TEXAS WATER DEVELOPMENT BOARD
COOPERATING TECHNICAL PARTNERS
MAPPING ACTIVITY STATEMENT

March 2006

Mapping Activity Statement No. 2 – Topographic Data Development

In accordance with the Cooperating Technical Partners (CTP) Partnership Agreement dated December 21, 2000 between the Texas Water Development Board (TWDB) and the Federal Emergency Management Agency (FEMA), Mapping Activity Statement (MAS) No. 2 is as follows.

Section 1—Objective and Scope

The objective of the Flood Map Project documented in this MAS is to develop new digital elevation data that will be used by FEMA study contractors in the development of Digital Flood Insurance Rate Maps (DFIRM) and Flood Insurance Studies (FIS) for Aransas, Brazoria, Calhoun, Jackson, Matagorda, Refugio, San Patricio and Victoria Counties, Texas.

The following Project Team (PT) will complete this Flood Map Project:

- Texas Water Development Board (CTP)
- FEMA
- FEMA National Service Provider (NSP), Michael Baker, Jr. Inc.

The activities for this Flood Map Project, including required Quality Assurance/Quality Control (QA/QC) reviews, and the Mapping Partners that will complete them are summarized in Table 1-1. All activities that are to be accomplished by TWDB, or contractors to TWDB, including contractors that may be selected after the project startup, are included in the "CTP" column. The sections of this MAS that follow Table 1-1 describe the specific activities, responsible Mapping Partner(s), FEMA standards that must be met, and resultant map components.

Table 1-1. Summary of Project Activities and Assignments

Activities	CTP	FEMA (NSP)
Topographic Data Development	X	
Independent QA/QC Review of Topographic Data		X

The FEMA Region VI Regional management Center (RMC) will perform QA/QC review activities.

FEMA will provide download/upload capability for submittals through the Mapping Information Platform (MIP).

Topographic Data Development

Responsible Mapping Partner: TWDB

Scope: TWDB shall contract to obtain new topographic data (LiDAR Acquisition and DEM) for Aransas, Brazoria, Calhoun, Jackson, Matagorda, Refugio, San Patricio and Victoria Counties, Texas using LiDAR. Data will be collected at a five-foot (1.4-meter) spacing. The resulting digital elevation model (DEM) will be developed as a 5-meter rectangular grid with a vertical accuracy of 1.2 ft (95% confidence interval) or a vertical Root Mean Square Error (RMSE) = 0.6 ft. (18.5 cm), and a horizontal accuracy of NSSDA 2.4 foot (0.7315 m) @95% confidence level, based on the National Standard for Spatial Data Accuracy (NSSDA). This standard will be met except where heavy vegetation hinders LIDAR collection. DEMs in these areas will be created to support orthophoto development for a 1"=-200' (1:2,400) mapping scale.

TWDB shall address all concerns or questions regarding this activity that are raised during the independent QA/QC review.

Standards: All Topographic Data Development work shall be performed in accordance with the standards specified in Section 5 - Standards.

Deliverables: In accordance with the TSDN format described in Appendix M of FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners (http://www.fema.gov/fhm/dl_cgs.shtm)* , TWDB shall upload the digital data to the MIP or submit to FEMA by using other digital media if the MIP is unavailable so that NSP can access it for an independent QA/QC review in accordance with the schedule outlined in Section 6 - Schedule. A Federal Geographic Data Committee (FGDC) adopted metadata profile, Content Standard for Digital Geospatial Metadata (CSDGM), must accompany the uploaded digital data in order to facilitate proper cataloging of the data for search and retrieve capabilities within the MIP. The metadata profile should be obtained from FEMA or its contractor to assure compliance. The MIP shall be updated for status reporting not less than prescribed biweekly periods and when the activity is complete. Where paper documentation is required by State Law for Professional certifications, you may submit the paper in addition to a scanned version of the paper for the digital record.

Deliverable Protocol

- LIDAR Deliverables and Quality Control Reports will be delivered on a County by County basis.
- FINAL Product Deliverables will be organized by county.
- Draft and Final LIDAR Deliverables will be made to the MIP.

