be investigated. A little more than half of all thermoplastics will sink in seawater.

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1. Introduction

A major unforeseen consequence of the "Plastic Age" is the material's ability to proliferate in innumerable sizes, shapes and colors throughout the marine environment worldwide (Moore, 2003). The physical characteristics of most plastics show high

* Fax: +1 562 433 2361.
E-mail address: cmoore@algalita.org

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resistance to aging and minimal biological degradation. When exposed to the UVB radiation in sunlight, the oxidative properties of the atmosphere and the hydrolytic properties of seawater, these polymers become embrittled, and break into smaller and smaller pieces, eventually becoming individual polymer molecules, which must undergo further degradation before becoming bioavailable. The eventual biodegradation of plastics in the marine environment requires an unknown amount of time (Andrady, 2005). A wide range of undocumented estimates for the time needed to completely mineralize or biodegrade marine plastics—on the order of centuries—have been made; but they are all, at best, educated guesses (Andrady, personal communication). Their persistence contributes to the fact that plastics are accumulating in increasing quantities in the marine environment (Copello and Quintana, 2003; Ogi et al., 1999). Slow biodegradation rates do not mean that plastic polymers and their additives are not bioactive. The process of polymerization of the monomers that form plastics is never 100% complete, and the remaining monomer building blocks of the polymer, such as styrene and bisphenol-A, along with residual catalysts, can migrate from the polymer matrix into compounds with which they come in contact. Polycarbonate plastics, when exposed to the salts in seawater, show accelerated leaching of the bioactive bisphenol-A monomer (Sajiki and Yonekubo, 2003). Many plastic polymers in commercial use have high concentrations of bioactive monomer additives, such as UV stabilizers, softeners, flame retardants, non-stick compounds, and colorants, which leach out at faster or slower rates based on environmental conditions. It is estimated that plastic products overall are composed of about 50% fillers, reinforcements and additives by weight (Colton et al., 1974).

While it is beyond the scope of this paper to delve into the intricacies of polymerization, and the production of thermoset and thermoplastic resins, the leaching of some bioactive substances from commercial plastics will be covered by other papers in this series. Briefly, thermoplastics, the main type of consumer plastics, are formed by melting the plastic raw material and forming it into products, which can be recovered and re-melted. Thermoplastics are distinguished from thermoset plastics; liquids which are "set" by the use of a catalyst, and scorch rather than re-melt when exposed to heat. Thermoset plastics also break into small bits and persist in the environment, and though produced in less quantity than thermoplastics, are recovered or recycled at an even lower rate.

The modern trend is for nearly all consumer goods to contain and/or be contained by plastic, and recovery of the material often does not provide readily realizable profits, or options for reuse (Unnithan, 1998); therefore, plastics are the fastest growing component of waste. Some of this waste reaches disposal sites, but much of it litters the landscape. Since the ocean is downhill and downstream from virtually everywhere humans live, and about half of the world's human population lives within 50 miles of the ocean, lightweight plastic trash, lacking significant recovery infrastructure, blows and runs off into the sea. There, it moves to innumerable habitats, where it causes at least eight complex problems, none of which is well understood: (1) plastic trash foul beaches worldwide, devaluing the experience of beachgoers, with a concomitant impact on the tourism industry. Medical waste, plastic diapers and sanitary waste often found among this debris constitute a public health hazard. (2) Plastic entangles marine life and kills through drowning, strangulation, dragging, and reduction of feeding efficiency. So-called "ghost nets" continue to fish after being lost or abandoned by their owners, and kill untold numbers of commercial species. (3) Ingestion of plastic items that mimic natural food fails to provide nutrition proportionate to its weight or volume. It weakens and may kill seabirds through starvation and false feelings of satiation, irritation of the stomach lining, and failure to put on fat stores necessary for migration and reproduction. Sea turtles and marine mammals with ingested plastic have been found washed up or floating dead, but linking mortality unequivocally to the ingested debris is difficult. (4) Petroleum-based plastic polymers do not readily biodegrade, and are long-lived and slow moving in the ocean. As such, they provide substrata for "bryozoans, barnacles, polychaete worms, hydroids and mollusks (in order of abundance)," and may present a more effective invasive species dispersal mechanism than ship hulls or ballast water (Barnes, 2005), and are implicated in the northward range extension of the large barnacle *Perforatus perforatus* (Rees and Southward, 2008). In some areas, e.g. the central Pacific gyre, these plastic substrates are so numerous that their ready availability is likely to alter the species composition of sessile organisms. (5) Plastic resin pellets and fragments of plastic broken from larger objects are sources and sinks for xenoestrogens and persistent organic pollutants (POPs) in marine and aquatic environments (Moore et al., 2005a; Mato et al., 2001; Rios et al., 2007), and can be readily ingested by invertebrates at the base of the food web (Thompson et al., 2004). (6) Since the majority of consumer plastics are neutrally buoyant (within 0.1 g/mL of seawater density, USEPA, 1992), grains of sand caught in their seams or fouling matter make many plastics sink to the sea floor. Much of this material consists of thin packaging film and has the potential to inhibit gas exchange, possibly interfering with CO_2 sequestration (Goldberg, 1997). Plastic deposited on the sea floor also has the potential to change the composition, interfere with or smother inhabitants of the sediments (Katsanevakis et al., 2007; Uneputty and Evans, 1997; Goldberg, 1997). (7) Marine litter threatens coastal species by filling up and destroying nursery habitat where new life would otherwise emerge (UNEP, 2001). (8) Marine plastic litter fouls vessel intake ports, keels and propellers, and puts crew at risk while working to free the debris; incurring significant damage to vessels, with economic losses estimated by Takehama (1990) to be 6.6 billion Yen/yr in Japanese fishing vessels <1000 gross tons. According to the US National Oceanographic and Atmospheric Administration's (NOAA's) office of Response and Restoration, in 2005, the US Coast Guard found that floating and submerged objects caused 269 boating accidents resulting in 15 deaths, 116 injuries and $US 3 million in property damage.

