

THRASHER

2020 Greenbrier County Aerial Triangulation And Ground Control Report

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The Thrasher Group (TTG) has successfully completed the aerial triangulation (AT) for the countywide spring flight.

Using semi-automatic analytical aerial triangulation procedures, TTG determined the exterior orientation parameters for each exposure in the photography that covers the project area.

The results of the final adjustments are sufficient to enable TTG to photogrammetrically produce orthophotos from the photography. The AT solution ensures that the project data will meet or exceed the accuracy expectation as outlined in the contract.

Ground Control

The ground control network was designed to provide a geometrically strong horizontal and vertical control system within the project area.

Sufficiently identified ground control points (GCPS) were surveyed within the block to provide horizontal and vertical control.

Aerial Photography

Aerial photography for the project was captured between April 3, 2020 and April 4, 2020.

The photography was acquired with an approximate 60 percent overlap and an approximate 30 percent side lap. The flight altitude of the photography was approximately 7,700 feet above mean terrain.

Airborne GPS

Airborne-GPS (ABGPS) data was captured during the acquisition of the aerial photography. An appropriate GPS antenna was mounted on each aircraft used on the project, and the relationship between the antenna phase centers and the camera perspective centers was then determined through close-range survey techniques. Dual frequency, geodetic quality receivers were utilized for the data collection.

The GPS data was post-processed, and the appropriate interpolations, transformations and reductions were applied to derive the camera's spatial position referenced to the World Geodetic System of 1984 (WGS84) at each instant of exposure.

Flight

The flight plan was comprised of 49 flight lines. The designed ground sample distance per pixel was 10 centimeters.

The block consisted of a total of 4,405 images.

A fully equipped aircraft was employed for the photographic mission. In the aircraft, the instrumentation utilized in the acquisition of aerial photography and ABGPS data comprised of a Zeiss DMC III aerial camera featuring forward motion compensation, and a GPS Novatel Span Receiver with a collection rate of one half-second.

During each flight, every exposure triggered by each camera was recorded in the associated GPS data file as an external event. A time stamp for each event later allowed the interpolation of the camera position at each instant or exposure.

Aerial Triangulation

Aerial triangulation is the simultaneous space resection of image rays projected and recorded at one source, the perspective center of the aerial camera. These image rays projected from two or more overlapping images (stereo-models) intersect at the corresponding ground location to determine the three-dimensional coordinates of each point measured. This collection of image rays is fit to known ground survey control in a simultaneous three-dimensional least squares adjustment. After the completion of this adjustment, coordinates of the 'unknown' ground points are derived by the intersection of the adjusted image points.

The aerial triangulation was performed utilizing the ground control and the airborne GPS-assisted techniques. These data are then introduced along with the reduced image coordinates, as observations, into a combined three-dimensional simultaneous least squares adjustment by bundles. This approach allows a substantial reduction in the amount of ground control required for the AT solutions.

The purpose of aerial triangulation is to densify horizontal and vertical control from relatively few ground control points (GCPs). Since obtaining GCPs is a relatively significant expense in any mapping project, AT procedures are used to reduce the amount of field survey required by extending control to all stereo-models.

Internal software checks were performed to detect gross errors in the photo measurements.

Bundle Adjustment

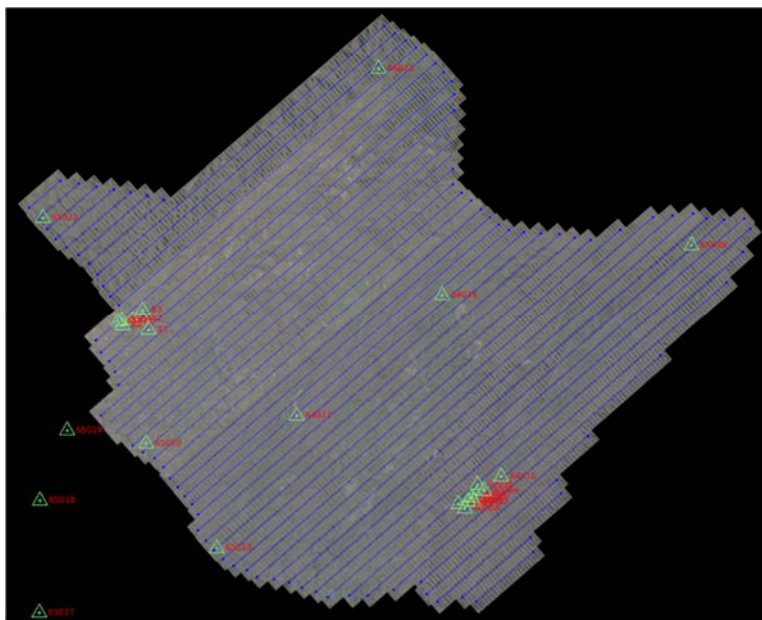
The surveyed control, along with the reduced image coordinates, served as input into the 'combined' block adjustment. Three-dimensional, simultaneous least squares adjustments by bundles, were undertaken using Match-AT bundle adjustment software. This bundle block adjustment software has proven to be a very rigorous and stable platform.

