

## EIM Help – pH, Alkalinity, Hardness, and Acidity in Water

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pH, alkalinity, hardness, and acidity are interrelated water quality parameters that are often reported together – and sometimes confused. This document explains these parameters and how to enter them into EIM.

For assistance in filling out all other required fields, [download the Result Template Help document](#).

### pH

pH is a measure of the free hydrogen ion ( $H^+$ ) effective concentration, or activity, in water. When the hydrogen ion activity increases, the water becomes more acidic. The pH scale ranges from 0 to 14. Because pH is expressed as the negative logarithm of the hydrogen ion activity ( $-\log_{10}(H^+)$ ), lower values on the pH scale represent higher acidity. A value of 7 (at 25 °C) is neutral whereas less than 7 is acidic and greater than 7 is basic. At neutral pH 7, ( $H^+$ ) equals ( $OH^-$ ).

pH is usually measured in the field with a meter – in situ or shortly after the time of collection because storage and transport can affect it.

### How to enter pH data into EIM

In EIM, these are the key fields (with column numbers) and valid values for pH:

#### Parameter

| Result Parameter Name (AH) | Result Value (AM) | Result Value Units (AN) |
|----------------------------|-------------------|-------------------------|
| pH                         | 0-14              | pH                      |

#### Methods

Following are some common pH methods in EIM. If you don't see your method here, you can [search for more Method Valid Values online](#). If you still can't find it, contact your EIM data coordinator.

| Category    | Result Method (AY) | Description                                              |
|-------------|--------------------|----------------------------------------------------------|
| Measurement | PHMETER            | pH by field meter/electrode                              |
| Measurement | EPA150.1M          | pH, Electrometric, field                                 |
| Measurement | SM4500H+B          | pH by Electrometric Method                               |
| Analysis    | SW9045D            | Soil and Waste pH by electrometric procedure, Revision 4 |

## Alkalinity

Alkalinity is a measure of the pH buffering or acid-neutralizing capacity of water. Higher alkalinity keeps pH stable by neutralizing the effect of added acids such as rainwater, which can be acidified by atmospheric CO<sub>2</sub>, and acidic wastewater such as acid mine drainage. Total alkalinity is made up of all the titratable bases in a sample, primarily carbonate (CO<sub>3</sub><sup>2-</sup>), bicarbonate (HCO<sub>3</sub><sup>-</sup>), and hydroxide (OH<sup>-</sup>) anions. To a lesser extent, borates, phosphates, silicates, and other bases may contribute to total alkalinity.

Total alkalinity is measured by titrating water with a strong acid until the carbonate, bicarbonate, and other bases have been neutralized to specific pH end points.

Alkalinity is sometimes confused with pH, not only because the two are interrelated, but because pH measurements with values above 7 are sometimes referred to as “alkaline,” a synonym for “basic.”

## How to enter alkalinity data into EIM

### Parameter – total alkalinity

EIM accepts total alkalinity data in calcium carbonate equivalents (“as CaCO<sub>3</sub>”). Some labs report this using the unit “mg/L as CaCO<sub>3</sub>.” **Do not use this unit in your template!** In EIM we indicate “as CaCO<sub>3</sub>” in the parameter name. Use the parameter name and unit below.

| Result Parameter Name (AH)             | EIM Name Type               | Result Value Units (AN) |
|----------------------------------------|-----------------------------|-------------------------|
| Alkalinity, Total as CaCO <sub>3</sub> | Primary                     | mg/L, rarely ug/L       |
| Alkalinity as CaCO <sub>3</sub>        | Synonym (OK for data entry) | mg/L, rarely ug/L       |

### Parameters – alkalinity constituents

Sometimes concentrations of the three main constituent anions of alkalinity, carbonate (CO<sub>3</sub><sup>2-</sup>), bicarbonate (HCO<sub>3</sub><sup>-</sup>), and hydroxide (OH<sup>-</sup>), are calculated and reported. These must also be reported in calcium carbonate equivalents (“as CaCO<sub>3</sub>”). Use the parameters and units below.

| Result Parameter Name (AH)                   | EIM Name Type               | Result Value Units (AN) |
|----------------------------------------------|-----------------------------|-------------------------|
| Alkalinity, Carbonate as CaCO <sub>3</sub>   | Primary                     | mg/L, rarely ug/L       |
| Alkalinity, Carbonate                        | Synonym (OK for data entry) | mg/L, rarely ug/L       |
| Alkalinity, Bicarbonate as CaCO <sub>3</sub> | Primary                     | mg/L, rarely ug/L       |
| Alkalinity, Bicarbonate                      | Synonym (OK for data entry) | mg/L, rarely ug/L       |
| Alkalinity, Hydroxide as CaCO <sub>3</sub>   | Primary                     | mg/L, rarely ug/L       |
| Alkalinity, Hydroxide                        | Synonym (OK for data entry) | mg/L, rarely ug/L       |

## Methods

Following are some common alkalinity methods in EIM. If you don’t see your method here, you can [search for more Method Valid Values online](#). If you still can’t find it, contact your EIM data coordinator.

| Result Method (AY) | Description                                                                    |
|--------------------|--------------------------------------------------------------------------------|
| SM2320B            | Alkalinity, Total (Hydroxide, Carbonate and Bicarbonate) by Titrimetry, pH 4.5 |
| EPA310.2           | Alkalinity (Colorimetric, Automated, Methyl Orange)                            |

## Hardness

Hardness is a measure of dissolved metals ions, primarily calcium ( $\text{Ca}^{2+}$ ) and magnesium ( $\text{Mg}^{2+}$ ), in water. Harder water can reduce the bioavailability of certain toxic metals to aquatic organisms.