Given the variety of problems caused by plastic debris, it is important to gauge its rate of change. In the early 1970s, a study in the Atlantic Ocean of 247 surface plankton samples from Cape Cod to the Caribbean found plastic in 62% of samples (Colton et al., 1974). A similar study in the Pacific during the mid-1980s of 203 samples from the Japan Sea to the Bering Sea and north of Hawaii found plastic in 59% (Day et al., 1990). Evidence from archived plankton samples taken from the 1960s–1990s off Great Britain showed that microscopic marine plastics increased significantly in the North Atlantic. (Thompson et al., 2004). During the decade of the 1990s, plastics in the US municipal waste stream tripled (USEPA, 2003) and researchers found increased levels in the marine environment. Plastic was found in all trawl samples in studies from 1999 to 2007 in the north Pacific (Moore C.J., et al., 2001, and unpublished data from 2002 to 2007). Moore C.J., et al. (2001) found maximum neuston (surface) plastic levels three times greater than Day et al. (1990) had found a decade earlier. From 1994 to 1998, debris levels around the United Kingdom coastline doubled (Barnes, 2002), "and in parts of the Southern Ocean it increased 14–15 fold during the early 1990s" (Walker et al., 1997). Ogi et al. (1999) found that neuston plastic increased 10-fold in coastal areas of Japan during the 1970s–1980s, but that during the 1990s, densities increased 10-fold every 2–3 years.

Once plastic debris reaches the ocean, the floating component is dispersed in various ways. Onshore winds force debris back to

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Fig. 1. Trawl Sample, August, 2005, AMRF survey: 40° North Latutude, 140° West Longitude. Photo: Capt. Charles Moore.

the shore, while offshore winds push debris toward major ocean current transport systems. Both types of wind have a greater effect on objects that have appendages above the sea surface, such as fishing floats and bathtub toys. In the deep ocean, large high-pressure systems known as gyres tend to accrete the debris, while low-pressure systems tend to disperse it (Ingraham and Ebbesmeyer, 2000). In the largest gyre, located in the central North Pacific, neuston trawls lined with 0.333 mm mesh yielded the astounding figure of six kilos of plastic fragments for every kilo of zooplankton >0.333 mm in size (Moore C.J., et al., 2001, Fig. 1).

2. Plastic debris concerns

It was inevitable that a lightweight, long-lived (slow biodegrading) product that fills so many commodity niches, and which is often used only once and discarded, would eventually cause problems for the marine and terrestrial environments where it accumulates.