Pre-Project Deliverables (April 2003 - G&S Appendix A, Section A.8.7.1)

1. **Project Map** - (typically a USGS map is desirable) showing the study area boundaries and flight path, at a medium scale (1:24,000) or small scale (1:50,000).
2. **Documentation** - specifying altitude, airspeed, scan angle, scan rate, LIDAR pulse rates, and other flight and equipment information deemed appropriate.
3. **Chart** - of areas of high Position Dilution of Precision (PDOP) for a list showing the time of the beginning and end of high PDOP.

Project Deliverables (April 2003 - G&S Appendix A, Section A.4.2)

Data will be provided in the appropriate UTM projection, (zone 15) NAD 83 datum, with z values reflecting the Orthometric height in feet. The following formats are required:

1. Filtered Bare Earth Points in Comma Delimited xyz format and xyzi format
2. Digital Elevation Surfaces in USGS DEM and Lattice format.
3. Raw mass point files in Comma Delimited xyz, las, and xyzi format
4. LIDAR Intensity image and grid

Post-Project Deliverables (April 2003 - G&S Appendix A, Section A.8.7.2)

1. A LIDAR System Data Report
2. A Flight Report
3. A Ground Control Report
4. Ellipsoid Model - used as part of the collection
5. Geoid Model - used to compute orthometric heights
6. Data Processing Procedures - for selection of postings, and all orthometric values
7. A System Calibration Report
8. LIDAR System Mission Data Collection Checklist

Delivery of Digital Data (April 2003 - G&S Appendix A, Section A.8.7.3)

In addition to the pre- and post-project deliverables described above, the assigned Mapping Partner shall submit the following:

1. All raw datasets, dataset of survey points filling voids, dataset of transects (if generated), dataset of all data points removed, bare-earth mass points data, and breaklines in separate data files; and
2. All returns and uniformly spaced bare earth DEM(s), on ISO 9660 standard CD-ROM (or DVD) media in a format specified in *Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix L: Guidance for Preparing Draft Digital Data and DFIRM Database.*
3. Datasets will be delivered in blocks or tiles, corresponding to USGS's quarter quadrangle grid (1.875' x1.875'). A spatial Tile Index file needs to be provided with the submission. In addition to the Tile Index file, the all returns mass points, bare-earth mass points, and associated DEMs must be delivered where data does not overlap or have gaps between tiles. Please refer to the

Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix N: Data Capture Standards.

4. Metadata shall be completed and delivered metadata file shall follow the *Content Standard for Digital Geospatial Metadata (version 2.0),* FGDC-STD-001-1998. Details of this standard are available at www.fgdc.gov.

5. Quality Assurance Plan (QAP) report including QA/QC methodologies and results.

NOTE: All products and processes related to obtaining, processing, and delivering topographic data shall comply with standards and specifications regarding data accuracy, data requirements, ground control, methodology, format, and organization as set forth in the FEMA document ***Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying, Appendix L: Guidance for Preparing Draft Digital Data and DFIRM Database, and Appendix N: Data Capture Standards.***

Independent QA/QC Review of Topographic Data

Responsible Mapping Partner: NSP

Scope: NSP shall review the mapping data generated by TWDB under the Topographic Data Development to ensure the data is consistent with the signed contract.

Standards: All work under this activity shall be performed to ensure data received from TWDB's Contractor meets all contract requirements. Analysis will be performed to meet National Standard for Spatial Data Accuracy (NSSDA).

Procedures for Independent Data Collection and Assessment:

Independent data collection is necessary to perform QA/QC for DEM product deliverables. This task will include gathering data points from various entities including cities, commercial entities, other government agencies, etc. Also, a contract surveyor will be required in areas where current data is not available or that data in needed terrain is not available. QA/QC assessment methods will compare these independently collected points to the delivered data from TWDB.

Collection Guidelines:

NSP will conduct an independent QA using three-dimensional check points derived using traditional surveying techniques[1] according to published FEMA guidelines. A summary of these guidelines is given below and the surveyor shall consider all relevant guidelines for all collected QA check points. If one or more of these guidelines can not be adhered to for one or more check points, the surveyor will notify the TWDB to discuss possible alternatives.

