Certificate of measurement

4005

Hard drinking water - metals

Certified Reference Material LGC6026

Certified Values

Constituent[1, 2]	Number of laboratories	Units	Certified value [3]	Uncertainty [4]	Coverage factor, k [4]
Aluminium	23	µg/L	199.9	6.1	2.02
Antimony	22	µg/L	4.99	0.17	2.07
Arsenic	23	µg/L	10.00	0.31	2.04
Barium	21	µg/L	116.1	3.5	2.08
Beryllium	14	µg/L	5.08	0.26	2.16
Boron	23	µg/L	983	26	2.03
Cadmium	21	µg/L	4.98	0.15	2.03
Chromium	23	µg/L	50.0	1.9	2.05
Cobalt	17	µg/L	4.88	0.17	2.07
Copper	23	µg/L	2017	56	2.03
Iron	24	µg/L	198.4	5.5	2.03
Lead[1]	1	µg/L	9.98	0.14	2.00
Lithium	12	µg/L	11.24	0.58	2.20
Manganese	24	µg/L	48.4	1.5	2.03
Molybdenum	17	µg/L	4.77	0.25	2.10
Nickel	23	µg/L	19.00	0.72	2.05
Selenium	22	µg/L	10.19	0.59	2.07
Strontium	15	µg/L	491	20	2.06
Thallium	11	µg/L	5.11	0.42	2.23
Uranium	12	µg/L	4.95	0.40	2.20
Vanadium	16	µg/L	4.96	0.15	2.07
Zinc	22	µg/L	621	19	2.07
Calcium	22	mg/L	77.1	2.2	2.03
Magnesium	23	mg/L	18.50	0.76	2.04
Potassium	24	mg/L	5.30	0.15	2.03
Sodium	22	mg/L	24.60	0.79	2.03

Notes:

1) Lead was determined at LGC using Isotope Dilution Inductively Coupled Plasma Mass Spectrometry (IDMS).

2) The remaining constituents were certified using the results of an inter-laboratory comparison using different methods (see Table 1). Robust estimates of dispersion and location were used as the values of the concentration determined by participant laboratories. Each data set was obtained in a different laboratory and/or using a different method of measurement.

3) The results are traceable to the SI through the physical and chemical standards used by LGC and the inter-laboratory study participant laboratories. The certified values are reported to the same number of decimal places as the uncertainties (reported to 2 significant figures).

4) The quoted uncertainty is the half-width of the expanded uncertainty interval calculated using a coverage factor (k), which gives a level of confidence of approximately 95 %.

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Signed: _____

Gill Holcombe (Mrs)

for the Government Chemist

Material number: LGC6026

Batch number: 003

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Material Preparation

Hard drinking water was sourced from the Lichfield (Staffordshire, UK) potable mains supply. The water was filtered through a set of 8 µm, 1.2 µm and 0.45 µm in-line filters and acidified by addition of nitric acid to give a final concentration of approximately 0.1 % nitric acid and pH < 2.0. High purity metal standards were used to spike the base material to reach the target levels, reflecting the regulatory limits in the European Drinking Water Directive [1] and the UK Water Supply (Water Quality) Regulations 2016 [2].

The material was bottled in 250 mL portions in screw cap high density polyethylene bottles and stored at (5 ± 4) ºC.

Homogeneity Assessment

The homogeneity of the material was assessed for each of the elements of interest. Analysis was carried out at LGC by inductively coupled plasma optical emission spectrometry (ICP-OES) for boron, calcium, copper, magnesium, potassium, sodium, strontium and zinc, with all other elements analysed by inductively coupled plasma mass spectrometry (ICP-MS) apart from lead where an assessment was made using isotope dilution mass spectrometry (IDMS).

The results showed the material was fit-for-purpose for a sample size of 1 mL which is the recommended minimum sample intake.

Stability

The nature of the material is such that deterioration is not anticipated over its lifetime when stored under the recommended conditions. The material will be monitored at LGC and customers will be notified of any changes in the certified values.

Certification

The material was certified using results from characterisation studies organised by LGC. This was a combination of IDMS measurements carried out at LGC (for lead) and an inter-laboratory study. The decision to use IDMS for the characterisation of the material for lead was based on the known difficulties of the measurement of lead.

IDMS characterisation

Samples were analysed at LGC using a method accredited to ISO/IEC 17025. The samples were spiked with a solution containing enriched ^{206}Pb (NIST SRM 983, USA). Ten units were analysed in duplicate in a single run using two independent sets of calibrants.

Measurements were performed using an Agilent 7700 in no gas mode. The samples were bracketed with the calibration standard blend. The primary standard was NIST SRM 3128 for lead. An independent standard was prepared from a secondary source of Pb rod.

