# ABOUT OUR MAPS

There are a few important facts to know with regard to our maps and topographic maps in general:

**Disclaimer**

First of all, while our maps are as accurate as we can make them with the tools at our disposal, the trails depicted on the maps may not conform precisely to conditions on the ground. Trails may have been rerouted or improved since the maps were last updated. In addition to the location of trails on the land, actual mileages usually are greater than map mileages. This is particularly true of steep trails, where switchbacks may be fewer in number and shorter in length on the maps compared to on-the-ground trail conditions. Mile markers are there only as a guide and should not be used to precisely locate a trail junction or other points of interest. For this purpose, we use geographical coordinates (see **Waypoints**).

**Waypoints**

We try to limit waypoints to trailheads, road and trail junctions, and other critical decision points. Coordinates are shown in degrees (°) and decimal minutes (') for both latitude (e.g., **37°25.845' N**) and longitude (e.g., **109°56.985' W**). There are 60 minutes in each degree and 60 seconds (”) in each minute (e.g., **20.500' = 20'30”**). Latitude is measured north and south of the equator (**0°**). The North Pole is **90°N** and the South Pole is **90°S.** Lines of latitude are parallel to the equator, and the distance between them is constant around the globe. Longitude is measured ≤**180° E** and **W** from the Greenwich Meridian (**0°**) in Greenwich, England. Lines of longitude are perpendicular to lines of latitude, converging at the poles. Therefore, distance between them is greatest at the equator and decreases as latitude increases (**Fig. 1**).

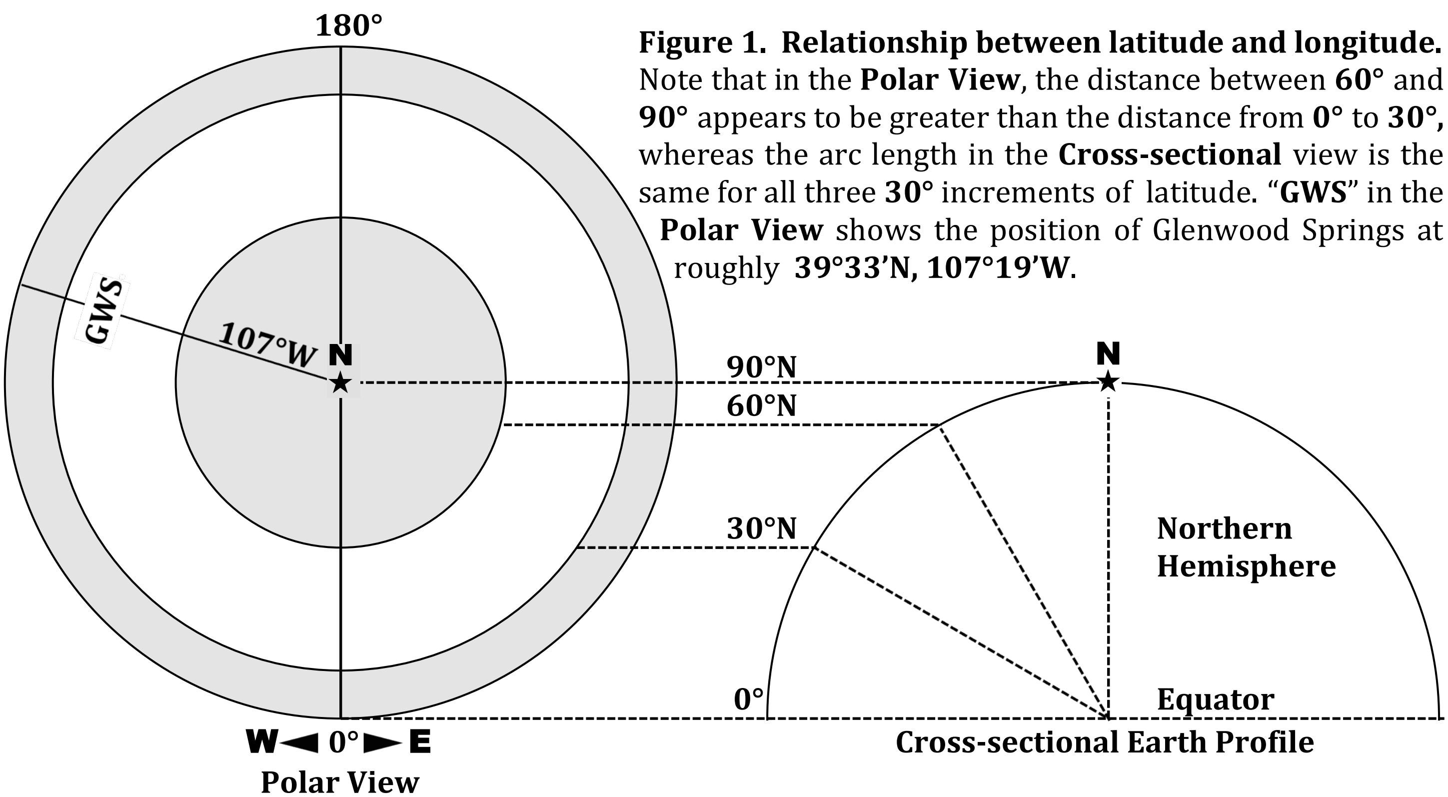



**Figure 1. Relationship between latitude and longitude.** Note that in the **Polar View**, the distance between **60°** and **90°** appears to be greater than the distance from **0°** to **30°,** whereas the arc length in the **Cross-sectional** view is the same for all three **30°** increments of latitude. “**GWS**” in the **Polar View** shows the position of Glenwood Springs at roughly **39°33’N, 107°19’W**.

