THE UNIVERSITY OF NEW SOUTH WALES
SCHOOL OF SURVEYING
29.7050 SURVEY CAMP

TECHNICAL INSTRUCTIONS
SURVEY CAMP
BATHURST
13 - 24 FEBRUARY 1989

Dr. J.M. Rüeger
Technical Director

JANUARY 1989

THE UNIVERSITY OF NEW SOUTH WALES

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Technical Instructions

CONTENTS:

I. GENERAL

1. SURVEY PROJECTS

The survey projects - triangulation, trigonometric levelling, ground control for photogrammetry, trilateration and cadastral survey - have been chosen so that the work involved will consolidate the third year class material. The technical programme can be completed well within the times allocated, providing the weather is suitable.

2. ORGANISATION

2.1 Computation Days

Computation days have been scheduled between the actual field days in order to provide sufficient time to process the field measurements at the camp site. These days should be utilised for this purpose only.

2.2 Use of Equipment

In order to make maximum use of the equipment and the time available, the class will be divided into groups of three. A work schedule is attached which should be strictly adhered to. However, should a group complete a project early, then it may commence work on the following project if the necessary equipment is available and if the necessary briefing has been given.

2.3 Use of Computing Facilities

NEC computers, software packages and printers will be available at camp. You will be encouraged to write your own programmes for the reduction of your work. The following programmes are available:

Name	Description
Wordstar	Editor/word processor.
SOLVPARM	Solution of parametric equations.
EDMRED	EDM reductions - first velocity, slope, sea level and ISG corrections, also provides height differences.
SGLPNT	Single point determination using Least Squares. (Directions, Distances, Bearings)
COORDCNV	Conversion between geographic Coord. and ISG/AMG Coord.
MBD	Missing bearing and distance (Close).
RESECT	3 ray resection.
TRAVBA	Traverse adjustment by BOWDITCH.

2.4 Use of Vehicles and Transceivers

Students will NOT use private vehicles on private property, except with the express permission of a supervisor and the owner of the land in question.- Radio transmissions with transceivers should be kept to a bare minimum. Appendix E specifies the CB channels to be used.

2.5 Use of Field Forms

The following field forms will be available at the camp:

* Zenith Angle Measurement (3 Hair Technique)
* Direction Observations
* Beacon Eccentricity
* Beacon Dimensions
* Reconnaissance & Maintenance Report
* Electronic Distance Measurement
* Traversing and Detail Surveys
* Direction Measurement (Zenith Angle Measurement)
* Distance Measurement with Band
* Reflector Station (Trilateration Exercise)
* Summary Sheet for Lines (Trilateration Exercise)
* Station Diagram: Plan & Section (Trilateration Ecercise)
* Summary sheet for Baseline Measurements (Trilateration Exercise)

3. MAP PROJECTIONS

Two distinct projections will be used in the calculations. These are the Australian Map Grid (AMG) and the NSW Integrated Survey Grid (ISG) systems. The ISG system should be adopted for all projects except the triangulation survey, where the AMG system shall be chosen. Both projections refer to the Australian National Spheroid (a = 6378160m and f = 1:298.25). The elevations are on Australian Height Datum (AHD).

4. SUBMISSIONS

4.1 Report

Separate reports on each of the survey projects performed at camp shall be submitted by the due dates. These reports are to contain the following:

(a) an index page;
(b) a summary of results;
(c) an abstract of all field measurements;
(d) reductions, calculations and adjustments;
(e) explanatory remarks to clarify procedures adopted; and
(f) appropriate cross-referencing where data used in one project is derived in another part.

4.2 Field Notes

All field notes shall be submitted.

5. DATA

5.1 Projections

QUANTITY	AMG	ISG
Zone Width	6°	2°
Zone Number	55	55/3
Central Meridian	147 E	149 E
Scale Factor (k_o)	0.9996	0.99994
False Origin - East	-500 000 m	-300 000 m
- North	-10 000 000 m	-5 000 000 m

5.2 Formulae

E' = true Easting
N' = true Northing
k_0 = central scale factor
$\rho\nu$ = product of both principal radii
S = projection distance
s = spheriodal distance

5.2.1 Arc-to-chord

$$\delta_{1-2} = \frac{(N'_1 - N'_2)\ (2E'_1 + E'_2)}{6\ k_0^2\ \rho\nu\ \sin 1''} \qquad \text{[in arc seconds]}$$

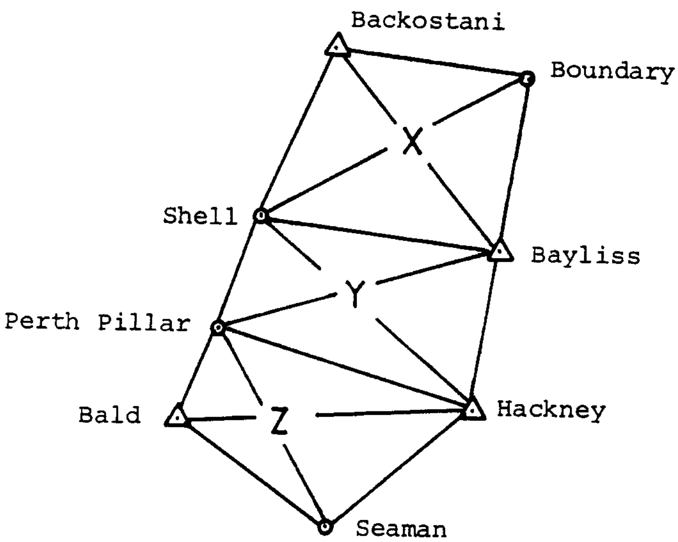
5.2.2 Scale Factor

$$\frac{S}{s} = k \left[1 + \frac{E_1'^2 + E'_1\ E'_2 + E_2'^2}{6\ k_0^2\ \rho\nu} \right]$$

5.2.3

$$\frac{10^8}{\rho\nu\ \sin 1''} = 0.5083754$$

5.3 Triangulation



Scheme

Z: Perth-Pillar, Hackney, Seaman, Bald

Y: Shell, Bayliss, Hackney, Perth Pillar

X: Backostani, Boundary, Bayliss, Shell

Δ Coordinates given
o Coordinates to be determined

5.4 Coordinates and Elevations

5.4.1 AMG Zone 55; Elevations on AHD

POINT	E (m)	N (m)	HT (m)
Bayliss 88	740 299.47	6 294 601.37	716.74
Hackney	740 218.93	6 292 453.65	-
Bald	735 930.76	6 292 379.23	-
Backostani 88	738 687.48	6 297 784.97	-
Perth Pillar	-	-	879.66

