

# THRASHER

## 2023 Tyler County Aerial Triangulation And Ground Control Report

Prepared by:

Craig Fry, CP

The Thrasher Group

600 White Oaks Blvd.

Bridgeport, WV 26330

Phone: (304) 624-4108

[cfry@thethrashergroup.com](mailto:cfry@thethrashergroup.com)

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 March 8, 2020 and April 9, 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 24 flight lines. The designed ground sample distance per pixel was 10 centimeters.

The block consisted of a total of 1,167 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 an Ultracam Eagle 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.

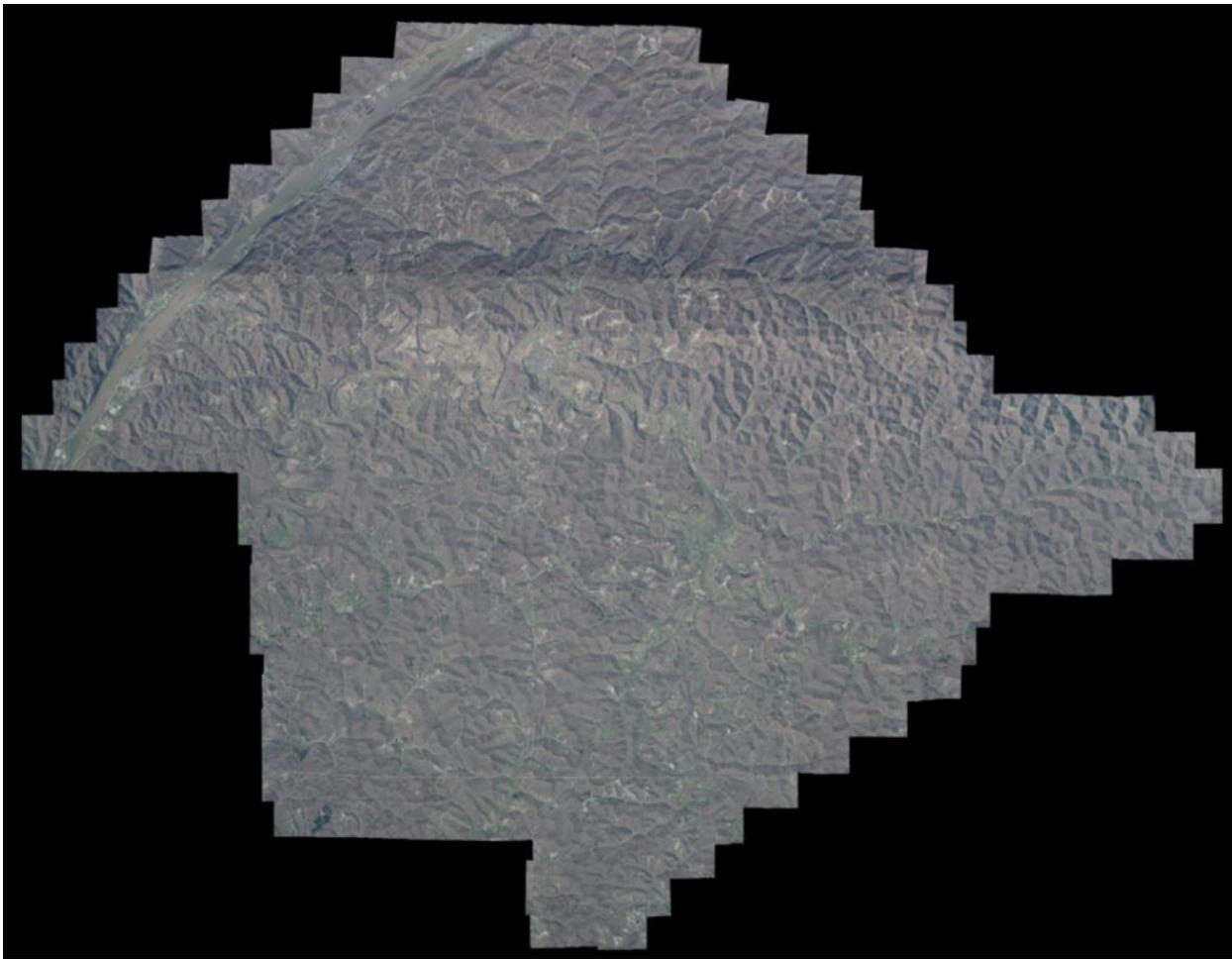
Internal software checks were performed to detect gross errors in the photo measurements.

## 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.

Eleven control points were used to constrain the AT solution. The residuals of the control points from measured position to surveyed position are as follows:

Point Name	Bundle Coord Residuals		
	Delta X	Delta Y	Delta Z
3655	0.094	-0.039	-0.285
3656	0.010	0.146	-0.072
620101	-0.034	-0.016	-0.135
3681	0.005	0.035	-0.146
3671	0.042	0.004	0.097
3682	-0.004	0.024	-0.093
3652	-0.034	0.024	-0.036
3654	-0.030	0.007	-0.061
3653	-0.004	-0.018	-0.070
3651	0.001	0.001	-0.048
3691	-0.008	0.008	-0.038



## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Mon, 06 Mar 2023, 9:25 AM (UTC-05)

