

## 13. QUALITY CONTROL

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This chapter covers the procedures relating to quality control and which will be undertaken by the Client on the different type of surveys as dealt with in this document.

Further, this chapter also covers the quality control work which must be undertaken by the Surveyor prior to the submission of a completed survey.

The following specifications will enable the systematic evaluation of survey work for acceptance or rejection:

### 13.1. Topographical surveys and Permanent Survey Control

All quality control work shall be undertaken by a Registered Surveyor.

All survey work undertaken under the above heading must be thoroughly checked and must be certified as having complied with quality standards as more clearly set out below.

**Note: The Client will utilise similar quality control standards as those defined in Annexure 24. This may however vary according to project specific requirements.**

#### 13.1.1 Quality control office check by the Client

- a) Check and certify the completeness of the data submitted where the following is relevant:
  - i) That the survey project file is collated in terms of the project specifications;
  - ii) That the information and data contained in the survey project file conforms to the project specifications;
  - iii) That all work specified in the project specifications have been fully submitted;
  - iv) That the digital data is submitted, documented and labelled and is compliant with the terms of the project specifications; and
  - v) That the formats of all data submitted (digital and hard copy) fully complies with the project specifications.
  
- b) Check and certify the completeness of the survey work submitted where the following is relevant:
  - i) That all work as specified in the project requirements has been undertaken;
  - ii) That the required area has been covered by the survey;

- iii) That the Survey System and the datum used conform to both the general standards and also to the special requirements as per the contact document or specifications; and
  - iv) That all required schedules conform to the prescribed requirements.
- c) Check and certify the survey procedures where the functions as listed below conform to the project requirements, specifications and standard survey practices:
- i) Horizontal fixing;
  - ii) Vertical fixing;
  - iii) Survey control verification;
  - iv) Tying in and calibration onto and with respect to existing control;
  - v) DTM and detail observations;
  - vi) Point numbering;
  - vii) Structural survey;
  - viii) Photogrammetric Photo Ground Control configuration;
  - ix) Photogrammetric Mapping and Orthophotos;
  - x) Methodology used for aerial triangulation and calculations;
  - xi) Long- and Cross sections; and
  - xii) Other work undertaken.
- d) Check and certify the calculations and survey reduction procedures where the items listed below conform to standard survey practices and the specific requirements of the project:
- i) Horizontal fixing;
  - ii) Vertical fixing;
  - iii) Verification of survey control;
  - iv) DTM and detail positions;
  - v) Permanent Survey Control values;
  - vi) Structural dimensions;
  - vii) Photogrammetric Photo Ground Control;

- viii) Aerial triangulation;
  - ix) Geo- referencing of the photo images for orthophotos;
  - x) Scanned images and Pixel size;
  - xi) Long- and Cross sections; and
  - xii) Other work undertaken.
- e) Check and certify the specified accuracies for the phases of the survey project, as listed below, have been complied with:
- i) Horizontal fixing;
  - ii) Vertical fixing;
  - iii) Verification of survey control and verification report;
  - iv) DTM and detail;
  - v) Permanent Survey Control;
  - vi) Structural dimensions;
  - vii) Photogrammetric Photo Ground Control;
  - viii) Aerial triangulation;
  - ix) Long- and Cross sections;
  - x) DTM checks undertaken by the contactor; and
  - xi) Other work undertaken.
- f) Check and certify that the items listed below with reference to the CAD (Continuous Model and individual sheets) drawings conform to the specified requirements:
- i) Title block;
  - ii) Description of the project;
  - iii) Route and section numbers;
  - iv) Survey project number;
  - v) Plan numbers;
  - vi) Sheet numbers;

- vii) Co-ordinate list;
- viii) Survey system;
- ix) Grid spacing;
- x) Grid values;
- xi) Drainage structures and invert levels;
- xii) Cad symbols;
- xiii) Contours;
- xiv) Contour values;
- xv) Spot heights;
- xvi) Detail and transfer of field checked data onto the final drawings;
- xvii) Embankments;
- xviii) Destinations;
- xix) Vegetation;
- xx) Side drains;
- xxi) Road numbers;
- xxii) Under- and over passes;
- xxiii) Cadastre;
- xxiv) Ortho-photo image quality and sharpness;
- xxv) Cloud cover and cloud shadows;
- xxvi) The completion and neatness of all other features;
- xxvii) DTM intervals and observation positions;
- xxviii) DTM and triangle formation;
- xxix) Break lines and the utilization of such break lines;
- xxx) DTM digital data;
- xxxi) CAD layers; and
- xxxii) Check that the CAD data co-insides with the plotted sheets as submitted.

g) Reporting

- i) The Office Checks shall be reported on a check list consisting of all the different elements of the office check (Refer to **Annexure 24**).
- ii) After completion of all the final checks, the survey must be certified as complete and compliant with the specified accuracy by a Registered Surveyor or professional Surveyor (Refer to **Annexure 23**).

