



APEX



HydroXC Workshop Session

HydroXC Schema 3.0: Sub-Schemas Preview

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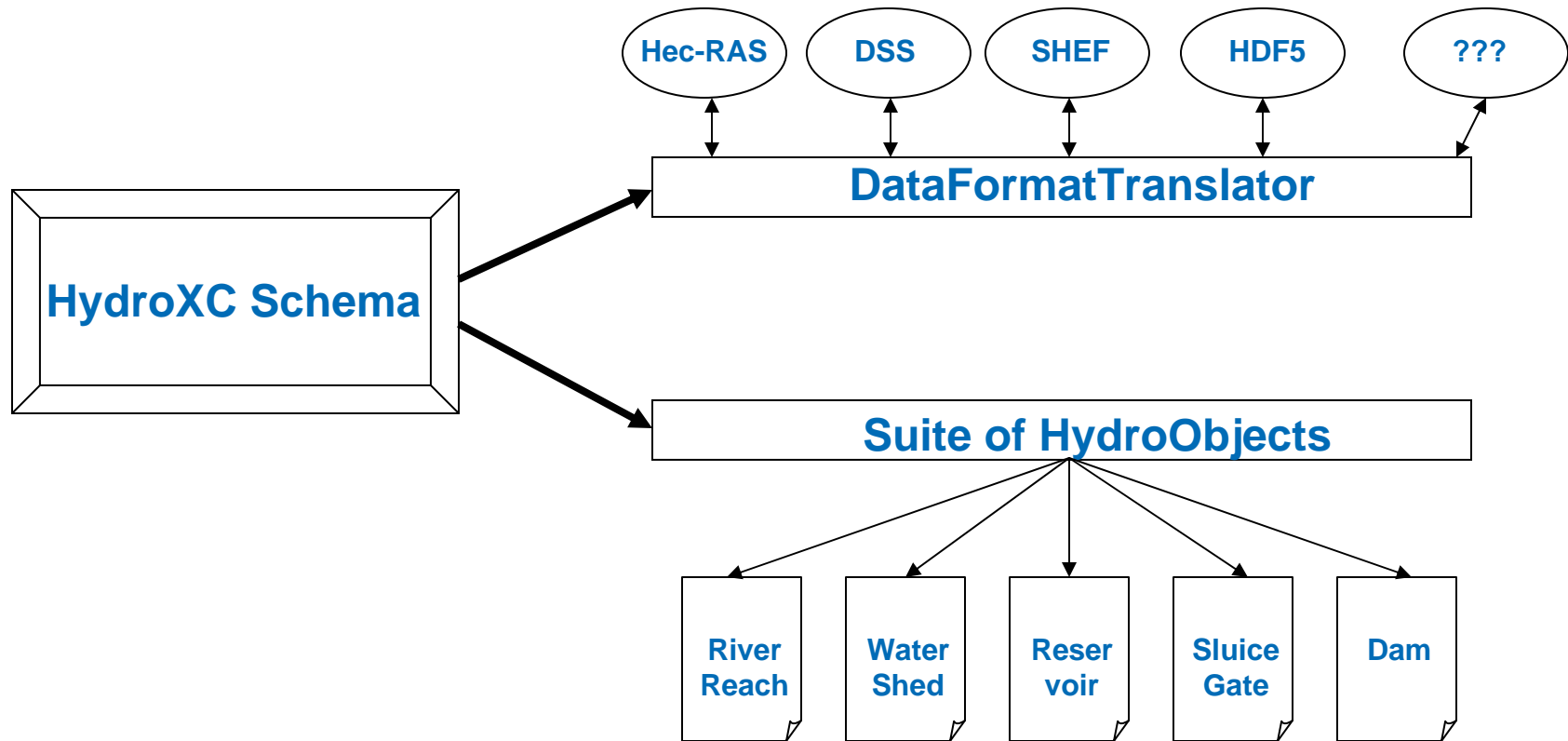


Meeting Agenda

- Welcome
- HydroXC 3.0: Sub-schema Preview
 - ▶ HydroXC General Schema Objectives
 - ▶ Existing Schema Review
 - ▶ GeoReferencing: Geographic Markup Language (GML)
 - ▶ National Hydrography Dataset (NHD)
 - ▶ Sub-schemas
- Next Steps
 - ▶ Data Adapters
 - ▶ Website
- Open Discussion