1. A minimum of twenty (20) three-dimensional QA checkpoints are required in any combination of three major land cover categories in the survey area. The major land cover categories relevant to the subject counties are:

- Bare earth and short grass
- Brush lands and low trees
- Forested areas (deciduous and coniferous)
- Urban areas

2. Independent checkpoints in urban and bare earth terrain will be assimilated by TWDB and NSP from existing local data sources including cities, counties, the highway department and the private sector. Additional checkpoints in these land cover types will be collected, as necessary, by the NSP for use in the independent QA/QC process.

3. QA checkpoints shall be located in areas with less than 20% slope in all directions for five (5) meters. Checkpoints shall also be far (>= five (5) meters) from any natural and man-made breaklines.

4. A registered surveyor will be used to collect these additional points:

- Collect 20 three-dimensional ground control points in forested areas distributed so that at least one point falls in each of the twelve zones. These points should also be distributed so they fall somewhat evenly under deciduous and coniferous canopies.
- Collect 20 three-dimensional ground control points in brush lands and low trees distributed so that at least one point falls in each of the twelve zones, as depicted within the digital "candidate" sample location maps. The land cover type sampled at a checkpoint need not match that candidates estimated land cover type as depicted on the provided maps.

5. QA points shall be referenced to the National Spatial Reference Systems (NSRS) using monuments of high vertical accuracy. If possible, these will include the same monuments used for the Differential Global Positioning System (DGPS) LIDAR survey.

6. NGS-58 (NOAA, 1997) guidelines for establishing GPS-derived ellipsoid heights (five (5) cm local network accuracy) are recommended to extend control from ellipsoid heights to orthometric heights. GPS RTK procedures are acceptable as long as temporary bench marks within the project area are surveyed twice with distinctly different satellite geometry to overcome the possibility of GPS multipath error.

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[1] This includes static and RTK (Real-Time-Kinematic) GPS surveys conducted in such a way as to achieve high vertical accuracy.

Subsequent to GPS surveys to extend control into the project area, conventional third-order surveys can be used to extend control to checkpoints that are typically located within forested areas or urban canyons where GPS signals would be blocked. Whatever method is used, vertical accuracy relative to NSRS framework points shall be no less than six (6) cm RMSE.

7. QA checkpoints should be photographed on the ground for land-cover and slope verification. Check points should be marked with a 60d or larger nail or pipe at ground level (or equivalent) and a wooden stake (within one (1) foot) marked with the checkpoint ID.

Collection Requirements

1. Monumentation may be placed in appropriate areas. If the surveyor decides to not place monumentation, then the check point data sheets must contain enough information to reliably "stake-out" the location.

2. Deliver data sheets for each point stating the unique checkpoint ID, state plane coordinates (SPCS 301) of the point, geodetic coordinates with ellipsoid and orthometric height of the point consistent with the NSRS, confidence intervals in the horizontal and vertical coordinates of the point, a description of the area in which the point was collected including an estimate of the slope and ground cover, and photographs of the monument and the surrounding area. It is assumed that the data sheets will be in electronic format (Microsoft Access mdb, or Microsoft Excel xls).

3. Deliver all adjustment reports (including loop closures and least squares adjustment results) and covariance matrices associated with the established check points.

Accuracy Assessment

Accuracy Assessment will be performed using a minimum of 60 independent three dimensional control points for each county, following National Standard for Spatial Data Accuracy procedures, part three for horizontal and vertical accuracies.

Deliverables: The MIP shall be updated for status reporting not less than prescribed biweekly periods and when the activity is complete. NSP shall make the following products available to FEMA and TWDB:

- A Summary Report that describes the findings of the independent QA/QC review; and
- Recommendations to resolve any problems that are identified during the independent QA/QC review.

Section 2—Technical and Administrative Support Data Submittals and Special Problem Reports

The Project Team members for this Flood Map Project that have responsibilities for activities included in this MAS shall comply with the data submittal requirements summarized below.

