US Army Corps of Engineers®

USACE New Orleans District Minimum Survey Standards

FOR PERFORMING TOPOGRAPHIC, HYDROGRAPHIC, PHOTOGRAMMETRIC, LIDAR, SPECIALTY PURPOSE, AND STATIC GNSS CONTROL SURVEYS

EDITION 5
June 2022

Proponent Office:
Engineering Division - Design Services Branch - Survey Section

This document and any updates or supplements thereto may be found at:
http://www.mvn.usace.army.mil/Missions/Engineering/SurveySection/SurveyingGuidelines.aspx

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Preface

In reviewing these Survey Standards and the supporting Engineering Manuals, the ultimate objective of a given survey task is the timely delivery of data, information that satisfies the requirements of the Scope of Work (SOW) and that the work products are complete, consistent, accurate, and properly documented.

While this document provides guidance for work performed directly for the U.S. Army Corps of Engineers (USACE) New Orleans District (MVN), and other Districts performing work in the Louisiana area on New Orleans District projects, any surveyor performing work in south Louisiana may find these standards, referenced methods, software and tools applicable to work performed for state and local agencies providing survey data to the New Orleans District. Additionally, this document serves as a supplement to the Engineering Manuals referenced in this document; all of which shall be reviewed prior to performing any survey work for the New Orleans District.

Given the variability of specific survey objectives and field conditions, as well as a technological environment that is constantly changing, no set of written procedural or technical guidelines can adequately address all possible circumstances that may be faced by land and hydrographic surveyors.

As such, the following expectations should be kept in mind when applying these Survey Guidelines. A survey contractor should provide:

Contractor Skills and Integrity:

The survey contractor is expected to possess the requisite personnel, equipment, skill, experience, and integrity necessary for the timely and successful completion of a given survey task.

Clearly Defined Objectives:

The USACE MVN provides scopes of work (SOW) that set out clearly defined and attainable survey objectives and timelines. To help ensure this, USACE Survey Section personnel consult directly with the USACE requesting office throughout the task order process.

Thorough Preparation:

Prior to task order negotiation, the Architect-Engineer (A-E) survey contractor should fully review the SOW requirements and perform all research and field investigation necessary to thoroughly discuss all technical and logistical details of the given task. Any questions regarding SOW ambiguities or any concerns should be expressed during this period. If an A-E feels that a SOW meeting or a joint sight visit is warranted, it should be requested at this time.

Communication and Clarity:

It is imperative that all communications between the contractor and the USACE regarding survey task orders be conducted via the Contracting Officer's Representative (COR) to ensure no unauthorized commitments are made. The COR may at his/her discretion authorize direct communication with a subject matter expert (SME) for specific purposes during the duration of a task order. This provision is NOT intended to prohibit the A-E from communicating directly with Survey Section personnel regarding general matters or provisions not related to a survey task order. Survey Section encourages open lines of communication between A-Es and USACE regarding new technologies, capabilities, and best practices as our industry evolves.

Section A
Introduction

Purpose:
This document provides guidance to perform detailed engineering surveys of facilities and civil works projects for the USACE, New Orleans District. Technical specifications, procedural guidance, and quality control criteria are outlined for the consistent provision of surveying services in support of USACE activities. The New Orleans District Survey Section can provide sample scopes of work and/or sample estimating spreadsheets upon request.

Applicability & Distribution:
This document applies to all USACE In-House and Architect-Engineer (A-E) contract surveying services having responsibility for the planning, engineering and design, operation, maintenance, construction, and related real estate and regulatory functions of civil works, and environmental restoration projects. It is also applicable to surveys performed or procured by local interest groups under various cooperative or cost-sharing agreements. This document is approved for public release; distribution is unlimited. Current copies may be obtained from:http://www.mvn.usace.army.mil/Missions/Engineering/SurveySection/SurveyingGuidelines.aspx

Use of Manual:
This document is intended to be a reference guide for all engineering surveys conducted for the USACE New Orleans District. These activities may be performed by In-House, A-E Contractors, or combinations thereof under the responsible charge of a Professional Land Surveyor.

Evolving Technology and Procedures:
Survey equipment operation, calibration, and procedural methods used to acquire, log, process, and plot survey data are adequately detailed in operation manuals provided by the various survey equipment manufacturers and software vendors. Since instrument and data collector operations and data processing methods are unique to each vendor, and are being constantly updated, this document will only provide a general overview of the methodologies required by the New Orleans District. Other USACE regulations may dictate mandatory requirements to process, display, transfer, and archive survey data. These mandatory regulations are not superseded by this document.

Survey Data Submittal:
All survey data should be submitted electronically via USACE designated FTP site, or alternately by physical digital media (CD/DVD/External HDD). Flash drives or thumb drives are not permitted on USACE networked devices and will not be accepted.

Survey data is considered to have been submitted on the date which it is transmitted via FTP, or on the date it is postmarked for data submitted via digital media. All digital media transferred via mail or commercial shipment should be expedited and tracked. Hardcopy data requiring impressed stamping by the PLS shall be conveyed to Survey Section in a timely manner, unless otherwise directed in the SOW.

Final Data Review and Acceptance:
Once all data has been received by the Corps, Survey Section will initiate a full and thorough review of the submittal package. All packages will be evaluated for compliance with the SOW, the USACE New Orleans District Minimum Standards, and applicable Engineering Manuals. They will also be evaluated based on completeness, statistical accuracy, and proper data formatting. Submittals not meeting requirements will be returned to the contractor for revision prior to final acceptance.

Section B

Survey Contractor's General Responsibilities

Overview:

The Contractor shall perform surveys and related services in accordance with specifications contained herein. The types of surveys performed for the New Orleans District include (but are not limited to): single and multi-beam hydrographic surveys, topographic surveys, photogrammetric surveys, LiDAR surveys, control surveys, and infrastructure monitoring surveys.

The Contractor assumes responsibility for all site investigations to determine the nature and location of the work, the general and local conditions, availability of roads, boat ramps, and suitable lodging, the topography and conditions of the ground, the uncertainties of the weather, tidal action and flood stages, and the character of the equipment and facilities needed during prosecution of the work. The Contractor is also responsible for all other matters that may in any way affect the work or the cost thereof and for which information (both field and record) is reasonably available or obtainable.

Safety:

All Contractor personnel and equipment shall comply with the provisions of US Army Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1, dated 2022 or most current later version. Additionally, Contractor's field crews shall consist of duly qualified and experienced personnel and shall be able to perform the required survey services in a manner that is satisfactory to the COR. Field personnel shall be subject to particular scrutiny in regard to unsafe work practices, the lack of specified Personal Protection Equipment (PPE) and apparel, and the improper or reckless use of equipment. At least two field party members shall carry CPR and 1st Aid Certification Cards with them at all times.

The COR reserves the right to require the replacement of any work unit immediately upon his determination that the unit's performance of the required service is not in accordance with recognized standards of surveying and safety procedures.

Equipment and Personnel:

In the performance of surveys and related work, the Contractor shall furnish:

- All vehicles, boats, survey equipment, safety equipment, communications, and supplies not otherwise specified within the scope of work as Government furnished.
- All survey field books, concrete, iron rods, survey disks and all other material necessary to accomplish assigned work.
- All professional survey management personnel necessary to plan, supervise, perform, verify, and certify all work.
- All field labor, transportation, fuel, materials, supplies and supervisory personnel necessary to ensure expeditious completion of services requested in each task order.
- All office equipment, software, and systems as well as properly trained technical and other personnel necessary to correctly process, compile and ensure prompt and timely delivery of all specified project data sets.

All Contractor costs in connection with the supervision, outfitting and re-supply of employees - including all equipment, safety apparel, and other miscellaneous supplies - shall be included in the contract unit prices listed in the Contractor's "Section B, Supplies or Services and Prices/Costs". Any equipment which the COR considers unsatisfactory for the accurate and expeditious performance of the requested survey services shall be replaced by the Contractor immediately upon notification by the COR.

Processing Capabilities:

The Contactor shall be competent to perform the basic and advanced survey data processing tasks demanded by the SOW. These tasks may include the following:

- Compute, compile, verify, plot, map, and otherwise construct Bentley OpenRoads and ESRI Grid Analyst compatible Digital Terrain Models (DTM).
- Construct MicroStation .dgn file drawings conforming to the USACE A/E/C CADD Standards.
- Digitize hydrographic survey chart data.
- Filter and graphically depict onshore field and hydrographic survey data.
- Provide Professional Land Surveyor (PLS) signature and stamp on all field books, hardcopy plots and/or final drawings, all survey plats, any other graphic depictions of survey data, and survey reports.
- Process, filter, and extract airborne and terrestrial LiDAR data.
- Process, filter, and extract Structure from Motion (SFM) photogrammetric point cloud data.
- Create LiDAR and photogrammetry derived digital elevation models (DEM) and associated visualization products.
- Extract Cross Sectional and Profile from point cloud datasets; provide appropriately filtered and classified point cloud data for future processing requirements.
- Research titles.
- Prepare abstracts for servitudes and rights-of-way.
- Prepare benchmark descriptions and survey field books, etc.
- Provide Elevation Certificates.

Scope of Work/Extent of Services:

Upon receipt of a formal Request for Proposal (RFP), the Contractor may request scheduling of a Joint Field Inspection with USACE field inspectors to familiarize themselves with conditions on the ground at the subject project site. The Contractor may then request the scheduling of a formal Scope of Work Meeting with the COR, USACE field inspectors, and other Survey Section personnel (as well as the Requestor, if necessary). During the SOW meeting, the COR and the contractor's designee shall discuss each proposed assignment to develop a mutual understanding of:

- Type and limits of work to be done.
- Approved or restricted routes of access and egress.
- Existing data available.
- Specific benchmarks, datums, epochs, and elevations to be used.
- Special Equipment or other considerations required for efficient collection of data.
- Format, content, and manner of transmission of deliverables.
- End results, plans, plots, comparative plots, CADD drawings, GIS products, DTMs, DEMs and other finished products, etc., expected by the COR.
- Task order completion date expected by the COR.

Scope meetings and joint site visits shall be scheduled at the request of the A-E. At a scope meeting, the A-E should clearly communicate any concerns or confusion regarding the requirements of the SOW. All questions and/or perceived uncertainties/ambiguities relating to the survey tasks detailed in the SOW shall be clarified and resolved to the satisfaction of both the survey contractor and USACE.

The Contractor shall then submit to the COR a formal time and cost proposal and detailed plans for performance of the work for each proposed assignment. Following receipt and review of the Contractor's detailed proposal, the COR will schedule a final negotiation with the Contractor. If negotiations result in mutually acceptable terms, a formal Task Order will be issued which shall serve as the Contractor's Notice to Proceed (NTP).

Comprehensive Quality Assurance and Control:

The survey contractor shall use the requisite equipment and personnel as well as those field and office procedures necessary to gather all specified data and to meet the tolerances and accuracy standards defined in the SOW. It is further expected that the survey contractor shall implement all necessary Quality Assurance/Quality Control (QA/QC) processes and shall fully log and document the results of the same (e.g., RTK check shots, hydrographic survey bar checks, etc.). Documentation of all QA/QC procedures shall be submitted with the final deliverables package.

Complete and Accurate Deliverables:

The survey contractor should ensure that the form and content of all deliverables specified in the SOW are complete and accurate. In addition to all other specified deliverables, the Contractor shall provide all raw data, field books, all text and graphic files, and all other intermediate computations and processing output files (e.g., minimally constrained GNSS network processing results). These intermediate processing files shall be neat and orderly and presented in a form and manner such that all computations and processing procedures are easily followed. Of particular importance are the final Survey Report, the digital ASCII-text file of "Engineering Manual" (EM) survey coordinate data, QA/QC checklists and data including notes or logs of all procedures and observations.

The organization/presentation of ***all*** deliverables should lend itself to efficient, comprehensive, and meaningful quality assurance review and analysis by both the Contractor and Survey Section personnel. Final deliverables shall be arranged as outlined in Appendix 7 - File Index.

All detailed technical survey drawings shall be provided in MicroStation format and shall be based on the government supplied seed file with appropriate working units and subunits and utilize US Survey Feet. Contents of all MicroStation files shall conform to the latest published MVN A/E/C CADD Standard available on the USACE CADD/BIM website (https://cadbimcenter.erdc.dren.mil/).

The Contractor shall submit PDF files of survey field books to the COR for review after the completion of fieldwork. The PDF files shall be multi-page and contain all pages of the field book. It is especially important that each field book be properly indexed, and, for projects that require three or more field books, that a master field book index of all books used on a given project is prepared and included in the PDF file.

The Professional Land Surveyor (PLS or RLS - registered in the state that the work is being performed) shall certify that the field survey notes and computations are complete, correct and that they meet or exceed the specified project accuracy requirements prior to delivery of any derivative survey data to the COR. All survey reports, field books, plans, plots, and other finished hardcopy products shall also be stamped and signed by the PLS as follows: "I hereby certify that the information shown hereon is true and correct to best of my knowledge and belief."

When applicable, digital and hard copy products shall comply with the Spatial Data Standards (SDSFIE) for GIS and the A/E/C CADD Standards for CADD Products (https://www.sdsfieonline.org/). When applicable, the contractor shall provide a report of all significant software products and their versions (including any Government provided software) used to produce a final product within the survey report.

The contractor may be called upon to provide products in phases or in preliminary form, where urgency merits. These preliminary deliverables shall be organized/presented in a manner that lends itself to efficient, comprehensive, and meaningful quality assurance review and analysis by both the Contractor and Survey Section personnel.

The Contractor shall not release any data, analyses, results, conclusions, or computations relative to any work performed under a USACE contract to any agency, business concern, or individual outside the US government without advance express approval of the COR.

For detailed specifications regarding all deliverables, refer to Section L below.

Section C
Technical Survey Provisions

Survey Plan:
All contracted survey task orders shall require a Survey Plan to be submitted to the USACE New Orleans District's Survey Section for technical review prior to the planned surveying activities. This requirement applies, whether the surveying activity is primary or incidental to the contract or task order purpose. Technical review of the survey plan does not impact mobilization or initiating surveying activities; the parties engaged in data collection remain responsible for selecting appropriate surveying approaches and methodologies and as such may be required to provide clarification, adjustments to the methods and data, or as a last resort, partial or complete recollection.

This Survey Plan shall include, as a minimum, the following information:
- Job Number
- USACE Contract Number
- Approximate Geographic Coordinates of Project (or bounding polygon)
- Horizontal and Vertical Control Points.
- Horizontal and Vertical Datums and Epochs to be used.
- Proposed Equipment.
- Proposed Methodology
- Static GNSS Network Design Plan and Session Schedule (if applicable)
- Proposed Field Operations Schedule
- A-E Points of Contact

Survey Section's District Datum Coordinator (DDC) will review the survey plan and provide approval or request revisions/clarifications.

Monumentation:
The Contractor, when required by the terms of the scope of work, shall be prepared and able to establish physical monumentation in accordance with USACE specifications. See referenced "U.S. Army Corps of Engineers Manual, EM 1110-1-1002, Survey Markers and Monumentation" for monument specifications.

The term "Permanent Monument" as used herein encompasses all published National Geodetic Survey (NGS) monuments and all monuments defined as "Permanent" in the above referenced EM 1110-1-1102. The meaning of the term "Permanent Monument" may be extended further – in certain circumstances and at the sole discretion of the District Datum Coordinator – to include other monumentation that is relatively stable, self-identifying and which incorporates, at a minimum, a stamped brass/aluminum disk set on a length of driven steel rod or a stemmed disk which has been epoxied into a drillhole in suitably stable existing concrete. Bare rods, nails (PK, 60d, etc.), railroad spikes, wooden hubs, etc., shall not be considered permanent monuments under any circumstances.

All newly established Permanent Monuments shall be published within the National Spatial Reference System (NSRS) and have an associated Point Identification Number (PID) assigned by the National Geodetic Survey (NGS). This is typically achieved by using the Online Position User Service (OPUS) Shared database: https://geodesy.noaa.gov/OPUS/view.jsp

All permanent benchmarks used shall be properly recorded utilizing #V records in the corresponding EM Format file for the survey and shall have a completed USACE Survey Monument Archival & Retrieval Tool (U-SMART)

PDF filled out and archived in the survey control folder. A sample U-SMART form is included in Appendix 5 and is available for download as a fillable PDF at the following link: https://rsgis.crrel.usace.army.mil/pcdb/U-SMARTForm.pdf .