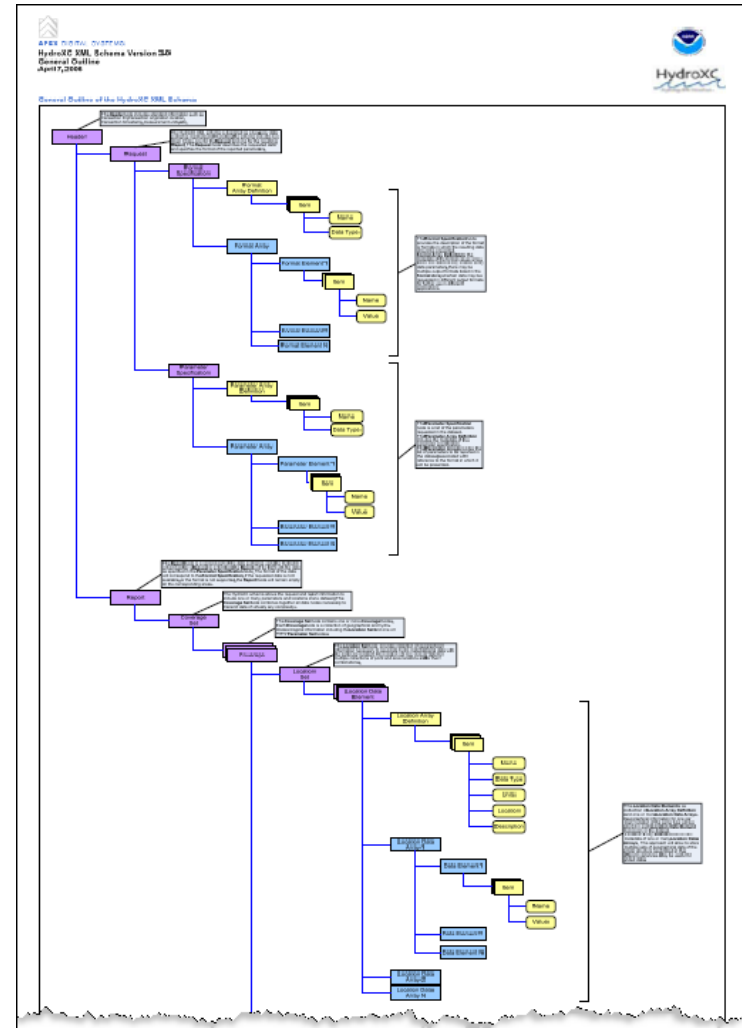
HydroXC General Schema Objectives





Existing Schema Review: Schema 2.0

- General structure for basic hydrologic data
 - ▶ Generic data containers
 - ▶ Structured to allow for data format definitions paired with a set of data values
 - ▶ Meant to be able to support any type of hydrologic data, but with required thought to definition with every instance
 - No object-specific sub-schemas
- Documented only in Visio
 - ▶ No schema (.xsd) file
- Based on data samples provided by NOAA (OHD and RFCs), USGS, and Duke





Existing Schema Review: Limitations

- Need georeferencing structure
 - ▶ The schema does not contain a section that would relate the data collected or computed at a specific point to a coordinate system that in turn would be referenced to a vertical datum and specific projection.
- Need a link to the referencing system used by the National Hydrographic Dataset (NHD)
 - ▶ This is incorporated within the Geography Markup Language (GML) and in other schemas.
- Need more precise and standardized time referencing
 - ▶ Example: The existing version uses “the nearest year”, which works for NOAA’s SHEF format but is much too vague for most other applications. We suggest to incorporate a time reference standard like ISO 8601 conventions.



GeoReferencing: Geography Markup Language (GML)

- Need a Spatial Reference System (SRS)
- Several choices:
 - Latitude/Longitude, projection, vertical datum
 - Local Coordinate System (State Plane COS)
 - Universal Transverse Mercator (UTM), => X, Y [meters] plus Northing/Easting
- European Petroleum Survey Group (EPSG) code list. EPSG is now part of the Int'l Association of Oil and Gas Producers (OGP)
 - EPSG:4326 = WGS84 [latitude/longitude](#) coordinates in degrees with [Greenwich](#) as the central [meridian](#).
 - EPSG:26917 = NAD83 UTM Zone 17
- Points, Line, Line String, Polygon



GeoReferencing: GML Examples

```
<gml:Point gml:id="point1" srsName="urn:ogc:def:crs:EPSG:6.6:4326">  
  <gml:pos>45.67 88.56</gml:pos>  
</gml:Point>
```

EPSG code for WGS 84

Point e.g. station

```
<gml:LineString gml:id="line1" srsName="urn:ogc:def:crs:EPSG:6.6:4326">  
  <gml:posList>45.67 88.56 55.56 89.44</gml:posList>  
</gml:LineString >
```

Line e.g. river channel

```
<gml:Polygon gml:id="polygon1" srsName="urn:ogc:def:crs:EPSG:6.6:26986">  
  <gml:exterior>  
    <gml:LinearRing>  
      <gml:posList> 45.256 -110.45 46.46 -109.48 43.84 -109.86 45.256 -110.45 </gml:posList>  
    </gml:LinearRing>  
  </gml:exterior>  
</gml:Polygon>
```

