

Project Survey Control Report

STATEMENT OF PURPOSE

This control survey and post-processed kinematic survey were performed to support Aerial LiDAR acquisition in the San Francisco Bay Area and Sacramento Delta.

PROJECT LOCATION

The mapping area covers from San Francisco in the west, San Jose in the south, Modesto in the East, and Sacramento in the north. The total coverage is shown in the figure below.

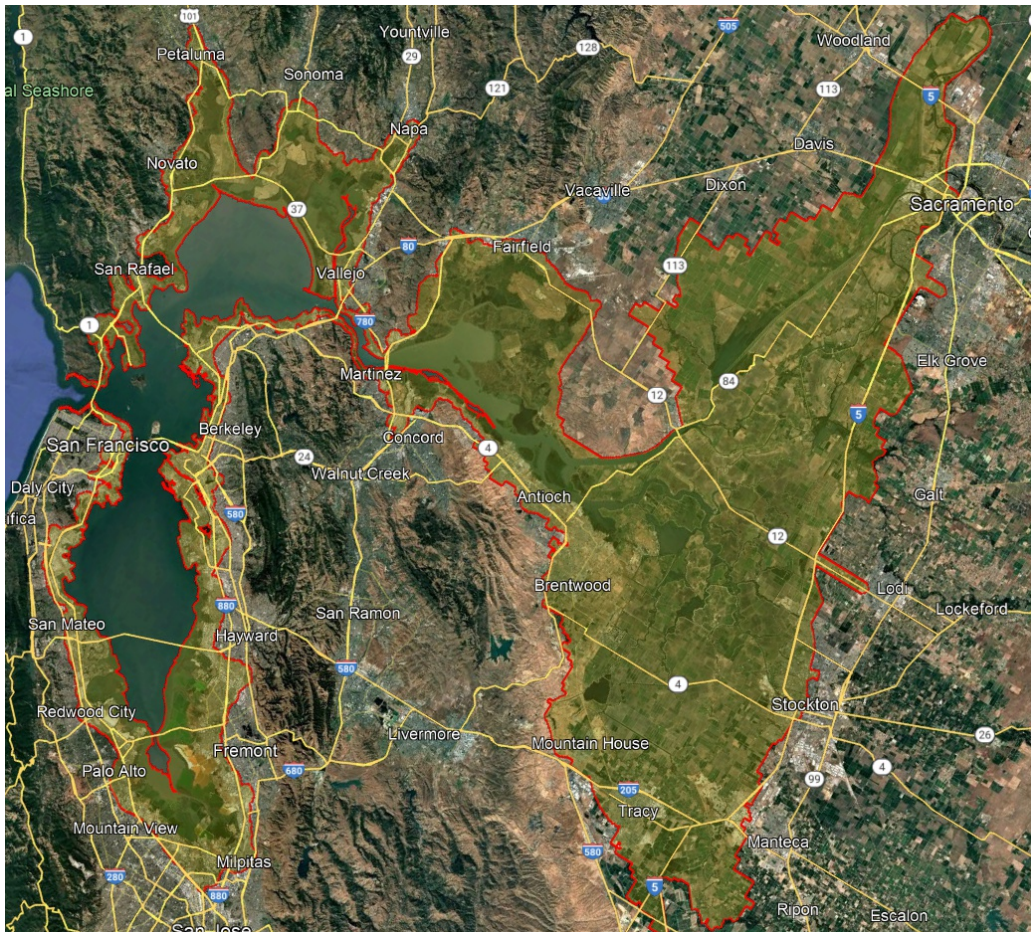


Figure 1: Approximate area of LiDAR Collection, Delta, and Bay Areas.

BASIS OF CONTROL AND DATUM NOTES

As directed by DWR, the following datums were utilized for this survey.

1. Coordinates are referenced to UTM 10 North based on the North American Datum of 1983 (2011), Epoch 2025.00, defined locally by CSRS CGPS stations 108W, P271, P276, PP268, P275, P267, P266, P261, P262, P248, P256, P262, P261, P266, P275, P256, P309, CMOD, S300, and P230, OHLN, MHC2, ZOA1, SLAC, P176, UCSF, FARI, TIBB, P181, WINT, LUTZ, P222, P224, P225, P226, P178, P221, P213, P177, P194, AND P198.

- Elevations (Zone 2) are referenced to the North American Vertical Datum of 1988 (NAVD88) defined locally by CSRS CGPS stations 108W, P271, P276, PP268, P275, P267, P266, P261, P262 P248, P256, P262, P261, P266, P275, P256, P309, CMOD, S300, and P230, OHLN, MHC2, ZOA1, SLAC, P176, UCSF, FARI, TIBB, P181, WINT, LUTZ, P222, P224, P225, P226, P178, P221, P213, P177, P194, AND P198. Elevations have been derived by applying the NGS Geoid 18 model to ellipsoid heights and are expressed in U.S. survey feet.