Date Mon, 06 Mar 2023

Project Name Tyler County Control

Project Location Friendly,WV

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30065001	WVRS	SE corner of DI	356726.728	1514942.909	617.656	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Mon, 06 Mar 2023, 10:03 am  
**Tags:**  
**Description:** SE corner of DI  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Mon, 06 Mar 2023, 10:41 AM (UTC-05)

Date Mon, 06 Mar 2023

Project Name Tyler County Control

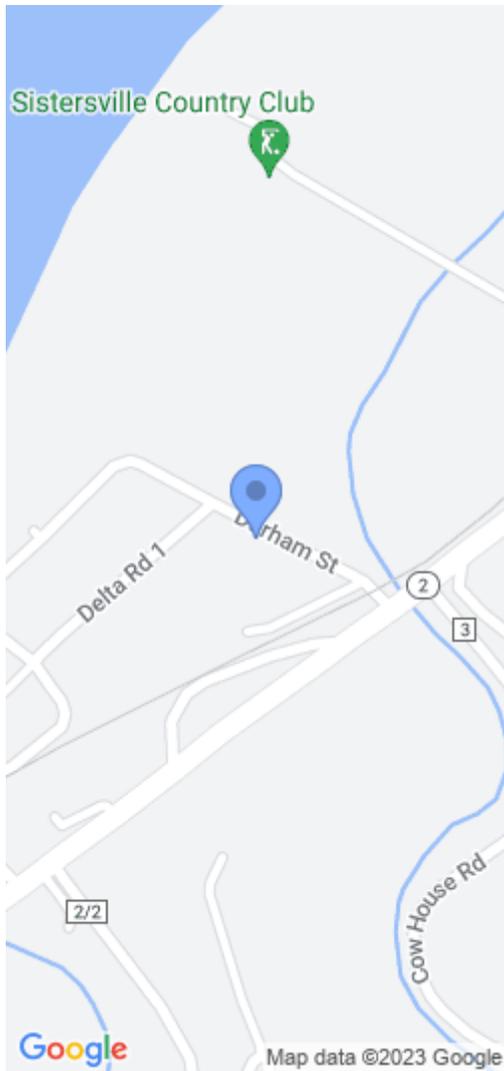
Project Location Durham St

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30065002	WVRS	SE corner of conc. walkway	386617.481	1542462.650	631.59	 See full page photos attached at end of PDF

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Mon, 06 Mar 2023, 10:44 am  
**Tags:**  
**Description:** Corner of Conc. Walkway  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

**John Leary**  
Created Mon, 06 Mar 2023, 11:11 AM (UTC-05)

Date Mon, 06 Mar 2023

Project Name Tyler County Control

Project Location Paden City

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30065003	WVRS	Corner of yellow parking paint	406064.077	1565761.504	659.993	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Mon, 06 Mar 2023, 11:12 am  
**Tags:**  
**Description:** Corner of parking lot paint  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Mon, 06 Mar 2023, 12:40 PM (UTC-05)

