2024 API PIPELINE CONFERENCE AND EXPO

PIPELINE, CONTROL ROOM AND CYBERNETICS

May 6-8, 2024 Hyatt Regency Salt Lake | Salt Lake City, UT

Application and Evaluation of a Novel Drone-Based Approach to Measuring Pipeline Burial Depth

Jeff Barry – Geomorphic Solutions

Vincent Benet– Skipper NDT

Jared Rinker – Marathon Pipe Line

Goals of Bringing a New Technology to Market

- Pipeline Operator Perspective
- Technical Development Perspective
- Field Perspective

Operator Perspectives

- Pipeline Operator Concerns
  - Well Over 100,000 Miles of Pipelines Across North America
  - Across a Variety of Unstable Environments Such as Rivers, Unstable Slopes, Coastlines, Marshes, etc.
  - Safe Operations Understand Depth of Cover Regardless of Location
  - Field Data Collection Face Various Challenges and Safety Concerns Associated with

Data Needs Vs Safe and Accurate Data Collection

Safety Challenges

- Working in Cold and Hot Temperature
- Biological Hazards (Snakes / Insects / Alligators)
- Working In Water (Boats / Kayaks / Diving)
- Walking Along Steep Slopes and Stream Banks

Data Needs

- Significantly Greater Data Density
- Rapid Data Collection
- Real-Time Confirmation of Data Quality

Marathon Pipe Line 2023 / 2024 Drone Based Evaluations

- 2 Water Crossing Inspections Using Both Drone Based and Traditional GPS Surveying and Line Locating Techniques
- 14 Smaller Waterway Inspections in 2024 Using Both Drone Based and Single Beam Sonar Surveys Along With Traditional Line Finding Equipment
- 9 Larger Waterway Inspections in 2024 Using Both Drone Based and Multi-Beam Sonar Surveys Along With Traditional Line Finding Equipment

Development of Drone Based Technology

- ❑ 5 lbs carbon fiber payload
- ❑ 5.3 ft wingspan enabling underwater mapping

Skipper NDT's embedded system mounted under an off-the-shelf UAS

Magnetometers

- Fluxgate 3-axis magnetometers
- Light, robust with high acquisition frequency
- Allows calibration/compensation process

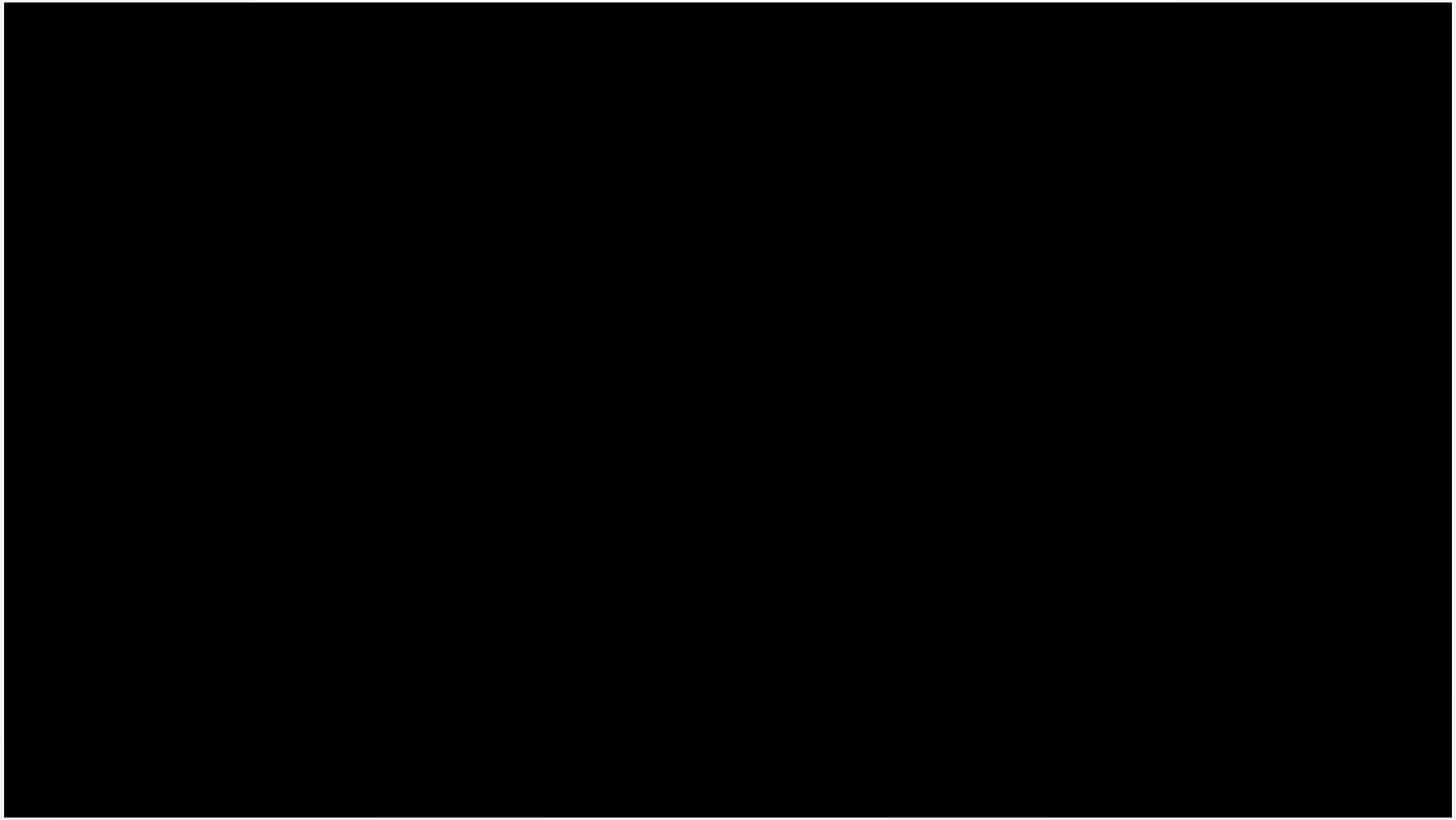
GNSS

- Real time Precise Point Positioning (PPP) correction services
- Accuracy ± 4 cm at 95% rms worldwide
- Facilitates operations and logistics

Navigation sensors

- Inertial Measurement Unit (IMU) for level-control
- Telemetric sensors for topography
- Allow post-processing corrections

