SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Arc Hydro Enhanced Database Quality Assurance Plan

And

Quality Control Procedures

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AHED Population Quality Assurance Plan & Quality Assurance Procedures

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1.0	7/13/2007	Tim Minter	Completed Sections 3.3 – 4.3 and finalized document
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1 Introduction

The Arc Hydro Enhanced Database (AHED) will serve as the database of record for hydrologic feature locations within the South Florida Water Management District (District). Holistically, AHED is a system composed of numerous staff resources, spatial and non-spatial data sources, computing hardware, software, networking, customized applications, and supporting technologies. The AHED system relies on existing federated systems and workflows for some of its data content. Systems such as the Operations Decision Support System (ODSS) rely on AHED as a source of data content.

The overall quality of the AHED system is defined by how well it meets its functional requirements. Accuracy of the AHED data content is the primary contributor to how well the AHED system will be perceived by the Key Business Customers (KBCs) as having the required quality to be useful.

This document is organized into sections including an Introduction to set expectations for what is being addressed, a Quality Assurance (QA) Plan to describe how required quality levels are achieved in deliverables, Quality Control (QC) Procedures to specify testing, and QA/QC Process Improvement to handle situations that result in changing the activities described in this document.

1.1 Purpose

This QA Plan and QC Procedures document establishes a framework for developing AHED content that meets quality requirements defined in the AHED Compliance Specification. The QA Plan organizes and refers to AHED data development process steps and data input methods designed to ensure that quality requirements are met while the data content is being developed. The QC Procedures section establishes tests that are performed after data development and QC reports that are generated to determine whether or not acceptable levels of quality are being met. Acceptance criteria are provided with their respective assessment tests.

1.2 Scope

For the purposes of this document, the WhatIs.com general definition of Quality Control and Quality Assurance is adopted:

> "Quality control (QC) is a procedure or set of procedures intended to ensure that a manufactured product or performed service adheres to a defined set of quality criteria or meets the requirements of the client or customer. QC is similar to, but not identical with, quality assurance (QA). QA is defined as a procedure or set of procedures intended to ensure that a product or service under development (before work is complete, as opposed to afterwards) meets specified requirements. QA is sometimes expressed together with QC as a single expression, quality assurance and control (QA/QC)."

The application of the QA Plan and QC Procedures is limited to the data content to be completed during AHED Population Project Phase II Section 2 Work Order contract

(P2S2 Work Order) and to be promoted to the production multi-user geodatabase instance (GHYDP) established for the AHED system.

AHED GHYDP hydrologic features are presently related to content in NEXRAD and DBHydro federated databases. For the purposes of meeting AHED system functional requirements, the AHED project team assumes that existing QA plans and QC procedures for the NEXRAD and DBHydro databases are sufficient for their respective content to provide acceptable quality data to AHED system users. Cases establishing that this assumption is invalid will be addressed as they arise according to section 4.2 QA/QC Issue Resolution.

The AHED content is most often perceived by staff and systems that support and use it as discrete, related geospatial features such as monitoring points, USGS watersheds, SFWMD water control structures, and canals. Identically or similarly defined features such as water control structures are grouped into sets of geospatial objects which are called "feature classes." QA Plan and QC Procedures approach AHED content primarily from this perspective of individual geospatial features and feature classes.

1.3 Roles and Responsibilities

Within the scope and context of the QA Plan and QC Procedures, the following roles will have specific responsibilities:

1.3.1 Key Business Customer (KBC)

- Define required levels of accuracy for feature definitions
- Perform AHED custom application tests against integrated features
- Review and provide guidance for improving QA Plan and QC Procedures

1.3.2 Subject Matter Expert (SME)

- Describe feature geometries and properties identified for AHED population
- Communicate feature descriptions and feature level metadata to Data Editors
- Review and recommend any required revisions to AHED features constructed by Data Editors, regardless of source SME

1.3.3 Data Editor (DE)

- Construct features under guidance from SMEs, AHED Data Ingestion Workflows & Protocols, AHED Compliance Specification, and ArcGIS geodatabase feature construction instructions
- Perform QC assessments and generate results reports
- Correct critical errors and perform QC assessments until acceptance criteria is achieved
- Communicate unhandled errors and similar situations that may arise to Database Owner for resolution