Date Mon, 06 Mar 2023

Project Name Tyler County Control

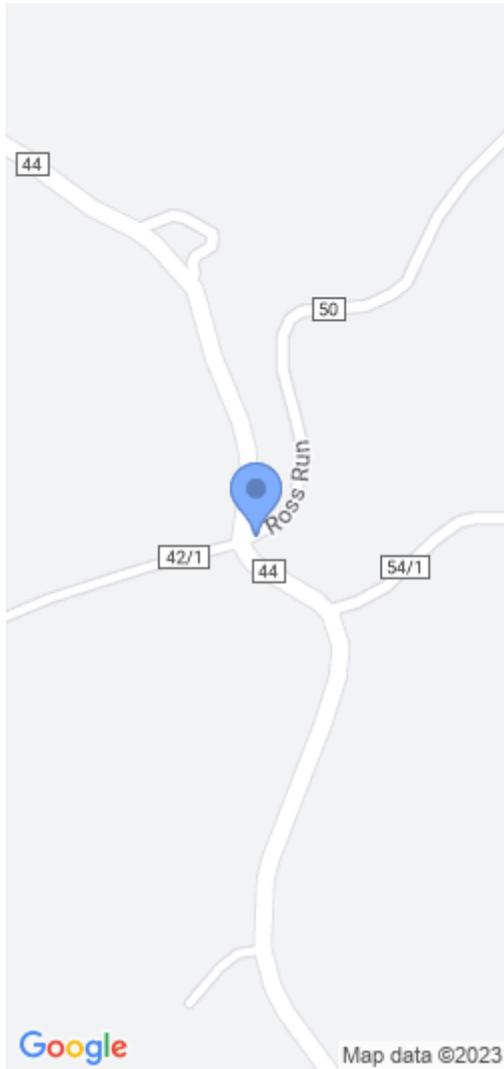
Project Location Atwood

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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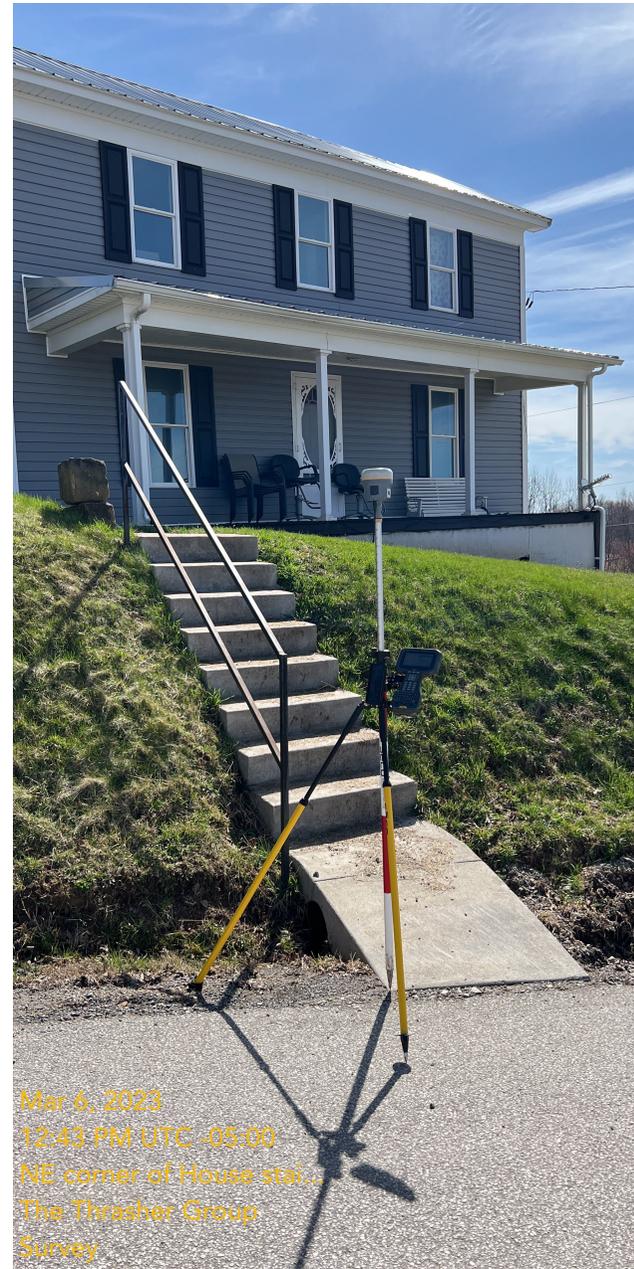
Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30065004	WVRS	NE corner of conc house stairs	370868.438	1618183.139	1244.441	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Mon, 06 Mar 2023, 12:43 pm  
**Tags:**  
**Description:** NE corner of House stairs  
**Comments:**



Mar 6, 2023  
12:43 PM UTC -05:00  
NE corner of House stairs  
The Thrasher Group  
Survey

