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A STUDY OF THE METAL CONTENT OF MUNICIPAL SOLID WASTE

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1. Introduction

Knowledge of the content of toxic components, so called pollutant precursors, in the municipal solid waste (MSW) stream is essential to development of the strategies for source reduction and reuse, recycling, composting and disposal¹. Data are scarce; trends in composition for any locality even more so.

Examples of pollutant precursors and where they are found in concentrated form in the waste stream are heavy metals in plastics, paper, batteries, leather, solder, and glass; chlorine in bleached paper products, food salt, PVC plastic; and sulfur in rubber. The associated pollutants produced by means of incineration would be: heavy metals, metal oxides, or metal chlorides in the vapor or in the ash; chlorine as hydrochloric acid (part of acid rain), toxic organic chlorine compounds such as dioxins, furans; and sulfur as sulfuric acid (part of acid rain) and as metal sulfates.

There are synergistic effects between different categories of pollutant precursors. For example, consider the simultaneous presence of heavy metals and chlorine. It has been found that, in incinerators, copper serves as a catalyst in the formation of chlorinated phenols, chlorinated benzenes, dioxins, furans, and the precursors of dioxans and furans. Apparently, trace amounts of not only copper, but antimony, cadmium, chromium, lead, and zinc in combustion gases can serve as catalysts. Also, metal chlorides are more water soluble than oxides or the pure metal. This increases the ease of leaching from ash in landfills and enhances the threat of contamination of the water supply.

In a previous study² the total and water soluble chlorine content of the components of municipal solid waste were determined from sampling studies at two sites, Baltimore County, MD, and Brooklyn, NY, each for a five day period. The total sulfur content of the of the combined combustible components was also determined. Because of the scarcity of data and the synergistic effects mentioned in the preceding paragraph, it seemed appropriate to determine the heavy metal content of the preceding material prior to its disposal. The metals chosen were the so-called priority pollutant metals (PPM): antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.

2. Preparation of Samples

The components of the waste stream available were paper, soft (film) plastics, hard (rigid) plastics, wood/vegetable matter, textiles, and the "fines" (sweepings). Components will be referred to as fractions in the remainder of the text. The glass/ceramics and metals fractions had been discarded. The paper from Brooklyn, NY, had been separated into a bleached and unbleached fraction. All fractions have been reduced to 2 mm particle size. These separated fractions have been stored at 5 °C since 1985 in glass bottles or bottles and bags made of polyethylene.

Each fraction was brought to room temperature, blended separately as described earlier², and then a grab sample of about 20 to 30 grams was removed. An extra sample was removed from one day's stock of each of the main fractions (i.e., unbleached and bleached were counted as one fraction) and set aside for possible later use. Each sample was analyzed for residual moisture and the amount of

each of the priority pollutant metals (PPM). This set of measurements is referred to as series 1. The remainder of the fractions was returned to their respective storage containers and returned to refrigeration.

As a result of a preliminary examination of the series 1 results, it was deemed essential to determine the reproducibility of the results. Three samples, one from each of three days of each type of fraction (i.e., the source was not considered) were selected for duplicate analysis of moisture and PPM content by removing grab samples from the storage containers without reblending. These samples and the extra samples drawn at the same time as the samples for series 1 were analyzed as a second set, series 2.

3. Analysis of samples.

Each sample was divided into four portions by the principal analyst at Spotts, Stevens, & McCoy (SSM) Laboratories of Reading, PA. The first portion was analyzed for the residual moisture content using ASTM method E790-81, Residual Moisture in a Refuse-Derived Fuel Analysis Sample. The second and third portions were combined and dissolved by SSM Method IN013-01, Metal Sample Preparation - Solid, and is equivalent to Method 3050, Acid Digestion of Sediments, Sludges, and Soils, from Test Methods for Evaluating Solid Waste, Physical & Chemical Methods, Third Edition, Environmental Protection Agency Publication: EPA SW-846, (1986) and analyzed for the PPM content by atomic absorption (AA) analysis by direct aspiration and graphite furnace (with Zeeman Background correction). The fourth portion of the sample was prepared and analyzed for mercury by EPA Method 7471 of EPA SW-846, Mercury in Solid and Semi-Solid Waste (Hach and Ott's Manual Cold-Vapor Technique).

In each series, measurements on the samples of the same type of fraction, independent of source or day, were made as a group by the analyst. A control supplied by NIST and a quality control test was carried out with each group. The control sample was one of two Standard Reference Materials (SRM 1646 and SRM 2704) prepared by NIST from river sediment with concentrations in the range encountered in MSW.

The quality control test for each matrix (i.e., type of fraction) consisted of the following. (1) One sample of each type of fraction was analyzed in duplicate to determine if the sample supplied to the analyst was homogeneous in the sense that each quarter of the sample, as described in the first paragraph of this section, is representative of the whole sample. (2) A known amount of each element was added to the sample prior to digestion to determine the percent recovery. (3) If the recovery was not in the acceptable range of $100 \pm 15\%$, a serial dilution of 1:5 was made on a sample of suitably high concentration and analyzed; a difference of greater than $\pm 10\%$ (after correction for the dilution) indicated a matrix interference. When solution concentrations were too low, the dilution was carried out using a post digestion spike of known amount of the element. (4) In the second series of measurements, a complete set of post digestion recoveries was determined by adding a known amount of the element to each sample solution after the digestion.

The dissolution procedure, in brief, was as follows. Approximately 2 g of the sample is dissolved by

refluxing, without boiling, in 1:1 HNO₃ for a total of about 75 minutes in three stages followed by reaction of the cool sample with 1-3 ml increments of 30% aqueous H₂O₂ until gas evolution ceases (e.g., is minimal) or a total of 10 ml of peroxide has been used. For analysis by flame AA or cold vapor techniques, the sample is refluxed without boiling with 1:3 aqueous HCl for 15 minutes, cooled, and filtered with Whatman 41 filter paper. For analysis by graphite furnace (i.e., flameless AA), the volume of the sample digestate volume is reduced to about 5 ml, cooled, and filtered. The three stages of oxidation mentioned above consist of refluxing with 10 ml of HNO₃ for 10-15 min, cool, add 5 ml of HNO₃, reflux for 30 minutes, and a repeat of the latter to ensure complete oxidation.

The cold vapor technique for mercury involves oxidation of organic mercurials to mercuric ion with permanganate and persulfate followed by reduction of mercuric to mercury using stannous ion. Mercury is determined by volatilization of the mercury vapor by aeration of the solution in a closed system and determining the concentration by AA.

4. Results

4.1 Series 1

4.1.1 PPM Content for each Fraction

The metal content of each fraction for a given day for the Baltimore County, MD samples are given in tables 1a through 1f and those for Brooklyn, NY in tables 2a through 2g. Table 1g gives results on "virgin" newsprint and glossy magazine print and is discussed in section 4.14. The units are mg/kg of the metal and is equivalent to parts per million (ppm), however, the latter unit is not used because it is too close in resemblance to the acronym we use for priority pollutant metal, (PPM). As received values of metal contents for each day of each fraction were converted to a dry basis using measured moisture contents. For metal contents less than the detection limits, the detection limit was converted to a dry basis. Detection limits are identified by contents preceded by a "<". Results were rounded to two significant figures. An estimate of uncertainties, given in Appendices A through C and summarized in section 4.2, indicates results are probably good to only one significant figure.

The last row of each table gives the composition of the original sample from earlier chlorine analysis² in mass percent. This sample is the dry sample after the metal and glass fractions have been removed; the sum of the mass percent of the fractions for a given day will be less than 100 by the sum the mass percent of metal and glass/ceramic fractions.

The average for the five days for each element, when any of the values for an element are below the detection limit, is given as an upper and a lower limit in columns seven and eight. The upper and lower limits correspond to averages when an elemental content below the detection limit is set equal to the detection limit or zero, respectively. The ninth column, %CV, is the coefficient of variation expressed in percent. It is calculated only for elements in a given fraction for which the contents at least three of the five days are above the detection limit. The %CV is calculated assuming elements below the detection limit have the value of zero.

The variability in the waste stream is reflected in the large values for % CV. Very large values for % CV are quite often due to the occurrence of a very large value of the metal content of one of the days for a given fraction that is bigger than the range of the other four days by an order of magnitude or more. The effect of excluding these very large values on the % CV and average is given in footnotes in the various tables 1 and 2.

For example, consider the Baltimore County results. One sees from table 1a that copper and lead for day 1 are very large for the wood vegetable fraction. From table 1b, nickel and lead for day 1 are very large for the textile fraction. However, from table 1c, there seem to be no "abnormal" values for soft plastics. From table 1d, one sees that copper is small for day 3 and zinc is large for day 2 for the hard plastics fraction. From table 1e, one can speculate that "abnormal" values occur, for example day 3 for zinc, but really what is striking for the " fines" fraction is the large scatter. In table 1f, mercury is very large for day 1 and copper and nickel are very large for day 3 of the paper fraction.

We believe this phenomenon, the single occurrence of an elemental content outside the range of the other four contents of the same element, is due to the combination of the relatively few days each source was sampled as well as the large variability of the waste stream.

4.12 PPM Content of Composite Sample

The elemental content of the dry composite sample has been calculated using the composition given in the last row of tables 1 and 2 and is given in the second and third columns of tables 3a through 3e for Baltimore county, MD, and tables 4a through 4e for Brooklyn, NY. Columns four through nine of these tables contain the distribution of the element in the fractions in mass percent whenever at least three fractions have metal contents above the detection limits and the distribution is not grossly altered by assigning metals below the detection limit either value of the limit or the value zero. The distribution is calculated assuming the metal contents below the detection limit have the value zero; the fractions for which this applies have a parenthesis around the zero.

Generally, the percent composition results are that the paper, hard plastics, and fines fractions contain most of the metal for both the Baltimore County, MD, and Brooklyn, NY, samples. In the case of the latter, only the regular paper contained appreciable amounts of metal.

4.13 Average PPM content for each Fraction and Composite Sample

Elemental contents less than the detectability limit were assigned a value of one half the detectability limit in calculating the average elemental content over the five day period for fractions and the composite sample. Thus, the average is the mean of the upper and lower limit values whenever both appear in the composite sample in tables 1 through 4. Values appear in columns three, five, seven, and nine of table 5 for Baltimore and columns two, four, six, and eight for table 6 for Brooklyn. The approximate detectability limit for each element on a as received basis is listed only in column two of table 5; the same values apply to table 6.

In tables 5 and 6, the range is taken as one half the detectability limit for elements present below the detectability limit for all the five days of a fraction. For example, in table 5, the beryllium, silver, and thallium contents were below the detectability limit for all fractions and all days for Baltimore. In table 6, beryllium and thallium contents were below the detectability limit for all fractions and all days for Brooklyn. Otherwise, the range is the standard deviation, which is identified with an asterisk. If any of the values in the average are below the detectability limit, this is indicated by a comma and the number of days after the asterisk. For the composite sample, the range is the standard deviation when any of the days of any fraction have an elemental content above the detectability limit except for antimony in table 4. In the latter case, one half the detectability limit is a better estimate of the range.

In tables 5 and 6, the mass percent of each of the fractions divided by the total of the composite sample for each day is given in the row following the list of elements along with the standard deviation to provide an indication of the relative contribution of each fraction to the composite sample. Actual rather than average values were used to calculate the numbers for the composite sample.

The choice of value and range when the elemental content is below the detectability limit does produce an anomaly. When, for example, the elemental contents of a few of the five days have elemental contents above the detectability limit, the average may be only slightly above half the detectability limit. However, the range may be much less than the case where all the contents for the five days are below the detectability limit. For example, see the selenium contents for the wood/vegetable and textile fraction in table 5.

4.14 Summary of PPM Results of Series 1.

Antimony (detectability 25mg/kg) Referring to table 5, all fractions from Baltimore except textiles and hard plastics have contents below the detectability limits. From table 1b, four of the five days of the textile fraction are above the detectability limit but barely so. From table 1d, only one day of the hard plastics is above the detectability limit (day 1). From table 6, all fractions from Brooklyn have contents below the detectability limit except for textiles which contained 540 mg/kg. This value and the large range, 1000 mg/kg, is, from table 2b, due primarily to the very high value of a single day (day 4).

Arsenic (detectability 0.26 mg/kg) From tables 5 and 6, all but one of fractions from Baltimore and all the fractions from Brooklyn have means of less than 3 mg/kg and a range less than 6 mg/kg. The exception, from Baltimore, has a content of 9 mg/kg is due, from table 1a, to a content of 45 mg/kg for one day (day 1).

Beryllium (detectability 1.6 mg/kg) From tables 5 and 6, the contents of all fractions from both Baltimore and Brooklyn were below the detectability limit.

Cadmium (detectability 1.6 mg/kg) From tables 5 and 6, the only fractions that contained amounts substantially (factor of ten) above the detectability limit were the hard plastics fraction from Baltimore

with an average of 47 and range of 58 mg/kg, and the hard plastics fraction from Brooklyn with an average of 49 and range of 68 mg/kg. All days of both Baltimore and Brooklyn hard plastics, referring to tables 1d and 2d, respectively, had significant cadmium contents. Because the mass fraction of Brooklyn hard plastics is nearly four times that of Baltimore, 11 versus 3 mass percent (see tables 5 and 6), the cadmium content of the Brooklyn composite sample, 8 mg/kg, is well above the detection limit.

Chromium (detectability 5 mg/kg) From tables 5 and 6, the fractions with the highest contents were the hard plastics and "fines" of Baltimore which have averages of 120 mg/kg and 330 mg/kg, respectively, and Brooklyn, averages of 140 and 190 mg/kg, respectively.

