New Photogrammetric Tools for Highway Mapping

Trimble Navigation Limited
Colorado, USA

Presenter

George Southard

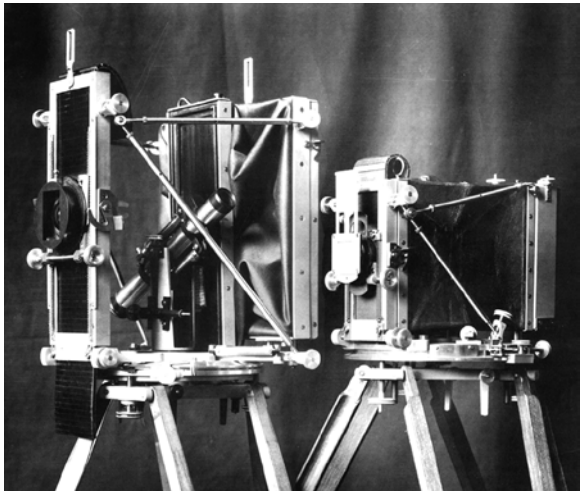
27 July 2015

Photogrammetric Mapping

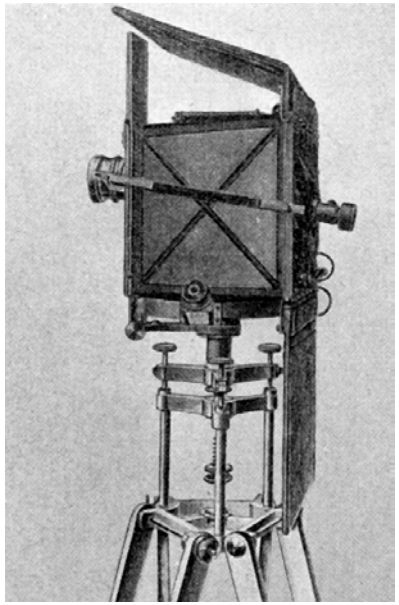
First - a Little History

Photogrammetric Mapping

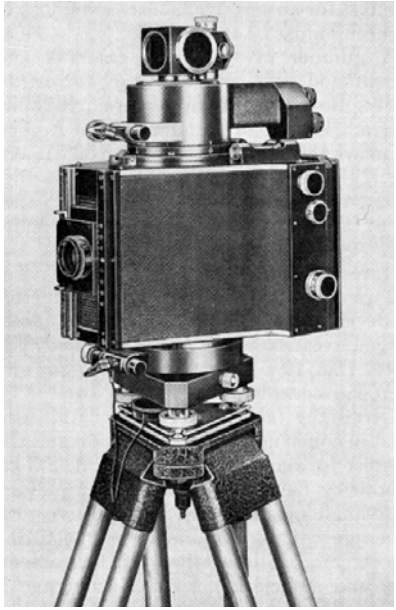
The “Plane Table” era of photogrammetry



Meydenbauer
Metric
Cameras 1890



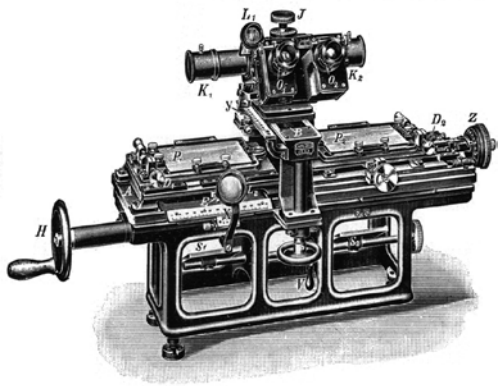
Finsterwalder
phototheodolite
1895



Zeiss Jena
Phototheodolite
1904

Photogrammetric Mapping

The “Analog” era of photogrammetry



Pulfrich, stereocomparator, 1901

Multi-plex Stereoplotter 1940s

Wild-Heerbrugg A7 Stereoplotter 1950s

Photogrammetric Mapping

The “Analytical” era of photogrammetry

Wild BC1

Kern DSR12

Zeiss P1

Photogrammetric Mapping

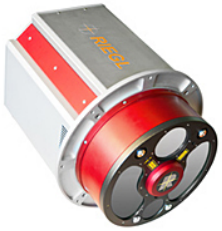
The “Airborne” era of photogrammetry

Photogrammetric Mapping

The “Airborne” Film era photogrammetry cameras

Photogrammetric Mapping

The “Digital” era of Airborne photogrammetry sensors



Photogrammetric Mapping

Three new photogrammetric data collection tools for the Highway Mapping community

- Unmanned Aircraft System (UAS)
- Tripod Mounted camera System
- Land Mobile System

- Unmanned Aircraft System (UAS)
  - UX5 HP
  - New software

- Tripod Mounted Survey Imagery Tool
  - V10
  - New software

- Land Mobile Imaging/Laser System
  - MX7

Trimble Photogrammetry

UX5 HP Unmanned Aerial camera system

- Onboard high accuracy GNSS for precise position data
- 36 MP camera - 1 cm GSD
- Multiple lens options
- RGB or NIR Camera
- Up to centimeter level position accuracy (PPK)
- Point cloud density up to 1000 pts. per m^2

UX5 HP

Trimble UX5 HP Specifications

Weight: 6.4 lbs

Wingspan: 39.4 inches

Launch Type: Catapult

Cruise Speed: 55 MPH

Endurance (flight time): 40 min

Flight Height (AGL): 245 ft to 2,500 ft

Image GSD: 1.0cm to 25cm

Flight Ceiling: 16,500 ft

Wind Speed: 35 MPH

Landing Type: Belly

Camera: 36 MP, Sony a7R (multiple lens available)

GNSS: L1/L2 (GPS, Glonass, Beidou, Galileo Ready)

UX5 Camera

- Sony a7R digital camera
- 36MP full frame image
- Customized lenses, 15mm, 25mm, 35mm
- Standard RGB color & near Infra-Red versions
- Lens Distortion Correction

Launcher Components

- Ramp
  - Bungee
  - Winching tool
  - Release handle
  - Safety pin
- Launcher Dock
- Bi-pod Support

Launcher

- Consistent launch
  - Speed
  - Launch angle
  - No risk of stall
  - Short learning curve for operator
  - Less stressful (user has to control speed & angle with a hand launch)
- Safety
  - Consistent & controlled launch sequence
  - User not exposed to running motor
  - Complies with Machinery Directive 2006/42/EC

