

# Geospatial Data Accuracy Standards

Precision. Accuracy. Reliability

# WHAT?

Direct measurement

Imagery (Orthos)

LiDAR

Elevation Models

Contours

Planimetrics

UAV data

Any digital mapping data layer

Scale, resolution, precision...confidence

# AGENDA

What are the Standards anyway?

Horizontal Accuracy

Vertical Accuracy

Accuracy Assessments

# *United States National Map Accuracy Standards*

With a view to the utmost economy and expedition in producing maps which fulfill not only the broad needs for standard or principal maps, but also the reasonable particular needs of individual agencies, standards of accuracy for published maps are defined as follows:

1. **Horizontal accuracy.** For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. This shall apply in all cases to positions of well-defined points only. Well-defined points are easily visible or recoverable on the ground, such as the following: monuments, such as bench marks, property boundary monuments; intersections of lines, such as corners of large buildings or structures (or center points of small buildings) or the intersection of two road or property lines meeting at right angles. The definition of a well-defined point is well defined will be determined by what is plottable on the scale of the map. Thus while the intersection of two road or property lines meeting at right angles within a sensible interpretation, identification of the intersection of such lines at a small angle would obviously not be practicable within 1/100 inch. Similarly, features on the ground within close limits are not to be considered as test points unless they are clearly marked on the map, even though their positions may be scaled closely upon the map. In the case of timber lines, soil boundaries, etc.
2. **Vertical accuracy,** as applied to contour maps on all publication scales, not more than 10 percent of the elevations tested shall be in error more than one-tenth of the contour interval. In checking elevations taken from the map, the apparent vertical error shall be assumed by assuming a horizontal displacement within the permissible horizontal error on the scale.
3. **The accuracy of any map may be tested** by comparing the positions of points on the map or elevations are shown upon it with corresponding positions as determined by surveys of a higher accuracy. Tests shall be made by the producing agency, which shall also determine which of its maps are to be tested, and the extent of the testing.
4. **Published maps meeting these accuracy requirements** shall note this fact on their legends, as follows: "This map complies with National Map accuracy Standards."
5. **Published maps whose errors exceed those aforesaid** shall omit from their legends all mention of standard accuracy.
6. **When a published map is a considerable enlargement** of a map drawing (manuscript) or of a published map, that fact shall be stated in the legend. For example, "This map is an enlargement of a 1:20,000-scale map drawing," or "This map is an enlargement of a 1:24,000-scale published map."
7. **To facilitate ready interchange and use of basic information for map construction** among all Federal mapmaking agencies, manuscript maps and published maps, wherever economically feasible and consistent with the uses to which the map is to be put, shall conform to latitude and longitude boundaries, being 15 minutes of latitude and longitude, or 7.5 minutes, or 3-3/4 minutes in size.

*Issued June 10, 1941*  
*Revised April 26, 1943*  
*Revised June 17, 1947*

*Issued June 10, 1941*  
*Revised April 26, 1943*  
*Revised June 17, 1947*

U.S. BUREAU OF THE BUDGET

# ASPRS ACCURACY STANDARDS FOR LARGE-SCALE MAPS

The American Society for Photogrammetry and Remote Sensing  
Approval by the ASPRS Professional Practicing Division, March, 1990

Table 1E. — Planimetric Coordinate Accuracy Requirement  
(Ground X or Y in feet) for Well-defined Points - Class 1. Maps  
PLANIMETRIC (X or Y) ACCURACY<sup>3</sup>

| (limiting rms error, feet)                  | TYPICAL MAP SCALE |
|---|-------------------|
| 0.05  | 1:60              |
| 0.1   | 1:120             |
| 0.2   | 1:240             |
| <hr style="border-top: 1px dashed black;"/> |                   |
| 0.3   | 1:360             |
| 0.4   | 1:480             |
| 0.5   | 1:600             |
| 1.0   | 1:1,200           |
| 2.0   | 1:2,400           |
| 4.0   | 1:4,800           |
| 5.0   | 1:6,000           |
| 8.0   | 1:9,600           |
| 10.0  | 1:12,000          |
| 16.7  | 1:20,000          |

1"=10'

1"=30'

1"=100'

\*indicates the practical limit for aerial methods - for scales above this line, ground methods are normally used.

# ASPRS ACCURACY STANDARDS FOR LARGE-SCALE MAPS

The American Society for Photogrammetry and Remote Sensing  
Approval by the ASPRS Professional Practicing Division, March, 1990

## 2. Vertical Accuracy:

Vertical map accuracy is defined as the rms error in evaluation in terms of the project's evaluation datum for well-defined points only. For Class 1. maps the limiting rms error in evaluation is set by the standard at *one-third* the indicated contour interval for well-defined points only. Spot heights shall be shown on the map within a limiting rms error of *one-sixth* of the contour interval.