FIELD SURVEY OPERATIONS

- GUIDA set and surveyed a total of 51 Calibration Control points and 120 NVA and VVA points consisting of Bare earth, urban, forest, tall grass, shrub as directed by the aerial team.
- GUIDA performed Static GNSS surveys on nineteen calibration points set with a Trimble GNSS receiver on a fixed height tripod (2 meters), with a five (5) second recording interval and 10-degree mask. Each point was occupied for minimum of 2 hours.
- Static GNSS calibration point include CA032, CA010, CA034, CA046, CA035, CA030, CA007, CA049, CA031, CA014, CA005, CA043, CA026, CA024, CA020, CA003, CA018, CA042, AND CA015.
- GUIDA performed Post-processed Kinematic surveys on thirty two (32) calibration points set with a Trimble GNSS receiver on a fixed height tripod (2 meters), with a five (5) second recording interval and 10-degree mask. Each point was occupied for minimum of 15 hours.
- Post-processed Kinematic (PPK) calibration points include CA002, CA008, CA033, CA011, CA001, CA047, CA051, CA012, CA044, CA013, CA028, CA036, CA050, CA037, CA009, CA038, CA029, CA048, CA040, CA045, CA006, CA039, CA004, CA027, CA025, CA023, CA022, CA021, CA019, CA017, CA016, and CA041 were occupied for a minimum of 15 minutes.
- All Vegetated and non-vegetated points (VVA and NVA) were collected with Post Processed Kinematic methods for 5-minute observations.
- The surveys were performed in accordance with the DWR DOE-Geomatics Field Surveying Specifications.

STATIC BASE (minimum 1-hr)	15-Min Static (Calibration Points)	5-Min Static
CA032	CA002	TG001
	CA008	UA001
	CA033	BE031
	CA011	UA032
		BE022
		UA025
		BE018
CA010	CA001	UA027
		UA029
		UA031
		BE021
		BE037

Example Data Collection Plan (see Appendix 3 for full plan).

ADJUSTMENTS AND ANALYSIS

Standards

GNSS data was processed using Trimble Business Center 2025.10 software and adjusted using Star*Net v13 software. The adjustments were performed in UTM Zone 10 North coordinates with exports to UTM 10 North and California Coordinate System 1983, Zone 2 and 3 coordinate values.

LiDAR Calibration (Static GNSS) Control Minimally Constrained Adjustment

1. The Latitude, Longitude, and Ellipsoid Heights of P262 were held fixed in a least-squares adjustment.
2. A centering error of 2mm was applied to observed vectors.
3. Geoid modeling was applied using the NGS Geoid18 model. No transformations applied.
4. After initial analysis (one outlier vector was detected and ignored), a scale factor of 1.778 was applied to the weighting of observed vectors to achieve an a-posteriori error factor of 1.00.
5. Relative error ellipses (horizontal) are within the 2cm range at the 95% confidence level.
6. Relative error ellipses (vertically) are within the 10cm range at the 95% confidence level.

LiDAR Calibration (Static GNSS) Control Constrained Adjustment – Horizontal & Vertical

1. The Latitude, Longitude, and elevation of 108W, P271, P276, PP268, P275, P267, P266, P261, P262 P248, P256, P262, P261, P266, P275, P256, P309, CMOD, S300, and P230, OHLN, MHC2, ZOA1, SLAC, P176, UCSF, FARI, TIBB, P181, WINT, LUTZ, P222, P224, P225, P226, P178, P221, P213, P177, P194, AND P198 were held fixed in a least-squares adjustment.
2. A centering error of 2mm was applied to observed vectors.
3. Geoid modeling was applied using the NGS Geoid18 model.
4. Transformations were applied.
5. Scale factor of 1.778 was applied to the weighting of observed vectors and the resulting a-posteriori error factor was 1.008.
6. Relative error ellipses (horizontal) are within the 2cm range at the 95% confidence level.
7. Relative error ellipses (vertically) are within the 5cm range at the 95% confidence level.

LiDAR Post-Processed Kinematic Adjustment – Horizontal & Vertical

1. Base stations were set on the 19 calibration points established by static GNSS methods. These calibration points include CA032, CA010, CA034, CA046, CA035, CA030, CA007, CA049, CA031, CA014, CA005, CA043, CA026, CA024, CA020, CA003, CA018, CA042, and CA015.
2. From the base stations, 32 calibration points were collected and 120 NVA and VVA points.
3. A centering error of 2mm was applied to observed vectors.
4. Geoid modeling was applied using the NGS Geoid18 model.
5. Transformations were applied.
6. Scale factor of 1.778 was applied to the weighting of observed vectors and the resulting a-posteriori error factor was 0.995.

PUBLISHED COORDINATES

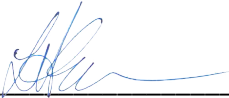
The final coordinate values are included in the coordinate listings attached as Appendices C and D in pdf and csv format.

LIST OF APPENDICES

- Appendix A1 – Static GNSS Minimally Constrained Control Adjustment
- Appendix A2 - Static GNSS Fully Constrained Control Adjustment
- Appendix A3 - Data Collection Plan
- Appendix B1 - Post-Processed Kinematic Data Fully Constrained Control Adjustment
- Appendix C1 - LiDAR Calibration Coordinate Listing (UTM10N), pdf
- Appendix C2 - LiDAR Calibration Coordinate Listing (UTM10N), csv
- Appendix C3 - LiDAR Calibration Coordinate Listing (NAD83 Z2), csv
- Appendix C4 - LiDAR Calibration Coordinate Listing (NAD83 Z3), csv
- Appendix D1 - LiDAR NVA_VVA Coordinate Listing (UTM10N), pdf
- Appendix D2 - LiDAR NVA_VVA Coordinate Listing (UTM10N), csv
- Appendix D3 - LiDAR NVA_VVA Coordinate Listing (NAD83 Z2), csv
- Appendix D4 - LiDAR NVA_VVA Coordinate Listing (NAD83 Z3), csv
- Appendix E1 - Calibration Control Vectors
- Appendix E2 - Post-Processed Kinematic Vectors

SURVEYOR'S STATEMENT

This survey was conducted by me or under my direction in conformation with the requirements of the Professional Land Surveyors' Act in July, August, and September 2025.

SIGNED: 
Lisa M. Henstridge Spivak

DATE: 10/03/2025

