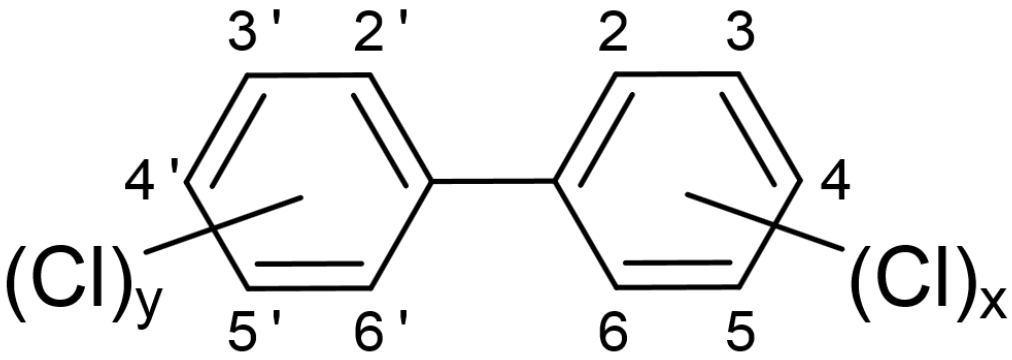
DEPARTMENT OF
ECOLOGY
State of Washington

Polychlorinated Biphenyls in Consumer Products



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This project was funded by the Hazardous Waste and Toxics Reduction (HWTR) Program of the Washington State Department of Ecology (Ecology). All studies conducted by Ecology must have an approved Quality Assurance Project Plan (QAPP). This study is based on a previous QAPP (Ecology, 2013) and Addendum (Ecology, 2014b), which identified additional samples for analysis. This report summarizes the results of this QAPP Addendum on the presence of inadvertent PCB contamination in consumer products.

This report is available on Ecology's website at
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Polychlorinated Biphenyls in Consumer Products

Department of Ecology
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Summary

In this study, the Washington Department of Ecology (Ecology) evaluated the presence of polychlorinated biphenyls (PCBs[1]) in 201 consumer products. An emphasis was placed on products likely to be contaminated with PCBs due to inadvertent PCB production in the manufacturing process. Although many chemicals may contain low levels of PCB contaminants due to use of chlorine in their manufacture, recent studies have shown a PCB presence in pigments and dyes used in consumer products. Products known to contain PCB contaminants include paints (Hu, 2010), newspapers, glossy magazines, cereal boxes, yellow plastic bags (Rodenburg, 2012), labels, boxes, and paint colorants (Ecology, 2014c).

The objectives of the study were to 1) evaluate whether consumer products contain PCBs as a contaminant, 2) if found, evaluate the contribution from organic pigments and dyes using PCB-11 as an indicator species, and 3) evaluate the range and amounts of PCBs found in consumer products (Ecology, 2014c). To evaluate specific PCB congeners in consumer products, samples were analyzed for the 209 PCB congeners using Analytical Method 1668C. Results are discussed in this report for total PCBs and specific congeners for each sample. This report summarizes the results for 216 samples evaluated in this study. The 216 samples were grouped into 14 categories:

Table 1. Categories of Samples

Category	Count	Category	Count
Caulks	8	Misc.	2
Children's Products	14	Office	17
Clothing	5	Paints/Colorants/Dyes	24
Comic Books	10	Pesticides/Lawn and Road Care	19
Containers/Boxes (paper)	31	Plastics	17
Cosmetics/Body Care	11	Printed Material/Newsprint	12
Labels	35	Road Paints	11
		Total =	216

Two hundred sixteen samples were selected from 201 consumer products. Some products were separated into multiple components. For example, a child's finger paint set (one product) was separated into samples of three different colors (three components and samples). All 216 samples were analyzed for all 209 PCB congeners. Special emphasis was placed on congeners such as PCB-11, which was used as an indicator species for the possible presence of PCB contamination from pigments and dyes. Therefore, the presence of PCB-11 suggests the source of PCBs in consumer products is from pigments and dyes – not historical uses. Other pigments and dyes also contain PCB contaminants represented by other PCB congeners and are discussed in this report.

[1] A list of acronyms and abbreviations used in this publication is available in Appendix A.

Summary of Total PCB Results

- Three samples contained total PCBs over 1,000 ppb (equal to 1 part per million or ppm) (a child's yellow sidewalk chalk at 1,060 ppb, a single-serving cereal packaging at 2,320 ppb and a yellow foam office product at 2,310 ppb).
- Ten samples (including the three mentioned above) contained total PCBs above 100 ppb (0.1 ppm).
- One hundred ninety-three samples (89%) contained detectable total PCBs above the method reporting limit (MRL).
- One hundred fifty-six samples (72%) contained a total PCBs above 1 part per billion (ppb).

Table 2. Total PCB Results Grouped into Concentration Ranges:

Category	Number of samples	< MRL*	< 1	1 to <10	10 - <100	≥ 100
			ppb			
Total	216	23	37	80	66	10
Percentages	99.9	10.6%	17.1%	37.0%	30.6%	4.6%

* *Method reporting limit*

Total PCB compared to PCB-11 results: The presence of the PCB-11 congener suggests the source of PCBs in consumer products is from pigments and dyes. PCB-11 was detected in 135 (62%) of the 216 samples. Several of the products contained PCB-11, and PCB-11 often accounted for a majority of the total PCBs. For example, for the three products mentioned above with PCB concentrations in the ppm range (a child's yellow sidewalk chalk, a single-serving cereal packaging, and a yellow foam office product), PCB-11 accounted for 99% of the total PCB. This indicates that PCBs in pigments or dyes may be the major source of PCB contamination in these products. Often correlations between PCB-11 and total PCB concentrations were not as pronounced.

For example, a phthalo-cyanide green paint colorant sample reported a PCB-11 and total PCB concentrations of 7 and 339 ppb, respectively. A review of the full 209 congeners indicated that PCB-209 was responsible for most of the PCBs, 320 ppb or 94% of the total PCB concentration for this colorant. PCB congeners other than PCB-11, such as PCB-209, from pigments and dyes may also be contaminating products in addition to other potential sources of PCBs.

Summary of PCB congener results: Several products contained broad distributions of PCB congeners. For example, the only caulk sample found to contain PCBs contained PCB-11 and total PCB concentrations of 7.6 and 390 ppb, respectively. A detailed review of the 209 PCB congeners for this sample found concentrations of PCB-1, -2 and -3 at 61.6, 205 and 96.1 ppb, respectively for a total of 362.7 ppb (93% of the total PCB concentration). The cause of this distribution remains unclear and suggests that additional process review is necessary to determine PCB sources.

Lastly, PCB congener results were evaluated for the presence and distribution of specific congeners in the 216 samples. Sampling results identifying any specific or co-eluting congener(s) above 0.5 ppb were separated and reviewed. The results indicated that a majority of the congeners (approximately 57%) were

found in at least one sample at concentrations above 0.5 ppb. At least one PCB congener or co-eluting PCB congeners was detected in 145 of 201 products (72%). PCB-11 as an individual congener was found in the most samples (134 samples), followed by PCB-52 (48 samples) and co-eluting PCBs-61/70/74/76 (39 samples). A majority of the 145 products, however, had either a single (58 of 145 or 40%) or 2-5 (51 or 35%) PCB congeners. Of those 58 products containing only a single PCB, PCB-11 accounted for 53 (91%), followed by PCB-209 (4 products, 7%) and PCBs-12/13 (1 product, 2%).

Low and non-detect PCB samples: Samples in several product categories contained either non-detectable (23 samples) or very low levels (37 samples) of total PCBs. These results suggest that products can be manufactured with minimal PCB contaminant concentrations.

Conclusions

Based on the results of this study, Ecology concludes that:

- PCBs in consumer products are widespread and found at appreciable concentrations.
- Pigments and dyes are a source of PCB contamination.
- Further review of products and associated manufacturing processes are warranted where pigments and dyes are not the likely source.
- It may be possible to manufacture products without PCBs or PCBs at lower levels.
- An alternatives assessment is recommended to identify and support pigments and dyes that are not contaminated with PCBs.

Please note that this report does not investigate the effects of PCBs on human health or the environment, nor does it reach any conclusions concerning the risk they pose.

Background

Polychlorinated biphenyls (PCBs) are a class of persistent, bioaccumulative, and toxic (PBT) compounds that historically had a wide range of uses, including consumer products. PCBs are created by reacting biphenyl with chlorine (Pomerantz, 1978). PCBs were used in:

- Electrical transformers and capacitors
- Heat transfer and hydraulic systems
- Vacuum pumps and lubricants
- Surface coatings
- Adhesives
- Plasticizers
- Inks
- Insulating materials
- Pesticides

(UNEP, 2007)

From 1929 to 1979, PCB production in the United States was approximately 1.4 billion pounds (600,000 metric tons), with 77 percent used in transformers or capacitors (U.S. Environmental Protection Agency [EPA], 1976). PCBs were valued for their persistence, inability to conduct electricity, flame retardancy, plasticizing, and anti-microbial effects. Commercial PCB production ended by 1979 under the Toxics Substances Control Act (TSCA), but inadvertent PCB generation continues. Current levels of PCBs in

Washington stem from cycling of PCBs in the environment, continuing releases from historic uses, and releases of newly generated PCBs.

In the Puget Sound, surface runoff is the largest pathway to aquatic environments, followed by wastewater treatment plants, and air deposition. PCBs are released in the highest quantities in commercial areas compared to other land covers, making PCB contamination especially relevant to the highly urbanized Puget Sound Basin (Ecology, 2011). Surface runoff has also been shown to be a problem affecting waterways in the Spokane, Washington area. Analysis of such samples as motor oils, transmission fluids, traffic paints, and other similar inputs to stormwater were found to be contaminated with PCBs (Spokane, 2015).

Studies indicate that PCBs are ubiquitous throughout the natural environment, in air, soil, and sediments, and are found in animals throughout the food chain (ATSDR, 2000). PCBs were detected in migrant Chinook salmon tissue and fish, and other marine mammals locally important to the Puget Sound region. Concentrations, however, appear to be declining in Puget Sound harbor seals and mussels. No equivalent trend can be identified in fish, although modeling suggests levels will start to decline in English sole by 2020 (Ecology, 2011). Fish consumption advisories have been issued for both marine and fresh water species in Washington due to PCB concentrations.

Historically, PCBs were manufactured in nine major mixtures called Aroclors. Aroclor was the tradename of the technical mixture of PCBs sold in the United States by Monsanto Chemical Company (Monsanto). Prior to 1979, Monsanto in Sauget, Illinois produced approximately 99% of the PCBs used within the U.S. The nine Aroclor mixtures included Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262 and 1268 (ATSDR, 2000). Production of these Aroclor mixtures decreased from over 86 million pounds per year in 1970 to 35 million pounds in 1977 (EPA, 2012a).

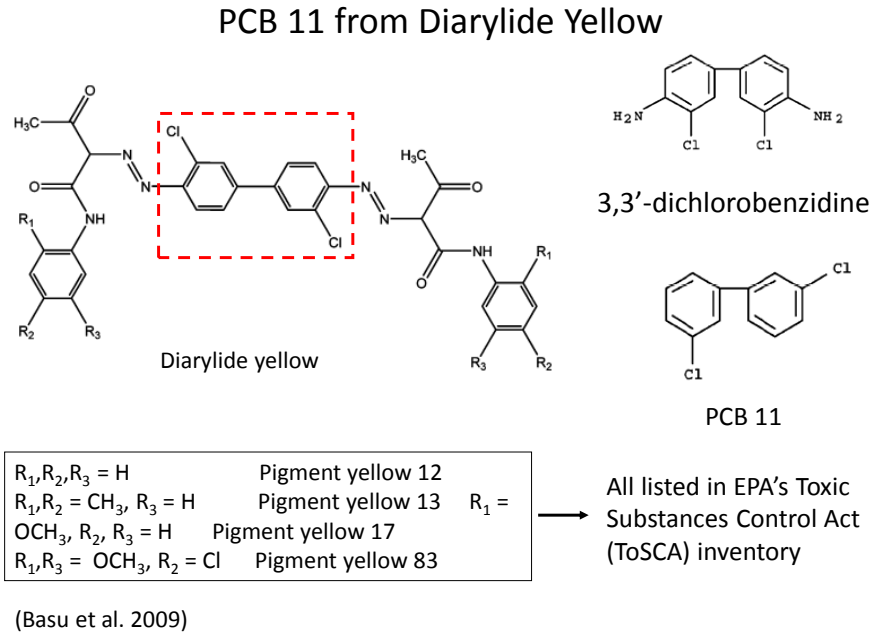
PCBs in Products

Although commercial production of PCBs ended in 1979, PCBs can still be found in products (Hu, 2010; Rodenburg, 2012; Ecology, 2015). Many of these products contain PCBs as an impurity created during production processes. As part of rulemaking on inadvertently generated PCBs, EPA identified 200 chemical processes with a potential for generating PCBs and narrowed it to 70 with a high potential (NYAS, 2005). Hu et al. (2010) sampled consumer paints containing specific azo (yellow and orange) and phthalocyanine (blue and green) organic pigments and found PCB levels ranging from 2 to 200 ppb in 15 of 33 consumer paints tested. Rodenburg et al. (2012) detected PCBs in consumer products in the range of 1 to 38 ppb.

Diarylide yellow comprises approximately 25% of the 250 million kilograms of organic pigments produced yearly worldwide (Ecology, 2015). Testing has shown PCBs (especially PCB-11) are produced during its manufacture. As shown in Figure 1, PCB-11, indicated in the red box, is part of the structure of diarylide yellow. PCB-11 is either produced as a byproduct during the manufacturing process or results from degradation of the pigment. PCB-11 functions in this study as an indicator of the

presence of pigment or dye because 1) it is not found in traditional Aroclor mixtures and 2) is not believed to be a degradation product from traditional Aroclors. Therefore, if PCB-11 is found, its presence is most likely due to diarylide yellow pigment that contains PCB-11 as a contaminant.

Figure 1. Diarylide yellow and PCB-11 (Rodenburg, 2012)

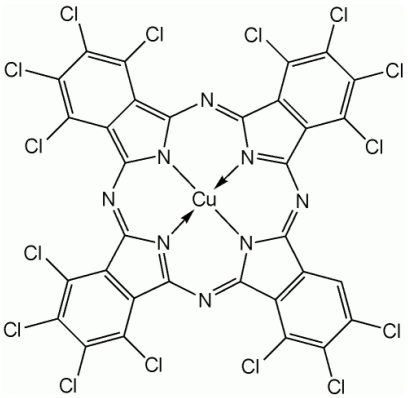


(Basu et al. 2009)

In addition to PCB-11, higher molecular weight PCBs (PCB-206, PCB-208, and PCB-209) are produced as byproducts from one of the common manufacturing processes of the inorganic pigment titanium dioxide (TiO_2) (Rodenburg, 2012). Chlorine is reacted at high temperatures with TiO_2 ore to form the liquid titanium tetrachloride ($TiCl_4$). $TiCl_4$ is reacted with oxygen to make pure TiO_2 (UNEP, 2007). Higher molecular weight PCBs are created as a reaction byproduct.

Other dyes are also shown to contain higher PCB congeners. For example, Ecology (2014c) found high levels of PCB-209 in the pigment phthalocyanine green (Figure 2).

Figure 2. Structure of the green pigment, phthalocyanine green



TiO_2 and phthalocyanine green are just two examples of how PCBs may contaminate production processes.

Awareness of PCB contamination in pigments and dyes is increasing.

- EPA recently announced the enforcement settlement against Titanium Metals Corporation (TIMET) for the improper disposal of PCB-contaminated waste generated during TiO_2 production. As part of the settlement, TIMET agreed to pay a $13,750,000 penalty (EPA, 2014).
- The Japanese Ministry of Economy, Trade and Industry along with two related ministries reanalyzed 242 organic pigments found to contain PCBs as contaminants. 101 of the organic pigments contained PCBs over 0.5 ppm (METI, 2013a).
- Reanalysis of four yellow pigment samples detected PCB concentrations in the range of 59 to 1,000 ppm (METI, 2013b). According to one expert, development of new pigments is a long-term project (Christie, 2014).

In addition to PCB contamination in pigments and dyes, PCBs were used extensively in caulking compounds. It is unknown if new caulk contains PCBs. Historically, PCBs were intentionally added to joint sealant caulks at high levels to improve their flexibility, increase their resistance to mechanical erosion, and improve adherence to other building materials (Diamond et al., 2010). PCBs can be lost from caulk through volatilization, as well as wash-off and erosion. PCBs in caulk are associated with higher levels of PCBs in indoor air and dust, and the external soil (Priha et al., 2005; Herrick, 2007; SAIC, 2011). Larger amounts of PCBs may be released during renovations or destruction. Certain removal practices can reduce the amount of PCBs released to workers and the environment (Sundahl et al., 1999).

Sealants with high levels of PCBs have been found at varying levels in buildings built from about 1950 to 1980 in several studies in the U.S. and other countries. In general, PCBs in caulk ranged from 5-30% (Priha et al., 2005). The most comprehensive study of legacy caulk in buildings was conducted in Switzerland (Kohler et al., 2005). In this study, 1,348 caulk samples from concrete buildings built between 1950 and 1980 were analyzed for PCBs. Forty-eight percent (647) of the caulk samples contained PCBs, from less than 50 ppm up to 550,000 ppm (550,000 ppm indicates the samples consist of 55% PCBs by weight). Similar results were found in smaller studies, including the 2011 study in the Duwamish (SAIC, 2011). Eight of 17 (47%) composite caulk samples from representative buildings (industrial buildings from 1950-1977) had PCB concentrations from 3 to 920 mg/kg (parts per million).

Project Description

Ecology conducted this study of current consumer products that are believed to contain PCBs as a production impurity at the ppb level. As defined in the Quality Assurance Project Plan (QAPP) (Ecology, 2014b), the study objectives were to:

- Evaluate whether consumer products contain PCBs as a contaminant.
- If PCBs are found, evaluate the contribution from pigments and dyes using PCB-11 as an indicator species.

- Evaluate the range and amounts of PCBs found in consumer products.

This report combines the results from two analytical efforts on a total of 201 products. In 2014, 68 products were analyzed for all 209 PCB congeners (Ecology, 2014c). In 2015, an additional 133 products were purchased for analysis. These additional products expanded on existing categories and added new product categories for analysis. Product categories where PCBs have been identified as a contaminant at the ppb level (Hu, 2010; Rodenburg, 2012; Ecology, 2015) include:

- Paint
- Yellow plastic bags
- Glossy magazines
- Pigments/colorants
- Newspapers
- Labels
- Cardboard containers
- Caulks

Washington State law requires the Department of Enterprise Services (DES) to establish a procurement preference for products and packaging that does not contain PCBs (RCW 39.26.280 and RCW 39.26.290). This study included products purchased under DES contracts.

Additional sources were searched to identify potential products contaminated with PCBs. Sources included Safety Data Sheets (SDS) for specific products, product labels, National Institute of Health's Household Product Database, and sampling reports from authoritative bodies (Ecology, 2014b). For these additional products, emphasis was placed on:

- Yellow, green, or blue products using organic azo pigments or dyes.
- Products containing chlorinated active ingredients listed on labels.
- Products purchased under state contract.