Temporary Monumentation may be established on site in support of active survey activity but shall not be utilized in lieu of permanent control in the performance of required daily checks. Temporary control shall consist of discrete markings or objects (e.g., Crosscut, PK, 60d, bare rod, wooden hub, etc.) of suitable stability as required to support collection of data by integrated survey or conventional means. Temporary control marks shall not be used in subsequent survey efforts or for long term monitoring of projects. All temporary benchmarks shall be recorded utilizing #T records in the corresponding EM Format file for the survey.

Horizontal Reference:

Acquisition of new horizontal coordinate data shall be in conformance with the Survey Plan approved by the District Datum Coordinator. All newly acquired horizontal survey data shall be connected to horizontal control points in the National Spatial Reference System (NSRS) having coordinates with respect to the most recently determined epoch of the North American Datum of 1983 (e.g., NAD83(NA2011), NAD83(NSRS2007), etc.). The coordinate data shall be reduced and reported with respect to the Louisiana State Plane Coordinate System (SPCS) of 1983, either North Zone (1701) or South Zone (1702) as appropriate, in U.S. Survey Feet, unless specifically specified otherwise in the SOW.

On certain projects, the Government may furnish digital and/or hard-copy files of historical or legacy horizontal coordinate data (e.g., a baseline alignment file). These historical data sets were usually the result of conventional surveys (transit and tape, theodolite and EDM, or electronic total station) of varying complexities, accuracies, and dependences to earlier conventional surveys. Therefore, the coordinate value for a given physical monument (e.g., a baseline PI monument) as determined by prior conventional survey may be significantly different from the coordinate value of that same physical monument as recovered and surveyed via modern, more precise methods.

Historical/legacy coordinates are helpful as they provide a reasonable approximation of the relative positions of nearby monuments and are an aid to their recovery. The Contractor may be called upon to conduct surveys with respect to either the older historical coordinate values associated with recovered physical monuments, or to use the coordinates for those monuments as determined by more current GNSS surveys.

The contractor may also be called upon to develop a local conformal relationship between the two "systems" and provide coordinate data with respect to each. In any event, the Contractor must be extremely careful not to confuse the historical and current coordinates for any given physical location or set of physical locations. The horizontal datum and epoch of all surveys must be clearly identified in the deliverables in order to make distinctions between above mentioned "systems" (e.g. NAD83(NA2011), NAD83(CORS96)). Refer to the EM File Format Specifications for more information.

On occasion, the Contractor may be required to establish additional horizontal control via conventional methods. The results of conventional control surveys shall generally conform to third-order accuracy/closure requirements as indicated in Appendix 4, Figure 1 (unless specified otherwise in the SOW). Angular tolerances and azimuth closures for conventional control traverses may be found in Appendix 4, Figure 2. The Contractor shall adjust all conventional baseline surveys and may be required to use Government-furnished software to prepare and submit the associated raw traverse and adjustment files.

Vertical Reference:

Acquisition of new elevation/orthometric height data shall conform to the Survey Plan approved by the District Datum Coordinator and USACE-MVN Engineering Division Datum Policy Memorandum #3 'Requirements for Use of Benchmarks for USACE Projects," dated March 23, 2009, as well as any applicable project-specific datum memorandums.

Adherence to the above referenced Datum Policy Memorandums and approved Survey Plan shall ensure that all Project Benchmarks (one of which shall be designated as the Project Primary), all Secondary and Tertiary Local Vertical Control, and all other vertical survey data are properly connected to the NSRS (i.e., all elevations/orthometric heights are correct with respect to the appropriate epoch of the North American Vertical Datum of 1988 at a 95% confidence level of 0.25 feet) and that local vertical accuracy is maintained (i.e., all elevations/orthometric heights have a local or relative network accuracy of 0.15 feet at the 95% confidence level). These are the nominally acceptable vertical accuracies. More stringent or lenient NSRS and local accuracies may be specified by the District Datum Coordinator if the needs of the project dictate.

Verification Surveys of Local Vertical Control with respect to Project Control shall be done in accordance with the requirements of the previously referenced Datum Policy Memorandums.

The Survey Contractor shall perform and document daily and/or site-specific vertical control checks. This is done to ensure that the correct local vertical control points are being utilized and that they are undisturbed. If a daily or site-specific check reveals relative height differences in excess of the specified accuracy requirements, this fact shall be documented and resolved by the Contractor in the field if possible. If not resolved in the field, the discrepancy and all relevant documentation shall be immediately reported to the COR for joint review with the District Datum Coordinator.

On certain projects, the District Datum Coordinator may require that GNSS derived elevations be established in accordance with the guidelines in "NOAA Technical Memorandum NOS NGS-58" published in November 1997 (https://geodesy.noaa.gov/library/pdfs/NOAA_TM_NOS_NGS_0058.pdf), and Guidelines for Establishing GPS-derived Orthometric Heights (https://geodesy.noaa.gov/library/pdfs/NOAA_TM_NOS_NGS_0059.pdf).

Section D
Topographic Surveys

General:
All topographic surveys shall follow the Control and Topographic Surveying Manual EM 1110-1-1005 and relevant portion of the NAVSTAR Global Positioning System Surveying manual, EM 1110-1-1003.

The elevations of all PBMs and TBMs recorded in the field book of any total station, RTK, or differential leveling survey shall be annotated with the correct Vertical Datum and Epoch.

The contractor shall submit all raw data files generated by electronic survey equipment. All ASCII coordinate PNEZD data shall be additionally submitted in EM format (see referenced EM File Format Specifications). All check shots shall be documented in the EM file (as miscellaneous shot records). In addition to supplying all specified coordinate data and metadata, the final EM file shall contain all explanatory comments relating to unique problems and/or special procedures (e.g., obstructions; etc.).

Care shall be taken to utilize appropriate feature codes during survey activities. In addition to the codes listed in Appendix 2, codes may be created for specific features as required by the SOW. These additional features shall be included in a "codes.dat" ASCII file and shall be applied consistently throughout the survey. Where a relative code currently exists and can be used without ambiguity, preference should be given to using an existing feature code.

Conventional Surveys & Traverses:
All conventional traverses in support of topographic surveys shall meet or exceed third-order class II specifications horizontally, and third order vertically. (See Appendix 4, Figures 1 and 2) unless otherwise specified in the scope of work. All traverse measurements shall be recorded in field books. Where short tangents (less than 800') are required, a sub-traverse shall be run in which the angles shall close to no more than 10"/setup and the positional error shall be no more than 1:2500.

Field notes for total station surveys shall document changes in setup, backsights, instrument height (HI), rod height (HR), cross section numbers, etc. In order to prevent the possible misidentification of occupied or backsight control points and/or to detect control point disturbances, check shots shall be performed and documented in the field book for each instrument setup. At a minimum, this shall include the occupied point number, occupied point description, measured HI, backsight point number, backsight point description, HR, difference in measured distance to the backsight and difference in measured elevation of the backsight. Additionally, a check shot should be made to the next nearest control point and the difference in distance/coordinates and elevation should be recorded.

If the measured differences for either the backsight or check shot exceed that which might reasonably be expected, additional control points shall be measured/documented and examined until the discrepancy is satisfactorily resolved. All check shot entries shall be recorded in the field book and maintained in the relevant total station data collector files.

On-the-fly re-sectioning utilizing co-mounted GNSS receivers and EDM reflectors in integrated survey modes is permitted but shall include a minimum of two (2) resection points and one (1) check shot using both GNSS and EDM observations for each station. GNSS observations for re-sections shall be a minimum of 30 epochs, and all reference shots shall be taken with the use of a bipod and be properly annotated in the field notes.

Differential Leveling:

All differential leveling in support of topographic surveys shall be, at a minimum, to third-order loop-closure standards or higher if specified (see Appendix 4, Figure 1). The contractor shall strive to balance backsight/ foresight shot distances and, in all cases, limit them to less than 300 feet in order to reduce or eliminate typical instrumentation errors. The level loop shall be reviewed and initialed in the field book by a person independent of the field crew performing the level loop. In addition, each day, just before any differential leveling survey is begun, the "Two-Peg Test" should be performed and documented as follows:

- Select two TBMs "A" and "B" approximately 200 feet apart.
- Set up the level midway between the two points "A" and "B" and record the rod readings of each point and determine their difference in elevation.
- Move the level 20 feet beyond either benchmark, and record the rod reading of both points again, once again determine their difference in elevation.
- If the difference in elevation measured at each setup is the same (within 0.02'), the level is in adjustment and work can proceed.

Digital levels shall be calibrated in accordance with manufacturer specifications and shall meet or exceed the tolerances set forth for conventional levels. Leveling utilizing digital instruments shall conform to all standards and practices outlined for conventional levels, including the recording of field notes.

RTK Surveys:

When performing RTK surveys, raw observation data must be collected at the base station and submitted to OPUS for QA/QC purposes. In addition, an observation log (Appendix 8) shall be completed for each base station occupation and photographs documenting the occupation shall be acquired. All RTK equipment shall be capable of On-The-Fly ambiguity resolution/ initialization (OTF).

Field notes shall be kept to document, at a minimum:

- Base station setup control point number and ID/description, antenna type, antenna reference point/ARP height, antenna serial number
- Remote/rover antennae type and ARP/APC height and any changes thereto, rover antenna serial number
- All check ties to established control (including control point number and ID/description, observed position and elevation, difference between control and observed elevation and coordinates)
- Point numbers and IDs/descriptors of surveyed points and stationing of cross section ties.

The field procedures outlined in Section 9.22 of EM 1110-1-1003, NAVSTAR Global Positioning System Surveying and Chapter 9 of EM 1110-1-1005, Control and Topographic Surveying should be followed.

Checks to an established control point shall be done at the beginning and end of each day's work, and/or before and after each base station setup and shall be logged digitally and in a field book. RTK dataloggers shall have the NGS' latest published National Geoid Model (currently Geoid 18) loaded onboard and shall be configured to properly incorporate geoid heights differences into the solution of final orthometric height values. Beta Geoid models released by NGS shall not be used unless specifically requested by the SOW or District Datum Coordinator. Older geoid models may be specified for use in the SOW to ensure consistency in monitoring/construction of existing projects at the discretion of the District Datum Coordinator.

Unless specified otherwise, the Rover PDOP mask should be set to not less than 5.0 and the elevation mask no lower than 10 degrees. Only coordinates that are the result of a "fixed" solution and have a horizontal and vertical precision (rms) of 2cm and 5cm respectively are acceptable. In addition to final coordinate data, raw XML data files containing quality indicators associated with each point surveyed shall be recorded and delivered (i.e., number of satellites observed, PDOP, fixed/float solution, horizontal and vertical accuracy, etc.).

All temporary benchmarks established using RTK shall be observed for a minimum of 180 epochs with a fixed solution and the aid of an appropriate stabilization device (bipod or tripod).

RTN Surveys:

Real-Time Network (RTN) is a network of Continually Operating GNSS Reference Stations (CORS) that delivers real-time GNSS corrections using a cell phone modem. Subscription-based systems are operated in our area of responsibility by the LSU Center for Geoinformatics (C4G), Trimble (RTX) and Leica (SmartNet). Local Jurisdictions and areas outside of the New Orleans District will have differing local providers. A subscription to these systems enables end-users with a single RTK rover and internet access to conduct surveys anywhere within the state and achieve precisions that meet or exceed the minimum requirements for conventional or single base-station RTK methods.

To reliably achieve these precisions, all relevant guidelines with regards to standard RTK procedures are required for the use of RTN (PDOP and elevation mask, fixed solution only, horizontal and vertical rms, etc.). In addition, specific calibration procedures must also be carried out to achieve the required accuracies. These procedures are described below.

The NGS' latest National Geoid Model (currently Geoid 18) shall be loaded onboard and properly utilized by the RTK rover/data collection system unless otherwise specified. The same provisions for Beta and superseded Geoid Models as previously defined in RTK Surveys apply to RTN surveys. The proper antenna profile shall be utilized, and the antenna make, model number, serial number, and phase-center offsets from the Antenna Reference Point (ARP) shall be noted in the project field book together with the correct ARP height (where possible, fixed height rods should be utilized).
Following system initialization at the project site, but prior to the commencement of any survey data collection session, the raw RTN derived horizontal coordinates and elevation (180-epoch observation) of the nearest validated project or local control point shall be observed and logged, both digitally in the data collector file and in hardcopy in the project field book.

The instrument shall then be "calibrated" utilizing the site calibration procedures specific to the brand of GNSS equipment in use, to the given horizontal coordinates and elevation of the Primary Permanent Benchmark using a second 180-epoch observation. Once the RTN rover/data collection system has been calibrated or indexed, the control point shall then be re-observed to confirm that the output horizontal coordinates and elevation matches the given elevation. This re-observation shall be logged digitally and in the project field book.

Once initial calibration is complete, a second validated project or local control point shall be observed with the calibrated RTN rover/data collection system and the results logged digitally and in the project field book. If the observed horizontal coordinates is within the specifications outlined in the SOW, data collection may proceed; if not, contact USACE Survey Section immediately for further instruction.

Topographic Sections & Profiles:

All topographic cross sections shall be collected in a consistent manner, and shall include all features and intervals outlined in the SOW. All Cross-Sectional Data should be collected and digitized from Left to Right with respect to increasing Baseline Station, unless otherwise specified. All Profiles should be collected and digitized in the direction of increasing station. Care shall be taken to avoid unnecessary "zig-zags" and "joggles" in sections due to misaligned and overlapping data. In the absence of an existing baseline, the survey party shall contact survey section for further guidance.

In performing certain topographic surveys (e.g., centerline profile surveys of earthen levees), motorized vehicles may be used. If a vehicular platform is used in data collection, the forward speed during collection shall at no time exceed ten miles-per-hour and the data collection should be governed by a set distance between shots of not more

than half the profile interval specified in the SOW. Additionally, the appropriate digital feature code shall be selected and used. Great care shall be taken to ensure that the vehicular antenna mount is secure, free from obstruction, and placed so that acquisition along the specific requested discrete feature is assured. A detailed sketch, showing the location of the antenna on the vehicle and the offset from natural ground to ARP, shall be included in the project field book. A note describing the general surface condition, the start and stop times of the vehicular data logging session, and a diagram of the start and stop locations (showing detail of transitions to/from wall structures, for example) should be included in the project field book.

Profile and Cross-Sectional Data shall be properly recorded in the EM Format files utilizing #X and #P records.

Topographic Location of Floodwall Features:

Surveys of the top of sheet-pile walls, I-walls, or T-walls shall be conducted on foot at a data collection interval of not more than 50 feet per survey observation, both sides of any expansion joints, and at all abrupt grade changes more than 0.25 feet unless otherwise specified. A detailed sketch of the wall system, the height of the wall above the adjacent ground or earthen levee, the wall thickness, and the side of the wall at which the measurement was made (protected or flood side) shall be noted in the project field book.

Bridge Profiles & Sections:

All profiles shall be submitted ordered from the left descending bank (LDB) to the right descending bank (RDB). When the direction of flow is undetermined, indicate the direction (North-South, East-West, etc.) of each profile. Cross Sections are required at each pier station. These shots shall include centerline road, top of curb, top of guard rail, low chord or top of bent, and ground shots. These shots shall be collected at each pier and shall be perpendicular to the bridge C/L at the pier station. Sections shall run left to right with regards to the profile directions. When the bridge is a railroad bridge, the rails shall be collected in place of curbs. Sections of the bridged stream or ground feature shall be collected at the upstream and downstream faces of the bridge, and as further specified in the SOW. Low chords shall be collected at the center of each span where possible.

Miscellaneous Data:

Miscellaneous Data shall be collected in topographic surveys as requested in the SOW Documents. Care should be taken to use appropriate codes as outlined in Appendix 2 to the maximum extent possible. Miscellaneous shots shall be collected as required to accurately depict required features in drawings, as well as to fully define changes and contours in terrain during the building of DTMs and DEMs. Miscellaneous shots shall be properly recorded in field books and using #M records in the EM Format record.

Section E
Hydrographic Surveys

General:
All hydrographic surveys shall be conducted in accordance with the Hydrographic Surveying Manual, EM1110-2-1003.