## 3. Lower-Accuracy Maps:

Map accuracies can also be defined at lower spatial accuracy standards. Maps compiled within limiting rms errors of twice or three times the those allowed for a Class 1. map shall be designated Class 2. or Class 3. maps respectively. A map may be compiled that complies with one class of accuracy in elevation and an other in plan. Multiple accuracies on the same map are allowed provided a diagram is included which clearly relates segments of the map with the appropriate map accuracy class.

# ASPRS ACCURACY STANDARDS FOR LARGE-SCALE MAPS

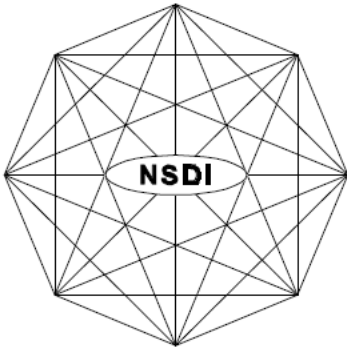
The American Society for Photogrammetry and Remote Sensing  
Approval by the ASPRS Professional Practicing Division, March, 1990

“Produced to meet...”

Vs

“Tested to meet...”

FGDC-STD-007.3-1998



National Spatial Data Infrastructure

# Geospatial Positioning Accuracy Standards Part 3: National Standard for Spatial Data Accuracy

Subcommittee for Base Cartographic Data  
Federal Geographic Data Committee

Sharing Scri

## NMAS and the NSSDA

### NMAS- 1947

- ▶ Paper Map produced at a certain scale
- ▶ Not appropriate to use for digital data
- ▶ “2 foot accuracy” and “1 foot accuracy” terms no longer apply, but are still WIDELY used

### NSSDA - 1998

- ▶ Applies to point, vector or raster data
- ▶ Must compare your data against a “reference”
- ▶ Reference must be 3x more accurate
- ▶ RMSE vs 95% Accuracy

# Standards

## RMSE vs 95% Accuracy in NSSDA

RMSE is a measure of the data itself- the ERROR measured in the data

i.e.,  $RMSE_z = 0.312$  ft

95% confidence is a measure of selected data points against a target, or “tested to meet” standard

i.e., 95% of the measurements will be within a certain threshold of a “reference” or “true” value

Note: 5% of the measurements may not meet the target threshold

$$\text{Accuracy}_{(x)} = 1.7308 * \text{RMSE}_{(z)}$$

$$\text{Accuracy}_{(z)} = 1.9600 * \text{RMSE}_{(z)}$$

# Standards

## NSSDA vs NMAS

- ▶ NMAS Contour Interval =  $3.2898 \cdot \text{RMSE}(z)$
- ▶ NMAS Contour Interval =  $\text{Accuracy}(z) / 0.5958$

Note that Accuracy ( z ) is based on 95% CI, a statistical calculation.

| NMAS Equivalent Contour Interval (in feet) | NSSDA RMSE(z)      | NSSDA Accuracy(z)   | Required Accuracy for Reference Data for "Tested to Meet" |
|--|--------------------|---------------------|---|
| 0.5  | 0.15 ft or 4.60 cm | 0.30 ft or 9.10 cm  | 0.10 ft   |
| 1  | 0.30 ft or 9.25 cm | 0.60 ft or 18.2 cm  | 0.20 ft   |
| 2  | 0.61 ft or 18.5 cm | 1.19 ft or 36.3 cm  | 0.40 ft   |
| 4  | 1.22 ft or 37.0 cm | 2.38 ft or 72.6 cm  | 0.79 ft   |
| 5  | 1.52 ft or 46.3 cm | 2.98 ft or 90.8 cm  | 0.99 ft   |
| 10   | 3.04 ft or 92.7 cm | 5.96 ft or 181.6 cm | 1.98 ft   |

The fourth column in this table refers to the NSSDA Accuracy required for Reference Data or Checkpoints to be used in assessing data Accuracy

*Map*  
**MODERNIZATION**  
Federal Emergency Management Agency



**FEMA's Flood Hazard Mapping Program**

**Guidelines and Specifications**  
*for*  
**Flood Hazard Mapping Partners**

*Appendix A: Guidance for Aerial Mapping and Surveying*



**FEDERAL EMERGENCY MANAGEMENT AGENCY**

[http://www.fema.gov/fhm/dl\\_cgs.shtm](http://www.fema.gov/fhm/dl_cgs.shtm)