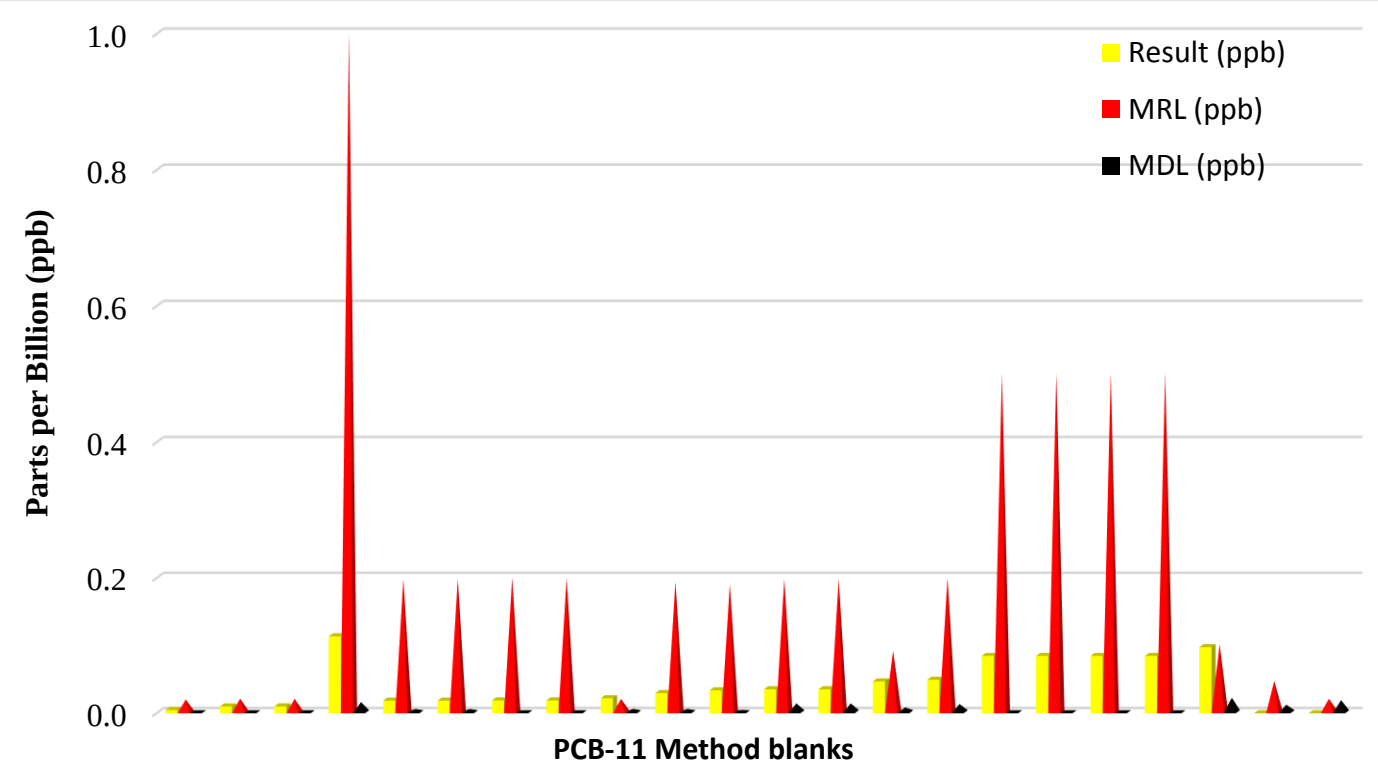
Product SDSs that listed high levels of TiO_2 were tested before samples reported to contain lower levels. This prioritized testing of products believed to contain the highest levels of pigments or dyes. Samples were sent to a contract laboratory for analysis. This study focused on products offered for sale in the current market and therefore, caulks currently for sale were sampled and tested but historical caulks were not.

Data Quality

All samples were analyzed using EPA Method 1668C (EPA, 2010). This analytical method has a detection limit at the parts per trillion (ppt) level. Because of the low detection limit of these analyses at ppt levels, the method blanks were reviewed closely. The detection limits and quantitation levels using Method 1668C are usually dependent on levels of interferences and laboratory background levels rather than instrument limitations. This report includes total PCB (sum of all PCB congeners found in the sample) and individual PCB congener results for 74 samples from a previous study (Ecology, 2014c) and 142 additional samples. The original 74 samples were re-evaluated to obtain both total PCB and individual congener results. PCB-11 method blank results for the initial 74 samples can be found in a previous report (Ecology, 2014c).

Twenty-two method blanks were run during analysis of the additional 142 samples. Detectable levels of PCB congeners were found in all twenty-two method blanks. PCB-11 was found above the method detection limit (MDL) (Figure 3) at the ppb level but below the method reporting limit (MRL) at the ppb level. PCB presence in most the method blanks is due to background laboratory levels, which are likely from low-level contamination from background sampling preparation.

Figure 3. Detectable amounts of PCB-11 in additional twenty-two method blanks



PCB-11 was found in the method blanks at an average of 0.04 ppb (Table 3). These method blank results agree with PCB-11 blanks in the previous study (Ecology, 2014b).

Table 3. Evaluation of PCB-11 Data in Additional 22 Method Blanks

	PCB-11	MRL*	MDL**
	ppb		
Maximum	0.11	1.00	0.02
Minimum	0.00	0.02	0.00
Average	0.04	0.23	0.01
Mean	0.03	0.20	0.00

**Method reporting limit* ***Method detection limit*

Several samples proved challenging to analyze and the quality assurance/quality control (QA/QC) goal of 1.0 ppb for all congeners could not be met, particularly for the higher molecular weight congeners. For example, complex matrices such as caulks and personal care products like soap proved difficult to

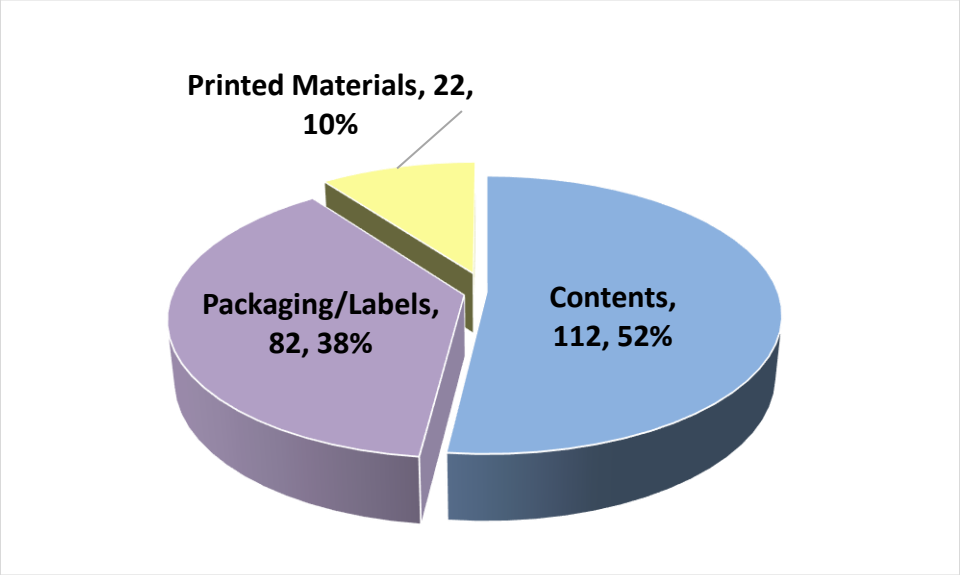
extract and analyze. In those instances where the 1.0 ppb requirement could not be met, the laboratory discussed the issues with Ecology's Project Manager who was provided sufficient information to show that all reasonable actions had been taken. The Project Manager approved all deviations from the 1.0 ppb method reporting limit.

All remaining QA/QC requirements established within the QAPP (Ecology, 2014b) were within acceptable limits.

Summary of Product Sampling

The results section of this report combines the 68 products reported in 2014 (Ecology, 2014c) with an additional 133 products tested in 2015 for a total of 201 products. Two hundred sixteen samples from these 201 products (Appendix B) were sent to the laboratory. The samples were analyzed for all 209 PCB congeners and summed at least for total PCB concentrations. Products were sampled for either their content or their packaging. To clarify what was sampled, the 216 samples were separated into three groups (Figure 4).

Figure 4. Separation of the 216 samples into group types



Appendix B contains a table listing all of the samples collected for PCB analysis. This table is color-coded identifying the group type shown in Figure 4. Samples labeled 'contents' (blue color code) indicate that the contents of the product were sampled – the packaging was not sampled. Samples identified as 'packaging/labels' (purple color code) identify that the product's container/box or label were sampled – the contents of the container was not sampled. Samples identified 'printed materials' (yellow color code) reflect paper products (newspapers, comic books, phone books, etc.) that were sampled. An example of a product split into two sampling groups would be a ream of paper that was split into one sample of the plastic outer wrap (packaging) and one sample of the paper (contents). The plastic packaging is identified as a Packaging/Labels sample while the paper is identified as a Contents sample.

Sample Numbering: Each sample is assigned a unique number. The numbering system for the 2014 sampling effort used a product naming convention to identify each sample. The 2014 samples were retroactively assigned a sample number to allow the data to be entered into the product testing database. For this report, this assigned number appears first followed by the original sample name in parenthesis except for the graphs where only the assigned database names are used. Appendix B lists all samples analyzed in this project and indicates which were retroactively assigned a sample number as described above. The samples collected during the 2015 effort were assigned unique product component numbers. An example of the sample numbers used for each year is shown below.

Sampling Year	Sample ID	Sample Description
2014	00-2-1-1 (3MPOIT)	Post-It 3" by 3"
2015	00-7-7-1	Yellow Chlorinated Rubber Zone Marking Paint

Products that had multiple components (such as a container of different colored chalk or a tray with different colored paint) were reflected by a different number in the end of the sample name for the second or third product component. The following are examples of multiple samples from a single product:

- Washable Sidewalk Chalk Paint
  - Yellow (WM-12-9-1)
  - Green (WM-12-9-2)
  - Blue (WM-12-9-3)

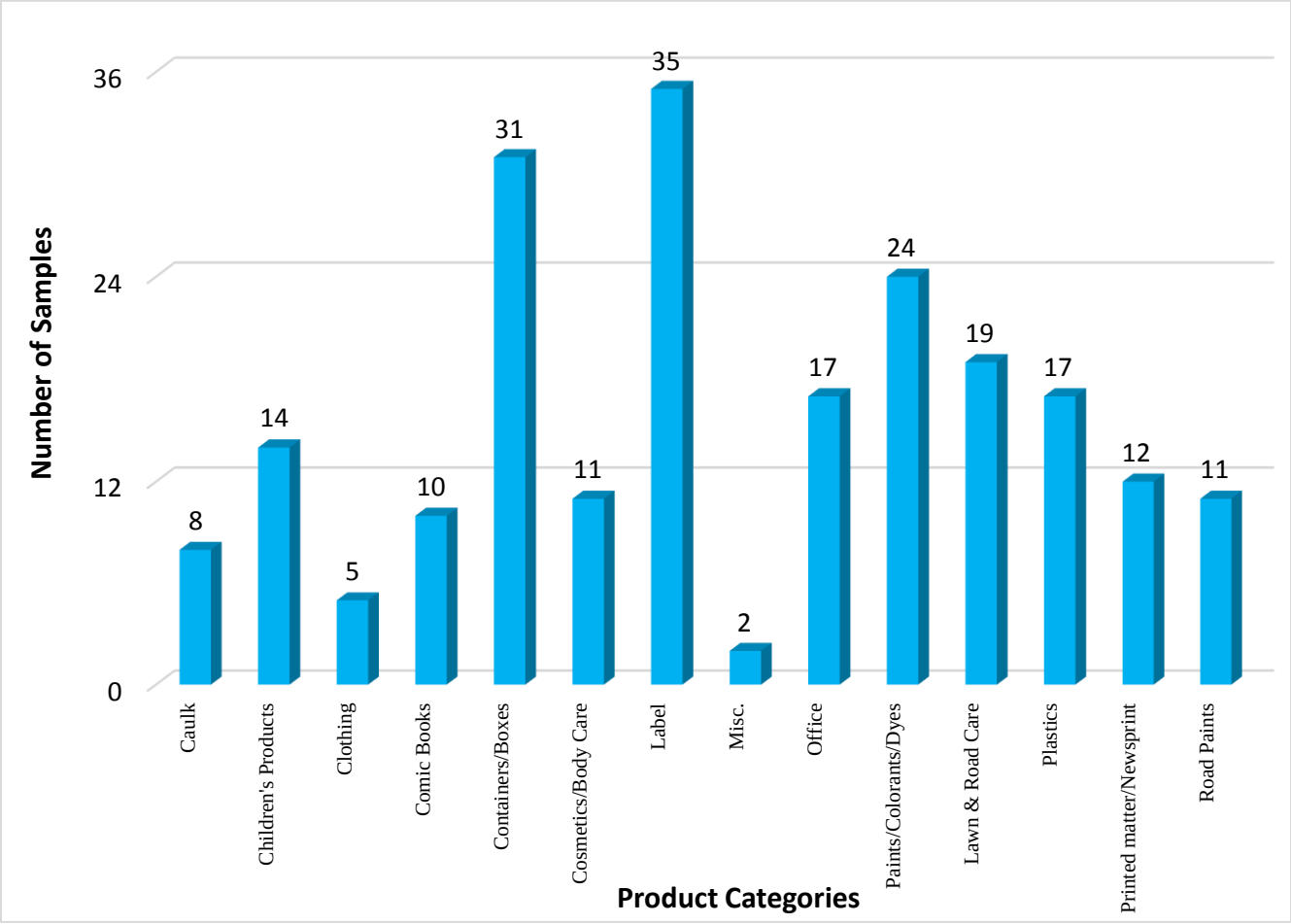
- Finger Paint
  - Yellow (WM-12-8-1)
  - Green (WM-12-8-2)
  - Blue (WM-12-8-3)
  - Red (WM-12-8-4)

All sampling results are available at the following website address: https://fortress.wa.gov/ecy/ptdbpublicreporting/. The study names are:

- PCBs in General Consumer Products – 2013 – Part 1
- PCBs in General Consumer Products – 2014/2015 – Part 2

Product Collection: Products were purchased from local retailers or obtained from state agencies for items purchased under state contract. Pictures were taken of some products prepared for analysis. Products were sampled using the standard operating procedure (SOP) developed for product sampling (Ecology, 2014a). The 216 samples fall into fourteen product categories (Figure 5):

Figure 5. Product categories for the 216 samples



Products were generally purchased for either the packaging or the contents. For example, labels or containers were obtained during sampling visits by Ecology staff from products purchased by state agencies. Products were also purchased from stores based on state purchasing constraints. The contents of many products were not sampled and analysis was limited to product labeling or packaging. Products were also purchased from a large office retailer identified under state contract as the sole provider of office products to the state. Other products such as lawn and road care products, however, were purchased to sample the contents. In those instances, the packaging was not tested. The product descriptions (Appendix B) identify which portion of the product was sampled.

Sample Collection: For the collection of labels or packaging samples, the printed portions of the packaging were separated from any backing paper or cardboard to concentrate the sample on the printing. The paper or cardboard backing was discarded. The packaging samples were further reduced in size using cleaned scissors and placed into sterile glass sampling jars for shipment to the laboratory per the SOP (Ecology, 2014a). In some limited instances, products were cryomilled to provide a uniform sample for analysis. All sample processing equipment was cleaned between samples using the procedure identified in Ecology's sample preparation SOP (Ecology, 2014a).

Product content samples were placed directly into glass sampling jars. For many products, this simply entailed squeezing an aliquot into the jar. For example, lawn and road care products were poured directly into the glass sampling jars.

Similar to the label and packaging products, printed materials were reduced in size using cleaned scissors and placed into glass sampling jars for shipment to the laboratory. Where possible, special emphasis was given to printed portions that contained higher amounts of yellow pigment. For example, one magazine sample consisted primarily of a yellow corporate advertisement.

Samples were sent to a contract laboratory for PCB analysis. Samples were analyzed using EPA Method 1668C (EPA, 2010).

Special care was taken to quantify all analyses for all 209 PCB congeners.

Results

The following sections provide summaries and limited details for the 216 samples. Sample results that are presented in this section are summarized in the following categories:

- Total PCB summary
- Total PCB and PCB-11 results for:
  - Children's products
  - Office products
  - Plastic packaging
  - Labels

Total PCB results for all remaining product categories can be found in Appendix C. In addition, individual congener results were graphed for all 216 samples but are not included in this report due to the amount of data involved.

PCB Totals

A total PCB concentration was calculated for all 216 samples. Of the 216 samples, 156 samples (72%) contained total PCBs over 1.0 ppb. Table 4 details the total PCB results for selected concentration ranges:

Table 4. Summary of Total PCB Results for Each Product Category

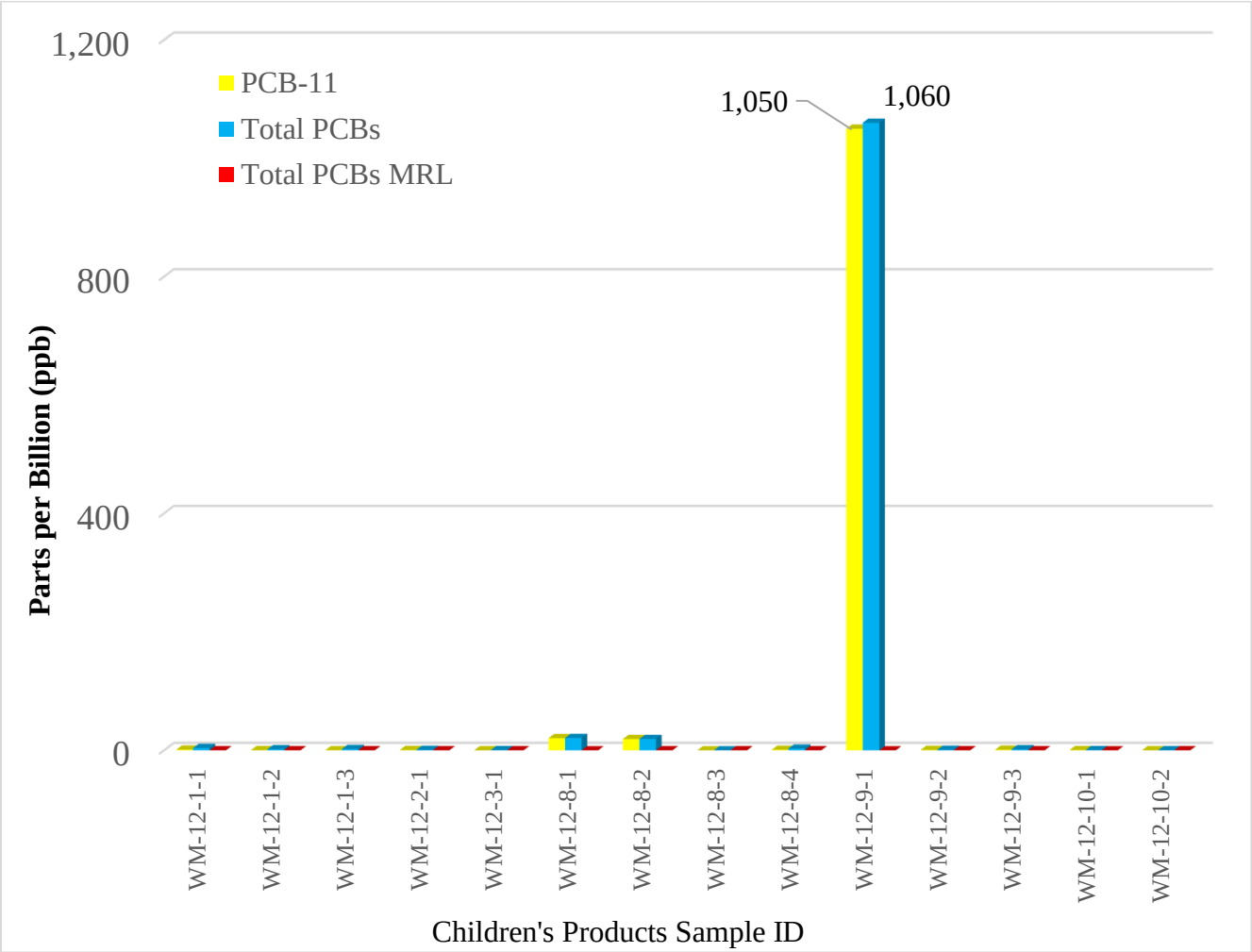
Category	Number of samples	No. < MRL*	< 1	1 to <10	10 to <100	≥100	Min.	Max.	Avg.
			ppb						
Caulk[1]	8	7	0	0	0	1	0.04	390.0	N/A
Children's Products	14	2	4	5	2	1	<0.08	1,060.0	79.6
Clothing	5	0	0	3	2	0	1.3	16.6	8.5
Comic Books	10	0	0	10	0	0	1.1	5.0	2.7
Containers/Boxes	31	0	0	4	24	3	2.7	226.0	47.5
Cosmetics/Body Care	11	0	8	3	0	0	0.1	7.8	1.4
Labels	35	0	0	13	21	1	3.8	138.0	17.2
Misc. [1]	2	0	2	0	0	0	0.05	0.2	N/A
Office	17	4	2	6	3	2	0.2	2310.0	108.1
Paints/Colorants/Dyes	24	4	5	9	5	1	0.06	339.0	22.0
Lawn & Road Care	19	4	10	5	0	0	0.03	7.0	1.1
Plastics	17	1	3	9	3	1	2.0	2,320.0	144.4
Printed materials/Newsprint	12	0	0	8	4	0	2.4	53.5	16.5
Road Paints	11	1	3	5	2	0	<0.08	102.0	14.9
TOTAL Count	**216**	**23**	**37**	**80**	**66**	**10**			
TOTAL Percentage	**99.9**	**10.6**	**17.1**	**37.0**	**30.6**	**4.6**			

[1] *For those categories where only one sample contained PCBs, the 'Min' and 'Max' in this instance, are the minimum and maximum levels for that single sample. No 'Average' can be calculated and therefore is assigned 'N/A' for 'Not Applicable.'*
**Method reporting limit*

As Table 4 indicates, 76 of the 216 samples (35.2%) contained total PCBs above 10 ppm. A similar amount (80 samples, 37%) contained total PCBs between 1 and 10 ppb. Total PCB concentrations for each product category was reviewed. A comparison of total PCB and PCB-11 results are presented for selected examples. For many of the figures in the following discussion, the x-axis on the chart is adjusted to show high and lower concentrations on the same graphic. A dashed line is used for the highly concentrated sample results to show the change in axes.

