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LiDAR PROCESSING REPORT

FOR

TUCK MAPPING SOLUTIONS, INC.

OZAUKEE COUNTY, WI

December 29, 2010

AERO-METRIC PROJECT NO. 1-101025

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Tuck Mapping Solutions, Inc.

STARR
Ozaukee County, WI

AeroMetric Project No. 1101025

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1 INTRODUCTION

This report contains a summary of the LiDAR data acquisition and processing for **STARR – Ozaukee County, Wisconsin**.

1.1 Contact Info

Questions regarding the technical aspects of this report should be addressed to:

Aerometric, Inc.
4020 Technology Parkway
Sheboygan, WI 53081

Attention: Robert Merry (Geomatics Manager)
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FAX: 920-457-0410
Email: rmerry@aerometric.com

1.2 Purpose

Aerometric acquired highly accurate Light Detection and Ranging (LiDAR) data for an area that comprises approximately 248 square miles for Tuck Mapping. Using Aerometric, Inc. Optech Gemini LiDAR system, data was collected at an altitude to support the project area's requirement.

1.3 Project Location

The project area is approximately 248 square miles and is located in Ozaukee County, WI. This project area was defined and supplied by STARR on September 10, 2010.

1.4 Time Period

LiDAR data acquisition was completed between October 31st, 2010 and November 23rd, 2010. A total of 6 flight missions were required to cover the project area. See Section 3.3 for a sketch of the acquisition mission and Section 5 of the report for the flight logs.

1.5 Project Scope

Aerometric acquired highly accurate Light Detection and Ranging (LiDAR) data for an area that encompassed approximately 248 square miles in Ozaukee County, WI. Using Aerometric, Inc. Optech Gemini LiDAR system, data was collected to support the project area's requirements.

We were to achieve a TIN accuracy of 15 cm for Ozaukee County, Wisconsin. The accuracy as tested and published in this report in Section 7 has easily met both vertical accuracy requirements.

1.6 Conditions Affecting Progress

- None.

2 GEODETIC CONTROL

2.1 Network Scope

Base horizontal and vertical control for the Airborne GPS and ground control surveys consisted of various NGS CORS and WISCORS stations.

Horizontal control is referenced to the Universal Transverse Mercator (UTM) Coordinate System – Zone 16, based on the North American Datum of 1983/2007 (NAD83/07). Final coordinates are published in meters.

Vertical control is based on the North American Vertical Datum of 1988 (NAVD88).

2.2 Network Computations

The ground control survey was performed by CompassData, Inc of Centennial, CO. The detailed report can be found in section 2 and the final coordinates list in section 4 of this report.

3 LiDAR ACQUISITION & PROCEDURES

3.1 Acquisition Time Period

LiDAR data acquisition and Airborne GPS control survey was completed between October 29th, 2010 and November 23rd, 2010. A total of 6 flight missions were required to cover the project area.

3.2 LiDAR Planning

The LiDAR data for this project was collected with Aerometric, Inc. Optech Gemini Airborne LiDAR system (Serial Number 07SEN201). All flight planning and acquisition was completed using Optech's ALTM-Nav, version 2.1.25b (flight planning and LiDAR control software).

The following are the acquisition settings for Ozaukee County, Wisconsin:

- Flying Height (Above Ground): 1500 meters
- Laser Pulse Rate: 70 kHz
- Mirror Scan Frequency: 40 Hz
- Scan Angle (+/-): 17°
- Side Lap: 50 %
- Ground Speed: 160 kts
- Nominal Point Spacing: 1 meter

3.3 LiDAR Acquisition

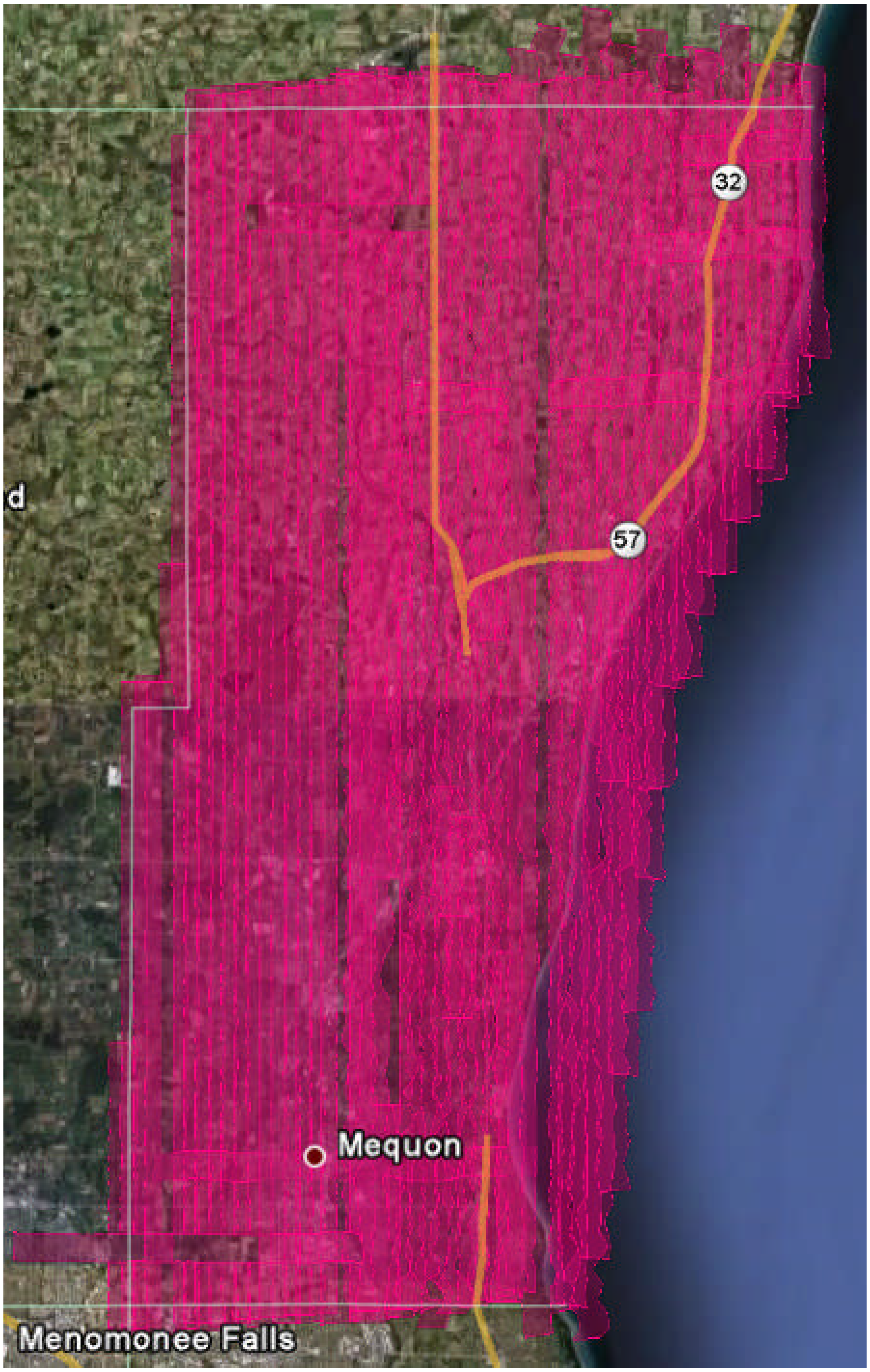
A total of 6 flight missions were required to cover the project area. The missions were flown using the above planned values. See below for a sketch of the acquisition missions and Section 5 of the report for the flight logs.

Airborne GPS and IMU trajectories for the LiDAR sensor were also acquired during the time of flight.

The missions usually average three to four hours duration. Typically, before take-off, the LiDAR system and the Airborne GPS and IMU systems were statically aligned for a period of five minutes and then again after landing for another five minutes. The missions acquired data according to the planned flight lines and included a minimum of one (1) cross flight. The cross flights were flown perpendicular to the planned flight lines and their data used in the in-situ calibration of the sensor.

3.4 LiDAR Trajectory Processing

The airborne positioning was processed using the following CORS stations: SHAN, WILMS, and RRW1.



4 QC SURVEYS

The check point survey was performed on October 29th and October 30th, 2010 using Rapid Static GPS techniques. A total of 21 check points were surveyed across the project area. These points were collected in open terrain to assess Fundamental Vertical Accuracy.

See Section 4 of the control report for a complete listing.

5 FINAL LiDAR PROCESSING

5.1 ABGPS and IMU Processing

Airborne GPS

Applanix - POSGPS
Utilizing carrier phase ambiguity resolution on the fly (i.e., without initialization). The solution to sub-decimeter kinematic positioning without the operational constraint of static initialization as used in semi-kinematic or stop-and-go positioning was utilized for the airborne GPS post-processing.

The processing technique used by Applanix, Inc. for achieving the desired accuracy is Kinematic Ambiguity Resolution (KAR). KAR searches for ambiguities and uses a special method to evaluate the relative quality of each intersection (RMS). The quality indicator is used to evaluate the accuracy of the solution for each processing computation. In addition to the quality indicator, the software will compute separation plots between any two solutions, which will ultimately determine the acceptance of the airborne GPS post processing.

Inertial Data

The post-processing of inertial and aiding sensor data (i.e. airborne GPS post processed data) is to compute an optimally blended navigation solution. The Kalman filter-based aided inertial navigation algorithm generates an accurate (in the sense of least-square error) navigation solution that will retain the best characteristics of the processed input data. An example of inertial/GPS sensor blending is the following: inertial data is smooth in the short term. However, a free-inertial navigation solution has errors that grow without bound with time. A GPS navigation solution exhibits short-term noise but has errors that are bounded. This optimally blended navigation solution will retain the best features of both, i.e. the blended navigation solution has errors that are smooth and bounded.
The resultant processing generates the following data:

- Position: Latitude, Longitude, Altitude
- Velocity: North, East, and Down components
- 3-axis attitude: roll, pitch, true heading
- Acceleration: x, y, z components
- Angular rates: x, y, z components

The Applanix software, version 4.4, was used to determine both the ABGPS trajectory and the blending of inertial data.

The airborne GPS and blending of inertial and GPS post-processing were completed in multiple steps.

1. The collected data was transferred from the field data collectors to the main computer. Data was saved under the project number and separated between LiDAR mission dates. Inside each mission date, a sub-directory was created with the aircraft's tail number and an A or B suffix was attached to record which mission of the day the data is associated with. Inside the tail number sub-directory, five sub-directories were also created: EO, GPS, IMU, PROC, and RAW.

2. The aircraft raw data (IMU and GPS data combined) was run through a data extractor program. This separated the IMU and GPS data. In addition to the extraction of data, it provided the analyst the first statistics on the overall flight. The program was POSPac (POS post-processing PACkage).

3. Executing POSGPS program to derive accurate GPS positions for all flights:

   Applanix POSGPS

   The software utilized for the data collected was PosGPS, a kinematic on-the-fly (OTF) processing software package. Post processing of the data is computed from each base station (Note: only base stations within the flying area were used) in both a forward and backward direction. This provides the analyst the ability to Quality Check (QC) the post processing, since different ambiguities are determined from different base stations and also with the same data from different directions.

   The trajectory separation program is designed to display the time of week that the airborne or roving antenna traveled, and compute the differences found between processing runs. Processed data can be compared between a forward/reverse solution from one base station, a reverse solution from one base station and a forward solution from the second base station, etc. For the Applanix POSGPS processing, this is considered the final QC check for the given mission. If wrong ambiguities were found with one or both runs, the analyst would see disagreements from the trajectory plot, and re-processing would continue until an agreement was determined.

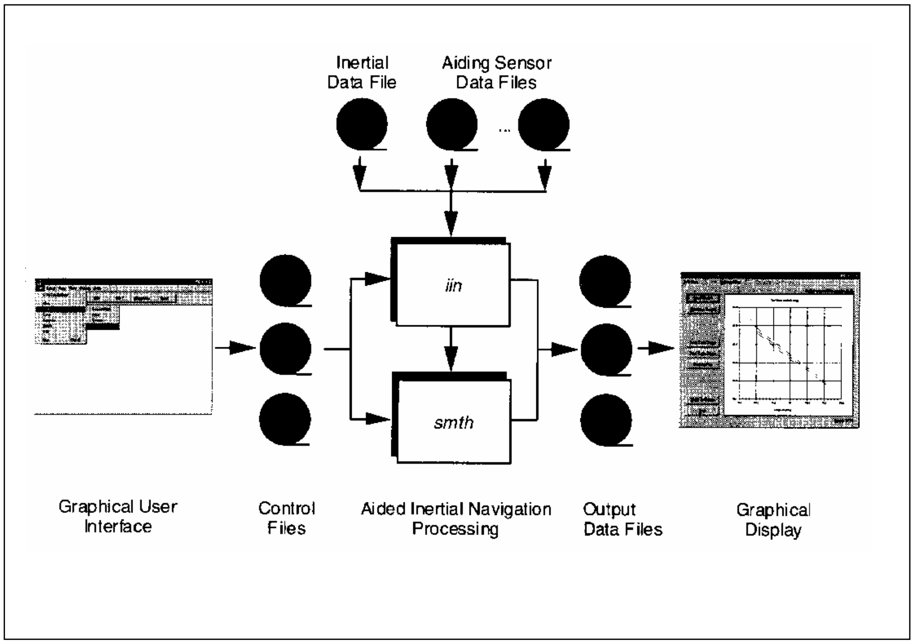
   Once the analyst accepts a forward and reverse processing solution, the trajectory plot is analyzed and the combined solution is stored in a file format acceptable for the IMU post processor.

   Please see Section 6 of the control report for the final accepted trajectory plots.

1. When the processed trajectory (either through POSGPS) data was accepted after quality control analysis, the combined solution is stored in a file format acceptable for the IMU post processor (i.e. POSProc).

2. Execute POSProc.
   POSProc comprises a set of individual processing interface tools that execute and provide the following functions:

   This diagram shows the organization of these tools, and is a function of the



   POSProc processing components.

   - Integrated Inertial Navigation (*iin*) Module.
     The name *iin* is a contraction of Integrated Inertial Navigation. *iin* reads inertial data and aiding data from data files specified in a processing environment file and computes the aided inertial navigation solution. The inertial data comes from a strapdown IMU. *iin* outputs the navigation data between start and end times at a data rate as specified in the environment file. *iin* also outputs Kalman filter data for analysis of estimation error statistics and smoother data that the smoothing program *smth* uses to improve the navigation solution accuracy.
     iin implements a full strapdown inertial navigator that solves Newton's equation of motion on the earth using inertial data from a strapdown IMU. The inertial navigator implements coning and sculling compensation to handle potential problems caused by vibration of the IMU.

- Smoother Module (*smth*).
  smth is a companion processing module to *iin*. *smth* is comprised of two individual functions that run in sequence. *smth* first runs the *smoother function* and then runs the *navigation correction function*.

  The *smth* smoother function performs backwards-in-time processing of the forwards-in-time blended navigation solution and Kalman filter data generated by *iin* to compute smoothed error estimates. *smth* implements a modified Bryson-Frazier smoothing algorithm specifically designed for use with the *iin* Kalman filter. The resulting smoothed strapdown navigator error estimates at a given time point are the optimal estimates based on all input data before and after the given time point. In this sense, *smth* makes use of all available information in the input data. *smth* writes the smoothed error estimates and their RMS estimation errors to output data files.

  The *smth* navigation correction function implements a feedforward error correction mechanism similar to that in the *iin* strapdown navigation solution using the smoothed strapdown navigation errors. s*mth* reads in the smoothed error estimates and with these, corrects the strapdown navigation data. The resulting navigation solution is called a Best Estimate of Trajectory (BET), and is the best obtainable estimate of vehicle trajectory with the available inertial and aiding sensor data.

The above mentioned modules provide the analyst the following statistics to ensure that the most optimal solution was achieved: a log of the *iin* processing, the Kalman filter Measurement Residuals, Smoothed RMS Estimation Errors, and Smoothed Sensor Errors and RMS.

5.2 LiDAR “Point Cloud” Processing

The ABGPS/IMU post processed data along with the LiDAR raw measurements were processed using Optech Incorporated’s DASH MAP software. This software was used to match the raw LiDAR measurements with the computed ABGPS/IMU positions and attitudes of the LiDAR sensor. The result was a “point cloud” of LiDAR measured points referenced to the ground control system.

5.3 LIDAR CALIBRATION

Introduction

The purpose of the LiDAR system calibration is to refine the system parameters in order for the post-processing software to produce a “point cloud” that best fits the actual ground.

The following narrative outlines the calibration techniques employed for this project.

Calibration Procedures

Aerometric, Inc. routinely performs two types of calibrations on its Optech Gemini LiDAR system. The first calibration, system calibration, is performed whenever the LiDAR system is installed in the aircraft. This calibration is performed to define the system parameters affected by the physical misalignment of the system versus aircraft. The second calibration, in-situ calibration, is performed for each mission using that mission’s data. This calibration is performed to refine the system parameters that are affected by the on site conditions as needed.

System Calibration and Correction Software

Optech has developed proprietary calibration software in December of 2009 that performs the system calibration. The results from this new software achieved excellent results and an accuracy that meets the project requirements.