**April 2003**



# Guidelines for Digital Elevation Data

**Version 1.0**

**National Digital Elevation Program (NDEP)**  
**May 10, 2004**

# ASPRS Guidelines

## Vertical Accuracy Reporting for Lidar Data

|           |                             |
|-----------|-----------------------------|
| Version   | 1.0                         |
| Drafted   | May 15, 2004                |
| Released  | May 24, 2004                |
| Ownership | ASPRS Lidar Committee (PAD) |
| Editor    | Martin Flood                |

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### Scope

This document identifies the vertical accuracy reporting requirements that are recommended by the American Society for Photogrammetry and Remote Sensing (ASPRS) when analyzing elevation data generated using airborne light detection and ranging or laser radar (lidar) technology. ASPRS recommends all mapping professionals adhere to and follow these guidelines when generating mapping products derived from lidar data.

### Reference Standards

These ASPRS guidelines are harmonized with the relevant sections of the Guidelines for Digital Elevation Data (Version 1.0) released by the National Digital Elevation Program (NDEP). The sections on vertical accuracy testing and reporting from the NDEP guidelines have been submitted to the Federal Geographic Data Committee (FGDC) for inclusion as approved revisions to the National Standard for Spatial Data Accuracy (NSSDA). The NDEP guidelines are available online at [www.ndep.gov](http://www.ndep.gov). For reference, the corresponding section references from the NDEP guidelines are cross-referenced and tabulated against section numbers in this document in Appendix A. If cases occur where these ASPRS guidelines are found to be in conflict with the NSSDA, the NSSDA is the controlling document and takes precedent.

1947

NMAS- Paper Only

1990

ASPRS- Relates Paper to Digital  
Establishes Quality (Class I, II, III)

1998

NSSDA- Establishes Digital Accuracy

2003

FEMA- sets Federal program standards

2004

NDEP- Codifies Federal program Standards

2004

ASPRS- establishes bridge between Federal and  
non-Federal project standards

# U.S. Geological Survey National Geospatial Program Lidar Guidelines and Base Specification

Version 13 – ILMF 2010

The U.S. Geological Survey National Geospatial Program (NGP) has cooperated in the collection of numerous lidar datasets across the nation for a wide array of applications. These collections have used a variety of specifications and required a diverse set of products, resulting in many incompatible datasets and making cross-project analysis extremely difficult. The need for a single base specification, defining minimum collection parameters and a consistent set of deliverables, is apparent.

Beginning in late 2009, an increase in the rate of lidar data collection due to American Reinvestment and Recovery Act (ARRA) funding for The National Map makes it imperative that a single data specification be implemented to ensure consistency and improve data utility. Although the development of this specification was prompted by the ARRA stimulus funding, the specification is intended to remain durable beyond ARRA funded NGP projects.



FEMA

September 27, 2010

**MEMORANDUM FOR:**

Regional Risk Analysis Branch Chiefs

**FROM:**

Doug A. Bellomo  
Director, Risk Analysis Division  
Federal Insurance and Mitigation Administration

A handwritten signature in black ink, appearing to read "D. Bellomo", written over a horizontal line.

**SUBJECT:**

Procedure Memorandum No. 61—Standards for Lidar and  
Other High Quality Digital Topography

**EFFECTIVE DATES:**

Immediately for all FY10 procured and collected data

**Background:** Beginning in Fiscal Year (FY) 2010, Federal Emergency Management Agency (FEMA) initiated a five-year program for Risk Mapping, Assessment, and Planning (Risk MAP). FEMA's vision for the Risk MAP program is to deliver quality data that increases public awareness and leads to mitigation actions that reduce risk to life and property. To achieve this vision, FEMA will transform its traditional flood identification and mapping efforts into a more integrated process of accurately identifying, assessing, communicating, planning for, and

mitigating flood risks.

# 2010- FEMA Policy Memorandum

Aligns FEMA Appendix A with USGS *Lidar Guidelines and Base Specifications* v 13

Defines terms DEM, DSM, DTM

Calls out NSSDA as the standard for Accuracy Reporting, supplemented by NDEP 2004 and ASPRS 2004 for vertical accuracy.

