The University of New South Wales

School of Geomatic Engineering

GMAT4052 FIELD PROJECTS 1 (SURVEY CAMP) 1998

Closebourne Anglican Conference Centre, Morpeth

Monday, 5 October 1998 (14.00 h) – Saturday, 10 October 1998 (20.00 h)

TECHNICAL INSTRUCTIONS

Personal Study Equipment: In addition to the items listed in the *Administrative Camp Instructions*, students must also bring the following items to Camp:

- 3.5" double sided (DS), high density (HD) disk for use on PCs (IBM format)
- metric scale, straight edge, set square
- large protractor
- mechanical pencil(s) (0.5 mm diameter, B, HB, H) for booking in the field
- good quality pencils (H, 2H, 4H; for drafting) and a pencil sharpener
- loose leaf field book (of the type sold by Survey Store; inserts for sale at camp)
- pocket calculator (preferably programmable, with charger) (or laptop / notebook computer)
- short instructions on the use of the various EDM instruments and electronic tacheometers
- Rüeger, J. M. 1996 (or 1990). *Electronic Distance Measurement – An Introduction.* 4th ed. (or 3rd ed.) Springer Verlag, Berlin-Heidelberg, New York, 266 + XVII pages
- Bannister, A., Raymond, S. and Baker R. 1992. *Surveying.* 6th ed., Longman Scientific and Technical, London, 482 pages
- relevant lecture notes
- exercise book for briefing notes
- drawing pen(s) and Indian ink (the final contour plan is required in Indian ink!)
- one carpenter's/builder's pencil (for setting out exercise)

Camp Preparation: Before coming to camp, **each student** must calculate the building set-out following the instructions given under **Preparations** in **Section 9**. This includes the set-out data (direction, horizontal distance) for all points from two suitable instrument stations. **These computations must be handed in during the briefing at 14.00 h on the first day.**

1. Introduction

Ideally, the program of work for all survey parties would be the preparation of a detail and contour plan of the camp area, with additional set-out of structures and calibration of used instruments. The survey work would then be divided into the following steps:

- field reconnaissance, marking of selected control points
- calibration of electronic tacheometer or distance meter
- connection of the control to an integrated coordinate survey system and, over the area of detail survey, the execution of horizontal and vertical control
- computation of coordinates and elevations of control points
- detail and contour survey
- plotting of detail, spot heights and interpolation of contours
- setting-out of structures
- preparation of final plan

Because of the large number of students involved and the lack of time and equipment, the sequence listed above is not followed. The first step has been largely completed by the camp director. The student groups will execute the following exercises:

Dam capacity determination (contour survey)
Precise levelling
Traverse
Setting out of a building
Calibration of an EDM instrument

Because of student numbers and other constraints, the exercises of each group will not cover one and the same specific area of the camp. Instead, the different exercises will be completed in different areas of the conference centre.

The **groups of two students** have been arranged into four blocks (A,B,C,D). All groups in a particular block will be working on the same type of field work on anyone day. A timetable showing the days, on which the groups will be doing the different exercises, is given in the table below. **The two students of a group must share the different field and office tasks *equally*.** The field notes should clearly state the observer of all particular sets of data. On computation sheets, the authors must be clearly indicated. One student does the **original computations**, the second the **check computations**. Both computations are submitted. In the report, the author of each section should be stated. Refer to **Appendix A** for equipment used.

Day		EDM Calibration	Traverse	Dam Capacity	Building Setout	Precise Levelling
Mon	5 October	<———————————Reconnaissance———————————>				
Tue	6 October	A	D	C	B	—
Wed	7 October	B	A	D	C	—
Thu	8 October	C	B	A	D	—
Fri	9 October	D	C	B	A	—
Sat	10 October	—	—	—	—	A,B,C,D

Note: Blocks A and B only in 1998!

Student Groups per Block			
A	B	C	D
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32

2. Marking of Control Stations

The approximate locations of the control stations are shown in the sketch in **Appendix B**. Each station will be marked with a marking stake placed in close proximity (one foot) bearing the station number. If you have difficulties in locating a particular station, contact your supervisor. Four types of marks are used as control stations: Concrete blocks with brass nail (or bolt) as centre mark, brass bolts in galvanised iron pipes (with concrete collar), galvanised iron pipes (GIP), galvanised iron (GIN) or *Ramset* or *Hilti* nails and, rarely, pegs with nail as centre mark.

The approximate locations of trigonometric stations may be found in a sketch in **Appendix C**. All stations except *Terrace* and *Johnstone* are marked with a standard concrete pillar and steel vane. During the camp, stations **T4, T6A and T9** will be **permanently marked** with about 3 m high beacons.

3. Field Notes

Usually, all measurements are to be recorded on field forms. The field book should be used for sketches and other data not fitting the field forms. All records must be in pencil and must be neat and original. They are to be taken in the general manner of the sample bookings on the forms shown in the Appendices. The name of the observer must always be recorded.

Erasures are nor permissible. Alterations to recorded measurements are to be made by striking out the erroneous entry with a neat single line and recording the correct value above. As an aid to your success in this work, it is emphasised that neat legible figures are a prime protection against confusion in notes and unnecessary repetition of the work.

4. Hall of Fame

HALL OF FAME

This list gives the names of the students who achieved the best accuracy in three of the five Camp components. The list will be updated annually.

Rank	Names of Students	Year	Score
EDM-Traverse (Criterion: largest 3-D error vector)			
1	M. Sestito & D. Sproule	1995	4.5
2	F. Ho & H.C. Lok	1997	5.0
3	B. Cummins & J. Underwood	1995	5.4
Building Set-out (Criterion: largest error in E and N)			
1	J. Bryson & E. Sheil	1995	8.1
2	C. Reid & T. Rofe	1997	8.9
3	D. Finnigan & D. Rowsell	1996	10.5
Levelling (Criterion: 1-km precision and max height error)			
1	D. Finnigan & D. Rowsell	1996	1.5
2	J. Bryson & E. Sheil	1995	1.8
3	J. Cowley & M. Knox	1995	2.0

5. Dam Capacity Determination (Contour Survey)

The capacity of a dam (volume of water) is to be determined when the water level is at 19.00 m. The dam wall, whose side slopes are 1 to 1, has a straight centre-line defined by two points (ISG coordinates, Point 1 (E 358 200.00, N 1377 150.00) and Point 2 (E 358 300.00, N 1377 300.00)). The top of the dam, which is level, has an RL of 19.50 m and is 4.00 m wide. A contour plan at 1:500 scale is prepared for the purpose.

The field work consists of a survey of the relevant area by EDM tacheometry. Directions, horizontal distances and height differences are measured (the latter to centimetre only), together with height of instrument and height of reflector. Details other than topography in the area of interest are also surveyed (fences, trees etc). In uniform terrain, spot heights should be taken at about 15 m intervals. All surveyed points have to be numbered and have to appear on a sketch in the field book. The observations are booked on the attached field form. A sample booking is shown in **Appendix E** and blank forms may be found in **Appendix Z**. Note that **three** orientations are required on all stations.

Instruments may be set up on Stations T5A to T5D, T34 to T34D, T34X to T34Z and T49 to T49D. **Do *not* occupy** Station T5! The coordinates and elevations of these stations are given in **Appendix D**.

Before the work is commenced **on any station**, the *vertical circle index error* of the electronic tacheometer must be determined and recorded in the field notes. If it exceeds one minute of arc, it must be calibrated using the instrument's built-in program routine. Check and book again after any calibration. Do measure and record the *height of the theodolite* above the ground mark at each station after setting up. To avoid problems and simplify calculations, set the reflector to the height of instrument at each station. Also measure temperature and pressure (and, if applicable, apply additive constants given in **Appendix Q**) at the beginning of the work at any station and enter these values (or the equivalent ppm correction) into the electronic tacheometer.

Before starting with the contour survey on the first station, the group with the smallest number on the day sets out the Point 1 (to one metre accuracy); the group with the largest number on the day sets out Point 2. Mark the Points 1 and 2 with range poles. All groups must survey the Points 1 and 2. In your report, discuss the discrepancy between the marked and the true locations of these two points!

It is strongly suggested that you locate a few points on the 20 m contour from your first station so that you know exactly how far your survey has to extend. Also, make sure that you know where the dam is located in the field (e.g. plot dam on locality sketch given in these instructions).

The trigonometric stations Brinteg, Great Sugarloaf, Hinton, Kanwary, King, Joice, Seaham and R.C. Church (and, possibly, C.O.E. Belfry) may be used for orientation. Should this fail, one or more of the stations T4, T6A, T9 may be used for the purpose, as they are marked with survey beacons. Three orientations should be used on every station. Compute the bearings from your station to these three targets. Set the horizontal circle of the tacheometer to the bearing to one of the three targets. Measure (and book) the directions to the other two and calculate the differences to the computed bearings. (Do not proceed with the work, if these differences are excessive. Find source of problem [wrong bearing? pointed to wrong target?] and rectify.) One of the three orientations is to be checked and booked whenever starting a new field sheet as well as after the last detail point on a station. Do not radiate further than 100 m (unless you remove the index error to much less than 1 minute of arc).

Before moving to the next station, do measure and book the *height of the theodolite* again, measure and book the *temperature and pressure* again and measure and book the direction to one of the three orientations targets again. (If this check of the orientation does not agree with the computed bearing, all measurement taken after the last orientation check, which did agree, must be repeated!)

Briefing

During the briefing, the supervisor will issue one cartridge paper and one tracing paper per group. The supervisor will also **demonstrate** how to use the **planimeter**, the **grid template** and how to interpolate contours from spot height information.

Preparations

As a preparation, students are encouraged to plot the grid (with the template), the control points and the dam (crest and contour lines) on the cartridge paper on the night before the exercise. Also, the final plan (in Indian ink, on tracing paper) can be commenced as far as grid, title block and control points are concerned. You may also come to an agreement with the other groups on who will occupy what stations during the day. This allows you to compute the orientation bearings in the evening before the exercise. If you are required to set-out Point 1 or Point 2 (see above), also compute the bearing and (horizontal) distance from your first station to said point.

Office Work

The reduced levels of all detail points must be computed before the cartridge plan in scale 1:500

can be drawn. The horizontal distances and the bearings to the points are known as they were measured directly. (The horizontal circle of the tacheometer was orientated to Grid North.)

On the **original plan** (in pencil, on cartridge paper), plot the detail points by bearing and distance (protractor & ruler). Show spot heights to nearest 0.1 m. Interpolate the contours along the sides of the triangles formed by the spot heights. Draw contours in 1.0 m intervals. 10 m index contours to be distinguished. Show instrument set-ups as well as position and outline of dam. Do not rub out construction lines.

Before measuring the **areas** defined by the contours on the ground and on the planned dam, the **planimeter must be calibrated**. Draw the borders of a 200 by 200 mm (100 m by 100 m = 10 000 m^2) area between grid points. Set the planimeter to units of "m^2" and to a "500.0" SCALE. The planimeter's scale factor is then "SF? –> 250000". (See **Appendix R** for some instructions on the planimeter.) Measure the area of this reference square **10 times**. Compute the mean area. Compute the correction factor. In a table, continue with the measurement of the areas between the contours. Measure each area **four times**, compute the mean and correct it with the previously determined correction factor.

Compute the **water volume** behind the planned dam, using the "End Areas" **and** the "Prismoidal" (="Simpson's Rule") formulae. (For reference, see pages 291-294 and 304-306 in Bannister, Raymond and Baker, *SURVEYING*, 6th edition, 1992). Don't forget the water volume below the lowest contour on the up-stream side of the dam.

The **final** contour **plan** (in Indian ink) can be completed once the work with the planimeter on the cartridge paper plan has ended. Add: title, number of the group, names of group members, north point ("Grid North"), grid intersections at 10 cm spacing, scale, datum of elevations, date of survey, all control points in the area covered by your survey, datum of coordinate system, heights of contours. Show spot heights to nearest 0.1 m and contours at 1.0 m interval. 10 m index contours to be distinguished. Show instrument set-ups and position and outline of dam.

Field Notes

(a) Sketch showing the locations of the occupied control points as well as the directions to the orientation points, signed by preparing student
(b) Sketch(es) showing all surveyed spot heights and detail points with their respective numbers, singed by student making sketch
(c) All other booking on field sheets (see **Appendix Z**), each form signed by the respective booker

Submission

(a) Title page with title, number of group, names of students, date, make, type and serial number of instrument, make, type and number of reflector
(b) All field notes, each page signed by the booker
(c) Computations of bearings from instrument set-ups to orientation stations (at least three per instrument set up) and check computations, each page signed by the calculating student
(d) Original plot 1:500 on cartridge paper, signed by the student that did the pencil drawing. Do not rub out construction lines. (see above for details)
(e) Neat plan drawn **in Indian ink** on tracing paper at a scale of 1 to 500, showing 1 m contours of the natural surface and the dam wall, signed by the student that did the ink drawing (see above for details)
(f) Volume calculation and calibration of planimeter (list make, type, serial number of planimeter used) and check computations, each page signed by the student that did the respective calculations.
(g) Appendix (if applicable) with any other workings, drawings, calculations, each page duly signed by author.
(h) Work Share Statements (duly signed) of all members of the group (see **Appendix Z**)

6. Precise Levelling

The precision levelling survey encompasses the perimeter of the camp area and is executed with a precision digital levelling instrument and one invar bar code staff of three metre length. Eight levelling runs (x) are distinguished. The table below specifies which party takes which run. The terminal marks have fixed elevations. The elevations of all other marks are to be determined (to a tenth of a millimetre) from the double run precision levelling.

The groups listed in Column x.1 start on the first BM (shown in bold), level all the way through to the last station and then level all the way backwards (from the last station to the first). The groups listed in Column x.2 start on the second BM (the next after the BM shown in bold), level all the way through to the last station, then level all the way back to the first (shown in bold) and then forwards to the second BM. The groups listed in Column x.3 start on the third BM, level all the way through to the last station, then level all the way back to the first (shown in bold) and then forwards to the third BM. The groups listed in Column x.4 start on the fourth BM (that is in the middle of the level run), level all the way through to the last station, then level all the way back to the first BM (shown in bold) and then again forwards to the fourth BM (in the middle).

Run x	Sections (all forward and backward)	Groups / Starting Pt			
		x.1	x.2	x.3	x.4
1	**BM2** – BM5 – PM56265 – T67 – T25 – T68 – PM18505	1	4	6	22
2	**PM18505** – T68 – T25 – T67 – PM56265 – BM5 – BM2	16	9	19	13
3	**PM18505** – BM1 – T3 – T4A – L42 – BM4 – T10	2	12	7	24
4	**T10** – BM4 – L42 – T4A – T3 – BM1 – PM18505	18	11	21	15
5	**T10** – T65B – T9 – T8 – T7 – L39 – BM2	3	8	5	23
6	**BM2** – L39 – T7 – T8 – T9 – T65B – T10	17	10	20	14
7	**T2** – L42 – T1 – BM2 – L39 – T8 – T22	29	25	27	31
8	**T22** – T8 – L39 – BM2 – T1 – L42 – T2	30	26	28	32

Precise Levelling Procedures

Equal sighting distances (equal number of paces) in foresight and backsight are to be maintained. Sighting distances must be shorter than 30 m at all times. The **BB-FF levelling procedure** is to be used, where the spot bubble is always set when the telescope points to the backsight staff. Use the level mode ("Menu Levelling") with **no data recording**. Record the mean of four readings per backsight or foresight, **to 0.000 01 m**. A booking example (showing readings to mm rather than the 0.01 mm required here) may be found in **Appendix F** and blank forms in **Appendix Z**.

Prepare the TOPCON DL-101C digital level for the work, using the SET MODE commands, as follows (in upward scroll sequence):

- "Set Measure" N=4. (The instrument will then measure each staff four times and display the average (as well as N and the standard deviation, if one scrolls the display).
- "Set Fix" to "precise" (readout to 0.01 mm, 0.000 01 m)
- "Set Item" to extended data display
- "Display Time": Set length of display time to about 6 s. This means that you have only 6 seconds to book results before they vanish. You can set the display time to maximum of 9 seconds (and press ESC (to get to the next step) once you have read the numbers you want!)
- "Display Unit": Set unit to metres.
- "Out Module": Turn recording to off (and not to RAM or RS232!).
- "Auto Cutoff": Set the automatic cut-off to "off".
- "Inverse Mode": Set to "inverse not used".
- "Swing Correct": Set the swing correction to "on". (This corrects staff readings taken with a compensator out of its equilibrium position.

Before work is commenced, the adjustment of the circular level has to be checked and, if necessary, adjusted by the field party. Follow Section 10.1 (on Page 5 of the *DL-101C Short Instructions*) and ask the assistance of the supervisor, if an adjustment is necessary. (The supervisor will have an adjustment pin.) In addition, the levelling instrument has to be tested, **separately by each student,** by a two-peg test (over 50 m) and, if necessary, the collimation error correction to be reset in the instrument. Follow the procedure outlined in Section 10.2 of the

Topcon DL-101C manual (see Page 17 of the *DL-101C Short Instructions*), but book the four values manually. (Start from "Menu Adjust"!) Record the two differences (in seconds of arc and in metres) shown and tell the instrument to apply the correction. Skip the Steps 9 to 13 in Section 10.2 by pressing [ENT] three times. For confirmation, compute the height differences measured at A and B manually and work out the difference. Turn the instrument off.

At your starting point, select your first instrument position and set up the instrument. Level carefully whilst the telescope points to the backsight, that is your starting bench mark in this case.

(1) Switch the instrument on and press Menu.
(2) Scroll to the line levelling mode ("Menu Level"), press ENTER.
(3) Scroll to the "Start Levelling" mode, press ENTER.
(4) Scroll to the BBFF levelling mode "Level2 (B1B2L1L2)", press ENTER
(5) Set "EVLimit" (= tolerance for (B1-F2)-(B2-F2)) to 0.3 mm. (Use ESC to remove shown numbers and type in 0.3.) Press ENTER.
(6) On prompt "GH ?" enter a fictitious height of the starting bench mark (100.0 m). Then, press ENTER. The screen should then prompt for "Back 1".
(7) Point to backsight (starting point), focus. Wait 2 seconds.
(8) Press the measure button, wait for the four measurements to be taken and the mean to be calculated. Book the mean of B1 on the field form (to 0.000 01 m). Scroll up, read and book distance. Press ESC. (The display shows now "Back 2".)
(9) Press the measure button, wait for the four measurements to be taken and the mean to be calculated. Book the mean of B2 on the field form (to 0.000 01 m). (No need to book distance a second time!) Press ESC. (The display shows now "Fore 1".) Tell your field hand to move the staff to the (next) change point.
(10) Point to the foresight. Focus to the foresight staff. (The display still shows "Fore 1"). Wait 2 seconds.
(11) Press the measure button, wait for the four measurements to be taken and the mean to be calculated. Book the mean of F1 on the field form (to 0.000 01 m). Scroll up once and read and book the sighting distance. Press ESC. (The display shows now "Fore 2".)
(12) Press the measure button, wait for the four measurements to be taken and the mean to be calculated. Book the mean of F2 on the field form (to 0.000 01 m). Scroll up once and read and book (to 0.01 mm) the EV value (difference between (B1-F1) and (B2-F2)) in the Δ column of the form. Press ESC. (The display now shows the prompt "Back 1".)

Note: The instrument will complain if your actual EV is larger than the set "EVlimit" (0.3 mm). As you cannot remeasure to the backsight, press ESC to clear the message. Make a note in "Remarks" column on field form.