## GNSS CONTROL POINT LOCATION SHEET

Created Mon, 06 Mar 2023, 12:40 PM (UTC-05) **John Leary**

Date Mon, 06 Mar 2023

Project Name Tyler County Control

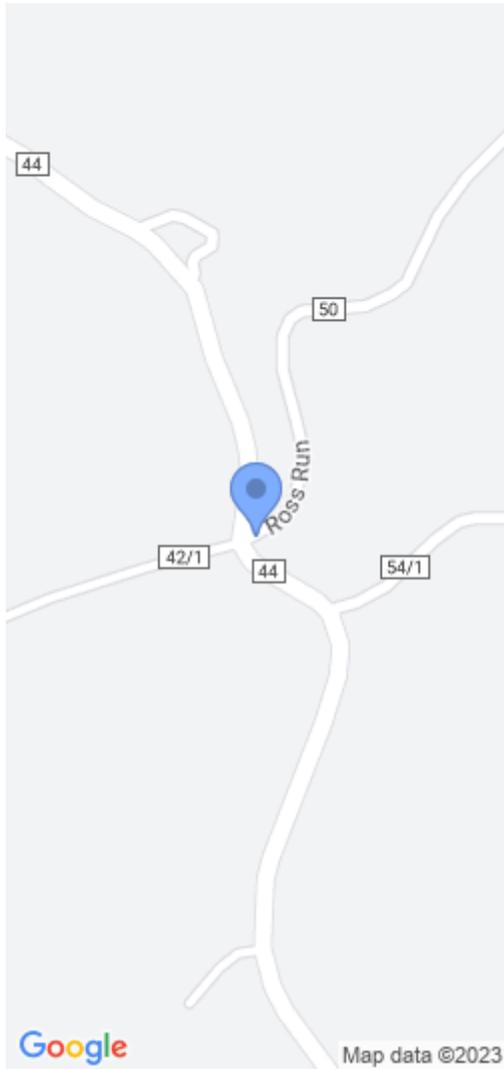
Project Location Atwood

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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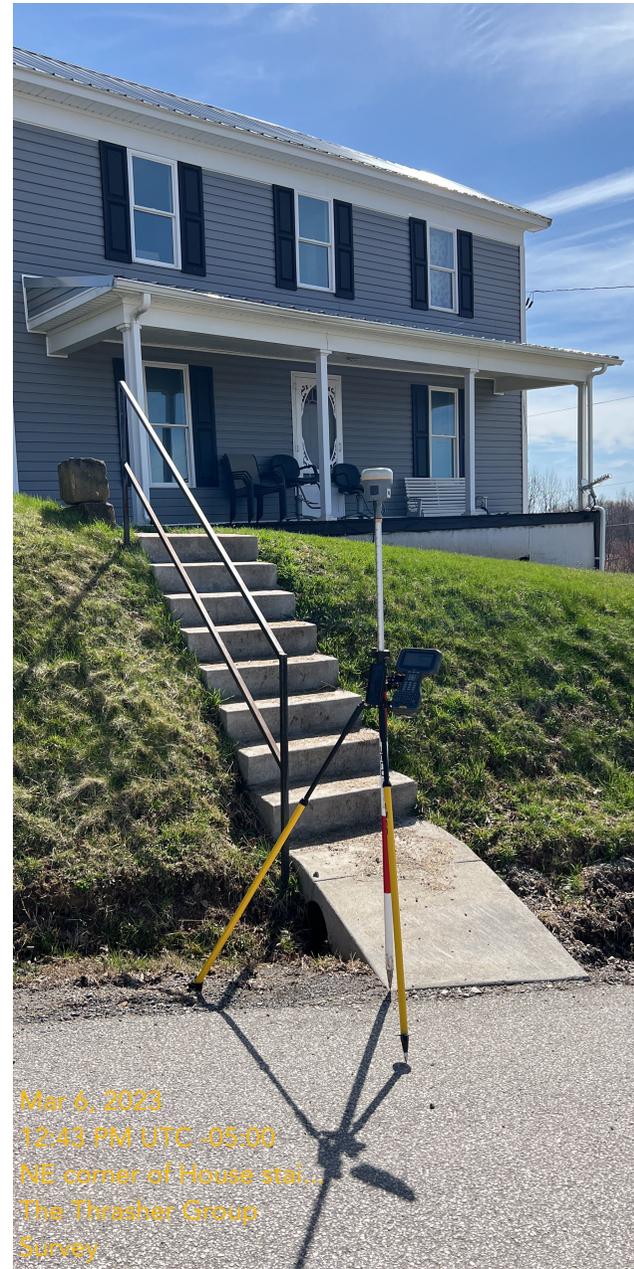
Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30065004	WVRS	NE corner of conc house stairs	370868.438	1618183.139	1244.441	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Mon, 06 Mar 2023, 12:43 pm  
**Tags:**  
**Description:** NE corner of House stairs  
**Comments:**



Mar 6, 2023  
12:43 PM UTC -05:00  
NE corner of House stairs  
The Thrasher Group  
Survey

## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Mon, 06 Mar 2023, 2:42 PM (UTC-05)

Date Mon, 06 Mar 2023

Project Name Tyler County Control

Project Location Union Bank in Middlebourne

Horizontal Datum	NAD83	Vertical Datum	NAVD88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30065006	WVRS	Corner of Concrete in parking lot	364705.054	1572291.039	732.084	 See full page photos attached at end of PDF

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Mon, 06 Mar 2023, 2:44 pm  
**Tags:**  
**Description:** Concrete for ATM  
**Comments:**



Mar 6, 2023  
2:44 PM UTC -05:00  
Concrete for ATM  
The Thrasher Group  
Survey

## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Wed, 08 Mar 2023, 10:25 AM (UTC-05)

Date Wed, 08 Mar 2023

Project Name Tyler County Control

Project Location Hebron Rd.

Horizontal Datum	NAD83	Vertical Datum	NAVD88	Geoid	18
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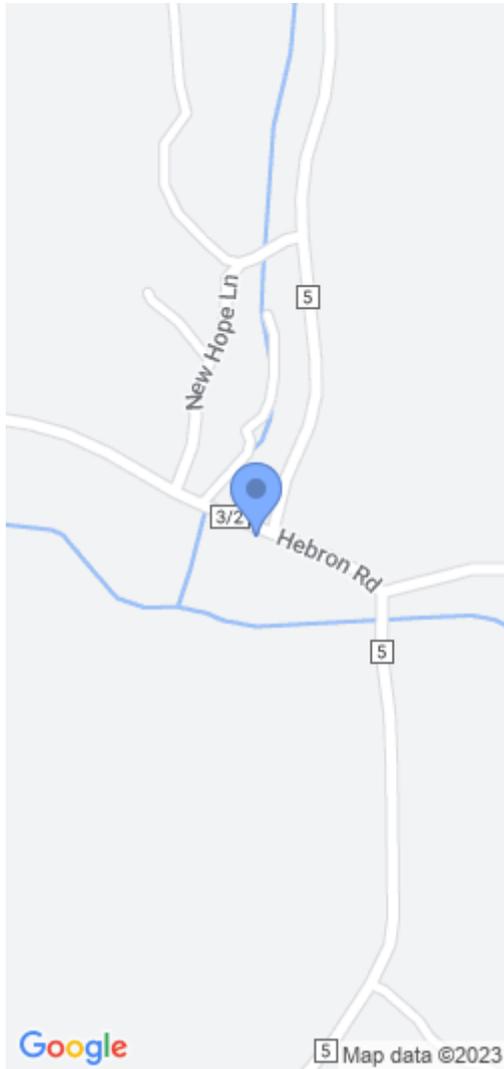
Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30067001	RTK INFILL	SE Corner of sidewalk	316878.406	1539264.624	754.991	 See full page photos attached at end of PDF

Signature james Howes, Tue, 21 Mar 2023, 8:29 am



Signature james Howes, Tue, 21 Mar 2023, 8:29 am





**Captured by:** John Leary  
**Captured on:** Wed, 08 Mar 2023, 10:26 am  
**Tags:**  
**Description:**  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Wed, 08 Mar 2023, 12:14 PM (UTC-05)

