MAPPING EMIGRANT TRAILS MANUAL

PART B
OVERVIEW OF GPS AND MAPPING SOFTWARE

Prepared by the
Mapping and Marking Committee

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GPS AND MAPPING SOFTWARE

INTRODUCTION AND OVERVIEW

The purpose of this publication is to provide an introduction to the technology available for mapping emigrant trails. The publication is not an instructional guide to mapping; that is covered in other publications in the Mapping Emigrant Trails (MET) series, in particular Parts A and C.

Since the development of the mapping approach described in OCTA's original Mapping Emigrant Trails (MET) Manual, remarkable improvements in the mapping technology available at reasonable cost to non-professionals have occurred. The satellite-based Global Positioning System (GPS) permits an individual to locate a position on the surface of the earth within a few feet (or less). The information gathered by hand-held GPS units costing less than $150 can be downloaded to mapping software in personal computers to generate maps identical to the USGS 1:24,000 scale topographic quadrangles (quads) used in MET mapping.

The methodology described in the MET Manual Part A includes techniques for researching, identifying and classifying trails as well as the transfer of this information to printed maps. An understanding of that process is a prerequisite for understanding that which follows. The MET methodology is sound and widely accepted. The approach described herein exploits modern technology to facilitate the MET process. Moreover, the manual mapping process described in the MET Manual remains valid and can be used by those not comfortable with the "high tech" approach using GPS and mapping software.

The essential elements of the information recorded on a MET map are (1) trail location, (2) trail condition, and (3) trail documentation (notes that support the trail location and condition assessment). Trail condition is defined by the six MET classes as described in the MET Manual Part A. When OCTA began documenting trails, location data was originally acquired during field visits by relating the topography and evidence on the ground to a position on the paper map. A line representing the trail was drawn on the map. Later, GPS units were used to record the data which was plotted on the paper map. The objective of the new approach is to acquire, record and print this information using computer-based software.

Before proceeding, some general comments on GPS devices and software are appropriate. Any GPS unit that is capable of recording and storing "tracks" and "waypoints" is appropriate[1]. All consumer-grade units provide similar accuracy which is more than adequate for trail mapping. The most popular brands are Garmin, Magellan and Trimble. Higher priced units add "bells and whistles," but usually do not provide significant improvements in the capabilities used for our

[1] Both the terms "waypoints" and "markers" are used by manufacturers to describe points recorded by a GPS. This paper uses the term "waypoint" to describe recording a point rather than a track or area. As shown later, a GPS may use the term "mark" in a menu to record a waypoint.

mapping projects. The capabilities of various brands and devices may be examined at the manufacturer's websites. User manuals may also be downloaded for additional information.

Separately, the National Park Service has developed a Graphics Information System (GIS) approach using more sophisticated (and costly) hardware and software. The system is part of a much larger effort to document National Trails of all types[2]. It is OCTA's objective to provide compatible information to the NPS system using the procedures described in this paper with less costly hardware and software.

THE MAPPING PROCESS: YESTERDAY AND TODAY

Before GPS deployment, the mapping process involved observation (or detection) of the field evidence and location of the evidence on a map by reference to other physical features (topographic contours, streams, unique features, etc.). John Latschar, a member of the team that mapped the Oregon Trail as part of its designation as a National Historic Trail in 1979, described the process as follows:

> "Way, way back in the old days … we did all of our trail mapping through old-fashioned terrain analysis; i.e., we worked with USGS maps, compasses, odometers, and triangulation. With the new GIS and GPS technologies available today, you could probably do in five weeks what it took us five months to accomplish."

With the availability of the GPS, very accurate recorded data became available that could be plotted on the quads. Coincident with the introduction of hand-held GPS units, mapping software became available. This software permits downloading of mapping data (tracks and waypoints) from a GPS to a personal computer which hosts (or has access to) digital versions of the USGS maps. This permits a segment to be mapped precisely without a hand-plotting processes.

Over the years, OCTA mapping projects for the NPS have taken three forms. The first maps of trails were prepared at the 1:100,000 scale. These were hand-drawn maps prepared by members based upon their knowledge and expertise but generally did not use GPS data. They were submitted to the NPS for use in their 1999 Comprehensive Management and Use Plan. These maps are stored at the NPS office in Salt Lake City and are available to OCTA members as digital files (TIF format).

OCTA's second product for the NPS is the "MET maps" which are done at a scale of 1:24,000. Up to 2012 the preferred approach for submitting trail data to the NPS was the paper maps. The submitted maps are scanned and geo-referenced to the NPS baseline. Trail data are then digitized.

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[2] National Trails are designated by Congress under the National Trails System Act. The Oregon, California, Mormon Pioneer and Pony Express trails are designated under the category "National Historic Trail." Trails like the Appalachian Trail are designated "National Scenic Trails."

The third approach is to provide the NPS with trail data in digital format as provided by a GPS device.

Regardless of whether a manual or digital mapping process is used, a structured procedure is employed. The procedure may be summarized as follows:

1. Conduct research: review of old maps and documents.
2. Setup the GPS for field work (clear old data, add maps as appropriate).
3. Collect data (tracks, waypoints, and features)
4. Download data to a computer with mapping software.
5. Evaluate and select data (discard erroneous or redundant data).
6. Integrate with other information (maps, images and text)
7. Generate maps and output files.

Research is a prerequisite for field work. All too often this step is underemphasized and field work is begun without the information needed to establish the trail's credibility. The process for conducting research is well documented in the MET Manual Part A so we will not discuss it further in this paper.

The computer-based approach to mapping is summarized in Figure 1.

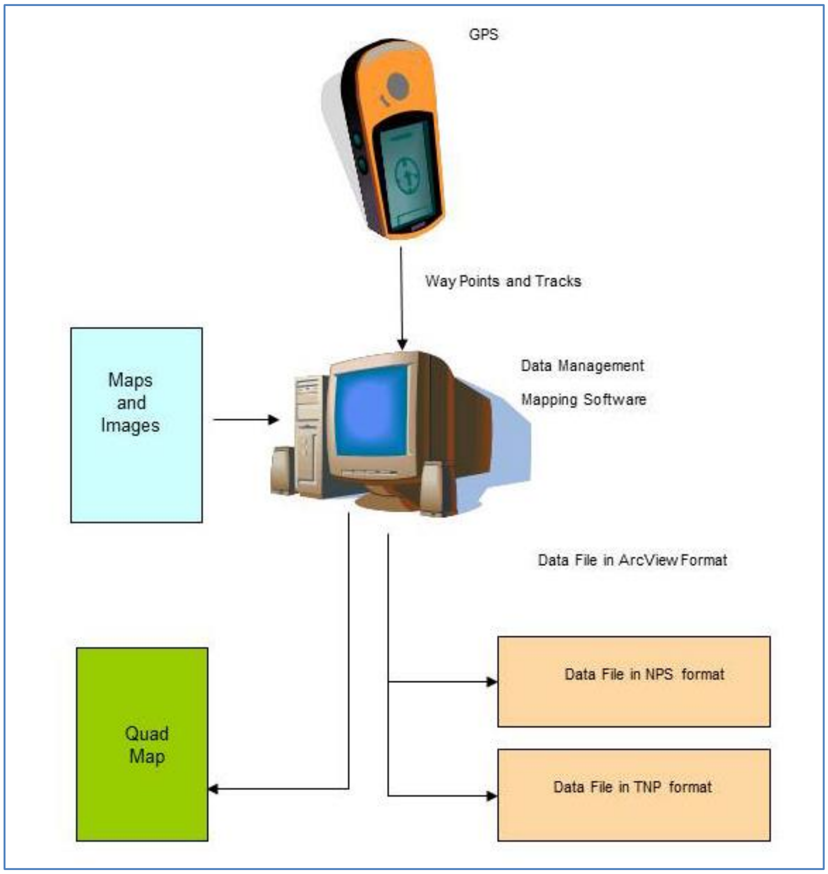

Figure 1. Mapping Using GPS and Mapping Software

THE GLOBAL POSITIONING SYSTEM (GPS)

