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# Information Model

This standard defines the conceptual models for the description of groundwater observations and interpretive data, making use of ISO19156 as the base conceptual model. The standardization target for the UML conformance classes are:

Encoding models derived from the conceptual model of this standard.

Software implementations seeking compliance to this standard.

## Logical Model

The Logical Model for the GroundWaterMl2-Core <<Application Schema>> is summarized in three UML diagrams. Figure xx focuses on the groundwater hydrogeological unit (GW\_HydrogeoUnit) and its relationships to associated features. Figure xx presents the groundwater properties and relationships, and Figure xx the fluid body (GW\_FluidBody) properties and relationships. These are all ‘views’ of the same GroundWaterMl2-Core Logical Model.

Naming conventions …



Figure 1. UML of the GWML2-Core GW\_HydrogeoUnit Logical Model.



Figure 2. UML of the GSML2-Core groundwater properties Logical Model



Figure 3. UML of the GW\_FluidBody Logical Model

# Requirements Classes

## Structural overview of requirements classes

The requirements classes of the standard are structured as shown in **Erreur ! Source du renvoi introuvable.**.

Figure 4. GroundWaterML2.0 over view of Requirements Classes

## Package dependencies

GroundWaterML2-Core has dependencies on other external standards. These dependencies are shown in Figure XX.

Figure 5. GroundWaterML2.0-Core external dependencies.

## Use of vocabularies

Controlled vocabularies, also known as code-lists, are used in data exchange to identify particular concepts or terms, and sometimes relationships between them. For example, an organisation may define a controlled vocabulary for all observed phenomena that are to be exchanged between parties. Some of these definitions may be related in hierarchies or through other relationships such as equivalence.

GroundWaterML2.0 specifies that a full set of vocabularies for data exchange should be established as a first step for groundwater data exchange.

These vocabularies are defined within the OGC definition namespace (**http://www.opengis.net/def/groundwaterml/2.0/**), which is governed by the OGC Naming Authority (OGC-NA). The OGC-NA is responsible for processing requests to change or add new definitions to this namespace. The procedures for the OGC-NA are outlined in OGC document 09-046 (OGC-NA – Procedures) and the structure of URIs is outlined in OGC 09-048 (OGC-NA – Name type specification – definitions).

It is envisaged that GroundWaterML2.0 will be used alongside existing sets of vocabularies as agreed upon within communities. The parties involved in exchange will determine the vocabularies that are to be used in exchanged. Future work within the Hydrology Domain Working Group should address the area of controlled vocabularies for the groundwater domain. These vocabularies require a governance structure that allows changes to be made as definitions evolve.

## Requirements Class: XML rules

Groundwater features and their properties will be encoded in XML using standard GML encoding rules.

|  |  |
| --- | --- |
| **Requirements class** | /**[req/xsd-xml-rules](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Target type** | XML data document |
| **Dependency** | http://www.w3.org/TR/xmlschema-2 |
| **Dependency** | http://www.opengis.net/doc/IS/GML/3.2/clause/2.4 |
| **Dependency** | http://www.opengis.net/spec/SWE/2.0/req/xsd-simple-components |
| **Dependency** | urn:iso:dis:iso:8601:2004:clause:4 |
| **Requirement** | /req/xsd-xml-rules/time-zone |
| **Requirement** | /req/xsd-xml-rules/unit-of-measure |
| **Requirement** | /req/xsd-xml-rules/swe-types |
| **Recommendation** | /req/xsd-xml-rules/xlink-title |
| **Recommendation** | /req/xsd-xml-rules/vocabulary-references |

The date-time formats will conform to ISO standards.

|  |  |
| --- | --- |
| **/req/xsd-xml-rules/iso8601-time** | All date-time elements shall be encoded using ISO8601 extended time format |

Note that this precludes the use of time-coordinate systems such as UNIX time. This is specified in order to be maximally consistent with WML2 requirements. The time zone will be included in the time element.

|  |  |
| --- | --- |
| **/req/xsd-xml-rules/time-zone** | The value of each time element shall include a time zone definition using a signed 4 digit character or a ‘Z’ to represent Zulu or Greenwich Mean Time (GMT). This is defined by the following regular expression:  (Z|[+-]HH:MM) |