“All of these standards, designed for digital elevation data, replace the National Map Accuracy Standard (NMAS)”

# 2010- FEMA Policy Memorandum

**Table 2.3. Accuracy Terms that Equal “Equivalent Contour Accuracy”**

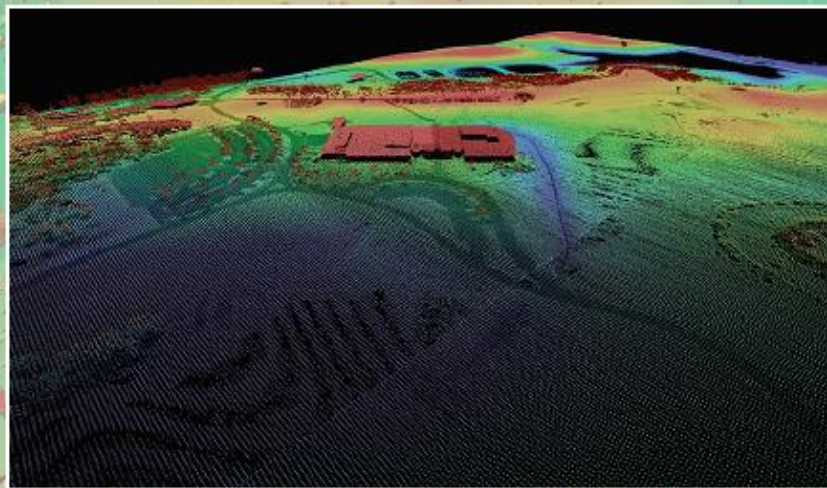
| Equivalent Contour Accuracy | FEMA Specification Level | RMSE <sub>z</sub>  | NSSDA Accuracy <sub>z</sub> 95% confidence level | SVA (target)       | CVA (mandatory)    |
|-----------------------------|--------------------------|--------------------|--|--------------------|--------------------|
| 1 ft                        |                          | 0.30 ft or 9.25 cm | 0.60 ft or 18.2 cm                               | 0.60 ft or 18.2 cm | 0.60 ft or 18.2 cm |
| 2 ft                        | Highest                  | 0.61 ft or 18.5 cm | 1.19 ft or 36.3 cm                               | 1.19 ft or 36.3 cm | 1.19 ft or 36.3 cm |
| 4 ft                        | High                     | 1.22 ft or 37.1 cm | 2.38 ft or 72.6 cm                               | 2.38 ft or 72.6 cm | 2.38 ft or 72.6 cm |
| 5 ft                        |                          | 1.52 ft or 46.3 cm | 2.98 ft or 90.8 cm                               | 2.98 ft or 90.8 cm | 2.98 ft or 90.8 cm |
| 8 ft                        | Medium                   | 2.43 ft or 73.9 cm | 4.77 ft or 1.45 m                                | 4.77 ft or 1.45 m  | 4.77 ft or 1.45 m  |
| 10 ft                       |                          | 3.04 ft or 92.7 cm | 5.96 ft or 1.82 m                                | 5.96 ft or 1.82 m  | 5.96 ft or 1.82 m  |
| 12 ft                       | Low                      | 3.65 ft or 1.11m   | 7.15 ft or 2.18 m                                | 7.15 ft or 2.18 m  | 7.15 ft or 2.18 m  |

National Geospatial Program

# Lidar Base Specification Version 1.0


Chapter 4 of  
Section B, U.S. Geological Survey Standards  
Book 11, Collection and Delineation of Spatial Data

2012



Techniques and Methods 11–B4

U.S. Department of the Interior  
U.S. Geological Survey



# ASPRS Positional Accuracy Standards for Digital Geospatial Data

(EDITION 1, VERSION 1.0. - NOVEMBER, 2014)

|                                   |    |
|-----------------------------------|----|
| Foreword.....                     | A3 |
| 1. Purpose.....                   | A3 |
| 1.1 Scope and Applicability ..... | A3 |
| 1.2 Limitations .....             | A3 |
| 1.3 Structure and Format.....     | A3 |
| 2. Conformance.....               | A3 |
| 3. References.....                | A4 |
| 4. Authority .....                | A4 |

## ASPRS Positional Accuracy Standards for Digital Geospatial Data

(EDITION 1, VERSION 1.0. - NOVEMBER, 2014)

|                                  |   |    |
|----------------------------------|---|----|
|                                  | <b>B.2 DIGITAL ORTHOIMAGERY<br/>HORIZONTAL ACCURACY CLASSES</b>     | A3 |
| 1. Purpose.....                  |   | A3 |
| 1.1 Scope and Applicability..... | <b>B.3 DIGITAL PLANIMETRIC DATA<br/>HORIZONTAL ACCURACY CLASSES</b> | A3 |
| 1.2 Limitations .....            |   | A3 |
| 1.3 Structure and Format.....    |   | A3 |
| 2. Conformance.....              | <b>B.4 DIGITAL ELEVATION DATA<br/>VERTICAL ACCURACY CLASSES</b>     | A3 |
| 3. References.....               |   | A4 |
| 4. Authority.....                |   | A4 |