Again, waypoints are as accurate as we can make them, using satellite imagery, where possible, to confirm the locations of trailheads and junctions. But remember that the accuracy of your GPS also may vary, so your GPS waypoint may not precisely conform with the ones on the maps. But they should be within a few 100ths of a minute (') in both latitude and longitude. They are based on **True North** (★), rather than **Magnetic North** (**MN**); the relationship between them may differ in both time and place.

The angular difference between **True North** and **Magnetic North** is called "declination", and the declination angle is the number of degrees by which **True North** deviates from **Magnetic North** relative to your position. Due to the parallax between these points, declination varies as you travel east-west or north-south (**Fig. 2**). Where we live, declination in 2016 is roughly 9.5°E, but as **Magnetic North** can and does migrate, the value of declination at any point on Earth will vary over time. Declination in any given region usually can be found in the lower right or lower left corner of the map next to the map scale (**Fig. 3**).

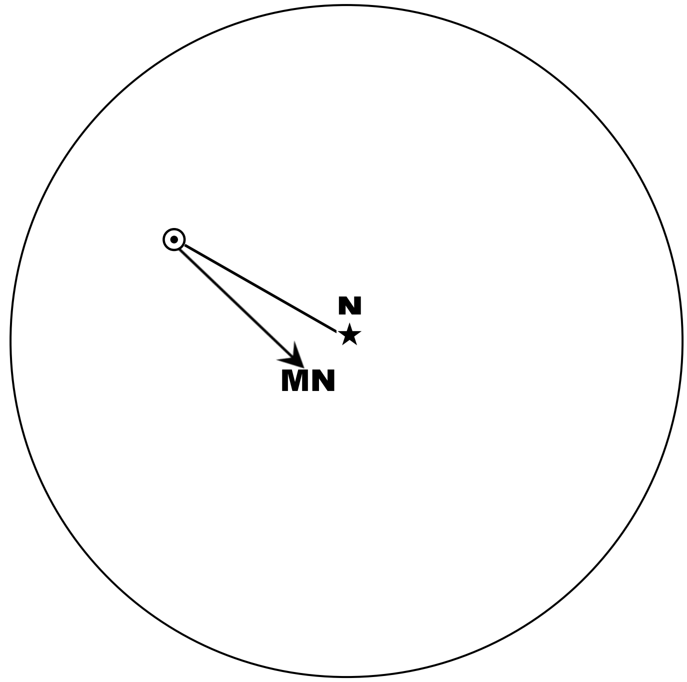
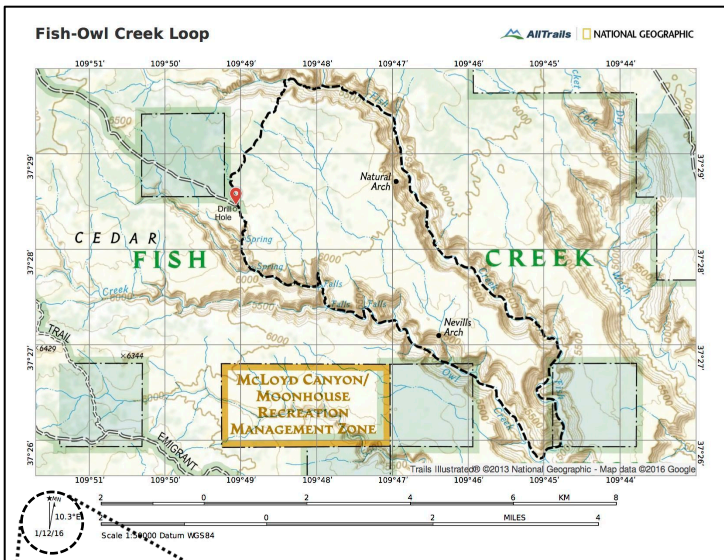
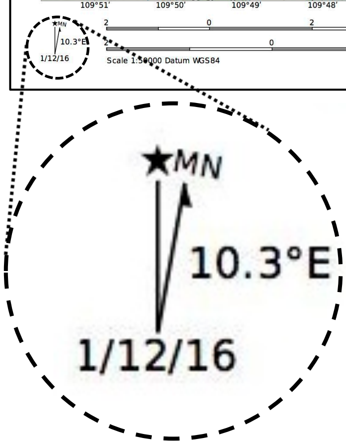



**Figure 2 (Above). Declination**: The relationship between **True North** (★) and **Magnetic North** (**MN**) relative to a fixed position (⦿). [**Polar View**]




◄ **Figure 3. Declination Angle** as depicted on topographic maps (left) indicates both magnitude and direction (**10.3°E**). The date (**1/12/16**) shows the currency of the declination measurement. If there is no date or the date is more than a few years old, the declination angle may not be accurate.

If navigating by compass, it is critical to account for declination accurately, because an error of less than 1° can amount to 100s of yards over a long distance. Moreover, navigating by compass…or orienteering…requires hours of hands-on experience with map and compass to fully master it.

## Map Scale

Most of our maps are rendered at a scale ≈1:31000. Since there are 63,360 inches in a mile, this map scale is roughly equivalent to 2" = 1 mile. We may at times use other maps scales, and these scales would be noted prominently on the map. Other common map scales are 1:24000, 1:50000, or 1:100000. The larger the number to the right of the colon, the larger the area covered by the map. A map scale of 1:31000 covers four times the area of 1:15500, while topographic features are only 25% as large at 1:31000 (**Fig. 4** and **Fig. 5**).