Ground Control

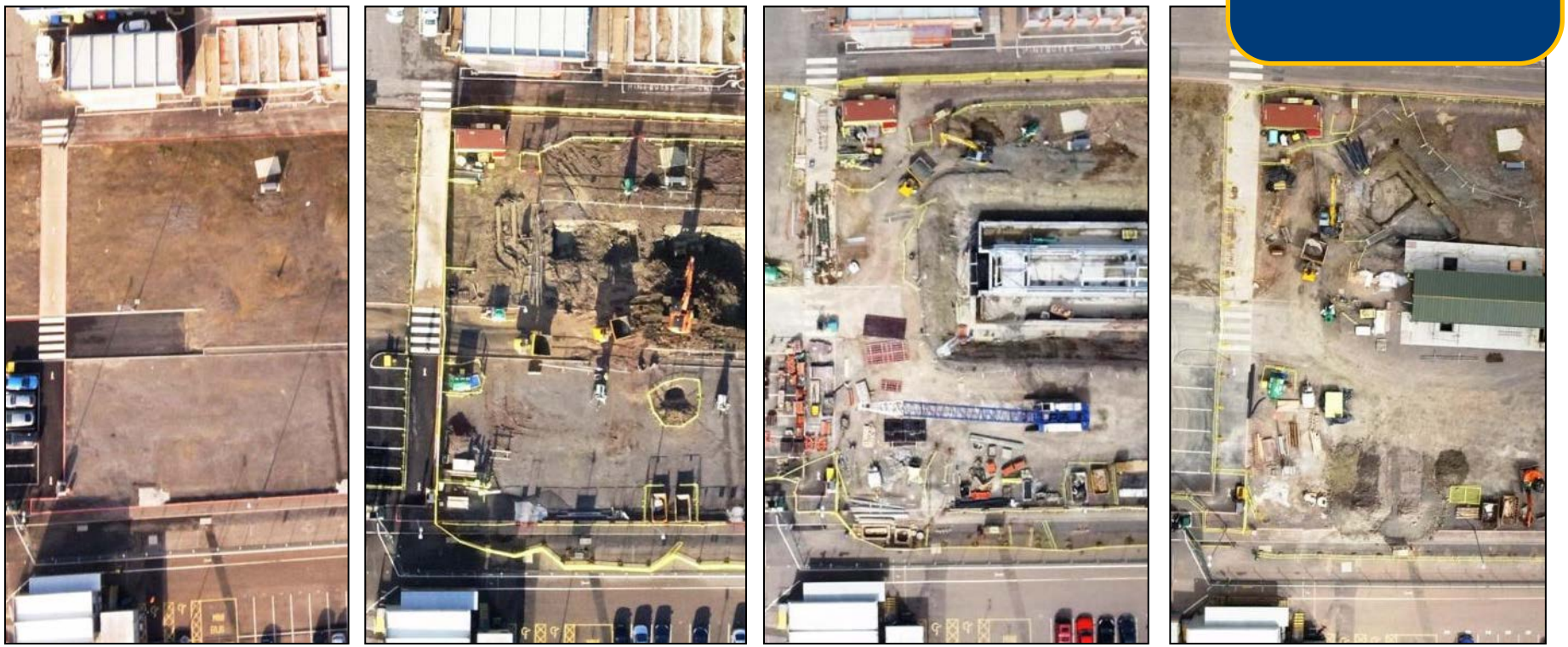
- Rugged Tablet
- Flight Planning & Control Software
- Communications Link
- Download Connector

Route Planning Example

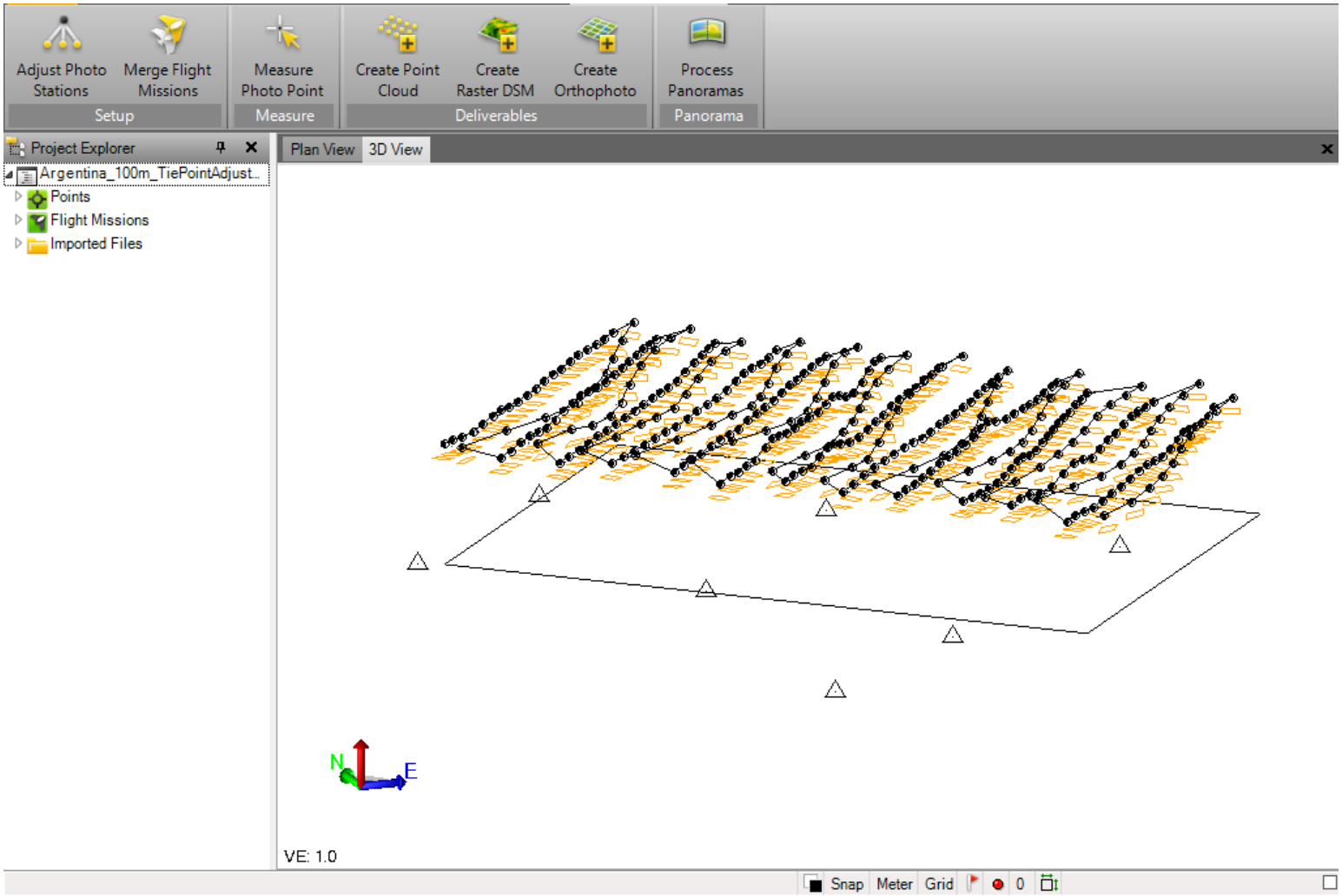
Belgium
462 Images
150 m Flight Height
5 cm GSD
0.8 km^2

