55 Creek Rock Road • Sedona, Arizona 86351 • www.geodetic.xyz

STATEMENT OF QUALIFICATIONS

COMPANY OVERVIEW

Geodetic Analysis, LLC, offers a variety of geodetic consulting, GIS, and educational services. Geodetic Analysis, LLC, provides consulting and educational services throughout the U.S. The firm is registered to provide professional civil engineering and land surveying services in Arizona.

Services Provided

The services provided by Geodetic Analysis, LLC, include coordinate system design, spatial data management, survey and GIS data integration, GIS and socioeconomic data analysis, data visualization (e.g. infographics, data dashboards), storymap development, educational seminars, and creation of custom computer algorithms. Additional details of the types of services provided are listed below.

Services Related to GIS and Data Analysis

- Gather, compile, and scrub geospatial data. Integrate data into maps and/or geospatial analysis. Includes any necessary geocoding of collected or client-supplied data, preparation of maps, technical documentation, and write-up.
- Socioeconomic data analysis. This includes area socioeconomic profiles based on available data from the U.S. Census, the U.S. Bureau of Labor Statistics, and other available sources as required/needed. Also includes technical write-up on findings and analysis.
- Data visualization. Includes custom online data dashboards, infographics, and charts/tables/maps for integration into reports, presentations, and websites.
- Development of ArcGIS Online web maps. Includes custom story maps and web map viewers.
- Design and development of reports, presentations, and websites for distribution of socioeconomic data, GIS, and analysis.
- Data needs assessment. An assessment of data collection, maintenance, and storage procedures and policies. This includes recommendations for enhancements and suggested implementation process.

Geodetic Consulting Services

- Design and select coordinate systems best suited to the needs of the client. Includes specification of appropriate projection parameters and datum definitions. For areas where low-distortion (i.e., “ground”) coordinates are desired, rigorously defined Low Distortion Projection coordinate systems can be designed that are compatible with a wide range of software packages.
- Assist in performing and selecting coordinate transformations appropriate for changing datasets from one coordinate system to another. Includes determining and defining characteristics of spatial data with poorly or undefined coordinates, and development of geodetically rigorous definitions that allow georeferencing of data while preserve legacy coordinates.

- Develop geospatial data standards customized to the particular needs of the client. This includes assistance in developing technically correct contractual scope for spatial data products (such as aerial mapping deliverables) with regard to accuracy, format, documentation, and metadata. This can be done in conformance with current Federal Geographic Data Committee (FGDC) standards and with Federal Emergency Management Agency (FEMA) requirements.
- Perform spatial accuracy assessment of datasets (such as aerial imagery and topographic surface models), including comparison of precision and accuracy to determine the presence of bias. This includes the performance of calculations and/or fieldwork, and the numerical assessments can be done per FGDC (or other) standards. For topographic surface models, a very large number of well-distributed spot elevations can be used both to assess the model and remove bias from the final delivered model.
- Plan, coordinate, and process Global Navigation Satellite System (GNSS) data to establish accurate and reliable survey control consistent with the National Spatial Reference System. Methods are based on redundant observation and rigorous least-squares adjustment utilizing both post-processed and real-time data. Includes formatting, documentation, and submittal to the National Geodetic Survey (NGS) for publication (i.e., "Bluebooking").
- Analysis of existing control surveys to determine accuracy and coordinate system characteristics. Includes planning for update or densification of control, and rigorously defining or modifying coordinate systems for compatibility with other software packages.

Services Related to GIS and Survey Data Integration

- Provide guidance in selection and use of appropriate coordinate systems definitions, including geodetic datums (i.e., geographic coordinate systems) and their relationship to other datums.
- Development of FGDC compliant metadata and feature-level (record-by-record) metadata with regard to spatial characteristics of the data (such as accuracy, coordinate systems, source, equipment used, persons in responsible charge, etc.).
- Accuracy assessments and georeferencing of GIS and survey datasets. This includes coordination with the provider of Real Time Network (RTN) positioning services to ensure coordinate system consistency.
- Assist in developing workflows to facilitate direct import of survey-grade spatial data into GIS.