Nineteen control points were used to constrain the AT solution. The sigma naught is a significant indicator of the quality of the adjustment. The sigma value derived by the block adjustment is the root mean square of all photo measurement residuals for the entire block. The lower the sigma naught, the less tension within the AT solution. The sigma naught for this adjustment was 0.7 microns. The

residuals of the control points from measured position to surveyed position are as follows:

Residual point x y z (ft.)

40001	0.0116	-0.0824	0.0463
40002	-0.0254	0.0321	0.0082
40004	0.0096	0.0480	0.0197
40005	-0.0218	-0.0044	0.0415
40007	0.0066	0.0059	0.0272
40008	0.0038	-0.0184	-0.0096
64009	0.0736	-0.0161	-0.0323
64010	-0.0077	0.0712	-0.1161
64011	-0.0182	-0.0817	-0.0194
65013	0.0120	0.0582	-0.0305
65020	-0.0162	0.0552	0.0271
65021	0.0190	0.0338	-0.0289
65022	0.0010	0.0256	-0.0015
81	-0.0444	0.0190	0.0864
82	-0.0611	-0.0304	0.0684
83	-0.0060	-0.0751	0.0846
84	-0.0373	-0.0582	-0.0307
85	0.0310	-0.0327	-0.1094
86	0.0039	-0.0051	-0.0603



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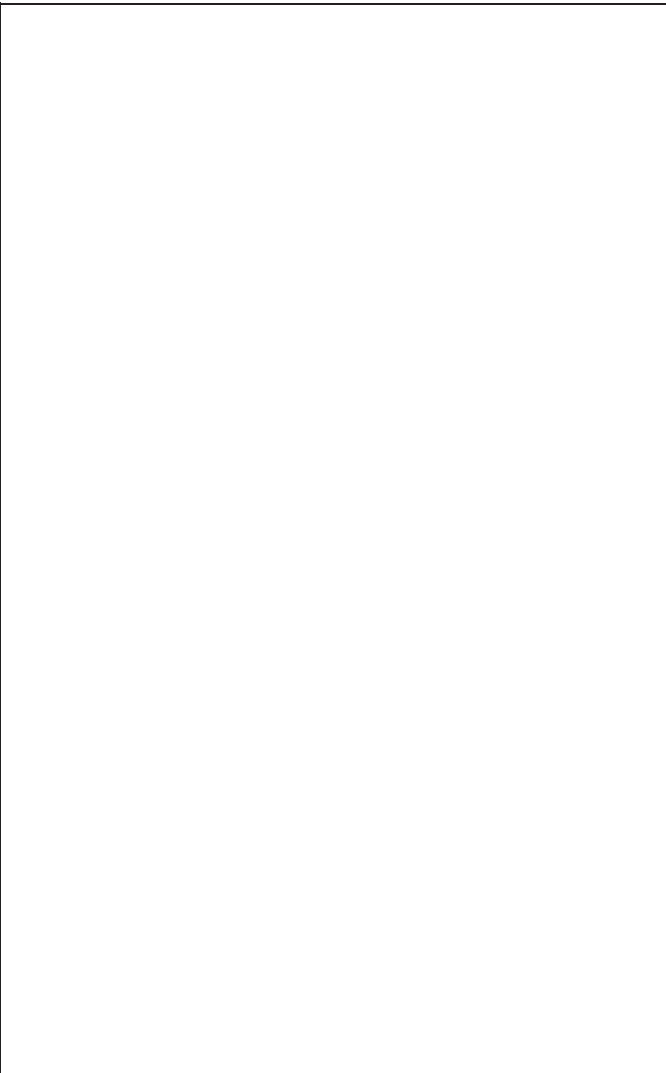
GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD 83	Vertical Datum: NAVD88
Projection: SPC WV South	Geoid: G12BUS
Precisions (ft): Hz Prec 0.018 Vt Prec 0.148	Method: GPS Static
Date: 03-04-2020	
Location: Trainer, Greenbrier Co, WV	

Point 64009 - ACP 064009

Detailed Description:
040-10259 BM5730 SPRING FLIGHT

Northing (ft): 381197.22
Easting (ft): 2247437.181
Elevation (ft): 2291.403



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GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD 83	Vertical Datum: NAVD88
Projection: SPC WV South	Geoid: G12BUS
Precisions (ft): Hz Prec 0.026 Vt Prec 0.043	Method: VRS
Date: 03-04-2020	
Location: White Sulphur Springs, Greenbrier Co, WV	