Polygon e.g. watershed

```
<gml:Envelope gml:id="boundingBox1" srsName="urn:ogc:def:crs:EPSG:6.6:4326">  
  <gml:lowerCorner>42.943 -71.032</gml:lowerCorner>  
  <gml:upperCorner>43.039 -69.856</gml:upperCorner>  
</gml:Envelope>
```

A bounding box



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GeoReferencing: HydroXC Schema 3.0

<pre> #comment xs:element name xs:complexType xs:sequence xs:element ref minOccurs xs:element ref minOccurs xs:element ref xs:element name xs:complexType xs:choice xs:element ref xs:element name type xs:element name type xs:element name type xs:element name type xs:attribute ref use default xs:attribute ref use default xs:attribute name xs:simpleType xs:restriction base xs:pattern value xs:attribute name type xs:element name type </pre>	<pre> count Additions Start LocationDataElement Coordinates 0 OtherIdentifier 0 LocationDataArray Coordinates Point Line LineType BoundingBox BoundingBoxType Polyline PolylineType Polygon PolygonType coordinateUnits required Decimal Degrees SRS required WGS84 coordinateUnits xs:string Decimal Degrees Degree Minute Second Feet Meters Miles Kilometers SRS xs:string Point PointType </pre>
--	--



GeoReferencing: HydroXC Schema 3.0

<pre> xs:group name xs:choice xs:sequence xs:element name type maxOccurs minOccurs xs:element name type maxOccurs minOccurs xs:sequence xs:element name type maxOccurs minOccurs xs:element name type maxOccurs minOccurs </pre>	<p>CoordGroup</p>
<p style="text-align: center;">Lat/Lon Referencing</p>	<p>Latitude xs:float 1 1</p> <p>Longitude xs:float 1 1</p>
<p style="text-align: center;">UTM Referencing</p>	<p>Northing xs:float 1 1</p> <p>Easting xs:float 1 1</p>
<p style="text-align: center;">Local Referencing</p>	<p>LocalX xs:float 1 1</p> <p>LocalY xs:float 1 1</p>



GeoReferencing: HydroXC Schema 3.0

<ul style="list-style-type: none"> xs:complexType <ul style="list-style-type: none"> xs:element <ul style="list-style-type: none"> name type xs:complexType <ul style="list-style-type: none"> name xs:sequence <ul style="list-style-type: none"> xs:element <ul style="list-style-type: none"> name type minOccurs xs:element <ul style="list-style-type: none"> name type minOccurs xs:element xs:element xs:complexType <ul style="list-style-type: none"> name xs:simpleContent <ul style="list-style-type: none"> xs:extension <ul style="list-style-type: none"> base xs:attribute <ul style="list-style-type: none"> name type use #comment xs:attribute <ul style="list-style-type: none"> name type use 	<pre> OtherIdentifier OtherLocationIdentifierType OtherLocationIdentifierType StationID IDType 0 StationName IDType 0 IDType xs:string Domain xs:string required example: URL for a de-referencing web service GazetteerURL xs:anyURI optional </pre>
---	--



