



# Certificate of Analysis

## Certified Reference Material

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### MOOS-4

#### Nearshore Seawater Certified Reference Material for Nutrients

MOOS-4 is a nearshore seawater Certified Reference Material (CRM) from the National Research Council of Canada (NRC). A unit of MOOS-4 consists of approximately 50 mL of seawater, and it can be used for calibration, method development, validation, and quality control for the analysis of phosphate, silicate, nitrite, and nitrate in seawater.

Table 1 shows the certified values established for MOOS-4. The expanded uncertainty ( $U_{CRM}$ ) in the certified values is equal to  $U_{CRM} = k u_c$  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 ( $k = 2$ ) was applied which corresponds to approximately 95 % confidence.

**Table 1: Certified quantity values and expanded uncertainties ( $k = 2$ ) for MOOS-4**

Analyte	Amount concentration, $\mu\text{mol/L}$	Mass fraction, mg/kg	International recognition of measurement capability (CMC)
Phosphate, $\text{PO}_4^{3-}$ (a)	$2.835 \pm 0.031$	$0.2637 \pm 0.0029$	<a href="#">TEW40</a>
Silicate, as $\text{SiO}_2$ (a,b)	$7.16 \pm 0.13$	$0.4214 \pm 0.0076$	<a href="#">TEW41</a>
Nitrite, $\text{NO}_2^-$ (a,c)	$1.676 \pm 0.013$	$0.07552 \pm 0.00056$	<a href="#">TEW39</a>
Nitrate, $\text{NO}_3^-$ (c)	$17.14 \pm 0.44$	$1.041 \pm 0.027$	–

#### Additional information

The density of MOOS-4 at  $22 \pm 1$  °C is  $1.0210 \pm 0.0010$  g/mL. Phosphate was measured by spectrophotometry with molybdenum blue derivatization [2, 3].

#### Coding

The coding refers to the instrumental method of analyte determination

- a Matrix-matching external calibration spectrophotometry [2,3]
- b Exact-matching isotope dilution liquid chromatography inductively coupled plasma mass spectrometry [4]
- c Exact-matching isotope dilution gas chromatography mass spectrometry [5]

### **Certified values**

Certified values are considered to be those for which the 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 true value and uncertainty (Table 1).

### **International recognition of measurement capability**

The measurement capabilities supporting these results are registered at the Calibration and Measurement Capabilities (CMC) database of the *Bureau international des poids et mesures* (BIPM) indicating recognition of the measurement certificates by National Metrology Institutes (NMIs) participating in the Mutual Recognition Arrangement (MRA) with the corresponding identifiers. A list of all registered measurement capabilities in water matrices can be found in the BIPM database at [bipm.org/kcdb](http://bipm.org/kcdb).

### **Intended use**

MOOS-4 can be used for calibration, method development, validation, and quality control for the analysis of phosphate, silicate, nitrite, and nitrate in seawater. Although dissolved nutrients in seawater are assumed homogenous within the unit, the certification exercise was carried out by measuring minimum sample volumes of 6 mL for phosphate, 3 mL for silicate, and 2 mL for both nitrite and nitrate.

### **Storage and sampling**

This material should be stored under typical refrigerator conditions (nominal temperature of 4 °C) within its original packaging. Each unit is packaged in a trilaminate foil pouch which provides protection against evaporation and light. The material shall not be frozen. Once opened, biological contamination may induce changes in the measurands, therefore the bottle should be opened for the minimal amount of time in a clean area.

### **Preparation of material**

MOOS-4 was collected in February 2017 from Ketch Harbour, Nova Scotia, Canada, at a latitude of 44° 27' 59.9" N and longitude of 63° 33' 31.3" W. The water was sampled from a depth of about 10 to 12 m, and it was ultrafiltered at 0.02 µm. The material was gamma irradiated with a minimum dose of 25.0 kGy, then it was homogenized and bottled in its final unit size of 50 mL.

### **Stability**

The stability of MOOS-4 was evaluated under transportation and storage conditions. Silicate, nitrite, and nitrate were stable under the conditions tested. Relative standard uncertainty components of 0.06 % and 0.39 % were determined for the stability of phosphate under transportation and storage conditions, respectively. Monitoring of the stability will continue throughout the lifecycle of the CRM.

### **Homogeneity**

The homogeneity of MOOS-4 was assessed from randomly selected units of CRMs using the analysis of variance (ANOVA). No homogeneity component was determined for phosphate, silicate, and nitrite. For nitrate, the relative standard uncertainty component for homogeneity (i.e., between-bottle variation) was 0.20 %.

## Uncertainty

Included in the overall combined standard uncertainty ( $u_c$ ) are the uncertainties arising from batch characterization, between-bottle homogeneity, and stability under transportation and storage conditions.

## Metrological traceability

Results presented in this certificate are traceable to the International System of Units (SI) through gravimetrically prepared standards of established purities and CRMs produced by National Metrology Institutes. As such, MOOS-4 serves as suitable reference material for laboratory quality assurance programs, as outlined in ISO/IEC 17025.

## Quality Management System (ISO 17034, ISO/IEC 17025)

This material was produced in compliance with the NRC Metrology Quality Management System, which conforms to the requirements of ISO 17034 and ISO/IEC 17025. The Metrology Quality Management System supporting NRC Calibration and Measurement Capabilities, as listed in the *Bureau international des poids et mesures* (BIPM) Key Comparison Database ([bipm.org/kcdb](http://bipm.org/kcdb)), 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 CIPM Mutual Recognition Arrangement. The SIM approval is available upon request.

## Updates

Users should ensure that the certificate they have is current. For updates, please refer to: [doi.org/10.4224/crm.2024.moos-4](https://doi.org/10.4224/crm.2024.moos-4)

## References

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3. Pagliano E, Nadeau K, Mihai O, Pihillagawa Gedara I, Mester Z (2022) From sea salt to seawater: a novel approach for the production of water CRMs. *Anal. Bioanal. Chem.* 414:4745-4756. [doi.org/10.1007/s00216-022-04098-0](https://doi.org/10.1007/s00216-022-04098-0)
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5. Pagliano E, Meija J, Mester Z (2014) High-precision quadruple isotope dilution method for simultaneous determination of nitrite and nitrate in seawater by GCMS after derivatization with triethyloxonium tetrafluoroborate. *Anal. Chim. Acta* 824:36-41. [doi.org/10.1016/j.aca.2014.03.018](https://doi.org/10.1016/j.aca.2014.03.018)

## Cited by

The list of publications citing MOOS-4 can be found at: [doi.org/10.4224/crm.2024.moos-4](https://doi.org/10.4224/crm.2024.moos-4)

**Authorship**

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**Acknowledgments**

Indumathi Gedara Pihillagawa, Kelly L. LeBlanc, Kenny Nadeau, Lisa Shi, Lu Yang, Natasha Luckovitch, Ovi Mihai, and Scott MacQuarrie (NRC) are greatly acknowledged for their contribution to the MOOS-4 preparation and certification.

**Citation**

Pagliano E, Gajdosechova Z, Meija J, Chartrand MMG, Mester Z, and Grinberg P. MOOS-4: Nearshore Seawater Certified Reference Material for Nutrients. Ottawa: National Research Council Canada; 2024. Available from: [doi.org/10.4224/crm.2024.moos-4](https://doi.org/10.4224/crm.2024.moos-4)

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*Date of issue: July 2024*

*Date of expiry: March 2028*

**Approved by:**

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**This Certificate is only valid if the corresponding material was obtained directly from the NRC or an Authorized Reseller.**

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