5.4.2 Coordinates in ISG 55/3 System, Elevations on AHD

STATION NO.	STATION NAME	EASTING (m)	NORTHING (m)	ELEVATION (m)
90	Red Hill	333 166.56	1 291 080.33	
91	Mulley (CMA)	352 623.70	1 299 490.10	731.76(Top pillar)
92	Durham Court Pillar	361 005.51	1 299 149.74	768.07(Top pillar)
93	Baanya Pillar	350 940.80	1 301 958.80	731.82(Top pillar)
94	Avondale Pillar	350 502.00	1 307 950.10	723.52(Top pillar)
95	Clarke	330 143.97	1 283 996.21	
96	Macquarie	316 673.11	1 275 602.25	
97	Errol	322 236.56	1 284 793.46	
98	Crackersack	338 149.77	1 304 547.17	
99	Edrop	344 963.09	1 309 186.82	
100	Rankin	347 444.18	1 312 180.98	
101	Lowes Pillar	375 182.00	1 281 532.89	1 133.52(Top pillar)
102	Ovens Pillar	372 099.23	1 301 416.35	1 273.90(Top pillar)
103	Rocks Pillar	337 609.29	1 298 393.38	1 038.45(Top pillar)
104	Bald	350 107.74	1 293 874.29	851.5*
105	Bayliss 88	354 431.44	1 296 179.38	716.74
106	El Woodara	342 929.60	1 299 282.28	
107	Cherry Tree	349 031.23	1 299 106.63	827.96
108	Evernden Pillar	350 451.01	1 284 884.82	990.5*
110	Hackney	354 392.26	1 294 031.23	753.0*
112	Hollis	351 552.61	1 290 745.47	787.97
114	Lenehan	347 131.77	1 292 057.34	812.88
115	Boundary	354 869.26	1 298 610.71	680.5*
117	Shell	351 143.71	1 296 558.49	873.5*
118	Peel	363 578.74	1 307 341.58	878.18
120	Seaman	352 176.26	1 292 479.96	734.5*
121	St. Stanislaus	353 015.28	1 299 583.33	738.36 (see sketch)
122	Three Brothers	336 080.31	1 275 516.46	
124	Williams	348 604.89	1 292 964.50	795.37
126	Panorama	350 822.85	1 297 238.54	874.02(Top pillar)
127	Perth-Pillar	350 579.52	1 295 238.07	879.66
128	Rutherford	355 518.02	1 303 906.86	701.98
131	Lee Pillar	358 911.85	1 300 003.49	740.00
134	Bushranger Pillar	344 729.91	1 292 362.33	865.37(Top pillar)
135	Oakleigh Pillar	358 450.04	1 303 347.43	771.23(Top pillar)
136	Tareen Pillar	358 673.00	1 297 009.00	754.46(Top pillar)
137	Hackney Pillar	354 784.60	1 294 999.64	741.08(Top pillar)
138	Gormans Hill Pillar	354 945.01	1 298 271.82	687.75(Top pillar)

STATION NO	STATION NAME	EASTING (m)	NORTHING (m)	ELEVATION (m)
139	SSM2234	351 784.39	1 296 552.98	
141	Cadastral 2	352 670.40	1 296 333.52	
143	Tarella Pillar	359 894.80	1 315 005.36	
150	Carrawarra	354 088.39	1 305 469.67	
151	Carto School (TAFE)	352 495.86	1 299 096.42	710.57
152	Backostani	352 749.45	1 299 322.63	717.5*
153	Backostani 88	352 759.00	1 299 330.32	717.5*
154	Boundary 88	354 901.05	1 298 623.17	680.31
155	PM 59226	353 206.60	1 296 282.11	664.99
156	PM 54656	353 448.42	1 296 729.30	664.73
157	PM 54659	352 968.46	1 295 778.89	668.70

* Rounded to the nearest 0.5m. If higher accuracy is needed, use your own data determined in the trigonometric levelling project.

6. ORGANISATION OF TECHNICAL PROGRAMMES

6.1 Projects and Supervisors

IDENT.	PROJECT	DAYS ALLOCATED	WEEK	SUPERVISOR (Briefing, Supervision, Marking)
1	Reconnaissance	0.5	1	Dr.J.M. Rueger
2	Triangulation and Trig. Heighting	2	1	Mr. J.R. Pollard
3	Ground Control for Photogrammetry	2	2	Mr. S. Ganeshan
4.	Cadastral Survey	2	1	Dr. B.R. Harvey
5.	Trilateration	2	2	Mr. R.W. Pascoe
6.	Computations	2.5		

6.2 Directors

Administrative Director - Dr. A.W. Kearsley
(Dr. E.G. Masters)

Technical Director - Dr. J.M. Rueger
(Dr. E.G. Masters)

6.3 Storeman

Mr. A.W. Stevens

7. WORK SCHEDULE

7.1 Timetable

GROUP	MON 13	TUE 14	WED 15	THU 16	FRI* 17	SAT 18	SUN** 19	MON 20	TUE 21	WED 22	THU 23	FRI+ 24 Feb 89
1	1	3	5	5	C	3	C	4u	4u	2x	2x	C
2	1	3	5	5	C	3	C	4v	4v	2x	2x	C
3	1	3	5	5	C	3	C	4w	4w	2z	2z	C
4	1	3	5	5	C	3	C	4u	4u	2z	2z	C
5	1	3	5	5	C	3	C	2x	2x	4w	4w	C
6	1	3	5	5	C	3	C	2z	2z	4v	4v	C
7	1	3	5	5	C	3	C	2x	2x	4u	4u	C
8	1	3	5	5	C	3	C	2z	2z	4w	4w	C
9	1	3	5	5	C	3	C	4w	4w	2z	2z	C
10	1	3	5	5	C	3	C	2x	2x	4u	4u	C

7.2 Tasks

1. Travel to Bathurst, Reconnaissance.
2. Triangulation & Trigonometric Heighting: 2x - Area X, 2y - Area Y, 2z - Area Z.
3. Ground Control for Photogrammetry
4. Cadastral Surveying: 4u - Area U, 4v - Area V, 4w - Area W
5. Trilateration.
C. Computations.
* Visit C.M.A.and Social Function with local surveyors
\+ Camp closing at 10.30 hours.
** Briefings at 13.00 hours.

7.3 Submission: Normally, before 23.00 hours on the day indicated below. On last day (Friday, 24 February 1989) before 10.30 hours.

1.	Reconnaissance	same day
2.	Triangulation	2nd day plus one
3.	Ground Control	2nd day plus one
4.	Cadastral	2nd day plus one
5.	Trilateration	2nd day plus one

An extension of time will not be granted.

II. PROJECTS

1. RECONNAISSANCE

This exercise will involve a familiarisation of the camp area and surrounding control network, erection of beacons, and the preparation of access and recovery sketches. (See Appendix A). These sketches will be displayed for the use of parties involved in Projects 2, 3 and 5. Two eccentric stations, one due North (AMG) and another one due East (AMG), each 10.0m from the trigonometric station should be placed during reconnaissance. (They will be used subsequently to check the plumbing of the beacon during each occupation of the station.)

1.1 Equipment

1 Topographic Map 1:25000 BATHURST 8831-III-S (per group, return at end of camp)
1 Bathurst Beacon each comprising 3 rods, 3 foot plates, one A-frame, 12 steel nails, 2 yellow vanes fitting each other with vane support pipe and locking screw, target cone on top.
1 Clipboard
1 Magnetic Compass
1 2 m folding ruler
1 100m steel band
1 3m pocket tape
1 30m steel tape
1 one second Theodolite + Tripod
1 Plumbob with 3 m string
2 x dumpy pegs
1 hammer
1 Binoculars
1 Shifting Spanner
1 Allan Key (Perth Pillar) (3/8 inch)
(1 pocket calculator: supplied by group)

2. TRIANGULATION AND TRIGONOMETRIC HEIGHTING

2.1 Equipment

1 clipboard
1 one second Theodolite + Tripod
1 Plumbob with 3m string
1 30m Tape
2 Umbrellas with steel bases
1 Hammer
1 2m folding ruler
1 3m pocket tape
3 dumpy pegs (as base for tripod legs)
1 KERN pillar plate (Kern theodolites on trigonometric pillars, only)

2.2 Project

2.2.1 Triangulation

The aim of the exercise is to determine the AMG coordinates of 2 stations and the A.H.D. heights of 3 stations in a braced quadrilaterial based on coordinates and heights given in Section I-5.4.1.

On all four stations of the quadrilateral, the group shall measure six arcs of horizontal directions to the stations of the braced quadrilateral which is specified in the network schedule. At least two members of the group shall share the observations on each station.

Before commencing the daily observations and before leaving the site, the beacon must be checked for verticality and measured for eccentricity. Eccentricities should be noted in summary sheet in camp.

