

Third Quarterly Report

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Center (CSRC)
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Project Title: California Spatial Reference Center, FY 2007 Height
Modernization Program

Period: January-March, 2008

Attn: Gilbert Mitchell (Gilbert.Mitchell@NOAA.gov)

Highlights

- Analyzed GPS data from the North San Joaquin Valley 2006 and Central Coast Height Modernization 2007 projects – created first version of bluebook files (B-file, G-file, SERFIL) from CSRC database
- Created bluebook files for North San Joaquin Valley 2006 height modernization project
- Published enhanced analysis of Southern California 2006 height modernization project
- Enhanced PGM software (server and client side) for height modernization projects – released version 1.2 of PGM client
- Evaluated and endorsed HTDP 3.0 for NGS
- Organized with CLSA two real-time GPS workshops
- Engaged in significant outreach efforts
- Participated in National Height Modernization activities

Height Modernization Projects

Central Coast 2007-2008

We completed field GPS observations at 151 monuments for the Central Coast project during the period 27 November 2007 to 22 January 2008. PGM Client user training was provided to the contractors by CSRC staff in La Jolla on 27 September 2007. Observation schedules, monument locations, field personnel, receiver model numbers, antenna model numbers, and monument images were entered through PGM client (Manager Mode). Session metadata were collected through PGM client (Technician Mode). Raw GPS observation data were uploaded with PGM client, and converted to RINEX format. The RINEX file headers were produced by the SOPAC database, based on the session metadata entered through PGM client. A focused and very successful PGM problem-solving session was conducted by CSRC staff on 7 January 2008 in La Jolla with Pete DeKrom (Towill Field Manager) and Marti Ikehara (CSRC Project Manager). The status of the project can be accessed at <http://csrc.ucsd.edu/projects/pgm/cchm2007-map.html>.

CSRC analyzed all GPS data for the project using session-mode GPS post-processing with the RTD software. This includes 151 monuments and 48 CGPS stations (PBO and

BARD). We used SECTOR-based CGPS coordinates in ITRF2005 at epoch 2008 (day 001). We applied the NOAA Trop model to correct for tropospheric refraction and improve the precision and accuracy of ellipsoidal heights. The output for each session is a SINEX file with full covariance information.

The SINEX files were converted to a G-file by transforming each SINEX file into a non-trivial set of independent baselines. The B-file was created from PGM entry and the CSRC database, as well as the SERFIL. This is the first height modernization project for which CSRC has created bluebook files directly from the CSRC database and PGM entry.

The CSRC contractor (Towill) is evaluating the CSRC GPS analysis, and the CSRC-output B-file, G-file & SERFIL. They are performing the orthometric adjustment and preparing the final report. The project will be submitted to CSRC and NGS by the end of June.

Northern San Joaquin Valley 2006

This project was conducted between 24 July and 29 September 2006 by Johnson Frank Associates. In parallel, Caltrans District 10 conducted GPS observations at a set of additional and overlapping monuments. There was a considerable delay in uploading the complete set of Caltrans data and metadata to the CSRC archive. We are now completing the GPS analysis for the Caltrans data and performing the network adjustment for the entire data set, consisting of 152 monuments observed by 26 surveyors and 31 CGPS stations (PBO and BARD). The status of the project can be viewed at <http://csrc.ucsd.edu/projects/pgm/nsjv2006-map.html>.

As described for the CENCHM2007 project, we have created the B-file, G-file and SERFIL for this project. These will be the basis for the orthometric adjustment, which will be performed by one of our on-call contractors (Penfield and Smith). We expect to have the contract in place by June.

Southern California 2006

This project was the first one to make use of the California Real Time Network (CRTN) and to explore new ways to conduct height modernization surveys. Rather than conduct synchronized multi-team surveys, in this project we operated single survey teams that positioned monuments in real time with respect to the real time GPS infrastructure provided by CRTN. NAVD88 monuments were chosen within the region to evaluate and enhance the determination of GPS-derived orthometric heights. The CSRC contractor, Psomas, surveyed 46 monuments in two 5-hour sessions from 18 August 2006 to 27 January 2007. The project can be viewed at <http://csrc.ucsd.edu/projects/pgm/schm2006-map.html>. Initial results were published in *Whitaker et al. (2007)*.

