Maps – A Primer for Content & Production of Topographic Base Maps For Design

Presented by SurvBase, LLC

Definition and Purpose of,

Map: a representation of the whole or a part of an area.

Maps serve a wide range of purposes. From determining the destination of a cruise missile - to - modeling the human genome – to - showing people where they are on the world and where that world is in the universe; maps are used to plan, document, and teach.

Maps are a form of Communication.
Printed Maps are a form of graphical communication and, limited, written communication.
Digital maps are also a form of graphical communication but they can also incorporate written, spoken, and numeric communication.

Maps are abstractions of reality.
Maps are reduction of reality.

Planimetric and Topographic Maps

> **Planimetric** maps communicate the horizontal relationship of physical things. Planimetric maps do not have a vertical component.
>
> **Topographic (or topo)** maps show the horizontal and vertical relationship of physical things. Topographic Maps are planimetric maps that show relief.

The US Geological Survey (USGS) produces some of the most frequently used maps in the US – the quadrangle series of topographic maps. In Alaska the most commonly used USGS maps are the “Inch to the mile” topographic quadrangles.

USGS defines a topographic map as:

> “A map is a representation of the Earth, or part of it. Traditionally, maps have been printed on paper. When a printed map is scanned, the computer file that is created may be called a digital raster graphic.
> The distinctive characteristic of a topographic map is that the shape of the Earth's surface is shown by contour lines. Contours are imaginary lines that join points of equal elevation on the surface of the land above or below a reference surface such as mean sea level. Contours make it possible to measure the height of mountains, depths of the ocean bottom, and steepness of slopes.
> A topographic map shows more than contours. The map includes symbols that represent such features as streets, buildings, streams, and woods.”

This is a fairly limited and specific definition that fits best with the USGS Quad Map family of topographic maps.

Doctors make topographic maps of people's eyes so that they can diagnose vision problems. That's a topo map that doesn't fit the USGS definition very well!

Geologists make topographic maps that represent the surface of materials that lie far below the surface of the earth. That's another topo map that doesn't fit the USGS definition very well!

The maps that are most frequently used for project design and construction are representations of the earth's surface. They fit the USGS definition pretty well. The maps used for this purpose are typically larger scale than the mapping USGS produces.

Most topographic maps are initially made for two reasons:

1. To facilitate development.
2. For military purposes.

Map Elements

1. Graphical Content
    a. Points
        i. Symbols
    b. Lines
        i. Symbols
    c. Regions
        i. Hatching
    d. All of the above are augmented with:
        i. Text
        ii. Penweights
        iii. And maybe.. Colors

2. Map Data
    a. Title block
        i. Map Title
        ii. Location (MTRS, City, etc.)
        iii. Name of client
        iv. Name of cartographer
        v. Name of map checker (this cannot legitimately be the cartographer)
        vi. Date produced
        vii. Path & Filename (digital mapping)
    b. Legend
        i. Symbols
        ii. Linetypes

c. North Arrow (type of north – NOT "True")
   i. WGS84
   ii. NAD83
   iii. NAD27
   iv. Record Document (Plat, Deed, Lease, etc)
d. Scale
   i. Bar scale
   ii. Units
e. Notes
   i. Metadata
   ii. Exceptions/Problems/Warnings
   iii. Instructions
f. Vicinity Map (Not always needed)
g. Revision History
   i. Identifies changes made after first publication.

3. Source Metadata – data about the source data
   a. For each data source
      i. Source of data
      ii. Date of data
      iii. Accuracy of data
      iv. Coordinate system
         - Must be reproducible
      v. Vertical Datum – NAVD88, MSL, Assumed, etc…

4. Output Format
   a. Plotted Sheet(s)
      i. Sheet size should reduce well
         - 22"x34" reduces to 11"x17"
   b. Digital Format

Map Scale

Scale is the relationship between a distance on a plotted map and the distance it represents in the real world. The map scale can be represented as a ratio or as a comparison of two units.

For example:

Ratio scale of 1:63,360 means 1 inch on the map = 63,360 inches in the real world (which is one mile)

Two unit scale of 1" = 50' means 1 inch on the map = 50 feet in the real world.

Small scale – things appear small.
Large scale – things appear large.

These terms are relative to the task at hand. If you are trying to determine the direction of drainage on the lot that you are building a house on, a USGS map at 1:24,000 seems like a small scale map. If you are planning ride a bicycle across the U.S. and want to take paper maps along, this seems like a scale that is much too large – it is doubtful that you could even carry the required maps on your bicycle. 1:1,000,000 may be a more reasonable scale.

