

**DIVISION OF NATIONAL MAPPING
SPECIFICATIONS
FOR
ONE WAY FOOT-METRIC, CONTRACT, THIRD ORDER LEVELLING
March 1968**

STATEMENT OF WORK AND LINES TO BE LEVELLED

1. General Requirements

(a) The Contractor shall furnish all personnel, materials, superintendence, equipment except as herein provided and transportation necessary for the performance of the contracts, shall execute and complete the levelling operations set out in the accompanying Schedule and shall deliver to the Surveyor General such sets of original field notes, records of observations, certificates and reports as are required by this Specification and the accompanying Schedule. All work shall be executed in an expeditious and professional manner to the complete satisfaction and acceptance of the Surveyor General and in complete accordance with this Specification and the Conditions of Contract attached hereto, by a Professional Surveyor with qualifications that are acceptable to the Surveyor General.

(b) The Surveyor General shall furnish to the Contractor at the commencement of the contract:

one set of the illustrative maps attached to and forming part of the accompanying Schedule.

numbered level books, to be used solely for the entry of field observations, level reductions and certifications associated with the levelling as specified herein.

the equipment listed in the attached Schedule. This will be made available to and will be accepted by the Contractor solely for use on this particular contract and the Contractor shall on completion of the Contract return all this equipment to the Surveyor General in proper condition.

TECHNICAL REQUIREMENTS

2. Datum

(a) The datum of the levels shall be the level value of an originating Permanent Bench Mark as supplied by the Surveyor General, and all levels shall be determined in reference to this datum. Levelling operations shall commence where instructed.

(b) In the following the term "Bench Mark" shall include Permanent Bench Marks and Gravity Survey Bench Marks (which may be trees, bottles, posts, concrete blocks, steel droppers with concrete collars, etc.).

3. Equipment

All levelling shall be carried out with modern levels of the automatic collimation type and with high quality calibrated levelling staves. Levels proposed to be used on the Contract are to be approved by the Surveyor General prior to the commencement of the Contract. For the purpose of approval levels shall either be submitted for inspection by the Surveyor General or fully described in writing to the Surveyor General indicating the Manufacturer, Type, Number, etc., of the level to be used. Only those levels that are approved are to be used in the Contract. Only those automatic levels fitted with a viewing mirror or prism viewer to enable the circular bubble to be observed free from parallax will be approved. Staves having graduations in feet on one side and in metres on the reverse side will be supplied to the Contractor by the Surveyor General. These staves shall be made available for calibration at intervals not exceeding three (3) months and at the completion of the Contract.

4. Lines of Levelling

(a) The levels shall be run in Sections between consecutive Bench Marks along lines set out in the accompanying Schedule. The levelling of each Section shall be carried out simultaneously in feet and metres. The two staff method shall be employed and the interval of time between consecutive sights at each set up of the level shall be kept to a minimum. All Bench Marks including Main Roads, Irrigation and Water Supply and Railway Bench Marks levelled en route shall be change points.

(b) Alternate lengths of approximately twenty-four (24) miles shall be levelled in opposite directions. These lengths will comprise a number of Sections between Bench Marks,

5. Bench Marks

(a) The Contractor shall locate Bench Marks indicated in the accompanying Schedule and effect levelling to each of such marks. Where any Bench Mark is destroyed, damaged or not located, the circumstances are to be reported to the Surveyor General.

(b) In these instances a substitute Bench Mark is to be established - without additional fee - in proximity to the reported position of the destroyed, damaged, or lost Permanent Bench Mark.

(c) Substitute Bench Marks established for this purpose shall take the form of a galvanised iron fencing dropper five feet six inches (5'6") long driven with the top at least one (1) inch below the surface of firm ground and surrounded by a circle of rocks. If, for any reason, the dropper cannot be driven for its full length and provided that at least three feet of the dropper is below ground level the top may be neatly cut off at a point one (1) inch below ground level. The new substitute Bench Mark shall be further indicated by another galvanised iron fencing dropper driven to within about two feet of the ground surface and within, one foot of the substitute Bench Mark.

(e) Each substitute Bench Mark is to be fully described in the field level book and allocated an identification number. The Surveyor General shall supply to the Contractor a list of Identification Numbers to be used. The Identification Number allocated to each substitute Bench Mark is to be legibly stamped on a metal plate and this metal plate is to be firmly attached to the indicator dropper.