# Horizontal Standards

TABLE B.6 HORIZONTAL ACCURACY/QUALITY EXAMPLES FOR HIGH ACCURACY DIGITAL PLANIMETRIC DATA

| ASPRS 2014   |                        |  |  | Equivalent to map scale in |                    |                                 |
|--|------------------------|--|--|----------------------------|--------------------|---------------------------------|
| Horizontal Accuracy Class RMSE <sub>x</sub> and RMSE <sub>y</sub> (cm) | RMSE <sub>r</sub> (cm) | Horizontal Accuracy at the 95% Confidence Level (cm) | Approximate GSD of Source Imagery (cm) | ASPRS 1990 Class 1         | ASPRS 1990 Class 2 | Equivalent to map scale in NMAS |
| 0.63   | 0.9                    | 1.5  | 0.31 to 0.63                           | 1:25                       | 1:12.5             | 1:16                            |
| 1.25   | 1.8                    | 3.1  | 0.63 to 1.25                           | 1:50                       | 1:25               | 1:32                            |
| 2.5  | 3.5                    | 6.1  | 1.25 to 2.5                            | 1:100                      | 1:50               | 1:63                            |
| 5.0  | 7.1                    | 12.2   | 2.5 to 5.0                             | 1:200                      | 1:100              | 1:127                           |
| 7.5  | 10.6                   | 18.4   | 3.8 to 7.5                             | 1:300                      | 1:150              | 1:190                           |
| 10.0   | 14.1                   | 24.5   | 5.0 to 10.0                            | 1:400                      | 1:200              | 1:253                           |
| 12.5   | 17.7                   | 30.6   | 6.3 to 12.5                            | 1:500                      | 1:250              | 1:317                           |
| 15.0   | 21.2                   | 36.7   | 7.5 to 15.0                            | 1:600                      | 1:300              | 1:380                           |
| 17.5   | 24.7                   | 42.8   | 8.8 to 17.5                            | 1:700                      | 1:350              | 1:444                           |
|  |                        |  | 10.0 to 20.0                           | 1:800                      | 1:400              | 1:507                           |
|  |                        |  | 11.3 to 22.5                           | 1:900                      | 1:450              | 1:570                           |
|  |                        |  | 12.5 to 25.0                           | 1:1000                     | 1:500              | 1:634                           |
|  |                        |  | 13.8 to 27.5                           | 1:1100                     | 1:550              | 1:697                           |
|  |                        |  | 15.0 to 30.0                           | 1:1200                     | 1:600              | 1:760                           |
|  |                        |  | 22.5 to 45.0                           | 1:1800                     | 1:900              | 1:1,141                         |

Table 1E. — Planimetric Coordinate Accuracy Requirement (Ground X or Y in feet) for Well-defined Points - Class 1. Maps PLANIMETRIC (X or Y) ACCURACY<sup>2</sup> (limiting rms error, feet) TYPICAL MAP SCALE

|       |          |
|-------|----------|
| 0.05  | 1:60     |
| 0.1   | 1:120    |
| 0.2   | 1:240    |
| ----- |          |
| 0.3   | 1:360    |
| 0.4   | 1:480    |
| 0.5   | 1:600    |
| 1.0   | 1:1,200  |
| 2.0   | 1:2,400  |
| 4.0   | 1:4,800  |
| 5.0   | 1:6,000  |
| 8.0   | 1:9,600  |
| 10.0  | 1:12,000 |
| 16.7  | 1:20,000 |

\*indicates the practical limit for aerial methods - for scales above this line, ground methods are normally used.

