



Coding System Approach for Coastal and Marine Ecological Classification Standard (CMECS) Classification and Modifier Units

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Marine and Coastal Spatial Data Subcommittee
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<https://iocm.noaa.gov/cmecs/index.html>

<https://my.usgs.gov/confluence/display/CMECSIG/CMECS+Community+Forum+Home>

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Background/Purpose

A logically consistent code set for classification units is essential for any system to be applicable for developing and managing data. For this reason, Coastal and Marine Ecological Classification Standard (CMECS) coding was designed to be logical, workable, and flexible. A well-designed code set should

- Support database queries
- Support map legend development
- Attribute spatial data
- Simplify data entry

- Provide a short hand for referring to units
- Allow users to combine strings of codes to describe derived units

Because CMECS is a dynamic standard, the coding system must also accommodate new units and allow modifications in the classification framework and hierarchy. Updates to the code and crosswalks between code versions are planned to facilitate this process. It should be noted that the code update process will involve retiring previous units (codes) as the standard evolves. Thus while the legacy of various code versions will be preserved, numerical sorting of codes that reflect hierarchical relationships will become less feasible over time. A list of codes assigned to each unit can be found at <https://iocm.noaa.gov/cmecs/index.html>

Classification Unit Code Structure

The following describes how the CMECS code system is organized and how to apply the codes to subcomponents, individual classification units, and modifiers. Guidance on assembling a code sentence for attributing features using multiple CMECS components, and applying modifier codes, is also included. Below are the principal characteristics of the CMECS code:

- Alpha-numeric values.
- Uppercase letters identify component.
- Periods delimit hierarchical units. This allows potentially hundreds of new units per level and results in a more visually understandable code. Lowercase letters identify subcomponent in which the unit code lies for Geoform and Water Column. There is no period separating subcomponent characters (e.g., Gg, see Geoform Component below) since there is no hierarchy present between them.
- Null values (X) can be used in code sentence where no information is available.

In cases where a user is not confident that the next level up in the hierarchy is appropriate, as in a new provisional lower-level unit, use of the “X” is recommended.

Biogeographic Setting (Component Code E*)

Realm – **E1**, **E2**, **E3**, etc.

Province – **E1.1**, **E1.2**, etc.

Ecoregion – **E1.1.1**, **E1.1.2**, etc.

* For Ecoregional

Aquatic Setting (Component Code A)

- System – **A1, A2, A3**
- Subsystem – **A1.1, A1.2, A1.3**, etc.
- Tidal Zone – **A1.1.1, A1.1.2, A1.1.3**, etc.

Geoform Component (Component Code G)

- Tectonic Setting – **Gt1, Gt2, Gt3**, etc.
- Physiographic Setting – **Gp1, Gp2, Gp3**, etc.
- Origin – **Gg1, Gg2, Gg3**
- Geoform – **Gg1.1, Gg1.2, Gg1.3**, etc.
- Geoform Type – **Gg1.1.1, Gg1.1.2, Gg1.1.3**, etc.
- Level – added as separate field

Substrate Component (Component Code S)

- Origin – **S1, S2, S3**
- Class – **S1.1, S1.2, S1.3**, etc.
- Subclass – **S1.1.1, S1.1.2, S1.1.3**, etc.
- Group – **S1.1.1.1, S1.1.1.2, S1.1.1.3**, etc.
- Subgroup – **S1.1.1.1.1, S1.1.1.1.2, S1.1.1.1.3**, etc.

Biotic Component (Component Code B)

- Setting – **B1, B2**
- Class – **B1.1, B1.2, B1.3**, etc.
- Subclass – **B1.1.1, B1.1.2, B1.1.3**, etc.
- Group – **B1.1.1.1, B1.1.1.2, B1.1.1.3**, etc.
- Community – **B1.1.1.1.1, B1.1.1.1.2, B1.1.1.1.3**, etc.

Water Column Component (Component Code W)

- Layer – **Wl1, Wl2**, etc.
- Salinity – **Ws1, Ws2**, etc.
- Temperature – **Wt1, Wt2, Wt3**, etc.
- Hydroform Class - **Wh1, Wh2**, etc.
- Hydroform – **Wh1.1, Wh1.2**, etc.
- Hydroform Type – **Wh1.1.1, Wh1.1.2**, etc.
- Water Column Feature – **Wf1, Wf2, Wf3** etc.