This new calibration tool incorporates Optech’s proprietary optical sensor models to compute laser point positions and provide laser point calibration improvements on a per flightline basis for the entire project area. It furthermore calculates planar surfaces at different angles from each flight line and then uses a robust least squares solution to compute the orientation parameters at the optical level instead of the traditional methods relating to the ground points. Determining and correcting at the optical level is critical when correcting the data in this project. Each flight line was computed individually and output in LAS 1.2 format.

In-situ Calibration

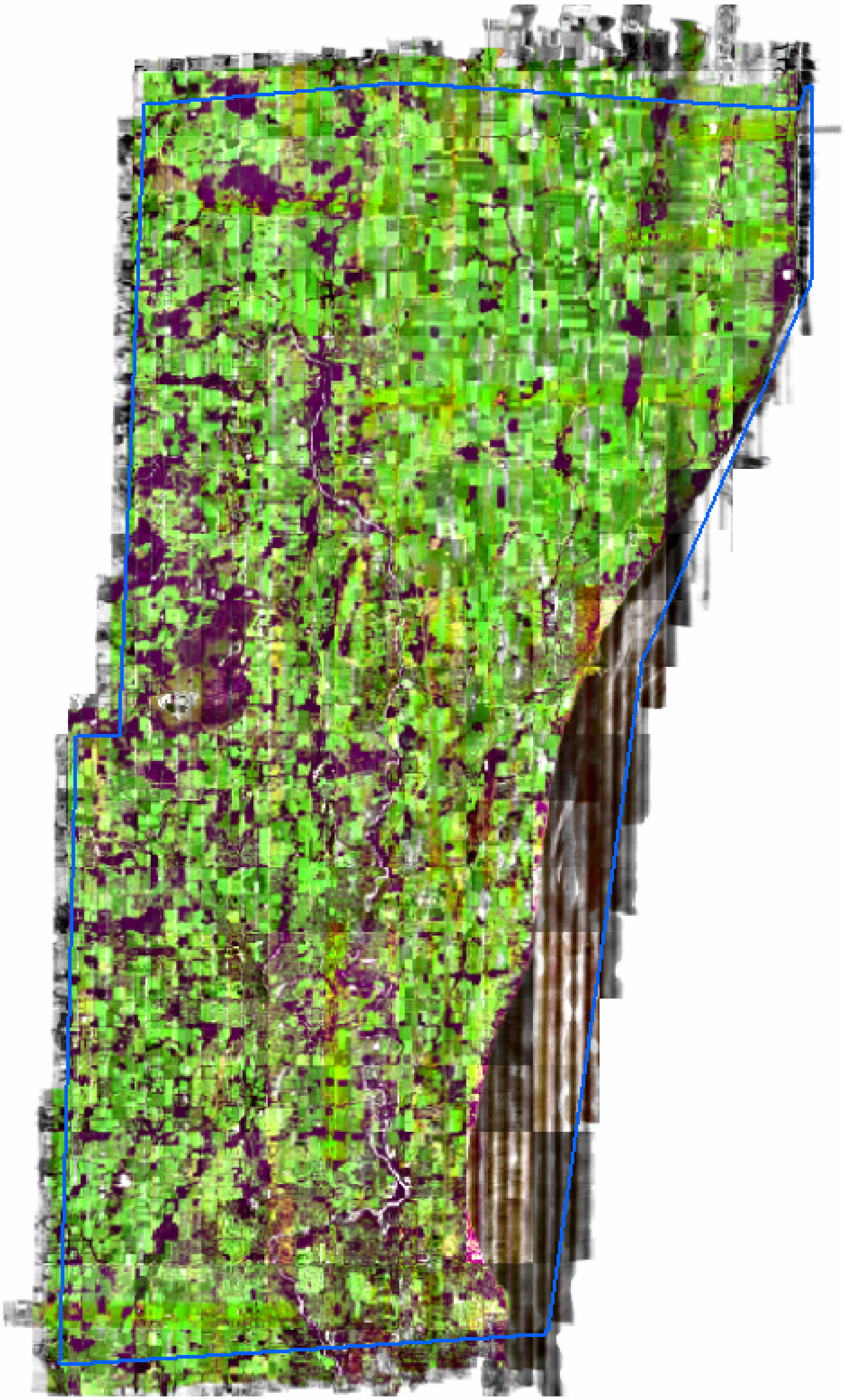
The in-situ calibration is performed as needed using the mission’s data. This calibration is performed to refine the system parameters that are affected by the on site conditions.

For each mission, LiDAR data for at least one cross flight is acquired over the mission’s acquisition site. The processed data of the cross flight is compared to the perpendicular flight lines using either the Optech proprietary software or TerraSolid's TerraMatch software to determine if any systematic errors are present. In this calibration, the data of individual flight lines are compared against each other and their systematic errors are corrected in the final processed data.

5.4 LiDAR Processing

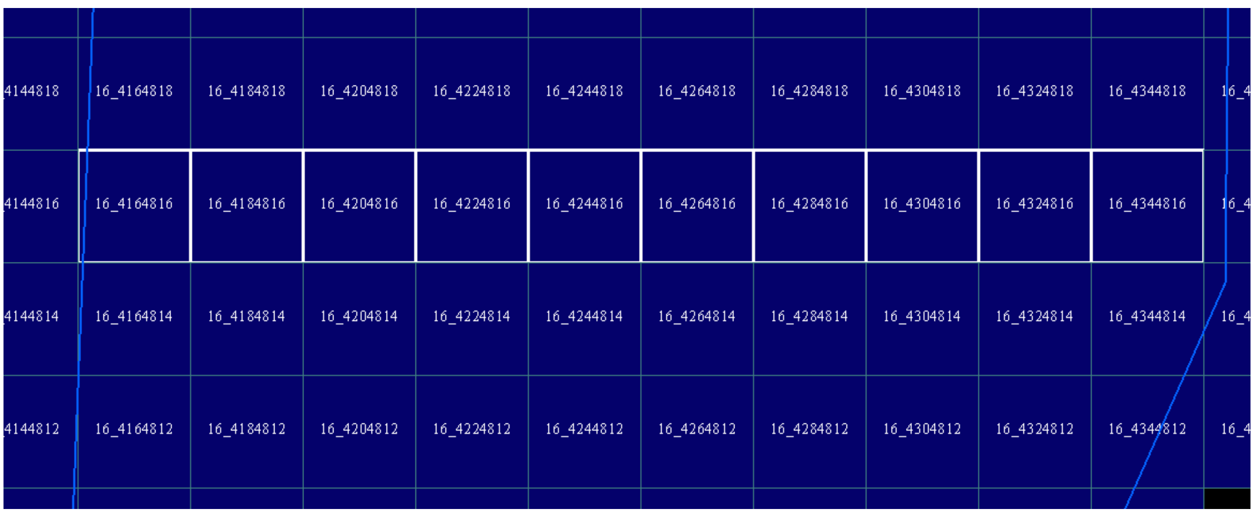
The LAS files were then imported, verified, and parsed into manageable, tiled grids using GeoCue version 7.0.34.0.

The first step after the data has been processed and calibrated is to perform a relative accuracy assessment on the flightline to flightline comparisons and also a data density test prior any further processing. To determine a proper accuracy assessment between flightlines, Aerometric uses GeoCue to create Orthos by elevation differences. The generated orthos have assigned elevation ranges that allow the technician to evaluate if the data passes the accuracy assessment and also determine if additional calibration efforts are needed based on the bias trends. Below are screen captures of the elevation orthos where green indicates a flightline comparison of less than 5 cm; yellow is 5-10 cm; orange is 10-15 cm; red is 15-20 cm, and magenta is greater than 20 cm.



Ozaukee County Wisconsin

In addition to the relative accuracy assessment, Aerometric also performs a sample review of tiles to ensure that the desired point density has been met. Aerometric utilized an in-house proprietary software to complete this task. Initially a grid was placed according to the version 12 specification that is based on the nominal post spacing. The results indicated that the density of the sampled tiles achieved only 94.4% of the grids meeting the specified data density criteria. However, using the latest USGS specification, version 13, which modifies the requirements to allow up to 2 times the nominal post spacing our data tests easily meets the desired density requirements with 99.6% grids containing one or more points. Below are the statistics of the results for the inspected tiles from the image shown.



Sample tiles: Ozaukee County, Wisconsin
16_4164816, 16_4184816, 16_4204816, 16_4224816, 16_4244816, 16_4264816, 16_4284816, 16_4304816, 16_4324816, and 16_4344816

(Version 12 – tiles sampled: 10 using a grid size of 1.0 meter)
Total number of cells: 40,000,000
Total number of cells with one point: 11,580,659
Percentage of tiles with 1 point or more: 94.4%

(Version 13 – tiles sampled: 10 using a grid size of 2.0 meters)
Total number of cells: 10,000,000
Total number of cells with one point: 9672
Percentage of tiles with 1 point or more: 99.6%

Once both the accuracy between swaths and data density is accepted an automated classification algorithm is performed using TerraSolid's TerraScan, version 010.017. This will produce the majority of the bare-earth datasets.

5.4 Check Point Validation

The data was then verified using the ground control data collected by CompassData, Inc. TerraScan computes the vertical differences between the surveyed elevation and the LiDAR derived elevation for each point.

A report listing the differences and common statistics was created and can be found in Section 7 of this report.

5.5 LiDAR Data Delivery

Raw point cloud data supplied is in the following format:

- LAS, version 1.2
- GPS times as Adjusted GPS
- Full swaths and delivered as 1 file per swath not to exceed 2gb.

Classified point cloud data is also being supplied using the following criteria.

- LAS, version 1.2
- GPS times as Adjusted GPS
- Classification schemed:
    - Code 1 – Processed, but unclassified
    - Code 2 – Bare-earth Ground
    - Code 7 – Noise
    - Code 12 _ Overlap

6 CONCLUSION

Because of the rigorous procedures and use of new technology, this project will serve STARR and all users requiring LiDAR derivative products for the project area in Ozaukee County, Wisconsin well into the future. For this project the results are extremely accurate and reliable.

FEMA Region 5 - Ozaukee County, WI
Ground Control Project Report for AeroMetric Inc.

December 6, 2010

Project Information

CDI Project Number:	**FSG1530**
Geographic Location:	**Ozaukee County, Wisconsin**
Number of GCPs Requested:	**20**
Number of GCPs Collected:	**21**

Project Specifications

Precision (Horizontal/Vertical):	**CDI Precision-1 ≤ 8cm H/V**
Coordinate System:	**UTM**
Datum:	**NAD83**
Zone:	**16 N**
Altitude Reference:	**HAE (WGS84) and NAVD88 (09)**
Units:	**Meters**

RTK GPS

All Ground Control Points for this project were collected within the boundaries of the WisCors Virtual Reference Station System, which provides continuous real-time broadcast correction signals within a network of 22 base stations encompassing the South-Central and Southeast Wisconsin region.

All Control Points were observed for 180 epochs to determine a coordinate location ≤ 8cm in both Horizontal and Vertical to support subsequent LiDAR post-processing and bare earth deliverables generation.

All data collected were well within the confines of the WisCors VRS system with multiple base locations providing position and correction data for each point collected.

Summary

The purpose of this project was to locate and survey photo-identifiable ground control points (GCPs) in multiple areas of interest as defined by FEMA-supplied shape and kml files. The GCP coordinates are to be used to control the vertical aspect of all newly-flown LiDAR data during post-processing and subsequent deliverables creation. CompassData visited the project area, found suitable GCPs, and determined accurate coordinates for each GCP according to the customer's specifications.

Equipment

CompassData used a Trimble R8-3 to perform the Control survey. This device is accurate to within 1 cm on a position-by-position basis per Trimble specifications. Operating within the VRS network provided accurate coordinate values at or around 3 cm H/V within 3-5 minutes observation times. CompassData has consistently demonstrated this level of accuracy on many GCP collection jobs across North and South America and Africa. Specifications for the Trimble R8 are available upon request.

Survey Methodology

CompassData has met the required precision for this project by using a high-quality GPS receiver with differential corrections provided by a VRS network surrounding the project area. The GPS antenna sat atop a bubble-leveled, fixed-height range pole that was placed over the center of the desired GCP. At least 180 positions (captured at a rate of one per second) were geometrically averaged to calculate a single coordinate for each GCP. All required field documentation was filled out and the points were identified on web-based imagery and diagrammed on the CompassData-supplied sketch sheets. Digital pictures of each GCP location were collected in the field.

Quality Control Procedures

CompassData collects GCPs with an unobstructed view of the sky to ensure proper GPS operation. CompassData works to avoid potential sources of multipath error such as trees, buildings, and fences that may adversely affect the GPS accuracy.

Additional quality control comes from the fact that at least 180 GPS positions are collected for each GCP. While operating within a VRS, valid solutions are reached within seconds; however, we continue to collect additional data to ensure meeting collection specifications. To ensure project integrity, a GCP will be reobserved or moved to a more suitable location if it does not meet project specifications.

In addition to the aforementioned procedures, CompassData observes existing geodetic control monuments to verify that our coordinates match the published coordinates to the required accuracy. These monuments are usually established by the National Geodetic Survey (NGS) in the United States. If it is found that our coordinates are outside the acceptable accuracy, the reason for the difference will be found or the GCPs will be reobserved under different GPS constellation constraints. There are certain geodetic considerations that must be taken into account that affect whether a GPS-derived coordinate will line up with a survey monument, especially when these monuments reference local coordinate systems or the systems of another country. Sometimes the published coordinates for a monument are not accurate, although this is very infrequent.

CompassData visited multiple survey monuments during the course of this project. The results of those monument measurements are summarized in the Accuracy Report.

Deliverables

Deliverables for this project include:

- Coordinates (in spreadsheet format)
- Image Chips
- Sketch Sheets
- Digital Pictures
- QA/QC Data

Project Notes

All collected points were retrieved from the Trimble Survey Controller in Decimal Degrees, NAD83, HAE Meters.

CorpsCon was used to generate files in the following format:

Degrees Minutes Decimal Seconds, NAD83 HAE (QC purposes)
UTM Meters, NAD83 HAE

Geoid09 was then used to generate the geoid separation at every Lat/Long location. NAVD88(09) orthometric heights were then generated in spreadsheet form using the formula HAE - Geoid = Orthometric Height. Those values were then included into the final delivery coordinate CSV files and have been tested against NGS monuments collected during the course of this survey and are showing millimeter-level agreement.

The Horizontal and Vertical accuracies reported in the Final Coordinates file were obtained from the Survey Report generated by Trimble Survey Controller. The report contains all points collected during each daily survey deployment, including CVAs, FVAs and Ground Control. Copies of these reports can be provided upon request once the CVA and FVA data has been redacted.

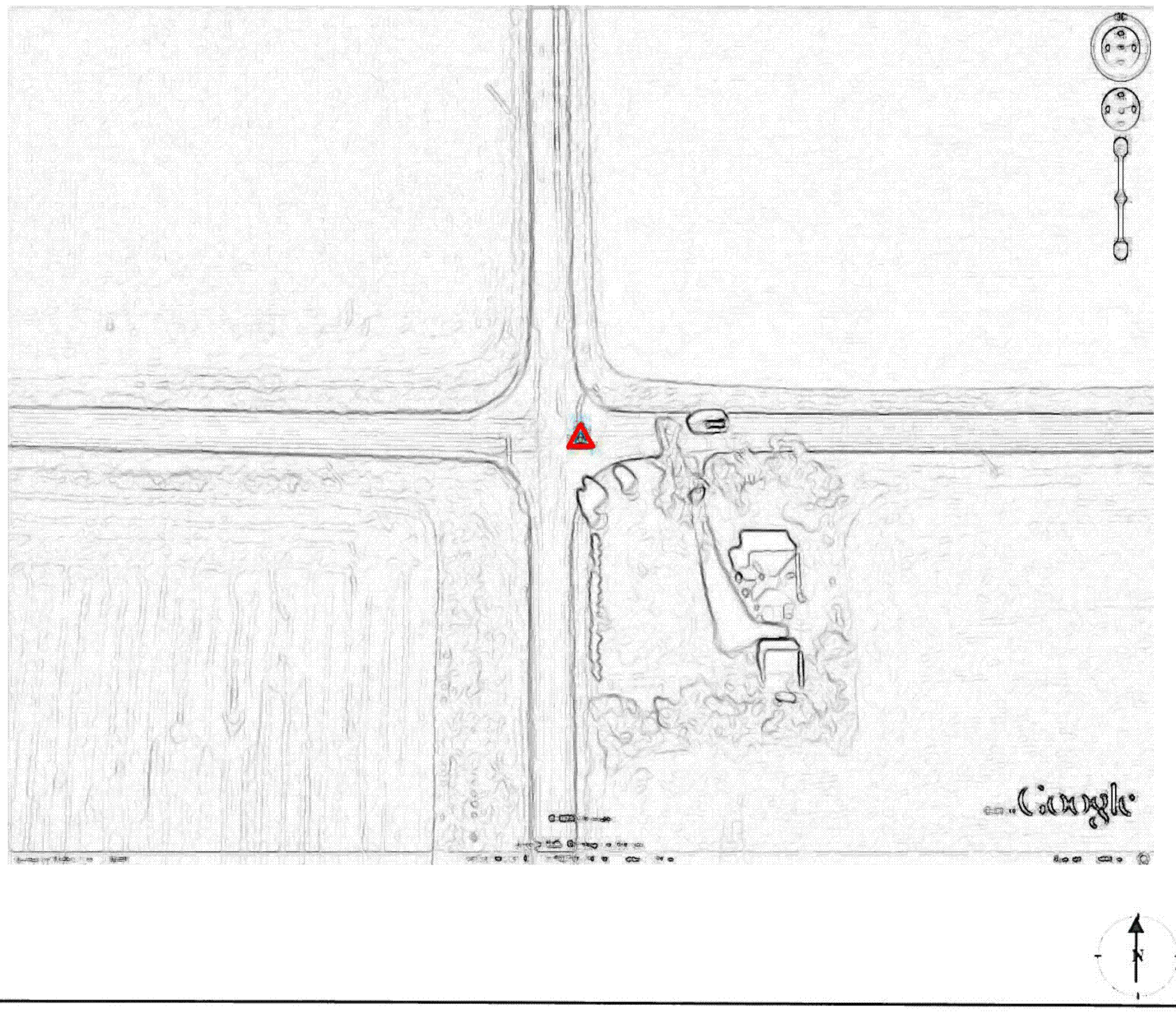
Contact Information

Hayden Howard Phone: (303) 627-4058 E-mail: haydenh@compassdatainc.com

CompassData

GCP Station Diagram for LiDAR

Project Name: Ozaukee	**GCP Number:** OZK101
CDI Project Number: 1508	**Date:** 10/30/2010