Gages and Benchmarks:
The elevation of the zero mark on all relevant project gages shall be determined with respect to the appropriate NAVD88 epoch in accordance with the Vertical Control Plan approved by the District Datum Coordinator. This will typically be done via conventional differential leveling ties or RTK survey techniques from nearby benchmarks that have been recovered and/or established in the vicinity of the gage. These nearby benchmarks shall be directly connected, by the contractor, if necessary, to National Geodetic Reference System (NSRS) PBMs having published elevations expressed with respect to the current NAVD88 epoch (e.g., NAVD88 (2009.55), et seq.).

The Contractor shall fully document all raw gage readings and the reduction of those readings to their corresponding NAVD88 values in the field book. This shall include the location/identity of the subject gage as well as the precise time of each gage reading. The Contractor shall prepare a final report of the vertical control survey to include pictures of all vertical control monuments, descriptions, published and found elevations, network adjustments, reconnaissance notes, field notes, sketches, etc. The Contractor shall furnish pictures, descriptions and elevations of all benchmarks established for vertical control.

The contractor shall utilize the government's existing gages when possible, and shall only use gages that will allow the data to be reduced to the datum / epoch that is specified in the SOW. The contractor shall access all PBM descriptions and elevations from NGS (http://www.geodesy.noaa.gov/) or as indicated in the scope of work.

Hydrographic Survey Operations:
The Contractor shall inspect each survey site to determine if waterway obstructions such as moored barges prevent the use of automated positioning and sounding equipment for portions of ranges. If collection by non-traditional means (side looking multibeam, pole sounding, etc.) is not plausible, contact survey section for further guidance.

All soundings shall be reduced to the datum and epoch required by the SOW and tabulated to the nearest hundredth of a foot. A GNSS system capable of receiving and applying corrections from Satellite Based Augmentation System SBAS, RTN, or RTK may be used depending on the accuracy requirements set forth in the scope of work. Multibeam surveys require a minimum of RTN level corrections. All GNSS/Inertial navigational data shall be post-processed using CORS or standalone GNSS data from a published control point to compute a Single Best Estimated Trajectory (SBET) for use in post-processing.

While hydrographic surveys operations are underway, the contractor shall record and report gage readings at all relevant project gages to the nearest tenth of a foot. These readings will be recorded at that interval necessary to adequately track the tidal curve (especially at times of predicted high and low tides) and to always ensure the correct determination of the water surface elevation during the survey. Predicted tides can be obtained at the following web sites and shall be included in the survey report: http://tidesandcurrents.noaa.gov/ . Alternatively, automated gage readings may be obtained from the Automatic DCP network operated cooperatively by USACE and USGS, provided appropriate corrections are applied to readings. Hourly readings can be obtained from www.rivergages.com.

Recent advancements in survey technology have also led to the introduction of "RTK tides" in survey data collection software. Where GNSS corrections of sufficient accuracy exist, RTK tides may be used in place of periodic readings to monitor changes in tide. Surveyors shall, however, still observe the water levels directly before and after the survey as a constraint for these tidal adjustments using stream gages, topographic GNSS, or conventional means.

Bar check readings shall be made twice daily (to adjust the depth sounder for water temperature and salinity); once before work commences and once at the close of each day and must be performed in the project area. When bar checks are made, the Contractor shall follow the operating procedures described in the previously referenced EM 1110-2-1003. The use of a Sound Velocity Profiler (SVP) or Conductivity-Temperature-Depth Probe (CTD) is recommended to accurately adjust the speed of sound in a water column due to temperature and salinity variations and is required for multi-beam surveys. The use of such a device does not negate the requirement of a bar check.

Single-Beam Surveys:

Single-Beam Hydrographic Surveys shall be conducted with a depth sounder able to measure not less than 5 soundings per second. The transducer shall have a beam width of not more than five degrees. In areas of suspended sediment, a low or dual frequency fathometer shall be used and set such that the hard bottom is digitized. To insure/confirm that the hard bottom is properly digitized, the requestor may require that additional lead-line or pole check soundings be made. If so, the contractor shall take a minimum of two (2) check soundings on every fifth (5) range using a 13 lb. mushroom type lead or topographic level rod.

Hydrographic survey soundings shall be taken at intervals as specified in the SOW, but not to exceed 20 feet. Overbank elevations shall have a maximum interval of 20-feet and at all abrupt changes (+/- 2') in elevation unless otherwise specified in the scope of work. Measured elevations shall have an accuracy of +/-0.20 ft or better unless otherwise specified by the scope of work. All overbank data collected shall conform to the requirements of Section D of these minimum standards.

Multi-Beam Surveys:

Multi-Beam Hydrographic Surveys shall be conducted in accordance with industry best practices and the Hydrographic Surveying Manual, EM1110-2-1003. Each multibeam head shall be restricted to a 90-degree swath centered and on the Nadir of the transducer unless a wider swath is specifically authorized by survey section for recon purposes. Heads may be mounted in off-vertical positions to allow for surveying under and around structures, and multiple transducer configurations may be used. All multibeam surveys shall be conducted with 50% side lap, in opposing directions where possible, effectively generating 200% coverage. No returns longer than 350' slope distance shall be used. Patch tests for multibeam surveys shall be performed prior to data collection on an as needed basis. Boat mounted SVP's and remote sound velocity measurements shall be taken as required to eliminate edge "curling". All point clouds shall be properly filtered to remove artifacts. All "hard-strikes" shall be annotated in the survey report.

Hydrographic Survey Deliverables:

The Contractor shall reduce, edit, correct and combine overbank and hydrographic survey data in the EM file format as outlined in the referenced EM File Format Specifications and, if specified, the legacy file format "MVN Extended LMN830 Format" (LMN830 format specifications will be provided on request). A final hydrographic survey report shall be submitted in PDF format and shall include survey methodology, baseline computations, survey control, survey procedures, correspondence, photos, tabulation of monuments with elevations, feature descriptions, etc. All hydrographic and GNSS raw data, processed vectors, network adjustments, reports, field notes, and Project Files etc. shall be submitted. All data files and photos shall be submitted via FTP or Digital Media (CD/DVD/External HDD).

Section F

sUAS Aerial Surveys

General:

All small unmanned aerial systems (sUAS) operations shall be conducted in accordance with Aviation Policy Letter 19-08, USACE Aviation sUAS Policies and Procedures, and only after receiving approval from the New Orleans District Aviation Training Program Manager (ATPM). Under no circumstances shall flights be conducted without an approved flight plan listing the approved platform and qualified Pilot in Command (PIC).

All third party and contractor sUAS flights shall be pre-approved by the MVN ATPM and conducted in accordance with Aviation Policy Letter 20-06, Small Unmanned Aircraft Third Party Flights on USACE Projects and Lands. All third party and contractor flights shall be performed in compliance with FAA, state, and local laws and restrictions. All aerial surveys shall be conducted in accordance with USACE Photogrammetric and LiDAR Mapping, EM 1110-1-1000.

Licensing Requirements & Equipment Restrictions:

All pilots and visual observers shall be qualified in accordance with FAA Part 107 requirements or USACE equivalent. Contractor Remote Pilots shall hold a valid FAA Part 107 license. Only approved platforms listed in Appendix A of APL 19-08 may be used on controlled USACE Environments and only approved platforms listed in Appendix B of APL 19-08 may be used on benign USACE Environments. The most current list of approved platforms can be obtained from the MVN ATPM.

Flight Plans:

Every sUAS flight requires an approved flight plan prior to deployment to the field. Flight plans shall include at a minimum, type of SUAS platform, date and location of flight, name of all aircrew members and Part 107 certificate number if applicable. Flight plans shall be submitted to the ATPM at least one week before the scheduled flight. Third Party and contractor flights require supervision by a USACE Trusted Agent designated by the MVN ATPM. Under no circumstances shall sUAS operations take place without an approved flight plan.

Cybersecurity Requirements:

USACE Small Unmanned Aircraft Systems shall be maintained as a Closed Restricted Network (CRN) at all times, and data transfer is restricted to approved Air-Gapped machines per APL 19-08. Third Party and Contractor flights shall comply with all cyber security policies per APL 20-06.

Survey Ground Control & Mission Blocks:

All sUAS surveys shall be conducted using an appropriate number of Ground Control Points (GCPs) for the scale of the aerial survey. A minimum of five points shall be placed, with additional marks placed for larger areas at the discretion of Survey Section. Mission Blocks shall be appropriately laid out to achieve requisite side and end lap per the accuracies required in the SOW.

Post-Processing:

Raw data shall be processed using software specific to the platform being flown to properly export, geotag, and compile the flightpath for processing into final deliverables. LiDAR and Photogrammetric data shall be further processed into Point Clouds and Ortho-mosaics and shall be ground-truthed using an appropriate number of targets as dictated by the scale of the project. Point clouds shall be filtered to remove noisy data and shall be presented in both classified and bare earth formats.

Deliverables:

Deliverables for aerial surveys shall be presented in a logical format and shall consist of Point Cloud and Ortho-mosaic images per specification in the scope of work. When required, point clouds shall be submitted in .las and .xyz formats for raw point clouds, and as a GeoTIFF for raster format Digital Elevation Models. Ortho-mosaics shall be delivered in GeoTIFF Format. Resolutions shall be as specified in the SOW document.

Section G

Terrestrial LiDAR Surveys

General:

Terrestrial LiDAR data may be collected by stationary or mobile means to produce point clouds of feature rich areas for topographic data extraction or production of high-density terrain models. Stationary terrestrial LiDAR may be performed using a wide variety of scanner units that produce either referenced or unreferenced point clouds. Units that do not produce referenced points clouds require the use of GCP targets for orientation and meshing, while units equipped with total station features may be oriented prior to scanning using traditional traverse methods. All Stationary Terrestrial LiDAR surveys shall be conducted in accordance with EM 1110-1-1005.

Mobile Terrestrial LiDAR systems function much like hydrographic or aerial units using combined inertial/GNSS navigation systems and correlated scanning arrays. These arrays may be mounted to a wide variety of vehicles including trucks, boats, and ATVs, and may be coupled with 360-degree cameras.

In all forms of terrestrial scanning, care shall be taken when performing scans of vegetated areas, as even with high-end multiple return units, it can be hard to distinguish between low-lying vegetation and the hard ground. The accuracy requirements and the likelihood of full penetration of emitted laser pulses at the incident angle and distance should be carefully considered before using terrestrial LiDAR to collect natural ground features.

Unregistered Stationary Scanning:

Unregistered stationary scanning requires the use of GCP shape or flat refractive targets for orientation and geolocation of scans. Each scan should have a clear view of not less than 5 targets, and subsequent scans intended to be meshed together should share at least 3 common targets where practical. Targets shall be surveyed in accordance with the traversing standards outlined in Section D, and within the tolerances set forth in the scope of work. Readily identifiable discrete objects within the scanning area (i.e., fire hydrants, slab corners, etc.) may also be used as GCPs.

Registered Stationary Scanning:

The advent of scanning-capable total stations has introduced registered stationary scanning as a viable alternative to the use of GCPs. These units provide orientations and geolocation via traditional EDM traverse methods. All registered scanning setups shall be conducted per the traversing standards outlined in Section D. The use of fixed targets during registered scanning is recommended whenever possible as a backup to the internal orientation to prevent the loss of data. As with unregistered scanning, readily identifiable discrete features may be used as GCPs for QAQC purposes.

Mobile Terrestrial Scanning:

Mobile Terrestrial scanning shall be conducted in accordance with industry best practices and software manufacturer recommendations. When mobile LiDAR surveys are collected using dual-purpose software primarily geared for the collection of Multibeam hydrographic data, the applicable provisions of EM 1110-2-1003 shall be applied. Provisions for Terrestrial Vehicle mounted systems shall also apply to boat-mounted LiDAR systems. Vehicle mounted systems are required to comply with federal, state, and local ordinances and regulations regarding allowable configurations for operation on roads and highways, including but not limited to exterior lighting, vertical clearances, occupant restraints, and driver distraction laws. The operator of the survey vehicle shall be solely responsible for compliance with all applicable laws during survey operations.

Mobile systems shall be patch tested regularly to ensure proper orientation parameters. When practical, reciprocal lines run over the same area should be used to ensure proper sensor orientation parameters. All data shall be validated by ground-truthing using sparsely placed GCPs or discrete features of known position and elevation in conjunction with random topographic ground sampling.

RTN positioning may be used during collection of Mobile Terrestrial Data, but all tracks shall be post-processed using CORS or standalone static data collected at a published control point during the duration of the project to develop a SBET for use in post processing.

Post-Processing / Deliverables:

All terrestrial LiDAR data shall be post-processed using final adjusted station positions and orientations and fully processed SBET tracks. Where simultaneously collected photo data is available, point clouds should be colorized to aid in classification. All LiDAR files shall be classified and filtered for noisy and errant data prior to feature extraction.

All extracted feature data shall be presented and delivered in EM format. Point cloud datasets shall be delivered inLAS and XYZ formats. DEMs shall be delivered as GeoTIFFS and include all supporting files, and any DTMs shall comply with CADD/BIM standards and be compatible with Bentley OpenRoads. The SOW shall dictate which deliverable formats are required to be delivered on LiDAR surveys.

All topographic truthing data and GNSS raw data, processed vectors, network adjustments, reports, field notes, and Project Files etc. shall be submitted. All data files and photos shall be submitted via FTP or Digital Media (CD/DVD/External HDD).

Section H

Periodic Inspections & Structural Monitoring

General:

All Periodic Inspection Surveys of structures shall be conducted in such a way as to lend itself to the direct comparison of historical data at the designated Settlement Reference Marks (SRMs). This is typically accomplished using common ties to historically observed control points. Surveys shall be conducted in the most recent available common datum and epoch, and subsequently adjusted to the historical Primary Benchmark elevation for direct comparison. All Structural Settlement and Deformation surveys shall meet the requirements of EM 1110-2-1009, USACE Structural Deformation Surveying Manual.

Recent efforts to upgrade control marks to deep-founded rod marks detached from the structures in question have proved successful, and all structures shall be brought into compliance with new standards at the earliest availability of funding.

Gage readings shall be taken every day of the survey and logged in the field notes. Painted marks and designations shall have yellow marking paint reapplied at the time of survey. Aerosol spray paints shall not be used for this purpose.

Benchmark Requirements:

New structures being added to the Periodic Inspection Program shall be reference to a minimum of 2 Stability B or greater benchmarks located outside of the immediate footprint of the structure, and a third, remote stability B or greater within 1 mile of the structure. All three marks shall be GPS suitable at the time of installation. One of the local marks shall be designated as the Primary Mark. Existing structures should have the existing control evaluated for compliance with the above guidelines for new structures and be brought into compliance at the earliest opportunity. At least one mark at all existing structures shall be GPS suitable.

Control Levels:

Levels shall be run between control marks at the applicable structure during each PI survey. Levels between benchmarks shall meet or exceed Second Order-Class 2 closure standards. Level loops should be processed hold the elevation of the local Primary mark. When New marks are established to bring older structures into compliance, a direct tie from the historic Primary Mark and the new Remote Mark shall be established by leveling. This tie shall meet or exceed Second Order-Class 1 closure standards. Existing local marks shall continue to be surveyed along with any new marks established in this process.

SRM Requirements:

Newly established SRMs shall be constructed of a resilient material, such as stainless steel or brass, and be embedded in the building material where practical. Markers which allow for the SRM designation to be inscribed into the face are highly preferred to eliminate ambiguous surveys. Marks should be dome-topped and set to protrude above the surrounding material for maximum accessibility. Punch-marks and inscribed crosscuts are not acceptable for new markers. On high walls where the top of wall is not accessible to survey personnel, marks may be alternatively place in the face of the wall, provided there is sufficient protrusion to allow a survey rod to be reliable placed atop the mark, although this is only recommended as a last resort. Existing structures with non-discrete or inaccessible marks should be evaluated for future conversion to a compliant configuration at the earliest availability of funding.

SRMs shall be observed by leveling from the nearest benchmark included in the Control Level Loop, holding the adjusted elevation from the adjusted survey data with reference to the Primary Benchmark. All SRM elevations shall be recorded in the latest available datum and epoch and be adjusted based on historical elevation of record. SRM level loops shall meet or exceed Second Order-Class 2 closure requirements.

Scour Ranges:

When requested, bottom and overbank scour ranges shall be surveyed in accordance with standard topographic and hydrographic survey techniques as outlines in Sections D and E of this document. When practical, the areas should be surveyed using multibeam sonar and cross sections should be extracted along the historical ranges for direct comparison. The multibeam data should also be archived in a 1'x1' grid for further analysis of scour as required. When multibeam is not practical, conventionally collected single-beam or RTK pole-sounding surveys at the required ranges shall be conducted. Maintained areas of overbank ranges may be surveyed using terrestrial LiDAR, but any evident scour damage and any vegetated areas shall be surveyed by conventional topographic methods.