# Horizontal Standards

TABLE B.6 HORIZONTAL ACCURACY/QUALITY EXAMPLES FOR HIGH ACCURACY DIGITAL PLANIMETRIC DATA

| ASPRS 2014   |                        |  |  | Equivalent to map scale in |                    | Equivalent to map scale in NMAS |
|--|------------------------|--|--|----------------------------|--------------------|---------------------------------|
| Horizontal Accuracy Class RMSE <sub>x</sub> and RMSE <sub>y</sub> (cm) | RMSE <sub>r</sub> (cm) | Horizontal Accuracy at the 95% Confidence Level (cm) | Approximate GSD of Source Imagery (cm) | ASPRS 1990 Class 1         | ASPRS 1990 Class 2 |                                 |
| 0.63   | 0.9                    | 1.5  | 0.31 to 0.63                           | 1:25                       | 1:12.5             | 1:16                            |
| 1.25   | 1.8                    | 3.1  | 0.63 to 1.25                           | 1:50                       | 1:25               | 1:32                            |
| 2.5  | 3.5                    | 6.1  | 1.25 to 2.5                            | 1:100                      | 1:50               | 1:63                            |
| 5.0  | 7.1                    | 12.2   | 2.5 to 5.0                             | 1:200                      | 1:100              | 1:127                           |
| 7.5  | 10.6                   | 18.4   | 3.8 to 7.5                             | 1:300                      | 1:150              | 1:190                           |
| 10.0   | 14.1                   | 24.5   | 5.0 to 10.0                            | 1:400                      | 1:200              | 1:253                           |
| 12.5   | 17.7                   | 30.6   | 6.3 to 12.5                            | 1:500                      | 1:250              | 1:317                           |
| 15.0   | 21.2                   | 36.7   | 7.5 to 15.0                            | 1:600                      | 1:300              | 1:380                           |
| 17.5   | 24.7                   | 42.8   | 8.8 to 17.5                            | 1:700                      | 1:350              | 1:444                           |
| 20.0   | 28.3                   |  |  |                            | 1:400              | 1:507                           |
| 22.5   | 31.8                   |  |  |                            | 1:450              | 1:570                           |
| 25.0   | 35.4                   |  |  |                            | 1:500              | 1:634                           |
| 27.5   | 38.9                   |  |  |                            | 1:550              | 1:697                           |
| 30.0   | 42.4                   |  |  |                            | 1:600              | 1:760                           |
| 45.0   | 63.6                   | 110.1  | 22.5 to 45.0                           | 1:1800                     | 1:900              | 1:1,141                         |

**UAV**

# Exercise Problems

Converting from NMAS to ASPRS 2014 Standards:

Given a map or orthoimagery with a horizontal accuracy of  $RMSE_x = RMSE_y = 15$  cm according to the new 2014 standard, what is the equivalent accuracy and map scale according to the legacy National Map Accuracy Standard (NMAS)?

**1:380 or 1"=32'**

# Exercise Problems

Converting from NMAS to ASPRS 2014 Standards:

Given mapping requirements for creating planimetric data at 1:400 scale:

A) What is the lowest resolution imagery that can be used?

**15cm or 6”**

B) What is the horizontal accuracy requirement for the orthoimagery?

**-same-**

# Exercise Problems

Converting from NMAS to ASPRS 2014 Standards:

Given mapping requirements for creating planimetric data at **1:100** scale:

A) What is the lowest resolution imagery that can be used?

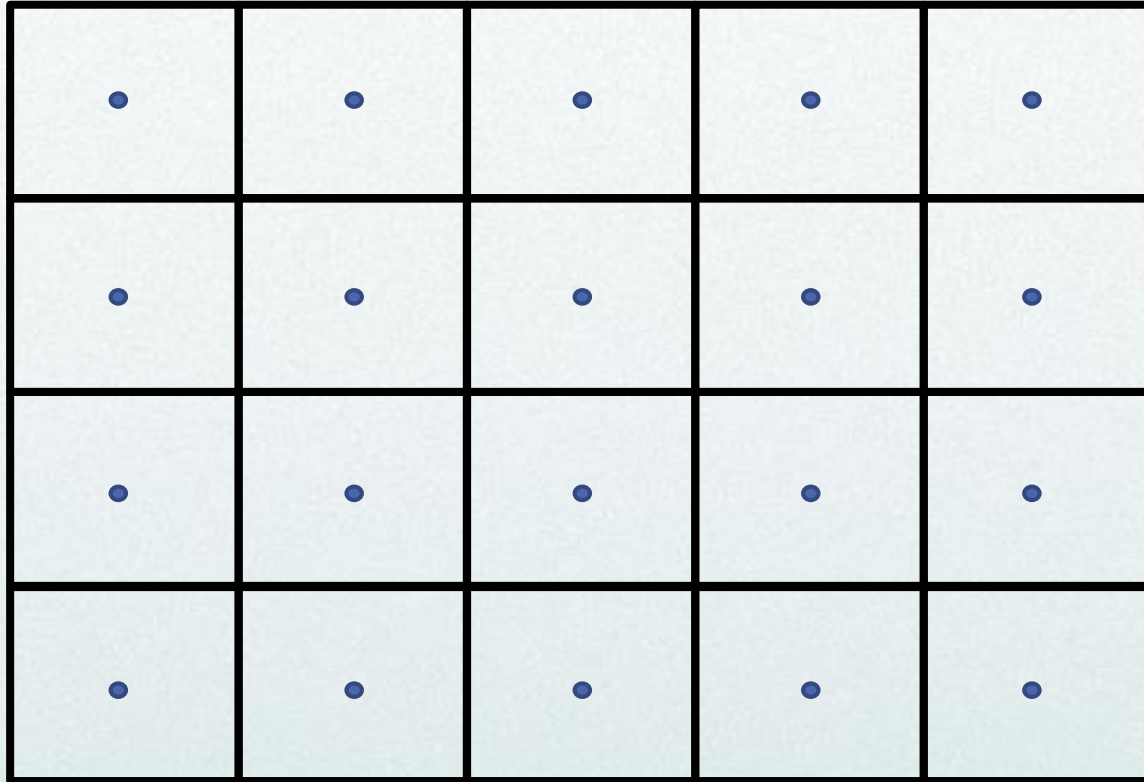
**5cm or 2”**

B) What is the horizontal accuracy requirement for the orthoimagery?

