

# Certificate of Analysis

**NRC-CMRC**

Certified Reference Material

## SLRS-6

River Water Certified Reference Material for Trace Metals and other Constituents

The following tables show those constituents for which certified, reference and information values have been established for this river water certified reference material (CRM).

The expanded uncertainty ( $U_{\text{CRM}}$ ) in the certified value is equal to  $U = ku_c$  where  $u_c$  is the combined standard uncertainty calculated according to the JCGM Guide [1] and  $k$  is the coverage factor. A coverage factor of two (2) was applied for all elements. It is intended that  $U_{\text{CRM}}$  accounts for every aspect that reasonably contributes to the uncertainty of the measurement. The density of SLRS-6 is 0.9985 g/mL.

**Table 1: Certified quantity values for SLRS-6**

Element	Mass fraction, $\mu\text{g}/\text{kg}$	Mass concentration, $\mu\text{g}/\text{L}$
aluminium (b,c,d)	$33.9 \pm 2.2$	$33.9 \pm 2.2$
antimony (a,b)	$0.3377 \pm 0.0058$	$0.3382 \pm 0.0058$
arsenic (b,c,e)	$0.57 \pm 0.08$	$0.57 \pm 0.08$
barium (a,b,c,d)	$14.30 \pm 0.48$	$14.32 \pm 0.48$
cadmium (a,b)	$0.0063 \pm 0.0014$	$0.0063 \pm 0.0014$
calcium (c,d)	$8770 \pm 200$	$8790 \pm 200$
chromium (a,b,d)	$0.252 \pm 0.012$	$0.253 \pm 0.012$
copper (a,b,c,d)	$24.0 \pm 1.8$	$24.0 \pm 1.8$
iron (a,b,c,d)	$84.5 \pm 3.6$	$84.6 \pm 3.6$
lead (a,b)	$0.170 \pm 0.026$	$0.170 \pm 0.026$
magnesium (c,d)	$2137 \pm 58$	$2140 \pm 58$
manganese (b,c,d)	$2.12 \pm 0.10$	$2.12 \pm 0.10$
molybdenum (a,b,d)	$0.215 \pm 0.018$	$0.215 \pm 0.018$
nickel (a,b,d)	$0.617 \pm 0.022$	$0.618 \pm 0.022$
potassium (c,d)	$652 \pm 54$	$653 \pm 54$
sodium (c,d)	$2770 \pm 220$	$2770 \pm 220$
strontium (a,b,c,d)	$40.72 \pm 0.32$	$40.78 \pm 0.32$
uranium (a,b)	$0.0699 \pm 0.0034$	$0.0700 \pm 0.0034$
vanadium (b,d)	$0.352 \pm 0.006$	$0.352 \pm 0.006$
zinc (a,b,c,d)	$1.76 \pm 0.12$	$1.76 \pm 0.12$



**Table 2: Reference values for SLRS-6**

Element	Mass fraction, µg/kg	Mass concentration, µg/L
beryllium (b)	0.0066 ± 0.0022	0.0066 ± 0.0022
cobalt (b)	0.053 ± 0.012	0.053 ± 0.012

### Coding

The coding refers to the instrumental method of analyte determination.

- a Isotope dilution inductively-coupled plasma mass spectrometry (ID-ICP-MS)
- b Standard addition inductively-coupled plasma mass spectrometry (SA-ICP-MS)
- c Inductively-coupled plasma mass spectrometry (ICP-MS)
- d Standard addition inductively-coupled plasma atomic emission spectroscopy (SA-ICP-AES)
- e Hydride generation SA-ICP-MS

### Certified values

Certified values are considered to be those for which the National Research Council Canada (NRC) has the highest confidence in accuracy and that all known and suspected sources of bias have been taken into account and are reflected in the stated expanded uncertainties. Certified values are the best estimate of the uncertainty and mean (Table 1).

### Reference values

Reference values are non-certified values for which insufficient data are available to provide a comprehensive estimate of uncertainty to permit their full certification (Table 2).

### Intended use

This certified reference material is primarily intended for use in the calibration of procedures and the development of methods used for the analysis of water for trace metals. A minimum sample mass of 10 mL is recommended.

### Storage and sampling

It is recommended that the material be stored in a cool, clean location. The bottles should be opened only in a clean area with precautions taken against contamination during sampling.