System Description

For the reader desiring detailed information on the GPS system, there are numerous articles available on the Internet such as Wikipedia. A simplified description follows.

The GPS unit is a radio receiver. It receives signals from a constellation of approximately twenty-four satellites that have known positions at any given time. Coverage is world-wide. The satellites broadcast a time-stamped "message" that is received on the ground after a short delay. The GPS unit compares the time of transmission to the time of receipt and calculates the distance to the satellite by multiplying the signal's speed (the speed of light) and the time difference.

$$\text{Distance} = \text{Velocity} \times \text{Time}$$

Using the data from four (or more) satellites gives four (or more) values of D which combine to determine the position on the surface of the earth.

From the first measurement, the observer could be anywhere on the surface of a sphere centered at the satellite with radius D, but we know that the observer must be on the circle that is the intersection of this sphere and the surface of the earth. Other measurements provide other spheres and their resulting circles on the surface of the earth. The common point among them all is the observer's location. There are small errors in all of the measurements that may be reduced by measurements from additional satellites and collection over an interval of time. Corrections from known calibration sites with known positions may also be used to improve accuracy.

Russia has also deployed a navigation satellite system (GLONASS) that can be used by some GPS devices.

GPS Operations – Recording Markers and Tracks

For the purpose of this discussion, a Garmin eTrex Legend[3] is used as an example. The discussion will focus on major functions and is not intended as an endorsement or an instruction manual for the unit. The Main Menu of an eTrex Legend is shown in Figure 2.

[3] The Garmin eTrex Legend Cx was purchased in 2008, but similar units may still be purchased. Additional information on this and other Garmin GPSs may be found at www.garmin.com. Information on Magellan and Trimble devices is available at their websites.

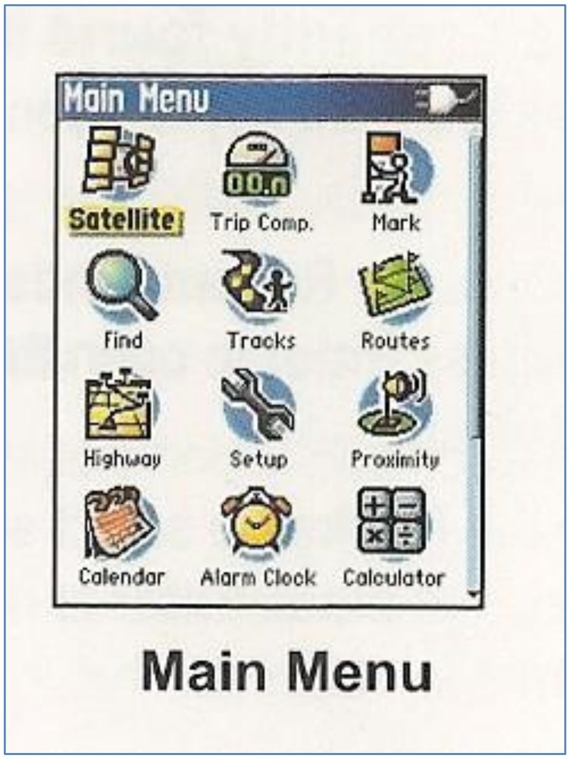

Figure 2. Main Menu – eTrex Legend GPS

The essential features for our purposes are the icons "Satellite," "Mark" and "Tracks." The "Satellite" icon provides information on the satellites that are visible (not hidden by the earth or local features) and are being used at any given time to calculate position. A geometric spread of satellites generally improves accuracy as would the use of more than four satellites. Closely clustered satellites result in poorer accuracy. A GPS user has no control over this situation other than choosing another time of day for observations since the satellite constellations are constantly changing. See PDOP discussion that follows.

From a functional standpoint, the two things to be accomplished are (1.) to record the route (track) of the trail and (2.) to record markers or the locations of trail features. This is accomplished with the icons "Mark" and "Tracks."

A waypoint is recorded when something changes along the trail like its classification or a defining trail feature appears. It is a discrete point described by its coordinates, typically in latitude and longitude or Universal Trans-Mercator (UTM) coordinates. With an eTrex Legend a point is marked by going to the main menu, selecting "Mark" and then selecting "OK." This is accomplished with a toggle on the eTrex, but other units may use other techniques.

To mark successive points the process is repeated. Note that the result is a series of unconnected points, not a continuous line. The display for a waypoint on the eTrex is shown in Figure 3.

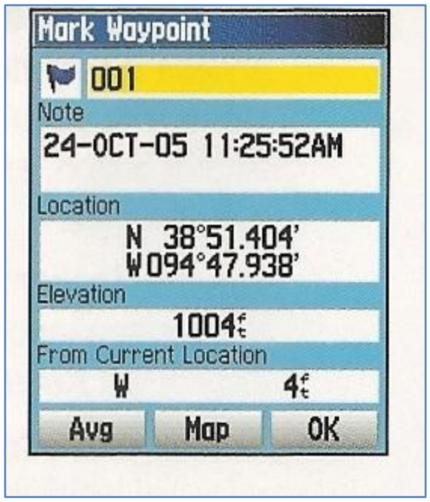

Figure 3 – eTrex Screen for Marking Waypoints

In an eTrex Legend the waypoint numbers (001 above) are assigned automatically and can be edited in the field, but it is probably better to wait until the data is downloaded to a computer with a keyboard. Supplementary field notes should be used to record the event that Waypoint 001 is recording (such as a change in trail classification or a trail feature).

A "track" is a continuous line recorded as you walk down the trail. With the eTrex Legend it is recorded by selecting "Tracks" from the main menu and then turning the track log on. Recording is continuous until the track log is turned off with the same menu selection. The continuous nature of the GPS's track recording means that everywhere you walk is recorded when it is "on." If you are walking and recording a defined trail trace and divert off that trace to examine and interesting feature, that diversion will be recorded. A degree of discipline is required to record an accurate track.