2.1. Aesthetics

According to the World Health Organization, a clean beach is one of the most important characteristics sought by visitors (Bartram and Rees, 2000). The negative effects of debris, defined as solid materials of human origin, are: loss of tourist days, resultant damage to leisure/tourism infrastructure, damage to commercial activities dependent on tourism, damage to fishery activities, and damage to the local, national and international image of a resort. "Such effects were experienced in New Jersey, USA in 1987 and Long Island, USA in 1988 where the reporting of medical waste, such as syringes, vials and plastic catheters, along the coastline resulted in an estimated loss of between 121 and 327 million user days at the beach and between US$ 1.3×10^9 and US$ 5.4×10^9 in tourism related expenditure" (Bartram and Rees, 2000). Clean beaches, free from debris, are a thing of the past. In the 20 years since the US-based organization, Ocean Conservancy organized the first annual International Coastal Cleanup Day, 6 million volunteers from 100 countries have removed 100 million pounds of litter from 170,000 miles of beaches and inland waterways. Reports of groups finding nothing to pick up do not exist. While the International Cleanup Day effort expands each year, so does the amount of debris recovered. Between 1996 and 2006, at Escondido Beach, California, 310 total debris items were removed, but 182 of those were found in 2005, representing 59% of the total recovered in the last year of the 10-year effort. At Torrey Pines State Beach, California, in the four quarters of 2005, 136 items were removed, but in the second quarter of 2006 alone, 189 items were found (Ocean Conservancy, 2007).

It must be remembered that beach cleanups focus on macro-debris. Numerous studies have found micro-debris on beaches and in their sediments worldwide, many of the beaches remote from human activity. (McDermid and McMullen, 2004; Moore S.L., et al., 2001; Gregory, 1977, 1978, 1983, 1991, 1996, 1999; Thompson et al., 2004; Ng and Obbard, 2006). In a study of a beach, near an urban river mouth, Moore et al. (unpublished data) found the sand to be 1% plastic by volume down to a depth of 20 cm.

Floating debris is an aesthetic issue for swimmers, mariners, coastal and inland water body dwellers, and submerged debris is an aesthetic issue for divers.

2.2. Entanglement

In the 1980s, researchers estimated that there were approximately 100,000 marine mammal deaths per year in the North Pacific related to entanglement in plastic nets and fishing line (Wallace, 1985). Currently in the US, the NOAA is using digitally enhanced photos of wounds suffered by marine mammals to identify the type of line they were entangled in (National Oceanic and Atmospheric Administration). Lost and abandoned nets, termed "ghost nets", continue to fish and destroy resources. A report by Canada's Food and Agriculture Organization (FAO, 1991) estimates that 10% of all static fishing gear is lost, and that this results in a loss of 10% of the target fish population. Efforts to remove this gear are growing, but are not widespread, and the great cost of removal of derelict gear is not borne by those who manufacture it or lose it. Such costs could threaten the economic viability of commercial fishing.

Documentation of entanglement of seabirds and other marine species in six-pack rings used to hold cans and bottles has resulted in changes to the plastic formula to speed up disintegration in the environment. The polymer can be changed chemically during manufacture so that it absorbs UV-B radiation from sunlight and breaks down into a very brittle material in a fairly

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short period of time; however, the resulting particles are no more biodegradable than the untreated polymer (Gregory and Andrady, 2003). Such embrittlement accelerators are not used in nets and lines, however; and volunteer groups worldwide are regularly called on to free entangled cetaceans and other sea life.

2.3. Ingestion

The term "plastic" means "capable of being formed into any shape." The plastic objects that populate the marine and aquatic environments, with the exception of fishing lures, are not made to look like natural food to marine creatures. However, thin plastic shopping bags balloon out in water and resemble jellyfish, and are regularly consumed by sea turtles (Lutcavage et al., 1997), especially critically endangered leatherbacks (Barreiros and Barcelos, 2001; Karla McDermid, personal communication). It is probable that the infinite ways in which the mega-tons of multi-colored plastic debris break down in the marine environment create mimics for virtually every natural food source. Bern (1990) found that a crustacean zooplankton, *Bosmina coregoni*, when offered polystyrene beads of 2 and 6 μm and ^{14}C-labelled alga of equal size, ingested both non-selectively within combinations. Andrady (personal communication) reported on feeding studies by Alldredge at UC Santa Barbara, using Ivlev's Electivity Index (designed to quantify prey-selection by predators, especially planktivores), showing that two common species of crustaceans, *Euphausia pacifica* (krill) and the copepod *Calanus pacificus*, had values of the index that suggested the ingestion of contaminant-free, uncolonized plastic particles, versus natural prey, from a mixture of these, appeared to be non-preferential. Most feeding that takes place in the ocean, is accomplished by indiscriminate feeders with mucus bodies or appendages, which trap anything of an appropriate size with which the organism comes in contact. Collection of salps in the North Pacific Central Gyre by Algalita Marine Research Foundation (AMRF) (2006), using both plankton trawls and hand nets, found individuals with plastic particles and fishing line embedded in their tissue (Moore C.J., et al., 2001). The optimum size class of plastic for filter feeder ingestion appears to be less than 1 mm in diameter, although larger particles have been found in some individuals. A 1999 AMRF study of 27,448 plastic particles trawled from the surface of the North Pacific Central Gyre found 9470 particles near 1 mm in size, 4646 near 0.5 mm, and 2626 near 0.3 mm, suggesting that smaller particles are being removed, or are leaving the system by some unknown mechanism (Moore C.J., et al., 2001). Thompson et al. (2004) kept intertidal invertebrates in aquaria with microscopic plastic particles <2 mm in diameter. The microscopic plastics were ingested by polychaete worms, barnacles, and amphipods during these laboratory trials. Documentation of transmission of these types of particles up the food web has been provided by Eriksson and Burton (2003), who surveyed Southern fur seal scat on Macquarie Island. They found that scats contained plastic particles from the night-feeding myctophids (Lantern fish), active near the sea surface, and consumed by the seals.

