Quality Assurance in Surveying & Mapping, Part 2

>> By Fred Henstridge, LS

Essential to client service and long-term professional and business success is your commitment to producing quality work that is in accordance with industry and client mandated standards, on schedule, and within budget. It is also, in my opinion, a means to raise our surveying profession to the professional and business status we constantly strive to achieve.

In a recent edition of *CNN Money* there was a report on the value of a proper boundary survey to a homeowner or buyer provided by a qualified licensed land surveyor. I was appalled at the CNN reporter's comments and mention of the price to pay. The report stated that a proper boundary survey made under the direction of a qualified licensed land surveyor should be priced at from $500 to $1,500. First of all the reporter should not have stated any price, since boundary surveys – depending on locale, conditions, research and field work required – cannot be priced across the board. This gives the public a false sense of expectations of what the professional surveyor does. In today's economic environment the cost to equip a field survey crew can run as high as $80,000. This is the case if you consider the cost of the vehicle, total station, digital level, GPS receivers and miscellaneous survey equipment. When you consider your capital, labor and overhead costs it would take an awful lot of $500 boundary surveys to stay in business. This is why we must continue to improve our technical skills, quality and client service.

As mentioned in my previous article [May 2006], I have formulated a five-point plan for Quality Assurance (QA) and client service for surveying and mapping professionals. My approach to QA is based on the management of the *processes* rather than accepting or rejecting results at the end of the project. This assures a total quality approach thus saving time and money and meeting the expectations of the client. In order to assure the accuracy and completeness of project deliverables and documents, specific quality assurance review and checking procedures should be established. These review and checking procedures may require modifications for specific projects and will require periodic updating, primarily by the project or survey manager.

QC When making a GPS control survey, make sure to record everything about the station in the field, including weather conditions.

5 Steps to Quality Assurance

In accordance with Deming's 14 points [see previous article] I believe there are five basic steps to insure quality and outstanding client service in surveying

QA Take pencil rubbings of the station mark, copy to a PDF file, and store with the project data.

and mapping. These steps may be defined as:

- Project Delivery Planning
- Adherence to Established Standards
- Clear Assignments of Tasks and Responsibilities
- Tracking and Documentation
- The Use of Qualified Staff

QC Verify the station and monitor the data collection during the survey.

Project Delivery Planning

Quality assurance begins with Project Delivery Planning. Technical standards and specifications, defining of deliverable items, and milestone schedules will be identified at the project planning stage. A written quality assurance plan is an element of all work plans. These plans vary widely by service and tasks being performed. The following guidelines can be used as a general checklist for the main elements of any project work plan.

Unless a specific plan is required by the contract, at a minimum the following should be considered as appropriate quality assurance measures:

- Detailed statement of work and scope of required services
- Schedules, budgets and milestone points
- Precise definition of required deliverables, contract standards, client imposed standards, and/or industry standards to be used
- The use of advanced technology
- Tasks and responsibilities
- Adherence to established industry and professional standards
- Forms and reporting documents that will be required
- Compliance with client-mandated standards and deliverable requirements
- Statements of safety procedures for fieldwork

The Project Delivery Plan should include time and budget allowances for reviews and checking – Quality Control, or QC – that are a part of the QA program. A few examples of your QC plan might include the following:

- Survey or mapping criteria
- Definition of standards and/or agency or client manuals to be used
- Survey or mapping criteria review and checking forms
- Drafting and CAD standards to be used
- Computer calculation review forms
- Field survey forms required for the project
- Internal review forms and checklists

Adherence to Standards

Three types of established standards should be considered for each project: industry or discipline standards, client-imposed standards, and your firm's standards. Industry standards may be considered the minimum level of standards for a given project. These are the common standards used throughout the industry or discipline and are generally based on liability and protection of the public. Client standards are those unique standards

QC When taking digital photos of a monument, make sure to capture a vicinity view, a medium close view showing the area immediately adjacent to the monument, and a close-up view of the monument showing any markings or tags.

QC Medium close view

QC Macro view

required by the client for the project. They may include CADD standards, drafting styles, and the level of confidence (sigma) required for the data. Your firm's standards are those developed by you for your local conditions or in-house operations. These standards focus on client service, communication, reporting, documentation, and the use of advanced technology, such as GPS, LIDAR, Ground Penetrating Radar and safety. When preparing a work plan you will need to consider all three types of standards and communicate these evaluations and decisions to the client prior to approval of the plan or acceptance of the assignment.

Tasks and Responsibilities

During the project planning and start-up phase, you will need to work with the technical managers and office staff to select the checking program and review forms applicable to a particular project. They may add additional review forms and checking program items that are unique for that project.

On a specific project, the project manager takes responsibility for the implementation of a QA Program for the entire project. This includes making sure that the project team has a clear understanding of the latest scope of work and contract conditions, and has the available staff and resources to perform quality work. The survey managers or project surveyors take responsibility for the detailed standards, checking, and reviews required.