Piezometer and Gage Surveys:

Piezometers and staff gages/wired weights at structures shall be surveyed in accordance with SOW requirements. The tops of all Piezometer tubes, staff gages, and wire weight check bars shall be observed by a level loop meeting or exceeding Second Order-Class 2. Staff gages should be observed by leveling to the most accessible even foot mark.

Piezometers shall be read by use of an M-scope to determine the depth to water level. Clogged piezometers should be sounded to determine the level of the clog. Dry piezometers shall be annotated as "Dry". If a piezometer tube has apparent damage to the riser tube, contact survey section for further guidance.

Adjustment and Reduction of Data:

All level loops shall be adjusted for closure and have adjusted elevations applied to dependent loops. SRM and Benchmark adjusted elevations shall be recorded in the supplied Settlement reference mark spreadsheet tables for "raw data". The average of staff gage readings on the date of observation for the SRMs and the highest temperature for that date shall be recorded in the spreadsheet. An adjustment factor based on the difference between the observed and historical elevation for the Primary Benchmark shall be calculated in the "adjusted data" tables of the SRM spreadsheet, and the adjustment factor shall be applied to SRM elevations in the "raw data" table to calculate the adjusted SRM values for direct comparison with historical values.

Recorded piezometer depths shall be reduced to an elevation by subtracting from the historical Top of Pipe elevation listed in the provided piezometer spreadsheet. This reduced elevation shall be logged in the piezometer spreadsheet along with the staff gage readings on the day of measurement.

Destroyed, damaged, missing, or inaccessible SRMs, Benchmarks, Gages, and Piezometers shall be annotated in the field notes and in the appropriate spreadsheet for later action by survey section.

Deliverables:

All raw and adjusted level data and calculation files shall be provided for review. Benchmark SRM, and piezometer elevation data shall be submitted via the provided SRM and piezometer spreadsheets. Scour surveys shall be submitted in .em format along the historical ranges and profiles as designated in the SOW. Any multibeam data collected shall also be submitted as a 1'x1' grid in LAS or XYZ format. Photographs of all Benchmarks, SRMs, Piezometers, and Staff gages shall be included in the submittal. PI survey deliverables shall also contain all minimally required documents for all activities performed as described in Section L.

Section I

Notification of Completed Construction Surveys

General:

All Notification of Completed Construction (NCC) Surveys shall be conducted in accordance with the standards set forth previously in Section D for the specific method of surveying required. Hardened Flood Protection features such as floodwalls, walls of buildings designed to be the primary line of protection, and flood control structures shall be surveyed by precise leveling conforming to Second Order-Class 2 or better. Earthen Protection and armored features such as slope pavement, riprap, and sheet-pile may be surveyed using RTK-GPS or EDM surveys unless otherwise specified. The use of network RTK on NCC surveys shall not be allowable except in special circumstances as directed by the DDC.

NCC survey requests should be initiated 90 days prior to the NCC letter date and scheduled to occur not more than 30 days prior to. Survey requests for NCC surveys shall include the Project Control Benchmarks designated in the plans and specifications, the project baseline, and the endpoint coordinates of the reach. All NCC surveys shall be constrained to the elevation of the Primary Project Benchmark as listed in the plans and specifications unless otherwise directed specifically by survey section.

Intervals and Methodology:

The maximum shot spacing for line of protection profiles shall be 100’ plus any breaks in grade, and any transition in construction materials (i.e., edge of slope pavement, transition to sheet pile, transition to floodwall, etc.). Shorter spacing intervals such 50’ for manual surveys are highly encouraged. Mobile data collection of earthen construction profiles is allowable provided all provisions set forth in Section D (and Section G if applicable) are followed. Recommended shot spacing for mobile profile collection is 25’.

The survey of floodwalls shall consist of shots within 0.5’ of the end of each monolith, using one or any combination of the following three methods:

- direct observation on top of wall
- inverted rod reading hanging from top of wall using appropriate bracket
- direct reading at the foot of wall plus measure up distance (average of 3 height observations)

When wall segments contain PIs or are longer than 50’ in length, additional shots shall be taken at the PI and/or midpoint of the wall. In order to meet levee data archiving requirements, the toe elevation of floodwalls shall be collected at a maximum of 100’ intervals and at each break in grade along the side of the wall with the lowest ground elevation. These toe of wall shots may be collected via RTK-GPS or EDM. When surveying floodwalls, it is highly recommended to set temporary marks of suitable stability at 2000’ intervals along the wall for use during the top of wall survey. Earthen features and transitional shots required by the SOW at the ends of floodwalls may be observed using RTK-GPS or EDM methods. All leveled shots on tops of floodwalls shall have XY locations provided by co-located RTK-GPS or EDM observations. Any features additionally requested for survey outside of the base NCC survey requirements shall be subject to the applicable sections of these minimum standards.

Deliverables:

NCC survey deliverables shall contain all minimum required documents including but not limited to EM and PRO files associated to the proper project baseline, Benchmark Datasheets for each Project Control Mark, NCC Spreadsheet detailing shot elevations, locations, stations, and design parameters, and all raw data and field notes. Any temporary marks set shall be included in the EM file as #T records. Only marks specified as Project Control in the plans and specifications or specifically called for in the SOW shall be listed as #V records.

Section J

Benchmark Verification During Construction

General:

All Benchmark Verification During Construction surveys shall be performed in accordance with Section D, subsection "Conventional Leveling" and shall at a minimum meet the requirements outlined in Engineering Division Datum Policy Memo #3. All district Datum memorandums are available online at : https://www.mvn.usace.army.mil/Missions/Engineering/Survey-Section/Datum-Policy-Memorandoms/.
Benchmarks designated in the plans and specifications for construction projects shall meet the stability and publishing requirements set forth in Engineering Division Datum Policy Memos # 2 & 3. Substitution of any designated mark shall be at the sole discretion of the District Datum Coordinator.

To reduce the duplication of efforts, it has been agreed upon that should multiple contractors be working on the same contracted project simultaneously, only one benchmark verification submission is required for each 6-month construction period, provided the results of that survey were within required tolerances set forth by USACE, and that results were acceptable to all contractors as accurate.

Benchmarks:

The benchmarks included in verification surveys shall be those designated in the approved plans and specifications. Unless otherwise specified, all marks shall be included in all benchmark verification submissions. Any Temporary Benchmarks set by the contractor for local use during construction activities shall also be included in these verification surveys. Replacement or reobservation of destroyed or disturbed project benchmarks shall only occur at the direction of the District Datum Coordinator or their assigned representative.

Field Notes:

Clear and concise field notes taken during the performance of level loops shall be stamped by the surveyor and submitted with the results of the loops for review by survey section. On submittals including elevation certificates for concrete monoliths, loops shall show a tie back to one or more of the project control points designated in the plans and specifications having been included in the latest 6-month benchmark verifications.

Standards and Frequency:

In accordance with Engineering Division Datum Policy Memo #3, verification surveys shall be conducted prior to the start of construction, and thenceforth at the conclusion of each 6-month period of construction, ending with a final verification during production of the as-built surveys. Verification level loops shall meet or exceed Second Order-Class 2 standards. Al level loops shall be adjusted for closure and adjusted elevations applied to dependent loops. Errors shall be distributed by either proportional distribution (preferred) or, in the absence of observed sight distances, equal distribution method.

Deliverables:

All calculations, results, and stamped field documents shall be forwarded to survey section for review and archiving in EGIS and ProjectWise. Deliverables should be organized in such as manner as to lend themselves to a quick and thorough review. All Project Benchmarks and contractor-set TBMs shall be clearly labeled in all documentation.

Section K

Static GNSS Control Surveys

General:

All Static GNSS Control Surveys shall be performed in accordance with the NAVSTAR Global Positioning System Surveying Manual, EM1110-1-1003. All GNSS network results shall be submitted to Survey Section for approval prior to commencement of any dependent survey operations. Any additional survey work undertaken prior to approval of the network results may not be acceptable and will be at the contractor's risk.

Acquisition of new elevation/orthometric height data shall conform to the Survey Plan approved by the District Datum Coordinator, USACE-MVN Engineering Division Datum Policy Memo #3, "Requirements for Use of Benchmarks for USACE Projects," dated March 23, 2009, as well as any subsequent applicable project-specific datum memorandums.

Determining Orthometric Heights using Static GNSS:

When static GNSS survey techniques are called for to establish a high-accuracy control network or to establish additional project or local control, there are three basic rules that need to be followed:

- Adhere to MVN's guidelines outlined in this booklet for establishing GNSS-derived ellipsoid and orthometric heights when performing GNSS surveys.
- Use NGS' latest National Geoid Model (at the time of publication, Geoid18), when computing GNSS-derived orthometric heights. Beta and superseded Geoid models released by NGS shall not be used unless specifically requested by the SOW or District Datum Coordinator.
- Use the latest NGS control point positions/elevations found in the NSRS Database (or as specified by USACE): https://geodesy.noaa.gov/datasheets/index.shtml

In some unique situations, available NGS control may be so distant and/or so sparse that full adherence to more stringent and demanding technical guidelines is required. The District Datum Coordinator will advise when/if these more demanding guidelines (NOAA Technical Memorandum NOS NGS-58, developed by the National Geodetic Survey in November 1997 titled "*Guidelines for Establishing GPS-Derived Ellipsoid Heights*", Version 4.3; NGS's "A *Guide for Establishing GPS-Derived Orthometric Heights*", Version 1.5; U.S. Army Corps of Engineers Technical Letter No. 1110-1-183 dated April 1, 1998 and titled "*Using Differential GPS Positioning for Elevation Determination*") are to be followed.

Network Design Planning:

When the use of static multi-frequency carrier-phase differential GNSS is specified in the Scope of Work for a New Orleans District project, a Network Design Plan and Session Schedule must be developed. The Network Design Plan and Sessions Schedule must be submitted to the District Datum Coordinator for approval prior to commencement of any work.

The location and density of available NSRS control should be carefully reviewed. The network should ordinarily incorporate a minimum of three nearby, published, and undisturbed primary control monuments having valid horizontal and vertical positions expressed with respect to the current horizontal and vertical datum/epoch. If, after the incorporation of three valid NSRS vertical control points, all baseline lengths in the network are less than 15 kilometers, then no additional NSRS vertical control need be included. If the network requires baseline lengths of from 15 to 40 kilometers, ties to four or more NSRS vertical control points surrounding the project site may be required.

Session Planning and GPS Scheduling:

For baselines of 15 to 40 kilometers in length, the sessions should be scheduled for a minimum common observation period of 4 hours with a minimum of 2 sessions on different days. The purpose is to ensure different atmospheric conditions (different days) and significantly different satellite geometry (different times) for the two occupation periods.

For example, if the first day occupation were made between 8:00 am to 12:00 pm, the second observation would be made on the next day anytime between 1:00 pm and 5:00 pm. If the second observation is not made for a couple of days or even a week, be sure to compensate for the daily 4-minute change in the GPS satellite constellation. It has been shown that the average ellipsoid height of repeat observations is closer to the true value, with a few exceptions, than the ellipsoid height of a single observation.

For baselines of 15 kilometers or less, the sessions may be scheduled for a minimum common observation period of 40 minutes with a minimum of 2 sessions at different times of the day and a minimum 4-hour offset, or on different days, at different times. For example, if the first occupation is made between 8:00 am to 9:00 am, the second observation could be made on the same day any time after 1:00 pm. If the second observation is not made for a couple of days or even a week, be sure to compensate for the daily 4-minute change in the GNSS satellite constellation.

A Session Schedule form should be assembled showing the proposed start time and session duration time for each session. Travel times should be calculated using a road map to compute distance and travel times between set-ups. Input the GNSS operator and station names of the points that will be occupied by each operator.

It is important to remember that useful data in a multi-receiver static differential GNSS survey session spans only the timeframe common to all receivers, i.e., from the time that the last GPS receiver in the group starts data logging, to the time that first GPS receiver in the group terminates data logging.

GPS Equipment:

Fixed height tripods are required to be used for each set-up. Fixed height tripods provide a consistent station occupation height that can reduce the likelihood of antenna height measurement blunders. In the event that a setup cannot be performed with a fixed height tripod because of an obstruction such as a fence, then an adjustable tripod can be used. In this case make certain that the procedure for antenna height measurement on an adjustable tripod is used. In no instance is the use of a bipod acceptable unless granted prior approval by the District Datum Coordinator.

The use of multi-frequency receivers can correct GNSS measurements for ionospheric-based range errors. This will extend the feasible baseline length and resolve integer ambiguities reliably within 40 km. Multi-frequency receivers shall be used on all baselines.

Use of geodetic quality antennas is mandatory. The use of the same geodetic antenna type for all observations is preferred. Different makes and models of GNSS antennas can have different phase-center offsets. Mixing different types of antennas can cause errors in the vertical component of up to 10 cm. The use of differing antenna models will be permitted only if the processing software can account for the different phase-center offsets of the antennas, and if great care is exercised by field operators and data processors to identify, document and use the appropriate antenna phase-center offsets.

GPS Field Essentials:

GPS Log Sheets are the field notes for the static GPS survey and should be filled out in their entirety. The information on this sheet is important for field coordination and communication and is essential to proper data downloading and processing. If problems are encountered with the raw data, the problem can often be traced

back to a particular GPS receiver that may have malfunctioned or been configured incorrectly. Field operators should be aware not to stand near and block the GPS antenna or park a vehicle nearby, blocking the antenna view to the sky.

The data required to be logged on the GPS Log Sheets by the technician include the following: Operator, Station Name, Monument Type, Julian Date, Session Number, Receiver Serial Number, GNSS Antenna Model Number, Antenna Height, Start and Stop Times, and Session Notes. A sample GNSS Log Sheet is included in Appendix 8. A Station Sketch with reference ties is preferred on the back page of the sheet for future relocation and confirmation that the correct monument was used in the survey. If you occupy an existing monument, make a note on the GNSS Log Sheet as to the condition of the monument. Note if the monument may have been disturbed and report to the DDC if any effort is required to re-enforce its stability.

When the use of a slip-leg or adjustable-height tripod is required, the field operator should take extreme care to measure and record the slant-height measurement of the antenna in meters on the GNSS log sheet. This measurement procedure should then be repeated at 180° from previous measurement. Record the average value on the GNSS Log Sheet. This is your survey quality control check measurement. Make certain that the measurement is recorded properly. If the two values differ by more than 0.016 feet or 5 mm, begin the measurement procedure all over again (Note that it is the responsibility of the data processor to ensure that the slant-height measurements to the antenna as recorded in the field are properly reduced to vertical heights at the antenna reference point or ARP before processing).

If a second session is scheduled on the same GPS Station, the surveyor shall break setup and re-measure the antenna height. This will eliminate the possible use of an incorrect antenna height for both sessions.

GPS Control Survey Summary:

1) Capture critical field data and occupation information.

It is essential that all observations are logged on an appropriate GPS Observation Log form and that each station is documented with a detailed Station Location Sketch and Visibility Diagram if there are any obstructions to the sky. This documentation, which is usually accompanied with photographs of the mark and equipment set up, provides the processor and QC analyst with information about and/or confirmation of critical occupation details, especially antenna reference point height and antenna type used.

2) Confirm that all antenna reference point heights are correct and that the correct antenna phase-center offsets for each antenna type have been selected/entered. Process and evaluate individual baseline solutions, duplicates, and loop closures.

Once the processor has confirmed that all antenna heights (i.e., antenna reference point or ARP heights) and antenna types (i.e., calibrated phase-center offsets from NGS relative calibration report for given antenna types) have been correctly entered, individual baseline solutions are computed and evaluated for statistical reliability (these being usually the fixed double-differenced results). Prior to a minimally constrained adjustment, loop closures and duplicate baselines should be evaluated to confirm that there are no large mistakes or blunders (typically, any duplicate baseline check or loop closure greater than a few centimeters in any component ought to be cause for re-examining basic input information).

3) Perform minimally constrained adjustment to detect remaining baseline outliers, if any, and evaluate relative height differences among control points. Incorporate the appropriate Geoid model to examine orthometric heights.