At each station, the station adjustment is carried out in the field by computing the reduced means, the grand mean, the standard deviation of a single observation (in 2 faces) and of the grand mean directions. The standard deviation of a direction in the grand mean shall be less than or equal to ±0.8 second of arc. If required, additional arcs should be observed until the above specification is met.

On completion of the field work, the observations will be corrected for arc-to-chord (AMG) and any eccentricities of the beacons at the target stations. Groups shall compute the four triangle misclosures and derive the standard deviation of a (grand mean) direction from the FERRERO equation, where the ε are the triangle misclosures and n is the number of triangles.

$$\sigma_{DIR} = \pm(\Sigma\varepsilon^2/6n)^{0.5}$$

Observations will then be adjusted by the "parametric" method to give corrections to the observations, the station coordinates (AMG) and their a posteriori 95% confidence ellipses.

The variance of the observations is estimated by:

$$\sigma^2 = (\sigma_{GM}^2 + \frac{0.206265^2}{s^2}(\sigma_I^2 + \sigma_T^2)) \quad (sec^2)$$

where σ_{GM} = estimated standard deviation of grand mean of arc concerned

σ_I = estimated standard deviation of centring at instrument station (in millimetre)

σ_T = standard deviation of centring of beacon (in millimetre)

s = distance between instrument and target stations (in kilometre)

The observation equations and other details of the adjustment are given in the Appendix B.

Field notes should conform with the example shown in Appendix B.6. Special booking forms will be supplied.

2.2.2 Trigonometric Heighting

On all four stations of the quadrilateral, the group shall measure four arcs of zenith angles by the Three-Hair-Method to the other stations of the braced quadrilateral. These observations should be carried out between 9.00h and 15.00h (standard time) and should be shared between group members. The measurement of heights of instruments and beacons is important.

Special booking forms for the 3-Hair-Method will be provided. The

meteorological conditions at the time of measurement shall be recorded (cloudiness, visibility, time, shadow/sun, wind). At each station and for each line, the standard deviation of a single zenith angle observation and of the mean of 12 zenith angles (four observations by 3-hair-method) shall be computed.
The individual height differences are to be calculated using the following formula (dimensions are in metres):

$$\Delta h = s\left(1 + \frac{H}{R}\right)\left[\cot Z + \frac{(1-k)\,s}{2R}\right] + (HI - HT)$$

where

- Δh is the height difference;
- s is the spheroidal distance;
- H is the altitude of observation station;
- R is the radius of spheroidal section (6370 100m for this project);
- Z is the observed zenith angle;
- k is the refraction coefficient (assume +0.14 for this project);
- HI is the height of instrument; and
- HT is the height of target.

The spheroidal distance s should be computed from the given I.S.G. coordinates (see I-5.4.2) and NOT from AMG coordinates.

The field work should be checked by computing the four triangle misclosures from the mean height differences of each line and by deriving an overall standard deviation for mean height differences from:

$$\sigma_{\overline{\Delta h}} = \left\{\frac{\Sigma \varepsilon^2}{3n}\right\}^{0.5}$$

where the ε are triangular misclosures(in centimetre) and n is the number of misclosures (four in this case). Check triangular misclosures with misclosure around quadrilateral.

The mean height difference for each line will then be entered into a least squares adjustment by the parametric method to produce the adjusted heights of the stations as well as their standard deviations and 95% confidence intervals. The variance of a mean height difference from reciprocal observations should be estimated by the formula:

$$s_{\Delta h}^2 = 0.24\ s^2\ (s_z^2 + 450\ s^2\ s_k^2)$$

where

$s_{\Delta h}^2$ is the variance of the mean height difference in cm ;

s is the distance in km; and

s_z is the standard deviation of the grand mean of the zenith angle in seconds of arc (mean st. dev of forward and backward zenith angle).

s_k is the uncertainty of the coefficient of refraction k for non-simultaneous reciprocal trigonometric heighting. Use ±0.03 in this exercise.

Note: Above equation is based on the assumption that the standard deviations of height of instrument and height of beacon are in the millimetre range and, thus, ineffective.

2.3 Submission

Each group shall submit for assessment the field notes, the calculations and a report on the project, including a discussion of the achieved precision.

The report shall include:

(1) Reduction of directions from beacon top to ground mark and arc-to-cord corrections.
(2) Statement on assumed centring errors at instrument station and target station.
(3) Stated precision (at 95% confidence level) of coordinates, based on the a posteriori variance factor.
(4) A plot of the network (1:25000) with overlayed 95% confidence point error ellipses (1:1).
(5) List of forward, backward and mean height differences.
(6) Stated precision (at 95% confidence level) of adjusted elevations based on a posteriori variance factor.
(7) All computer outputs, fully documented and labelled.

3. GROUND CONTROL FOR PHOTOGRAMMETRY

3.1 Equipment

1	30 m Steel tape
1	Clipboard
1	Pair of transceivers
1	Umbrella with steel base
1	2 m folding ruler
1	3 m pocket tape
1	One second Theodolite + Tripod
1	100m Steel band + Spring Balance + Thermometer
1	EDM instrument + Ancillary equipment
2	Thommen Barometer "Everest 6000 m"
2	Thermometers
1	Magnifying Glass
1	Pocket stereoscope
1	Automatic levelling Instrument with tripod
1	4 m wooden folding levelling staff with staff bubble
1	Hammer
5	Dumpy pegs
1	Pair of photographs 1:8000 from - NSW 3328/163 (M1542) Run 1 29.8.83 - NSW 3328/167 (M1542) Run 1 29.8.83 - NSW 3328/171 (M1542) Run 1 29.8.83 Note: DO NOT write on photographs, return them at end of camp.

3.2 Ground Control

The task at camp will be to reconnoitre, identify and fix two ground control points. The supervisor will select and mark the approximate positions of these two ground control points in **opposite** corners of the overlapping area of two photographs. See Appendices C1 and C2 for examples of typical control points. The points should be fixed in plan and height with a precision of 0.10 m or better, but separate plan and height controls may be chosen in each of the two locations if a suitable single point cannot be found.

At least one of the control points must be fixed by a closed (not loop) traverse. The other may be fixed by triangulation or/ and trilateration. The calculation of the coordinates must include all observations that are made. Repeated arcs or repeated measurements of the same distance will not count as redundant observations. This means that there must be an independent geometric check for each point.

All trigonometric stations (refer to Sect. 5.4.2) may be used for fixing the photo control points. However, groups working on the Triangulation Exercise have absolute priority on the stations concerned.

3.3 Submissions

A single group report will be submitted including a reconnaissance sketch, photo point diagrams (see Appendix C2), computations and field notes.

IMPORTANT: Each group must keep a complete copy of both photo point diagrams for subsequent use in 29.7510 Photogrammetry 2.

4. CADASTRAL SURVEY OF CAMP BOUNDARY

4.1 Aim

The purpose of the exercise is to redefine the boundaries for a Real Property Application of nominated land fronting College Road, Bathurst. Information relating to procedures can be found in Appendix D.

4.2 Equipment

1	30 m steel tape
1	2 m folding ruler
1	Hammer
1	Semi-electronic Tacheometer with Accesories
10	G.I.Nails
1	100m Steel band + Spring balance + Thermometer
1	Clipboard
2	Prisms + Tribrachs + Tripods
2	Sighting Tripods
1	Thommen Barometer "Everest 6000 m"
1	12 V car Battery
3	Plumb bobs
1	Umbrella with steel base
5	Dumpy pegs
1	Set of plans (to be returned at end of camp) comprising: - D.P. 527246 - D.P. 535178 - D.P. 254943 - D.P. 749241 - D.P. 249642 - D.P. 609975 - Reg. Conv. No. 576 Bk. 2927 - Reg. Conv. No. 288 Bk. 3198

4.3 Survey

The survey will consist of a loop traverse around the boundaries of the property together with a connection to one of the listed controls

(Cadastral 3, 4 or 5). From the latter, a connection to the State Survey Control must be made by a bearing. Cutting of scrub and timber is not permitted. Do not break branches or stand on seedlings. Traverse lines must therefore be selected so as to be clear of all obstacles.

