The Surveyor's Essential Hand-held GPS: State Plane Coordinates

By Jon B. Purnell, PLS

In a previous article I tried to make the case for making an inexpensive hand-held navigation grade GPS receiver part of your corner-finding toolkit. Combine a GPS unit with a magnetic locator and a shovel, and you've got a powerful set of tools you can use to help you quickly recover coordinated points in the field. Trouble is, when we do make use of "real world" coordinates, most surveyors use the State Plane system, but most hand-held GPS units are set up to use latitude-longitude coordinates. What to do?

Selective Availability (SA), the purposeful degrading of GPS timing information, was turned off on May 1, 1999 via an executive order issued by President Bill Clinton. Prior to that, GPS positions derived from C/A code pseudoranges were accurate to about +/-75 meters at best. Consequently, up to that time, I had never considered using inexpensive "navigation grade" GPS receivers for corner recovery or searches: I figured that one could get closer to a search position using a compass and "hip chain". With SA turned off though, the accuracy of uncorrected C/A code positions was predicted to improve dramatically. Later, my students and I had a great deal of success recovering coordinated monuments with a metal detector and Magellan's 315 and SporTrak GPS receivers; I therefore revised my opinion concerning of the utility of navigation grade GPS for surveyors.

After some encouraging initial results, my students and I decided to use our Magellan 315's to recover several monuments in the field that we needed to tie so that we could complete a project. The monuments had been set in 1976 and we had NAD'27 State Plane Coordinates (SPC) values for them. Now, it occurred to me that we could have used datum conversion software to convert the State Plane values on the map to WGS'84 latitudes and longitudes—the receivers' default coordinate system and datum—but I wondered if there wasn't a better way…

The upshot is this: Magellan GPS receivers allow users to create a "user defined" map projection, which can be set up using a two-parallel Lambert conic system—just what is needed for working with Washington State Plane Coordinates. By entering the proper datum and zone constants, it is possible to enter State Plane values directly into the receiver, thereby eliminating the need to convert them to latitude and longitude first. The tables below give constants for the Washington State Plane Coordinate System Zones 4601 (North Zone) and 4602 (South Zone) in both the NAD27 and NAD83 datums, modified as noted for use with Magellan's hand-held GPS units:

Table 1: User Grid Settings for Magellan GPS 315, 320, 330 and SporTrak Receivers
Washington Coordinate System, NAD'83, Zone 4601 (North Zone) - US Survey Feet

Screen Prompt	*User Selection / Input*
Projection Type:	Lambert Conic
No. of Standard Parallels:	Two
Latitude of Grid Origin[1]:	47.00000 N
Longitude of Grid Origin[1]:	120.83333 W
Latitude of Standard Parallel 1 (North Standard Parallel) [1]:	48.73333 N
Latitude of Standard Parallel 2 (South Standard Parallel) [1]:	47.50000 N
Scale Factor:	1.00000000
Units to Meters Conversion[2]:	0.30480061
False Easting at Origin[3]:	1640416.7
False Northing at Origin[3]:	0

[1] NGS constant expressed in decimal degrees
[2] SI meters to US Survey Foot conversion factor
[3] NGS constant (NAD'83) expressed in US Survey Feet

Table 2: User Grid Settings for Magellan GPS 315, 320, 330 and SporTrak Receivers
Washington Coordinate System, NAD'27, Zone 4601 (North Zone) - US Survey Feet

Screen Prompt	*User Selection / Input*
Projection Type:	Lambert Conic
No. of Standard Parallels:	Two
Latitude of Grid Origin[1]:	47.00000 N
Longitude of Grid Origin[1]:	120.83333 W
Latitude of Standard Parallel 1 (North Standard Parallel) [1]:	48.73333 N
Latitude of Standard Parallel 2 (South Standard Parallel) [1]:	47.50000 N
Scale Factor:	1.00000000
Units to Meters Conversion[2]:	0.30480061
False Easting at Origin[3]:	2000000
False Northing at Origin[3]:	0

[1] NGS constant expressed in decimal degrees
[2] SI meters to US Survey Foot conversion factor
[3] NGS constant (NAD'27) expressed in US Survey Feet

Table 3: User Grid Settings for Magellan GPS 315, 320, 330 and SporTrak Receivers
Washington Coordinate System, NAD'83, Zone 4602 (South Zone) - US Survey Feet