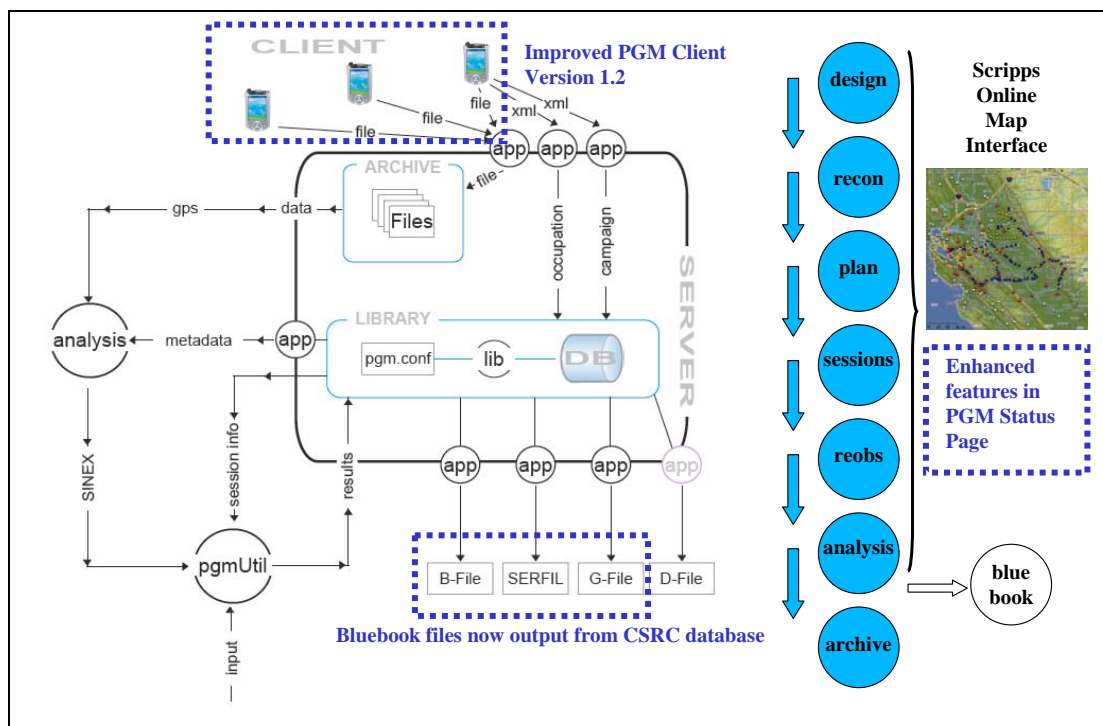
Whitaker, C., G. A. Helmer, Y. Bock, K. Launen, D. E. Morgan, NAVD88 Orthometric Height Determination Utilizing the California Real Time GPS Network, Proc. ION GNSS 20th International Technical Meeting of the Satellite Division, 25-28 September, 2007, Fort Worth, TX, 2155-2162.

Further analysis of the project was published in *Whitaker et al. (2008)*.

Whitaker, C., Y. Bock and G.A. Helmer (2008), *NAVD88 Orthometric Height Determination Utilizing the California Real Time GPS Network and varied Occupation Time Intervals*, 13th FIG International Symposium on Deformation Measurements and Analysis, Lisbon, May 12-15, 2008.

IT for Height Modernization: PGM Software Enhancements

As shown in the figure we made enhancements to PGM in 3 main areas: improved PGM client (version 1.2), enhanced features in PGM status page, and output of NGS bluebook files.



Improvements to PGM client (version 1.2) are outlined at:
http://troy.ucsd.edu/ubbcgi/ultimatebb.cgi?ubb=get_topic;f=35;t=000005

The software can be downloaded from:
<ftp://geopub.ucsd.edu/pub/public/PGM/2008/>

There are 4 versions:

[PGMClient-MM-20080428-Installer.exe](#) - manager version for desktop/laptop
[PGMClient-TM-20080428-Installer.exe](#) - technician version for desktop/laptop

Evaluation of HTDP 3.0

We were requested to evaluate HTDP 3.0 for NGS. Working closely with Chris Pearson we compared HTDP 3.0 values at CGPS stations to SECTOR-computed velocities in the Western U.S. The comparison (in mm/yr) can be viewed at <http://sopac.ucsd.edu/maps/residuals/> (choose velocity layer). In general, we found very good agreement with exceptions at short-lived PBO stations and areas of postseismic deformation. Based on the agreement between HTDP 3.0 and SECTOR velocities we notified NGS of our endorsement of HTDP 3.0. We plan to adopt this model for CSRC and work with NGS to improve the model.

