250 N. Water Street
Mobile, AL 36602
www.alports.com

Alabama State Port Authority

Port of Mobile

ASPA GIS Standards for CAD

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Table of Contents

Purpose

Client	ASPA
Subject	GIS Standards for CAD
Author	NorthSouth GIS LLC

Introduction

Purpose

The Alabama State Port Authority (APSA), or Port of Mobile, utilizes a Geographic Information System (GIS) to track, maintain and analyze facilities within the Port's jurisdiction, such as roads, buildings, and utilities. Consultants and contractors participating in projects that involve removal, addition or modification of these facilities are required to provide AutoCAD drawing (DWG) files to the Port at the end of each project detailing the work performed in a format compliant with the Port's enterprise GIS. These GIS compliant deliverables are not expected nor intended to replace planned deliverables (i.e. those that would normally be submitted as per standards of practice) but as supplementary deliverables.

This document was developed to provide guidelines for consultants and contractors on creating the GIS-compliant post-project drawing files to submit to the Port.

GIS & CAD: Key Differences

Although GIS and CAD systems can often display and maintain similar data, the fundamental aspect of how that data is organized, stored, and manipulated is quite different. Table 1 summarizes the major differences.

Table 1 - Summary of GIS & CAD Key Differences

Aspect	CAD	GIS
Use	CAD information typically represents discrete engineering projects whether those be a conceptual design, an as-built, or a system schematic.	GIS data typically represent real-world features such as land areas, lakes, and rivers, as well as made-made features such as roads, buildings, docks, and utilities. Each of those features is tied to a true location in the real world. GIS map layers tend to coalesce data from multiple projects and data sources into single, facility-wide content.
Focus	CAD is a design tool, and the focus is therefore on precision and detail.	GIS is for geographic data management and visualization. The focus is on data integration, display, query and reporting.

Aspect	CAD	GIS
Data vs. graphical objects	With CAD, the lines on screen are what are important, i.e., the drawing **IS** the information. These graphical objects have associated data, but it is often limited to information related to the graphics such as color, thickness, and line type.	With GIS, the lines you see on screen are just a representation of the data behind it. GIS data is really composed of 2 parts: the feature's geometry and the feature's database attributes. Attributes are extremely important in GIS. Attributes provide information about the real-world object the point, line, or polygon is representing.
Organization	CAD files are typically organized into layers where a layer is a logical grouping of objects in the design. CAD object properties such as color, line weight, thickness and line types are used to distinguish design elements or features (i.e., the design **IS** the information).	GIS data is organized by features. Similar features (for example roads) often will all be on a single feature layer for the *entire* facility, and can be displayed according to their attributes.
Geometry	CAD includes many types of geometry, including points, lines, polylines (multi-segment lines), circles, arcs, splines, text, dimension marks, and more. These can be combined in a design to get the graphics **exactly** right and to eliminate any confusion when a design is to be constructed.	GIS data is composed of primarily 3 types of feature geometries: point features, linear features (lines & polylines) and polygon features (closed polylines). Additionally, Annotation features (similar to labels) can be stored in the GIS but typically are created on the fly using automated labeling functions based on attributes. Note that no Annotation features will be included in this described workflow. A feature layer can only contain one type of geometry.

Aspect	CAD	GIS
Coordinate systems	Most CAD designs are in a relatively small local area, so the curvature of the earth is often ignored. Consequently, many CAD designs do not have an established well-known coordinate system and instead set an arbitrary origin point or are tied to local control.	GIS features represent real-world objects in real-world locations and require a well-known coordinate system. The appropriate coordinate system for the Port of Mobile is the Alabama State Plane West, North American Datum 1983 (NAD83 2011), U. S. Survey Feet (WKID Esri 9749). Vertical (height) North American Vertical Datum 1988, U.S. Survey Feet, Positive Up (WKID EPSG 6360). Vertical (depth) North American Vertical Datum 1988, U.S. Survey Feet, Positive Down (WKID EPSG 6358).

CAD Data

CAD information typically represents discrete engineering projects, whether it be a conceptual design, an As-Built, or what the system in operation looks like. The very name CAD (computer aided drafting/design) indicates that CAD software is typically used for design or to automate the task of drafting, whether the drawing is created from scratch or from referential information. CAD files are typically organized into layers where a layer is a logical grouping of objects in the design. CAD object properties such as color, line weight, thickness, and line types are used to distinguish design elements or features. Labeling and arrows add information to drawn objects.

