



NGS Project Plan Summary

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Project Objectives and Purpose

The overarching objective of the National Adjustment of 2011 (NA2011) Project is to determine updated North American Datum of 1983 (NAD 83) coordinates on passive control stations with positions determined using Global Navigation Satellite System (GNSS) technology. The new coordinates will be determined for passive GNSS stations that already exist in the NGS Integrated Data Base (IDB). There are three main components to this objective:

1. Perform a simultaneous least-squares adjustment of GNSS vectors held in the NGSIDB to derive accurate and consistent NAD 83 coordinates (latitude, longitude, and ellipsoid height) for passive marks positioned using these vectors.
2. Optimally align the new passive control coordinates with the latest realization of the Continuously Operating Reference Station (CORS) network by constraining the adjustment to the current NAD 83 CORS coordinates.
3. Seamlessly integrate the results of this Project into the NGSIDB and all affected NGS products and services.

Additional details and ancillary objectives are provided in the Project Scope section of this document. The purpose of this Project is to improve how NGS meets the wide range of customer needs in providing convenient and efficient access to the National Spatial Reference System (NSRS). Successful completion of this project will represent a significant step toward a more integrated suite of NGS products and services, and a coherent strategy for change management.

Project Scope

The NA2011 Project consists of three primary scope items. These items are also the main objectives of the project, as listed in the Project Objectives and Purpose section of this document. These scope items are listed below in somewhat greater detail.

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1. Determine updated NAD 83 coordinates (latitude, longitude, and ellipsoid height) on passive control positioned using GNSS technology. This will be done via a simultaneous least-squares adjustment of GNSS vectors held in the NGSIDB to derive coordinates that are accurate, internally consistent, and meet the diverse needs of NGS customers in providing convenient and efficient access to the National Spatial Reference System (NSRS).
2. Optimally align the passive control with the current realization of the CORS network, and hence its associated products and services, such as the Online Positioning User Service (OPUS). This will be done by constraining the final adjustment to the NAD 83(2011) coordinates determined in the Multi-Year CORS Solution (MYCS). The intent is that only MYCS coordinates will be constrained in the adjustment.
3. Seamlessly integrate the results of this project into the NGSIDB and all affected NGS products and services. This includes ensuring that the NA2011 outputs and NGSIDB data structures are developed and modified as necessary to ensure that the NA2011 results can be readily loaded and retrieved from the NGSIDB. In addition, the availability of NA2011 and MYCS results in the NGSIDB will be coordinated as a singular rollout of NAD 83(2011) epoch 2010.00.

Ancillary scope items for the NA2011 Project are as follows:

- A1. Update the NGS program ADJUST to provide a mechanism for determining FGDC-compliant network and local accuracies on passive control for survey projects added to the NGSIDB after the NA2011 Project is complete. The guideline documentation for using ADJUST will also be updated to reflect these changes. A graphical user interface and additional output types will likely also be included with this update of ADJUST.
- A2. Perform separate adjustments for two areas not included in the NA2011 simultaneous adjustment for the conterminous US, Alaska, and the Caribbean (which is referenced to the North American tectonic plate). One of these two consists of Hawaii and American Samoa (referenced to the Pacific tectonic plate), and the other is Guam and the Commonwealth of the Northern Mariana Islands (CNMI), referenced to the Mariana tectonic plate. All three adjustments will have a realization year (“datum tag”) of 2011, and an epoch date of 2010.00.
- A3. For all stations included in the adjustments, compute and publish network and local accuracies that comply with the requirements of the Federal Geographic Data Committee (FGDC) Geospatial Positioning Accuracy Standards.
- A4. Adjust and load GNSS projects received between the cutoff date for inclusion with the NA2011 simultaneous adjustment and completion of the project. This will provide test datasets for the revised version of ADJUST and will be used to help update guideline documentation for using ADJUST. To minimize this task,

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NGS will encourage stakeholders with projects underway to postpone constrained adjustment (and submittal to NGS) until after NA2011 is complete.