### Preparation of material

Untreated river water was collected at the City of Ottawa's Britannia Water Purification Plant. The water was peristaltically pumped through 0.45 µm porosity acrylic copolymer filters and immediately acidified with ultrapure nitric acid to pH 1.6 during transfer to polypropylene carboys. The water was later refiltered through 0.2 µm porosity acrylic copolymer filters into a polyethylene tank in a clean room at NRC. It was subsequently blended and bottled in precleaned polyethylene containers. The bottled water was gamma irradiated to a minimum dose of 25 kGy at the Canadian Irradiation Centre, Laval, Quebec, to inhibit any bacterial action.



## Stability

Studies of similar waters indicate that the material is stable with respect to total trace metal concentrations for at least ten years. Uncertainty components for long and short term stability were considered negligible and are thus not included in the uncertainty budget.

## Homogeneity

The material was tested for homogeneity at NRC using ICP-MS. Results from sub-samples (10 mL) were evaluated using ANOVA and/or the DerSimonian-Laird random effects model and included in the calculation of the certified values [2].

## Uncertainty

Included in the overall combined uncertainty estimate ( $u_c$ ) are uncertainties in the batch characterization ( $u_{char}$ ), uncertainties related to possible between-bottle variation ( $u_{hom}$ ), and uncertainties related to inconsistency between the various measurement methods ( $u_{method}$ ). Expressed as standard uncertainties, these components are listed in Table 3.

**Table 3: Uncertainty Components for SLRS-6**

Element	$u_c$ , µg/kg	$u_{char}$ , µg/kg	$u_{hom}$ , µg/kg	$u_{method}$ , µg/kg
aluminium	1.1	1.0	0.0	0.5
antimony	0.0029	0.0026	0.0013	0.0000
arsenic	0.04	0.04	0.00	0.00
barium	0.24	0.21	0.11	0.00
cadmium	0.0007	0.0007	0.0001	0.0000
calcium	100	90	40	0
chromium	0.006	0.006	0.000	0.000
copper	0.9	0.9	0.2	0.0
iron	1.8	1.7	0.5	0.0
lead	0.013	0.013	0.000	0.000
magnesium	29	17	23	0
manganese	0.05	0.05	0.00	0.00
molybdenum	0.009	0.008	0.005	0.000
nickel	0.011	0.008	0.008	0.000
potassium	27	12	24	0
sodium	110	100	40	0
strontium	0.16	0.14	0.08	0.00
uranium	0.0017	0.0017	0.0000	0.0000
vanadium	0.003	0.003	0.000	0.000
zinc	0.06	0.05	0.03	0.00

**Table 3 (continued): Uncertainty Components for SLRS-6**

Element	$u_c$ , µg/kg	$u_{char}$ , µg/kg	$u_{hom}$ , µg/kg	$u_{method}$ , µg/kg
beryllium	0.0011	0.0011	0.0003	0.0000
cobalt	0.006	0.006	0.000	0.000

**Metrological traceability**

Results presented in this certificate are traceable to the SI through gravimetrically prepared standards of established purity, CRMs and international measurement intercomparisons. As such, SLRS-6 serves as suitable reference material for laboratory quality assurance programs, as outlined in ISO/IEC 17025.

**Quality System (ISO/IEC 17025, ISO Guide 34)**

This material was produced in compliance with the documented NRC Measurement Science and Standards (MSS) Quality System, which conforms with the requirements of ISO/IEC 17025 and ISO Guide 34.

The MSS Quality System supporting NRC calibration and measurement capabilities, as listed in the Bureau international des poids et mesures (BIPM) key comparison database (<http://kcdb.bipm.org/>), has been reviewed and approved under the authority of the Inter-American Metrology System (SIM) and found to be in compliance with the expectations of the Comité international des poids et mesures (CIPM) Mutual Recognition Arrangement. The SIM certificate of approval is available upon request.

**Updates**

Users should ensure that the certificate they have is current. Our website at [www.nrc.gc.ca/crm](http://www.nrc.gc.ca/crm) will contain any new information.

**References**

1. Evaluation of measurement data: Guide to the expression of uncertainty in measurement JCGM100:2008.
2. R. DerSimonian, N. Laird (1986) Meta-analysis in clinical trials. *Controlled Clinical Trials* 7: 177-188

**Authorship**

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