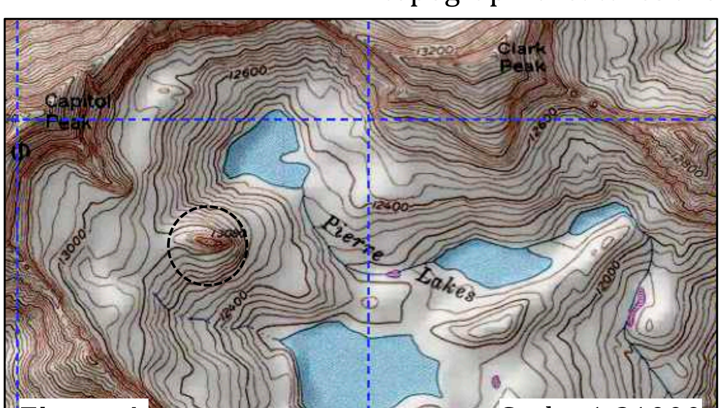



**Figure 4.** Scale=1:31000

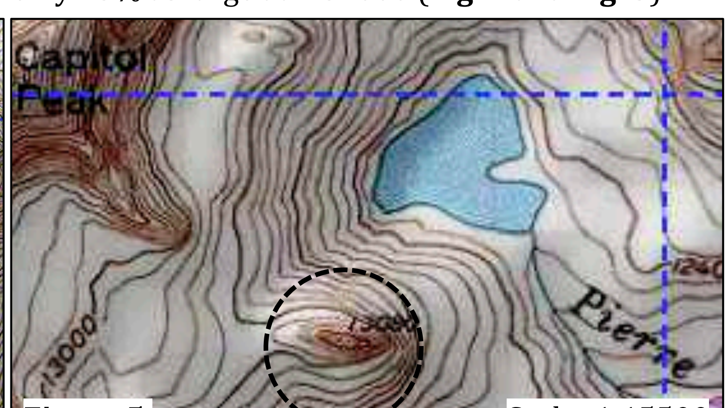



**Figure 5.** Scale=1:15500

## Reading Contours

What differentiates topographic maps from other types of maps is the use of topographic **contour lines** to represent elevation. Contour lines are the same elevation for their entire length. Most of our maps, based on USGS 7.5' quadrangles, have labeled contour lines every 200' of elevation (e.g., 10800, 11000), with 4 minor contour lines each representing 40' of elevation change (e.g., 10840, 10880, 10920, 10960) between major contours. Occasionally different contour intervals may be used. The map legend may or may not show which contour interval is used. If not, check the major contour lines on the map to confirm.

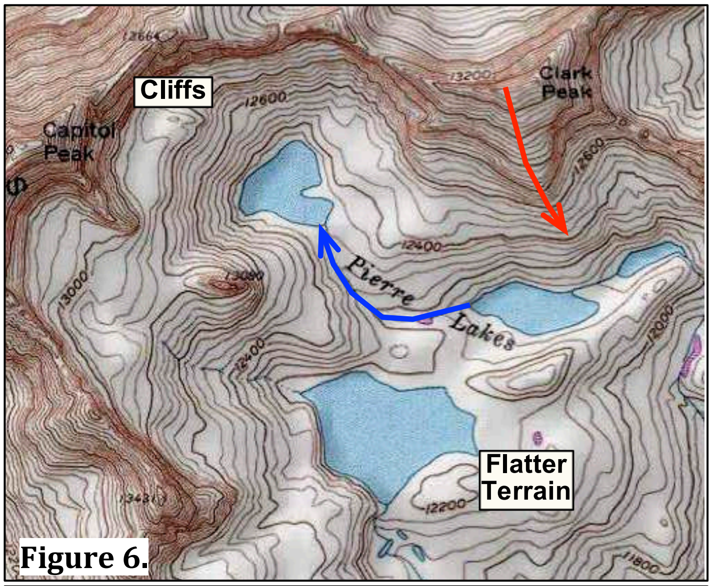



Figure 6.

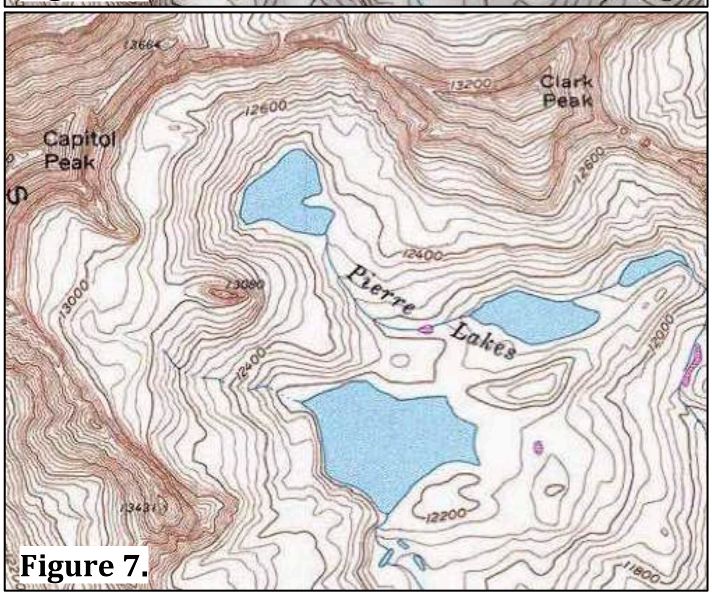



Figure 7.

Once you understand that contour lines are parallel horizontal lines of elevation, you can appreciate that contours spaced closely together indicate steeper terrain. The more widely spaced the contour lines, the flatter the terrain (**Fig. 6**). And a line (or trail) crossing the contours at right angles runs uphill and downhill, whereas a line running parallel to them is more or less level. From the direction in which they point, contour lines can help to differentiate ridges from valleys and peaks from pits (**Fig. 6)**. Where the 'V' they form points downhill, there is a ridge ( ); where the 'V' points uphill, there is a valley ( ). Both peaks and pits are encompassed by closed contour lines (rings). What differentiates them is that depressions or pits have tick marks on inside of each closed contour that point toward the center of the depression or pit (**Fig. 12**, last page). Typically, though they fill depressions, alpine lakes do not show bathymetric (underwater) contours and may or may not include a water surface elevation.