The units of measure shall be taken from a standard water quality vocabulary governed by the groundwater community. The unit of measure must be suitable for the observed property (constraint inherited from OM\_Observation).

|  |  |
| --- | --- |
| **/req/xsd-xml-rules/unit-of-measure** | All units of measure shall be specified using the URI for an individual from the class http://qudt.org/schema/qudt#Unit defined in http://environment.data.gov.au/water/quality/def/unit |

Some SWE Common types are restricted to avoid ambiguity.

|  |  |
| --- | --- |
| **/req/xsd-xml-rules/swe-types** | When using the SWE Common types, the following elements shall not be used: swe:quality (*AbstractSimpleComponentType)*, swe:nilValues (*AbstractSimpleComponentType)*, swe:constraint (*QuantityType*, *QuantityRangeType*, *CategoryType*). The attributes ‘*optional’* and ‘*updatable’* from the base type ‘*AbstractDataComponent’* shall not be used. |

The xlink:title attribute ought contain a text label when an xlink:href refers to a controlled vocabulary or ontology.

|  |  |
| --- | --- |
| **/req/xsd-xml-rules/xlink-title** | If an xlink:href is used to reference a controlled vocabulary item, the element should encode the xlink:title attribute with a text label of the referenced item. |

Vocabulary references made via xlink:href ought to be a resolvable URI in the form of an HTTP URL.

|  |  |
| --- | --- |
| **/rec/xsd-xml-rules/vocabulary-references** | When specifying references to vocabulary (code) items using an xlink:href, a resolvable HTTP URL should be used which, when resolved, should provide suitable description of the concept being referenced. |

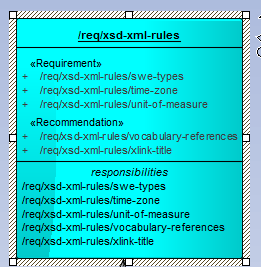
This requirements class defines common rules and recommendations for all XML instances.

Figure 6. Requirements Class for XML rules.

## Requirements Class: GroundWaterML2-Core

The XML encoding of the GroundWaterML2-Core features and their properties shall conform to the properties, data types and cardinalities defined in the GroundWaterML2-Core Logical Model UML (Figure xx).

|  |  |
| --- | --- |
| **Requirements class** | /**[req/gwml2-core](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Target type** | XML data document |
| **Dependency** | /req/xsd-xml-rules |
| **Dependency** | /req/geosciml-geologicunit |
| **Dependency** | **/req/observation** |
| **Requirement** | /req/core-uml |
| **Recommendation** |  |

The properties, constraints, cardinalities and associations documented in the UML will be honoured in the XML.

|  |  |
| --- | --- |
| /req/core-uml | All XML elements SHALL conform to the GroundWaterML2-Core Logical Model UML as defined at **http://www.opengis.net/def/groundwaterml/2.0/ftc** |

## Requirements class: observations (OM\_Measurement)

Concrete observations of groundwater properties use the OMXML element OM\_Measurement. The observed property common to these elements inherited from OM\_Observation must be taken from the GroundWaterML2-Core Logical Model. The feature of interest property common to these elements also must come from the GroundWaterML2-Core Logical Model feature catalogue. The units of measure used in the result are taken from a groundwater vocabulary.

|  |  |
| --- | --- |
| **Requirements class** | **/req/observation** |
| **Target type** | **XML data document** |
| **Dependency** | **http://www.opengis.net/spec/OMXML/2.0/req/observation** |
| **Requirement** | **/req/observation/observed-property** |
| **Requirement** | /req/observation/feature-of-interest |

The observed property of the observation is to be a property in the GroundWaterML2-Core Logical Model.

|  |  |
| --- | --- |
| **/req/observation/observed-property** | The XML element om:observedProperty SHALL have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/ftc#PropertyKind** defined in **http://www.opengis.net/def/groundwaterml/2.0/def/property** |

The ultimate feature of interest (domain sampled feature) is to be a feature in the GroundWaterML2-Core Logical Model.

|  |  |
| --- | --- |
| **/req/observation/feature-of-interest** | The XML element om:featureOfInterest SHALL have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/ftc#Feature** defined in **http://www.opengis.net/def/groundwaterml/2.0/def/feature** |

This is the core requirements class for all XML instances of groundwater observations.