(13) Move the instrument forward and continue with Steps (7) to (13).

At next Benchmark: When you have measured the foresights to the staff on the next bench mark (screen shows "Back 1" prompt, press MENU and scroll up to "Close Levelling". Press ENTER. The screen then shows "End of CP". Press ENTER. The display then shows "Δh CP", which is the height difference from the last BM. Book this value to 0.000 01 m in the remarks column of the form. Scroll up once. This gives the "Δh ΣCP". Ignore that. Scroll up again. The "ΣD CP" gives you the total levelling distance from the last BM. Book (to 0.1 m) in the "Remarks" column. Scroll up again. The "ΣD ΣCP" should be ignored. Scroll up again to see the (local datum) ground height (GH) of the present bench mark. Book (to 0.000 01 m) in the "Remarks" column. (Once you are on the way back, you may compare this value with the equivalent value of the forward run.) Press ENTER. The display then shows "Cont Levelling". Move the instrument to the next set-up. Point to the (backsight) staff on the BM. Level (with the telescope pointing to the backsight). Focus. With the display on "Cont Levelling", press ENTER. The screen prompt then shows "Back 1". On the field form, leave four black lines before starting with the booking of the next section. Continue as per Steps (7) to (13) above.

Level on the shortest route between BMs. No staff readings should be smaller than 0.5 m to minimise refraction effects. When going down or up hills, reduce your sighting distances accordingly. At all times, the invar bar code staff should be supported by two ranging poles at right angles (one parallel to face, one perpendicular to it). Always level the spot bubble of your automatic level when the telescope points to the back sight. This procedure eliminates the obliquity of horizon in the mean of forward and backward runs. Use the staff shoe when the staff is on change spikes. Remove the staff show for measurements on permanent marks. Be careful when lowering the invar staff on marks in cover boxes and make sure that the staff sits on the pin (and not the sand around it).

Levelling Marks

The approximate locations of bench marks and other levelling marks are shown in **Appendix B**. BM1 (PM 18578), PM 18505 and PM56265 are permanent marks of the Department of Lands, which is a stainless steel rod set in concrete below ground level and covered with a cast iron cover box, BM2 is a bolt on the rim of a manhole, BM4 is a G.I. bolt set in concrete and BM5 a brass bolt in a round concrete block. L39 is a bolt in a GIP in concrete and L42 is a bolt in the road.

The elevations (Epoch 1997.8) on the Australian Height Datum (AHD) of the terminal marks PM18505, T2, BM2, T10, T22 are given in **Appendix D**.

Tolerances

The forward and backward levelling runs between the consecutive marks (sections) listed in the table above shall not differ by more than $4\sqrt{S}$ mm where S is the distance in kilometre between the two marks (or terminals in latter case) measured along the levelling route. Sections not meeting the requirements of the tolerance should be levelled a third time.

In principle, the same tolerance of $4\sqrt{S}$ mm applies also for the difference between the published height difference between the terminals and the measured one. In Morpeth, many bench marks are in expanding soils and, sometimes, do change their heights. If you find good agreement between your forward and backward level runs but poor agreement against published values, discuss the matter with your supervisor before levelling the entire run a third time.

Analysis of Data

Unless something went wrong with the calculations on-board the TOPCON DL-101C, there is no need to reduce the field observations by the Rise and Fall Method. See **Appendix F** for a sample, if you have to carry out this reduction for one reason or another. If applicable, the reductions and checks required are to be executed for every section between any two (permanent) marks.

List the forward and backward values (to 0.0001 m) for every section, the difference (to 0.1 mm), mean height difference (to 0.0001 m) of each section, the distance along the route (to 0.1 m) and the misclosure between the terminals (to 0.1 mm). See **Appendix G** for sample.

The levelling run is to be adjusted according to the example in **Appendix G,** using two different adjustment schemes. Three adjustment procedures are given in **Appendix G**: proportional to the number of set-ups, proportional to the levelled height difference and proportional to the levelled distance. For the level runs in Morpeth, the **adjustments proportional to the number of set-ups** and **proportional to the height differences** are the most appropriate. Discuss the differences between the two different solutions and select the most appropriate one for the final result. (See **Appendix G** for guidance.)

The standard deviation of a single and of a double levelling run over 1 km is to be calculated from the differences (to 0.1 mm) between the forward and the backward run of all (six) sections (see **Appendix G**). The distances (as measured by the digital level) are required for the weighting of the observations in the error analysis and taken from the field form . Compare the calculated 1-km double run precision with the manufacturer's specification of ±0.4 mm (for the TOPCON DL-101C digital precision level with invar staffs).

For each section, compare (and discuss) the differences between forward and backward runs with the specified tolerance. Then, also compare (and discuss) the overall misclosure with the tolerance. If certain sections were measured more than twice, **use all** those **measurements** in the above analysis, which do not included gross errors (but at least two per section).

Field Notes

(a) Diagram of level run, showing all permanent levelling marks and temporary change points, signed by student that did the drawing

(b) Measurements and results of two-peg test of each student, signed by respective student
(c) All measurements of forward and backward runs on field sheets (attached in **Appendix Z**) each page signed by the respective booker
(d) All measurements of third (fourth, ..) runs on sections where tolerance was exceeded, each page signed by the respective booker

Submission

(a) Title page - Level Run Morpeth – Group Number – Names – Date – Instrument make and type and serial number – Staff make, type, number and condition
(b) All field notes (see above)
(c) If required, field observations reduced by the Rise and Fall Method (on field forms). Add statement "Reductions by (student's name)" on all field forms
(d) Computations as described above and check computations. All computing sheets must be signed by the student doing the respective calculations.
(e) A table of all stations and elevations to **0.0001 m** (do not round as in **Appendix G**), signed by the student preparing it.
(f) Appendix (if applicable) with any other workings, drawings, calculations, each page duly signed by author.
(g) Work Share Statements (duly signed) of all members of the group (see **Appendix Z**)

7. Traverse

Each group of students will complete an EDM traverse along the route shown in the table below. The coordinates of intermediate stations shall be determined in the NSW ISG (Zone 56/I) and heights in AHD, both to mm. Centring (and measurement of heights of instrument and reflector) to mm is therefore required at all stations. Generally, groups will use the same electronic tacheometer as during the EDM calibration exercise. In cases where the traverse exercise precedes the EDM instrument calibration exercise, the supervisor will allocate the distance meters to groups during the briefing.

Traverse Route	Starting Station	Finishing Station	Intermediate Stations	Blocks & Groups			
				A	B	C	D
1	**T6**	T51	T23A, T69, T70	1	30	27	32
2	**T51**	T6	T70A, T69A, T23	29	14	3	16
3	**T7A**	T52	T63A, T71, T16A	5	26	19	28
4	**T52**	T7B	T16, T71A, T63	21	10	7	12
5	**T59**	T53	T8A, T64, T66	9	22	23	24
6	**T53**	T59	T66A, T64A, T8B	25	6	11	8
7	**T50A**	T54A	T22, T9B, T72A	13	2	31	4
8	**T54**	T50	T72, T9A, T22A	17	18	15	20

Preparation

It is strongly recommended that, before the briefing, students walk along the route of the traverse, locate all marks and investigate (make a list) possible orientation rays at the terminals. Compute the bearings from the terminals to all visible orientation targets prior to the field work. They assist in finding and identifying the distant targets used for orientation.

Three distant stations **must** be used for the **orientation of the traverse** at the starting and closing stations (see also sketch in **Appendix H**). Wherever possible, the trigonometric stations Brinteg, Great Sugarloaf, Hinton, Kanwary, King, Joice, Roman Catholic Church and Seaham should be used. Where this is not possible, the following stations may be used: C.O.E. (Church of England) Belfry, T4, T6A and T9. During the camp, the stations T4, T6A and T9 will be permanently marked with 3 m high beacons.

Calibration of EDM Instrument

All groups will use the same instrument for the exercises "EDM Calibration" and "Traverse". Most groups calibrate their distance meter on the day before the day of the traverse exercise. In this case, the calibration values determined will be applied for the traverse measurements. Groups, who calibrate "their" distance meter after the traverse exercise, should obtain appropriate calibration values from the supervisor.

Measurements

All reflectors must be pointed horizontally **and** vertically to the EDM instrument. The KERN reflector is aligned vertically by using the gun sight on top. Book make, type and numbers of the reflectors used.

Warning: Do not attach the Wild GZT-4 target plates to the Wild GPR1/GPH1 reflector/prism holders in strong wind. Tripods may be blown over in such conditions if the target plates are attached.

At Terminals:

- Set up and shade instrument. Centre **to mm**, level tacheometer accurately. Measure height of instrument **twice** with folding ruler **(to mm)**. Book every single measurement.

- **Measure** two arcs of **directions** (in two faces) to three "distant" targets of known coordinates (see Appendix 1) and to second (or second last) traverse station. If you use a WILD TC1010/1600/1610 or a NIKON DTM-300 electronic tacheometer, rotate the base of the instrument 120° counterclockwise inside the tribrach after the first arc. Do not forget to lock the tribrach and to re-level afterwards. With other instruments, change circle randomly after first arc. See **Appendix J** for booking example. Blank forms in **Appendix Z**. Point to the centres of the prisms. In consequence, it is essential that the prisms are accurately pointed to the tacheometers at all times, both horizontally and vertically!

- **Measure** two **zenith angles** to second (or second last traverse) station (in two faces) to centre of prism. Before doing so, make sure that the electronic level sensor of your electronic tacheometer is switched on. Check the sum (FL + FR) **immediately** after the measurement. If this sum differs from previous values, **remeasure** the zenith angle immediately. See **Appendix J** for booking example. Blank forms in **Appendix Z**. Measure the height of the reflector with the folding ruler **twice (to mm)**. Book every single measurement.

Note: When using Kern Centring Tripods with Kern instruments, the height of instrument/reflector may be read off the scale on the centring rod. When setting up over a galvanised iron pipe (GIP) with no brass bolt in its centre, the rod must be unscrewed a bit and the tip of the rod placed on the rim of the pipe. Take a second reading to a point on the pipe's rim diametrically opposite and take the mean. Don't forget to put the rod back into the centre of the pipe and to lock the rod before centring and levelling.

- **Measure** (at instrument height and in the shade) and book atmospheric **temperature and pressure**. Set the PPM correction of your distance meter to the neutral position (usually zero ppm) and leave it like that during the whole field work. If the reference temperature and pressure need to be entered (rather than a zero ppm-correction), refer to the instrument manual. (When using the NIKON DTM-300, set the "Weather Compensation" to "OFF": –> FNC –> SET –>2:DIST –> (second item) –> ENT. The Nikon NTD-3 and the Pentax PX-06D require a setting of +15°C and 760 mm Hg.) – Should your distance meter display any built-in additive constant or reflector constant (or both), book this (these) value(s). **Refer to the in-house instrument manual for the required reflector constant (offset) setting. Measure distances** to second (or second last) traverse station four times in most precise "single shot" distance measuring mode. Repoint in between.

At Intermediate Stations:

- Set up and shade the instrument. Centre **to mm**, level the tacheometer accurately. Measure the height of the instrument twice with the folding ruler **(to mm)**. Book every single measurement.

- Measure two **horizontal angles** (in 2 faces, clockwise from backsight to foresight). If you use a WILD TC1010/1600/1610 or a NIKON DTM-300 electronic tacheometer, rotate the base of the instrument 120° counterclockwise inside the tribrach after the first arc. (Do not forget to lock the tribrach and to re-level afterwards.) With other instruments, change the circle randomly after the first arc. See **Appendix** J for booking example. Blank forms in **Appendix Z.** Point again to the centres of the reflectors.

- Measure two **zenith angles** each (in two faces) each to the reflectors on the previous and the next stations. Check sum of FL and FR **immediately**. If this sum differs from previous values, **remeasure** the zenith angle **immediately**. See **Appendix J** for a booking example. Blank forms are in **Appendix Z.** Measure both reflector heights **twice** with the folding ruler (**to mm!**). Book every single measurement. The heights of the instrument and the heights of the reflectors are later used for the computation of elevations in the traverse.

- Measure (at instrument height and in the shade) and book atmospheric temperature and pressure. Set distance meter to a zero ppm correction (or equivalent, see above). **Measure the distances** to the previous and the next traverse station four times in most precise "single shot" distance measuring mode. Repoint in between. (This means that the length of each traverse leg is measured forward and backward.)

Computations

- **Reduce directions and zenith angles.**

- **Apply** the **instrument correction** IC (additive constant, cyclic error correction, etc.) and the first velocity correction (see Rüeger. 1990. *Electronic Distance Measurement*. Springer-Verlag, Eq. (6.11) p. 232) to all distances. Correct the measured pressures for the additive constant of the barometer (see **Appendix Q**) before computing the first velocity correction. With the aid of the measured zenith angles, **reduce** all measured **distances into ISG** Zone 56/1 according to the formulae in Rüeger (1990, Eqs. (7.53), (7.54), (7.55) p. 98-99, (8.55) p.122). This is done to mm and separately for the mean forward and the mean backward distance measurement. (Use a coefficient of refraction k =0.0.) List forward, backward, mean ISG distance as well as difference between forward and backward ISG distance.
All measured distances are first reduced to horizontal distances (at the elevation of the trunnion axis of the theodolite at the instrument station), then to sea level and finally to ISG. The so-called *Sea Level Correction* is computed as (equivalent to Eqs. (7.54) and (7.55) in Rüeger 1990):

sea level distance = horizontal distance (at station height H) x (1.0 – H / R)

where the earth's radius R is taken as 6 370 100 m and the elevation H in metres. Within the camp area, sea level distances can be converted to grid distances using the equation (equivalent to Eq. (8.55) in Rüeger 1990):

Grid distance = 0.999 981 (sea level distance).
Mean the forward/backward value of the ISG distances before continuing!

- **Compute** the plane **bearings** (to seconds of arc) from both terminals to the distant stations. **Orientate** the **directions** at both terminals. Use form "Orientation of Arcs" for this purpose. (Sample computation in **Appendix L**, blank form in **Appendix Z.**) For coordinates of all points: **See Appendix D**. This leads to the plane bearings of the first and the last traverse legs. These values are subsequently regarded as being error free.

- **Calculate** the **traverse** (to mm and seconds of arc) including the actual linear and angular misclosures. Use the Bowditch Method for the adjustment. "Traverse Computation" forms are attached (in **Appendix Z**) and should be used for the submission. A sample computation is given in **Appendix M.** All given coordinates refer to the New South Wales Integrated Survey Grid (ISG), Zone 56/1. Note that the plane bearings of first and last leg are fixed. Adjust all intermediate angles to fit these bearings.

- From measured zenith angles, slope distances and heights of instrument/reflector **compute** the forward and backward **height differences** for each traverse leg according to Rüeger (1990, Eq. (8.27) p.109). This should be done in a table and in connection with the reduction to ISG. Use a coefficient of refraction of k = 0.0.

Once the forward and backward Δh of each leg have been computed, take the mean, and compute the misclosure between the terminals. Adjust the mean of the Δh for the height misclosure the same way as the ΔE and ΔN were adjusted for the misclosures in Easting and Northing in the horizontal traverse (that is proportional to the measured (slope) distances). Then compute the heights of all intermediate traverse points.

Tolerances

The **angular misclosure** for the traverse should not exceed $40'' \sqrt{n}$, where n is the number of stations occupied in the traverse. If this figure is exceeded it is likely that a gross error has been made in the angular measurements. In such cases, locate the error and, if necessary, remeasure appropriate angle(s).

The **linear misclose** should not exceed $K\,(\mathrm{mm}) = 2.0\,F \sqrt{0.04 + S^2}$

where F = 50 and S is the length of the traverse in km. If your traverse is outside the above tolerance, check all computations before discussing the matter with your supervisor. A remeasurement of some lines may be necessary.

Field Notes

(a) Sketch of traverse showing bearings to distant stations (orientation targets) at start and finish, all intermediate stations and angles measured, signed by student preparing the sketch
(b) All direction, zenith angle and slope distance measurements on field form "Traversing and Detail Surveys" (attached in **Appendix Z**), each form signed by the respective booker

Submission

(a) Title page with traverse number, number of group, names of students, date, make, type and serial number of theodolite; make, type and number of reflectors; make, type and serial number of barometer; number of thermometer
(b) All field notes as outlined above
(c) Instrument correction used for the distance meter
(d) All computations as outlined above (each page signed by calculating student) and all totally separate check computations (each page signed by calculating student)
(e) A table of all stations and their final coordinates and elevations, to 0.001 m, signed by the student preparing it.
(f) Appendix (if applicable) with any other workings, drawings, calculations, each page duly signed by the author.
(g) Work Share Statements (duly signed) of all members of the group (see **Appendix Z**)

8. EDM Instrument Calibration

EDM instruments can only be used with confidence, if they are calibrated periodically. A calibration (determination of the overall *Instrument Correction IC*) of an EDM instrument involves (at least) the determination of the following components of the Instrument Correction (IC):

(i) the additive constant (of EDM instrument *and* reflector),
(ii) any departure from linearity over a full unit length (short periodic error correction),
(iii) the scale correction of the EDM observations with respect to the National Standard of length.

The *additive constant* of a combination of an individual EDM instrument and a specific type of reflector is that small amount, which has to be added to every distance measured with the EDM instrument, because the electrical-mechanical-optical origin of the EDM instrument does not lie in the vertical axis of the instrument and the prism corner not in the vertical axis of the reflector.

The *short periodic errors* repeat in a sinusoidal pattern with distance and can be modelled by a forced period Fourier series. Short periodic errors are caused be electrical and/or optical cross-talk between transmitter and receiver signals.

The *scale error* is mainly caused by constant or temperature dependent errors in the modulation frequency. It can be determined by frequency measurement or by comparison with accurate, known distances.

Electronic distance meters and electronic tacheometers are routinely calibrated (at least once per annum) on multi-pillar baselines of known length. Such baselines have been established in all States and Territories of Australia by the respective Department of Lands. However, each surveyor is perfectly capable to calibrate the additive constant and the short periodic errors of distance meters on an "in-house" baseline at more frequent intervals. The procedure used at camp illustrates the design, measurement and analysis procedures used in such cases.

Preparation

Each group of students will design a **six-station** *Heerbrugg-type* EDM calibration baseline of about 300 m length for the area north of the conference centre, between Tank Street and Morpeth Road. It is suggested that students do a brief reconnaissance of the site to see where 300 m long sites are available. See RÜEGER (1996/1990, Sect. 13.2.2, pp. 195-197) for information on ideal sites.

For the design of EDM baselines, the unit length of the distance meter or electronic tacheometer must be known. The supervisor will allocate the distance meters to groups during the briefing. The unit lengths of instruments are given in the respective short instructions and in RÜEGER (1996/1990, Appendix D.) The design of Heerbrugg-type baselines is discussed in detail in RÜEGER (1996/1990, Section 13.2.1.2, pp 190-192). The instructions given there should be followed closely. The selected design should be shown to the supervisor prior to the setting out of the baseline.

Field Procedure

After your baseline design has been accepted by the supervisor, set out the row of six pegs. All pegs must be on line (±1 cm). The slope distances between the first peg and the others should be within ±5 cm of your design distances. The centre of the pegs must be marked with a bullet head nail (flush, unless you use Kern tripods, in which case you sink the nails about 2 mm into the peg). Set up the theodolite or tacheometer over Station 1 for the alignment, level it carefully, and centre it to better than ±1 mm. Set up a second tripod with one reflector/target at the precalculated distance of the last baseline mark (Station 7). Clamp alidade. Turn reflector away from instrument so that this reflector does not interfere with the second reflector used in the setting out of the intermediate stations. Set out intermediate stations with the second reflector mounted on a reflector pole. Draw locality sketch of baseline in your field book. Number pegs with 1, 2, 3, 4, 5 and 6.