1.3.4 Database Owner (DBO)

- Review QC results reports provided by DEs and perform feature sampling QC assessments
- Perform AHED end user application tests against integrated features
- Construct and test geometric networks
- Communicate geodatabase performance degradations and errors with ArcSDE Application Administrator and Database Administrator as these conditions are identified

1.4 Document and Data Management

1.4.1 Document Management

The AHED Core Team IT group has developed a web portal site for the AHED Population Project and has linked project documentation to the site. This document will refer to supporting documents by title which can be used to find the document in the portal site. The P2S2 Work Order consultant has been provided with remote access to the District's computing environment, so every team member has access to all related documents.

AHED data development and management documentation assumes that the user has the necessary technical knowledge and experience to use ESRI's ArcGIS 9.3 toolset to perform required functions. ArcGIS 9.3 toolset usage instructions are not repeated in the AHED documentation. ArcGIS 9.3 Desktop Help is available online.

QC Reports generated during the performance of the P2S2 Work Order will be linked in appropriate locations in the AHED Population Project Portal as they are generated.

1.4.2 Data Management

AHED content is managed within the District's Enterprise GIS Data Library (EGDL) multi-user geodatabase (mGDB) production server environment within the GHYDP and GHYDS ArcSDE/Oracle instances. Upon completion of the AHED Population Project, GHYDP will be the database of record for hydrologic feature locations and will be populated from the Default version of the GHYDS mGDB. GHYDS is a versioned, editable mGDB in which the AHED features are constructed, tested, and confirmed for promotion into GHYDP.

Input and reference data for the AHED mGDB that has been published internally at the District is managed within the EGDL file structure and mGDB resources and may be discovered via the GIS Data Catalog. AHED Core Team members have compiled a list of data sources and their system locations. The AHED Population Project includes a task to retire legacy GIS data sets that have been migrated into the AHED. Existing applications will be revised to use the AHED data sources, and revisions to GIS Data Catalog entries will be completed.

Data Management Documentation & Resources:

- AHED Input Data Sources
- GIS Data Catalog
- GIS ArcSDE Diagram (EGDL mGDBs)

2 Quality Assurance

Acceptable quality of AHED content is assured by people who have been assigned to the roles above who perform their work correctly according to the AHED data ingestion workflows, methods, and protocols to create deliverable products that meet the requirements defined in the AHED Compliance Specification. Essentially, people perform the work correctly, and then check to make sure the results of their efforts are correct. When errors are found at this stage, they are corrected and the results are rechecked for errors. The goal of QA for AHED content is to meet or exceed the acceptance criteria when the QC tests are performed. When QC test results indicate that acceptance criteria have not been achieved, then those responsible for performing and ensuring the quality of their work have not done so correctly.

Quality Requirements Documentation:

- AHED Population Project Phase II Section 2 Work Order
- AHED Compliance Specification

2.1 Workflows, Methods, and Protocols

Carefully designed, documented, and formalized data ingestion workflows control what work is performed by whom and when in relation to which other process steps, processes and workflows within the AHED data environment. Communication among various roles is indicated in the process steps. The workflows are provided in these documents:

- AHED Data Ingestion Workflow
- AHED Data Ingestion Methods and Protocols Diagrams and Manual
- AHED Feature Class Edit Matrix

2.2 Input Controls

AHED content input is defined by the AHED Data Dictionary and controlled by the AHED schema design, feature editing tools, and ArcMap editing tools.

Structure:

- AHED Data Dictionary
- AHED Entity Relationship Diagram

Editing Tools:

3 Quality Control

The quality of AHED content is controlled by testing the features that have been described and constructed after the work has been completed. In many cases, tests are performed on partial samples of completed deliverables. The results are compared to established acceptance criteria. If error rates in the test results exceed established acceptance criteria, then the deliverables are rejected for correction at no further cost to the District.

3.1 Data Assessment

The AHED Compliance Specification categorizes AHED feature development into description and construction activities. QC tests will be performed to answer the two questions:

- Was the AHED data content described correctly?
- Was the AHED data content constructed correctly?

