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Information Technology – Geographic Information

Framework Data Content Standard

Part 4: Geodetic control

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Contents

Foreword

Geographic information, also known as geospatial information, both underlies and is the subject of much of the political, economic, environmental, and security activities of the United States. In recognition of this, the United States Office of Management and Budget issued Circular A-16 (revised 2002), which established the Federal Geographic Data Committee (FGDC) as a coordinating organization.

Work on this standard started under the Geospatial One-Stop e-Government initiative. The standard was developed with the support of the member agencies and organizations of the FGDC and aids in fulfilling a primary objective of the National Spatial Data Infrastructure (NSDI), that is, creation of common geographic base data for seven critical data themes. The seven core data themes are considered framework data of critical importance to the spatial data infrastructure.

The increasing need to coordinate collection of new data, identify applicability of existing data, and exchange data at the national level led to the submission of this standard to the ANSI process to become an American National Standard. The national standard contained in this document and its parts was sponsored by Technical Committee L1, Geographic Information Systems, of the InterNational Committee for Information Technology Standards (INCITS), an ANSI-accredited standards development organization.

As the Geographic Information Framework Data Content Standard was developed using public funds, the U.S. Government will be free to publish and distribute its contents to the public, as provided through the Freedom of Information Act (FOIA), Part 5 United States Code, Section 552, as amended by Public Law No. 104-231, “Electronic Freedom of Information Act Amendments of 1996”.

Introduction

The Geographic Information Framework Data Content Standard, Part 4: Geodetic Control was developed with a certain philosophy which includes the following concepts:

- Keep it simple; have the fewest data elements possible, but make those data elements mandatory. This encourages use of the part.
- Anticipate which data elements surveying and mapping organizations, at all levels of government, have readily available. Again, this encourages use of the part.
- Use single data types, for example, coordinate types. Different organizations store their data or make them available using a variety of data types, for example, latitude longitude, State Plane coordinates, UTM coordinates, elevations in meters, elevations in feet, and so on. Because the data provider, the organization creating the data, is the one most knowledgeable about their data, they should be responsible for converting their data into this single data type. Multiple data types would make the part less useful to data users. The rationale for this concept is based on the availability of tools, validated through the Federal Geographic Data Committee/Federal Geodetic Control Subcommittee, for converting other types of horizontal coordinate values to latitude-longitude.
- Although geospatial data users often associate geodetic control coordinates with the highest accuracy coordinates attainable, there is no threshold set in this part for the accuracy of geodetic control coordinates, but the accuracy of the coordinates is a required data element.
- Make the part compatible with current GIS software so data users do not have to convert the data to import them into their systems.
- Require metadata supporting how the coordinates were derived and how their corresponding accuracy values were estimated.

This part of the Framework Data Content Standard has been developed to fulfill one of the objectives of the NSDI, namely, to create common geographic base data for seven critical data themes. These core themes are known as framework data, reflecting their critical importance as geographic infrastructure.

As stated in FRAMEWORK – Introduction and Guide, National Spatial Data Infrastructure, FGDC, 1997 (p. 18):

"Geodetic control provides a common reference system for establishing the coordinate positions of all geographic data. It provides the means for tying all geographic features to common, nationally used horizontal and vertical coordinate systems. The main features of geodetic control information are geodetic control stations. These monumented points (or in some cases active Global Positioning System control stations) have precisely measured horizontal or vertical locations and are used as a basis for determining the positions of other points. The geodetic control component of the framework consists of geodetic control stations and related information – the name, feature identification code, latitude and longitude, orthometric height, ellipsoid height, and metadata for each station. The metadata for each geodetic control point contains descriptive data, positional accuracy, condition, and other pertinent characteristics for that point.

Geodetic control information plays a crucial role in developing all framework data and users' applications data, because it provides the spatial reference source to register all other spatial data. In addition, geodetic control information may be used to plan surveys, assess data quality, plan data collection and conversion, and fit new areas of data into existing coverages."

The Federal Geodetic Control Subcommittee (FGCS) of the Federal Geographic Data Committee was established to promote standards of accuracy and currentness in geodetic data financed in whole or part by Federal funds; to exchange information on technological improvements for acquiring geodetic data; to encourage the Federal and non-Federal communities to identify and adopt standards and specifications for geodetic data; and to collect and process the requirements of Federal and non-Federal organizations for geodetic data. The lead agency responsible for the coordination, management, and dissemination of geodetic data is the Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Geodetic Survey.