GPS Antenna Height: 2m

Comments:

Point taken at intersection of Jay Rd and CO Rd E
in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

LiDAR

LiDAR

CompassData

GCP Station Diagram for LiDAR

LiDAR

Project Name: Ozaukee	**GCP Number:** OZK102
CDI Project Number: 1508	**Date:** 10/30/2010

GPS Antenna Height: 2m

Comments:

Point was taken at the intersection of Jay Rd and Kay K Rd in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

LiDAR

CompassData

GCP Station Diagram for LiDAR

Project Name: Ozaukee	**GCP Number:** OZK103
CDI Project Number: 1508	**Date:** 10/30/2010

GPS Antenna Height: 2m

Comments:

Point was taken at the intersection of Jay Rd and Clay Ridge Rd in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

LiDAR

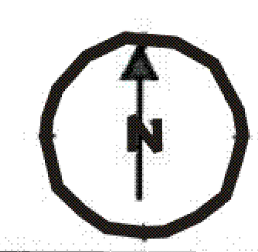
LiDAR

CompassData

GCP Station Diagram for LiDAR

LiDAR

Project Name: Ozaukee	**GCP Number:** OZK104
CDI Project Number: 1508	**Date:** 10/30/2010



GPS Antenna Height: 2m

Comments:

Point was taken at the intersection of CO HWY A and County Lane in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

LiDAR

CompassData

GCP Station Diagram for LiDAR

LiDAR

Project Name: Ozaukee	**GCP Number:** OZK105
CDI Project Number: 1508	**Date:** 10/30/2010

N

GPS Antenna Height: 2m

Comments:

Point was taken at the intersection of CO Rd A and Kay K Rd in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

LiDAR

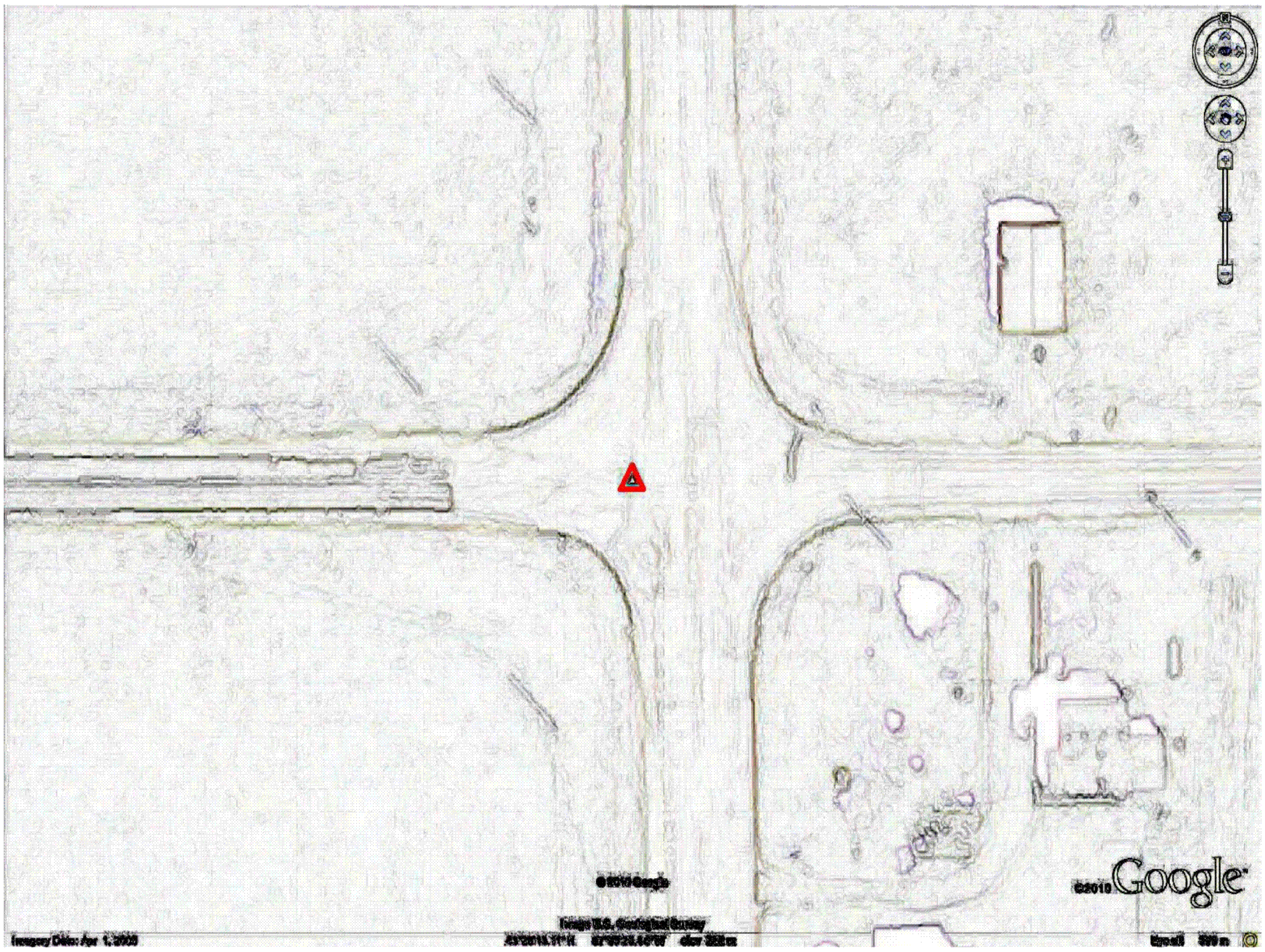
CompassData

GCP Station Diagram for LiDAR

LiDAR

LiDAR

Project Name: Ozaukee	**GCP Number:** OZK106
CDI Project Number: 1508	**Date:** 10/30/2010



GPS Antenna Height: 2m

Comments:

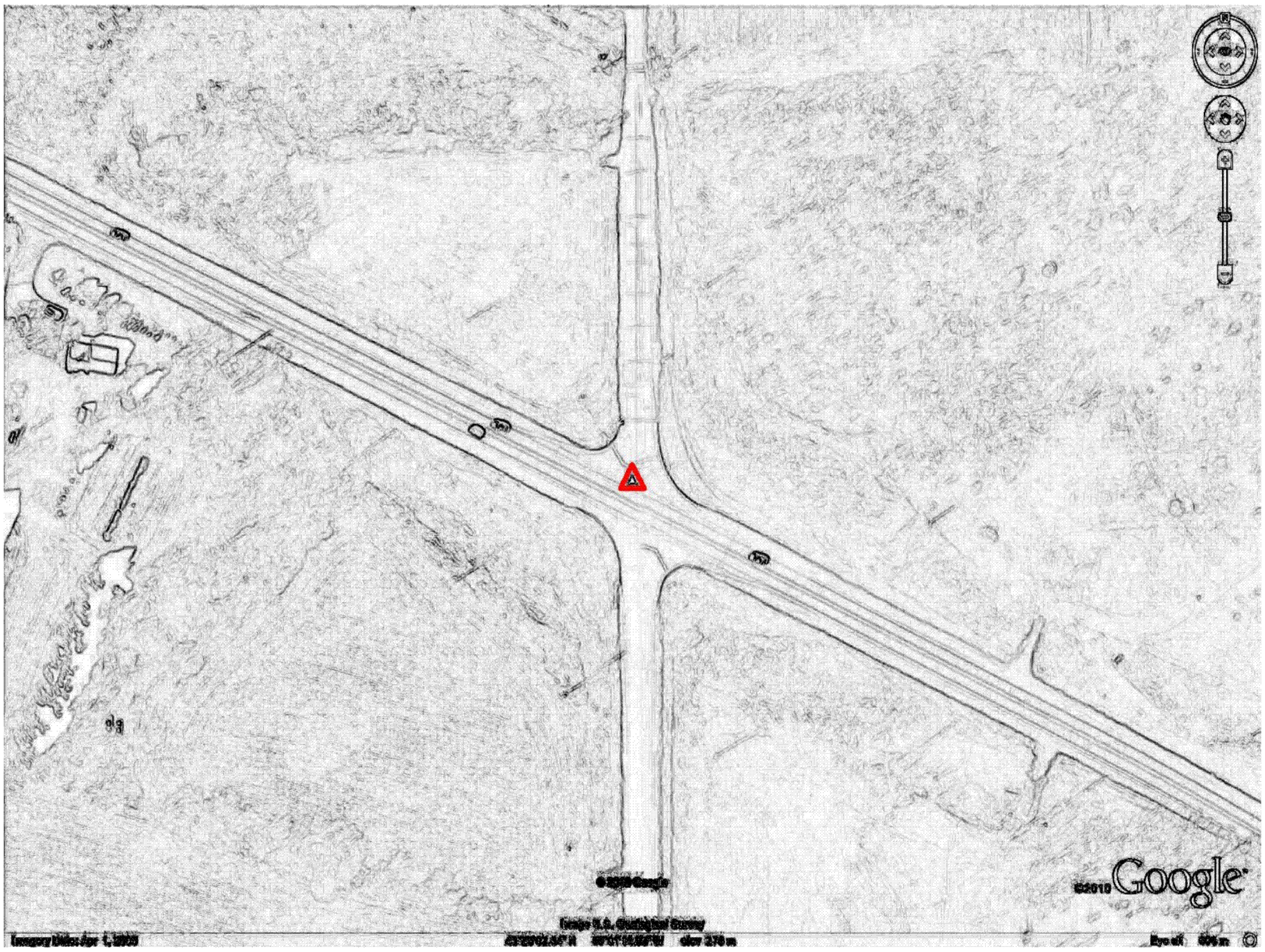
Point was taken at the intersection of CO Rd A and CO Truck HWY H in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

CompassData

GCP Station Diagram for LiDAR

Project Name: Ozaukee	GCP Number: OZK107
CDI Project Number: 1508	Date: 10/30/2010



LiDAR

LiDAR

GPS Antenna Height: 2m

Comments:

Point was taken at the intersection of HWY 33 and Blue Goose Rd in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	Sketch 1 of 1
Collected By: Bryan Frazier	Checked By:

CompassData

GCP Station Diagram for LiDAR

LiDAR

Project Name: Ozaukee	GCP Number: OZK108
CDI Project Number: 1508	**Date:** 10/30/2010

GPS Antenna Height: 2m

Comments:

Point was taken at the intersection of Co Hwy O and the entrance to Tendick Nature Park in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	Sketch 1 of 1
Collected By: Bryan Frazier	**Checked By:**

LiDAR

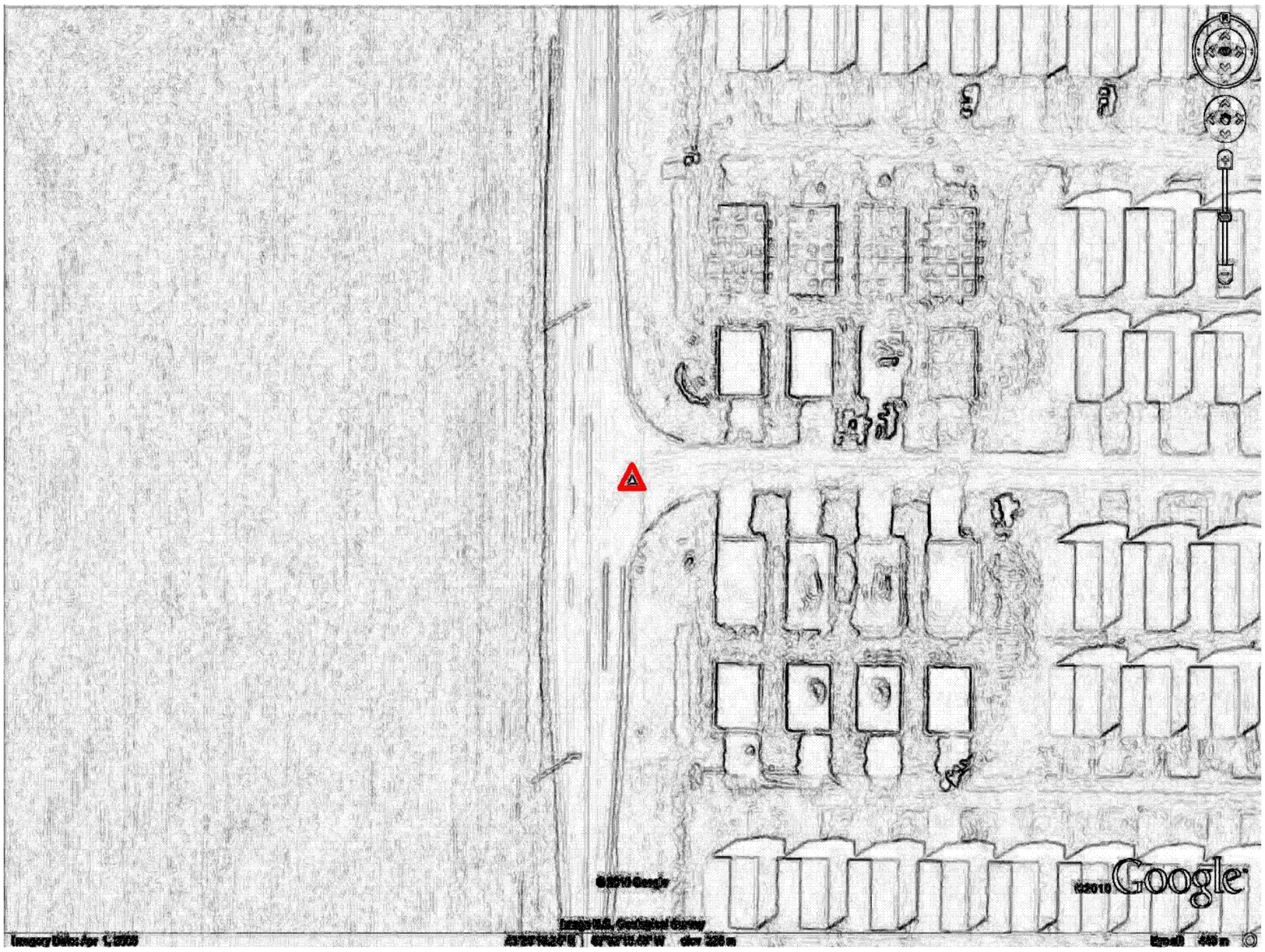
CompassData

GCP Station Diagram for LiDAR

LiDAR

LiDAR

Project Name: Ozaukee	**GCP Number:** OZK109
CDI Project Number: 1508	**Date:** 10/30/2010



GPS Antenna Height: 2m

Comments:

Point was taken at the intersection of Co Rd KW and entrance to a small industrial area consisting of several storage buildings with blue roofs in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