Once the apparent blunders or inadequate baseline solutions detected in the process above (if any) have been corrected or eliminated, a minimally constrained solution may be attempted, holding the latitude, longitude, and height of a single control point fixed. At this point NGS' latest National Geoid Model needs to be incorporated (either manually deduct the geoid height from the control point orthometric height to work with ellipsoid heights

directly or enter the orthometric height of the control point and point to the appropriate geoid model if the software can handle the ellipsoid/orthometric height conversion automatically).

The minimally constrained adjustment may further help identify and eliminate any remaining large mistakes or blunders. In the absence of any blunders, the residuals of the baseline vectors (adjusted - observed) should be small (typically less than a centimeter in easting and northing and less than two centimeters in height) and may be representative of the precision of the observations themselves.

In addition, the orthometric heights of other control points in the network computed from the minimally constrained adjustment (computed by the software if it can perform the ellipsoid/ orthometric height conversion automatically or computed manually by adding back the Geoid height for the subject point to the computed ellipsoid height) ought to be compared to their published values. If the differences between the computed and published orthometric heights at the control points are reasonable (usually less than two centimeters), you may proceed to the constrained adjustment. If, however, there is a difference of two or more centimeters at one or more of the control points, an examination of the relative height difference among them may reveal which control point or points need to be reviewed further and possibly rejected.

4) Perform a constrained adjustment - holding to valid control points only - to generate final latitude, longitude, ellipsoid height and orthometric height values of all other points in the network.
When the focus of the network is vertical control extension, the latitude and longitude of a single control point and the orthometric heights of all valid vertical control points are usually held fixed (the validity of the selected vertical control points having been established through evaluation of the minimally constrained adjustment).

Following the constrained adjustment, the residuals of the baseline vectors (adjusted - observed) should again be relatively small (typically less than a centimeter in easting and northing and less than two centimeters in height) and the final standard errors of all computed coordinates and elevations should be realistic (typically, less than 1.5 centimeters in easting and northing and less than 3 centimeters in local height). At this point, there should be a relatively high degree of confidence in the results. If not, further analysis and/or the re-observation of problematic baselines may be required.

5) Document and report *all* the above as well as any final QC checks (e.g., comparisons to OPUS).

- Provide all observation logs, visibility diagrams, station location sketches, station and occupation pictures, network diagrams, etc.
- Provide all raw data in RINEX format.
- Provide a spreadsheet that shows a daily summary of the points occupied and associated ARP heights, antennas, receivers, tripods, RINEX file name, occupation start and stop time, and any additional explanatory notes.
- Provide basic vector processing, duplicate and loop closure reports.
- Provide report from minimally-constrained adjustment.
- Provide final fully-constrained adjustment report and final coordinate listing.
- Provide all final benchmark datasheets.
- Provide spreadsheet showing final-adjusted versus OPUS comparison.
- Provide narrative of scope of work, field acquisition, data processing and QC procedures, results, problems, problem resolutions, etc.

Section L
Deliverables

General:
The delivery of all raw and processed data shall be accompanied by a detailed Survey Report as described below. All project deliverables are to be submitted electronically via ftp file transfer. Upon ftp transfer, the COR should be notified immediately via e-mail. The organization and presentation of *all* deliverables should lend itself to efficient, comprehensive, and meaningful quality assurance review and analysis by both the Contractor and Survey Section personnel.

Survey Report:
Adherence to the referenced Survey Report outline is mandatory for all contractors. *All* section and sub-section headings indicated in the outline shall be included in the Final Survey Report. Those sections and/or sub-sections that are not applicable shall be noted as "N/A". See Appendix 6 for complete Survey Report outline. All survey reports shall be stamped/signed by a PLS registered in the state where the work weas performed.

Field Notes / Adjustment Reports:
All field notes recorded during a contract survey effort shall be stamped/signed by a PLS registered in the state where the survey was performed. The field noted shall be scanned and submitted electronically with the data files. All level adjustment reports/notes shall be initials by the reviewer and included with the raw data. All GPS adjustment reports specified in Section K shall be included in the final delivery.

Data Submittals:
All raw, intermediate and final data sets and all intermediate and final processing results, as well as any other relevant data or information supplied and/or developed in connection with a given project or task order shall be included in the deliverables. All data and information submitted shall be organized in accordance with the file index outlined in Appendix 7.

In addition to any other deliverable format required by the SOW, all survey coordinate data shall be submitted in the "EM" or logical record format specified in the referenced EM File Format Specifications. All submitted EM files will adhere to the referenced manual for submission of data. Appropriate #T, #V, #H, and #G records will be inserted before affected Cross Sections, Profiles, or Miscellaneous shots. The purpose is to associate a particular survey activity with the metadata describing the date, time, and control used while collecting survey data. When appropriate, certain data sets (e.g., overbank and hydrographic survey data) shall be combined or grouped logically (e.g. to form a complete cross section).

To assist with the development of properly formatted EM files, several helpful utilities are available at: http://www.mvn.usace.army.mil/Missions/Engineering/GeospatialSection/USACESurveyDrivers.aspx The current release of "USACE Survey Drivers" may be downloaded from the website above and be installed locally. This utility makes available the following:

- EM File Format Specification
- LMN830 File Format Specification
- Profile Format Specification
- Survey Utilities Shell (this includes DOS executables "survey_checker.exe" that can be run against an EM file to detect format errors, and the utility "survey_to_kml.exe" that converts EM files to KML format for viewing within Google Earth) .
- If assistance is needed to use Survey Drivers please contact Survey Section.

Appendix 1
Acronyms & Abbreviations

A-E / "A/E/C"	Architect-Engineer Contactor
APC	Antenna Phase Center
APL	Aviation Policy Letter
ARP	Antenna Reference Point
ATPM	Aviation Training Program Manager
BIM	Building Information Modeling
CADD	Computer Aided Drafting & Design
C/L	Centerline
COR	Contracting Officer's Representative
CORS	Continuously Operating Reference Station
CRN	Closed Restricted Network
CTD	Conductivity-Temperature-Depth Probe
DDC	District Datum Coordinator
DEM	Digital Elevation Model
DTM	Digital Terrain Model
EDM	Electronic Distance Measurement
EM	Engineering Manual
FAA	Federal Aviation Administration
FGDC	Federal Geodetic Data Committee
FTP	File Transfer Protocol
GCP	Ground Control Point
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HI	Height of Instrument
HR	Height of Rod
KML	Keyhole Markup Language
LDB	Left Descending Bank
LiDAR	Light Detection and Ranging
MVN	USACE New Orleans District
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NCC	Notification of Completed Construction
NGS	National Geodetic Survey
NGVD29	National Geodetic Vertical Datum of 1929
NTP	Notice to Proceed
NOAA	National Oceanic and Atmospheric Administration
NSRS	National Spatial reference System
OPUS	Online Positioning User Service
OTF	On the Fly
PBM	Permanent Benchmark
PDOP	Positional Dilution of Precision
PIC	Pilot in Command
PID	Permanent Identifier
PLS / RLS	Professional (Registered) Land Surveyor (varies by state)

PPE	Personal Protective Equipment
QAQC	Quality Assurance/Quality Control
RDB	Right Descending Bank
RH	Rod Height
RTK	Real Time Kinematic
RTMS	Real-Time Monitoring System
RTN	Real Time Network
SBAS	Satellite Based Augmentation System
SBET	Single Best Estimated Trajectory
SDSFIE	Spatial Data Standards for Facilities, Infrastructure, and Environment
SFM	Structure from Motion
SOW	Scope of Work
SPCS	State Plane Coordinate System
SME	Subject Matter Expert
SRM	Settlement Reference Mark
sUAS	Small Unmanned Aerial System
SVP	Sound Velocity Probe
TBM	Temporary Benchmark
U-SMART	USACE Survey Monument Archival & Retrieval Tool
USACE	U.S. Army Corps of Engineers
VDOP	Vertical Dilution of Precision
VO	Visual Observer
XML	Extensible Markup Language

Appendix 2
Feature Codes

Priority should be given to the existing codes below. Any additional codes shall be included in a "codes.dat" file as previously described. Codes list is available as a Trimble Feature Library upon request.

CODE	DESCRIPTION
60D;	60D NAIL
AC;	TOP OF AC PAD
AGF;	CULTIVATED AG FIELDS
ALP;	ALIGNMENT PIN
ANT;	ANTENNA
AP;	ABANDONED PIPE
APL;	APPROACH LIGHT
APR;	APRON
APS;	APRON SHOULDER
APT;	AERIAL PANEL (TEMPORARY)
ASP;	ASPHALT
AST;	TANK, ABOVE GROUND STORAGE
ATM;	AUTOMATED TELLER MACHINE
ATN;	AID TO NAVIGATION
ATO;	TOE OF ABUTMENT
ATP;	TOP OF ABUTMENT
AWH;	ABANDONED WELLHEAD
BAE;	EDGE OF BALLAST
BAL;	BALLAST
BAR;	BRIDGE ARCH
BAS;	BRIDGE APPROACH SLAB
BBP;	BOTTOM OF BORROW PIT
BBQ;	BBQ PIT / GRILL
BBT;	BOTTOM OF BENT
BC;	BUILDING CORNER
BCD;	BOTTOM OF CONCRETE DITCH
BCL;	CENTERLINE OF BERM
BCR;	BRIDGE CORNER
BDE;	BARRICADE
BEE;	TREE, BEECH
BEJ;	BRIDGE EXPANSION JOINT
BFB;	BRICK FLOWER BED
BFO;	UNDERGROUND FIBER OPTIC
BFW;	BASE OF FLOODWALL
BGR;	BRIDGE GUARDRAIL
BHL;	BOREHOLE
BIL;	BILLBOARD
BKT;	TOE OF BANK
BL;	BASELINE
BLD;	BUILDING
BLK;	BULKHEAD
BLP	BASKETBALL POLE
BLT;	BOLT
BM;	BENCHMARK
BMV	BENCHMARK (VERTICAL FACE)
BNK;	BANK
BNT;	BRIDGE BENT
BOD;	BOTTOM OF DITCH
BOI;	BOIL
BOL;	BOLLARD
BOR;	SOIL BORING
BOS;	BOTTOM OF STREAM
BOT;	BOTTOM
BPB;	BUMPER BLOCK
BPP;	BUMPER POST
BRA;	BRIDGE ABUTMENT
BRC;	BRIDGE CONCRETE
BRD;	BRIDGE DECK
BRF;	BRIDGE FENDER
BRK;	BREAKLINE
BRM;	BERM
BRW;	BREAK WALL
BSC;	BACKSIGHT CHECK
BSH;	BUSH
BST;	BACKSIGHT
BTO;	BREAKLINE, TOE
BTP;	BREAKLINE, TOP
BUS;	BUS STOP
BUY;	BUOY
BW;	BRICK WALL
BWF;	FENCE, BARBED WIRE

CA;	CONCRETE ASPHALT
CAA;	CAR AXLE
CAC;	CACTUS
CAP;	CONCRETE APRON
CAR;	CENTERLINE OF AGGREGATE RD
CB;	DRAIN, CATCH BASIN
CBC;	CABLE SERVICE
CBI;	DRAIN, CURB INLET
CBK;	CONCRETE BULKHEAD
CBL;	CABLE (TENSION)
CBP;	POLE, CABLE
CBR;	CROWN OF BERM
CBT;	CONCRETE BLUT TOE
CBX;	BOX CULVERT
CCD;	CENTERLINE OF CONCRETE DITCH
CCL;	CENTERLINE OF CONC. CULVERT
CCP;	CENTERLINE OF CONCRETE PAD
CCR;	CENTERLINE OF CONCRETE CURB
CDH;	CORE DRILL HOLE
CDR;	CONCRETE DRIVE
CED;	TREE, CEDAR
CEM;	CEMETARY
CFP;	CORNER, FLAGPOLE BASE
CG;	CATTLE GUARD
CH;	CORNER, HOUSE
CHC;	CENTERLINE OF CHANNEL
CHE;	TREE, CHERRY
CHT;	TOP OF BANK, CHANNEL
CHW;	CENTERLINE OF HEAD WALL
CK;	CHECK SHOT
CKE;	STATION ELEVATION CHECK
CL;	CENTERLINE
CLB;	CENTERLINE OF BRIDGE
CLC;	CENTERLINE OF CONCRETE
CLD;	CENTERLINE OF DITCH
CLE;	CLEAT
CLF;	CENTERLINE OF FLOODWALL
CLG;	CENTERLINE OF GABION
CLJ;	CENTERLINE OF JETTY
CLL;	CENTERLINE OF LEVEE
CLP;	CENTERLINE OF PROTECTION
CLR;	CENTERLINE OF ROAD
CLS;	CENTERLINE OF STREAM
CLT;	CENTERLINE OF TRACKS (MISC)
CLW;	CENTERLINE OF WALKWAY
CMP;	PIPE, CORRUGATED METAL
CND;	CONDUIT
CNL;	CANAL
COH;	CONCRETE HEAD WALL
COL;	COLUMN
CON;	CONCRETE
COR;	CORNER
CP;	TREE, CRAPE MYRTLE
CPG;	CONCRETE PILING
CPL;	POLE, CABLE
CPT;	CONE PENTROMETER LOCATION
CR;	CROWN OF LEVEE
CRA;	CENTERLINE OF RAIL
CRB;	CURB
CRD;	CROWN OF DIKE
CRJ;	CROWN OF JETTY
CRK;	CENTERLINE OF ROCK
CRN;	CROWN
CRT;	CROSSTIE
CRW;	CONCRETE RETAINING WALL
CSP;	CONCRETE AT SWIMMING POOL
CSS;	ELEVATION SHOT, CONCRETE
CTD;	CENTER OF DRAIN
CTE;	EDGE OF CAT TAILS
CTN;	TREE, COTTONWOOD
CTR;	TREE, CONIFEROUS
CUB;	BOTTOM OF CULVERT
CUL;	CULVERT
CYP;	TREE, CYPRESS
DCK;	DOCK, MARINE
DCT;	DUCT
DDR;	DEAD DOG ON ROAD
DEB;	DEBRIS
DEC;	DECK
DGS;	TREE, DOGWOOD
DIT;	DITCH
DKB;	TOE OF DIKE
DKE;	DIKE
DKT;	TOP OF DIKE
DL;	DIESEL SUPPLY LINE
DLI;	INVERT, DRAIN LINE

DLT; DRIPLINE, TREE
DOL; DOLPHIN
DRF; DRAIN FIELD
DRH; DRILL HOLE
DRI; DRAIN, DROP INLET
DRL; DRAIN LINE
DRN; DRAIN
DRP; DRAIN PIT
DRR; DRAIN, DROP INLET, ROUND
DRV; DRIVEWAY
DTR; TREE, DECIDUOUS
DUN; DUNE
DWS; DOWNSPOUT
EAR; EDGE OF AGGREAGATE ROAD
EBA; END OF BRIDGE ABUTMENT
EC; EDGE OF CONCRETE
ECB; EDGE OF BRIDGE, CONCRETE
ECC; EDGE OF CURB, CONCRETE
ECP; POLE, ELECTRIC/CABLE
ECR; EDGE OF ROAD, CONCRETE
ECW; EDGE OF WALL
ECY; EDGE OF CANOPY
ED; EDGE OF DRIVEWAY
EDA; EDGE OF DRIVEWAY, ASPHALT
EDC; EDGE OF DRIVEWAY, CONCRETE
EDG; EDGE OF DRIVEWAY, GRAVEL
EDR; EDGE OF DIRT ROAD
EFB; EDGE OF FLOWER BED
EGB; EDGE OF GABION
EGL; EDGE OF GRASS LINE
ELC; POLE, ELECTRIC/LIGHT/CABLE
ELD; TREE, ELDERBERRY
ELI; EDGE OF LIMESTONE
ELM; TREE, ELM
ELP; POLE, ELECTRIC/LIGHT
EM; ELECTRICAL METER
EMG; EDGE OF METAL GRATING
EOA; EDGE OF ASPHALT
EOB; EDGE OF BRIDGE
EOC; EDGE OF CULVERT
EOD; EDGE OF DISTURBANCE
EOG; EDGE OF GRAVEL
EOM; EDGE OF MEDIAN
EOP; EDGE OF PAVEMENT
EOR; EDGE OF RIP RAP
EOS; EDGE OF SLAB
EOT; EDGE OF TIES
EP; EDGE OF PLATFORM
EPL; EDGE OF PARKING LOT
EQP; EQUIPMENT
ER; EDGE OF ROAD
ERF; EDGE OF ROAD, FLOOD SIDE
ERK; EDGE OF ROCK
ERP; EDGE OF ROAD, PROTECTED SIDE
ESA; EDGE OF SHOULDER, ASPHALT
ESB; ELECTRICAL SERVICE BOX
ESC; EDGE OF SHOULDER, CONCRETE
ESG; EDGE OF SHOULDER, GRAVEL
ESL; EDGE OF SLAG ROAD
ESP; EDGE OF SHEET PILE
ESR; EDGE OF SHELL ROAD
ESW; ELECTRICAL SWITCH
ETC; POLE, ELEC./TELEPHONE/CABLE
ETL; POLE, ELEC./TELEPHONE/LIGHT
ETP; POLE, ELEC./TELEPHONE
EV; ELECTRICAL VAULT
EW; EDGE OF WOODS
FC; FENCE CORNER
FEP; FENCE POST
FFE; FINISHED FLOOR ELEVATION
FG; FLOODGATE
FGW; FLOATING GUIDEWALL FACE
FHL; FOXHOLE
FIP; 4" POST
FL; FENCE LINE
FLB; FENCE, BRICK
FLC; FENCE, CHAIN LINK
FLD; FLOODWALL
FLG; MARKER FLAG
FLL; FLOWLINE
FLN; FAULTLINE
FLP; FLAGPOLE
FLW; FENCE, WOODEN
FLY; FLY POINT
FPP FUEL PUMP
FPR; FIXED PRISM