- A5. Prepare formal project report detailing the methods and results of the NA2011 Project, and including recommendations for how NGS will manage passive control in the future.
- A6. Develop comprehensive communication and outreach to the NGS user community during the execution (and at the conclusion) of the project. This will include, but is not necessarily limited to, a Frequently Asked Questions (FAQ) document, informational NGS website pages, presentations, workshops, publications, and the project report. The intent is to ensure users understand the reasons for and benefits of the project, how it relates to previous (and future) realizations of the NSRS, and guidance on how users can most appropriately incorporate the results into their processes and data holdings.
- A7. Incorporate lessons learned from the previous (2007) nationwide adjustment of passive control. This will include consideration of recommendations made by users and NGS internal analyses of the 2007 adjustment, in particular the NSRS2007 report prepared by Dennis Milbert.

In addition to the tasks that are specifically included as part of the NA2011 Project, there are a number of other related subsequent tasks or projects. Some of these will be done, whereas others are more tentative, as indicated.

- B1. A new hybrid geoid model (GEOID12) will be determined using the NAD 83(2011) epoch 2010.00 ellipsoid heights on benchmarks. Note that release of NA2011 results will likely be postponed to allow a simultaneous release with GEOID12. However, NA2011 results may be released ahead of GEOID12 if significant delays to the release of GEOID12 occur.
- B2. Research will be performed to assess the feasibility of creating useable datum transformations between the High Precision Geodetic Network/High Accuracy Reference Network (HPGN/HARN), the CORS96/NSRS2007, and the 2011 realizations of NAD 83. If feasible, such transformation models (or tools) will be created, along with error estimate models.
- B3. A nationwide vertical adjustment to determine GPS-derived orthometric heights may be performed. If done, this adjustment will use GEOID12 constrained to leveled NAVD 88 bench marks that have NAD 83(2011) ellipsoid heights. Note; if this vertical adjustment occurs it will not, by necessity, be a part of the NA2011 Project. The NA2011 Project will provide a summary of ellipsoid height issues observed (e.g. change in station height due to subsidence or uplift) during accomplishment of the project for use in the possible nationwide vertical adjustment.
- B4. A study may be performed to determine the viability of reprocessing raw GNSS data on passive control, and using these results to obtain coordinates on passive

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control based on consistent and modern GNSS processing methods and models. The purpose is to assess whether using (complete or partial) reprocessed data will produce more accurate and consistent results than using only the existing GNSS vectors presently held in the NGSIDB, as done for the 2011 and 2007 adjustments.

- B5. Develop comprehensive documentation for the NETSTAT software and resolve minor issues, if found necessary, based on NA2011 execution and results.
- B6. An investigation may be performed to assess the feasibility of performing a nationwide adjustment of stations with classical observations constrained to NAD 83(2011) horizontal positions.
- B7. If warranted, new least-squares adjustment software may be developed that makes better use of modern matrix manipulation capabilities, can be parallelized to run on multiple processors simultaneously, and with more sophisticated data snooping and outlier detection capabilities.

Project Timeline and Key Milestones

The timeline for the NA2011 Project is driven largely by the MYCS. Because MYCS will be available in August 2011, and because of the decision to maintain alignment between the CORS and passive control, the NA2011 Project has been placed on an expedited schedule. The following project start and end dates are based on this history and expedited schedule:

- **NA2011 Project start date: April 8, 2011.** This start date is based on first meeting called by the OAD Chief (Mark Eckl) to define a team and overall general scope for the project. This was preceded by a more general meeting on March 28, 2011 where the high-level ideas and options for the project were discussed.
- **NA2011 Project end date: January 31, 2012.** Note that this is a target project completion date, and that it includes all project tasks, such as the project report. Results, including partial results may be released earlier. For example, results referenced to the North American tectonic plate may be released prior to those referenced to the Pacific and Mariana tectonic plates.
- Key milestones for the NA2011 Project are given below. **Dates are best estimates, but subject to variation due to interdependence of activities or unforeseen events.****April 8, 2011.** OAD meeting to formally initiate project and determine overall scope. The project manager (Michael Dennis) and technical lead (Jarir Saleh) were identified at this time, as was the need to form a project steering committee. Also identified was the need to prepare a Statement of Work (SOW) to hire a contractor familiar with the NGS NETSTAT least-squares adjustment software required for performing the adjustment.