(f) Diagrams of Bench Marks in the field level books are to be on separate pages and are to be free from all levelling information.

(g) When a Bench Mark at the end of a Section is reached, entries on that page of the book are to be discontinued and a fresh start made on a new page for the beginning of each new Section.

6. Recovery Data

(a) The Contractor will examine the numbering of each Bench Mark found and ensure agreement exists with the provided diagram, sketch or description, He shall annotate each diagram or sketch with further information should such be necessary to facilitate location of the mark on future occasions.

7. Accuracy

(a) The two levellings of a section, one in feet and the other in metres, between consecutive Bench Marks, shall not differ by more than $0.050 \sqrt{M}$ feet, where M is the distance between these Bench Marks in miles measured along the levelling route. When levelling fails to reach this accuracy the work must be repeated and relelevelling must be made for a complete section between Bench Marks. The full responsibility for this relelevelling shall be borne by the contract surveyor.

(b) When the mean, difference in elevation between consecutive Bench Marks, as determined by the two levellings of a section, one in feet and the other in metres (and then converted to feet), differs from the original departmental levelling of this section by not more than $0.075 \sqrt{M}$ feet the work is acceptable and no relelevelling is required.

(c) When this mean difference in elevation between consecutive Bench Marks of a section as referred to in Clause 7(b) differs from the original departmental levelling of this section by more than $0.075 \sqrt{M}$ feet, levelling shall first proceed in the normal manner to the next forward Bench Mark. If the levelling of this forward section also fails to agree as specified, but the levelling from and to end over the two sections does meet the specified accuracy of $0.075 \sqrt{M}$ feet, no relelevelling shall be necessary.

(d) If the two sections fail to meet the specified accuracy of $0.075 \sqrt{M}$ feet and the two sections as a whole also fail to meet this accuracy then both sections shall be relevelled.

(e) Payment for relelevelling will only be recommended by the Surveyor General if the difference between the first levelling and the relelevelling by the contract surveyor does not exceed $0.050 \sqrt{M}$ feet and the mean of the first levelling and the relelevelling by the contract surveyor differs by more than $0.050 \sqrt{M}$ feet from the original

departmental levelling.

(f) When levelling fails to reach the specified accuracy, and is repeated, an entirely separate record is to be entered in the field level book and appropriate cross references made. Complete releveling must be made for a complete section between Bench Marks or substitute Bench Marks.

(g) The conversion from metres to feet referred to in the foregoing shall be:

$$\text{Feet} = \text{Metres} / 0.3048$$

8. Records

(a) All level observations and relevant survey observations taken in the field are to be properly recorded in blue or black ink or ball point pen in the numbered field level books provided. All notations in field level books, other than actual observed readings, are to be neatly made in pencil to avoid, confusion with observed readings.

(b) Only original field notes will be accepted. Transcription of original notes is expressly forbidden.

(c) No adjusting of recorded readings shall be made. Final adjustment of levels to a common datum will be arranged by the Surveyor General.

(d) No field notation is to be over-written. Incorrect readings may be lightly ruled through in blue or black ink or ball point pen with the corrected field reading noted in blue or black ink or ball point pen on the next line below the cancelled reading.

(e) Location sketches adequate to define the general location of each line of levels shall be drawn in each field level book unless such a sketch has been supplied with the instructions.

(f) Totals of the backsight and foresight columns are to be shown at the bottom of each page.

9. Reports

The Contractor shall supply to the Surveyor General on completion of the work copies of his report on the whole of the survey, neatly bound in a properly fitted foolscap size folder and which shall include:

(a) in chronological order, a brief description of all work done on each day of the survey with appropriate cross references to the field level books.

(b) a consecutive list of Bench Marks showing:
the respective differences in height, as levelled, in feet and metres between successive Bench Marks including Main Roads, Irrigation and Water Supply, and Railway Bench Marks levelled en route.
the adopted mean value of these differences of height in feet.
the reduced level of all Bench Marks, including Main Roads, Irrigation and Water Supply, and Railway Bench Marks levelled en route, referred to the originating Bench Marks.

the recorded vehicle mileage read to the nearest one tenth (1/10) of a mile in respect of each successive Bench Mark commencing with zero at the originating Bench Mark.

(c) unused level books, maps, diagrams, sketches as provided with the original instructions for survey.

