SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Arc Hydro Enhanced Database Compliance Specification

Project Number : MB11

Project Title: AHED Population

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Document Revision Number: <3.0>
Document Revision Date: <10/26/2011>
Filename: AHED Compliance Specification.docx
Approvals:

AHED Technical Lead –	Date	Version

AHED Compliance Specification

AHED Technical Lead –	Date	Version
AHED PM –		
Other Approving Authority, if needed	Date	Version

Document Revision History:

Version	Date	Revised By	Description of Changes
0.1	6/6/07	Bill Millinor	Initial draft
0.1	6/29/2007	Tim Minter	Restructured and Re-wrote
0.1	7/3/2007	Tim Minter	Incorporated comments from Maryam Mashayekhi and Ashish Shah
1.0	7/31/2007	Tim Minter	Incorporated comments from Bill Millinor & finalized
2.0	7/28/2008	Tim Minter	Incorporated updates for AHED Population Phase 2 Section 2 & finalized
2.1	12/11/2008	Maryam Mashayekhi	Updated topology rules with rules used during Phase 2 Section 2
2.2	6/22/2010	Maryam Mashayekhi	Updated links
3.0	10/26/2011	Maryam Mashayekhi	Updated document with new schema changes, topology rules and software version. Moved Topology and Network construction steps to AHED Data Construction Manual. Incorporated Tim Minter's comments.

AHED Compliance Specification

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1 INTRODUCTION

The Arc Hydro Enhanced Database (AHED) serves as the system of record for hydrographic feature locations within the South Florida Water Management District (District). This AHED Compliance Specification document establishes absolute requirements for spatial data description and construction to bring data into compliance with the AHED structure. Attendant Quality Assurance Plans and Quality Control Procedures for AHED content development events establish variable acceptance criteria that may not require absolute accuracy in all aspects of AHED data deliverables.

2 SPECIFICATIONS

2.1 Data Formats & Schema

The required data framework is Environmental Systems Research Institute's (ESRI) ArcGIS 9.3.1 geodatabase (GDB) in which all AHED compliant data and metadata will be contained or managed. AHED compliant data in the ArcGIS 9.3.1 GDB format are organized using the AHED schema. The capacity exists for those delivering AHED compliant data to construct it in an edit version within a versioned, multi-user geodatabase (mGDB) using ArcSDE 9.3.1 in Oracle 11g in the District's computing environment. Alternatively, AHED compliant data can be constructed in an ESRI ArcGIS 9.3.1 file Geodatabase (fGDB). The fGDB can be generated from an AHED mGDB and provided to those developing and delivering AHED compliant data.

2.2 Feature Description

Subject Matter Experts (SMEs) research available data and documentation and use their expert knowledge to describe AHED feature geometries, properties, and inter-relationships. SMEs communicate feature descriptions to AHED Data Stewards via written, graphic, and verbal consultation modes. SME and Data Steward roles may be filled by the same person.

2.2.1 Feature Geometry

SMEs accurately describe feature geometries to represent physical, real-world features and conceptual, data model features within AHED. Physical area features such as water bodies, watersheds, basins, etc. are represented by polygons. Conceptual linear features such as flow lines are represented as lines. Conceptual point features such as monitoring sensor locations are represented as points.

Global Positioning System (GPS) technology, traditional surveying measurements, on-screen digitizing of spatial features using digital aerial photography as reference data, and

other methods are used to acquire coordinate pairs used in turn to construct the feature geometry.

All AHED compliant feature geometries will be described accurately to represent their respective physical, real-world objects correctly within the context of the AHED data model. AHED feature geometry properties are described and defined in detail in the AHED Data Dictionary.

2.2.2 Feature Properties

Feature properties are used to describe the physical, real-world feature. Adding the feature to a specific AHED feature class such as MONITORINGPOINT describes the feature as being the location of a monitoring point. Feature attribute fields are used to describe identifiers, parameters, and conditions of the feature. The SME is responsible for describing and / or confirming the description of AHED feature properties correctly and providing feature level metadata to indicate the quality of the feature description.

