Introduction to GWML 2 standard

Eric Boisvert – Geological Survey of Canada
Natural Resource Canada

WORLD METEOROLOGICAL ORGANIZATION

WMO HydroHub

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Natural Resources Canada • Geological Survey of Canada
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Groundwater Markup Language 2

OGC WaterML 2: Part 4 - GroundWaterML 2 (GWML2) 2.2.1 OGC 16-032r3

Boyan Brodaric (GSC), Eric Boisvert (GSC), Francois Létourneau (GSC) , Jessica Lucido (USGS), Bruce Simons (CSIRO) , Peter Dahlhaus (FedUni), Mickaël Beaufils (BRGM), Sylvain Grellet (BRGM), Laurence Chery (BRGM), Alexander Kmoch (U Salzburg)

- Geological Survey of Canada (GSC), Canada
- U.S. Geological Survey (USGS), United States of America
- Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
- Bureau of Meteorology (BOM), Australia
- Federation University Australia (FedUni), Australia
- Bureau de Recherches Géologiques et Minières (BRGM), France
- Salzburg University (U Salzburg), Austria

HydroDWG

Hydrology Domain Working Group (HydroDWG)

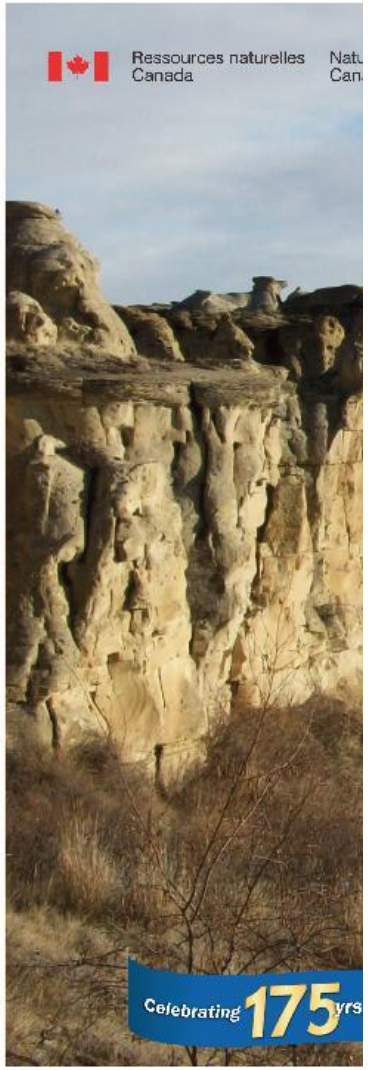
- Tony Boston (ANU, Australia)
- Silvano Pecora (ARPA, Italy)
- David Blodgett (US Geological Survey, USA)

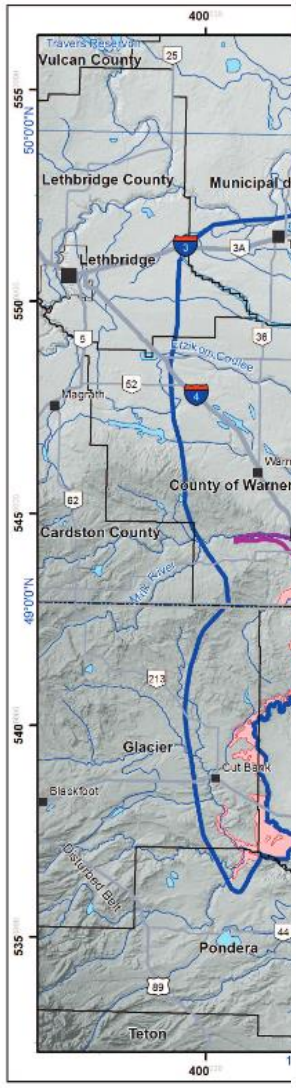
- OGC ® WaterML 2.0 : Part 1 – Timeseries 2.0.1
- OGC ® WaterML 2.0 : Part 2 – Rating, Gauging and Sections 1.0
- OGC ® WaterML 2.0 : Part 3 – Surface Hydrology Feature (HY_Feature) 1.0
- **OGC ® WaterML 2.0 : Part 4 – GroundwaterML 2.2.1**
- OGC ® WaterML 2.0 : Part 5 – Water Quality

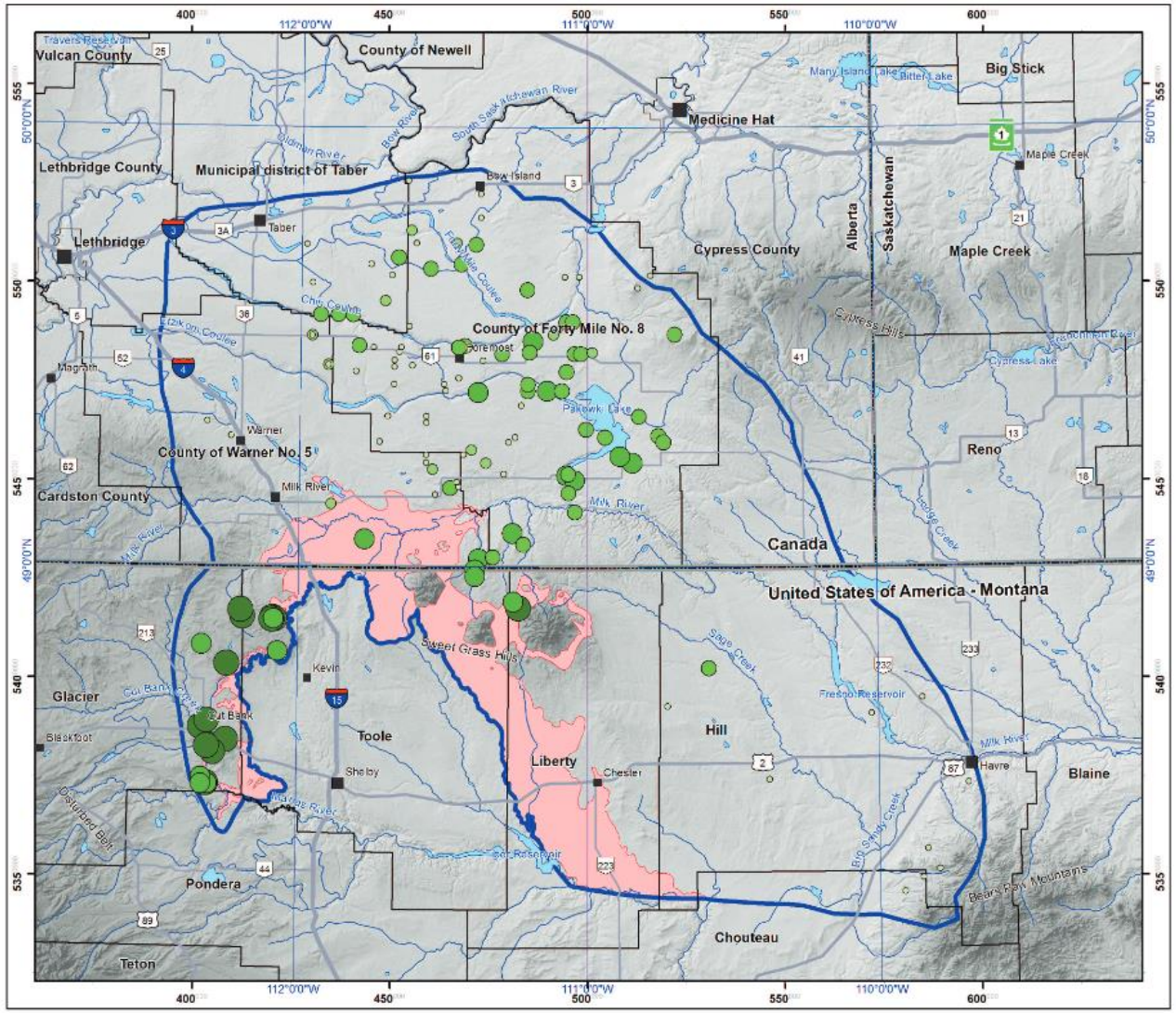
Background

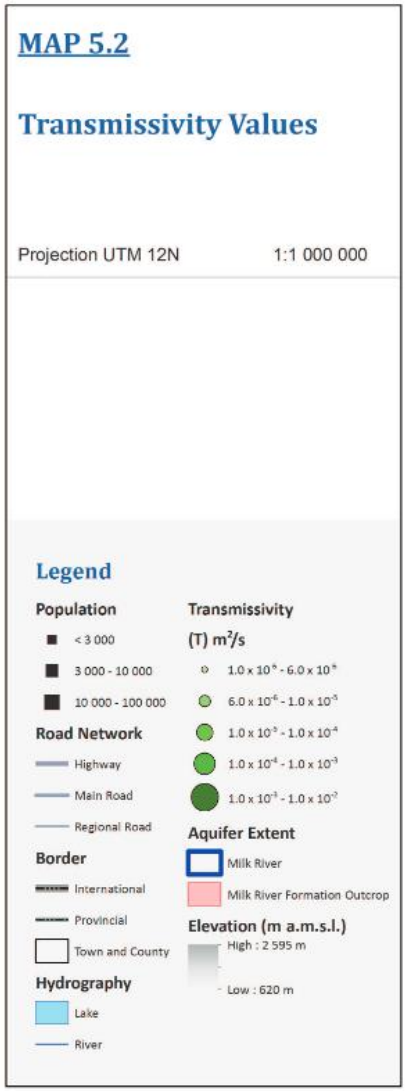
- GWML1: a GML application schema for groundwater data developed at Natural Resources Canada
- GWIE1: an interoperability experiment within the OGC HydroDWG
- GWIE2: a second interoperability experiment within the OGC HydroDWG, tested a precursor of GroundWaterML2 (GWML2, version 2.1)
- INSPIRE Data Specification on Geology — hydrogeology package: a conceptual model and GML application schema for hydrogeology
- BDLISA: the French Water Information System information models for water wells and hydrogeological features