GIS Data

GIS data typically represents real-world phenomena. Each of the “features” in GIS typically represent some tangible asset and is tied to a true location in the real world. The linework in GIS is a representation of the data held in feature attribute database tables. GIS data is composed of two parts: the feature geometry and the feature attributes. Feature geometry is the graphical elements of GIS data, the points, lines, and polygons. Feature attributes are the information about each of those features. And while in CAD this additional information (e.g. pipe diameter, soil depth) is represented visually by text and arrows, in GIS these attribute descriptors are stored in database tables. Typically, feature attributes are used to determine how the feature geometry will be represented on screen (i.e. *symbolized*). That means that the representation of features can change depending on which attribute is used for that representation, e.g. the same data can use color to denote different pipe materials, then changed to use color to depict different pipe diameters. With GIS data, the location of each feature is important as it refers to a real-world location on the Earth’s surface, which is critical for accurate spatial data management and analysis.

Geometry

In CAD many objects can be used to create a single design (e.g., points, lines, polylines, arcs, circles, spines, multi lines, etc.). GIS data, however, is primarily composed of only 3 types of feature geometries; point features, linear features (lines & polylines) and polygon features (closed polylines).

Point objects

Point features define discrete locations of geographic features too small to be depicted as lines or areas (e.g., monitoring wells, utility poles, incident locations, etc.).

Point objects can be represented using CAD points or blocks. It is essential when using blocks that the insertion point accurately represents the real-world geographic location of the object (i.e., the center).

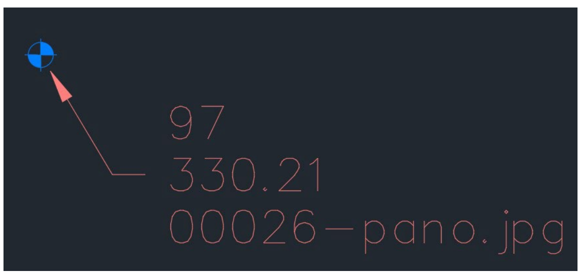

Figure 1. Point features

Line objects

Linear features represent the shape and location of geographic objects too narrow to depict as areas. Lines are also used to represent features that have length but no area, such as contour lines.

Line objects can be represented using lines, polylines, or arcs. It is acceptable for multi-segment polylines to include arc segments. However, do not use the width feature in polylines, and do not include closed polylines to represent line objects.

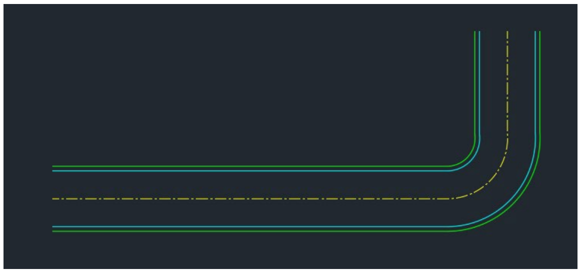

Figure 2. Linear features

Polygon objects

Polygon features are enclosed areas (many-sided figures) that represent the shape and location of homogeneous areas (e.g., jurisdictional boundaries, parcels, soil types, and land-use zones, etc.).

Polygon objects *must be represented by properly closed polylines*.

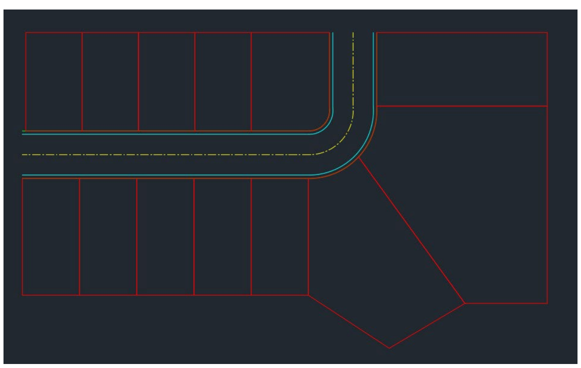

Figure 3. Polygon features

In addition, any given feature layer in GIS can only be composed of a single type of geometry. For example, a Rivers feature layer must be composed of all linear geometry (small scale) or all polygon geometry (large scale). The Rivers feature layer cannot be composed of both linear and polygon feature geometries.

Attributes

As stated elsewhere, GIS data is composed of two parts: the feature geometry and the feature attributes. Feature attributes are the information about each feature. Attributes are extremely important in GIS (the "Information" component in GIS). Attributes provide information about the real-world object the point, line or polygon is representing in the data set (the "Geographic" component in GIS).

