"Deschutes13" Transformation

Introduction:

The purpose of this transformation is to provide a method to transform positions from the new NAD 83 (2011) epoch 2010.00 base station coordinates as broadcast by the Oregon Real Time GPS Network (ORGN) to Central Oregon Coordinate System (COCS) values. This transformation is named the "***Deschutes13***" transformation and will allow users to utilize the ORGN as a source for providing COCS positions without the need to do a 'local transformation".

Prior to ODOT's March 2013 update of the GPS base station coordinates of the ORGN, the Deschutes County Surveyors Office (DCSO) had developed and circulated a county-wide "Transformation" (or "localization" or "calibration", depending on the nomenclature of the software one uses) known as "***Deschutes09***". With the change of ORGN GPS base station coordinates the ***Deschutes09 transformation became obsolete***. Therefore the DCSO developed the ***Deschutes13*** transformation to work with the new broadcast coordinate values.

Background information:

The COCS is a low distortion projection developed by the Deschutes County Surveyors office in the early 1990s which has been adopted and used by many local surveyors over the intervening years. The COCS was designed to reduce the distortion between ground distances and grid distances and is defined as follows:

Linear unit: International foot (ift)
Geodetic datum: North American Datum of 1983 (1991)
Vertical datum: National Geodetic Vertical Datum of 1929 (NGVD29)
System: Central Oregon Coordinate System
Projection: Transverse Mercator
Latitude of grid origin: 43° 00' 00" N
Longitude of central meridian: 121° 17' 00"W
Northing at grid origin: 0.000 ift
Easting at central meridian: 3,300,000.000 ift
Scale factor on central meridian: 1.00016 (exact)

Transformation Explanation:

In order to utilize Real Time network GNSS technology broadcasting data on newer datums (in this case the ORGN), a transformation is needed to obtain legacy values that are compatible with the many existing surveys and monuments.

A Classical 3D transformation approach (3D similarity transformation) consisting of three translations, three rotations and one scale factor was selected as the transformation method

utilizing the Molodensky-Badekas model (transformation model where the rotation origin is the center of gravity of the common points of system A, in this case the ORGN derived positions). The transformation was performed within the Leica GNSS suite of software using Leica Geo Office (LGO) version 8.2.

In order to utilize this type of transformation, a number of common points must be included. For the **Deschute13** transformation project, 14 COCS monuments were selected that were randomly distributed across the original extent of the COCS within Deschutes County, favoring those points that were considered to be solid primary points in both the horizontal and vertical components from the original 1990's surveys. 13 of these points had been used in developing the **Deschutes09** transformation.

GEOID12a[1] was utilized to provide ellipsoid heights by adding the geoid height to the published NGVD29 heights. It should be noted that these published COCS "ellipsoid heights" are actually pseudo ellipsoid heights due to the fact that the NGS developed geoid models are developed to work with NAD83 and NAVD88, NOT NGVD29. The original COCS mark information sheets as published by DCSO do not have correct NAD83 ellipsoid heights published, therefore users who wish to obtain measured NAD83 ellipsoid heights on a mark can do so by measuring a point with no transformation selected in either their hardware or software.

Transformation Field Work:
Each of the 14 points was occupied multiple times by dual frequency Leica GNSS receivers in March and April of 2013. Using the weighted mean measured positions of these 14 occupations as obtained from a network solution from the ORGN served as the basis of the resulting transformation. The transformation was then computed from the 14 measured points to the record positions of those same points.

Field Checks:
After the **Deschutes13** transformation was created, we performed field checks by loading the transformation into our GPS rovers and staking out to 61 points throughout Deschutes County. Observations were 2 minutes in durations with a GDOP < 5.0. For the sake of expediency these checks were not necessarily performed during optimum satellite constellations for the horizon obstructions at any given check point. Prudent field practices and cognizance of site conditions vs. satellite locations will hopefully assist users in obtaining desirable accuracies with this transformation.

The overall results of this transformation are similar to those of the now obsolete **Deschutes09** transformation. When all the inverses are added up, the totals pretty much zero out. Therefore we calculated the N, E and Z absolute values to see what the average fallings were (since being off by -0.03' is still missing the point by 0.03').

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[1] ODOT recommends using Geoid12a with the ORGN and also using absolute antenna values on GPS receivers. Please see the information at http://www.theorgn.org/

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In horizontal positioning, the average difference in Northing in both *Deschutes09* and *Deschutes13* is 0.04', the average difference in Easting in both *Deschutes09* and *Deschutes13* is 0.04' and the average delta difference in Northing and Easting is 0.06'.

The average difference in ortho heights for *Deschutes13* field checks is 0.06', whereas the *Deschutes09* was 0.13

Data Available to Local Surveyors:

To distribute this information to interested parties, I have posted the following information to the County's ftp site:

Reports –
ftp://ftp.deschutes.org/Road/Mike/Deschutes13/Reports/
This directory contains .pdf files with the transformation parameters together with a spread sheet and map of the field check inverses.

Leica Data –
ftp://ftp.deschutes.org/Road/Mike/Deschutes13/Leica_data/
This directory contains a transformation data set to load the *Deschutes13* transformation into Leica software and GPS units and a Geoid12a field geoid file sampled at a spacing of 1320 feet which covers Deschutes County.

Using *Deschutes13* with non-Leica GPS receivers and software:

Unfortunately there is no universal transfer file language that I am aware of to convert a Leica "transformation" to other brand name "calibrations".

I know that back in 2009 some of the local surveyors supplied our *Deschutes09* transformation parameters to their software venders to develop files for using the county created transformation.

We will be glad to supply you any information we can to help you do likewise with the *Deschutes13* transformation. And, if you get a viable transformation loaded up in your GPS receiver we would be glad to meet with you in the field to see how it compares with the results we get on our Rovers.

Feel free to contact me if you have any questions or need additional data regarding *Deschutes13.* Our office will serve as a clearing house for any information we obtain on how non-Leica users can translate the information we have on hand to other GPS brands.

Sincerely,
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