Progress Monitoring Example

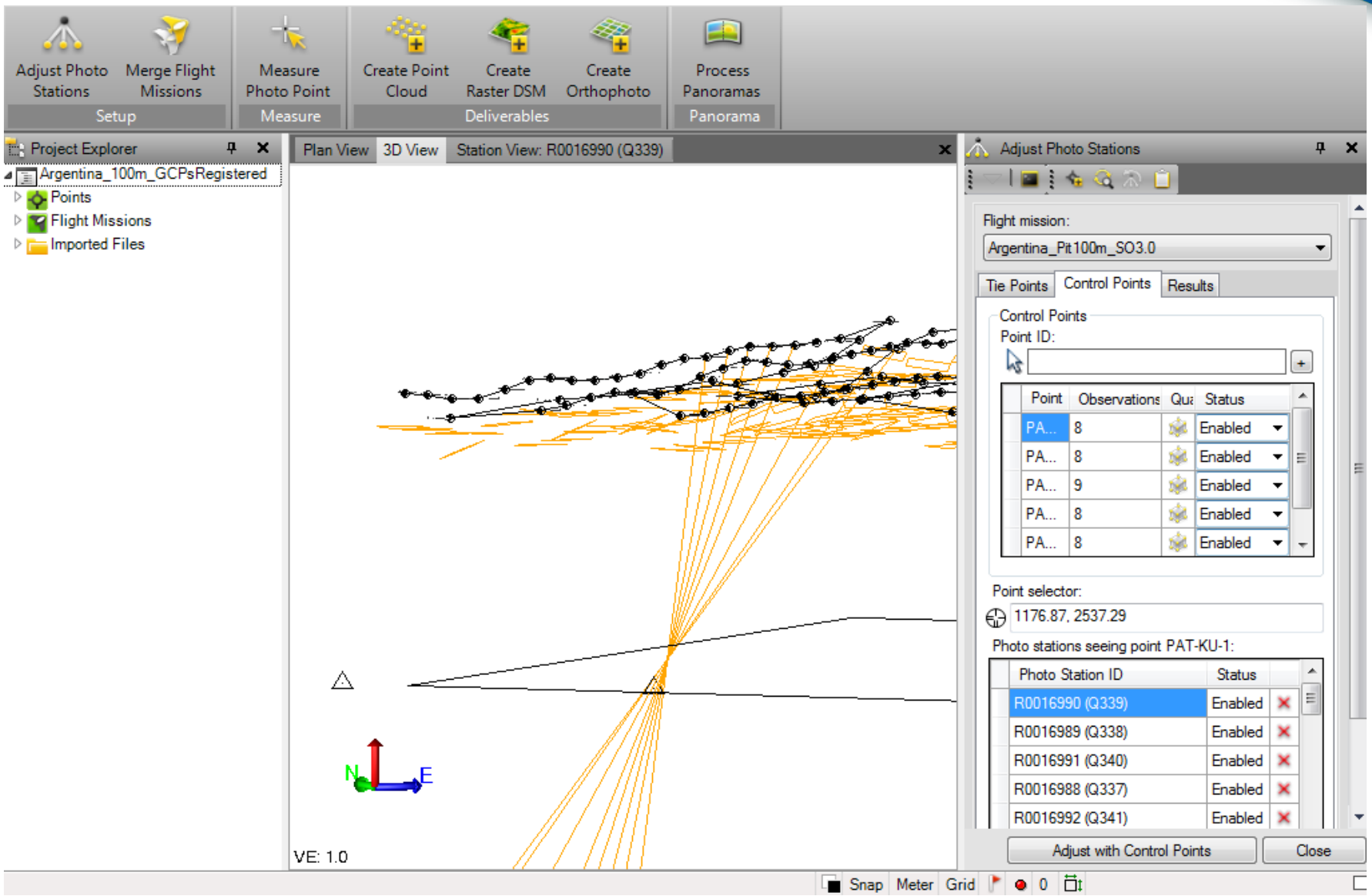
United Kingdom
150 m Flight Height
5.7 cm GSD
2.4 km^2