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- **April 21, 2011.** Initial meeting of NA2011 Steering Committee; finalize selection of committee members; adopt official name and abbreviation for project, **National Adjustment of 2011 (NA2011)**.
- **April 26, 2011.** Two NA2011 Project kickoff meetings to announce project to NGS leadership (one with NGS Director, one with Deputy Director and division chiefs), and to answer questions and solicit input on the project.
- **May 4, 2011.** Adopt NA2011 Steering Committee Charter (serves as interim project charter and plan).
- **May 5, 2011.** Finalize SOW to hire geodetic consulting contractor to assist with project.
- **May 6, 2011.** Send draft Frequently Asked Questions (FAQ) document to all NGS employees and geodetic coordinators for review and input.
- **May 16, 2011.** Selected geodetic consulting contractor begins work on project (at NGS Headquarters).
- **May 27, 2011.** Public announcement of NA2011 Project posted as NGS “In The News” item on NGS Home page.
- **June 13, 2011.** Add link to Frequently Asked Questions (FAQ) document in NGS “In The News” item on NGS Home page.
- **June 17, 2011.** Announce NA2011 project via NGS News listserve email, with hyperlink to FAQs.
- **June 21, 2011.** First full run of nationwide free adjustment; begin residual and outlier detection analysis.
- **June 28, 2011.** Solicit input from Geodetic Advisors and Coordinators, and from appropriate stakeholders.
- **August 8, 2011.** Query Geodetic Advisors and Coordinators to see if they are aware of any “major” GNSS projects that are underway and may have difficulty meeting August 31 cutoff date for submittal.
- **August 15, 2011.** Begin creation of dedicated NA2011 web page.
- **August 31, 2011.** Cutoff date.
 - Cutoff date for submittal of new GNSS projects to NGS for inclusion in NA2011.

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- **Contingency.** “Important” projects submitted after the cutoff date may be added to the NA2011 project, but these will be decided on a case-by-case basis.
 - Cutoff date for contacts provided by Advisors and Coordinators.
- **September 16, 2011.** Public release of dedicated NA2011 web page.
- **September 19, 2011.** Cutoff for comments w/r to new ADJUST output format(s).
- **September 21, 2011.** Final nationwide free adjustment and first nationwide adjustment constrained to MYCS coordinates, utilizing all projects submitted to NGS through August 31 cutoff date.
 - Provide results of first nationwide constrained adjustment to Geoid Team for preliminary work on development of GEOID12, and to SDD to begin coordination of NA2011 release with NGSIDB and related products and services (e.g., datasheets).
- **September 30, 2011.** Cutoff date for comments regarding surveys being included in NA2011.
- **October 3, 2011.** Geodetic Advisors and Coordinators solicited for input to GEOID12, i.e. identification of problem bench marks solicited by GEOID12 Team or NA2011 team.
- **October 5, 2011.** Finalize identification and approach to dealing with “problem” areas where additional analysis and filtering of observations may be necessary (e.g., subsidence and uplift areas).
- **October 19, 2011.** Test modified version of ADJUST, begin adjusting GNSS projects submitted after cutoff date projects in modified version of ADJUST, compare to NETSTAT results, begin revision of project adjustment user guidelines.
- **November 18, 2011.** Deadline for input from Geodetic Advisors and Coordinators on GPS bench marks used for GEOID12
- **November 28, 2011.** Begin adjustments for networks referenced to Pacific and Mariana tectonic plates (both NETSTAT and revised version of ADJUST will be used, and results compared).
- **December 1, 2011.** Determine final constrained NAD 83(2011) epoch 2010.0 adjusted coordinates (i.e., referenced to North American tectonic plate),
 - Delivered to SDD for final test loading into NGSIDB
 - Delivered to Geoid Team for GEOID12 (CONUS and Alaska).