When plastic debris enters the sea, the proportion that floats, heads for surface accumulation zones. Modeling done by Ingraham and Ebbesmeyer (2000), using the Ocean Surface Current Simulator (OSCURS), seeded 113 drifters uniformly over the North Pacific from the US Coast to China. The model showed that after 12 years, winds and currents had gathered 75% of the drifters into an area of the Central Gyre equal to 28% of the total area seeded. The five enormous high-pressure gyres in the oceans comprise 40% of the sea surface, or 25% of the area of the entire earth (Koblentz-Mishke et al., 1970). The mountains of air that create the highs, force the sea level lower near their centers and create accumulation zones described as "gentle maelstroms" (Moore, 2003). These areas are over the deep ocean and are oligotrophic, oceanic deserts (Koblentz-Mishke et al., 1970). Thus, the ratio of plastic particles to plankton is highest near the center of high-pressure gyres on average, although after heavy rains, which cause runoff of plastic particles from urban areas, higher ratios are found near urban coastal zones (Moore et al., 2002; Lattin et al., 2004). Detritus feeders, like the Laysan albatross, have been demonstrated to feed primarily in and around the north Pacific subtropical gyre (Henry, 2004), and the stomach contents of their chicks, receiving nutriment only by regurgitation from adult birds, contain alarming quantities of plastic (Auman et al., 1997), as shown in Fig. 2. Sileo et al. (1990) documented 80 species of seabirds that ingest plastic. Carpenter et al. (1972) found plastic pellets in eight of 14 species of fish and one chaetognath off Southern New England. In USEPA (1992), it was reported that pellet ingestion was more common in lobster than winter flounder in the New York Bight in 1991.

Plastics as a means to transport pollutants to organisms in aquatic and marine ecosystems have become the focus of scientific research as levels of macro- and micro-plastics in these environments increase (Thompson et al., 2004). Mato et al. (2001) studied how polypropylene (PP) pellets in the marine environment adsorb (with adsorption coefficients of 10^5–10^6 from ambient seawater), and transport PCBs, DDE and nonylphenols (NP). Field and laboratory studies of the physiological effects on seabirds that ingest contaminated plastic resin pellets by this group are in press. Moore et al. (2005a) found polycyclic aromatic hydrocarbons and phthalates in samples of pre-production plastic pellets, and post consumer fragments of the same general size (<5 mm), from rivers and marine beaches near urban centers. Ryan et al. (1988) found that the mass of ingested plastic in Great Shearwaters was positively correlated with PCBs in their fat tissue and eggs.

In the ocean, degraded and fragmented bits of polymeric material are assuming the characteristics of a new class of sediments. Such fragments are floating on the surface, mixed into the water column, and embedded in bottom sediments and beach sand (Colton et al., 1974; Rios et al., 2007). Studies by Gregory (1996), Moore et al. (2005c), and Zitco and Hanlon (1991) have drawn attention to small fragments of plastic derived from hand cleaners, cosmetic preparations, airblast cleaning media, and production waste from plastic processing plants. The quantities and effects of these contaminants on the marine environment have yet to be fully determined, but in a study conducted on the

Fig. 2. Laysan albatross chick, Kure Atoll, 2002, photo: Cynthia Vanderlip, AMRF.

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Los Angeles and San Gabriel Rivers in 2004–2005, sample analysis with extrapolation found 2 billion plastic particles of all types, <5 mm in size, flowing toward the ocean in 3 days of sampling (Moore et al., 2005b). Teuten et al. (2007) found that a priority pollutant, phenanthrene, was transmitted to the lugworm, *Arenicola marina*, by polyethylene contaminated with phenanthrene absorbed from seawater mixed into sediments inhabited by the worm. According to Andrady (2003) "… plasticizers tend to migrate slowly to the surface of the product and can therefore enter the environment or come into human contact. Common plasticizers are indeed found in low levels dispersed in the environment in most parts of the world and generally believed to be even ingested routinely along with food… Another more recent health concern is endocrine disruption by chemicals, and plasticizers are included in the class of relevant chemical agents." Whether or to what extent estrogenic compounds in plasticizers added to plastics at the time of manufacture, or absorbed from the environment, are linked to findings such as a high percentage of intersex in Mediterranean swordfish (De Metrio et al., 2003), has not been investigated; but the presence of micro-plastics in the sea surface microlayer where xenoestrogens are known to accumulate, has been documented by Ng and Obbard (2006). Some phthalate plasticizers have been banned by the European Commission (Andrady, 2005), and numerous studies have found deleterious effects from another common plasticizer, bisphenol-A (vom Saal and Welshons, 2005).

