# Metal Leaching from Water Bottles

prepared for

**SIGG USA**
**Stamford, CT**


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27 May 2008

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|---|---|
| **Client:** | SIGG USA<br>1177 High Ridge Road<br>Stamford, CT 06905 |
| **Requestor:** | S. Wasik |
| **Study:** | **Re: Metal Leaching from Water Bottles** |
| **LIMS #:** | 20080096 |

## BACKGROUND

A set of experiments were performed to evaluate whether metals leach into the container contents of SIGG aluminum bottles, Klean Kanteen stainless-steel bottles, Enviro New Wave stainless-steel bottles, or Pottery Barn aluminum bottles due to corrosion by RO (reverse osmosis) water.

While the lined SIGG bottles were not expected to contribute metal contamination (e.g. aluminum) to liquids contained in the bottle provided its internal coating remained intact, other bottles (e.g. stainless steel) may be susceptible to corrosion under certain conditions contributing metals to the bottle contents.

Two brands of stainless steel bottles (Klean Kanteen and Enviro New Wave) and two brands of aluminum bottles (SIGG and Pottery Barn) were subjected to leaching tests in deionized, reverse osmosis (RO) water @ 45-50°C for 14 days.

After incubation, the water samples were characterized for metals by ICP-OES (inductively coupled plasma-optical emission spectroscopy).

## EXPERIMENTAL

8 water bottles were purchased at retail stores and entered into a Laboratory Information Management System (LIMS). The samples were designated as shown in Table I.

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**Table I: Sample Designations**

| LIMS # | Client ID/Description |
|---|---|
| 20080096-01 | SIGG#1 |
| 20080096-02 | SIGG#2 |
| 20080096-07 | Stainless Steel ENW #1 |
| 20080096-08 | Stainless Steel ENW #2 |
| 20080096-13 | Generic Aluminum #1 |
| 20080096-14 | Generic Aluminum #2 |
| 20080096-19 | Stainless Steel KK #1 |
| 20080096-20 | Stainless Steel KK #2 |

Four bottle types were used for this study (Figure 1):

- SIGG (0.6 L),
- Klean Kanteen (27 oz),
- Enviro New Wave (0.6 L), and
- Pottery Barn generic aluminum (25 oz).

Duplicate bottles of each type were prepared and tested with RO water. Each bottle was rinsed twice with 200 ml of the water to be tested, filled with 500 ml of RO water, and capped. For the water tests, 8 bottles were placed in a temperature controlled water bath (Blue M) and incubated at 45-50°C for 2 weeks. Following this exposure, the water samples were analyzed by ICP-OES (Perkin Elmer Optima 3300DV) for leached elements. An unexposed sample of the RO water source was also analyzed to establish its initial elemental content.

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**Figure 1: Bottle Types Used in the Metal Leaching Study**


**SIGG Aluminum (0.6 L)**

**Pottery Barn Aluminum (25 oz)**


**Klean Kanteen SS (27 oz)**

**Enviro New Wave SS (0.6 L)**

## RESULTS & DISCUSSION

The results of the ICP-OES elemental analysis of the water samples appear in Table III. The following elements were observed above the detection limits and above the levels present in the water sources:

**Table II: Summary of Observed Metal Contamination**

**Deionized RO Water**

| Analyte | SIGG Al | Klean Kanteen SS | Enviro New Wave SS | Pottery Barn Al |
|---|---|---|---|---|
| Ca | | | X | X |
| Fe | | X | X | |
| Na | | | X | |
| Si | | X | X | |
| Al | | | X | X |

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**Table III: ICP-OES Analysis Results of Warm Water Extractions (ppm)***

| | Water Blank | SIGG #1 | SIGG #2 | Stainless Steel ENW #1 | Stainless Steel ENW #2 | Generic Aluminum #1 | Generic Aluminum #2 | Stainless Steel KK #1 | Stainless Steel KK #2 |
|---|---|---|---|---|---|---|---|---|---|
| | RO Water | 20080096-01 | 20080096-02 | 20080096-07 | 20080096-08 | 20080096-13 | 20080096-14 | 20080096-19 | 20080096-20 |
| **Ag** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Al** | **<0.05** | <0.05 | <0.05 | 0.21 | 0.10 | 0.12 | 0.13 | <0.05 | <0.05 |
| **As** | **<0.1** | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **Au** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **B** | **0.21** | 0.18 | 0.15 | 0.14 | 0.13 | 0.12 | 0.10 | <0.1 | <0.1 |
| **Ba** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Be** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Bi** | **<0.1** | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **Ca** | **<0.025** | <0.025 | <0.025 | 0.17 | 0.29 | 0.12 | 0.04 | <0.025 | <0.025 |
| **Cd** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Co** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Cr** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Cu** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Fe** | **<0.025** | <0.025 | <0.025 | 0.04 | 0.05 | <0.025 | <0.025 | 0.06 | 0.18 |
| **Hg** | **<0.1** | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **Ga** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **K** | **0.10** | 0.14 | 0.19 | 0.15 | 0.11 | 0.10 | 0.10 | 0.10 | 0.09 |
| **Li** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Mg** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Mn** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Mo** | **0.16** | 0.12 | 0.10 | 0.10 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 |
| **Na** | **<0.1** | <0.1 | <0.1 | 0.42 | 0.13 | <0.1 | <0.1 | <0.1 | <0.1 |
| **Ni** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **P** | **<0.2** | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| **Pb** | **<0.1** | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **Pd** | **<0.1** | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **Pt** | **<0.2** | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| **S** | **<0.5** | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| **Sb** | **<0.1** | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **Se** | **<0.2** | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| **Si** | **<0.1** | <0.1 | <0.1 | 1.95 | 0.16 | <0.1 | <0.1 | 0.57 | 0.35 |
| **Sn** | **<0.1** | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **Sr** | **<0.01** | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| **Th** | **<0.5** | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| **Ti** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Tl** | **<0.5** | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| **U** | **<0.1** | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| **V** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **W** | **0.42** | 0.39 | 0.37 | 0.55 | 0.37 | 0.31 | 0.30 | 0.30 | 0.29 |
| **Zn** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |
| **Zr** | **<0.025** | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 |

***The differences in the detection limits reported above are associated with the variable sensitivity of the instrument to individual elements.**