Copper (detectability 5 mg/kg) From tables 5 and 6, the fractions containing the largest amounts of copper are the hard plastics fractions with 12,000 mg/kg for Baltimore and 3600 mg/kg for Brooklyn. From table 1d, four of the five days of the hard plastics fraction have concentrations greater than 1700 mg/kg for Baltimore and from table 2d, 2500 mg/kg for Brooklyn. The remaining fractions have average concentrations less than 300 mg/kg except for the paper fraction from Baltimore, which contains 610 mg/kg. From table 1f, the latter is due, however, to a 2800 mg/kg concentration during one day. If this day is excluded, the average paper concentration from Baltimore is about 70 mg/kg (see footnote in table 1f).

Lead (detectability 5 mg/kg) From tables 5 and 6, the hard plastics fraction from Baltimore and the fines fraction from Brooklyn contain the highest average amount of lead, about 1300 mg/kg each. The remaining fractions have average lead concentrations in the range from 70 to 350 mg/kg.

Mercury (detectability 0.26 mg/kg) From table 5 and 6, virtually all the fractions contained less than 7 mg/kg; the average concentration of a fraction was 3 mg/kg or less.

Nickel (detectability 5 mg/kg) From table 5, the paper fraction from Baltimore has the highest average content, 1400 mg/kg, but, from table 1f, this is due to only one day which had a content of 6800 mg/kg. If this single day is excluded, the paper from Baltimore as well as the paper, regular or bleached, from Brooklyn has a concentration less than 10 mg/kg (see footnote to table 1f). From tables 5 and 6, the fines fractions from both Baltimore and Brooklyn contain the highest average amounts, 330 and 600 mg/kg, respectively, and from tables 2e, the concentrations from each source tend to be uniform. From tables 5 and 6, the fractions having the next highest contents are the soft plastics fraction of Baltimore which contains 180 mg/kg and the soft and hard plastics fractions of Brooklyn which contain about the same amount, 75 mg/kg. The hard plastics of Baltimore contains only 29 mg/kg.

Selenium (detectability 0.3 mg/kg) From tables 5 and 6, the contents of all fractions were at or below the detectability limit except for the hard plastics, and the fines fractions of Brooklyn. From tables 2d and 2e, these averages are due to a single large concentration, day 4.

Silver (detectability 3 mg/kg) From tables 5 and 6, the contents of almost all fractions were below the detectability limit. The exceptions are the soft plastics from Baltimore, and the soft plastics, hard

plastics, and "fines" from Brooklyn. In each case, this is due to the occurrence of contents on only one or two days that is above the detectability limit.

Thallium (detectability 27 mg/kg) From tables 5 and 6, the contents of all fractions were below detectability.

Zinc (detectability 5 mg/kg) From tables 5 and 6, zinc was present in all fractions; averages ranged from 130 mg/kg to 1500 mg/kg. The hard plastics fractions contained the most, averages of 1300 and 1500 mg/kg for Baltimore and Brooklyn, respectively. The fines fractions were the next highest average concentrations - 630 and 850 mg/kg for Baltimore and Brooklyn, respectively.

Paper Fraction It was of considerable interest to determine to what extent the paper fractions of either Baltimore or Brooklyn are similar to fresh newsprint or magazine print. PPM contents are given in the last two columns of table 1g. The PPM content of these examples of fresh printed matter are much less than those encountered in the Baltimore paper and the two Brooklyn paper fractions, wherever the elemental content in the latter three exceed the detectability limit. Possibly the paper fraction traps additional metal by absorption of soluble salts or segregation.

Composite Sample Looking at the values for the composite sample, one can see that the main part of the PPM content of the combustible part of the Baltimore MSW consists, in order of decreasing content, nickel, copper, zinc and lead and the same elements but in different order for Brooklyn: copper, zinc, lead, and nickel.

For Baltimore, almost all the nickel is contributed by the paper fraction, and in particular the paper fraction of only one day, see table 3c, and the fines fraction, which has fairly uniform day to day concentration. The main part of the copper is contributed almost equally by the paper and hard plastics fractions. Again, almost all of the paper fraction is contributed in one day. The zinc is contributed primarily by the "fines" and paper fractions with no abnormally large contribution from one day for either fraction.

For Brooklyn, most of the copper is contributed by the hard plastics fraction. The Zinc is contributed about equally by the hard plastics and paper fractions. The lead is contributed by the paper, "fines", and hard plastics fractions. Finally the nickel is contributed by the "fines" fraction and hard plastics fractions.

4.2 Summary of Uncertainties

Uncertainties are analyzed in the Appendices. The following are our main conclusions.

Referring to Appendix A:

- 1) The subdivision of the sample by the analyst produces a representative sample within the reproducibility limits listed in columns two and three of table 7.

2) Comparison of the series 1 and series 2 measurements indicates that only about one half of the twenty four sample pairs were identical. (Identical is defined to exist when less than half the total number of elemental contents that are above the detectability limit for a specific sample pair exceed the reproducibility limits in table 7.) There is an indication that there is a systematic difference between the series 1 and 2 results.

3) Systematic differences associated with differences in sample preparation in series 1 and series 2 samples appear to be unimportant. Grinding the stock of each sample to a finer particle size than minus 2mm mesh size may be required to produce a representative sample.

Referring to Appendix B:

4) The imprecision obtained with measurements on two standard reference samples (SRM's), used as controls, was comparable to the estimates in table 7. The SRM's are homogeneous river sediments.

5) A significant systematic difference was observed in only the arsenic and chromium contents of the SRM's. The percent recoveries of 60% for arsenic and 50% for chromium have not been applied to MSW fraction data because of the unknown effect in the different matrices (components of MSW versus river sediments).

6) The estimated uncertainty of the data in table 1 that is well above the detection limits or the lower limits of imprecision listed in table 7 is estimated to be about 40%. Actual values for this case are given in column six of table 7.

Referring to Appendix C:

7) The large number of out of bound recoveries found in the quality control test suggest that the analytical method and /or procedure does not give consistent results with MSW.

8) Neither the out of bounds or within bound recoveries for series 1 and 2 are consistent with the control measurements which indicate our measured values for arsenic and chromium are low.

5. References

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2. Churney, K.L., Ledford, A.E., Jr., Bruce, S.S., and Domalski, E.S. "The Chlorine Content of Municipal Solid Waste from Baltimore County, MD and Brooklyn, NY. NBSIR 85-3213, U. S. Department of Commerce, National Institute of Standards, Gaithersburg, MD, 20899.
3. Low, S.L., Haynes, B.W., and Campbell, W.J., "Development of Analytical Reference Materials for Refuse-Derived Fuels" Bureau of Mines Report RI 8926

Appendices - Assessment of Uncertainties

A. Homogeneity

The homogeneity test of each matrix (i.e., fraction independent of source) made by the analyst in the quality control tests for series 1 and 2 measurements was based on the reproducibility limits, cited by the analyst, given in the second and third columns of table 7. To determine homogeneity, we elected to first calculate an imprecision for the measurement of each element in a single sample as given in column 4 and 5 of table 7. Imprecisions for supposed duplicates were then computed separately, combined as the square root of the sum of squares, and then divided into the observed difference of the measurements on duplicates. This ratio of the observed difference divided by the imprecision of the difference indicates homogeneity if the absolute value is one or less.

The homogeneity test results are given in table 8a to 8c. Nine ratios have an absolute value larger than one; four are above two. The bulk of the ratios were near or less than one. We interpret the tests show that the samples in both series 1 and 2 are acceptably homogeneous. Homogeneous here means the analyst is subdividing a given sample into parts that are representative of the total sample sent to the analyst.

We have attempted to address the question of whether the samples in series 1 are representative of our entire stock of each fraction by comparison of results of series 2 with series 1 measurements. The results are given in tables 9a to 9f. Samples from four different days of the six fractions were analyzed. One sample of each fraction was prepared at the time of preparation of the series 1 samples. Bleached, regular, and unsorted (i.e., from Baltimore, MD) paper were present in the paper samples. The ratio of the observed difference of series 2 minus series 1 contents divided by the apriori estimate of this difference, calculated as described for tables 8, is given in columns four and seven.

The pattern of results found in table 9 is summarized in table 10. The number of elements that have a ratio with an absolute value greater than one divided by the total number of elements for which ratios could be calculated for each sample limit are given in the second column. Ratios could not be calculated for elements below detectability in either or both of the series. The number of elements which had a ratio with an absolute value greater than 2 is given in column three. These elements are identified in column 4 by their chemical symbol. Underlined elements are those for which the series 2 content was greater than the series 1 content.

Using the criteria that two samples from the same fraction are identical if column 2 is less than 1/2, the number of pairs of samples that are identical for each fraction are two of Wood/Vegetable (Br5 and Br4), one of textiles (Br4), two of soft plastics (Ba3, Br4), one of the hard plastics(Br3), none of the fines, and two of the paper fractions(Br1 and Br3) for a total of eight. Thus, 33% (8/24) of the samples are identical. If we were to use the ratios whose absolute values are greater than two in place of those greater than one in the numerator of column two, the numbers of pairs of samples that are identical increases by nine so that 71% (17/24) are identical. Alternatively, if we count elemental contents to be in agreement if they are below detectability in both series 1 and 2, the denominator in

column two of table 5 would be near 13 and close to all the samples would be identical whether the absolute value of the ratio (ab ratio) is greater than one or two. Thus, we conclude that the number of samples that are identical within the imprecision of the measurements is greater than 33% but may be less than 71% ; we select somewhat arbitrarily 50%.

Since 18 of the 55 elements in column four of table 10 are underlined, one third of the series 2 measurements are larger than series 1 measurements for ab ratios greater than two. If we consider ab ratios greater than one or all calculated ratios, whatever their values, the fraction of the series 2 measurements greater than the series 1 measurements remains one third. Since for random differences we expect a fraction of about one half, there may be a systematic difference between series 1 and 2 measurements.

It is pertinent to note that almost all the elements having ab ratios greater than one or two are in the group of chromium, copper, lead, mercury, nickel, and zinc. These elements, excluding mercury, are present in the largest amount in the Brooklyn fractions or composite samples. In all the elements of this group, one third or less of the series 2 measurements are greater than series 1 measurements whether the ab ratio is greater than one or two except for nickel. For nickel, the series 2 measurements are greater than the series 1 measurements in 80% of cases where the ab ratio is greater than one and also two. This reinforces our belief that there is a systematic difference between series 1 and 2.

There seems to be no significant difference in the samples pulled at the time of the series 1 measurements, denoted by an asterisk in column 1 of table 10, and those actually pulled later for the series 2 measurements. That is, there are no striking systematic differences in columns two or column three of table 10 between the single starred sample and the remaining three of the same fraction type. This suggests that pulling two grab samples after homogenizing the material (series 1 and the asterisk series 2) and removing another grab sample (remainder of series 2, not denoted by an asterisk) after the homogenized material was returned to its container probably produced no significant difference in elemental content.

We believe that a possible reason that most samples for series 1 and 2 were not identical is the particle size of our fractions (minus 2mm mesh size) and the method used to sample the fraction, homogenization followed by a grab to collect the sample, did not produce a reasonably representative sample for metal determinations. A finer particle size and riffing might produce better agreement. For example, earlier work³ at the Bureau of Mines indicates that unseparated combustible part of MSW had to be milled to 200 mesh size to obtain reproducible results.

B. Controls

A total of seven control samples in series 1 and two controls in series 2 were supplied to the analyst. In the main measurements, series 1, a control was run with the samples belonging to the same type (six types in all corresponding to what are designated in the tables as fractions except that regular and bleached paper were considered to be in the same fraction type). The controls were either NIST Standard Reference Material (SRM) 2704 or SRM 1646; the SRM's are homogeneous at the sample size cited (see footnote 2 of table 11) and are river sediments.

The results are presented in tables 11 and 12. In the top half of each table, the certificate metal contents of the SRM are given in column two. Parentheses around values in column two in table 12 were not certified by NIST and are the average of round robin measurements by other laboratories. The measurements in series 1 are given in columns four, six, seven, eight, and, in table 12, column nine also. The uncertainties in the SRM's are given in column three and, for comparison, the estimated uncertainty for a single measurement for sample 19, Table 11, and 25, table 12, are given in column five. The uncertainties are calculated according to table 7. Measured values on a dry basis are given to the same number of significant figures provided by the analyst. The agreement of the values in columns four through eight in the top half of table 9a and four through nine of table 9b, indicate the analyses were in good control.

The average and the standard deviation of the measurements is given in columns two and three in the bottom half of each table. The ratio of the difference of samples 120 and 121, both series 2 measurements, with the corresponding average divided by the standard deviation is listed in column four. The single series 2 measurement on each SRM is not significantly different from the average of the series 1 measurements in magnitude-deviations are within one or two times the standard deviation. A trend in the sign of the deviations is, if anything, the reverse of those in tables 9 - series 2 measurements tend to be greater than series 1. However, there are too few series 2 measurements to draw conclusions.

The fourth column in the bottom half of the tables is the estimate of the imprecision of a single measurement calculated from table 7. The standard deviation of a measurement is less than or comparable to the estimated imprecision of a single measurement. Thus, we conclude that the estimated imprecision seems to be reasonable.

The estimated uncertainty of the average of our measurements and the ratio of the difference of the average and certificate value divided by the total uncertainty of the difference is given in columns six and seven, respectively, in the bottom half of each table. The systematic error is estimated to be ± 15 percent of the measured value based on the analyst's criteria for an acceptable recovery to 100 ± 15 percent (see subsequent discussion of recoveries). For ratios having an absolute value greater than one, a recovery in percent is calculated. There is systematic disagreement between measured and certified values for arsenic and chromium for both SRM's, nickel in SRM 2704, and lead in SRM 1646. The nickel or the lead disagreement is probably borderline since 1) both did not occur in both samples; 2) the values are not very far from a normal recovery, and 3) if the systematic error is increased from $\pm 15\%$ to $\pm 38\%$, the ratios for lead and nickel become less than one. In view of this result and problems with recoveries identified in Appendix C, we have increased the estimate of systematic error to $\pm 38\%$. The recoveries of arsenic and chromium are clearly real but have not been applied since a river sediment matrix may be significantly different from the MSW fractions.