FS; FLOOD SIDE LEVEE
FSC; FLOOD SIDE CROWN
FST; FLOOD SIDE TOE
FTG; FOOTING
FUA; FUEL ACCESS LID
FUJ; FUEL LINE, JET FUEL
FUL; FUEL LINE
FUP; FUEL PIT
FUT; FUEL TANK
FWW; FENCE, WOVEN WIRE
GAC; GROUND AT CULVERT
GAG; GROUND AT GATE
GAP; GROUND AT PIER
GAT; GATE
GCP; GROUND CONTROL POINT
GDM; DAY MARKER, GREEN
GGE; GAGE
GGS; GAGE, STUDY
GL; GAS LINE
GLT; GROUND LIGHT
GM; GAS METER
GR; GUARD RAIL
GRG; GAS REGULATOR
GRL; GROUNDING LOOP
GRN; GROUND
GRV; GRAVEL
GSS; SET GRADE STAKE
GTB; GAS TEST BOX
GUL; GUTTER LIP
GUM; TREE, GUM
GUP; GUY POST
GUR; GUTTER, ROCK
GUT; GUTTER, CONCRETE
GUY; GUY WIRE
GVL; GAS VALVE
GVP; GAS VENT PIPE
GWH; GAS WELLHEAD
HBK; HIGH BANK
HBT; HESCO BASKET TOE
HCM; HIGHWAY CENTERLINE MARKING
HCR HANDICAP RAMP
HDS; HEADSTONE
HEB; HESCO BASKET
HED; HEDGES
HEM; TREE, HEMLOCK
HFL; HIGHWAY FOGLINE MARKING
HH; HAND HOLE
HIC; TREE, HICKORY
HIW; HIGHWALL
HL; HEDGE LINE
HLM; HIGHWAY LANE MARKING
HND; HANDRAIL
HSB; HOSE BIB
HSE; HOUSE
HT; TREE, HACKBERRY
HUB; HUB
HVC; HVAC (CENTER)
HVO; HVAC OUTLINE
HWF; FENCE, HOG WIRE
HWL; HEAD WALL
HWM; HIGH WATER MARK
HYB; FIRE HYDRANT BONNET BOLT
HYD; FIRE HYDRANT
INO; INLET OUTLINE
INV; INVERT
IP; IRON PIPE
IR; IRON ROD
IRC; IRON ROD W/ CAP
IRL; IRON RAIL
IRO; IRON ROD W/OTH CAP
IRU; IRON ROD W/USACE CAP
IWL; INDUSTRIAL WASTE LINE
JB; JUNCTION BOX
JBC: JUNCTION BOX, CABLE
JBF; JUNCTION BOX, FIBER OPTIC
JT; JOINT
JTC; JOINT, CONTRACTION
JTE; JOINT, EXPANSION
JTN; JOINT, CONSTRUCTION
LAD; LADDER
LC; LOW CHORD
LD; LINE DROP
LDK; LOADING DOCK
LDR; LIDAR
LED; LEAK DETECTOR
LET; TOP OF LEVEE

LFD; LEACH FIELD
LFL; LEACH FIELD LINE
LGT; LIGHT
LOC; TREE, LOCUST
LP; LIQUIFIED PROPANE LINE
LPD; POLE, DECORATIVE LIGHT
LPL; POLE, LIGHT
LPT; LEAD PLUG AND TACK
LS; LIMESTONE
LSL; LANDSCAPE LIGHT
LSO; LANDSCAPE OUTLINE
LSP; LAWN SPRINKLER
LST; LIFT STATION
LW; LOW WIRE
MAG; MAG NAIL
MAP; PROPERTY CORNER, MAG NAIL
MB; TREE, MULBERRY
MBX; MAILBOX
MDV; MONITORING DEVICE
MEC; MISC ELEVATION CHECK
MER; MULTI-ELECTRODE RESITIVITY
MET; TOP OF GATES, METAL
MF; MUD FLAT
MGT; TREE, MAGNOLIA
MH; MANHOLE COVER
MHC; MANHOLE, CABLE
MHD; MANHOLE, DRAINAGE
MHE; MANHOLE, ELECTRICAL
MHF; MANHOLE, FIBER OPTICS
MHG; MANHOLE, GAS
MHI; MANHOLE, INDUSTRIAL WASTE
MHM MANHOLE, MECHANICAL (STEAM)
MHS; MANHOLE, SANITARY
MHT; MANHOLE, TELECOMM
MHV; MANHOLE, COMMUNICATIONS
MHW; MANHOLE, WATER
MHX; MANHOLE, MISC/UNDEFINED
MIM; MILE MARKER
MNC; MONUMENT, CONCRETE
MNN; MONUMENT, NGS OR USCGS
MNP; MINE PORTAL
MNS; MONUMENT, STONE
MNT; MONUMENT, TIDAL
MNU; MONUMENT, USACE
MON; MONUMENT
MOT; MOTOR
MP; MACHINERY PIT
MPL; TREE, MAPLE
MSH; MARSH
MSS; MISC SITE STRUCTURE
MTR; METER
MTX; METER BOX
MW; MONITORING WELL
MWG; GROUND AT MONITORING WELL
MWP; MONITORING WELL, PVC
MWT; TOP OF MONITORING WELL
MWW; METAL WALKWAY (CATWALK)
NG; GROUND, NATURAL
NGP; GROUND AT PILING
NL; NAIL
NS; NORTH SIDE
OCV; OVERHEAD CONVEYOR
OH; OVERHEAD POWER LINES
OHC; OVERHEAD CABLE LINE
OHF; OVERHEAD FIBER OPTIC LINE
OHT; OVERHEAD TELEPHONE LINE
OHU; OVERHEAD UTILITY LINES
OHV; OVERHEAD COMMS LINE
OHX; OVERHEAD MISC
OPN; RTN-GPS OPEN CHECK
OT; TREE, OAK
OVH; OVERHANG
OWS; OIL/WATER SEPARATOR
PAD; PAD
PAL; TREE, PALM
PAT; PATIO
PB; PHONE BOOTH
PC; TREE, PECAN
PCL; POLE, CABLE/LIGHT
PCR; PROPERTY CORNER
PE; PADEYE
PED; PEDESTAL
PIC; INVERT, CONCRETE PIPE
PIM; INVERT, CORR. METAL PIPE
PIN; INVERT, PIPE
PIP; INVERT, CORR. PLASTIC PIPE

PIR; PIER
PIS; INVERT, STEEL PIPE
PIZ; PIEZOMETER
PK; PK NAIL
PKM; PARKING METER
PL; PIPELINE CROSSING
PLC; POWER LINE CROSSING
PLG; PILING
PLL: PIPELINE TEST LEAD
PLM; PIPELINE MARKER
PLS; PIPELINE SUPPORT
PLT; PLATFORM
PM; PAINT MARK
PMC; PAINT MARK, CABLE
PME; PAINT MARK, ELECTRICAL
PMF; PAINT MARK, FIBER
PMG; PAINT MARK, GAS
PMP; PUMP
PMS; PAINT MARK, SANITARY
PMT; PAINT MARK, TELEPHONE
PMW; PAINT MARK, WATER
PNL; PANEL
POL; POLE
POP; TREE, POPLAR
POR; PORCH
POS; POST
POW; WOODEN POST
PP; PICTURE POINT
PPC; PIPE, CONCRETE
PPD; PIPE, CLAY
PPE; PIPE
PPL; POLE, POWER
PRB; PROBE
PRC; PERC TEST
PRK; PIPE RACK
PRV; PRESSURE REGULATING VALVE
PS; PROTECTED SIDE LEVEE
PSC; PROTECTED SIDE CROWN
PST; PROTECTED SIDE TOE
PT; TREE, PINE
PTT; TEST PIT
PUB; PULL BOX
PUS; PUMP STATION
PVC; PVC PIPE
PWC; POST WITH CABLE
PWD; POWER DROP
PWL; POWERLINE
PZG; GROUND AT PIEZOMETER
PXP; PIEZOMETER, PVC PIPE
PZT; TOP OF PIEZOMETER TUBE
RCK; ROCK
RCP; INVERT, REINFORCED CONC. PIPE
RD; ROAD
RDH; HIGH POINT OF ROAD
RDM; DAY MARKER, RED
REA; EDGE OF ASPHALT REVETMENT
REC; EDGE OF CONCRETE REVETMENT
RFB; ROOF BOLT
RIF; RIFFLE
RKO; ROCK OUTCROP
RLW; RELIEF WELL
RMP; RAMP
ROM RIGHT OF WAY MONUMENT
ROP; ROTATION POINT
ROW; RIGHT OF WAY
RP; RIP RAP
RPE; EDGE OF REFUSE PILE
RPT; REFERENCE POINT
RR; RAILROAD
RRC; RAILROAD CONTROL BOX
RRD; RAILROAD DWARF SIGNAL
RRF; RAILROAD FROG POINT
RRG; RAILROAD CROSSING GATE
RRP; RAILROAD POST
RRR; RAILROAD RAIL
RRS; RAILROAD SIGNAL
RRT; TOP OF RIPRAP
RRW; RAILROAD SWITCH
RSR; RISER
RUI; RUINS
RVA; REVETMENT, ASPHALT
RVC; REVETMENT, CONCRETE
RVT; REVETMENT
RWL; RUNWAY LIGHT
RWS; RUNWAY SHOULDER
RWY; RUNWAY

RXR; RAILROAD CROSSING
SAN; SAND
SAP; STANDPIPE
SAT; SATELLITE DISH
SB; SANDBAG
SBT; SANGBAG TOE
SCO; SEWER CLEAN OUT
SCT; SQUARE CUT / CHISELED SQUARE
SDB; SANDBAR
SDP; SEDIMENT PIN
SEA; SET AERIAL PANEL
SEH; SET HUB
SEM; SET MAG NAIL (CORNER)
SEO; SET OTHER PROPERTY MARKER
SER; SET IRON ROD W/CAP (CORNER)
SES; SET RR SPIKE (CORNER)
SG; SECTOR GATE
SGM; SIGN, MULTIPOST
SGN; SIGN
SGP; SIGNPOST
SHD; EDGE OF SHOULDER
SHE; SHED
SHL; SHELL
SIP; SOLID IRON PIN
SKH; SPRINKLER HEAD
SLB; SLOPE BLUFF
SLI; INVERT, SANITARY LINE
SLP; SLOPE SHOT, LEVEE
SMP; STEAM PIT
SND; SOUNDING
SOC; SLOPE ON CONCRETE
SP; SHEET PILING
SPE; STEAM PIPE
SPK; RAILROAD SPIKE (VERTICAL)
SPL; SOLAR PANEL
SPO; SPOIL
SPR; SPRING, SEEPAGE
SPT; TOE OF SHEET PILING
SPU; TREE, SPRUCE
SPV; SLOPE PAVING
SRB; SHRUB
SRC; SHRUB, CONIFEROUS
SRD; SHRUB, DECIDUOUS
SRL; SHRUB LINE
SRM; SETTLEMENT REFERENCE MARK
SRR; SLOPE ON RIP RAP
SS; SOUTH SIDE
STH; STUMP HOLE
STP; STEPS
STR; STRUCTURE
STU; STUMP
SVF; SERVICE, FIBER OPTIC
SVT; SERVICE, TELEPHONE
SWA; SIDEWALK, ASPHALT
SWC; SIDEWALK, CONCRETE
SWK; SIDEWALK
SWL; SWALE
SWP; SWAMP
SWR; SEWER LINE
TAB; TABLE
TAR; TARGET
TB; TOE OF OLD RR BED
TBK; TOP OF BANK
TBL; TOE OF BALLAST
TBM; TEMPORARY CONTROL
TBP; TOP OF BORROW PIT
TBR; TOE OF BERM
TBS; TOP OF BALLAST
TC; TOP OF CONCRETE
TCB; TOP OF CONCRETE BANK
TCD; TOP OF CONCRETE DITCH
TCL; POLE, TELEPHONE/CABLE/LIGHT
TCN; CENTER OF TOWER
TCP; POLE, TELEPHONE/CABLE
TCR; TOE OF CURB
TCS; TOP OF CONC. PAVEMENT (SLOPE)
TCW; TOP OF CONCRETE WALL
TDC; TOE OF DITCH, CONCRETE
TDR; TRENCH DRAIN
TEC; TOP EDGE OF CONCRETE WALL
TEP; PEDESTAL, TELEPHONE
TER; TERRAIN POINTS
THB; TOP OF HESCO BASKET
THL; THALWEG
THP; THREADED PLUG
THR; THRESHOLD

TIP; 3" POST
TKS; TANK, SEPTIC
TL; TRAIL
TLE; EDGE OF TRAIL
TLP; POLE, TELEPHONE/LIGHT
TLT; THRESHHOLD LIGHT
TMC; TICKET MACHINE
TNK; TANK
TOB; TOE OF BORROW PIT
TOC; TOE OF CONCRETE
TOD; TOE OF DITCH
TOE; TOE ON NATURAL GROUND
TOF; TOP OF FLOODWALL
TOJ: TOE OF JETTY
TOL; TOP OF LEVEE
TOP; TOP ON NATURAL GROUND
TOR; TOE OF ROCK
TOW; TOP OF WALL
TP; TOP OF OLD RR BED
TPB; TOP OF BERM
TPC; TOP OF CURB
TPD; TOP OF DITCH
TPL; POLE, TELEPHONE
TPO; T-POST
TPP; TOP OF PIPE
TPR; TOP OF ROCK
TPS; TOP OF STRUCTURE
TPT; TOP OF SETTLEMENT PLATE
TPW; TOP OF CONCRETE WING WALL
TR; TREE
TRA; TOE OF GUARD RAIL
TRB; TRAFFIC SIGNAL BOX
TRC; CORNER OF TRAILER
TRF; TRAFFIC SIGNAL
TRK; RR TRACK
TRL; TREELINE
TRN; TRANSFORMER
TRP; TRAFFIC SIGNAL PEDESTAL
TRS; TRAFFIC SIGNAL SUPPORT POST
TRT; TRAFFIC SIGNAL POST
TRV; TRAFFIC SIGNAL VAULT
TRW; TOE OF RETAINING WALL
TSB; TOP OF SANDBAG
TSP; TOP OF THE SHEET PILING
TSW; TEST WELL
TWL; TOE OF WALL
TWB; TOP OF WOODED BANK
TWC; CENTERLINE OF TAXIWAY
TWL; TAXIWAY LIGHT
TWR; TOWER
TWS; TAXIWAY SHOULDER
TWW; TOE OF WING WALL
TWY; TAXIWAY
UBX; UTILITY BOX
UDK; DISK, USACE
UGC; UNDERGROUND CABLE LINE
UGE; UNDERGROUND ELCTRICAL LINE
UGT; UNDERGROUND TELEPHONE LINE
UGV; UNDERGROUND COMMS LINE
UGX; UNDERGROUND MISC
UNT; UNDERGROUND TANK
UPD; USACE PEDESTAL
UPL; UTILITY POLE
UTL; UNDERGROUND UTILITIES
UTP; POLE, ELEC./PHONE/LIGHT/CABLE
VAL; VALVE
VNT; VENT
VRP; VERNAL POOL
VT; VAULT
VTG; VAULT, GAS
VTM; VAULT, MECHANICAL (STEAM)
VTS; VAULT, SANITARY
VTT; VAULT, TELPHONE
VTV; VAULT, TELECOMM
VTW; VAULT, WATER VALVE
VTX; VAULT, SEPTIC
WAL; WALL
WBK; WOODEN BULKHEAD
WBT; TOE OF WOODED BANK
WDP; WOODEN PILING
WDW; WOODEN WALKWAY
WE; WATER EDGE
WEL; WATER WELL
WF; WATER FAUCET
WFN; WATER FOUNTAIN
WGW; WOODEN GUIDEWALL FACE