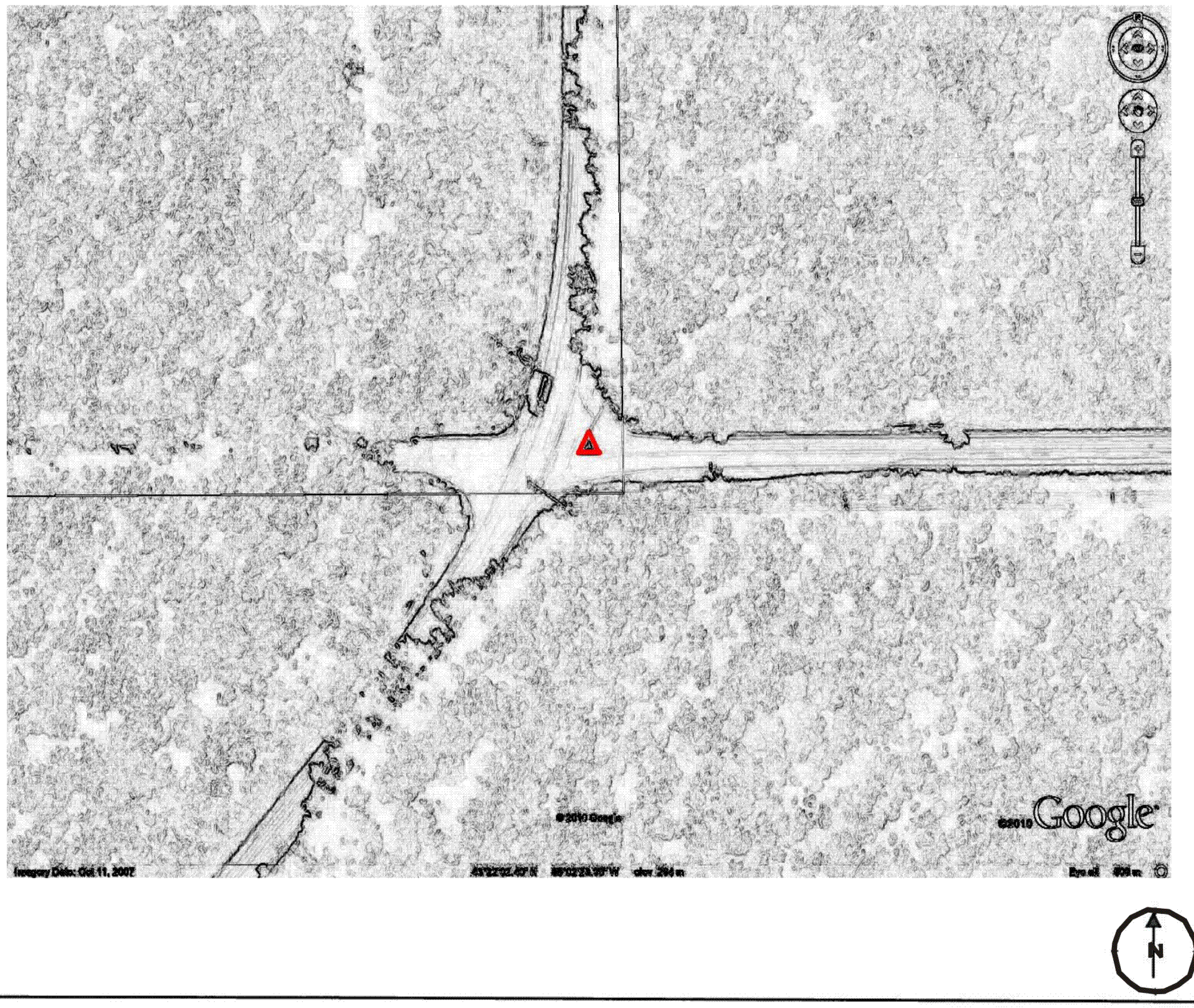
CompassData

GCP Station Diagram for LiDAR

LiDAR

LiDAR

Project Name: Ozaukee	**GCP Number:** OZK110
CDI Project Number: 1508	**Date:** 10/29/2010



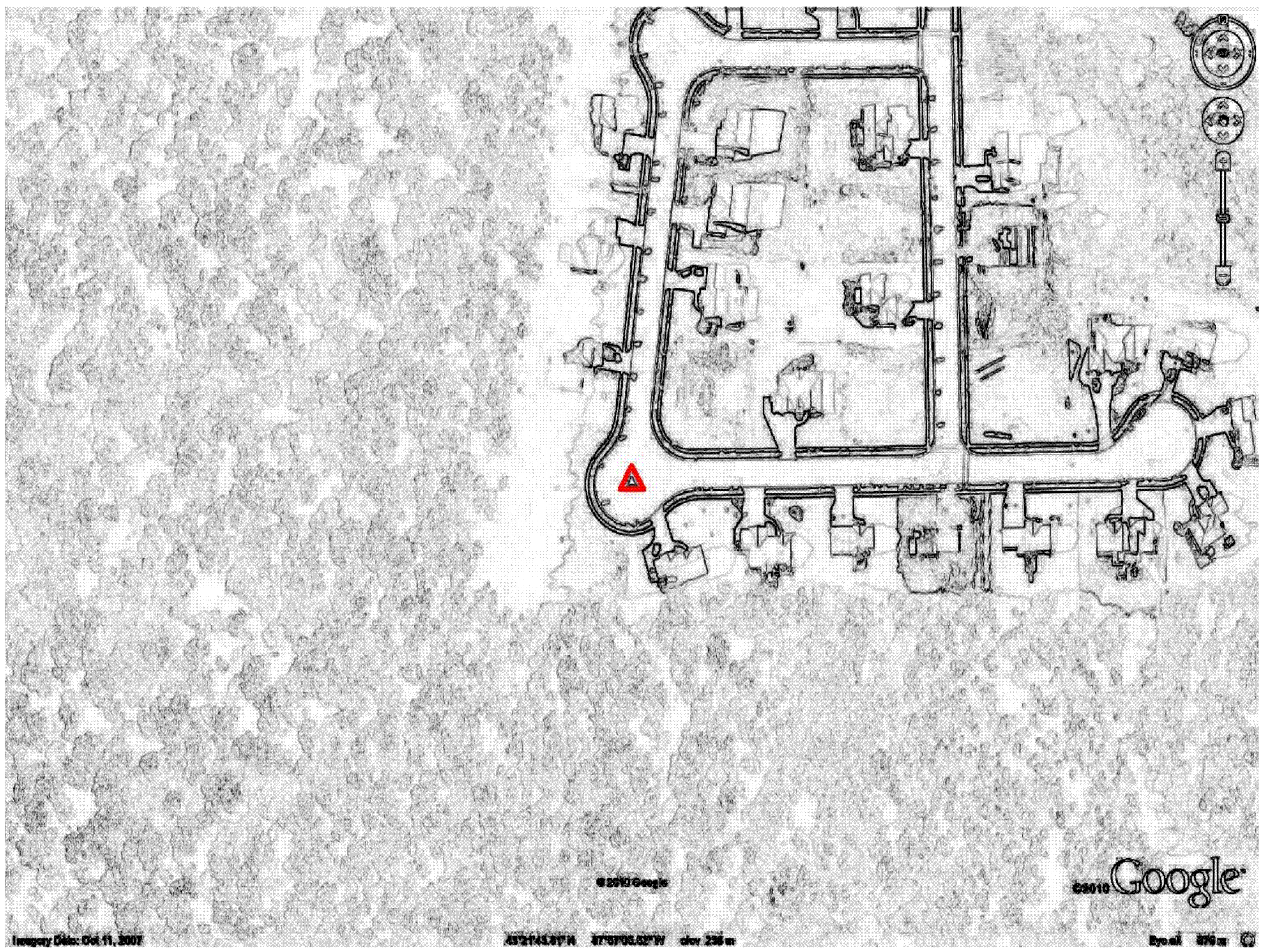
GPS Antenna Height: 2m	
Comments: Point was taken at the intersection of Co Rd Y and Cedar Sauk Rd in Lone Island County, Wisconsin	
Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

CompassData

GCP Station Diagram for LiDAR

LiDAR

Project Name: Ozaukee	GCP Number: OZK111
CDI Project Number: 1508	Date: 10/30/2010



GPS Antenna Height: 2m

Comments:

Point was taken in a cul-de-sac at W Arcadia Dr and Dahlia Ln in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	Sketch 1 of 1
Collected By: Bryan Frazier	Checked By:

LiDAR

CompassData

GCP Station Diagram for LiDAR

LiDAR

LiDAR

Project Name: Ozaukee	**GCP Number:** OZK112
CDI Project Number: 1508	**Date:** 10/30/2010

GPS Antenna Height: 2m

Comments:

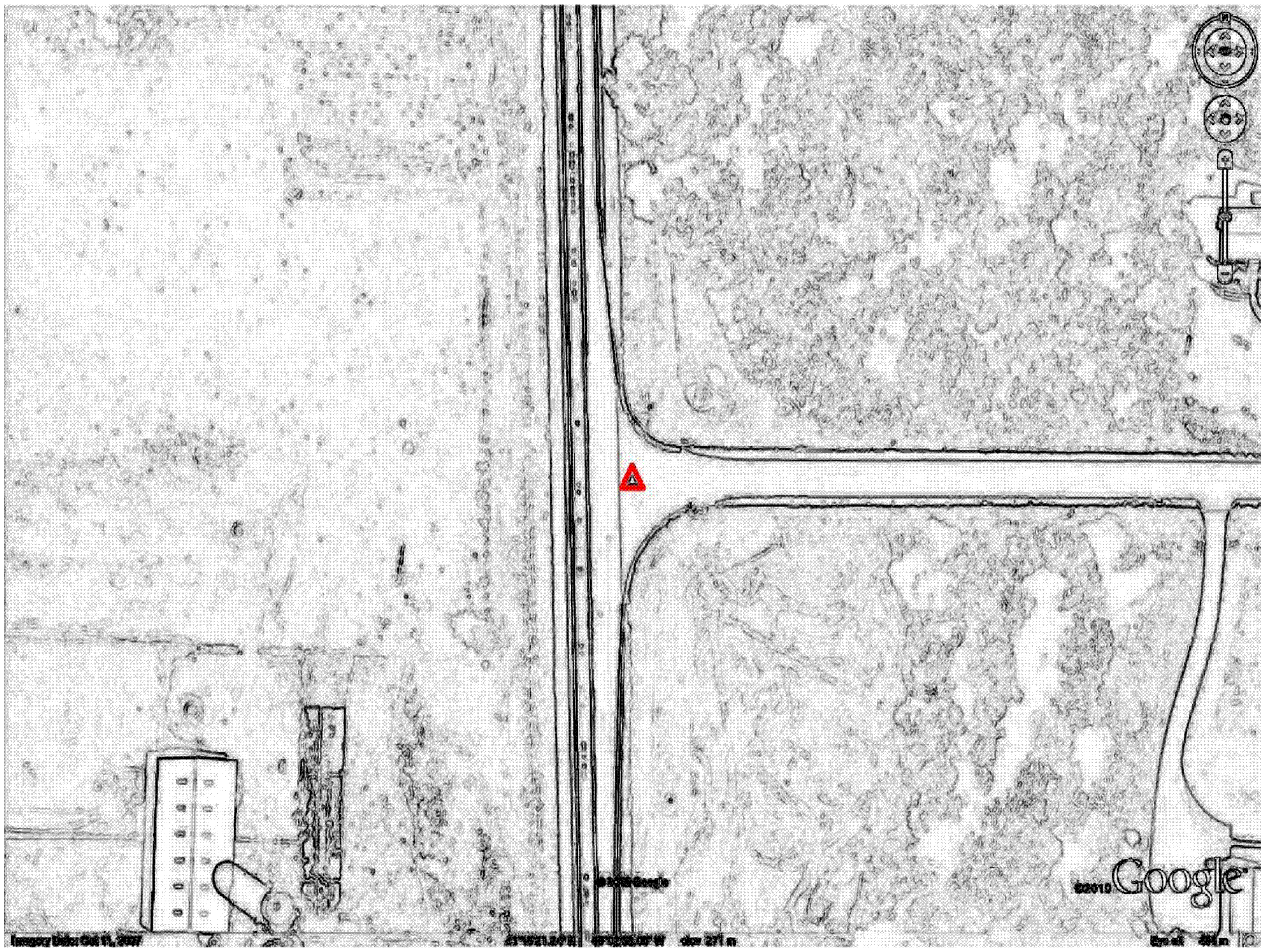
Point was taken in a field west of CO Rd C approx. .58 miles north of Stonecroft Dr in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

CompassData

GCP Station Diagram for LiDAR

Project Name: Ozaukee	GCP Number: OZK113
CDI Project Number: 1508	Date: 10/29/2010



LiDAR

LiDAR

GPS Antenna Height: 2m

Comments:

Point was taken at the intersection of Granville Rd and Ridgefield Ct in Ozaukee County, Wisconsin

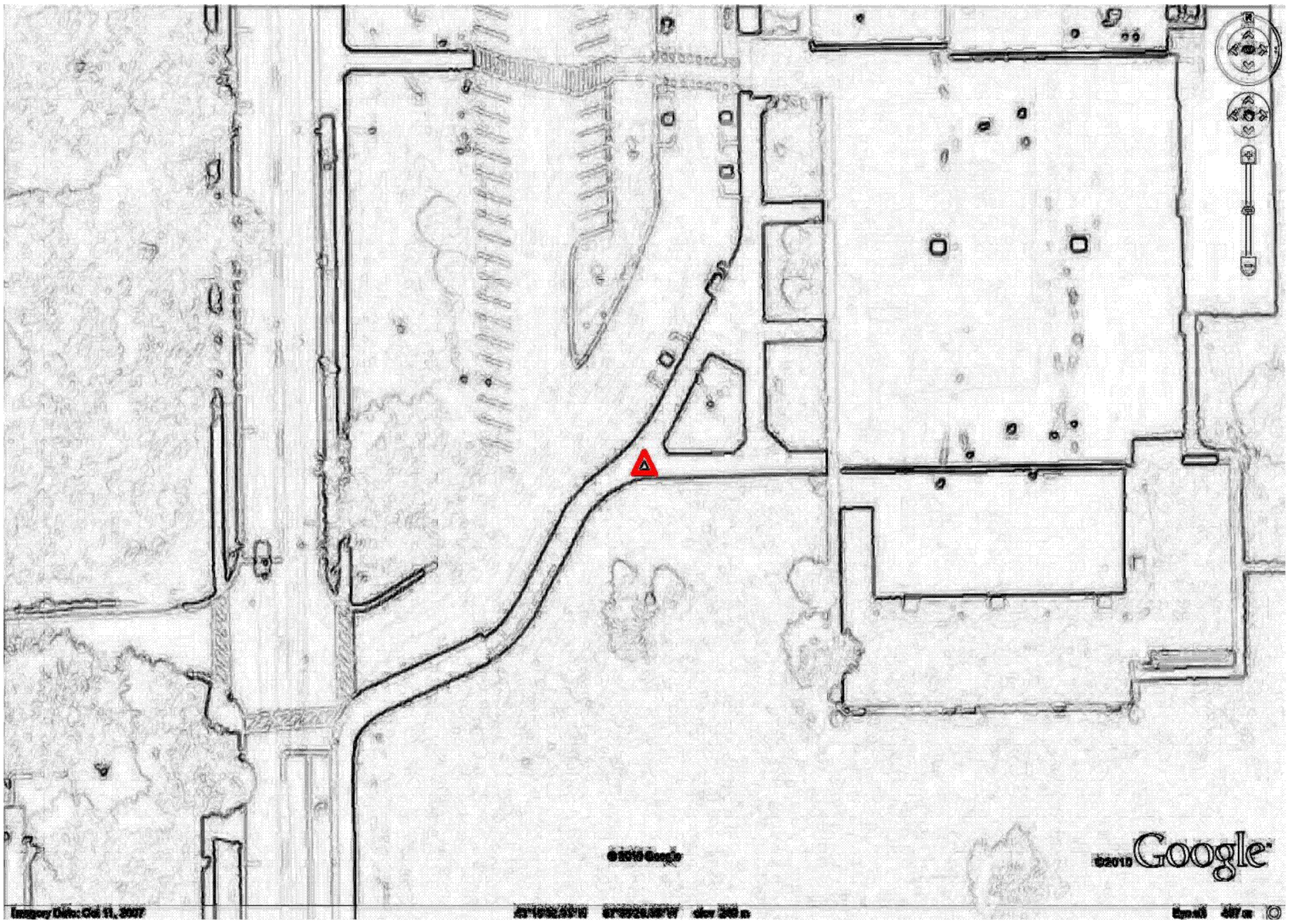
Disk (Roll) / Frame Number:	Sketch 1 of 1
Collected By: Bryan Frazier	Checked By:

CompassData

GCP Station Diagram for LiDAR

LiDAR

Project Name: Ozaukee	**GCP Number:** OZK114
CDI Project Number: 1508	**Date:** 10/29/2010



GPS Antenna Height: 2m

Comments:

Point was taken on school property at sidewalk just southwest of flagpole east of Keup Rd.
Ozaukee County Illinois.