Educational Services

- Provide training, seminars, and workshops to educate users on the use and integration of Census data with GIS. These can be tailored to suit particular audiences such as GIS professionals and grant writers.
- Provide training, seminars, and workshops on essential data visualization tools and techniques.
- Provide training and workshops on storytelling with data. This includes presentations skills and StoryMap creation.
- Deliver seminars and workshops to educate users on geodetic issues relevant to their work. These can be tailored to suit particular audiences, including surveyors and GIS professionals.
- Provide training on "best practices" for the use of GIS and surveying software packages, as well as survey and mapping equipment. Although not all vendor software and equipment types can be covered in detail, many general concepts can be applied to most products.

CLIENTS AND PROJECT EXPERIENCE

Client List

Geodetic Analysis, LLC, has and continues to provide geodetic consulting and educational services to a variety of clients, including government agencies from the federal to municipal level, utilities, large to small private firms, and individuals. A representative list of some of our larger clients is given below.

State government and transportation

- Alaska Department of Transportation & Public Facilities
- Iowa Department of Transportation
- Kansas Department of Transportation
- North Dakota Department of Transportation
- Oregon Department of Transportation (Geometronics Division)
- Southeast High Speed Rail (SEHSR) Project
- Washington Metropolitan Area Transit Authority, Washington DC

County, city, and regional government

- Androscoggin Valley Council of Governments, Auburn, Maine
- City of Casa Grande, Arizona
- City of Flagstaff, Arizona
- City of Phoenix, Arizona
- City of Safford, Arizona
- City of Surprise, Arizona
- Cochise County, Arizona
- Coconino County, Arizona
- Craighead County/City of Jonesboro, Arkansas
- Gila County, Arizona
- Graham County, Arizona
- Maricopa Association of Governments, Phoenix, Arizona
- Mohave County, Arizona
- Northeast Ohio Areawide Coordinating Agency, Cleveland, Ohio
- Oregon Cascades West Council of Governments, Albany, Oregon
- Pima County, Arizona

Federal and tribal government

- National Geodetic Survey
- Navajo Division of Transportation
- Rocky Mountain Tribal Transportation Association
- U.S. Geological Survey (Grand Canyon Monitoring and Research Center)

Non-Profit Organizations

- The Winston-Salem Foundation, North Carolina

Private consulting and software firms

- A Team Professional Associates, Inc.

- AMEC Earth & Environmental, Inc.
- Applied Economics
- A/R360 Consultants, LLC
- Arth Analytics
- Clark Hill, PLC
- Cooper Aerial Surveys Co.
- David Evans & Associates, Inc.
- Dynamic Visions GIS
- Eagle Point Software Corporation
- Edge-U-Cate, LLC, Colorado
- Eos Positioning Systems, Inc.
- Northern Engineering and Consulting, Inc.
- Psomas, Inc.
- Shephard-Wesnitzer, Inc.
- Ushr, Inc.

Mining and utilities

- ASARCO, Mission Mine Complex
- Freeport-McMoRan Copper & Gold, Bagdad Operations
- Freeport-McMoRan Copper & Gold, Globe – Miami
- Resolution Copper Mine
- Rio Tinto Limited
- Sulphur Springs Valley Electric Cooperative, Inc.

Professional societies

- Alaska Surveying and Mapping Conference
- American Congress on Surveying and Mapping
- Arizona Geographic Information Council
- Arizona Professional Land Surveyors Association
- California Land Surveyors Association
- Montana Association of Registered Land Surveyors
- Oregon GPS Users Group
- Women In GIS International
- Women In GIS – Arizona Chapter

REPRESENTATIVE PROJECT EXPERIENCE

- **COMPREHENSIVE ECONOMIC DEVELOPMENT STRATEGY (CEDS).** Performed data analysis and developed data visualizations for regional economic development strategies in Ohio and Maine. Developed StoryMaps to disseminate CEDS information to stakeholders. Northeast Ohio Areawide Coordinating Agency (June 2022: https://arcg.is/0POHez); Androscoggin Valley Council of Governments CEDS 2023-2028 (https://arcg.is/Xzrj0).