Children's Products: Figure 6 shows the analytical results for six children's products, including the total PCB (blue), PCB-11 (yellow) and the method reporting limits (MRL) (red) for the 14 samples in this category. One product, a yellow chalk (WM-12-9-1) used by children to draw on sidewalks, contained total PCBs at 1,060 ppb, equivalent to 1.06 ppm. In the yellow chalk sample, 99% of the total PCB results are due to the amount of PCB-11 in the sample, indicating that the PCB contents of this product appear strongly correlated to the pigment or dye used. Two other chalk colors (WM-12-9-2 and WM-12-9-3) were tested but reported total PCBs at much lower levels (Figure 7).

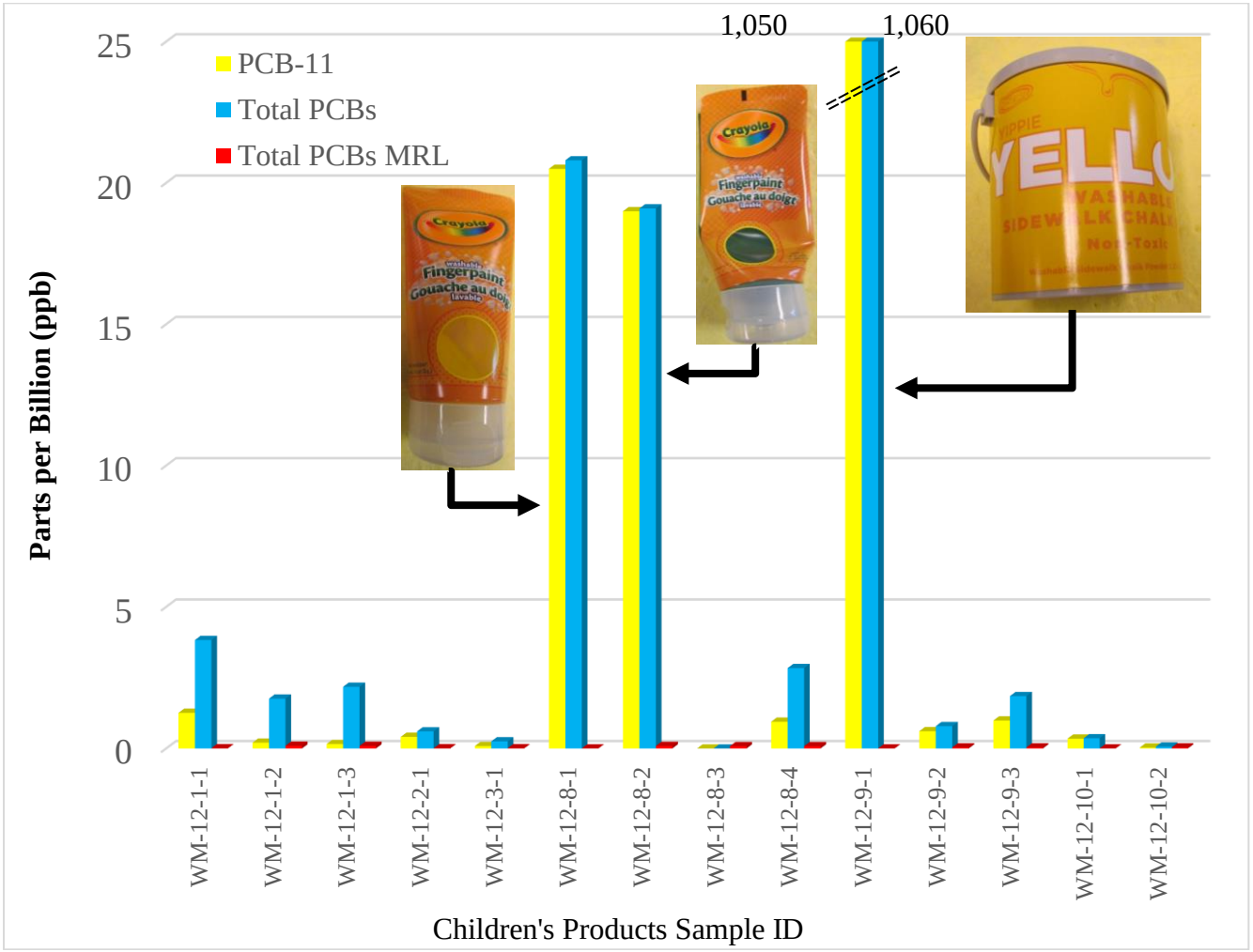
Figure 6. Total PCBs and PCB-11 in children's products



As is the case with many of the sample categories, one product present at a high concentration (WM-12-9-1) may mask the results from the other products. The results on Figure 6 are presented in Figure 7 with an adjusted axis to better review the lower PCB concentration sample results. The dashed line is used to show the change in axes for the highly concentrated sample (WM-12-9-1). This presentation method is used in several other figures for this discussion.

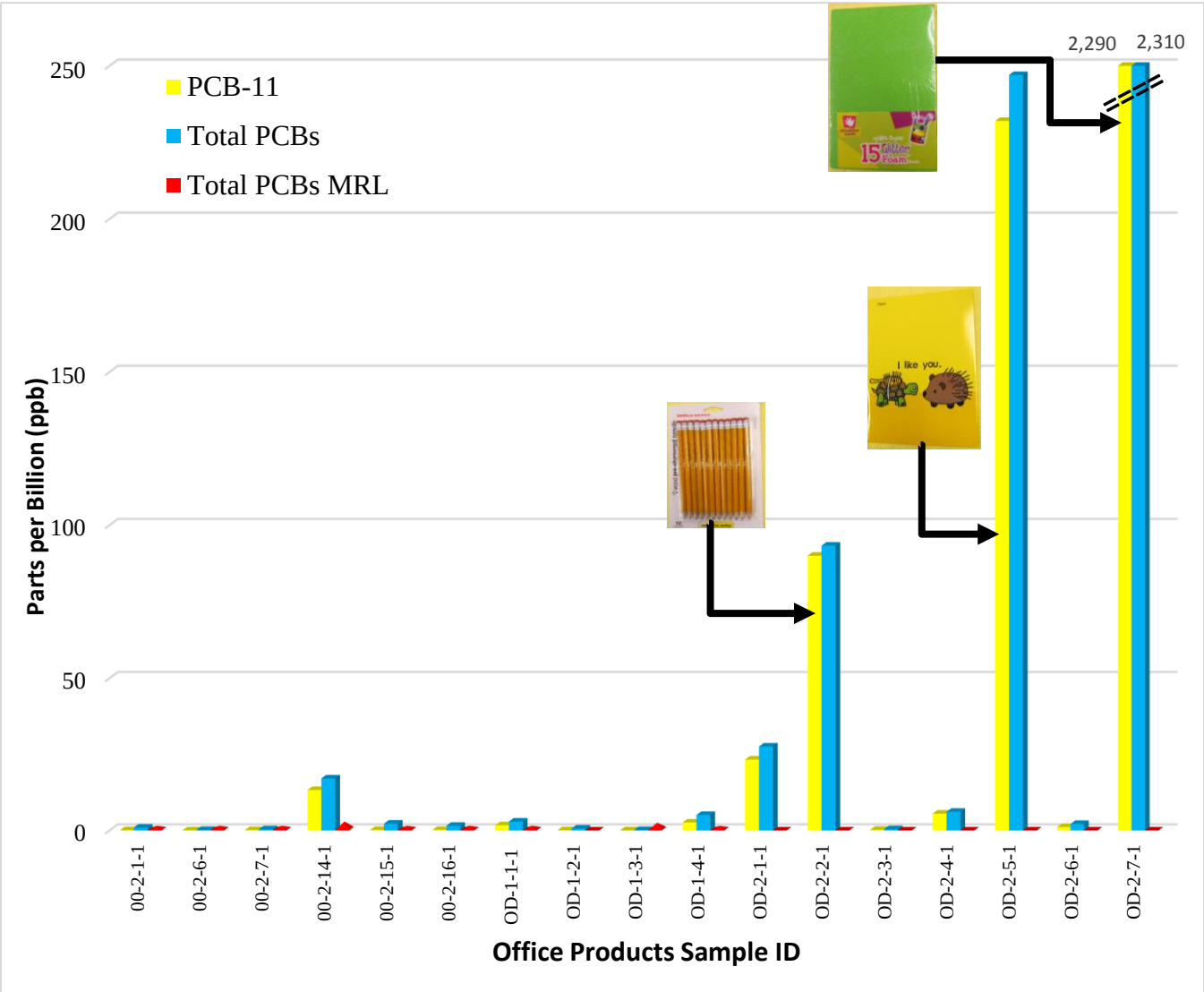
Figure 7 shows two additional samples, yellow (WM-12-8-1) and green (WM-12-8-2) children's finger-paint, also contain total PCB levels which appear to correlate strongly with PCB-11 values. The blue finger-paint sample from the same product (WM-12-8-3) contained no detectable PCBs. Several other products containing detectable levels of total PCBs do not show the strong correlation with PCB-11 as the yellow chalk and yellow and green finger-paint samples. Several yellow children's products contained low or no observable levels of PCB contamination, which suggests products can be manufactured without PCB contamination.

Figure 7. Total PCBs and PCB-11 in children's products with adjusted axis



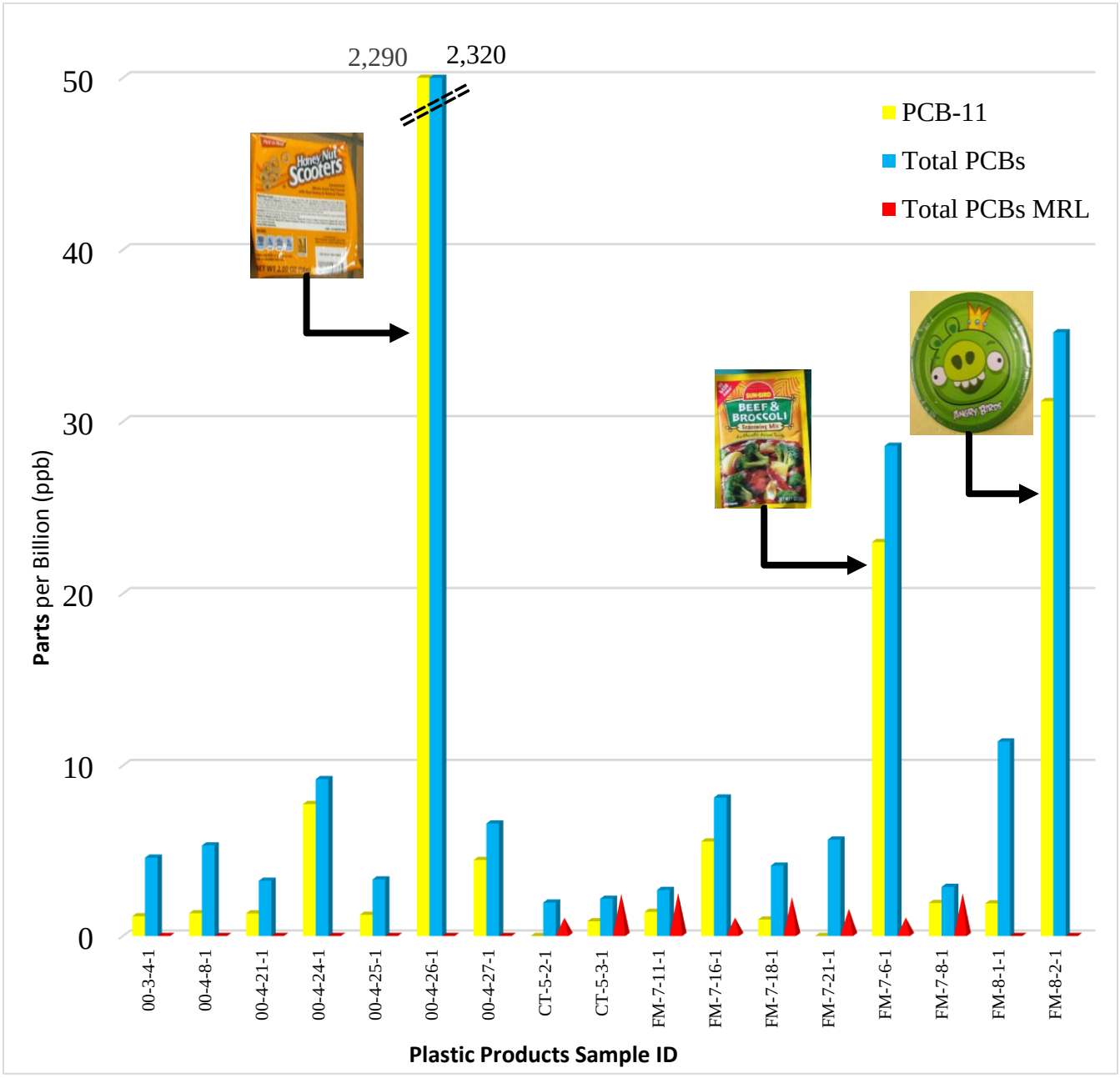
Office Products: One sample from each of the 17 office products were tested (Figure 8). The yellow sheet from a plastic foam product (OD-2-7-1) contained total PCBs at 2,310 ppb (2.31 ppm). Two other yellow products, pocket folder (OD-2-5-1) and pencils (OD-2-2-1), contained total PCBs concentrations of 247 ppb and 93.30 ppb. The total PCBs concentrations for all three of these products appear to correlate strongly with the PCB-11 concentrations detected in each sample. Several yellow products in this category had no observable or very low concentration of total PCBs, for example, two printer cartridges containing yellow ink (OD-1-2-1 and OD-1-3-1). These results suggest that, at least for this category, yellow products can be manufactured with minimal PCB contamination.

Figure 8. Total PCBs and PCB-11 in office products with adjusted axis



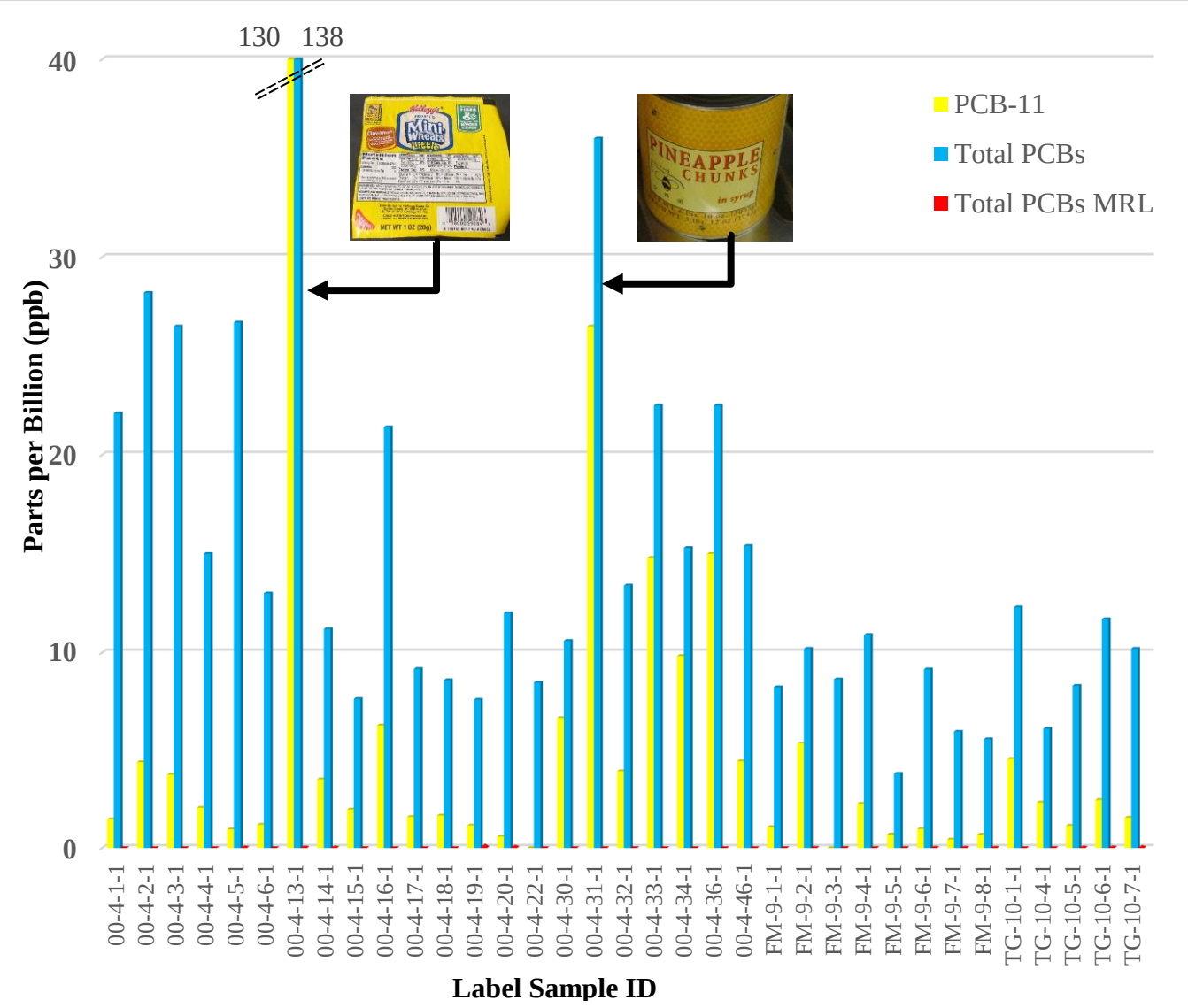
Plastic Packaging: A comparison of total PCB and PCB-11 indicated similar results for the 17 plastic packaging products evaluated (Figure 9). One product, packaging from a single cereal serving (00-4-26-1), contained total PCBs at 2,320 ppb (2.32 ppm). Two other products, paper plates (FM-8-2-1) and a seasoning packet (FM-7-6-1), contained total PCBs of 35.20 ppb and 28.6 ppb, respectively. The total PCB results for these three products appear to correlate strongly with PCB-11 concentrations, suggesting pigments and dyes are the source of the PCB contamination. Several other packaging samples show similar agreement between total PCB and PCB-11 (00-4-25-1, 00-4-27-1, and FM-7-16-1).