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

LiDAR

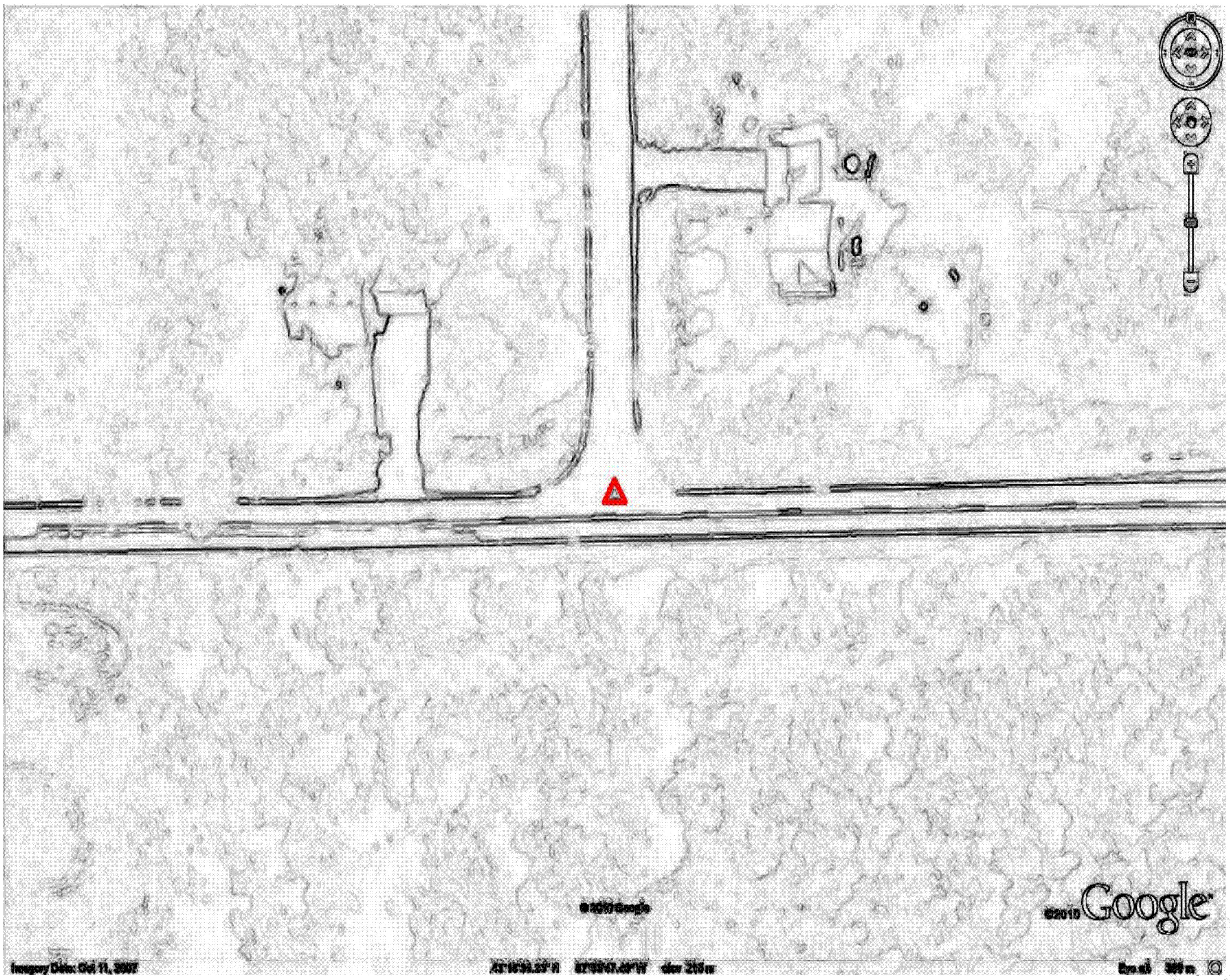
CompassData

GCP Station Diagram for LiDAR

LiDAR

LiDAR

Project Name: Ozaukee	GCP Number: OZK115
CDI Project Number: 1508	Date: 10/29/2010



GPS Antenna Height: 2m

Comments:

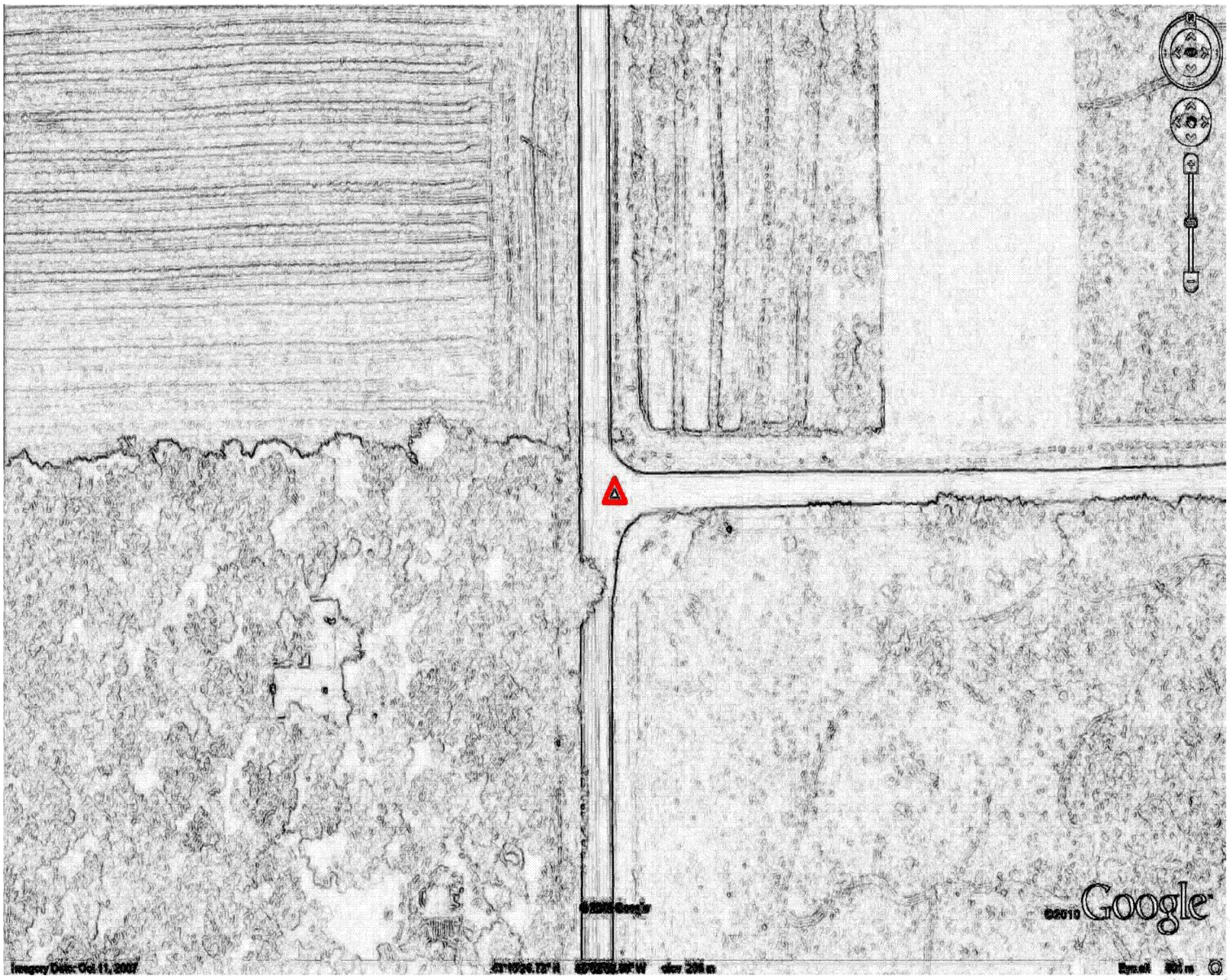
Point was taken at the intersection of Falls Rd and Lakeland Rd in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	Sketch 1 of 1
Collected By: Bryan Frazier	Checked By:

CompassData

GCP Station Diagram for LiDAR

Project Name: Ozaukee	**GCP Number:** OZK116
CDI Project Number: 1508	**Date:** 10/29/2010



GPS Antenna Height: 2m

Comments:

Point was taken at the intersection of N Granville Rd and Hawthrone Rd in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

LiDAR

LiDAR

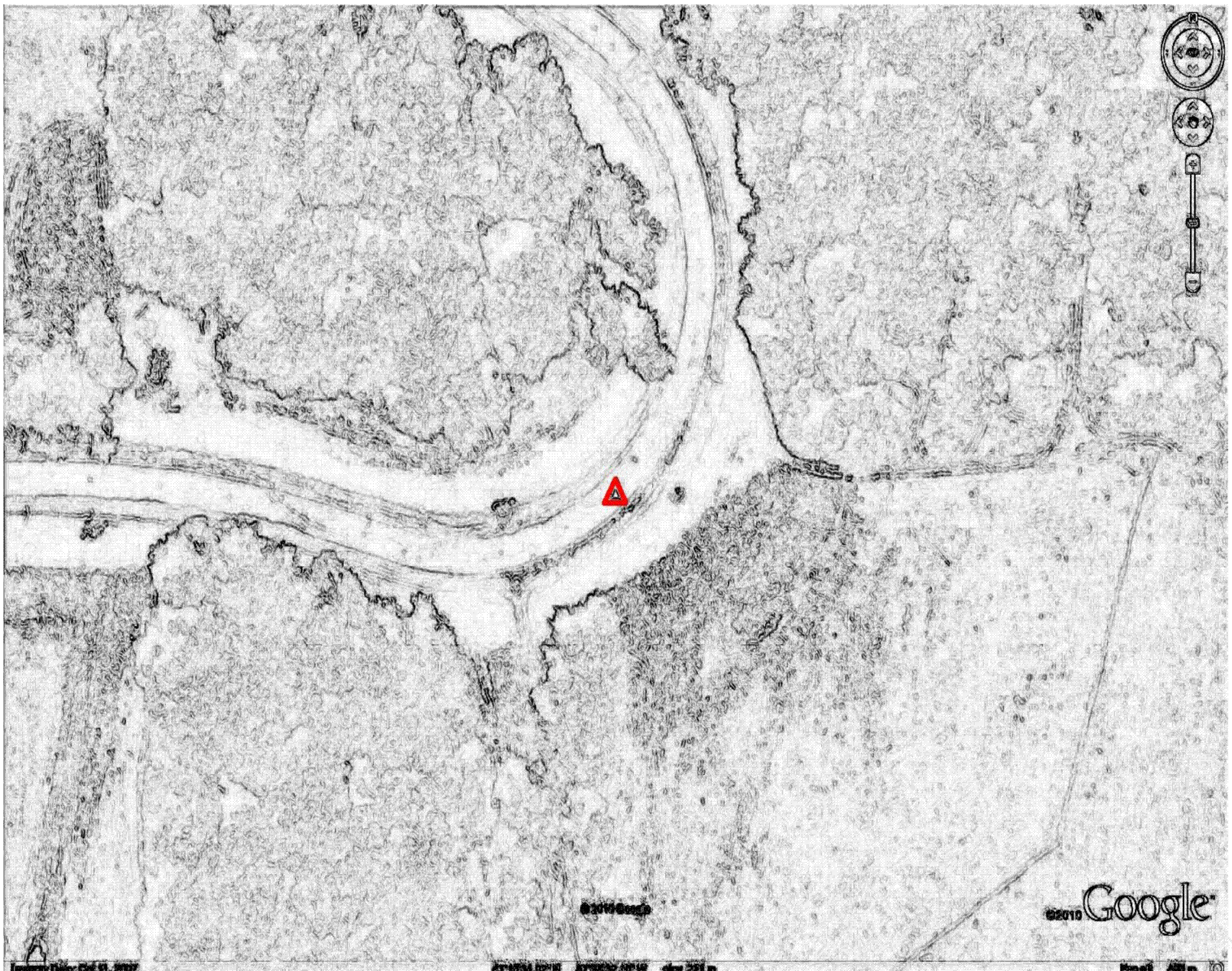
CompassData

GCP Station Diagram for LiDAR

LiDAR

LiDAR

Project Name: Ozaukee	**GCP Number:** OZK117
CDI Project Number: 1508	**Date:** 10/29/2010



GPS Antenna Height: 2m

Comments:

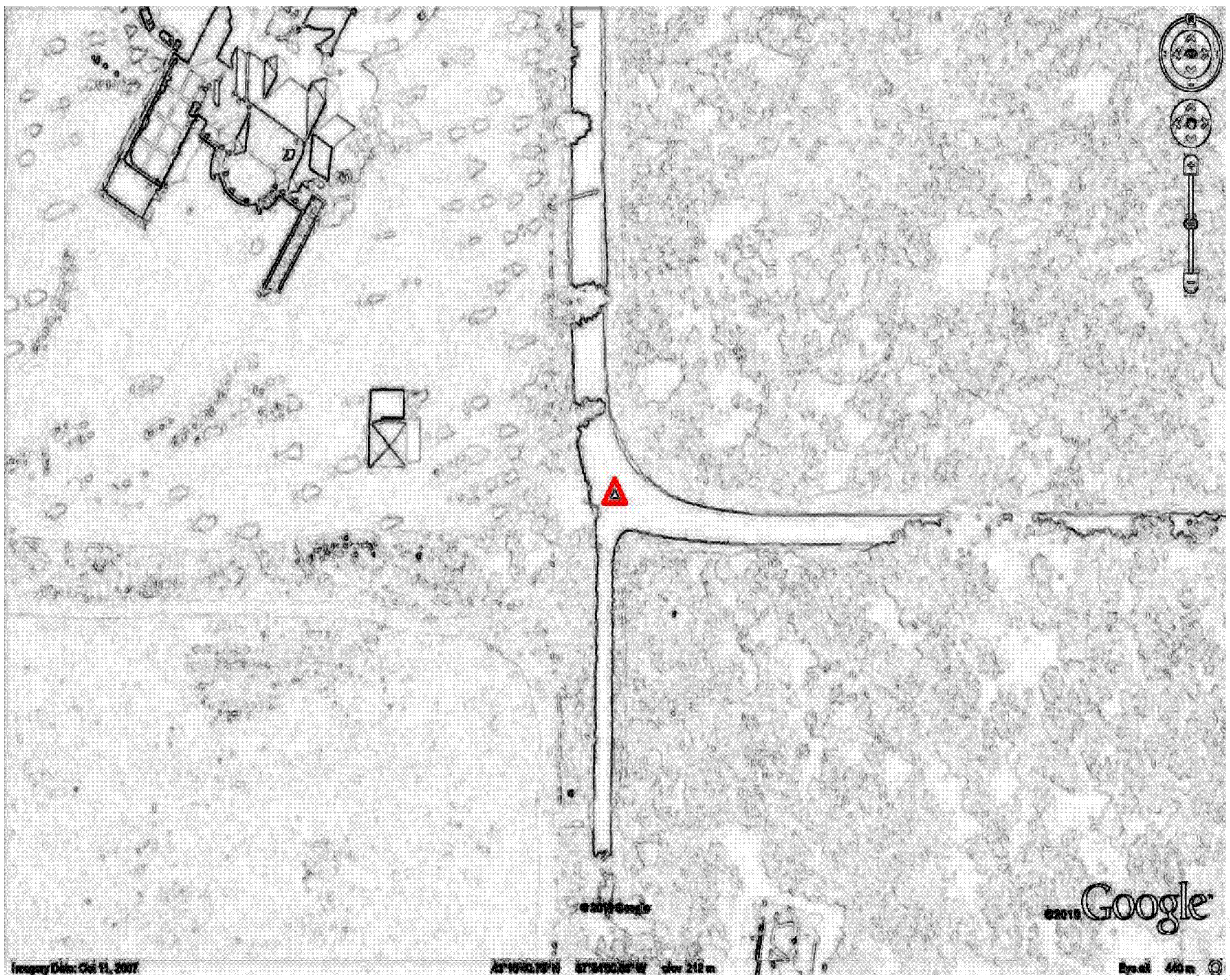
Point was taken in a new development east of Green Bay Rd and east of Mee-Kwon Park Golf Course in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

CompassData

GCP Station Diagram for LiDAR

Project Name: Ozaukee	**GCP Number:** OZK118
CDI Project Number: 1508	**Date:** 10/29/2010



GPS Antenna Height: 2m

Comments:

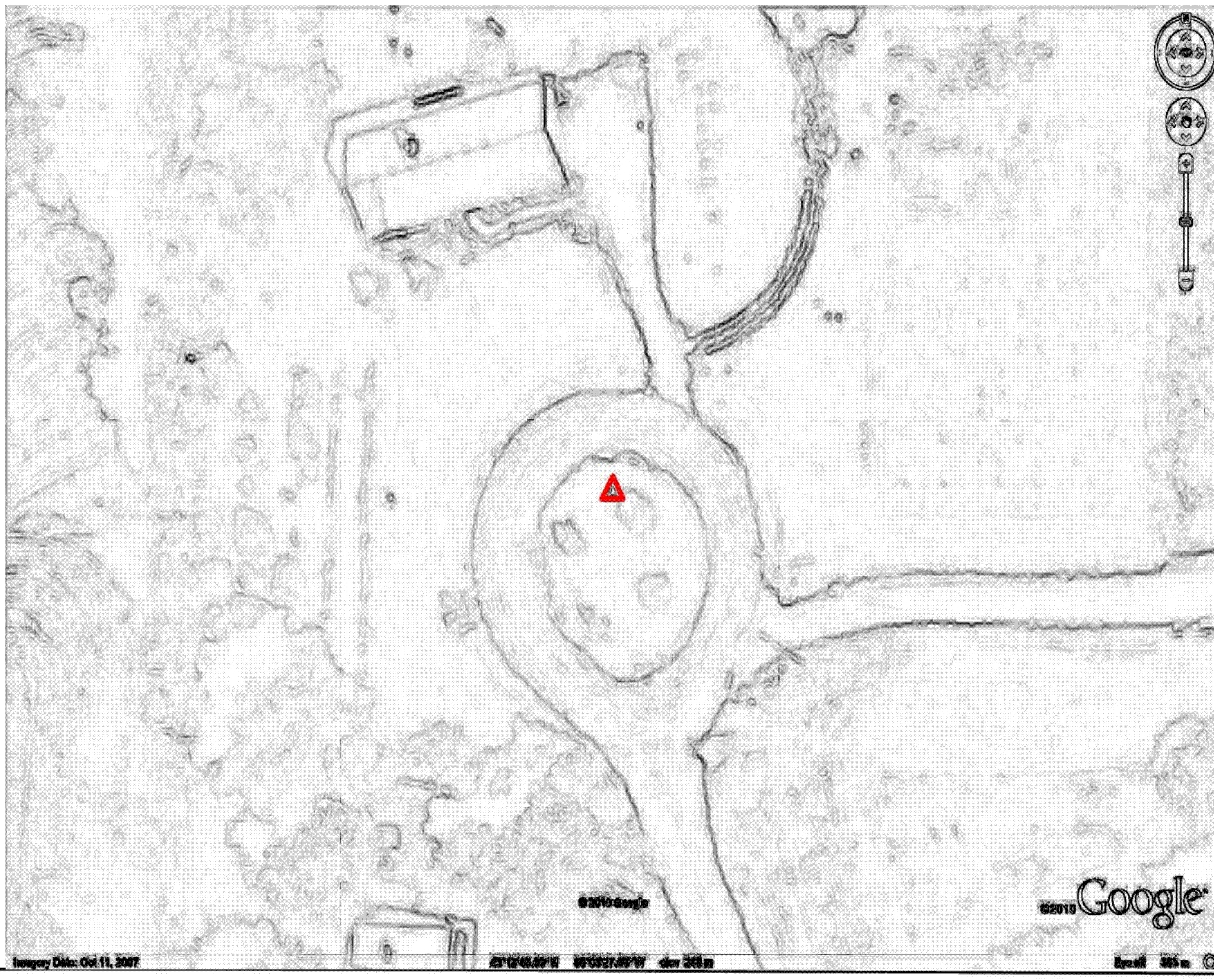
Point was taken on the corner of N Northwood Ln and W Bonness Ln in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