Warning: Do not attach the Wild GZT-4 target plates to the Wild GPR1/GPH1 reflector/prism holders in strong wind. Tripods may be blown over in such conditions if the target plates are attached.

The transceiver (walkie-talkie) may be used to facilitate communication between the student on the instrument and the students setting out the pegs. Refer to **Appendix S** for details of channels to be used. Do not use **Emergency Channels**. Keep your radio communications to a bare minimum.

Set up tripods over the intermediate pegs. Make sure that the heights of the tripods are such that all tripods are clearly visible from all other tripods. Adjust height of tripods, where necessary. Then, attach tribrachs, level them, and centre to better than ±1 mm using the optical plummet. With KERN tripods, the centring rod is to be used.

Set the PPM correction of your distance meter to the neutral position (usually zero ppm) and leave it like that during the whole field work. If the standard temperature and pressure need to be entered (rather than a ppm-correction), refer to the instrument manual. (When using the NIKON DTM-300, set the "Weather Compensation" to "OFF": -> FNC -> SET ->2:DIST -> (second item) -> ENT. Nikon NTD-3 and Pentax PX-06D require a setting of +15°C and 760 mm Hg.) – Should your distance meter display any built-in additive constant or reflector constant (or both), book this (these) value(s). **Refer to the in-house instrument manual for the required reflector constant (offset) setting.**

Measure the height of the EDM instrument (from the top of the peg and to mm) and book it.

Attach the reflector (and point it accurately to the EDM instrument) alternatively to the tribrachs at Stations 2, 3, 4, 5 and 6. For each reflector position:

- measure the "**height of reflector**" {to the centre of the reflector} to mm, from the top of the peg and book,
- measure one **zenith angle** (in both faces) to the centre of the reflector,
- measure the **slope distance** four times, repeating the pointing in between,

- record the atmospheric **temperature** and **pressure** (both in the shade),
- measure the "**height of instrument**" {the height of the trunnion axis of the electronic tacheometer} to mm, from the top of the peg and book,
- book all observation on the *EDM field form* (attached in **Appendix Z**)

Note:
The reflectors must be pointed horizontally **and** vertically to the EDM instrument. Only one reflector should be used through out. Book its make, type and number. Pack the second reflector away, once the alignment and setting out has been completed.

Move EDM instrument/theodolite or tacheometer to Station 2 and measure distances and zenith angles to reflector and target, respectively, on Stations 3, 4, 5 and 6. Take notice of instructions given for Station 1. — Move EDM instrument/theodolite or tacheometer to Station 3 and measure distances and zenith angles to Stations 4, 5 and 6. Follow same procedures as on Station 1.

Move EDM instrument/theodolite or tacheometer to Station 4 and measure distance and zenith angle to Stations 5 and 6. — Move EDM instrument/theodolite or tacheometer to Station 5 and measure distance and zenith angle to Stations 6.

Calculations

Compute the mean of the slope distance measurements of all lines. Reduce the zenith angles measured on all lines. From the 15 measured pairs of zenith angles and mean slope distances, compute *(in tabular form)* the height differences of the 15 combinations. (The fact, that the first velocity correction is ignored, does not affect the computed height differences in this case.) Use Eq. (8.27) in RÜEGER (1996/1990, p. 109) for this purpose. Using only the *five inter-station height differences* (1–2,2–3,3–4,4–5,5–6), compute then the peg elevations of the six Stations, assuming an elevation of 0.000 m for the lowest peg. Check the other ten height differences against these elevations. Height differences measured over relatively short distances should agree within a few millimetres. The following table gives an example for the comparison of the "other ten height differences". (Fill in length of line column in your case!)

Line (1)	Comp Δh (m) (2)	Meas Δh (m) (3)	Diff (mm) (4)=(2)-(3)	Length (m) (5)	Line (1)	Comp Δh (m) (2)	Meas Δh (m) (3)	Diff (mm) (4)=(2)-(3)	Length (m) (5)
1–3	–3.514	–3.513	–1	...	2–5	–6.791	–6.790	–1	...
1–4	–6.179	–6.181	+2	...	2–6	–6.961	–6.962	+1	...
1–5	–7.696	–7.703	+7	...	3–5	–4.182	–4.182	0	...
1–6	–7.866	–7.871	+5	...	3–6	–4.352	–4.353	+1	...
2–4	–5.274	–5.271	–3	...	4–6	–1.687	–1.689	+2	...

Make a table of all heights of the EDM instrument/tacheometer and of the reflector/target measured at each station. (A sample is shown on the next page.) Compute the mean height of EDM instrument/tacheometer and the mean height of reflector/target for each station. Compute the difference between heights of EDM instrument/tacheometer and heights of reflector/target at each station and take the mean. Compare and discuss this mean difference with the information given under "Note" below.

The PC program AED used for the analysis of the EDM calibration data assumes that the measurements were carried out from pillars. In consequence, the elevations must be transferred to the "pillar heights". *If (for stations 2,3,4,5) the **reflector/target heights** were always **smaller*** (that is the mean of **(6) is negative**), add these [Column (5)] to the peg elevations (7) to get the "pillar heights" (8). [On Station 1, no reflector was used. Compute a fictitious reflector height subsequent processing take the height of reflector/target as zero and the height of EDM instrument/tacheometer as the "mean difference between heights of EDM instrument/tacheometer and heights of reflector/target" as computed above (mean (6), but positive).

Station	Instr Heights		Reflector Heights		Difference	Elevation	
	Measured	Mean	Measured	Mean		Peg	"Pillar"
(1)	(2)	(3)	(4)	(5)	(6) = (5) - (3)	(7)	(8)
1	1.568	1.568	(calculated)	(1.584)	(0.016)	5.821	7.389
1	1.566	.....	.....	.....	.....	.....	.....
1	1.568	.....	.....	.....	.....	.....	.....
1	1.570	.....	.....	.....	.....	.....	.....
1	1.568	.....	.....	.....	.....	.....	.....
2	1.578	1.578	1.594	1.594	0.016	5.293	6.871
2	1.580	.....	.....	.....	.....	.....	.....
2	1.576	.....	.....	.....	.....	.....	.....
2	1.578	.....	.....	.....	.....	.....	.....
3	1.568	1.568	1.588	1.585	0.017	4.009	5.577
3	1.570	.....	1.582	.....	.....	.....	.....
3	1.566	.....	.....	.....	.....	.....	.....
4	1.575	1.575	1.592	1.592	0.017	2.264	3.839
4	1.575	.....	1.591	.....	.....	.....	.....
4	.....	.....	1.592	.....	.....	.....	.....
5	1.574	1.574	1.591	1.589	0.015	0.760	2.334
5	1.575	.....	1.585	.....	.....	.....	.....
5	.....	.....	1.590	.....	.....	.....	.....
5	.....	.....	1.589	.....	.....	.....	.....
6	(calculated)	(1.516)	1.536	1.532	(0.016)	**0.000**	1.516
6	.....	.....	1.535	.....	.....	.....	.....
6	.....	.....	1.532	.....	.....	.....	.....
6	.....	.....	1.530	.....	.....	.....	.....
6	.....	.....	1.529	.....	.....	.....	.....

If (for Stations 2,3,4,5) the ***EDM instrument/tacheometer heights*** *were always* ***smaller*** than the reflector/target heights (mean of all **(6) is positive**), add the EDM instrument/tacheometer heights (3) to the elevation of the pegs (7) to get the "pillar heights" (8). [On Station 6, the instrument was not set up. Compute a fictitious instrument height based on the reflector height at Station 6 minus the mean difference (6) (from Stations 2-5).] During the subsequent computer processing take the height of EDM instrument/tacheometer as zero and use the "mean difference between heights of EDM instrument/tacheometer and heights of reflector/target" [mean of all (6)] as the height of reflector/target.

NOTE:

- The WILD TC1600, TC1610 and TC1010 are 29.2 mm higher than the old WILD T16 theodolite.
- The WILD Prism GPR1 in tiltable prism holder GPH1 (or GPH3) on fixed height carrier GZR2 (with plate level) is 26.5 mm higher than old WILD T16 theodolite.
- The old WILD T2 is 29 mm higher than the old WILD T16 theodolite.
- The WILD GPR1 prism in GPH1 tiltable prism holder on carrier GRT 10 (set to T2/TC1 position) is 29.0 mm higher than the old WILD T16 theodolite.
- The NIKON DTM-300 electronic tacheometer is 15.6 mm higher than the old WILD T16 theodolite.
- The TOPCON ET-1 electronic tacheometer is 14.6 mm higher than the old WILD T16 theodolite.
- The WILD GPR1 prism, in the tiltable prism holder GPH1, on the carrier GZR3 (with plate level and optical plummet) is 29.4 mm higher than the old WILD T16 theodolite.
- The TOPCON GTS-2 Semi-Electronic Tacheometer is 15.5 mm higher than the old WILD T16 theodolite.
- The SOKKISHA SDM-3ER Semi-Electronic Tacheometer is 23.5 mm higher than old WILD T16 theodolite.
- The NIKON NTD-3 Semi-Electronic Tacheometer is 36.5 mm higher than the old WILD T16 theodolite.
- The PENTAX PX-06D Semi-Electronic Tacheometer is 15.5 mm higher than the old WILD T16 theodolite.

Prepare the computer processing by filling in the three input data forms (see **Appendix Z**) for the EDM calibration program AED. Apply the appropriate barometer corrections to the measurements of atmospheric pressures (see **Appendix Q**). Adopt the following input parameters:

Line 7: P = 06, AUTO = 1, LAB = 0, FIELD = 1, U = unit length of instrument; see

RÜEGER (1996, Appendix D, pp 232-240), ML = 0, MF = 1, C–TERM: see RÜEGER (1996, Appendix D, pp 232-240), D-TERM: see RÜEGER (1996, Appendix D, pp 232-240), HEI = 1
Line 8,9: blank
Line 10: as per Column (8) above
Line 11: as per discussion above, HR = 0.000 m

Transfer the data in the three AED input forms to the computer. Save file as a "text only" file. A sample input file is given in **Appendix P**. On the PC, run the program AED. This program reduces the distances for temperature and pressure (first velocity correction) as well as to a common horizon (at elevation HR) and then computes the adjusted baseline lengths, the precision of an input distance as well as the additive constant and two sine term sand two cosine terms of the short periodic error correction, if statistically significant. If necessary, correct any input errors. Get a paper output of your solution.

Field Notes

(a) Locality sketch of baseline, indicating location of six station and chainage (distance from first station), signed by student doing sketch
(b) Field forms with all EDM, zenith angle and height of instrument/reflector measurements (blank form in **Appendix Z**), each form signed by the respective booker

Submission

(a) Title page - Calibration of a Distance Meter/Tacheometer – Group Number – Names – Date – Instrument make and type and serial number – Reflector make, type and number – Barometer make, type, serial number and correction – Thermometer make, type, number
(b) sketch of the EDM baseline, showing locality, point numbers, inter-station distances and elevations (of pegs), signed by student that did the sketch
(c) computations for design of Heerbrugg-type baseline (each page signed by calculating student) and check computations (each page signed by calculating student)
(d) all field notes (see above)
(e) all computations (see above, each page signed by calculating student) and all check computations (each page signed by calculating student)
(f) longitudinal profile of baseline, showing chainage and elevations of pegs and "pillars", signed by student doing the drawing
(g) discussion of results of analysis with program AED. In particular list the final instrument correction (IC) (which is the sum of additive constant and the short periodic error correction) and its precision, the precision of a (mean of four) distance measurement, the values and precisions of the adjusted distances. Each page or chapter is to be signed by the author.
(h) Appendix (if applicable) with any other workings, drawings, calculations, each page duly signed by the author.
(i) Work Share Statements (duly signed) of all members of the group (see **Appendix Z**)

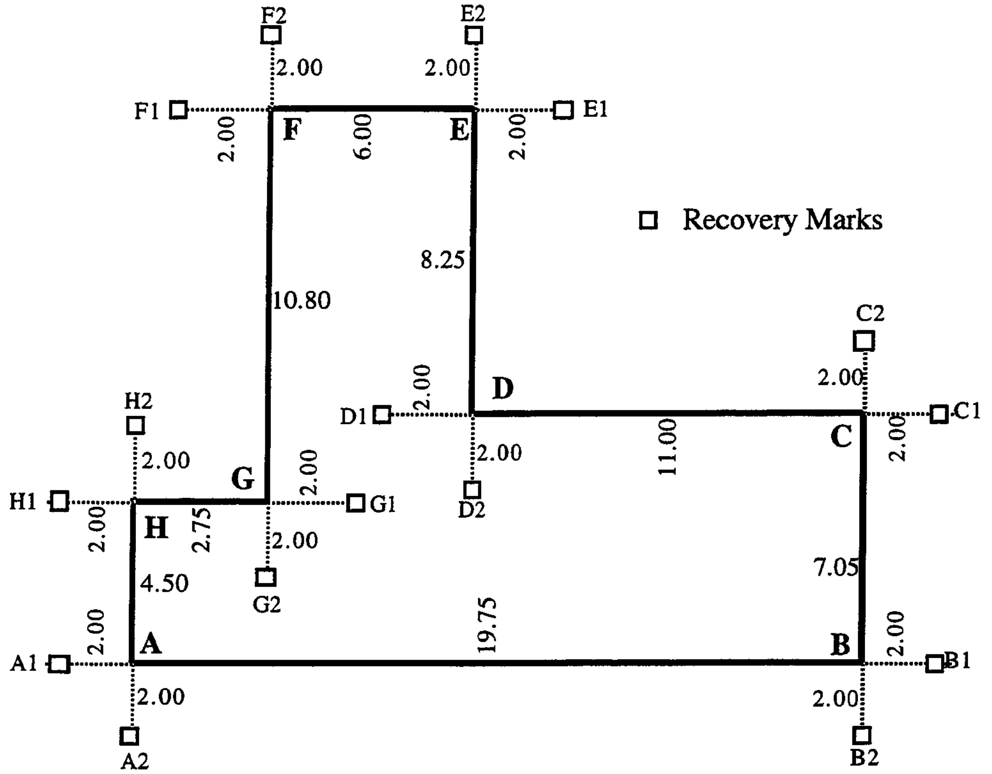
9. Building Set-Out

The building shown in the figure below (all measurements in metres) is to be set out on **Lot No. 7** of the cadastral plan shown in **Appendix N**. To do so, Lot No.7 of the subdivision must be set out first. (The Point "V" of the parcel as well as the direction from Point V to Point W will be indicated to you in the field by the supervisor.) The owner of the parcel wishes that the side A-B of the building be set out parallel to and as close as possible to the boundary V-W and as close to the road as possible (that is at minimum set back). Boundary and building should be set out to ±10 mm (relative to Point V and line V–W).

The architect's plan shows the width of the eaves and gutters as 0.600 m. The following **Building Regulations** apply and must be considered in the set out:

- minimum distance between gutter and boundary is 0.675 m
- minimum distance between building and boundary is 0.900 m
- minimum set back of the building's wall from the (circular) road boundary is different for each group: 6.400 m + {(0.100 m) × GrNo}

where the number (1 – 32) of the student group is denoted by 'GrNo'.
[e.g. Group No. 30 –> minimum set back = 6.400 + 3.000 = 9.400 m]



All dimensions in metre.

Preparations

The setting out of the parcel and the building is to be prepared **before the Camp**. The following approach is suggested for the computation of the setout data:

- Select a local coordinate system for all computations, with **V** as the origin and the y-axis (Easting) towards and through **W**. Compute the coordinates of V, W, X, Y, Z.
- Check the closure of the traverse around Lot No.7. Adjust the closed traverse, if required.
- Based on the available data of the circular road boundary, compute the coordinates of the centre "CE" of the curve.
- Based on the building regulations given, compute the minimum building offset (side A–B) from the boundary V-W.
- As the owner requests that the house be at minimum set back from the road and the boundary V-W, either A, H or F will be at the minimum set-back from the circular road boundary and, thus, at a given distance (radius + minimum road set-back) from the centre CE of the circular curve.
- Compute the coordinates of that point (either A, H or F), which is closest to CE, under the condition that A–B is parallel to V-W and a minimum legal offset from it.
- Once the coordinates of the point at minimum road offset (either A or H or F) are known, the **coordinates of all** other **building corners** compute easily, as A-B is parallel to the Easting axis of the local coordinate system.
- From the coordinates of the building corners A to H, compute the coordinates for all recovery marks A1, A2, B1, B2, ... H1, H2. Note that no recovery points should be placed *across the boundary*. Where necessary, such marks should be placed **on the boundary** (at less than 2.00 m from the building alignment) with the non-standard offset marked on the sketch. (See also **Appendix N.**)
- Once the coordinates of all boundary corners, all building corners and all recovery marks have

been computed, **compute the bearings and distances** to all boundary corners and recovery marks **from two boundary corners** (V to Z). As V defines the origin of your local datum, it must be used as one of the two instrument stations. The second station can be any other boundary corner (W, X, Y or Z).

- **Check all your computations** by plotting the coordinates at a scale of 1:250. Check your set-out data on this plot with protractor and rule. This plot is to show the boundary marks, the building corners, the recovery points. Clearly mark the stations from which the lot and the building are to be marked and checked. During the fieldwork, all steel tape measurements taken will be booked on this plot.

- As special attention must be paid to the squareness of the building, it is appropriate to compute all diagonals between recovery marks, which can be measured with a steel tape (less than 30 m).

All **above computations must be carried out by both** members of the group. (Refer also to the Section "Preparations" on Page 1.) If any computations are wrong, the set out of the building will fail.

Field Procedure

The field work is carried out with electronic tacheometers. Atmospheric temperature and pressure must be measured (and booked) at the beginning, at noon and at the end of the EDM tacheometry work. After correcting for the additive constant of the barometer (see **Appendix Q**), these values (or ppm corrections computed from these) are entered into the electronic tacheometer.

- At the Point V, which has been provisionally marked by the supervisor, place a dumpy peg and mark its centre with a nail (nail head about 5 mm above peg). Place marker peg next to it. Set up your electronic tacheometer. Centre (to millimetre) and level it. Use the umbrella to shade the instrument. Set the appropriate ppm and reflector corrections in the instrument. Switch the display to give a readout of direction and horizontal distance.

- In direction to W (also provisionally marked by your supervisor), set out the Point W as per your computations and mark with a dumpy peg and nail (nail head about 5 mm above peg) and flag with marker peg.

- Point from V to W and set the horizontal circle to 90°00'00" (bearing). Then set out the following marks by bearing and distance: X, Y, Z. These points are marked with dumpy pegs (flush with ground, centre marked eventually by short galvanised iron nail (GIN), nail head about 5 mm above peg). Set marker pegs next to these marks. First, the builder's pencil is used to draw lines on the peg for the correct direction and distance. Once the final position has been obtained, hammer in the nail until its head is about 5 mm above the peg. The final measurements to the nail on the peg should be booked on the form *Traversing and Detail Surveys* (**Appendix Z**). The misclosures between original set-out and check measurements should be recorded in tabular form.