C. Recoveries

The recovery data for series 1 and 2 are given in tables 13a to 13c. Predigestion recoveries, denoted by the symbol bd followed by the number of the series, are given in columns two for series 1 and

column four for series 2. Postdigestion spike recoveries, denoted by the symbol ad, are given in column six for series 2. Values exceeding 115% or below 85% are indicated by a H or L, respectively, in columns three and five. The ratio of the two predigestion recoveries and the predigestion to the post digestion recovery for the series 2 measurements is given in columns seven and nine, respectively. The markers H and L given in column eight indicates the ratio $bd1/bd2$ is either greater than 1.35, which is $1.15/0.85$, or lower than 0.74, which is $0.85/1.15$. Thus, this marker identifies that two recoveries are not correlated or do not match in the sense that both are out of bounds (OB) in different directions. This same marker can be applied to the ratio of $bd2/ad2$ in column nine. It has not been listed since only three values are outside of these bounds in column nine, two for fines and one for paper in table 13c.

The predigestion recoveries for series 1 and 2 from the same fraction are treated as being from the same matrices since they are from the same source (except for the series 2 quality control test on magazine print).

Matrix interference was observed only the for mercury in the series 1 sample in the paper fraction.

If one examines columns three and five, one finds that about 50% of the series 1 and 30% of the series 2 measurements, a total of 78 (6 fractions x 13 elements) measurements for each, are out of bounds (OB). 25% of the OB ratios are high. The "fines" fraction has the most OB ratios. These percentages do not change much if we reject some measurements because we think there may be error. For example, if we were to reject all recoveries greater than 200% or less than 10% as being unreasonable or in error, seven series 1 measurements and three series two measurements must be dropped and the number of OB recoveries is 36% for series and 28% for series 2. 25% of the OB ratios are still high. From these results, we conclude that something is wrong with the analytical procedure in the sense that it does not give sufficiently consistent results when applied to MSW.

An average of eight of the thirteen elements for each fraction have an OB recovery for either series 1 or 2 or both. The number of marked ratios of $bd1/bd2$ divided by the number of elements having OB recoveries for each fraction is about 20% for textiles; 40% for wood/vegetable, soft plastics, and paper; 80% for hard plastics; and 90% for the "fines" fractions. Thus, we conclude that essentially none of the elements having OB recoveries for series 1 and 2 that match for the "fines" and hard plastics fractions and that less than half of the out of bound elemental recoveries match in the other fractions. We conclude that there may be some difference between the series 1 and 2 measurements of recoveries but see no consistent basis for making a correction to results for OB recoveries.

Averages for a given element for the three or more fractions having ratios $bd1/bd2$ within the bounds of 0.76 to 1.35 are listed in the the second column in the bottom half of table 14a. The averages equal one within one standard deviation, given in column three in the bottom half of the table, except for cadmium. Thus, there seems to be no significant systematic difference between the series 1 and 2 recoveries that are within bounds. Ratios for elements which were OB for more than three fractions are designated as inconsistent in table 14a. The elements having inconsistent ratios of series 1 and 2 recoveries were copper, silver, and zinc. The ratios were low due to low recoveries for copper and silver while they were both low and high for zinc.

The ratio of the predigestion divided by the post digestion recoveries are examined. in table 14b. The correlation is better than for the predigestion recoveries. The OB ratios are fewer by a factor of three, the standard deviations for a given element are smaller than those in table 14, and the averages are slightly less than one, except for lead. This better consistency of the postdigestion and predigestion recoveries of series 2 as compared to the series 1 and 2 predigestion recoveries suggests that the assumption that the analytical method is valid for different days of the same of fraction for the same source is incorrect. We would regard this as a defect of the analytical method.

**Table 1a. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Wood/ Vegetable Fraction
Baltimore County, MD**

Day	1	2	3	4	5	Avg up lim ¹	Avg low lim ¹	%CV ^{2,3}
Elements								
Antimony	<28 ¹	<26	<27	<27	<27	<27 ,	>0	
Arsenic	45	1.3	<0.27	0.34	<0.27	<9.4 ,	>9.3	210
Beryllium	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6 ,	>0	
Cadmium	3.1	7.3	<1.6	<1.6	<1.6	<3.0 ,	>2.1	
Chromium	64	10	6.2	7.0	<5	<18 ,	>17	150
Copper	560	22	8.5	32	8.5	130		190
Lead	1200	33	18	23	18	260		200
Mercury	1.6	1.3	0.19	0.12	0.45	0.72		92
Nickel	6.4	<5	6.3	<5	<5	<5.5 ,	>2.5	
Selenium	<0.28	<0.26	<0.27	<0.27	<0.27	<0.27 ,	>0	
Silver	<3	<3	<3	<3	<3	<3 ,	>0	
Thallium	<28	<26	<27	<27	<27	<27 ,	>0	
Zinc	1240	330	800	210	120	540		87
%comp, dry ⁴	2.9	2.1	1.0	0.4	1.9			

**Table 1b. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Textile Fraction
Baltimore County, MD**

Day	1	2	3	4	5	Avg up lim	Avg low lim	%CV ⁵
Elements								
Antimony	27	<26	27	30	38	<30 ,	>24	59
Arsenic	1.4	10	0.56	0.46	<0.26	<2.5 ,	>2.5	170
Beryllium	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6 ,	>0	
Cadmium	12	3.6	<1.5	1.7	<1.6	<4.1 ,	>3.5	150
Chromium	140	16	12	16	11	39		150
Copper	170	63	22	340	58	130		100
Lead	540	21	31	130	46	150		150
Mercury	5.7	1.3	1.8	1.8	3.2	2.8		65
Nickel	230	21	9.8	9.6	5.8	55		180
Selenium	<0.26	0.28	0.30	<0.26	<0.26	<0.27 ,	>0.12	
Silver	<3	<3	<3	<3	<3	<3 ,	>0	
Thallium	<26	<26	<26	<26	<26	<26 ,	>0	
Zinc	140	480	160	160	210	230		62
%comp, dry	3.6	0.8	0.5	11.7	5.1			

1 <#, lower than detection limit, #, except in columns 7 and 8, where "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

2 Based on metal contents used to compute lower limit when at least three components have contents above the detection limit.

3 If day 1 is excluded, copper avg=18, %CV=64; and lead avg=23, %CV=31

4 Composition in mass % of original dry sample; does not include metal and glass/ceramic fractions.

5 If day 1 is excluded, lead avg=57, %CV=87; and nickel avg=12, %CV=59.

**Table 1c. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Soft Plastic Fraction
Baltimore County, MD**

Day	1	2	3	4	5	Avg up lim ¹	Avg low lim ¹	%CV ²
Elements								
Antimony	<26 ¹	<26	<26	<26	<25	<26 ,	>0	
Arsenic	0.73	7.1	0.36	0.67	<0.25	<1.8 ,	>1.8	160
Beryllium	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5 ,	>0	
Cadmium	3.4	2.7	2.7	1.7	<1.5	<2.4 ,	>2.1	63
Chromium	82	76	52	81	61	70		19
Copper	56	65	27	37	29	43		43
Lead	310	130	140	350	210	230		43
Mercury	2.6	0.36	0.36	0.50	1.8	1.1		91
Nickel	210	170	240	120	140	180		28
Selenium	<0.26	0.28	0.31	<0.26	<0.25	<0.27 ,	>0.12	
Silver	<3	<3	7	<3	<3	<3.8 ,	>1.4	
Thallium	<26	<26	<26	<26	<25	<26 ,	>0	
Zinc	310	610	350	200	170	330		53
%comp, dry ³	4.0	2.2	3.0	9.2	5.0			

**Table 1d. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Hard Plastic Fraction
Baltimore County, MD**

Day	1	2	3	4	5	Avg up lim	Avg low lim	%CV ⁴
Elements								
Antimony	70	<25	<25	<25	<25	<34 ,	>14	
Arsenic	0.63	<0.25	<0.25	<0.25	1.5	<0.58 ,	>0.48	
Beryllium	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5 ,	>0	
Cadmium	150	37	24	15	11	47		120
Chromium	54	61	200	220	59	120		70
Copper	4300	40000	31	16000	1700	12000		130
Lead	420	3700	96	1700	730	1300		110
Mercury	7.3	<0.25	0.56	<0.25	0.42	<1.8 ,	>1.7	190
Nickel	20	55	28	14	26	29		
Selenium	0.64	<0.25	<0.25	<0.25	<0.25	<0.33 ,	>0.13	
Silver	<3	<3	<3	<3	<3	<3 ,	>0	
Thallium	<25	<25	<25	<25	<25	<25 ,	>0	
Zinc	120	5400	650	260	250	1300		170
%comp, dry ³	3.0	3.0	1.9	3.6	2.1			

1 <#, lower than detection limit, #, except in columns 7 and 8, where "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

2 Based on metal contents used to compute lower limit when at least three components have contents above the detection limit.

3 Composition in mass % of original dry sample; does not include metal and glass/ceramic fractions.

4 If day 2 is excluded, zinc avg=320, %CV=72.

**Table 1e. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in "Fines" Fraction
Baltimore County, MD**

Day	1	2	3	4	5	Avg up lim ¹	Avg low lim ¹	%CV ^{2,3}
Elements								
Antimony	<25 ¹	<25	<25	<25	<26	<25 ,	>0	
Arsenic	2.8	5.5	0.7	<0.5	<0.5	<2.0 ,	>1.8	130
Beryllium	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5 ,	>0	
Cadmium	1.7	2.8	<1.5	<1.5	<1.5	<1.8 ,	>0.9	
Chromium	190	460	200	410	400	330		39
Copper	360	69	26	32	87	110		130
Lead	460	41	26	190	45	150		120
Mercury	0.40	<0.25	<0.25	2.40	3.72	<1.4 ,	>1.3	130
Nickel	300	400	270	340	350	330		15
Selenium	<0.51	0.53	0.51	<0.51	<0.51	<0.51 ,	>0.21	
Silver	<3	<3	<3	<3	<3	<3 ,	>0	
Thallium	<25	<25	<25	<25	<26	<25 ,	>0	
Zinc	420	320	2000	150	310	640		120
%comp, dry ⁴	18.9	14.1	18.4	14.7	9.1			

**Table 1f. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Paper Fraction
Baltimore County, MD**

Day	1	2	3	4	5	Avg up lim	Avg low lim	%CV ⁵
Elements								
Antimony	<27	<27	<27	<28	<26	<27	>0	
Arsenic	1.7	8.6	0.71	0.40	<0.26	<2.3 ,	>2.3	160
Beryllium	<1.6	<1.6	<1.6	<1.7	<1.6	<1.6 ,	>0	
Cadmium	2.6	2.5	<1.6	<1.7	<1.6	<2.0 ,	>1.0	
Chromium	21	17	33	15	22	22		32
Copper	120	78	2800	47	22	610		200
Lead	170	59	74	140	140	120		40
Mercury	5.0	0.44	0.62	0.38	1.2	1.5		130
Nickel	12	<5	6800	7.9	<5	<1400 ,	>1400	220
Selenium	<0.27	0.27	0.33	<0.28	<0.26	<0.28 ,	>0.12	140
Silver	<3	<3	<3	<3	<3	<3 ,	>0	
Thallium	<27	<27	<27	<28	<26	<27 ,	>0	
Zinc	540	270	440	200	210	330		46
%comp, dry	50.9	56.9	61.5	56.6	67.6			

1 <#, lower than detection limit, #, except in columns 7 and 8, where "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

2 Based on metal contents used to compute lower limit when at least three components have contents above the detection limit.