All AHED compliant feature properties will be described accurately to represent their respective physical, real-world objects correctly within the context of the AHED data model. Attribute fields and valid values for recording feature properties are described and defined in detail in the AHED Data Dictionary.

2.3 Feature Construction

AHED Data Stewards use SME feature descriptions, documented processes and toolsets, and ArcGIS technical knowledge and experience to construct and validate AHED features.

AHED feature construction is guided by the following workflows, protocols, and toolset instructions:

- Data Ingestion Methods & Protocols
- Feature Class Edit Matrix
- AHED Data Construction Manual
- ESRI ArcGIS 9.3 Desktop Help: Editing and data compilation

2.3.1 Geometry

From the GDB perspective, seven geometry errors can exist because of incorrect construction or importation from other data formats. Point features are not affected by these errors. The ArcToolbox Check Geometry and Repair Geometry tools can be used to detect and correct these errors. AHED compliant features will not possess any of these errors:

- Line and Polygon Geometry Errors:
  - Short Segment

  - Null Geometry
- Polygon Geometry Errors:
  - Incorrect Ring Ordering
  - Incorrect Segment Orientation
  - Self-Intersections
  - Unclosed Rings
  - Empty Parts

The spatial accuracy of AHED compliant data will be determined by the accuracy requirements of the project for which the data is developed. However, AHED compliant data spatial accuracy must meet or exceed the 1998 National Standard for Spatial Data Accuracy (NSSDA) developed by the Federal Geographic Data Committee (FGDC). The baseline reference for AHED is currently the District's 2004 - 2005 Digital Ortho Quarter Quads 1-meter Natural Color Aerial Photography raster dataset. This data is 1:12,000 Digital Orthophotographic Quarter Quadrangles (DOQQs) acquired between November 2004 and February 2005. The NSSDA horizontal accuracy requirements for 1:12,000 scale data corresponds to a minimum AHED accuracy of at least 38.02 feet or an Root Mean Squares Error (RMSE) of 21.97 feet. Aerial Photography datasets that are identified as being newer and / or having higher spatial accuracy than the AHED baseline reference dataset are candidates for use in the editing process to extract or locate AHED features.

Any data to be included in AHED must have its spatial accuracy reported in the appropriate SOURCEQUALITY table fields.

The reference base DOQQ dataset may change in the future. AHED compliant geospatial deliverables must meet the minimum accuracy of the current baseline reference dataset. The most current baseline reference dataset can be verified by contacting SFWMD's GIS Development Section at (561) 682-6394.

Any AHED features that have higher positional accuracies and may have related coincident AHED features that need to be moved will be addressed on a case-by-case basis. The decision to move coincident features will be made by the appropriate AHED Data Steward or SME while viewing the data at a scale no larger than (not zoomed in farther than) 1:1, no smaller than (not zoomed out farther than) 1:8000, and according to the guidelines for editing feature classes outlined in AHED Data Construction Manual.

2.3.2 Attribute Coding

AHED compliant data content will contain correctly coded attribute fields to correctly record feature properties as described by the SME. Population of attribute fields falls into three cases:

1. Required: Must be accurately coded

2. Conditionally Required: If a defined condition exists, then must be accurately coded
3. Optional: If accurate data content is available, then must be accurately coded (note: this is not the usual definition of "optional." This word has been hijacked for AHED purposes to stave off change control.)

The AHED Entity Relationship Diagram specifies required, conditionally required, and optional fields for population. The AHED Data Dictionary defines the fields, their valid values, and conditions under which population of specific fields is required. The AHED Data Construction Manual includes instructions on populating fields.

Queries against required fields for null values can be used to test whether or not these coding requirements have been met. In many cases attribute field coding input is controlled by valid value domains. Many attribute fields allow free form data entry controlled only by the attribute field data type and length specifications. Errors when recording feature properties can be made despite both data entry controls. Data Steward care when coding attributes can prevent transcription errors, and Data Steward review of field values and SME review of AHED features can confirm correct attribute coding.

