

Duke | FACILITIES MANAGEMENT GIS STANDARDS GUIDELINE

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2 Acronyms

Architect/Engineer/Contractor	AEC
Building Information Modeling	BIM
Computer-Aided Design	CAD
Construction Document	CD
Design Development	DD
Duke University	Duke
Duke Utility & Engineering Services	DUES
Drawing File Extension - AutoCAD® Native	DWG
Facilities Management Department	FMD
Geographic Information Systems	GIS
Geodatabase	GDB
Schematic Design	SD

3 Introduction

Spatial data that is collected by internal staff and external vendors/contractors with the purpose of being used in the Duke University Facilities Management (FMD) geographic information system (GIS) must adhere to the FMD GIS Data Standard. Any site specific utility infrastructure data as well as landscaping data must be submitted by the guidelines set forth in this document. This ensures that FMD has the most up to date spatial information for Duke University's campus.

4 Spatial Reference

Digital data provided to or produced for FMD needs to be in the North American Datum 1983 (NAD83) horizontal geodetic datum and referenced in North Carolina State Plane Coordinates (NCSPC); and in the North American Vertical Datum of 1988 (NAVD 88). The NCSPC is the official survey base for the State of North Carolina.

The specifics of the referencing system requirements are as follows:

Projection: Lambert Conformal Conic
Geographic Coordinate System: GCS_NAD_1983_2011 FIPS Zone: 3200
False Easting: 2000000.0 (as per ESRI)
False Northing: 0.0 (as per ESRI)
Central Meridian: -79.0
Scale Factor:
Latitude of Origin: 33.75
Linear Unit: US Foot
Angular Unit: Degree
Horizontal Datum: North American Datum of 2011 Vertical Datum: NAVD 88
Spheroid: GRS1980
Semi Major Axis: 6378137.0
Semi Minor Axis: 6356752.314140356
Inverse Flattening: 298.257222101

FMD requires that all coordinate values be reported in units of US survey feet, with the units clearly defined in the attached metadata. This requirement applies to all ground survey data as well, which must be submitted with equivalent NCSPC values for all points, if the points were not originally captured in NCSPC.

5 Data Creation and Collection

There are many techniques that can be used to create geospatial data, which in turn can be submitted to FMD. The two most common are:

A). Compiling data from base sources like digital imagery, using interactive editing, digitizing overlays which are then scanned and georeferenced, vector based analysis, classification, etc.

B). Data captured from the field using measurement technology instruments like TPS, GPS/GNSS, Digital Levels, and Lidar.
Base Sources:

- Any recent digital aerial photography at large or small scale must meet or exceed the NSSDA (Standard for Spatial Data Accuracy) testing methodology. Accuracies for historical digital imagery (prior to 2002) can be reported using the NMAS (National Map Accuracy Standards).
- Non-digital (hard copy) base maps: Since some data needed to represent historical conditions may have to be generated from non-digital sources, those sources must meet a NMAS threshold value for the appropriate scale.
- User geo-referenced digital imagery: Geo-referencing is the process of defining a coordinate system and a projection for an undefined data source, such as a historic map or image. In those cases where the data submitted to FMD was generated from a source geo-referenced by the data provider, the source material should be identified and its accuracy characteristics described, along with a full description of the geo-referencing process used by the data provider. Control point files with a report about accuracy, errors, and procedures are also to be provided.
- Vector data sets: Data submitted to FMD may be based on existing vector data sets. In these cases, a full description of the accuracy of the base vector data sets (including the accuracy of the source layer) used to create the data needs to be reported.
- In cases where data was created from base sources not referenced to NCSPC, all data will be projected to NCSPC before submittal to FMD.

6 Supported Data Formats

FMD's enterprise system is built using ESRI software and there are several acceptable formats for data to be submitted. These formats are listed below in order of preference, with any specific requirements applicable to each:

6.1 Geodatabase (File or Personal)

Data developed and submitted to FMD shall be in a compatible version of ESRI's file or personal geodatabase (10.x version or higher). All data submitted must be topologically correct.