4.4 Computations

The surround survey should be adjusted by an appropriate method. Reduced distances should be derived and shown on the plan of survey. The report on the project will contain a comparison between measured ground distances (reduced for slope) and distances shown on the relevant survey plans.

4.5 Submissions

Each group is required to submit field notes, calculations, a sketch plan of boundaries, and to attend an oral exam. The sketch plan should be at appropriate scale and drawn on quality drafting paper and show boundary marks, reference marks, occupations, the traverse line, the final boundary bearings and distances and the connections to control points, (See Appendix D).

5. TRILATERATION

5.0 Aim

The purpose of the exercise is to demonstrate the precision of EDM trilateration surveys with and without the use of length ratios in the quadrilaterals X and Y (Refer to I - 5.3).

5.1 Equipment

5.1.1. Instrument Station:

1 WILD centring rod (for tripod)
1 WILD One Second Theodolite T2 S/N 190934 (T107)
2 WILD GST 20 tripods
1 WILD Distomat DI 3000 with cables and ancilliaries
2 Umbrellas with steel stands
1 Hammer
1 Rotronic Hygroskop (with 9Vdc spare battery)
1 Precision Barometer
2 Clipboards
2 Transceivers (no batteries fitted, with 12 V dc supply cable)
3 Honda Petrol Generator with 12 V output cable
2 Sets of size A batteries for transceivers
3 12 V car batteries
1 2 m folding ruler
1 Plumb bob
6 Bathurst Beacon Steel Nails
1 Ball of String
1 Knife
4 Torches with one set of spare batteries each
1 folding camping chair
1 3 m pocket tape
\- Field Forms
2 WILD GDF 6 tribrachs (test optical plummet + spot bubble)
1 WILD Prism GPR-1 in GPH-1 holder on carier GRT-10 with target plate GZT4

1 binoculars
3 Marker pegs
1 Dumpy peg
* few small nails
1 Theodolite (WILD) lighting box with cables and 3 sets of 1.5 V batteries
1 Set of jumper leads (for car batteries)
1 Can of Petrol (for generator)

5.1.2 Reflector Stations:

1 WILD centring rod (for tripod)
1 Tripod WILD GST 20
1 WILD prism GPR-1 in holder GPH-1 on WILD carrier GRT 10 with target plate WILD GZT 4
1 WILD tribrach GDF-6 (test optical plummet + spot bubble)
1 2 m folding ruler
1 plumb bob
1 Umbrella with steel base
1 Hammer
1 3 m Pocket Tape
1 Knife
1 Ball of String
3 Bathurst Beacon Steel Nails
1 Transceiver with 12 V supply cable (no batteries fitted)
1 Full set of size A batteries for transceiver
1 12 V car battery
1 Precision Barometer
1 Hygroskop (with spare batery, 9 V) or Psychrometer with bottle of distilled water (wick checked)
1 Clipboard
2 Torches (with full set of spare batteries each)
3 Marker Pegs
* Field forms
* Cloud charts

Additional Equipment for longest lines (Do not use without Supervisors instruction):

either (on Bayliss, Shell, Perth)

1 WILD triple prism holder GPH-3
2 WILD prisms GPR-1

or (on Hackney, Boundary, Backostani 88)

1 old AGA triple prism reflector
1 HP swivel base

Additional Equipment for "Boundary" and "Perth"

1 DWYER WIND METER

5.2 Field Work

All groups scheduled at the same time will share the field work. The supervisors will split the work between groups.
The distance meter should be set to the following routines for all measurements: readout in metre, zero ppm correction, readout to 0.1 mm, automatic switch off disabled, zero prism constant.

5.2.1 Calibration of Distance Meter (2-3 groups working together)

The additive constant of the WILD Distomat DI 3000 is to be determined on the CMA EDM baseline (See Appendix G). From each pillar, distances are to be measured to all other pillars in quick succession. Two sets of prisms to be used to speed up procedure.

Measure each distance as follows:

- level and point prism - measure height of prism (mm)
- check levelling of theodolite
- measure temperature + pressure at both ends
- point electronically to max signal
- make two distance measurements
- repoint electronically to max signal
- make two distance measurements
- read pressure and temperature at both ends

EDM instrument to be shaded at all times. Clearly note the number of the prism used on each line. The EDM instrument is left switched on between 15 minutes prior to first measurement to last measurement on baseline.

5.2.2 Calibration of Relative Reflector Constants

This part should be executed by each group separately.

The relative reflector constants of all prisms used in the survey is determined by an intercomparison of the prisms over 100 metres. Set up EDM instrument and reflector "UNSW 11" on tripods, and shade both. Level carefully. Take 6 readings to the prism, with electronic pointing after every 2nd measurement. Replace then prism "UNSW 11" with next by unlocking the prism lock on the carrier GRT 10. Do another 6 observations as before. Continue until last prism measured and measure again (6 x) reference prism "UNSW 11". Repeat then procedure in reverse order, and conclude with another 6 measurements of the reference prism.

5.2.3 Network Measurement

The network Backostani 88, Boundary,Bayliss 88, Hackney, Perth and Shell is measured repeatedly on two days. The EDM instrument occupies Shell on the first day and Bayliss 88 on the second. All 5 long distances as well as a short reference distance at the instrument section are measured in 30 minute intervals, beginning at 16.00 h and ending at 23.00 h (last measurements starting at 22.30 h). This provides 14 sets of measurements per line.

5.2.3.1 Activities at Reflector Station

Setting up of station includes proper centring of tripod (with centring rod) , proper levelling of reflector, set-up of umbrella, anchoring umbrella with strings and beacon nails, attachment of temperature probe to umbrella at about 1.5 from ground, measurement of reflector height to mm, recording of (serial) numbers of tribrach, prism, barometer, thermometer. On separate field form, sketch of tripod/reflector with indication of height difference between mark and ground surface. Secure tripods on ground with string and marker pegs. Beginning at 16.00 record every 10 minutes

- time
- temperature (to 0.1 C)
- pressure (to 0.1 mb)
- visibility (in km)
- cloud type (see cloud charts)
- clouds factor, surface wetness factor, surface roughness factor (see Appendix G)
- wind direction and strength (see Appendix G)
  (Note: Wind speed measured at PERTH + BOUNDARY)
- any precipitations
- state of centring of reflector (if no longer centred, measure eccentricity in direction of line measured (e.g. .. mm in front of mark as seen from EDM instrument) and RECENTRE and repoint afterwards.
- measure height of reflectors (to mm): Measure and book every ten minutes
- any special events (such as SUNSET, Begin of Rain,..)

Do not interrupt EDM beam when executing above observations.

5.2.3.2 Activities of EDM Instrument Station

Setting up of station includes proper centring of tripod (with centring rod), proper levelling of theodolite, set-up of 2 umbrellas with anchorage in ground with strings, attachment of temperature probe (1.5 m from Ground), measurement of trunnion axis of T2 above ground and above mark, recording of serial numbers of all equipment (theodolite, EDM instrument, tribrachs, prism, barometer, hygroskop). Sketch of tripod set-up on separate field form.

At a distance of 50 m, a mark is established and a reflector set up, centred and levelled. Secure tripod with string to marker pegs, measure height of prism.