2.4. Collateral concerns

Just as plastics are widely variable in structure and use, so are the concerns raised by their ubiquitous presence as poorly controlled non-degradable waste. Foremost among these concerns is the recent explosion in what may be termed "pelagic plastics." For most of their history, synthetic, petroleum-based polymers were used and discarded principally in Europe and the United States, and more recently, Japan. Levels of plastic pollution off these coasts increased similarly to the level of plastic production until recently (Ogi et al., 1999; Moore C.J., et al., 2001). During the last decade of the 20th century, and continuing to the present, proliferation of plastic packaging and products accelerated worldwide. Sales of PET plastic water bottles in the US alone rose from a million tons in 1996, to 2.5 million tons in 2005 (Beck, 2005). Many of these bottles are shipped around the world for disaster relief and other purposes, where no recycling infrastructure exists. Dr. Curtis Ebbesmeyer, of the Beachcombers and Oceanographers International Association (personal communication), has estimated that a single, 1 l plastic water bottle will photodegrade into enough small pieces to put one piece on every mile of beach in the world. Two studies in the North Pacific reveal a rapid rise in micro-plastic marine debris. Moore C.J., et al. (2001) found the maximum abundance of plastic particles to be three times that found by Day et al. (1990). Ogi et al. (1999) found plastic particle abundance to be increasing by a factor of 10 every 2–3 years in the most extreme case off of Japan during the decade of the 1990s. There are now 65,000 plastic processors in India and China, consuming nearly as much plastic resin, 49.8 mt/yr, as the United States (Mehta, 2007). Exports of primary plastic resins from the Middle East are growing rapidly in every global market except North and South America (Al-Sheaibi, 2002). Consumer plastics are going global. Tracking their fate is difficult. Based on statistics compiled in a 2003 California "Plastics White Paper," that included amounts of plastics made, disposed of, and recycled nationwide, approximately 25% of all disposable plastics remain unaccounted for (CIWMB, 2003). With total US thermoplastic resin sales at 50×10^6 tons, 25×10^6 tons (50%) are disposed of as municipal waste, 5% is recycled and an estimated 20% is made into durable goods. That leaves 12.5 million tons (25%) unaccounted for, which could make its way via rivers to the sea. In 3 days of sampling on the Los Angeles and San Gabriel Rivers, AMRF found 60 tons of plastic debris flowing towards the sea, representing 2.3 billion individual pieces of plastic trash of all size classes >1 mm (Moore et al., 2005b).

Many islands, which act as sieves for ocean-borne plastics, have already been heavily impacted by plastic debris originating far from their shores. On the surface of one square foot of beach sand on Kamilo Beach, Hawaii, 2500 plastic particles >1 mm were found, and the fact that 500 of them were pre-production plastic pellets, with no processors located in Hawaii, lends credence to the concept that these particles are of distant origin (Moore, unpublished data). McDermid and McMullen (2004) collected 19,100 plastic particles from nine remote Hawaiian beaches separated by 1500 miles, and 11% were pre-production pellets by count. These pellets come in a variety of shapes, including rounded, flattened oval, and cylindrical, and are normally <5 mm in diameter. Plastic producers make these pellets and ship them to plastic manufacturers or processors to be melted into consumer products. A 1998 study of Orange County Beaches in Southern California showed plastic pellets to be the most abundant items, with an estimated count of over 105 million, comprising 98% of the total debris (Moore S.L., et al., 2001). Southern California has the largest concentration of plastic processors in the western United States. A 2005 study by AMRF (Moore et al., 2005b) of the two main rivers draining the Los Angeles, California basin found in one dry and two rainy days of sampling, over 2.3×10^9 plastic objects and fragments being transported to the Pacific Ocean at San Pedro Bay. Macro-debris >5 mm accounted for 10% of the total. Of the identifiable objects, the largest single component was pre-production plastic pellets at 2.3×10^8. Ignoring such inputs results in underestimates of the total number of pieces of litter entering the ocean worldwide on a daily basis. A widely quoted figure of 8 million pieces per day given in UNEP (2001) is, in reality, only 1% of the total number of plastic pieces flowing to the sea from the Los Angeles area in a single day, based on AMRF's 3-day totals. AMRF's figures do not include anthropogenic debris other than plastic.