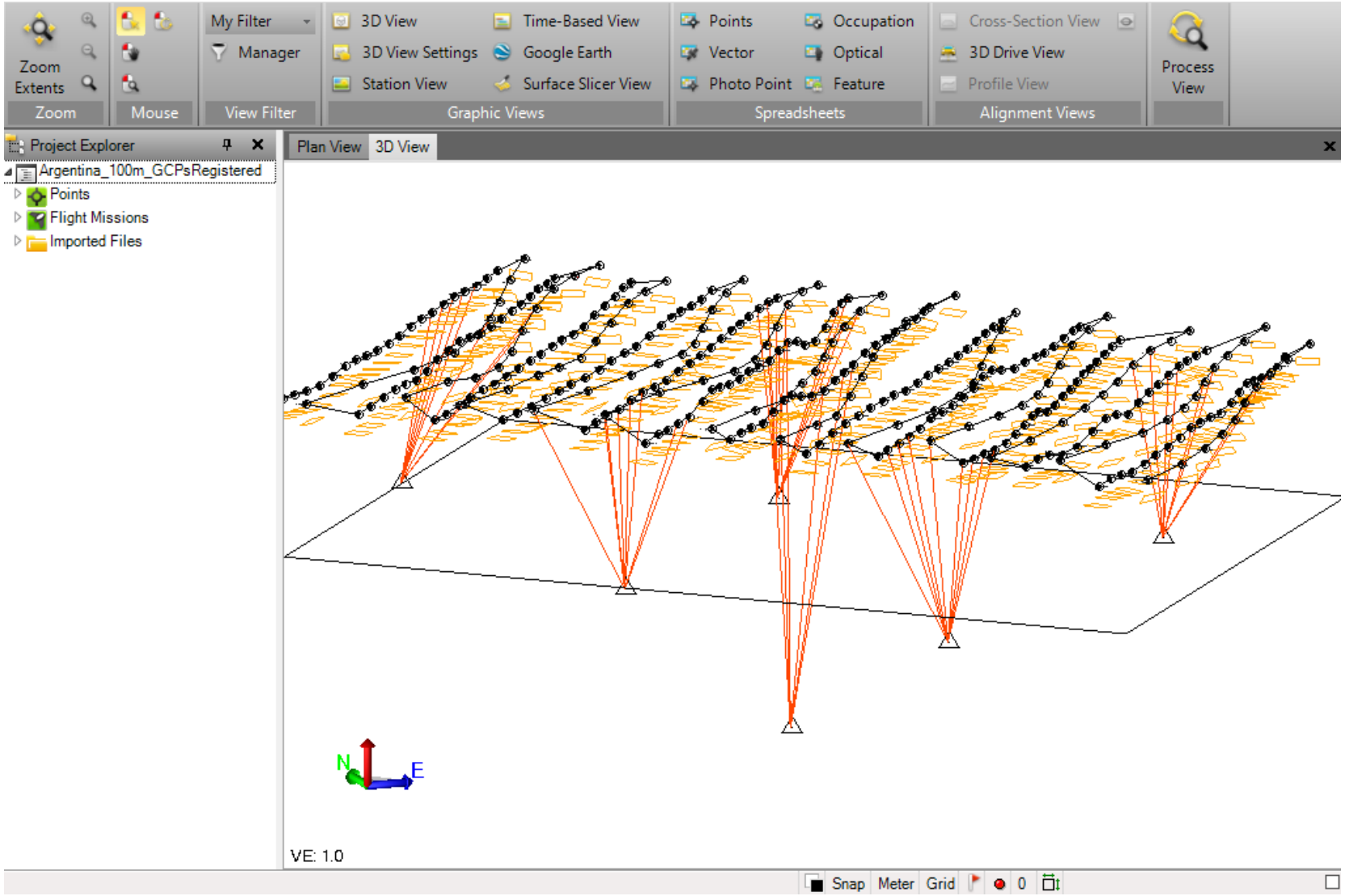
3D View – Flight plan w/ GCPs



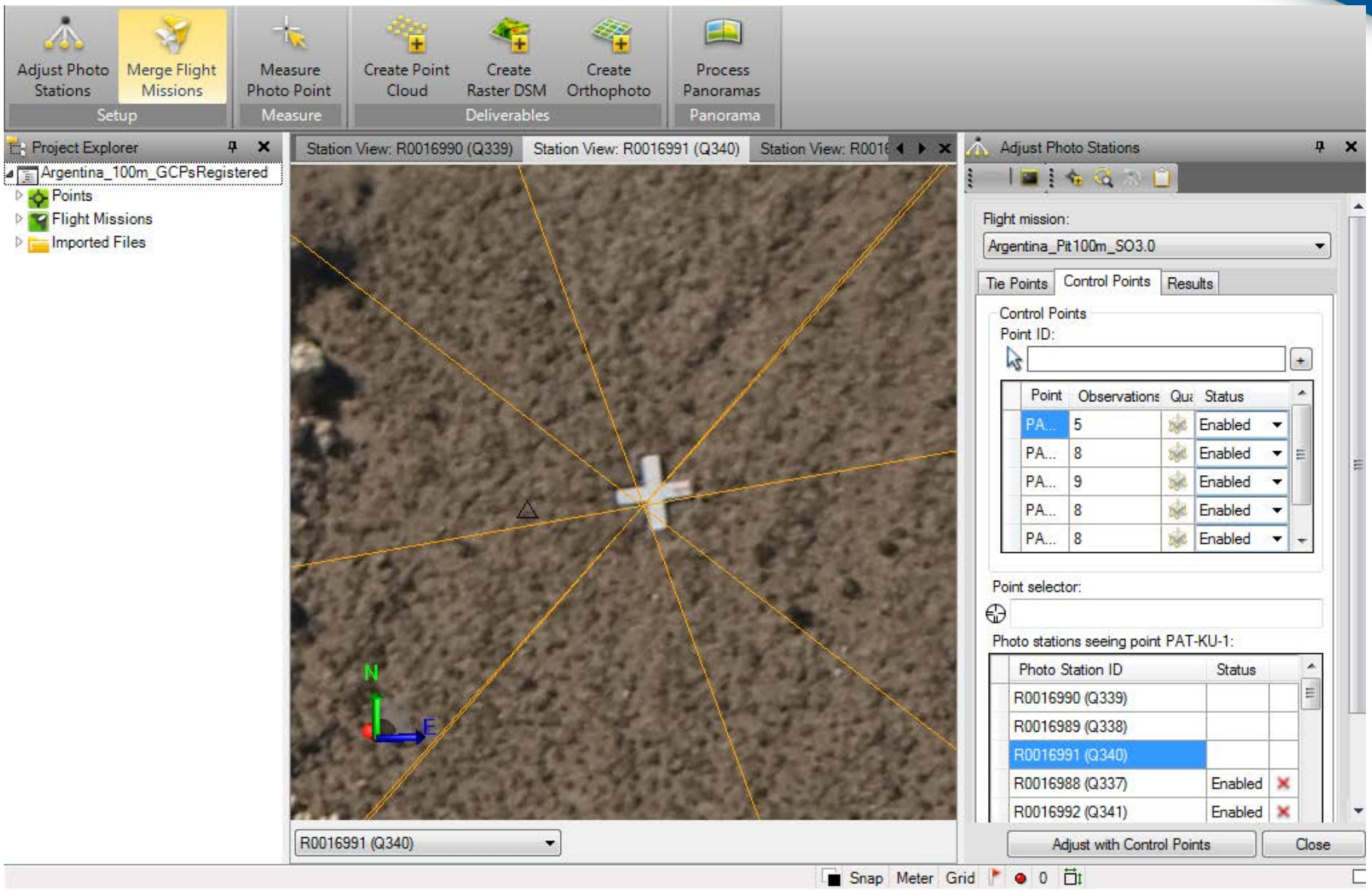
Control Point Registration



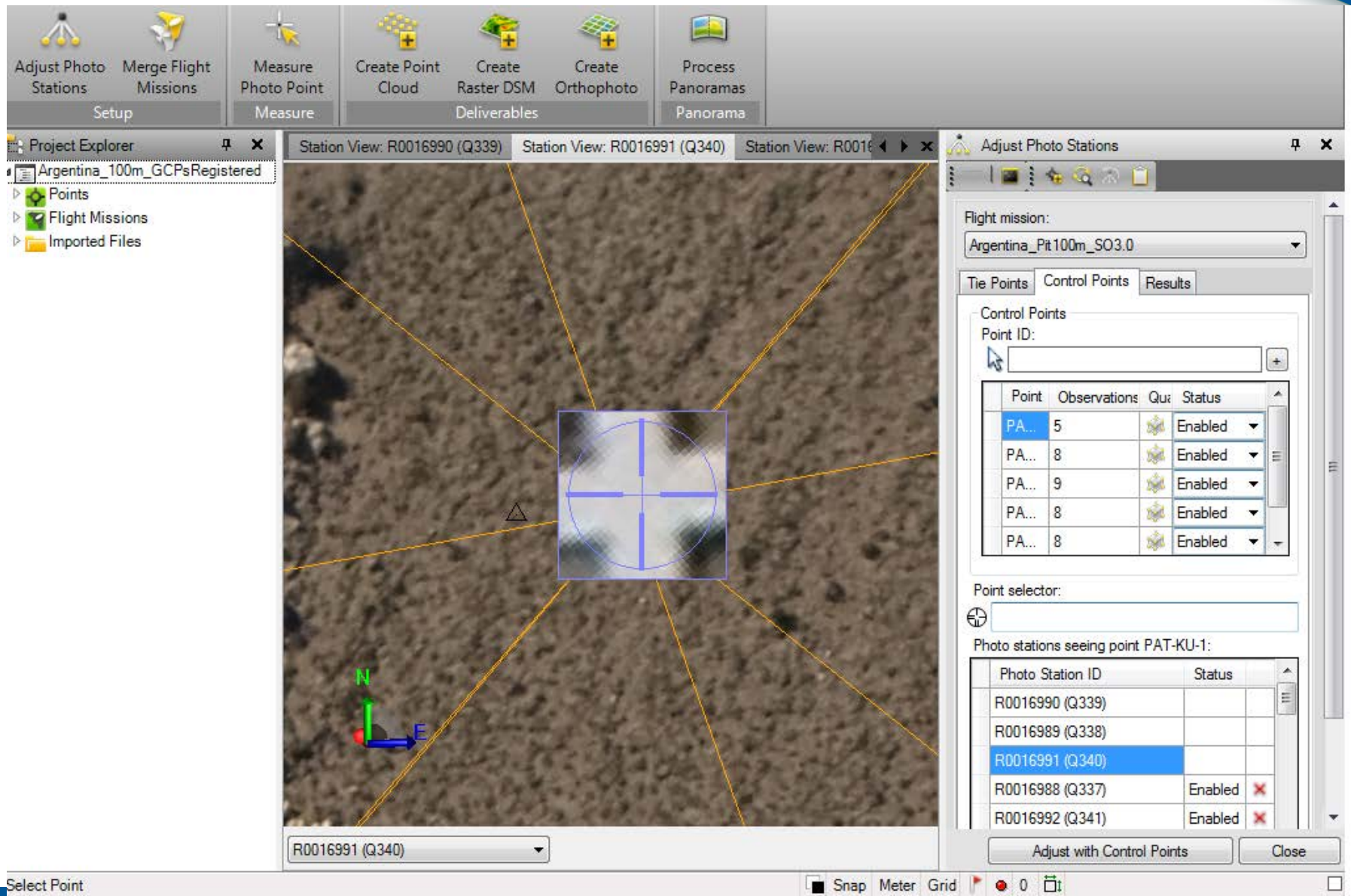