Figure 9. Total PCBs and PCB-11 concentrations for 17 plastic products with adjusted axis



Labels: Product labels comprised the largest number of samples collected for one product category (Figure 10). Most of these samples were obtained from facilities that had purchased the product under state contracts. Although the labels showed lower total PCB levels than the previously described categories, most of the labels contained detectable levels of total PCBs. One product, a Mini Wheats cereal package (00-4-13-1), contained total PCB levels that appear to correlate well with the PCB-11 level. Several additional products (for example, 00-4-2-41, 00-4-27-1, FM-7-16-1, etc.) showed similar correlations between total PCBs and PCB-11; however, several other products did not (for example, 00-3-4-1, 00-4-21-1, FM-8-1-1, etc.). Further evaluation may suggest a correlation between specific color or colors and possible PCB contamination.

Figure 10. Total PCBs and PCB-11 concentrations for 35 labels with adjusted axis



The graphs for the remaining product categories can be found in Appendix C. The total PCB and PCB-11 results support the following conclusions:

- Most samples contained appreciable levels of total PCB.
- Many products appear to correlate strongly between the amount of total PCB and PCB-11.
- Three products contained total PCB in the ppm level.
- For these three products, PCB-11 accounted for 99% of the observed total PCB concentrations.
- Several samples did not appear to exhibit a strong correlation between PCB-11 and total PCB. A difference in pigments or dyes used may be responsible for this lack of correlation.

PCB-11 Results:

PCB-11 results for all 216 samples are shown in Figure 11 and summarized by concentration range in Table 5. Figure 11 shows that PCB-11 was found across all products with several at levels above 50 ppb.

Table 5 supports the widespread detection of PCB-11, which indicates it was detected in 163 samples (75.5%) at concentrations above 0.1 ppb. PCB-11 was reported in six samples (2.8%) at concentrations above 100 ppb. PCB-11 was reported in 23 samples (10.6%) at concentrations between 10 ppb and 100 ppb. PCB-11 was reported in 87 samples (40.3%) at concentrations between 1 and 10 ppb.

Figure 11. PCB-11 concentrations in all 216 samples with adjusted axis

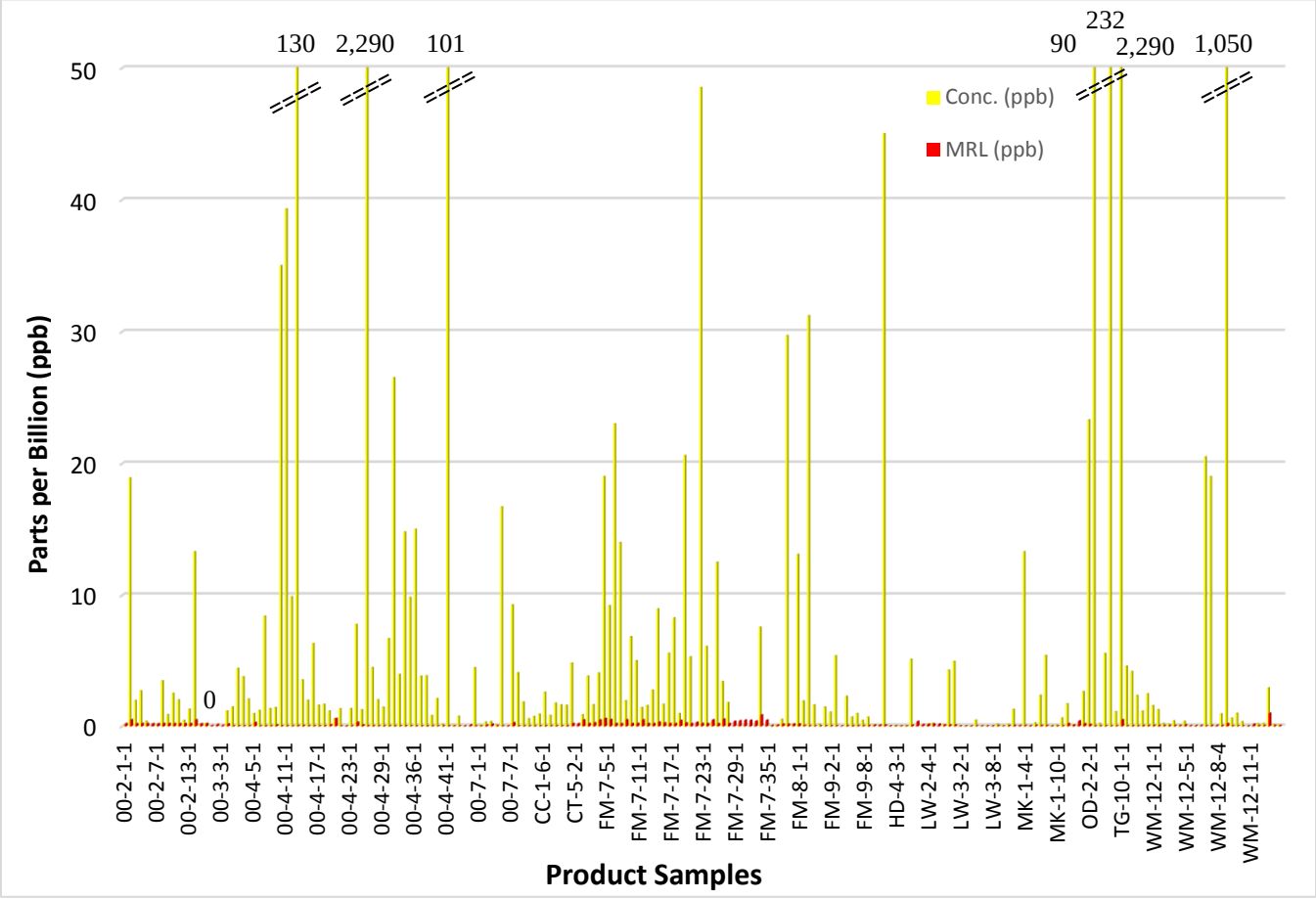


Table 5. PCB-11 in Samples Within Specific Ranges

Results (ppb)	Count	% of total	Cumulative %	Results (ppb)	Count	% of total	Cumulative %
> 1,000	3	1.4	1.4	**< 0.1 - 1**	47	21.8	75.5
> 100 - 1,000	3	1.4	2.8	**< 0.1***	39	18.0	93.5
> 10 - 100	23	10.6	13.4	**Non-detects**	14	6.5	100.0
> 1 - 10	87	40.3	53.7				

**Many of these values are estimates and may be an artifact of contamination identified in the method blanks.*

Based on the results, the following conclusions can be reached:

- PCB-11 was detected in a majority of the samples tested.
- Although PCB-11 is found in several products between 100 ppb and 1 ppm, a majority of the detections occur below 10 ppb. In fact, 62.1% of the sample results were below 10 ppb.

Individual PCB Congener Results

Appendix D presents an evaluation of PCB congener data above 0.5 ppb for all 216 samples. The selection of 0.5 ppb as the screening level was based on a review of the MRLs for many of the samples. The value of 0.5 ppb was selected to present data reasonably above the MRL for a majority of the samples.

PCB congeners were detected in 145 samples above the 0.5 ppb level. Additional data review was completed, resulting in a total of 835 PCB congener results reported above the associated MRL for the analytical sample. This review identified two results reported at levels close to the MRL. For example, one product reported a PCB congener concentration at 0.502 ppb with an MRL of 0.497. Table 7 (Appendix D) provides a summary of the individual congeners detected in these 835 results.

Closer examination at many of the PCB signatures suggest that sources of PCBs may be varied and not clearly understood. It should be noted that additional data for each product may be available; other PCB congeners under 0.5 ppb but above the MRL may have been eliminated from this evaluation. However, a detailed assessment of the manufacturing processes and individual PCB signatures from specific pigments and dyes would provide valuable information to assist with identifying the sources of PCB contamination in consumer products. More details on which PCBs are found in pigments and dyes would allow greater interpretation of potential PCBs sources found in these products.

Conclusions

Based on the results described above and the study objectives, the following conclusions can be reached:

1. Consumer products contain PCBs as a contaminant.
    - PCBs are widespread and found in consumer products. 72% of the samples (156 out of 216) contained total PCB concentrations above 1 ppb. One hundred ninety-three samples (89%) contained detectable total PCBs above the method reporting limit (MRL).
    - Three products (1.4%) reported total PCBs in the ppm level.

2. Organic pigments and dyes contribute to PCB contamination.
    - PCB-11 contributed to many observed total PCB concentrations.
        - For the three products with total PCB concentrations above 1 ppm, PCB-11 accounted for 99% of the total PCB concentration, an indicator of potential pigment and dye contamination from pigments such as diarylide yellow in these products.
        - One product designed specifically for children, the yellow sidewalk chalk, contained PCB-11 at the ppm level.
    - PCB-11 is found in a majority of samples above 0.5 ppb (134 of 216 samples or 62%).
    - Pigments and dyes appear not to be the only source.
        - Numerous products possessed wide distribution of congeners. 60% of the samples contained two or more PCB congeners and 15% contained more than ten.
        - Reasons for PCB distributions are not clear.
3. Range and amounts of PCBs found.
    - A majority of samples (72%) reported total PCBs above 1 ppb.
    - A majority PCB congeners (95 of approximately 165 individual or co-eluting congener groups or 58%) were found in at least one sample above 0.5 ppb.
    - Results suggest products can be produced without PCB contamination.

The study also documents the need for an alternatives assessment to help identify safer alternatives to pigments and dyes contaminated with PCBs. Fifty-six products in this study contained no PCB congeners above 0.5 ppb and 60 samples contained total PCBs under 1.0 ppb suggesting that safer alternatives may already be available. An alternatives assessment would carefully access alternatives to guarantee that, in addition to no inadvertent PCB contamination, no other toxicity concerns exist for potential alternatives.

References

Agency for Toxic Substances and Disease Registry (ATSDR), 2000. Toxicological Profile for Polychlorinated Biphenyls (PCBs).

Christie, Robert M., 2014. Alternatives for elimination of polychlorinated biphenyls (PCBs) in pigments used for printing inks and architectural paints, Publication no. 14-0-005, 39 pages.

Diamond ML, L Melymuk, SA Ciczar and M Robson, 2010. Estimation of PCB Stocks, Emissions, and Urban Fate: Will our Policies Reduce Concentrations and Exposure?, Environ. Sci. Tech., *44* (8), pp. 2777–2783.

Ecology 2011. Control of Toxic Chemicals in Puget Sound: Assessment of Selected Toxic Chemicals in the Puget Sound Basin, 2007-2011.

Ecology, 2013. Quality Assurance Project Plan for PCBs in General Consumer Products, 23 pages.

Ecology, 2014a. Product Sampling Procedure, 13 pages.

Ecology, 2014b. Addendum #1 to Quality Assurance Project Plan – PCBs in General Consumer Products, 7 pages.

Ecology, 2014c. Polychlorinated Biphenyls (PCBs) in General Consumer Products, Publication number: 14-04-035, 64 pages.

Ecology, 2015. PCB Chemical Action Plan, Publication number: 15-07-002, 223 pages.

Environmental Protection Agency (EPA), 1976. *Summary of the Toxics in Substances Control Act*.

EPA, 1996. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (aka SW-846) Method 8270B Semi-Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS).

EPA, 2010. Method 1668C, Revision C-Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by HRGC/HRMS; EPA No. EPA-820-R-10-005; U.S. Environmental Protection Agency, Office of Water, Washington, DC.

EPA, 2012a. Consumer Factsheet on Polychlorinated Biphenyls, 3 pages.

EPA, 2012b. Consumer Factsheet on PCBs in Caulks, 2 pages.

EPA, 2014. Titanium Metals Corporation Settlement website, accessed May 2014.

Erickson, M.D., 1997. Analytical Chemistry of PCBs. CRC Press, New York City, pp. 17-96 (Chapter 2).

Herrick, Robert F., John D. Meeker, Russ Hauser, Larisa Altshul and George A. Weymouth, 2007. Serum PCB levels and congener profiles among US construction workers, Environ. Health, 8 pages.

Hu, Dingfei and Keri C. Hornbuckle, 2010. *Inadvertent Polychlorinated Biphenyls in Commercial Paint Pigments*, Environ. Sci. Technol., *44*, pp. 2822-2827.

Kohler, Martin, Josef Tremp, Markus Zennegg, Cornelia Seiler, Salome Minder-Kohler, Marcel Beck, Peter Lienemann, Lukas Wegmann and Peter Schmid, 2005. *Joint Sealants: An Overlooked Diffuse Source of Polychlorinated Biphenyls in Buildings*, Environ. Sci. Technol., 2005, *39*, pp. 1967-1973.

Ministry of Economy, Trande and Industry (METI), et al., 2013a.Compiled Results of Renanalysis of the Presence of Polychlorinated Biphenyls (PCBs) as By-products in Organic Pigments, English Press Release, Report only in Japanese, accessed 5/2014.

METI, 2013b. Administrative Guidance on Manufacture, Import, etc. of Organic Pigments that can Unintentionally Contain Polychlorinated Biphenyls (Seventh Report), English Press Release, Report only in Japanese, accessed 5/2014.

New York Academy of Sciences (NYAS), 2005. *Pollution Prevention and Management Strategies for Polychlorinated Biphenyls in the New York/New Jersey Harbor*, 110 pages.

Pomerantz, I., J. Burke, D. Firestone, J. McKinney, J. Roach and W. Trotter, 1978. *Chemistry of PCBs and* PBBs', Environ. Health Persp., *24*, pp. 133-146

Priha, Eero, Sannamari Hellman and Jaana Sorvari, 2005. PCB contamination from polysulphide sealants in residential areas—exposure and risk assessment, Chemosphere, *59*, pp. 537-543.

Rodenburg, Lisa A., J. Guo, Songyan Du, Gregory, J. Cavallo, 2010. *Evidence for Unique and Ubiquitous Environmental Sources of 3,3'-dpchlorobiphenyl (PCB 11)*, Environ. Sci. Technol. 44, 2816-2821.

Rodenburg Lisa A, 2012. *Inadvertent PCB production and its impact on water quality* [panel discussion presentation]. ECOS Annual Meeting, Colorado Springs, CO, 28 Aug 2012.

Science Applications International Corporation (SAIC), 2011. *Lower Duwamish Waterway Survey of Potential PCB-Containing Building Material Sources-Summary Report*, 339 pages.

Science Applications International Corporation (SAIC), 2011. *Lower Duwamish Waterway Survey of Potential PCB-Containing Building Material Sources*. Prepared for Ecology. 339 pages.

Spokane, City of, 2015. *PCBs in Municipal Products*, revised, Publication by the City of Spokane, Wastewater Management Department under Ecology Municipal Stormwater Grants of Regional or Statewide Significant, Grant No. G1400545, 45 pages.

Sundahl, M., E. Sikander, B. Ek-Oluasson, A. Hjorthage, L. Rosell and M. Tornevall, 1999. *Determinations of PCB within a project to develop cleanup methods for PCB-containing elastic sealant used in outdoor joints between concrete blocks in buildings*, J. Environ. Monit., 1999, 1, pp. 383-387.

United Nations Environmental Program (UNEP), 2007. *Guidelines on Best Available Techniques and Provisional Guidance on Best Environmental Practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants*, 37 pages.

Washington State Legislature, 2014. Senate Bill 6086 – Agency Purchasing and Procurement – Polychlorinated Biphenyls, 6 pages.

Appendix A

Acronyms and Abbreviations Used in this Report

DOH	Washington State Department of Health
EAP	Environmental Assessment Program
EC	Environment Canada
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
et al.	Et alia or and others
EU	European Union
GC-MS	Gas Chromatography-Mass Spectroscopy
HNO_3	Nitric acid
HQ	Headquarters
HWTR	Hazardous Waste and Toxics Reduction Program
i. e.	Id est or In other words
LCS	Laboratory control sample
LOQ	Limit of Quantitation
MEL	Manchester Environmental Laboratory
MDL	Method detection limit
MQO	Measurement quality objective
MRL	Method reporting limit
NEP	National Estuary Program
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
OECD	Organisation for Economic Cooperation and Development
PCB	Polychlorinated biphenyls
PBT	persistent, bioaccumulative, and toxic substance
PPB	Parts per billion
PPM	Parts per million
PQL	Practical quantitation limit
RCW	Revised Code of Washington
RDP	Resorcinol diphenyl phosphate
RL	Reporting limit
QA	Quality assurance
QC	Quality control
QAPP	Quality Assurance Project Plan
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedures
SRM	Standard reference materials

Units of Measurement

ng	nanogram, a unit of mass equal to one millionth of a gram
mg	milligram, one thousandth of a gram
g	gram, a unit of mass
kg	kilograms, a unit of mass equal to 1,000 grams.
meter	meter, a unit of distance
mm	millimeter, a unit of distance equal to one thousandth of a meter
Liter	liter, a unit of volume
mL	milliliter, equal to one thousandth of a liter
ppb	parts per billion
ppm	parts per million
mg/kg	milligrams per kilogram (parts per million)
ng/g	nanograms per gram (parts per billion)
ng/kg	nanograms per kilogram (parts per trillion)
mg/L	milligrams per Liter (parts per million)
ng/L	nanograms per Liter (parts per trillion)
s.u.	standard units

Appendix B

Table 6. List of 216 Samples Included in this Study ** At the date of this report, manufacturers were notified of the results of the analysis of these products. Additional notifications may occur in the future.*

Blue=contents	Purple=packaging/labels	Yellow=printed materials

Sample ID	Product Description	Total PCBs (ppb)
00-2-1-1* (3MPOIT)	Post-It 3" by 3"	0.98
00-2-2-1* (BHGMAG)	Magazine #1 - cover & 1st page	53.50
00-2-3-1* (CONREP)	Magazine #2-cover & first 3 pages	44.90
00-2-4-1* (COOLIG)	Magazine #3 - 3 inside pages	8.58
00-2-5-1 (CSPAHO)	CSPA Mid-Year meeting handouts	4.39
00-2-6-1* (HPMUPA)	Multi-purpose paper	0.17
00-2-7-1 (NOTPAD)	Yellow lined note pad	0.41
00-2-8-1* (OLYCOM)	Newspaper - comics	8.49
00-2-9-1* (OLYFRO)	Newspaper - front page	2.36
00-2-10-1* (OLYINS)	Newspaper - glossy inserts	5.59
00-2-11-1* (OLYNGI)	Newspaper - non glossy insert	7.06
00-2-12-1* (OPRMAG)	Magazine #4-back page w/yellow ad	11.00
00-2-13-1 (TACCCB)	Comm. College Continuing Education mailer	4.41
00-2-14-1 (REPDIV)	Yellow report dividers	17.10
00-2-15-1 (WRITAB)	Legal ruled yellow writing sheets	2.26
00-2-16-1 (YELPAP)	Yellow printer paper	1.58
00-3-1-1	Thalo Green Paint	9.33
00-3-2-1	White Paint	0.00
00-3-3-1	Bright Jade Met Paint	1.64
00-3-4-1*	Plastic Corn Starch container	4.61

Blue=contents	Purple=packaging/labels	Yellow=printed materials

Sample ID	Product Description	Total PCBs (ppb)
00-4-1-1*	Vegetarian Refried Beans label	22.10
00-4-2-1*	Cut Sweet Potatoes label	28.20
00-4-3-1*	Wax Beans label	26.50
00-4-4-1*	Tomato Soup label	15.00
00-4-5-1*	Mashed Potatoes Complete Instant label	26.70
00-4-6-1*	Fancy Diced Carrots label	13.00
00-4-7-1*	Low fat milk 1/2 pint container	18.00
00-4-8-1*	Oven Baked Barbecue Chips bag	5.33
00-4-9-1*	Multigrain premium Pancake Mix box	29.30
00-4-10-1*	Plastic Wrap box	46.00
00-4-11-1*	Aluminum Foil box	61.00
00-4-12-1*	Old Fashioned Oats container	24.60
00-4-13-1*	Mini Wheats Little Bites Cereal label	138.00
00-4-14-1*	Honey Nut mini package label	11.20
00-4-15-1*	Cream of Chicken Soup label	7.66
00-4-16-1	Chunk Light Tuna in Water label	21.40
00-4-17-1*	Pineapple Chunks label	9.18
00-4-18-1*	Baked Beans label	8.61
00-4-19-1*	Green Beans label	7.62
00-4-20-1*	Graham Crackers mini package label	12.00
00-4-21-1*	Ranch Dressing small packages	3.25
00-4-22-1*	Fancy Whole Kernel Corn label	8.49
00-4-23-1*	Pineapple Juice box	2.71
00-4-24-1*	Graham Toasters Cereal individual package	9.21
00-4-25-1*	Frosted Flakes individual package	3.33
00-4-26-1*	Honey Nut Scooters individual package	2,320.00
00-4-27-1*	Tootie Fruities Cereal individual package	6.62
00-4-28-1*	Quick Grits box	24.40