CAD object properties, on the other hand, are only properties of the graphical point, line or polygon used to control the appearance and behavior of objects and are used to organize a drawing. Color, line weight, line type and point style all describe the drawn geometry. These properties do not **explicitly describe** what the real-world object the point, line or polygon (closed polyline) is representing.

CAD *object data*, however, is attribute data that is attached to individual objects and stored in tables in the drawing. Object data tables store text and numerical information related to an object.

Layers

Although both CAD and GIS utilize the term *layer*; the meaning of each is different.

When drafting in CAD, layers are used to help organize objects. This is typically a logical organization regardless of object type. For example, all rivers, ponds, lakes, and creeks may reside on a single layer called "Water". Ponds and lakes could be designed using closed polylines, rivers and creeks could be represented by a series of lines/polylines or a mix of open and closed polylines.

GIS features are grouped together and referred to a *feature layer* (more formally, a *feature class*). A GIS feature layer is composed of like-features which are all of the same geometry.

Coordinate Systems

With GIS data, the location of each feature on screen refers to a real-world location on the Earth's surface. A set of coordinate frameworks are used for defining real-world locations called coordinate systems. The most common is the Geographic Coordinate System, which measures locations on the Earth in terms of Latitude and Longitude. Another common coordinate system used throughout the USA is called the State Plane Coordinate System. The State Plane Coordinate System is a projected coordinate system (i.e., the 3D Earth has been mathematically projected onto a 2D surface) that originates from a well-known Geographic Coordinate System (i.e., *horizontal datum).* The State Plane Coordinate System uses Cartesian coordinates, that is "X" and "Y" values rather than Latitude and Longitude to specify locations.

Port of Mobile requires that all drawings be provided in the State Plane Coordinate System: Alabama State Plane West, North American Datum 1983 (NAD83 2011), U. S. Survey Feet. Vertical Height (as applicable): North American Vertical Datum 1988, U.S Survey Feet, Positive Up; Vertical Depth (as applicable): North American Vertical Datum 1988, U.S. Survey Feet, Positive Down.

Table 2 - ASPA Projection Parameters

Parameter	Value
Projected Coordinate System	NAD 1983 (2011) StatePlane Alabama West (US Feet)
Projection	Transverse Mercator
WKID	9749
Authority	Esri
Linear Unit	US Survey Feet (0.3048006096012192)
False Easting	1968500
False Northing	0
Central Meridian	-87.5
Scale Factor	0.999933333
Latitude Of Origin	30
Horizontal	
Parameter	**Value**
Geographic Coordinate System	NAD 1983 (2011)
WKID	6318
Previous WKID	104145
Authority	EPSG
Angular Unit	Degree (0.0174532925199433)
Prime Meridian	Greenwich (0.0)
Datum	D NAD 1983 2011
Spheroid	GRS 1980
Semimajor Axis	6378137
Semiminor Axis	6356752.314
Inverse Flattening	298.2572221

Vertical (Height)	
Parameter	**Value**
Vertical Coordinate System	NAVD88 height (ftUS)
WKID	6360
Previous WKID	105703
Authority	EPSG
Linear Unit	US Survey Feet (0.3048006096012192)
Direction	positive up
Vertical Shift	0.0
Vertical Datum	North American Vertical Datum 1988
Vertical (Depth)	
Parameter	**Value**
Vertical Coordinate System	NAVD88 depth (ftUS)
WKID	6358
Authority	EPSG
Linear Unit	US Survey Feet (0.3048006096012192)
Direction	positive down
Vertical Shift	0.0
Vertical Datum	North American Vertical Datum 1988

Drawing Standards & CAD Settings

All GIS-compliant drawings provided by consultants and contractors to the Port are intended for sharing data between consultants and contractors and the Port. Since these drawings are vehicles for data transfer between CAD and GIS, there is no need to use CAD Paper Space. All data must reside in Model Space only. In addition, the following practices should be followed:

- Drafting in Model Space at full scale – objects should not be scaled or rotated, nor should scaled viewports be utilized.
- All drawings must be provided in a well-known projected coordinate system: **Alabama State Plane West, North American Datum 1983 (NAD83 2011), U. S. Survey Feet. Vertical Height (as applicable): North American Vertical Datum 1988, U.S Survey Feet, Positive Up; Vertical Depth (as applicable): North American Vertical Datum 1988, U.S. Survey Feet, Positive Down.** Consultants and contractors are required to work within this coordinate system.
- Units are **decimal U.S. Survey feet**. Do not use Architectural units.

Within the CAD software, the following settings are suggested:

- Some layers have line weights; it is suggested to enable line weights.
- Point style is set to default “dot” symbol (PDMODE = 0).