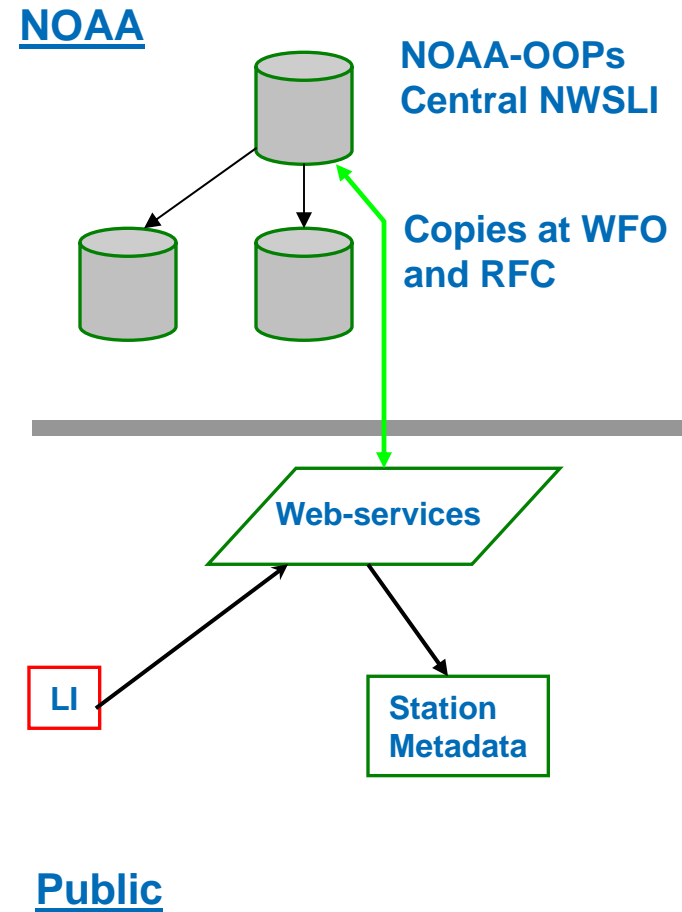
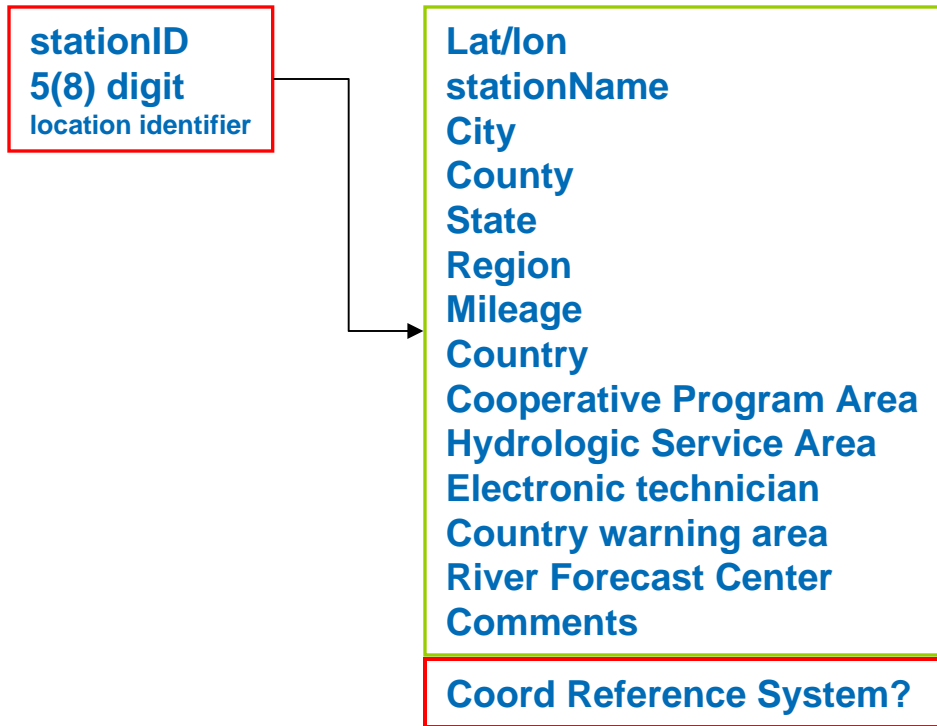
GeoReferencing: Example of GML Conventions in HydroXC

```
- <Report Name="Perennial River" ID="0128071057" Count="1">
- <CoverageSet Count="1">
-   <Coverage Count="1" ID="788012" Name="River Channel">
-     <LocationSet Count="1">
-       <LocationDataElement Count="1" ID="1345" Name="Channel Path">
-         <LocationArrayDefinition ID="9841" Name="Curve">
-           <Item Name="latitude1" DataType="real" />
-           <Item Name="latitude2" DataType="real" />
-           <Item Name="latitude3" DataType="real" />
-           <Item Name="longitude1" DataType="real" />
-           <Item Name="longitude2" DataType="real" />
-           <Item Name="longitude3" DataType="real" />
-           <Item Name="srsName" DataType="String" />
-         </LocationArrayDefinition>
-       <LocationDataArray Count="1">
-         <DataElement>
-           <Item Name="latitude1" Value="45" />
-           <Item Name="latitude2" Value="45.3" />
-           <Item Name="latitude3" Value="46.1" />
-           <Item Name="longitude1" Value="-83" />
-           <Item Name="longitude2" Value="-82.2" />
-           <Item Name="longitude3" Value="-82.7" />
-           <Item Name="srsName" Value="urn:ogc:def:crs:EPSG:6.6:4326" />
```

A Curve Section



GeoReferencing: Standard Hydrologic Exchange Format (SHEF)





National Hydrography Dataset (NHD) Referencing

Federal Geographic Data Committee (FGDC) Framework data model uses references to National Hydrography Dataset (NHD) to describe Stream-Reaches.