In preparation of survey, with R.O. to tripod close by, measure and book one arc of directions and zenith angles (2 faces) to all 6 reflectors (optical pointing to centre of prism). Repeat in FL only using angular readings after electronic pointing.

At the commencement of every half-hour execute:

- temperature, pressure and humidity measurement,
- distances to all 6 prisms, clockwise on the hour, anti-clockwise on half-hour, with sequence:
  - electronic pointing
  - 2 measurements
  - electronic pointing
  - 2 measurements
- temperature, pressure and humidity measurement
- measure height of instrument (T2) to mm
- check centring (if off, measure, then re-centre)

Initial pointing at night is by pointing torch to reflector and by pointing to light flash returned. Alternatively, preset direction and scan zenith angle.

5.3 Computations

On the basis of the tests executed by your group, determine the relative reflector constants of all prisms with respect to the reflector "UNSW 11".

Reduce then the measurements carried out on the Bathurst EDM baseline to the reference prism "UNSW 11", apply the first velocity correction and reduce all distances to horizontal and to the elevation of pillar No. 4. The additive constant (DI 3000/prism UNSW 11) as well as the unknown baseline distances can then be computed. Consider all distances measured North and South as independent observations and adjust them separately according to the procedure given in Appendix G. Compare the two sets of results.

One of the stations Backostani 88, Boundary, Hackney, Perth will be allocated to each group for further analysis. Please note the following arrangements:

Groups	Lines to be analysed
all	Shell-Bayliss, Bayliss-Shell
...	Shell-Backostani 88, Bayliss-Backostani 88, 50 m Shell
...	Shell-Boundary, Bayliss-Boundary, 50 m Shell
...	Shell-Hackney, Bayliss-Hackney, 50 m Bayliss
...	Shell-Perth, Bayliss-Perth, 50 m Bayliss

All measurements made between Shell and the nominated station and between Bayliss and the nominated station should be reduced to ground mark to ground mark slope distance first, and then be corrected for the additive constant. The same procedure should be applied to the measurements between Bayliss and Shell and vice-versa. All groups apply also the same procedure to the one of the two sets of 50 m distances measured (see list above). This yields a total of 5 sets (2 for Bayliss-Shell, 2 for nominated station, one for 50 m distance) of 14 raw distances.

For each set of raw distances, compute the mean and the standard deviation of a single distance. Plot a histogramme of the 14 distances between "your" station and Shell/Bayliss, and those of the short 50 m line. (Class width: 1 mm).

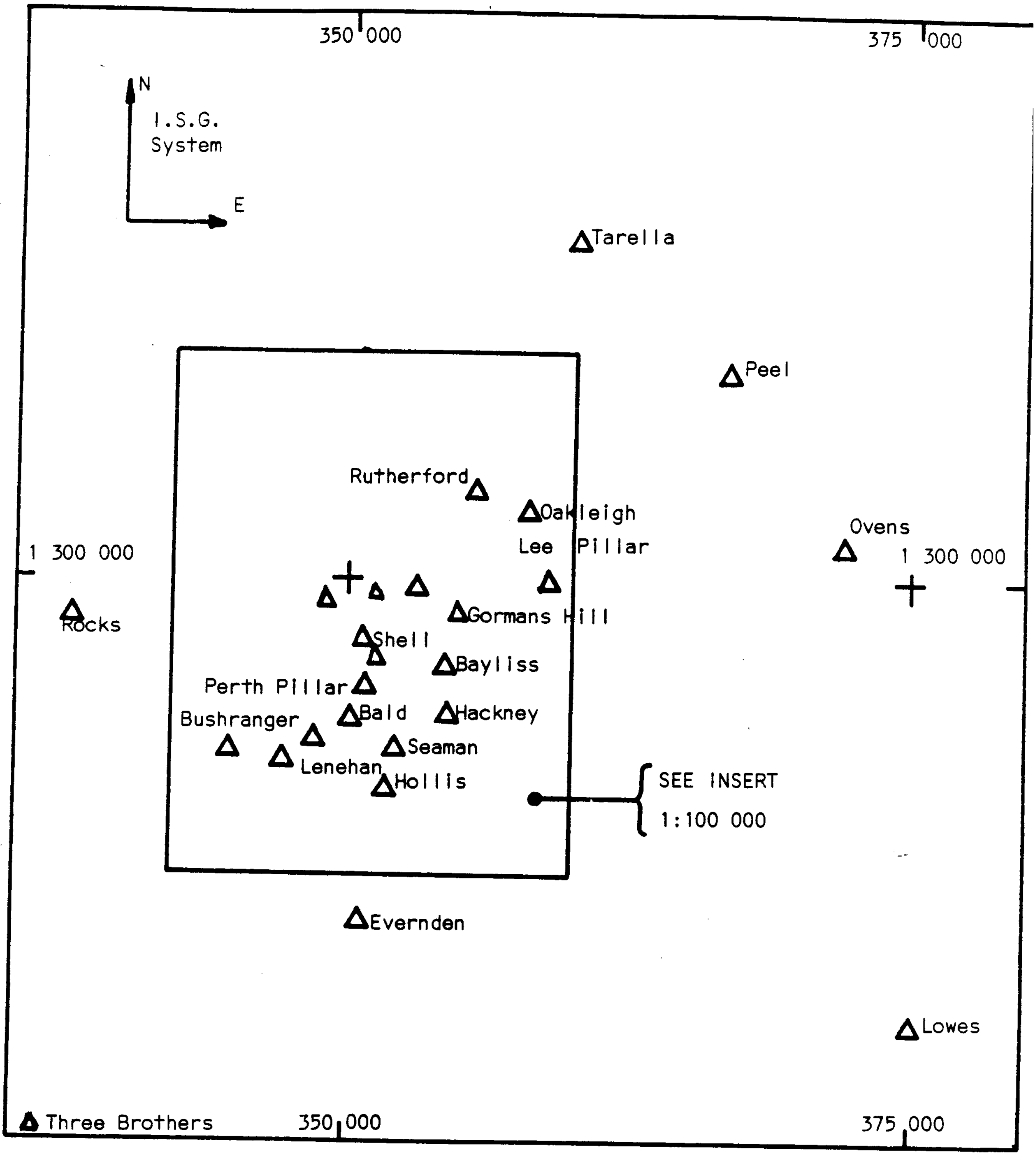
In a next step, reduce the distances betweeen Shell/Bayliss and "your" station as well as the short 50 m distance for the first velocity correction. (All additive constants of barometers and thermometers should be considered). For these three sets of 14 corrected distances, compute the mean and standard deviation (single observation). Plot histogrammes for the three lines.

In a final step, scale "your" three sets of raw distances with the corresponding (date and time wise) Bayliss 88-Shell distance with the ratio

scaled distance = raw distance x (3313.6738 m/raw distance B-S)

where 3313.6738 is the nominal ground mark to ground mark slope distance between Bayliss 88 and Shell (B-S). For these three sets of scaled distances, again compute the mean, the standard deviation (single observation) and plot the histogrammes.