Generally, AHED content acceptance criteria allow for very low error rates. In many cases, single geometry or description errors can cause business user application tools to fail. For example, critical features participating in a geometric network must be constructed with coincident coordinates among their geometries in order for a network trace to function correctly. Therefore acceptance criteria for many tests of geometry construction may require that no errors be present.

The scope of this QA Plan and QC Procedures document is limited to the P2S1 Work Order. The Work Order specifies that many non-primary features from the National Hydrography Dataset (NHD) are to be loaded into new areas of development, but are not to be developed to meet AHED requirements. Only the features indicated in the Work Order for completion will be tested for QC acceptance.

3.2 QC Tests & Acceptance Criteria

QC Tests are performed in the QA_Default and Default versions of GHYDS after the data development work is completed. Initial QC tests are performed to check for basic requirements that support further tests. Feature class QC tests are performed on the entire feature class, or may be performed on features randomly selected from the feature class when QC test and feature set quantities warrant. Geometric Networks and feature class-level metadata are built and tested in the GHYDS Default version after all other development, tests, and revisions are complete. Finally, business applications are tested

against the AHED GHYDS Default version to confirm that they are generating expected results from the new data content. If any errors are found, the cause is determined. If the cause is the AHED data content, then errors are identified and corrected.

3.2.1 Initial Tests

- Unique HYDROIDs
  - Test for duplicate or missing HydroIDs by running the AHED Validate IDs Tool.
- Topology Rules
  - Test topology definition, if it doesn't match definition in Compliance Spec, reject deliverable
  - Test topology for dirty areas, if dirty areas exist reject deliverable
  - Test for errors. If non-excepted errors exist, reject deliverable
- Geometric Network
  - Check for expected behavior and feature participation. If it's obviously not working correctly, reject deliverable
  - Check for participating feature classes:
    - HYDROEDGE features participating as Complex Edges and HYDROJUNCTION features participating as Simple Junctions)
  - Check for Connectivity Rules:
    - HYDROEDGE features of subtype "Flowline" connected to HYDROJUNCTION features of subtypes: "CONTROLLED", "UNCONTROLLED", and "NETWORKJUNCTION"
  - Check for the Network Build Errors Table in the workspace, networkname_BUILDERR, to identify possible existing errors in the network.
  - Run Verify Network Connectivity and Verify Network Geometry commands to identify network errors
- Feature-level Metadata
  - Check for error conditions of duplicate and orphaned SourceID records in SOURCEQUALITY table
- Quality Control Status
  - Check the QCSTATUS fields to ensure all values are greater than 0.

Acceptance Criteria: No errors resulting from the above tests

3.2.2 Feature Class Tests

Feature Class: **BASIN**

- Geometry Description

- Test: SMEs review BASIN features for correct composition of constituent WATERSHED features
- Acceptance Criteria: Consensus agreement among SMEs that BASIN feature compositions are acceptable

- Test: SMEs compare BASIN boundaries with NHD Basin feature boundaries for general agreement.
- Acceptance Criteria: BASIN boundaries generally follow NHD Basin feature boundaries

- Test: SMEs review WATERSHED features for geometry description accuracy in reference to features visible in the 2004-05 USGS DOQQ-specification aerial photography (or better)

  WATERSHED features are aggregated to compose SUBBASIN features, and SUBBASIN features are in turn aggregated to compose BASIN features. Therefore, if WATERSHED features have correct geometry, then BASIN features have correct geometry.