CompassData

GCP Station Diagram for LiDAR

Project Name: Ozaukee	GCP Number: OZK119
CDI Project Number: 1508	Date: 10/29/2010



GPS Antenna Height: 2m

Comments:

Point was taken in round-a-bout at the north end of O'Connell Ln in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	Sketch 1 of 1
Collected By: Bryan Frazier	Checked By:

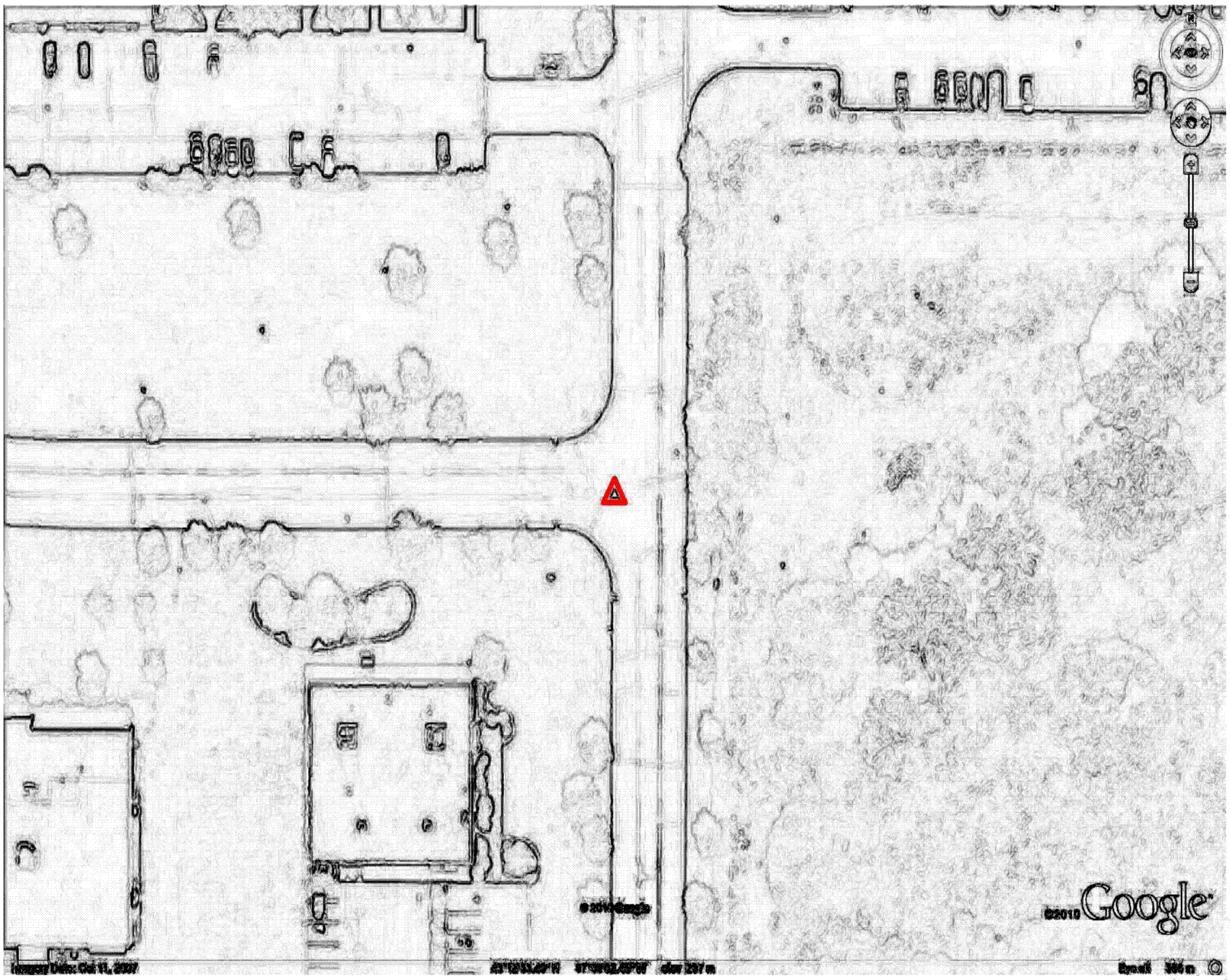
LiDAR

LiDAR

CompassData

GCP Station Diagram for LiDAR

Project Name: Ozaukee	**GCP Number:** OZK120
CDI Project Number: 1508	**Date:** 10/29/2010



GPS Antenna Height: 2m

Comments:

Point was taken in the intersection of Baehr Rd and W Executive Dr in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

CompassData

GCP Station Diagram for LiDAR

Project Name: Ozaukee	**GCP Number:** OZK121
CDI Project Number: 1508	**Date:** 10/29/2010

GPS Antenna Height: 2m

Comments:

Point was taken in the intersection of Wood Crest Ct and Pine Ridge Dr in Ozaukee County, Wisconsin

Disk (Roll) / Frame Number:	**Sketch** 1 **of** 1
Collected By: Bryan Frazier	**Checked By:**

Ozaukee, Wisconsin									
GCP	**Date**	**Vert_Prec**	**Horz_Prec**	**Latitude**	**Longitude**	**Northing**	**Easting**	**HAE**	**MSL**
OZK101	10/30/2010	0.0082	0.0058	43.52734872	-88.02055867	4819884.546	417530.639	234.277	269.469
OZK102	10/30/2010	0.0098	0.0061	43.52885974	-87.92092222	4819958.402	425583.963	218.248	253.539
OZK103	10/30/2010	0.0094	0.0067	43.52850211	-87.81086466	4819826.111	434476.92	177.573	212.986
OZK104	10/30/2010	0.0058	0.0043	43.46901556	-88.03048544	4813416.014	416648.26	222.098	257.208
OZK105	10/30/2010	0.0079	0.0055	43.47048734	-87.92060056	4813475.344	425538.249	212.1	247.35
OZK106	10/30/2010	0.0091	0.0055	43.47035363	-87.8405471	4813392.026	432013.161	187.542	222.892
OZK107	10/30/2010	0.0073	0.004	43.41749422	-88.02083121	4807684.542	417359.047	240.506	275.572
OZK108	10/30/2010	0.0094	0.0055	43.41624758	-87.95257908	4807480.688	422882.816	217.561	252.728
OZK109	10/30/2010	0.0082	0.0061	43.42105918	-87.87098181	4807942.795	429494.235	194.701	229.994
OZK110	10/29/2010	0.0058	0.004	43.36733215	-88.03998593	4802132.862	415738.901	228.824	263.83
OZK111	10/30/2010	0.0076	0.0046	43.36225616	-87.95194139	4801483.985	422866	205.254	240.4
OZK112	10/30/2010	0.0088	0.0055	43.3642333	-87.8842429	4801643.202	428353.833	177.475	212.741
OZK113	10/29/2010	0.0094	0.0052	43.30598676	-88.04396134	4795324.114	415331.605	236.618	271.595
OZK114	10/29/2010	0.0082	0.0055	43.30925776	-87.9740313	4795618.862	421007.412	214.679	249.777
OZK115	10/29/2010	0.0091	0.0058	43.30963502	-87.89659559	4795590.434	427287.823	180.449	215.694
OZK116	10/29/2010	0.0094	0.0061	43.2576447	-88.04334	4789954.86	415314.967	222.255	257.222
OZK117	10/29/2010	0.0101	0.0061	43.25960921	-87.97572771	4790106.757	420805.451	186.965	222.059
OZK118	10/29/2010	0.0091	0.0061	43.26153722	-87.91416435	4790264.391	425804.585	177.126	212.326
OZK119	10/29/2010	0.0091	0.0058	43.21259612	-88.05774167	4784966.722	414082.744	214.207	249.15
OZK120	10/29/2010	0.0079	0.0055	43.20936159	-87.98407065	4784534.5	420062.639	171.559	206.629
OZK121	10/29/2010	0.0091	0.0058	43.21118305	-87.91025348	4784668.905	426061.14	177.453	212.634
Survey Control									
NGS_DE7475	10/30/2010	0.007	0.0043	43.39925018	-87.98507883	4805623.585	420229.442	236.824	271.928
NGS_DF6124	10/29/2010	0.0104	0.0064	43.25086005	-87.99920278	4789157.631	418888.482	197.041	232.091
RASN	10/29/2010			43.03636973	-88.12153575	4765463.885	408638.995	234.374	269.2
WEBE	10/29/2010			43.42054699	-88.14874235	4808158.343	407008.653	771.58	188.655
SHAN	10/30/2010			43.74762833	-87.73478486	4844105.415	440840.068	501.79	270.119
Metadata									
UTM 16 North, NAD83, NAVD88									
All units in meters where applicable.									
MSL = Geiod09									

LIDAR FLIGHT LOG

Ozaukee/Rock
180

RB1

ALTM

MISSION: L103110E
DATE: 103110 RUT?
PILOT: J. Billington
OPERATOR: R. Boe
AIRCRAFT: 73TM

PROJECT NUMBER	LINE NO. & Hdg		GND SPEED (KTS)	SCAN FREQ	SCAN ANGLE	PRF	ALT (m)	TIME START	TIME STOP	Tranzpak Drive	REMARKS
1101025			165	40.3	17	20	1500m	534	545	180	STATIC / T105BM
Fema Lidar	Test 1							2251	2251		
Ozaukee Cty	Test 2							2252	2252		
	1	S	165	40.3	17	20	1500m	2253	2255		
	2	N	165	40.3	17			2259	2301		
	3	S	165	40.3				2305	2307		
	4	N	165	40.3				2310	?		Lots of error codes after line
	5	S	165	40.3				2316	2319		Lots of errors throughout line
	6	N	165	40.3				2323	?		Errors / Reboot!
	7	S	165	40.3				2334	2336		Errors! Change settings / Slow speed
	8	N	150	38.4				2340	2343		Errors
	Test 3										Errors
	Test 4										Errors
								1800			RTB / STATIC

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC START:	STOP:	NOTES:
1101025	[illegible]	8	All	1.0	—	1734 to 1800.	—	Range Header Errors / DT Clipped a value
						WX SCT 3700		

AERO-METRIC, INC. N.6216 Resource Drive Sheboygan Falls, WI. 53085 PHONE: 920-467-2655 **FAX: 920-457-1451** E-Mail: amephoto@aerometric.com

Nov 01 10 11:20a Aero-Metric Hangar 920-467-1220 p.1

LIDAR FLIGHT LOG

MISSION: L111110A DATE: 11-10-2010 Veteran's Day **ALTM** RB1

PILOT: CAM/KELLY OPERATOR: R. BOLL AIRCRAFT: 73TM

PROJECT NUMBER	LINE NO. & Hdg		GND SPEED (KTS)	SCAN FREQ	SCAN ANGLE	PRF	ALT (m)	TIME START	TIME STOP	Tranzpak Drive	REMARKS
1101025	—		—	≈40	17	70	1500m	2114	2120	180	STATIC / T/O SBM
Ozaukee	2 Test Fires		152	39.3				2130	2132		
Fema Lidar	1	S	157	39.3				2132	2134		
	2	N	152	40.3				2139	2141		
29"	3	S	155	39.0				2146	2148		
23"	4	N	155	39.0				2153	2155		
	5	S	155	39.0				2200	2203		
	6	N	155	39.0				2207	2210		[redacted]
	7	S	155	39.0				2215	2218		
	8	N	155	39.0				2222	2226		
	9	S	155	39.0				2230	2234		Virga (Laser shut off 2m after line)
	56	S	153	39.0							move west side prj (Rain)
East	X	Tie	153	39.0				2246	2247		eye safe shut off
West	X	Tie	153	39.0				2251	2252		
								2304	2309		LAND SBM / STATIC

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START:	STOP:	NOTES:
○ 1101025	56	9	45	1.7	—		2114	2309	
○						WX OVC 6500 LT RN Devl'pd			
○									

AERO-METRIC, INC. N.6216 Resource Drive Sheboygan Falls, WI. 53085 PHONE: 920-467-2655 **FAX: 920-457-1451** E-Mail: amephoto@aerometric.com

Flight Log

Project Number: 0
S/N : 0
Operator : ???
Pilot(s) : ???
Aircraft : ???
Airport : ???
Mission : ???
Wheels Up : ???
Flight Length :
HOBBS Start :
HOBBS End :

Weather

Date : November 11, 2010
Julian Day : 315
Temperature : ???
Visibility : ???
Clouds : ???
Precipitation : ???
Wind Dir : ???
Wind Speed : ???
Pressure : ???

Statistics

Laser Time : 00:23:33

START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV	RC	HDG	Plan File
21:30:44.677	21:31:04.078	1	1719	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
21:31:18.878	21:31:33.178	1	1716	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
21:32:19.978	21:34:24.678	1	1680	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
21:39:11.879	21:41:31.879	2	1662	70	40.30	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
21:46:29.08	21:48:56.28	3	1664	70	39.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
21:53:15.481	21:55:57.481	4	1662	70	39.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
22:00:23.382	22:03:16.583	5	1665	70	39.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
22:07:34.583	22:10:36.484	6	1663	70	39.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
22:15:10.385	22:18:37.486	7	1666	70	39.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
22:22:42.787	22:26:08.187	8	1662	70	39.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
22:51:27.393	22:52:38.694	1	1670	70	39.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.

LIDAR FLIGHT LOG

RB1

MISSION: L111510A **DATE:** 11-15-2010

PILOT: G. Howe / J. Billington **OPERATOR:** R. Boll **AIRCRAFT:** 73TM

PROJECT NUMBER	LINE NO. & Hdg		GND SPEED (KTS)	SCAN FREQ	SCAN ANGLE	PRF	ALT (m)	TIME START	TIME STOP	Tranzpak Drive	REMARKS
1101025				40	17	70	1500m	1436	1441	180	STATIC / T/O SBM
Ozaukee	Test							1452			
Fema LIDAR	10	S	160	40	17	70	1500	1452	1456		
	11	N	165	40				1500	1504		
	12	S	165	40				1509	1513		
	13	N	165	40				1518	1522		
	14	S	165	40				1527	1533		
	15	N	165	40				1537	1543		
	16	S	165	40				1548	1555		
	17	N	165	40				1601	1608		
	18	S	165	40				1615	1623		
	19	N	165	40				1626	1634		
	20	S	165	40				1639	1648		
	21	N	165	40				1653	1701		
	22	S	165	40				1708	1717		
	23	N	165	40				1720	1728		
	24	S	165	40				1731	1739		
	25	N	165	40				1742	1744		Cu / No Line good
	X	Tie	165	40				1749	1751		
								1849	1854		Land SBM / STATIC

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC START:	STATIC STOP:
1101025	56	15	32	4.0	—	1436	1854

WX High Cloud → Cu forming → LYR @ 5500 moved in

NOTES:

AERO-METRIC, INC. N.6216 Resource Drive Sheboygan Falls, WI. 53085 PHONE: 920-467-2655 **FAX: 920-457-1451** E-Mail: amephoto@aerometric.com

Flight Log

```
Project Number: 0
S/N           : 0
Operator      : ???
Pilot(s)      : ???
Aircraft      : ???
Airport       : ???
Mission       : ???
Wheels Up     : ???
Flight Length :
HOBBS Start   :
HOBBS End     :
```

Weather

```
Date          : November 15, 2010
Julian Day    : 319
Temperature   : ???
Visibility    : ???
Clouds        : ???
Precipitation : ???
Wind Dir      : ???
Wind Speed    : ???
Pressure      : ???
```

Statistics

```
Laser Time    : 01:37:39
```

START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV	RC	HDG	Plan File
14:52:06.757	14:52:16.657	10	1719	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
14:52:28.857	14:52:33.957	10	1719	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
14:52:28.857	14:56:09.757	10	1704	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
15:00:47.157	15:04:23.857	11	1706	70	40.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
15:09:34.657	15:13:39.657	12	1710	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
15:18:09.558	15:22:34.858	13	1696	70	40.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
15:27:18.858	15:33:08.759	14	1701	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
15:37:06.259	15:43:02.26	15	1702	70	40.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
15:48:17.66	15:55:22.961	16	1707	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
16:01:10.962	16:08:18.963	17	1628	70	40.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
16:15:03.364	16:23:23.965	18	1681	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
16:26:27.166	16:34:33.367	19	1675	70	40.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
16:39:55.168	16:48:08.17	20	1687	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.