3.1.2 Quality control Field Check by the Client

a) Permanent Survey Control

- i) Check and certification that, with respect to the Permanent Survey Control, their positioning, construction and their stability conforms to the survey specifications and where the procedure is as follows:
  - Undertake a check-survey of all the Permanent Survey Control (Normally 300m apart) spread over the entire extent of the project. This survey can be undertaken by using GPS equipment in order to check the relative accuracy of co-ordinate values in relation to the control itself and to the trigonometric beacons in the area. The heights shall be checked by one way spirit levelling in order to compare the height differences between the Surveyors' heights and the check survey heights. Horizontal calibration shall be done by including at least 3 trigonometric beacons within the survey area. (No extrapolation shall be done. This calibration may change depending on the Survey Datum prescribed in the project requirements);
  - Where horizontal and height errors are evident then these must be further confirmed as such by a further independent survey of that control that appears to be in question;
  - A comprehensive report must be submitted where the following aspects are specifically dealt with;
  - Quality of the beacon(s);
  - The positional integrity and efficiency of its use;
  - Distance from the Road Reserve fence or the Declaration boundary (where there is no fence);
  - The beacons' stability; and
  - The quality checks with reference to the control point's position (XY) and its height (Z) i.e. the actual differences as determined by the check data.

Reference must also be made to **Annexure 14** in regards to the beacon verification report.

- b) Check cross sections
  - i) Check and certification that the DTM heights conform to the accuracies as per the project specifications.
    - Check Cross-Sections must be carried out at 500m intervals which must extend to the full width of the survey area and where all changes of the slope and the features of the Road Prism are surveyed. Such Check Cross-Sections must be observed from the Permanent Survey Control established for the survey project. No GPS observations are permitted and the observations undertaken by a total station survey instrument must be limited in distance to 150 meters.
- c) DTM height comparisons
  - i) Co-ordinates and the heights of all cross section points surveyed must be calculated; and
  - ii) The heights for those positions must then be interpolated from the contractor's DTM. A comparison must then be made between the observed 'check' heights and the interpolated heights.
- d) Topographical Detail accuracy
  - i) Detail as specified must be observed and its position calculated. Such positions must then be compared with coordinates as derived from the digital CAD drawing.
  - ii) Such quality checks must be spread over the entire survey project. The number of check points surveyed is left to the discretion of the Surveyor but must be sufficient to be able to evaluate the accuracy of the detail. The result hereof must be highlighted in the quality control report.
- e) Drainage structures
  - i) Spot checks with respect to the dimensions and invert levels must be undertaken and based on a sample of at least 20% of all structures. The results hereof must be highlighted in the quality control report.

- f) Final quality control report
- i) Field Check results must be submitted in separate tables for each of the following:
- Permanent Survey Control;
  - Cross Sections (DTM);
  - Topographical detail; and
  - Drainage structures and, where the contractor's survey, the quality control survey and the residuals (errors) are listed.
- ii) Statistical accuracy results must be specifically reported on where a scientific assessment is made on the general accuracy of the entire survey where the Road Prism and the Road Surface are particularly highlighted.
- iii) 'Test' results must be expressed as percentages in relation to the total number of test points and where these are grouped in 30mm steps from 0mm to 30mm up to 0mm to 500mm. Errors exceeding 500mm must be highlighted and separately recorded.
- iv) With respect to photogrammetric surveys the above may be extended to 1000m where 50mm steps are used.
- g) Certification
- i) The Registered Surveyor undertaking the quality control survey must certify his findings in writing and must specifically express a view on the completeness, quality and accuracy of the survey checked.
- ii) Recommendations in regards to any re-surveys must be made by the registered Surveyor.
- iii) Once the registered or professional Surveyor, undertaking the quality control survey, is fully satisfied then he shall certify as such in writing.

## **13.2 Checking (quality control) by the Surveyor prior to submission of the data**

### **13.2.1 General**

The Surveyor must be fully conversant with the checks to be undertaken by the Client. Refer to paragraph 13.1 "Topographical surveys and Permanent Survey Control" above.

The Surveyor must therefore ensure that the survey that he is required to perform not only conforms to the project specifications but that he pays specific regard to the checks that the Client will perform on his survey. For quality control check lists refer to **Annexure 24**.

#### 13.2.2 The topographical Survey

- a) In addition to the checks as specified for laser surveys, a test cross section must be surveyed every 300 meter of the entire extent of the survey and must be utilised as test points for the DTM once finalized. These test results must then be submitted with the final survey data.
- b) The test cross-section must be surveyed using a total station survey instrument. Such observations must be undertaken independently from the original DTM observations and all feature codes of where the spotshot was taken must be recorded.
- c) A field and office check relating to the survey work must be undertaken by the Surveyor. The field and office check plans (prescribed A0 sheets) must be submitted together with the survey data.
- d) The Surveyor must complete the quality control check list as per **Annexure 24** and submit same with the final dataset.

#### 13.2.3 Structures

Office and field quality control checks must be carried out on the entire survey. At least 10 check observations per structure must be undertaken in order to check the quality of the survey once the drawings have been completed. These check points must not form part of the structural survey data set. Test results must record the Y, X and Z differences calculated between the data reflected on the drawing and the test data. These results must be submitted together with all other records.

#### 13.2.4 Staking

All positions staked must be checked and compared with the corresponding design coordinates. The differences so determined must be listed in a schedule.

#### 13.2.5 Certification

- a) A Registered Surveyor must certify all the check results.
- b) A Compliance certificate shall be issued by the Surveyor and which must state that:
  - i) All work has been thoroughly checked; and
  - ii) That the work and quality of the work conforms to the project requirements and the relevant specifications. (Refer to **Annexure 23**)