Framework Data Content Standard – Geodetic control

1 Scope, purpose, and application

1.1 Scope

Geodetic control surveys are usually performed to establish the basic positional framework from which supplemental surveying and mapping are performed. Geodetic control surveys are distinguished by use of redundant, interconnected, permanently monumented control points that comprise the National Spatial Reference System (NSRS) or are often incorporated into NSRS.

Geodetic control surveys are performed to far more rigorous accuracy and quality assurance standards than those for local control surveys for general engineering, construction, or topographic mapping purposes. Geodetic control surveys included in NSRS meet automated data recording, submittal, project review, and least squares adjustment requirements established by the Federal Geodetic Control Subcommittee (FGCS).

1.2 Purpose

This document provides a common methodology for creating datasets of horizontal coordinate values and vertical coordinate values for geodetic control points represented by survey monuments, such as brass disks and rod marks. It provides a single data structure for relating coordinate values obtained by one geodetic survey method (for example, a classical line-of-sight traverse) with coordinate values obtained by another geodetic survey method (for example, a Global Positioning System geodetic control survey).

1.3 Application

This part of the Framework Data Content Standard is applicable to any geodetic control dataset and is intended to facilitate a common methodology to create, manage, and share geodetic control datasets from various organizations at the Federal, State, Tribal, and local government levels; academia; and the private sector.

Although this part does not encompass non-geodetic control points, such as Public Land Survey System points, local government control points, project control points for public and private projects, aerial-photo control points, and so on, it can be used as a model for other control points and coordinated points (see Annex D).

2 Normative references

Annex A lists normative references to standards that are applicable to this part of the Framework Data Content Standard. Informative references are listed in Annex E. Annex A of the Base Document (Part 0) lists normative references applicable to two or more parts of the standard. Annex D of the Base Document lists informative references applicable to all of the parts.

3 Maintenance authority

3.1 Level of responsibility

The FGDC is the responsible organization for coordinating work on all parts of the Geographic Information Framework Data Content Standard. The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Geodetic Survey, working with the FGDC, is directly responsible for development and maintenance of the Geographic Information Framework Data Content Standard, Part 4: Geodetic Control.

The FGDC shall be the sole organization responsible for direct coordination with the InterNational Committee for Information Technology Standards (INCITS) concerning any maintenance or any other requirements mandated by INCITS or ANSI.

3.2 Contact information

Address questions concerning this part of the standard to:

Federal Geographic Data Committee Secretariat
c/o U.S. Geological Survey
590 National Center
Reston, Virginia 20192 USA

Telephone: (703) 648-5514
Facsimile: (703) 648-5755
Internet (electronic mail): gdc@fgdc.gov
WWW Home Page: http://fgdc.gov

Or

Director
National Geodetic Survey, NOAA, N/NGS
1315 East-West Highway
Silver Spring, Maryland, 20910-3282.

4 Terms and definitions

Definitions applicable to the Geodetic Control part are listed below. More general terms can be found in the Base Document (Part 0).

4.1
control point

high-accuracy **coordinated point** used in determining the location of other points

4.2
coordinated point

point with location defined by coordinates

4.3
geodetic control

set of **control points** whose coordinates are established by geodetic surveying methodology

EXAMPLE classical line-of-sight triangulation, traverse, and geodetic leveling or satellite surveys such as Doppler or GPS

4.4
geodetic datum

datum describing the relationship of a coordinate system to the Earth [ISO 19111]

4.5
horizontal geodetic control

control points for which horizontal coordinates that have been accurately determined can be identified with physical points on the Earth and used to provide horizontal coordinates for other surveys

4.6
local accuracy

correctness of the coordinates of a **control point** relative to the coordinates of other directly connected, adjacent **control points**

NOTE The reported local accuracy is an approximate average of the individual local accuracy values between this control point and other observed control points used to establish the coordinates of the control point.