Control Point Registration



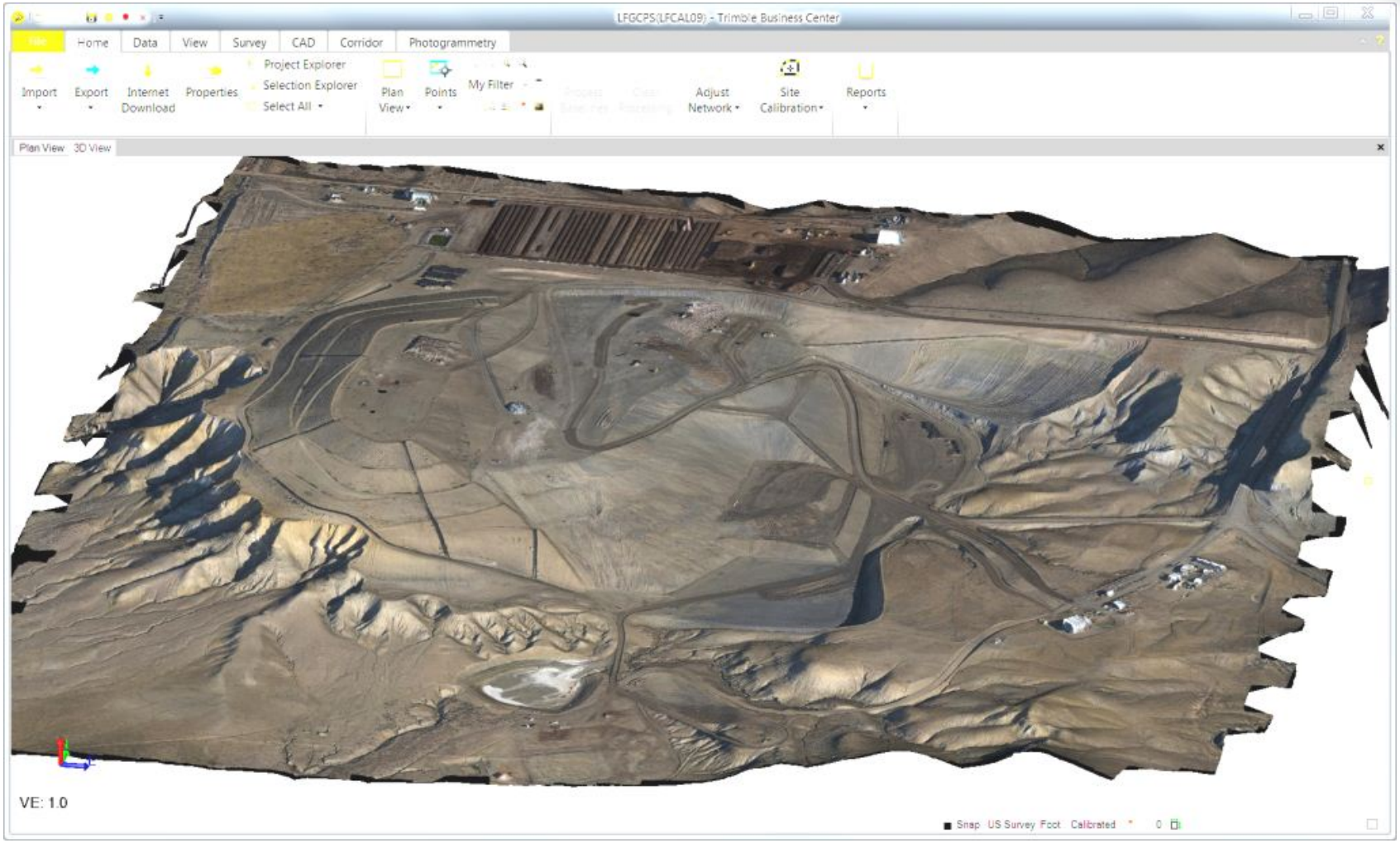
Control Point Registration



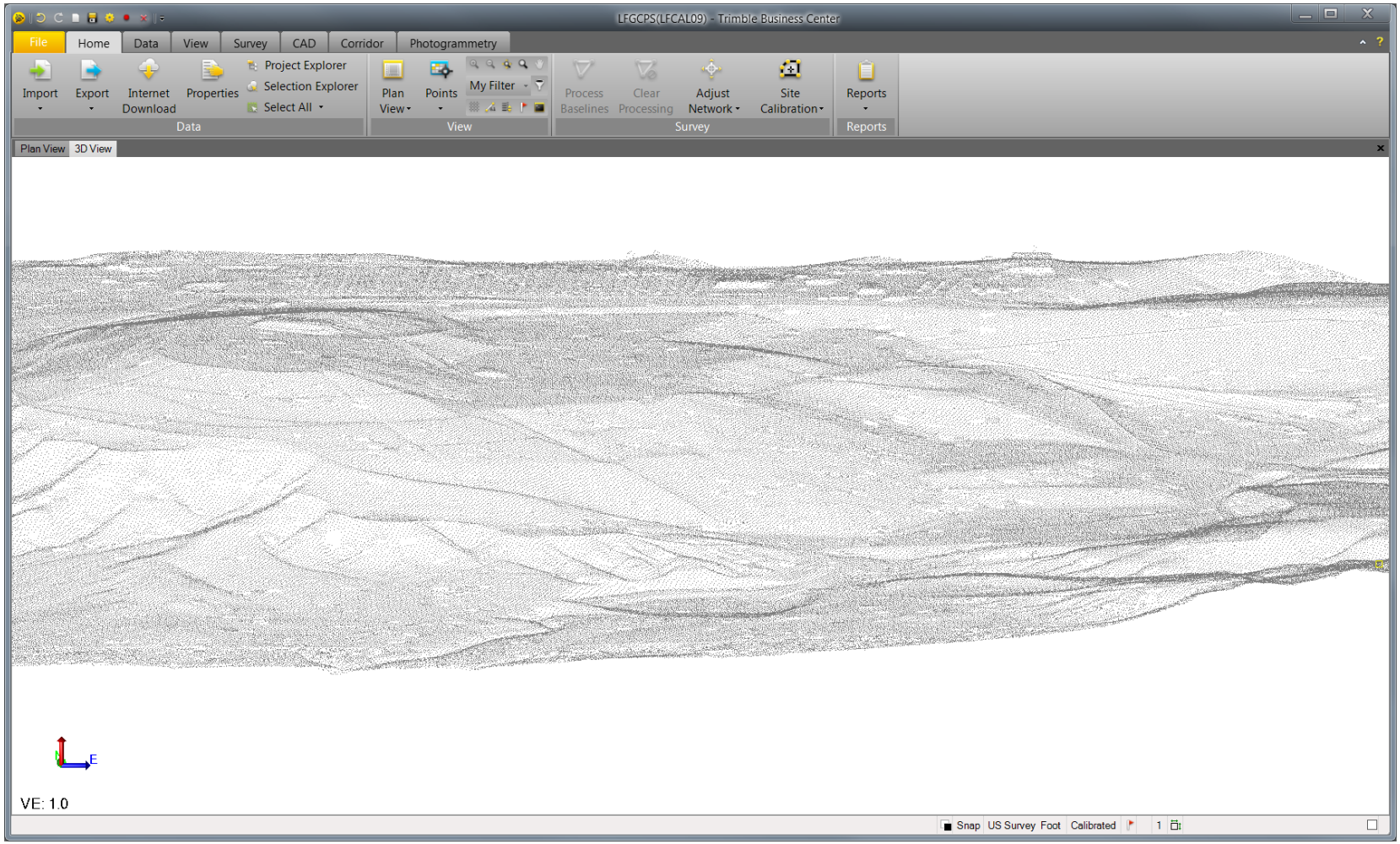
Control Point Registration



Orthophoto Mosaic (3D view)