Layers

Ensure all objects reside on the appropriate CAD layers. Each CAD layer should be named to differentiate the data content held in the layer. The following guidelines detail how layers should be named.

Table 3 - CAD Layer Naming Guidelines

Parameter	Description	Examples	Notes
Class	General classification of the layer content	Utility, Structure, Boundary, etc.	
Category	The category of the content within the Class	Storm, Water, Building, Parcel, etc.	
Type	The type of content within the Category	Culvert, Pipe, Footprint, Lot, etc.	
Subtype	Specific subtype properties (attributes) of the Type	24in.CMPA, 8in.HDPE.Service, etc.	Include multiple subtype elements separated by a period (“.”) delimiter.

Layer Name construct examples:

- Storm water ditch: Utility-Storm-Culver-24in.CMPA
- Water service line: Utility-Water-Pipe-8in.HDPE.Service
- Lease lot: Boundary-Parcel-Lot.Lease.Existing

Note: In the event that CAD layer name character limits prevent following these naming guidelines a detailed layer naming key (i.e., lookup table) may be used to **clearly and fully** document drawing layers and the corresponding features held in the layer. This information is required and must be included in the accompanying metadata (see Metadata section).

Geometry types

Confirm each object residing in a particular layer contains only the valid geometry of that layer. For example, all objects in the “Utility-Water-Pipe-8in.HDPE” layer must be line or polyline objects.

Feature locations

Ensure all features are correctly located. Ensure that the GIS-compliant drawing is in a well-known projected coordinate system: **Alabama State Plane West, North American Datum 1983 (NAD83 2011), U. S. Survey Feet. Vertical Height (as applicable): North American Vertical Datum 1988, U.S Survey Feet, Positive Up; Vertical Depth (as applicable): North American Vertical Datum 1988, U.S. Survey Feet, Positive Down.**

Valid Geometry

Consultants and contractors should always adhere to the following:

- No duplicate objects.
- For point features that use blocks, the insertion point of the block should represent the real-world location of the feature.
- All non-block point features must utilize the CAD Point object. Use of multi-points is not supported.
- All linear features must be drafted using CAD Line or Polyline objects. Arcs are acceptable but not recommended. Circles, Splines, Rays, Ellipses, and Multi-lines are not supported.
- All polygon features must be drawn using **closed** CAD Polylines; this includes CAD Rectangle, Polygon and Boundary objects. Wipe outs, Regions, etc. are not acceptable.
- None of the segments of a closed polygon should cross any other segment in the closed polyline. Closed polyline segments that cross are referred to as crossing polygons which are invalid.

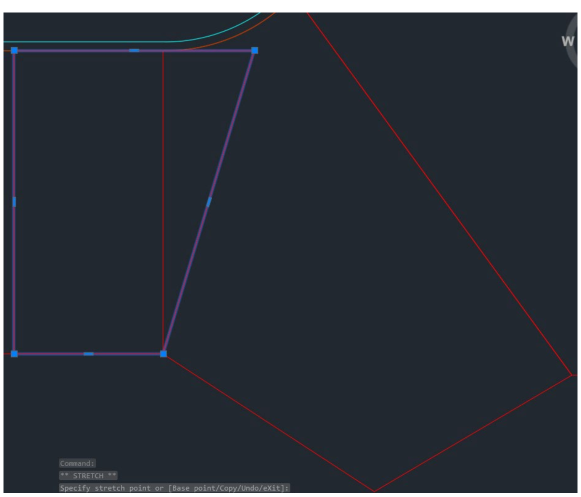

Figure 4. Example of a crossing polygon

Attributes

- Attributes must be stored as Object Data. Object data is stored in a table with one row for each feature and a column for each attribute.

  Note: Object Data can only be viewed and manipulated using AutoCAD Map 3D and AutoCAD Civil 3D. Object Data is not visible using basic AutoCAD or AutoCAD LT software.

Properties

- All features should reside on the appropriate layers as described in Table 3.
- All CAD properties should be set to 'ByLayer'. Properties such as color, line weight, thickness or line type should not be set for any individual object.
- Drawings should **NOT** contain any additional, non-GIS compliant objects such as design elements.

Drafting

As features are modified and new features drafted, it is critical to adhere to the following:

- Connect lines using OSNAP. If pipes/lines butt up against each other on the ground, the CAD end point of one line should be the same as the start point of the next line.
- Use of text is not required to describe objects or object properties/attributes. This information should be included in the feature attributes (object data).
- Leaders and text shout **NOT** be used.