All supporting documentation for the activities checked in Table 2-1 shall be submitted in the TSDN format in accordance with Appendix M of the FEMA *Guidelines and Specifications for Flood Hazard Mapping Partners*, dated April 2003. Table 2-1 indicates the sections of the TSDN that apply to each mapping activity.

Table 2-1. Mapping Activities and Applicable TSDN Sections

TSDN Section	Mapping Activities	
	Topo Data	QA/QC of Topo
General Documentation		
Special Problem Reports	X	X
Telephone Conversation Reports	X	X
Meeting Minutes/ Reports	X	X
General Correspondence	X	X
Mapping Information	X	X
Miscellaneous Reference Information	X	X

If any issues arise that could affect the completion of an activity within the proposed scope or budget, the responsible Mapping Partner shall complete a Special Problem Report (SPR) as soon as possible after the issue is identified and submitted to FEMA. The SPR is to describe the issue and propose possible resolutions.

Section 3—Period of Performance

The mapping activities outlined in this MAS will begin on March 1, 2006, and will be completed no later than August 1, 2006. The mapping activities may be terminated at the option of FEMA or TWDB in accordance with the provisions of the Partnership Agreement dated December 21, 2000. If these mapping activities are terminated; the remaining funds from uncompleted activities, provided by FEMA for this MAS, will be returned to FEMA.

Section 4—Funding/Leverage

FEMA is providing funding, in the amount of to TWDB for the completion of this Flood Map Project. TWDB shall provide any additional resources required to complete the assigned activities for this Flood Map Project. During the scoping process, additional needs may be identified. Activities associated with any additional needs would be performed based on availability of additional funds.

Funding for Project	FEMA Contribution	CTP Contribution	% Leverage	Total Project Cost
TOTAL FUNDING AMOUNTS				

The FEMA funds identified above are available to be used for the activities included in Table 4.1.

Table 4.1 - FEMA funds identified above are available to be used for the following activities*

Activities	FUNDABLE?
Topographic Data Development	No, unless approval given during scoping phase by Regional Project Officer
Independent QA/QC Review of Topographic Data	No, unless approval given during scoping phase by Regional Project Officer

*This table is for information purposes only.

Section 5—Standards

The standards relevant to this MAS are provided in Tables 5-1 and 5-2. Information on the correct volume, appendix, section, or subsection of the FEMA *Guidelines and Specifications for Flood Hazard Mapping Partners* to be referenced for each mapping activity are summarized in Table 5-2. Data provided will not necessarily meet all specifications referenced in Table 5-2.

Table 5-1. Applicable Standards for Project Activities

Applicable Standards	Activities	
	Topo Data	QA/QC Topo Data
Guidelines and Specifications for Flood Hazard Mapping Partners, April 2003	X	X
American Congress on Surveying and Mapping Procedures	X	X
Global Positioning System (GPS) Surveys: National Geodetic Survey (NGS-510), "Guidelines for Establishing GPS-Derived Ellipsoid Heights," November 1997	X	X
Engineer Manual 1110-1-1000, *Photogrammetric Mapping* (USACE), July 1, 2002	X	X
Engineer Manual 1110-2-1003, *Hydrographic Surveys* (USACE), January 1, 2002		
"Numerical Models Accepted by FEMA for NFIP Usage," Updated April 2003		
Content Standard for Digital Geospatial Metadata (Federal Geographic Data Committee), 1998	X	X
Document Control Procedures Manual, December 2000		
44 Code of Federal Regulations Part 66 and 67		

Table 5-2. Project Activities and Applicable Portions of FEMA Guidelines and Specifications

Activity Description	Applicable Volume, Section/Subsection, and Appendix
Topographic Data Development	Volume 1, Section 1.4 (specifically Subsection 1.4.2.1)
	Appendix A, Sections A.2 , A.3, A.7, and A.8
	Appendix M
Independent QA/QC Review of Topographic Data	Volume 1, Section 1.4 (specifically Subsections 1.4.1 and 1.4.2.1)
	Appendix A, Sections A.2, A.3, A.7 (specifically Subsection A.7.5), and A.8 (specifically Subsection A.8.6)
	Appendix M
	Appendix A, Section A.1 (specifically Subsection A.1.1)

Section 6—Schedule

The activities documented in this MAS shall be completed according to a mutually agreed upon schedule. This schedule shall be provided to FEMA within five (5) days of the signed Mapping Activity Statement.