The certified value was assigned as the mean of the replicate measurements.

In order to convert the IDMS value obtained for Pb from µg/kg to µg/L, the density of the material was measured in duplicate on three units, using an Anton Paar DMA 5000 five-place density meter at (20.00 ± 0.01) °C. A mean value of 0.999054 g/cm^3 was obtained for the density.

Interlaboratory study characterisation

Units of the candidate material were distributed to laboratories that had previously agreed to participate in the inter-laboratory study. Participant laboratories chose suitable methods with which they were familiar. The number of laboratories that used a particular method is shown in Table 1.

The data from the inter-laboratory study were processed using a robust statistical approach after screening laboratories based on their performance in analysing a separate QC sample. The certified value for each constituent was assigned as the robust estimate of location of the accepted laboratory data. Uncertainties were based on the robust estimate of dispersion (taking into account the number of laboratories and corrected for the efficiency of the estimator), and combined with the uncertainties related to homogeneity and stability.

Table 1

Constituent	ICP-MS	ICP-OES	UV/VIS-S	FP	FAAS	GFAAS	IC	Total
Aluminium	18	4	1					23
Antimony	22							22
Arsenic	22					1		23
Barium	18	3						21
Beryllium	13	1						14
Boron	15	6	2					23
Cadmium	20					1		21
Calcium	12	8			1		1	22
Chromium	20	2				1		23
Cobalt	17							17
Copper	19	2			1	1		23
Iron	15	7	1		1			24
Lithium	10	2						12
Magnesium	13	7	1		1		1	23
Manganese	17	5			1	1		24
Molybdenum	16	1						17
Nickel	21	1				1		23
Potassium	13	8		2			1	24
Selenium	22							22
Sodium	11	8		2			1	22
Strontium	13	2						15
Thallium	11							11
Uranium	12							12
Vanadium	15	1						16
Zinc	19	2			1			22

Participants

The following laboratories participated in the inter-laboratory study for this material:

ALS Environmental (Wakefield)	UK
Anglian Water Central Laboratory	UK
British Geological Survey	UK
Cavendish Nuclear Limited	UK
Centre for Ecology and Hydrology (CEH - Lancaster)	UK
Dwr Cymru Welsh Water	UK
Edinburgh Scientific Services (City of Edinburgh Council)	UK
Eurofins Water Hygiene Testing UK Limited	UK
Fitz Scientific	Ireland
Glasgow Scientific Services	UK
I2 Analytical Ltd	UK
Industrial Technology Institute	Sri Lanka
Instituto Nacional de Saúde Dr. Ricardo Jorge (INSA) - Lisbon	Portugal
Instituto Nacional de Saúde Dr. Ricardo Jorge (INSA) - Porto	Portugal
Intertek Caleb Brett	UK
Northumbrian Water Scientific Services	UK
Seibersdorf Labor GmbH, Chemical Analytics	Austria
SES Water	UK
Severn Trent Water	UK
South West Water Ltd	UK
States Analysts' Laboratory - Guernsey	UK
Technological Laboratory of Uruguay (LATU) – Atomic Spectrometry Department	Uruguay
Thailand Institute of Scientific and Technological Research	Thailand
Thames Water Utilities	UK
The James Hutton Institute	UK
Wessex Water Scientific Centre	UK

Accreditation

Property values on this certificate are within LGC's scope of accreditation to ISO 17034.

Intended Use

This reference material is primarily intended for use in the development, validation or quality control of analytical methods for the determination of metals in hard drinking water. The material may also be applicable to other similar matrices where more closely matched reference materials are not available.

Instructions for Use

Before use, the material should be thoroughly mixed by inversion, and allowed to equilibrate to room temperature. The minimum amount of sample to be used is 1 mL. After use, the bottle should be securely sealed and returned to storage at (5 ± 4) °C.

Storage

The material should be stored at (5 ± 4) °C in its original packaging.

Shelf Life

If stored under the recommended conditions the certified values will remain valid for 12 months from the date of shipment (see page 6 for shipment date).

Metrological Traceability

For the analytes characterised through the interlaboratory study, the results are considered traceable to the SI through the physical and chemical standards used by the participant laboratories.

For lead, the results are traceable to the SI through the primary calibration standard used for the calibration of the IDMS analysis. This was NIST SRM 3128.

References

[1] Drinking Water Directive. Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption.

[2] Statutory Instrument 2016 No. 614, Water, England and Wales, The Water Supply (Water Quality) Regulations 2016.

Certificate Revision

The certificate was revised in June 2022 to reflect an update to the UKAS symbol.

Unit Number	Date of Shipment

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