## Shading

Most of our maps have topographic shading applied by the mapping software to heighten our perception of topographic relief. Shadows are cast such that the human brain correctly perceives topographic relief. That is, valleys look like valleys, ridges look like ridges, etc. To better appreciate the effect of this enhancement, compare moderately shaded **Figure 6** with **Figure 7**, where the "shaded relief" option has been disabled.

## Elevation Profiles

Whenever possible, elevation profiles are included to graphically show the steepness of the hiking trail or route we plan to follow, including variations in the angles of ascent or descent (**Fig. 8**). Slopes of 20% (~1000' per mile) or greater are steep; slopes of 10% (~500' per mile) are moderate; and slopes ≤5% (~250' per mile) are mild. There may be short, steep sections of trails that otherwise are mild or moderate in slope. Because elevation profiles consume space on the map, we do not include them where space is limited due to the length of the trail, the complexity of the driving route to the trailhead, etc.

A noteworthy trait of these profiles is that they are <u>non-directional</u>. The trailhead is always at 0 mi. (left), and the destination is always on the right, regardless of the direction of the travel (**Fig. 8**). Therefore, an elevation profile for a trail traveling generally from east to west on the map would <u>appear</u> to travel in the opposite direction. However, the mileage scale (x-axis) on the profile always corresponds to the mileage markers on the map. Use them to find your position on the profile or to translate the profile to the map.

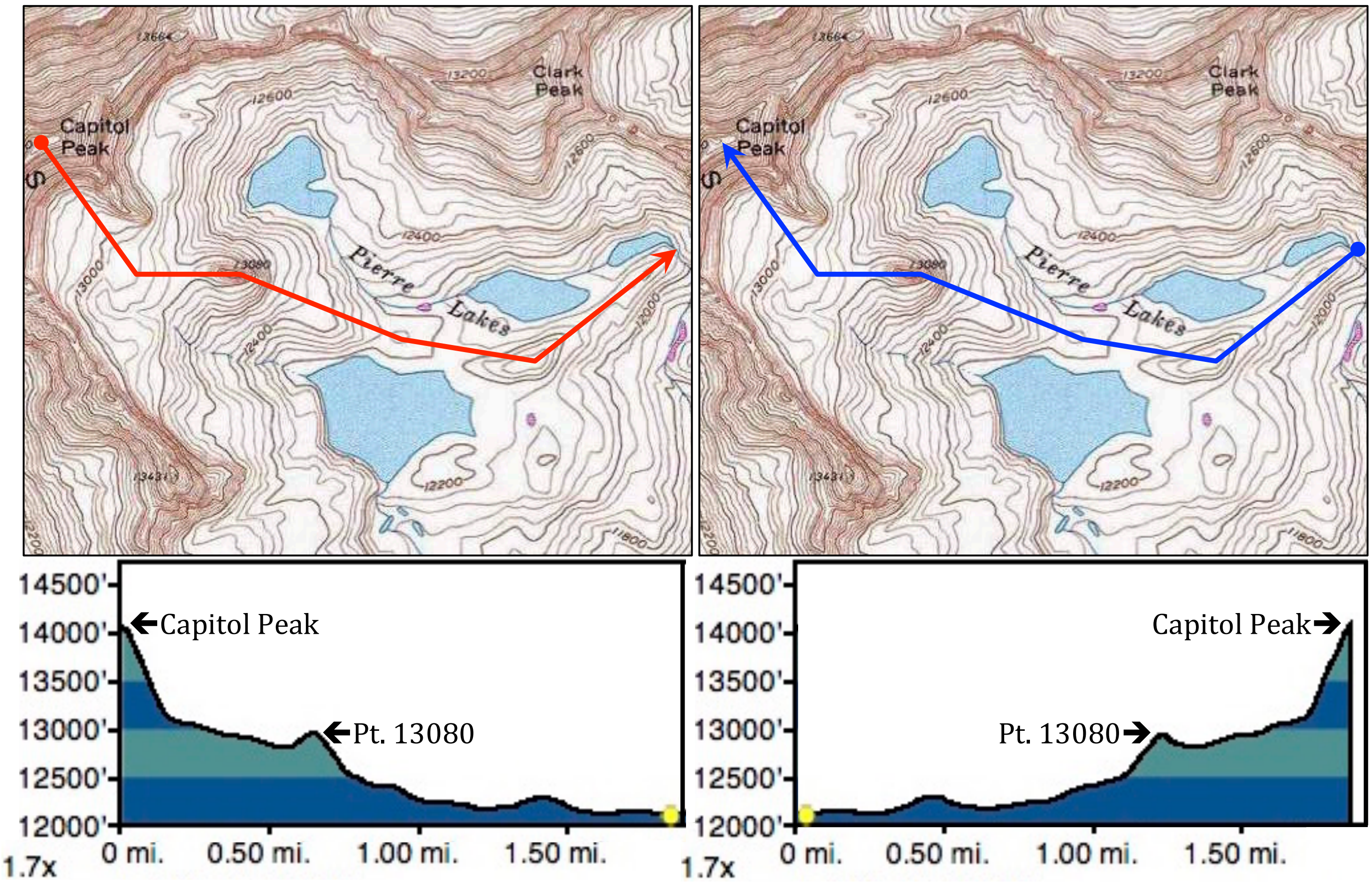



**Figure 8. Elevation Profiles**
Note that the profile on the right, where the direction of travel ( ) is east to west, is the mirror image of the profile on the left, where the direction of travel ( ) is west to east. However, for out-and-back hikes, elevation profiles are always read from left to right on the out-bound leg. Conversely, you would read the profile from right to left on the return leg. The same holds true for northbound and southbound hikes. Through/loop hikes are one-way only; read profiles according to which direction you are hiking (i.e., left to right if map mileage increases in your direction of travel and right to left if mileage decreases). Route shown is for illustration only and does not depict an actual route, except perhaps for Spiderman.