- **LOW DISTORTION PROJECTION DESIGN.** Designed Low Distortion Projections (LDPs) for various organizations throughout the US, including Oregon Department of Transportation, Kansas Department of Transportation, Iowa Department of Transportation, Washington Metropolitan Transit Authority, City of

Safford, Pima County, Cochise County, City of Surprise (covering Maricopa County, Arizona), the Navajo Nation, Rocky Mountain Tribal Transportation Association, City of Flagstaff (Arizona), and numerous project-specific applications. LDPs are rigorously defined conformal coordinate systems designed to minimize map projection distortion at the topographic surface. Objective is to create coordinate systems that provide "ground" distances appropriate for surveying and engineering and yet are fully compatible with GIS. Developed computer program to perform optimization computations and generate GIS-compatible output (2004 – 2022).

- **DIGITAL EQUITY PLAN, FORSYTH COUNTY, NORTH CAROLINA.** Collected and analyzed a variety of socioeconomic and infrastructure data for the region and state. Developed data visualizations (maps, charts, graphics) for the Digital Equity Plan and created a data demographics summary infographic. (2021, https://www.fcdigitalequity.org/plan).

- **ESTABLISHED GPS AND GEODESY WORKSHOP PROGRAM.** Developed and presented "GPS, Geodesy, and the Ghost in the Machine", a full-day workshop with accompanying workbook for teaching geodetic principles to professional users of GPS technology. Includes examples of common GPS positioning errors, explanation of relevant geodetic theory and terminology, useful GPS and geodetic resources, and detailed step-by-step geodetic computations. Presentations given at surveying and mapping conferences throughout US (2005 – 2017).

- **STATE OF THE REGION PROJECT, OREGON.** Provided subject matter expertise on Census and other socioeconomic data. Collected, scrubbed, and analyzed a variety of data related to the three-county region of Benton, Lincoln, and Linn counties in Oregon. Created maps, charts, tables, and infographics to visualize the data. Write technical analysis about the data in a manner that is easily consumable by stakeholders. Build and customize ArcGIS Online Story Map with 13 different sections. **www.stateoftheregion.org** (2014 – 2015).

- **DEVELOPMENT AND MAINTENANCE OF WEBSITE FOR THE ARIZONA GEOGRAPHIC INFORMATION COUNCIL (AGIC) ANNUAL CONFERENCE.** Design, develop, and customize the website for the AGIC Education and Training Symposium. This includes content updates, graphic design, and custom coding for conference registration, payment, forms, e-newsletter, and surveys. Continue to maintain and update website as needed (2010 – 2019).

- **SURVEY CONTROL AND GEODETIC ANALYSIS, GRAND CANYON, ARIZONA.** Assist Grand Canyon Monitoring and Research Center of the U.S. Geological Survey in establishing high-accuracy geodetic control along the Colorado River corridor in the Grand Canyon, as well as in the overall Grand Canyon region. Includes GPS baseline processing, control network adjustments, established control for aerial mapping, combining GPS and terrestrial observations, analysis of gravitational effects (particularly with regard to height determination), evaluation of existing control, and development of standards for control surveys and data collection (2004 – 2013).

- **DEVELOPMENT OF COMPREHENSIVE SURVEY-GRADE GIS, SAFFORD, ARIZONA.** Assist City of Safford in the capture and management of survey-grade data for their GIS (with emphasis on GPS data). Includes development of field and office procedures, assisting with control surveys, planning and execution of high-accuracy utility system inventories, establishing data quality control and metadata protocols, performing accuracy evaluations of aerial mapping, establishing a permanent GPS base, and designing a Low Distortion Projection suitable for GIS as well as surveying and engineering applications (2006 – 2010).

- **DEVELOPMENT OF MAG REGIONAL ONLINE DATA CENTER.** Designed web template, created graphics and visualizations. Gathered data and reports to be distributed on the website. Organized website content and populated it with data along with write-up about each data item/section (2011 – 2012).