3 If day 3 is excluded, zinc avg=300, %CV=37.

4 Composition in mass % of original dry sample; does not include metal and glass/ceramic fractions.

5 If day 3 is excluded, copper avg=67, %CV=63; nickel avg=5, %CV=100. If day 1 is excluded, mercury avg=0.66, %CV=57.

Table 1g. Priority Pollutant Metals in Municipal Solid Waste Contents in mg/kg, Dry, Paper Fraction and Unmixed Paper Baltimore County, MD

Day	1	2	3	4	5	WP ¹	Mag ²
Elements							
Antimony	<27 ³	<27	<27	<28	<26	<27	<26
Arsenic	1.7	8.6	0.71	0.40	<0.26	<.27	<.26
Beryllium	<1.6	<1.6	<1.6	<1.7	<1.6	<1.6	<1.6
Cadmium	2.6	2.5	<1.6	<1.7	<1.6	<1.6	<1.6
Chromium	21	17	33	15	22	<5	<5
Copper	120	78	2800	47	23	6.4	26
Lead	170	59	74	140	140	12	<10
Mercury	5.0	0.44	0.62	0.38	1.2	<.27	<0.26
Nickel	12	<5	6800	7.9	<5	<5	<5
Selenium	<0.27	0.27	0.33	<0.28	<0.26	<.27	<.26
Silver	<3	<3	<3	<3	<3	<3	<3
Thallium	<27	<27	<27	<28	<26	<27	<26
Zinc	540	270	440	200	210	19	25

1 Newspaper (Washington Post)

2 Magazine, glossy (Waste Age)

3 <#, lower than detection limit, #, except in columns 7 and 8, where "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

**Table 2a. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Wood/ Vegetable Fraction
Brooklyn, New York**

Day	1	2	3	4	5	Avg ¹ up lim	Avg ¹ low lim	%CV ^{2,3}
Elements								
Antimony	<27 ¹	<27	<26	<28	<27	<27	>0	
Arsenic	0.55	0.43	<0.26	0.50	<0.27	<0.40	>0.30	92
Beryllium	<1.6	<1.6	<1.6	<1.7	<1.6	<1.6	>0	
Cadmium	<1.6	4.5	1.8	<1.7	<1.6	<2.2	>1.3	
Chromium	14	15	9.0	12	<5.5	<11	>10	60
Copper	21	130	23	530	100	160		130
Lead	210	75	31	96	72	97		70
Mercury	0.28	0.35	0.38	0.42	<0.27	<0.34	>0.29	59
Nickel	25	17	<5	13	<5	<13	>12	99
Selenium	<0.27	<0.27	<0.26	<0.28	<0.27	<0.27	>0	
Silver	<3	<3	<3	<3	<3	<3	>0	
Thallium	<27	<27	<26	<28	<27	<27	>0	
Zinc	230	140	82	130	60	130		51
%comp, dry ⁴	5.9	7.0	8.1	8.1	6.9			

**Table 2b. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Textile Fraction
Brooklyn, New York**

Day	1	2	3	4	5	Avg up lim	Avg low lim	%CV*
Elements								
Antimony	<26	34	33	2400	220	<540	>540	190
Arsenic	0.28	0.71	<0.26	8.2	<0.25	<1.9	>1.9	190
Beryllium	<1.6	<1.6	<1.6	<1.5	<1.5	<1.6	>0	
Cadmium	<1.6	2.4	2.7	5.4	<1.5	<2.7	>2.1	110
Chromium	8.7	7.1	4.1	16	<5	<8.2	>7.2	83
Copper	35	34	17	49	8.0	29		57
Lead	65	94	42	130	14	69		65
Mercury	0.47	0.92	0.89	0.47	0.44	0.64		38
Nickel	9.9	9.7	5.6	13.1	<5	<8.6	>7.6	66
Selenium	<0.26	<0.26	0.36	<0.26	<0.25	<0.28	>0.07	
Silver	<3	<3	<3	<3	<3	<3	>0	
Thallium	<26	<26	<26	<26	<25	<26	>0	
Zinc	120	980	590	540	76	460		81
%comp, dry	3.0	1.7	2.1	3.1	1.8			

1 <#, lower than detection limit, #, except in columns 7 and 8, where "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

2 Based on metal contents used to compute lower limit when at least three components have contents above the detection limit.

3 If day 4 excluded, copper avg=69, %CV=80.

4 Composition in mass % of original dry sample; does not include metal and glass/ceramic fractions.

5 If day 4 excluded, antimony avg=72, %CV=120.

**Table 2c. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Soft Plastic Fraction
Brooklyn, New York**

Day	1	2	3	4	5	Avg ¹ up lim	Avg ¹ low lim	%CV ^{2,3}
Elements								
Antimony	<26 ¹	<26	<26	<26	<26	<26 ,	>0	
Arsenic	0.26	0.63	2.81	<0.26	<0.26	<0.84 ,	>0.79	150
Beryllium	<1.6	<1.5	<1.6	<1.5	<1.6	<1.6 ,	>0	
Cadmium	<1.6	5.1	5.5	3.4	<1.6	<3.4 ,	>2.8	96
Chromium	55	61	42	41	110	61		46
Copper	34	97	38	2900	63	630		200
Lead	310	710	230	270	250	350		57
Mercury	0.32	0.31	0.98	0.38	0.39	0.48		60
Nickel	120	60	32	70	62	69		47
Selenium	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26 ,	>0	
Silver	<3	12	<3	<3	17	<8 ,	>6	
Thallium	<26	<26	<26	<26	<26	<26 ,	>0	
Zinc	160	230	220	190	180	200		15
%comp, dry ⁴	2.3	4.6	3.4	5.1	1.5			

**Table 2d. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Hard Plastic Fraction
Brooklyn, New York**

Day	1	2	3	4	5	Avg up lim	Avg low lim	%CV ⁵
Elements								
Antimony	<26	<25	31	38	<25	<29 ,	>14	
Arsenic	0.47	0.29	<0.25	0.92	0.30	<0.45 ,	>0.40	81
Beryllium	<1.6	<1.5	<1.5	<1.5	<1.5	<1.5 ,	>0	
Cadmium	27	14	16	170	18	49		140
Chromium	54	18	8.7	560	36	140		180
Copper	6600	2500	84	3900	5000	3600		69
Lead	250	67	42	440	150	190		85
Mercury	0.40	<0.25	0.35	0.38	0.28	<0.33 ,	>0.28	58
Nickel	250	18	14	24	67	75		130
Selenium	0.46	1.7	1.1	15	<0.25	<3.7 ,	>3.7	180
Silver	<3	<3	<3	4.5	<3	<3.3 ,	>0.9	
Thallium	<26	<25	<25	<25	<25	<25 ,	>0	
Zinc	720	1100	210	2300	3500	1600		85
%comp, dry	6.9	7.2	5.9	8.9	10.6			

- 1 <#, lower than detection limit, #, except in columns 7 and 8, where "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.
- 2 Based on metal contents used to compute lower limit when at least three components have contents above the detection limit.
- 3 If day 4 is excluded, copper avg=58, %CV=50.
- 4 Composition in mass % of original dry sample; does not include metal and glass/ceramic fractions.
- 5 If day 4 chromium is excluded, chromium avg=29, %CV=69.

**Table 2e. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in "Fines" Fraction
Brooklyn, New York**

Day	1	2	3	4	5	Avg ¹ up lim	Avg ¹ low lim	%CV ²
Elements								
Antimony	<25 ¹	<26	<26	<26	<27	<26 ,	>0	
Arsenic	2.2	4.4	1.9	0.9	<1.9	<2.3 ,	>1.9	84
Beryllium	<1.5	<1.6	<1.6	<1.5	<1.6	<1.6 ,	>0	
Cadmium	3.1	4.7	9.5	8.5	5.2	6.2		44
Chromium	340	140	130	190	150	190		46
Copper	100	87	120	200	350	170		63
Lead	90	2900	960	860	1700	1300		82
Mercury	1.6	1.8	2.1	3.5	2.3	2.3		50
Nickel	700	620	390	520	780	600		25
Selenium	<0.51	<0.52	<0.52	15	<0.53	<3.4 ,	>3.0	
Silver	<3	<3	4	<3	6.40	<3.9 ,	>2.1	
Thallium	<25	<26	<26	<26	<27	<26 ,	>0	
Zinc	840	940	980	940	550	850		21
%comp, dry ³	8.5	2.8	2.2	4.9	0.9			

**Table 2f. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Regular Paper Fraction
Brooklyn, New York**

Day	1	2	3	4	5	Avg up lim	Avg low lim	%CV
Elements								
Antimony	<27	<27	<27	<27	<28	<27	>0	
Arsenic	<0.53	<0.54	<0.55	<0.54	<0.55	<0.54	>0	
Beryllium	<1.6	<1.6	<1.6	<1.6	<1.7	<1.6	>0	
Cadmium	13	<1.5	<1.6	<1.6	<1.7	<3.9 ,	>2.6	
Chromium	21	13	8.7	7.2	10.3	12		46
Copper	39	54	21	24	46	35		38
Lead	150	130	54	78	57	94		47
Mercury	0.29	0.43	0.33	0.35	0.28	0.34		18
Nickel	11	<5	7.6	<5	5.3	<7	>5	101
Selenium	<0.27	<0.27	<0.27	<0.27	<0.28	<0.27	>0	
Silver	<3	<3	<3	<3	<3	<3	>0	
Thallium	<27	<27	<27	<27	<28	<27	>0	
Zinc	130	530	190	140	300	260		65
%comp, dry	46.0	43.7	44.3	40.7	37.7			

1 <#, lower than detection limit, #, except in columns 7 and 8, where "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

2 Based on metal contents used to compute lower limit when at least three components have contents above the detection limit.

3 Composition in mass % of original dry sample; does not include metal and glass/ceramic fractions.

**Table 2g. Priority Pollutant Metals in Municipal Solid Waste
Contents in mg/kg, Dry, in Bleached Paper Fraction
Brooklyn, New York**

Day	1	2	3	4	5	Avg ¹ up lim	Avg ¹ low lim	%CV ^{2,3}
Elements								
Antimony	<25 ¹	<27	<27	<27	<27	<25 ,	>0	
Arsenic	<0.50	<0.53	<0.54	<0.54	<0.55	<0.51 ,	>0	
Beryllium	<1.5	<1.6	<1.6	<1.6	<1.6	<1.6 ,	>0	
Cadmium	<1.5	<1.6	<1.6	<1.6	<1.6	<1.6 ,	>0	
Chromium	11	<5	<5	<5	<5	<6.2 ,	>2.2	
Copper	30	260	10	9.4	8.2	64		173
Lead	92	89	28	42	26	55		59
Mercury	<0.25	<0.27	<0.27	<0.27	<0.27	<0.26 ,	>0	
Nickel	<5	23	<5	<5	<5	<8.6 ,	>4.6	
Selenium	<0.25	<0.27	<0.27	<0.27	<0.27	<0.27 ,	>0	
Silver	<3	<3	<3	<3	<3	<3.2 ,	>0	
Thallium	<25	<27	<27	<27	<27	<27 ,	>0	
Zinc	47	950	33	58	67	230		174
%comp, dry ⁴	4.7	3.0	6.2	5.0	4.3			

1 <#, lower than detection limit, #, except in columns 7 and 8, where "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

2 Based on metal contents used to compute lower limit when at least three components have contents above the detection limit.

3 If day 2 excluded, copper avg=15,%CV=75 and zinc avg=51,%CV=29.

4 Composition in mass % of original dry sample; does not include metal and glass/ceramic fractions.

**Table 3a Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 1, Baltimore County, MD**

Fraction	Amount, mg/kg, Dry Composite Sample		Distribution of Contents ¹ Percent					
	up lim	low lim ²	Paper	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Elements								
Antimony	<28,	>4	--	--	--	--	--	--
Arsenic	3		31	46	2	1	1	19
Beryllium	<1.6,	>0	--	--	--	--	--	--
Cadmium	8		19	1	6	2	67	5
Chromium	68		19	3	9	6	3	60
Copper	340		21	6	2	1	46	24
Lead	300		34	14	8	5	5	34
Mercury	3.8		80	1	6	3	7	2
Nickel	96		8	0	11	10	1	71
Selenium	<0.34,	>0.02	--	--	--	--	--	--
Silver	<3,	>0	--	--	--	--	--	--
Thallium	<26,	>0	--	--	--	--	--	--
Zinc	490		67	9	1	3	1	19

**Table 3b Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 2, Baltimore County, MD**

Fraction	Amount, mg/kg, Dry Composite Sample		Distribution of Contents ¹ Percent					
	up lim	low lim ²	Paper	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Elements								
Antimony	<26,	>0	--	--	--	--	--	--
Arsenic	<7.3	>7.3	83	0	1	3	(0)	13
Beryllium	<1.6,	>0	--	--	--	--	--	--
Cadmium	4.0		45	5	1	2	35	12
Chromium	120		13	0	0	2	2	83
Copper	1510		4	0	0	0	96	1
Lead	190		22	0	0	2	72	4
Mercury	<0.45	>0.39	85	9	3	3	(0)	(0)
Nickel	<110	>100	(0)	(0)	0	6	3	91
Selenium	<0.33,	>0.31	65	(0)	1	3	(0)	31
Silver	<3,	>0	--	--	--	--	--	--
Thallium	<26,	>0	--	--	--	--	--	--
Zinc	490		40	2	1	3	42	12

1 Based on metal content used to compute lower limit of composite sample concentration when at least three fractions have metal content above the detection limit. () = elemental content below the detection limit; assigned the value zero ppm.

2 "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

**Table 3c Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 3 Baltimore County, MD**

Fraction	Amount, mg/kg, Dry Composite Sample		Distribution of Contents ¹ , Percent					
	up lim	low lim ²	Paper	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Elements								
Antimony	<26,	>1	--	--	--	--	--	--
Arsenic	<0.66,	>0.65	74	(0)	1	2	(0)	23
Beryllium	<1.6,	>0	--	--	--	--	--	--
Cadmium	<2.4	>1.0	--	--	--	--	--	--
Chromium	76		33	0	0	3	6	58
Copper	1700		100	0	0	0	0	0
Lead	63		80	0	0	7	3	9
Mercury	<0.56,	>0.50	92	0	2	3	3	(0)
Nickel	4300		99	0	0	0	0	1
Selenium	<0.36,	>0.35	68	(0)	0	3	(0)	29
Silver	<3,	>0	--	--	--	--	--	--
Thallium	<27,	>0	--	--	--	--	--	--
Zinc	800		40	1	0	2	2	55

**Table 3d Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 4, Baltimore County, MD**

Fraction	Amount, mg/kg, Dry Composite Sample		Distribution of Contents ¹ , Percent					
	up lim	low lim ²	Paper	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Elements								
Antimony	<27,	>0	--	--	--	--	--	--
Arsenic	<0.43	>0.31	66	0	16	18	(0)	(0)
Beryllium	<1.6,	>0	--	--	--	--	--	--
Cadmium	<2.1	>0.70	(0)	(0)	23	17	60	(0)
Chromium	120		10	0	2	9	9	70
Copper	630		4	0	6	1	89	1
Lead	210		36	0	7	15	29	13
Mercury	<0.89	>0.88	26	0	25	6	(0)	43
Nickel	<89	>89	7	(0)	2	16	1	75
Selenium	<0.33,	>0	--	--	--	--	--	--
Silver	<3,	>0	--	--	--	--	--	--
Thallium	<27,	>0	--	--	--	--	--	--
Zinc	190		62	1	10	10	5	12

1 Based on metal content used to compute lower limit of composite sample concentration when at least three fractions have metal content above the detection limit. () = elemental content below the detection limit; assigned the value zero ppm.