- + arbolateSumKm: Real
- + divergenceFlag: Integer
- + downstreamDrainCount: Integer
- + downstreamDrainLevel: Integer
- + downstreamLevelPathId: Integer
- + downstreamMinorHydrologicSequenceNumber: Integer
- + drainStreamLevel: Integer
- + fromNode: Integer
- + hydrologicSequenceNumber: Integer
- + levelPathId: Integer
- + pathLengthKm: Real
- + startFlag: Integer
- + streamOrder: Integer
- + terminalDrainId: Integer
- + terminalFlag: Integer
- + thinner: Integer
- + toNode: Integer
- + upstreamHydrologicSequenceNumber: Integer
- + upstreamLevelPathId: Integer
- + upstreamMinimumHydrologicSequenceNumber: Integer



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NHD: Elements

fromNode	Nationally unique ID for the "from" node (upstream node) endpoint	drainStreamLevel	Current stream level; supports upstream mainstream navigation
toNode	Nationally unique ID for the "to" node (downstream node) endpoint	downstreamDrainLevel	Stream level of downstream mainstem reach; supports downstream navigation
hydrologicSequenceNumber	Nationally unique sequence number for the current reach	streamOrder	Strahler stream order number for the reach
startFlag	Code to mark headwater features	upstreamLevelPathId	Level path identifier of the immediately upstream mainstem reach; supports navigation traversals through SQL queries
terminalFlag	Code to mark features that terminate in the ocean, the Great Lakes, Canada, Mexico or in closed basins	upstreamHydrologicSequenceNumber	Hydrologic sequence number of the immediately upstream mainstem
terminalDrainId	Hydrologic sequence number for the terminal reach to which this drain flows	upstreamMinimumHydrologicSequenceNumber	Minimum hydrologic sequence number of all immediately upstream reaches
levelPathId	Hydrologic sequence number of the most downstream reach that is on the same level path	downstreamLevelPathId	Level path identifier of downstream reach
arbolateSumKm	Sum of the lengths, in kilometers, of all the reaches that drain to the downstream end of the current reach	downstreamDrainCount	Number of drains immediately downstream
pathLengthKm	Distance from this reach's downstream end to the terminal reach downstream end	downstreamMinorHydrologicSequenceNumber	At a divergence, the Hydrologic Sequence Number of the immediately downstream minor path reach
thinner	Ordinal value to allow selection of progressively more dense networks; least dense network is where thinner = 1		
divergenceFlag	Code signifying if reach is part of a flow divergence		



Sub-schemas/HydroObjects

- Standard Hydrologic Exchange Format (SHEF - NOAA data format)
- StreamReach (GML based)
- Reservoir (GML based)
- More to come!



HydroObjects: GML HydroFeatures as a first start

HydroFeature Types
in DHS model

- + areaOfComplexChannels
- + areaToBeSubmerged
- + artificialPath
- + canalDitch
- + coastline
- + connector
- + damWeir
- + estuary
- + flume
- + gate
- + iceMass
- + inundationArea
- + lakePond
- + lockChamber
- + pipeline
- + reservoir
- + seaOcean
- + shoreline
- + sinkRise
- + spillway
- + springSeep
- + streamRiver
- + swampMarsh
- + waterIntakeOutflow
- + well

**Department of Homeland Security (DHS)
Geospatial Data Model
Federal Geographic Data Committee (FGDC)
Framework**

ANSI Geographic Information Framework Data
Content Standard

Part 6: Hydrography

GML Application Schema (Features)

To describe HydroFeatures

Why no WaterShed?



