

## *Statement of Work*

The Joint Institute of Marine Observations (JIMO) is requesting funding to support a partnership between the National Geodetic Survey and the Scripps Institution of Oceanography (SIO) California Spatial Reference Center (CSRC). The purpose of this partnership between the National Ocean Service (NOS) National Geodetic Survey and the CSRC is for the mutual benefit of both organizations and the American taxpayers. The synergy will expand the National Spatial Reference System (NSRS), and the California Spatial Reference System (CSRS).

We propose to work on the tasks outlined below in the year ahead:

### **1. California CORS Data Portal**

Building upon the database and web interface of the existing Site Information Manager (SIM) at SOPAC (<http://lox.ucsd.edu/permanentGPSsites/sim.html>) the CSRC will expand this system's capabilities to become a full-service online data portal for CORS coordinates and metadata. This effort will include a comprehensive review of existing CORS site data to resolve any erroneous or ambiguous records for antenna types or antenna heights. In support of Height Modernization, each site will include a definitive geodetic reference mark and measurements to recover the station height relative to the current antenna reference point (ARP) should the equipment be changed or removed at some date. The latest processed and approved coordinates will be linked to the database, and using the NGS-approved transformation parameters and velocity model, made available in either ITRF or NAD83 at an NGS-published epoch or at any user-selectable epoch date. Data will be output from the online interface through interactive data pages as exists currently, a printable station summary page, and as a complete data table format, such as the Spatial Data Transfer Standard, for a selected set of stations.

#### Anticipated Project Tasks

- Comprehensive review and cleanup of existing site database
- Software development to expand output formats of SIM
- Development of database links between SOPAC data processing and NGS transformation and velocity models
- Evaluate coordinate differences generated through Scripps' coordinate generator and NGS' OPUS programs.
- Continued database maintenance
- Preparation and distribution of interactive training CD for new users

Total budget: \$149,990

### **2. Height Modernization: CORS NAVD88 Heights**

A complete data set of NAVD88 heights will be computed for the California CORS network. This will include analysis of the HPGN 1998.50 and Hector Mine Earthquake GPS campaigns to refine the process used to derive orthometric heights from the SOPAC processing infrastructure. Existing leveling data from NGS and MWD, as well as additional leveling ties to be determined and collected in the program, will provide the primary vertical network constraints used in the computations. While the entire Statewide network will not be able to be computed to the highest levels of elevation accuracy, a major focus of the program will be to assign a network accuracy to a published NAVD88 height for each station in the network.

#### Anticipated Project Tasks

- Review of existing vertical GPS campaigns to refine processing procedures for orthometric height determination
- Assemble existing leveling data to California CORS and plan new leveling ties
- Collect and archive leveling and GPS ties to selected CORS
- Review CORS and survey-mode GPS data and quantify geographic weaknesses (i.e. geoid model, limited network constraints) in the Statewide network
- Populate the coordinate database with derived NAVD88 heights and estimated errors
- Provide seamless links to conclusions through SIM

Total budget: \$200,080

### 3. California Spatial Reference Network Master Plan

CSRC will design and document the proposed build-out of the California Spatial Reference System geodetic control network. This single network will encompass both horizontal and vertical components, although the vertical component may drive the overall network design. This program will include a review of existing monumented stations and CORS, and availability of high-quality observation data linking these points to the reference frame. Analysis of geographic, demographics and geophysical weaknesses will be used to design the required station spacing and needed observation data such as additional leveling or gravity data, and/or new CORS sites in development and support of the height modernization program. A written report will be prepared, with an associated GIS, to document the requirements for monument placement and construction, and to guide the collection of new observations and required maintenance.

#### Anticipated Project Tasks

- Assemble data on existing geodetic control records
- Populate database and design a graphical user interface to the data
- Select potential locations for CORS densification
- Identify and document monument specifications
- Prepare Master Plan report including a Height Modernization Plan
- Perform public outreach including seminars, professional publications, and interactive web page

Total budget: \$50,030

### 4. Height Modernization: South San Francisco Bay

This task is the continuation of the Height-Modernization demonstration project started in 1998, with the addition of a real-time GPS infrastructure component to the network. The GPS campaign will be expanded to approximately 30 stations in the South San Francisco Bay with observations and data processing in accordance with the NGS 2-cm Ellipsoid Height Guidelines [http://www.ngs.noaa.gov/PUBS\\_LIB/NGS-58.html](http://www.ngs.noaa.gov/PUBS_LIB/NGS-58.html). The network will include sufficient ties to tidal benchmarks and NAVD88 benchmarks to allow accurate modeling of these surfaces in relation to GPS-derived ellipsoid heights. Project data will be formatted in accordance with Blue Book specifications and following the instructions set in the previous projects. In conjunction with proposed expansion of the local CORS network, data processing, management, and high-speed communications equipment will be installed in the region to demonstrate the capabilities of real-time GPS surveying over a regional area.

#### Anticipated Project Tasks

- Perform local GPS height modernization surveys
- Perform vertical ties to benchmarks in support of height modernization
- Perform network analysis and adjustments for GPS survey projects
- Demonstrate the capabilities of real-time GPS surveying
- Assist in coordinating activities with contractors
- Provide QA/QC of contractors work

Total budget: \$200,035

### 5. Southern California Real-Time GPS Network

This task will develop and demonstrate a real-time three-dimensional GPS network capability in collaboration with the Geomatics/Land Information Division of Orange County's Public Facilities and Resource Department (PFRD). The central telemetry sites will receive data continuously from the CORS sites and relay the data to the Central Facility at the CSRC Operational Center in La Jolla and to a mirror facility at PFRD. The data will be analyzed for integrity, stored on data servers, and real time kinematics (RTK) data will be streamed via the Internet at both facilities. Surveyors will be able to receive RTK data through cellular modems attached to a personal computer and obtain real-time three-dimensional position fixes with cm-level horizontal precision and 5-cm vertical precision. Longer occupations at a site will allow improved precision in both the horizontal and vertical coordinates.

#### Anticipated Project Tasks

- Demonstrate use of real-time, centimeter-level, horizontal and vertical RTK positioning
- Provide technical consultation to state and local surveyors

Total budget: \$300,140

## **6. Height Modernization: Interferometric Synthetic Aperture Radar (InSAR)**

Investigators at SIO and USGS have demonstrated that InSAR can be an effective tool for monitoring land subsidence, an important factor in maintaining a modern vertical reference network. It is quite difficult to develop models for vertical deformation, unlike horizontal deformation and models such as NGS' HTDP. Furthermore, GPS observations and traditional measurements such as leveling are too expensive for monitoring vertical deformation. InSAR provides excellent spatial resolution with good precision to identify, map, and quantify regions of subsidence. On the negative side, this technique may not be suitable in areas that are subject to signal de-correlation (such as agricultural land). This task will apply techniques developed in the scientific community to the problem of defining a vertical reference system for the CSRC. The focus will be in Los Angeles and Orange Counties where there is significant land subsidence.

### Anticipated Project Tasks

- Develop and test InSAR capabilities and effectiveness in determining heights
- Prepare draft guidelines and training materials related to height mod activities
- Provide technical consultation for InSAR projects

Proposed budget: \$97,725