Outreach Efforts in California

- 10 January 2008: League of California Surveying Organizations (LCOS) Meeting, Los Angeles County (Canas)
- 12 January 2008: CCHM Project Meeting with Towill @ SIO, La Jolla (Canas)
- 24 – 26 January 2008: Fresno Geomatics Conference – operated CSRC exhibit booth, presented on CRTN and height modernization projects (Whitaker)
- 5 February 2008: Presentation to the Cal Poly Pomona survey/engineering students on the CSRC and CRTN (Whitaker)
- 7 February 2008: LCOS Meeting, RBF Consulting, Irvine, CA (Canas)
- 24-27 February 2008: Presentation at CLSA conference in Reno on height mod projects, epoch methods and CSRC utilities (Whitaker)
- 4-7 March 2008: Hosted CSRC exhibit booth at ACSM in Spokane, Washington (Whitaker)
- 5 March 2008: County Engineers Association Meeting (CEAC) Meeting La Jolla Hilton (Canas)
- 13 March 2008: LCOS Meeting, County of Ventura (Canas)

National Height Modernization

- 20-22 February 20-22, 2008 NGS Convocation/Height Modernization Partners Meeting, Virginia Beach, Virginia
- Participated in monthly conference calls

Governance

CSRC is governed by an Executive Committee, which holds monthly conference calls and occasional face-to-face meetings. Minutes of these minutes can be found at <http://csrc.ucsd.edu/general/reports.html>.

New and Up-to-Date Financial Reports

The last CSRC monthly financial report for this quarter is given in Appendix A.

Planning for Real Time Network Seminars

CSRC and CLSA (California Land Surveyors Association), led by Steve Martin (CSRC EC member and liaison to CLSA), are planning two seminars on real-time networks. The workshops will be held on 2 May in Ontario (Southern California) and 9 May in San Jose/ Santa Clara (Northern California). The announcement for the seminars is given in Appendix B.

Appendix A: Monthly financial report up to March 31, 2008

CALIFORNIA'S PATIAL REFERENCE CENTER												
FY 2007-2008 NOA/NCS Grant Budget by Task - Budget from October 1, 2007 to September 30, 2008												
Review and Expenses from October 1, 2007 to March 31, 2008												
TRAIL	Task 1 Start Overhead	Task 2 SW Zone	Task 3 Info Tech/ Data Panel	Task 4 CGRS Op/Mkt	Task 5 ESM Task Ad/In-Sm Journals	Task 6 ESM Task Surveys	Task 7 ESM Task Out Reach By Mail	Task 8 ESM Task Ad/In-Sm Journals	Task 9 ESM Task Surveys	Task 10 ESM Task Out Reach By Mail	Task 11 ESM Task Ad/In-Sm Journals	TO TAL
REVENUE												
PT0607 Carry Forward Transfer*	61,864		145,116	41,263			164,168			131,110	180,313	319,500
PT0618 Award	40,000	25,000	50,000	24,000	10,000	22,000	225,000			23,000	50,000	669,000
PT0619 Budget	3,000	25,000	21,000	26,337	10,000	493,292				160,700	28,000	1,105,000
EXPENSES												
Subsites	11,864	0	31,300	27,056	4,437	15,463	6,225	0	0	441	0	253,579
Consultants	7,147	0	0	0	0	0	0	0	0	1678	4,730	32,713
Subcontractors	5,769	0	1,025	24,464	34	751	1,133	0	0	5,034	0	362,166
Supplies	0	0	0	0	0	0	0	0	0	0	0	42,112
Equipment	0	0	0	0	0	0	0	0	0	0	0	0
Travel	812	0	0	2,283	0	0	0	0	0	0	0	36,471
Total Direct Costs (DC)	26,472	0	32,325	51,764	4,441	17,214	209,217	0	0	5,174	4,102	816,958
Indirect Costs (IDC)	11,467	0	17,024	10,763	2,420	14,864	85,203	0	0	2,050	657	343,033
EXPENSES THROUGH MARCH 31, 08	38,939	0	49,349	62,527	6,861	42,078	294,420	0	0	7,224	4,759	771,219
AVANCE	1,499	25,000	17,200	14,333	43,242	187,218	187,653	0	0	13,816	34,240	376,646
PROJECTS/EXPENSES												
Subsites	3,000	500	2,500	7,260	7,248	3,972	500	0	0	4500	0	29,048
Consultants	0	0	0	0	0	0	0	0	0	5000	0	16,200
Subcontractors	0	0	0	0	0	0	17,700	0	0	0	0	314,700
Supplies	3,515	200	0	300	200	0	0	0	0	200	0	4,216
Equipment	0	0	0	1,000	0	0	0	0	0	0	0	1,000
Travel	1,500	500	0	0	0	0	0	0	0	0	0	3,200
Project Indirect	5,515	1,700	1,000	5,260	25,405	7,972	178,200	0	0	9,700	35,500	268,500
Project Indirect	4,943	977	1,600	4,294	13,800	4,145	98,500	0	0	5,207	8,448	197,743
PROJECTS THROUGH SEP 30, 08	13,968	2,677	4,100	12,824	29,298	13,117	227,200	0	0	14,907	43,948	276,671
PROJECTS	13,968	2,677	4,100	12,824	29,298	13,117	227,200	0	0	14,907	43,948	276,671
AVANCE	13,968	2,677	4,100	12,824	29,298	13,117	227,200	0	0	14,907	43,948	276,671