## Interpreting Other Map Features

Topographic maps contain much useful information in addition to elevation. Prominent landforms, such as peaks, lakes and streams, are labeled, along with man-made structures, such as roads, towns, dams, canals, etc. Forested areas are shaded green on the map (**Fig. 9**). Generally, the extent of forested areas is reasonably accurate, even on older maps, unless wildfire, avalanche or some other natural catastrophe or construction altered the vegetation "cover-type". Buff-colored map areas are not forested, but typically are not differentiated between non-forested cover-types, such as alpine tundra, bare rock, grassland, meadow, flooded bottomland, or chaparral to name just a few. However, distinguishing those different cover-types on the ground is not difficult. Some cover-types and other features, both natural and man-made, are graphically represented by symbols on the map (**Fig. 9**). The myriad of symbols are far to numerous to mention them all here, and may or may not be labeled on the map. Understanding the significance of map symbols can help you identify these features on the ground, which can be helpful in orienting yourself on the map, as well as alerting you to areas, such as marshes and bogs, to avoid if you are bushwhacking. We try to label such features if they are relevant landmarks to navigation, or they are of historical significance, such as old mining sites, ghost towns, railroad grades and tunnels, etc.

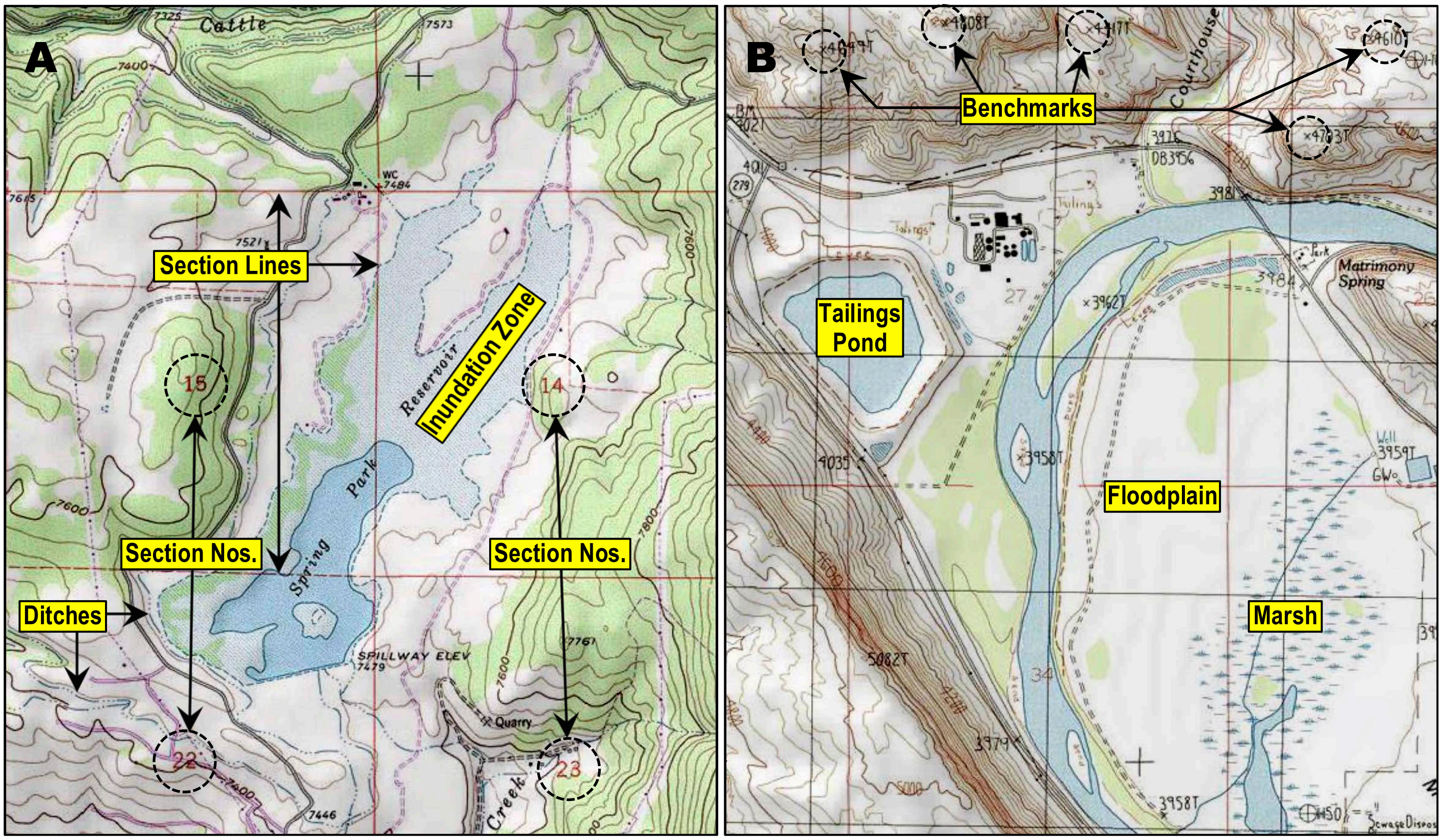
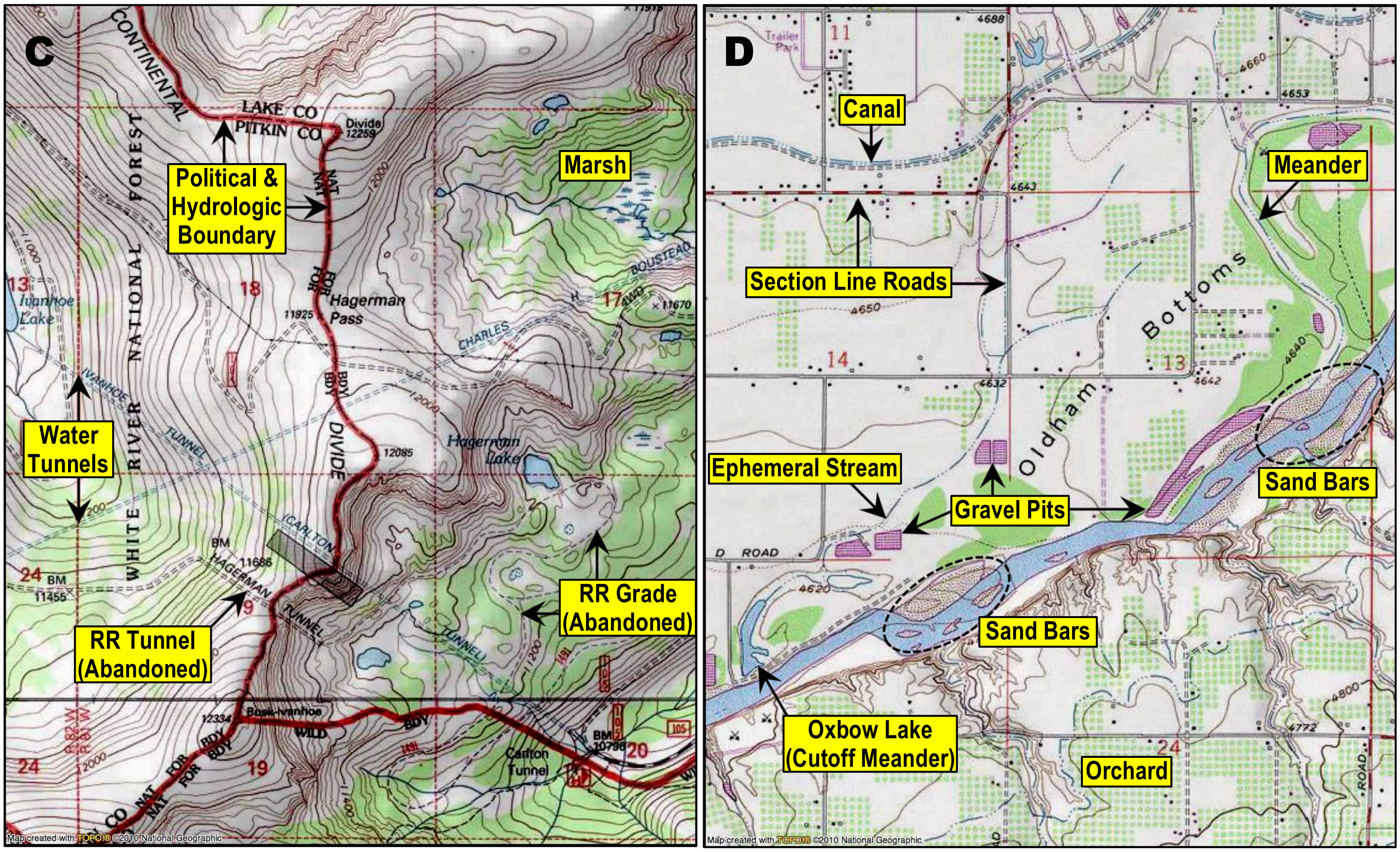