- Acceptance Criteria: Consensus agreement among SMEs that all WATERSHED feature geometry descriptions are acceptable

o Geometry Construction
  - Test: Run ArcToolbox Check Geometry tool on BASIN feature class
  - Acceptance Criteria: Check Geometry tool run results in finding no errors

o Properties Description
  - Test: SMEs review BASIN features for correct values in attribute fields in feature class and related tables
  - Acceptance Criteria: Consensus agreement among SMEs that BASIN feature property descriptions are acceptable

o Properties Construction
  - Test: Inspect Required attribute fields for <Null> values
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Contextually Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Optionally Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect attribute fields that are not controlled by domains for valid values
  - Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect BASINHASSUBBASIN relationship class for correct relationship to SUBBASIN features
- Acceptance Criteria: SUBBASIN features correctly related in 95% of tested features

Feature Class: **SUBBASIN**

- Geometry Description
  - Test: SMEs review SUBBASIN features for correct composition of constituent WATERSHED features
  - Acceptance Criteria: Consensus agreement among SMEs that SUBBASIN feature compositions are acceptable

  - Test: SMEs compare SUBBASIN boundaries with NHD Subbasin feature boundaries for general agreement.
  - Acceptance Criteria: SUBBASIN boundaries generally follow NHD Subbasin feature boundaries

  - Test: SMEs review WATERSHED features for geometry description accuracy in reference to features visible in the 2004-05 USGS DOQQ-specification aerial photography (or better)

    WATERSHED features are aggregated to compose SUBBASIN features. Therefore, if WATERSHED features have correct geometry, then SUBBASIN features have correct geometry.

  - Acceptance Criteria: Consensus agreement among SMEs that all WATERSHED feature geometry descriptions are acceptable

- Geometry Construction
  - Test: Run ArcToolbox Check Geometry tool on SUBBASIN feature class
  - Acceptance Criteria: Check Geometry tool run results in finding no errors

- Properties Description
  - Test: SMEs review SUBBASIN features for correct values in attribute fields in feature class and related tables
  - Acceptance Criteria: Consensus agreement among SMEs that SUBBASIN feature property descriptions are acceptable

- Properties Construction
  - Test: Inspect Required attribute fields for <Null> values
  - Acceptance Criteria: No <Null> values present in 95% of tested features

- Test: Inspect Contextually Required attribute fields for <Null> values when context is present
- Acceptance Criteria: No <Null> values present in 95% of tested features
- Test: Inspect Optionally Required attribute fields for <Null> values when context is present
- Acceptance Criteria: No <Null> values present in 95% of tested features

- Test: Inspect attribute fields that are not controlled by domains for valid values
- Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect SUBBASINHASWATERSHED relationship class for correct relationship to WATERSHED features
- Acceptance Criteria: WATERSHED features correctly related in 95% of tested features

- Test: Inspect BASINHASSUBBASIN relationship class for correct relationship to BASIN features
- Acceptance Criteria: BASIN features correctly related in 95% of tested features

Feature Class: **WATERSHED**

- Geometry Description
  - Test: SMEs review WATERSHED features for geometry description accuracy in reference to features visible in the 2004-05 USGS DOQQ-specification aerial photography (or better)
  - Acceptance Criteria: Consensus agreement among SMEs that all WATERSHED feature geometry descriptions are acceptable

- Geometry Construction
  - Test: Run ArcToolbox Check Geometry tool on WATERSHED feature class
  - Acceptance Criteria: Check Geometry tool run results in finding no errors

  - Test: Inspect WATERSHED feature boundaries at STRUCTURE feature locations to ensure that boundary is coincident with the HYDROJUNCTION feature related to the STRUCTURE feature.
  - Acceptance Criteria: All WATERSHED feature boundaries are coincident with HYDROJUNCTION features related to STRUCTURE features.

- Properties Description
  - Test: SMEs review WATERSHED features for correct values in attribute fields in feature class and related tables
  - Acceptance Criteria: Consensus agreement among SMEs that WATERSHED feature property descriptions are acceptable

- Properties Construction
  - Test: Inspect Required attribute fields for <Null> values
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Contextually Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Optionally Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect attribute fields that are not controlled by domains for valid values
  - Acceptance Criteria: No invalid values present in 95% of tested features

  - Test: Inspect WATERSHEDHASSUBWATERSHED relationship class for correct relationship to SUBWATERSHED features
  - Acceptance Criteria: SUBWATERSHED features correctly related in 95% of tested features

  - Test: Inspect SUBBASINHASWATERSHED relationship class for correct relationship to SUBBASIN features
  - Acceptance Criteria: SUBBASIN features correctly related in 95% of tested features