4.7
National Spatial Reference System
NSRS

control framework for latitude, longitude, height, scale, gravity, orientation, and shoreline throughout the United States, comprised of coordinates of **geodetic control points** and models describing geophysical processes

4.8
network accuracy

correctness of the coordinates of a **control point** with respect to the geodetic datum

NOTE For NSRS network accuracy classification, the datum is considered to be best expressed by the geodetic values at the Continuously Operating Reference Stations (CORS) supported by the National Geodetic Survey (NGS). By this definition, the local and network accuracies at CORS sites are considered to be infinitesimal, that is to say, to approach zero.

4.9
North American Datum of 1983
NAD 83

horizontal and 3-dimensional geodetic datum for the United States, Canada, Mexico, and Central America, based on the Geodetic Reference System 1980 ellipsoid and derived from the adjustment of more than 250,000 horizontal geodetic control points

4.10
North American Vertical Datum of 1988
NAVD 88

orthometric height geodetic datum for the United States, Canada, and Mexico, based on a minimally-constrained adjustment of more than 750,000 vertical geodetic control points

4.11
relative accuracy

accuracy that accounts for only random errors in a dataset

NOTE For positional data, the general measure of relative accuracy is an evaluation of the random errors (that is, where systematic errors and blunders have been removed) in determining the positional orientation (for example, distance, azimuth, elevation) of one point or feature with respect to another.

4.12
reference ellipsoid

ellipsoid of specified dimensions and associated with a geodetic reference system or a geodetic datum

NOTE Coordinates given in this system are said to be with respect to the reference ellipsoid. Reference ellipsoids are most commonly ellipsoids of revolution (that is to say, have two of the three possible axes of equal length) and are sometimes called reference spheroids.

4.13
vertical geodetic control

control points with accurately determined orthometric heights and/or ellipsoidal heights identified with physical points on the Earth that can be used to provide elevations for other surveys

5 Symbols, abbreviated terms, and notations

The following symbols, abbreviations, and notations are applicable to this part of the standard. More symbols, abbreviations, and notations applicable to multiple parts are listed in the Base Document (Part 0).

CORS – Continuously Operating Reference Stations

HARN – High Accuracy Reference Network

NGS – National Geodetic Survey

NAVD88 – North American Vertical Datum of 1988

URI – Uniform Resource Identifier

6 Requirements

6.1 General

For the purpose of this part of the Federal Data Content Standard, each geodetic control point shall have four (4) basic elements. They are:

- Designations
- Coordinates
- Accuracy
- Geodetic datum

Each element is described in detail in the following paragraphs. For an example, see Annex B.

6.2 Designations

Designations refer to three types of identifiers used for each point in the dataset: 1) a unique identifier (mandatory); 2) a descriptive identifier (optional); 3) a Uniform Resource Identifier (URI) (optional).

6.2.1 Unique identifier

A unique identifier for each point within a dataset shall be composed of two parts: 1) a permanent identifier and 2) a namespace. The permanent identifier can be the organization's unique database identifier. The namespace is the organization's identifier (for example, abbreviation) for the organization who assigned/maintains the permanent identifier. The unique identifier allows traceability of each data point back to the organization and to other data held by that organization about the point. For example, NGS has a multitude of information about each geodetic control point, but only the basic information conforming to this part need be contained in the produced dataset.

NOTE For geodetic control datasets, the uniqueness of namespace is maintained by the National Geodetic Survey through Input Format and Specifications of the National Geodetic Survey Data Base, Appendix C - Contributors of Geodetic Control Data, FGCS, 1994.

If an organization has separate components, each providing its own datasets, the namespace shall be unique within that organizational element. For example, the U.S. Army Corps of Engineers has several districts. The permanent identifier shall be unique within a particular district, and each district shall have its own organizational identifier. The combination of the permanent identifier and the namespace provides for a truly unique identifier.

6.2.2 Descriptive identifier

A descriptive identifier, such as the designation/point name or stamping which provides the user with a more meaningful name for the point, facilitates certain interactions with the point, for example, an understanding of what to physically look for in the field. Descriptive identifiers do not have to be unique within a dataset.

6.2.3 URI

A permanent URI, such as a URL, which provides the user with a direct link to an Internet-based resource that facilitates certain interactions with the point, for example, a link to an NGS datasheet or a scanned tie-sheet image. URI do not have to be unique within a dataset.

6.3 Coordinates

6.3.1 General

Coordinates are of two types: horizontal and vertical. If only approximate values are present, they shall be used with their corresponding accuracies.