Represents things that are important for hydrogeology









GWML feature types

- **Hydrogeological units**
  - *Geological container, composition*
- **Voids**
  - *The empty spaces in the geological container*
- **Fluid bodies**
  - *The fluid hosted by the spaces, its nature (composition, shape)*
- **Fluid flow**
  - *Movement of that fluid, recharge, discharge*
- **Wells *** (More O&M than GWML)
  - *Anthropological features, borehole, casing, screen*

Hydrogeological units, fluid bodies

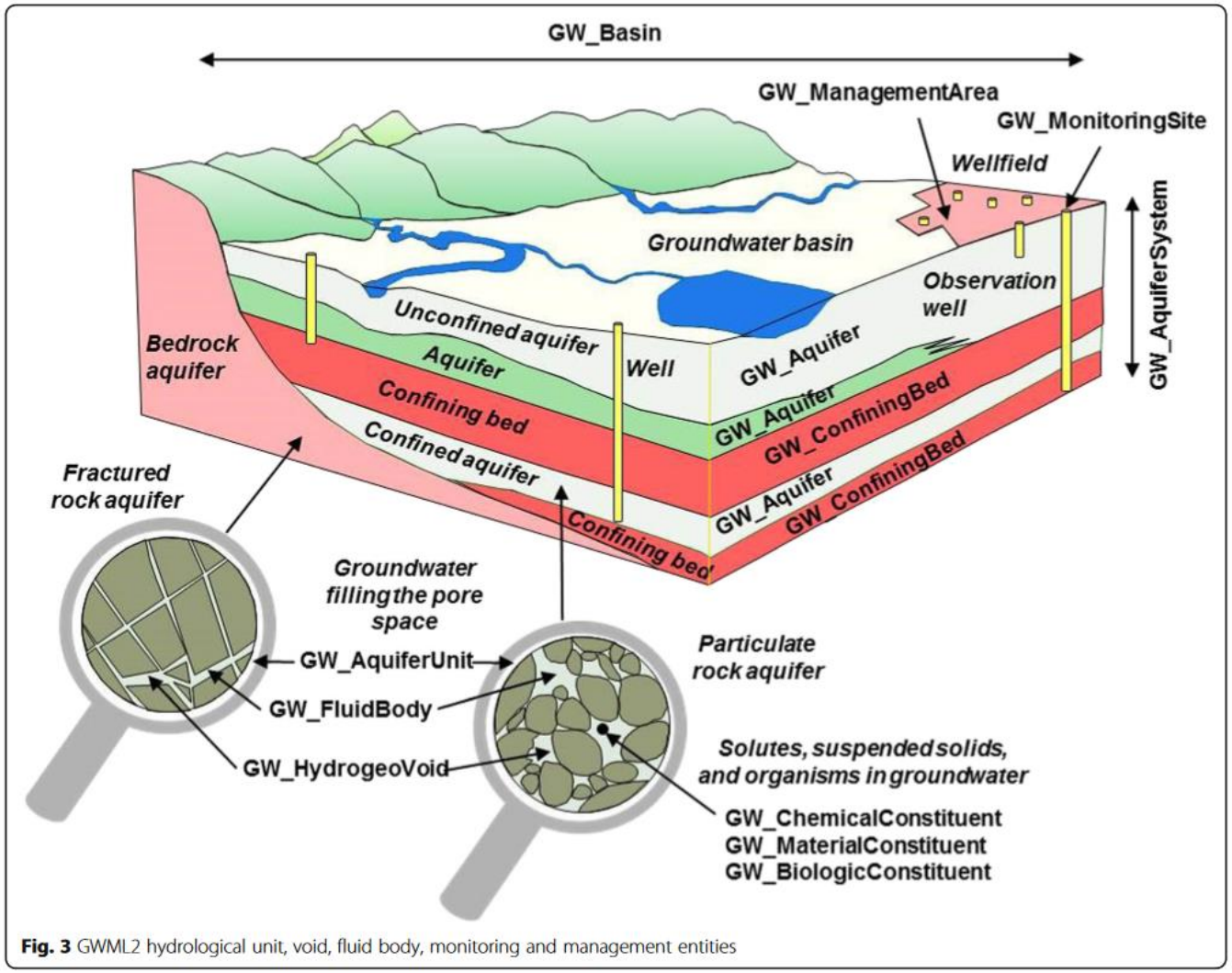
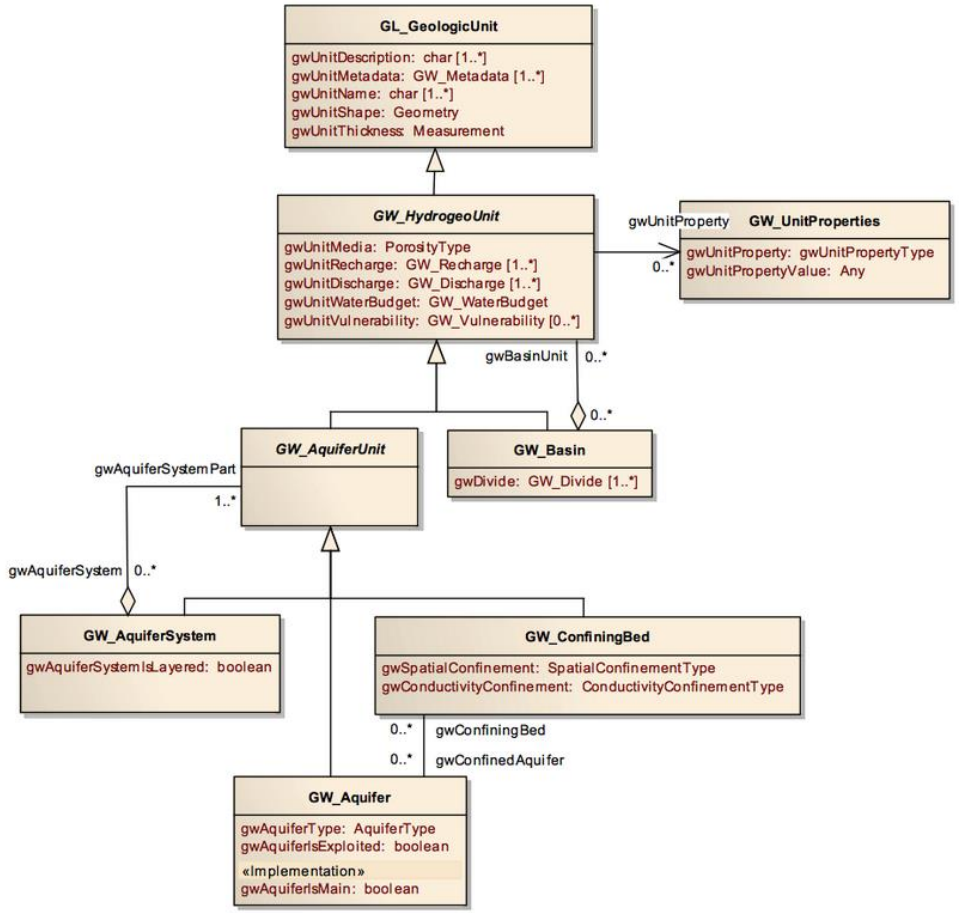
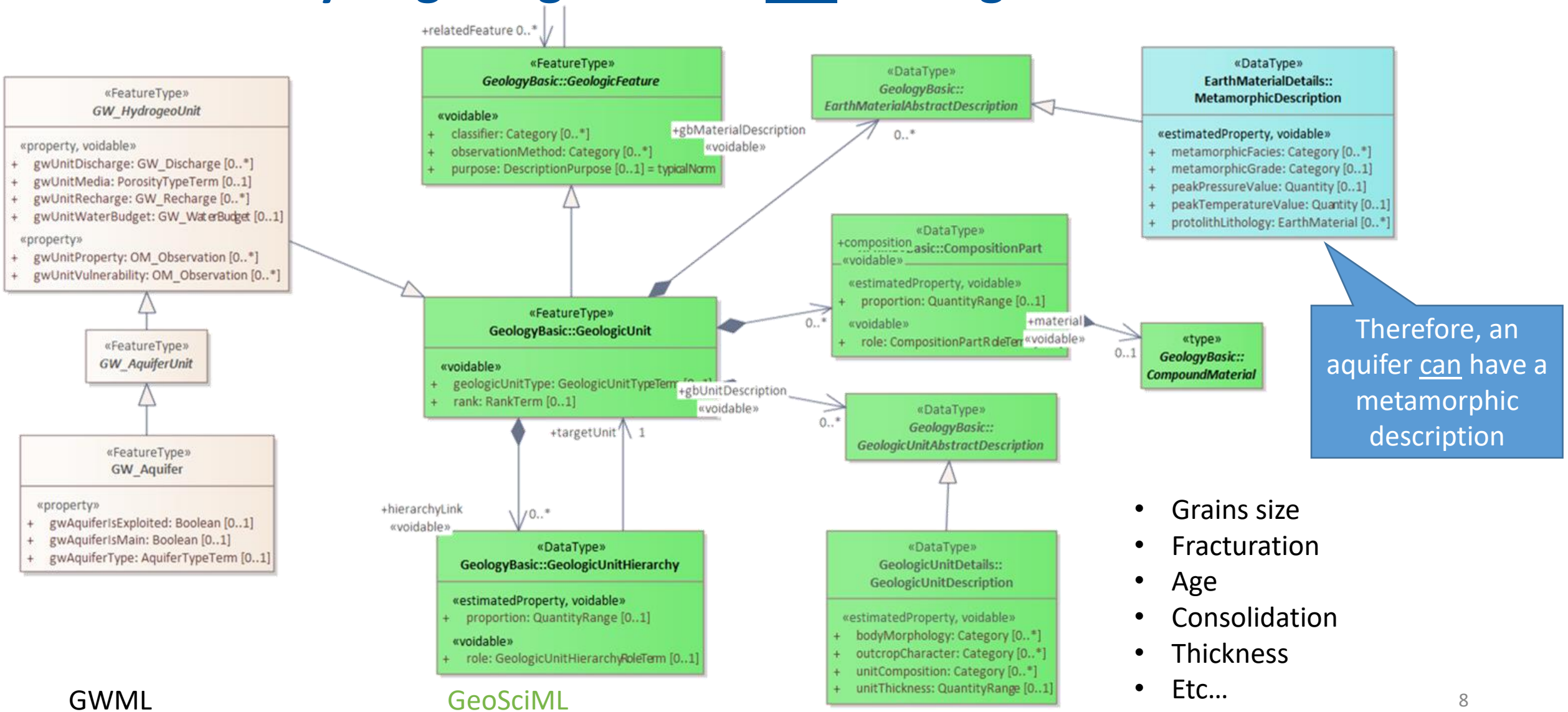