Create Digital Point Cloud



Introducing - Trimble Mobile Mapping

MX8 – Precision Mobile Surveying

MX7 – Mobile Photogrammetric Imager

MX2 – Imaging and Laser Mapping System

Introducing the Trimble MX7

Mobile Mapping and Survey:

- 360° Mobile Imagery
- Applanix AP15 – GNSS/INS
- POSPac post-processing engine
- Trimble Trident s/w workflow
- Trimble TBC – software options
- Accurate measurements, X,Y,Z
- Data Export to most GIS and CAD systems
- Intuitive Capture Software

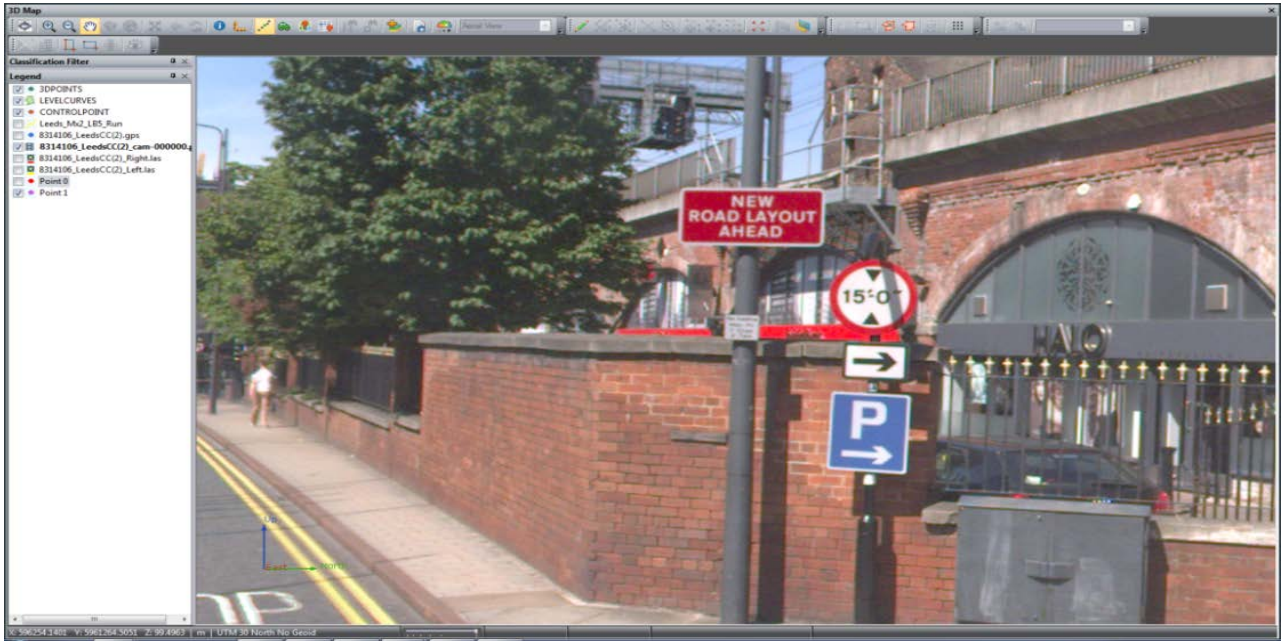
MX7 – Product Introduction

Features and Concept:

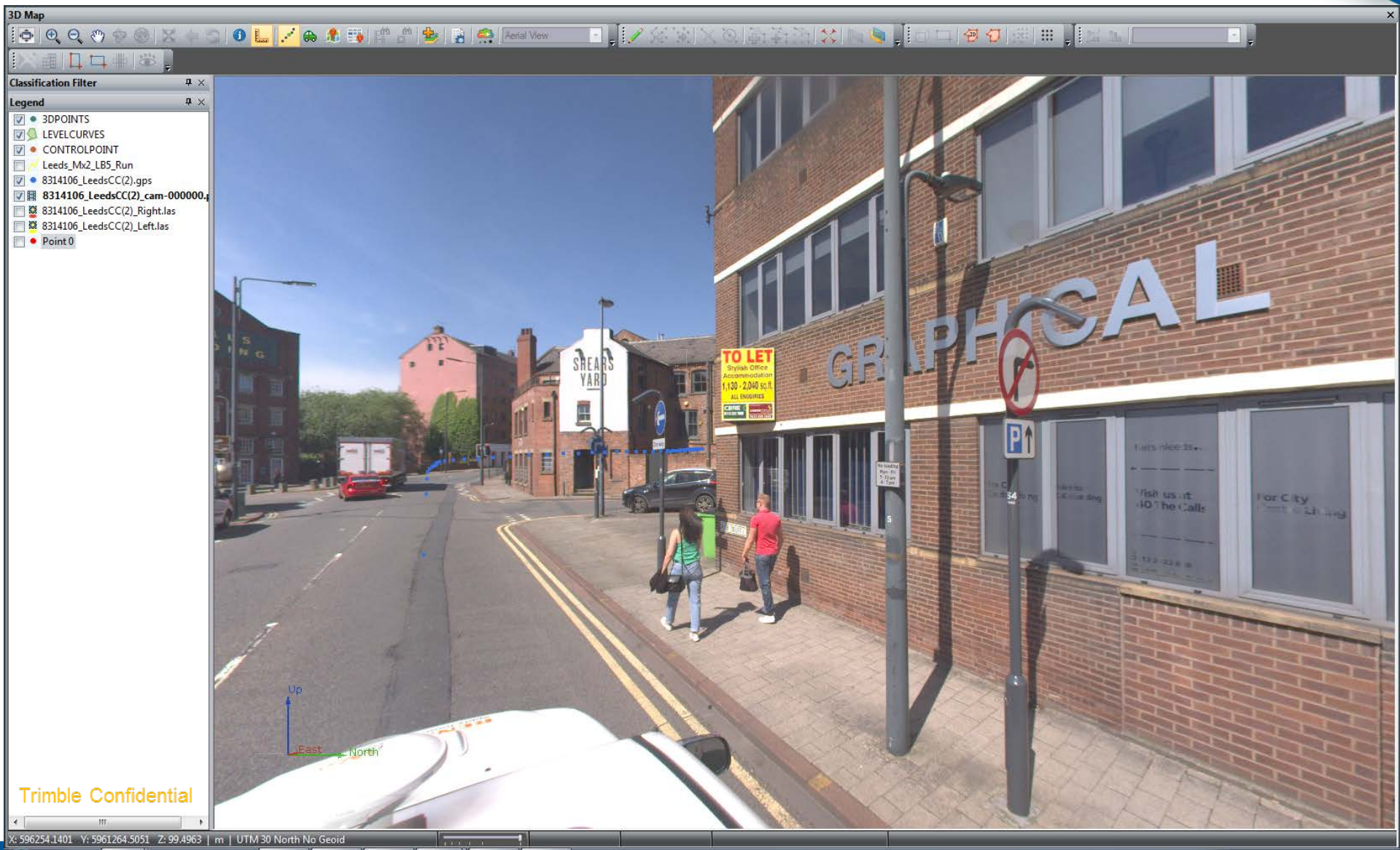
- Mobile video – with high accuracy (cm level)
- Raise / lower for collection and transport
- Flexible mounting options
- No need for dedicated vehicle
- All computers and sensors in one housing
- Complement to current field survey workflows
- Collect once – no need to return to the site
- 360° intuitive field of view
- Full photogrammetric accuracy across images
- Designed for future laser upgrade
- Mobile Imaging based data collection software
- Simple and easy to operate – i.e. touch screen