2 "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

**Table 3e Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 5, Baltimore County, MD**

Fraction Elements	Amount, mg/kg, Dry Composite Sample up lim, low lim ²		Distribution of Contents ¹ , Percent					
			Paper	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Antimony	<27,	>0	--	--	--	--	--	--
Arsenic	<0.36	>0.07	--	--	--	--	--	--
Beryllium	<1.6,	>0	--	--	--	--	--	--
Cadmium	<1.9	>0.40	--	--	--	--	--	--
Chromium	<110	>110	26	(0)	1	6	2	65
Copper	100		14	0	2	1	62	20
Lead	140		63	0	1	8	20	8
Mercury	1.8		41	1	8	5	1	46
Nickel	<91	>87	(0)	(0)	1	18	1	80
Selenium	<0.32,	>0	--	--	--	--	--	--
Silver	<3,	>0	--	--	--	--	--	--
Thallium	<26,	>0	--	--	--	--	--	--
Zinc	230		56	2	4	4	4	31

1 Based on metal content used to compute lower limit of composite sample concentration when at least three fractions have metal content above the detection limit. () = elemental content below the detection limit; assigned the value zero ppm.

2 "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

**Table 4a Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 1, Brooklyn, NY**

Fraction	Amount, mg/kg, Dry Composite Sample		Distribution of Contents ¹ Percent						
	up lim	low lim ²	Paper, regular	Paper, bleached	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Elements									
Antimony	<27,	>0	--	--	--	--	--	--	--
Arsenic	<0.69	>0.35	--	--	--	--	--	--	--
Beryllium	<1.6,	>0	--	--	--	--	--	--	--
Cadmium	<11	>11	74	(0)	(0)	(0)	(0)	23	3
Chromium	58		22	1	2	1	3	8	64
Copper	630		4	0	0	0	0	94	2
Lead	160		57	4	11	2	6	14	6
Mercury	<0.45	>0.43	40	(0)	5	4	2	8	41
Nickel	<110	>110	6	(0)	2	0	3	20	69
Selenium	<0.31,	>0.04	--	--	--	--	--	--	--
Silver	<3,	>0	--	--	--	--	--	--	--
Thallium	<27,	>0	--	--	--	--	--	--	--
Zinc	260		29	1	7	2	2	24	35

**Table 4b Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 2, Brooklyn, NY**

Fraction	Amount, mg/kg, Dry Composite Sample		Distribution of Contents ¹ Percent						
	up lim	low lim ²	Paper, regular	Paper, bleached	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Elements									
Antimony	<27,	>1	--	--	--	--	--	--	--
Arsenic	<0.67	>0.31	--	--	--	--	--	--	--
Beryllium	<1.6,	>0	--	--	--	--	--	--	--
Cadmium	<3.5	>2.5	--	--	--	--	--	--	--
Chromium	<22	>21	39	(0)	7	1	19	8	26
Copper	330		11	4	4	0	2	78	1
Lead	260		31	1	3	1	18	3	44
Mercury	<0.46	>0.43	60	(0)	8	5	5	6	16
Nickel	<36	>34	0	3	5	1	12	6	74
Selenium	<0.4,	>0.2	--	--	--	--	--	--	--
Silver	<4,	>1	--	--	--	--	--	--	--
Thallium	<27,	>0	--	--	--	--	--	--	--
Zinc	580		58	7	2	4	3	19	7

1 Based on metal content used to compute lower limit of composite sample concentration when at least three fractions have metal content above the detection limit. () = elemental content below the detection limit; assigned the value zero ppm.

2 "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

**Table 4c Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 3, Brooklyn, NY**

Fraction	Amount, mg/kg, Dry Composite Sample		Distribution of Contents ¹ Percent						
	up lim	low lim ²	Paper, regular	Paper, bleached	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Elements									
Antimony	<27,	>3.5	--	--	--	--	--	--	--
Arsenic	<0.63	>0.23	--	--	--	--	--	--	--
Beryllium	<1.6,	>0	--	--	--	--	--	--	--
Cadmium	<3.2	>2.1	--	--	--	--	--	--	--
Chromium	<14	>13	41	(0)	8	1	15	5	30
Copper	29		44	3	9	2	6	24	13
Lead	84		40	3	4	1	13	4	35
Mercury	<0.43	>0.41	49	0	10	6	11	7	16
Nickel	<21	>20	24	(0)	(0)	1	8	6	62
Selenium	<0.34,	>0.12	--	--	--	--	--	--	--
Silver	<3.0,	>0.12	--	--	--	--	--	--	--
Thallium	<26	>0	--	--	--	--	--	--	--
Zinc	200		57	1	5	8	5	9	15

**Table 4d Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 4, Brooklyn, NY**

Fraction	Amount, mg/kg, Dry Composite Sample		Distribution of Contents ¹ Percent						
	up lim	low lim ²	Paper, regular	Paper, bleached	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Elements									
Antimony	<125,	>103	--	--	--	--	--	--	--
Arsenic	<0.90	>0.55	--	--	--	--	--	--	--
Beryllium	<1.6,	>0	--	--	--	--	--	--	--
Cadmium	<22	>21	(0)	(0)	(0)	1	1	95	3
Chromium	<87	>87	4	(0)	1	1	3	76	14
Copper	740		2	0	8	0	27	62	2
Lead	190		23	1	6	3	10	28	30
Mercury	<0.57	>0.55	34	(0)	8	4	5	8	41
Nickel	<46	>43	--	--	--	--	--	--	--
Selenium	<3.0 ,	>2.7	--	--	--	--	--	--	--
Silver	<3.2 ,	>0.5	--	--	--	--	--	--	--
Thallium	<27,	>0	--	--	--	--	--	--	--
Zinc	460		17	1	4	5	3	58	13

- 1 Based on metal content used to compute lower limit of composite sample concentration when at least three fractions have metal content above the detection limit. () = elemental content below the detection limit; assigned the value zero ppm.
- 2 "up lim" and "low lim" are calculated concentrations when all fractions containing <# have a concentration of # or 0, respectively.

**Table 4e Priority Pollutant Metals in Municipal Solid Waste
Composite Sample
Day 5, Brooklyn, NY**

Fraction	Amount, mg/kg, Dry Composite Sample		Distribution of Contents ¹ , Percent						
	up lim	low lim	Paper, regular	Paper, bleached	Wood/veg	Textiles	Plastics, soft	Plastics, hard	"Fines"
Elements									
Antimony	<33,	>6	--	--	--	--	--	--	--
Arsenic	<0.48	>0.06	--	--	--	--	--	--	--
Beryllium	<1.6,	>0	--	--	--	--	--	--	--
Cadmium	<4.4	>3.1	--	--	--	--	--	--	--
Chromium	<18	>17	36	(0)	(0)	(0)	15	36	13
Copper	870		3	0	1	0	0	95	1
Lead	99		34	2	8	0	6	25	24
Mercury	<0.31	>0.27	56	(0)	(0)	4	3	16	11
Nickel	<28	>27	13	(0)	(0)	(0)	5	41	41
Selenium	<0.27,	>0	--	--	--	--	--	--	--
Silver	<3.6,	>0.5	--	--	--	--	--	--	--
Thallium	<27,	>0	--	--	--	--	--	--	--
Zinc	780		23	1	1	0	1	74	1

¹ Based on metal content used to compute lower limit of composite sample concentration when at least three fractions have metal content above the detection limit. () = elemental content below the detection limit; assigned the value zero ppm.

**Table 5 Summary of Priority Pollutant Metals in Municipal Solid Waste
Baltimore County, MD**

Fraction	Detect ^a	Wood/Veg		Textiles		Plastics, soft		Plastics, hard	
		Mean ^b	Range ^c	Mean	Range	Mean	Range	Mean	Range
<u>Elements</u>									
Antimony	25 ^d	14	14	27	9 *,1	13	13	24	27 *,4
Arsenic	0.26	9.4	20 *,2	2.5	4.2 *,1	1.8	3.0 *,1	0.53	0.58 *,3
Beryllium	1.6	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Cadmium	1.6	2.6	2.8 *,3	3.8	4.7 *,2	2.3	1.0 *,1	47	58 *
Chromium	5	18	26 *,1	39	57 *	70	13 *	120	84 *
Copper	5	130	240 *	130	130 *	43	17 *	12000	17000 *
Lead	5	260	530 *	150	220 *	230	100 *	1300	1500 *
Mercury	0.26	0.73	0.68 *	2.8	1.8 *	1.1	1.0 *	1.7	3.1 *
Nickel	5	4.0	2.1 *,3	55	98 *	180	49 *	29	16 *
Selenium	0.3	0.15	0.15	0.19	0.09 *,3	0.19	0.09 *,3	0.23	0.23 *,4
Silver	3	1.5	1.5	1.5	1.5	2.6	2.5 *,4	1.5	1.5
Thallium	27	14	14	13	13	13	13	13	13
Zinc	5	540	470 *	230	140 *	330	170 *	1300	2300 *
Av. Mass Fact. ^e		2.0	1.2	4.7	4.7	5.2	2.7	3.1	0.8

Fraction	Detect	"Fines"		Paper		Composite Sample	
		Mean	Range	Mean	Range	Mean	Range
<u>Elements</u>							
Antimony	25	13	13	14	14	14	13
Arsenic	0.26	1.9	2.3 *,2	2.3	3.6 *,1	2.4	3.0 *
Beryllium	1.6	0.8	0.8	0.8	0.8	0.8	0.8
Cadmium	1.6	1.4	0.9 *,3	1.5	1.0 *,3	3.2	3.0 *
Chromium	5	330	130 *	22	7.0 *	98	24 *
Copper	5	110	140 *	610	1200 *	860	720 *
Lead	5	150	180 *	120	48 *	180	90 *
Mercury	0.26	1.3	1.6 *	1.5	2.0 *	1.5	1.4 *
Nickel	5	330	51 *	1400	3000 *,2	920	1900 *
Selenium	0.3	0.36	0.15 *,3	0.20	0.09 *,3	0.24	0.09 *
Silver	3	1.5	1.5	1.5	1.5	1.6	1.6
Thallium	27	13	13	14	14	13	13
Zinc	5	640	770 *	330	150 *	440	250 *
Av. Mass Fact.		17.4	5.1	67.5	7.0		

a: Approximate detection limit.

b: The mean is calculated using one half the detectability limit when the measured value was below the detectability limit.

c: Number without an *: for element in any fraction - one half of the detectability limit; for element in the composite sample - half the difference of the maximum and minimum metal content. Number with an *: the standard deviation; the number following the comma for element in any fraction - the number of days with measured values below the detectability limit ; a blank after the comma means zero.

d: units are mg element/kg of dry sample.

e: Average mass factor - the average over the five days of each mass percent of the fraction divided by the total mass percent of the composite sample on a dry basis; the range is the standard deviation.

Table 6 Summary of Priority Pollutant Metals in Municipal Solid Waste
Brooklyn, New York

Fraction	Wood/veg Mean ^a Range ^b		Textiles Mean Range		Plastics, soft Mean Range		Plastics, hard Mean Range	
<u>Elements</u>								
Antimony	14 ^c	14	540	1000 *,1	13	13	21	15 *,3
Arsenic	0.35	0.20 *,2	1.9	3.5 *,2	0.8	1.1 *,2	0.42	0.30 *,1
Beryllium	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Cadmium	1.8	1.6 *,3	2.4	1.9 *,2	3.1	2.3 *,2	49	68 *
Chromium	11	5 *,1	7.7	5.2 *,1	62	28 *	140	240 *
Copper	160	210 *	29	16 *	630	1300 *	3600	2500 *
Lead	98	68 *	69	45 *	350	200 *	190	160 *
Mercury	0.31	0.11,1	0.64	0.24 *	0.48	0.28 *	0.31	0.11 *,1
Nickel	12	10 *,2	8.2	4.2 *,1	68	32 *	75	100 *
Selenium	0.14	0.15	0.18	0.10 *,4	0.13	0.15	3.7	6.4
Silver	1.6	1.6	1.6	1.6	6.7	7.3 *,4	2.1	1.3
Thallium	14	14	13	13	13	13	13	13
Zinc	130	66 *	460	370 *	200	29 *	1600	1300 *
Mass Fact. ^d	10.1	1.4 *	3.2	0.7 *	4.7	2.0 *	11.2	3.4 *

Fraction	"Fines" Mean Range		Paper, regular Mean Range		Paper, bleached Mean Range		Composite Sample Mean Range	
<u>Elements</u>								
Antimony	13	13	14	14	14	14	35	44 *
Arsenic	2.1	1.4 *,1	0.3	0.3	0.3	0.3	0.5	0.2 *
Beryllium	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Cadmium	6.2	2.7 *	3.3	5.5 *,4	0.8	0.8	8.3	8.1 *
Chromium	190	87 *	12	6 *	4.2	3.8 *,4	39	32 *
Copper	170	110 *	35	13 *	64	110 *	520	340 *
Lead	1300	1100 *	94	44 *	55	33 *	160	73 *
Mercury	2.3	0.74 *	0.34	0.06 *	0.15	0.15	0.43	0.10 *
Nickel	600	150 *	5.8	3.6 *,2	6.6	9.2 *,4	48	37 *
Selenium	3.2	6.6 *,4	0.15	0.15	0.15	0.15	0.74	1.2 *
Silver	3.0	2.2 *,3	1.5	1.5	1.5	1.6	1.8	0.3 *
Thallium	13	13	14	14	13	13	13	13
Zinc	850	180 *	260	170 *	230	400 *	460	240 *
Mass Fact.	5.2	3.7 *	59.2	3.4 *	6.5	1.5 *		

a: The mean is calculated using one half the detectability limit when the measured value was below the detectability limit.

b: Number without an *: for element in any fraction - one half of the detectability limit; for element in the composite sample - the average of the maximum and minimum metal content. Number with an *: the standard deviation; the number following the comma for element in any fraction - the number of days with measured values below the detectability limit.

c: units are mg element/kg of dry sample.

d: Average mass factor - the average over the five days of each mass percent of the fraction divided by the total mass percent of the composite sample on a dry basis; the range is the standard deviation.