Fig. 3 GWML2 hydrological unit, void, fluid body, monitoring and management entities



HydrogeologicalUnits are GeologicalUnits



Therefore, an aquifer can have a metamorphic description

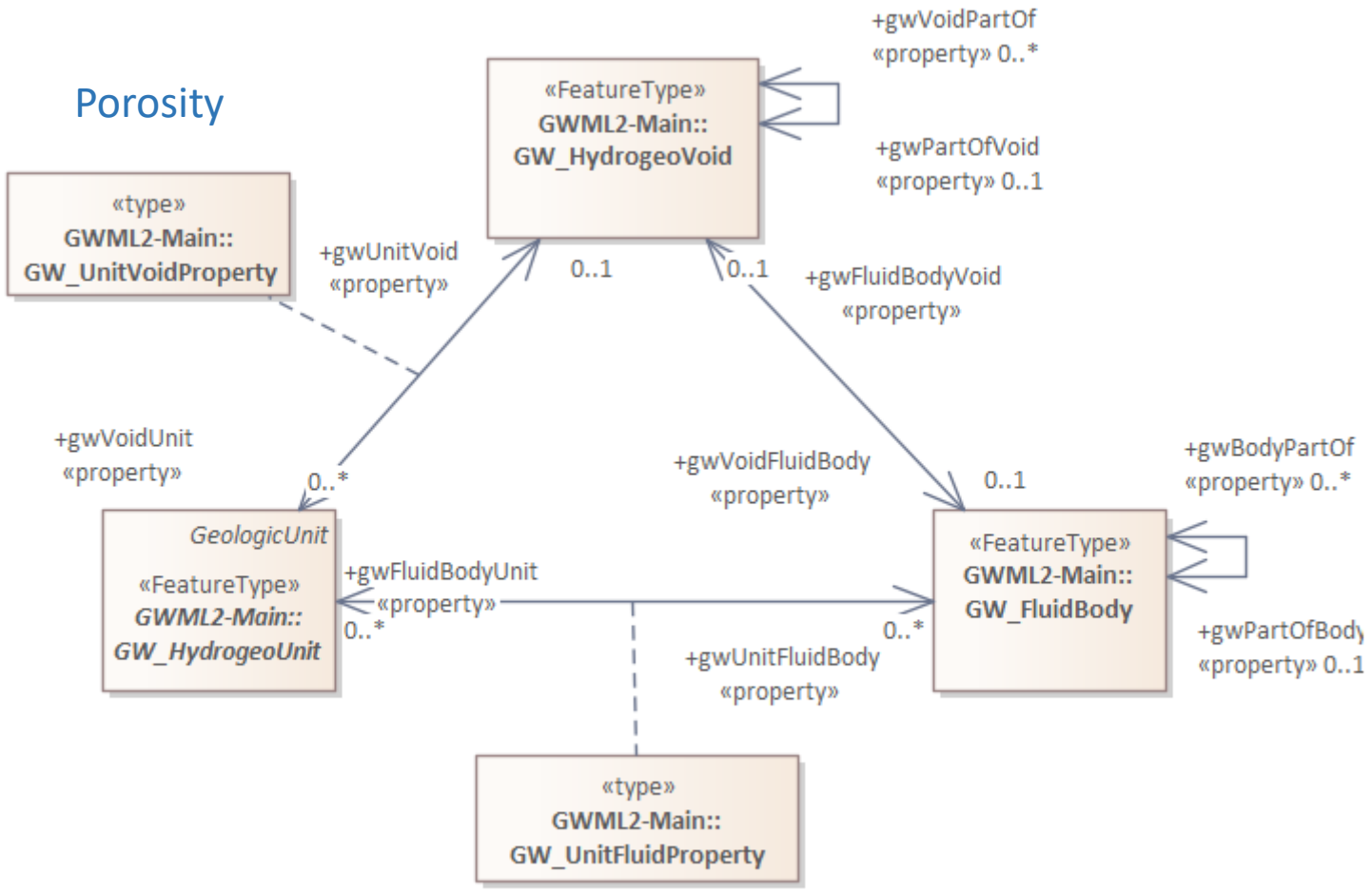
- Grains size
- Fracturation
- Age
- Consolidation
- Thickness
- Etc…

GWML

GeoSciML

Voids

Porosity



Hydraulic conductivity

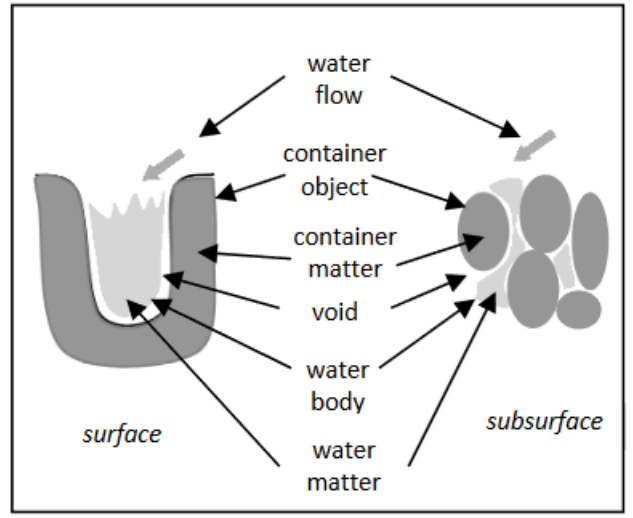


Figure 1: hydro container schema entities

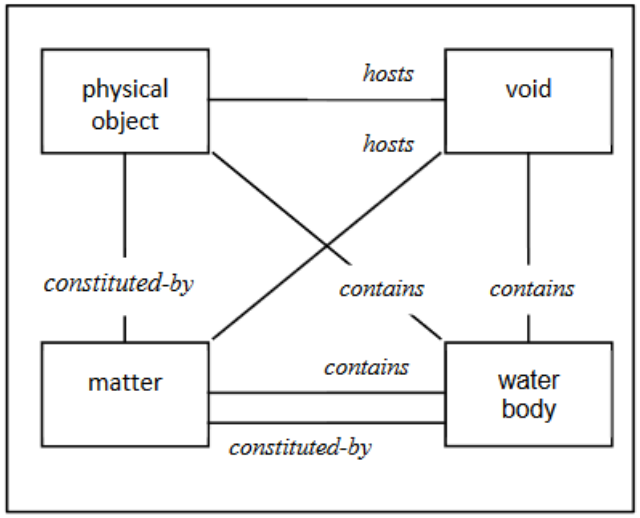
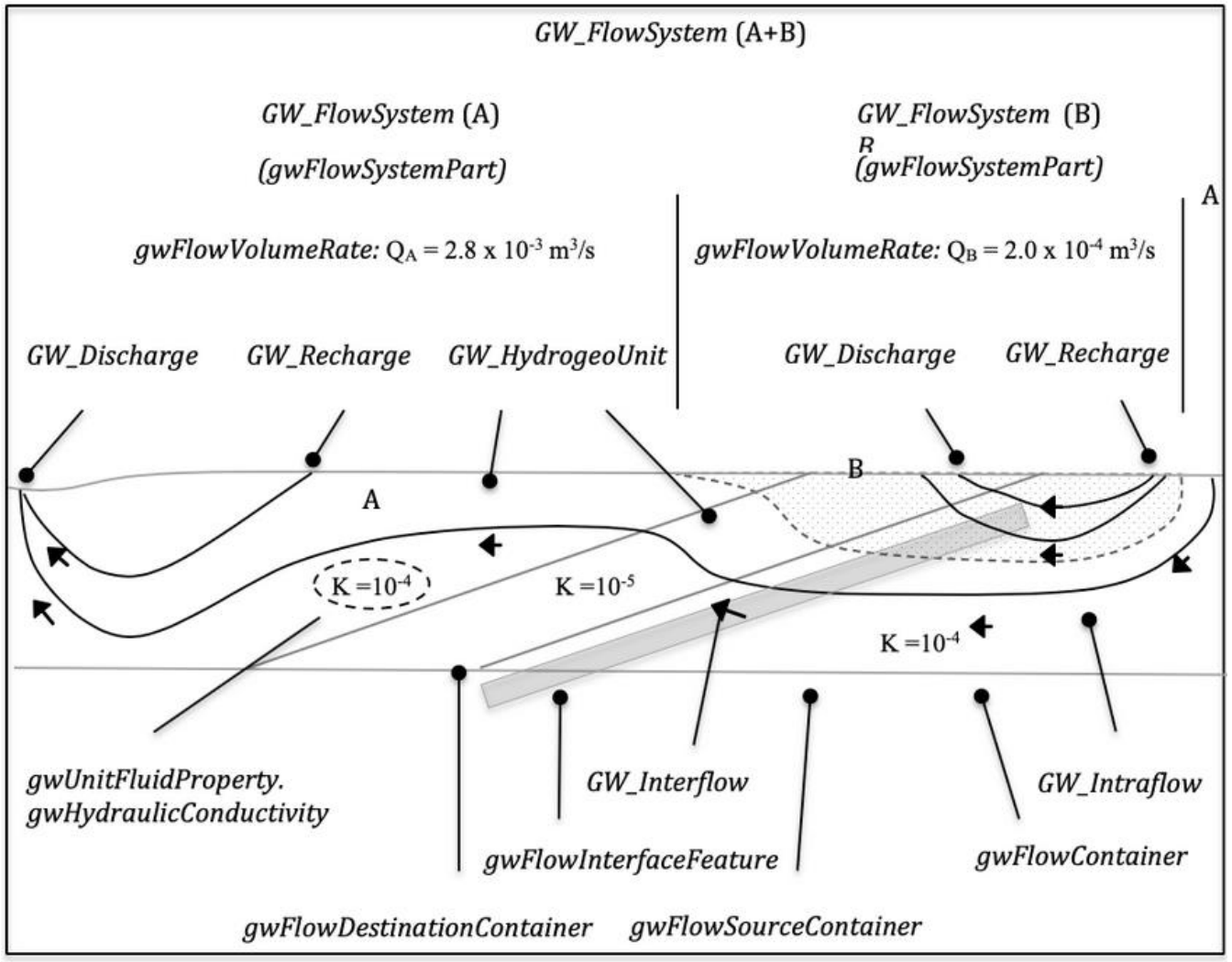