Blue=contents	Purple=packaging/labels	Yellow=printed materials

Sample ID	Product Description	Total PCBs (ppb)
00-4-29-1*	Yellow Cake box	34.20
00-4-30-1*	Apricot Halves label	10.60
00-4-31-1*	Pineapple Chunks in syrup label	36.00
00-4-32-1*	Tropical Fruit Salad label	13.40
00-4-33-1*	Pineapple Slices label	22.50
00-4-34-1*	Ketchup label	15.30
00-4-36-1*	Corn Beef Hash label	22.50
00-4-37-1*	Yellow Pages-cover	42.20
00-4-37-2*	Yellow Pages-internal pages	5.47
00-4-38-1	Orange Jumpsuit	9.07
00-4-39-1*	Yellow Road Striping	5.45
00-4-40-1	White Road Striping	2.45
00-4-41-1*	Yellow Liquid Road Paint	102.00
00-4-42-1*	City of Spokane Toothpaste	0.38
00-4-43-1	Yellow Liquid Road Paint # 2	1.44
00-4-44-1*	White Road Paint # 1	0.58
00-4-45-1*	White Road Paint # 2	0.30
00-4-46-1*	Mixed Fruit Jelly label	15.40
00-7-1-1*	Ecofiber	1.77
00-7-2-1*	Hydrostraw	1.08
00-7-3-1*	Ecofiber Wood Mulch	1.45
00-7-4-1*	Hydrostraw BFM	0.34
00-7-5-1	Paint	17.90
00-7-6-1	Yellow Alkyd Zone Marking Paint	0.12
00-7-7-1*	Yellow Chlorinated Rubber Zone Marking Paint	40.50
CC-1-1-1*	Batman Comic	4.87
CC-1-2-1*	Dark Horse comic	3.32
CC-1-3-1*	Spider-Man comic	1.10

Blue=contents	Purple=packaging/labels	Yellow=printed materials

Sample ID	Product Description	Total PCBs (ppb)
CC-1-4-1*	Wolverine Marvel comic	1.74
CC-1-5-1*	Superman comics	1.91
CC-1-6-1*	Angry Birds Comics	5.01
CC-1-7-1*	Doodle Jump comics	1.46
CC-1-8-1*	Powerpuff Girls comics	2.01
CC-1-9-1*	My Little Pony comic	2.61
CC-1-10-1*	Captain Action Cat Comics	2.95
CT-5-1-1* (KIANGR)	Ancient Grains-box	226.00
CT-5-2-1* (KIRSUN)	Dried plums-plastic container	1.97
CT-5-3-1* (KISDAP)	Sun-dried apricots-plastic package	2.19
FM-7-1-1* (CHECAR)	Whole grain cereal-box	36.60
FM-7-2-1* (BARPAS)	Farfalle pasta-box	16.40
FM-7-3-1* (CAPCRU)	Crunch Berries Cereal-box	35.20
FM-7-4-1* (JELGRE)	Green lime Jello box	50.70
FM-7-5-1* (JELYEL)	Lemon yellow Jello box	66.60
FM-7-6-1* (BEFBRO)	Beef & Broccoli Seasoning Mix-package	28.60
FM-7-7-1* (CLIWRA)	Cling wrap-box	51.50
FM-7-8-1* (FMMUTB)	Yellow mustard-bottle	2.89
FM-7-9-1* (FRUBTF)	Fruit by the Foot-box	19.30
FM-7-10-1* (FMSTSN)	Fruit Flavored Snacks-yellow box	157.00
FM-7-11-1* (FREMUB)	Classic Yellow mustard-bottle	2.71
FM-7-12-1* (KEECLU)	Green Club crackers container	5.93
FM-7-13-1* (LEMWAF)	Yellow Lemon wafers-box	46.50
FM-7-14-1* (MACCHE)	Macaroni and Cheese-box	48.60

Blue=contents	Purple=packaging/labels	Yellow=printed materials

Sample ID	Product Description	Total PCBs (ppb)
FM-7-15-1* (MILKDUD)	Milk Duds Chocolate and caramel-box	3.54
FM-7-16-1* (NABNFT)	Fruit Thins-plastic container	8.14
FM-7-17-1* (NATVAL)	Crunch granola bars-box	40.80
FM-7-18-1* (NESCHO)	Toll House Chocolate Chip-bag	4.14
FM-7-19-1* (NEWTHI)	Fruit Thins-box	30.50
FM-7-20-1* (NILWAF)	Nilla wafers-box	174.00
FM-7-21-1* (OREOGO)	Golden Oreos-packaging	5.67
FM-7-22-1* (RITZHS)	Crackers Handi-Snack box	69.70
FM-7-23-1* (SPLEND)	No calorie sweetener-box	26.70
FM-7-24-1* (STEVLE)	Natural zero calorie sweetener-box	5.16
FM-7-25-1* (TACSHE)	Taco Shells-box	49.40
FM-7-26-1* (VELVSC)	Shells & cheese packaged dinner	34.40
FM-7-27-1* (WHETHI)	Wheat Thins original-carton	19.90
FM-7-28-1* (CAUDKS)	Kwick Seal-kitchen and bath adhesive caulk	0.04
FM-7-29-1* (CAUDMU)	Beats the Nail Construction Adhesive caulk	0.18
FM-7-30-1* (CAUKAP)	Acrylic latex caulk plus silicone caulk	0.19
FM-7-31-1* (CAULOC)	Polyseamseal all purpose caulk	0.04
FM-7-32-1* (CAURDC)	Color Cure acrylic sealant plus silicone caulk	0.07
FM-7-33-1* (CAUSOI)	Advanced Formula Sealant caulk	390.00
FM-7-34-1* (CAUWBP)	Phenoseal vinyl adhesive caulk	0.08
FM-7-35-1* (FREMUY)	Classic Yellow mustard-mustard sample	0.05
FM-7-36-1* (MEYMUY)	Yellow mustard-mustard sample	0.16

Blue=contents	Purple=packaging/labels	Yellow=printed materials

Sample ID	Product Description	Total PCBs (ppb)
FM-7-37-1* (HDDEGRE)	Green Interior/Exterior Spray Paint	2.62
FM-7-38-1* (HDDEYEL)	Yellow Interior/Exterior Spray Paint	34.80
FM-7-39-1 (KRYLOBL)	Blue Ocean Breeze Gloss spray paint	0.56
FM-7-40-1 (KRYLSYE)	Sun Yellow Gloss spray paint	16.00
FM-8-1-1*	Yellow Flexible Straws	11.40
FM-8-2-1*	Green Angry Birds Paper Plates	35.20
FM-8-4-1*	Yellow Cotton Onesie	3.65
FM-8-5-1	White Girls Tank Top	1.31
FM-8-6-1*	Boys Neon Yellow Shirt	16.60
FM-9-1-1*	Ready Made Infant formula Label	8.26
FM-9-2-1*	Nutritional Kids Vanilla Shake label	10.20
FM-9-3-1*	Nutritional Kids Strawberry Shake label	8.65
FM-9-4-1*	Hypoallergenic Infant Formula label	10.90
FM-9-5-1*	Infant Formula Gentle label	3.82
FM-9-6-1*	Soy Infant Formula label	9.16
FM-9-7-1*	NeoSure Infant Formula label	5.98
FM-9-8-1*	Infant Formula label	5.59
HD-3-1-1* (BEHRTGR)	Thalo Green colorant	1.19
HD-3-2-1* (BEHRTI02)	Titanium dioxide low VOC colorants (white)	2.14
HD-3-3-1* (BEHRYEL)	Medium yellow colorants	68.40
HD-4-1-1*	Advanced Brush Killer Plus	0.05
HD-4-2-1*	Weed & Feed	0.26
HD-4-3-1*	Roundup Wild Blackberry	0.11
HD-4-4-1*	Turf Builder Grass Seed	0.19
HD-4-5-1*	PatchMaster	6.86
LW-2-1-1* (CAUBGS)	Big Stretch white caulk	0.10

Blue=contents	Purple=packaging/labels	Yellow=printed materials

Sample ID	Product Description	Total PCBs (ppb)
LW-2-2-1* (DUTBDF)	Dirt Fighter paint and primer	0.32
LW-2-3-1* (PARPIA)	Wall Kolor interior acrylic paint	0.10
LW-2-4-1* (RUSTFGR)	Fluorescent neon green spray paint	6.04
LW-2-5-1* (RUSTFYE)	Fluroescent neon yellow spray paint	4.71
LW-2-6-1* (NOVOBLU)	Phthalo blue Universal colorant	0.71
LW-2-7-1* (NOVOGRE)	Phthalo green Universal colorant	339.00
LW-2-8-1* (NOVOYEL)	Med. YellowUniversal colorant	8.12
LW-3-1-1*	Image Noxall Granules	7.01
LW-3-2-1*	Liquid Turf Builder	0.03
LW-3-3-1*	Weed B Gone	0.07
LW-3-4-1*	Weed & Crabgrass Killer	0.24
LW-3-5-1*	Image Brush & Vine Killer	0.19
LW-3-6-1*	Spectracide Weed Stop for lawns	0.20
LW-3-7-1*	Sta-Green Weed & Feed	0.04
LW-3-8-1*	UltraGreen Weed & Feed	0.37
LW-3-9-1*	Turf Builder Weed & Feed	0.11
LW-3-10-1*	Phosphorous Free Weed & Feed	0.21
MK-1-1-1*	Yellow Acrylic Paint	1.48
MK-1-2-1*	Shamrock Acrylic Paint	0.24
MK-1-3-1*	Acrylic Paint - Deep Yellow	13.80
MK-1-4-1*	Fabric paint - Neon Green	0.28
MK-1-5-1*	Fabric paint - Yellow	0.90
MK-1-6-1*	Shamrock Green 3D Fabric Paint	3.39
MK-1-7-1*	Sunny Yellow 3D Fabric Paint	5.64
MK-1-8-1*	Sunshine Yellow Fabric Dye Tulip	0.06
MK-1-9-1*	Lime Green Fabric Dye Tulip	0.23

Blue=contents	Purple=packaging/labels	Yellow=printed materials

Sample ID	Product Description	Total PCBs (ppb)
MK-1-10-1*	Daisy Yellow Shirt	11.60
OD-1-1-1* (HPPAPA)	Multi-purpose paper-packaging	2.94
OD-1-2-1* (HP02XL)	Yellow inkjet printer ink	0.65
OD-1-3-1* (HPYEINK)	Yellow inkjet printer ink	0.16
OD-1-4-1* (POCFOL)	2-Pocket folder	5.11
OD-2-1-1*	#2 Ticonderoga Pencils	27.60
OD-2-2-1*	#2 Yellow Pencils	93.30
OD-2-3-1*	Multi Color Post it Pack	0.43
OD-2-4-1*	Construction Paper Yellow	6.15
OD-2-5-1*	Yellow Pocket Folder	247.00
OD-2-6-1*	Yellow File Jacket	2.17
OD-2-7-1	Yellow Glitter Foam Sheet	2,310.00
TG-10-1-1*	Berry Juice label	12.30
TG-10-2-1*	Crispy Corn Puffs Cereal box	16.30
TG-10-4-1*	Baby Oatmeal Cereal label	6.13
TG-10-5-1*	Beef and Gravy baby food label	8.33
TG-10-6-1*	Baby Sweet Potatoes label	11.70
TG-10-7-1*	Baby bananas label	10.20
WM-12-1-1*	Yellow Outdoor Colored Bubbles	3.83
WM-12-1-2*	Blue Outdoor Colored Bubbles	1.76
WM-12-1-3*	Purple Outdoor Colored Bubbles	2.18
WM-12-2-1*	Lime Green Bathtub Fingerpaint Electric	0.61
WM-12-3-1*	Laser Lemon Yellow Bathtub Finger-paint	0.25
WM-12-4-1*	Sport 100 SPF Sunscreen Lotion	0.72
WM-12-5-1*	Health for Me toothpaste	0.10
WM-12-6-1*	Sensitive Whitening toothpaste	0.11
WM-12-7-1*	Kids Cavity Protection toothpaste	0.11

Blue=contents	Purple=packaging/labels	Yellow=printed materials

Sample ID	Product Description	Total PCBs (ppb)
WM-12-8-1*	Yellow Finger-paint Washable	20.80
WM-12-8-2*	Green Finger-paint Washable	19.10
WM-12-8-3	Blue Finger-paint Washable	0.00
WM-12-8-4*	Red Finger-paint Crayola Washable	2.84
WM-12-9-1*	Yellow Washable Sidewalk Chalk Paint	1,060.00
WM-12-9-2*	Blue Washable Sidewalk Chalk Paint	0.79
WM-12-9-3*	Red Washable Sidewalk Chalk Paint	1.85
WM-12-10-1*	Fizzy Colored Bath Yellow Tab	0.36
WM-12-10-2*	Fizzy Colored Bath Blue Tab	0.07
WM-12-11-1*	Color Tattoo Eye shadow	0.18
WM-12-12-1*	Irish Spring Body Soap	4.34
WM-12-13-1*	Dial Gold Body Soap	1.32
WM-12-14-1*	Olay Ultra Moisture Body Soap	7.81
WM-12-15-1*	Blue Nail Lacquer	0.28
WM-12-16-1*	Yellow Nail Polish	0.32

** At the date of this report, manufacturers were notified of the results of the analysis of these products. Additional notifications may occur in the future.*