**-same-**

# Vertical Standards

## Surface Modeling



# Vertical Standards

## Surface Modeling

- ▶ FEMA- NPS should be equal to or less than the DEM post spacing (resolution) required
- ▶ 1-meter DEM for 1ft contours
- ▶ 2-meter DEM for 2ft contours
- ▶ 5-meter DEM for 5ft contours
- ▶ 0.7m NPS -> 2ppsm -> 1m DEM -> 1ft contours (QL 2)
- ▶ 1.4m NPS -> 0.5ppsm -> 2m DEM -> 2 ft contours (QL 3)

Note: Higher density data may still fail vertical RMSE test  
Lower density data may meet higher accuracy tests for discrete points.

Accuracy is tested from a sample of points against the surface model, regardless of the point density

# Vertical Standards

TABLE B.8 VERTICAL ACCURACY OF THE NEW ASPRS 2014 STANDARD  
COMPARED WITH LEGACY STANDARDS

| Vertical Accuracy Class | RMSE <sub>z</sub> Non-Vegetated (cm) | Equivalent Class 1 contour interval per ASPRS 1990 (cm) | Equivalent Class 2 contour interval per ASPRS 1990 (cm) | Equivalent contour interval per NMAS (cm) |
|-------------------------|--------------------------------------|---|---|---|
| 1-cm                    | 1.0                                  | 3.0   | 1.5   | 3.29                                      |
| 2.5-cm                  | 2.5                                  | 7.5   | 3.8   | 8.22                                      |
| 5-cm                    | 5.0                                  | 15.0  | 7.5   | 16.45                                     |
| 10-cm                   | 10.0                                 | 30.0  | 15.0  | 32.90                                     |
| 15-cm                   | 15.0                                 | 45.0  | 22.5  | 49.35                                     |
| 20-cm                   | 20.0                                 | 60.0  | 30.0  | 65.80                                     |
| 33.3-cm                 | 33.3                                 | 99.9  | 50.0  | 109.55                                    |
| 66.7-cm                 | 66.7                                 | 200.1   | 100.1   | 219.43                                    |
| 100-cm                  | 100.0                                | 300.0   | 150.0   | 328.98                                    |
| 333.3-cm                | 333.3                                | 999.9   | 500.0   | 1096.49                                   |

# Vertical Standards

TABLE B.9 EXAMPLES ON VERTICAL ACCURACY AND RECOMMENDED LIDAR POINT DENSITY FOR DIGITAL ELEVATION DATA ACCORDING TO THE NEW ASPRS 2014 STANDARD

| Vertical Accuracy Class | Absolute Accuracy                    |                                  | Recommended Minimum NPD <sup>8</sup> (pls/m <sup>2</sup> ) | Recommended Maximum NPS <sup>8</sup> (m) |
|-------------------------|--------------------------------------|----------------------------------|--|--|
|                         | RMSE <sub>z</sub> Non-Vegetated (cm) | NVA at 95% Confidence Level (cm) |  |  |
| 1-cm                    | 1.0                                  | 2.0                              | ≥20  | ≤0.22                                    |
| 2.5-cm                  | 2.5                                  | 4.9                              | 16   | 0.25                                     |
| 5-cm                    | 5.0                                  | 9.8                              | 8  | 0.35                                     |
| 10-cm                   | 10.0                                 | 19.6                             | 2  | 0.71                                     |
| 15-cm                   | 15.0                                 | 29.4                             | 1  | 1.0                                      |
| 20-cm                   | 20.0                                 | 39.2                             | 0.5  | 1.4                                      |
| 33.3-cm                 | 33.3                                 | 65.3                             | 0.25   | 2.0                                      |
| 66.7-cm                 | 66.7                                 | 130.7                            | 0.1  | 3.2                                      |
| 100-cm                  | 100.0                                | 196.0                            | 0.05   | 4.5                                      |
| 333.3-cm                | 333.3                                | 653.3                            | 0.01   | 10.0                                     |

Converting from NMAS to ASPRS 2014 Standards:

Given an elevation dataset with a vertical accuracy of  $RMSE_z = 10$  cm according to the new 2014 standard, what is the equivalent contour interval according to the legacy National Map Accuracy Standard (NMAS)?