Classification Unit Code Examples

Biogeographic Setting

E3.1.6 = Temperate Northern Pacific, Cold Temperate Northeast Pacific, Northern California

Aquatic Setting

A2.3.1 = Estuarine, Estuarine Tidal Riverine Coastal, Estuarine Tidal Riverine Coastal Subtidal

Geomorph Component (fully attributed unit)

Gt2p3g1.3.2 = Convergent Active Continental Margin, Bight, Geologic Origin, Bar, Longshore Bar

Geomorph Component (partially attributed unit; tectonic setting and physiographic setting unknown)

Gg1.3.2 = Geologic Origin, Bar, Longshore Bar

Geomorph Component (partially attributed unit: tectonic and physiographic settings known; origin and geomorph unknown)

Gt2p3 = Convergent Active Continental Margin, Bight

Substrate Component

S1.2.3.1.4 = Geologic Origin, Unconsolidated Mineral Substrate, Coarse Unconsolidated Substrate, Gravel, Granule

Biotic Component

B2.1.2.3.1 = Benthic/Attached Biota, Reef Biota, Shallow/Mesophotic Coral Reef Biota, Encrusting Coral Reef, Encrusting Millepora Reef

Water Column Component (fully attributed unit)

WI5s1t4h1.1.2f2 = Estuarine Open Water Surface Layer, Oligohaline Water, Cool Water, Current, Boundary Current, Western Boundary Current, Boundary Layer

Water Column Component (partially attributed unit: Layer, salinity, and temperature known; hydroform and water column features unknown)

WI5s1t4 = Estuarine Open Water Surface Layer, Oligohaline Water, Cool Water

Water Column Component (partially attributed unit: hydroform and feature known; water column layer, salinity, and temperature unknown)

Wh1.1.2f2 = Current, Boundary Current, Western Boundary Current, Boundary Layer

Water Column Component (partially attributed unit: salinity and feature known; water column layer, temperature, and hydroform unknown)

Ws1f2 = Oligohaline Water, Boundary Layer

Modifier Unit Code Structure

Modifier unit codes follow the same design as the classification units: alpha-numeric structure with alphabetic characters defining the modifier and numeric values representing units within that modifier. The modifier codes have the same intended uses as the classification codes except that they should also

- Be short so as to not result in an excessively long code string
- Allow combination with other modifier codes to further describe derived units
- Support attribution of data that only uses modifiers (e.g., rugosity maps)
- Fit within a unit code string (see next section) to clarify which component they are modifying

Below are two examples of codes for CMECS modifiers.

Modifier Code Examples

Anthropogenic Impact

AI03 = Developed

Primary Water Source

PWS04 = Marine

Combining Codes to Produce Unique Derived Units

Users will likely want to attribute features using units from multiple components and may want to add modifiers as well. The following examples illustrate how to assemble such a code “sentence.”

A single observation (record) may have characteristics from more than one CMECS component. For those cases individual component code strings should be separated by a pipe (|) as in the third example below.

Modifier codes should follow the classification unit to which they refer. For the hierarchical components this typically would mean at the end of the classification code string. In the non-

hierarchical Geform and Water Column components, the modifier code should follow the subcomponent unit code to which it refers, as in the first example below. In both cases, parentheses should be used to separate the modifier and classification unit code. Some situations may require more than one modifier to describe a classification unit. In those cases both modifier codes should be enclosed within one set of parentheses and separated by a comma.