Table 7 Apriori Reproducibility, Imprecision, and Uncertainty

	Reproducibility ¹		Imprecision ²		Uncertainty ³
	%	ppm	%	ppm	%
Antimony					
Arsenic	35	1	25	0.7	45
Beryllium					
Cadmium	15	5	11	3.5	39
Chromium	15	5	11	3.5	39
Copper	20	10	14	7.1	41
Lead	20	10	14	7.1	41
Mercury	7	0.1	5	0.07	38
Nickel	5	3	4	2.1	38
Selenium	13	0.25	9	0.18	39
Silver	15	5	11	4	39
Thallium					
Zinc	10	15	7	10.6	39

1 Taken to be whichever is greater. Cited by analyst.

2 Taken to be whichever is greater; estimated as the reproducibility divided by the square root of two.

3 Calculated as the square root of the sum of squares of the imprecision, based on columns three and four, and the square of .38 times the content.

The numbers apply when the contribution of column four is much greater than column five in calculating the imprecision.

**Table 8a Homogeneity in Wood and Textile Samples
Contents in mg/kg, As Received**

Sample Series # Type	Br5 ¹			Br1		
	Sample	Duplicate	Ratio ²	Sample	Duplicate	Ratio
1				2		
317				107		
Wood/Veg				Wood/Veg		
Elements						
Antimony	<25	<25	NC	<25	<25	NC
Arsenic	<0.25	<0.25	NC	<1.3	<1.3	NC
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	<1.5	<1.5	NC	<1.5	<1.5	NC
Chromium	<5	<5	NC	12	9.6	-0.5
Copper	97	130	1.4 <	18	15.0	-0.3
Lead	68	68	0.1	120	130	0.4
Mercury	0.3	0.3	0.3	<0.25	<0.25	NC
Nickel	<5	<5	NC	14	16	0.7
Selenium	<0.25	<0.25	NC	<0.25	<0.25	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<25	<25	NC	<25	<25	NC
Zinc	56	52	-0.3	160	120	-2.6 <<

Sample Series # Type	Br2,5			Br4		
	Sample	Duplicate	Ratio	Sample	Duplicate	Ratio
1				2		
38,55				112		
Textiles				Textiles		
Elements						
Antimony	33	33	NC	1900	2000	NC
Arsenic	<0.25	<0.25	NC	7.8	8.4	NC
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	2.4	1.7	-0.1	5.4	6.0	0.1
Chromium	6.8	6.8	0.0	17	16	-0.2
Copper	32	32	0.0	43	40	-0.3
Lead	90	90	0.0	120	110	-0.4
Mercury	0.44	0.42	-0.2	0.31	0.37	0.6
Nickel	9.3	9.2	-0.0	12	14	0.7
Selenium	<0.25	<0.25	NC	<.50	<.50	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<25	<25	NC	<25	<25	NC
Zinc	1100	1000	-1.0	340	370	0.8

1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day - more than one number indicates a mixture of samples from two days.

2 Ratio = sample minus duplicate content divided by the square root of the sum of squares of values of sample and duplicate imprecision calculated according to table 7. NC= not calculated; "<" in next column if absolute value of ratio >1, "<<" in next column if >2.

**Table 8b Homogeneity in Plastics Samples
Contents in mg/kg, As Received**

Sample Series # Type	Br4,5			Br2		
	Sample	Duplicate	Ratio	Sample	Duplicate	Ratio
Elements						
Antimony	<25	<25	NC	<25	<25	NC
Arsenic	<0.25	<0.25	NC	0.54	0.58	0.0
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	3.3	3.3	0.0	2.1	2.1	0.0
Chromium	40	40	0.0	59	60	0.1
Copper	2800	2900	0.2	1500	1600	0.3
Lead	260	310	0.9	480	530	0.5
Mercury	0.38	0.40	0.2	0.26	0.26	0.0
Nickel	68	83	4.0 <<	64	63	-0.3
Selenium	<0.25	<0.25	NC	<0.25	<0.25	NC
Silver	<3	<3	NC	6.1	6.9	0.2
Thallium	<25	<25	NC	<25	<25	NC
Zinc	190	180	-0.5	220	220	0.0

Sample Series # Type	Br5			Br3		
	Sample	Duplicate	Ratio	Sample	Duplicate	Ratio
Elements						
Antimony	<25	<25	NC	<25	<25	NC
Arsenic	<0.25	<0.25	NC	<0.25	<0.25	NC
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	17	17	0.0	12	12	0.0
Chromium	35	28	-1.4 <	8.1	8.7	0.1
Copper	4900	330	-6.6 <<	86	100	0.8
Lead	150	110	-1.5	73	63	-0.7
Mercury	0.28	0.25	-0.3	<0.25	<0.25	NC
Nickel	66	66	0.0	11	10	-0.4
Selenium	<0.25	<0.25	NC	<0.25	<0.25	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<25	<25	NC	<25	<25	NC
Zinc	3400	3600	0.6	230	210	-0.9

1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day - more than one number indicates a mixture of samples from two days.

2 Ratio = sample minus duplicate content divided by the square root of the sum of squares of values of sample and duplicate imprecision calculated according to table 7. NC= not calculated; "<" in next column if absolute value of ratio >1, "<<" in next column if >2.

**Table 8c Homogeneity in "Fines" and Paper Samples
Contents in mg/kg, As Received**

Sample Series #	Br5 ¹			Br2		
	58			109		
Type	"Fines"			"Fines"		
Elements	Sample	Duplicate	Ratio ²	Sample	Duplicate	Ratio
Antimony	<25	<25	NC	<25	<25	NC
Arsenic	<0.25	<0.25	NC	<0.25	<0.25	NC
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	4.9	4.9	0.0	4.7	4.7	0.0
Chromium	140	140	0.0	170	160	-0.4
Copper	330	380	0.7	88	88	0.0
Lead	1600	2000	1.1 <	2700	2700	0.0
Mercury	2.2	2.0	-1.4 <	1.1	1.1	0.0
Nickel	730	780	1.3 <	540	560	0.7
Selenium	<0.25	<0.25	NC	<0.25	<0.25	NC
Silver	6.0	3.5	-0.5	<3	<3	NC
Thallium	<25	<25	NC	<25	<25	NC
Zinc	510	480	-0.6	1000	1000	0.0

Sample Series #	Ba4,5			WA		
	367,6			963		
Type	Paper			Magazine		
Elements	Sample	Duplicate	Ratio	Sample	Duplicate	Ratio
Antimony	<25	<25	NC	<25	<25	NC
Arsenic	<0.25	<0.25	NC	<0.25	<0.25	NC
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	<1.5	<1.5	NC	<1.5	<1.5	NC
Chromium	13	16	0.6	<5	<5	NC
Copper	42	48	0.6	25	24	-0.1
Lead	120	120	0.0	<10	<10	NC
Mercury	1.2	1.6	3.8 <<	<0.25	<0.25	NC
Nickel	6.9	7.0	0.0	<5	<5	NC
Selenium	<0.25	<0.25	NC	<0.25	<0.25	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<25	<25	NC	<25	<25	NC
Zinc	180	180	0.0	24	23	-0.1

1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day - more than one number indicates a mixture of samples from two days.

2 Ratio = sample minus duplicate content divided by the square root of the sum of squares of values of sample and duplicate imprecision calculated according to table 7. NC= not calculated; "<" in next column if absolute value of ratio >1, "<<" in next column if >2.

**Table 9a Homogeneity Between Samples from the Same Fraction
Wood/Vegetable Fraction
Contents in mg/kg, Dry**

Sample Series	Ba1 ¹ 1	Ba1 2	Ratio ²	Ba5 1	Ba5 2	Ratio
Elements						
Antimony	<28	<28	NC	<27	<28	NC
Arsenic	45	49	0.2	<0.27	<1.7	NC
Beryllium	<1.7	<1.7	NC	<1.6	<1.7	NC
Cadmium	3.1	2.4	-0.1	<1.6	<1.7	NC
Chromium	64	56	-0.9	<5	<6	NC
Copper	560	52	-6.4 <<	8.5	7.6	-0.1
Lead	1200	110	-4.8 <<	18	20	0.2
Mercury	1.5	1.5	-0.8	0.45	0.51	0.7
Nickel	6.4	5.8	-0.2	<5	<6	NC
Selenium	<0.28	<0.28	NC	<0.27	<0.28	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<28	<28	NC	<27	<28	NC
Zinc	1200	1400	1.3 <	120	190	4.2 <<

Sample Series	Br4 1	Br4 2	Ratio	Br1 1	Br1 2	Ratio
Elements						
Antimony	<28	<28	NC	<27	<27	NC
Arsenic	0.50	<1.4	NC	0.55	<1.4	NC
Beryllium	<1.7	<1.7	NC	<1.6	<1.6	NC
Cadmium	<1.7	2.8	0.3	<1.6	<1.6	NC
Chromium	12	9.8	-0.4	14	13	-0.2
Copper	530	217	-3.9 <<	21	19	-0.2
Lead	96	91	-0.3	210	130	-2.4 <<
Mercury	0.42	0.43	0.1	0.280	<0.27	NC
Nickel	13	9.7	-1.0	25	15	-3.2 <<
Selenium	<0.28	<0.28	NC	<0.27	<0.27	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<28	<28	NC	<27	<27	NC
Zinc	130	130	0.0	230	170	-3.1 <<

1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day.

2 Ratio = series 2 minus series 1 content divided by the square root of the sum of squares of values of sample and duplicate imprecision calculated according to table 7. NC= not calculated; "<" in next column if the absolute value of the ratio >1, "<<" in next column if >2.

**Table 9b Homogeneity Between Samples from the Same Fraction
Textile Fraction
Contents in mg/kg, Dry**

Sample Series	Ba1 ¹ 1	Ba1 2	Ratio ²	Ba4 1	Ba4 2	Ratio
Elements						
Antimony	27	<26	NC	30	<26	NC
Arsenic	1.4	1.3	0.1	0.46	<0.5	NC
Beryllium	<1.6	<1.6	NC	<1.6	<1.6	NC
Cadmium	12	12	0.1	1.7	<1.6	NC
Chromium	140	99	-2.3 <<	16	14	-0.3
Copper	170	49	-4.7 <<	340	36	-6.2 <<
Lead	540	350	-2.1 <<	130	120	-0.3
Mercury	5.7	3.8	-5.5 <<	1.8	0.40	-12 <<
Nickel	230	220	-1.2 <	9.6	13	1.1 <
Selenium	<0.26	<0.52	NC	<0.26	<0.52	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<26	<26	NC	<26	<26	NC
Zinc	140	570	10 <<	160	140	-1.4 <

Sample Series	Br2 1	Br2 2	Ratio	Br4 1	Br4 2	Ratio
Elements						
Antimony	34	<34	NC	2400	1900	NC
Arsenic	0.71	0.76	0.1	8.2	8.1	-0.0
Beryllium	<1.6	<1.6	NC	<1.5	<1.6	NC
Cadmium	2.4	<2.4	NC	5.4	5.6	0.0
Chromium	7.1	<7	NC	16	17	0.1
Copper	34	30	-0.4	49	44	-0.5
Lead	94	72	-1.3 <	130	122	-0.3
Mercury	0.92	0.79	-1.3 <	0.47	0.32	-1.5 <
Nickel	9.7	9.1	-0.2	13	13	-0.0
Selenium	<0.26	<0.42	NC	<0.26	<0.52	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<26	<26	NC	<26	<26	NC
Zinc	980	840	-1.5 <	540	350	-4.1 <<

1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day.

2 Ratio = series 2 minus series 1 content divided by the square root of the sum of squares of values of sample and duplicate imprecision calculated according to table 7. NC= not calculated; "<" in next column if the absolute value of the ratio >1, "<<" in next column if >2.

**Table 9c Homogeneity Between Samples from the Same Fraction
Soft Plastic Fraction
Contents in mg/kg, Dry**

Sample Series	Ba3 ¹ 1	Ba3 2	Ratio ²	Ba4 1	Ba4 2	Ratio
Elements						
Antimony	<26	<26	NC	<26	<26	NC
Arsenic	0.36	<0.5	-0.4	0.67	4.8	3.0 <<
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	2.7	1.9	-0.2	1.7	2.9	0.2
Chromium	52	51	-0.1	81	87	0.5
Copper	27	31	0.4	37	47	1.0
Lead	135	140	0.2	350	360	0.1
Mercury	0.36	0.33	-0.3	0.50	0.40	-1.1 <
Nickel	240	290	3.9 <<	120	130	1.4 <
Selenium	0.31	0.66	1.4 <	<0.26	<0.26	NC
Silver	7.50	4.5	-0.6	<3	<3	NC
Thallium	<26	<26	NC	<26	<26	NC
Zinc	350	190	-5.8 <<	200	160	-2.2 <<

Sample Series	Br4 1	Br4 2	Ratio	Br2 1	Br2 2	Ratio
Elements						
Antimony	<26	<26	NC	<26	<26	NC
Arsenic	<0.26	<0.5	-0.3	0.63	0.56	-0.1
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	3.4	2.9	-0.1	5.1	2.2	-0.6
Chromium	41	39	-0.4	61	60	-0.2
Copper	2900	2500	-0.8	97	1600	6.7 <<
Lead	270	240	-0.5	710	500	-1.7 <
Mercury	0.38	0.31	-0.7	0.31	0.27	-0.4
Nickel	70	79	2.5 <<	60	66	2.0 <
Selenium	<0.26	<0.26	NC	<0.26	<0.26	NC
Silver	<3	<3	NC	12	12	NC
Thallium	<26	<26	NC	<26	<26	NC
Zinc	190	83	-6.5 <<	230	230	-0.2

1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day.