Data providers shall provide the best set of coordinates available at the time of the request, but coordinates could change in the future based on improved, that is to say, more accurate, observational techniques. Data users are encouraged to be cautious and use the latest set of coordinate values. Typically geodetic coordinates do not change by more than their stated network accuracy.

6.3.2 Horizontal coordinates

The curvilinear system of latitude and longitude is required. Latitudes shall be referenced as positive north and negative south. Longitudes shall be referenced as positive east and negative west. If only an approximate value is available, use it along with its corresponding accuracy. The mandatory unit for latitude and longitude is decimal degrees.

6.3.3 Vertical coordinates

6.3.3.1 General

Vertical coordinates consist of two types, orthometric height and ellipsoid height. Either orthometric or ellipsoid height shall be provided, and both shall be provided if both are measured. If only approximate values are available, provide at least one, along with its corresponding accuracy. The mandatory unit for height values is meters.

6.3.3.2 Orthometric height

Orthometric height shall be provided if measured, for example, by precise optical or electronic bar code leveling; vertical angle; or GPS.

6.3.3.3 Ellipsoid height

Ellipsoid height shall be provided if measured, for example, by GPS.

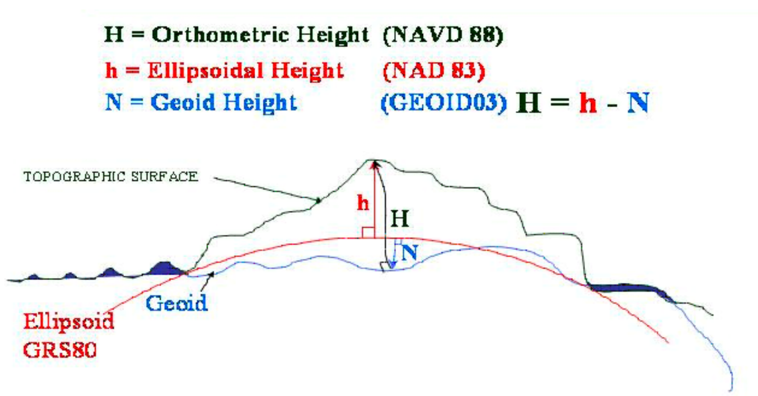

Figure 1 – Relationship between orthometric, ellipsoidal, and geoid heights

6.4 Accuracy

Local and network accuracies shall be provided in meters, expressed at the 95% confidence level. See FGDC-STD-007.2, Geospatial Positioning Accuracy Standards, Part 2: Geodetic Control Networks, for the methodology for defining local and network accuracies.

NOTE See Annex C for guidance on estimating local and network accuracy values for geodetic control established using the older (for example, first order) methodology.

6.5 Geodetic datum

6.5.1 General

Horizontal coordinates and ellipsoid heights shall be referenced to the North American Datum of 1983 (NAD 83) and shall include the datum tag (for example, “NAD 83 (1986)”) and the coordinate epoch date (for example, “[1997.0]”), for example, “NAD 83 (1986) [1997.0]”. See also the Federal Register Notice, 1989.

Orthometric heights shall be referenced to the North American Vertical Datum of 1988 (NAVD 88). See also the Federal Register Notice, 1993.

6.5.2 Datum tag

The datum tag represents the date of the regional least squares adjustment associated with the horizontal geodetic control point. NAD 83 (1986) indicates horizontal coordinate values and ellipsoid height values on the NAD 83 datum resulting from the North American Adjustment completed in 1986. NAD 83 (ccyy) indicates coordinate values on the NAD 83 datum for the North American Adjustment, but readjusted to a State or regional High Accuracy Reference Network (HARN) during the year shown in parentheses (ccyy). See Annex B for an example.

6.5.3 Epoch date

The epoch date shall be used for control points in regions of episodic and/or continuous horizontal and vertical crustal motion where the coordinates change with time. The epoch date indicates the date the published horizontal coordinates and heights are valid. All points with adjusted horizontal coordinates and/or heights that fall within a crustal motion region shall have an epoch date based on the date of the latest survey from which the coordinates were determined. Points outside crustal motion regions shall not have an epoch date.