(d) a statement that the work was done by him or under his continuous personal supervision.

10. Recommended Practices

The Contractor shall ensure that the levelling required to be completed in terms of this Specification and attached Schedule is carried out in conformity with the following recommended practices.

11. Instruments

(a) Levelling instruments used in the work shall be maintained in correct adjustment at all times. Vertical collimation error of instruments should at no time exceed ten seconds of arc. Field tests for vertical collimation error shall be made daily before work is commenced.

(b) Such field tests are to be properly recorded in the field level books, the results to indicate error before and residual error after adjustment together with distances over which the tests were conducted. A complete page of the field level book is to be used for each vertical collimation test.

(c) The Contractor will assume full responsibility for the performance of the level instrument used, whether such be his own property or on hire from any source.

12. Use of Automatic Collimation Levels

(a) Each time the level is set to take readings the dislevelment indicated by the circular bubble shall not exceed the tolerance laid down in the manufacturer's handbook. The level must always be set firmly so as to ensure complete stability during observations. The circular bubble must be in precise adjustment at all times.

(b) To mitigate systematic error due to dislevelment of the horizontal plane definition, the following routine is to be adhered to:

ensure that the circular bubble is in correct adjustment and level carefully at each station;

at consecutive bays, level the instrument with the telescope pointing in opposite directions. For example, at 1st and 3rd stations the telescope should point towards the backsight and at the 2nd and 4th stations the telescope should point towards the foresight when levelling the instrument. When staff men are "leap frogging" this is resolved by always pointing the telescope to the same staff when levelling the instrument.

(c) Prior to every reading the telescope is to be turned slightly in

one direction then the other.

13. Staves

The staves used, must be handled, with care and every effort made to preserve the markings from defacement. Only the staves supplied by the Surveyor General are to be used.

14. Lengths of Sight

(a) The length of any sight shall be such as to allow the positive resolution of staff graduations and no sight shall exceed three hundred (300) feet, even under very good visibility conditions.

(b) Foresights and backsights shall, as far as practicable, be of equal length. The lengths of foresights and backsights shall be measured by measuring tape, pacing, Stadia measurement or by any means of similar accuracy. In all cases the respective lengths of the foresights and backsights shall be recorded in the field level books in blue or black ink or ball point pen and shall be indicated to the nearest foot.

(c) The total length of backsights shall not differ from the total length of the foresights in any section between Bench Marks by more than one hundred and fifty (150) feet.

15. Placement of Staves

(a) Bases of staves are to be inspected and, if necessary, cleaned at every change point. When setting the staff for a levelling sight it shall be placed on a stable footing consisting of either a firmly driven peg with a galvanised roofing nail driven into and, projecting slightly from the top or a steel pin or steel spike driven firmly into the ground or a metal footplate approved by the Surveyor General and at each change point firmly set so that no settlement can occur during the course of an observation. The staff shall be held vertical in accordance with sound survey practice. In no instance are nails or other marks to be left where they may constitute a danger to vehicular traffic or to the public generally.

(b) When turning the staff on a change point care should be taken to ensure that no undue weight is placed on the staff thereby causing settlement of the change point mark. There is always to be an even number of instrument stations between consecutive Bench Marks so that the same staff is placed on the starting mark as backsight staff and on the next Bench Mark as foresight staff. This eliminates any zero errors in the graduations of the two staves.

16. Time of Observation

Levels shall only be taken when atmospheric and weather conditions allow reading of the staff with certainty. If unfavourable conditions are encountered the length of sight shall be reduced until certainty can be achieved, or work discontinued.

17. Readings

The staff readings shall be recorded to the nearest 0.005 feet, or in the case of metric divisions, to the nearest millimetre.

18. Temperature and Refraction

- (a) The temperature of the air shall be recorded together with the time of reading at the commencement, at the middle and at the conclusion of each days work.
- (b) All sight lines shall clear the intervening ground between the level and staff by at least one foot.
- (c) Staff readings of less than one (1) foot or thirty point five (30.5) centimetres will not be accepted.

19. Holding Marks

- (a) When levelling operations are to be suspended for a period a holding mark shall be established from which to resume levelling operations. Such holding mark shall consist of a length of metal piping driven firmly into the ground or a stoutly driven peg with a galvanised roofing nail driven into and projecting slightly from the top or other mark of similar stability.
- (b) Where circumstances oblige a holding mark to be in use overnight or for longer periods a subsidiary Bench Mark shall be established - such to be fully described in the field book.