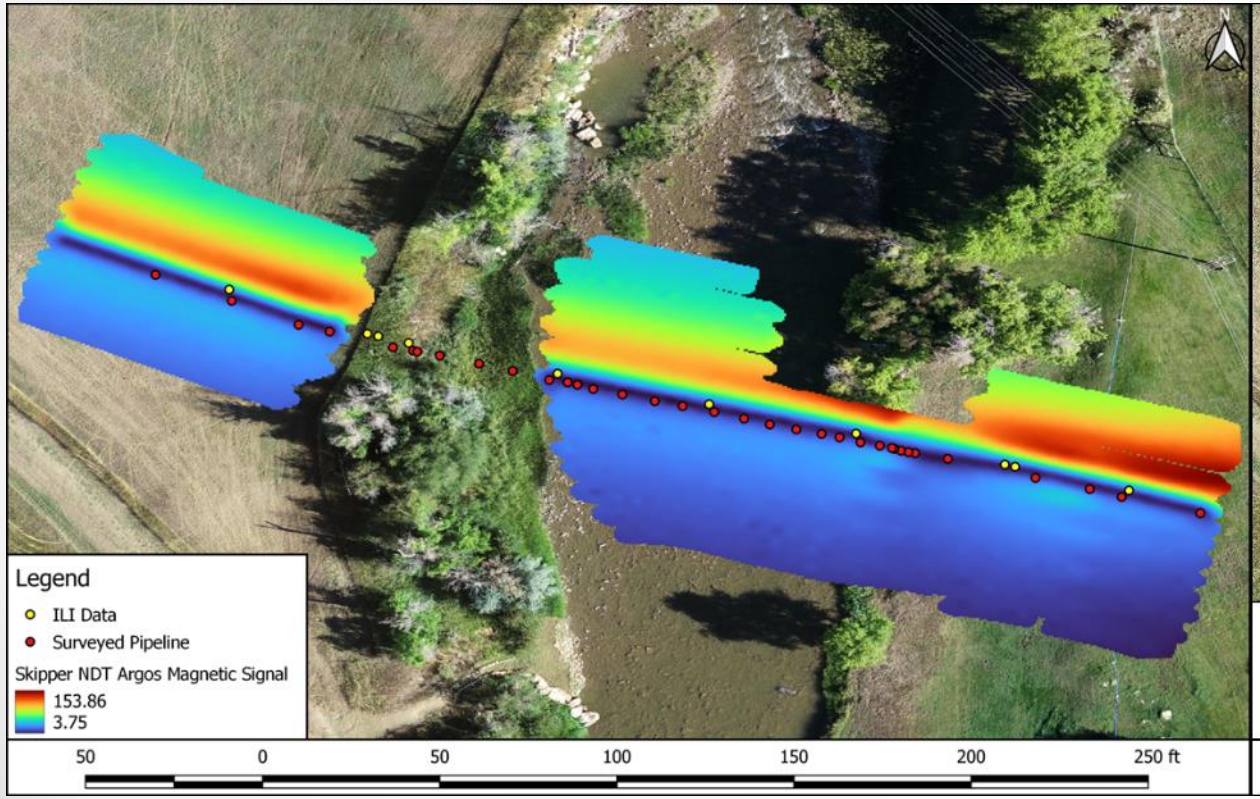
Development of Drone Based Technology



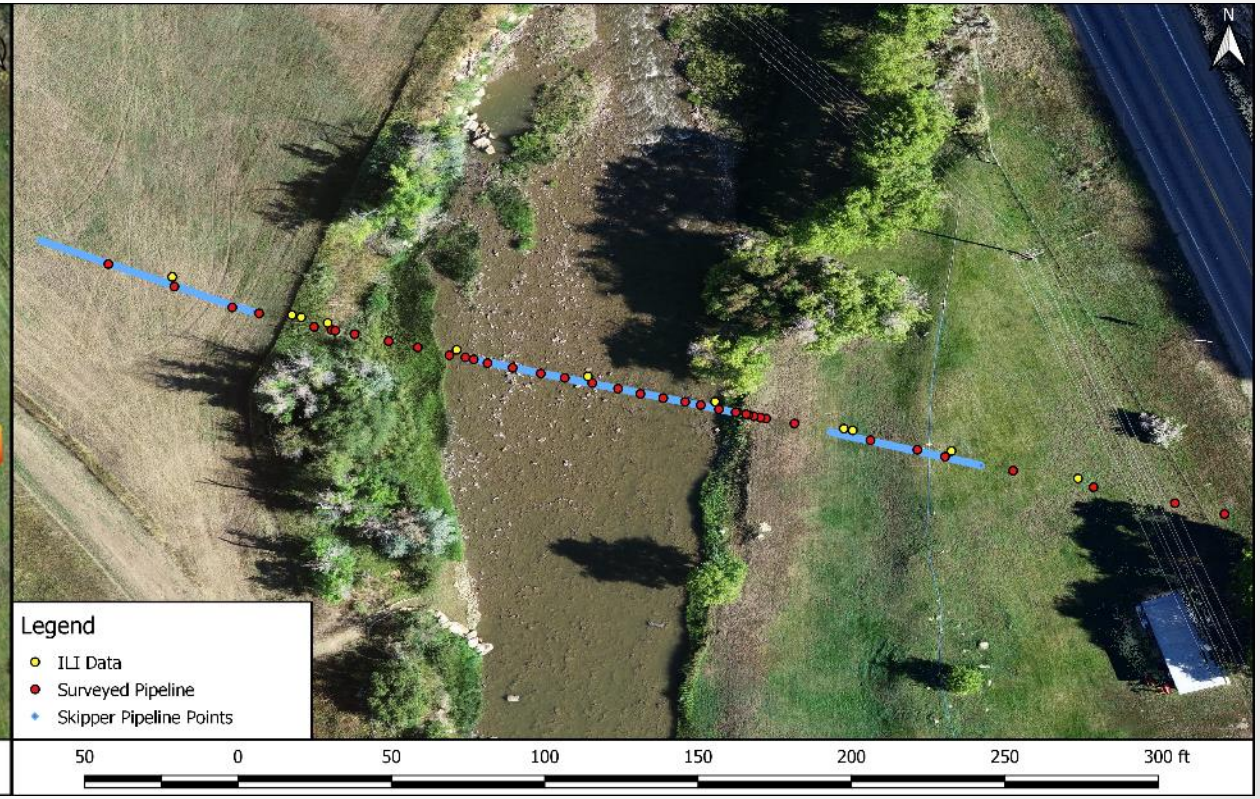
Application of Drone Based Technology

Site 1 - Manual vs Drone-based: Validation