Appendix C

Total PCB and PCB-11 Data for All Sample Categories not in the Main Report

Figure 12. Total PCBs and PCB-11 in Caulk Samples

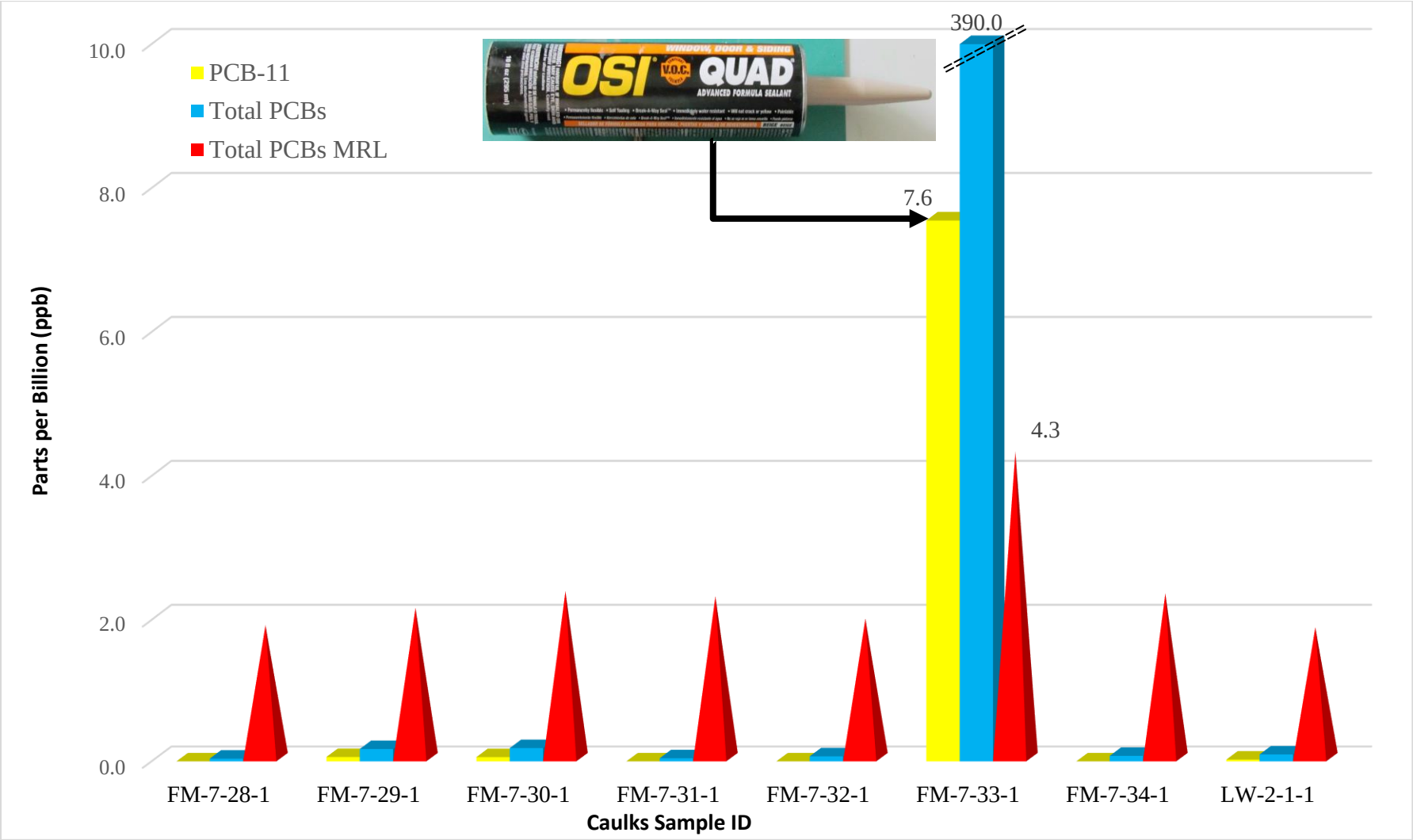


Figure 13. Total PCBs and PCB-11 in Clothing Samples

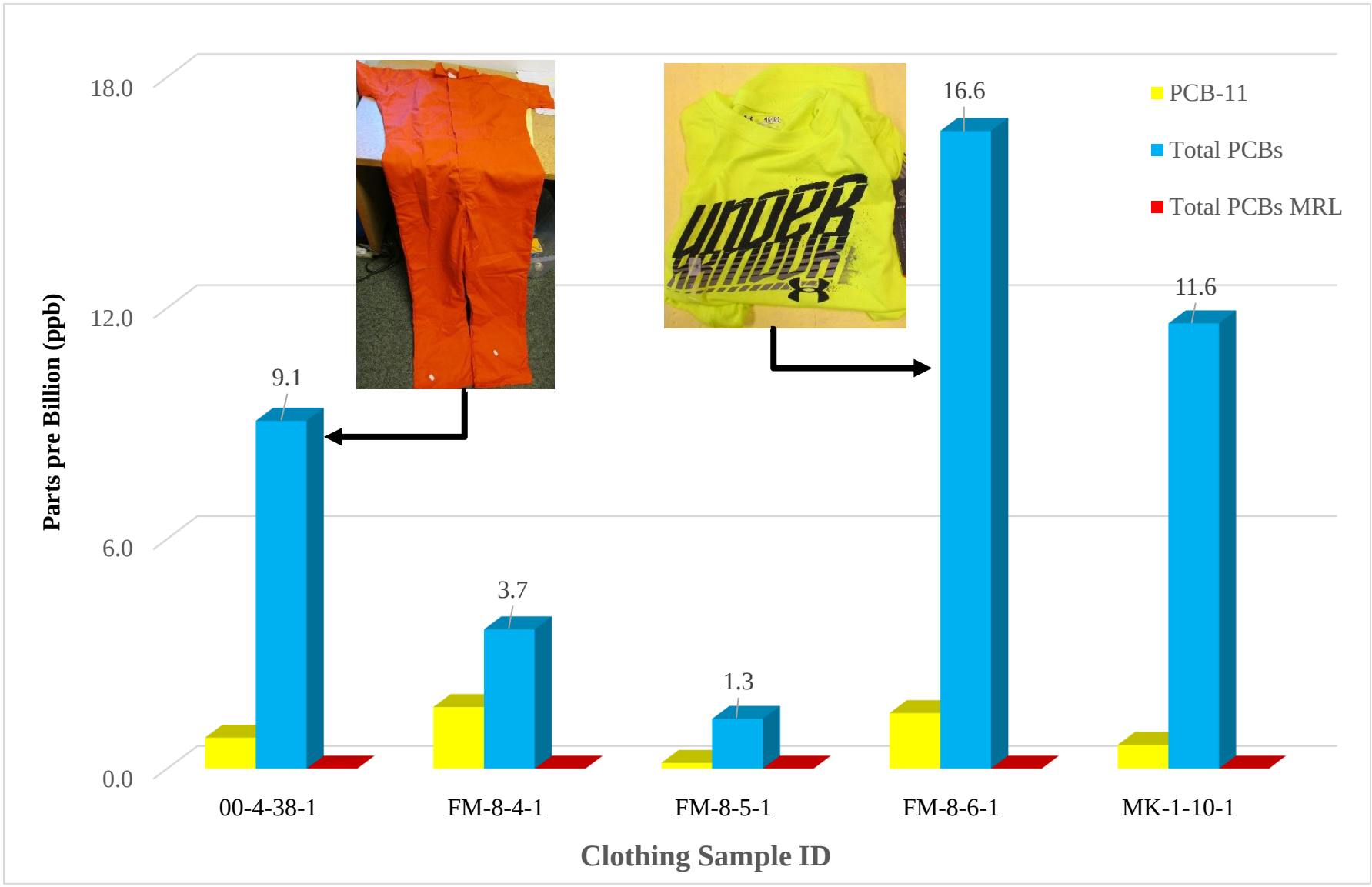


Figure 14. Total PCBs and PCB-11 in Container/Box Samples

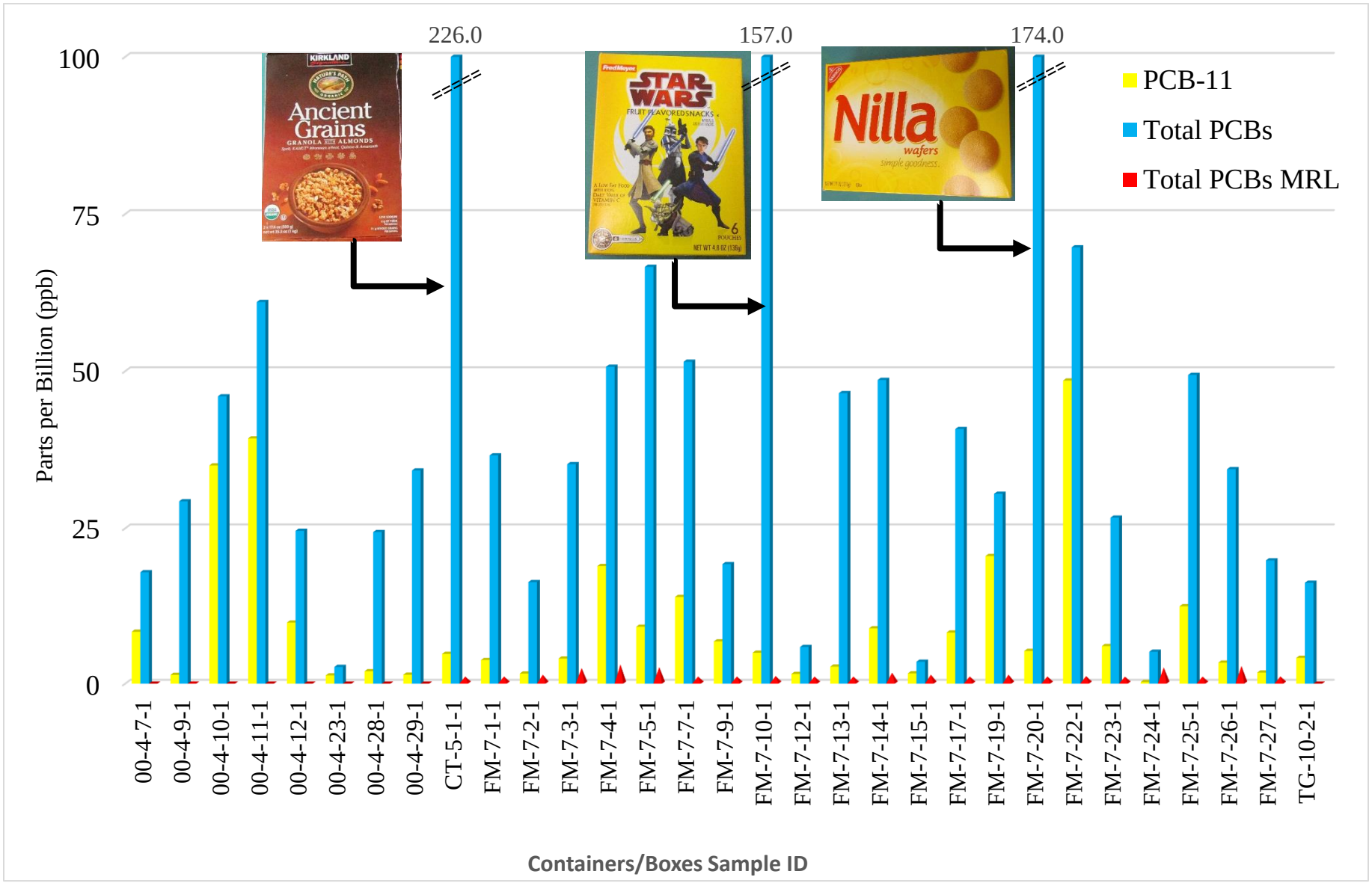


Figure 15. Total PCBs and PCB-11 in Cosmetics/Body Care Samples

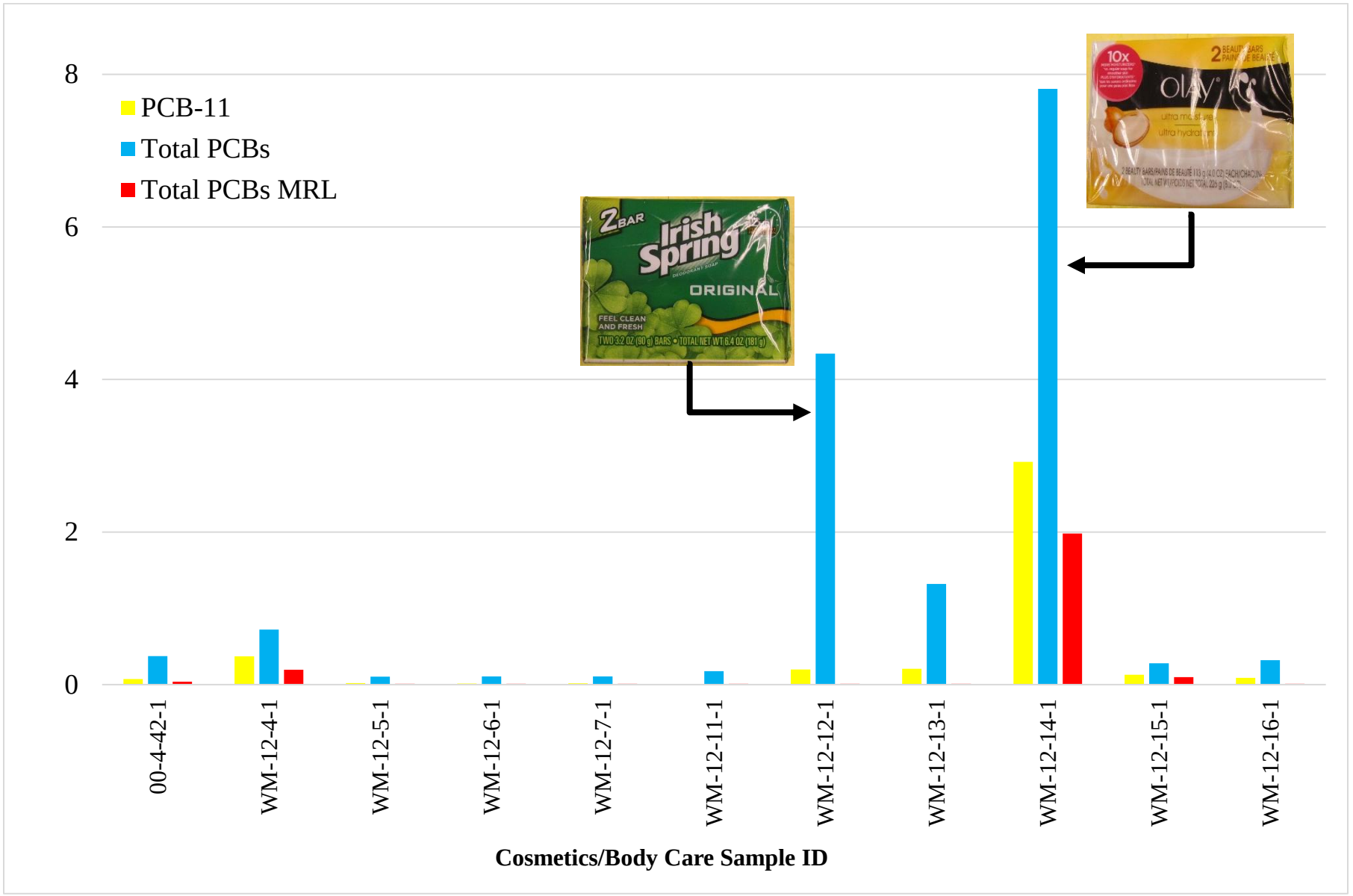


Figure 16. Total PCBs and PCB-11 in Lawn and Road Care Samples

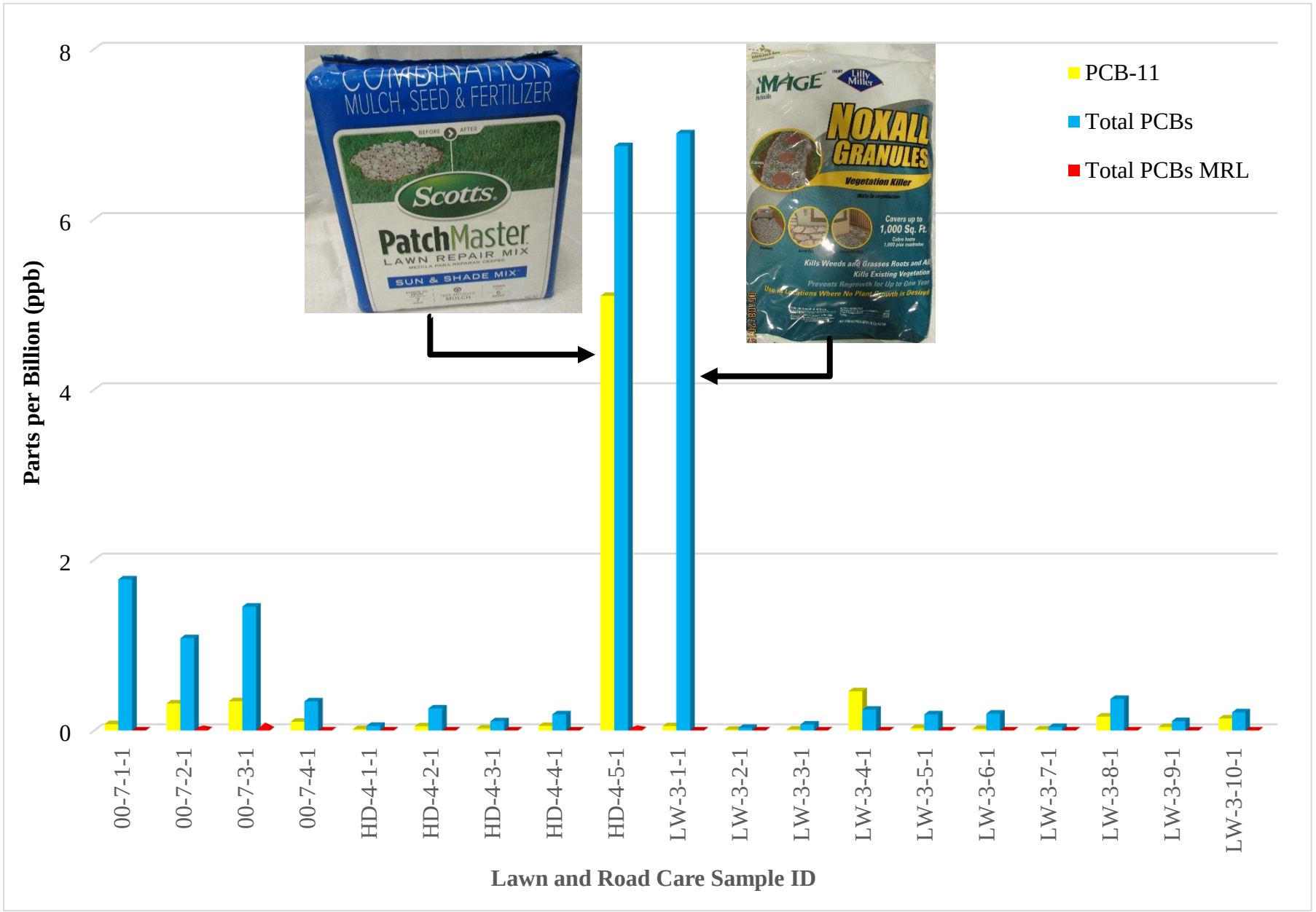


Figure 17. Total PCBs and PCB-11 in Paint/Colorant/Dye Samples

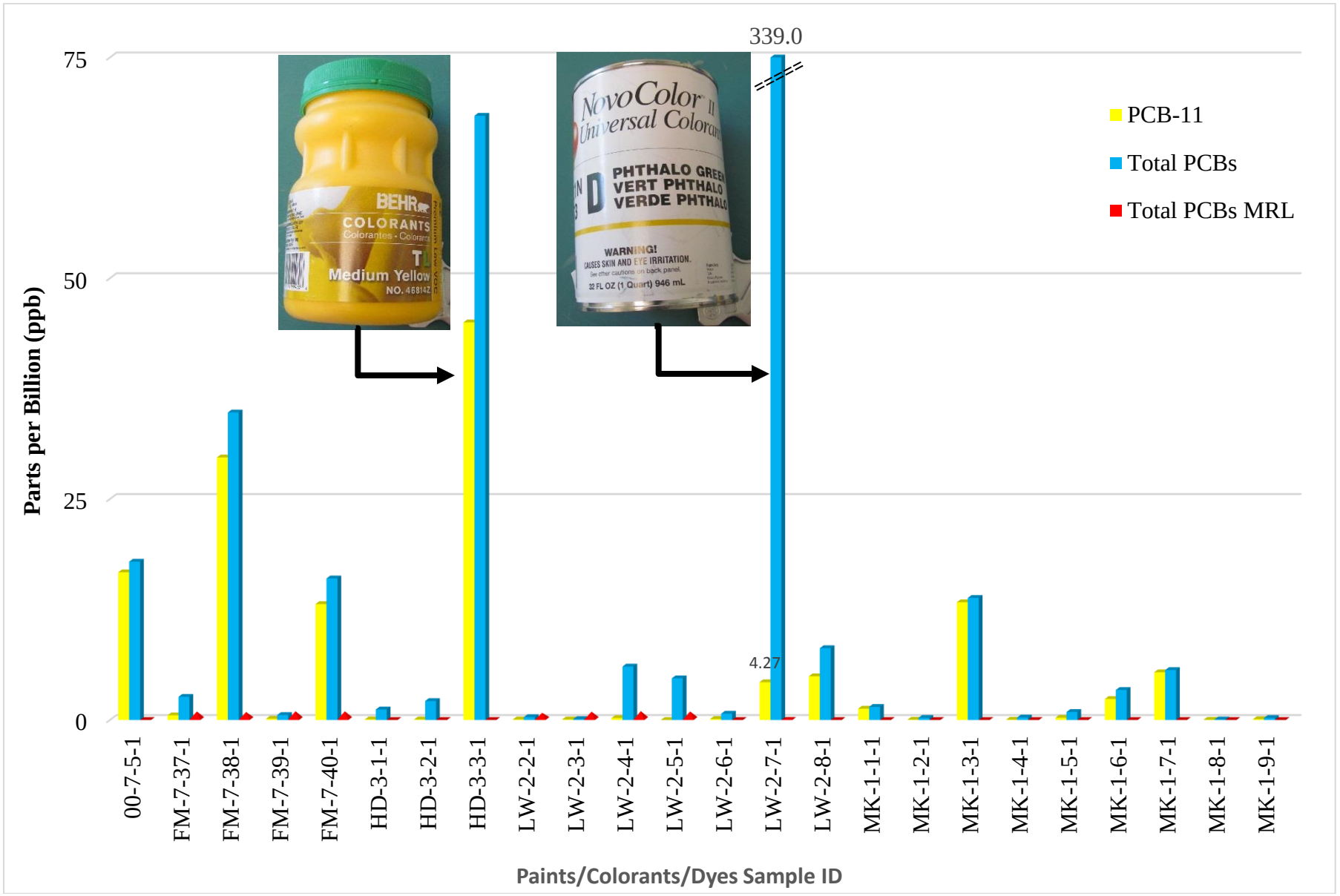


Figure 18. Total PCBs and PCB-11 in Road Paint Samples

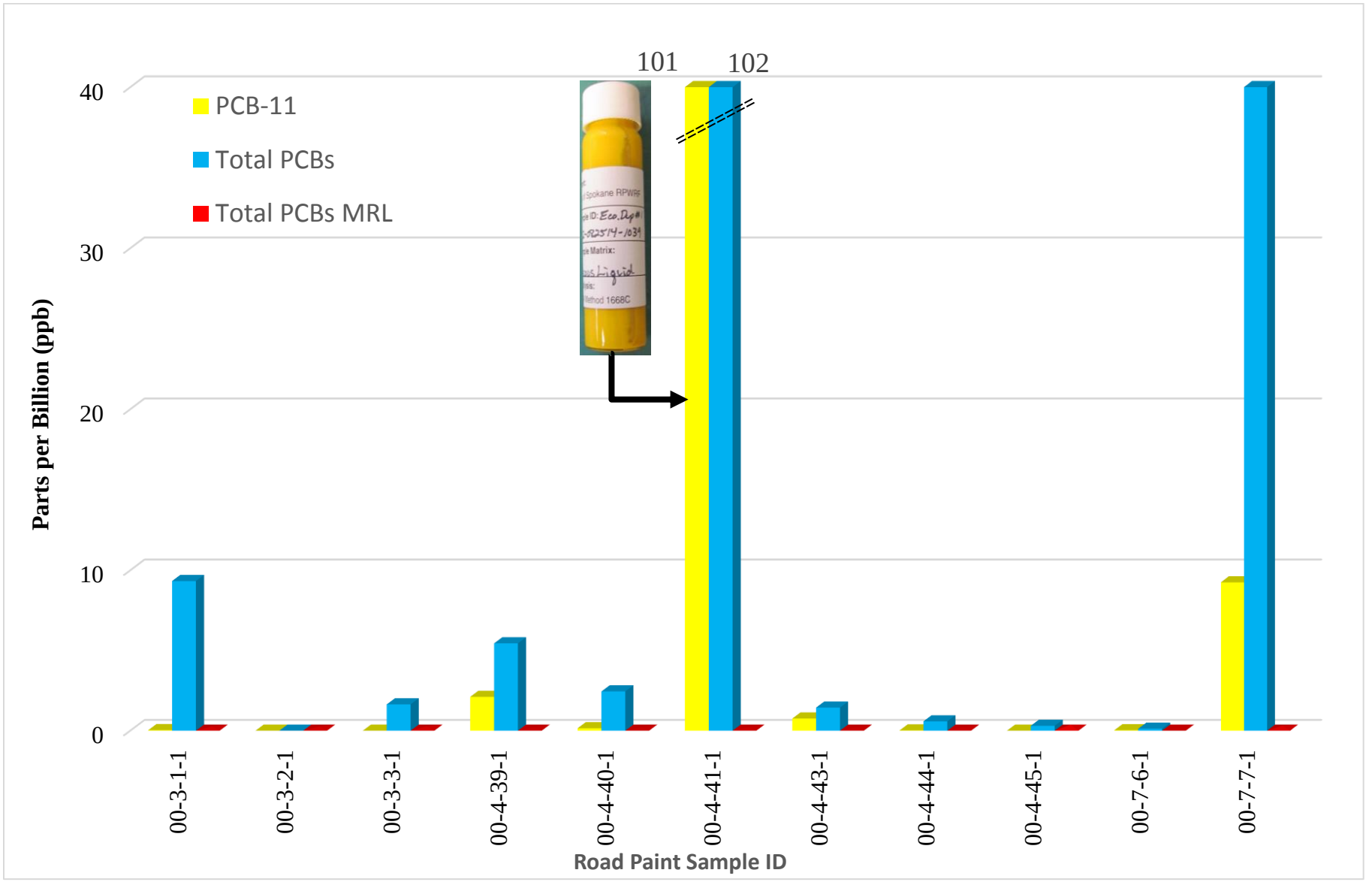
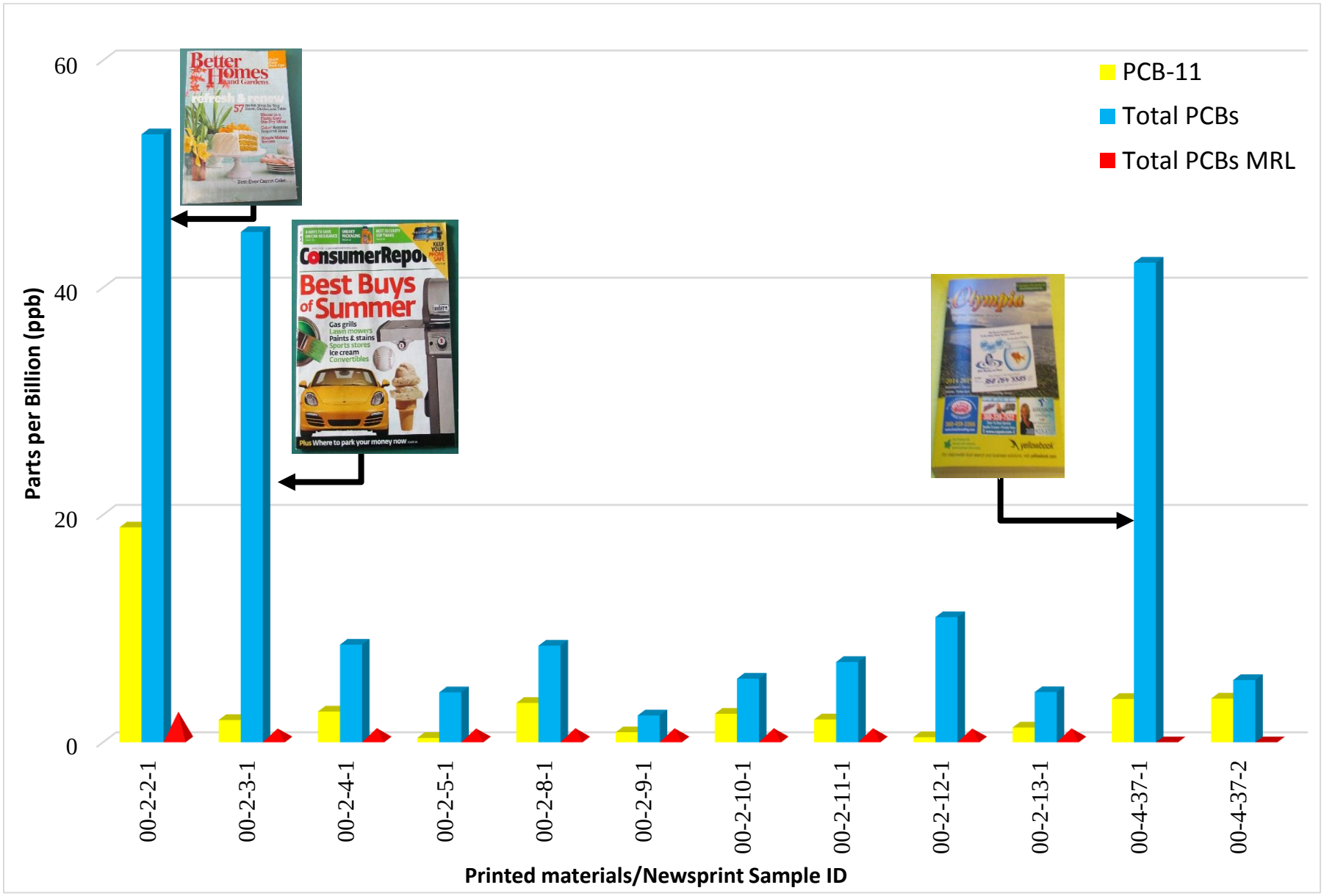


Figure 19. Total PCBs and PCB-11 in Printed Materials/Newsprint Samples



Appendix D

Individual PCB congener results for the full 216 samples

Table 7 shows that a majority of the 209 PCB congeners were found above 0.5 ppb in at least one product. PCB-11 was the most commonly detected PCB congener (134 detects) followed by PCB-52 (48 detects), co-eluting PCB-61/70/74/76 (39 detects) and PCB-31 (31 detects).

The 835 congener results were grouped into individual products (145) to evaluate the number of congeners found in each product (Figure 20). A majority of the products contained either a single congener (58 of 145 products, 40%) or 2 to 5 (51 products, 35%). Reviewing the 58 products for which there was only a single congener (Figure 21), PCB-11 accounted for the majority of these single detects (53 of 58 products, 91%). PCB-209 (4 products, 7%) and co-eluting PCBs-12/13 accounted for the remainder. These results suggest that although there may be multiple pathways, which are responsible for PCB contamination in consumer products pigments and dyes, diarylide yellows, and oranges appear to be a primary source.

The samples, which contained multiple PCB congeners, were also reviewed to determine if the distribution indicated any additional source of PCB contamination. Samples that contained at least one congener above 0.5 ppb were grouped into categories and compared against the original number of samples in each category (Figure 22). The two largest categories, Labels (35 samples) and Containers/Boxes (31) had the largest number of samples with at least one congener above 0.5 ppb at 34 and 30, respectively. The categories Lawn & Road Care (19), Cosmetics/Body Care (11) and Caulk (8) had the lowest number of samples with values above 0.5 ppb at 2, 1 and 1, respectively. It should be noted, however, that the low number of samples with PCB congener values above 0.5 ppb does not reflect upon the levels of total PCBs found in each sample. The single caulk sample, for example, reported at total PCB concentration of 390 ppb, one of the higher total PCB concentrations found. Comic Books was the only category for which all samples reported at least one PCB above 0.5 ppb.

Products that contained the largest number of congeners were plotted and reviewed. A printed cereal box (Figure 23) contained 59 individual PCB congeners above 0.5 ppb. The PCB congeners covered the full range from PCB-8 to PCB-187 with the highest concentrations found between PCB-052 and co-eluting PCBs 153/168. The highest concentration observed was for several co-eluting PCBs in the 12 to 15 ppb range. The pattern did not resemble any known Aroclor mixture and the source of the PCBs are unknown; however, the wide range of colors in the box printing may be responsible for a wide range of PCB congeners as individual dyes contribute PCBs congeners specific to the dyes used.

A printed cookie box (Figure 24) contained 47 congeners over a similar range from PCB-4 to co-eluting PCBs 153/168. The ranges were also the same with the two highest congeners concentrations observed in the 14.4 to 13.4 ppb range; however, the pattern appears different from the previous sample with the highest concentrations found at the lower end of the PCB congeners, specifically co-eluting congeners

PCB-20/28 and PCB-31. The greater use of yellow pigments in this product may account for the lower PCB congeners although a more detailed assessment of the product is warranted.