20. Certification

- (a) Immediately on completion of each page of the field level book the Surveyor doing the work shall certify on that particular page as follows:

"The observations recorded on this page were made by me / in my presence.

.....Surveyor".

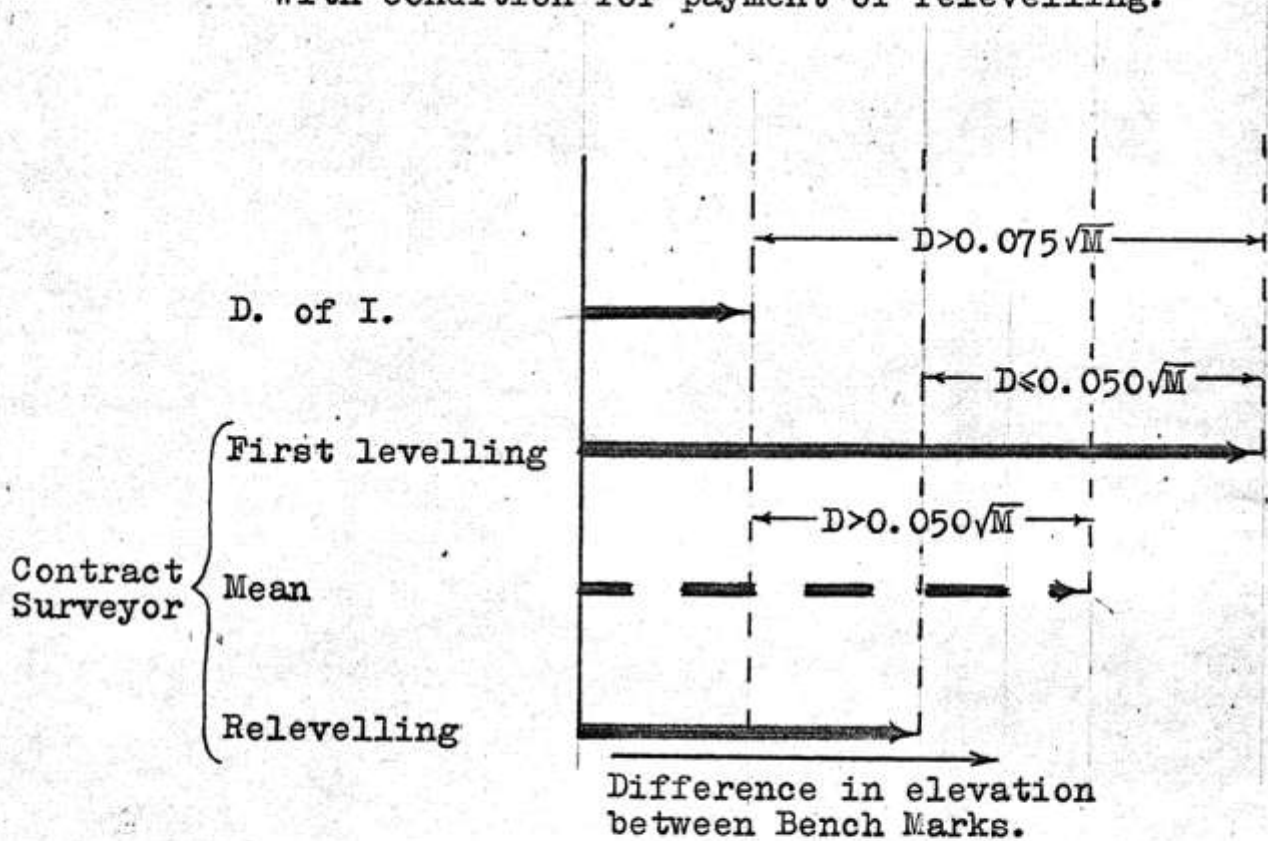
- (b) Each level book and all reports required in the terms of this Specification and accompanying Schedule shall be certified by the Contractor and such certificate shall declare that all the work has been carried out in strict conformity with this Specification and the attached Conditions of Contract.

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Graphical explanation of Clauses 7(d) and 7(e) dealing with condition for payment of releveling.



"D>" means "D is greater than"

"D≤" means "D is equal to or smaller than"