- Then set out the recovery points at each building corner (on line with house walls, at 2.000 m offset) by bearing and distance: A1, A2, B1, B2, ... H1, H2. Marking is with 600 mm long 50x50 mm square pegs (about 20 cm in ground, 40 cm above ground), with short galvanised iron nails (nail head about 5 mm above peg because of attachment of string line). (As mentioned before no recovery points should be placed *across the boundary*. Where necessary, such marks should be placed **on the boundary** with the non-standard offset marked on the sketch.) The final measurements to the nail on the peg should be booked on the form *Traversing and Detail Surveys* (**Appendix Z**). The misclosures between original set-out and check measurements should be recorded in tabular form.

- Before leaving the station, check direction to W. (If this reading is no longer 90°00'00", decide on the basis of the ±10 mm requirement, if the set-out has to be repeated.)

- Move your instrument to the second station of your choice. Shade, centre, level and orientate tacheometer. Measure the temperature and the pressure and set the ppm correction. In turn, set-up the reflector rod (stabilised with two ranging poles) on all boundary marks (V to Z) and all recovery pegs (A1, A2, B1, ... H1, H2). These (check) measurements from the second station should be booked on the form *Traversing and Detail Surveys* (**Appendix Z**). The misclosures between the computed set-out data and these check measurements should be recorded in tabular form. The set out must be improved if the misclosure is inconsistent with the required set-out accuracy. (The differences should below 10 mm. If this is not the case, talk to your supervisor.)

- Mark building outline with your 125 m long builder's string line. (**Do NOT cut at any time.**) Fix line at A1, go to B1 and then continue to B2, C2, C1, D1, D2, E2, E1, F1, F2, G2, G1, H1, H2, A2. Tie line at endpoint. **Visually inspect** the string line for the right angles at the corners.
- Use the plumbob to establish the actual building corners (A, B, C, D, E, F) from the intersections of the string lines. Mark house corners with short galvanised iron nail (nail head about 5 mm above peg) in dumpy pegs.
- Measure all precomputed diagonals between recovery pegs as well as the distances between building corners and their recoveries with the 30 m tape. Book measurements and difference from nominal on prepared 1:250 field sketch.

Once the group is confident that the set out of the parcel and the building has been completed satisfactorily, the supervisor will request that the group carry out some quality control measurements. A form for these measurements is given in **Appendix Y**. The station, coordinates and orientation for these measurements will be given by the supervisor after the group has indicated the completion of the set-out. *Directions and horizontal distances* are to be recorded to all boundary marks, building corners and recovery pegs.

Field Notes

(a) Diagram of parcel and building, showing all points set out, location of recovery point, any check measurements with tape, and all instrument set-ups, signed by preparing student
(b) Field forms with measurements by EDM tacheometry (attached in **Appendix Z**), each page signed by respective booker
(c) Table with discrepancies between original set-out and check measurements, signed by student doing the calculations (If applicable, indicate any action taken!)
(d) Form with quality control measurements requested by supervisor (**Appendix Y**), signed by booker

Submission

(a) Title page - Lot and Building Set-Out Morpeth – Group Number – Names – Date – Instrument make and type and serial number – Reflector make, type and number – tape make, type, number and condition – Barometer make, type, serial number and correction – Thermometer make, type, number
(b) All field notes (as outlined above)
(c) Discussion of the survey method adopted to set out the parcel and building and sequence of field measurements, signed by author
(d) All computations in preparation of the set-out (set-out from 1st station and (check) set-out from 2nd station) and all check computations **(as done prior to begin of camp, separately by each student, each page signed).**
(e) Neat tables of set-out data, signed by preparing student
(f) Discussion of field work and of achieved accuracy, signed by author
(g) A sketch (about 1 to 500), showing the set-out building in relation to the boundaries, the nominal wall lengths and the location of the recovery points, duly signed by preparing student (See **Appendix N** (bottom) for example). This sketch would be given to the owner or builder after the peg out.
(h) Neat pencil plot at a scale of 1 to 250, showing the boundary marks, the building marks and the stations from which the lot and the building were marked and checked. Show all measurements which were made with the steel tape. Plot signed by student preparing it.
(i) Appendix (if applicable) with any other workings, drawings, calculations, each page duly signed by the author.
(k) Work Share Statements (duly signed) of all members of the group (see **Appendix Z**)

10. Rules on Fieldwork, Office Work, Submissions and Assessment

Group submissions for each exercise are required on the day of the exercise. The field notes, calculations and plans to be submitted for marking are stated under *Submission* for each survey task. Because the submissions are prepared on a group basis, **all tasks in field and office must be equally shared.**

In the field, assuming groups of two students, each student must do about 50% of the measurements with the instrument and act as a field hand for the other 50% of measurements. The quality of the field notes, field work, calculations and plan drawing will be used to assess the submissions. All parties should ensure that the field notes are neatly set out and complete. Erasures are not permitted: both the original figure and the corrected figure should be legible. Poor field notes are not acceptable.

The **office work** component of any exercise begins after the return from the field (and after the return of the equipment to the store) and ends at the time of submission, with some interruptions for dinner and briefings. Students are to work on their reductions, calculations, plans and reports in the **nominated work rooms** (and not in the sleeping quarters). Students **not working in the rooms nominated for office work** are presumed to be in the field or not working on any exercises.

In the office, both students do manual calculations separately (Both sets must be submitted!) and divide the other work equally. In the case of plan drawings, one student does the draft plan on cartridge paper (in pencil) and the other student the ink plan (on tracing paper), for example. **All field notes, computations, chapters in submission and plans must identify the author, page-by-page, and must be signed by such.**

Students have to indicate their contribution to each exercise, in field as well as in office, on the ***Work Share Statements.*** Each student will fill in, sign for correctness and submit one of these forms per exercise. Please note that all listed contributions must be documented and submitted. Contributions that are not backed up by field notes, plans, computations and other submitted papers do not count. The supervisor will review and compare the statements from the different group members. Any disagreements will have to be resolved. The Camp Director reserves the right to expel from Camp those students that submit false *Work Share Statements.*

In general, the **submissions** are to be **handed in by 22.00 h** on the day of the exercise. On the **last day**, the submissions must be **handed in by 18.00 h**. **Submissions received after these deadlines will not be assessed.** All workings must be submitted, with "drafts" and "checks" in appendices. Items not submitted are presumed not to exist.

Due to the group nature of the exercises and the fact, that time for submissions is limited, only two grades will be awarded in this Camp. The **grades** are either **SATISFACTORY** or **FAIL.** Students are advised that, in consequence, the Camp will not count towards the honours grading.

In principle, both students of a group will be allocated the same mark unless the submitted *Work Share Statements* and/or the reports by the supervisors indicate the lack of contribution by one student. **Students not sharing the work equally (as outlined above) may get their marks reduced. In borderline cases, this may lead to one student passing the subject and the other failing it.**

11. Conflict Resolution

Students enrolled in the subject will be ask to **form groups (of 2 students)**. Students failing to do so within the given time frame will be put into groups by the Technical Director. Considering the above rules (see Section 10), students should select their group partners carefully. Before Camp, the Technical Director is able to move students between groups, as long as all students involved agree to the changes, **in writing**.

Should **conflicts** arise between the members of a group **at Camp**, the students involved should **notify the Technical Director** as early as possible, **in writing** (with details provided, in writing). The Technical and the Administrative Directors will then try to resolve the matter with the parties concerned. If conciliation is not possible, the students involved can try to arrange new groups. If all students concerned give their written consent to the proposed changes, the Technical

Director will announce the group changes, which then come into force on the next possible field day (and the briefing on the night before it). If no new groups can be arranged to the satisfaction of all concerned, the conflicting group members will leave camp and apply for discontinuation of the subject (without failure). Depending on the agreement between UNSW and the Camp management, it might or might not be possible to refund at least part of the non-used portion of the Camp fees.

12. Clearance Certificate

See the Administrative Director after having the Clearance Certificate (**Appendix X**) signed by the Storeman and the Technical Director. The clearance certificate is issued to groups, not individuals. **All losses (see Appendix A for issued equipment) and damages must be reported to the storeman.**

A/Prof. J. M. Rüeger
Technical Director
September 1998

(blank page)

List of Equipment

Group Equipment (collect on first day, return on last) (capacity: 12 groups)

1	hammer
1	2 m folding ruler
1	3 m pocket tape
1	clip board
1	plumb bob
1	chaining thermometer
1	barometer THOMMEN "Classic" or "Everest 6000 m" or AIR "HB-1A"
1	marker pen (black)

Precise Levelling (capacity: 11 groups)

1	digital precision levelling instrument TOPCON DL-101C (10 off) or Wild NA3000 (1 off)
1	matching tripod for above
2	charged on-board batteries for above
1	3 m bar code invar staff with attached staff bubble, matching above instrument
1	staff shoe (to prevent staff from sliding off change spike, standard accessory for TOPCON staffs, inhouse device for WILD instrument)
2	staff support rods (for holding staff upright)
2	change spikes
1	survey umbrella (in wet weather)
1	**matching** steel base for above (in wet weather)

Dam Capacity Survey (capacity: 5 groups, 10 planimeters)

1	electronic tacheometer NIKON DTM-300 in carrying case, with tribrach, DC-DC converter and battery cables
1	corresponding tripod for above
1	Wild GPR1 prism with tiltable prism holder GPH1, with target plate GZT4 (attached to rod below)
1	Wild reflector rod GLS 11 (with spot bubble)
1	12 V car battery (charged)
2	staff supports (rods for holding reflector rod)
1	survey umbrella
1	**maching** steel base for above
1	set of nylon cords and pegs for umbrella
1	PLANIX planimeter (with instructions)

Building Set-out (capacity: 5 groups)

1	electronic tacheometer NIKON DTM-300 in carrying case, with tribrach, DC-DC converter and battery cables
1	corresponding tripod for above
1	12 V car battery (charged)
1	Wild GPR1 prism with tiltable prism holder GPH1, with target plate GZT4 (attached to rod below)
1	Wild reflector rod GLS 11 (with spot bubble)
1	additional plumb bob
1	30 m steel tape
2	ranging rods (for setting out and stabilization of reflector rod)
2	red-and-whites
1	survey umbrella
1	**maching** steel base for above
1	set of nylon cords and pegs for umbrella

15	wooden 50x50 mm dumpy pegs (includes 2 spares)
18	600 mm long 50x50 mm square wooden pegs (includes 2 spares)
7	600 mm long marker pegs ("stakes")
40	short galvanized iron nails (clouts) (25 mm long, 1")
1	builders string line **(125 m) – not to be cut at any time !**

Traverse (capacity: 5 groups)

Note: Students use exactly the same instrument for EDM Traverse and EDM Calibration

1	survey umbrella
1	**matching** steel base for above
1	set of nylon cords and pegs for umbrella
1	second 2 m folding ruler
1	12 V car battery

PLUS EITHER:

OR (5 off):

1	Electronic tacheometer WILD TC1610 in carrying case, with battery cable
1	corresponding WILD GST-20 wooden tripod
2	additional wooden tripods
2	WILD prisms GPR-1 in tiltable prism holders GPH-1 with target plates GZT-4 on WILD prism carriers GRT-10 in WILD GDF-22 tribrachs (with optical plummet), in carrying case

OR (2 off, spare):

1	Electronic tacheometer WILD TC1010 in carrying case, with battery cable
1	corresponding WILD GST-20 wooden tripod

EDM Instrument Calibration (capacity: 5 groups)

Note: Students use exactly the same instrument for EDM Traverse and EDM Calibration

10	25 mm bullet (jolt) head nails
1	2 m folding ruler
7	wooden dumpy pegs
7	600 mm marker stakes
1	survey umbrella
1	**matching** steel base for above
1	set of three nylon cords and pegs for above
1	12 V car battery (**charged**)
2	transceivers, with fitted batteries, in wooden box
2	sets of spare batteries for above

PLUS EITHER:

(5 off):

1	Electronic tacheometer WILD TC1610 in carrying case, with battery cable
1	corresponding WILD GST20 wooden tripod
5	additional wooden tripods
2	WILD prisms GPR-1 in tiltable prism holders GPH-1 with target plates GZT-4 on WILD prism carriers GRT-10 in WILD GDF-22 tribrachs, in carrying case
3	additional tribrachs WILD GDF 6
1	WILD reflector rod GLS 11 with spot bubble

OR (2 off, spare):

1	Electronic tacheometer WILD TC1010 in carrying case, with battery cable
1	corresponding WILD GST-20 wooden tripod

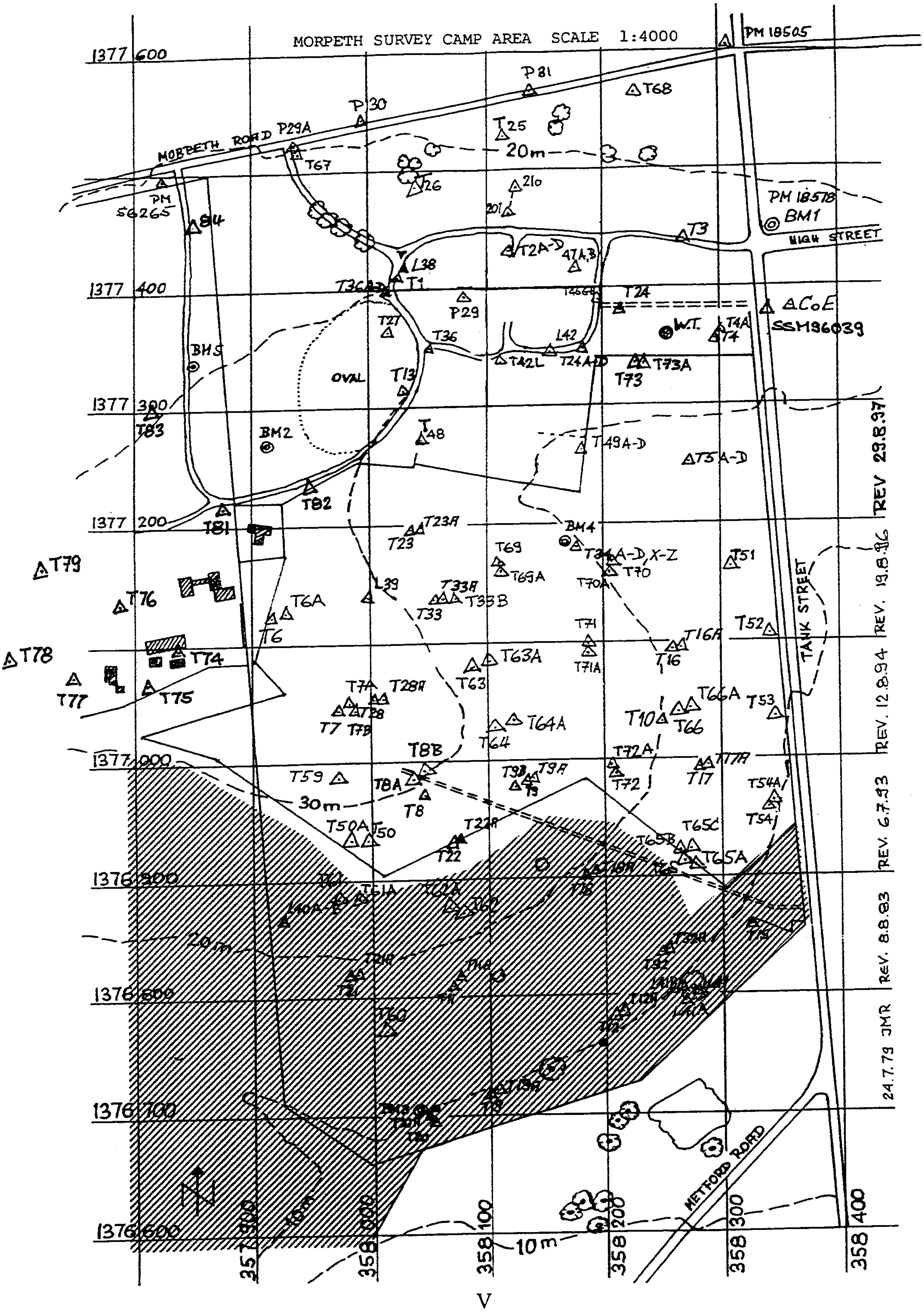
Note for Storeman:

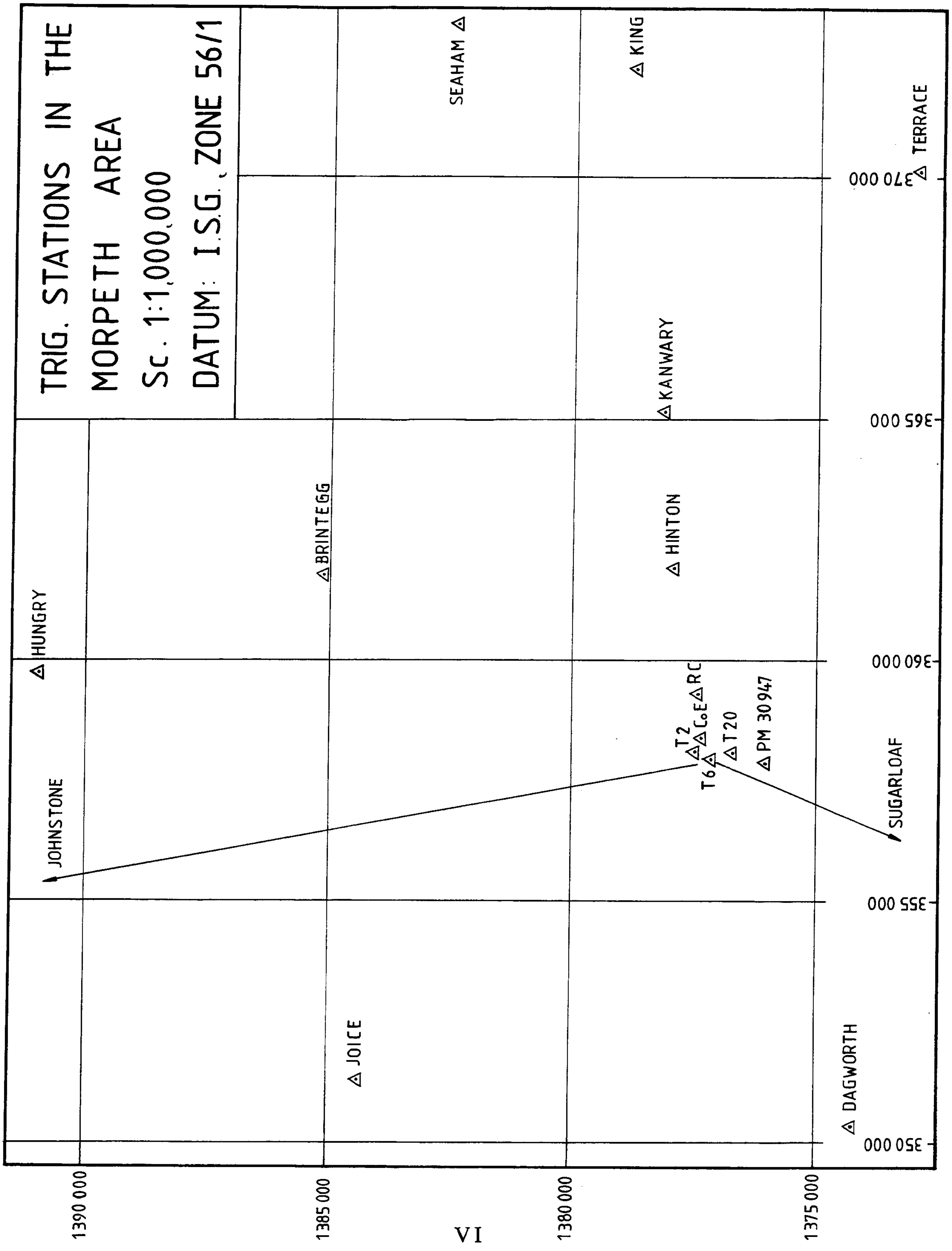
For 5 EDM Calibration groups and 5 EDM Traverse groups, at total of 25 additional tripods (not including those permanently assigned to the electronic tacheometers listed) are required. The 10 TOPCON wooden tripods assigned to the TOPOCON DL-101C digital levels are already at Camp for the levelling excercise.