16:53:39.271	17:01:47.672	21	1682	70	40.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
17:08:35.274	17:17:04.576	22	1687	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
17:19:58.876	17:28:07.578	23	1682	70	40.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
17:31:16.679	17:39:36.081	24	1687	70	40.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
17:49:27.683	17:51:48.484	9	1678	70	40.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.

LIDAR FLIGHT LOG

ALTM J51

MISSION: L111610A **DATE:** 11-16-10 TUE

PILOT: GLEN H. **OPERATOR:** JIM **AIRCRAFT:** N73TM

PROJECT NUMBER	LINE NO.	Hdg	GND SPEED (KTS)	SCAN FREQ	SCAN ANGLE	PRF	ALT (m)	TIME START	TIME STOP	Tranzpak Drive	REMARKS
1101025							GMT	14:40	14:56	180	FERRY: SBM → SITE .2
OZAUKEE CO.	TEST				17	70	1500	14:56	14:57		
	TEST							14:57	14:57		
	25	180	155	39				14:58	15:06		
	26	360						15:11	15:19		
	27	180	160	39.6				15:24	15:32		
	28	360						15:38	15:46		
	29	180						15:52	16:00		
	30	360						16:04	16:12		
	31	180						16:18	16:26		
	32	360						16:30	16:38		
	33	180						16:43	16:51		
	34	360						16:55	17:03		
	35	180						17:09	17:17		
	36	360						17:21	17:29		
	37	180						17:33	17:41		
	38	360						17:45	17:53		
	39	180						17:58	18:06		
	CROSS	E						18:10	18:13		
	38.5	360						18:18	18:19		GAP AREAS → J52

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START:	STOP:
Ø 1101025						4.3	14:40	19:01
Ø OZAUKEE	56	39	17	3.9	.4	BKN OK TO OVC	VIS 4.5	
O								

NOTES:

AERO-METRIC, INC. N.6216 Resource Drive Sheboygan Falls, WI. 53085 PHONE: 920-467-2655 **FAX: 920-457-1451** E-Mail: amephoto@aerometric.com

LIDAR FLIGHT LOG

MISSION: L111610A **DATE:** 11-16-10 TUE

PILOT: GLEN H. **OPERATOR:** JIM **AIRCRAFT:** N73TM

ALTM

JS2

PROJECT NUMBER	LINE NO.	Hdg	GND SPEED (KTS)	SCAN FREQ	SCAN ANGLE	PRF	ALT (m)	TIME START	TIME STOP	Tranzpak Drive	REMARKS
110125	35.5	360	160	39.6	17	70	GMT	18:20	18:23	180	GAP AREAS
OZAUKEE CO.	39	360						18:24	18:26		" "
	37	180						18:30	18:32		" "
	33.5	180						18:33	18:34		
	29.5	180						18:35	18:36		
	28.5	360						18:40	18:42		
	26.5	360						18:43	18:44		
	24.5	360						18:45	18:47		
									19:01		FERRY: SITE → SBM .2

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START:	STOP:	NOTES:
○									
○						WX			
○									

AERO-METRIC, INC. N.6216 Resource Drive Sheboygan Falls, WI. 53085 PHONE: 920-467-2655 **FAX: 920-457-1451** E-Mail: amephoto@aerometric.com

Flight Log

Project Number: 1101025
S/N : Ozaukee County
Operator : Jim
Pilot(s) : Glen
Aircraft : N73TM
Airport : KSBM
Mission : L111610A
Wheels Up : ???
Flight Length : 4.3
HOBBS Start : 14:40
HOBBS End : 19:01

Weather

Date : November 16, 2010
Julian Day : 320
Temperature : ???
Visibility : 4
Clouds : BKN-OVC 6K
Precipitation : ???
Wind Dir : ???
Wind Speed : ???
Pressure : ???

Statistics

Laser Time : 02:15:41

START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV	RC	HDG	Plan File
14:56:33.763	14:57:06.063	25	1725	70	40.30	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
14:57:15.663	14:57:36.063	25	1731	70	40.30	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
14:58:43.263	15:06:52.764	25	1720	70	39.00	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
15:11:57.865	15:19:31.965	26	1719	70	39.00	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
15:24:33.666	15:32:32.367	27	1721	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
15:38:39.268	15:46:43.87	28	1717	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
15:52:30.671	16:00:32.072	29	1721	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
16:04:33.673	16:12:34.374	30	1716	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
16:18:29.876	16:26:39.977	31	1714	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
16:30:39.178	16:38:39.58	32	1703	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
16:43:45.781	16:51:39.783	33	1703	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
16:55:43.284	17:03:48.086	34	1699	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
17:09:01.388	17:17:00.59	35	1701	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.

17:21:16.991	17:29:16.593	36	1699	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
17:33:58.094	17:41:58.896	37	1698	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
17:45:49.897	17:53:55.199	38	1695	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
17:58:21.9	18:06:32.603	39	1708	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
18:10:47.404	18:13:34.605	24	1709	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
18:18:27.106	18:19:35.206	38	1705	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
18:18:27.106	18:19:36.606	38	1705	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
18:20:24.106	18:23:11.107	35	1705	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
18:24:33.108	18:26:21.008	39	1707	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
18:30:59.309	18:32:14.31	37	1713	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
18:33:21.81	18:34:20.71	33	1711	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
18:35:33.911	18:36:26.811	29	1712	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
18:40:45.612	18:42:06.712	28	1713	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
18:43:15.413	18:44:56.913	26	1713	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
18:45:49.313	18:46:59.314	24	1712	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.

LIDAR FLIGHT LOG

ALTM

J53

MISSION: L111610B

DATE: 11-16-10 TUE

PILOT: CAM

OPERATOR: JIM

AIRCRAFT: N73TM

PROJECT NUMBER	LINE NO. & Hdg		GND SPEED (KTS)	SCAN FREQ	SCAN ANGLE	PRF	ALT (m)	TIME START	TIME STOP	Tranzpak Drive	REMARKS
1101025							GMT	19:37	19:51	081	FERRY: SBA → SITE .2
OZAUKEE CO.	TEST		160	39.6	17	70	1500	19:51	19:52		
	TEST							19:52	19:52		
	16.5	180						19:52	19:58		GAP AREA (43:21:39, 87:52:66)
	35	360						20:03	20:05		GAP AREA (43:16 - 43:18)
	40	180						20:12	20:21		
	41	360						20:25	20:33		
	42	180						20:38	20:46		
	43	360						20:50	20:58		
	44	180						21:03	21:11		
	45	360						21:15	21:23		
	46	180						21:27	21:35		
	47	360						21:39	21:47		
	48	180						21:51	22:00		
	49	360						22:04	22:12		
	50	180						22:16	22:25		
	51	360						22:29	22:37		
	52	180						22:43	22:48		
	53	360						22:52	22:56		
	54	180						23:00	23:04		→ J54

STATUS		TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START:	STOP:
⊘	1101025	[illegible]					4.2	19:37	23:48
⊗	OZAUKEE	56	56	∅	3.6	.6	WX HIGH THICK CIRRUS		
○							VIS 14		

NOTES:

AERO-METRIC, INC. N.6216 Resource Drive Sheboygan Falls, WI. 53085 PHONE: 920-467-2655 FAX: 920-457-1451 E-Mail: [illegible]

LIDAR FLIGHT LOG

MISSION: L111610B **DATE:** 11-16-10 TUE

PILOT: CAM **OPERATOR:** JIM **AIRCRAFT:** N73TM

ALTM

J54

PROJECT NUMBER	LINE NO. & Hdg		GND SPEED (KTS)	SCAN FREQ	SCAN ANGLE	PRF	ALT (m)	TIME START	TIME STOP	Tranzpak Drive	REMARKS
1101025	55	360	160	39.6	17	70	1500	23:09	23:13	081	
OZAUKEE CO.	56	180	↓	↓	↓	↓	↓	23:18	23:20		
	CROSS	E						23:23	23:25		
									23:48		FERRY: SITE → SBM .4

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START:	STOP:
○								
○						WX		
○								

NOTES:

AERO-METRIC, INC. N.6216 Resource Drive Sheboygan Falls, WI. 53085 PHONE: 920-467-2655 FAX: 920-457-1451 E-Mail: amephoto@aerometric.com

Flight Log

Project Number: 1101025
S/N : Ozaukee County
Operator : Jim
Pilot(s) : Cam
Aircraft : N73TM
Airport : KSBM
Mission : L111610B
Wheels Up : ???
Flight Length : 4.2
HOBBS Start : 19:37
HOBBS End : 23:48

Weather

Date : November 16, 2010
Julian Day : 320
Temperature : ???
Visibility : 4
Clouds : Hi thick cirrus
Precipitation : ???
Wind Dir : ???
Wind Speed : ???
Pressure : ???

Statistics

Laser Time : 02:04:19

START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV	RC	HDG	Plan File
19:51:40.618	19:52:00.918	16	1670	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
19:52:32.318	19:52:54.718	16	1665	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
19:56:45.219	19:58:09.719	16	1664	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
20:03:38.221	20:05:13.321	35	1664	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
20:12:53.123	20:21:07.525	40	1659	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
20:25:24.426	20:33:45.028	41	1657	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
20:38:20.329	20:46:36.231	42	1674	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
20:50:18.432	20:58:40.434	43	1675	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
21:02:52.135	21:11:01.737	44	1681	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
21:15:00.538	21:23:16.24	45	1682	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
21:27:27.241	21:35:45.443	46	1683	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
21:39:34.244	21:47:45.447	47	1683	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
21:51:45.548	22:00:06.65	48	1684	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.

22:04:17.151	22:12:30.153	49	1688	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
22:16:44.754	22:25:08.556	50	1688	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
22:29:00.957	22:37:02.659	51	1687	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
22:43:11.461	22:48:19.062	52	1685	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
22:52:15.464	22:56:41.565	53	1688	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
23:00:39.366	23:04:57.967	54	1688	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
23:09:07.168	23:13:34.569	55	1689	70	39.60	17.00	NAR	OFF	OFF	360.00	Ozaukee_10_23_10_Fixline.
23:18:17.571	23:20:10.071	56	1687	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.
23:23:11.672	23:25:32.672	39	1689	70	39.60	17.00	NAR	OFF	OFF	180.00	Ozaukee_10_23_10_Fixline.

LIDAR FLIGHT LOG

J53

ALTM

MISSION: L112310B **DATE:** 11-23-10 TUE

PILOT: CAM **OPERATOR:** JIM **AIRCRAFT:** N73TM

PROJECT NUMBER	LINE NO.	& Hdg	GND SPEED (KTS)	SCAN FREQ	SCAN ANGLE	PRF	ALT (m)	TIME START	TIME STOP	Tranzpak Drive	REMARKS
1101025							GMT	19:55	20:04	008 WD9564	FERRY: JVL → SITE .2
Rock	TEST				17	70	1500	20:06	20:07		
	TEST							20:07	20:07		
	12	360	155	39.0				20:11	20:20		
	13	180						20:23	20:32		
	14	360						20:36	20:45		
	15	180						20:49	20:58		
	16	360						21:02	21:11		
	17	180						21:15	21:23		
	18	360						21:28	21:37		
	CROSS	E	160	39.6				21:41	21:42		
OZAUKEE	[redacted]										
	TEST							21:52	21:52		
	35	360	155	39.0				22:03	22:12		
	36	180						22:16	22:24		
	37	360						22:28	22:37		
	38	180						22:40	22:49		
	39	360						22:54	23:02		
	CROSS	E	160	39.6				23:06	23:07		.3
									23:24		FERRY: SITE → SBM

STATUS		TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START:	STOP:	NOTES:
⊘	1101025						3.5	19:55	23:24	
⊘	Rock	92	53	39	1.6	.2	WX SKC VIS 20			
⊗	OZAUKEE	5 REFTS	5	Ø	1.4	.3				

Flight Log

Project Number: 1101025
S/N : Ozaukee
Operator : Jim
Pilot(s) : Cam
Aircraft : N73TM
Airport : KJVL/KSBM
Mission : L112310B
Wheels Up : ???
Flight Length : 3.5
HOBBS Start : 19:55
HOBBS End : 23:24