In summary, the process of data collection is as follows:

1. The GPS unit should be initialized before beginning a session to remove old tracks and markers.
2. At the start of the segment to be recorded, the first waypoint is recorded. The field notes would record the start and the trail class. If there is some feature at that point it would also be noted.
3. Next the track recording is started. The track and waypoints should be recorded in the direction of the emigrant's travel on the westward journey.
4. The next waypoint would either be some feature (trail marker, unique landmark, etc.) or a change in trail classification. The track logger need not be stopped when this waypoint is recorded, although it may be a good idea to stop and start the logger if significant time is being spent in one location.
5. The process is continued until the entire segment of interest is recorded.

Theoretically, the entire segment could be recorded as one track with waypoints along the track. However, it may be more convenient to record the track in short segments so that it will be easier to re-do a segment if a problem arises.

Other GPS Features

Basic Functions

Most GPSs come with built-in maps of limited scale, detail and geographic coverage. This "basic" map software is not adequate for the preparation of MET-quality mapping products, but is essential for GPS operations in the field.

For a Garmin GPS this up software is MapSource Topo USA.[4] With the GPS linked to a computer, maps can be selected and downloaded to the GPS. MapSource maps are 1:100,000 scale and cover the entire U.S. If storage space in the GPS is an issue, then only those maps covering the work area may be downloaded to the GPS.

Many of the ancillary functions of a GPS are shown in Figure 2. A GPS can be used to navigate to prescribed points and record trips, as well as serving as a calculator, calendar, clock and camera. Each brand and model varies to some degree and generally the more features, the higher the cost. Display quality also improves in higher priced units.

Accuracy

Typical accuracy as stated in the specification for a consumer grade GPS unit is 10 meters (33 feet). Accuracy is similar across various consumer grade units unless it incorporates an external antenna or additional processing using corrections from known reference points. You will probably observe that your unit on most occasions provides much better accuracy (under three meters or ten feet) especially if conditions permit "seeing" many satellites and other degradations are not present. The best time for taking readings can be determined by doing so in optimal times. See discussion of PDOP below.

Datum

In order to map locations on earth, an approximation of the earth's surface must be established to define a reference surface. The approximation of the earth's surface is described by the geodetic datum. The datum defines the size and shape of the ellipsoid used to approximate the shape of the earth and its origin and orientation. There are two main categories of datum: 1) locally-centered and 2) earth-centered. NAD27 is an example of a locally centered datum which uses an ellipsoid that is centered in Kansas to provide more accurate local measurements in North America. WGS84 is an earth-centered datum that provides equally good measurement around the world and is the standard for GPS data collection. NAD83 is also an earth-centered datum. There is very little difference between NAD83 and WGS84 coordinates.

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[4] For a Magellan GPS this function is provided by MapSend and MapSend Topo software.

If you would like more detail on datum, NOAA has developed a good online training, “Understanding Datum, Coordinate Systems and Map Projections.” The link is:

http://www.csc.noaa.gov/digitalcoast/_/elearning/datums/index.html

Signal Interference

Radio signals at the frequency used by GPS do not penetrate forest canopy well. Use of units with external antennas can alleviate this problem. Sun spot activity also causes signal interference. Data collection in times of high sun activity should be avoided.

PDOP – Scheduling Data Collection for Best Results

Position Dilution of Precision (PDOP)[5] is a measure of the geometric goodness of the satellite constellation that is being used at a given time and location. High numbers indicate closely clustered constellation while low numbers show a spread of satellites from overhead to the horizon in various directions (see Figure 4). Table 1 summarizes the impact on accuracy of various PDOP values. When planning a trip go to one of these websites to check current conditions.

http://asp.ashtech.com/GNSSPlanningMobile/en.html
http://www.spectraprecision.com/support/gnss-planning/
http://www.trimble.com/planningsoftware.shtml

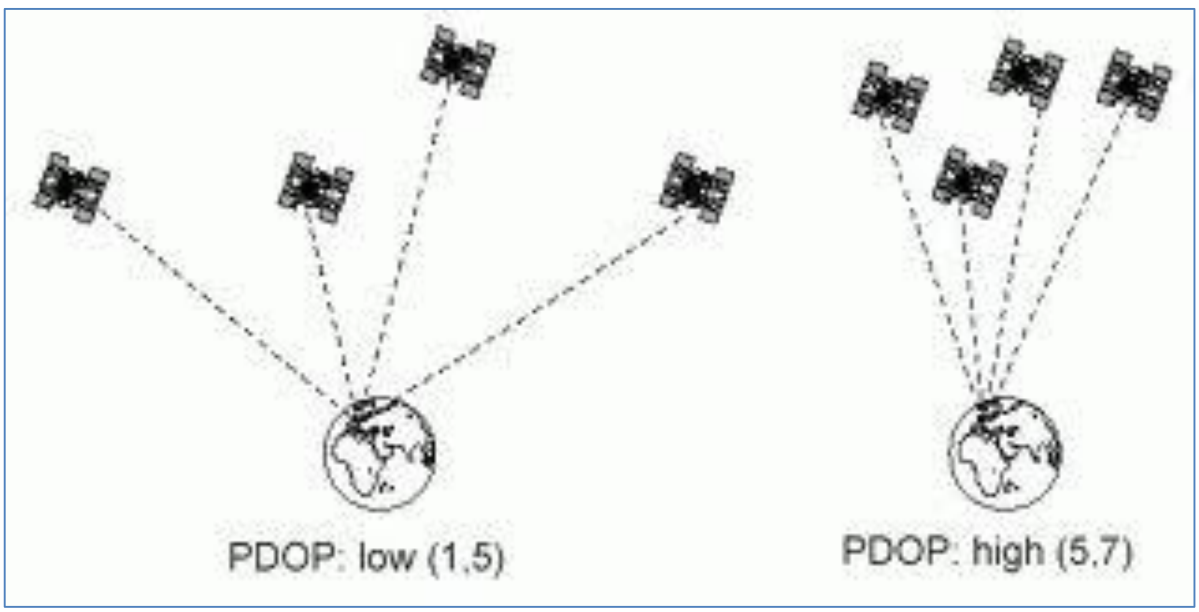

Figure 4. Satellite Constellations with Good (Low) and Bad (High) PDOP

[5] Wikipedia, “Dilution of Precision GPS”

DOP Value	Rating	Description
<1	Ideal	This is the highest possible confidence level to be used for applications demanding the highest possible precision at all times.
1-2	Excellent	At this confidence level, positional measurements are considered accurate enough to meet all but the most sensitive applications.
2-5	Good	Represents a level that marks the minimum appropriate for making business decisions. Positional measurements could be used to make reliable in-route navigation suggestions to the user.
5-10	Moderate	Positional measurements could be used for calculations, but the fix quality could still be improved. A more open view of the sky is recommended.
10-20	Fair	Represents a low confidence level. Positional measurements should be discarded or used only to indicate a very rough estimate of the current location.
>20	Poor	At this level, measurements are inaccurate by as much as 300 meters with a 6 meter accurate device (50 DOP × 6 meters) and should be discarded.

Table 1. PDOP Ratings

With the proliferation of deployed satellites, PDOP has become a less critical parameter. Other factors such as vegetative cover and sunspot activity may have greater impacts on field operations.