WH; WELLHEAD
WL; WOODLINE
WLD; WELL, DRY
WLH; WELLHOUSE
WLK; WALKWAY
WLN; WATER LINE
WLS; TREE, WILLOW
WLT; TREE, WALNUT
WM; WATER MAIN - METER
WMA; WATER MAIN HOLE
WP; WITNESS POST
WPC; WITNESS POST, CABLE
WPE; WITNESS POST, ELECTRICAL
WPF; WITNESS POST, FIBER OPTIC
WPG; WITNESS POST, GAS
WPT; WITNESS POST, TELEPHONE
WPW; WITNESS POST, WATERLINE
WR; WEIR
WRW; WOODEN RETAINING WALL
WS; WATER SURFACE
WSB; BUSH, WISTERIA
WTB; WATER BASIN
WTL; WETLAND
WTW; WATER TOWER
WV; WATER VALVE
WW; WING WALL
XBR; BRIDGE CROSS BR
XCT; CROSSCUT / CHISELED X

Appendix 3
References

• EM1110-1-1000 Photogrammetric and LiDAR Mapping
http://www.publications.usace.army.mil/USACEPublications/EngineerManuals.aspx

• EM1110-1-1002 Survey Markers and Monumentation Manual
http://www.publications.usace.army.mil/USACEPublications/EngineerManuals.aspx

• EM1110-1-1003 NAVSTAR Global Positioning System Surveying
http://www.publications.usace.army.mil/USACEPublications/EngineerManuals.aspx

• EM1110-1-1005 Control and Topographic Surveying Manual
http://www.publications.usace.army.mil/USACEPublications/EngineerManuals.aspx

• EM1110-2-1003 Hydrographic Surveying Manual
http://www.publications.usace.army.mil/USACEPublications/EngineerManuals.aspx

• EM1110-2-1009 Structural Deformation Surveying
http://www.publications.usace.army.mil/USACEPublications/EngineerManuals.aspx

• EM1110-2-6056 Standards and Procedures for Referencing Project Elevation Grades to Nationwide Vertical Datums
http://www.publications.usace.army.mil/USACEPublications/EngineerManuals.aspx

• EM File Format Specification
https://www.mvn.usace.army.mil/portals/56/docs/engineering/geospatial/em_format15.pdf

• LMN830 File Format Specification
http://www.mvn.usace.army.mil/Portals/56/docs/engineering/SurveySection/LMN830_Revision11_06-Mar-2006.pdf

• A/E/C CAD Standards
https://cadbimcenter.erdc.dren.mil/

• Spatial Data Standards (SDSFIE) for GIS
https://www.sdsfieonline.org/

• US Army Corps of Engineers Safety and Health Requirements Manual," EM 385-1-1, dated 15 September 2008.
http://publications.usace.army.mil/publications/eng-manuals/EM_385-1-1_languages/EM_385-1-1_English_2008/toc.html

• NOAA Technical Memorandum NOS NGS-58" published in November 1987
(https://geodesy.noaa.gov/library/pdfs/NOAA_TM_NOS_NGS_0058.pdf)

• Guidelines for Establishing GPS-derived Orthometric Heights (Standards: 2 cm and 5 cm)
(https://geodesy.noaa.gov/library/pdfs/NOAA_TM_NOS_NGS_0059.pdf)

Appendix 4
Conventional Accuracy/Closure Requirements

Figure 1
USACE Closure Accuracy Standards
Ref: USACE EM 1110-1-1005

Table 4-1
Minimum Closure Accuracy Standards for Engineering and Construction Surveys

USACE Classification	Closure Standard	
Engr & Const Control	Distance (Ratio)	Angle (Secs)
First-Order	1:100,000	$2 \cdot \sqrt{N}$ [1]
Second Order, Class I	1:50,000	$3 \cdot \sqrt{N}$
Second Order, Class II	1:20,000	$5 \cdot \sqrt{N}$
Third Order, Class I	1:10,000	$10 \cdot \sqrt{N}$
Third Order, Class II	1: 5,000	$20 \cdot \sqrt{N}$
Engineering Construction (Fourth-Order)	1: 2,500	$60 \cdot \sqrt{N}$

[1] N = Number of angle stations

Figure 2
USACE Elevation Closure Accuracy Standards
Ref: USACE EM 1110-1-1005

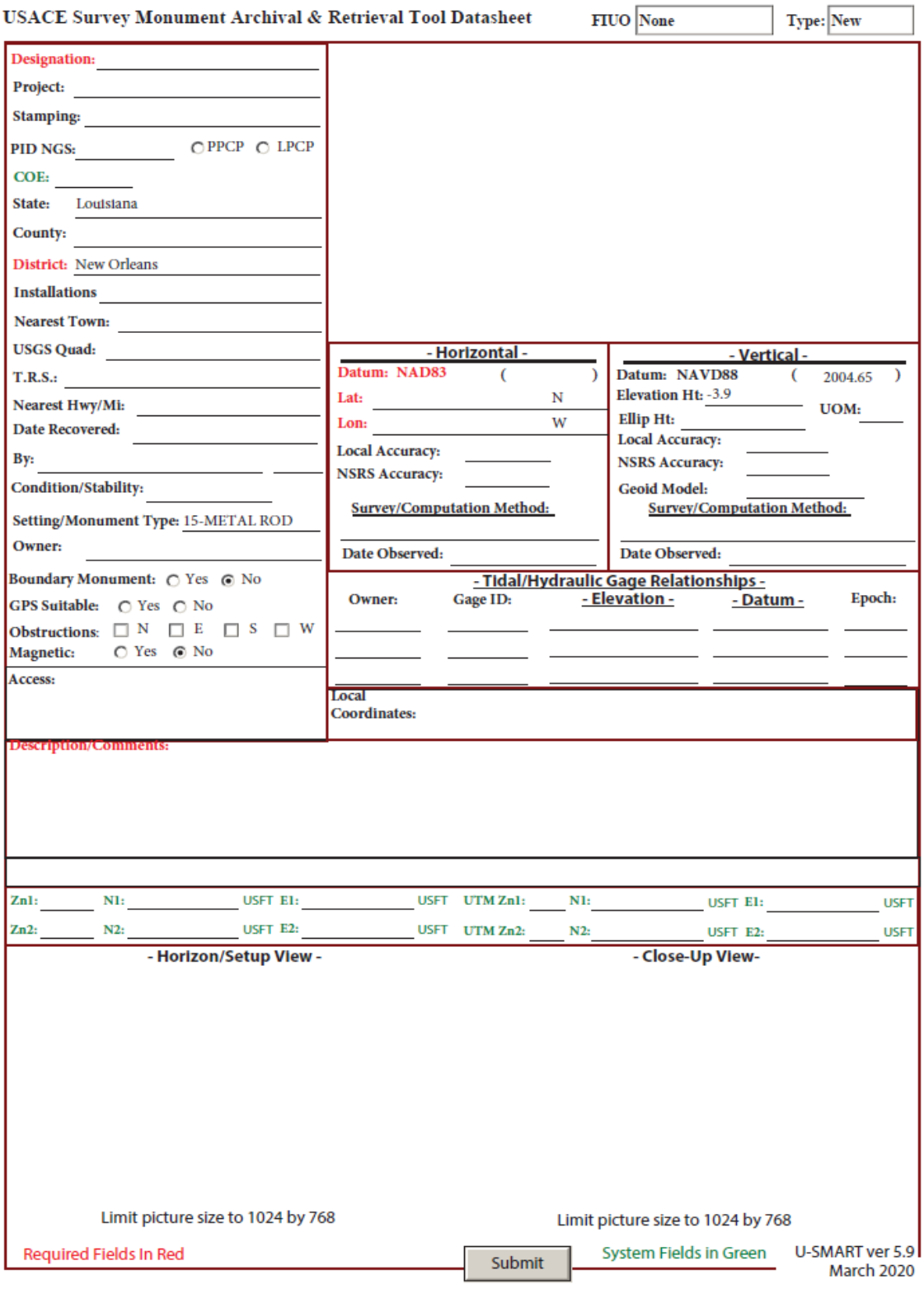
Table 4-2
Minimum Elevation Closure Accuracy Standards for Engineering and Construction Surveys

USACE Classification	Elevation Closure Standard (ft)[1]	(mm)
First-Order, Class I	$0.013 \cdot \sqrt{M}$	$3 \cdot \sqrt{K}$
First-Order, Class II	$0.017 \cdot \sqrt{M}$	$4 \cdot \sqrt{K}$
Second Order, Class I	$0.025 \cdot \sqrt{M}$	$6 \cdot \sqrt{K}$
Second Order, Class II	$0.035 \cdot \sqrt{M}$	$8 \cdot \sqrt{K}$
Third Order	$0.050 \cdot \sqrt{M}$	$12 \cdot \sqrt{K}$
Construction Layout	$0.100 \cdot \sqrt{M}$	$24 \cdot \sqrt{K}$

[1] $\sqrt{M}$ or $\sqrt{K}$ = square root of distance in Miles or Kilometers

Appendix 5

USACE Survey Monument Archival & Retrieval Tool



USACE Survey Monument Archival & Retrieval Tool Datasheet

FIUO: None Type: New

Designation:
Project:
Stamping:
PID NGS: ○ PPCP ○ LPCP
COE:
State: Louisiana
County:
District: New Orleans
Installations
Nearest Town:
USGS Quad:
T.R.S.:
Nearest Hwy/Mi:
Date Recovered:
By:
Condition/Stability:
Setting/Monument Type: 15-METAL ROD
Owner:
Boundary Monument: ○ Yes ◉ No
GPS Suitable: ○ Yes ○ No
Obstructions: ☐ N ☐ E ☐ S ☐ W
Magnetic: ○ Yes ◉ No
Access:

- Horizontal -
Datum: NAD83 ( )
Lat: N
Lon: W
Local Accuracy:
NSRS Accuracy:
Survey/Computation Method:
Date Observed:

- Vertical -
Datum: NAVD88 (2004.65)
Elevation Ht: -3.9
UOM:
Ellip Ht:
Local Accuracy:
NSRS Accuracy:
Geoid Model:
Survey/Computation Method:
Date Observed:

- Tidal/Hydraulic Gage Relationships -

Owner:	Gage ID:	- Elevation -	- Datum -	Epoch:

Local Coordinates:

Description/Comments:

Zn1: N1: USFT E1: USFT UTM Zn1: N1: USFT E1: USFT
Zn2: N2: USFT E2: USFT UTM Zn2: N2: USFT E2: USFT

- Horizon/Setup View -
Limit picture size to 1024 by 768

- Close-Up View-
Limit picture size to 1024 by 768

Required Fields In Red
Submit
System Fields in Green
U-SMART ver 5.9
March 2020

Appendix 6
Survey Report Outline

Title Page

- "Survey Report"
- Date
- COE Job Name
- COE Job Number
- Contractor Name
- Contractor Address
- Contractor POC Phone Number
- Contractor POC E-mail Address
- Supervising Professional Land Surveyor Stamp and Signature, attesting as follows: "I herby certify that the work described in this survey report was performed under my supervision and that the results described and/or referenced herein are complete and correct to the best of my knowledge and ability."

Table of Contents

Section 1: General Project Description

Brief and meaningful (one paragraph) overview of the project with vicinity map.

A. Project Overview

- What – Type of survey(s)
- Where – General Location
- When – Start and Stop Date
- Why – Purpose of Survey
- How – Methodology

B. Vicinity Map

- Insert vicinity map with aerial background
- Post and label key control points and area of interest outline
- Label other significant features
- North Arrow and Scale

Section 2: Project Background

All technical documentation, meeting minutes, communications, and any other descriptive detail regarding the Scope of Work, Field Reconnaissance, Scope of Work Meeting, Contract Proposal, Negotiations, and Notice to Proceed.

A. Request for Proposal/Scope of Work

- Insert SOW Document supplied by COE
- Reference: EDD-S_SOW: List SOW file name
- Reference: EDD-S_Survey_Control/Corps: List COE provided files (control data/diagrams, traverse/baselines, etc.) with short description of each file.

B. Field Reconnaissance/Joint Site Visit

- Overview of site conditions, access, etc
- Monuments recovered and their condition
- Other issues, concerns

C. SOW meeting, Contract Proposal, Negotiation Minutes, Notice to Proceed

- Insert minutes and/or summary of key points from relevant meetings
- Reference: EDD-S_Correspondence: List file name(s) containing SOW meeting minutes/correspondence, contract proposal document, negotiation minutes/correspondence, notice to proceed document, and all other clarifying documents/communication with short description of each file.

Section 3: Project Planning

All plans, schedules and other information and communications regarding project planning.

A. Survey Plan

- Insert Survey Plan approved by COE
- Reference: EDD-S_Correspondence: List file name(s) containing Survey Plan document/meeting minutes/correspondence, if any

B. Reference Systems and Survey Accuracy

Clearly restate required reference systems and accuracy requirements for survey

- Horizontal datum/epoch
- Vertical datum/epoch
- Grid System and units
- Note any unusual variances (e.g, use of a localized or "pseudo state-plane" system based upon legacy/historical coordinates of recovered monument or monuments)
- Horizontal accuracy of control points (NSRS and local or project)
- Vertical accuracy of control points (NSRS and local or project)
- Horizontal accuracy of all other plan detail
- Vertical accuracy of all other topographic/hydrographic detail

C. Proposed Field/Office QC measures

The purpose of this section is to ensure that the Contractor has given, in advance of actual survey data collection, serious thought and attention to the detection, characterization, and proper handling of all errors: random, systematic, and gross or spurious (i.e, human blunders, equipment malfunctions). In particular, procedures for the detection and mitigation of blunders (e.g., incorrect antenna reference height measurement, incorrect antenna type selected, incorrect backsight point, incorrect target height, failure to properly incorporate the appropriate geoid model in static GPS network processing, etc.) should be thoroughly reviewed with all field and data processing personnel.

- Brief narrative of general field and office QC/QA procedures
- Explain how accuracies will be confidently achieved
- Describe key field and office procedures susceptible to blunders
- Explain key blunder detection/elimination procedures

D. Key schedules/predictions (insert as required)

- Static GPS session schedules
- Anticipated PDOP/satellite visibility
- Tide predictions, etc.