7 Geodetic control Unified Modeling Language (UML) model

7.1 Unified Modeling Language (UML) class diagram

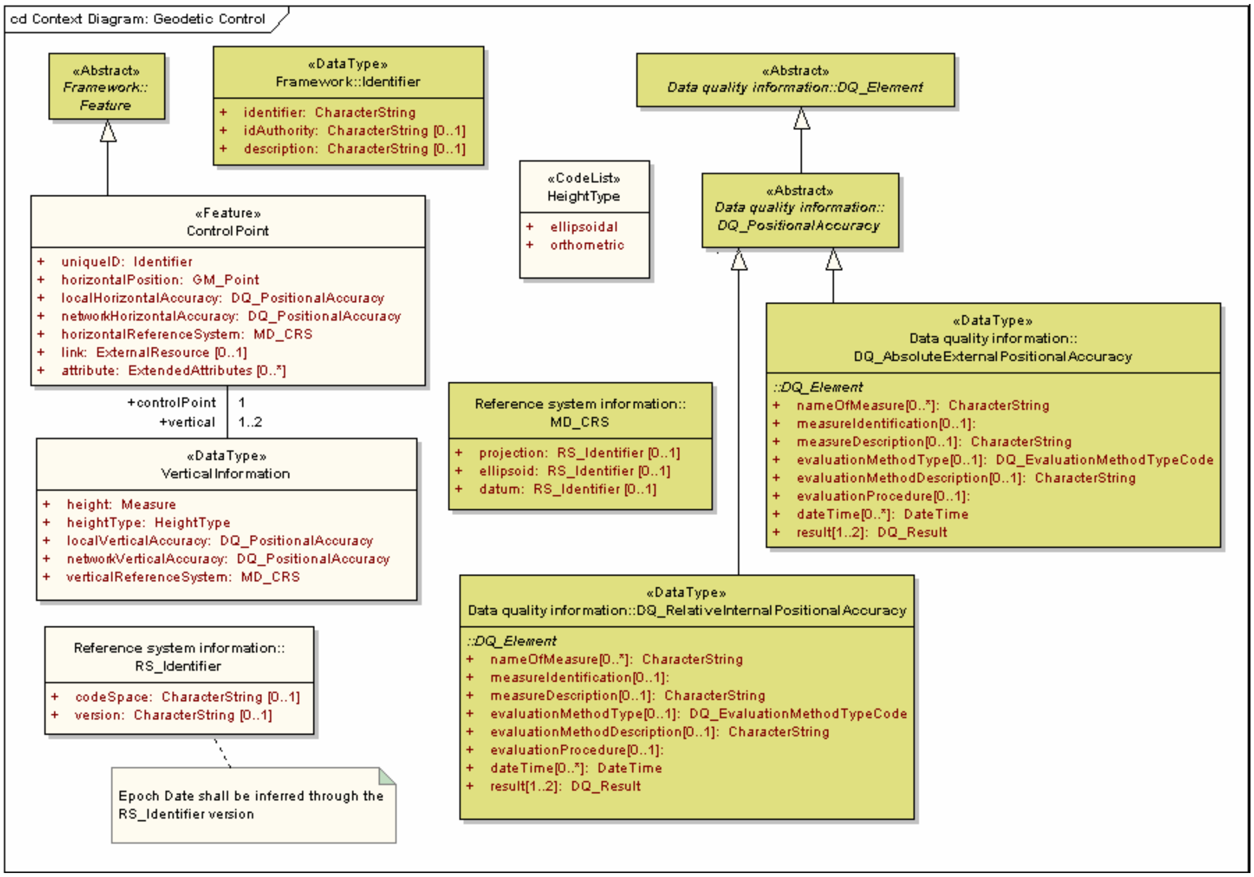

Figure 2 – Geodetic control UML model

7.2 UML objects

7.2.1 ControlPoint

ControlPoint is a class that contains the identifier for the point (see 6.2.1), information about horizontal coordinates (see 6.3.2), accuracy (see 6.4), and datum (see 6.5). ControlPoint also contains a link to a resource for the point (see 6.2.3). It also contains an association with the UML class VerticalInformation.