Date Wed, 08 Mar 2023

Project Name Doddridge County Control

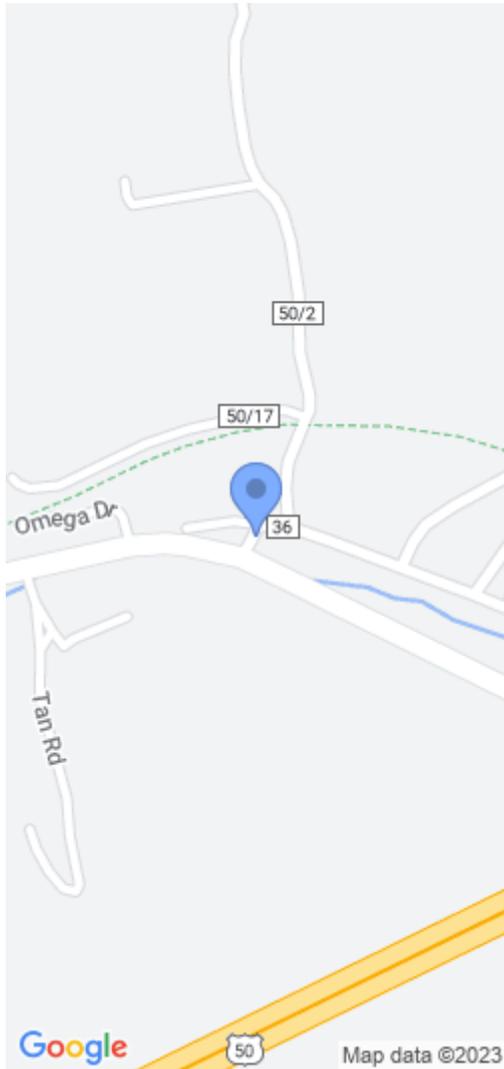
Project Location Greenwood

Horizontal Datum	NAD83	Vertical Datum	NAVD88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30067002	WVRS	Corner of concrete mailbox pad	285402.359	1574084.029	831.174	 <p>See full page photos attached at end of PDF</p>

Signature  james Howes, Tue, 21 Mar 2023, 8:33 am

Signature -



**Captured by:** John Leary  
**Captured on:** Wed, 08 Mar 2023, 12:16 pm  
**Tags:**  
**Description:**  
**Comments:**



Mar 8, 2023  
12:16 PM UTC -05:00  
The Thrasher Group  
Survey

## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Wed, 08 Mar 2023, 1:39 PM (UTC-05)

Date Wed, 08 Mar 2023

Project Name Doddridge County Control

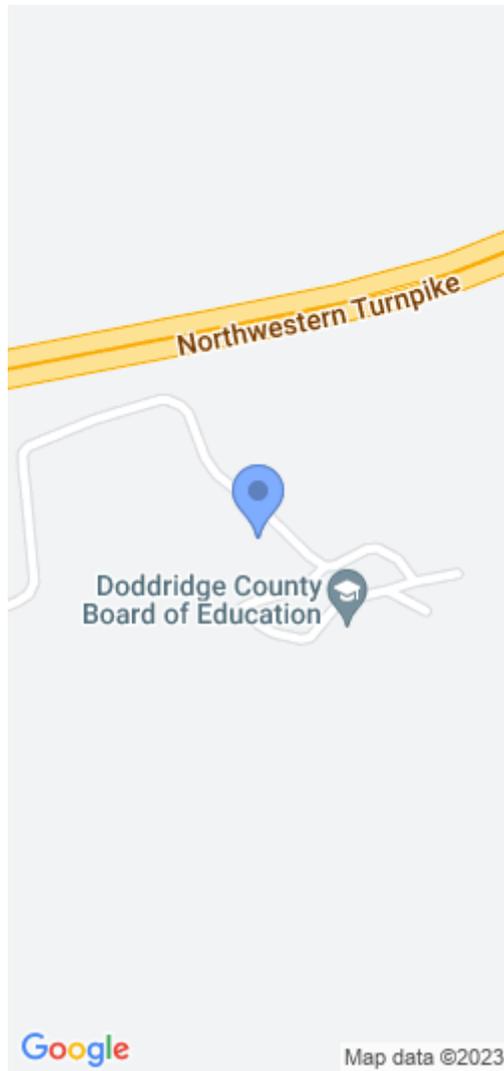
Project Location Doddridge county high school

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30067003	WVRS	Concrete around Sewer	285678.154	1605768.999	1095.196	 See full page photos attached at end of PDF

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Wed, 08 Mar 2023, 1:40 pm  
**Tags:**  
**Description:**  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

Created Wed, 08 Mar 2023, 2:56 PM (UTC-05) **John Leary**

Date Wed, 08 Mar 2023

Project Name Doddridge County Control

Project Location West Union Bank in Salem

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30067004	WVRS	Corner of Concrete in parking lot	292106.198	1658492.696	1162.885	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Wed, 08 Mar 2023, 2:58 pm  
**Tags:**  
**Description:**  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Thu, 09 Mar 2023, 8:27 AM (UTC-05)

Date	Thu, 09 Mar 2023
Project Name	Tyler County Control
Project Location	Arnold's creek Christian Church