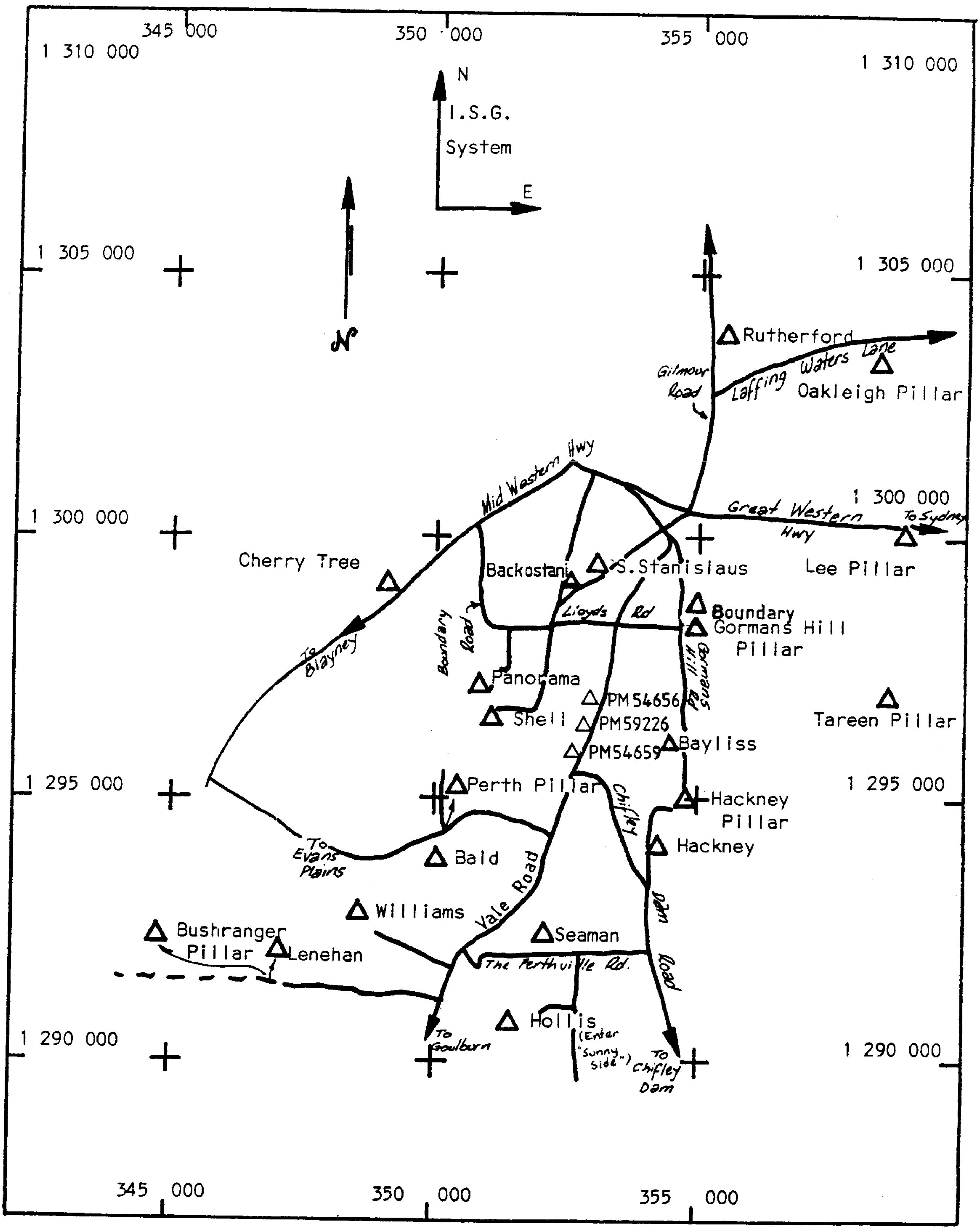
Comment on the merits of the ratio method as against the standard method (application of first velocity correction) in terms of precision and mean values obtained.



PLAN

SHOWING TRIG STATIONS IN THE BATHURST AREA.

SCALE: 1:250 000



INSERT

SHOWING TRIG STATIONS AND LOCAL ROAD SYSTEMS.

SCALE: 1:100 000

CENTRAL MAPPING AUTHORITY

Department of Lands

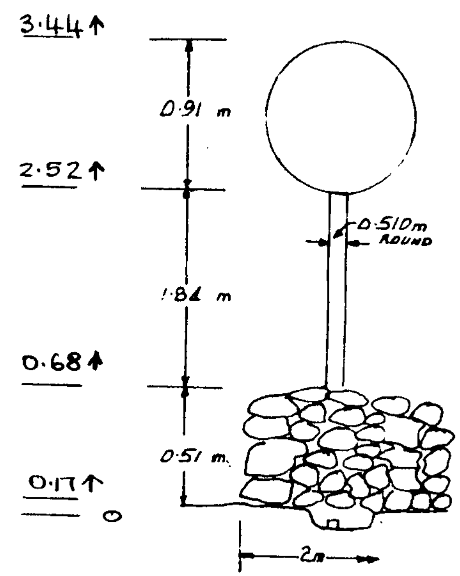
Trigonometrical Survey of N.S.W.

RECONNAISSANCE and MAINTENANCE REPORT

STATION *DOME T.S.*

Co:	Ph:
Map Sheet:	No:
Inspected by: *D. KAIN*	Date: *1 JUNE 1973.*
Authority *C.M.A.*	Field Book:

Beacon Diagram — Not to Scale



This Trig. Station has been:-

Note: Cross out word or words which do not apply

1. Completely cleared to permit 360° vision to surrounding Trigs.
2. Cleared by lanes bearing .... from Trig. Mast
3. Trig. Mast & Vanes have been painted white & black respectively.
4. The Trig. was unpiled/~~not unpiled~~, dimensions now being:

   Description of mark *COPPER CARTRIGE CASE* .... should be explicit, e.g. Steel plug, Brass plug, Bolt, G.I. Pipe

   Height of mark *0·022* .... m above/~~below~~ ~~rock~~/concrete *0·20* m ~~above~~/below G.L.

   Height of Top Vanes to Top Mark *3·444* m. Diameter of Vanes (vertical) *0·916* m.

   Height of Cairn *0·510* .... m. Diameter of Cairn *2·0* .... m.

   Length of Mast *2·528* .... m. (approximate if not unpiled)

5. A *Cu NAIL* ....set in conc/~~rock~~ has been placed *2·680* m. bearing *86* ......°M from Trig. Mast
6. A *G.I.PIPE* ....set in conc/~~soil~~ has been placed *2·065* m. bearing *23* ....°M from Trig. Mast
7. A.......... ...set in conc/soil has been placed ....m. bearing ....°M from Trig. Mast
8. A....... ....set in conc/rock has been placed ....m. bearing ....°M from Trig. Mast
9. Connection *PLUG* to *Cu NAIL* : *2·680* m. bearing *266* °M
10. Connection *PLUG* to *G.I.P.* : *2·065* m. bearing *113* °M
11. Connection *G.I.P.* to *Cu NAIL* : *4·595* m. bearing *279* °M
12. Connection......... to......... : .... m. bearing .... °M
13. Diff. Ht. *TRIG PLUG* ...... is *0·210* m. above *Cu NAIL* ....
14. Diff. Ht. *TRIG PLUG* ...... is *0·190* m. above *G.I.PIPE* ......
15. Diff. Ht. .... is .... m. ......
16. Diff. Ht. .... is .... m.

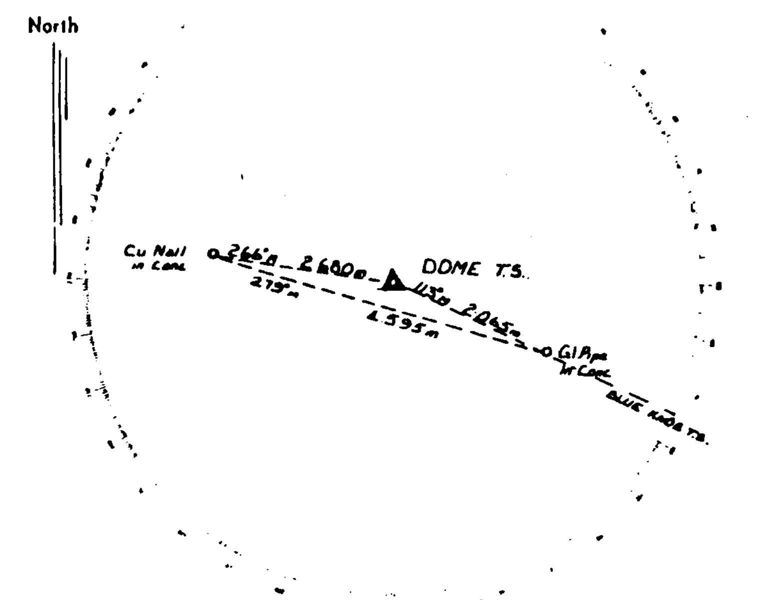
Prepared by: .... Checked .... Noted on U.T.M. Card .... Checked ....