**Figure 9. Map Symbols, Labels and Landforms.** An illustration of just a few symbols and other useful information that can be found on topographic maps. Part of the Public Land Survey System (PLSS), **Sections** (Map **A**) are ~1 mile square, invisible on the ground unless delineated by fences (e.g., property lines) or otherwise defined by a network of **section line roads** (Map **D**). **Benchmarks** (×) are survey monuments (Map **B**) usually marked with cast brass discs imbedded in concrete or stone. Maps may also depict man-made structures, such as tunnels, that may not be readily apparent above ground (Map **C**).



A couple of items warrant further discussion. In most of the Western States, lands are divided by the Public Land Survey System into a network of **Townships** and **Ranges**. Like lines of latitude, Township Lines run east-west, whereas Ranges are bounded on east and west by north-south running Range Lines. Each Township is 6 miles from north to south, and each Range is 6 miles from east to west. Each of these Township-Range blocks encompasses an area of 36 square miles, divided into 36 **Sections**, each of which is roughly one square mile in area. Section lines and/or section numbers may or may not appear on the map. If present, they follow the pattern depicted in **Figure 10.**

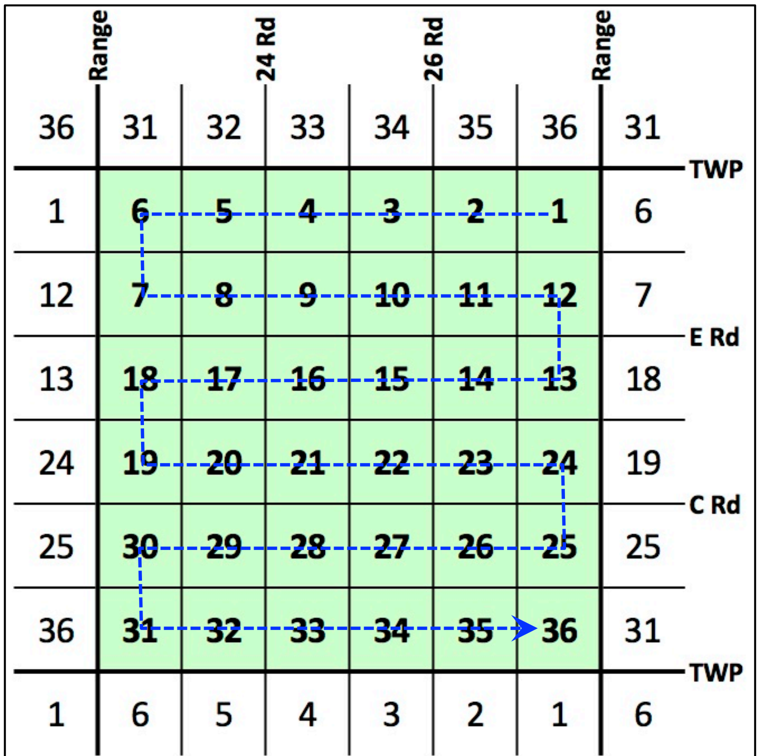



**Figure 10. Townships, Ranges & Sections**
Section numbers (1–36) begin in the NE corner and follow a serpentine pattern (-------) to the SE corner of each Township-Range grid. The diagram has been annotated to illustrate the spatial relationship and orientation of Grand Valley roads within this system.