MAPPING SOFTWARE

The basic objective for our use of mapping software is to functionally replicate the paper MET maps in either physical or digital form. This in turn requires the ability to record markers, tracks and trail classification on a computer generated map.

Map Basics

Some mapping software includes maps for a specified area (like a state) while others use maps published in digital format by the USGS. The USGS's website (start at www.usgs.gov) provides a source for all USGS maps in both printed and digital form. A search tool at the website quickly identifies maps of interest by a number of search parameters. Maps at all standard scales are available. Digital information is free. Printed quads are currently $8 each (as of January 1, 2014).

Throughout the west, mapping was originally done by the General Land Office (GLO), the predecessor of the Bureau of Land Management. Their product (GLO maps) is an excellent starting point for trails research although other historic maps should be sought. A GLO map (Figure 5) covers one township and range and vary greatly in geographical content depending on the original surveyor. Often the maps are accompanied by "field notes" where section line crossings are noted. The maps were drawn in the office using the field notes, by a draftsman.

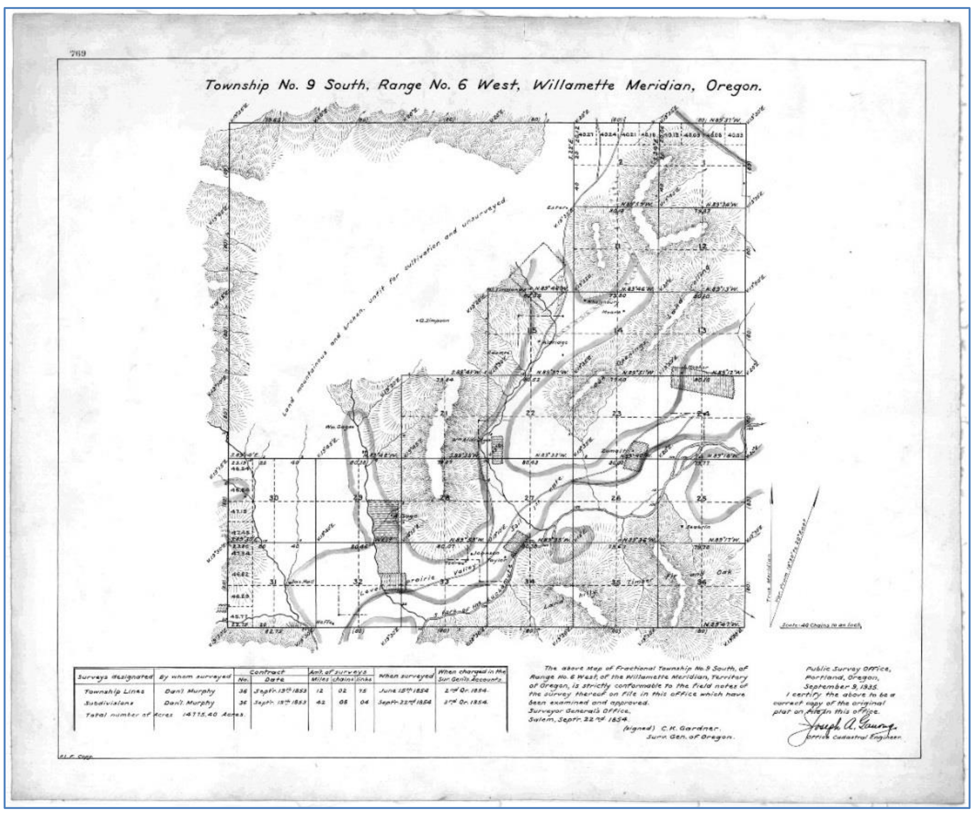

Figure 5. General Land Office (GLO) Survey Map

The GLO maps use the Public Lands Survey System (PLSS), where township, range and section are surveyed from a meridian. Many GLO Maps have been scanned and can be downloaded from site http://www.glorecords.blm.gov/. Coordinates of corners of townships and sections can be obtained from site http://www.earthpoint.us/Townships.aspx.

UTM WGS84 probably works best, because section lines crossing from survey notes are given in chains[6]. From a corner, convert the chains to meters in a spreadsheet. The resulting coordinates are in UTM WGS84 and then can be converted to any datum if desired. The PLSS is also useful for determining location and is a standard reference for property ownership.

Printed versions of the GLO maps are often available at state libraries and archives. In addition, some are available from BLM offices. The national BLM website www.blm.gov provides links to state offices or try www.xx.blm.gov where "xx" is the two-letter state designation (for example www.ut.blm.gov for Utah). Field offices within the states can usually be accessed from the state websites. Other Internet map sources are summarized in Appendix 8.

Figures 6 and 7 illustrate typical labeling on a quad map. Figure 6 shows the lower right corner with the quad name and date of preparation. Note that the right hand corner on this map corresponds to 119 degrees west longitude, 41 degrees north latitude (a point in Northwestern Nevada). The UTM NAD27 coordinates of the nearest grid crossing are 331000E and 4541000N. This is a distance in meters measured from central meridian in Zone 11, a reference line of 500000M, and the distance north of the equator, one of eleven UTM zones that cover the continental U.S. A complete description of the UTM system and other geographic references may be found in the publication "USGS GeoData" available at the USGS website (www.usgs.gov).

The lower left corner of the same map is shown in Figure 7. It gives information on the dates date and basis of updates and on the datum (NAD27). Corrections for other datum are also described.

Survey of Software Packages

There are two generic types of "mapping software" packages. The first is either included with the GPS unit itself or is available as a supplementary package. It is generally not suitable for OCTA's final mapping needs. The second is that used on a desktop or laptop computer for processing the data and generating maps or data files. From this point on, the first will be referred to as "data management software" and the second as "mapping software."

Mapping software products include products like MyTopo (MapTech) Terrain Navigator (not the Pro version), the National Geographic Society's Topo! and DeLorme's Topo products. These products include USGS quads at multiple scales and a variety of output file formats along with the ability to print maps. The have limited or no ability to use maps from other sources and output in a limited formats. The retail price of these packages is about $100 per state although a careful search for discounts can bring this down to less than $50 per state in some cases.

[6] GLO maps have supporting documentation in the form of field notes. These notes describe the locations of points where there are road, trail or creek crossings of section lines as measured in rods and chains. Familiarity with this measurement system permits full exploitation of this information.