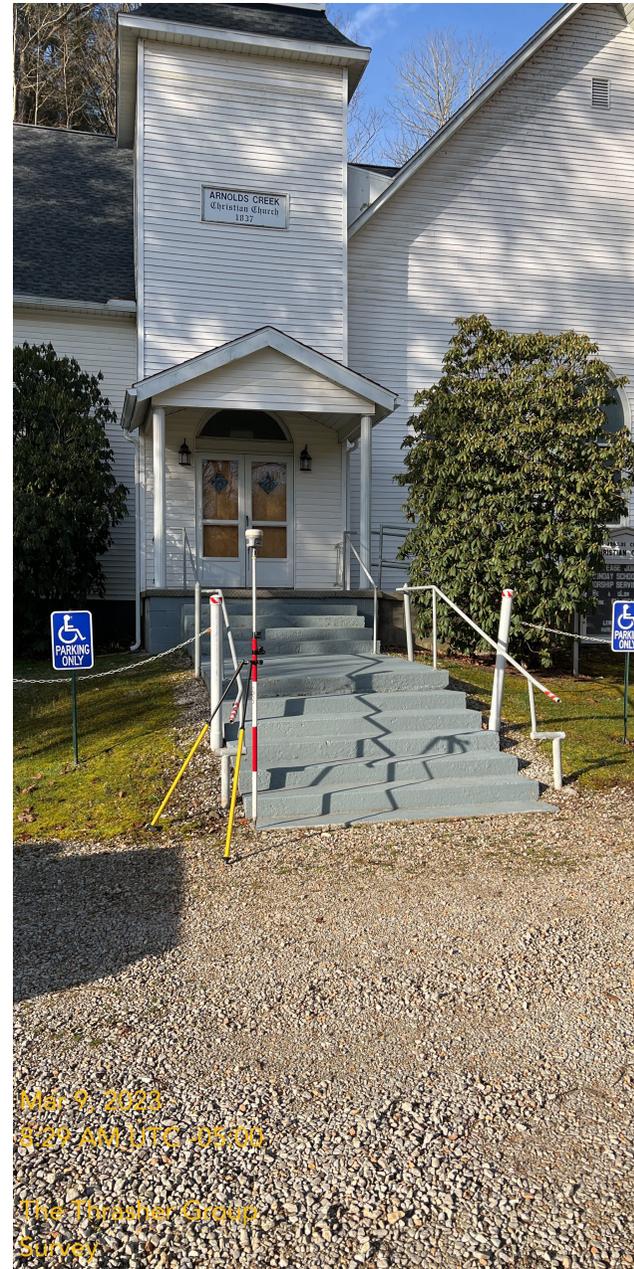
Horizontal Datum	NAD83	Vertical Datum	NAVD88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30068001	RTK INFILL	Corner of blue concrete steps of church	308608.623	1589669.227	736.543	 <p>See full page photos attached at end of PDF</p>

Signature	-
Signature	-



**Captured by:** John Leary  
**Captured on:** Thu, 09 Mar 2023, 8:29 am  
**Tags:**  
**Description:**  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Thu, 09 Mar 2023, 10:01 AM (UTC-05)

Date Thu, 09 Mar 2023

Project Name Tyler County Control

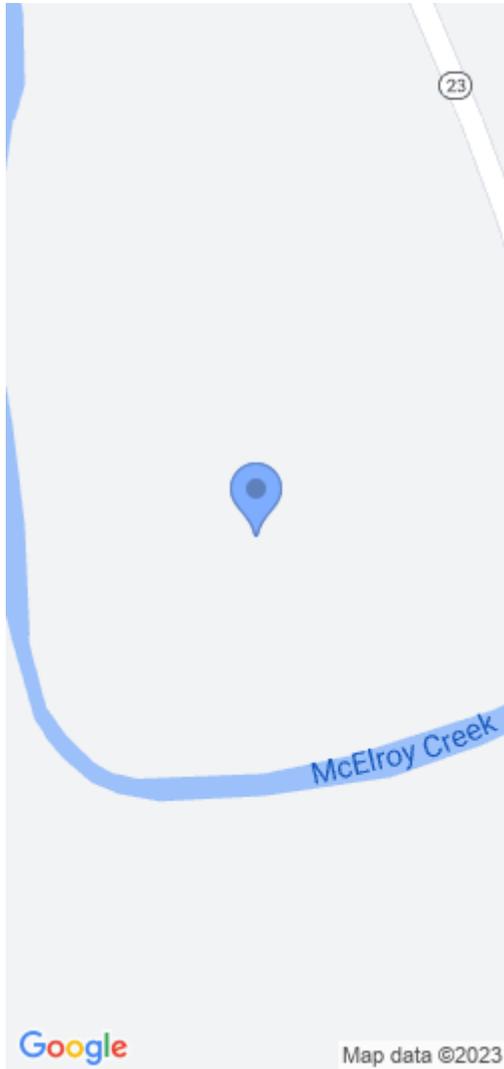
Project Location Antero Well pad in Shirley

Horizontal Datum	NAD83	Vertical Datum	NAVD88	Geoid	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30068002	RTK INFILL	Corner of concrete pad	328274.487	1616025.424	826.893	 See full page photos attached at end of PDF

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Thu, 09 Mar 2023, 10:03 am  
**Tags:**  
**Description:** SE Corner of concrete pad  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Thu, 09 Mar 2023, 1:58 PM (UTC-05)

Date Thu, 09 Mar 2023

Project Name Doddridge County Control

Project Location Turtletree fork rd

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30068003	RTK INFILL	NE Corner of concrete outside church	262745.482	1675483.673	1119.130	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Thu, 09 Mar 2023, 2:54 pm  
**Tags:**  
**Description:** Corner of concrete outside church  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

Created Fri, 10 Mar 2023, 8:48 AM (UTC-05)  
**John Leary**

Date Fri, 10 Mar 2023

Project Name Doddridge County Control

Project Location MT. Zion church Franks Run rd.