AHED compliant features possess feature level metadata recorded in attribute fields in a related metadata table named SourceQuality. The AHED Metadata Maintenance, p. 8 tool is used to record feature level metadata.

2.3.3 Feature Relationships

Feature relationships can be spatial and tabular. Most AHED relationships are specified as GDB relationship classes. Spatial relationships support spatial query and relational functions. Spatial relationships rely on features in one feature class being placed correctly in relation to features in other feature classes. For example, a MonitoringPoint must be placed within a Watershed polygon in order to establish a spatial relationship between the two features. Tabular relationships support tabular query and relational functions. AHED tabular relationships rely on coding a primary key in one feature class and a foreign key in another feature class or table with an identical value in order to relate the two features. For example, in the relationship class "HydroJunctionHasMonitoringPoint," a HydroJunction feature with a specific HydroID (primary key) value is related to a MonitoringPoint by storing the HydroID value in the MonitoringPoint JunctionID (foreign key) attribute field.

AHED compliant spatial feature relationships are constructed during feature geometry construction with an understanding of the AHED data model and with guidance from SMEs. AHED compliant tabular feature relationships are constructed by following guidelines in the AHED Data Construction Manual. All AHED compliant feature relationships are established correctly and can be tested by traversing the relationships among related features using ArcGIS tools.

AHED drainage features are linked to the NEXRAD rainfall database via spatial feature relationships. Any time AHED drainage polygon features are edited, these spatial relationships must be updated by running the Pixel-Polygon Relationship Builder Tool, p. 12.

AHED HydroIDs are unique identifiers of all features within the AHED. HydroIDs are assigned by the AHED Data Steward in the District's GHYDS mGDB instance edit version where AHED edits are being performed. For details, please refer to the AHED Data Construction Manual.

2.3.4 Topology Rules

Numerous AHED spatial functions, relationships, and networks rely on the construction of correct coordinate geometry to support coordinate coincidence among features within the same feature class and among features among different feature classes. Topology rules are used to define, identify, and correct coordinate coincidence errors.

ESRI training instructors recommend that topologies not be validated within ArcCatalog in order to avoid the potential of introducing unspecified geometry errors into the feature class. AHED topologies should be validated and any errors corrected using appropriate tools available on the ArcMap Topology Toolbar. When editors are working in an edit version, topology must only be validated by using the "Validate Topology In Specified Area" or "Validate Topology In Current Extent" validation tools. The "Validate Entire Topology" tool must only be used by the DBO when working in the QA_Default version

AHED compliant data must not contain any topology dirty areas or any errors defined in AHED Topology Class. AHED Topology Rules are listed below:

BASIN
- Must Not Have Gaps
- Must Not Overlap

SUBBASIN
- Must Not Have Gaps
- Must Not Overlap
- Area Boundary Must Be Covered By Boundary Of BASIN

WATERSHED
- Must Not Have Gaps
- Must Not Overlap
- Area Boundary Must Be Covered By Boundary Of SUBBASIN

SUBWATERSHED
- Must Not Have Gaps
- Must Not Overlap

- Area Boundary Must Be Covered By Boundary Of WATERSHED

HYDROJUNCTION
- Point Must Be Covered By Line HYDROEDGE

HYDROJUNCTION : CONTROLLED
- Must Be Covered By Boundary Of WATERSHED
- Must Be Covered By Boundary Of SUBWATERSHED
- Must Be Covered By Boundary Of WATERCONTROLSYSTEM
- Must Be Covered By Endpoint Of HYDROEDGE

HYDROEDGE
- Must Not Self-Intersect
- Endpoint Must Be Covered By HYDROJUNCTION

RAINAREA
- Must Not Have Gaps
- Must Not Overlap
- Area Boundary Must Be Covered By Boundary Of WATERSHED