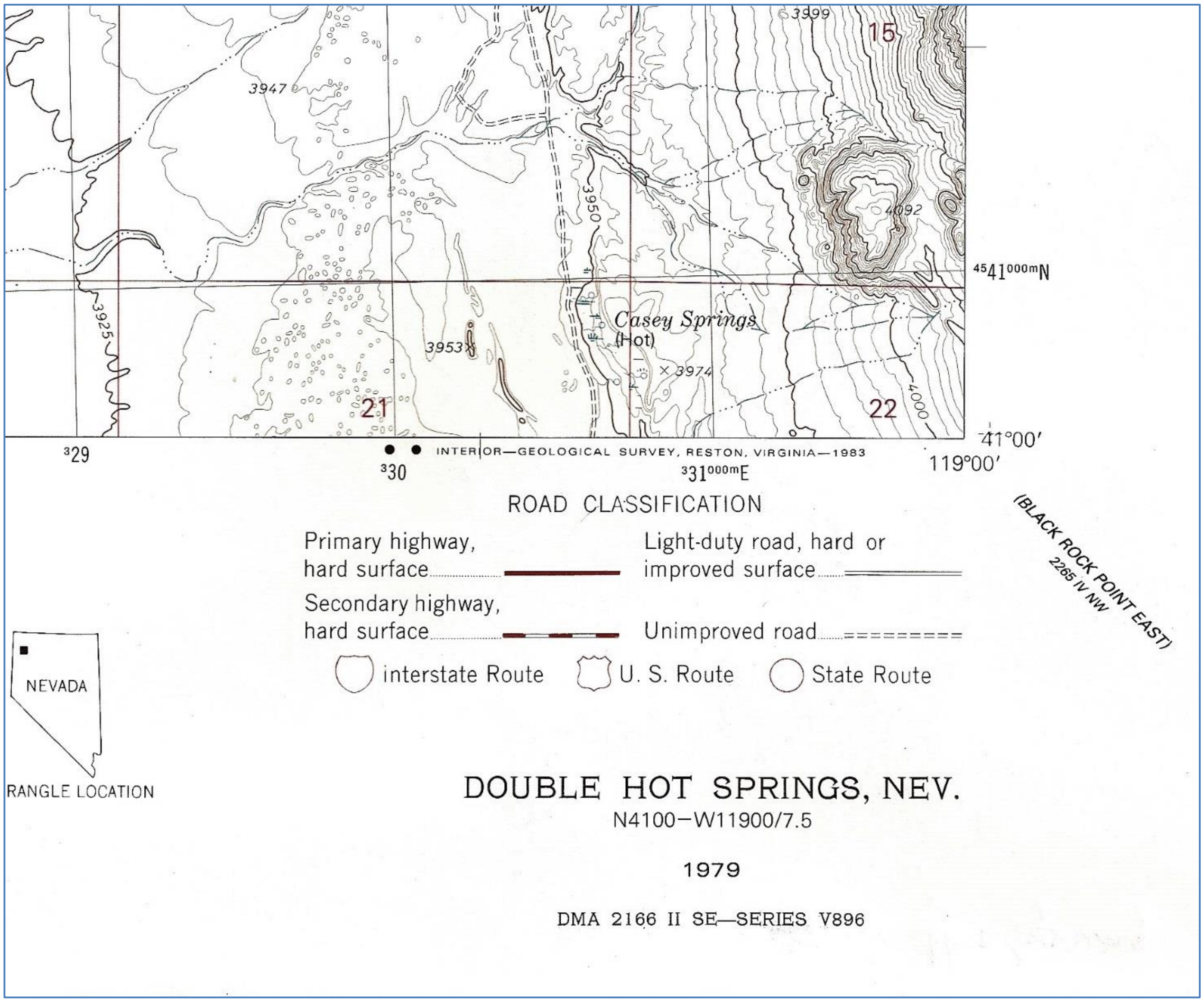

Figure 6. Quad Map Labeling, Right Corner

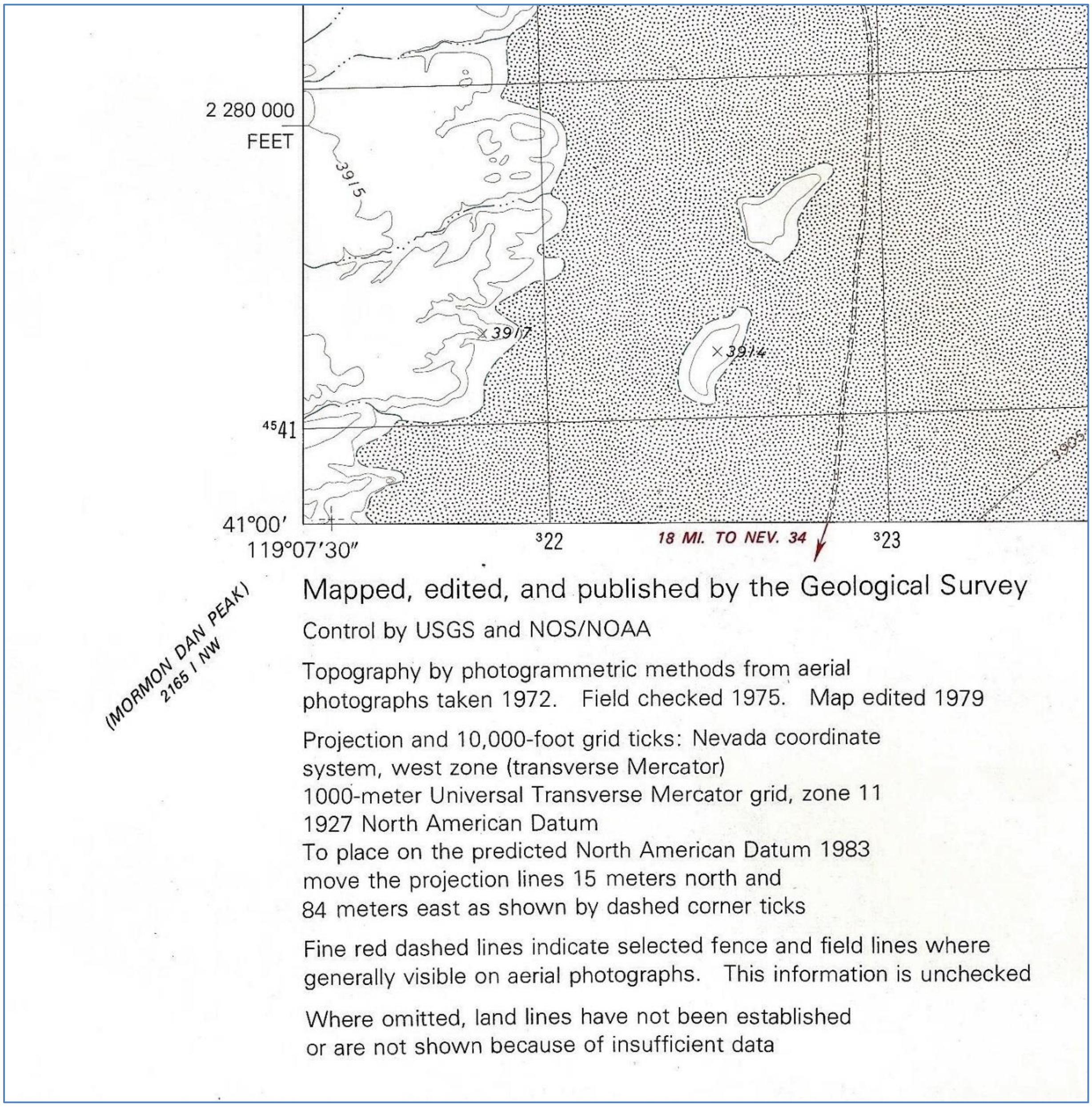

Figure 7. Quad Map Labeling, Left Corner

A second class of mapping software expands the capabilities of the first group to include data layers and direct access to aerial and satellite photographs. The images are geo-referenced so that they may be overlaid on the maps to provide clues of trail locations. Packages in this category include Terrain Navigator Pro (TNP) and Global Mapper (GM). These packages sell for about $300. For TNP this cost is per state. Since GM uses external sources for maps which can be acquired at no cost, this is the total cost for multi-state coverage.

