

Summary of Oneida County base station network
Prepared by Ayres Associates, 7/28/13

Ayres Associates delivered OPUS reports for the base stations that were set by Ayres and AeroMetric during the lidar flight over the Oneida/Vilas block. Oneida County requested the OPUS reports and did a field survey to compare the XYZ coordinates using a Trimble rover GPS unit running on WISCORS. This exercise was important to make sure the base station vertical data was checking out against the County's GPS vertical data because the County will be doing the FEMA survey portion of the project.

On June 18, 2013, Oneida County reported its results from base station checks at the Eagle River and Rhinelander (RHI) airports, as well as the Hiles monument. The Eagle River and Hiles base stations were less than 0.1-foot vertical difference compared to the County GPS results, which meets expectations for the project. However, at RHI the County detected a +2.21-foot vertical offset compared to the OPUS report. The RHI base station was not located over a known monument; it was located over a nail set in the grass at the airport grounds by the flight crew each day during the lidar mission.

To determine the source of the vertical offset, Ayres and AeroMetric, along with the County, followed these trouble-shooting steps:

- Ran OPUS reports on multiple days of data from the RHI base
- Re-ran OPUS reports using modified ARP height of 1.5 meters
- Re-ran OPUS reports without Ant Name and manually entered Novatel antenna height
- Re-ran OPUS reports using different CORS stations
- Compared flight trajectories using nearby RHER CORS data from mission days
- The County measured the nail at the RHI on three different occasions
- The County ran a static session over the RHI nail and sent it to OPUS

Based on the results of these tests, it was ultimately determined that the original base height of 2.0 meters entered in the OPUS report was incorrect and that the crew set the tripod at 1.5 meters. That 0.5-meter difference did not explain the full +2.21-foot difference, but it did reduce the size of the shift. The nearby RHER CORS data was used in conjunction with the airborne GPS to compare the trajectories to the County's elevation values. This test confirmed that the County elevation values were correct and that the RHI base data was of poor quality. The combination of human error and poor quality GPS data collected at RHI led to the decision to use the backup RHER CORS data for lidar calibration.

On July 2, 2013, Oneida County and Ayres Associates met to discuss the best way to handle the offset at the RHI base station. Ayres' recommendation was to not use the RHI base data and instead use the nearby RHER CORS. By design, the central base stations for this project had secondary bases running during the lidar mission in case of equipment failure, human error, power losses, or poor GPS data. We discussed the concern of using base stations that were different than the primary bases in the flight plan.

The key concept from the discussion was that the secondary base station (RHER) was operating during the mission and collecting satellite data simultaneously with the airborne GPS and IMU onboard the aircraft. What this means is that the GPS data from the secondary base station is a valid because it is within one mile of the primary base station, and its accuracy is more than adequate for the project specifications.

The initialization of the airborne GPS is done within range of a RHER CORS station, and then the baseline length of 30km is maintained from the RHER to the flight lines until the aircraft is within range of another base station. The airborne GPS and base station data is post-processed and used in combination to create highly accurate trajectories of the aircraft during acquisition across the entire flight block.

In order to make sure there were not additional vertical offsets throughout the county, ground check points near the county corners and county center were surveyed by two independent crews. Five points were selected for this exercise. The County set and measured northing/easting/elevation values using its Trimble GPS connected to WISCORS at each location. Then the horizontal coordinates were delivered to Ayres survey crew, who re-visited the points on July 18, 2013, and measured XYZ coordinates using a Trimble receiver with a WISCORS connection. The resulting Z values were delivered to the County for comparison to its Z values. The table below shows the results:

Survey Shot#	Oneida Co. #	Northing	Easting	Ayres NAVD88	Oneida Co. GPS Elevation	Difference
1753	753	256637.598	351472.264	1675.072	1674.714	-0.358
1754	754	248218.796	112490.025	1578.116	1578.013	-0.103
1756	756	134444.554	102142.543	1569.025	1569.18	0.155
1759	759	205097.604	223702.827	1579.753	1579.922	0.169
1828	828	114483.635	326819.614	1604.579	1604.562	-0.017

Oneida Co. #753 was a location that had some shading from nearby tree canopy. The higher vertical variance is likely due to poor satellite solution from this shading. The other vertical checkpoints were within expectations for the project. Ultimately, the lidar block calibration was done without using #753 to see if there were any vertical biases evident at any other checkpoints throughout Vilas and Oneida counties.

The calibration report showed that there were no vertical issues at any other points and no vertical adjustment to the block will be necessary. Oneida County plans to do a replacement checkpoint near Sevenmile Dam to replace #753. This checkpoint will be used to do another independent vertical check on the calibrated lidar block. Again, no block adjustment will be necessary based on the calculated block RMSE, which is well within specifications for the project.