To quote Roger Lawrence of Redlands University in California.
"Note that the larger a scale is, the smaller the number in the scale fraction. For example, a 1:18,000-scale map is said to have a larger scale than a 1:136,000-scale map. Mapmakers did this intentionally to confuse you and increase your reliance upon their profession…they learned this practice from lawyers."

Note: Stated Numeric Map scale is only valid if the map has not been enlarged or reduced and… it was plotted at the stated map scale. This is why it is important to include a bar scale on every plot.

Appropriate Scale is that *STANDARD* scale which facilitates clear communication of the data for the intended purposes.

Digital Mapping is scaleless.

Accuracy

A map will never be more accurate than the data that it is based upon. However, it can be much less accurate than the data it is based upon.

In 1947 the U.S. Bureau of the Budget came up with the standard for mappers. The US National Map Accuracy Standards. USGS quad maps meet this accuracy and many organizations still rely on this standard.

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. These limits of accuracy shall apply in all cases to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as bench marks, property boundary monuments; intersections of roads, railroads, etc.; corners of large buildings or structures (or center points of small buildings); etc. In general what is well defined will be determined by what is plottable on the scale of the map within 1/100 inch. Thus while the intersection of two road or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would obviously not be practicable within 1/100 inch. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map. In this class would come timber lines, soil boundaries, etc.

2. **Vertical accuracy,** as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.

3. **The accuracy of any map may be tested** by comparing the positions of points whose locations 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 aforestated** 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.

U.S. BUREAU OF THE BUDGET

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Types of Mapping Errors

1. Missing data
    a. Not located in the field
    b. Lost in the course of reducing field data
    c. Feature located but not described

2. Incorrect data
    a. Blunder in measurement
    b. Blunder in recording measurement
    c. Incorrect descriptor/description in the field

3. Map production errors
    a. Incorrect symbology associated with a feature
    b. Computation errors
    c. Oversimplification
    d. Ambiguity

4. Scale problems
    a. Scale too small for purpose of map
    b. Distortion
    c. Non-Standard Scale
    d. Miss-Identified Scale
    e. Scale that doesn’t half size to a Standard Scale

Planning for the Creation of a Map

Prior to collecting data or drawing anything; do the following:

1. Determine the purpose of the map.
   a. Planning
   b. Environmental studies
   c. Design
      i. Roads, utilities, buildings, etc.
   d. Legal matters
   e. Historical documentation/preservation
   f. Maintenance
   g. Public education
   h. Is the map a final product or will it be the base for other uses?

2. Who is the audience?
   a. Do the users regularly use this type of map?
      i. Are there mapping standards they expect to see?
      ii. Are they novices?
   b. Will it be used outside of your organization?
      i. Can you control distribution?

3. Determine what is critical to the purpose.
   a. Water wells?
   b. Bedrock?
   c. Drainage?
   d. Vegetation?
   e. etc.

4. Determine the area to be mapped.
   a. Does this encompass the end users needs?
   b. Will the project expand?

5. Consider the source data.
   a. Existing data
      i. Who did the work?
      ii. What is the accuracy of the data?
      iii. What is the age of the data?
      iv. Is this copyrighted data?
   b. New field survey data
      i. Compass and Tape
      ii. Conventional Survey Gear
      iii. GPS
      iv. Electronically collected data
         - format of that data
   c. Photography
   d. Etc.

6. What is the estimated life of the map?
   a. Will it be recorded?
   b. Is it for a single project or multiple projects?
   c. Will it be distributed digitally?

7. Is there a high risk of litigation associated with this map?
   a. Is it being used to settle a dispute?

8. Determine the format of the map.
   a. Paper, mylar
      i. Sheet size
   b. Digital
      i. What software will be used to create
      ii. What software will be used to view

9. Determine a scale for the map

10. Sketch a sample sheet to get a sense of proportion

11. If plotted, estimate the number of sheets – be sure to allow plenty of white space.

12. Determine time to produce such a map (budget talks don't go nearly as well after the money is spent).

Successful Map Communication

Assuming you have good source data, map graphical elements are shown in the proper relationship and content is appropriate for the audience; Successful communication largely becomes an artistic effort. Don't make your audience work hard to understand the content.

1) Hierarchical organization relative to importance.
   a) Penweight
   b) Screening
   c) Size
   d) Orientation

2) Emphasis
   a) Italics
   b) ALL CAPS
   c) Boxed Text
   d) Underlined
   e) Enlargement

3) Balance.
   a) White Space

b) Orientation
c) Consistency
d) Organization
    i) Tables
        (1) Size
        (2) Location
        (3) Content
    ii) Details