

Construction Guidelines

| Version | Date | Comments |
|---------|--------------------------------|---|
| 1.0 | August 24 th , 2021 | First draft from the Professional Standards Committee |

Communications

1. Clear statement of work agreed to (signed acknowledgement of client)
 - This may be in the form of a contract (preferred), written signed statement or authoritative email
 - It should contain any relevant dates and technical specifications if appropriate
 - Version numbers and dates of any files or documents should be included
 - It should detail the process for change requests.
2. Limitations in work clearly communicated
 - Limitations can relate to timing (e.g., time required to check work before it can be relied upon)
 - Limitations can relate to the scope of work and should identify any items that are outside of the scope of work or that are subject to additional fees
 - Accuracy limitations should be made very clear using confidence intervals
 - Describe control reference(s) being used. (Many recent claims due to surveyor not clearly confirming they are using same reference points as others on site.)
 - Note that layout points should not be used for other purposes or phases of work.
3. When clients can rely on work (e.g., after checking/notification)
 - As noted above, the statement of work should provide sufficient time for checking (this can be difficult or impossible to enforce as many times construction activities happen within minutes of setting points but in these cases quality controls need to be thought out in advance)
4. Change Orders or clarification in writing Clear version control of documents
 - Any change orders should be in writing with approval of a client representative with sufficient authority to do so
 - If the individual refuses to sign the change order, the surveyor responsible for the work should communicate it in writing (this might include email) to the client as soon as possible and the work should not proceed without appropriate change orders.
 - All documentation pertaining to changes should be properly circulated to all project staff, filed and retained.

Office Work

5. Calculations performed using most current version of documents (as in contract or change orders)
 - Since version control is often a source of error anyone performing calculations should refer to the contract/statement of work and check for any change orders
 - Calculations should include a reference to the versions of document(s) used to perform the calculations
 - Have a process for removing all previous version's calcs from active upload directories and a process to confirm field staff remove old layout files daily from their field computers.

- Where there is any ambiguity, it should be resolved with the clients and documented accordingly; assumptions should not be made, and clarification should be sought from the client or the client's design consultants.
6. Calculations check by independent person Datums/Reference Systems verified with contract
 - The check should be complete and not rely on existing work or assumptions
 - A check against change orders and versions of documents should be performed
 - Datums, reference systems and scale factors should be checked (in calculations and equipment)
 - Connections to existing structures should be checked.
 - Confirmation from client as to which layer or drawing tab should be used for layout.
 - Checks should be signed off when complete
 7. Any assumptions made are verified in writing with the client (as noted above)
 8. Benchmarks and Horizontal Control, with values gathered
 - Care should be taken to ensure that the values are in the appropriate reference system (including epoch for CSRS values or adjustment date for other systems)
 - If assumed values are used and the surveyor has a choice, they should be completely different from existing published systems to avoid potential confusion
 - Source of values should be documented
 - If work of others on site is integrated, then checks should be made to ensure reference frame agreement before any calcs or layout commences.
 9. Scale factor to be used identified and communicated to the crew
 - It is critical that the crew is aware of any scale factors that need to be used in their equipment
 10. Any layouts performed checked within a day or time committed
 - Notes of layouts should be returned to the office and checked to ensure they met the specifications of the client and that appropriate points were set.
 - Checks should be completed in a timeframe consistent with those noted in the communications section above.
 - Calculations should always be checked against any site plans that exist.

Field Work

11. Calculations and directions received from the office in writing
 - Field crews should have clear written instructions which should include any out of the normal considerations and any project specific requirements
 - Field crews should not modify their proposed work based on client site representative requests. All requests should be sent to PM and documented / QC'd as above.
12. If performing grid line layout, starting points clear or approved by client
 - Starting points for grid layouts must be unambiguous and visible; if that is not the case they should be approved by the client in writing or made visible and unambiguous.
13. For horizontal work, independent control has been checked to ensure proper reference system is being used and equipment settings are correct

- At the very minimum three control points should be used and observations between them need to conform to published values; if there are any differences outside the accuracy tolerances for the project further control should be sought out
 - Control points should be ideally outside the area of influence of the project being performed.
 - Where layout work is being completed and existing features with known coordinates exist on the site, at least two other points on the existing features, which are also shown in the design drawings, should be checked to ensure there are no differences in the reference system being used
14. For horizontal work, backsights are always checked before picking up a total station, etc.
- Backsights should also be checked and recorded prior to commencing layout, at a predetermined interval during the setup and immediately before picking up the instrument; where they are not within an acceptable tolerance for the project work completed should be checked
15. For vertical work, two benchmarks are checked in for all work if possible and redundancy exists for all key points
- There should always be an acceptable closure between two independent benchmarks
 - Key points should be observed from two independent set-ups to ensure accuracy
 - Ensure that the benchmarks chosen for layout relate to the site design of the subject lands (i.e. use the same benchmarks and values or tie into them to ensure consistency).
 - If there are existing structures on site, ties should be taken to at least one existing feature to ensure the datum is correct (e.g. top of opening on a pipe). Furthermore, check into a critical feature such as existing finished floor for a building addition. As-built elevations may vary from design drawings.
16. For both horizontal and vertical work, the elevation/location of feature(s) on the site has been checked against client documents to ensure a consistent datum and reference system are being used Redundancy exists for observations to major points and points in close proximity (e.g. check with a steel tape)
- It is critical to have redundancy in observations to ensure no blunders or errors have been made
 - Checks should be independently performed and recorded (e.g. different set-up, or even different technology (measure directly between points)
17. Clear notes kept for all layout so that in the event of problems down the road, your work can be proven
- Clear notes that are kept demonstrate the checks that were performed and can be proof of the location of all points laid out should any allegations of problems with work arise.
18. Any change orders taken in the field are in writing and signed by the requestor and communicated to the office – and approved by office PM prior to any additional work.
- As noted above all change orders need to be properly documented in writing and communicated throughout the office.
19. Although not part of the checklist, it is important to use the appropriate calibrated equipment
- The surveyor should choose the appropriate equipment for a project based on the accuracy specifications for the project

- The equipment, including any range poles, optical or laser plumbs need to be checked for any signs of damage and regularly calibrated/checked.
- Staff need to understand limitations in using the equipment (e.g. inappropriate use of short backsights)

Information Management

Many errors in construction result from the using the wrong information. It is critical that companies have a common and known location for storing related project documents. This should allow any member of the company working on the project to access the current documents. Some firms have move files into cloud storage making it easier for field crews and office staff to share common information and avoid versioning issues.

Other consideration: try to have same team, especially same field crew attend the project throughout.