Wireless Tablet Operation

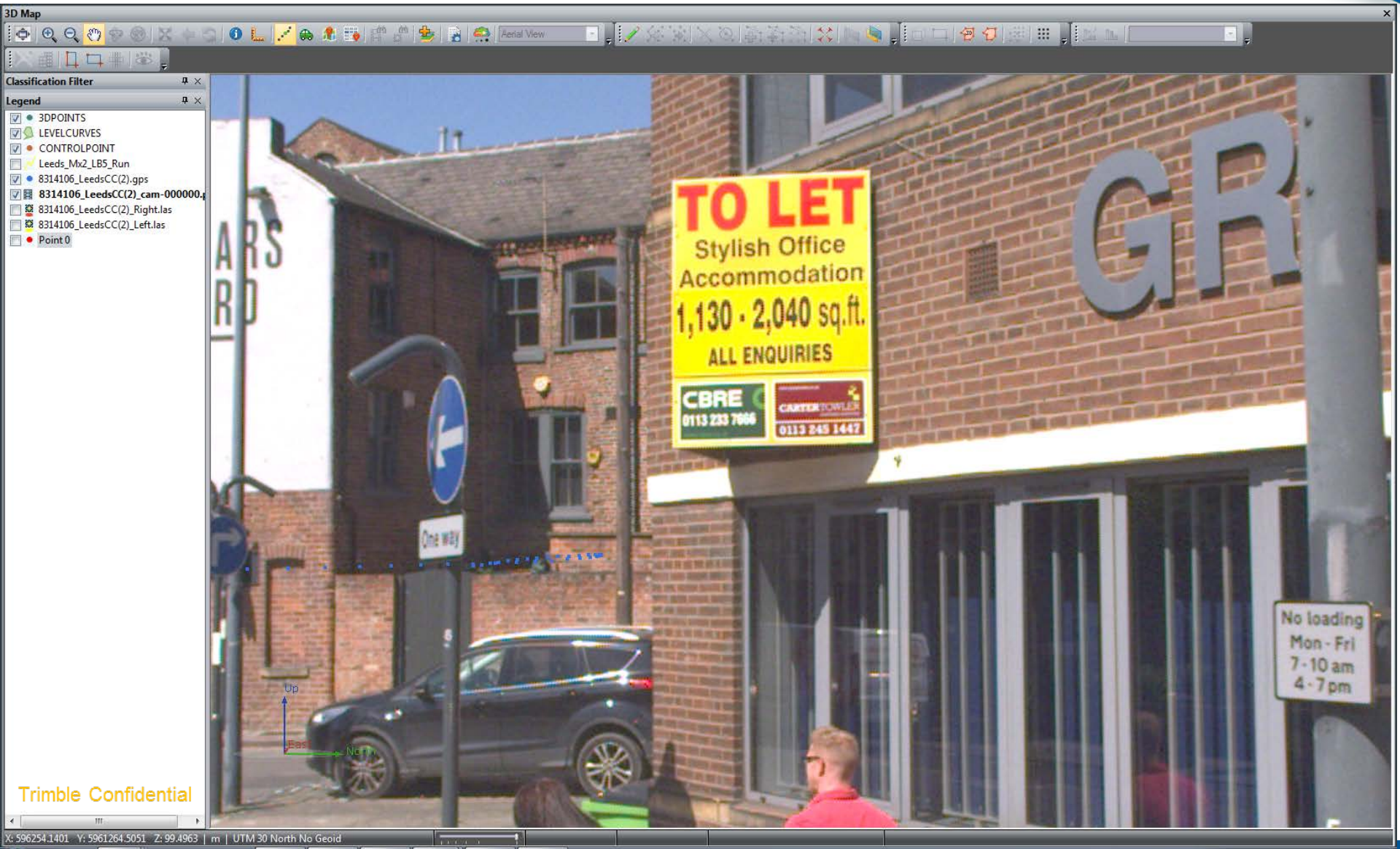
- WLAN
- Trimble Mobile Imaging Software
- 3D Map moving map for monitoring
- Images viewed in real time



High Resolution 360° Imagery

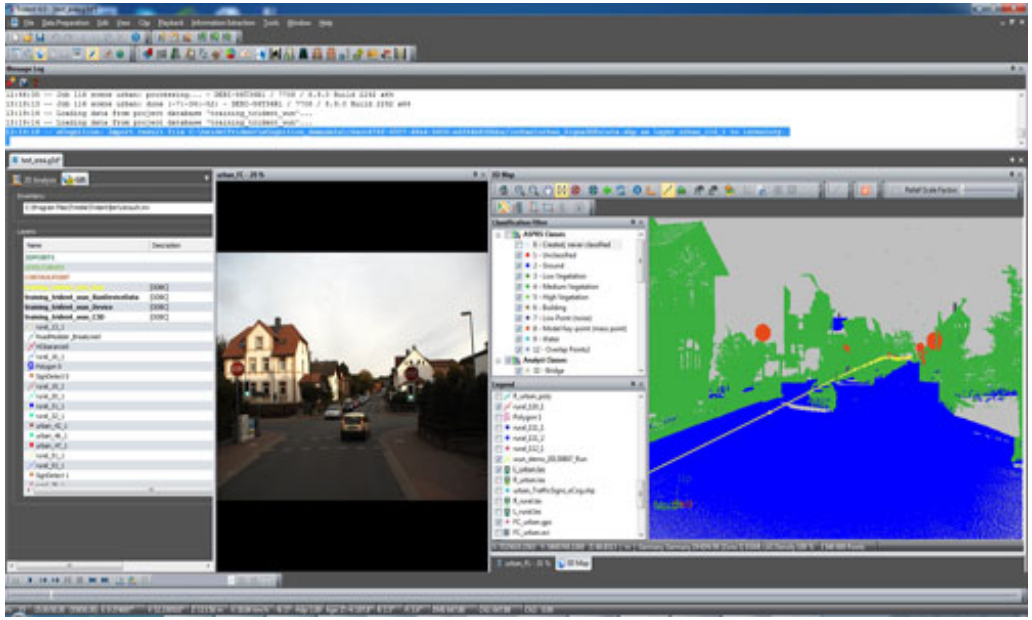


Zoom for Detail – High Accuracy



Trimble Trident Workflow

- Enhanced support for the Trimble MX7 spherical camera
- Easily visualize, interpret and extract information from Trimble MX7



- Export geo-referenced .jpg images

V10 Imaging Rover

CHANGING THE BUSINESS LANDSCAPE WITH IMAGING ROVERS

Product Vision Statement

The Trimble V10 Imaging Rover is an integrated camera system that precisely captures 360° digital panoramas used to visually document and measure the surrounding environment. The latest tool in the Land Surveyors toolbox.

