

2015 Western Washington Regional Aerials

Survey Report: Existing Data Review and New Control Plan

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By: GeoTerra, Inc.

Introduction

During the spring acquisition of imagery for the 2015 Western Washington Region Aerials project, King County and its participants provided GeoTerra, the awarded contractor for the project, all existing surveyed control available for use in Aerial Triangulation and subsequent production. The existing data was carefully reviewed by GeoTerra's Project Coordinator, Surveyor and Senior Photogrammetrist for accuracy, suitability and appropriate datum with the additional effort to determine the number and location of new, additional ground survey required to meet accuracy standards for the current project.

The following is a review of the existing survey control data provided and a proposed plan for adding additional control. It should be noted that the original intention of the project was to set photo-identifiable targets prior to flight throughout the project. However, given the unexpected late-season attainment of contract by the GeoTerra on March 16th, and the need to begin immediate image acquisition due an earlier than normal bud break, setting targets was not practical and would have interfered with the timely acquisition of imagery. Thus, the decision was made to utilize as much existing control as possible and to do a post-flight ground survey of photo-identifiable, man-made features.

2015 Project Coordinate System and Datum

The 2015 project coordinates, datum and units are as follows:

Coordinate system: Washington State Plane, North Zone

Horizontal Datum: NAD83(HARN) – as defined by ESRI's ArcGIS. Also known as NAD83(91) for Washington

Vertical Datum: NAVD88

Units: Survey Feet

Data Review and Issues

Below is a chart that provides a summary of GeoTerra's review of existing survey control data as provided by the county and its participants.

| Participant or Provider of Survey Data | NAD83(91) Confirmed with Metadata? | NAVD 88 Confirmed? | Scale Factor Applied? | Painted Target? | Notes |
|----------------------------------------|------------------------------------|--------------------|-----------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Auburn | Yes | Yes | No | Yes | 37 painted targets, provided by city's Survey Supervisor. |
| Bellevue | Yes | Yes | No | Yes | 94 pnts as xls per 2012 mapping; targets re-set for this project. |
| Bothell | Yes | Yes | No | Yes | Data includes: 1) 24 Pnts from 2000 project, pre-marked for 2015 per pdf map, but only 21 PDFs provided for coordinates; 2) shapefile with ctl from 2000-2012 --defined incorrectly as NAD83; 3) photo-id control from March 2008 -- as xls in lat-long; 4) Six monuments pre-marked for 2008 project as xls file. |
| Duvall | Yes | Yes | Unknown | No | 517 pnts, shp format only, defined NAD83(HARN); pnts are road CL "monuments", most of which are described as being below road grade. Adjusted elevations to surface using Excel and re-imported as shp -- possible use as vertical control only. |
| Edmonds | Yes | Yes | No | No | 1 pnt as 83/91 and 83(2007) -- 2008 road CL monument. |
| Federal Way | Yes | NGVD29 only | No | No | Monuments collect in 1992, Vertical = NGVD29, gdb of separate V and H points with H projected as NAD83 and V projected as NAD83(HARN), PDFs of each V and H point confirm data is actually NAD83(HARN). This is a mess; not useful data. |
| Issaquah | | | | | No control data provided |
| Kent | Yes | Yes | No | Yes | 77 targets painted in November, shp and Excel files. |
| WSDOT - Renton | No | Unknown | Unknown | ? | Included with 2012 Ortho Data; 5 points, Excel file; no metadata |
| WSDOT - Kirkland | No | Unknown | Unknown | Yes | Included with 2012 Ortho Data; 2 points, Excel file; no metadata |
| City of Kirkland | NAD83 only | Yes | Unknown | No | 153 pnts in shp file only, projected to NAD83, not NAD83(HARN). Found coincident point with Bellevue data (pnt #0333) that closely matches Bellevue's H coordinates. Karl Johansen with the City of Kirkland has confirmed NAD83(HARN) is correct. |
| City of Lynnwood | | | | | No data provided. |
| 2012 Project Data | Yes | Yes | No | Possible 8-9 PhID | 360 pnts provided as shp, includes: Kirkland, Seattle, Auburn, Kent, Bellevue, Bothell, Mercer, Lakeh, Shoreline, Tukwila, SeaTac. Some data coincides with other data provided. Includes points in other shp files provided for the 2012 data. Seems to be a compilation of all 2012 data, except for "GPS_Survey_Points_Report_WSDOT". Also provided: 9 photo-id pnts corresponding to two separately-provided shp and xls files for Kirkland and Renton called "True North". All are possible vertical-only ctl. |
| "GPS Survey Point Report WDOT" | Yes | Yes | No | No | 41 points in shp file format; monument data only. Provided with 2012 project data. |