- **HEIGHT MODERNIZATION SURVEY PROJECT MANAGEMENT AND DATA PROCESSING, ARIZONA.** Managed four National Geodetic Survey (NGS) Height Modernization survey projects in the Safford, Eloy-Casa Grande, Kingman, Flagstaff, Grand Canyon, and Arizona Strip areas of Arizona. Coordinated personnel and equipment from cities, counties, state and federal agencies, and private firms. Consisted of planning, correspondence, resource coordination, field logistics, training of field personnel, and data management. Also performed GPS baseline processing and network adjustment per NGS "Bluebook" procedures (2006 – 2010).

- **PHOTOGRAMMETRIC CONTROL AND ACCURACY ASSESSMENT FOR AERIAL MAPPING, SAFFORD, ARIZONA.** Developed aerial mapping accuracy specifications and established photogrammetric control for City of Safford aerial mapping project. Coordinated and processed a citywide manhole survey which yielded several hundred well-defined points for performing accuracy assessment of the imagery and digital terrain model. Accuracy assessments were performed per the FGDC National Standard for Spatial Data Accuracy (NSSDA). Served as a technical advisor to the City for the duration of the project (2006 – 2007).

- **COORDINATION OF CENSUS 2010 TECHNICAL PROGRAMS, PHOENIX, ARIZONA.** Collaborate with U.S. Census Bureau staff to review the Master Address File (MAF) for the Phoenix Metropolitan area leading up to the 2010 U.S. Census. Assist with 2010 Census outreach efforts. After the release of 2010 Census data, review data and geography outputs to assist MAG member agencies with Census Count Review Program efforts (2009 – 2011).

- **ARIZONA DEPARTMENT OF TRANSPORTATION (ADOT) MAP BOOK.** Created the first ADOT Map Book in 2000 – creating maps, organizing content, and designing cover page. Delegate map creation/update to staff in subsequent years while continuing to collaborate with staff to organize and update the map book annually (2000 – 2008).

- **OVERSIZE/OVERWEIGHT TRUCK PERMITTING PROJECT, PHOENIX, ARIZONA.** Serve as subject matter export for the routing component of online permitting of oversize/overweight trucks. Created route geodatabase and installed on Linux-based web application. Worked closely with ADOT Information Technology staff to connect permitting application with the web-based routing application. Troubleshoot application as needed during program enhancements and update route database as needed (2005 – 2008).

- **SURVEY CONTROL NETWORK AND QUALITY ASSURANCE FOR AERIAL MAPPING, FLAGSTAFF, ARIZONA.** Established survey control network to support aerial photogrammetry and LiDAR project for the City of Flagstaff. Designed survey network, coordinated data collection, reduced data, and performed network adjustment and analysis. Provided quality assurance evaluation of the imagery and topographic surface model submitted by the aerial company to ensure conformance to FEMA standards (2004 – 2005).

- **SPATIAL DATA STANDARDS AND DEFINITIONS PROJECT, PHOENIX, ARIZONA.** Developed standards and specifications for mapping and surveying the City of Phoenix water system. Standards developed in cooperation with the NGS Arizona Geodetic Advisor. Project scope also included coordination of data collection by independent contractors, data processing, software and equipment evaluations, data quality assurance and control, and development of education and outreach materials (2004 – 2005).

- **STORMWATER FACILITIES GPS MAPPING, SEDONA, ARIZONA.** Perform inventory of stormwater facilities (mainly culverts and engineered channels) for City of Sedona using mapping-grade GPS. Several hundred facility positions were collected throughout the City, differentially corrected, and exported to a format compatible with the City GIS. Detailed attributes and linked digital photographs were provided for all features. Included verification and reporting of GPS positional accuracy (2003).

- **NGS ARIZONA FEDERAL AND COOPERATIVE BASE NETWORKS.** Participated in static GPS observations with the National Geodetic Survey as part of the Arizona Federal and Cooperative Base Network surveys (FBN and CBN). This work resulted in the establishment of new High Accuracy Reference Network (HARN) stations in the Flagstaff and Verde Valley areas. Combining FBN and CBN data with GPS data from other project-specific observations allowed establishment of a regional survey control network covering approximately 22,000 square miles of central and northern Arizona (1999, 2001, 2003).