Metadata

Table 4 details the required basic information (metadata) that must be included with all CAD deliverables:

Table 4 - Basic Metadata Requirements

Who	Element	Description	Notes
Producer	Firm/Company/Organization name		
	Contact name		
	Telephone number		
	Email address		
	Address		
	Website		

What	Element	Description	Notes
Layer conventions and description	Layer naming	Name of each layer in the CAD data.	(See Layers section)
	Classes	Class names and descriptions	(See Layers section)
	Categories	Category names and descriptions	(See Layers section)
	Types	Types used and descriptions	(See Layers section)
	Subtypes	Subtypes used and descriptions	(See Layers section)
Block descriptions	Block descriptions.	Detail description of the purpose, use, attributes, etc. of each block.	
Predecessorial Information	Name	Names of documents, drawing, etc. that contributed to the CAD information.	
	Date		
	Type	Type information contributing to the CAD information.	Source, reference, supporting, associate, ancillary, etc.
Limitations	Constraints (inconsistencies, dependencies, issues, etc.)	Practical, legal, or other limitations of the CAD information.	
	Scale	Appropriate scale for the use of the CAD information.	
	Resolution	Order of accuracy and precision of the CAD information.	

Why	Element	Description	Notes
Purpose	Purpose statement	Detail statement of the purpose of the CAD information.	
	Date		
	Scope		
Delivery department	Department Name		

Why	Element	Description	Notes
	Contact name		
	Phone		
	Email		
Project	Project number		
	Contract number		

Where	Element	Description	Notes
Spatial reference	Coordinate system	Alabama State Plane West, North American Datum 1983 (NAD83 2011), U. S. Survey Feet. Vertical Height (as applicable): North American Vertical Datum 1988, U.S Survey Feet, Positive Up; Vertical Depth (as applicable): North American Vertical Datum 1988, U.S. Survey Feet, Positive Down.	
Subject area	Geographic extents		

When	Element	Description	Notes
Vintage	Date of creation		
	Date of modification		
Methods	Methods statement	Detailed description of the methods, approach, workflows, etc.	

Appendix A: Parameters Checklist

The following checklist provides a simple method to verify that the ASPA GIS Standards for CAD parameters have been applied by the drawing submitting organization, as well as a means for ASPA to confirm the drawing is in compliance with the Standards.
This checklist is not intended to be a replacement for fully reviewing and understanding the guidelines in the ASPA GIS Standards for CAD document.

Drafting Standard Parameter	Submitter Verified	ASPA Verified
Drafting		
Linework connected using OSANPs (no dangles or overshoots)		
Does not include text or leaders		

Spatial Reference Standard Parameter	Submitter Verified	ASPA Verified
Coordinate System		
Data is in Alabama State Plane West (US Feet): WKID 9749		
Horizontal		
NAD 1983 (2011): WKID 6318		
Vertical (Height)		
NAVD88 height (US Feet): WKID 6360		
Vertical (Depth)		
NAVD88 depth (US Feet): WKID 6358		

Standard Parameter	Submitter Verified	ASPA Verified
Drawing Space		
All data is in Model Space (Design Model)		
No scaling (objects, viewports)		
No rotation (objects)		
No external references (x-refs)		
Line weights are enabled		
Point style set to “dot” (PDMODE=0)		
Linework connected using OSANPs (no dangles or overshoots)		
Includes no text or leaders		
Includes only basic Line, Polyline, and Arc objects		

Layer Standard Parameter	Submitter Verified	ASPA Verified
Layers		
Layers are named according to Class-Category-Type-Subtype.Subtype…		
Contains no duplicate objects		
Geometry Types		
Point Layers		
Contain only Point, or Block objects		
Block Insertion point is in the center of the block		
Line Layers		
Contain only 0 width Line, Polyline, or Arc objects		
Includes no Circles, Splines, Rays, Ellipses or Multi-lines		
All Polylines are Open		
All line types are continuous and unbroken		
Polygon Layers		
All polygon features are closed Polylines		
Includes no Wipe Outs, Regions, etc.		
No closed Polyline segments cross or intersect any other segment.		

Attribute Standard Parameter	Submitter Verified	ASPA Verified
Attributes		
Attributes are stored as Object Data		

Metadata Standard Parameter	Submitter Verified	ASPA Verified
A complete and comprehensive metadata file has been included in the submittal.		

Submitted By:		ASPA Verified By:
Name:		
Position Title:		
Organization/Department:		
Phone:		
Email:		
Date Submitted/ Reviewed:		
Date Accepted/Returned for Compliance Revision:		
Signature:		