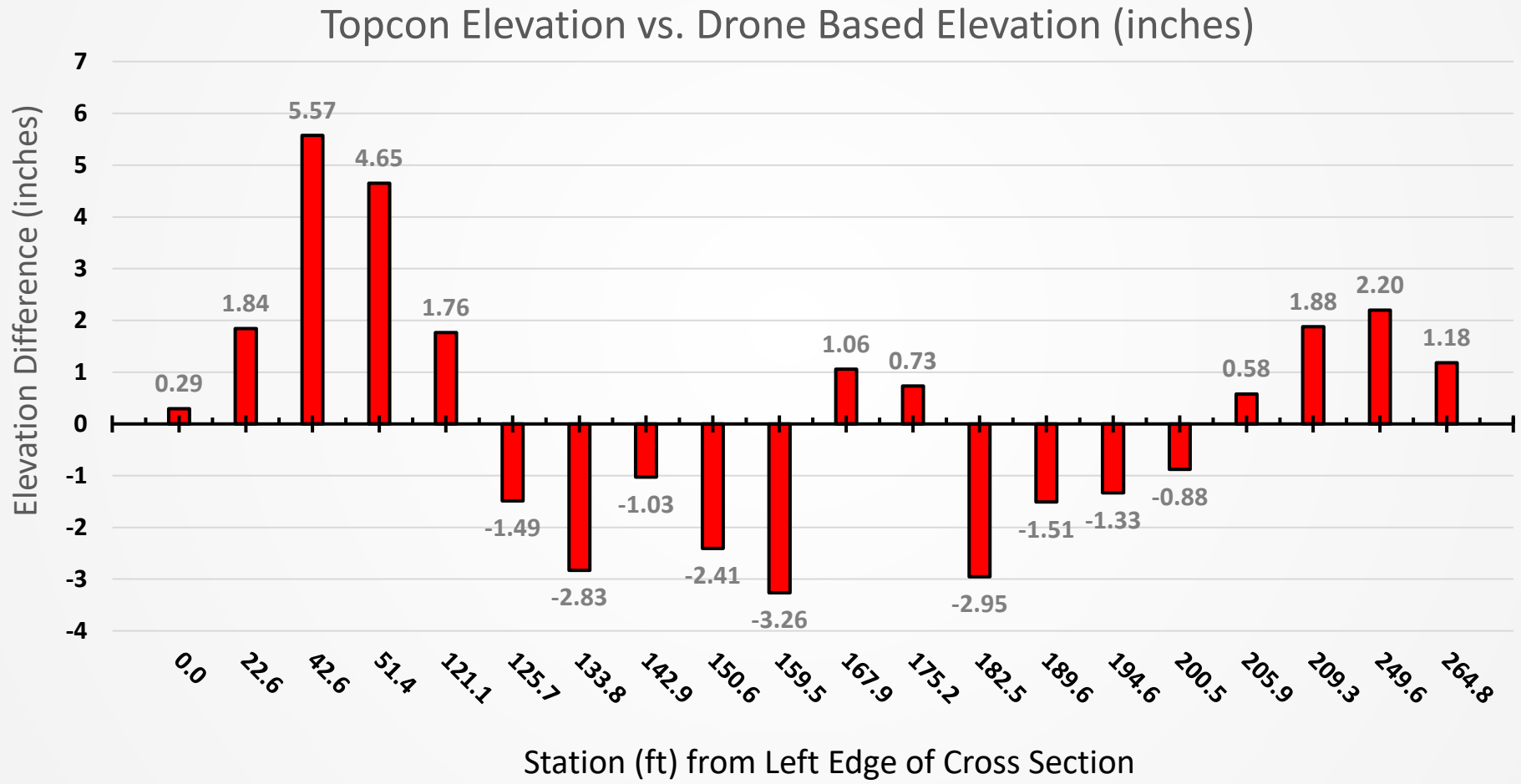
Magnetic Map



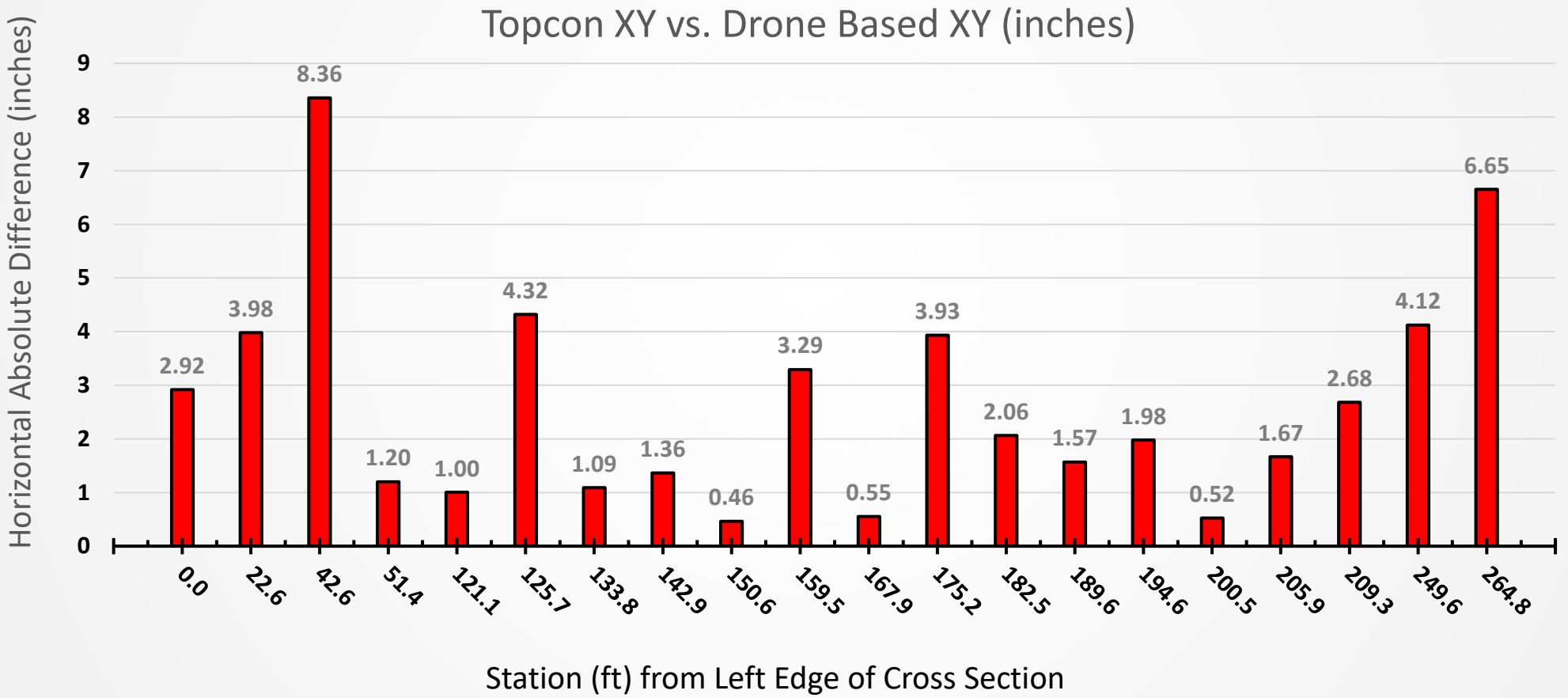
Plan-View of Top of Pipeline



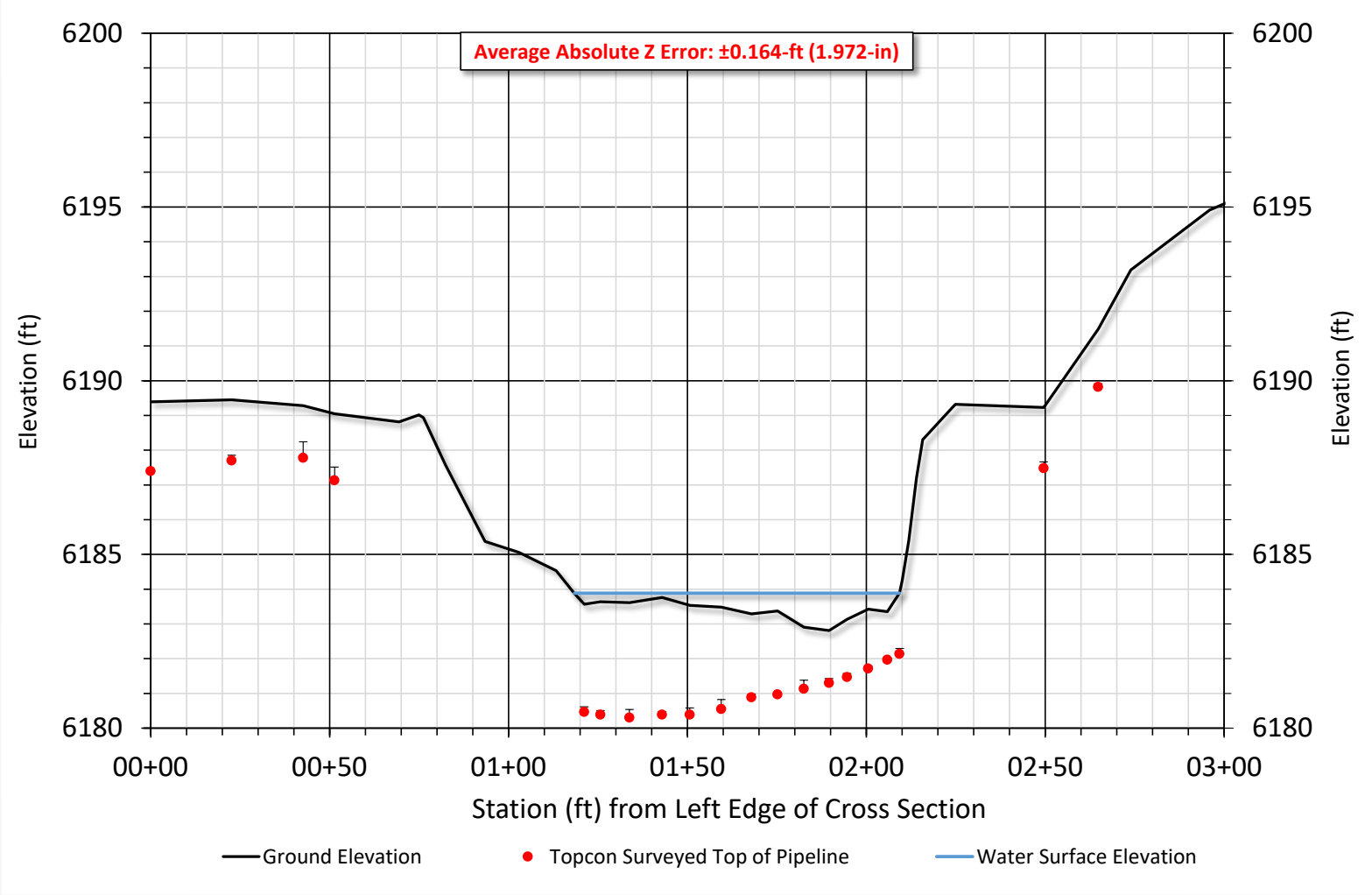
Site 1 – AVG 1.97-inch Difference in Elevation