## Requirements Class: GeoSciML v3.2 GeologicUnit

GW\_HydrogeoUnit is a specialization of GeologicUnit from GeoSciML v3.2 <<Application Schema>> Geologic Unit. The requirements for this GML application schema have not been formally described. This requirements class describes the specific GeoSciML v3.2 GeologicUnit requirements for GroundWaterML2-Core.

|  |  |
| --- | --- |
| **Requirements class** | /req/geosciml-geologicunit |
| **Target type** | XML data document |
| **Dependency** | http://xmlns.geosciml.org/GeologicUnit/3.2 |
| **Requirement** | /req/geosciml-geologicunit/hydrogeounit |
| **Requirement** | /req/geosciml-geologicunit/type |

The GW\_HydrogeoUnit is a specialization of a GeoSciML v3.2 GeologicUnit.

|  |  |
| --- | --- |
| /req/geosciml-geologicunit/hydrogeounit | A GW\_HydrogeoUnit is a kind of GeologicUnit and SHALL inherit all properties and requirements of GeologicUnit. |

The type of GeologicUnit is a hydrogeologic unit.

|  |  |
| --- | --- |
| /req/geosciml-geologicunit/type | The XML element gsml:geologicUnitType SHALL have an xlink:href property whose value is the URI for an individual from the class **http://resource.geosciml.org/classifier/cgi/geologicunittype/hydrogeologic\_unit** |

## Requirements Class: GW\_HydrogeoUnit

Hydrogeologic units (GW\_HydrogeoUnit) are any soil or rock unit or zone which by virtue of its hydraulic properties has a distinct influence on the storage or movement of groundwater (after ANS, 1980).

|  |  |
| --- | --- |
| **Requirements class** | /**[req/gw\_hydrogeounit](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Target type** | XML data document |
| **Dependency** | /**[req/gwml2-core](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Recommendation** | /req/unit-media |

The porosity type term should come from an appropriate porosity type vocabulary.

|  |  |
| --- | --- |
| /req/unit-media | The XML element gwml2:gwUnitMedia SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/porosity-type-term** |



Figure 7. UML specification for GW\_HydrogeoUnit

## Requirements Class: GW\_Aquifer

An aquifer is a body of ground that contains / potentially contains / potentially contained sufficient saturated permeable material to yield significant quantities of water to wells and springs (after Lohman and others, 1972).

|  |  |
| --- | --- |
| **Requirements class** | /**req/gw\_aquifer** |
| **Target type** | XML data document |
| **Dependency** | /**[req/gw\_hydrogeounit](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Recommendation** | /req/aquifer-type |

The porosity type term should come from an appropriate porosity type vocabulary.

|  |  |
| --- | --- |
| /req/aquifer-type | The XML element gwml2:gwAquiferType SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/aquifer-type-term** |



Figure 8. UML specification for GW\_Aquifer

## Requirements Class: GW\_ConfiningBed

A confining bed is a layer of rock having very low porosity and in consequence hydraulic conductivity that hampers the movement of water into and out of an aquifer (Heath 1983).

|  |  |
| --- | --- |
| **Requirements class** | /**req/gw\_confiningbed** |
| **Target type** | XML data document |
| **Dependency** | /**[req/gw\_hydrogeounit](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Recommendation** | /req/conductivity-confinement-type |
| **Recommendation** | /req/spatial-confinement-type |

The degree of confinement type term (e.g. aquiclude) should come from an appropriate confinement type vocabulary.

|  |  |
| --- | --- |
| /req/conductivity-confinement-type | The XML element gwml2: gwConductivityConfinement SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/conductivity-confinement-type-term** |

The degree of spatial confinement type term (e.g. "unconfined-confined", "partially confined") should come from an appropriate spatial confinement type vocabulary.

|  |  |
| --- | --- |
| **/req/spatial-confinement-type** | The XML element gwml2: gwSpatialConfinement SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/spatial-confinement-type-term** |



Figure 9. UML specification for GW\_ConfiningBed.