Packaging from a child's snack box (Figure 25) contained 46 congeners over the same range as the previous cookie box, i.e., from PCB-4 to co-eluting PCBs 153/168. However, the distribution looked very different. Only one PCB congener group was found above 9 ppb, co-eluting congeners PCBs-61/70/74/76. Six congeners from co-eluting PCBs-20/28 to PCB-66 were found above 6 ppb. As with previous samples, the pattern did not resemble any known Aroclor mixture and the source of the PCBs are unknown.

Two additional samples were reviewed to provide an example of products with fewer observed congeners. The first, a magazine cover (Figure 26) contained 25 PCB congeners. The levels for all the congeners was lower than the previous samples as the highest concentrations were slightly under 4.5 ppb. The three congeners found above 3.0 ppb were PCB-31, -52 and co-eluting PCBs-61/70/74/76. The second, a phthalocyanine green paint colorant (Figure 27) contained 16 PCB congeners above 0.5ppb. As indicated previously, PCB-209 dominated the sample results and accounted for 94% of the total PCB concentration of 339 ppb. Other PCB congeners were found in the range of 4-8 ppb including PCB-6 at 8 ppb and PCBs-8 and -206 both at approximately 5.2 ppb. PCB-11 was slightly lower at 4.3 ppb. Although it is clear that PCB-209 from sources such as phthalocyanine green is responsible for most of the total PCB concentration, additional components may contribute some of the lower PCB concentrations.

Table 7. PCB Congeners Reported Above 0.5 ppb

Analyte	PCB-1	PCB-2	PCB-3	PCB-4	PCB-5	PCB-6	PCB-7	PCB-8	PCB-9
Min	0.69	0.51	0.85	1.15	0.64	0.50	1.84	0.50	2.37
Max	61.60	205.	96.10	2.70	2.33	8.16	N/A	8.78	N/A
Average	23.09	40.26	21.90	2.01	1.19	2.54	N/A	3.05	N/A
Count	3	6	5	5	5	5	1	11	1
Analyte	PCB-24	PCB-25	PCB-26/29	PCB-27	PCB-31	PCB-32	PCB-35	PCB-37	PCB-40 /41/71
Min	0.72	1.06	0.51	2.63	0.53	0.53	0.50	0.50	0.50
Max	N/A	N/A	3.94	N/A	13.40	3.56	10.50	5.01	7.02
Average	N/A	N/A	1.78	N/A	1.88	1.41	2.34	1.85	1.70
Count.	1	1	4	1	31	4	11	7	19
Analyte	PCB-59/62/75	PCB-60	PCB-61/70/74/76	PCB-63	PCB-64	PCB-66	PCB-68	PCB-70/74/76	PCB-73
Min	0.59	0.50	0.54	0.58	0.55	0.54	0.61	0.58	0.81
Max	1.26	2.43	13.90	N/A	2.46	7.66	N/A	0.75	N/A
Average	0.95	1.33	2.51	N/A	1.23	1.94	N/A	0.68	N/A
Count	3	6	39	1	9	23	1	3	1
Analyte	PCB-93 /95/1	PCB-95	PCB-95/1	PCB-105	PCB-106	PCB-110/115	PCB-114	PCB-118	PCB-128/166
Min	0.63	0.56	0.52	0.50	1.32	0.50	0.80	0.50	1.19
Max	0.75	9.54	N/A	5.70	N/A	12.50	1.14	14.30	2.04
Average	0.69	1.68	N/A	1.16	N/A	1.88	0.97	1.67	1.62
Count	2	15	1	11	1	14	2	21	2
Analyte	PCB-147/149	PCB-153/168	PCB-155	PCB-156/157	PCB-158	PCB-160	PCB-164	PCB-167	PCB-170
Min	0.52	0.50	1.75	1.83	1.24	1.15	0.70	0.56	0.83
Max	7.98	7.08	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average	1.33	1.30	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Count	18	23	1	1	1	1	1	1	1

Table continues on next page.

Analyte	PCB-11	PCB-12/13	PCB-15	PCB-16	PCB-17	PCB-18/30	PCB-19	PCB-20/28	PCB-21/33	PCB-22
Min	0.53	0.51	0.62	0.52	0.51	0.50	0.79	0.50	0.50	0.52
Max	2,290.	5.89	3.14	6.72	3.16	8.90	1.76	14.40	10.70	5.67
Average	52.33	2.43	1.83	1.83	1.55	1.66	1.27	1.98	1.72	1.49
Count	134	10	8	6	7	13	2	27	18	11

Analyte	PCB-42	PCB-43/73	PCB-44 /47/65	PCB-45/51	PCB-46	PCB-48	PCB-49/69	PCB-50/53	PCB-52	PCB-56
Min	0.55	0.80	0.53	0.61	0.63	0.54	0.51	0.79	0.50	0.54
Max	2.	N/A	6.98	2.54	0.74	3.15	4.10	1.53	12.10	4.38
Average	1.20	N/A	1.74	1.16	0.69	1.58	1.57	1.17	2.06	1.42
Count.	5	1	26	8	2	6	13	3	48	18

Analyte	PCB-77	PCB-82	PCB-83/99	PCB-84	PCB-85/116	PCB-86/87/97/109/119/125	PCB-88/91	PCB-89	PCB-90/101/113	PCB-92
Min	0.51	1.50	0.53	0.94	0.61	0.54	0.58	0.82	0.52	2.45
Max	3.01	N/A	6.03	3.22	3.34	10.10	1.79	N/A	14.10	N/A
Average	1.22	N/A	1.46	1.71	1.58	1.40	1.18	N/A	1.64	N/A
Count	17	1	8	3	3	19	2	1	20	1

Analyte	PCB-129 /138/163	PCB-130	PCB-132	PCB-134	PCB-135/151	PCB-135/151/154	PCB-136	PCB-141	PCB-142	PCB-146
Min	0.51	0.81	0.79	0.60	0.81	0.63	1.37	0.51	1.68	1.54
Max	10.	N/A	4.07	N/A	2.90	N/A	N/A	1.86	N/A	1.96
Average	1.40	N/A	2.43	N/A	1.86	N/A	N/A	1.19	N/A	1.75
Count	25	1	2	1	2	1	1	2	1	2

Analyte	PCB-174	PCB-180/193	PCB-183/185	PCB-184	PCB-187	PCB-198/199	PCB-206	PCB-207	PCB-208	PCB-209
Min	0.59	0.52	0.51	2.63	0.67	0.52	5.24	1.42	1.41	1.
Max	0.77	1.28	0.69	N/A	1.19	N/A	N/A	N/A	N/A	320.
Average	0.68	0.91	0.58	N/A	0.93	N/A	N/A	N/A	N/A	37.89
Count	4	7	3	1	4	1	1	1	1	9

Figure 20. Distribution of PCB congeners above 0.5 ppb

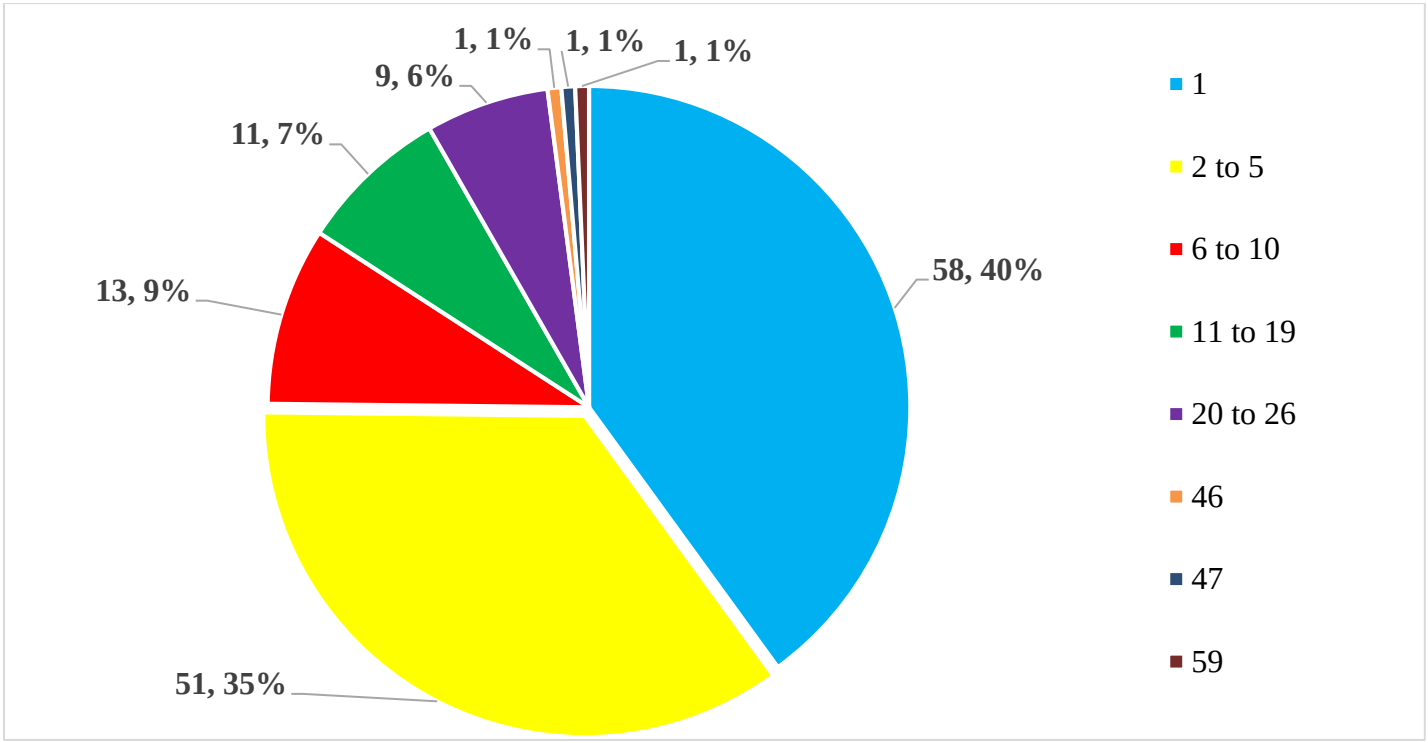


Figure 21. Distribution of PCB congeners found in only one product

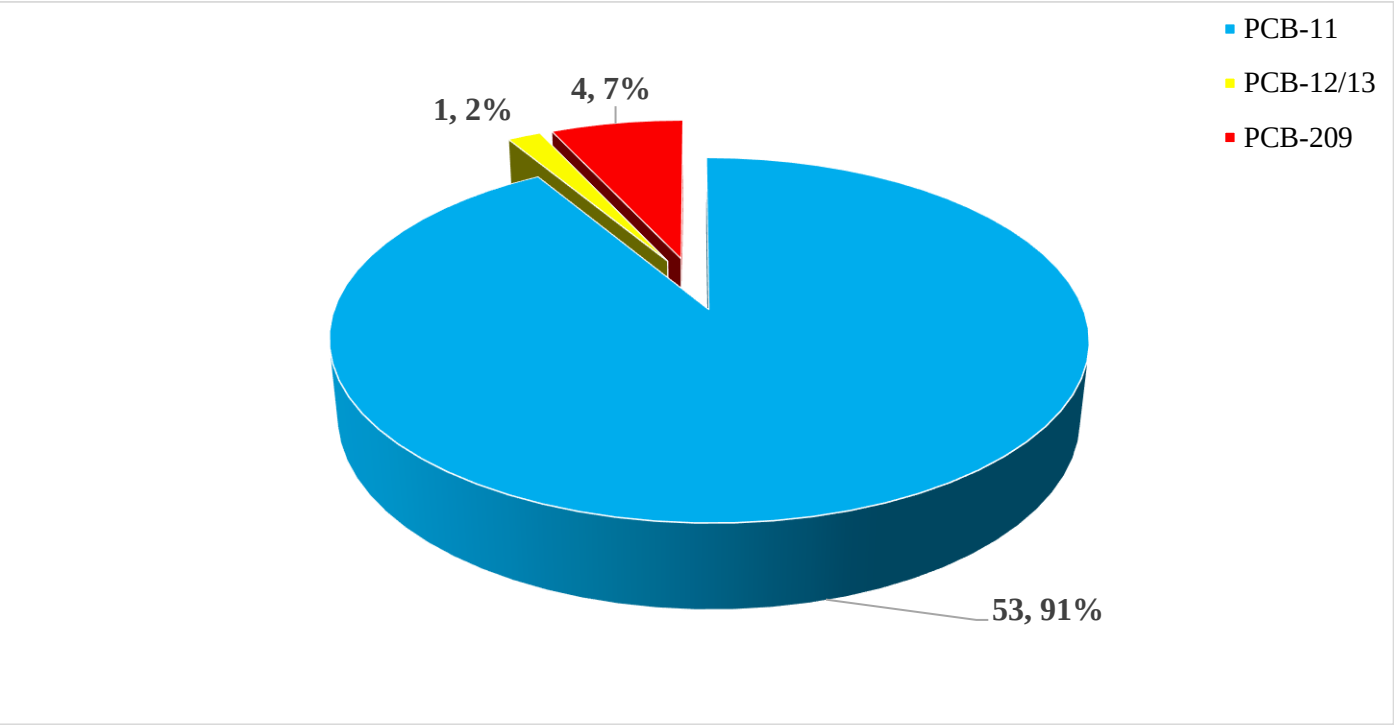


Figure 22. Number of samples in each category with at least one PCB above 0.5 ppb