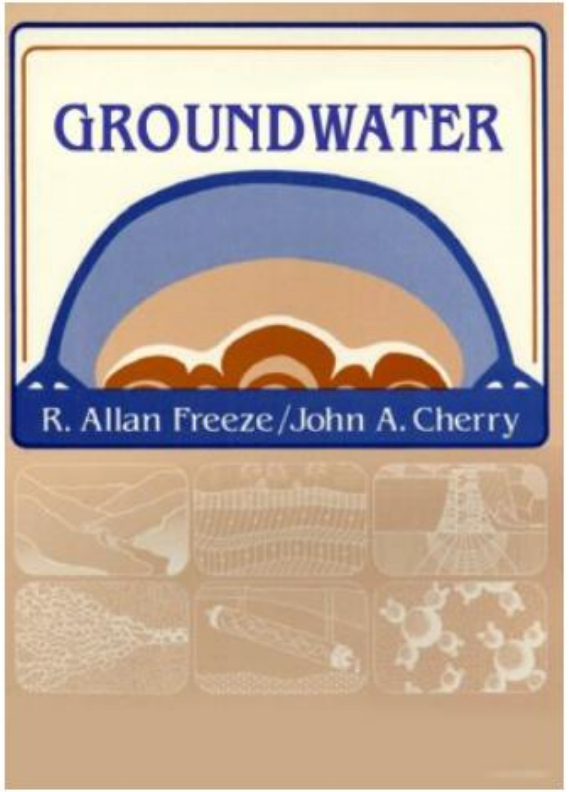
Figure 2: hydro container schema relations

Brodaric and Hahmann, 2014

Groundwater Markup Language 2



Example flow system with two subsystems (after Freeze & Cherry, 1978, p. 204)



https://gw-project.org/books/groundwater/

Online books and educational materials free of charge

Flow systems and wells

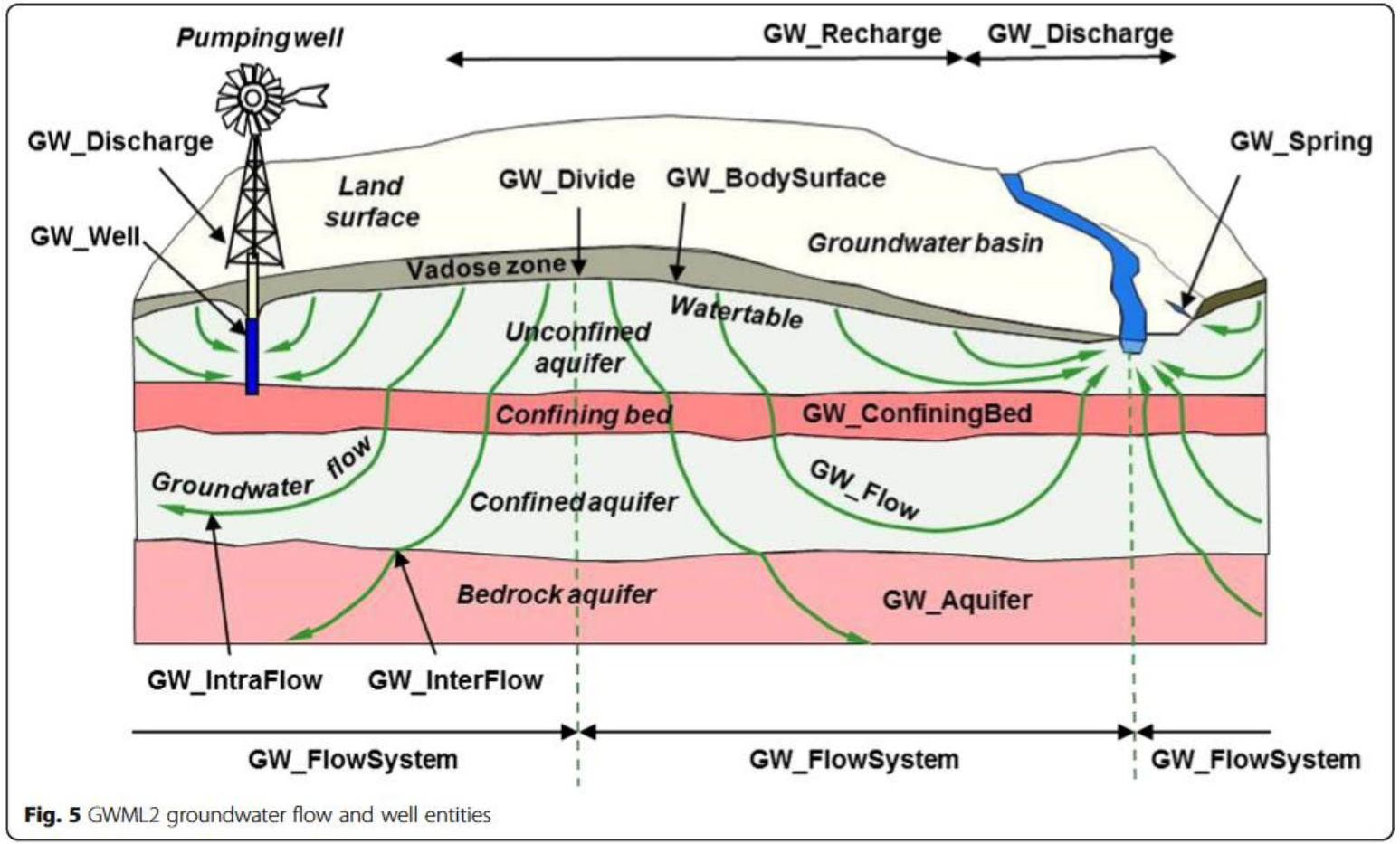
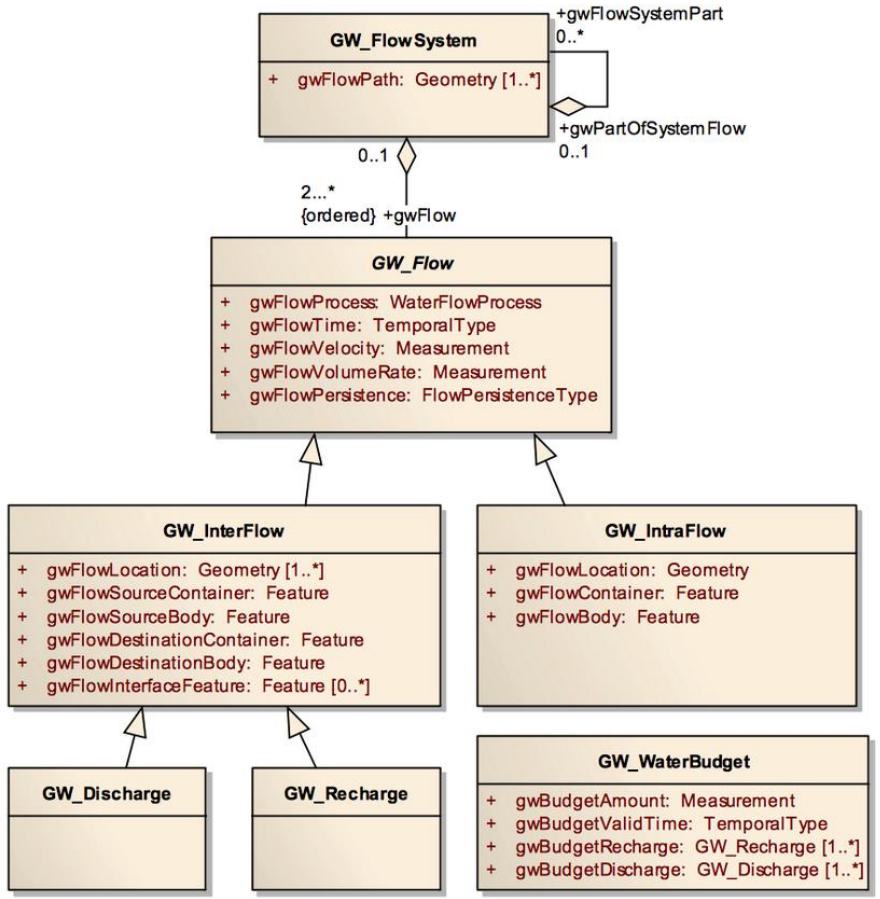
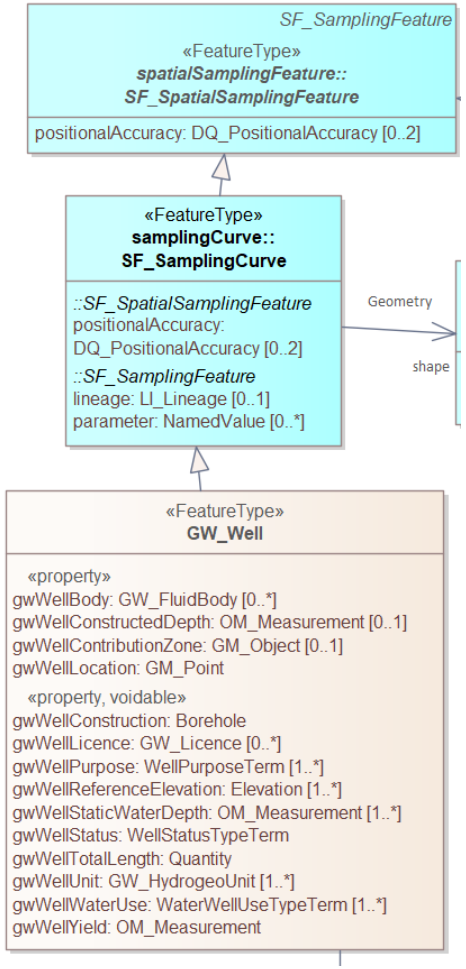
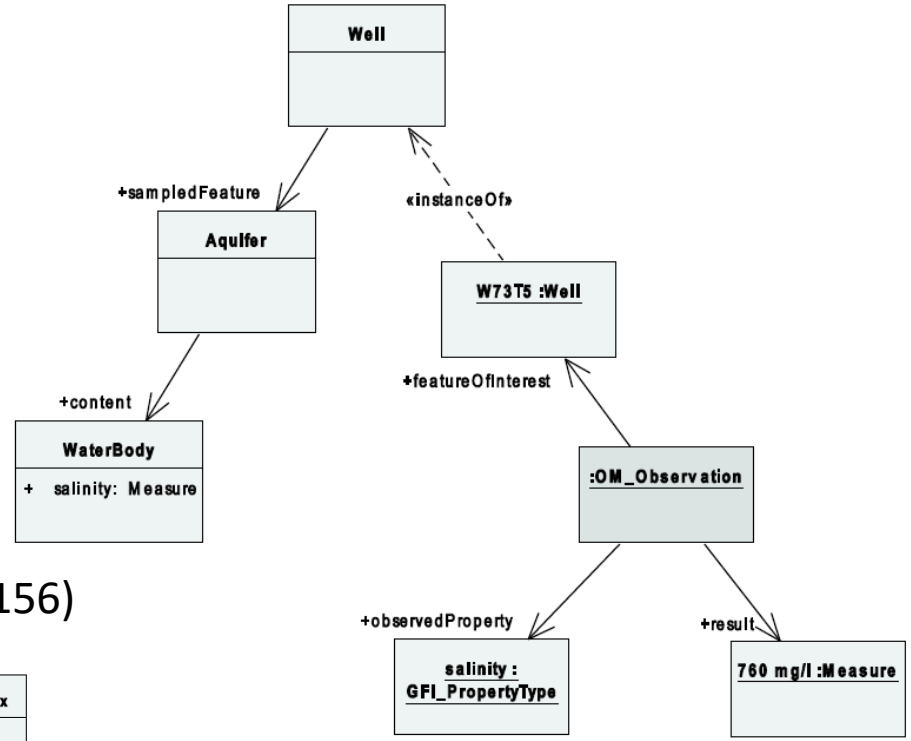