Plastics form a stable substratum for colonization by marine organisms, including bacteria, with larger floating items generally having one side exposed to the sun, and one side ballasted with fouling organisms (Moore, unpublished data). Less than 10% of the micro-debris in a 1999 North Pacific Central Gyre study, however, appeared to host multicellular fouling organisms at all (Moore C.J., et al., 2001). This may be due to their frequency of tumbling in wavelets and changing the side exposed to the sun. Barnes (2005) estimates "that rubbish of human origin in the sea has roughly doubled the propagation of fauna in the subtropics and more than tripled it at high ($>50^\circ$) latitudes." Globally, the proportion of plastic among marine debris ranges from 60% to 80%, although it has reached over 90–95% in some areas (Derraik, 2002). Bartram and Rees (2000) point out certain exceptions to the percentages, found during United Kingdom beach surveys, and state that "litter sourcing seems to be highly site specific."

Plastics made up 80–85% of the seabed debris in Tokyo Bay (Kanehiro et al., 1995). The consequences of partially covering the seabed with materials resistant to gas and water transport have not been fully investigated, although Katsanevakis et al. (2007) found a deviation in the community structure of the impacted benthic surface from their control and a clear successional pattern of change in benthic community composition. Goldberg (1997) speculated that benthic debris may interfere with carbon cycling in the ocean. Moore (2003) estimated that the weight of plastic debris on the surface, in an area of the North Pacific Central Gyre

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known as the "Eastern Garbage Patch," an area 1000 km in diameter, was about three million tons, based on an average of 5114 g/km^2. (Moore C.J., et al., 2001). Andrady (2000) found that plastic fishing gear "would initially increase in density because of copious fouling," and become negatively buoyant until it descended below the photic zone where the foulant colony would likely die due to lack of sunlight, allowing the plastic material to float again. This implies that as buoyant plastic fragments become mixed into marine "snow" (the natural detritus of the marine environment), the marine snow may be prevented from reaching the sea floor where it is a major sequestration vector for atmospheric CO_2.

3. Solutions

Because of the enormous diversity of plastic waste, the solutions to the plastic debris pollution problem will also have to be diverse. Despite the recent upsurge in development of solutions to prevent plastic pollution, the author is not aware of reports showing measurable overall reductions to this rapidly increasing despoiler of marine and aquatic environments.

3.1. Structural controls

Devices to capture plastic debris before it reaches rivers and oceans are being installed at urban catch basins, storm drains and pumping stations, and debris booms are being placed across rivers draining urban areas. Containment structures cover only a small percentage of debris conduits, and during heavy storms, these devices break or overflow, and release debris. Nevertheless, these devices are being relied upon by municipalities required to reduce trash input to urban waterways by regulations called total maximum daily loads (TMDLs), used by Water Resource Control Boards to regulate pollutants entering urban waterways. Structural controls typically capture macro-debris (>5 mm) only, as the legal definition of trash under the TMDL is anthropogenic debris that can be trapped by a 5 mm mesh screen (California Regional Water Quality Control Board, Los Angeles Region). Based on a study of the Los Angeles watershed, 90% of plastic debris by count, and 13% by weight are micro-debris <5 mm (Moore et al., 2005b).

3.2. Beach and reef cleanups

While beach cleanups by civic groups raise awareness among the general public of the plastic debris problem, they are infrequent and do not stem the tide of debris. In the Northwestern Hawaiian Islands, NOAA spends 2 million US dollars per year to remove 50–60 tons of derelict fishing nets and gear in an effort to save the critically endangered Hawaiian Monk Seal, over 200 of which have become entangled since records were kept (Foley and Veenstra, 2006; Pichel et al., 2007). The amount retrieved does not diminish significantly, year to year, and efforts are currently being made to find accumulation zones where the nets can be retrieved at sea before they damage coral reef habitat (Pichel et al., 2007). Recently, civic groups have begun to focus clean up efforts on storm drains and catch basins upstream from outlets to the sea, which will prevent the debris removed from reaching the ocean.