Both TNP and GM provide capabilities equal to many aspects to "high end" software which is typified by the products of ESRI, Inc. (such as the software packages in the ArcGIS Desktop). ESRI products are used by many cities, counties, states and federal agencies to maintain their geographic knowledge base. It is also the basis of the National Park's GIS database of historic trails. The ArcView software, part of the ArcGIS Desktop, costs about $1,500.

GM has the benefit of using external map information, but it introduces the need to import and integrate mapping data. A map is constructed by importing basic two-dimensional information of a quad (a digital raster graphic or DRG) and the terrain data (a digital elevation model or DEM) to form the complete three dimensional map. Adjacent quads may be "stitched" together to form a continuous map. Terrain Navigator Pro (and some other packages) provides seamless maps while allowing import of images to provide map overlays.

Recommended Software

The NPS mapping project uses the sophisticated GIS products of ESRI, Inc. This state-of-the-art system is widely used, but is complex and expensive ($1,500). Ideally we would use the same software, but it is not practical for most individuals to acquire these products and develop a proficiency in their use.

From the perspective of low cost and moderate complexity, MyTopo's Terrain Navigator Pro is preferred. The cost is $299 per state which includes all USGS maps for that state at 1:250,000, 1:100,000 and 1:24,000 scales. Aerial photos are also provided at 1:12,000 scale. The "Pro" version also includes the capability to import other maps and images for use with the quads included in the software. If these capabilities are not needed, then the standard version is available at a cost of $99 per state. The Pro version also accepts "ArcGIS Extensions" to provide interoperability with ESRI products.

A good alternative with a slightly different approach is Global Mapper (GM). A capability similar to ESRI's products is provided by Global Mapper (GM). Like ArcView, this software uses maps and data from other sources which are generally available at no cost. GM's complexity is greater than the Terrain Navigator products, but it provides some additional capabilities. GM is now priced at $399 for a single user, but there is no additional cost for maps,

The power of Global Mapper is its ability to work with a wide variety of formats for both input and output. For example, one can input files from any GPS, merge them with any of the USGS digital map products, add and geo-reference any image files such as a digitized GLO map, historical USGS topo map, historical USGS aerial photo, or image from Google Earth, and then output the products as final maps or collections of layers into almost any geographic format, including any of the ESRI file types. More info on Global Mapper can be found at:

http://www.bluemarblegeo.com/products/global-mapper.php

Terrain Navigator Pro (TNP)

TNP is an all-inclusive package at low to medium cost that is relatively easy to use. For that reason it is recommended and used as the baseline for our mapping discussion. The text that follows is not intended as an instruction manual for TNP. We will focus on those capabilities needed to meet our objectives.

The upper portion of the opening screen in TNP is shown in Figure 8. Transfer of data is initiated by connecting the GPS to a computer through a cable (usually a USB or serial port connection)[7]. TNP's operations are similar to many Windows-based programs. Pull-down menus appear for the main menu options in the bar below the title.

A set of tools (line drawing, labels, etc.) is provided in the second and third toolbars in the upper left corner. The magnifying glass with a plus and minus sign, the hand, and the bull's eye are the primary tools for navigation. See Appendix 13 for a description of TNP's basic tools.

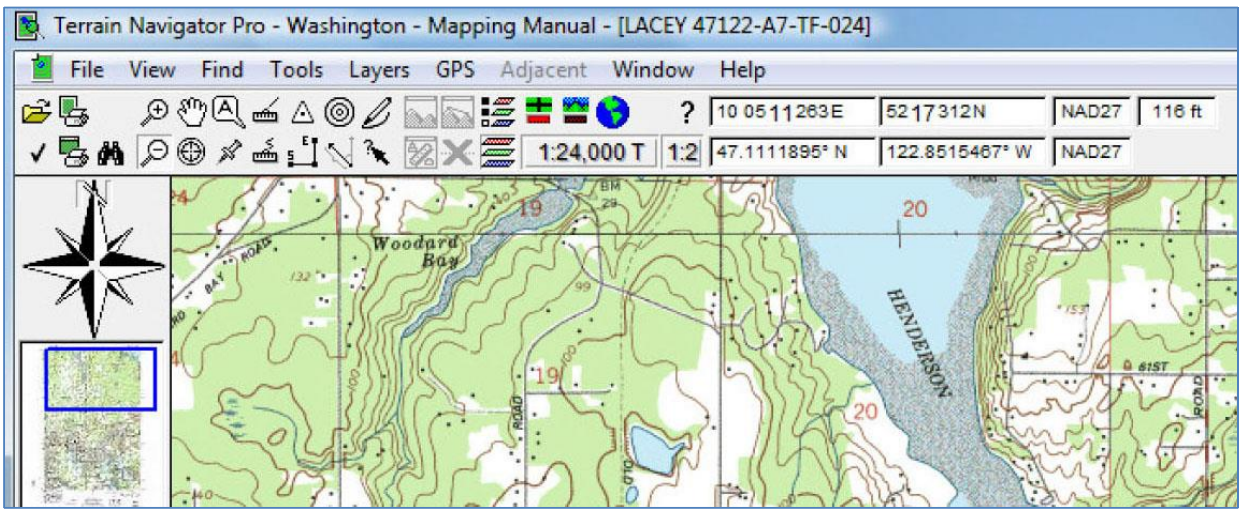

Figure 8 – Map and Menu Display for Terrain Navigator Pro

In the first menu bar below the title near the center is an item labeled "GPS." A sub-item in this menu allows you to download information ("Receive from GPS"). Once this has been done, the information will appear on the map as shown in Figure 9. If you do not see the expected tracks and waypoints, then the selected map may not be in the area of the tracks. This is corrected by moving the background map to the appropriate area.

[7] On first use, initialization of the interface is required. The software will automatically search for the GPS you are using.