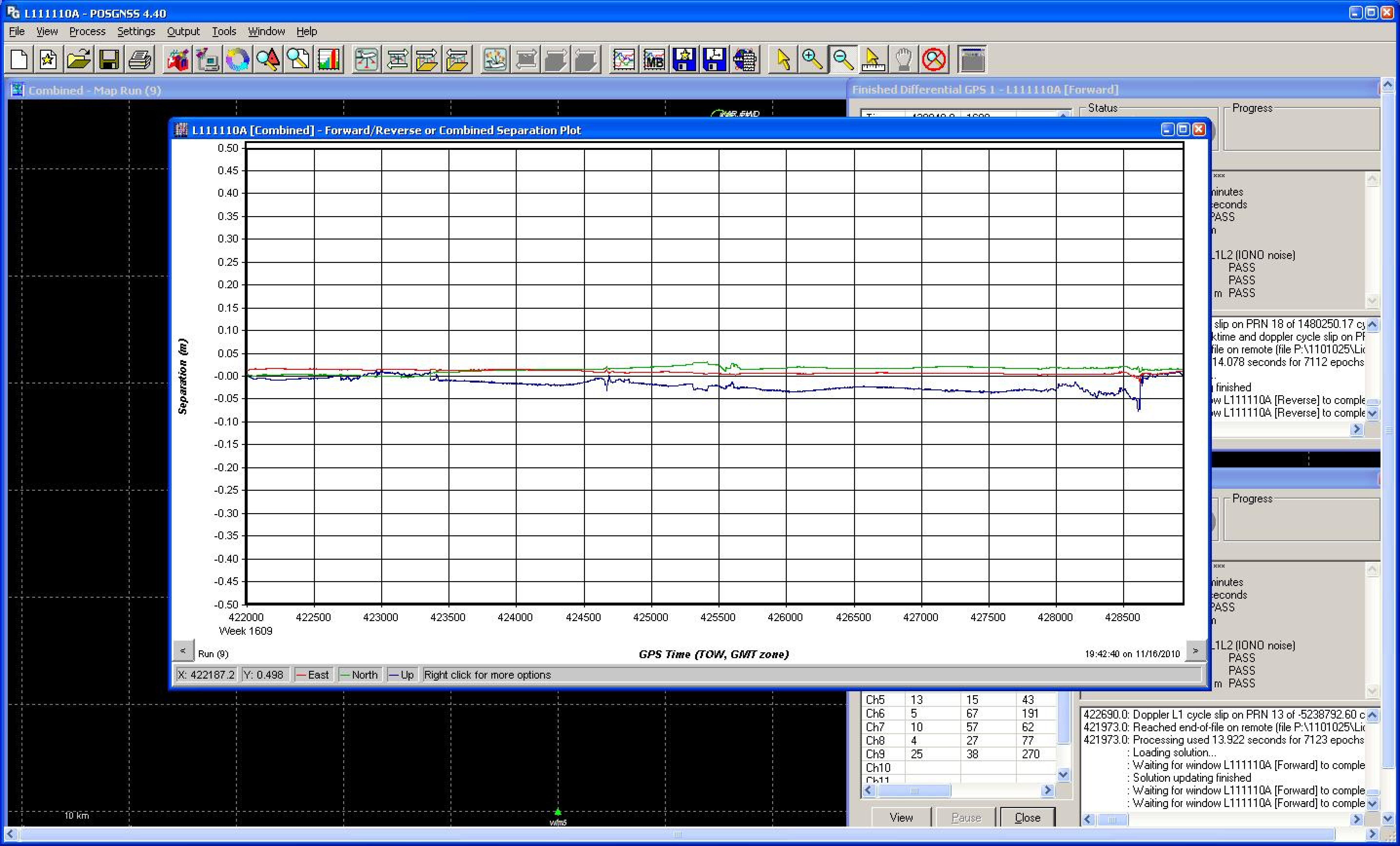
Weather

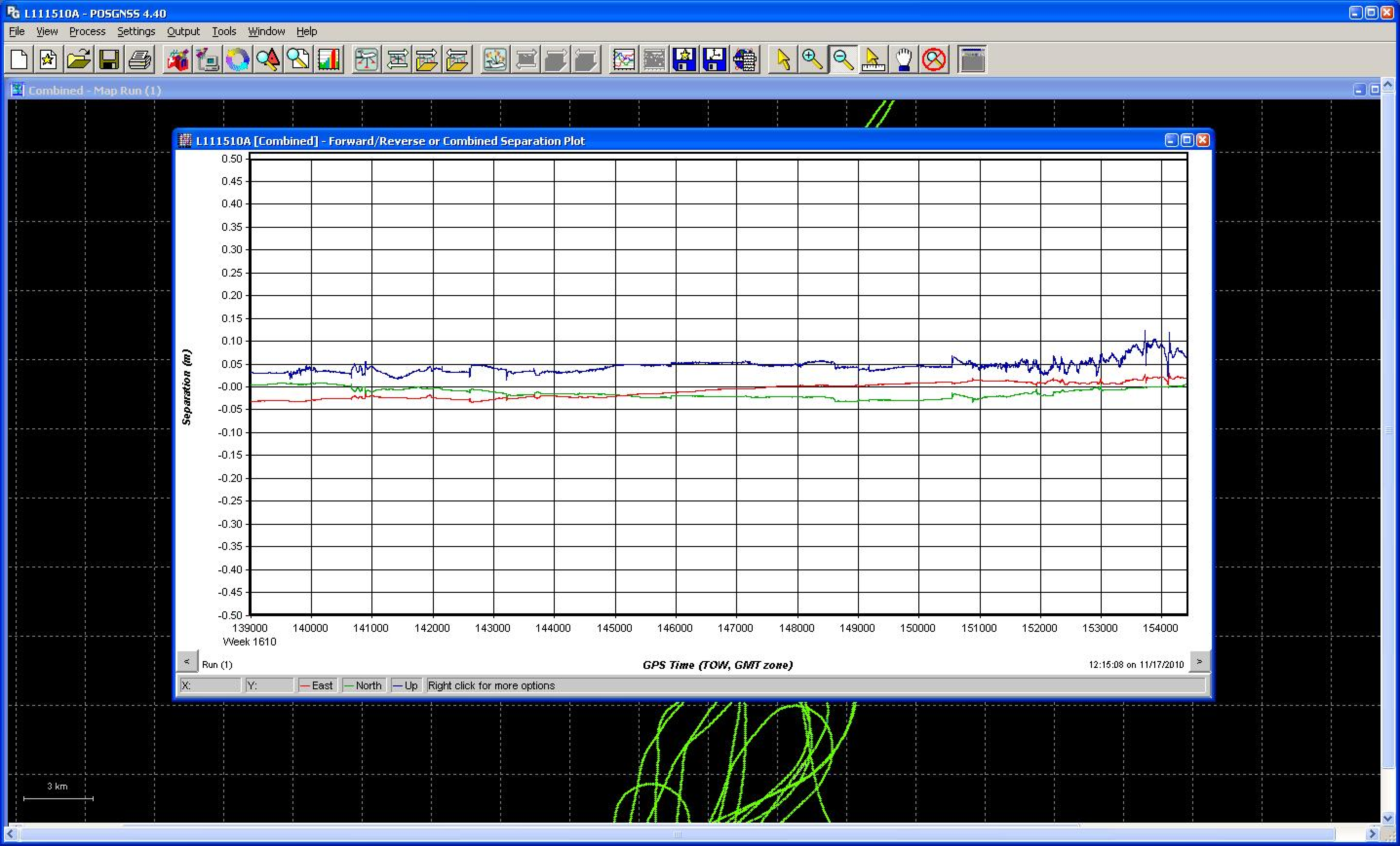
Date : November 23, 2010
Julian Day : 327
Temperature : ???
Visibility : ???
Clouds : ???
Precipitation : ???
Wind Dir : ???
Wind Speed : ???
Pressure : ???

Statistics

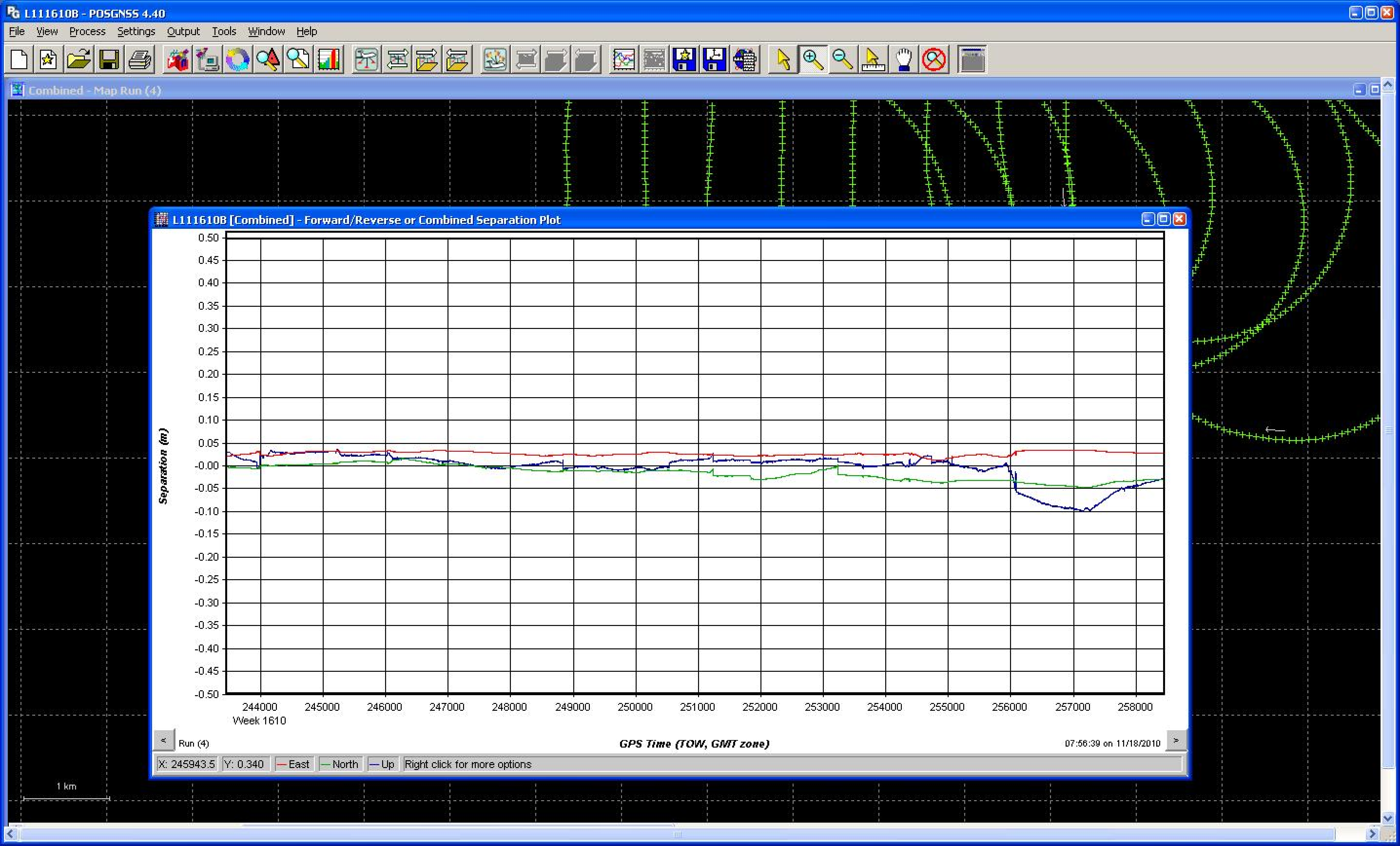
Laser Time : 00:44:11

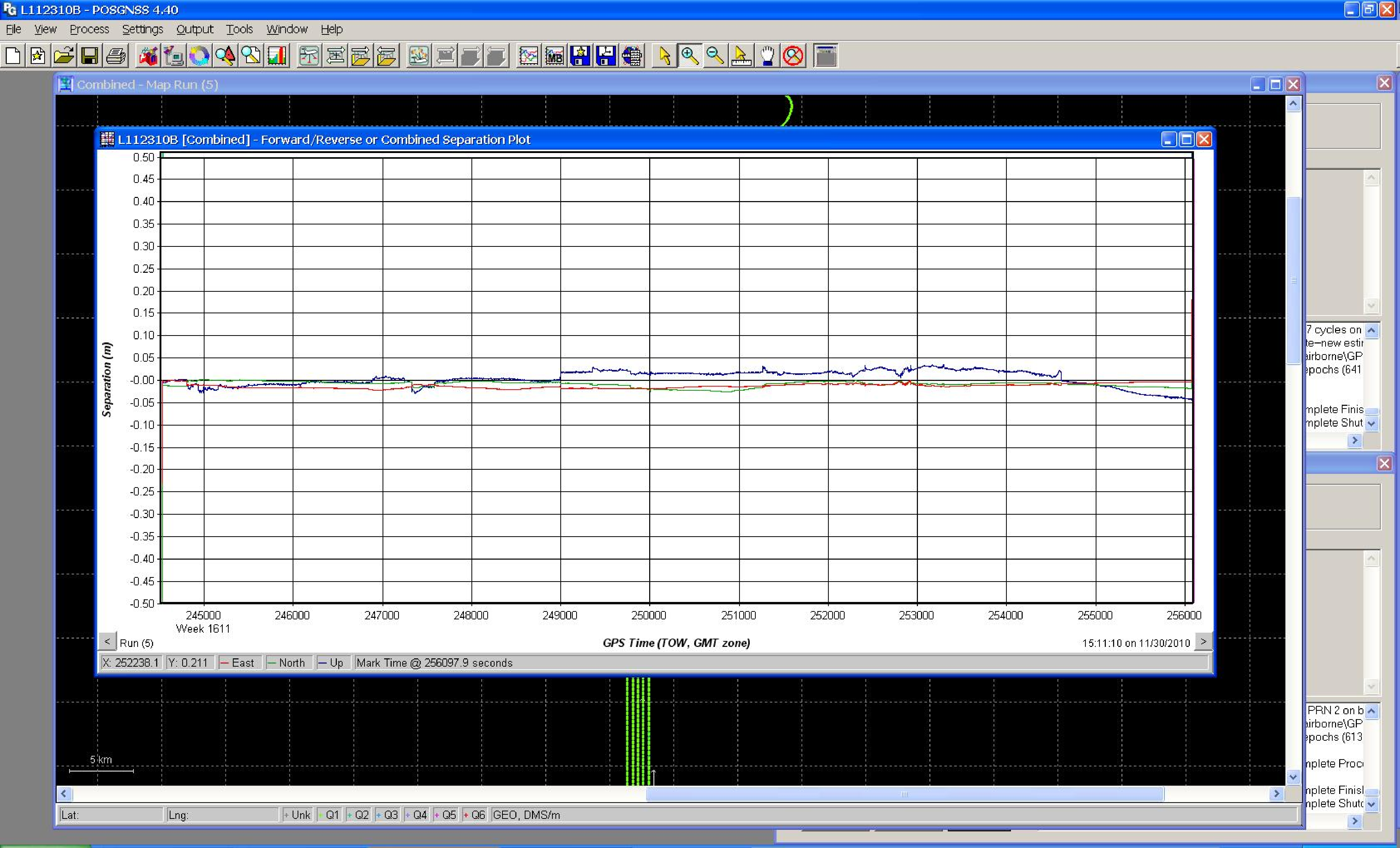
START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV	RC	HDG	Plan File
21:52:22.166	21:52:52.266	35	1720	70	39.60	17.00	NAR	OFF	ON	360.00	Ozaukee_10_23_10_Fixline.
21:52:22.166	21:52:54.866	35	1721	70	39.60	17.00	NAR	OFF	ON	360.00	Ozaukee_10_23_10_Fixline.
22:03:52.968	22:12:35.171	35	1685	70	39.00	17.00	NAR	OFF	ON	360.00	Ozaukee_10_23_10_Fixline.
22:16:06.872	22:24:29.374	36	1699	70	39.00	17.00	NAR	OFF	ON	180.00	Ozaukee_10_23_10_Fixline.
22:28:45.575	22:37:23.377	37	1701	70	39.00	17.00	NAR	OFF	ON	360.00	Ozaukee_10_23_10_Fixline.
22:40:57.078	22:49:18.08	38	1701	70	39.00	17.00	NAR	OFF	ON	180.00	Ozaukee_10_23_10_Fixline.
22:54:05.681	23:02:45.983	39	1696	70	39.00	17.00	NAR	OFF	ON	360.00	Ozaukee_10_23_10_Fixline.
23:06:16.884	23:07:33.084	35	1702	70	39.60	17.00	NAR	OFF	ON	360.00	Ozaukee_10_23_10_Fixline.


L111110A - POSGNSS 4.40
File View Process Settings Output Tools Window Help
Combined - Map Run (9)
Finished Differential GPS 1 - L111110A [Forward]
Status
Progress
L111110A [Combined] - Forward/Reverse or Combined Separation Plot
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-0.50
Separation (m)
422000 422500 423000 423500 424000 424500 425000 425500 426000 426500 427000 427500 428000 428500
Week 1609
Run (9)
GPS Time (TOW, GMT zone)
19:42:40 on 11/16/2010
X: 422187.2
Y: 0.498
East
North
Up
Right click for more options
1L2 (IONO noise)
PASS
PASS
m PASS
finished
Ch5 13 15 43
Ch6 5 67 191
Ch7 10 57 62
Ch8 4 27 77
Ch9 25 38 270
Ch10
422690.0: Doppler L1 cycle slip on PRN 13 of -5238792.60 c
421973.0: Reached end-of-file on remote (file P:\1101025\Li
421973.0: Processing used 13.922 seconds for 7123 epochs
: Loading solution...
: Waiting for window L111110A [Forward] to comple
: Solution updating finished
: Waiting for window L111110A [Forward] to comple
: Waiting for window L111110A [Forward] to comple
View
Pause
Close
10 km



L111510A - POSGNSS 4.40
File View Process Settings Output Tools Window Help
Combined - Map Run (1)
L111510A [Combined] - Forward/Reverse or Combined Separation Plot
Separation (m)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-0.50
139000 140000 141000 142000 143000 144000 145000 146000 147000 148000 149000 150000 151000 152000 153000 154000
Week 1610
Run (1)
GPS Time (TOW, GMT zone)
12:15:08 on 11/17/2010
X:
Y:
East
North
Up
Right click for more options
3 km


L111610B - POSGNSS 4.40
File View Process Settings Output Tools Window Help
Combined - Map Run (4)
L111610B [Combined] - Forward/Reverse or Combined Separation Plot
Separation (m)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-0.50
244000 245000 246000 247000 248000 249000 250000 251000 252000 253000 254000 255000 256000 257000 258000
Week 1610
Run (4)
GPS Time (TOW, GMT zone)
07:56:39 on 11/18/2010
X: 245943.5
Y: 0.340
East
North
Up
Right click for more options
1 km



L112310B - POSGNSS 4.40
File View Process Settings Output Tools Window Help
Combined - Map Run (5)
L112310B [Combined] - Forward/Reverse or Combined Separation Plot
Separation (m)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-0.50
245000
Week 1611
246000
247000
248000
249000
250000
251000
252000
253000
254000
255000
256000
Run (5)
GPS Time (TOW, GMT zone)
15:11:10 on 11/30/2010
X: 252238.1
Y: 0.211
East
North
Up
Mark Time @ 256097.9 seconds
5 km
Lat:
Lng:
Unk
Q1
Q2
Q3
Q4
Q5
Q6
GEO, DMS/m

P:\1101025\Lidar\QAQC\Ozaukee County WI Control\Ozaukee.txt

Number	Easting	Northing	Known Z	Laser Z	Dz
OZK101	417530.639	4819884.546	269.469	269.500	+0.031
OZK102	425583.963	4819958.402	253.539	253.490	-0.049
OZK103	434476.920	4819826.111	212.986	213.040	+0.054
OZK104	416648.260	4813416.014	257.208	257.240	+0.032
OZK105	425538.249	4813475.344	247.350	247.370	+0.020
OZK106	432013.161	4813392.026	222.892	222.820	-0.072
OZK107	417359.047	4807684.542	275.572	275.600	+0.028
OZK108	422882.816	4807480.688	252.728	252.670	-0.058
OZK109	429494.235	4807942.795	229.994	229.970	-0.024
OZK110	415738.901	4802132.862	263.830	263.840	+0.010
OZK111	422866.000	4801483.985	240.400	240.370	-0.030
OZK112	428353.833	4801643.202	212.741	212.890	+0.149
OZK113	415331.605	4795324.114	271.595	271.610	+0.015
OZK114	421007.412	4795618.862	249.777	249.780	+0.003
OZK115	427287.823	4795590.434	215.694	215.750	+0.056
OZK116	415314.967	4789954.860	257.222	257.290	+0.068
OZK117	420805.451	4790106.757	222.059	222.030	-0.029
OZK118	425804.585	4790264.391	212.326	212.330	+0.004
OZK119	414082.744	4784966.722	249.150	249.180	+0.030
OZK120	420062.639	4784534.500	206.629	206.700	+0.071
OZK121	426061.140	4784668.905	212.634	212.640	+0.006

Average dz	+0.015
Minimum dz	-0.072
Maximum dz	+0.149
Average magnitude	0.040
Root mean square	0.051
Std deviation	0.050