Trimble V10

– Precise Positions from Pictures

System Overview

- Position sensor (optional)
- Camera Head
- Power Rod
- Bipod
- Tablet 2 w/ Trimble Access Software
- TBC (advanced) software for processing

Trimble V10 Imaging Rover

- Position sensor (optional)
- Camera Head
- Power Rod
- Bipod
- Tablet / TSC3
- Trimble Access
- Trimble Business Center

Basic Statistics

- 12 Calibrated 5MP cameras
- Auto white balance
- System weight = ~12.8 lbs

  (Camera, Rod, Tablet, Bracket, Bipod, Batteries)
- Operating temperature, -5°F to +122°F
- 2 Hot Swappable batteries @ 4 hours ea.
- Quick release attaching point for total station or GPS receiver

Photogrammetric Properties

- New Panoramic Bundle Adjustment Software
- Camera integration and stability
- Camera calibration
- The Use of:
  - Stereo Imagery
  - Tie Points
    - Manual
    - Automated
  - Surveyed control points
  - Quality GPS hardware
- New photogrammetric applications software

V10 Value

- **Visualization**
  - **See the asset in the field**

    AND in the office
  - **Make decisions based on precise pixel positions**
- **Data**
  - **Points, Lines, Polygons**
  - **3D Models**
  - **Drawings**
  - **Surface**
  - **Contours**
  - **Attributes**

High Dynamic Range Imagery (HDR)

Normal exposure

Overexposed

Underexposed

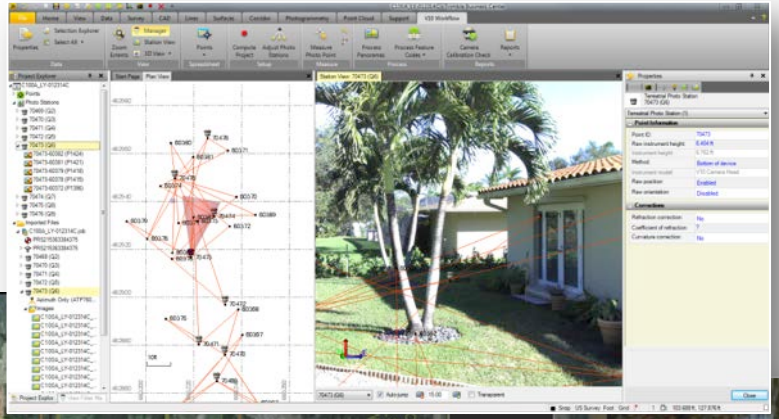
Bridge Inspection

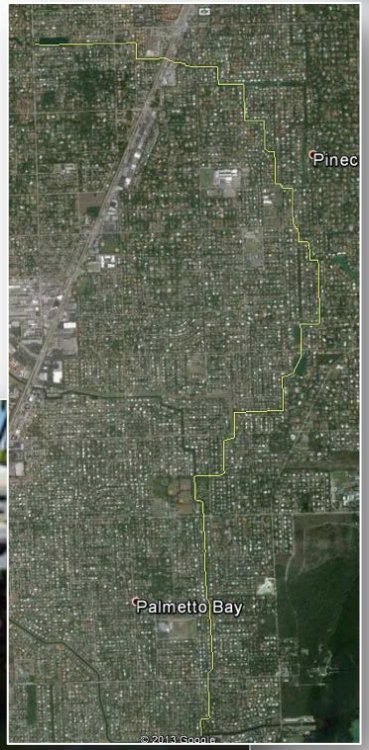
Benefits

- Comprehensive data
- Meets or exceeds compliance standards
- Allows inspection by domain experts in the office
- More information faster

Land Survey

Right of Way Survey





A FLORIDA SURVEYING COMPANY PUTS A NEW TECHNOLOGY TO THE TEST ON AN HISTORIC CANAL FRONTED BY 21 SUBDIVISIONS.

IMAGING ROVER

on the Canal

By Erik Dahlberg

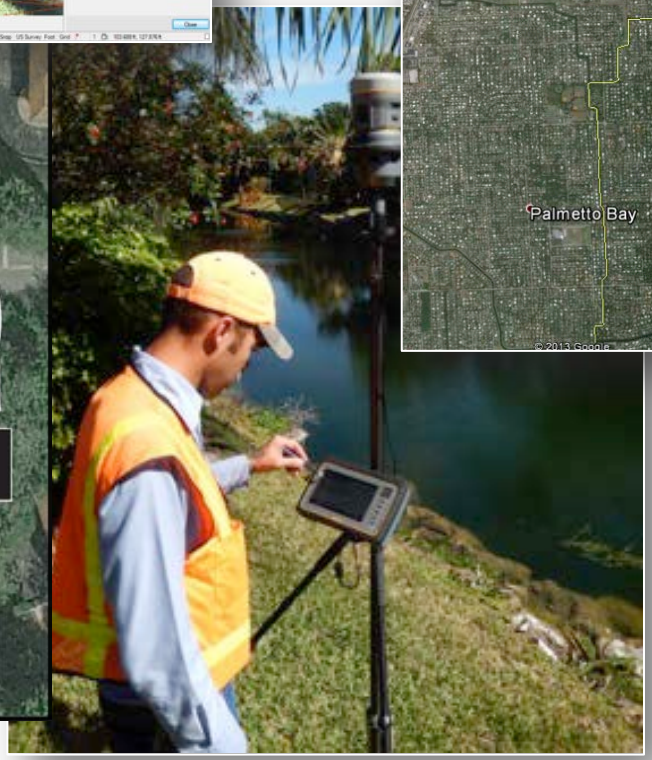
EDITOR'S NOTE

The announcement of the Trimble V10 imaging rover in late 2013 was greeted with a mix of excitement and questions ("what is it?"). With close-range photogrammetry just beginning to reach the toolboxes of surveyors and mappers, the V10 spurred a rare in-house product review (see "V10, R10, RTX et al." January 2014 *Professional Surveyor*) in which we expressed being "pleasantly shocked out of disbelief." There appears to be a bright future for this type of technology, and readers asked for a follow-up case study.

GCY, Inc., a professional surveying and mapping firm headquartered in Palm City, Florida faced a large and unique contract. What became known as the "C-100A" contract, named after the prominent canal south of Miami (see sidebar on page 25), contained several components. The contract called for GCY to survey and locate the section corners and key cadastral points in the 21 subdivisions that front the canal. They would reconcile all of the subdivisions and descriptions and then set markers and develop a map of the canal right of way.

The company would also set second-order vertical control benchmarks and provide locations for 12 core borings needed for geotechnical analysis. In addition, GCY needed to provide locations of all improvements and planted landscaping in the right of way, in its adjoining maintenance easement, and within 10 feet of the easement. GCY would also survey the canal itself, providing a full-length profile at 25-foot intervals with cross sections extending beyond the maintenance easement.

Even the client, the South Florida Water Management District (SFWMD), realized it would not be an easy project. "It's a challenging area for this type of surveying," noted SFWMD surveying and mapping administrator Rick Barnes. "It's all residential with a great deal of fences, improvements, and landscaping. There's a huge number of things to locate and not a lot of room to work in."



THANK YOU