Table 1 – UML class – ControlPoint

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
1	ControlPoint				<<Feature>>	Lines 2-9
2	uniqueID	The permanent identifier can be the organization's unique database identifier	M	1	<<DataType>> Framework::Identifier	
3	horizontalPosition	Position of horizontal coordinates for the control point	M	1	<<Type>> GM_Point	Defined in ISO 19107
4	localHorizontalAccuracy	Local horizontal accuracy for the control point	M	1	<<Abstract>> Data quality information:: DQ_PositionalAccuracy	Defined in ISO 19115
5	networkHorizontalAccuracy	Network horizontal accuracy for control point	M	1	<<Abstract>> Data quality information:: DQ_PositionalAccuracy	Defined in ISO 19115
6	attribute	Producer-defined attribute for inclusion in the transfer	O	*	<<DataType>> Framework:: ExtendedAttributes	Unrestricted
7	horizontalReferenceSystem	Information about referenceSystem, namely, datum	M	1	MD_CRS	Defined in ISO 19115
8	link	Identification of an external resource that provides documentation for the point	O	1	<<DataType>> Framework:: ExternalResource	
9	Role name: vertical	Relationship with VerticalInformation	M	2	<<DataType>>	VerticalInformation

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
					VerticalInformation	

7.2.2 VerticalInformation

VerticalInformation is a class that contains information about vertical coordinates associated with ControlPoint, including the type of height (see 6.3.3), accuracy (see 6.4), and datum (see 6.5). This class also contains an association with ControlPoint.

Table 2 - VerticalInformation

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
10	VerticalInformation				<<DataType>>	Lines 11-16
11	height	Distance above or below datum	M	1	Measure	Unrestricted
12	heightType	Indicator if height is ellipsoidal or orthometric (although this information is inferred from the datum)	M	1	<<CodeList>> HeightType	Restricted to the values in the code list HeightType
13	localVerticalAccuracy	Local vertical accuracy for the control point	M	1	<<Abstract>> Data quality information:: DQ_PositionalAccuracy	Defined in ISO 19115
14	networkVerticalAccuracy	Network vertical accuracy for control point	M	1	<<Abstract>> Data quality information:: DQ_PositionalAccuracy	Defined in ISO 19115
15	verticalReferenceSystem	Information about referenceSystem, namely, datum	M	1	MD_CRS	Defined in ISO 19115
16	Role name: controlPoint	Relationship to control point	M	1	<<Feature>> ControlPoint	ControlPoint

7.2.3 RS_Identifier

RS_Identifier is a class that contains information about the namespace used for the reference system, namely the datum.

Table 3 – RS_Identifier

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
17	Reference system information:: RS_Identifier	Identifier used for reference systems	Use obligation/ condition from referencing object	Use maximum occurrence from referencing object	<<DataType>>	Lines 18-19
18	codeSpace	Name or identifier of the person or organization responsible for maintenance of the namespace	O	1	CharacterString	Defined in ISO 19115
19	version	Version identifier for the namespace	O	1	CharacterString	Defined in ISO 19115

7.3 HeightType code list

HeightType is a non-exhaustive CodeList of values for the attribute heightType.

Table 4 – Codelist for HeightType

Name	Definition
ellipsoidal	Distance of a point from the ellipsoid measured along the perpendicular from the ellipsoid to this point
orthometric	Distance measured along the plumb line between the geoid and a point on the Earth's surface, taken positive upward from the geoid [adapted from the National Geodetic Survey, 1986]

Annex A
(normative)
Normative references

This annex lists normative standards that support only this part of the Framework Data Content Standard. Annex A of the Base Document (Part 0) lists normative references applicable to two or more parts of the standard.

FGDC-STD-007.2-1998, Geospatial positioning accuracy standards, Part 2: Standards for geodetic networks, http://www.fgdc.gov/standards/status/sub1_2.html, accessed January 2006

Federal Register Notice – Affirmation of datum for surveying and mapping activities; June 13, 1989 (NAD 83)

Federal Register Notice – Affirmation of vertical datum for surveying and mapping activities; June 23, 1993 (NAVD 88)

Annex B
(informative)
Example of geodetic control data content

Below are example values for geodetic control.