Sample Sub-Schema for SHEF

XML Notepad - C:\Documents and Settings\Michael Piasecki\Desktop\SHEFa.xml

File Edit View Insert Window Help

Tree View XSL Output

- xml
 - Dataset
 - xmlns:xsi
 - xsi:noNamespaceSchemaLocation
 - DatasetID
 - Schema
 - Header
 - DatasetType
 - Code
 - Name
 - MeasurementSystem
 - Code
 - Name
 - Language
 - Code
 - Name
 - TimeFormat
 - Code
 - Description
 - TimeZone
 - Code
 - Name
 - Comment
 - #text
 - Report

```

version="1.0" encoding="UTF-8"

http://www.w3.org/2001/XMLSchema-instance
file:/C:/Documents%20and%20Settings/Administrator/Desktop/HydroXC.xsd
z1x35641
http://noaa.gov/uhd.xml

S
ROUTINE TRANSMISSION OF SEVERAL PHYSICAL ELEMENTS

E
ENGLISH

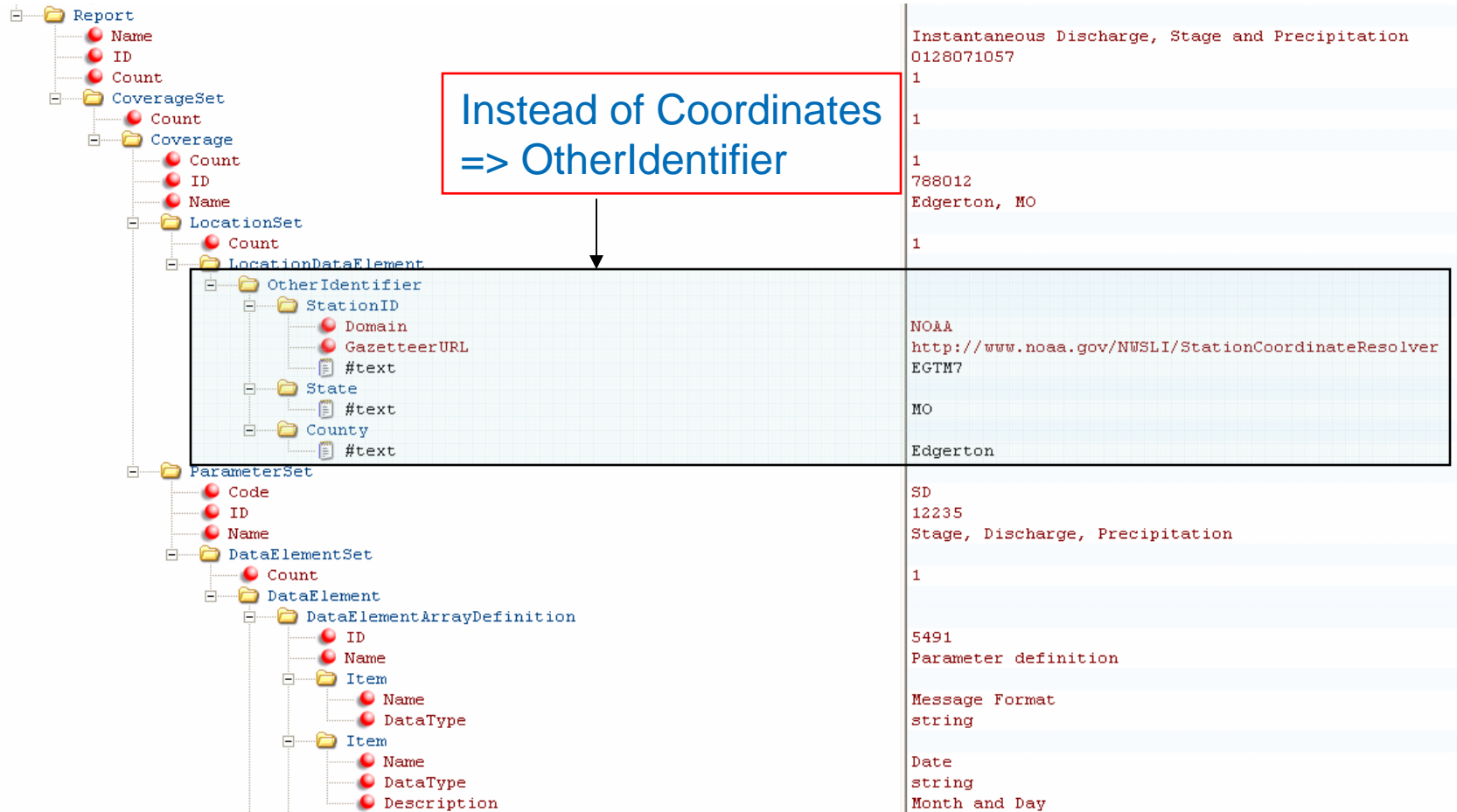
E
ENGLISH

MMDD24HHMM
Assume nearest year

CST
Central Standard Time

HydroXC presentation of a .A format SHEF data
  
```

SHEF (cont)





Sample Sub-Schema for StreamReach

<ul style="list-style-type: none"> xml <ul style="list-style-type: none"> Dataset <ul style="list-style-type: none"> xmlns:xsi xsi:noNamespaceSchemaLocation DatasetID Schema Header <ul style="list-style-type: none"> DatasetType <ul style="list-style-type: none"> Code Name MeasurementSystem <ul style="list-style-type: none"> Code Name Language <ul style="list-style-type: none"> Code Name TimeFormat <ul style="list-style-type: none"> Code Description TimeZone <ul style="list-style-type: none"> Code Name Comment Report <ul style="list-style-type: none"> Name ID Count CoverageSet <ul style="list-style-type: none"> Count Coverage <ul style="list-style-type: none"> Count ID Name LocationSet <ul style="list-style-type: none"> Count LocationDataElement <ul style="list-style-type: none"> Coordinates <ul style="list-style-type: none"> SRS coordinateUnits Polyline <ul style="list-style-type: none"> Point <ul style="list-style-type: none"> order Latitude Longitude Point <ul style="list-style-type: none"> order Latitude Longitude Point <ul style="list-style-type: none"> order Latitude Longitude 	<pre> version="1.0" encoding="UTF-8" http://www.w3.org/2001/XMLSchema-instance file://C:/Documents%20and%20Settings/Administrator/De... zix35641 http://noaa.gov/uhd.xml S River Feature according to DHS Geospatial Data Model E ENGLISH E ENGLISH YYYY-MM-DD ISO8601 N/A Not Applicable Storing features in HydroXC Perennial River 0128071057 1 1 1 788012 River Channel 1 </pre>	
		<h1>Lat/Lon ordered</h1>