  - Test: Inspect HYDROJUNCTIONHASWATERSHED relationship class for correct relationship to HYDROJUNCTION features
  - Acceptance Criteria: HYDROJUNCTION features correctly related in 95% of tested features

Feature Class: **SUBWATERSHED**

- Geometry Description
  - Test: SMEs review SUBWATERSHED features for geometry description accuracy in reference to features visible in the 2004-05 USGS DOQQ-specification aerial photography (or better)
  - Acceptance Criteria: Consensus agreement among SMEs that all SUBWATERSHED feature geometry descriptions are acceptable

- Geometry Construction
  - Test: Run ArcToolbox Check Geometry tool on SUBWATERSHED feature class
  - Acceptance Criteria: Check Geometry tool run results in finding no errors

- Properties Description
  - Test: SMEs review SUBWATERSHED features for correct values in attribute fields in feature class and related tables
  - Acceptance Criteria: Consensus agreement among SMEs that SUBWATERSHED feature property descriptions are acceptable

- Properties Construction
  - Test: Inspect Required attribute fields for <Null> values
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Contextually Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Optionally Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect attribute fields that are not controlled by domains for valid values
  - Acceptance Criteria: No invalid values present in 95% of tested features

  - Test: Inspect WATERSHEDHASSUBWATERSHED relationship class for correct relationship to WATERSHED features
  - Acceptance Criteria: WATERSHED features correctly related in 95% of tested features

Feature Class: **HYDROEDGE**

- Geometry Description
  - Test: SMEs review HYDROEDGE features for geometry description accuracy in reference to features visible in the 2004-05 USGS DOQQ-specification aerial photography (or better)
  - Acceptance Criteria: Consensus agreement among SMEs that all HYDROEDGE feature geometry descriptions are acceptable

- Geometry Construction
  - Test: Run ArcToolbox Check Geometry tool on HYDROEDGE feature class
  - Acceptance Criteria: Check Geometry tool run results in finding no errors

  - Test: Check feature geometry spatial accuracy against NSSDA horizontal accuracy requirements for 1:20,000 scale spatial data

- Acceptance Criteria: Feature geometry spatial accuracy meets NSSDA horizontal accuracy requirements for 1:20,000 scale spatial data in 95% of tested features

- Properties Description
  - Test: SMEs review HYDROEDGE features for correct values in attribute fields in feature class and related tables
  - Acceptance Criteria: Consensus agreement among SMEs that HYDROEDGE feature property descriptions are acceptable

- Properties Construction
  - Test: Inspect Required attribute fields for <Null> values
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Contextually Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Optionally Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect attribute fields that are not controlled by domains for valid values
  - Acceptance Criteria: No invalid values present in 95% of tested features

  - Test: Inspect HYDROEDGEHASNHDSTATUS relationship class for correct relationship to NHDSTATUS records
  - Acceptance Criteria: NHDSTATUS records correctly related in 95% of tested features

  - Test: Inspect HYDROJUNCTIONHASFROMEDGE relationship class for correct relationship to HYDROJUNCTION features
  - Acceptance Criteria: HYDROJUNCTION features correctly related in 95% of tested features

Feature Class: **HYDROJUNCTION**

- Geometry Description
  - Test: SMEs review HYDROJUNCTION features for geometry description accuracy in reference to STRUCTURE and HYDROEDGE features
  - Acceptance Criteria: Consensus agreement among SMEs that all HYDROJUNCTION feature geometry descriptions are acceptable

- Geometry Construction

- Test: Validate location of HYDROJUNCTION features of subtype Controlled and UnControlled to be either on controlled or uncontrolled structures as defined by SMEs.
- Acceptance Criteria: Locations verified and are correct..
- Test: Validate location of Hydrojunctions of type Internal and DrainPoint to be located within their related polygon features.
- Acceptance Criteria: All Internal and DrainPoint Hydrojunctions are within their related polygon features.

o Properties Description
- Test: SMEs review HYDROJUNCTION features for correct values in attribute fields in feature class and related tables
- Acceptance Criteria: Consensus agreement among SMEs that HYDROJUNCTION feature property descriptions are acceptable

o Properties Construction
- Test: Inspect Required attribute fields for <Null> values
- Acceptance Criteria: No <Null> values present in 95% of tested features