uniqueID = MN0298

uniqueIDAssigner = NGS

descriptiveID = PUMKIN

URI = http://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=MN0298

coordinates – horizontal – latitude = 41.583365925

coordinates – horizontal – longitude = -103.664305564

coordinates – horizontal – accuracy – local = 0.046

coordinates – horizontal – accuracy – network = 0.066

coordinates – horizontal – geodeticDatum – baseDatum = NAD 83

coordinates – horizontal – geodeticDatum – datumTag = 1995

coordinates – horizontal – geodeticDatum – epochDate = 1997.0

coordinates – vertical – orthometricHeight =1365.195

coordinates – vertical – orthometricHeight – accuracy – local = 0.002

coordinates – vertical – orthometricHeight – accuracy – network = 0.100

coordinates – vertical – orthometricHeight – geodeticDatum – baseDatum = NAVD 88

coordinates – vertical – orthometricHeight – geodeticDatum – datumTag = none

coordinates - vertical – orthometricHeight – geodeticDatum – epochDate = 2003.0

coordinates – vertical – ellipsoidHeight = 1346.13

coordinates – vertical – ellipsoidHeight – accuracy – local = 0.064

coordinates – vertical – ellipsoidHeight – accuracy – network = 0.127

coordinates – vertical – ellipsoidHeight – geodeticDatum – baseDatum = NAD 83

coordinates – vertical – ellipsoidHeight – geodeticDatum – datumTag = 1995

coordinates – vertical – ellipsoidHeight – geodeticDatum – epochDate = 1997.0

Annex C
(informative)
User guidance for estimating local and network accuracy values

Local accuracy for horizontal and vertical geodetic control points is similar to the older accuracy methodology, since they are both methods to describe the relative accuracy between points. Hence, the older methodology can be converted into local accuracy by taking the average length of line, using the older defined accuracy of the points, and converting that into a value in meters. Examples for horizontal and vertical surveys are:

- Second-order, class II horizontal survey (that is to say, 1:20,000) with average length line of 3,500 meters: 3,500 x 1/20,000 = 0.175 meters
- Second-order, class II leveling survey (that is to say, 1.3 millimeters per square-root of the distance in kilometers) with an average bench mark spacing of 1 mile (that is to say, 1.6 kilometers): 0.0013 x SQRT [1.6] = 0.0016 meters

Network accuracy for horizontal geodetic control points can be estimated in two ways. First, if the NAD 83 coordinates are consistent with the original NAD 83 adjustment, for example, the original NAD 83 (1986), then the network accuracy has been determined to seldom exceed 1.0 meters. Second, if the NAD 83 coordinates are the result of a statewide or regional High Accuracy Reference Network (HARN) adjustment, then the network accuracy has been determined to seldom exceed 0.05-0.1 meter. If better values have been determined for network accuracy for the area covered by the specific dataset, then those values should be used in place of these general values.

Annex D
(informative)
Control points and coordinated points

There are various categories of points that are described with coordinates. The most general category is coordinated points which can be any point on the ground or on a map for which coordinates have been determined. There are also many methods for determining the coordinates of these points. A subset category of coordinated points is control points. Control points have several common characteristics:

- They are physical points on the ground which can be revisited or located for future use
- They are used for subsequent projects, that is to say, they themselves are not the end product
- Their coordinates are determined using more accurate techniques because they will be used to control or fit future spatial data activities

Geodetic control is one type or category of control points.

This part can be expanded with additional elements to make it fit the more general class of control points. For example, one attribute that could be added is control point TYPES. Some examples of these TYPES are:

- NSRS – geodetic control points whose coordinates have been verified and placed in a national database
- PLSS – Public Land Survey System points whose coordinates have been determined
- Property corner – lot or property points, non-PLSS, whose coordinates have been determined
- Photo control – photographic identifiable points set for aerial photography whose coordinates have been determined
- Right-of-way – right-of-way points whose coordinates have been determined
- Local control – random control points whose coordinates have been determined that are not multi-functional (that is to say, established for a single use) and are not NSRS

Because the subject of control points involves almost every FGDC subcommittee, the task of developing a data content standard for all control points is much more involved than for geodetic control alone.

Annex E
(informative)
Bibliography

The following documents contain provisions that are relevant to this part of the Framework Data Content Standard. Annex D of the Base Document (Part 0) lists informative references applicable to two or more of the parts of the standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

Federal Geodetic Control Subcommittee, FGDC, Input formats and specifications of the National Geodetic Survey Data Base, FGCS, 2003, Silver Spring, MD, http://www.ngs.noaa.gov/FGCS/BlueBook/pdf/hContents.pdf, accessed January 2006