Geodatabases will adhere to at least the following standards:

- All feature classes included in the geodatabase will exist in one or more feature data sets
- The XY coordinate system for all feature datasets and feature classes will be in NCSPC
- Z coordinate system will be NAVD_1988
- The XY tolerance will be at least 0.01 ft. (A closer tolerance may be used where the accuracy of the data supports it, such as that collected with a survey grade GPS)
- The XY resolution will be at least 0.01 ft.

- Topologies will be created for all feature datasets and feature classes and all topologies will be checked before being submitted to FMD. Topologies may not have errors.
- For topologies that involve more than one layer, the most accurate layer will be given the highest rank

The minimum topology rules are:

- Features will not be duplicated
- Coincident boundaries will be corrected within a feature dataset (features that share boundaries with features in other feature classes in the dataset)
- Linear features will not overlap; i.e., all line intersections will require a node
- Linear features will maintain correct arc directionality for any data set with flow directions.
- Linear features will not have pseudo-nodes unless they are required to maintain a change in arc attribution
- Polygons must close
- Polygons will have no overshoots or dangles
- Polygons will not overlap
- Polygons sharing edges will not have gaps

Topologies should be submitted as part of the geodatabase delivered to FMD so that completeness and accuracy can be easily verified. In some cases, FMD GIS may develop project specific geodatabase templates or data dictionaries for data submittal consistency. Users should investigate with FMD whether or not geodatabase templates have been created and posted for download before developing a geodatabase for a project specific data submittal.

6.2 Shapefiles

All shapefile data sets must include at a minimum the following files:

- .shp (the file that stores the geometry)
- .shx (the file that stores the feature geometry index)
- .dbf (the file that stores the feature attribute information)
- .prj (the file that stores the coordinate information)

When applicable, the following files should also be submitted:

- .sbx, .sbn (the files that store the spatial index of the features)
- .ain, .aih (the files that store the attribute index of active fields in the attribute table)

Shapefiles must be created so that the following basic topology rules are not violated:

- Features will not be duplicated
- Linear features will not overlap; i.e., all line intersections will require a node
- Linear features will maintain correct arc directionality for any data set with flow directions
- Linear features will not have pseudo-nodes unless they are required to maintain a change in arc attribution
- Polygons must close
- Polygons will have no overshoots or dangles
- Polygons will not overlap or self-intersect
- Polygons sharing edges will not have gaps
- Polygons will have one and only one label point

6.3 Raster Data

Raster data sets that encompass imagery or elevation data are less likely to be submitted to FMD than vector data (points, lines, polygons). However, in those cases where submissions of raster are required, the following data formats will be accepted.