StreamReach (cont)

The screenshot shows the XML Notepad application with the following structure:

- Tree View
 - DataElement
 - DataElementArrayDefinition
 - ID: 5493
 - Name: Measurement
 - Item
 - Name: units
 - DataType: string
 - Item
 - Name: value
 - DataType: float
 - DataElementArray
 - Count: 1
 - DataElement
 - ID: 3
 - Item
 - Name: units
 - Value: reportedElevationMeters
 - Item
 - Name: value
 - Value: 35
 - DataElement
 - DataElementArrayDefinition
 - ID: 5494
 - Name: Computed Network Values
 - Item
 - Name: fromNode
 - DataType: integer
 - Item
 - Name: toNode
 - DataType: integer
 - Item
 - Name: hydrologicSequenceNumber
 - DataType: integer
 - Item
 - Name: startFlag
 - DataType: integer
 - Item
 - Name: terminalFlag
 - DataType: integer
 - Item
 - Name: terminalDrainId
 - DataType: integer

XSL Output (for the selected element):

```
5493
Measurement
units
string
value
float
1
3
units
reportedElevationMeters
value
35
```

NHD
elements



Sample Sub-Schema for Reservoir

<ul style="list-style-type: none"> xml <ul style="list-style-type: none"> Dataset <ul style="list-style-type: none"> xmlns:xsi xsi:noNamespaceSchemaLocation DatasetID Schema Header <ul style="list-style-type: none"> DatasetType <ul style="list-style-type: none"> Code Name MeasurementSystem <ul style="list-style-type: none"> Code Name Language <ul style="list-style-type: none"> Code Name TimeFormat <ul style="list-style-type: none"> Code Description TimeZone <ul style="list-style-type: none"> Code Name Comment Report <ul style="list-style-type: none"> Name ID Count CoverageSet <ul style="list-style-type: none"> Count Coverage <ul style="list-style-type: none"> Count ID Name LocationSet <ul style="list-style-type: none"> Count LocationDataElement <ul style="list-style-type: none"> Coordinates <ul style="list-style-type: none"> SRS coordinateUnits Polygon <ul style="list-style-type: none"> Point <ul style="list-style-type: none"> order Northing Easting Point <ul style="list-style-type: none"> order Northing Easting Point <ul style="list-style-type: none"> order Northing Easting Point <ul style="list-style-type: none"> order Northing Easting 	<pre> version="1.0" encoding="UTF-8" http://www.w3.org/2001/XMLSchema-instance file:/C:/Documents%20and%20Settings/Administrator/De z1x35641 http://noaa.gov/uhd.xml S Reservoir Feature according to DHS Geospatial Data. E ENGLISH E ENGLISH YYYY-MM-DD ISO8601 N/A Not Applicable Storing features in HydroXC Reservoir 012071057 1 1 1 7982 Polygon representing reservoir 1 EPSG:6.6:26713 Meters </pre>	
<ul style="list-style-type: none"> Point <ul style="list-style-type: none"> order Northing Easting Point <ul style="list-style-type: none"> order Northing Easting Point <ul style="list-style-type: none"> order Northing Easting Point <ul style="list-style-type: none"> order Northing Easting 	<pre> 1 4608547 308173 2 4609536 308692 3 4609931 308712 4 4608547 308173 </pre>	<h1>UTM ordered</h1>

Reservoir (cont)

XML Notepad - C:\Personal\HydroXC\Schema\reservoirHydroXC.xml

File Edit View Insert Window Help

Tree View XSL Output

```

urn:ogc:def:crs:EPSG:6.6:4326
contact
12235
Responsible Party
4
5491
Parameter definition
5149
Hydroelement properties
1
2
5493
Measurement
units
string
value
float
1
3
units
reportedAreaSqmi
value
12
  