Fig. 5 GWML2 groundwater flow and well entities

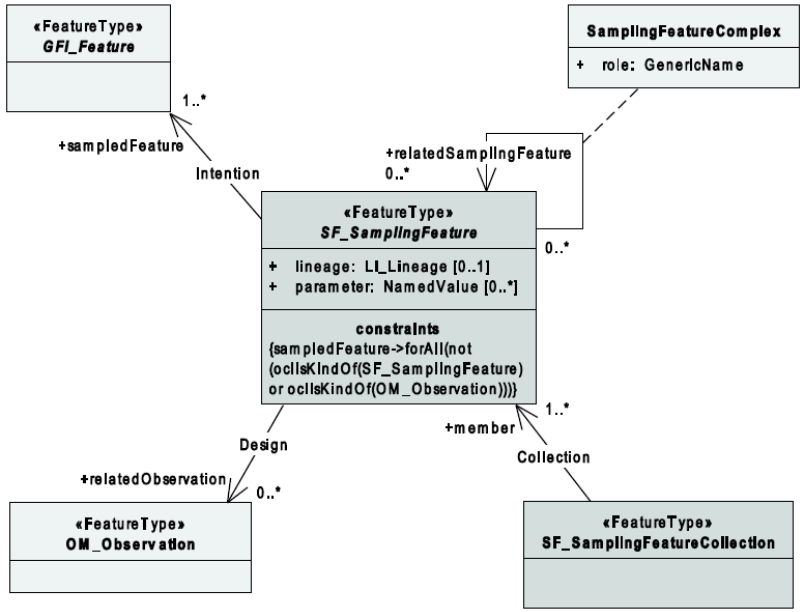


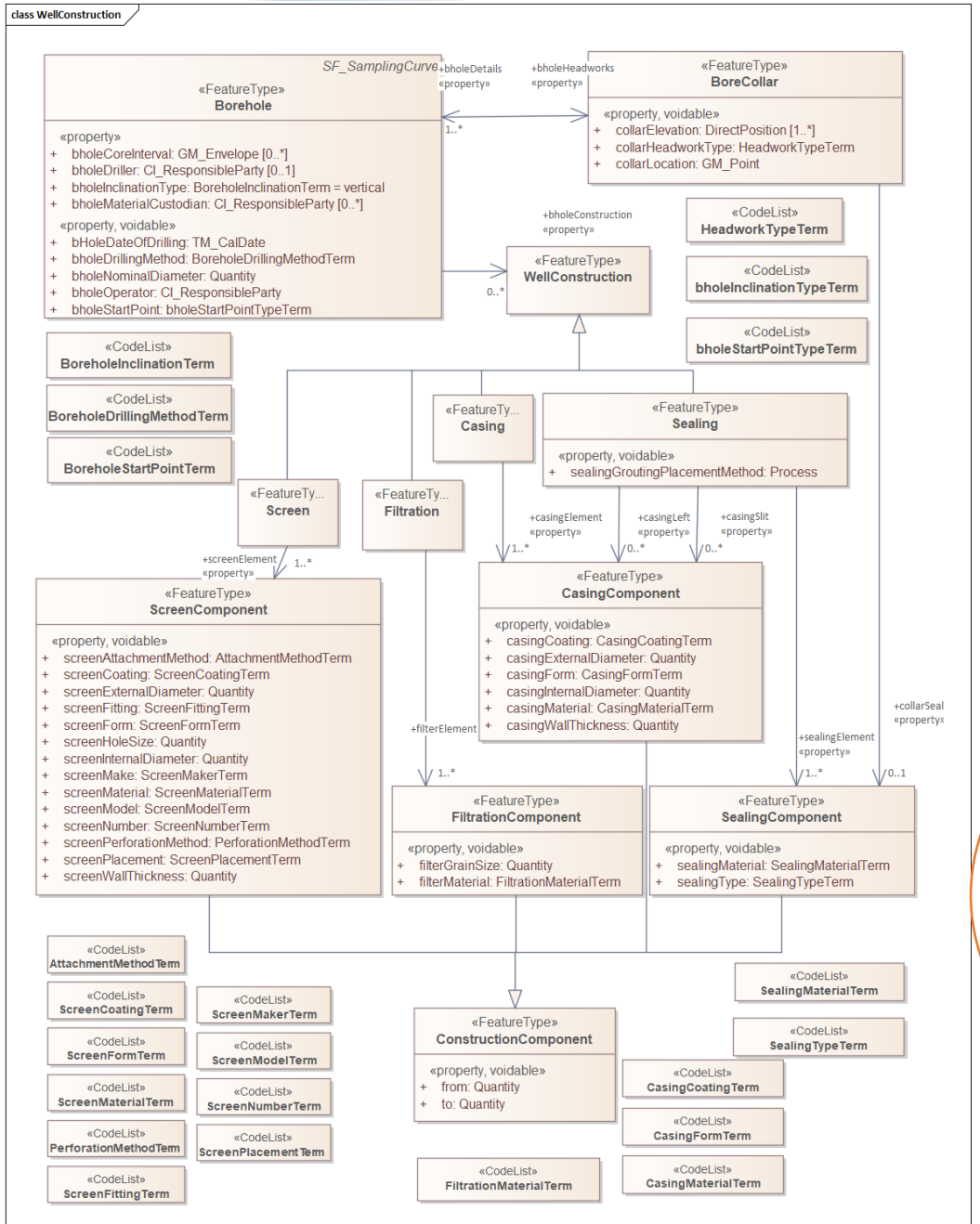
Wells





OGC 10-004r3 (ISO 19156)



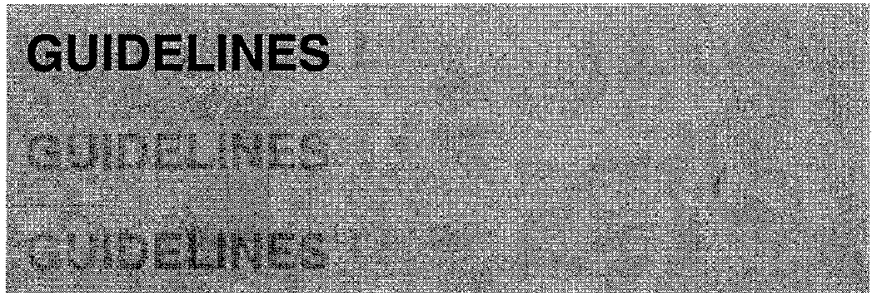


Construction (a.k.a. Borehole)

- Casing
- Filtration
- Sealing
- Screen

FPGWG GTFPES

Prepared by Environment Canada on behalf of the
FEDERAL PROVINCIAL GROUNDWATER WORKING GROUP



At the provincial database site, 4800 or 9600 baud service is suggested with 1200 or 2400 baud service for the drillers and infrequent users. These are speed suggestions based on medium traffic volumes, and they can be increased with no adverse impacts on the groundwater databases. If provincial sub-offices exist, the captured groundwater data could be sent to these sites to reduce the telecommunication charges to a more distant single provincial headquarters site.