To better appreciate this concept, consider the network of roads in the Grand Valley area. For example, 22 Road and 28 Road are Range Lines, 22 and 28 miles, respectively, east from the Utah state line. Similarly, one mile separates each of the 'Alphabet' roads (A, B, C, D, etc.), south to north, respectively. A and G Roads are Township Lines, whereas B–F Roads are Section Lines. D½ Road is ½ mile north of D Road, or halfway between D and E Roads.

## Triangulation

Absent a thorough discussion of navigation with map and compass, it is useful to consider one method of orientation: **Triangulation**. As the name implies, this method uses 3 points to determine the position of the observer on the map, where one of those points is the observer's position. The other two points are significant landmarks, identifiable not only on the map, but on the ground as well. Using a compass to determine the direction of each landmark relative to the observer, the observer can draw a straight line on the map along each of those compass bearings. The observer's position is at the intersection of these lines of position (LOPs). Additional LOPs can be added to improve the accuracy of the position (**Fig. 11**).

In **Figure 11**, an observer's position (☆) is the intersection of the red and blue LOPs. The red line connects two landmarks, Capitol Peak and Pt. 12902. Relative to the observer's position, Capitol Peak (bearing 303°) and Pt. 12902 (bearing 123°) are 180° apart. This was done intentionally to illustrate a situation, not to suggest that this situation is typical. You should never use reference points at such obtuse angles, because they cannot provide an accurate estimate of your position. Although you could conclude that your position is somewhere along the red line, you could be anywhere along that line without at least one other LOP at a more acute angle relative to your first LOP. If you took bearings on two reference points roughly 60° apart, such as Capitol Peak and Clark Peak (the blue line bearing 3° in this example), the accuracy of your position would be greatly enhanced.

In our mountainous region, prominant landmarks usually are readily available. Occasionally, however, the most prominant may be outside the relatively small area covered by our maps. If you have a larger map available to you, use that. Otherwise, you would need to select landmarks that can be found on the smaller map. In fact, the closer the landmarks/reference points, the more accurate your position will be. It is not the objective of this cursory examination to fully cover all the nuances of navigation with map and compass. I encourage you to take a class on the subject, including hands-on training in the field.