Site 1 – AVG 2.68-inch Difference in Horizontal

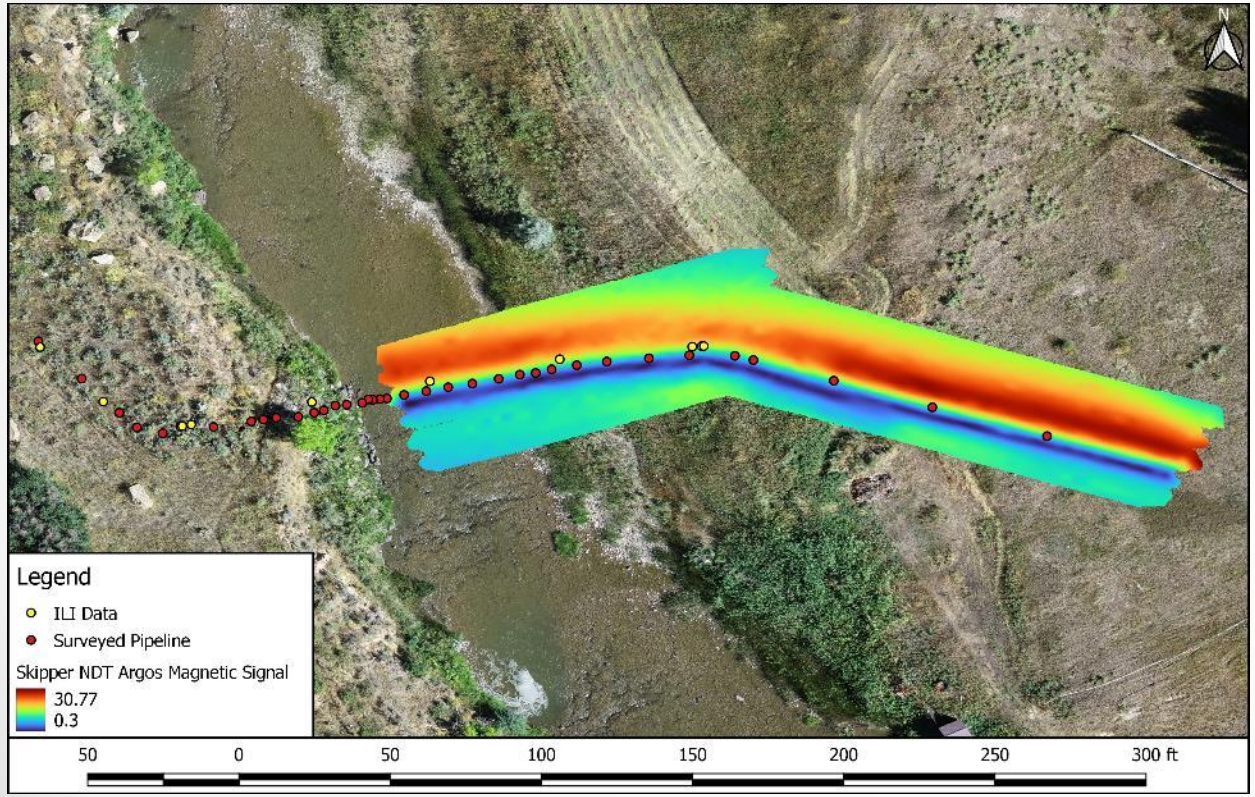


Site 1 - Manual vs Drone-based: Data Overlay

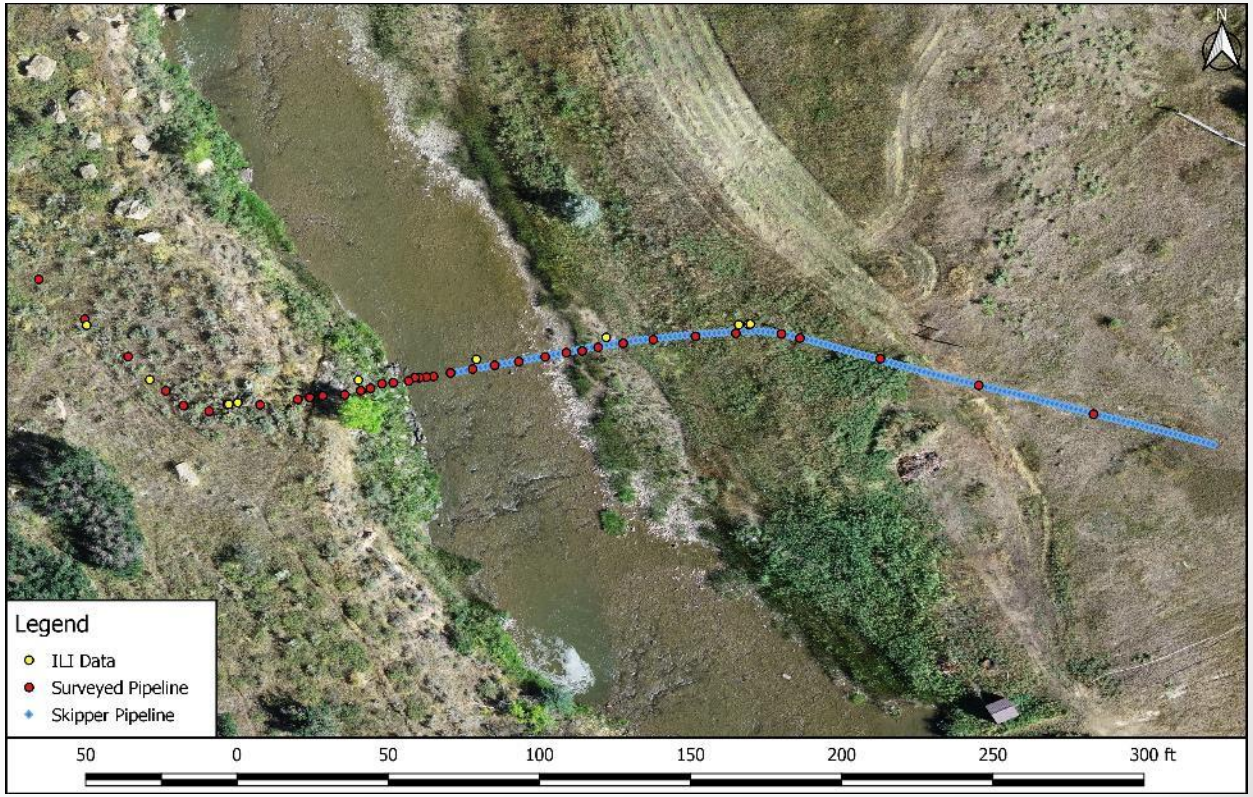


Site 2 - Manual vs Drone-based: Validation