Thus, an additional 15 tripods must be selected from the following list of suitable tripods:
WILD tripods GST-20 (of new T16 theodolites: T112, T113, T119, T120, T121; of theodolites Wild T2: T86, T90, T91, T92, T105, T106; GST-20 tripods No.1, No.2, No.3, No.4, No.5, No. 6, No.7)

A/Prof. J. M. Rüeger
Technical Director
September 1998

(Blank Page)


MORPETH SURVEY CAMP AREA SCALE 1:4000
PM 18505
1377 600
P81
T68
P30
T25
MORPETH ROAD
P29A
20m
T67
26
210
201
PM 56265
PM 18578
BM1
84
T3
HIGH STREET
T2A-D
47A,B
L38
T36A-D
T1
1377 400
P29
T24
ΔCoE
SSM96039
T27
W.T.
T4A
T4
BHS
T36
L42
T42L
T24A-D
T73
T73A
OVAL
T13
1377 300
T83
BM2
T48
T49A-D
T5A-D
T82
1377 200
T81
T23A
T23
BM4
T34A-D, X-Z
T69
T69A
T70A
T70
T51
T79
L39
T33A
T33B
T33
T6A
T6
T76
T71
T71A
T16A
T16
T52
TANK STREET
T78
T74
T63A
T63
T77
T75
T7A
T28A
T7
T7B
T28
T64A
T64
T10
T66A
T66
T53
T8B
1377 000
T59
T8A
T8
T9B
T9A
T9
T72A
T72
T17
T17A
T54A
T54
30m
T50A
T50
T22A
T22
T65C
T65B
T65A
T18A
T18
T65
1376 900
T61
T61A
T62A
T62
T40A-B
T15
20m
T21A
T21
T11A
T11
T32A
T32
L41B
L41
L41A
1376 800
T12A
T12
T60
T19A
T19
1376 700
T20
METFORD ROAD
1376 600
N
10m
10m
357 900
358 000
358 100
358 200
358 300
358 400
REV 29.8.97
REV. 19.8.96
REV. 12.8.94
REV. 6.7.93
REV. 8.8.93
24.7.79 JMR


TRIG. STATIONS IN THE MORPETH AREA
Sc. 1:1,000,000
DATUM: I.S.G. ZONE 56/1
SEAHAM
KING
TERRACE
KANWARY
BRINTEGG
HINTON
HUNGRY
JOHNSTONE
T2
CoE
RC
T6
T20
PM 30947
SUGARLOAF
JOICE
DAGWORTH
370 000
365 000
360 000
355 000
350 000
1390 000
1385 000
1380 000
1375 000

CO-ORDINATES AND ELEVATIONS OF CONTROL POINTS

HORIZONTAL DATUM:
N.S.W. I.S.G. ZONE 56/1 (Epoch 1996)

VERTICAL DATUM:
A.H.D. (Epoch 8/1997)

POINT	EASTING	NORTHING	ELEVATION	MARKING
Brinteg	361 729.566	1385 116.003		Trig. Stn.
CoE (St. James)	358 358.272	1377 381.928	39.34	Top Belfry Spike (New 1993)
Dagworth	350 341.950	1374 224.629	37.0	Pillar
Great Sugarloaf	350 239.335	1359 230.390		Trig. Stn.
Hinton	361 923.669	1377 905.244	35.74	TS. Centre of vane
Hungry	359 765.570	1390 921.962	271.0	Pillar
Johnstone	354 715.958	1395 127.151	349.0	Cairn with pole
Joice	351 288.023	1384 351.074	138.1	Pillar
Kanwary	365 132.047	1378 135.815	62.61	TS. Centre of vane
King	372 255.646	1378 750.833	139.80	Pillar
RC (Catholic Ch.)	359 287.787	1377 396.101		Church spire top
Seaham	373 153.509	1382 462.894	177.51	Pillar
Terrace	369 999.464	1372 942.301	30.5	Ground mark
*BM1	358 343	1377 443		Survey mark (=PM18578)
*BM2	357 901	1377 270	33.961	Iron bolt on manhole
*BM4	358 172	1377 183		G.I. bolt in concrete block
*BM5	357 851	1377 339		Brass bolt in concrete block
*T2	358 118	1377 430	26.274	Pin in concrete block
T4	358 296.258	1377 356.073		Bolt in G.I. Pipe in concrete
T5A	358 275.183	1377 255.332	17.97	Bolt in G.I. Pipe in conc
T5B	358 276.820	1377 257.823	18.21	Bolt in G.I. Pipe in concrete
T5C	358 278.469	1377 260.335	18.37	Bolt in G.I. Pipe in concrete
T5D	358 280.099	1377 262.818	18.60	Bolt in G.I. Pipe in concrete
T6	357 916.268	1377 124.649	35.729	Pin in concrete block
T6A	357 920.577	1377 127.155		Bolt in G.I. Pipe in concrete
T7A	357 974.276	1377 049.175	33.879	Bolt in G.I. pipe in concrete
T7B	357 975.225	1377 047.108	33.824	Bolt in concrete block
T9	358 132.046	1376 981.634		Pin in concrete block
*T10	358 248	1377 034	19.975	Pin in concrete block
*T22	358 068	1376 932	**	Bolt in concrete block
T34	358 173.043	1377 181.800	20.76	Bolt in G.I. Pipe in concrete
T34A	358 175.981	1377 182.371	20.54	Bolt in G.I. Pipe in concrete
T34B	358 178.931	1377 182.937	20.36	Bolt in G.I. Pipe in concrete
T34C	358 181.864	1377 183.501	20.11	Bolt in G.I. Pipe in concrete
T34D	358 184.827	1377 184.070	20.04	Bolt in G.I. Pipe in concrete
T34X	358 164.335	1377 180.133	21.31	Bolt in G.I. Pipe in concrete
T34Y	358 167.123	1377 180.669	21.17	Bolt in G.I. Pipe in concrete
T34Z	358 170.112	1377 181.242	20.96	Bolt in G.I. Pipe in concrete
*L42	358 163	1377 344		Bolt in road
T49	358 188.540	1377 273.978	20.40	Bolt in G.I. Pipe in concrete

CO-ORDINATES AND ELEVATIONS OF CONTROL POINTS (Cont.)

HORIZONTAL DATUM:
N.S.W. I.S.G. ZONE 56/1 (Epoch 1996)

VERTICAL DATUM:
A.H.D. (Epoch 8/1997)

POINT	EASTING	NORTHING	ELEVATION	MARKING
T49A	358 191.078	1377 275.595	20.50	Bolt in G.I. Pipe in concrete
T49B	358 193.601	1377 277.199	20.53	Bolt in G.I. Pipe in concrete
T49C	358 196.136	1377 278.812	20.50	Bolt in G.I. Pipe in concrete
T49D	358 198.672	1377 280.424	20.61	Bolt in G.I. Pipe in concrete
T50	357 980.467	1376 934.380	27.976	Bolt in G.I. Pipe in concrete
T50A	357 975.481	1376 934.410	27.885	Brass bolt in concrete block
T51	358 307.653	1377 161.385	13.436	Bolt in G.I. pipe in concrete
T52	358 342.026	1377 103.670	13.310	Bolt in G.I. pipe in concrete
T53	358 345.596	1377 031.318	11.337	Bolt in G.I. pipe in concrete
T54	358 343.651	1376 955.264	10.106	Bolt in G.I. pipe in concrete
T54A	358 343.170	1376 961.441	10.180	Bolt in concrete block
T59	357 969.298	1376 986.009	31.362	Bolt in concrete block
*PM18505	358 308	1377 602	13.441	Permanent Mark

* Levelling mark: approximate coordinates only
** Ask lecturer for elevation, if required for levelling exercise
During the Camp, beacons will be erected on Stations **T4**, **T6A** and **T9** (shown in bold print above)

A/Prof. J. M. Rüeger
August 1997

DETAIL and CONTOUR SURVEY
with Electronic Tacheometer (Manual Booking)

Page ____

Locality MORPETH
Date 5 OCT 93
Observer J. SMITH
Booker G. PETERS
Set Refl. Const: 0 mm
Begin: Time 07.30 h
End: Time 08.10 h

Tacheometer Make WILD Type TC1610 S/N 365558
Instrument Corr +0 mm Index Corr SEE BELOW
Reflector Make WILD Type GPR-1 No. 7A
Barometer Make THOMMEN Type EVEREST6000 S/N 674500
Add. Constant of barometer: -13 hPa applied? yes / no
Temperature: +21 °C Pressure: 1009 mb ppm corr: +9
Temperature: +24 °C Pressure: 1007 mb ppm corr: +13

Instrum. Station	Reflector Station	Direction	Horiz. Dist.	ΔH	H.I.	H.R.	Collim Height	R.L.	Remarks (on detail (point, weather, ...)
102	CHECK	OF INDEX ERROR							sunny, clear
	Z_{FL}	85°27'14"							Light breeze
	Z_{FR}	274°32'38"	$i = +4"$	✓					
	Σ	359°59'52"							
102	T6A	281°04'46"			1.51		21.59		R.L. of 102 = 20.08m
	CoE	19°06'31"							CHECK OF ORIENTAT.
	R.C.	72°14'32"							CHECK OF ORIENT.
	1	191°14'	55.12	+2.31		1.28		22.62	Spot Height
	2	165°36'	37.89	-1.55		1.20		18.84	Spot Height
	3	136°41'	76.23	-4.46		2.38		14.75	Fence Post

LINE LEVELLING (RISE AND FALL BOOKING)

Date 9 APRIL 1976 Location UNSW Time 0830 - 0930
Instr Type ZEISS NI2 Instr No 143260 Staff No 24
Observer H. MILLER Booker A. Cooper Staffman B. MOSS
Datum A.H.D. Weather OVERCAST, NO WIND

STA NO	BACK	FORE	RISE	FALL	D	RED LEVEL	V	FINAL LEVEL	REMARKS
FORWARD LEVELLING									
75	1 223								B.M.
CP 1	1 733	1 109	0 114		100				
CP 2	1 817	1 584	0 149		90				
CP 3	2 477	1 932		0 115	92				
CP 4	2 845	1 933	0 544		82				
75a		1 722	1 123		88				Temporary B.M.
	10 095	8 280	1 930	0 115	452				
	8 280		0 115						
	1 815 ✓		1 815 ✓						
75a	2 241								TEMPORARY B.M.
CP 5	3 359	1 294	0 947		80				
CP 6	2 791	2 671	0 688		72				
76		0 800	1 991		76				B.M.
	8 391	4 765	3 626	0 000	228				
	4 765		0 000						
	3 626 ✓		3 626 ✓						
BACKWARD LEVELLING									
76	0 756								B.M.
CP 7	2 813	2 682		1 926	80				
CP 8	1 375	3 264		0 451	74				
75a		2 626		1 251	76				TEMPORARY B.M.
	4 944	8 572	0 000	3 628	230				
		4 944		0 000					
		3 678 ✓		3 628 ✓					
75a	1 623								TEMPORARY BM
CP 9	1 813	2 738		1 115	90				
CP 10	2 045	2 365		0 552	84				
CP 11	1 818	1 923	0 122		94				
CP 12	0 969	1 675	0 143		88				
75		1 378		0 409	102				BENCH MARK
	8 268	10 079	0 265	2 076	458				
		8 268		0 265					
		1 811 ✓		1 811 ✓					

Adjustment and Error Analysis of Double Run Levelling

The example below shows three procedures for the adjustment of the levelled height differences as well as one method for the computation of the standard deviation of a levelling run over 1 km. The following definitions and equations are used:

Error Analysis

d_i = difference between the forward and return height difference in a levelling section "i"
= forward height difference minus backward height difference
D_i = length of a levelling section "i" (in km)
p_i = weight of levelling section "i" = $\frac{1.0}{D_i}$
n = total number of levelling sections "i" = number of differences "d_i"
$s_{1\text{km single}}$ = standard deviation of one single levelling run over 1 km
= $\pm(\frac{\Sigma pd^2}{2n})^{0.5}$; in the numerical example below: = $\pm(\frac{24.0}{8})^{0.5}$ = ±1.7 mm
$s_{1\text{km double}}$ = standard deviation of one double levelling run over 1 km
= $\pm(\frac{\Sigma pd^2}{4n})^{0.5}$; in the numerical example below: = $\pm(\frac{24.0}{16})^{0.5}$ = ±1.2 mm

Adjustment Procedure 1: Proportional to Levelled Distance

This method is suitable to adjust random errors in line levelling on a constant slope or in a plain, where the sighting distances and measured height differences do not vary greatly between set-ups.
m = misclosure = (total measured height difference between end points) minus (height difference between end points, calculated from given elevations)
p_i = weight of the levelling section "i" = $\frac{1.0}{D_i}$
v_i = residual (correction) of the levelling section "i"

$$= -(\frac{m}{\Sigma\frac{1}{p_i}}) \times \frac{1}{p_i} = -(\frac{m}{\Sigma D_i}) \times D_i$$

In numerical example below: v_i (mm) $= -(\frac{-4.5 \text{ mm}}{2.31 \text{ km}}) \times D_i$ (km)

Adjustment Procedure 2: Proportional to the Number of Instrument Set-ups

This method is suitable to adjust random errors in line levelling on changing slopes, where the sighting distances and measured height differences do vary greatly between set-ups or different sections of the level run.
p_i = weight of the levelling section "i" = $\frac{1.0}{N_i}$
N_i = number of instrument set-ups in the levelling section "i"
v_i = residual (correction) of the levelling section "i"

$$= -(\frac{m}{\Sigma\frac{1}{p_i}}) \times \frac{1}{p_i} = -(\frac{m}{\Sigma N_i}) \times N_i$$

In numerical example below: v_i (mm) $= -(\frac{-4.5 \text{ mm}}{35}) \times N_i$

Adjustment Procedure 3: Proportional to the Measured Height Differences

This method is suitable to adjust systematic errors in line levelling over significant height differences; ideally, the terminals with given heights should be the lowest and highest points in the level run. Systematic errors may be due to either changes of bench mark heights (e.g. due to expansive soils) or scale errors in measured height differences and are usually indicated by small differences d and large misclosures m. Note that, in this case, the signs of the residuals (corrections) depend on the signs of the height differences!

Adjustment and Error Analysis of Double Run Levelling (Cont)

ΔH_i = measured (mean) height difference in the section "i"

v_i = residual (correction) of the levelling section "i" $= -(\frac{m}{\Sigma \Delta H_i}) \times \Delta H_i$

In numerical example below: $v_i\ (mm) = -(\frac{-4.5\ mm}{46.3395\ m}) \times \Delta H_i\ (m)$

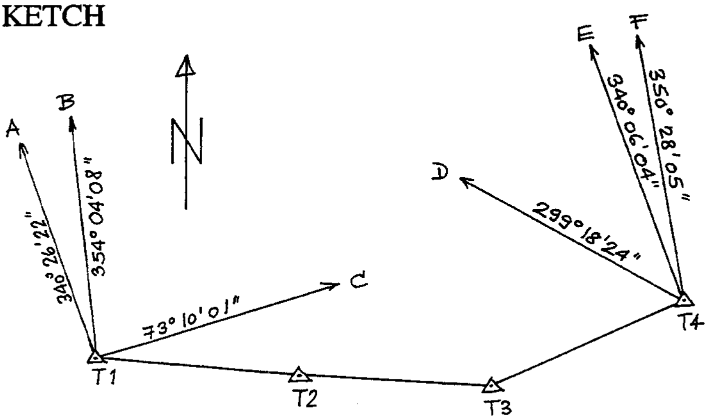
Error Analysis							Adjustment proportional to D			
Sta No	ΔH forward m	ΔH backward m	d mm	D km	d^2	pd^2	ΔH Mean m	v mm	ΔH adjusted m	Elevation m
75	+1.815	+1.814	+1	0.42	1	2.4	+1.8145	+0.8	+1.8153	**28.734**
76	+13.626	+13.629	−3	0.74	9	12.2	+13.6275	+1.4	+13.6289	30.549
77	+32.511	+32.509	+2	0.51	4	7.8	+32.5100	+1.0	+32.5110	44.178
82	−1.613	−1.612	−1	0.64	1	1.6	−1.6125	+1.2	−1.6113	76.689
84										**75.078**
Sum				2.31		24.0	46.3395	+4.4	46.3439	
					Given		46.3440	|		
					Misclose		−0.0045	—^		

	Adjustment proportional to N					Adjustment proportional to ΔH		
Sta No	ΔH Mean m	Set-Ups N	v mm	ΔH adjusted m	Elevation m	v mm	dH adjusted m	Elevation m
75	+1.8145	5	+0.6	+1.8151	**28.734**	+0.2	+1.8147	**28.734**
76	+13.6275	9	+1.2	+13.6287	30.549	+1.3	+13.6288	30.549
77	+32.5100	13	+1.7	+32.5117	44.178	+3.2	+32.5132	44.177_5
82	−1.6125	8	+1.0	−1.6115	76.689_5	−0.2	−1.6127	76.691
84					**75.078**			**75.078**
Sum	46.3395	35	4.5	36.3440		4.5	46.3440	
Given	46.3440	——	|	——^——	——————	|	——^	
m	−0.0045	——^——	——	——————	——————	^		

TRAVERSE FIELD NOTES

APPENDIX H

TRAVERSE SKETCH



TRAVERSING AND DETAIL SURVEYS

PAGE 2

Locality MORPETH
Date 3/7/1993
Observer A.COOPER
Booker B. SMITH
Reflector Type WILD GPR-1

EDM Instrument Type TOPCON GTS2 s/N B45056
Additive Constant -6.4mm (for INTERNAL CONST.)
Theodolite Type TOPCON GST-2 S/N B45056
Index Correction ~ +16"
~~Reflector~~ Constant SET INTERNALLY ("-07"mm)

Time 07.15h
Temperature +20°
Pressure 1033 hPa
Setting of Environmental Corr Dial:
SET TO "0" PPM

Time 08.05h
Temperature +22°C
Pressure 1032 hPa (uncorrected)
SET TO "0" PPM

BARO METER ~~Band~~ No. THOMMEN "EVEREST 6000m ~~Stand. Temp.~~ CORR = -1hPa ~~Stand. Tensions~~ S/N 145267 ~~Spring Balance~~ THERMOMETER No. "12"

STATION	TARGET	OFFSET	DIRECTION				ZENITH ~~DISTANCE~~ ANGLE				DISTANCE		HEIGHT DIFF	HORIZ. DIST.	H.I.	H.T.	REMARKS
			FL	FR	~~CORR~~ Δ	MEAN	FL	FR	SUM	MEAN	SLOPE	~~CORR~~ TO:					
									359°+								
T2	T1	—	0 04 00	180 04 00	0"	0 04 00	84 49 30	275 10 00	59'30	84 49 45	92 349	T1			1 622	1 527	sunny 07.15h
	T3	—	193 42 30	13 42 18	-12"	193 42 24	91 41 18	268 18 06	59'24	91 41 36	92 348	"				1 585	nowind
											92 349	"					
	T1	—	57 33 18	237 33 30	+12"	57 33 24	84 49 24	275 10 00	59'30	84 49 39	92 349	"			1 623	1 526	07.25h
	T3	—	251 11 48	71 12 00	+12"	251 11 54	91 41 12	268 18 12	59'24	91 41 30						1 586	
											89 740	T3					
			RED MEANS			GRAND M					89 741	"					
			0 00 00	0 00 00		0 00 00					89 740	"					
			193 38 24	193 38 30		193 38 27					89 739	"					

SCHOOL OF SURVEYING UNSW

APRIL 1979 JMR

ORIENTATION OF ARC OF DIRECTIONS

Station	Target	Plane Bearing	Observed Direction	Orientation	Oriented Direction	Residual V
		(1)	(2)	(3)=(1)-(2)	(4) = (2)+(0)	(5)=(1)-(4)
ORIENTATION AT STATION T1						
T1	A	340° 26'22"	0° 00'00"	340° 26'22"	340° 26'23"	− 1"
	B	354° 04' 08"	13° 38' 09"	340° 25'59"	354° 04' 32"	−24"
	C	73° 10' 01"	92° 43' 14"	340° 26' 47"	73° 09' 37"	+ 24"
	T2		114° 40' 32"		95° 06' 55"	
			O=	340° 26' 23"	Σ=	− 1" ✓
ORIENTATION AT T4						
T4	T3		0° 00'00"		245° 04' 22"	
	D	299° 18'24"	54° 14'00"	245° 04' 24"	299° 18' 22"	+ 2"
	E	340° 06'04"	95° 01'36"	245° 04' 28"	340° 05' 58"	+ 6"
	F	350° 28'05"	105° 23'51"	245° 04' 14"	350° 28' 13"	− 8
			O=	245° 04' 22"	Σ=	0" ✓

(0) = Mean Orientation = Mean of Column (3) Values
= Plane Bearing of Zero Direction of Arc
(5) = Check: Sum of V = Zero

PREPARED BY J.M. RÜEGER

AUGUST 1984.