Table 6-1. Project Schedule

ACTIVITIES	RESPONSIBLE PARTNER(S)	START DATE (MM/DD/YY)	DUE DATE (MM/DD/YY)
Topographic Data Development	TWDB	3/1/2006	7/20/2006
Independent QA/QC Review of Topographic Data	NSP	5/15/2006	8/1/2006

Section 7—Certifications

The following certifications apply to this MAS:

Activity 4 (Topographic Data Development)
A Registered Professional Engineer or a Licensed Land Surveyor, shall certify topographic data in accordance with 44 CFR 65.5(c)

Section 8—Technical Assistance and Resources

Project Team members may obtain copies of FEMA-issued LOMCs, archived engineering backup data, and data collected as part of the FEMA Mapping Needs Assessment Process from the NSP, who may be contacted by telephone at (940) 783-4155 or by facsimile at (940) 783-4144.

General technical and programmatic information, such as FEMA 265 and the Quick-2 computer program, can be downloaded from the FEMA Web site (http://www.fema.gov/fhm/). Specific technical and programmatic support may be provided through the NSP; such assistance should be requested through the FEMA Project Officer specified in Section 11 of this MAS.

Project Team members also may consult with the FEMA Regional Project Officer to request support in the areas of selection of data sources, digital data accuracy standards, assessment of vertical data accuracy, data collection methods or subcontractors, and GIS-based engineering and modeling training.

Section 9—Contractors

TWDB intends to use the services of the U.S. Geological Survey as a contractor for the Flood Map Project documented in this MAS. TWDB shall ensure that the procurement procedure follows applicable Texas State Law requirements governing professional services procurement.

Section 10—Reporting

Because funding has been provided to TWDB by FEMA for the Flood Map Project documented in this MAS, financial reporting requirements for TWDB will be in accordance with Cooperative Agreement Articles V and VI.

TWDB will meet with FEMA monthly to review the progress of the project. These meetings will take place at the TWDB office.

TWDB will submit bi-weekly reports to FEMA for this mapping activity statement for each individual county. This may, at FEMA's discretion be a spreadsheet template to be filled out and the use of the Mapping Information Platform (MIP) system will be used. It may include dollars spent, hours spent, and percent complete.

Section 11—Points of Contact

The points of contact for this Flood Map Project are Jack Quarles, the FEMA Regional Project Officer; Erika Boghici, the StratMap GIS Coordinator at TWDB (TNRIS); or subsequent personnel of comparable experience who are appointed to fulfill these responsibilities. When necessary, the assistance of the NSP should be requested through the FEMA Project Officer, Jack Quarles.

In addition, the NSP is required to coordinate project issues with the party that actually created the MAS deliverable or portions of the MAS deliverable product and will document all such coordination activities with the CTP and FEMA.

Section 12—Project Coordination

Throughout the project, all members of the Project Team will coordinate, as necessary, to ensure the products meet the technical and format specifications required and contain accurate, up-to-date information. Coordination activities may include:

- Meetings, teleconferences, and video conferences with FEMA and other Project Team members bi-weekly;
- Telephone conversations with FEMA and other Project Team members on a scheduled basis weekly and an ad hoc basis, as required;
- Updates to the MIP and other FEMA status information systems in accordance with requirements in Volumes 1 and 3 of *Guidelines and Specifications for Flood Hazard Mapping Partners*; and
- E-mail, facsimile transmissions, and letters, as required.

Each party has caused this MAS to be executed by its duly authorized representative.

3-6-06

J. Kevin Ward
Executive Administrator
Texas Water Development Board

Date

3-13-06

Jack Quarles
Regional Project Officer
Federal Emergency Management Agency, Region VI

Date