December
1991

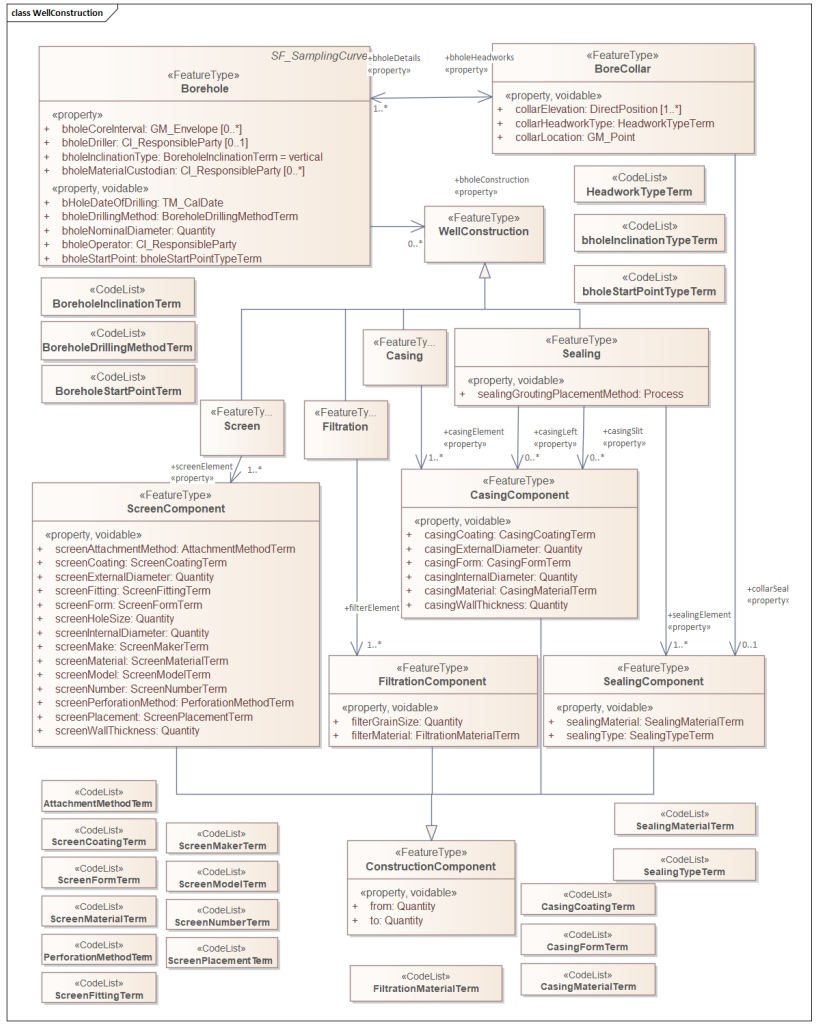
GB
1029
G76

Environment Canada Environnement Canada

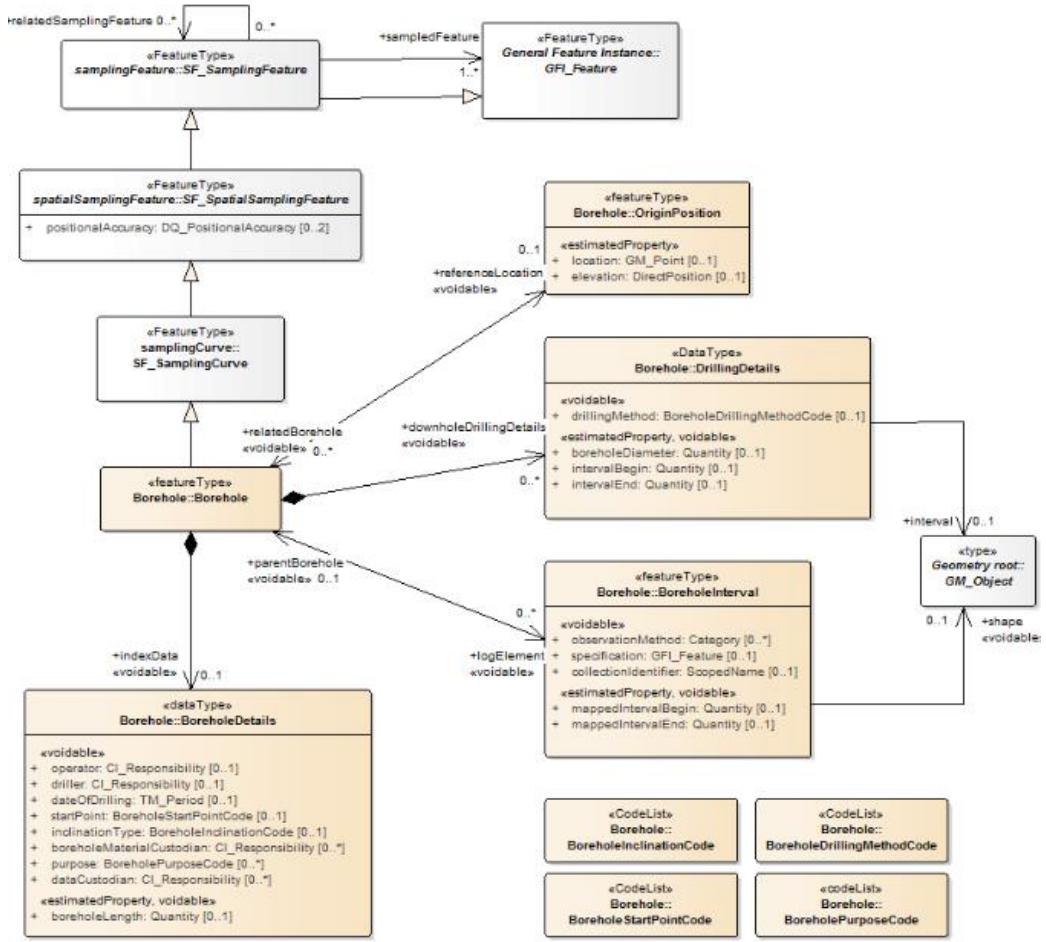
Canada

Already 2 Boreholes specs at OGC

GWML

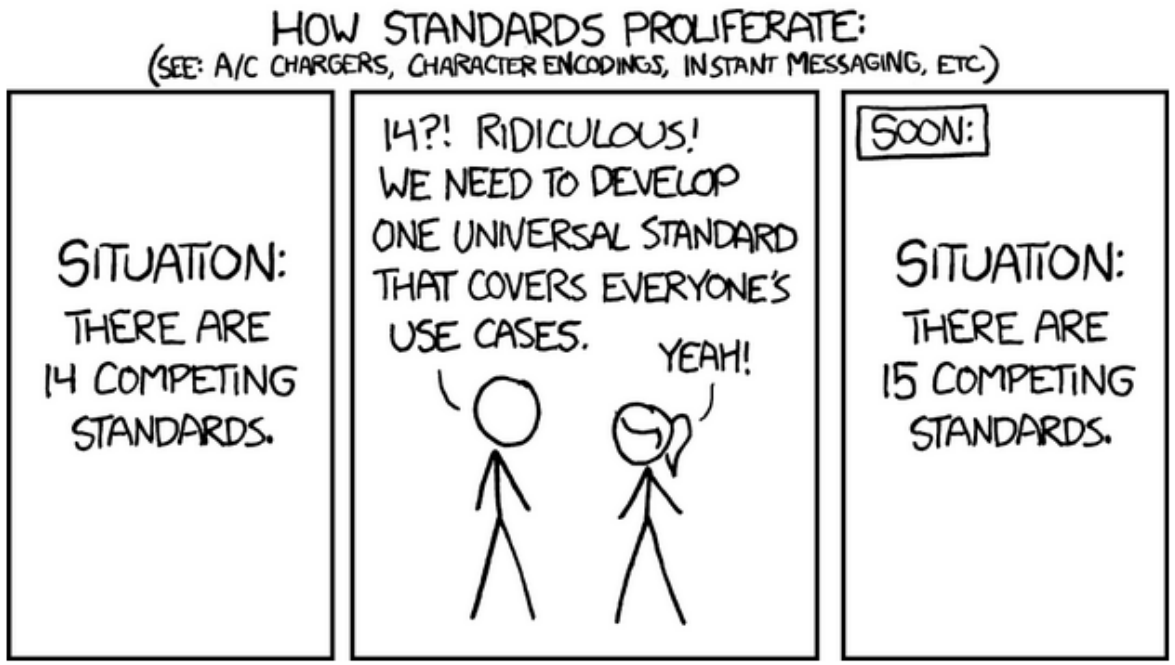


GeoSciML

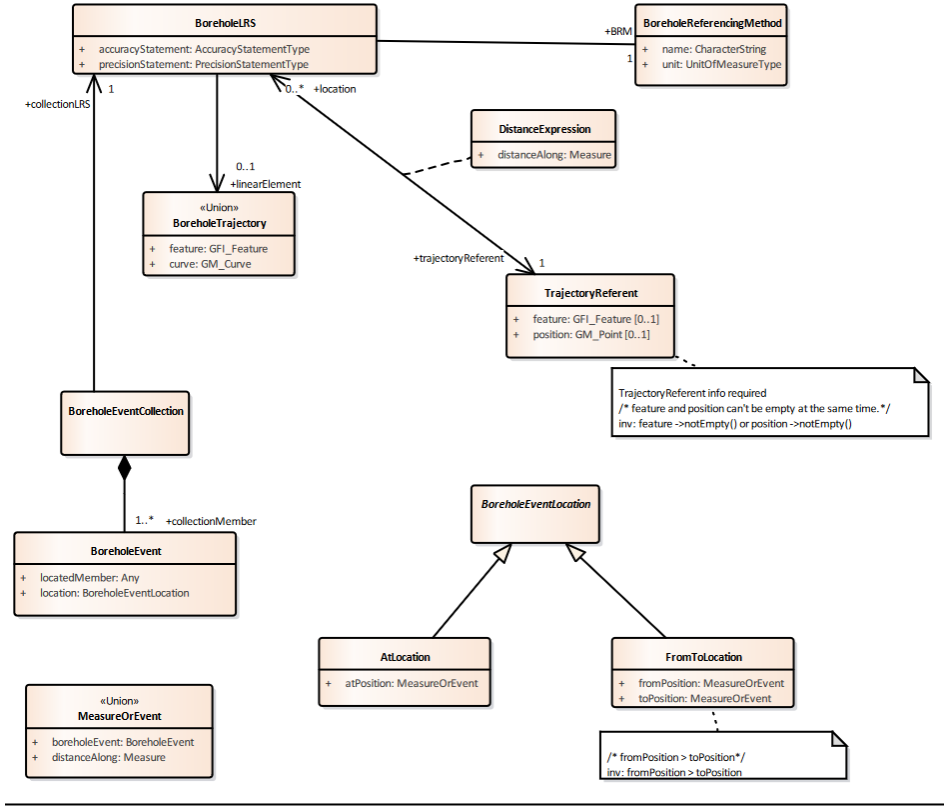