TRAVERSE OF MORPETH
FROM T1 TO T4

FORM FOR COMPUTATION OF TRAVERSE

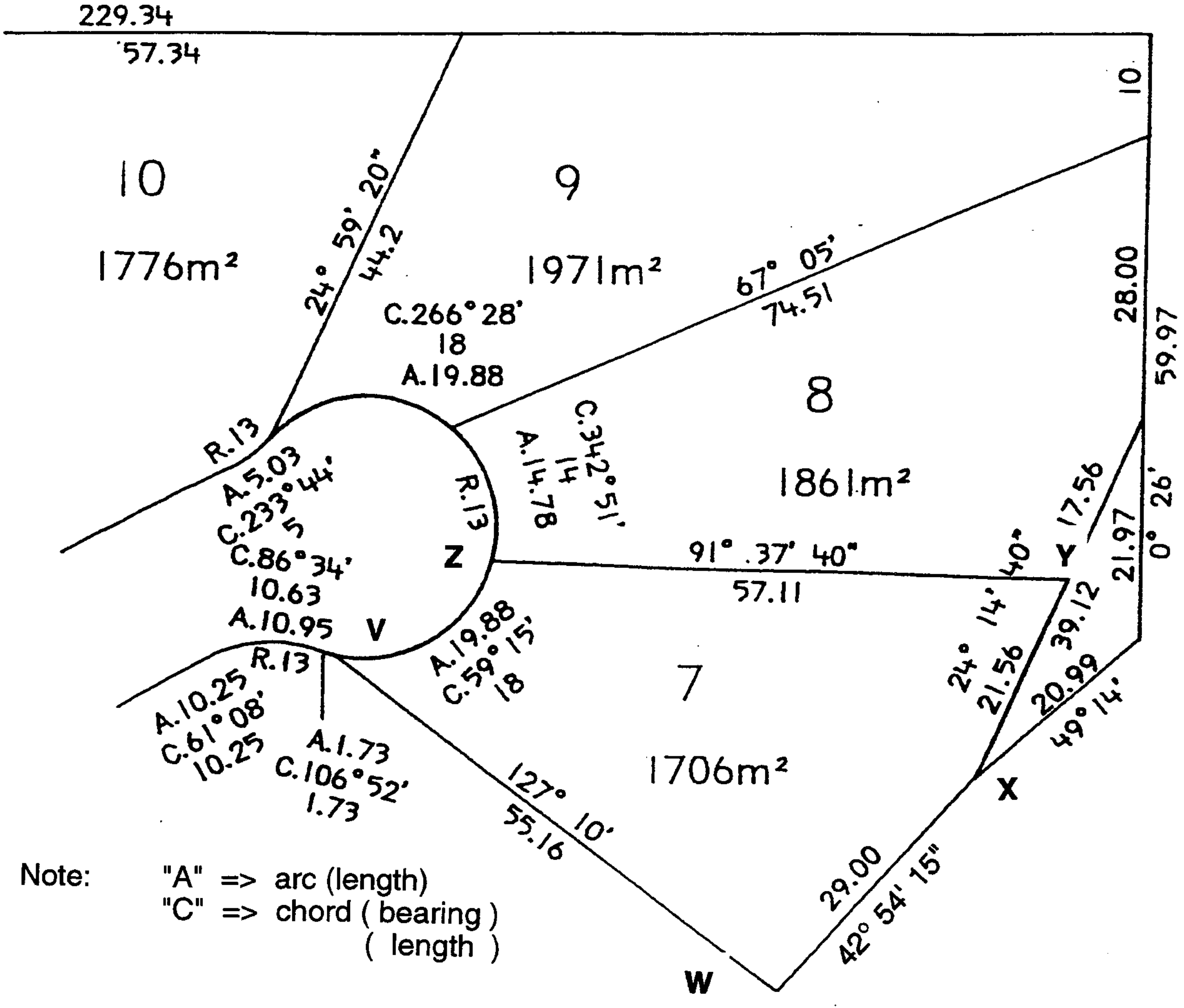
STN	OBSERVED ANGLE β	CORR.	BEARING θ	DISTANCE l (m)	ΔE = l sin θ (m)	COR (mm)	ΔN = l cos θ (m)	COR (mm)	E (m)	N (m)	STN
									358000+	1377000+	
T1											
			95°06'55"	91.946	91.580	+6	-8.198	-3	015.108	410.245	T1
T2	193°38'30"	+15	108°45'40"	89.679	84.914	+6	-28.843	-2	106.694	402.044	T2
T3	136°18'27"	+15	65°04'22"	97.392	88.319	+6	+41.047	-3	191.614	373.199	T3
T4				Σ= 279.017	264.813	+18 ✓	4.006	-8 ✓	279.939 ✓	414.243 ✓	T4
Σβ=	329°56'57"								+264.831	+3.998	ΔCOMP
-2x 180°	-360°00'00"								+264.813	+4.006	ΔOBS
Σβ-2x180°	329°56'57"	(MEASURED)							+ 0.018	-0.008	CORR(=COMP-OBS)
$(\theta_{T3/T4}-\theta_{T1/T2})$	329°57'27"	(COMPUTED)									
CORR=	+30"	(COMP-OBS)									
				Linear Mislose:	$m_\ell = \pm\sqrt{18^2+8^2}$	=	20 mm ✓				
				Angular "	: m_θ =	-	30" ✓				
			TOLERANCES:	Linear	$= 2\times 50\sqrt{0.04+0.28}$ =			34 mm			
				Angular	$= 40''\sqrt{4} = 80''$						
~~* Δθ~~											
~~Sum~~											
~~Angular Misclose~~											

~~* Δθ = Starting bearing – closing bearing~~

Student Group No. 25 Names (1) A. Cooper Computed by B. Smith Date 3 July 1979
(2) B. Smith Checked by A. Cooper

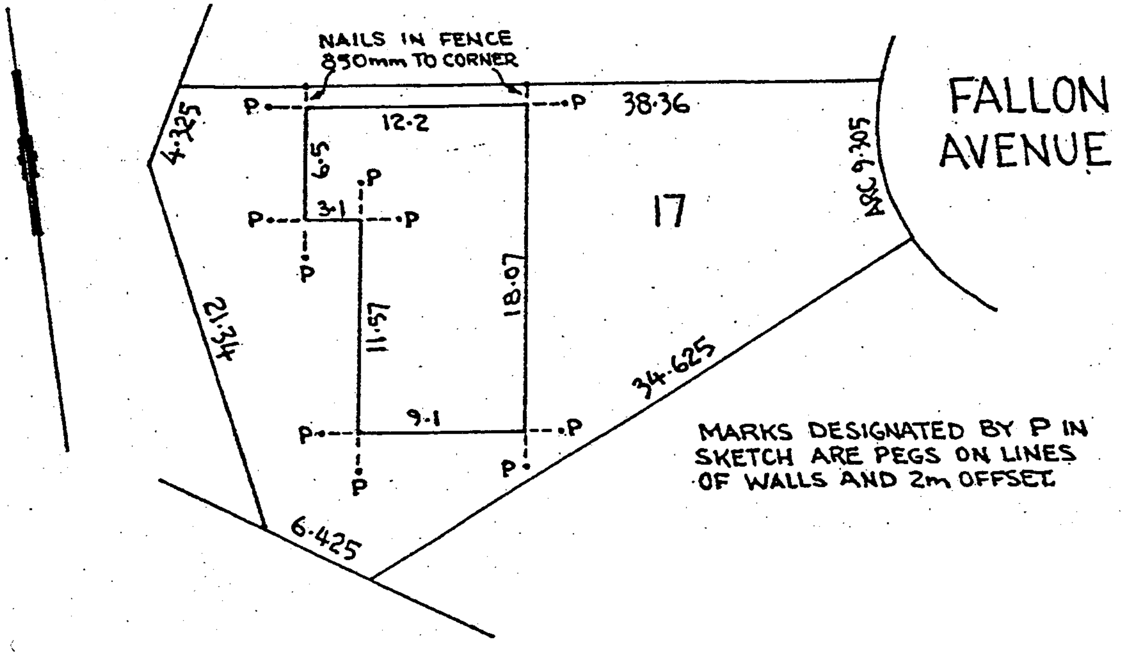
Prepared by S. Ganeshan
21st March 1978
AS AMENDED 1993 (JMR)

Subdivision Plan for Building Set out



Note: "A" => arc (length)
"C" => chord (bearing)
(length)

Sample Sketch of Building Setout



MARKS DESIGNATED BY P IN SKETCH ARE PEGS ON LINES OF WALLS AND 2m OFFSET

Sample Input for EDM Calibration Program AED

```
 KERN DM501              250942
 REGENTS  PARK           KERN
 UNSW                    Leslie/Rusu
 Sun & light winds       19th August, 1982
 SURVEY OF REGENTS PARK BASELINE - no scale, no cyclic
 error -- bias additive constant
  800110.000000002281.9079.1901


   34.303  31.278  30.187  28.501  26.329  23.956  22.252  22.000
    0.171   0.171  34.303
1 2 140.0372          12.4 1034.6 10.6
1 3 200.0442          12.5 1034.9 10.7
1 4 310.0588          13.3 1034.9 11.2
1 5 460.0642          15.3 1035.1 11.6
1 6 650.0815          16.7 1035.2 12.2
1 7 880.0760          18.5 1033.9 12.4
1 8 980.0755          18.2 1033.6 13.3
2 3  60.0068          13.4 1034.8 12.6
2 4 170.0318          14.3 1035.0 12.1
2 5 320.0350          15.0 1035.1 11.2
2 6 510.0505          17.1 1035.0 12.2
2 7 740.0505          18.9 1034.0 12.0
2 8 840.0528          19.1 1033.4 13.5
3 4 110.0208          15.4 1035.0 11.1
3 5 260.0272          14.9 1035.1 11.4
3 6 450.0420          17.3 1035.2 13.6
3 7 680.0420          18.7 1034.1 11.9
3 8 780.0438          19.8 1033.0 13.5
4 5 150.0130          14.3 1035.2 10.9
4 6 340.0235          19.1 1035.1 16.8
4 7 570.0228          18.1 1034.2 11.3
4 8 670.0282          19.2 1032.9 13.2
5 6 190.0222          18.6 1035.1 14.9
5 7 420.0130          18.0 1034.7 12.7
5 8 520.0202          18.5 1032.9 13.3
6 7 230.0020          18.6 1034.9 13.0
6 8 330.0025          19.0 1032.9 13.4
7 8 100.0063          19.7 1032.7 13.6
000
```

ADDITIVE CONTANTS OF BAROMETERS

Make/Type		S/N	01.77	02.80	02.83	02/03.87	01.90	02.93 ✱	08.94	03.95	02.96	03.97
Mechanism	2016/A	271/61	-3.5 mm	+4.0 mm	+4.2 mm	+4.0 mm	+2.2 mm	+2.3 mm	+2.4 mm	-16.8 mm	-16.8 mm	-17.0 mm
"	2016/A	302/62	-3.7 mm	-3.2 mm	-3.6 mm	-3.2 mm	-4.0 mm	-3.4 mm	-2.4 mm	-3.4 mm	-3.5 mm	-3.2 mm
"	2016/A	655/65	-2.8 mm	-3.7 mm	-3.7 mm	-3.5 mm	-0.8 mm	-0.8 mm	-0.6 mm	-0.7 mm	-0.8 mm	-0.9 mm
"	2016/A	656/65	-3.4 mm	-2.0 mm	-1.9 mm	-1.6 mm	-2.1 mm	+4.0 mm	-0.9 mm	-1.9 mm	-1.9 mm	-1.9 mm
"	2016/A	657/65	-1.7 mm	-2.3 mm	-2.2 mm	-2.3 mm	-2.3 mm	-1.8 mm	-2.0 mm	-2.1 mm	-2.1 mm	-2.1 mm
Thommen	2A2	25294	-3.1 mb	-6.4 mb	-2.1 mb	-2.1 mb	-2.8 mb	-3.4 mb	-3.4 mb	-3.5 mb	-3.7 mb	-3.4 mb
"	2A2.511.02	234619	-	-2.0 mb	+0.1 mb	❊ -2.2 mb	+3.1 mb	-2.0 mb	-2.0 mb	-2.5 mb	-2.5 mb	-2.5 mb
"	2A4.611.02	235745	-	-2.1 mb	-4.2 mb	-4.9 mb	-6.0 mb	-5.6 mb	-5.6 mb	-5.6 mb	-6.2 mb	-6.4 mb
"	2A2.511.02	220459	+0.1 mb	+1.1 mb	-2.2 mb	❊ -0.6 mb	-	-0.5 mb	-0.3 mb	-0.5 mb	-0.4 mb	-0.5 mb
Thommen	(Everest)	416441	-	-0.4 mb	-5.8 mb	-4.8 mb	-3.8 mb	-11.0 mb	-11.0 mb	-16.2 mb	-13.1 mb	-19.7 mb
"	(6000m)	416452	-	+0.6 mb	-7.0 mb	-14.5 mb	-14.9 mb	-	-17.3 mb	-15.2 mb	-16.8 mb	-20.7 mb
"		417701	-	+0.2 mb	-17.6 mb	-17.7 mb	-20.3 mb	-20.6 mb	-23.2 mb	-17.5 mb	-18.2 mb	-19.9 mb
"		417728	-	+0.1 mb	+0.3 mb	-0.2 mb	-0.2 mb	-2.7 mb	-2.6 mb	-1.7 mb	-3.3 mb	-4.1 mb
"		418885	-	-	-4.2 mb	❊ -3.3 mb	-14.5 mb	-17.8 mb	-17.5 mb	-18.0 mb	-20.9 mb	-18.4 mb
"		419048	-	+0.0 mb	+1.6 mb	-15.7 mb	-16.9 mb	-19.5 mb	-19.2 mb	-18.9 mb	-20.0 mb	-25.2 mb
"		416394	-	+0.6 mb	-3.4 mb	-6.3 mb	-8.8 mb	-8.5 mb	-10.3 mb	-11.3 mb	-11.8 mb	-12.3 mb
"		674500	-	-	-	-	-5.8 mb	-12.8 mb	-13.3 mb	-12.4 mb	-28.5 mb	❊ -4.1 mb
"		674700	-	-	-	-	-4.5 mb	-17.7 mb	-18.8 mb	❊ -3.1 mb	-1.3 mb	-2.4 mb
"		764314	-	-	-	-	-	+0.3 mb ❁	-1.0 mb	-0.2 mb	-1.8 mb	-2.3 mb
"		775631	-	-	-	-	-	-	-	★ -2.0 mb	-1.6 mb	-1.3 mb
"		776234	-	-	-	-	-	-	-	★ -0.5 mb	+1.1 mb	+1.8 mb
"		776518	-	-	-	-	-	-	-	★ +1.5 mb	+1.7 mb	-2.3 mb
"		777056	-	-	-	-	-	-	-	★ +1.5 mb	+2.3 mb	-0.5 mb
"		777059	-	-	-	-	-	-	-	★ +2.4 mb	+2.8 mb	-2.6 mb
"		777344	-	-	-	-	-	-	-	★ +0.2 mb	+1.9 mb	+1.9 mb
"		777412	-	-	-	-	-	-	-	★ +0.5 mb	+0.0 mb	-1.9 mb
"		777451	-	-	-	-	-	-	-	★ -0.5 mb	-2.2 mb	-2.1 mb
"		777505	-	-	-	-	-	-	-	★ -1.4 mb	-2.7 mb	-2.2 mb
AIR	AIR - HB - 1A	0223	-	-	-	+2.8 mb	+5.6 mb	+10.4 mb	+11.0 mb	+12.5 mb	+13.0 mb	+14.0 mb
"	AIR - HB - 1A	8E0551	-	-	-	-0.8 mb	-1.5 mb	-1.1 mb	-1.0 mb	-1.4 mb	-1.3 mb	-1.4 mb
"	AIR - HB - 1A	8E0716	-	-	-	-0.6 mb	-1.0 mb	-0.8 mb	-1.1 mb	-1.4 mb	-1.3 mb	-1.4 mb
"	AIR - HB - 1A	0D1383	-	-	-	-	-	-1.6 mb	-1.8 mb	-1.6 mb	-1.6 mb	-1.8 mb

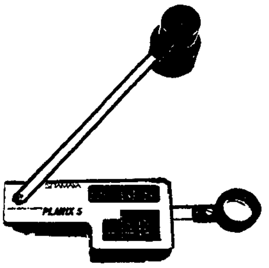
IMPORTANT : Use only the latest additive constant for the reduction of measurements (ie. last column).

❊ Repair work between calibrations. ❁ First calibrated August, 1993. ★ First calibrated July, 1995.

✱ February 1993 calibrations carried out in variable conditions (a/c was not operating in GAS 440)

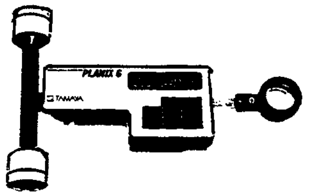
Short Instructions for Electronic Planimeter (Part 1)

PLANIX 5



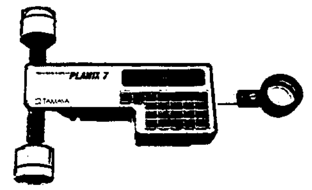
Polar planimeter that will measure area in actual square centimeters or square inches. Area shown in plan or drawing must be calculated from this value. Measuring range: 356mm/14" diameter.