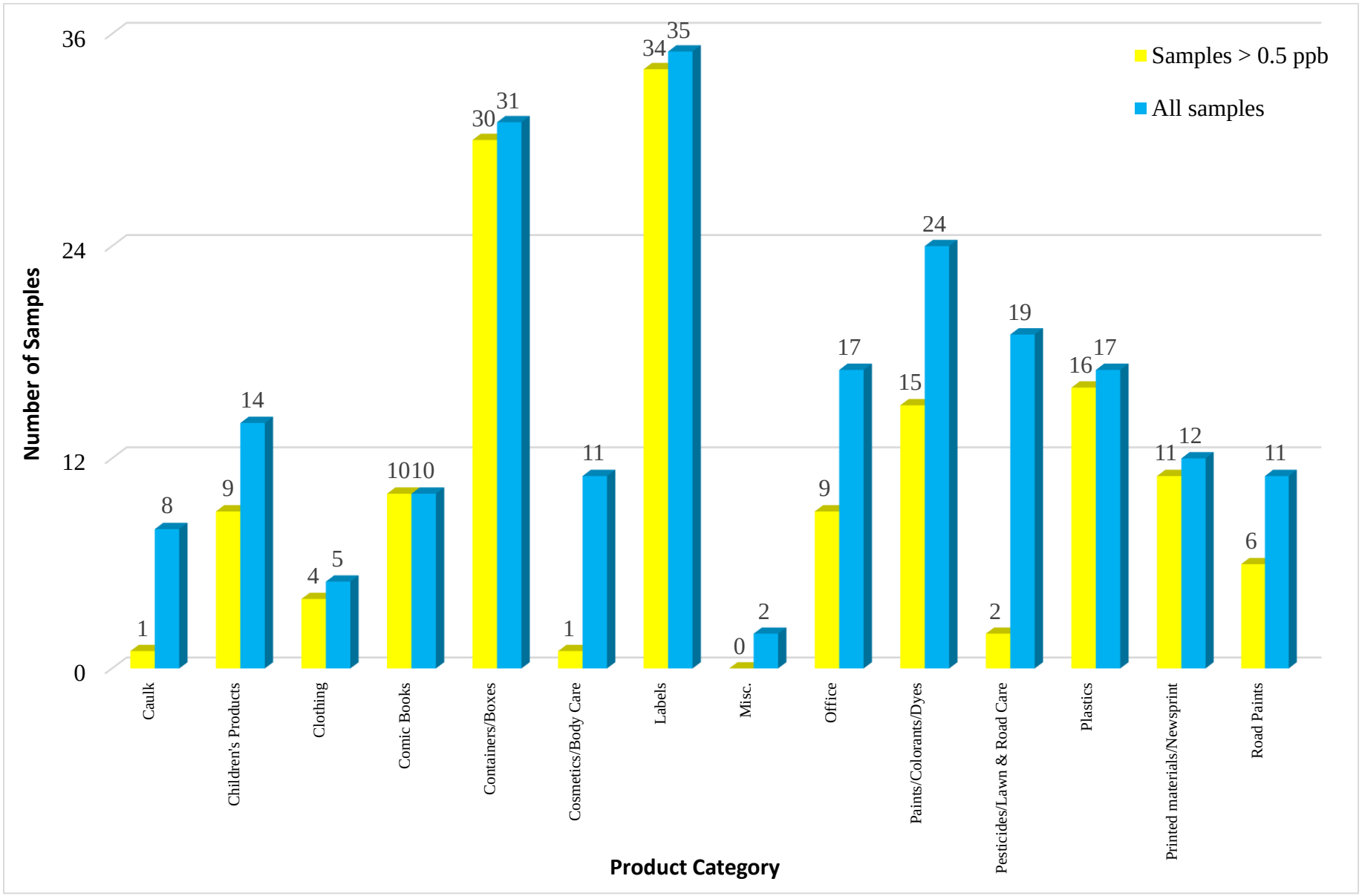


Figure 23. 59 PCB congeners detected in a printed cereal box

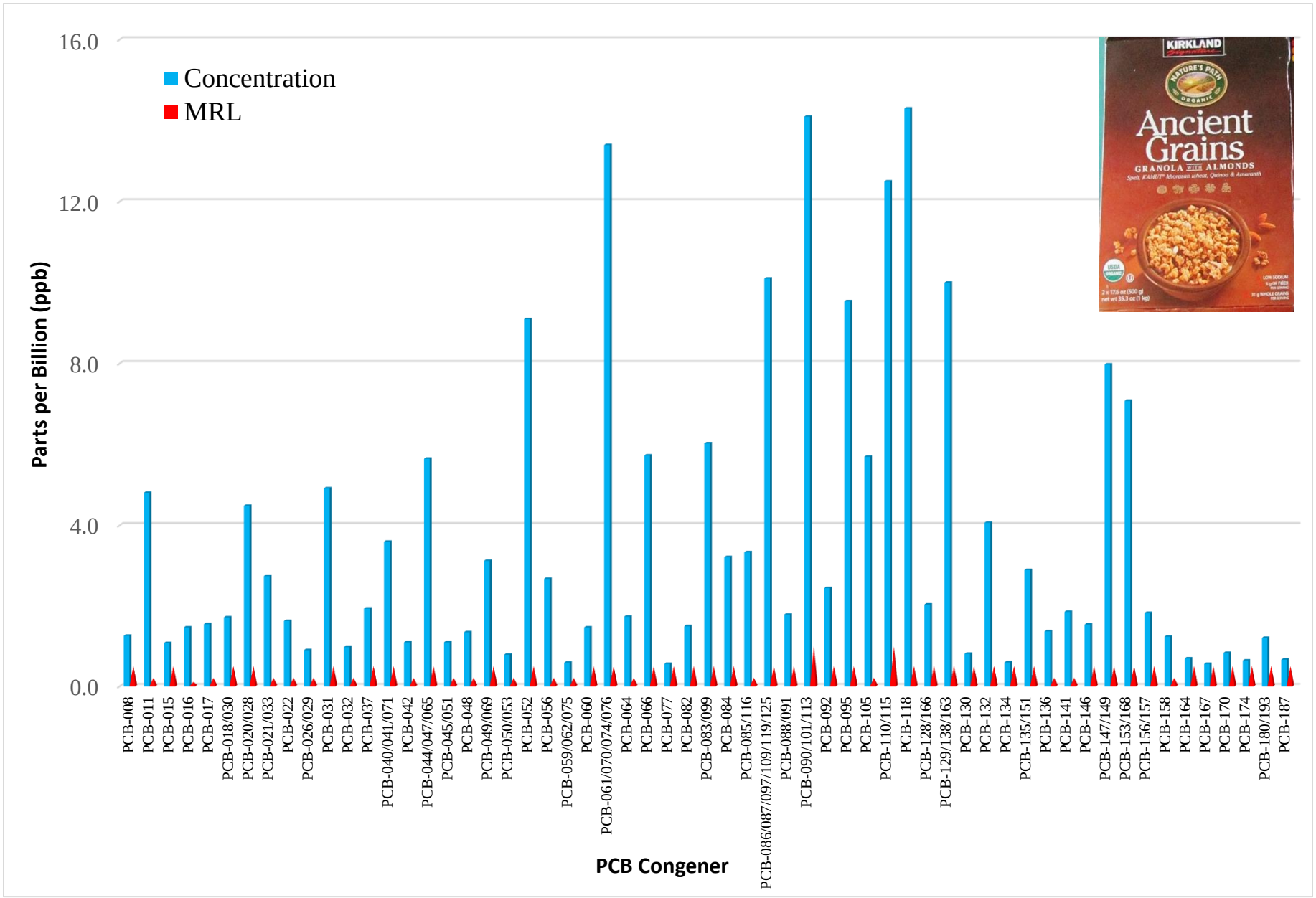


Figure 24. 47 PCB congeners in a printed cookie box

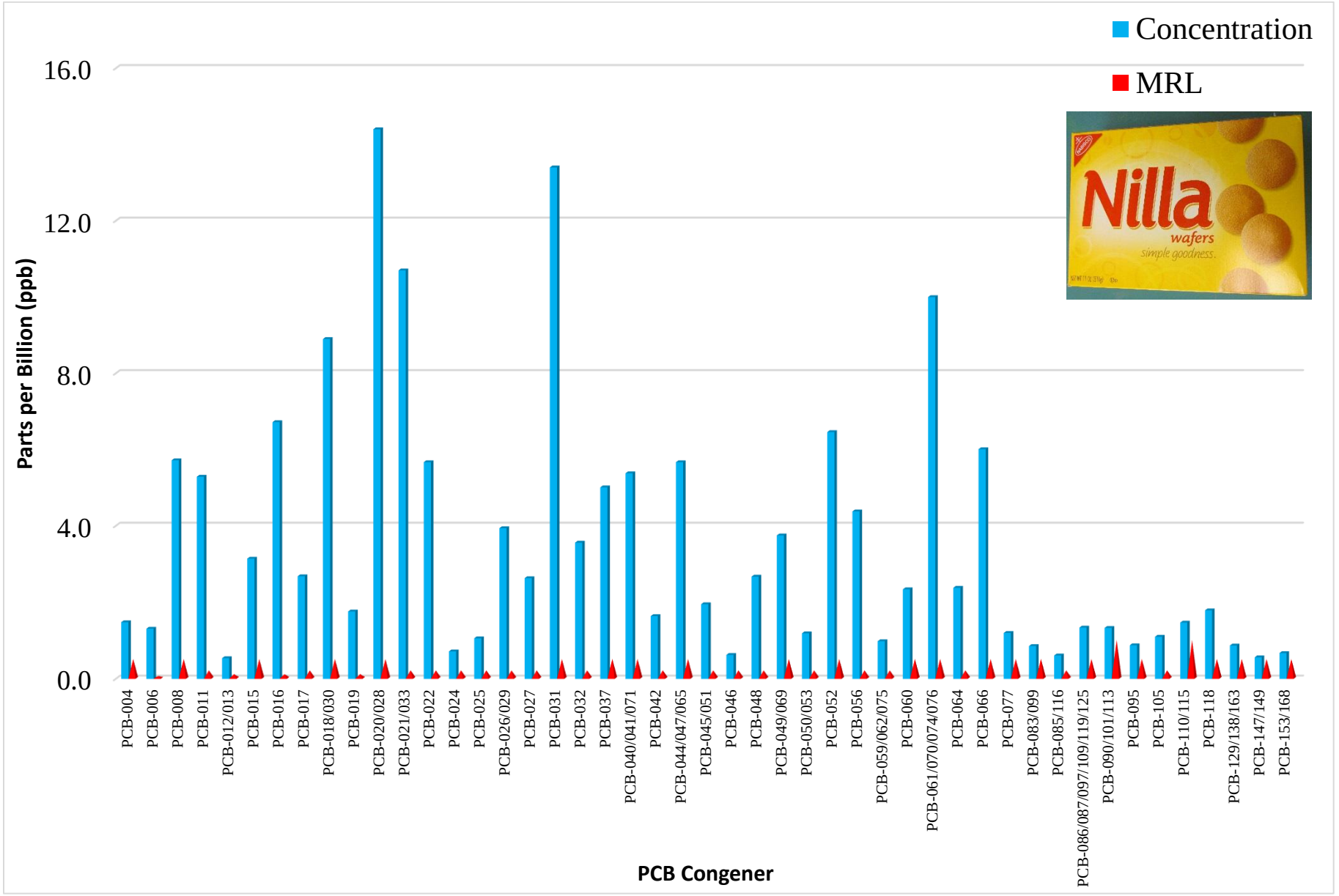


Figure 25. 46 PCB congeners in a children's snack box

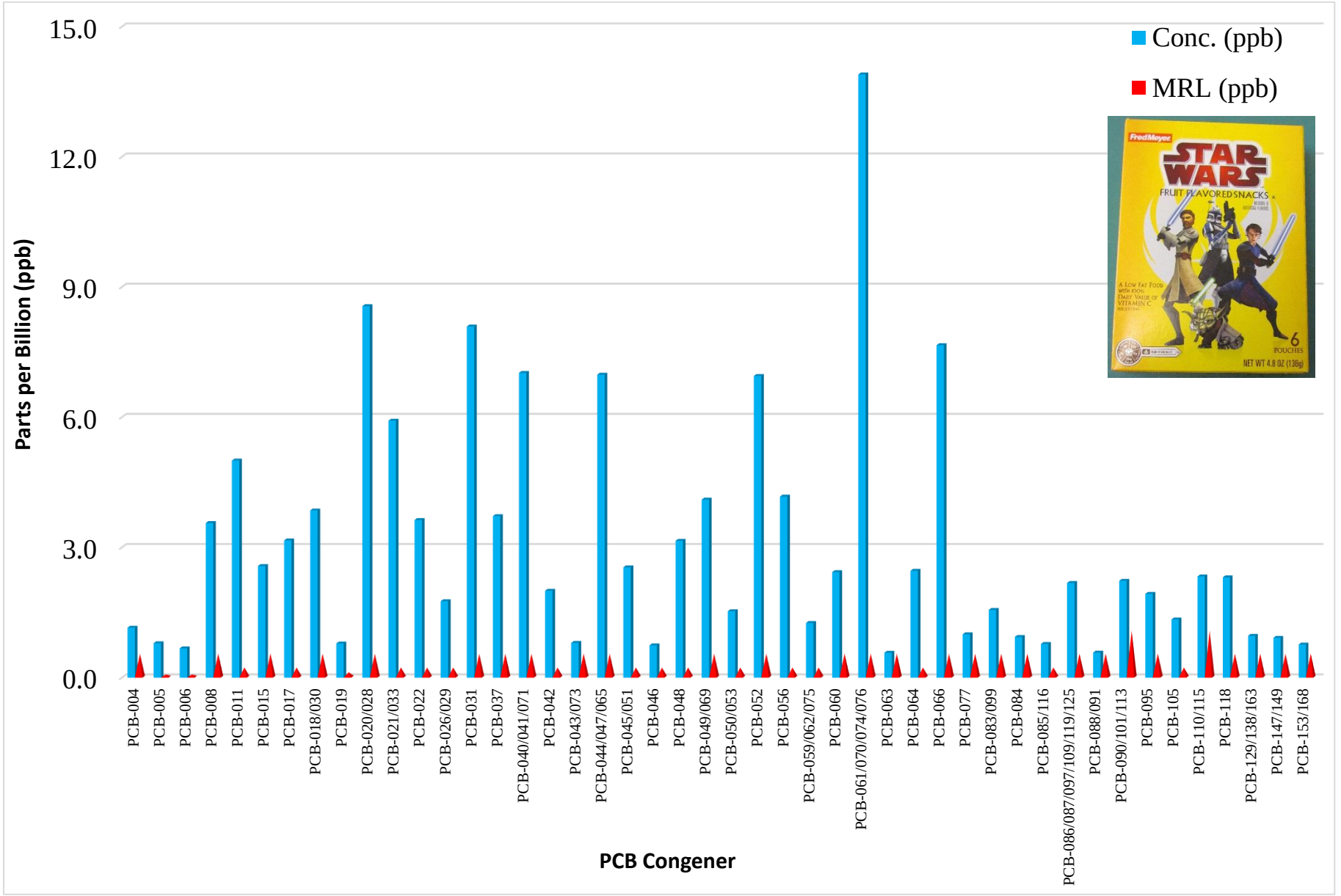


Figure 26. 24 PCB congeners in a magazine cover

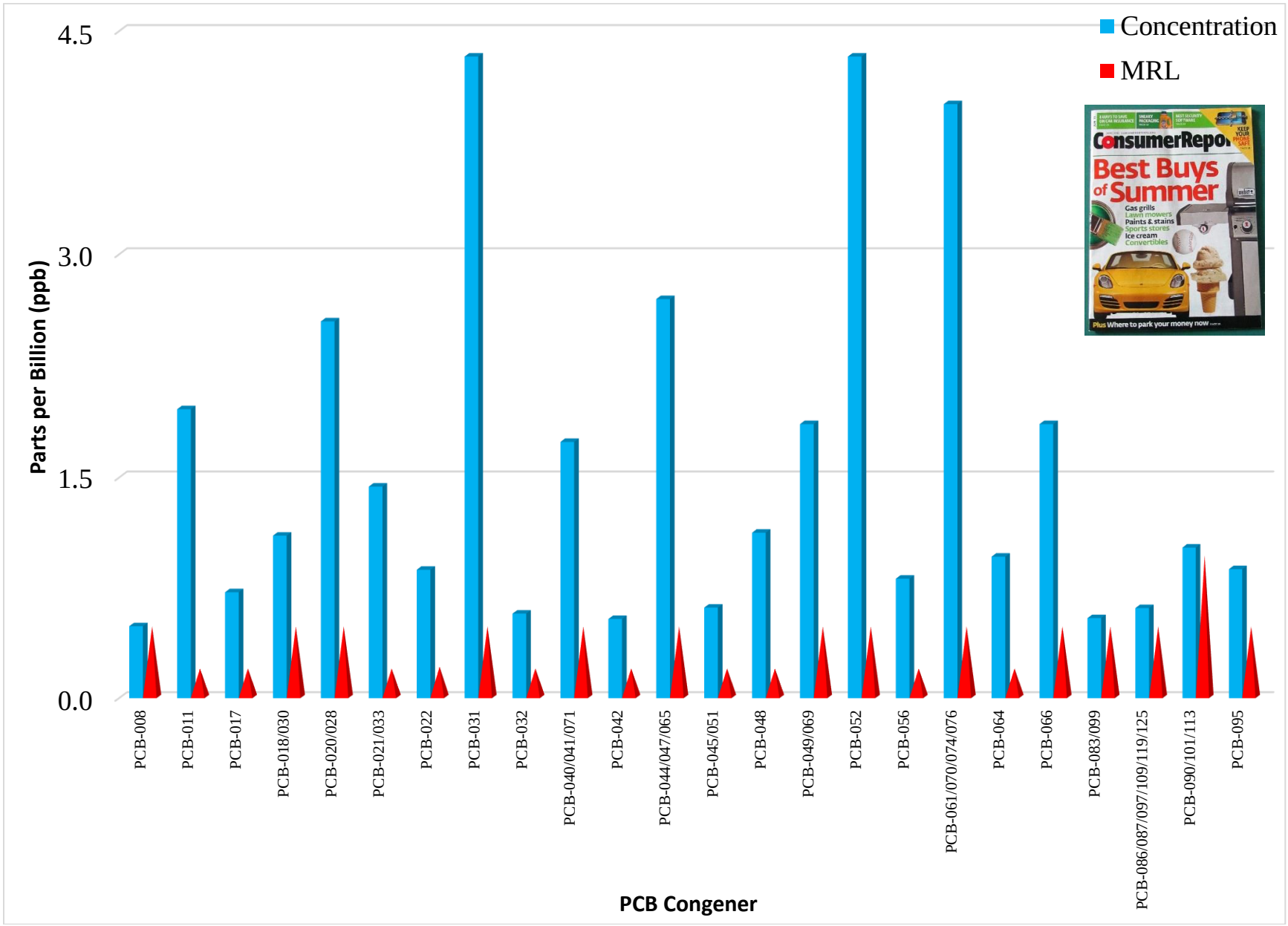


Figure 27. 16 PCB congeners in a green paint colorant