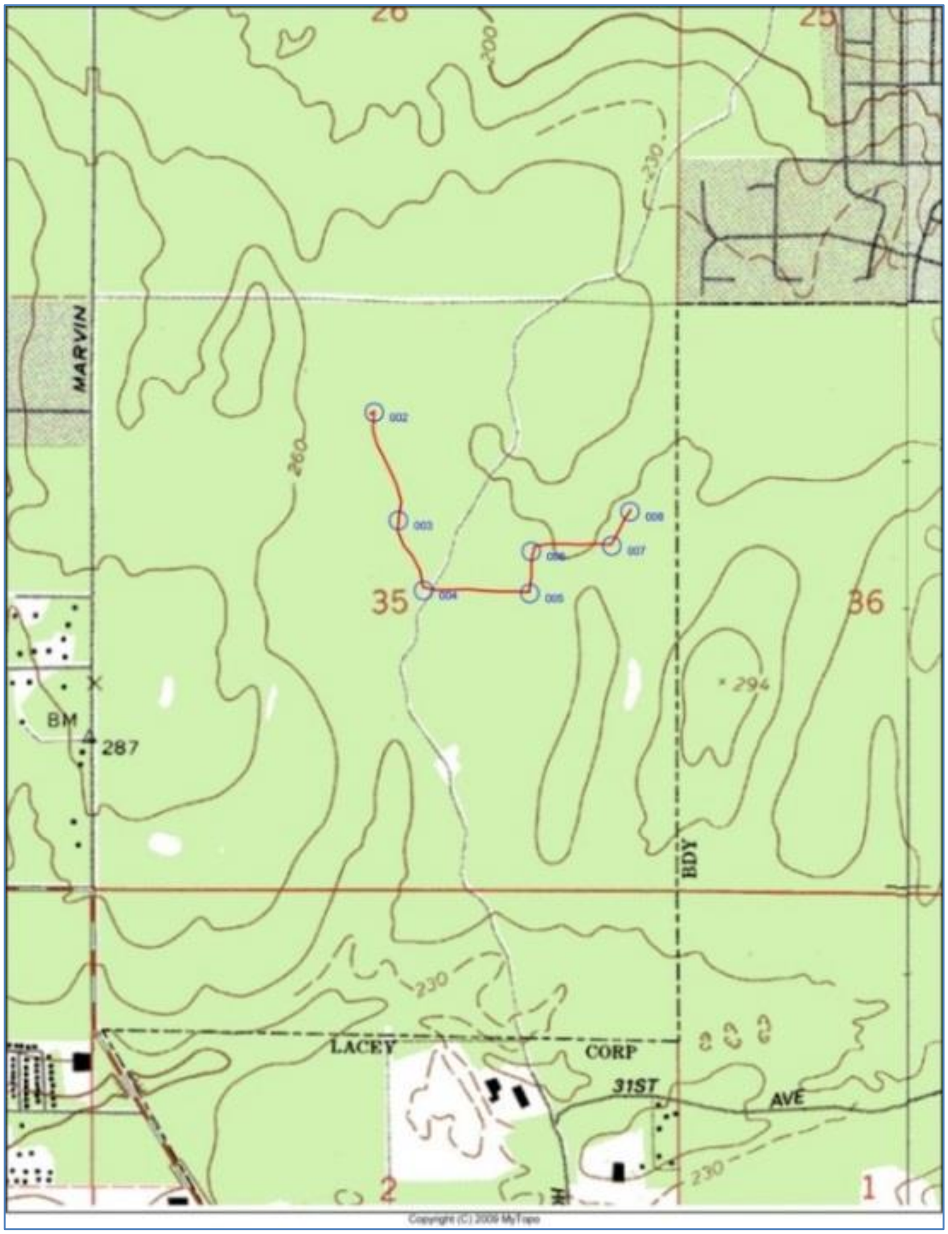

Figure 9 – Map Showing Downloaded Track and Markers

The example shows a track (red line) and seven waypoints (numbers 002 through 008). The numbers assigned to each waypoint are those automatically assigned by the GPS when the data are recorded in the field.

Each marker may be edited by selecting the item in the second menu bar labeled "Layers" and then the sub-item "Markers." This will display the dialog box for editing the names of the markers as shown below.

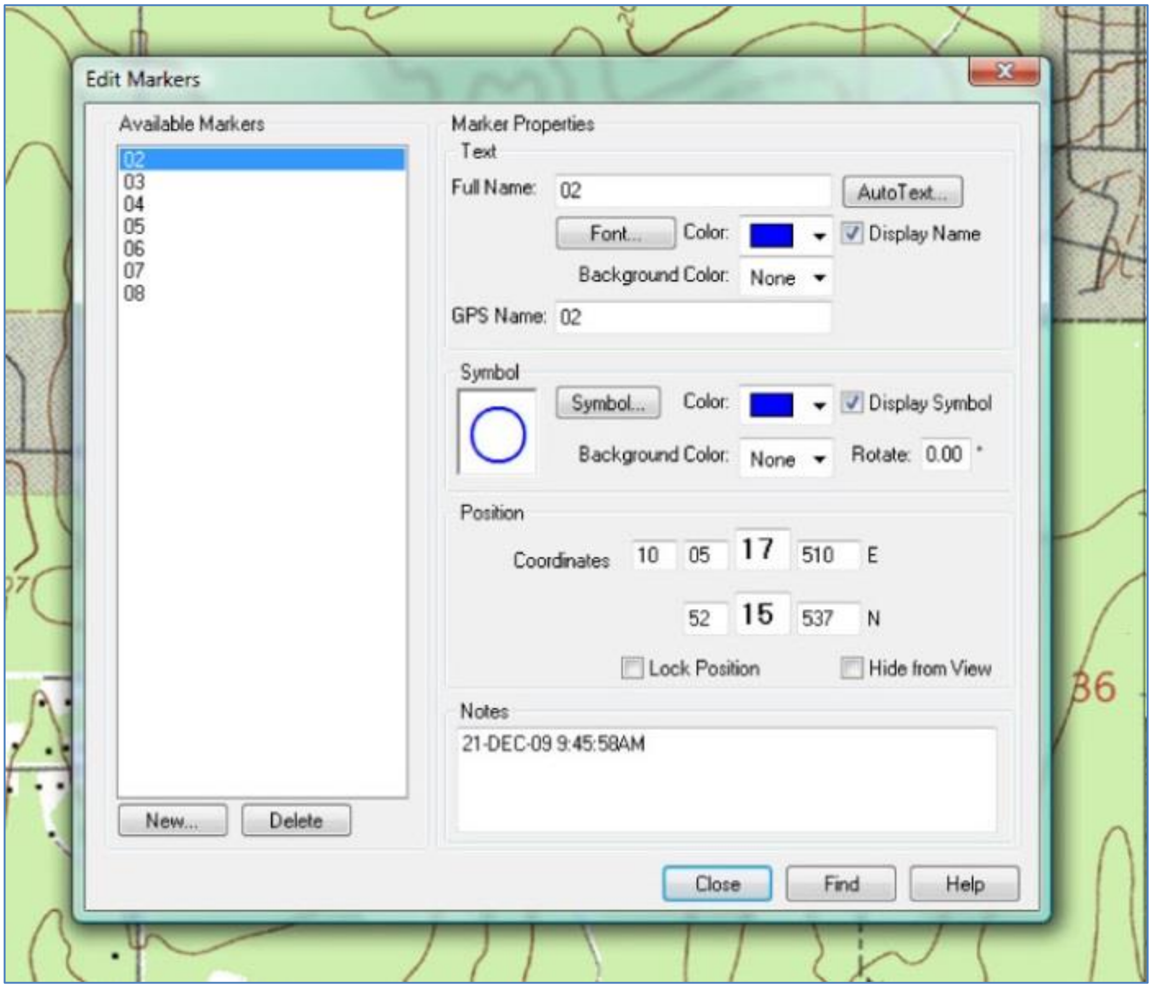

Figure 10 – Editing Marker Information

Two fields can be used to add the information we need: "Full Name" (upper right) and "Notes" (lower right. The proposed convention for naming a waypoint ("marker" in TNP terminology) is:

Township-Range-Section-Waypoint Number-Initials of Recorder

Example: T019N-R001W-35-01-DJW

Note that both township and range are given as three digit numbers to accommodate numbers in the 100's that occur in some states.