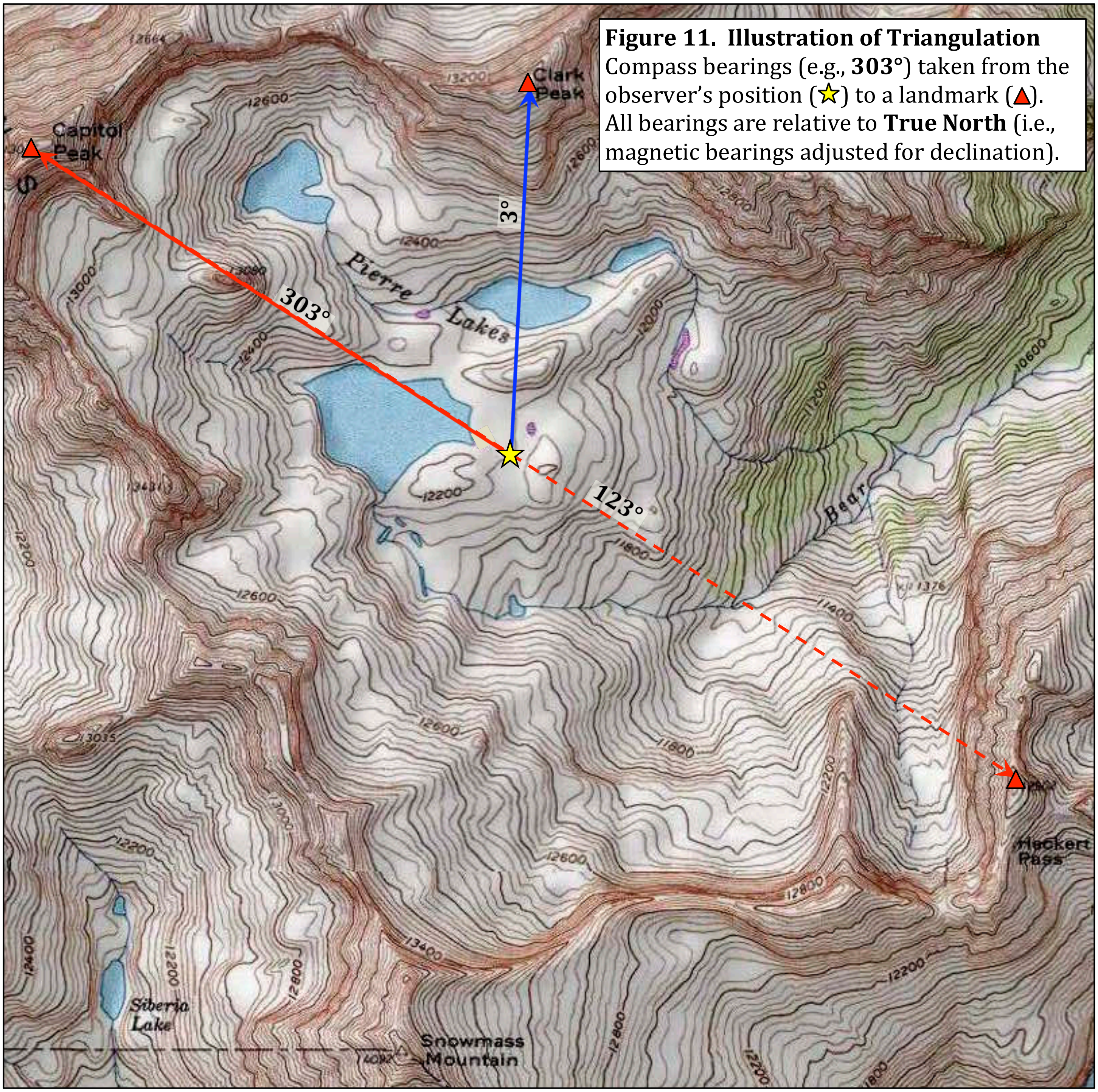



**Figure 11. Illustration of Triangulation**
Compass bearings (e.g., **303°**) taken from the observer's position (☆) to a landmark (▲). All bearings are relative to **True North** (i.e., magnetic bearings adjusted for declination).

## Standardization

Most of our maps are produced using the same National Geographic (TOPO!) software. However, because our intrepid group of map makers is an all-volunteer force, you can expect some variation between maps rendered by different map makers. Also, certain maps were adapted from National Park Service PDF files downloaded from their website, while others were produced using an online subscription service (AllTrails.com). Some of these are formatted to print on legal (8.5"x14") paper. Due to their larger size, these maps were not included with the 8.5"x11" paper maps you may have purchased, but were included on the CD, and also will be posted online at the URL [http://www.100clubcolorado.us/maps/](http://www.100clubcolorado.us/maps/) from which you may print them yourselves, if your printer supports the larger format.

TOPO! map printed on 12/11/16 from "Eagle-Fairview.tpo"

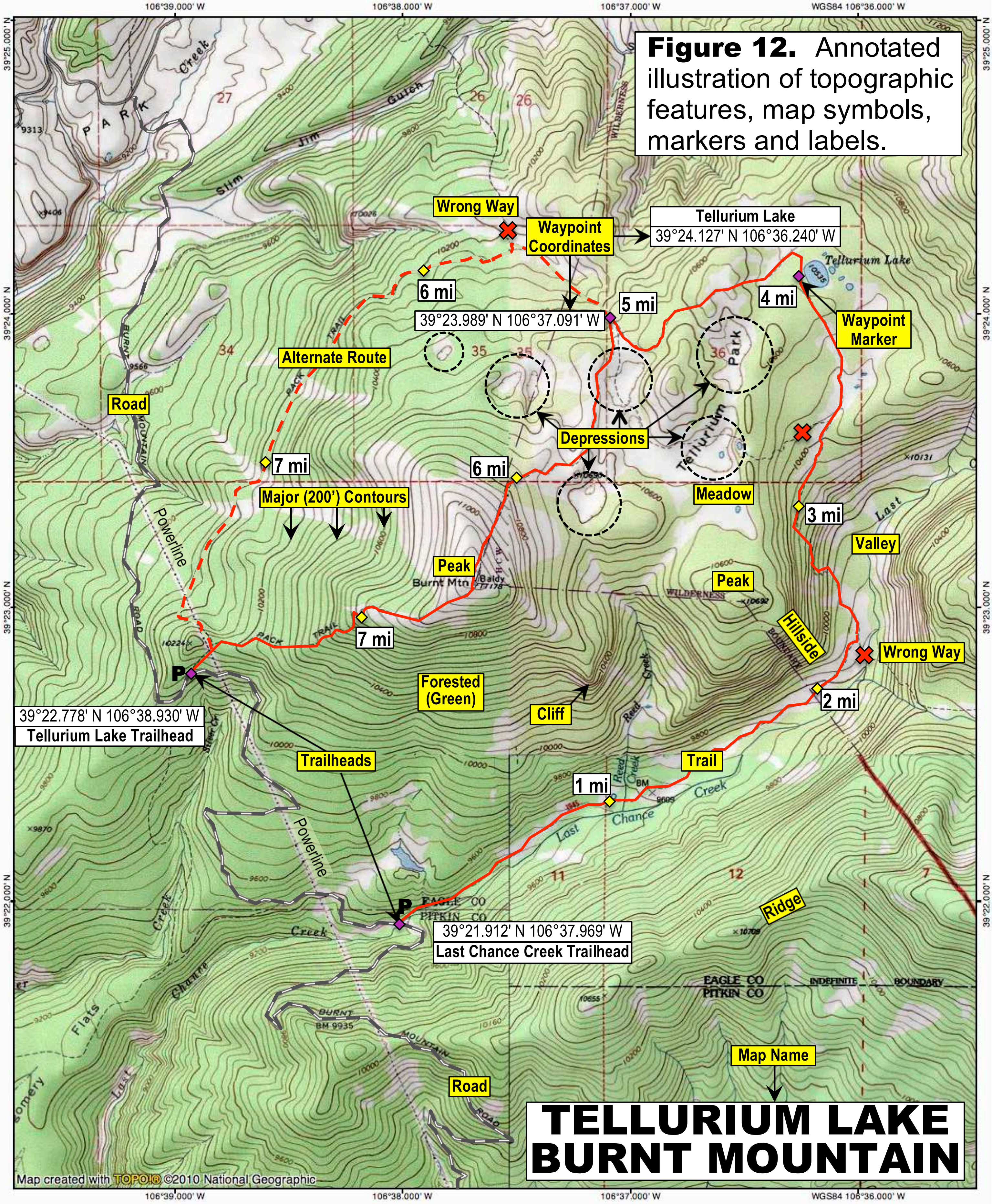



**Figure 12.** Annotated illustration of topographic features, map symbols, markers and labels.

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