3.3. Deposits, fees

Ten of 52 US states have implemented "bottle bills" which require a deposit on certain plastic bottles to aid in their recovery and recycling, and in 2005, only 17% of the over 50 billion polyethylene terephthalate (PET) plastic water bottles consumed in the US were recycled. The number of plastic bottles as a percentage of total debris recovered in beach cleanups is rising (Beck, 2005). Thin high-density polyethylene (HDPE) and thicker LDPE shopping bags are recycled at a rate of around 1% in the US (USEPA, 2003), with trillions being produced worldwide. Many become airborne and soar on the wind to distant waterways and seas. Recently, a BBC photographer (Rebecca Hosking, personal communication), after documenting the effects of plastic waste on the Hawaiian Archipelago, returned to her hometown of Modbury, UK, and succeeded in getting the town's merchants to stop using plastic bags. This movement has spread to other towns and the Mayor of London is now considering a 10 pence tax on the bags. The movement to tax or restrict the use of plastic shopping bags is growing, with new initiatives being reported from around the world on a regular basis, but the author has not been able to locate a summary report where details of these efforts can be found.

3.4. Source reduction, take-back schemes

Because plastic packaging extends the shelf life of products by providing an air and moisture barrier, it is increasingly used in global trade. In some applications, where space is a major concern, bulk packaging, rather than individual containers are preferred, but the trend is for more individual packaging. Producers of consumer plastics in the United States have little incentive to minimize the use of their products, or to design them for ease of recycling. The prevailing attitude among US manufacturers is that they are responding to the demands of the market, and that it is the responsibility of individuals and governments to create infrastructure for dealing with the resultant waste. Rarely are US processors required to subsidize the cost of land filling or otherwise disposing of their manufactured plastic products, which often become fast-track waste. A few US companies have adopted a "zero waste" policy, which requires that their suppliers take-back packaging and provide take-back programs for their customers, but these companies remain a small part of industry as a whole.

European countries, however, are responding to so-called "green dot" initiatives with some packaging reductions. In December 1994, the European Union issued the "Directive on Packaging and Packaging Waste." This legislation places direct responsibility and specific packaging waste reduction targets on all manufacturers, importers and distributors of products on the EU market. To meet the requirements of this legislation, manufacturers, importers and distributors must either develop their own take-back scheme or join industry-driven non-profit organizations, such as the Green Dot Program, to collect, sort and recycle used packaging. Green Dot is currently the standard take-back program in 19 European countries and Canada. Such programs encourage product and packaging design that gives waste value when it is recycled as another product in a "cradle to cradle" system (McDonough and Braungart, 2002). Such schemes may help to reduce plastic waste that ends up in the ocean, but they are far from universal.

3.5. Industry housekeeping

Plastic resin pellets, powders and fragments are widely dispersed from their places of origin. The impacts of powders and plastic debris smaller than pellets are not known, but ingestion by plankton (Bern, 1990; Moore C.J., et al., 2001) and several species of meso-pelagic myctophid fish does occur (Eriksson and Burton, 2003; Moore, C.J., unpublished data). The impacts of pelletized and powdered plastic additives,

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including colorants and conditioning chemicals in the marine environment are not well understood, as research is in the initial phases, but Teuten et al. (2007) states that …"plastics may be important agents in the transport of hydrophobic contaminants to sediment-dwelling organisms."

Pre-production plastics (in the form of pellets, powders and production scrap) are accidentally discharged to waterways during the transport, packaging, and processing of plastics when Best Management Practices (BMPs, i.e., proper housekeeping practices) are not adequately employed. For pellets transported by rail, cars are emptied via a valve that connects to a conveyance suction hose. The valve should be capped when not in use. Caps are often not replaced, causing pellet loss within the rail yard adjacent to a facility. A similar conveyance system exists for resins transported by hopper trucks. Pellets and powders escape when hoppers are emptied through pipes connected to valves at the bottom of the truck. When handled improperly, resin pellets and powders are also released from conveyance mechanisms on site. In addition to plastic resins, additives used for coloring or creating specific characteristics of processed plastics are also delivered in pellet and powder form. The discharges to local waterways include colorants and additives, not just plastic resins. Grindings, cuttings and fragments from the processing of plastics, known as production scrap, are often part of the mix of debris that is conveyed by wind and storm water as runoff from plastics facilities to storm drains and nearby waterways (Moore et al., 2005c).

Evidence suggests that pre-production plastic resin pellets accidentally released from plastic processors contribute approximately 10% by count to the plastic debris problem (Moore et al., 2005b; McDermid and McMullen, 2004). In response, the American Plastics Council (APC) and the Society of the Plastics Industry (SPI) in the United States have adopted a voluntary program of BMPs known as "Operation Clean Sweep" (OCS). OCS was first developed in 1980 by SPI. It was recently revised and improved by a collaborative effort between AMRF, APC, and SPI. Measurements of industrial discharge before and after implementation of the program showed reductions of approximately 50% in pellet discharge (Moore et al., 2005c), but recruiting participants from the thermoplastic processing sector has proved challenging (American Plastics Council, personal communication).