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30069001	RTK INFILL	NW Corner of headstone	347383.731	1652032.147	1267.391	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Fri, 10 Mar 2023, 9:02 am  
**Tags:**  
**Description:**  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

John Leary  
Created Fri, 10 Mar 2023, 11:27 AM (UTC-05)

Date Fri, 10 Mar 2023

Project Name Doddridge County Control

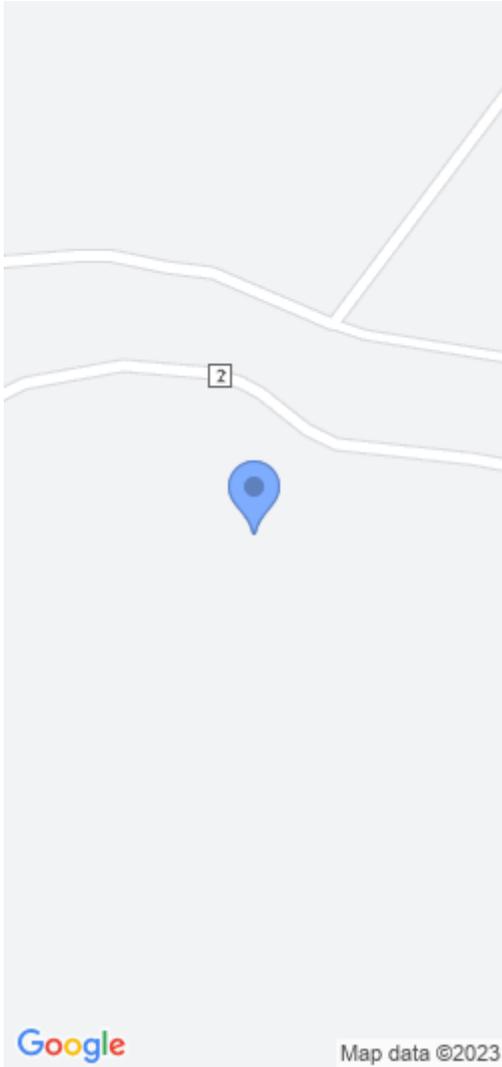
Project Location Talkington Fork

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30069002	RTK INFILL	Eastern Corner of concrete base at shallow well	340214.776	1668168.844	985.277	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Fri, 10 Mar 2023, 11:33 am  
**Tags:**  
**Description:**  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