**32.9cm or 1ft**

Converting from NMAS to ASPRS 2014 Standards:

Given the requirement for 6” contour elevation data, what is the minimum point spacing and/or point density?

**NPS = 35cm or ~1ft**

**NPD = 8 ppsm**

# Measuring Accuracy

I have drone data that is  
1" pixel resolution ortho  
and 6" contours.

How accurate is it?

**Who knows?.....**

# Measuring Accuracy

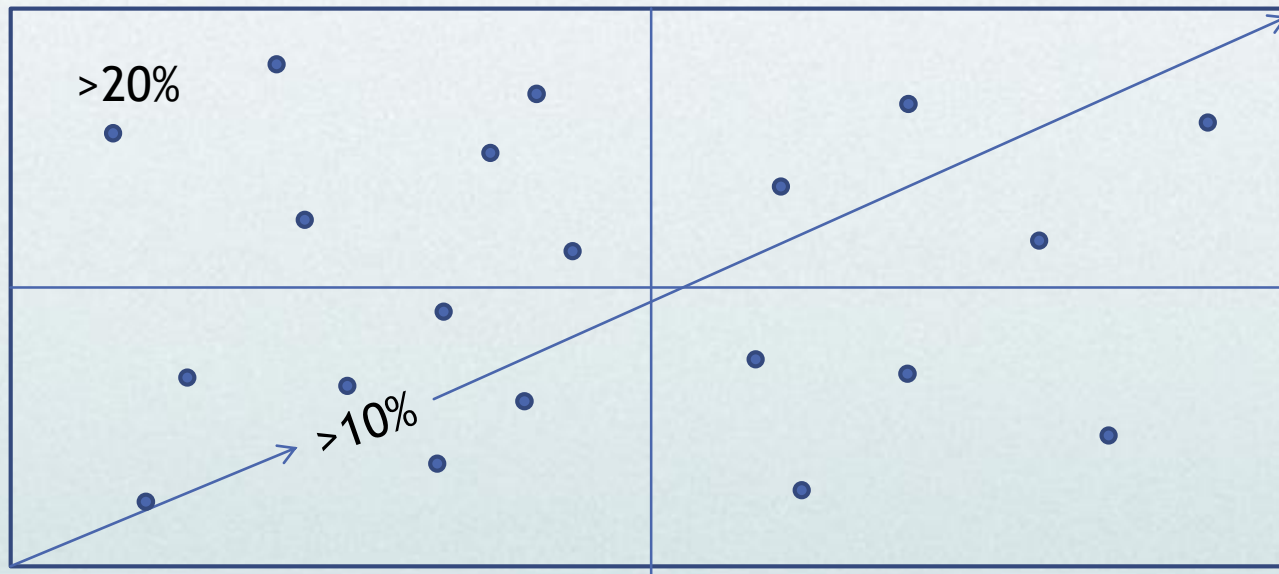
“Produced to meet...”

Vs

“Tested to meet...”

# Measuring Accuracy

- ▶ “In no case shall orthoimagery or planimetric accuracy be based on less than 20 checkpoints.”
- ▶ Vertical checkpoints on slopes  $<10\%$
- ▶ Checkpoints at intervals of at least 10% of the diagonal
- ▶ At least 20% of the points are located in each quadrant



# Measuring Accuracy

- ▶ NSSDA: minimum of 20 points
- ▶ NSSDA: 95% Accuracy means 1 point can fail
- ▶ FEMA and ASPRS: 20 per land cover type
- ▶ USGS: use land cover types >10% of area
- ▶ LiDAR Projects: Typically 100 points
  
- ▶ Reference must be 3X target accuracy
  
- ▶ For UAS collections- **MINIMUM of 20 POINTS !!!**
  
- ▶ Meeting accuracy specs does not necessarily equate to having quality data

# Measuring Accuracy

If I use ground control with +/- 0.1ft accuracy for each point on a UAV survey, And use the same to collect checkpoints across the project area, how do I report the resulting accuracy of the planimetrics and topo?

If UAV imagery is ~1inch → 2.5cm Accuracy Class

0.1ft → 3cm

3cm Checkpoints = 3x target accuracy = 9cm Accuracy Class

10cm Accuracy Class = 1:200 Planimetrics, 1ft contours

TESTED TO MEET Accuracy is only as good as the checkpoints used to TEST.

If you want to prove 0.1ft Accuracy (3cm)  
then you need 1cm Accurate Checkpoints

# Geospatial Data Accuracy Standards

Precision. Accuracy. Reliability



# SPATIAL ANALYTIX

Precise. Accurate. Reliable.