- Test: Inspect Contextually Required attribute fields for <Null> values when context is present
- Acceptance Criteria: No <Null> values present in 95% of tested features

- Test: Inspect Optionally Required attribute fields for <Null> values when context is present
- Acceptance Criteria: No <Null> values present in 95% of tested features

- Test: Inspect attribute fields that are not controlled by domains for valid values
- Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect if JUNCTIONTYPE attribute field is “NetworkJunction” value, then FTYPE attribute field must have “<Null>” value.
- Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect if JUNCTIONTYPE attribute field is “Controlled” value or “Uncontrolled” value, then FTYPE attribute field must have “Structure” value. Exception: if JUNCTIONTYPE attribute field is “Uncontrolled” value and the feature is not related to a structure, then FTYPE attribute field must have “<Null>” value.
- Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect if JUNCTIONTYPE attribute field is “DrainPoint” value, then FTYPE attribute field must have “Watershed” value.
- Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect if FTYPE attribute field is "Waterbody" value, then JUNCTIONTYPE attribute field must have "Internal" value.
- Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect if FTYPE attribute field is "MonitoringPoint" value, then JUNCTIONTYPE attribute field must have "Internal" value.
- Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect if feature is related to feature(s) in other feature class(es), then the HYDRO_ORDER attribute field value(s) must be identical (e.g. If a Structure feature has a HYDRO_ORDER attribute field "Primary" value, then the related HYDROJUNCTION feature's HYDRO_ORDER attribute field must have "Primary" value.)
- Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect HYDROJUNCTIONHASWATERSHED relationship class for correct relationship to WATERSHED features
- Acceptance Criteria: WATERSHED features correctly related in 95% of tested features

- Test: Inspect HYDROJUNCTIONHASFROMEDGE relationship class for correct relationship to HYDROEDGE features
- Acceptance Criteria: HYDROEDGE features correctly related in 95% of tested features

- Test: Inspect HYDROJUNCTIONHASWATERBODY relationship class for correct relationship to WATERBODY features
- Acceptance Criteria: WATERBODY features correctly related in 95% of tested features

- Test: Inspect HYDROJUNCTIONHASMONITORINGPOINT relationship class for correct relationship to MONITORINGPOINT features
- Acceptance Criteria: MONITORINGPOINT features correctly related in 95% of tested features

- Test: Inspect HYDROJUNCTIONHASSTRUCTURE relationship class for correct relationship to STRUCTURE features
- Acceptance Criteria: STRUCTURE features correctly related in 95% of tested features

Feature Class: **MONITORINGPOINT**

- Geometry Description

- Test: SMEs review MONITORINGPOINT features for geometry description accuracy in reference to features visible in the 2004-05 USGS DOQQ-specification aerial photography (or better)
- Acceptance Criteria: Consensus agreement among SMEs that all MONITORINGPOINT feature geometry descriptions are acceptable

o Geometry Construction
- Test: none
- Acceptance Criteria: none

- Test: Check feature geometry spatial accuracy against NSSDA horizontal accuracy requirements for 1:20,000 scale spatial data
- Acceptance Criteria: Feature geometry spatial accuracy meets NSSDA horizontal accuracy requirements for 1:20,000 scale spatial data in 95% of tested features

o Properties Description
- Test: SMEs review MONITORINGPOINT features for correct values in attribute fields in feature class and related tables
- Acceptance Criteria: Consensus agreement among SMEs that MONITORINGPOINT feature property descriptions are acceptable

o Properties Construction
- Test: Inspect Required attribute fields for <Null> values
- Acceptance Criteria: No <Null> values present in 95% of tested features

- Test: Inspect Contextually Required attribute fields for <Null> values when context is present
- Acceptance Criteria: No <Null> values present in 95% of tested features

- Test: Inspect Optionally Required attribute fields for <Null> values when context is present
- Acceptance Criteria: No <Null> values present in 95% of tested features

- Test: Inspect attribute fields that are not controlled by domains for valid values
- Acceptance Criteria: No invalid values present in 95% of tested features