Point 64010 - ACP 064010

Detailed Description:
040-10259 BM5730 SPRING FLIGHT

Northing (ft): 292949.235
Easting (ft): 2174955.647
Elevation (ft): 1901.482



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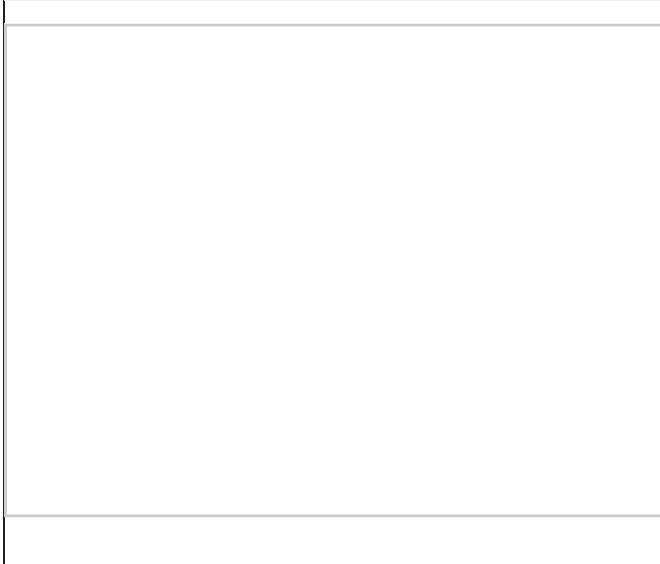
GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD 83	Vertical Datum: NAVD88
Projection: SPC WV South	Geoid: G12BUS
Precisions (ft): Hz Prec 0.031 Vt Prec 0.046	Method: VRS
Date: 03-04-2020	
Location: Renick, Greenbrier Co, WV	

Point 64011 - ACP 064011

Detailed Description:
040-10259 BM5730 SPRING FLIGHT

Northing (ft): 362248.014
Easting (ft): 2152492.611
Elevation (ft): 2045.878



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GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD 83	Vertical Datum: NAVD88
Projection: SPC WV South	Geoid: G12BUS
Precisions (ft): Hz Prec 0.026 Vt Prec 0.038	Method: GPS VRS
Date: 03-05-2020	
Location: Alderson, Greenbrier Co, WV	

Point 65013 - ACP 065013

Detailed Description:
040-10259 BM5730 SPRING FLIGHT

Northing (ft): 265874.738
Easting (ft): 2066664.349
Elevation (ft): 1542.407



ACP 065013: Corner of Concrete Pad
The Thrasher Group

040-10259
05 Mar 2020, 09:05:22

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GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD 83	Vertical Datum: NAVD88
Projection: SPC WV South	Geoid: G12BUS
Precisions (ft): Hz Prec 0.025 Vt Prec 0.060	Method: GPS VRS
Date: 03-05-2020	
Location: Lawn, Greenbrier Co, WV	

Point 65020 - ACP 065020

Detailed Description:
040-10259 BM5730 SPRING FLIGHT

Northing (ft): 305571.311
Easting (ft): 2039791.864
Elevation (ft): 2639.677



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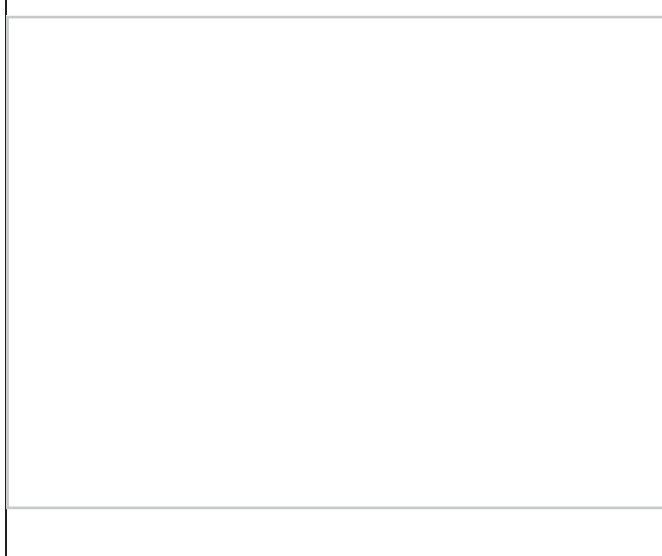
GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD 83	Vertical Datum: NAVD88
Projection: SPC WV South	Geoid: G12BUS
Precisions (ft): Hz Prec 0.030 Vt Prec 0.055	Method: GPS VRS
Date: 03-05-2020	
Location: Cottonwood Pl, Greenbrier Co, WV	

Point 65021 - ACP 065021

Detailed Description:
040-10259 BM5730 SPRING FLIGHT

Northing (ft): 351848.733
Easting (ft): 2029106.243
Elevation (ft): 2428.970



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GNSS CONTROL POINT LOCATION SHEET

Horizontal Datum: NAD 83	Vertical Datum: NAVD88
Projection: SPC WV South	Geoid: G12BUS
Precisions (ft): Hz Prec 0.034 Vt Prec 0.056	Method: GPS VRS
Date: 03-05-2020	
Location: Russellville, Fayette Co, WV	

Point 65022 - ACP 065022

Detailed Description:
040-10259 BM5730 SPRING FLIGHT

Northing (ft): 391658.270
Easting (ft): 2000497.053
Elevation (ft): 1986.182