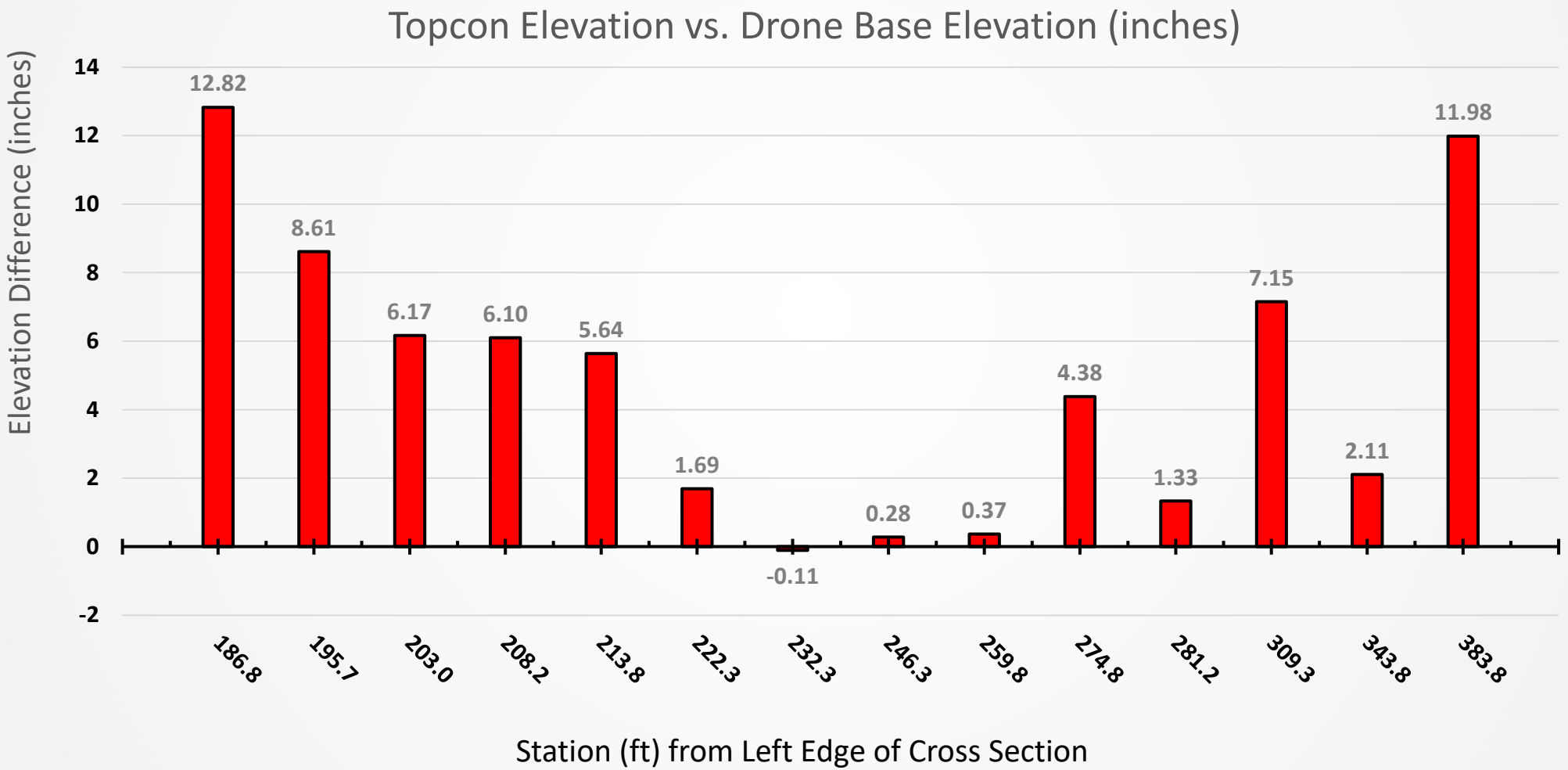
Magnetic Map



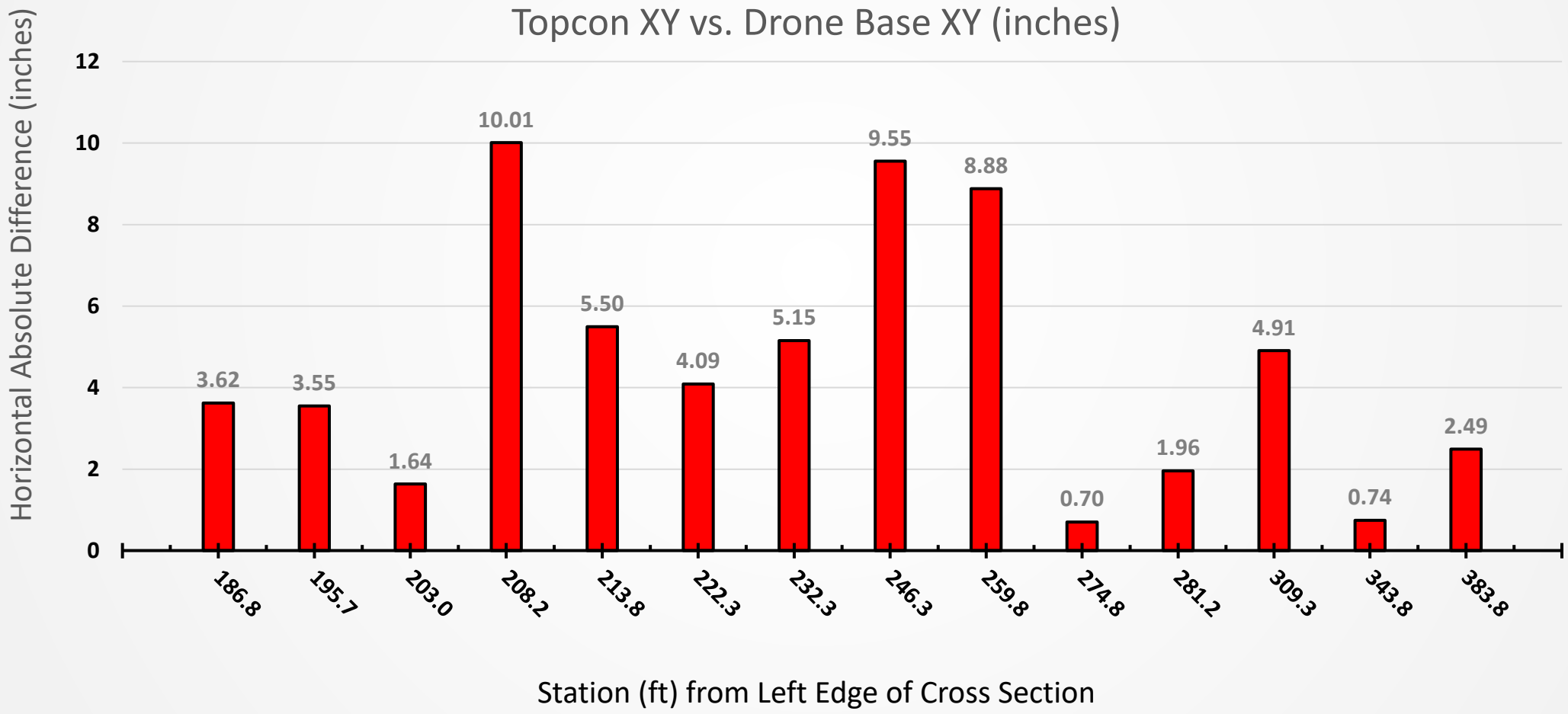
Plan-View of Top of Pipeline



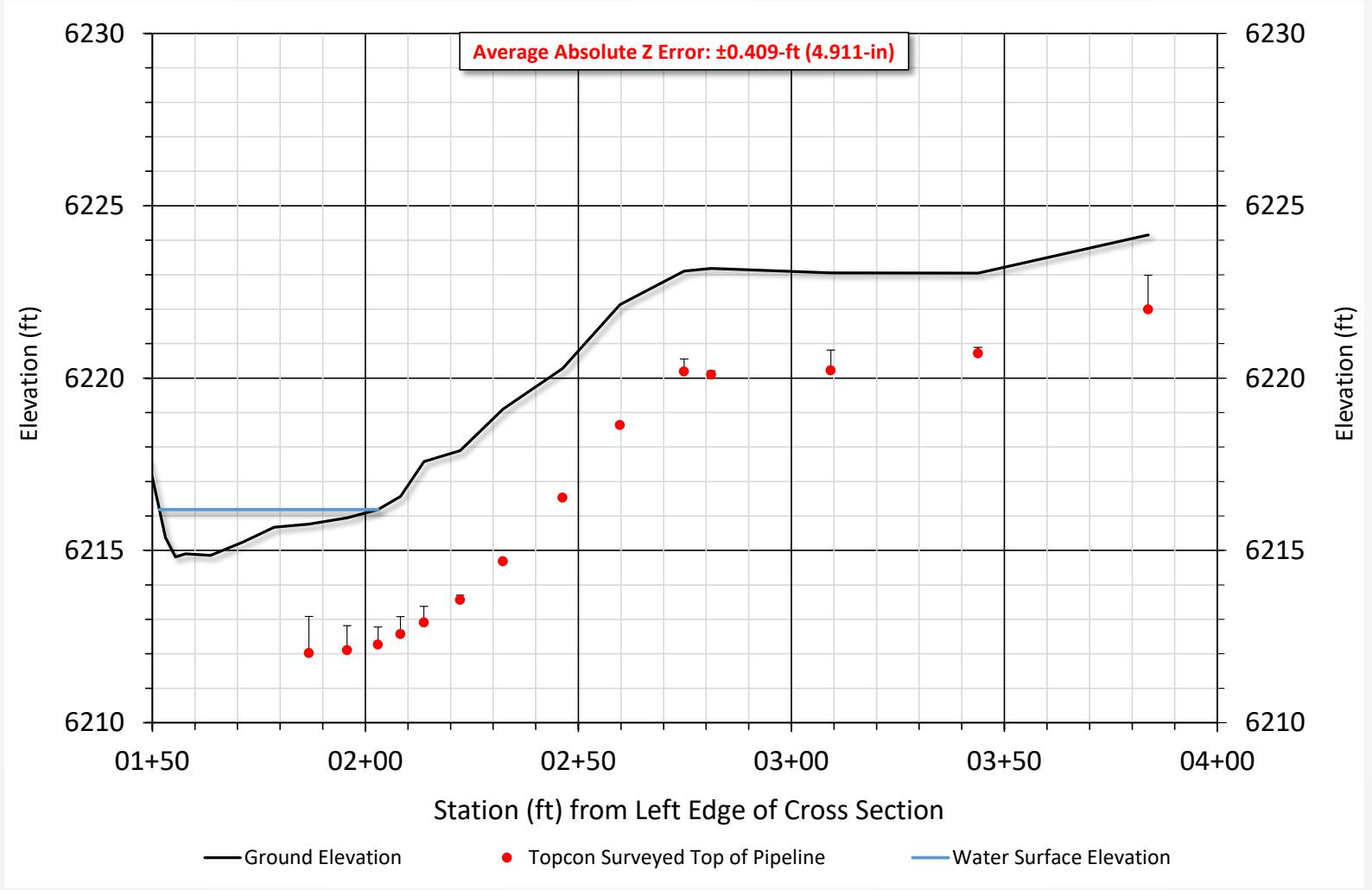
Site 2 – AVG 4.91-inch Difference in Elevation