```

Loaded in 00:00:00.0312500

Only attribute recorded





Next Steps: Sub-schemas

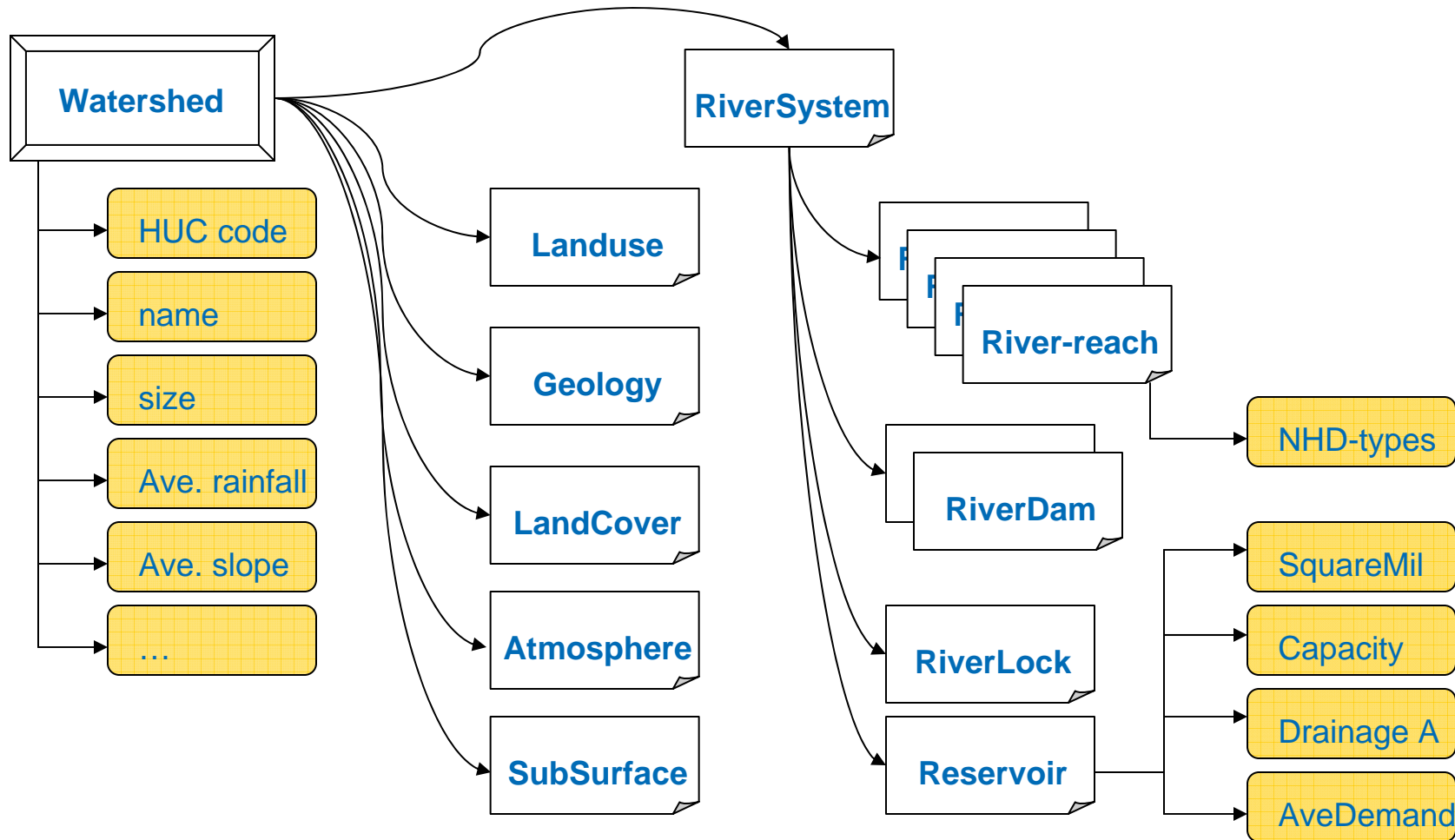
➤ HydroObjects

- ▶ Need to take a look at the GML based features, and possibly expand the descriptive scope (see Reservoir). Also, possible creation of new objects, like a WaterShed object, or a geoVolume object.
- ▶ Need to develop a framework such that hydro-objects can be linked in the context of a digital watershed (DW) representation.
- ▶ This may need to culminate in the development of a formal representation of a digital watershed and how hydro-objects can aid in forming a DW.
- ▶ Next on the list: Watershed
 - quite complex because it is one of the fundamental core objects that need to be described.



Next Steps: Sub-schemas (cont.)

Thoughts on Future HydroObjects Framework





Next Steps: Data Adapters and Website

➤ Data Adapters

- ▶ Creation of first example data adapter to translate HydroXC and SHEF formats
- ▶ Will highlight in next workshop meeting

➤ Website

- ▶ Launches at end of March at www.hydroxc.org



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Open Discussion

➤ Thank you!