2 Ratio = series 2 minus series 1 content divided by the square root of the sum of squares of values of sample and duplicate imprecision calculated according to table 7. NC= not calculated; "<" in next column if the absolute value of the ratio >1, "<<" in next column if >2.

**Table 9d Homogeneity Between Samples from the Same Fraction
Hard Plastic Fraction
Contents in mg/kg, Dry**

Sample Series	Ba2 ¹ 1	Ba2 2	Ratio ²	Ba5 1	Ba5 2	Ratio
Elements						
Antimony	<25	30	NC	<25	<25	NC
Arsenic	<0.25	<0.25	NC	1.5	<1.3	NC
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	37	8.6	-5.3 <<	11	7.2	-0.7
Chromium	61	28	-4.4 <<	59	52	-0.8
Copper	40000	55000	1.6 <	1700	2400	1.6 <
Lead	3700	220	-5.7 <<	730	400	-2.8 <<
Mercury	<0.25	<0.25	NC	0.42	0.42	0.0
Nickel	55	68	4.1 <<	26	49	7.8 <<
Selenium	<0.25	<0.25	NC	<0.25	<0.25	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<25	<25	NC	<25	<25	NC
Zinc	5400	4000	-3.0 <<	250	160	-4.0 <<

Sample Series	Br5 1	Br5 2	Ratio	Br3 1	Br3 2	Ratio
Elements						
Antimony	<25	<25	NC	31	<25	NC
Arsenic	0.30	0.27	-0.0	<0.25	<0.25	NC
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	18	15	-0.5	16	12	-0.8
Chromium	36	26	-1.9 <	8.7	8.2	-0.1
Copper	5000	1400	-4.9 <<	84	87	0.2
Lead	150	100	-2.0 <	42	74.0	2.5 <<
Mercury	0.28	<0.33	-2.8 <<	0.35	<0.25	NC
Nickel	67	180	17 <<	14	11	-0.9
Selenium	<0.25	<0.25	NC	1.1	<0.53	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<25	<25	NC	<25	<25	NC
Zinc	3500	900	-10 <<	210	210	-0.2

1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day.

2 Ratio = series 2 minus series 1 content divided by the square root of the sum of squares of values of sample and duplicate imprecision calculated according to table 7. NC= not calculated; "<" in next column if the absolute value of the ratio >1, "<<" in next column if >2.

**Table 9e Homogeneity Between Samples from the Same Fraction
"Fines" Fraction
Contents in mg/kg, Dry**

Sample Series	Ba3 ¹ 1	Ba3 2	Ratio ²	Bal 1	Bal 2	Ratio
Elements						
Antimony	<25	<25	NC	<25	<25	NC
Arsenic	0.75	<2.5	NC	2.8	<2.5	NC
Beryllium	<1.5	<1.5	NC	<1.5	<1.5	NC
Cadmium	<1.5	<1.5	NC	1.7	<1.5	NC
Chromium	200	280	2.2 <<	180	20	-5.5 <<
Copper	26	36	1.0	360	54	-5.9 <<
Lead	26	27	0.1	460	300	-2.0 <
Mercury	<0.25	<0.25	NC	0.40	2.0	13 <<
Nickel	270	580	13.8 <<	300	450	7.9 <<
Selenium	0.51	<0.5	NC	<0.51	<0.5	NC
Silver	<3	<3	-0.6	<3	<3	NC
Thallium	<25	<25	NC	<25	<25	NC
Zinc	2000	420	-11 <<	420	580	3.2 <<

Sample Series	Br5 1	Br5 2	Ratio	Br2 1	Br2 2	Ratio
Elements						
Antimony	<27	<26	NC	<26	<26	NC
Arsenic	<1.9	<1.9	NC	4.4	<2.6	NC
Beryllium	<1.6	<1.6	NC	<1.6	<1.5	NC
Cadmium	5.2	6.1	0.2	4.7	4.8	0.0
Chromium	150	220	2.5 <<	140	170	1.3 <
Copper	350	410	0.8	87	90	0.2
Lead	1700	1600	-0.2	2900	2800	-0.2
Mercury	2.3	1.0	-9.7 <<	1.9	1.1	-6.7 <<
Nickel	780	1500	11.9 <<	620	560	-1.9 <
Selenium	<0.53	<0.5	NC	<0.52	<0.5	NC
Silver	6.4	4.0	-0.5	<3	<3	NC
Thallium	<27	<26	NC	<26	<26	NC
Zinc	550	470	-1.5 <	940	1100	1.6 <

1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day.

2 Ratio = series 2 minus series 1 content divided by the square root of the sum of squares of values of sample and duplicate imprecision calculated according to table 7. NC= not calculated; "<" in next column if the absolute value of the ratio >1, "<<" in next column if >2.

**Table 9f Homogeneity Between Samples from the Same Fraction
Paper Fraction
Contents in mg/kg, Dry**

Sample Series Type	Br1 ¹ 1 Regular	Br1 2 Regular	Ratio ²	Br2 1 Regular	Br2 2 Regular	Ratio
Elements						
Antimony	<27	<27	NC	<27	<27	NC
Arsenic	<0.53	<0.36	NC	<0.53	0.35	-0.2
Beryllium	<1.6	<1.6	NC	<1.6	<1.6	NC
Cadmium	13	<1.5	NC	13	2.3	-2.1 <<
Chromium	21	19	-0.5	21	16	-1.1 <
Copper	39	30	-0.9	39	20	-1.9 <
Lead	150	140	-0.3	150	170	0.6
Mercury	0.29	<0.27	NC	0.29	0.75	4.6 <<
Nickel	11	9	-0.6	11	<7	NC
Selenium	<0.27	<0.27	NC	<0.27	<0.27	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<27	<27	NC	<27	<27	NC
Zinc	130	120	-0.7	130	830	12 <<

Sample Series Type	Br3 1 Bleach	Br3 2 Bleach	Ratio	Ba3 1 (Unsorted)	Ba3 2 (Unsorted)	Ratio
Elements						
Antimony	<27	<26	NC	<27	<27	NC
Arsenic	<0.54	<0.26	NC	0.71	0.50	NC
Beryllium	<1.6	<1.6	NC	<1.6	<1.6	NC
Cadmium	<1.6	<1.6	NC	<1.6	<1.6	0.3
Chromium	<5	<5	NC	33	15	3.6 <<
Copper	10	19	NC	2800	60	6.8 <<
Lead	28	24	-0.5	74	78	0.3
Mercury	<0.27	<0.26	NC	0.62	<0.25	NC
Nickel	<5	5.5	NC	6800	7.5	28 <<
Selenium	<0.27	<0.26	NC	0.36	0.36	NC
Silver	<3	<3	NC	<3	<3	NC
Thallium	<27	<26	NC	<27	<27	NC
Zinc	33	34	0.0	440	150	8.7 <<

1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day.

2 Ratio = series 2 minus series 1 content divided by the square root of the sum of squares of values of sample and duplicate imprecision calculated according to table 7. NC= not calculated; "<" in next column if the absolute value of the ratio >1, "<<" in next column if >2.

Table 10 Summary of Homogeneity Results Between Samples from Same Fraction

Fraction	No. Ab Ratios >1 ¹		No. of Ab Ratios >2	--Elements with ab Ratio >2---							
	Total Ratios			As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Wood/Vegetable											
Ba1 ²	3/8		2				Cu	Pb			
Ba5*	1/4		1							<u>Zn</u>	
Br4	1/7		1				Cu				
Br1	3/5		3					Pb	Ni	Zn	
Textiles											
Ba1	6/8		5			Cr	Cu	Pb	Hg	<u>Zn</u>	
Ba4	4/6		2				Cu		Hg		
Br2*	3/6		0								
Br4	2/8		1							Zn	
Soft Plastics											
Ba3*	3/10		2							<u>Ni</u> Zn	
Ba4	4/8		2							<u>Ni</u> Zn	
Br4	2/8		2							<u>Ni</u> Zn	
Br2	3/8		1				<u>Cu</u>				
Hard Plastics											
Ba2	6/6		5		Cd	Cr		Pb	Hg	<u>Ni</u> Zn	
Ba5*	4/7		3						Hg	<u>Ni</u> Zn	
Br5	6/8		4				Cu		Hg	<u>Ni</u> Zn	
Br3	1/6		1					<u>Pb</u>			
"Fines"											
Ba3	3/6		3			<u>Cr</u>				<u>Ni</u> Zn	
Ba1	6/6		6			<u>Cr</u>	Cu	Pb	<u>Hg</u>	<u>Ni</u> <u>Zn</u>	
Br5*	4/8		3			<u>Cr</u>			<u>Hg</u>	<u>Ni</u>	
Br2	4/7		1						Hg		
Paper											
Br1 (regular)	0/5		0								
Br2 (regular)	5/7		3		Cd				<u>Hg</u>	<u>Zn</u>	
Br3 (bleach)*	0/2		0								
Ba3	4/6		4			Cr	Cu			Ni Zn	

1 Ab Ratio: absolute value of ratios listed in columns four and seven of table 9; No.: number; Total: number of ratios calculated for a fraction.

2 Ba: Baltimore county, MD; Br: Brooklyn, NY; number is day.

* Samples prepared at the time of preparation of the series 1 samples.

**Table 11 Analysis of Priority Pollutant Metals in Control #1
Control Samples #25, 42, 76 of Series 1, #120 of Series 2**

Sample Series	SRM 2704		#25	#25	#42	#76	#120
	Cont. ¹ mg/kg	Uncert. ² mg/kg	Cont. mg/kg	Uncert. ³ mg/kg	Cont. mg/kg	Cont. mg/kg	Cont. mg/kg
Antimony	3.79	0.15	<25		<25	<25	<25
Arsenic	23.4	0.8	15	4	17	14.9	14.2
Beryllium			<1.5		<1.5	<1.5	<1.5
Cadmium	3.45	0.22	3.37	4	3.40	2.73	3.26
Chromium	135	5	74	14	70	71.9	75.4
Copper	98.6	5	90	19	94	85.1	91.7
Lead	161	17	142	29	140	141	148
Mercury	1.47	0.07	1.56	0.2	1.79	1.41	1.41
Nickel	44.1	3.0	54	8	56	50.9	59.7
Selenium	1.12	0.05	<0.25	0.18	<0.25	<0.25	<0.25
Silver			<3	4	<3	<3	<3
Thallium	1.06	0.07	<25		<25	<25	<25
Zinc	438	12	464	77	443	422	461

Sample	-----Av. 25, 42, 76, 120 -----						
	Average mg/Kg	Std.Dev. ⁴ mg/kg	(Av.-#120) ⁵ /(Std.Dev.	Imp, Calc. ⁶ mg/kg	Uncert. ⁷ mg/kg	Ratio ⁸	%R ⁹
Antimony	<25						
Arsenic	15	1.2	0.8	3.8	3.0	-2.7	65
Beryllium	<1.5						
Cadmium	3	0.3	-0.2	3.5	1.8	-0.1	
Chromium	73	2.3	-1.2	7.7	12	-4.9	54
Copper	90	3.6	-0.4	13	15	-0.5	
Lead	143	3.7	-1.4	20	24	-0.6	
Mercury	2	0.2	0.7	0.1	0.2	0.3	
Nickel	55	3.7	-1.2	2.1	8.3	1.2	125
Selenium	<0.25	<0.25					
Silver	<3	<3					
Thallium	<25	<25					
Zinc	447	19.6	-0.7	32	69	0.1	

- 1 Cont.:Contents, certified for SRM, measured for other samples.
2 Stated to be the 95% confidence interval using a 250 mg sample.
3 Calculated from uncertainty columns of table 7.
4 Standard deviation.
5 Average minus contents of #120 divided by standard deviation.
6 Calculated from imprecision columns of table 7.
7 Square root of the sum of (Imp, calc.)²/5 and (.15 Average)².
8 The difference of the average (measured) minus certified value divided by the square root of the sum of squares of the uncertainty of measured and certified values.
9 %R is the ratio of the measured /certified value in percent.