Borehole Interop Experiment

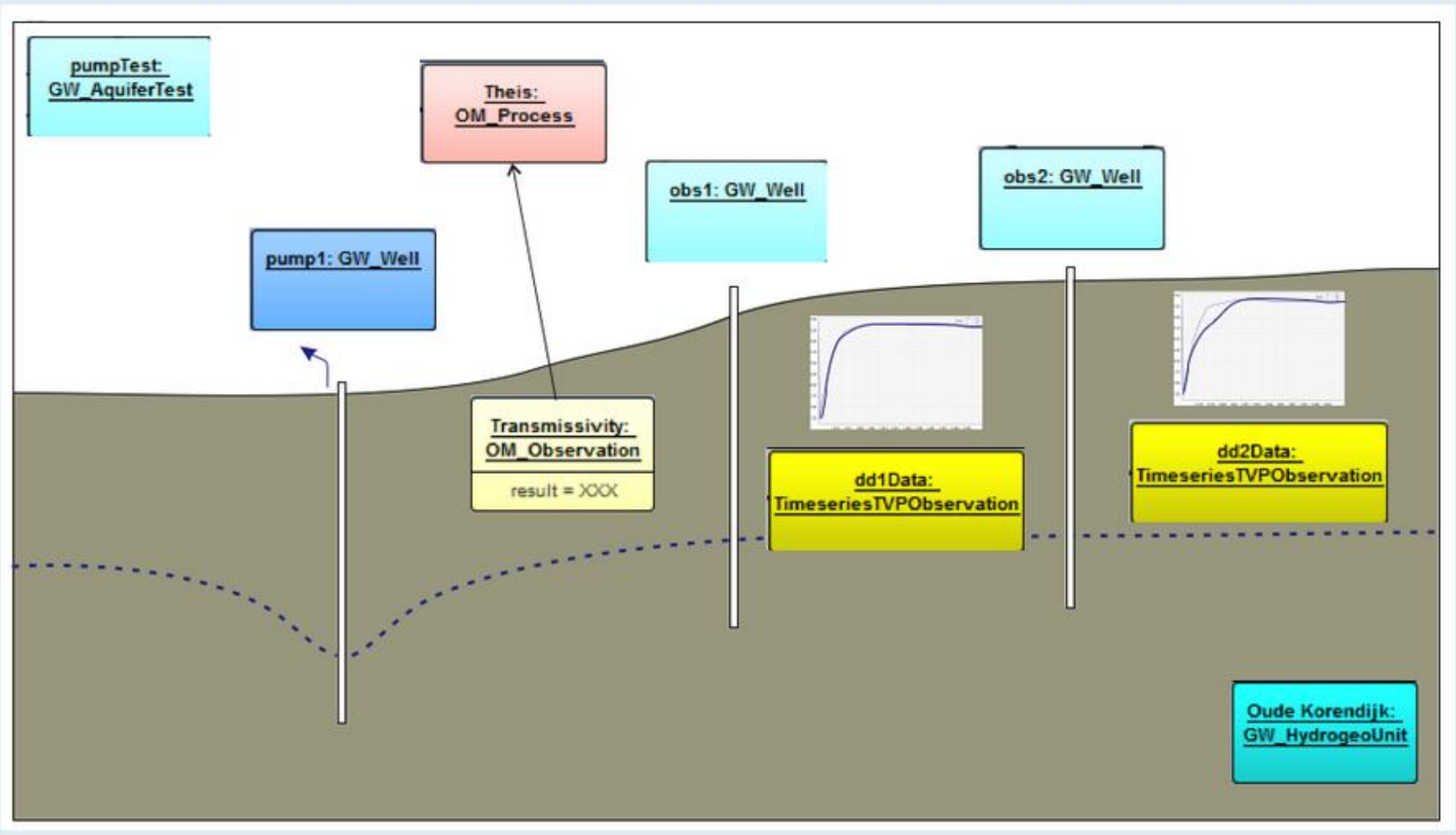
OGC 19-075



https://xkcd.com/927/

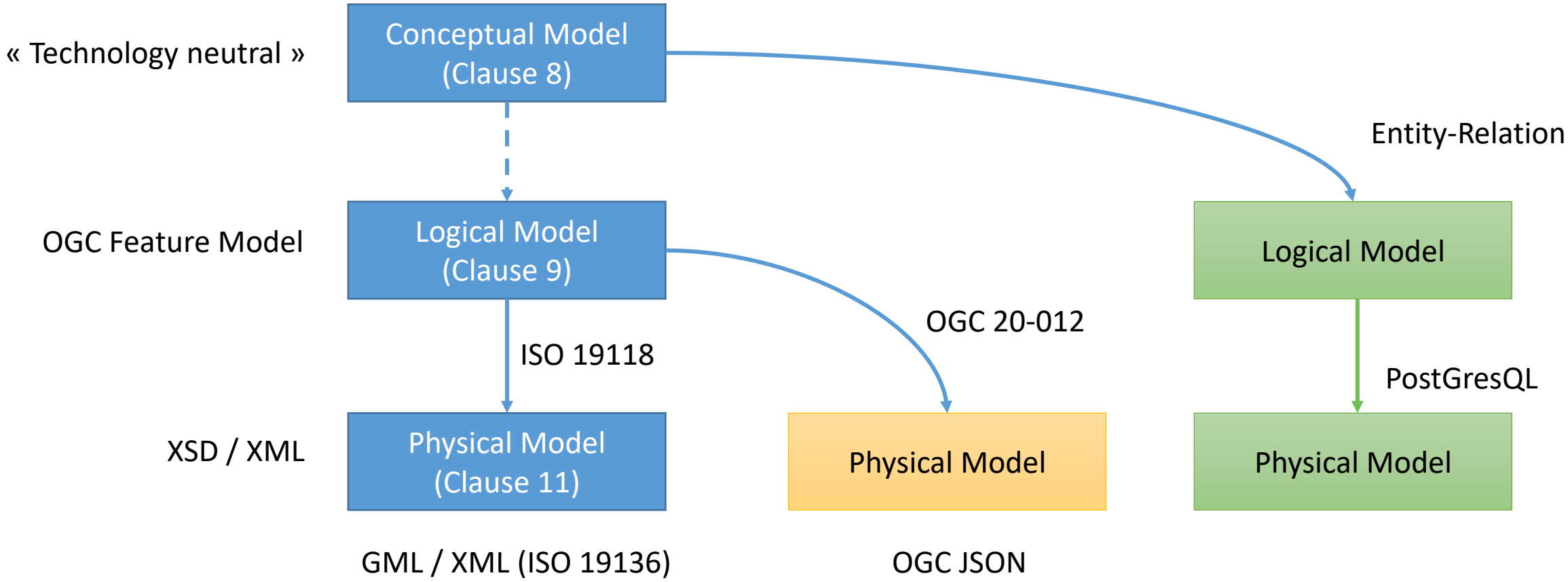


Aquifer test (pump test)



Completely modelled as Observations and Measurements and TimeSeries (WaterML 2.0 Part 1)