## Requirements Class: GW\_ManagementArea

An area of ground identified for groundwater management purposes and can be delineated by human factors such as policy or regulation concerns, as well as hydrogeological or hydrological concerns. A groundwater management area does not necessarily align exactly with hydrogeological or hydrological boundaries.

|  |  |
| --- | --- |
| **Requirements class** | /**req/gw\_management-area** |
| **Target type** | XML data document |
| **Dependency** | /**[req/gwml2-core](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Requirement** | /req/gw\_areayield-result |
| **Recommendation** | /req/gw\_areayield-property |
| **Recommendation** | /req/management-area-type |

The result of the area yield of the aquifer or management area (e.g. specific yield, safe yield, license yield etc. but excludes well yield) shall be a quantity range of type swe:QuantityRange.

|  |  |
| --- | --- |
| /req/gw\_areayield-result | The XML element om:result associated with the gwml2: gwAreaYield SHALL have a data type swe:QuantityRange |

The type of yields of the aquifer or management area (e.g. specific yield, safe yield, license yield etc. but excludes well yield) should come from an appropriate yield type vocabulary.

|  |  |
| --- | --- |
| /req/gw\_areayield-property | The XML element om:observedProperty associated with gwml2:gwAreaYield SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/area-yield-property-term** |

The type of management area (e.g. restricted use zone, irrigation area, consumption area) should come from an appropriate management area type vocabulary.

|  |  |
| --- | --- |
| /req/management-area-type | The XML element gwml2: gwAreaType SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/management-area-type-term** |



Figure 10. UML specification for GW\_ManagementArea

## Requirements Class: GW\_FluidBody

A distinct body of some fluid (liquid, gas) that fills the voids of a container such as an aquifer, system of aquifers, water well, etc; in hydrogeology this body is usually constituted from groundwater, but the model allows for other types of fillers e.g. petroleum.

|  |  |
| --- | --- |
| **Requirements class** | /**req/gw\_fluid-body** |
| **Target type** | XML data document |
| **Dependency** | /**[req/gwml2-core](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Requirement** | /req/gw\_body-volume |
| **Recommendation** | /req/fluid-body-quality |

The result of the volume or quantity of water present in a container at a certain time shall be a quantity range of type swe:QuantityRange.

|  |  |
| --- | --- |
| /req/gw\_body-volume | The XML element om:result associated with the gwml2:gwBodyVolume SHALL have a data type swe:QuantityRange |

The type of mixtures associated with the fluid body (e.g. solution, suspension, emulsion, precipitate) should come from an appropriate mixture type vocabulary.

|  |  |
| --- | --- |
| /req/gw\_mixture-type | The XML element gwml2:gwMixture associated with gwml2:gwBodyConstituent SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/mixture-type-term** |

The categorical assessment of fluid quality (e.g. saline, brackish, fresh, turbide, sulfurous, mixed, 1000-3000mg/l tds, etc.) should come from an appropriate fluid quality vocabulary.

|  |  |
| --- | --- |
| /req/fluid-body-quality | The XML element gwml2: gwBodyQuality SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/fluid-body-quality-term** |



Figure 11. UML specification for GW\_FluidBody

## Requirements Class: GW\_HydrogeoVoid

Voids represent the spaces inside (hosted by) a unit or its material (e.g. the pores in an aquifer, or in the sandstone of an aquifer). Voids are hosted by a container (e.g. an aquifer), and can contain water bodies. Voids are differentiated from 'porosity' in that porosity is the proportion of void volume to total volume (i.e. container plus voids), while voids are the spaces themselves. Their delineation as a distinct entity is necessary, for example, to capture the volume of fractures in an aquifer.

|  |  |
| --- | --- |
| **Requirements class** | /**req/gw\_hydrogeo-void** |
| **Target type** | XML data document |
| **Dependency** | /**[req/gwml2-core](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Recommendation** | /req/void-type |

The void type porosity term should come from an appropriate porosity type vocabulary.

|  |  |
| --- | --- |
| /req/void-type | The XML element gwml2:gwVoidType SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/porosity-type-term** |



Figure 12. UML specification for GW\_HydrogeoVoid.