**Table 12 Analysis of Priority Pollutant Metals in Control #2
Control samples #19,31,48 and 75 of series 1 and #121 of Series 2**

Sample Series	SRM 1646		#19	#19	#31	#48	#75	121
	Cont. ¹ mg/kg	Uncert. ² mg/kg	Cont. mg/kg	Uncert. ³ mg/kg	Cont. mg/kg	Cont. mg/kg	Cont. mg/kg	Cont. mg/kg
Antimony	(0.4)		<25		<25	<25	<25	<25
Arsenic	11.6	1.3	7.4	2	7.2	7.7	6.9	6.8
Beryllium	(1.5)		<1.5		<1.5	<1.5	<1.5	<1.5
Cadmium	0.36	0.07	<1.5	4	<1.5	<1.5	<1.5	<1.5
Chromium	76	3	31.7	5	29.9	36.5	33.7	36.6
Copper	18	3	16.4	7	14.7	18.4	14.3	16.0
Lead	28.2	1.8	18.7	7	22.0	21.5	19.0	17.9
Mercury	0.063	0.012	<0.25	0.1	<0.25	<0.25	<0.25	<0.25
Nickel	32	3	29.0	3	27.4	31.3	27.7	34.8
Selenium	(0.6)		<2.5	0.18	<2.5	<2.5	<2.5	<2.5
Silver			<3	4	<3	<3	<3	<3
Thallium	(0.5)		<25		<25	<25	<25	<25
Zinc	138	6	132	17	129	128	131	121

Sample	-----Avg19, 31, 48, 75, 121 -----						
	Average mg/Kg	Std.Dev. ⁴ mg/kg	(Av.-#121) ⁵ /(std.Dev.	Imp, Calc. ⁶ mg/kg	Uncert. ⁷ mg/kg	Ratio ⁸	%R ⁹
Antimony	<25						
Arsenic	7.2	0.4	1.1	1.8	1.4	-2.3	62
Beryllium	<1.5						
Cadmium	<1.5						
Chromium	33.7	2.9	-1.0	3.6	5.4	-6.9	44
Copper	16.0	1.6	-0.0	7.1	4.3	-0.4	
Lead	19.8	1.8	1.1	7.1	4.6	-1.7	70
Mercury	<0.25						
Nickel	30.1	3.1	-1.5	2.1	4.6	-0.4	
Selenium	<0.25						
Silver	<3						
Thallium	<25						
Zinc	128.3	4.3	1.7	10.6	20.0	-0.5	

1 Cont.:Contents, certified for SRM, measured for other samples.

2 Stated to be the 95% confidence interval using a 250 mg sample.

3 Calculated from uncertainty columns of table 7.

4 Standard deviation

5 Average minus contents of #121 divided by standard deviation.

6 Calculated from imprecision columns of table 7.

7 Square root of the sum of (Imp,calc.)²/5 and (.15 Average)².

8 The difference of the average (measured) minus certified value divided by the square root of the sum of squares of the uncertainty of measured and certified values.

9 %R is the ratio of the measured /certified value in percent.

Table 13a Recoveries for Wood/vegetable and Textile Fractions

Type	Wood/Vegetable					
Sample Series	Br5 ¹ 1	Br1 2		Br1 2		
	Bd1 ²	Bd2	Ad2 ⁴	<u>Bd1</u>	<u>Bd2</u>	
Elements	%R ? ³	%R ? ³	%R	Bd2 ? ⁵	Ad2	
Antimony	89	102	107	0.87	0.95	
Arsenic	86	66 L	87	1.30	0.76	
Beryllium	85	78 L	85	1.09	0.92	
Cadmium	102	87	94	1.17	0.93	
Chromium	99	79 L	97	1.25	0.81	
Copper	548 H	83 L	106	6.60 H	0.78	
Lead	146 H	114	98	1.28	1.16	
Mercury	107	96	---	1.11	---	
Nickel	117 H	104	98	1.13	1.06	
Selenium	104	90	75	1.16	1.20	
Silver	13 L	103	103	0.13 L	1.00	
Thallium	98	90	99	1.09	0.91	
Zinc	78 L	108	98	0.72 L	1.10	

Type	Textiles					
Sample Series	Br2,5 1	Br4 2		Br4 2		
	Bd1	Bd2	Ad2	<u>Bd1</u>	<u>Bd2</u>	
Elements	%R ?	%R ?	%R	Bd2 ?	Ad2	
Antimony	72 L	92	112	0.78	0.82	
Arsenic	98	0 L	107	---	---	
Beryllium	91	87	87	1.05	1.00	
Cadmium	93	87	95	1.07	0.92	
Chromium	74 L	90	97	0.82	0.93	
Copper	93	102	99	0.91	1.03	
Lead	78 L	62 L	108	1.26	0.57	
Mercury	78 L	103	---	0.76	---	
Nickel	82 L	108	98	0.76	1.10	
Selenium	86	74 L	94	1.16	0.79	
Silver	58 L	95	104	0.61 L	0.91	
Thallium	90	90	99	1.00	0.91	
Zinc	1480 H	116 H	94	13 H	1.23	

-
- 1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day.
 - 2 Bd#: Bd=spike of know added before digestion; # = number of series.
 - 3 %R: Recovery in percent; ?: Is recovery low or high? (Outside of 100 ± 15 %), L= low, H= high.
 - 4 Ad#: Ad=spike of known added after digestion; # = number of series.
 - 5 Bd1/Bd2 >1.15/.85 = 1.35, H; Bd1/Bd2 <.85/1.15 = .74, L.

Table 13b Recoveries for Plastic Fractions

Type	Soft Plastics						
Sample Series	Br4,5 1		Br2 2		Br2 2		
	Bd1 ²		Bd2		Ad2 ⁴		
Elements	%R	? ³	%R	? ³	%R		
					$\frac{Bd1}{Bd2}$? ⁵	
						$\frac{Bd2}{Ad2}$	
Antimony	89		102		107	0.87	0.95
Arsenic	101		66	L	87	1.53	H
Beryllium	92		78	L	85	1.18	0.92
Cadmium	95		87		94	1.09	0.93
Chromium	63	L	79	L	97	0.80	0.81
Copper	646	H	83	L	106	7.8	H
Lead	95		114		98	0.83	1.16
Mercury	99		96		---	1.03	---
Nickel	65	L	104		98	0.63	L
Selenium	81	L	90		75	0.90	1.20
Silver	77	L	103		103	0.75	1.00
Thallium	74	L	90		99	0.82	0.91
Zinc	1210	H	108		98	11	H

Type	Hard Plastics						
Sample Series	Br5 1		Br3 2		Br3 2		
	Bd1		Bd2		Ad2		
Elements	%R	?	%R	?	%R		
					$\frac{Bd1}{Bd2}$?	
						$\frac{Bd2}{Ad2}$	
Antimony	98		96		104	1.02	0.92
Arsenic	78	L	99		107	0.79	0.93
Beryllium	91		95		99	0.96	0.96
Cadmium	98		86		91	1.14	0.95
Chromium	40	L	91		101	0.44	L
Copper	286	H	112		94	2.55	H
Lead	10	L	38	L	103	0.26	L
Mercury	113		105		---	1.08	---
Nickel	111		95		100	1.17	0.95
Selenium	96		---		91	---	---
Silver	0	L	19	L	95	0	L
Thallium	103		92		90	1.12	1.02
Zinc	0	L	117	H	97	0	L

- 1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day.
- 2 Bd#: Bd=spike of know added before digestion; # = number of series.
- 3 %R: Recovery in percent; ?: Is recovery low or high? (Outside of 100 + 15 %), L= low, H= high.
- 4 Ad#: Ad=spike of known added after digestion; # = number of series.
- 5 $Bd1/Bd2 > 1.15/.85 = 1.35$, H; $Bd1/Bd2 < .85/1.15 = .74$, L.

Table 13c Recoveries for Fines and Paper Fractions

Type	Fines						
Sample Series	Br5 1		Br2 2		Br2 2		
Elements	Bd1 ² %R	? ³	Bd2 %R	? ³	Ad2 ⁴ %R	$\frac{Bd1}{Bd2}$? ⁵ $\frac{Bd2}{Ad2}$
Antimony	67	L	73	L	102	0.92	0.72
Arsenic	70	L	95		85	0.74	1.12
Beryllium	88		91		92	0.97	0.99
Cadmium	102		912	H	93	0.11	L 9.81
Chromium	0	L	78	L	95	0	L 0.82
Copper	26	L	91		101	0.29	L 0.90
Lead	472	H	118	H	106	4.0	H 1.11
Mercury	14	L	107		---	0.13	L ---
Nickel	171	H	123	H	103	1.39	H 1.19
Selenium	110		95		78	1.16	1.22
Silver	12	L	16	L	96	0.75	0.17
Thallium	102		97		92	1.05	1.05
Zinc	47	L	902	H	94	0.05	L 9.60

Type	Paper	Magazine	Magazine			
Sample Series	Ba4,5 1		WA 2		WA 2	
Elements	Bd1 %R	? ³	Bd2 %R	? ³	Ad2 %R	$\frac{Bd1}{Bd2}$? $\frac{Bd2}{Ad2}$
Antimony	83	L	79	L	97	1.05 0.81
Arsenic	108		94		100	1.15 0.94
Beryllium	96		100		101	0.96 0.99
Cadmium	100		92		95	1.09 0.97
Chromium	98		89		102	1.10 0.87
Copper	90		104		89	0.87 1.17
Lead	88		49	L	103	1.80 H 0.48
Mercury	44	L	108		---	0.41 L ---
Nickel	97		97		93	1.00 1.04
Selenium	101		90		100	1.12 0.90
Silver	7	L	93		101	0.08 L 0.92
Thallium	97		103		101	0.94 1.02
Zinc	939	H	100		101	9.4 H 0.99

- 1 Br=Brooklyn, NY; Ba= Baltimore county, MD; number after Br or Ba is day.
 2 Bd#: Bd=spike of know added before digestion; # = number of series.
 3 %R: Recovery in percent; ?: Is recovery low or high? (Outside of 100 + 15 %), L= low, H= high.
 4 Ad#: Ad=spike of know added after digestion; # = number of series.
 5 $Bd1/Bd2 > 1.15/.85 = 1.35$, H; $Bd1/Bd2 < .85/1.15 = .74$, L.

Table 14a Ratio of Predigestion Recoveries, Series1/Series2

Fraction	Wood/Veg	Textiles	Plastics, Soft	Plastics, Hard	"Fines"	Paper	
Elements							
Antimony	0.87	0.78	0.87	1.02	0.92	1.05	
Arsenic	1.30	---	L ¹ 1.53	H 0.79	0.74	1.15	
Beryllium	1.09	1.05	1.18	0.96	0.97	0.96	
Cadmium	1.17	1.07	1.09	1.14	0.11	L 1.09	
Chromium	1.25	0.82	0.80	0.44	L 0.00	L 1.10	
Copper	6.60	H 0.91	7.78	H 2.55	H 0.29	L 0.87	
Lead	1.28	1.26	0.83	0.26	L 4.00	H 1.80	H
Mercury	1.11	0.76	1.03	1.08	0.13	L 0.41	L
Nickel	1.13	0.76	0.63	L 1.17	1.39	H 1.00	
Selenium	1.16	1.16	0.90	---	1.16	1.12	
Silver	0.13	L 0.61	L 0.75	0.00	L 0.75	0.08	L
Thallium	1.09	1.00	0.82	1.12	1.05	0.94	
Zinc	0.72	L 12.76	H 11.20	H 0.00	L 0.05	L 9.39	H

No. in,out of Average

Elements	Average Value	Std.Dev. ²	In Av. #In ³	Out #H ⁴	Out #L ⁵
Antimony	0.92	0.10	6	0	0
Arsenic	0.99	0.28	4	1	1
Beryllium	1.03	0.09	6	0	0
Cadmium	1.11	0.04	5	0	1
Chromium	0.99	0.22	4	0	2
Copper	incon,H	---	--	3	1
Lead	1.12	0.25	3	2	1
Mercury	0.99	0.16	4	0	2
Nickel	0.91	0.22	4	1	1
Selenium	0.92	0.23	5	0	1
Silver	incon,L	---	--	0	4
Thallium	1.00	0.11	6	0	0
Zinc	incon,N	---	--	3	2

1 H, Ratio =>1.31 (1.15/.85);L, Ratio =<0.76 (.85/1.15). Ratios listed in column 7 of table 13.

2 Standard deviation.

3 number included in average.

4 number excluded from average that are high.

5 number excluded from average that are low.

6 incons,H,L,N= results are inconsistent with deviations tending to be high, low, or both high and low, respectively.

Table 14b Predigestion/Postdigestion Recovery, Series 2

Fraction Elements	Wood/Veg	Textiles	Plastics, Soft	Plastics, Hard	"Fines"	Paper
Antimony	0.95	0.82	0.95	0.92	0.72 L	0.81
Arsenic	0.76	--	0.76	0.93	1.12	0.94
Beryllium	0.92	1.00	0.92	0.96	0.99	0.99
Cadmium	0.93	0.92	0.93	0.95	9.81 H	0.97
Chromium	0.81	0.93	0.81	0.90	0.82	0.87
Copper	0.78	1.03	0.78	1.19	0.90	1.17
Lead	1.16	0.57 L ¹	1.16	0.37 L	1.11	0.48 L
Mercury	---	---	---	---	---	---
Nickel	1.06	1.10	1.06	0.95	1.19	1.04
Selenium	1.20	0.79	1.20	---	1.22	0.90
Silver	1.00	0.91	1.00	0.20 L	0.17 L	0.92
Thallium	0.91	0.91	0.91	1.02	1.05	1.02
Zinc	1.10	1.23	1.10	1.21	9.60 H	0.99

No. in,out of Average

Elements	Average Value	Std.Dev. ²	In Av. #In ³	Out #H ⁴	Out #L ⁵
Antimony	0.89	0.07	5	0	1
Arsenic	0.90	0.13	5	0	0
Beryllium	0.96	0.04	6	0	0
Cadmium	0.94	0.02	5	1	0
Chromium	0.86	0.05	6	0	0
Copper	0.98	0.18	6	0	0
Lead	1.15	0.03	3	0	3
Mercury	----				
Nickel	1.07	0.08	6	0	0
Selenium	1.06	0.18	5	0	0
Silver	0.96	0.05	4	0	2
Thallium	0.97	0.07	6	0	0
Zinc	1.13	0.10	5	1	0

1 H, Ratio =>1.31 (1.15/.85); L, Ratio =<0.76 (.85/1.15); Ratios are listed in column 9 of table 13.

2 Standard deviation.

3 Number included in average.

4 Number excluded from average that are high.

5 Number excluded from average that are low.