- Test: Inspect HYDROJUNCTIONHASMONITORINGPOINT relationship class for correct relationship to HYDROJUNCTION features
- Acceptance Criteria: HYDROJUNCTION features correctly related in 95% of tested features

Feature Class: **MONITORINGSITE**

- Geometry Description
  - Test: SMEs review MONITORINGSITE features for geometry description accuracy in reference to features visible in the 2004-05 USGS DOQQ-specification aerial photography (or better)
  - Acceptance Criteria: Consensus agreement among SMEs that all MONITORINGSITE feature geometry descriptions are acceptable

- Geometry Construction
  - Test: none
  - Acceptance Criteria: none

- Properties Description
  - Test: SMEs review MONITORINGSITE features for correct values in attribute fields in feature class and related tables
  - Acceptance Criteria: Consensus agreement among SMEs that MONITORINGSITE feature property descriptions are acceptable

- Properties Construction
  - Test: Inspect Required attribute fields for <Null> values
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Contextually Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect attribute fields that are not controlled by domains for valid values
  - Acceptance Criteria: No invalid values present in 95% of tested features

Feature Class: **STRUCTURE**

- Geometry Description
  - Test: SMEs review STRUCTURE features for geometry description accuracy in reference to features visible in the 2004-05 USGS DOQQ-specification aerial photography (or better)
  - Acceptance Criteria: Consensus agreement among SMEs that all STRUCTURE feature geometry descriptions are acceptable

- Geometry Construction
  - Test: none
  - Acceptance Criteria: none

  - Test: Check feature geometry spatial accuracy against NSSDA horizontal accuracy requirements for 1:20,000 scale spatial data

- Acceptance Criteria: Feature geometry spatial accuracy meets NSSDA horizontal accuracy requirements for 1:20,000 scale spatial data in 95% of tested features

- Properties Description
  - Test: SMEs review STRUCTURE features for correct values in attribute fields in feature class and related tables
  - Acceptance Criteria: Consensus agreement among SMEs that STRUCTURE feature property descriptions are acceptable

- Properties Construction
  - Test: Inspect Required attribute fields for <Null> values
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Contextually Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Optionally Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect attribute fields that are not controlled by domains for valid values
  - Acceptance Criteria: No invalid values present in 95% of tested features

  - Test: Inspect STRUCTUREHASSYMBOLOGY relationship class for correct relationship to SYMBOLOGY records
  - Acceptance Criteria: SYMBOLOGY records correctly related in 95% of tested features

  - Test: Inspect HYDROJUNCTIONHASSTRUCTURE relationship class for correct relationship to HYDROJUNCTION features
  - Acceptance Criteria: HYDROJUNCTION features correctly related in 95% of tested features

Feature Class: **WATERBODY**

- Geometry Description
  - Test: SMEs review WATERBODY features for geometry description accuracy in reference to features visible in the 2004-05 USGS DOQQ-specification aerial photography (or better)
  - Acceptance Criteria: Consensus agreement among SMEs that all WATERBODY feature geometry descriptions are acceptable

- Geometry Construction
  - Test: Run ArcToolbox Check Geometry tool on WATERBODY feature class
  - Acceptance Criteria: Check Geometry tool run results in finding no errors

- Properties Description
  - Test: SMEs review WATERBODY features for correct values in attribute fields in feature class and related tables
  - Acceptance Criteria: Consensus agreement among SMEs that WATERBODY feature property descriptions are acceptable

- Properties Construction
  - Test: Inspect Required attribute fields for <Null> values
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Contextually Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect Optionally Required attribute fields for <Null> values when context is present
  - Acceptance Criteria: No <Null> values present in 95% of tested features

  - Test: Inspect attribute fields that are not controlled by domains for valid values
  - Acceptance Criteria: No invalid values present in 95% of tested features

  - Test: Inspect if WATERBODY feature contains HYDROEDGE feature that has HYDRO_ORDER attribute field "Primary" value, then WATERBODY feature's HYDRO_ORDER attribute field must have "Primary" value.
  - Acceptance Criteria: No invalid values present in 95% of tested features