PLANIX 6



Roller planimeter with the same features and equipment as the Planix 5. Measuring range: 300cm/118" × 30cm/11.8"

PLANIX 7



Roller planimeter with numeric keyboard allows user input of scale so area from plan or drawing can be computed. Measuring range: 300cm/118" × 30cm/11.8".

TAMAYA DIGITAL PLANIMETERS **PLANIX**

Which model do you need?

Look for the features that will make your job easier and save time. There are five different Planix planimeters. By answering these questions, you can select the model best suited to your needs:

1. Will measurements on a reduced or enlarged scale be made?
If the need is only to measure areas directly without a scale, the Planix 5 and Planix 6 will do the job quite well. If scale drawing or plans are used, a unit with selectable scales will be faster—and more accurate—because no additional calculation will be needed.

2. Will it be necessary to know the length of line as well as area?
Only the Planix 5000 will provide linear measurement.

3. What is the size of area that will be measured?
Areas that are less than 12" in diameter can be measured with all units easily. If the area is longer horizontally (e.g., cross section), it is easier to use a roller planimeter (Planix 6, Planix 7).

Answers to frequently asked questions about electronic planimeters

What is the difference between roller and polar planimeters?

Roller planimeters are attached to wheels that allow unlimited horizontal travel and vertical travel within the limits of the arm movement. Polar planimeters are attached to a weighted base by an arm that allows movement within a circular area. Planix products contain identical electronics whether you choose roller or polar. We recommend that the user choose roller units because they offer more versatility.

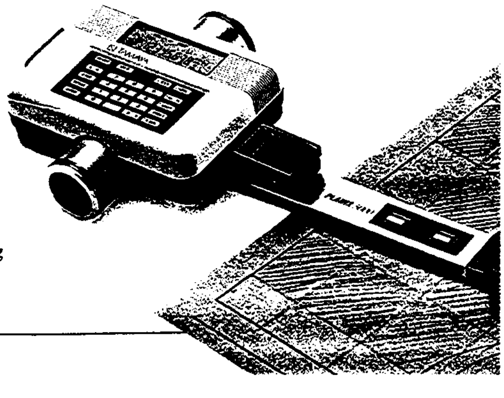
How do I enter the scale settings?

The scale settings must be a ratio of like units. If you have a ratio of 1 inch equals 1200 inches (1:1200), this can be entered directly. However, if the ratio contains unlike units then some computations must be done. First, if you have a ratio of 1 inch equals 50 feet, you must convert 50 feet to inches by multiplying by 12. The scale ratio then becomes 1 inch equals 600 inches or 1:600 and you enter 600 as the scale.

A fractional scale can be entered by converting it to whole numbers and then to inches. A scale of 1/4 inch equals 1 foot (1/4" = 1') would first be converted to whole units by multiplying by four with the result of 1 inch equals 4 feet. The 4 feet would be converted to inches by multiplying by 12. The ratio would then be 1 inch equals 48 inches 1:48). Forty-eight would then be entered as the scale. Actual scale entry is quite simple. On the Planix 7, Planix 8, and Planix 5000, you simply key in the right portion of the scale ratio as determined above and then press the scale key. The scale ratio is stored until changed even if the unit is shut off. To enter dual scales, simply key in the *x* ratio, press the *d-scl* key and then the *y* ratio and press the scale key.

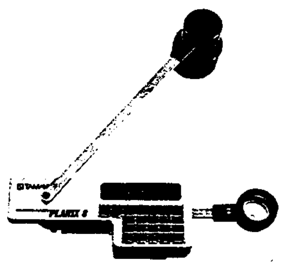
What is the scale factor?

The scale factor is the *x*-scale multiplied by the *y* scale. (This must be computed when using the Planix 5 and Planix 6 because they do not have built-in scale computation.) The reading from the planimeter is then multiplied by this to obtain the area in the drawing.



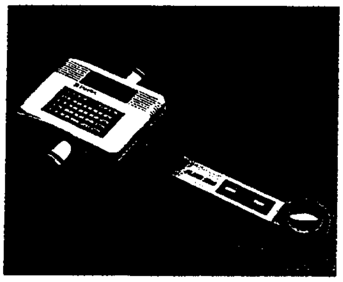
Short Instructions for Electronic Planimeter (Part 2)

PLANIX 8



Polar planimeter with same keyboard and equipment as Planix 7. Measuring range: 356mm/14" diameter.

PLANIX 5000

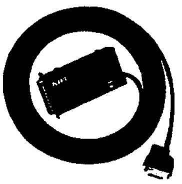


Digitizing Area Line Meter. Not a planimeter, but an encoder-based instrument that determines coordinates for points and can compute area and length of lines from that information. RS232C interface available.

Unconventional Approach, Unsurpassed Performance

- **Measures area and length of lines**
- **Better Accuracy — No integrating wheel to wear out**
- **Eliminates tedious tracing on straight lined figures**
- Twe rotary encoders
- Non-slip wheels
- RS232 compatible device available
- Scale can be entered for actual measurement of areas on plans or drawings
- Accepts different X and Y scales
- Dual rotary encoders replace the integrating wheel for better accuracy
- Point Mode for measurement of straight lines without tracing
- Stream Mode for measurement of curved lines
- Area and line measured with one operation
- Display hold and accumulative measurement
- Cordless operation
- Automatic power shut-off
- Zero reset by push button
- Four function calculator
- Metric English scale
- Averaging

PLANIX 5000 INTERFACE



Can I measure length and area?

Only the Planix 5000 will measure length and area. The other instruments will only measure area. One caution: the Planix 5000 will not measure length of line if a different *x* and *y* scale are entered.

What if the area I want to measure is larger than the reach of the planimeter arm?

All of the Planix instruments have a 'hold and accumulate' feature. Subdivide the area to be measured into smaller areas that are within the range of the unit. Measure each area pressing the hold key once to stop measurement and once again to initiate measurement once the planimeter is moved to the next area.

What direction should I move the tracer arm?

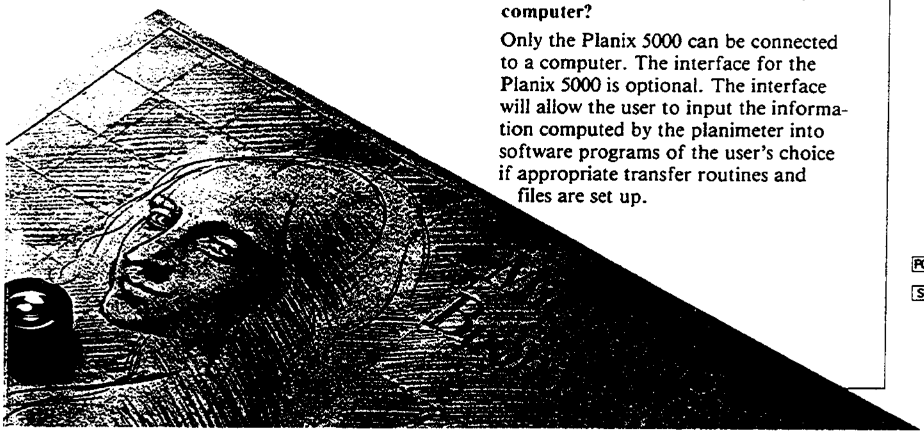
The tracer arm should be moved in a clockwise direction and returned to the original starting point. Moving the arm counterclockwise will give you a negative reading. This can be used to subtract smaller areas contained in larger ones. Please see the instruction manual for details.

How accurate are Planix planimeters?

Planix planimeters have a stated accuracy of 0.2% of the area measured. The Planix 5000 has an accuracy of 0.05% for length and 0.1% for area. For accurate work, we recommend that the work be done slowly and carefully and the averaging function by used so that the final measurement will be the result of several measurements.

Can I connect my planimeter to my computer?

Only the Planix 5000 can be connected to a computer. The interface for the Planix 5000 is optional. The interface will allow the user to input the information computed by the planimeter into software programs of the user's choice if appropriate transfer routines and files are set up.



OPERATION KEYS:

ON/CE·C	Power on/clear count
OFF	Power off
END	Measurement averaging — press END at end of measurement, repeat measurement, press END again, then press AVER. Average will be displayed. Gives you length as well as area averages.
CAL	Converts circuit to four-function calculator. In CAL mode, use keys shown below: m=ft Keys works as ÷ UNIT Keys works as × SCALE Keys works as − R·SCL Keys works as + X=Y Keys works as =
m=ft	Select Metric/English
UNIT	Select unit
R·SCL	Recall scale for confirmation
AVER	Average value calculation — after storing several measurements by use of END key, press AVER for display of average value.
TOTAL	Accumulative total
L/A	Press once for length of line traced (L), press again for area enclosed by line (A).
EXT	Output X and Y coordinate points (Requires interface)
X=Y	Select X or Y value
POINT/STREAM	Select point or stream mode
START/PLOT	Start a measurement or plot the point
SCALE	Set scale
0 ~ 9	Numeral keys

On the Use of Transceivers (Walkie-Talkies)

The School operates the following transceivers:

- REALISTIC TRC - 217, 40 Channel CB Transceiver
- NATIONAL PANASONIC RJ -380, 6 Channel Transceiver
  (Channel 1: 27.240 MHz, Channel 2: 27.125 MHz)
- SHARP MODEL CBT-66, 2 Channel Transceiver
  (Channel A: 27.240 MHz, Channel B: 27.125 MHz)

Notes:

1: Channel 14 on the Realistic transceiver corresponds (exactly) to the second frequency on the other walkie - talkies. Channel 24 on the Realistic Transceiver is close to the first frequency on all other walkie - talkies.

2: Channels 8, 9, 11, 16 on the Realistic transceiver are NOT to be used other than in emergencies (See below !)

3: Keep communications over the radio to a bare minimum.

4: The supervisors will allocate channels in such a way that minimum interference occurs between groups.

CB STATIONS HF Band (MHz)

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	26.965	11	27.085cd	21	27.215	31	27.315
2	26.975	12	27.105	22	27.225	32	27.325
3	26.985	13	27.115	23	27.255	33	27.335
4	27.005	14	27.125	24	27.235	34	27.345
5	27.015	15	27.135	25	27.245	35	27.355
6	27.025	16	27.155cs	26	27.265	36	27.365
7	27.035	17	27.165	27	27.275	37	27.375
8	27.055b	18	27.175	28	27.285	38	27.385
9	27.065a	19	27.185	29	27.295	39	27.395
10	27.075	20	27.205	30	27.305	40	27.405

A - Emergency channel
B - Road channel (Recommended)

CD- Call channel (DSB)
CS- Call channel (SSB - lower sideband

) These frequencies may
) also be used for the
) exchange of emergency
) type traffic when the
) frequencies designated
) "A" are not available

Channel 9 is the primary emergency channel.

Channels 8, 11 and 16 are secondary emergency channels.

April 1988 (as amended) Dr. J.M. Rüeger

(blank page)

The University of New South Wales
School of Geomatic Engineering

GMAT4052 FIELD PROJECTS 1

TO: ADMINISTRATIVE DIRECTOR

CLEARANCE CERTIFICATE

Students: .... GROUP No.: ....

....

....

Signing-Out by Storeman

These students have :

(a)
- returned all equipment (but that listed below) issued to their group **YES NO**
- paid for all breakages and/or lost items (if applicable) **YES NO**
- been advised that the results in this subject will be withheld until the outstanding amount of $ .... has been paid for the following broken or lost items: .... **YES NO**

....
Storeman's Signature

DATE: ....

TIME: ....

Signing-out by Technical Director

These students have :

- supplied complete submissions of all technical exercises **YES NO**
- not supplied complete submissions of the following exercise(s):

.... **YES NO**

....
Technical Director's Signature

DATE: ....

TIME: ....

(blank page)

BUILDING SET OUT - QUALITY CONTROL MEASUREMENTS

Date: .... Group No.: ..... Group Members: ....
Time at begin: .... Time at end: .... Instrument: ....
Temperature: .... Pressure: .... Add. Const. of Barometer: ....
PPM correction set in electronic tacheometer: .... ppm Weather: ....

Specified by Supervisor: Instr. Station: ......
To be entered by Supervisor! Orientate to Station ...... with Direction ....

Below and for each mark, record the **direction and *horizontal* distance.**

Mark	Direction	Horiz. Distance
A	....	....
A1	....	....
A2	....	....
B	....	....
B1	....	....
B2	....	....
C	....	....
C1	....	....
C2	....	....
D	....	....
D1	....	....
D2	....	....
E	....	....
E1	....	....
E2	....	....
F	....	....
F1	....	....
F2	....	....
G	....	....
G1	....	....
G2	....	....
H	....	....
H1	....	....
H2	....	....
V	....	....
W	....	....
X	....	....
Y	....	....
Z	....	....
Z1	....	....
Z2	....	....
Z3	....	....

Check Orientation at End: Instr. Station: .... Direction to Station .... = ...

(blank page)

Field Forms, Computation Forms and Work-Share Statements for Field Exercises

Traverse

Traversing and Detail Surveys	1 Sheet (2 Pages)
Orientation of Arc of Direction	1 Page
Traverse Computation	1 Page

Dam Capacity Survey

DETAIL and CONTOUR SURVEY with Electronic Tacheometer (manual Booking)	1 Sheet (2 Pages)

Precise Levelling

Precise Levelling with Digital Level	2 Sheets (4 Pages)

EDM Instrument Calibration

Electronic Distance Measurement	1 Sheet (2 Pages)
AED Input Data (Page1)	1 Page
AED Input Data (Page 2)	1 Page
AED Input Data (Page 3)	1 Sheet (2 Pages)

Building Setout

Traversing and Detail Surveys	1 Sheet (2 Pages)

Work Share Statements (Fill in one of these per exercise and per student!)

Traverse	1 Sheet
Dam Capacity Survey	1 Sheet
Line Levelling	1 Sheet
EDM Instrument Calibration	1 Sheet
Building Set-Out	1 Sheet

(blank page)

TRAVERSING AND DETAIL SURVEYS WITH ELECTRONIC TACHEOMETERS

PAGE ______

Locality ____________________
Date ____________________
Observer ____________________
Booker ____________________
Reflector Make ____________________

Tacheometer Make __________ Type _______ S/N __________
Preset Instr Corr ____________________
Preset Refl Corr ____________________
Index Correction __________
Type __________ No __________ Reflector Constant __________

Time __________
Temperature __________
Pressure __________
1st Vel. Correction
PPM (or t/p) __________

Time __________
Temperature __________
Pressure __________
PPM (or t/p) __________

Barometer Make __________ Type __________ S/N __________ Correction ______ Thermometer Make _______ Type __________ No __________ Corr ______

STATION	TARGET	Offset	DIRECTION				ZENITH ANGLE				DISTANCE			HEIGHT			REMARKS
			FL	FR	CORR	MEAN	FL	FR	SUM	MEAN	SLOPE/ HORZ	SLOPE/ HORZ	CORR	DIFF	HI	HR	Time, weather, additional t,p observ.

NOTE: CORR for directions and distances follow from possible OFFSETS of reflector (L, R, F, B)

Dec 1994 JMR

TRAVERSING AND DETAIL SURVEYS WITH ELECTRONIC TACHEOMETERS

PAGE ______

Locality ____________
Date ____________
Observer ____________
Booker ____________
Reflector Make ____________

Tacheometer Make ________ Type ______ S/N ________
Preset Instr Corr ____________
Preset Refl Corr ____________
Index Correction ________
Type ________ No ________ Reflector Constant ________

Time ________
Temperature ________
Pressure ________
1st Vel. Correction
PPM (or t/p) ________

Time ________
Temperature ________
Pressure ________
PPM (or t/p) ________

Barometer Make ________ Type ________ S/N ________ Correction ______ Thermometer Make ______ Type ________ No ________ Corr ______

			DIRECTION				ZENITH ANGLE				DISTANCE			HEIGHT			REMARKS
STATION	TARGET	Offset	FL	FR	CORR	MEAN	FL	FR	SUM	MEAN	SLOPE/ HORZ	SLOPE/ HORZ	CORR	DIFF	HI	HR	Time, weather, additional t,p observ.

NOTE: CORR for directions and distances follow from possible OFFSETS of reflector (L, R, F, B)

Dec 1994 JMR

ORIENTATION OF ARC OF DIRECTIONS

Station	Target	Plane Bearing	Observed Direction	Orientation	Oriented Direction	Residual V
		(1)	(2)	(3)=(1)-(2)	(4) = (2)+(0)	(5)=(1)-(4)

(0) = Mean Orientation = Mean of Column (3) Values
= Plane Bearing of Zero Direction of Arc
(5) = Check: Sum of V = Zero

TRAVERSE OF ________________

____

FORM FOR COMPUTATION OF TRAVERSE

STN	OBSERVED ANGLE	CORR.	BEARING θ	DISTANCE l	ΔE		ΔN		E	N	STN
					$= l \sin \theta$	COR	$= l \cos \theta$	COR			
* $\Delta\theta$											
Sum											
Angular Misclose											

* $\Delta\theta$ = Starting bearing - closing bearing

Student Group No. ____________ Names (1)__________________ Computed by________________ Date ____________

(2)__________________ Checked by ________________

Prepared by S. Ganeshan
21st March 1978
AS AMENDED 1993 (JMR)

DETAIL and CONTOUR SURVEY
with Electronic Tacheometer (Manual Booking)

Page ____

Locality ____________ Tacheometer Make ________ Type ____________ S/N ________
Date ______________ Instrument Corr ________________________ Index Corr ________
Observer ____________ Reflector Make ____________ Type ____________ No. ________
Booker ______________ Barometer Make __________ Type ____________ S/N ________
Set Refl. Const: ________ Add. Constant of Barometer: ______________ applied? yes / no
Begin: Time ________ Temperature: ____________ Pressure: __________ ppm corr: ____
End: Time ________ Temperature: ____________ Pressure: __________ ppm corr: ____

Instrum. Station	Reflector Station	Direction	Horiz. Dist.	ΔH	H.I.	H.R.	Collim Height	R.L.	Remarks (on detail (point, weather, ...)

Geomatic Engineering, UNSW AUG 1995 JMR

DETAIL and CONTOUR SURVEY
with Electronic Tacheometer (Manual Booking)

Page ____

Locality ______________
Date ________________
Observer ______________
Booker _______________
Set Refl. Const: ________
Begin: Time __________
End: Time __________

Tacheometer Make _______ Type _____________ S/N ________
Instrument Corr _________________________ Index Corr _________
Reflector Make _____________ Type ____________ No. _________
Barometer Make ___________ Type ____________ S/N _________
Add. Constant of Barometer: _______________ applied? yes / no
Temperature: _____________ Pressure: __________ ppm corr: ____
Temperature: _____________ Pressure: __________ ppm corr: ____

Instrum. Station	Reflector Station	Direction	Horiz. Dist.	ΔH	H.I.	H.R.	Collim Height	R.L.	Remarks (on detail (point, weather, ...)

Geomatic Engineering, UNSW

AUG 1995 JMR

LEVEL RUN FROM ....TO.......................
LOCALITY .... PROJECT ....

Group Nº - --------

Sheet ......of......Sheets

Instrument: .... S/N ....
Staves: "A"- S/N ....(t_s: °c) "B"- S/N ....(t_s= °c)

Observer ------------------
Recorder ------------------

Date ....Time ....
Weather ------------------

Station	Distance	STAFF	Backsight I Foresight I	Backsight II Foresight II
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.