Resource Management

A major part of the assignment of tasks and responsibilities will be the management of the various team members and subcontractors involved with this project. Management of these elements and insuring their compliance with the work plan, standards, schedule, budget and high quality results will be the major task of the project manager. To insure quality and adherence to the project standards the project manager should schedule site visits within the scope of the project and should:

1. Provide a complete project briefing prior to commencement of any work. The briefing should include all staff and subcontractors assigned tasks on the project.
2. Provide all team members or subcontractors with a written work plan including a description of tasks, schedule, budget and specifications for the work involved.
3. Have the subcontractors transmit weekly situation reports to the project manager via e-mail
4. Manage all milestone events on an individual basis, *i.e.,* the team members or subcontractors should not begin a new set of tasks until the milestone for the previous set of tasks has been met and accepted for quality and adherence to the stated project standards.

Tracking and Documentation

Cost control is synonymous with qualified staff, technical excellence, quality assurance and good project management. For any assignment you should consider the use of the following:

- Qualified, licensed professional surveyors who are in responsible charge of the work, and technical experts whose qualifications are specific to the task. All work should be carried out under the direct supervision of a locally licensed land surveyor.
- State-of-the-art survey equipment, survey software, desktop and notebook computers, communications equipment, and the Internet access for transmittal of data and reports.
- Quality control provided at all phases of the work.
- Hands on survey, mapping, imagining, GIS, modeling and photographic supervision and project management.
- Time and cost reporting accounting systems. These costs should be traced on a weekly basis; on smaller projects you may want to track labor costs on a daily basis. You should have a standard time reporting method for all employees.

- Coordination and communications are equally critical to quality and cost control.
- Communications within the team should be conducted on a daily basis in person or via telephone, fax, and/or e-mail. Data files should be transmitted on a daily basis to the project manager to be reviewed and archived. Client communications should be focused through the project manager. Clients should be furnished with weekly status reports and information of any unique situations requiring client input. Today most of this reporting can be transmitted via e-mail.

Qualified Staff

Training is a critical element of a QA program. Trained professional, technical and administrative staff provide a basis for all of your technical excellence, development, innovation and client service. At a minimum you should consider providing or participating in technical or management training on at least an annual basis. This training should include, but not be limited to:

- Basic project management
- Advanced project management
- Technical training classes
- GPS
- Remote sensing and imagining
- Geodesy
- Uses of new field to office software
- Client services and communications
- CADDs and computer modeling training
- Basic office tools

Typical Checklist

For any survey task you should develop a QC checklist as a part of your QA program. The following is a *sample* checklist for a typical GPS control survey. These QC measures may include, but not be limited to:

- Preparation of a Project QC Plan prior to the commencement of any work.
- Project personnel will be fully trained in all aspects of the GPS project.
- All survey work is to be carried out under the supervision of a local licensed land surveyor trained and qualified in geodesy and in the use of the firm's GPS equipment and software.
- Plot all existing geodetic stations and proposed locations considered for the project as an overlay on a topographic map for use in reconnaissance and GPS mission planning.
- All receivers will be dual frequency, full-wavelength and have sufficient free memory to record project data. The necessary tracking data will be entered (*i.e.,* tracking rate, minimum number of satellites, elevation mask, HI and 4-character ID).
- All antennas will be of geodetic quality, have a suitable ground plane and have an antenna calibration approved by the National Geodetic Survey. Antennas will be oriented to north for all station occupations.
- Data will not be deleted from the receiver until it has been verified in the field and office/headquarters.
- Vectors shall be processed using a 15-degree elevation mask.
- Where applicable, data from selected CORS stations will be incorporated into the project. Contact will be made with CORS operators to ensure that the selected stations will be operational during the planned project observations.
- A series of adjustments (both horizontal and vertical and both free and constrained) of all project data will be accomplished to ensure that all project data meet project accuracies.
- Repeat project station occupations (if required) will be observed on different days with a minimum of three hours between the two times of day.
- Fixed-height tripods will be used for all station occupations. All poles will be checked for plumb prior to the beginning of the project and after any event that might impact the accuracy of plumb.
- Sample observation logs will be provided to ensure that all necessary information is obtained during tracking.
- Field observers will be instructed to enter any unusual occurrences in the remarks section of the observation log.
- Observers will be instructed to verify station descriptions and to provide a station mark rubbing at every station occupation.
- Adherence to the Milestones as indicated on the project Schedule and Task Order Statement of Work.
- Internal team meetings on a minimal weekly basis to monitor progress.
- Daily QA reviews and progress meetings by the project manager.
- Pencil rubbings will be taken at all stations occupied along with ample digital photographs including area views, station close-ups and witness posts. All digital photographs will be checked for quality (color, brightness and contrast) prior to inclusion with the project files. Photos not meeting the quality standards will be retaken.
- Daily back up of all digital data on a secure server site.

Again, the above is a sample checklist for a GPS control survey and should be considered as a *minimal* list. You should develop standard QC checklist for all of your survey and mapping task, such a boundary surveys, ALTA surveys, topographic surveys, etc. Once these checklists have been developed, they should be incorporated into your work plan and adhered to as part of your QA program. This will provide the basis for the consistency of purpose for improving your services and for remaining competitive while providing superior customer service as stated by Deming.

In subsequent columns I will expand on each of these five basic steps and provide some examples of real world situations.

Fred Henstridge has more than 50 years of professional experience in geomatics engineering, surveying, mapping, transportation engineering, municipal engineering, and GIS management. After 10 years with Caltrans, he started his own geomatics and civil engineering firm, which was acquired by Psomas and Associates in 1982. Since that time, he has been a Principal of Psomas, and Corporate Director of Geospatial Services and GIS. He is currently Director of Psomas' Federal Programs Development.