Example 1. Water Column Component (fully attributed unit with modifiers for multiple classification units)

WI5(AI2)s1t4h1.1.2f2(OR1) = Estuarine Open Water Surface Layer (Contaminated), Oligohaline Water, Cool Water, Current, Boundary Current, Western Boundary Current, Boundary Layer (Anoxic)

Example 2. Water Column Component (fully attributed unit with multiple modifiers for a single classification unit)

WI5s1t4h1.1.2f2(OR1,PQ1)* = Estuarine Open Water Surface Layer (Contaminated), Oligohaline Water, Cool Water, Current, Boundary Current, Western Boundary Current, Boundary Layer (Anoxic, Aphotic)

* OR= Oxygen Regime modifier, PQ= Photic Quality modifier

Example 3. Substrate Component and Water Column Component values for same record (point, line, or polygon) in a single feature class

S1.2.3.1.4 | WI8s1t4h1.1.2f2 = Geologic, Unconsolidated Mineral Substrate, Coarse Unconsolidated Substrate, Gravel, Granule | Estuarine Open Water Lower Water Column, Oligohaline Water, Cool Water, Current, Boundary Current, Western Boundary Current, Boundary Layer

Co-occurring Elements and Codes

The CMECS system does not limit a user to assigning a single attribute to an observation or map delineation that contains multiple features. Rather, secondary (spatial or volumetric) features can be recorded as co-occurring elements. This approach is intended for situations where there is more than one unit *within the same CMECS component*, present in a single sample (grab, video image, etc.) or polygon.

Since several co-occurring elements may be present within an observation, users are encouraged to add an additional field (attribute) to the existing table for each co-occurring element rather than combine their codes into the code string for the primary unit attribute.

Table 1 illustrates how co-occurring unit codes could be included as additional attributes for an observation when working with one of the CMECS components.

Example	Tectonic Province	Physiographic Province	Geoform Origin	Geoform		CMECS Code	Co-Occuring Element 1	Co-Occuring Element 2	Co-Occuring Element 3
1			Geologic	Lagoon		Gg1.32	Gg3.10	Gg3.25	X
2		Lagoonal Estuary				Gp9(EI01,PWS02)	Gg3.1	X	X
Example	Biotic Setting	Biotic Class	Biotic Subclass	Biotic Group	Biotic Community	CMECS Code	Co-Occuring Element 1	Co-Occuring Element 2	Co-Occuring Element 3
3	Benthic/Attached Biota	Aquatic Vegetation Bed	Benthic Macroalgae	Filamentous Algal Bed	Aghardiella Communities	B2.5.1.4.1	B2.5.2.1.1	B2.5.1.5.4	X
4	Benthic/Attached Biota	Emergent Wetland	Emergent Tidal Marsh	Freshwater Tidal Marsh	Eriocaulon parkeri - Polygonum punctatum Herbaceous Vegetation	B2.6.1.2.1(PC04)	B2.7.1.2.3(TP05)	X	X
Example	Substrate Origin	Substrate Class	Substrate Subclass	Substrate Group	Substrate Subgroup	CMECS Code	Co-Occuring Element 1	Co-Occuring Element 2	Co-Occuring Element 3
5	Geologic Substrate	Unconsolidated Mineral Substrate	Fine Unconsolidated Substrate	Substrate Sand	Very Coarse Sand	S1.2.2.2.1(SP04)	S1.1.1	S3.2.2	S2.5.1.2
6	Biogenic Substrate	Coral Substrate	Coral Reef Substrate			S2.2.1(SR05)	S2.1.1.1(SP04)	X	X

Table 1. Co-Occurring element attributes for three sample CMECS component data records.

Examples from Table 1 are more fully described below:

- Example 1 = A mooring field and cable area in a lagoon.
- Example 2 = An aquaculture structure in a very low energy lagoonal estuary with local estuary exchange.
- Example 3 = An *Aghardiella sp.* algae community with co-occurring *Ruppia maritima* and *Codium sp.*
- Example 4 = An *Eriocaulon parkeri* and *Polygonum punctatum* freshwater tidal marsh with 20 to <30% cover with co-occurring *Alnus serrulata - Salix nigra / Pilea (fontana, pumila)* Tidal Shrubland having a temporal persistence on a scale of months.

- Example 5 = A rippled very coarse sand with co-occurring bedrock, wood rubble, and crepidula reef substrate.
- Example 6 = A highly rugose coral reef substrate with co-occurring rippled *Halimeda* sand.

The CMECS guidance document on nomenclature recommendations also provides examples of how to assemble individual CMECS units to describe observations and landscape features.