Date	Record of Station

STATION DOME T.S.

Station Diagram

Not to Scale



List of Observed Directions:–

Standpoint: Station	Direction	Standpoint: Station	Direction

Station	Direction	Station	Direction

Owners Name........................

Address........................

....

Current Occupant........................

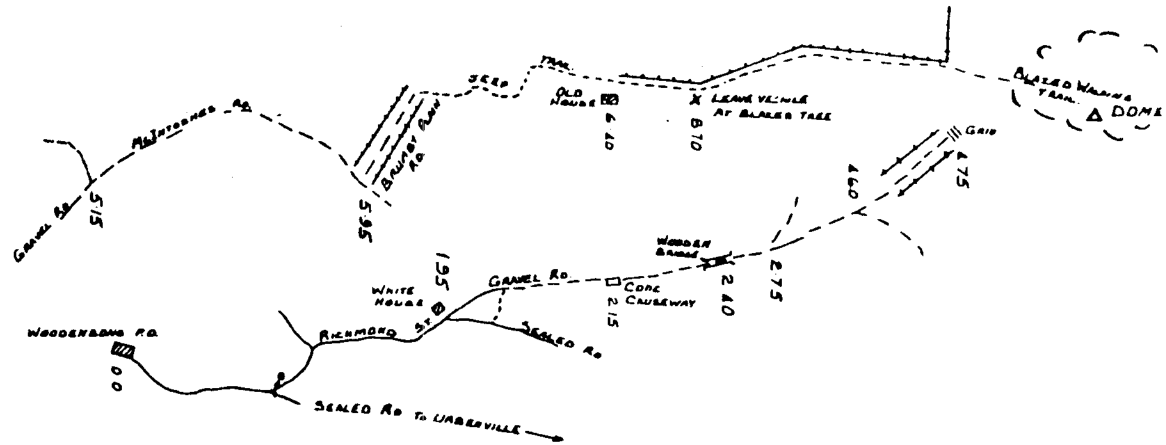
Address........................

....

Access

At Woodenbong post office at 0.0 miles on Macpherson Street travel towards Urbenville Bonalbo

0.05	Turn left into "Glennie Street" signpost
1.05	Turn right into "Richmond Street" signpost. Follow sealed road.
1.95	Pass white house on left
2.00	Take gravel road on left
2.15	Cross over concrete causeway.
2.40	Cross wooden bridge over creek, follow good gravel road
2.75	Take right fork in road, follow good gravel road
4.60	Take left fork in road up lane between fences.
4.75	Cross over grid. Signpost at grid "North Yabbra Road"
5.15	Take right turn onto "Mc Intoshes Road" signpost
5.95	Take gravel road on left "Brumby Plains Forest Road" signpost
6.40	Pass old disused house on left. Follow jeep trail
8.70	End of trail. Blazed trees. Fence on left. Leave vehicle and follow fence up fairly steep slope through Lantana thence through rain forest. Stay with fence until fence turns sharply down to your left. Just at top of range bear slightly to your right through rain forest to trig. Situated on western side of flat topped range. Walking time from sharp turn in the fence to trig is about 5 minutes. Walking trail was cut and blazed from here to trig. Walking time from vehicle is about 45 minutes with light load.



Not to Scale

A.4/1

BEACON DIMENSIONS

STATION: H A C K N E Y

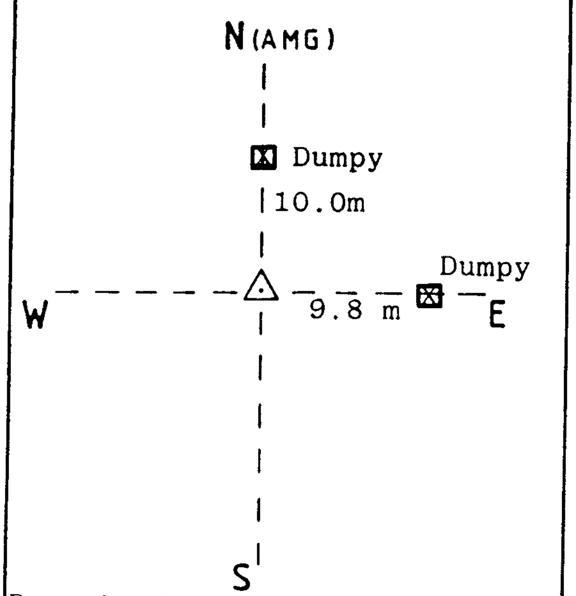
PLEASE MEASURE THE 4 DIMENSIONS (TO MILLIMETRE)

Y = Ground Mark to bottom of washer

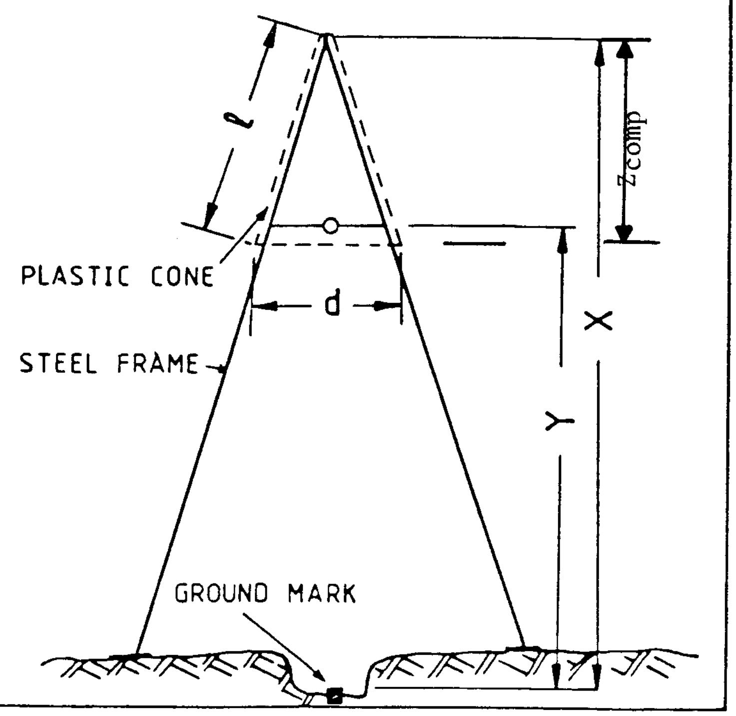
$Z^2 = l^2 - (d/2)^2$ CHECK: X - Y = approx. 610mm

DATE	TIME	GROUP No:	X	Y	ℓ	d
			mm	mm	mm	mm
3.12.84	15.00 h	1	3587	2985	870	830
5.12.84	14.00	5		2986		
6.12.84	16.30	9		2985		
7.12.84	13.38	12		2985		
8.12.84	14.36	12		2985		
9.12.84	17.00	3		2983		
7.12.84	9.00	8		2982		
10.12.84	6.25	13		2982		
10.12.84	11.30	13		2982		

SKETCH OF PLUMBING PEGS



Pegs by Group 1, 3.12.1984



A 4/2

BEACON ECCENTRICITY

STATION:

PERTH PILLAR

BOOK ECCENTRICITIES OF BEACON TOPS RELATIVE TO GROUND MARKS(or PILLAR) IN MILLIMETRE.