Hardness is related to alkalinity in that with hardness we measure the cations (e.g.,  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ ) in the carbonate molecule, whereas with alkalinity we measure the anions (e.g.,  $\text{CO}_3^{2-}$ ).

Like alkalinity, hardness is measured by titration and is reported in calcium carbonate equivalents (“as  $\text{CaCO}_3$ ”). It can also be measured by quantifying the concentration of calcium and magnesium cations and calculating hardness.

## How to enter Hardness data into EIM

### Parameter

Hardness is often reported using the unit “mg/L as  $\text{CaCO}_3$ .” **Do not use this unit in your template!** In EIM we indicate “as  $\text{CaCO}_3$ ” in the parameter name. Use the parameter name and unit below.

| Result Parameter Name (AH)         | EIM Name Type               | Result Value Units (AN) |
|------------------------------------|-----------------------------|-------------------------|
| Hardness, Total as $\text{CaCO}_3$ | Primary                     | mg/L, rarely ug/L       |
| Total Hardness as $\text{CaCO}_3$  | Synonym (OK for data entry) | mg/L, rarely ug/L       |

### Methods

Following are some common hardness methods in EIM. If you don’t see your method here, you can [search for more Method Valid Values online](#). If you still can’t find it, contact your EIM data coordinator.

| Result Method (AY) | Description                                                                                   |
|--------------------|-----------------------------------------------------------------------------------------------|
| SM2340B            | Hardness, Total (as $\text{CaCO}_3$ ), Calculated (from separate determinations of Ca and Mg) |
| EPA130.2           | Hardness, Total (as $\text{CaCO}_3$ ), Titrimetric, EDTA                                      |
| SM2340C            | Hardness, Total (mg/l as $\text{CaCO}_3$ ), Titrimetric, EDTA                                 |

**DO NOT report *metals methods* for hardness.** Metals methods are the analytical methods for individual components of hardness, like  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ . If you used a metals method to determine values for  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ , you need to calculate and report hardness using a derivation method like SM2340B. Here are examples of **methods you should NOT report**:

| Result Method (AY) | Description                                                                                                        |
|--------------------|--------------------------------------------------------------------------------------------------------------------|
| EPA200.7           | Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) |
| SW6010C            | Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) for Metals & Trace Elements, Rev 3               |

## Acidity

Acidity is related to pH, but not directly. pH is a measure of the free hydrogen ion ( $H^+$ ) effective concentration, or activity, in water. Acidity is a measure of the actual concentration of hydrogen ions. Like alkalinity, acidity is a measure of pH buffering, except that it measures the base-neutralizing capacity of water instead of the acid-neutralizing capacity.

Acidity can be an indicator of contamination and is usually measured as part of the characterization process for acid mine drainage. Acids affect chemical and biological reaction rates, chemical speciation, and can be an indicator of corrosion potential. Acidity measures the combined effect of strong mineral acids, weak acids, and hydrolyzing salts.

Acidity is measured by titrating water with a strong base until a specific pH is reached. Like alkalinity and hardness, acidity is reported in calcium carbonate equivalents (as  $CaCO_3$ ).

## How to enter acidity data into EIM

### Parameter

Sometimes acidity is reported using the unit “mg/L as  $CaCO_3$ .” **Do not use this unit in your template!** In EIM we indicate “as  $CaCO_3$ ” in the parameter name. Use the parameter name and unit below.

| Result Parameter Name (AH) | EIM Name Type | Result Value Units (AN) |
|----------------------------|---------------|-------------------------|
| Acidity as $CaCO_3$        | Primary       | mg/L                    |

### Methods

Following are some common acidity methods in EIM. If you don’t see your method here, you can [search for more Method Valid Values online](#). If you still can’t find it, contact your EIM data coordinator.

| Result Method (AY) | Description                   |
|--------------------|-------------------------------|
| SM2310B            | Acidity, Titrimetric (pH 8.2) |
| EPA305.1           | Acidity by Titration          |

## References

Hem, J.D., 1984. Study and Interpretation of the Chemical Characteristics of Natural Water., 3rd edition. Water Supply Paper 2254, U.S. Geological Survey, Washington, DC.

## Document Revision History

| Revision Date | Revision No. | Summary of Changes | Reviser(s) |
|---------------|--------------|--------------------|------------|
| 3/15/18       | 1.00         | Original document  | CN         |