NOTE:

1. Current PT0618 NOA/NCS award has not ended as of July 1, 2007 and June 30, 2008. We need to request an extension and obtain NCS approval to continue the award and to spend funds through September 30, 2008.
2. Balance Funds on PT0607 Carry Forward are (Revenue and/or for tasks completed in PT0607, \$45,301 in supplies funds (DCO), Coordination and Real Time Network) and \$300,100 in reserve funds were used to cover a deficit of \$28,504 (NADCO), San Jose Valley IDB, and North San Jose Valley IDB Mod Projects. Thus, the reserve funds were allocated to \$61,207. For the past report, Grants added that all negative carry forward balances be moved out; however, for this report, Expansions (DCPP Business Office) request that newly completed tasks be moved out.
3. Transfer from Revenue section: As discussed in EC teleconference, \$102,217 was added to the Central Grant IDB Mod tasks to cover the Towell PO; thus, \$71,317 in supplies funds (PT0607) improve Good Mood! teleconference was cut from the work plan and \$30,904 in reserve funds were transferred to cover this deficit.

CLSA

CALIFORNIA LAND SURVEYORS ASSOCIATION



In Conjunction with CSRC

Presents:

Real-Time Networks

Speakers:

Bryan Banister, PLS

Yehuda Bock, Ph.D.

Greg Helmer, PLS

Bill Henning, PLS (May 9th Only)

Marti Ikehara

Charlie Schwarz, Ph.D. (May 2nd Only)

Gavin Schrock, PLS

Two Locations

Friday, May 2, 2008

Ayres Hotel & Suites

Ontario, CA

Friday, May 9th

Biltmore Hotel & Suites

Santa Clara, CA

HOTELS:

Friday, May 2, 2008
Ayres Hotel & Suites Ontario
1945 East Holt Blvd.
Ontario, CA 91761

Friday, May 9, 2008
Biltmore Hotel & Suites
2151 Laurelwood Road
Santa Clara, CA 95054

SCHEDULE:

8:00 AM - Registration
8:30 AM - Seminar
12:00 PM - Lunch
1:00 PM - Seminar

The seminar will conclude at
5:00 PM

10% DISCOUNT:

A 10% discount to companies or agencies registering 5 or more registrants from the same office. All registration forms and payment must be received at the same time.

CANCELLATION POLICY:

Refunds for cancellation will be made if requested in writing 7 days prior to event and are subject to a \$35 cancellation fee. Substitutions welcome - Contact the CLSA Central Office for more information.

PROFESSIONAL DEVELOPMENT:

A certificate for 7 hours of professional development will be issued to each attendee.

SEMINAR TOPICS

Keynote Address: RTN Innovation, Infrastructure, or Industry Opportunity *Greg Helmer, PLS*

The capability of precise positioning within a real-time GNSS network is so powerful that there's no question that the technology will proliferate and replace much current positioning work. Real-time network capability then goes beyond to open technologies such as intelligent highway systems and any number of monitoring and precision navigation applications. RTN is here and it's very early in its adoption. Who will construct and operate these networks? How will they be funded and what formats will they embrace? Of an even grander perspective; what industries and professionals will embrace the value-added applications that await innovators and entrepreneurs?