Screen Prompt	*User Selection / Input*
Projection Type:	Lambert Conic
No. of Standard Parallels:	Two
Latitude of Grid Origin[1]:	45.33333 N
Longitude of Grid Origin[1]:	120.50000 W
Latitude of Standard Parallel 1 (North Standard Parallel) [1]:	47.33333 N
Latitude of Standard Parallel 2 (South Standard Parallel) [1]:	45.83333 N
Scale Factor:	1.00000000
Units to Meters Conversion[2]:	0.30480061
False Easting at Origin[3]:	1640416.7
False Northing at Origin[3]:	0

[1] NGS constant expressed in decimal degrees [2] SI meters to US Survey Foot conversion factor [3] NGS constant (NAD'83) expressed in US Survey Feet	

Table 4: User Grid Settings for Magellan GPS 315, 320, 330 and SporTrak Receivers Washington Coordinate System, NAD'27, Zone 4602 (South Zone) - US Survey Feet	
Screen Prompt	***User Selection / Input***
Projection Type:	Lambert Conic
No. of Standard Parallels:	Two
Latitude of Grid Origin[1]:	45.33333 N
Longitude of Grid Origin[1]:	120.50000 W
Latitude of Standard Parallel 1 (North Standard Parallel) [1]:	47.33333 N
Latitude of Standard Parallel 2 (South Standard Parallel) [1]:	45.83333 N
Scale Factor:	1.00000000
Units to Meters Conversion[2]:	0.30480061
False Easting at Origin[3]:	2000000
False Northing at Origin[3]:	0
[1] NGS constant expressed in decimal degrees [2] SI meters to US Survey Foot conversion factor [3] NGS constant (NAD'27) expressed in US Survey Feet	

Magellan GPS receivers, for which these tables were created, can display positions in two different coordinate systems simultaneously. For example, you can view both NAD'83 and NAD'27 State Plane values at the same time, or State Plane values and latitude-longitude, or any combination thereof. These receivers accomplish this by allowing users to specify a *Primary* and a *Secondary* coordinate system and datum. But bear in mind that the *Primary* system, (which can be set to ANY datum and projection) MUST be used for coordinate data input! The Secondary system (which likewise can be set to ANY datum and projection) is used for *display purposes only!*

Here is the procedure for setting up a Magellan hand-held's primary coordinate system to handle direct input of points in WCS NAD'83 North Zone coordinates expressed in US Survey Feet:

1. Press [Menu], and choose the SETUP option, press [Enter]: The Setup menu appears.

2. Choose the COORD SYSTEM option, press [Enter]

3. Choose the PRIMARY option, press [Enter]: Any changes you make will be applied to the receiver's Primary Coordinate System only. A list of coordinate system options is displayed.

4. Choose the USER GRID option, press [Enter]: A list of map projection options appears.

5. Choose the LAMBERT CON option, press [Enter]

6. Choose the TWO STANDARD PARALLELS option by pressing the ◄ ► keys if necessary. Press [Enter]

7. You will now be prompted to supply the User Grid mapping constants. At the screen prompts, enter the values from Table 1, which apply to the Washington Coordinate System, North Zone, NAD83 datum in US Survey Feet. ***CAUTION! You must enter a "leading zero" when entering the False Easting value!***

   When the last constant has been entered, you will be returned to the Setup Menu.

8. Choose the MAP DATUM option and press [Enter]

9. Choose the PRIMARY option, press [Enter]: Any changes you make will be applied to the receiver's Primary Coordinate System only. A list of map datum options is displayed. Choose the NAD83 option, press [Enter]

10. Press [Quit] to return to the STATUS screen

Although these instructions apply to the Magellan 315, 320, 330 and SporTrak receivers, the process is similar for other Magellan models. Check you user's manual for more information. To set up the receiver's auxiliary, Secondary Coordinate System, follow the same procedure as above, but choose the SECONDARY option in steps 3 and 9 instead of the Primary option.

A final word of caution: It is *extremely* easy to enter the zone constants incorrectly. You should ALWAYS check your input against a point whose coordinates you know before going out into the world. In lieu of that, try this procedure:

1. Set up the primary coordinate system for the desired SPC zone and datum
2. Set up the secondary coordinate system to read lat-lon in the same datum
3. Go outside and allow the receiver to calculate its position. From the Position screen, press the ◄► key to view both primary and secondary coordinate system values. Write down both sets of coordinates.
4. Go back to your desk and fire up whatever datum conversion utility you are using. Enter the SPC value and convert it to lat-lon. The values should check out within reason—if they don't you have entered a zone constant incorrectly.

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