## Requirements Class: GW\_BodySurface

A surface on a body of groundwater, for a local or regional area, e.g. piezometric, potentiometric, water table, salt wedge, etc.

|  |  |
| --- | --- |
| **Requirements class** | /**req/gw\_body-surface** |
| **Target type** | XML data document |
| **Dependency** | /**[req/gwml2-core](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Recommendation** | /req/surface-type |

The surface type term should come from an appropriate porosity type vocabulary.

|  |  |
| --- | --- |
| /req/surface-type | The XML element gwml2:gwSurfaceType SHOULD have an xlink:href property whose value is the URI for an individual from the class **http://www.opengis.net/def/groundwaterml/2.0/surface-type-term** |



Figure 13. UML specification for GW\_BodySurface.

## Requirements Class: GW\_Well

A well or a water well is a shaft or hole sunk, dug or drilled into the Earth to extract water (IGH1379). A Monitoring station is an observation site (e.g. well) used to watch for the advent of an anticipated condition, generally undesirable, such as the advance of the salt-water front in a coastal area where salt-water encroachment is occurring, or the movement of a pollutant injected into a disposal well. IGH0806

|  |  |
| --- | --- |
| **Requirements class** | /**req/gw\_well** |
| **Target type** | XML data document |
| **Dependency** | /**[req/gwml2-core](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Dependency** | http://www.w3.org/TR/xmlschema-2 |
| **Dependency** | http://www.opengis.net/doc/IS/GML/3.2/clause/2.4 |
| **Dependency** | <http://www.opengis.net/specs/SWE/2.0/req/xsd-simple-components> |
| **Dependency** | Sampling features |
| **Dependency** | /req/well-construction |
| **Dependency** | GeoSciML Borehole |
|  |  |

## Requirements Class: Geology\_Log

A geologic log (Geology log) is a collection of lithologic observations along the path of a bore. Lithologic observations can be either a Geologic unit or Earth materials.

|  |  |
| --- | --- |
| **Requirements class** | /**req/gw\_well** |
| **Target type** | XML data document |
| **Dependency** | /**[req/gwml2-core](http://www.opengis.net/spec/waterml/2.0/req/xsd-xml-rules)** |
| **Dependency** | http://www.w3.org/TR/xmlschema-2 |
| **Dependency** | http://www.opengis.net/doc/IS/GML/3.2/clause/2.4 |
| **Dependency** | <http://www.opengis.net/specs/SWE/2.0/req/xsd-simple-components> |
| **Dependency** | Sampling features |
| **Dependency** | /req/well-construction |
| **Dependency** | GeoSciML-Core |
| **Dependency** | GeoSciML-EarthMaterial |
| **Dependency** | O&M |
| **Dependency** | Discrete Coverage |
| **Requirement** | **/req/geologic\_log\_result** |

The geologic log is encoded as a CV\_Discrete\_Coverage

|  |  |
| --- | --- |
| /req/geologic\_log\_coverage | The XML element om:result associated with the gwml2:gwBodyVolume SHALL have a data type CV\_Discrete\_Coverage |

Depth shall be expressed as linear distance from reference elevation

|  |  |
| --- | --- |
| /req/geologic\_log\_depth | The fromDepth and toDepth of a LogValue shall be the linear distance along the bore path from the parent well gwWellReferenceElevation. |

fromDepth must be closer to reference elevation

|  |  |
| --- | --- |
| /req/geologic\_log\_depthOrder | The fromDepth of a LogValue shall be the closest to gw\_WellReferenceElevation while the toDepth shall be the farthest. |

## Media Types for groundwater data

Groundwater data conforming to this specification is encoded in GML-conformant XML documents. The standard MIME-type and sub-type for GML data should be used to indicate the encoding in internet exchange, as specified in **Erreur ! Source du renvoi introuvable.**, namely

application/gml+xml