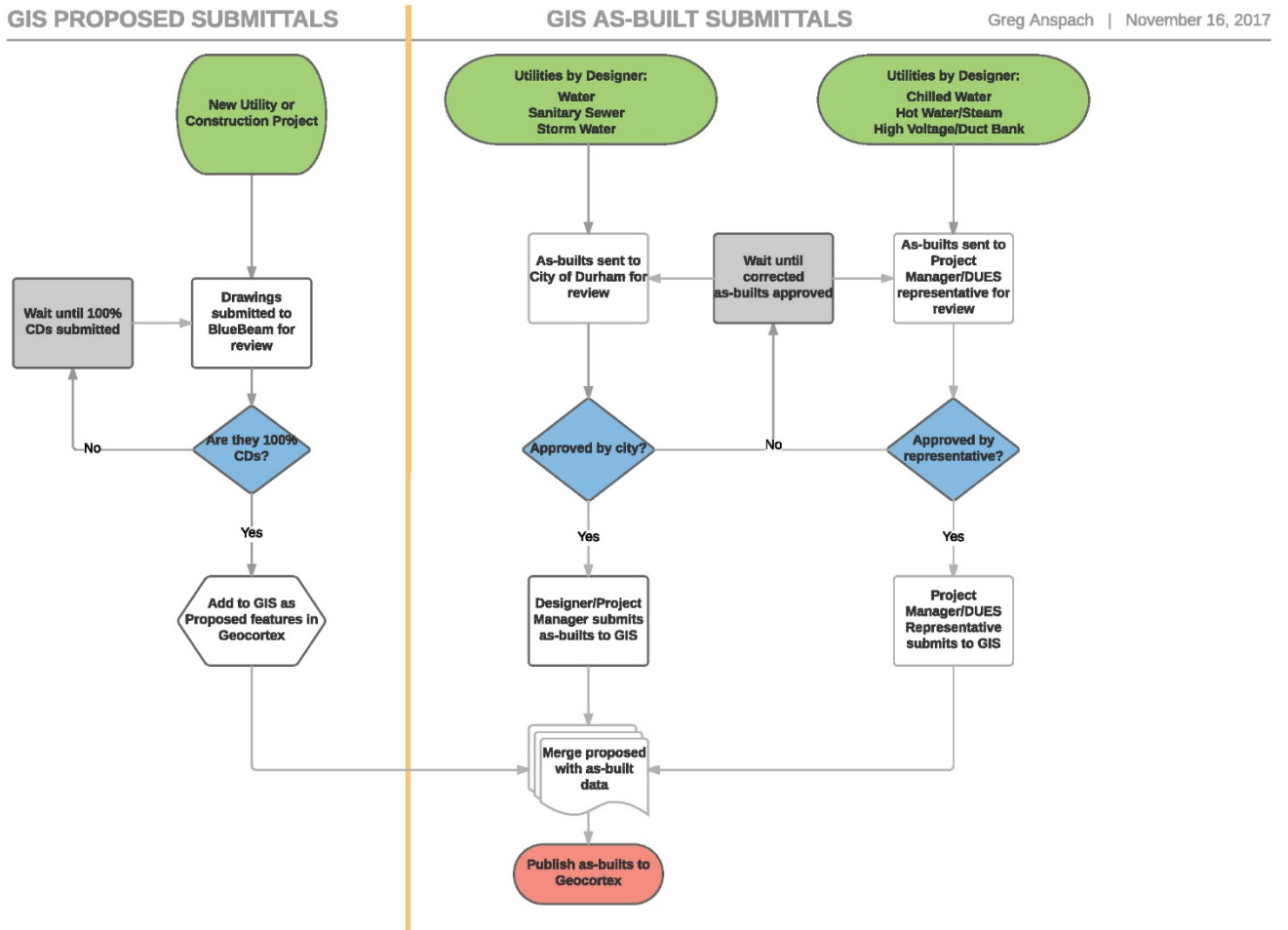
- ArcInfo grids (integer or floating point)
- Triangular Irregular Networks (TINs)
- MrSid (version 2, 3 or 4) with world file
- Tiff, Geotiff, with world file
- Jpeg, jpeg2000 with world file
- ERDAS Imagine

6.4 CAD

CAD data will not be accepted into the Duke University FMD GIS system. Any CAD data must be converted to an approved GIS format with the correct coordinate system.

7 GIS Submittals Process

GIS data submitted to Duke University FMD will adhere to the following process:



- GIS utility data will not be added until a 100% CD Bluebeam review session is submitted. This data will be shown as 'Proposed' and subject to change when more accurate data is acquired.
- Non-utility data (Building footprints and planimetric data) may be submitted earlier than when 100% CDs are submitted for planned and place marker purposes. This data is also subject to change when more accurate data is acquired.
- Utility as-builts submitted to the City of Durham must also be submitted to FMD GIS after approval from the city.
- Utility as-builts not required by the City of Durham must be submitted to FMD GIS by the Project Manager or Project Designer as soon as approved by the DUES representative.
- Any 'Proposed' data that is updated from as-built drawings will be reflected in GIS as no longer proposed but 'Existing'.

8 GIS Data Dictionary

A data dictionary is a list of attributes to be collected, the field characteristics for each attribute and the acceptable values. If a data dictionary exists for a feature, FMD requires that it be used for data collection and submission. This will ensure that data collected will be compatible with existing GIS data. These may be requested from FMD by contacting greg.anspach@duke.edu.