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- RDF posted on NA 2011 web page.
- **December 5, 2011.** Begin assembling notes and other documents to create a final comprehensive “user manual” for performing national adjustments using NETSTAT, including all related analysis tools and methods.
- **December 14, 2011.** Finalize modified version of ADJUST and associated project adjustment user guidelines.
- **January 2, 2012.** SDD performs IDB load.
 - Final NAD 83(2011) epoch 2010.0 adjusted coordinates and accuracies for passive marks
 - Final NAD 83(2011) epoch 2010.0 adjusted coordinates and accuracies for CORS
- **January 13, 2012.** Determine final constrained NAD 83(PA11) and (MA2011) epoch 2010.0 adjusted coordinates (i.e., referenced to Pacific and Mariana tectonic plates)
 - Delivered to SSD and loaded into NGSIDB
 - Provide to Geoid Team to develop GEOID12 for Hawaii, American Samoa, Guam, and CNMI.
- **January 31, 2012.** NA 2011 final report submitted.
 - Posted to NA2011 web page,
 - Public announcement that adjustment is entirely complete
 - Project closeout.
 - **NOTE:** Loading of projects submitted after August 31, 2011 cutoff date will continue beyond project closeout date if necessary.
- **February 15, 2012.** Projected delivery date for release of GEOID12 and publication of NAD 83(2011) epoch: 2010.00 coordinates. The release date of GEOID12 is assumed, for the purposes here, to be February 15, 2012, but could easily vary from that date. Additionally, if there is a significant delay in the release of GEOID12 it may be decided to release data sheets with NAD 83(2011) epoch 2010.00 coordinates prior to delivery of GEOID12.
 - Public Announcement that NAD 83(2011) epoch 2010:00 data sheets are available
 - Formal announcement submitted for publication in Federal Register

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- **April 15, 2012.** Cutoff date for projects constrained to NAD 83 (NSRS2007). Note this date is tentative as it is actually determined as two months from release of GEOID12 and the release of data sheets with NAD 83(2011) epoch 2010.00 coordinates.

Project Deliverables

Deliverables for the NA2011 Project are as follows:

1. Final adjusted NAD 83(2011) epoch 2010.00 coordinates (latitude, longitude, and ellipsoid heights) on passive marks constrained to the MYCS coordinates based on the stacked solution of data through April 16, 2011.
2. Network and local accuracies provided as *a posteriori* standard deviations (in centimeters) in the north, east, and up components (and horizontal correlations) for all adjusted stations, determined from the final constrained adjustment. These accuracies will also be provided to users on NGS datasheets as horizontal and ellipsoid height values, at the 95% confidence level, in centimeters.
3. Ancillary results and statistics for the project for the nationwide network and/or individual Helmert blocks, as appropriate. This includes, but is not limited to, residuals and statistics for the free and constrained adjustments; lists of used and rejected vectors; and coordinate changes from the previous NAD 83 realization.
4. Documentation that coordinates and accuracies were provided in a standardized format fully compatible with the NGSIDB. This includes validation that the NA2011 results were thoroughly tested to ensure all affected products and services are supported, such as NGS datasheets.
5. Comprehensive documentation on use of NETSTAT and the analyses necessary to perform large adjustments. This document will be of detail sufficient for NGS employees to successfully perform large adjustments without the need to consult with outside experts or the developer of NETSTAT.
6. An updated version of ADJUST that performs adjustments of GNSS observations in a manner consistent with NA2011, including output of network and local accuracies. This includes a revised version of the adjustment computation user guidelines and possible enhancements to the user interface and program output.
7. NA2011 web page providing project description, plan, status, results, station shift plots, frequently asked questions, and user feedback mechanism.
8. Various NA2011 education and outreach materials, including presentations, webinars, and articles. Such materials will continue to be developed after the formal project closeout, and only those developed prior to closeout are considered deliverables for this project.

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9. Adjustment and loading to NGSIDB of GNSS projects submitted to NGS between the August 31 cutoff date and public release of NA2011 (and an updated version of ADJUST). This process may continue after the formal project closeout, depending on the number and timing of projects received. To minimize this task, NGS will encourage stakeholders with projects underway to postpone constrained adjustment (and submittal to NGS) until after NA2011 is complete.
10. Final project report detailing all aspects of the project, including data acquisition, methodology, analysis, discussion of results, conclusions, and recommendations for future work.