  - Test: Inspect WATERBODYHASNHDSTATUS relationship class for correct relationship to NHDSTATUS records
  - Acceptance Criteria: NHDSTATUS records correctly related in 95% of tested features

  - Test: Inspect HYDROJUNCTIONHASWATERBODY relationship class for correct relationship to HYDROJUNCTION features
  - Acceptance Criteria: HYDROJUNCTION features correctly related in 95% of tested features

3.2.3 Feature Class-Level Metadata Tests

For each AHED feature class and table required to have metadata conforming to the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata (CSDGM), perform the following tests:

- Test: Use the USGS Geospatial Metadata Validation Service to check for errors
- Acceptance Criteria: No errors present in the report

- Test: Review the metadata for inconsistent, incorrect, or incomplete information
- Acceptance Criteria: No inconsistent, incorrect, or incomplete information in the metadata

3.2.4 Business Application Tests

- Test: After all previous tests have resulted in accepted deliverables, run the existing AHED tools test plans created for application development against the AHED GHYDS Default version. Be sure to use known new features to confirm that the applications are working with them as expected.
- Acceptance Criteria: Business applications are working as expected with new AHED data content

3.3 QC Reports

QC testing is performed during data development to assure quality and upon receipt of deliverables to test and confirm quality. QC test reports will be generated during each testing period during both data development and after the completed work has been delivered. The QC reports will contain an indicator of which tests were performed on which AHED geodatabase objects and features, by whom, when, the results with a clear "accept" or "reject" recommendation, any runtime output, and testing problem and final resolution descriptions. QC test reports will be stored in the AHED working directories and linked in the AHED Population Project portal page for access and review among data development team members.

3.4 Error Resolution

The QA Plan and QC Procedures are designed to support development of deliverables that meet or exceed the acceptance criteria for each test. Therefore, it is expected that QC reports generated after receipt of deliverables will show that the AHED data content meets the acceptance criteria at the first submittal of each AHED content deliverable. In the unlikely event that acceptance criteria are not met at the first submittal, the AHED data development team will identify and resolve the core problem, then correct errors in the deliverable and re-submit for final QC testing.

4 QA & QC Process Improvement

During the performance of the P2S1 Work Order data population tasks, elements of the QA Plan & QC Procedures may be shown to be insufficient or superfluous for meeting the contract AHED content deliverable requirements. If this condition arises, the steps below will be taken to improve the QA & QC processes.

4.1 QA/QC Problem Identification and Communication

When a problem with QA/QC is suspected, it will be analyzed to clearly identify it, understand its root cause, and bring it to issue with the full AHED data development team. The problem will be considered to be an issue when it has been clearly identified, agreed to be a problem, and when a limited set of feasible options for resolving the problem have been developed and a recommended resolution option clearly specified. The resolution options will be communicated among the AHED development team members for review, comment, and final resolution.

4.2 QA/QC Issue Resolution

When a QA/QC problem has been brought to issue, the AHED data development team will consider each of the options and perform the following tasks:

- Determine the impact to P2S1 Work Order schedule and budget
- Determine impact to AHED quality level
- Determine course of action at appropriate control level (KBU, SME, DE, DBO, project team, governance team, management oversight group, sponsors, etc.)
- Document and communicate resolution to all affected parties
- Implement resolution

4.3 QA/QC Change Control

When a QA/QC issue has been resolved, the QA Plan & QC Procedures document will be revised to incorporate the resolution and remove any requirements that have been found to be problematic or superfluous. A new copy of the document will be created and named according to the AHED Population Project document naming convention indicating that it has become a draft. The version will be updated with a minor version update indicator (e.g. v1.1, v1.2, etc) if the QC Procedures are improved, but the QA Plan is substantially unchanged. The version will be updated with a major version update indicator (e.g. v2.0, v3.0, etc.) if the QA Plan is substantially altered.

The draft document will be submitted to the AHED Population Project team for review, comments, and approval before the version is finalized. Upon finalization, the updated QA Plan and QC Procedures document will be linked in the AHED Population Project portal site and used for future P2S1 Work Order data deliverable activities.