California Real Time Network: Rationale, Results & Future Plans - Yehuda Bock, Ph.D.

CRTN evolved from a collaboration of the CSRC, the County of Orange, and the SCIGN project to develop the Orange County Real Time Network in 2001. The County was interested in continuous access to high-rate data to support real-time kinematic (RTK) surveys, for economical reasons and in support of photogrammetric and LIDAR airborne surveys. Scientists were interested in the project as a prototype for earthquake early warning systems. Additional stations and sub-networks were added over the next few years thanks to the efforts of SOPAC, USGS, San Diego County and the Metropolitan Water District, often leveraging PBO infrastructure. The CRSC's Southern California 2006 height modernization project was the first to make use of CRTN to explore new ways to conduct height modernization surveys. Rather than conduct synchronized multi-team surveys, in this project we operated single survey teams that positioned monuments in real-time with respect to the GPS infrastructure provided by CRTN. Results will clearly indicate that this real-time approach can be used more effectively and economically for height modernization and geodetic control projects than traditional post-processed approaches with no loss of accuracy and precision. These conclusions will be further demonstrated by describing a recent (February 2008) crustal deformation project conducted across the Imperial Fault by Scripps faculty and students using CRTN infrastructure. The rapid expansion of CGPS sites in California brought about by NSF's Earthscope/PBO project opens up the possibility of expanding real-time capabilities statewide. A grid of CGPS stations (already built) at an 80 km spacing could form the basis for a statewide network. This would guarantee that any user will be within 40 km of a real-time station, which is a reasonable distance for network RTK-type surveys. A vision on how this can be accomplished will be described.

The Evolution of RTN as a Global Utility - Gavin Schrock, PLS

Varied RTN models from around the U.S. and the world will be examined to illustrate the evolution in the implementation of RTN technology to serve as a reliable positioning utility and as the "active control" segment for modernized geodetic reference frameworks.

NGS Support for Real Time Positioning in the USA

Bill Henning, PLS and Charlie Schwarz, Ph.D.

As the caretaker of the National Spatial Reference System, NOAA's National Geodetic Survey (NGS) is developing guidelines for new applications of positioning using real time techniques. The goal is to link the burgeoning number of real-time networks (RTN) at a specific level of accuracy aligned to the NSRS. The guidelines may encompass the design, construction, administration and use of these RTN to insure their integrity and to provide users with the best methods of positioning with real time techniques. Additionally, the NGS is planning to implement the streaming of real time data in industry standard Radio Technical Commission for Maritime Service (RTCM) format from selected federally owned or operated Continuously Operating Reference Stations (CORS), so that RTN administrators may use the data as a fiducial value adjusted into their networks. This presentation will describe current NGS efforts in these areas.

Prevarications, Precisions, & Procedures: Lessons Learned by a New RTN Administrator *Bryan Banister, PLS*

Lessons learned and initial results of the Central Valley Spatial Reference Network (CVSRN) will be presented.

Coordinates, Epochs, Correctors for RT Applications - Marti Ikehara

What coordinates of which epoch are associated with the stations of a Real-Time Network? Does it matter? Does it matter if you are using a network solution vs. a single-base solution? Does the operator provide only correctors and expect you to include known control in your survey to get constraints? Will you be informed if the coordinates are changed? Do you have to provide the names and coordinates of all network stations on a recorded document? Was the network tied to any NSRS stations and if so, how and when? Do you need to use a velocity model as part of the process?

GENERAL INFORMATION

Registration Fees (each seminar):

CLSA State Association Member	\$135.00
Non-Member	\$235.00

These fees include lunch, seminar handouts, certificate of completion and refreshment breaks. For non-CLSA State Association members, the difference between member and non-member registration fees may be applied toward membership.

THE INSTRUCTORS

Bryan Banister, PLS has worked in the Surveying profession for the last 15 years. He attended California State University at Fresno and is a Professional Land Surveyor. He is currently employed at Caltrans in District 6, where he works both as a head of the Control processing unit and as an administrator of the Central Valley Spatial Reference Network.