| Participant or Provider of Survey Data | NAD83(91) Confirmed with Metadata? | NAVD 88 Confirmed? | Scale Factor Applied? | Painted Target? | Notes |
|----------------------------------------|------------------------------------|--------------------|-----------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Kitsap County | Confirmed verbally by GIS Admin | Yes | Unknown | Maybe? | 94 pts in shp and XLS; shp projected to NAD83. XLS has notes about pnts recovered in 2011; shp includes lat/long and elips/geoid and 2 ortho hgts. XLS file includes worksheet with image of 2003 control for Bremerton (11 pnts) and Poulsbo (50 pnts) in NAD83(91); all data provided confirmed by GIS admin to be NAD83(91), but Bremerton data is old and may have issues. Edited Kitsap main data file to 59 pnts of "found" data. Usefull as vertical-only data. |
| Mountlake Terrace | Yes | Yes? | No | No | 229 benchmarks in pdf and shp, with descriptions; some may be SW/drive intersections. Shp file provided defined as NAD83, but pdf of data confirms NAD83(91). Use as possible vertical ctl. |
| Seattle | Yes | Yes | No | No | 30 pts, shp file only, defined as NAD83(HARN); all but four points included coincide with points provided in the 2012 KingCo Ortho data. |
| Shoreline | Yes | Yes | No | No | 9 pts in XLS, in 83(91); All but one pnt coincides with 2012 KingCO Ortho 3" ortho data; pnts checked in October 2014. Use as possible vertical ctl. |
| Snohomish Co | Yes | Yes | No | No | Originally referred to WGS website for data. DEA was contacted, and they provided all control from the last few years, "Phases 1-4". Some points may be photo-id. Many are not. |
| Tacoma | Yes and No | NGVD29 | Unknown | no | No usefull info. Provided with XLS file with 1000's of H pts only, no metadata; email provides link to vertical data, but in NGVD29 -- with no Horiz coord included. |
| Tulalip | Yes | Yes | No | No | 14 Ctl pnts for 2007 ortho/mapping in DOC format. Possible vertical ctl only. |
| WSDOT Thurston Storm | Yes | Yes | No | Yes? | 14+ pnts as txt, from Spring/fall 2014. Bio-paint pre-marks may still be visible. Data provided in South Zone; Our surveyor re-projected to North. |
| WSDOT Snoho Storm | Yes | Yes | No | Yes? | 99 pts in txt file; Bio-paint pre-marks may still be visible. |
| WSDOT Pierce Storm | Yes | Yes | No | Yes? | 117 pnts as txt, from Spring/fall 2014. Bio-paint pre-marks may still be visible. Data provided in South Zone; Our surveyor re-projected to North. |
| WSDOT King Storm | Yes | Yes | No | Yes? | > 160 pts in txt file; Bio-paint pre-marks may still be visible. |

Many issues were encountered during the review of the existing survey data, as briefly described in the chart. Here is a further, more detailed explanation, of issues that are worth noting for future reference to the project.

1. As noted above, the horizontal datum for the 2015 project is NAD83(91). This is defined as NAD83(HARN) in ESRI's ArcGIS software. Some confusion appears to exist with many participants about this definition, particularly in terms of ArcGIS products. GeoTerra found a few participants had provided data in shapefile format with a defined projection of NAD83, when further investigation revealed that data was actually in NAD83(91) – or NAD83(HARN) as defined by ESRI. These two datums reveal a significant horizontal difference of close to 0.8' in the project area. Data provided with incorrect ESRI projections included: Bothell, Kirkland, Mountlake Terrace and Kitsap County.
2. Data for Bellevue, Auburn, Bothell, Issaquah and Kent were the most valuable of all data provided as the locations of the coordinates were painted with targets prior to the spring of 2015 flight.
3. WSDOT data for the 2014-2015 storm water projects may also have visible targets as they were painted within the previous year with biodegradable paint. Nonetheless, even if not visible in the current imagery, the coordinates were recently field verified and the elevation values can be held and trusted in the final AT solution.
4. Metadata was missing for much of the data provided, the lack of which added to confusion during the review of control for project use.
5. The shapefile file for Mountlake Terrace had an incorrectly defined projection of NAD83 rather than NAD83(HARN). A careful review of a pdf of the data provided with the shp and xls file confirmed the true datum of the data as NAD83(91). The data projection was redefined in ArcGIS.
6. City of Kirkland survey data was provided in NAD83 rather than NAD83(HARN). The NAD83 datum matches Kirkland's online GIS data. A little research found a coincident point with Bellevue data. Kirkland survey tied to Bellevue pnt # 0333, and the horizontal values were within 0.15' in X and Y. If a shift between NAD83 and NAD83(HARN) for this area is about 0.8', the final assumption was that the data provided is actually in NAD83(HARN), which matches surrounding city data. A final call and discussion with Karl Johansen (City of Kirkland confirmed that the survey data is indeed NAD83(HARN).
7. As noted above, the 2015 project horizontal datum is NAD83(HARN), however, Kitsap County's data was incorrectly identified and projected as simply NAD83. While this may seem like a minor difference, a brief review of the two datums revealed a horizontal shift of about 0.8' shift in the area, a significant error that would have had obvious consequences in the subsequent aerial triangulation results. The accuracy required for survey control is usually better than 0.125ft.
8. The City of Bothell's control was provided as a shapefile with an incorrect NAD83 projection. Additional resources provided for the city correctly defined the data as NAD83(91) (i.e.NAD83(HARN)).
9. Data provided for both Tacoma and Federal Way appear to be very old and in the NGVD29 vertical datum. While it may be possible to translate the data to the current NAVD88 datum, reliability of both data sets is suspect due to age.