$\Delta h_I = BS_I - FS_I$ $\Delta h_{II} = BS_{II} - FS_{II}$	Δ (mm)	$\Delta h = \frac{1}{2}(\Delta h_I + \Delta h_{II})$	Remarks
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	

Σ B.S. distances ....
Σ F.S. distances ....

$\Sigma \Delta^2$:

$\Sigma \Delta h$:

Signed ---------------------------

Prepared by J. M. Rüeger from a master by S. Ganeshan (September 1998)

XXXVa

Prepared by J. M. Rüeger from a master by S. Ganeshan (September 1998)

LEVEL RUN FROM ....TO....................
LOCALITY ....PROJECT...................

Group Nº - --------

Sheet ......of......Sheets

Instrument: .... S/N ....
Staves: "A"- S/N ....(t_s: °c)"B"- S/N .... (t_s= °c)

Observer ....
Recorder ....

Date .... Time ....
Weather ....

Station	Distance	STAFF	Backsight I Foresight I	Backsight II Foresight II
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.

$\Delta h_I = BS_I - FS_I$ $\Delta h_{II} = BS_{II} - FS_{II}$	Δ (mm)	$\Delta h = \frac{1}{2}(\Delta h_I + \Delta h_{II})$	Remarks
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	

Σ B.S. distances ....
Σ F.S. distances ....

$\Sigma\ \Delta^2$:

$\Sigma\ \Delta h$:

Signed ....

LEVEL RUN FROM ....TO..................
LOCALITY .... PROJECT ....

Instrument: .... S/N ....
Staves: "A"- S/N ....(t_s: °c)"B"- S/N ....(t_s= °c)

Group Nº - --------

Observer ------------------
Recorder ------------------

Sheet ......of......Sheets

Date .... Time ....
Weather ....

Station	Distance	STAFF	Backsight I Foresight I	Backsight II Foresight II
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.
			.	.

$\Delta h_I = BS_I - FS_I$ $\Delta h_{II} = BS_{II} - FS_{II}$	Δ (mm)	$\Delta h = \frac{1}{2}(\Delta h_I + \Delta h_{II})$	Remarks
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	

Σ B.S. distances ....
Σ F.S. distances ....

$\Sigma \Delta^2$:

$\Sigma \Delta h$:

Signed ------------------------

Prepared by J. M. Rüeger from a master by S. Ganeshan (September 1998)

XXXVIa

Prepared by J. M. Rüeger from a master by S. Ganeshan (September 1998)

LEVEL RUN FROM .... TO ....
LOCALITY .... PROJECT ....

Group Nº - ....

Sheet ......of...... Sheets

Instrument: .... S/N ....
Staves: "A"- S/N .... (t_s: °c) "B"- S/N .... (t_s= °c)

Observer ....
Recorder ....

Date .... Time ....
Weather ....

Station	Distance	STAFF	Backsight I Foresight I	Backsight II Foresight II	$\Delta h_I = BS_I - FS_I$ $\Delta h_{II} = BS_{II} - FS_{II}$	Δ (mm)	$\Delta h = \frac{1}{2}(\Delta h_I + \Delta h_{II})$	Remarks
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	
			.	.	.	.	.	

Σ B.S. distances ....
Σ F.S. distances ....

$\Sigma \Delta^2$:

$\Sigma \Delta h$:

Signed ....

ELECTRONIC DISTANCE MEASUREMENT

locality ____________
date ____________
observer ____________
booker ____________

edm instr. ______ No ______
int add const ____________
zero error ____________
scale factor ____________

theodolite ______ No ______
index corr. ____________
refl. const. ____________
envir. dial ____________

Barometer Type ______ No ______
const. ____________
Thermometer ______ No ______
const. ____________

Station	Target	Distance Measurements														Vertical angles			
		Instrument						Reflector								$i_v = i_D$	$t_v = t_D$		
		Slope dist		i_{D_m}	p_{mb}	t°C	Remarks: Time, s.d.,..	t_{D_m}	p_{mb}	t°C	Baro. No.	Th. No	Refl. Type	num of Refl.	obs	FL	FR	sum	vertic. angle
		1st	2nd																

ELECTRONIC DISTANCE MEASUREMENT

locality ______

date ______

observer ______

booker ______

edm instr. ______ No ______

int add const ______

zero error ______

scale factor ______

theodolite ______ No ______

index corr. ______

refl. const. ______

envir. dial ______

Barometer Type ______ No ______

const. ______

Thermometer ______ No ______

const. ______

Station	Target	Distance Measurements														Vertical angles			
		Instrument						Reflector								$i_v - i_D$	$t_v - t_D$		
		Slope dist		i_{D_m}	p_{mb}	t°C	Remarks: Time, s.d., ..	t_{D_m}	p_{mb}	t°C	Baro. No.	Th. No	Refl. Type	num of Refl.	obs	FL	FR	sum	vertic. angle
		1st	2nd																

Calibration of Electrooptical Distance Meters
Input Data
for
AED V2.0

Page 1

Line	Col. 1 – 24	25 – Col 60
1		
	Instrument Make, Type	Serial Number
2		
	EDM Calibration Baseline	Reflector Make, Type, No.
3		
	User/Firm	Observer
4		
	Weather	Date

Line	1 – 60
5	
6	
	Comment

Line	1	2	3	4	5	6 – 15	16	17	18 – 23	24 – 29	30
7											
	P		AUTO	LAB	FIELD	U	ML	MF	C-TERM	D-TERM	HEI

Legend:

P = Number of Baseline Stations (max: 10)
AUTO = 0 Program Execution: Interactive
= 1 Program Execution: Batch (automatic)
LAB = 0 Cyclic error testline observations: not available
= 1 Cyclic error testline observations: available
FIELD = 0 Baseline observations: not available
= 1 Baseline observations: available
U = Unit length in m (Format F10.7)
ML = 0 Without meteor. Correction
= 1 With meteor. Correction, p, t (Cyclic Error testline observations)
= 2 With meteor. Correction p, t, t'
= 3 With meteor. Correction p, t, RH
MF = 0 Without meteor. Correction
= 1 With meteor. Correction p,t (Base line observations)
= 2 With meteor. Correction p, t, t'
= 3 With meteor. Correction p, t, RH
C-TERM = C-Term = Reference Refractivity = $[(n_{REF} - 1)\ 10^6]$ (Format F6.2)
D-TERM = D-Term (Format F6.4)
HEI = 0 Without height reduction to common horizon (HR)
= 1 With height reduction to common horizon (HR)

APR 97

AED V2.0 INPUT DATA

Line

Page 2

Known Distances (m)

	Col. 1 9	10 18	19 27	28 36	37 Col. 45
8					
	S_{12}	S_{13}	S_{14}	S_{15}	S_{16}

	1 9	10 18	19 27	28 36
9				
	S_{17}	S_{18}	S_{19}	S_{1-10}

Elevations (m)

	1 8	9 16	17 24	25 32
10				
	H_1	H_2	H_3	H_4
	33 40	41 48	49 56	57 64
	H_5	H_6	H_7	H_8
	65 72	73 80		
	H_9	H_{10}		

Instrument and Reflector Heights, Reference Elevation (m)

	1 8	9 16	17 24
11			
	Instrument (G)	Reflector (R)	Reference Elevation, HR

Formats:

Distances (S) = F9.4 (Examples: 1029.1234, 756.0478, 0.910)
Elevations (H) = F8.3 (Examples: 1024.123 , 86.417 , 0.126)
H = Elevation of pillar top [or ground mark and tripod height (to tribrach)] F8.3
G = Instrument height above pillar or tribrach (m) F8.3
R = Reflector height above pillar or tribrach (m) F8.3
Note : If no values for S, H, or G, R, HR are available, input blank line.
HR = Value of Reference Elevation (m) F8.3
= - 1.0 Reduction to mean height of all pillars.

AED V2.0 Input Data: Measurements Page 3/..

S	Z	EDM-Measurement [m]	Known Distance or Cyclic Error Rail [m]	Temperature °C	Pressure mmHg or hPa	Wet Temp (°C) or Rel Hum (%)
1	2 3	4 12	13 21	22 26	28 33	34 38
1						
2						
3						
4						
5						
6						
7						
8						
9						
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
0						
1						

S = instrument station number
Z = reflector station number
Note: S < Z (Station number of reflector larger than station number of instrument)
End: S = 0 and Z = 00
If temperature, pressure or relative humidity is left blank, the value of the previous line is adopted.
Formats: S = I 1, Z = I 2, 2 Distances = F9.4, Temp. = F5.1, (Col. 27 blank), Press = F6.1, TFRH = F5.1.
TFRH = either wet temperature (in °C) or relative humidity (in %)
Laboratory measurements end with S = 0, Z = 00, followed by field measurements ending again with S = 0, Z = 00
(Last line of input file must be "000"!)

APR 97

SCHOOL OF GEOMATIC ENGINEERING THE UNIVERSITY OF NEW SOUTH WALES

AED V2.0 Input Data: Measurements Page 3/..

S	Z	EDM-Measurement [m]	Known Distance or Cyclic Error Rail [m]	Temperature °C	Pressure mmHg or hPa	Wet Temp (°C) or Rel Hum (%)
1	2 3	4 12	13 21	22 26	28 33	34 38
1						
2						
3						
4						
5						
6						
7						
8						
9						
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
0						
1						

S = instrument station number
Z = reflector station number
Note: S < Z (Station number of reflector larger than station number of instrument)
End: S = 0 and Z = 00
If temperature, pressure or relative humidity is left blank, the value of the previous line is adopted.
Formats: S = I 1, Z = I 2, 2 Distances = F9.4, Temp. = F5.1, (Col. 27 blank), Press = F6.1, TFRH = F5.1.
TFRH = either wet temperature (in °C) or relative humidity (in %)
Laboratory measurements end with S = 0, Z = 00, followed by field measurements ending again with S = 0, Z = 00
(Last line of input file must be "000"!)

APR 97

TRAVERSING AND DETAIL SURVEYS WITH ELECTRONIC TACHEOMETERS

PAGE ______

Locality ______
Date ______
Observer ______
Booker ______
Reflector Make ______

Tacheometer Make ______ Type ______ S/N ______
Preset Instr Corr ______
Preset Refl Corr ______
Index Correction ______
Type ______ No ______ Reflector Constant ______

Time ______
Temperature ______
Pressure ______
1st Vel. Correction
PPM (or t/p) ______

Time ______
Temperature ______
Pressure ______
PPM (or t/p) ______

Barometer Make ______ Type ______ S/N ______ Correction ______ Thermometer Make ______ Type ______ No ______ Corr ______

STATION	TARGET	Offset	DIRECTION				ZENITH ANGLE				DISTANCE			HEIGHT	HI	HR	REMARKS Time, weather, additional t,p observ.
			FL	FR	CORR	MEAN	FL	FR	SUM	MEAN	SLOPE/ HORZ	SLOPE/ HORZ	CORR	DIFF			

NOTE: CORR for directions and distances follow from possible OFFSETS of reflector (L, R, F, B)

Dec 1994 JMR

TRAVERSING AND DETAIL SURVEYS WITH ELECTRONIC TACHEOMETERS

PAGE ______

Locality ______
Date ______
Observer ______
Booker ______
Reflector Make ______

Tacheometer Make ______ Type ______ S/N ______
Preset Instr Corr ______
Preset Refl Corr ______
Index Correction ______
Type ______ No ______ Reflector Constant ______

Time ______
Temperature ______
Pressure ______
1st Vel. Correction
PPM (or t/p) ______

Time ______
Temperature ______
Pressure ______
PPM (or t/p) ______

Barometer Make ______ Type ______ S/N ______ Correction ______ Thermometer Make ______ Type ______ No ______ Corr ______

			DIRECTION				ZENITH ANGLE				DISTANCE			HEIGHT			REMARKS
STATION	TARGET	Offset	FL	FR	CORR	MEAN	FL	FR	SUM	MEAN	SLOPE/ HORZ	SLOPE/ HORZ	CORR	DIFF	HI	HR	Time, weather, additional t,p observ.

NOTE: CORR for directions and distances follow from possible OFFSETS of reflector (L, R, F, B)

Dec 1994 JMR

The University of New South Wales
School of Geomatic Engineering

GMAT4052 FIELD PROJECTS 1

WORK SHARE STATEMENT

for Field Exercise "Traverse"

Student: .... Date of Exercise: .... Group No.: ......

Please note that only documented or otherwise clearly identifiable contributions should be listed below. It is presumed that the student groups prepare the work through discussions between the group members and literature study.

My Contribution to the Field Work

I have carried out the field work and field functions listed below.

(Clearly specify where you observed what. For example, I measured all directions, all slope distances all zenith angles and the H.I. at Station T22. For example: I acted as booker and observer for the level runs from BM12 to BM13, from BM23 to BM24, from BM47 to BM58.
Also, clearly specify what you did as a fieldhand. For example: I acted as fieldhand (holding the staff) for the level runs from .. to, from .. to, etc.)

....

....

....

....

....

My Contribution to the Field Work

In the office, I did the calculations, plotted the plans and prepared the sections in the report as indicated below.
(Please note that all contributions must be documented and submitted. Sign each plan, cal culation and plan that you prepare!)

....

....

....

....

....

I declare that all above statements are correct:

Signature of Student ________________ Date ________________ Time ________

Supervisor Use Only

(a) I have no evidence that any of the above statements, in full or part, are incorrect. **YES/NO**

(b) Based on my direct observations, the statements marked .... are false. Initials: ....

(c) The statements marked ...... are in contradiction to the statements of the other group member(s). Initials: ....

The Supervisor: ________________________ Date: ____________

(blank page)

The University of New South Wales
School of Geomatic Engineering

GMAT4052 FIELD PROJECTS 1

WORK SHARE STATEMENT

for Field Exercise "Dam Capacity Survey"

Student: .... Date of Exercise: .... Group No.: ......

Please note that only documented or otherwise clearly identifiable contributions should be listed below. It is presumed that the student groups prepare the work through discussions between the group members and literature study.

My Contribution to the Field Work

I have carried out the field work and field functions listed below.

(Clearly specify where you observed what. For example, I measured all directions, all slope distances all zenith angles and the H.I. at Station T22. For example: I acted as booker and observer for the level runs from BM12 to BM13, from BM23 to BM24, from BM47 to BM58.
Also, clearly specify what you did as a fieldhand. For example: I acted as fieldhand (holding the staff) for the level runs from .. to, from .. to, etc.)

....

....

....

....

....

My Contribution to the Field Work

In the office, I did the calculations, plotted the plans and prepared the sections in the report as indicated below.
(Please note that all contributions must be documented and submitted. Sign each plan, calculation and plan that you prepare!)

....

....

....

....

....

I declare that all above statements are correct:

Signature of Student ______________ Date ______________ Time ______________

Supervisor Use Only

(a) I have no evidence that any of the above statements, in full or part, are incorrect. **YES/NO**

(b) Based on my direct observations, the statements marked .... are false. Initials: ....

(c) The statements marked ...... are in contradiction to the statements of the other group member(s). Initials: ....

The Supervisor: ______________________ Date: ______________

(blank page)

The University of New South Wales
School of Geomatic Engineering

GMAT4052 FIELD PROJECTS 1

WORK SHARE STATEMENT

for Field Exercise "Line Levelling"

Student: .... Date of Exercise: .... Group No.: ......

Please note that only documented or otherwise clearly identifiable contributions should be listed below. It is presumed that the student groups prepare the work through discussions between the group members and literature study.

My Contribution to the Field Work

I have carried out the field work and field functions listed below.

(Clearly specify where you observed what. For example, I measured all directions, all slope distances all zenith angles and the H.I. at Station T22. For example: I acted as booker and observer for the level runs from BM12 to BM13, from BM23 to BM24, from BM47 to BM58.
Also, clearly specify what you did as a fieldhand. For example: I acted as fieldhand (holding the staff) for the level runs from .. to, from .. to, etc.)

....

....

....

....

....

My Contribution to the Field Work

In the office, I did the calculations, plotted the plans and prepared the sections in the report as indicated below.
(Please note that all contributions must be documented and submitted. Sign each plan, cal culation and plan that you prepare!)

....

....

....

....

....

I declare that all above statements are correct:

Signature of Student ________________ Date ________________ Time ________________

Supervisor Use Only

(a) I have no evidence that any of the above statements, in full or part, are incorrect. **YES/NO**

(b) Based on my direct observations, the statements marked .... are false. Initials: ....

(c) The statements marked ...... are in contradiction to the statements of the other group member(s). Initials: ....

The Supervisor: ________________________ Date: ____________

(blank page)

The University of New South Wales
School of Geomatic Engineering

GMAT4052 FIELD PROJECTS 1

WORK SHARE STATEMENT

for Field Exercise "EDM Instrument Calibration"

Student: .... Date of Exercise: .... Group No.: ......

Please note that only documented or otherwise clearly identifiable contributions should be listed below. It is presumed that the student groups prepare the work through discussions between the group members and literature study.

My Contribution to the Field Work

I have carried out the field work and field functions listed below.

(Clearly specify where you observed what. For example, I measured all directions, all slope distances all zenith angles and the H.I. at Station T22. For example: I acted as booker and observer for the level runs from BM12 to BM13, from BM23 to BM24, from BM47 to BM58.
Also, clearly specify what you did as a fieldhand. For example: I acted as fieldhand (holding the staff) for the level runs from .. to, from .. to, etc.)

....

....

....

....

....

My Contribution to the Field Work

In the office, I did the calculations, plotted the plans and prepared the sections in the report as indicated below.
(Please note that all contributions must be documented and submitted. Sign each plan, cal culation and plan that you prepare!)

....

....

....

....

....

I declare that all above statements are correct:

Signature of Student ____________________ Date ____________ Time ____________

Supervisor Use Only

(a) I have no evidence that any of the above statements, in full or part, are incorrect. **YES/NO**

(b) Based on my direct observations, the statements marked .... are false. Initials: ....

(c) The statements marked ...... are in contradiction to the statements of the other group member(s). Initials: ....

The Supervisor: ____________________ Date: ____________

(blank page)

The University of New South Wales
School of Geomatic Engineering

GMAT4052 FIELD PROJECTS 1

WORK SHARE STATEMENT

for Field Exercise "Building Set-Out"

Student: .... Date of Exercise: .... Group No.: ......

Please note that only documented or otherwise clearly identifiable contributions should be listed below. It is presumed that the student groups prepare the work through discussions between the group members and literature study.

My Contribution to the Field Work

I have carried out the field work and field functions listed below.

(Clearly specify where you observed what. For example, I measured all directions, all slope distances all zenith angles and the H.I. at Station T22. For example: I acted as booker and observer for the level runs from BM12 to BM13, from BM23 to BM24, from BM47 to BM58.
Also, clearly specify what you did as a fieldhand. For example: I acted as fieldhand (holding the staff) for the level runs from .. to, from .. to, etc.)

....

....

....

....

....

My Contribution to the Field Work

In the office, I did the calculations, plotted the plans and prepared the sections in the report as indicated below.
(Please note that all contributions must be documented and submitted. Sign each plan, cal culation and plan that you prepare!)

....

....

....

....

....

I declare that all above statements are correct:

Signature of Student Date Time

Supervisor Use Only

(a) I have no evidence that any of the above statements, in full or part, are incorrect. **YES/NO**

(b) Based on my direct observations, the statements marked .... are false. Initials: ....

(c) The statements marked ...... are in contradiction to the statements of the other group member(s). Initials: ....

The Supervisor: ______________________________ Date: ____________

(blank page)