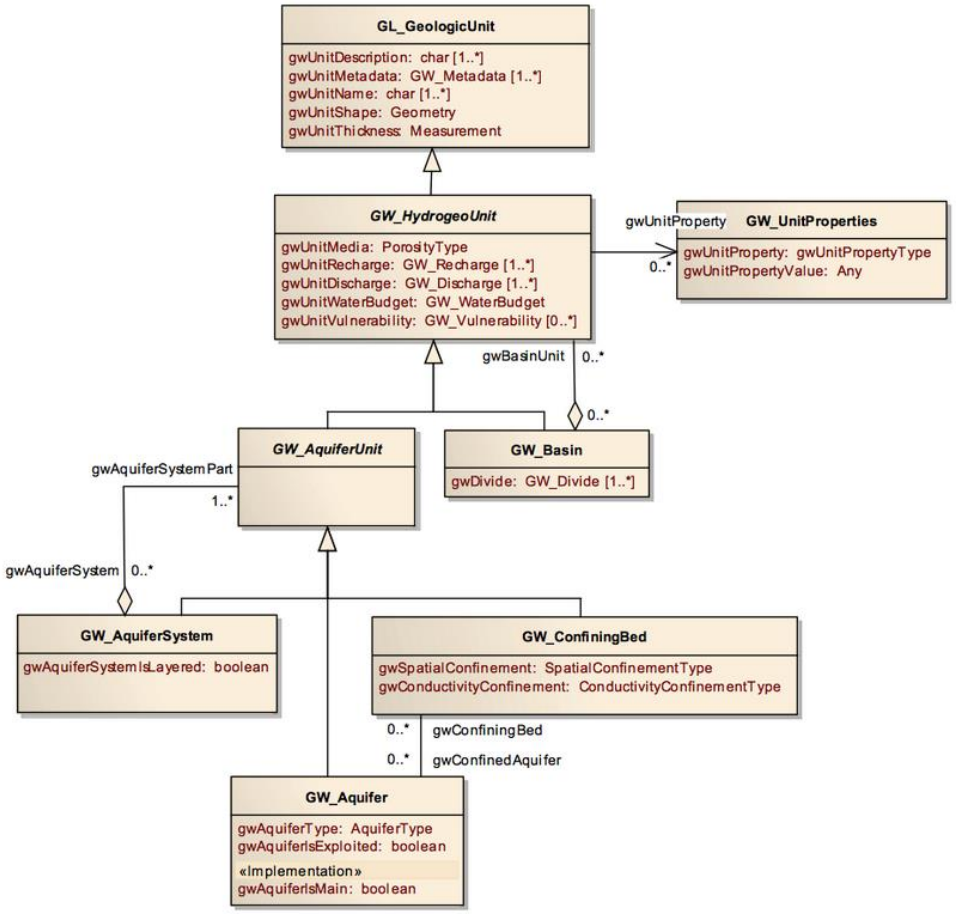
GWML models



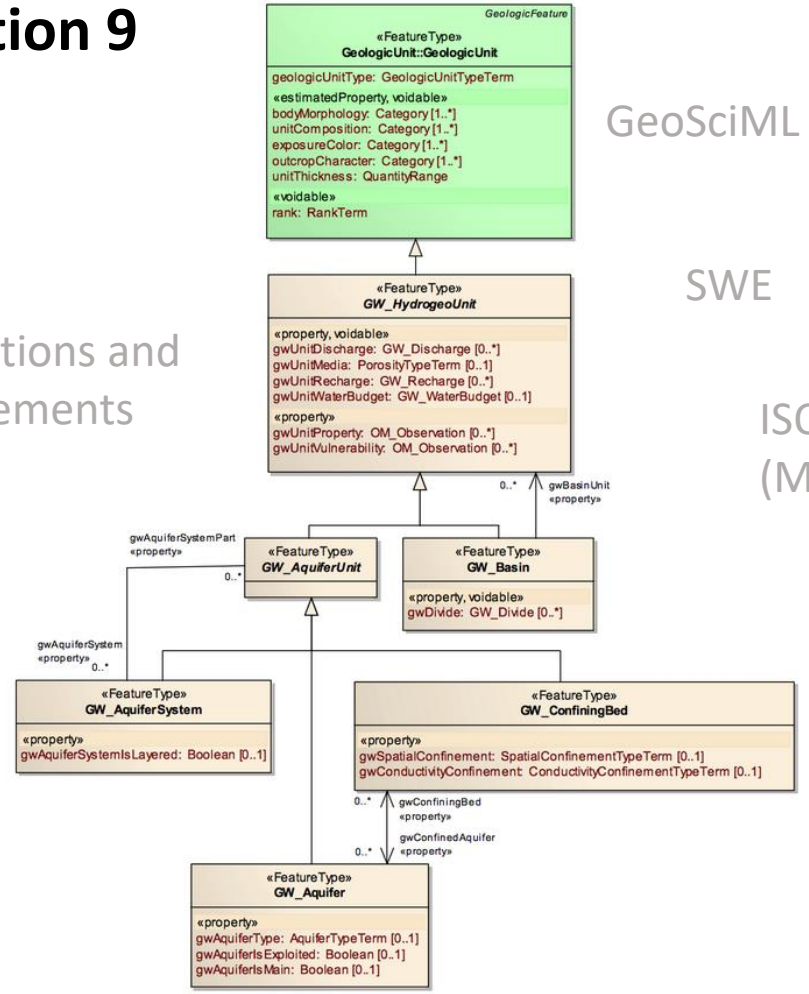
http://www.opengis.net/doc/IS/GWML/2.2.1

Conceptual -> Logical

Section 8



Section 9



GeoSciML 4.1

SWE

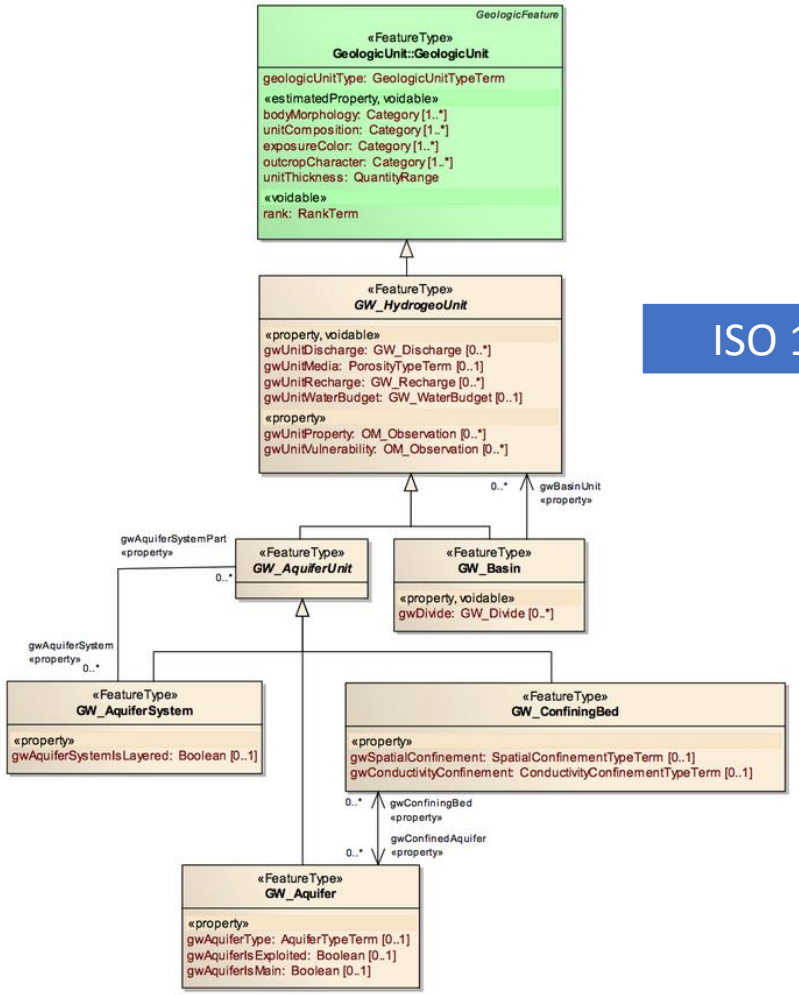
Observations and Measurements

ISO-19115 (Metadata)

OGC Feature Model

Logical -> Physical

Section 9



ISO 19118

Section 11

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    <annotation>
        <documentation>Logical Model for GroundWaterML version 2.0 containing the core elements required fo

        OGC WaterML 2.2 Part 4 - GroundWaterML 2 is an OGC Standard.
        Copyright (c) 2016 Open Geospatial Consortium.
        To obtain additional rights of use, visit http://www.opengeospatial.org/legal/ .
        </documentation>
    </annotation>
    <import namespace="http://www.opengis.net/gml/3.2" schemaLocation="http://schemas.opengis.net/gml/3.2.1
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    <import namespace="http://www.isotc211.org/2005/gco" schemaLocation="http://schemas.opengis.net/iso/191
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                        </annotation>
                    </element>
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                        <annotation>
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                        </annotation>
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                </sequence>
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« Markup Language »

Physical -> Instance

Section 11

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    <annotation>
        <documentation>Logical Model for GroundWaterML version 2.0 co

        OGC WaterML 2.2 Part 4 - GroundWaterML 2 is an OGC Standard.
        Copyright (c) 2016 Open Geospatial Consortium.
        To obtain additional rights of use, visit http://www.opengeos
        </documentation>
    </annotation>
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    <import namespace="http://www.opengis.net/gsml/4.1/GeoSciML-Basic
    <import namespace="http://www.isotc211.org/2005/gmd" schemaLocati
    <import namespace="http://www.isotc211.org/2005/gco" schemaLocati
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    <import namespace="http://www.opengis.net/swe/2.0" schemaLocation
    <import namespace="http://www.opengis.net/gwml-flow/2.2" schemaLo
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                        </annotation>
                    </element>
                    <element name="gwBasinUnit" type="gwml2:GW_Hydrog
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                            <documentation>Relates hydrogeologic unit
                        </annotation>
                    </element>
                </sequence>
            </extension>
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Data instance

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 xmlns:sam="http://www.opengis.net/sampling/2.0" xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:n29="http://gin.gw-i
 xmlns:gwml2="http://www.opengis.net/gwml-main/2.2" xmlns:gwml2f="http://www.opengis.net/gwml-flow/2.2" xmlns:gwml2c="
 xmlns:gsmlb="http://www.opengis.net/gsml/4.1/GeoSciML-Basic" xmlns:gsmle="http://www.opengis.net/gsml/4.1/GeoSciML-Ex
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   <gml:GenericMetaData gml:id="gin.5589781">
    <gmt:onlineResource xlink:href="http://aep.alberta.ca/default.aspx" xlink:title="Alberta Waterwell database"/>
   </gml:GenericMetaData>
  </gml:metaDataProperty>
  <gml:description>Well from WWIS</gml:description>
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  <gml:name codeSpace="https://data.environment.alberta.ca/awwid/GIC_Well_id">117719</gml:name>
  <gml:name codeSpace="https://environment.extranet.gov.ab.ca">https://environment.extranet.gov.ab.ca/apps/GIC/Report
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             </swe:Quantity>
            </swe:field>
            <swe:field name="Arsenic">
             <swe:Quantity definition="http://www.opengis.net/def/gwml/2.0/observedProperty/component/AS">
              <swe:uom xlink:href="http://www.opengis.net/def/uom/UCUM/0/ppm" xlink:title="ppm"/>
             </swe:Quantity>
            </swe:field>
            <swe:field name="Barium">
             <swe:Quantity definition="http://www.opengis.net/def/gwml/2.0/observedProperty/component/BA">
              <swe:uom xlink:href="http://www.opengis.net/def/uom/UCUM/0/ppm" xlink:title="ppm"/>
```

Conclusion

- GWML describes groundwater related features
- Conceptual, Logical and Physical models
- Borrows from other domain standards
  - GeoSciML
  - Observations and Measurements

Thank you!

WORLD METEOROLOGICAL ORGANIZATION

WMO HydroHub

Open Geospatial Consortium

Canada

Natural Resources Canada • Geological Survey of Canada
Ressources naturelles Canada • Commission géologique du Canada