HYDRAULICELEMENT
- Must Be Covered By Boundary Of WATERCONTROLSYSTEM

HYDRAULICELEMENTSET
- Must Be Covered By Boundary Of WATERCONTROLSYSTEM

STATION
- Must Be Properly Inside WATERBODY

WATERCONTROLSYSTEM
- Must Not Have Gaps
- Must Not Overlap
- Area Boundary Must Be Covered By Boundary Of WATERSHED
- Area Boundary Must Be Covered By Boundary Of SUBWATERSHED

WATERCONTROLUNIT
- Must Not Have Gaps
- Must Not Overlap
- Area Boundary Must Be Covered By Boundary Of WATERBODY

WATERCONTROLCATCHMENT
- Must Not Overlap
- Area Boundary Must Be Covered By Boundary Of WATERCONTROLSYSTEM

WMSJUNCTION

- Must Be Covered By Boundary Of WATERCONTROLSYSTEM

2.3.5 Geometric Networks

When developing feature data that participates in AHED geometric networks, the Data Steward must construct and confirm that topology and coordinate geometry of the new features will allow the features to participate accurately in the geometric network without further editing after acceptance.

This will include verification of flow directions and population of FROM_NODE and TO_NODE attributes of HYDROEDGES in a way that correctly represent the direction of flow.

The geometric network is constructed by the Database Owner following AHED Methods & Protocols. HYDROEDGE and HYDROJUNCTION feature classes participate in the network. Once the network is constructed, Data Stewards and/or DBO will verify flow directions and network connectivity.

The geometric network construction steps are described in the AHED Data Construction Manual.

2.4 FGDC CSDGM Feature Class Level Metadata

All AHED feature class deliverables are required to contain feature class-level metadata that complies with the Federal Geographic Data Committee's (FGDC) Content Standard for Digital Geospatial Metadata (CSDGM). Data Editors may use the tools noted below to create and edit FGDC CSDGM metadata for AHED feature class deliverables:

- ArcGIS 9.3.1 Desktop Help: Using the FGDC metadata editor
- CSDGM Metadata Workbook
- USGS Geospatial Metadata Validation Service

2.5 Spatial Reference System

AHED uses the District's standard spatial reference system (SRS) as defined in the "SFWMD GIS Data Steward Program User's Manual." Upon request the District can provide a template File GDB containing these SRS settings.

2.5.1 Horizontal Coordinate System

As defined in ESRI's ArcGIS 9.3.1 ArcCatalog application:

Name: NAD_1983_HARN_StatePlane_Florida_East_FIPS_0901_Feet
Details:
Alias:
Abbreviation:
Remarks:
Projection: Transverse_Mercator
Parameters:
False_Easting: 656166.666666666510000000
False_Northing: 0.000000000000000000
Central_Meridian: -81.000000000000000000
Scale_Factor: 0.999941176470588220
Latitude_Of_Origin: 24.333333333333329000
Linear Unit: Foot_US (0.304800609601219 meters per unit)
Geographic Coordinate System:
Name: GCS_North_American_1983_HARN
Alias:
Abbreviation:
Remarks:
Angular Unit: Degree (0.0174532925199433299)
Prime Meridian: Greenwich (0.000000000000000000)
Horizontal Datum: D_North_American_1983_HARN
Spheroid: GRS_1980
Semimajor Axis: 6378137.000000000000000000
Semiminor Axis: 6356752.314140356100000000
Inverse Flattening: 298.257222101000020000
Vertical Datum: North American Vertical Datum of 1988 (NAVD88)

2.5.2 X/Y Domain

MinX: -17791300
MaxX: 4691231820544.27
MinY: -41645400
MaxY: 4691207966444.27
Precision: High

2.5.3 Z Domain

Min: -4473924
Max: 1172807929037.07
Precision High

2.5.4 M Domain

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Min: 0
Max: 37529996894754.1
Precision High