Created Fri, 10 Mar 2023, 12:34 PM (UTC-05) **John Leary**

Date Fri, 10 Mar 2023

Project Name Doddridge County Control

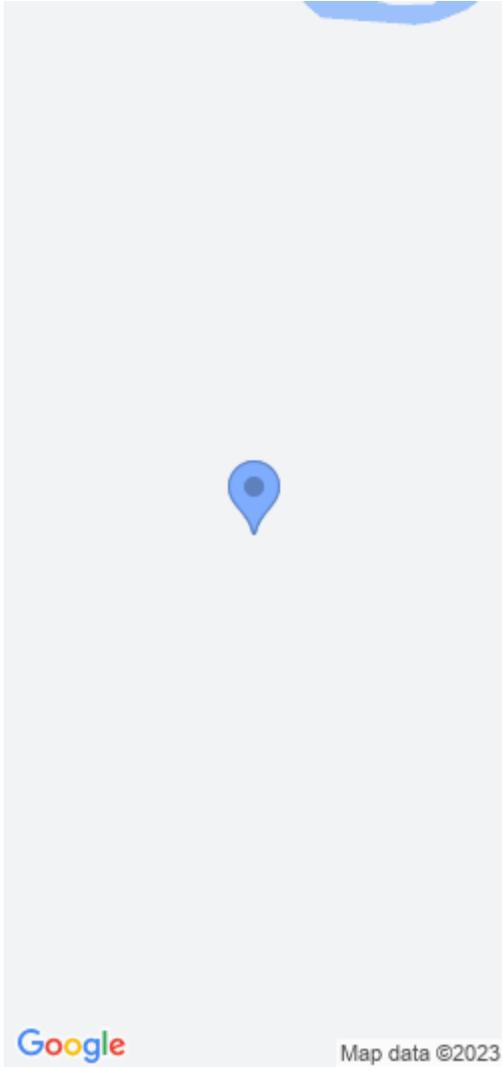
Project Location New Milton Compressor

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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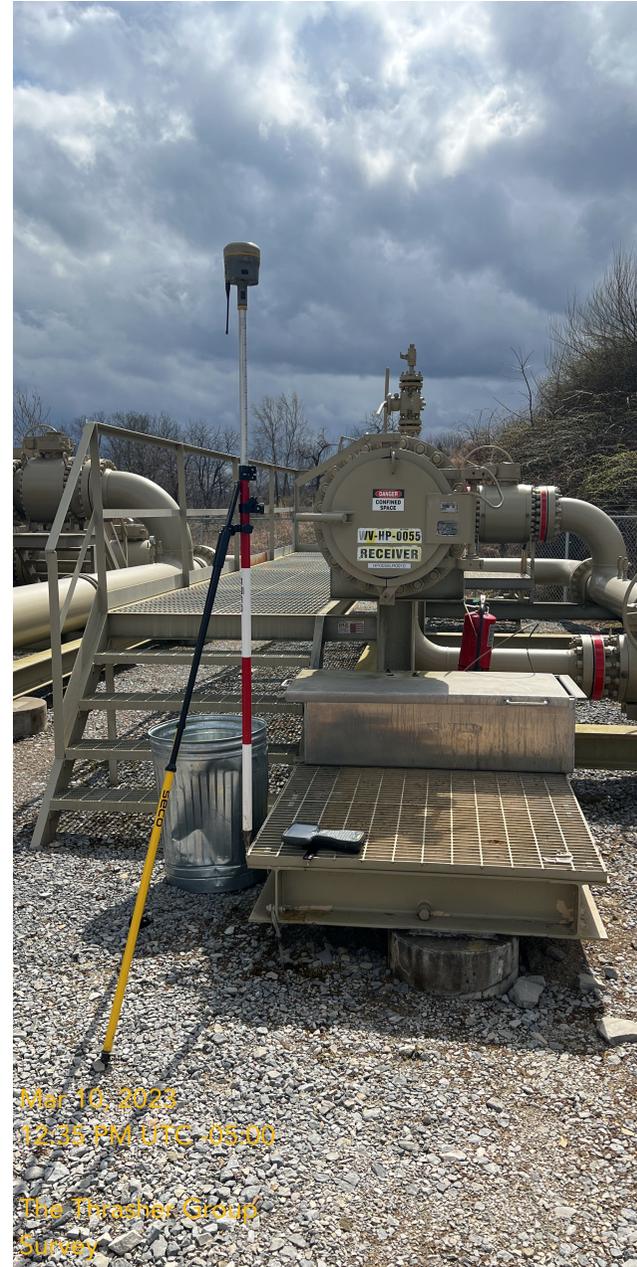
Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30069003	WVRS	Corner of platform around launcher	267436.757	1631894.350	1128.885	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Fri, 10 Mar 2023, 12:35 pm  
**Tags:**  
**Description:**  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

Created Fri, 10 Mar 2023, 1:28 PM (UTC-05)  
**John Leary**

Date Fri, 10 Mar 2023

Project Name Doddridge County Control

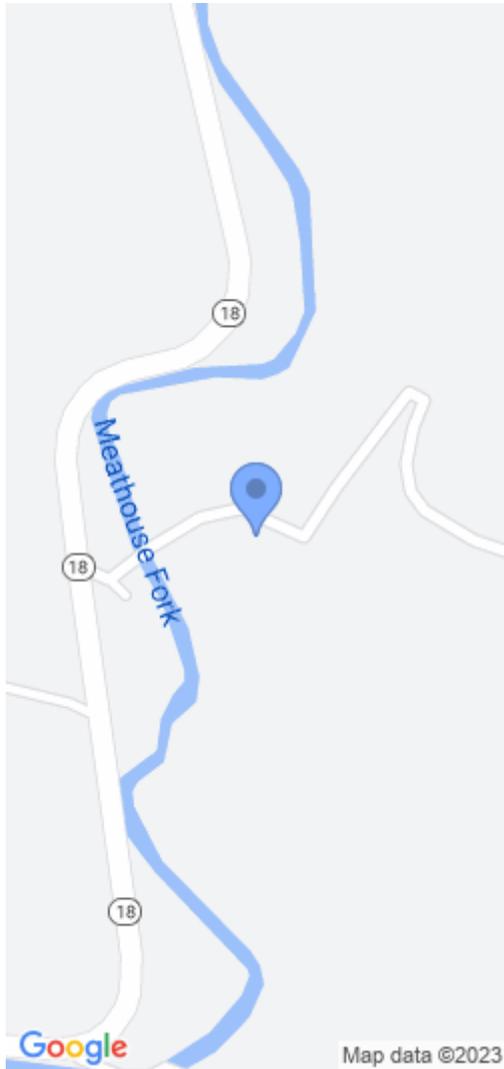
Project Location Straight fork rd.

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30069004	RTK INFILL	Corner of yellow spill containment	234370.068	1593605.403	853.896	 See full page photos attached at end of PDF

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Fri, 10 Mar 2023, 1:59 pm  
**Tags:**  
**Description:**  
**Comments:**



## GNSS CONTROL POINT LOCATION SHEET

Created Fri, 10 Mar 2023, 2:49 PM (UTC-05)  
**John Leary**

Date Fri, 10 Mar 2023

Project Name Doddridge County Control

Project Location Krenn School St Clara

<b>Horizontal Datum</b>	NAD83	<b>Vertical Datum</b>	NAVD88	<b>Geoid</b>	18
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Point Name	Method	Description	Northing(ft)	Easting (Ft)	Elevation (ft)	Photograph
30069005	RTK INFILL	Corner of concrete sidewalk and Pathway	229466.425	1630786.237	851.943	 <p>See full page photos attached at end of PDF</p>

Signature -

Signature -



**Captured by:** John Leary  
**Captured on:** Fri, 10 Mar 2023, 2:51 pm  
**Tags:**  
**Description:**  
**Comments:**



Mar 10, 2023  
2:51 PM UTC -05:00  
The Thrasher Group  
Survey