Site 2 – AVG 4.62-inch Difference in Horizontal

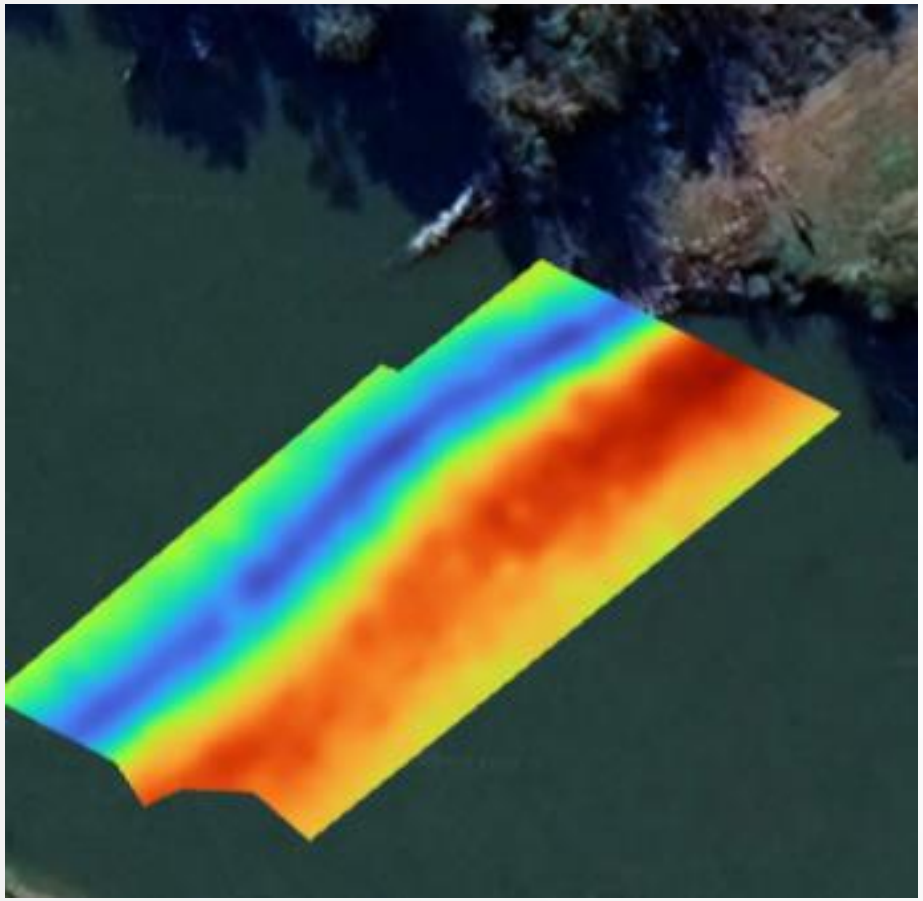


Site 2 - Manual vs Drone-based: Data Overlay

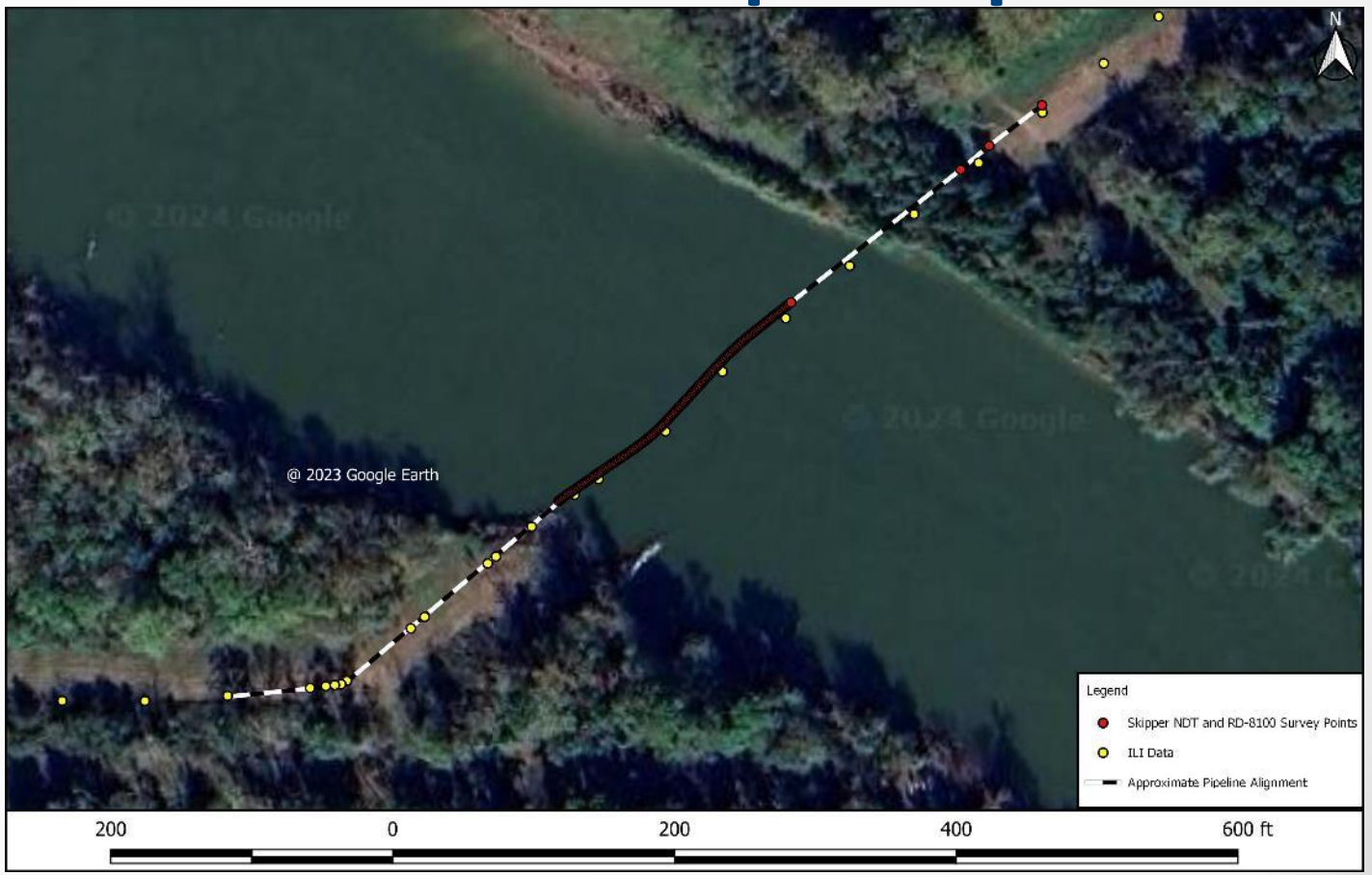


Site 3 – Addressing Line Finder Limitations

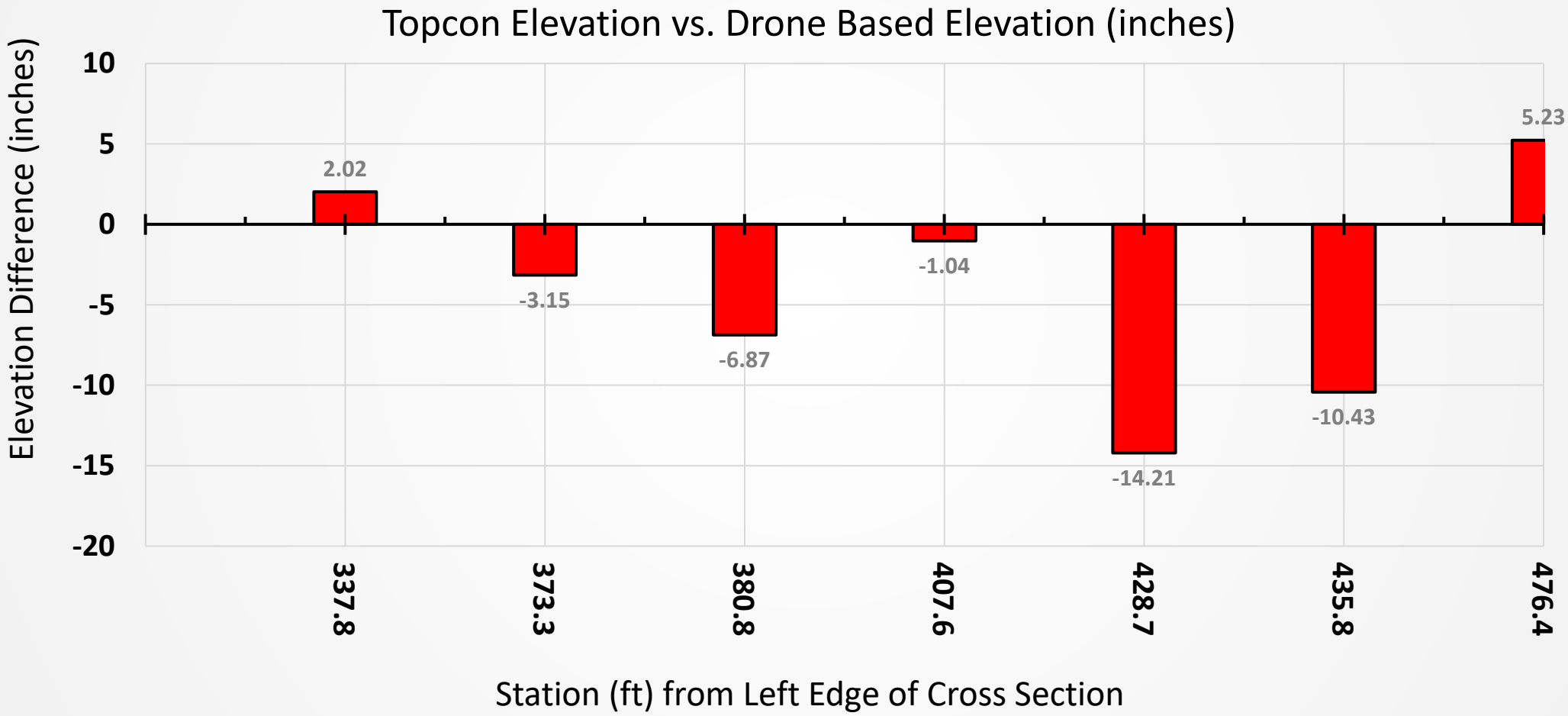
Magnetic Map



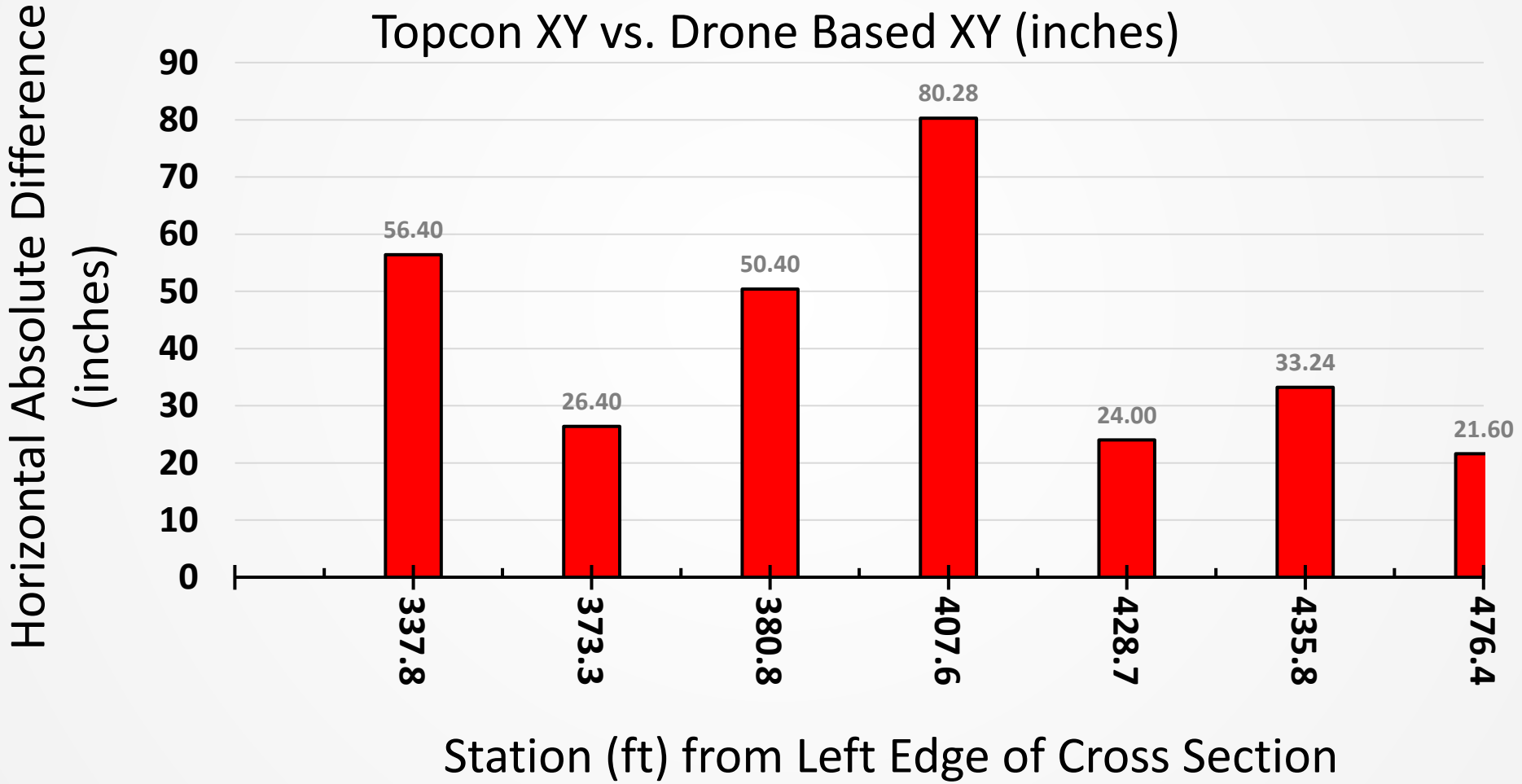
Plan-View of Top of Pipeline



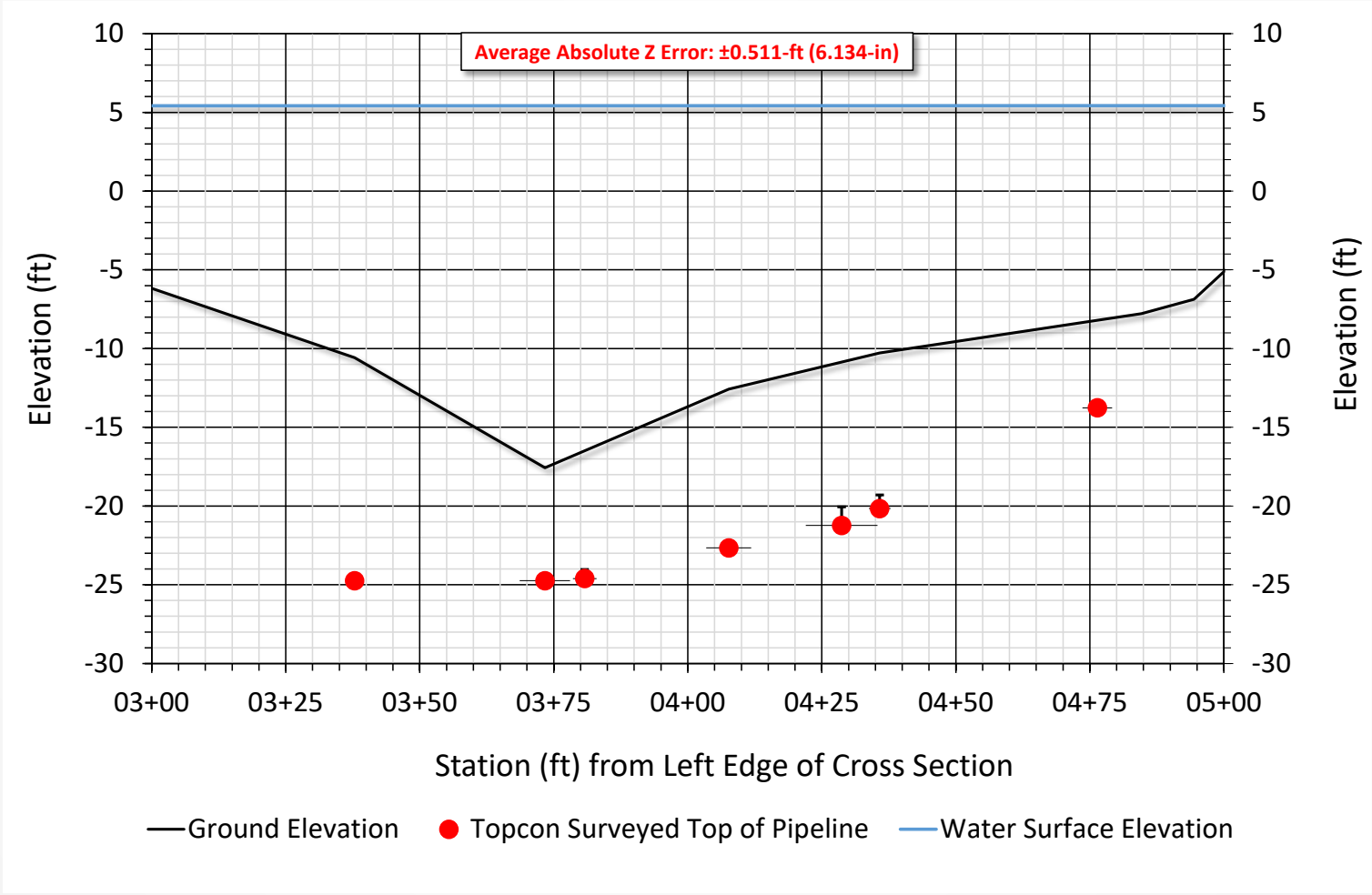
Site 3 – Enhanced Data Density 7 vs 132 Pts



Site 3 – Enhanced Data Accuracy



Site 3 - Manual vs Drone-based: Data Overlay



Conclusions

Performance

Accurate, precise and consistent positioning tool over several river crossings.

Range

Maximum tested range of 45ft sensor/pipe distance.
No error factor to be applied to the depth.
No theoretical limitations other than signal strength.

Speed

An average speed of 30 minutes of flight time per 300 ft inspected.

Safety

No personnel is deployed underwater increasing safety and simplifying logistics.

- **Pipeline operators need reliable pipeline depth of cover across their pipeline networks regardless of Environmental Hazards.**
- **Drone based platform for rapid collection of high-density top of pipeline elevation data.**
- **Increased data density and accuracy enables additional analysis including geohazard assessments.**
- **Challenges associated with applying drone-based payload are similar to traditional data collection methods and include:**
  - **Current induction.**
  - **Multi-Pipeline corridors.**