Abstract

The Harris County Flood Control District (HCFCD) established a benchmark control network of over 1,700 monuments to assist in the development of an updated Flood Insurance Study to a 2001 adjustment. The network will assist 35 communities in the administration of flood plain ordinances and serve as control for construction projects. Monuments were located based on the Federal Emergency Management Agency (FEMA) criteria of one every stream mile or per 2 square miles of floodplain. Existing networks owned by cities, Texas Department of Transportation (TxDOT), Harris-Galveston Coastal Subsidence District (HGCSD), US Army Corps, and others were analyzed. Where vacancies
were found, an aerial analysis of bridge locations developed suitable locations to meet the criteria.

Introduction

As part of the Tropical Storm Allison Recovery Project, DR-1379, Harris County, Texas, field surveys were taken by the Indefinite Delivery Indefinite Quantity (IDIQ) contractors, beginning in the Fall of 2001, at structures (bridges and pipelines) and at cross-sections spaced appropriately five per mile. The control for this survey effort consisted of existing HGCSD marks that had been releveled in 2000 and released by the NGS on October 19, 2001. Whenever one of these benchmarks was not present on a structure, other existing permanent markers (HCFCD, City of Houston, Harris County, TxDOT) were releveled or temporary benchmark consistent with FEMA’s requirements for Reference Marks (RM) was established. Over 300 existing permanent markers were used as reference marks during this effort and the IDIQ surveyors set over 150 temporary benchmarks. These temporary benchmarks include chisled x’s and squares or spikes in power poles. These reference marks meet the minimum standard for control in a Flood Insurance Study however their density does not meet the needs of the National Flood Insurance Program (NFIP) and its local Flood Plain Administrators, therefore, a more dense network was developed and implemented.
Development of the System

Five categories of monumentation were carefully examined with the use of ArcView 3.2 to determine their suitability and use for the benchmark control network. Coverage of these markers was carefully investigated on a stream-by-stream basis. The NGS monuments, used as control by the IDIQ surveyors, included approximately 114 RMs countywide and were utilized as the basis for the new system. Spatially referenced information including each monument’s Permanent Identifiers (PIDs), location and description was supplied by HGCSD. In ArcView 3.2, the coverage of these 114 points was loaded along with the existing permanent markers used by the IDIQ survey teams, which included over 300 monuments. These two systems, although permanent and recently occupied, did not meet the needs of the Flood Plain Administrators and surveyors of the community since the coverage was sparse. Also, subsidence varies differentially across the County and the control network used for the stream model cross-section data must be releveled over time and slab elevations need to be checked with a high degree of certainty in this highly populated area.
Next, a spatially referenced dataset of permanent monuments within Harris County was obtained from HCFCD and compared to the aforementioned monuments. There were approximately 360 suitable permanent markers in this grouping and the owners of these monuments include Harris County Flood Control District, the City of Houston, Texas Department of Transportation, United States Army Corp of Engineers and other governmental entities. These monuments were releveled in this effort. In 1998, 147 monuments were set in the Brays Bayou watershed as part of the pilot program providing very good coverage in this area. The temporary markers set by the IDIQ surveys teams was also set into the system. Approximately 140 permanent markers were placed on or near these temporary locations to further strengthen the network. Finally new monuments were placed in areas where the coverage did not meet the proposed criteria of one monument per stream mile or two monuments every square mile of drainage area. Their placement and location was determined through the use of ArcView 3.2, spatially referenced files of monument locations, stream files, street files and aerial photography. Proposed locations were estimated and supplied to the surveyors via an approximate Northing and Easting, street name and/or stream unit number. All new monument locations were merely proposed until the field
crews could occupy the positions. This brought the total countywide monument count up to 1,700.

A hierarchy of monument placement was followed to ensure stability over time. The first tier included placement in a bridge abutment or bridge deck. Brass Disks were epoxied into bridges in these suggested locations. The second tier was comprised of stable headwalls of culverts of greater than 48” RCP, stable box
culverts that are greater than 6” thick or stable curb inlets. Brass disks were epoxied into these locations as well. Headwalls of culverts less than 48” RCP, curbs and asphalt bridge roadways, after removal of asphalt to concrete compile the third tier and brass disks are also placed in these locations. If none of the aforementioned locations are available, Modified Class “A” monuments were constructed in the bare earth. These monuments consist of aluminum rod sections driven 24-feet into the ground or to refusal, whichever is first.
Construction phases of these monuments can be found in Figures 1 – 3. A greased sleeve is slid onto the rod so that the rod will remain undisturbed during changes in its contiguous soil (Figure 2). The sleeve is set in place by sand and an access cover protects the top of the rod (Figure 3).

**Conclusion**

Once all monuments were occupied and built by the survey teams, the system totaled 1,541 in all (Figure 4). This dense network will provide the monuments necessary for local Flood Plain Administrators and surveyors to perform elevation certificates and other map amendments exercises with ease when the new Flood Insurance Rate Maps are released. It will also provide the necessary information to update the model cross-section information and maintain the accuracy of the developed hydraulic models. These Geographical Information System (GIS) databases created for this network will be placed on the Internet for easy access by all. There will be an interactive map showing the locations of all of these monuments in relation to streets, as well as an interactive look-up system allowing the user to search by Reference Mark number, latitude/longitude or address. This Internet based system will be user friendly and will allow for easy
dissemination of this data. An integral part of the success of this benchmark network resulted in the fact that it was developed using the many tools of GIS.

Author Information

Primary Author
Elle Lewis Anderson, CFM
Engineer-In-Training
Brown & Gay Engineers, Inc.
11490 Westheimer, Suite 700
Houston, Texas 77077
Phone: (281) 558-8700
Fax: (281) 558-9701
E-mail: eanderson@browngay.com

Coauthor
Brandon T. Grimm
GIS Analyst
Brown & Gay Engineers, Inc.
11490 Westheimer, Suite 700
Houston, Texas 77077
Phone: (281) 558-8700
Fax: (281) 558-9701
E-mail: bgrimm@browngay.com

Coauthor
John S. Grounds, III, Ph.D., P.E., CFM
Project Manager