Yehuda Bock, Ph.D., is a research geodesist and senior lecturer at UCSD's Scripps Institution of Oceanography, and is Director of the California Spatial Reference Center (<http://csrc.ucsd.edu>) and the Scripps Orbit and Permanent Array Center (<http://sopac.ucsd.edu>). He is a founder of Geodetics, Inc., a developer of precision real-time GNSS software and hardware for civilian and military applications. With a BSc (1977) in Geodetic Engineering from the Technion, Israel Institute of Technology, and a PhD (1982) in Geodetic Science from The Ohio State University, Dr. Bock has held academic appointments at MIT and at Scripps (since 1989) and has published over 95 peer-reviewed journal articles on the application of GPS technology to a variety of geophysical and civil applications. Dr. Bock pioneered the development of regional and global continuous GPS networks for crustal deformation research and was a founding member of the IGS and SCIGN. He developed the first continuous GPS data archive and database (SOPAC) and designed GNSS data and analysis methods including GAMIT, RTD, and PGM softwares. Dr. Bock's research has contributed to understanding crustal deformation and present-day tectonics of California, Indonesia, Japan, and the Middle East. He has contributed to an operational NOAA system for near-real-time GPS meteorology in support of short-term weather forecasting. Over the last decade he has been researching early warning systems for natural hazards mitigation (earthquake, volcano, tsunami) and structural engineering using modern IT methods and real-time GNSS technology. As part of this research and in partnership with several organizations he founded and operates the California Real Time Network (<http://sopac.ucsd.edu/projects/realtime/>).

Greg Helmer, PLS is a Professional Land Surveyor in California, Colorado, Nevada and Arizona with over twenty-five years of experience in geodetic control, boundary surveying and mapping. As a Senior Vice President with the firm of RBF Consulting, he has been an innovator for advanced technologies. He is nationally recognized for his contributions to GPS surveying and high-precision geodesy. In addition to numerous high-profile projects, Mr. Helmer's experience includes GPS training for public and private organizations, and GPS-related publications and seminars for local and national professional organizations. For the last decade he has been one of the most vocal proponents of a statewide geodetic reference system including leadership positions with the California Geodetic Control Committee, the Coalition for the Implementation of NAVD88. Mr. Helmer is a contributing author to the National Height Modernization Program at NOAA, and is the immediate past Chairperson of the California Spatial Reference Center at Scripps Institution of Oceanography.

Bill Henning, PLS is employed by the National Geodetic Survey (NGS) as a real-time specialist, helping to develop NGS guidelines and policy related to real-time positioning. He is a registered professional land surveyor in Maryland with over 40 years of active experience in all phases of surveying technology. He has helped plan, implement and manage height modernization geodetic networks for county-wide projects in Maryland and Virginia. Mr. Henning is a Past President of the American Association for Geodetic Surveying (AAGS) and is the NGS representative to the RTCM special committee involved with differential positioning (SC-104). He has presented numerous talks at local, regional and national venues for over 12 years.

Marti Ikehara is the State Geodetic Advisor with National Geodetic Survey, which is an agency within NOAA. She has been in this position in California for 8+ years; prior to that, she was a ground-water hydrologist with the US Geological Survey for nearly 20 years, first in Honolulu (5 yrs) and then in Sacramento, investigating land subsidence while in California. One of her main duties is to help the public utilize accurate horizontal and vertical control in their surveying, engineering, and mapping projects. As California shifts to a spatial reference system—relying more on permanent GPS reference stations and GPS for both horizontal and vertical geodetic control surveys, a key role for the Advisor is to provide assistance in expanding, accessing, and utilizing the NSRS.

Charlie Schwarz, Ph.D recently retired from the position of Chief of the Systems Development Division of the National Geodetic Survey (NGS). In that position he was responsible for the NGS web site, the NGS Data Base, and the IT Infrastructure used by NGS. He created the NGS Geodetic Tool Kit and wrote much of the code in the popular OPUS utility. He now works part time for NGS as a consultant, where his main duties have been to create the rapid static version of OPUS (OPUS-RS) and to assist with the development of NGS's role in RTN. He holds a Ph.D. in Geodesy from The Ohio State University.

Gavin Schrock, PLS is a surveyor and GIS analyst for Seattle Public Utilities, where his strategic initiatives group focuses on improving soft-hard cost ratios for public works. He is also the administrator of the Washington State Reference Network (www.wsrn.org) a regional real-time GNSS network cooperative in the Pacific Northwest. He has worked in surveying, mapping, data management, and GIS for over two decades in public works, commercial development, defense, and utilities. He has published in these fields and has taught these subjects at local, state, national, and international conferences.

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