E. Safety Plan

- Insert proposed safety plan

Section 4: Data Collection

Detailed narrative of all data collection activities, including but not limited to: Equipment used (make and model); tolerances, rejection thresholds and alarm settings (e.g., PDOP, rms, elevation cutoff), data collections method(s) and or techniques; control and check points used; closures; number of crews and crew personnel; survey dates; blunders detected in the field and their resolution; other problems and their resolution (provide details for each survey category below – enter N/A where appropriate):

A. Static GPS Control Surveys

Narrative overview of Static GPS survey, including:

- Annotated network diagram posted on aerial imagery

- Receiver/antenna make(s) and model(s)/ tripods (fixed-height)
- Given control points
- Points to be determined from network
- Horizontal/vertical datum/epoch
- Observation details: dates, times, elevation mask, epoch interval, etc.
- Unique problems, conditions, concerns and their resolution
- Reference: EDD-S_GPS: List observation logs, occupation photos, site visibility diagrams, raw data files

B. RTK Surveys

Narrative overview of RTK survey, including:

- Annotated control/check point diagram posted on aerial imagery
- Base receiver/antenna make and model/ tripod (fixed 2-meter)
- Base station static data logging interval and elevation mask
- Rover receiver(s)/antenna(s) make and model
- Rover tripod(s)/bipods/range poles
- Given control and check points
- Additional temporary control set via RTK
- Horizontal/vertical datum/epoch and Geoid model
- Observation details: dates and times; basic rover configuration (elevation mask, output coordinate system definition, geoid selected, etc.); tolerances/rejection thresholds (Minimum number of satellites, PDOP, rms, horizontal and vertical accuracy, fixed only)
- Check point closure summary
- Unique problems, conditions, concerns and their resolution (e.g., loss of lock, float solutions, etc.)
- Reference: EDD-S_GPS: List base station observation logs, occupation photos, site visibility diagrams, raw data files
- Reference: EDD-S_GPS: List rover data collector files that contain configuration summary, point coordinates/elevations and descriptors/codes, HI information, data quality indicators/flags
  Reference: EDD-S_Fieldbooks: List fieldbook(s) and page ranges for rover data points

C. RTN Surveys

Narrative overview of RTN survey, including:

- Annotated control/calibration/check point diagram posted on aerial imagery
- Rover receiver(s)/antenna(s) make and model/tripod(s)/bipods/range poles
- Given control/calibration and check points
- Additional temporary control set via RTN
- Horizontal/vertical datum/epoch and Geoid model
- Observation details: dates and times; basic rover configuration (elevation mask, output coordinate system definition, geoid selected, etc.); tolerances/rejection thresholds (Minimum number of satellites, PDOP, rms, horizontal and vertical accuracy, fixed only)
- Calibration summary
- Check point closure summary
- Unique problems, conditions, concerns and their resolution (e.g., loss of lock, float solutions, etc.)
- Reference: EDD-S_GPS: List rover data collector files that contain configuration summary, point coordinates/elevations and descriptors/codes, HI information, data quality indicators/flags
- Reference: EDD-S_FieldBooks: List fieldbook(s) and page ranges for rover data points

D. Hydrographic Surveys

Narrative overview of Hydrographic surveys, including:

- Method of Collection and Planned Lines/Transects

- Method of Positioning (Vertical and horizontal) and points of reference
- Sonar Calibration (bar checks and patch tests)
- Predicted tides / applicable gage locations and readings
- Sound Velocity Measurements
- Any issues during data collection activities

E. Conventional Traverse

Narrative overview of traverse, including:

- Point of Beginning
- Point of Ending
- Basis of Bearing
- Apparent Misclosure

F. Conventional Leveling

Narrative overview of leveling, including:

- Point of constraint for vertical measurements (PI Primary)
- Results of Peg Tests
- Apparent Misclosure of loops

G. Periodic Inspection Surveys

Narrative overview of PI survey, including:

- Point of constraint for vertical measurements (PI Primary)
- Control Loop Results
- SRM loop results
- Damaged or missing marks
- New marks set
- Any issues during data collection activities

H. Aerial Surveys

Narrative overview of aerial surveys, including:

- Flight Plan filed with ATPM
- List of personnel involved in sUAS activities
- Layout of Ground Control Points and Ground Control Stations
- Horizontal and Vertical basis of position
- Method of Positioning
- Residuals of Ground Checks
- Any issues during data collection activities

I. Terrestrial LiDAR Surveys

Narrative overview of LiDAR surveys, including:

- Site Layout of Control Points and Observation Stations (Stationary)
- Planned Lines and Ground Control Points (Mobile)
- Horizontal and Vertical basis of position
- Method of Positioning
- Residuals of Ground Checks
- Any issues during data collection activities

J. NCC Surveys

Narrative overview of NCC surveys, including:

- P&S Control Marks and Values
- Project Baseline Tabulation
- Results of Control Verification
- Starting and Ending Stations for Profiles
- Narrative of profile collection methodology
- Any issues during data collection activities

K. Benchmark Verification Surveys

Narrative overview of Benchmark Verification surveys, including:

- P&S Control Marks and Values
- Any additional temporary marks set
- Control Loop Results and apparent misclosures
- Subservient loops to Temporary Control in use, results and misclosures
- Any Marks Disturbed or Destroyed
- Any derivative Elevation Certificates
- Any issues during data collection activities

Section 5: Data Processing

Detailed narrative of all data processing activities, including but not limited to: Software used (and version); tolerances, rejection thresholds and alarm settings (e.g., PDOP, rms, elevation cutoff, data collections method(s) and or techniques; control and check points used; closures; number of crews and crew personnel; survey dates; blunders detected in the field and their resolution; other problems and their resolution (provide details for each survey category below – enter N/A where appropriate):

A. Static GPS Control Surveys
B. RTK Surveys
C. GulfNet VRS Surveys
D. Hydrographic Surveys
E. Conventional Traverse
F. Conventional Leveling
G. Periodic Inspection Surveys
H. Aerial Surveys
I. Terrestrial LiDAR Surveys
J. NCC Surveys
K. Benchmark Verification Surveys

Section 6: Project Summary and Conclusions

Results of Survey

Include Safety Report - Summary of safety incidents and concerns, daily safety reports, safety meetings, etc.

Section 7: Checklists

General

__ SOW reviewed
__ MVN provided data reviewed
__ Control identified, and data processed
__ Correct field books (reduce levels, correct elevation, datum, epoch, etc.)
__ Intermediate CSV file created with corrected PNEZD information
__ MVN data structure implemented (Appendix 7)
__ Create EM files (import corrected PNEZD data)
__ EM data in correct order for LMN830 coding (Cross Sections before Profiles, Misc. Points last)
__ EM File name no more than 8 characters (LMN830 requirment)
__ All #H records included and populated in EM files
__ Field books and pages recorded in EM files as applicable
__ Date recorded in EM files as applicable
__ Equipment records included in EM files
__ LMN 830 run on EM files as necessary
__ .rep, .err, .rpt files created and filed
__ Codes.dat file created (if required)

Horizontal Control

__ Datum correct as recorded in EM files

__ Traverse files included as necessary (T-files and J-files)
__ Primary conventional traverse adjusted (1:5000, 5”/setup) Closure:
__ Secondary conventional traverse adjusted (1:2500, 10”/setup) Closure:
__ Horizontal control included in EM files
__ Traverse stationed

Vertical Control
__ Datum correct as recorded in EM files
__ Epoch correct as recorded in EM files (average ITRF date if OPUS used)
__ Geoid correct as recorded in EM Files
__ Permanent benchmarks or PBMs included in EM files (#V Records)
__ Temporary benchmarks or TBMs included in EM files (#T Records)
__ Control specified by Corps was used.
__ U-SMART forms for all control points
__ Do levels meet accuracy requirements
__ OPUS solution averaged and shown in field book and digital files
__ Benchmarks published to NSRS (OPUS Shared) as required

Staff Gauge
__ Gauge readings included in EM files before each range
__ Spot check of water surface interpolation performed
__ Gauges read before and after survey

Cross Sections
__ Spikes checked / errant data removed
__ Sections are linear (no zig-zags or overlaps)
__ Sections normal to B/L or C/L as specified
__ All sections included
__ Section lengths checked
__ Gaps checked
__ .830 files created
__ .830 Heading format correct
__ .830 Stations and Offsets Correct
__ Cross sections viewed in XVIEW.exe

Profiles
__ Spikes checked / errant data removed
__ Profiles are linear (no zig-zags or overlaps)
__ All transitions / grade changes captured
__ Profile Extents validated
__ Profile direction correct (Ascending Baseline)
__ .pro files created
__ .pro Heading format correct
__ .pro File Elevation column position correct

Miscellaneous Points
__ Descriptions, locations, etc., included in EM files (#M Records)
__ All feature located and included in EM FILES.
__ All points coded using the New Orleans CODES.dat file
__ .so files Created

GPS Control
__ Survey checked in primary processing software
__ Raw files submitted
__ Log files submitted

__ Processed files submitted (EM format)
__ Adjustment reports submitted (minimally and fully constrained)
__ OPUS solutions submitted
__ Observation Logs Submitted

Final Check
__ All field books scanned and legible
__ Field books / Hardcopies / Survey Report stamped and signed by PLS
__ Submitted in EM and 830 formats
__ All Raw Data and Data Collector XML files submitted
__ EM files reviewed in ArcGIS
__ LMN files reviewed in PUT.ma
__ DGN created with PUT.ma
__ Metadata files created
__ Job#, job name, date, contract#, and task# included on any physical media
__ Transmittal letter to include each file and/or hard item submitted

Date Submitted
FTP Date:
CD Date:
Hardcopy Date:
Y = Acceptable
N = Unacceptable
NA = Not Applicable

Appendix 7

File Index/Submittal Folder Structure

- YY-JJJC – Job Title Here
  - EDD-S_Aerial_Imagery
    - YYJJJC.tif (Orthmosaic Files for Aerial Surveys and required support files)
  - EDD-S_CADD_GIS
    - YYJJJC.dgn (Microstation DGN)
    - YYJJJC.dtm (Openroads DTM)
    - YYJJJC.dem, .tin, etc (Any GIS/CADD surface files and required support files)
    - YYJJJC.shp (any request ESRI shapefiles and required support files)
  - EDD-S_Correspondence
    - Email and Hardcopy Correspondence
  - EDD-S_EM_Format
    - YYJJJC.bl (EM format baseline file)
    - YYJJJC.em (EM Format data file)
    - YYJJJCA.em (Additional files sequenced by single character)
    - codes.dat (any non-standard codes used during survey)
  - EDD-S_Fieldbooks
    - YYNNNN-pgsXX-XX.pdf (field notes by book #, Stamped and Signed by PLS)
  - EDD-S_GPS
    - YYJJJC_fully_constrained.pdf
    - YYJJJC_minimally_constrained.pdf
    - *.dat / *.t0x (GPS Raw Files)
    - *.XXo (RINEX Observation Files)
    - *obs.pdf (associated observation logs)
    - *opus.pdf (OPUS reports for each observation)
  - EDD-S_Hydrographic
    - YYJJJC.xxx (Multibeam Grid Files in requested format, i.e. .jpeg, .tif, .xyz, .las)
    - Hypack Project Files
  - EDD-S_KML
    - YYJJJC.kmz (surveychecker.exe output from each .em file)
  - EDD-S_LiDAR_SFM
    - YYJJJC.las (Point Clouds in LAS Format)
    - YYJJJC.xyz (Point Clouds in XYZ Format)
    - Any associated processing files or reports.
  - EDD-S_LMN830
    - YYJJJC.830 (LMN output of each .em file submitted)
  - EDD-S_Miscellaneous
    - Any requested data not otherwise specified
  - EDD-S_Photos
    - YYJJJCx.jpg (Any Requested Photos, may be sorted into sub-folders)
  - EDD-S_Profile
    - YYJJJC.pro (LMN output of each file submitted)
  - EDD-S_Raw Data
    - All raw data exported from data collectors in ASCII and XML (i.e..jxl) formats
  - EDD-S_SOW
    - YYJJJC_SOW.pdf (Scope of Work)
  - EDD-S_Survey_Control
    - *.pdf (Benchmark U-SMART form for each #V record used)
    - *.83 (Any Traverse record referenced
  - EDD-S_Survey_Report
    - YYJJJC_SR.pdf (Final Report for Survey, Stamped and signed by PLS)
  - EDD-S_Technical_Review
    - .err, .rep, .rpt, .so, and any other misc files generated by survey programs.
    - Any files supporting your QAQC Process

Appendix 8

GNSS Log Sheet

GPS STATION OBSERVATION LOG
April 16, 2003

Station Designation: (check applicable: __ FBN __ CBN __ PAC __ SAC __ BM)

Station PID, if any:

Date (UTC):

General Location:

Airport ID, if any:

Station 4-Character ID:

Day of Year:

Project Name:

Project Number:
GPS-

Station Serial # (SSN):

Session ID:(A,B,C etc)

NAD83 Latitude
o ' "

NAD83 Longitude
o ' "

NAD83 Ellipsoidal Height
meters

NAVD88 Orthometric Ht.
meters

GEOID99 Geoid Height
meters

Agency Full Name:

Operator Full Name:

Phone #: ( )

e-mail address:

Observation Session Times (UTC):
Sched. Start _____ Stop _____

Actual Start _____ Stop _____

Epoch Interval=____ Seconds

Elevation Mask = _____ Degrees

Receiver Brand & Model:

P/N:
S/N:
Firmware Version:

❒ CamCorder Battery, ❒ 12V DC, ❒ 110V AC, ❒ Other

Antenna Code*, Brand & Model:

P/N:
S/N:
Cable Length, meters:

Vehicle is Parked _____ meters ____(direction) from antenna.

Antenna plumb before session?	(Y / N)	Circle Yes or No -If no, explain "
Antenna plumb after session?	(Y / N)	
Antenna oriented to true North?	(Y / N)	
Weather observed at antenna ht.	(Y / N)	
Antenna ground plane used?	(Y / N)	
Antenna radome used?	(Y / N)	If yes, describe. Use Vis. form
Eccentric occupation (>0.5 mm)?	(Y / N)	
Any obstructions above 10°?	(Y / N)	
Radio interference source nearby	(Y / N)	

Tripod or Antenna Mount: Check one:
❒ Fixed-Leg Tripod, ❒ Collapsible-leg tripod ❒ Fixed Mount
Brand & Model:
P/N:
S/N:
Last Adjustment date:

Psychrometer (if used) Brand & Model:

P/N:
S/N:
Last Calibration or check Date:

**** ANTENNA HEIGHT ****

	Before Session Begins: Meters	Before Session Begins: Feet	After Session Ends: Meters	After Session Ends: Feet
A= Datum point to Top of Tripod (Tripod Height)				
B=Additional offset to ARP if any (Tribrach/Spacer)				
H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP)				

Meters = Feet x (0.3048)
Height Entered Into Receiver = _____ meters.

Note &/or sketch **ANY** unusual conditions.
Be Very Explicit as to where and how Measured!

Barometer (if used) Brand & Model:

S/N:

Weather Data	Weather Codes	Time (UTC)	Dry-Bulb Temp Fahrenheit	Dry-Bulb Temp Celsius	WetBulb Temp Fahrenheit	WetBulb Temp Celsius	Rel. % Humidity	Atm. Pressure inches Hg	Atm. Pressure millibar
Before									
Middle									
After									

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Calculate

Weather codes are required. Weather data are optional but encouraged. *Antenna code comes from ant_info file furnished by project coordinator.

Data File Name(s):

(Standard NGS Format = aaaaddds.xxx)
where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension

Updated Station Description:	❒ Attached	❒ Submitted earlier
Visibility Obstruction Form:	❒ Attached	❒ Submitted earlier
Photographs of Station:	❒ Attached	❒ Submitted earlier
Pencil Rubbing of Mark:	❒ Attached	

LOG CHECKED BY:

Table of Weather Codes

CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
0	did not occur	Good, over 15 miles	Normal, 32° F- 80° F	Clear, below 20%	Calm, under 5mph (8km/h)
1	did occur	Fair, 7-15 miles	Hot, over 80°F (27 C)	Cloudy, 20% to 70%	Moderate, 5 to 15 mph
2	- not used -	Poor, under 7 miles	Cold, below 32° F (0 C)	Overcast, over 70%	Strong, over15 mph (24km/h)

Examples: 00000 = No problem, good visibility, normal temp, clear, calm wind 12121 = Problems, poor visibility, hot, overcast, moderate wind

Revision History:

Revision 2.1, 9-September-2009

- Removed references to EM1110-1-1004. This manual has been incorporated into EM1110-1-1005.

Revision 3, August-2013

- Updated links throughout document
- Updated references to epochs for vertical and horizontal datums
- Updated geoid references

Revision 4, August 2014

- Licensing requirements
- Addressed NGS Beta Geoid Models
- Updated requirements for level loops
- Updated requirements for C4G RTN
- Updated requirements for Hydrographic Surveys.
- Updated Appendix 6
- Updated Appendix 7.

Revision 4.1, February 2015

- Updated horizontal and vertical epoch references
- Updated links throughout document

Revision 4.2, April 2015

- Updated geoid model reference from GEOID12A to GEOID12B and added footnote regarding the change.

Revision 5, May 2022

- Updated geoid model reference from GEOID12B to GEOID 18.
- Revised standards for new generation survey equipment and evolving best practices
- Changes to delivery requirements.
- Repaired Broken Hyperlinks
- Updates to Benchmark Requirements
- Updates to GPS and Integrated Surveying Methods
- New Sub-Section for Multi-beam Hydrographic Surveying
- New Sections for Aerial, Terrestrial LiDAR, Periodic Inspections, NCC, and Benchmark Verification Surveys.
- Revisions to Static GNSS Surveys
- Revisions to Deliverables
- Revisions to Appendices and Submittal File Structure
- Addition of GPS Observations Logs and USMART Forms to Appendices
- Updates to Survey Report Outline and Checklist