3.6. Recycling

Plastic is hard to clean due to the penetration of contaminants into the polymer matrix. It is also difficult to separate composites and mixed plastic waste into the many different plastic types that require different reprocessing technologies. Furthermore, many thermoplastics melt at temperatures not far above the boiling point of water. Therefore, contaminants are not driven off during remanufacture. The price of recycled plastic materials often exceeds the current price of virgin plastic resin (Brandrup, 2003). Because of contamination, recycled plastics can rarely be used in true "closed-loop" recycling; for example, a layer of virgin plastic must be added onto the recycled material for food contact applications. Plastic bags are often used to make plastic "wood", rather than more bags. Plastic wood is not widely recycled and most will end up as land fill or otherwise discarded. In spite of separation schemes for households, only about 5% of plastics in the US are recycled in any way (CIWMB, 2003).

3.7. Bans, legislation

Bans typically focus on high profile waste, such as thin plastic shopping bags and expanded polystyrene cups and clamshell food service containers (commonly but incorrectly called Styrofoam, which is a patented insulation made by Dow Chemical Co.). Bans on some bags and foamed plastics have been adopted by several municipalities in the United States and by some other countries, but most types of plastic packaging and consumer products are unregulated and continue to litter the landscape, and make their way to the ocean.

3.8. Biodegradables

All polymers that occur in nature are biodegradable (Swift, 2003).

Many synthetic "bio-polymers" originate from non-petroleum sources. These include cellulose-based cellophane and rayon, as well as the more modern polylactic acid (PLA) and polyhydroxyalkanoate (PHA), which are derived from fermentation. In general, these plastics biodegrade more rapidly than their petroleum-based counterparts. However, typical tests for biodegradability rely on hot, aerated composting media, based on the metabolism of bacteria, fungi and insects. The marine environment is much colder, and many compostable "bioplastics" degrade very slowly at sea, and hardly at all in the deep ocean (Wirsen, 1971). Currently, substitution for conventional plastics is limited by the cost of bioplastics, which is five to ten times greater than for petroleum-based resins. A 1999 projection of the world biodegradables market was that it would grow from 30 to 250×10^6 pounds per year, while petroleum plastics sell at 1000 times that rate, or 250×10^9 pounds annually (New York Times, 1999). While bioplastics may offer a more sustainable industry product with reduced environmental effects, Swift (2003, p. 499) states: "…modification of natural polymers either by grafting synthetic polymers or by chemical conversions such as oxidation and esterification, changes their properties and biodegradation characteristics significantly. Therefore, polymers produced by any of these modifications must be evaluated for biodegradability in the same manner as purely synthetic polymers."

4. Recommendations

In 2002, the State of California Water Resources Control Board awarded a half million dollar US grant to AMRF and the California Coastal Commission (CCC) to assess the amount of plastic debris entering the ocean from the Los Angeles Basin's two largest watersheds. The grant provided for a process to develop recommendations to reduce these inputs. In 2005, during the first international conference on plastic debris, called "Plastic Debris, Rivers to Sea," sponsored by the CCC and AMRF (www.plasticdebris.org), the participants were encouraged to participate in writing these recommendations. The result was a comprehensive booklet (Gordon, 2006). It included 63 recommendations for action which were grouped into the following categories:

1. the need for improved coordination
2. research needs
3. specific sources of land-based discharges
4. product wastes.

In part as a result of these recommendations, the California Ocean Protection Council (2007) adopted a resolution on marine debris, which listed many of the recommendations found in AMRF and the CCC's Action Plan. Certain California legislators then proposed, under the mantle of "The Pacific Protection Initiative," two Assembly bills and two Senate bills to address marine debris issues. Assembly Bill 258 requires the State Water Board and

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Regional Water Boards to implement a program to control discharges of pre-production plastic pellets, which are used to make plastic products, into rivers and streams. The bill was signed into law by Governor Swarzenegger on October 1, 2007. Three other bills are still pending. Assembly Bill 904 would require that takeout food packaging be made from recyclable or compostable materials starting July 1, 2012. Senate Bill 898 would require the California Integrated Waste Management Board to address derelict (abandoned) fishing gear, and assign resin code labeling for bioplastics. Senate Bill 899 would implement a phased-ban of toxic additives in plastic packaging, such as Bisphenol-A. Details of international legal and other actions to deal with marine debris are beyond the scope of this review, and the author has not been able to locate a comprehensive report that lists and updates this type of international data, but such a compilation would be of benefit to those seeking solutions to the problems caused by persistent plastic debris.

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