10. Snohomish County provided a link to the WGS website for their existing control data. Unfortunately, this data was only accessible via a point by point download into individual pdf files with each point requiring careful scrutiny for suitability and accuracy, an effort that seemed very ineffective. David Evans and Associates was contacted as they were known to have done extensive survey work in the county, and GeoTerra will be sub-contracting with them to perform additional ground control for the 2015 project. DEA was able to assemble a collection of all recent and verified survey data for GeoTerra's use. The county thereby approved use of the data by GeoTerra. Data was provided as Phases 1-4 with a total of 3,283 points in xls format; data included photo clarification for some locations. Many points will be useful as photo-id control, while the vertical control in the mountainous corridors in the eastern part of the county will assist in shoring up the AT vertically.
11. Existing control data was lacking or non-existent for the southern extent of the 2015 project.
12. Much of the data provided that was not pre-marked for this project is usable only as a possible source of vertical control as most are not photo-identifiable. However, usage as vertical control has to be carefully considered as many are monuments that do not lie on the surface of the ground. Any of these points that are utilized in the final AT will have to be carefully scrutinized for validity and fit with the current imagery and AT solution.
13. Two islands, Blake and Gedney occur in the Puget Sound with no apparent existing control. Access to these islands will be difficult and expensive for acquiring additional control. GeoTerra has no funds available to acquire new control in these special circumstances. Airborne GPS and existing DEM data will be utilized in the AT.

Note: Issues expressed above about the existing survey control data lead to early concerns about working with and updating the existing DEM/DTM data. Terrain data will be provided by participants, often without proper metadata to verify their datum, coordinate system and vintage. GeoTerra will have to scrutinize the DEM/DTM as carefully as the existing surveyed control data before assembling the data for further update and use in rectifying the orthophotography.

Proposed Additional Control

The image below shows a layout of both the existing control and proposed new surveyed control.

After review of existing control, about 135 photo-identifiable locations were carefully chosen to best supplement the existing control and layout of the project's varying resolution areas. Locations with a more permanent nature (ex: sidewalk corners, concrete pad corners, street stop bars, etc...) were chosen wherever possible to allow potential use of these new points in future projects. New control will be surveyed in NAD83(2011) and an appropriate horizontal "shift" applied to bring the new coordinates into better alignment with NAD83(91). We will work with David Evans and Associates to re-measure known, existing NAD83(91) monuments and compare them to NAD83(2011) coordinates, if this information is not already available. An X and Y shift value will be calculated and applied to all new survey data.

New data in remote areas will be more sparse as not many photo-identifiable features (i.e. man-made) are available. However, these areas are typically at a lower resolution, so Airborne GPS can be heavily relied upon for the final AT solution. It is important to note that there is no existing control provided for Blake and Gedney Islands. Access for new control will be difficult and expensive as there is currently no WSDOT ferry service to these islands. Any ideas or support from the county or participants would be helpful.

Summary

The existing survey data has been carefully reviewed and scrutinized to determine suitability for use in the current 2015 Western Washington Regional Aerials project. New survey locations have been selected based on this review of current data that will supplement and verify existing data. Data provided by participants will continue to be reviewed as the imagery undergoes Aerial Triangulation. The AT process will likely reveal further issues with data or subsets of data, thereby further refining the final control data utilized. Once the AT is finalized, a list of control used will be provided to King County and its participants for historical documentation of the 2015 project.