For a full description of the standards for designating various trail markers, features and the trails themselves, see "MET Manual, Part C: Planning and Executing a Mapping Project." Symbols are summarized in Figure 10.

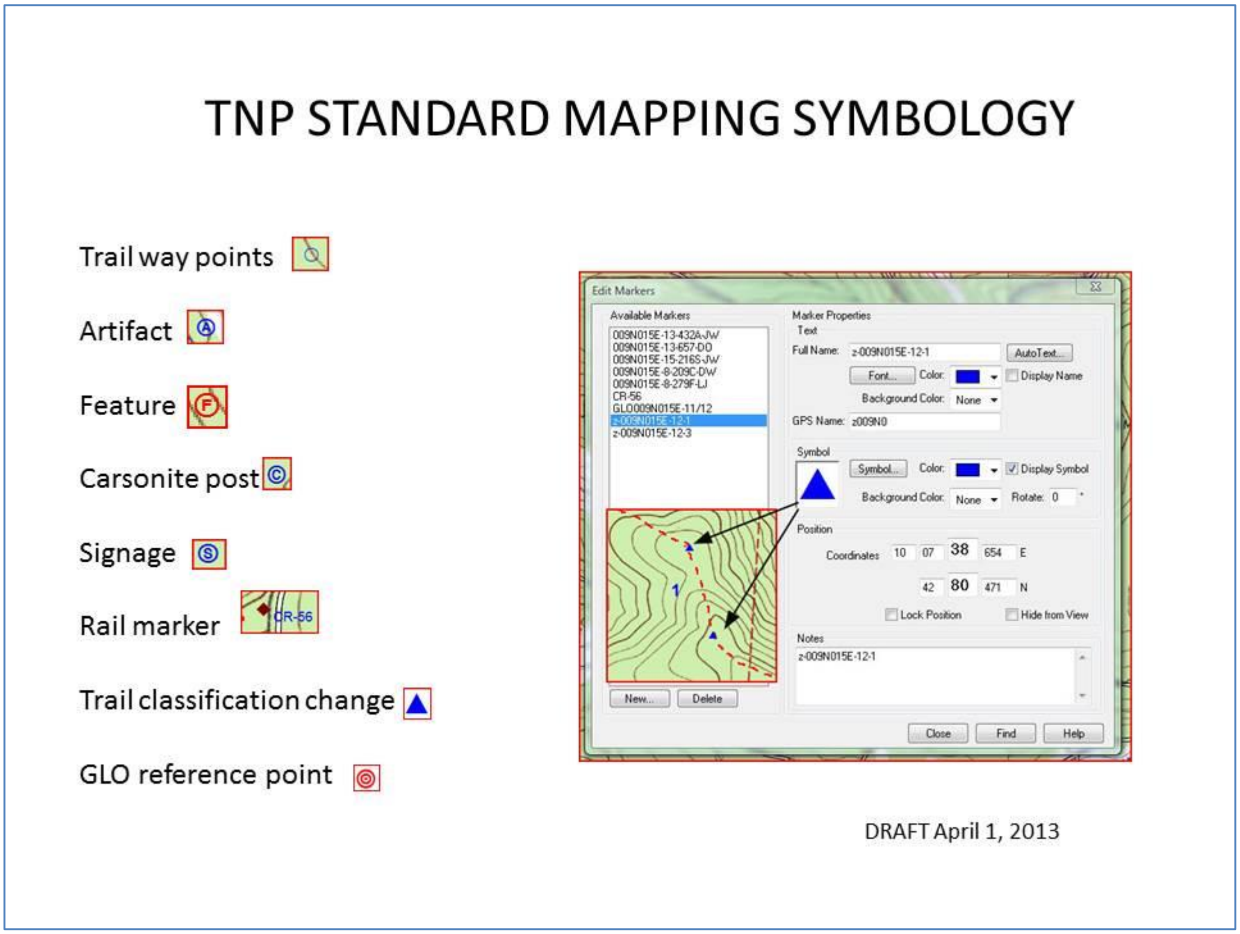

Figure 10. TNP Standard Mapping Symbology

Exchanging Data Electronically

Use of a GPS and mapping software presents the opportunity to easily exchange information between researchers. The format of the exchange is dependent upon whether the data is being exported to another TNP user or to a user with other software. However, since federal laws limit the publication of sensitive archaeological information, which in a few cases can include trail data, we will discuss that issue first.

Publishing Archaeological Data

The Archaeological Resources Protection Act (ARPA) prohibits the public disclosure of information regarding the location of historic and pre-historic artifacts. The trail location is generally known and is not subject to this limitation, but graves, campgrounds and associated artifacts may be subject to the law. In accordance with OCTA policy, no artifacts may be disturbed except under the direct supervision of a certified archaeologist and the land owner or land manager. See Appendix 9, “OCTA Policies” for more details.

Exchange of Data with other OCTA Users

For exchange with other OCTA users with TNP software, we can use the file formats provided by TNP. They are TXF for tracks, MXF for markers, and LXF for labels. To export a track, in the second menu bar, select “File” then “Export” followed by “Tracks.” Select the track or tracks to be saved, then click “Save.” Give the track a descriptive name such as “ORNHT DJW 001” and then select the TXF format in the “Save as type” at the bottom of the window if it is not the default option. Repeat the process for waypoints and markers.

For exporting to a non-TNP OCTA users, the process is the same, but it uses a different export format (GPX) that is selected in the format line. Both markers and tracks are saved in GPX format. Labels are saved in the LXF formats.

Tracks	Format GPX
Markers	Format GPX
Labels	Format LXF

The contents of these files may be viewed in a text program such as WordPad. For transfer to other researchers, these files may be attached to an email.

In TNP data is imported by selecting “Import” under the “File” menu and then selecting each data set. If you have a project open, the new data is added to that project. This may or may not be appropriate for the task at hand. To start a new project in TNP before importing data, select “Layers” and then “New Project.”

Exchanging Data with the NPS

Beginning with TNP Version 9.0, data may be exported in the ArcGIS format known as “shape files.” Once exported as noted above with the specification of the shape format, files may be sent to the NPS via email attachments.

Summary of File Formats for Data Exchanges

File Format	TNP Users	Other Software	NPS GIS
TXF, MXF, LXF	Yes	No	No*
GPX	Yes	Yes	No*
Shape Files	Yes	Yes?	Yes

* Exchange is possible but it requires additional steps by the NPS staff. Use of shape files is preferred.