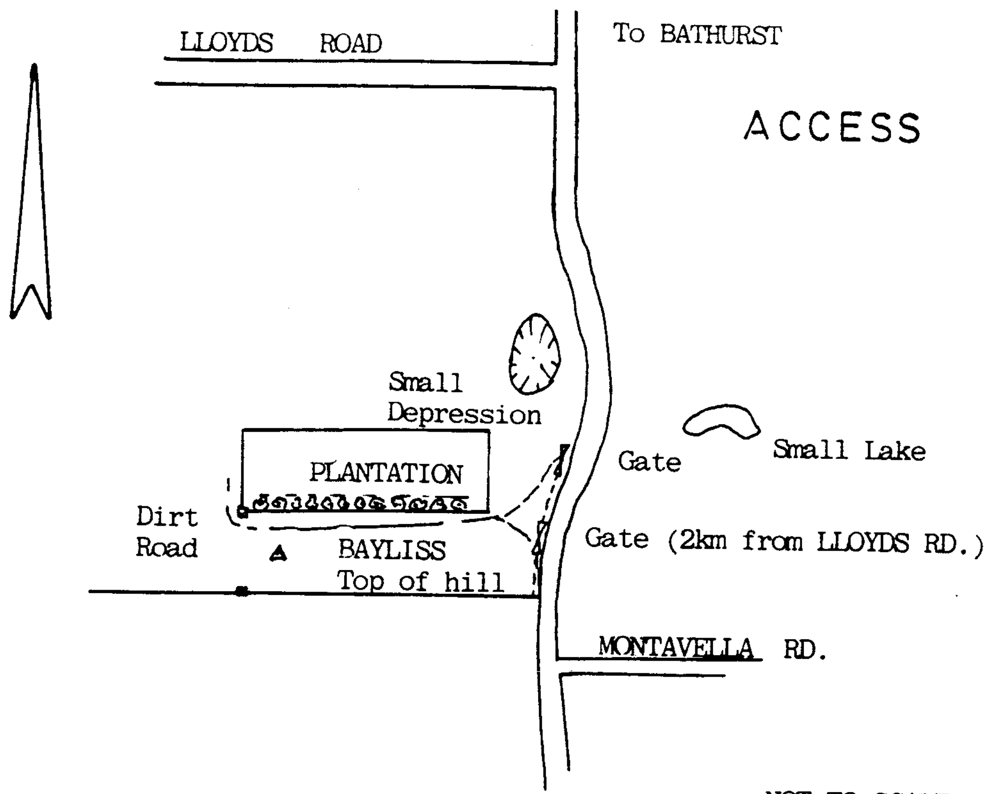
(e.q. 4.5 mm N = Top of Beacon is 4.5 mm North of ground mark.)

DATE	TIME	GROUP No.	N/S mm	E/W mm	ENTERED BY:
30.11.83	09.30	15	0.0	0.8 E	
30.11.83	14.00	15	0.0	0.5 E	
1.12.83	10.40	16	6.0 N	2.0 W	
1.12.83	14.45	16	8.0 N	1.0 W	
1.12.83	08.00	13	6.0 N	1.0 W	
1.12.83	10.30	13	6.0 N	2.0 W	
1.12.83	15.00	14	8.0 N	1.0 W	
1.12.83	18.10	14	6.0 N	1.0 W	
3.12.83	14.00	17	7.0 N	0.0	
3.12.83	17.45	17	15.0 N	7.0 E	
4.12.83	14.00	3	16.0 N	0.0 E	
4.12.83	16.30	3	16.0 N	0.0 E	
5.12.83	13.00	4	18 N	14 E	
5.12.83	16.00	4	18 N	14 E	
6.12.83	16.00	7	16 N	15 E	
7.12.83	16.00	7	15 N	14 E	
8.12.83	15.00	11	11 N	12 E	
8.12.83	18.30	11	11 N	12 E	
9.12.83	16.00	12	15 N	13 E	
9.12.83	18.30	12	15 N	13 E	

R.C.

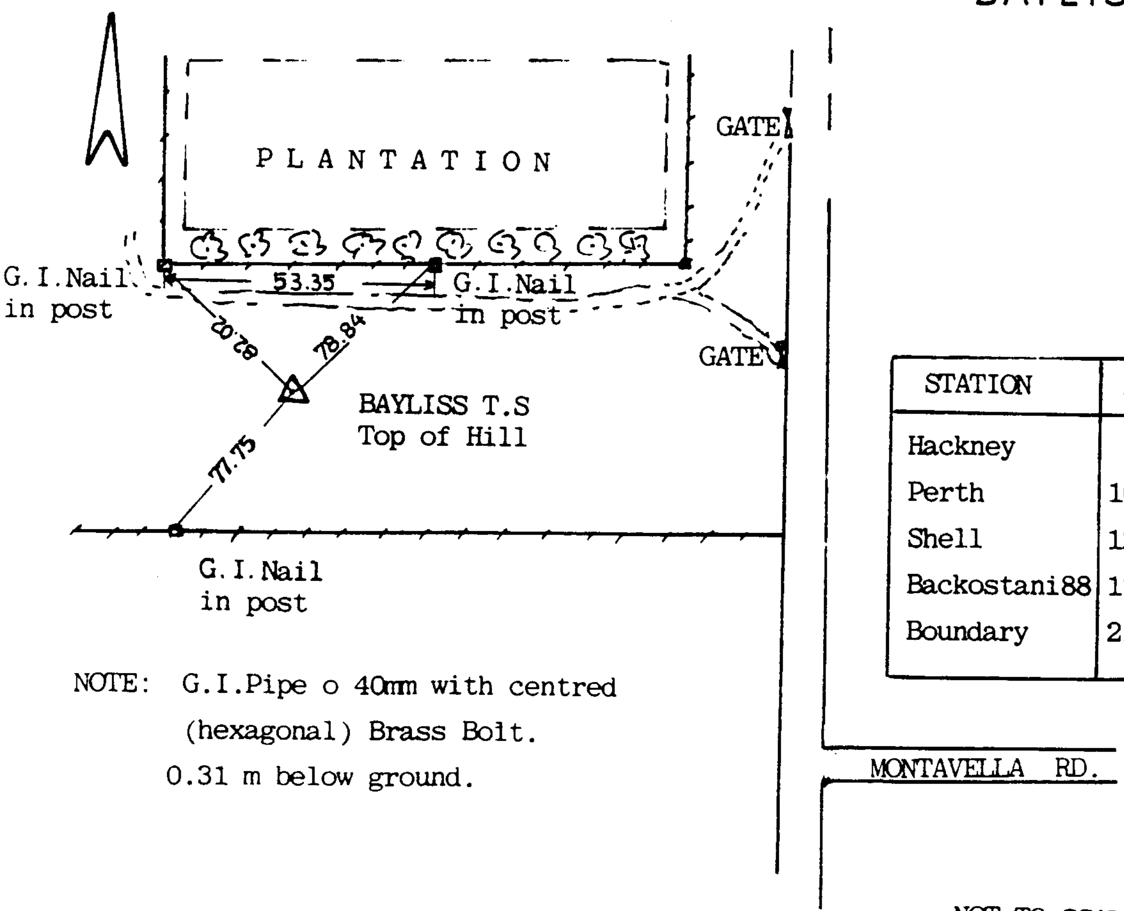
BAYLISS

ACCESS



NOT TO SCALE

BAYLISS

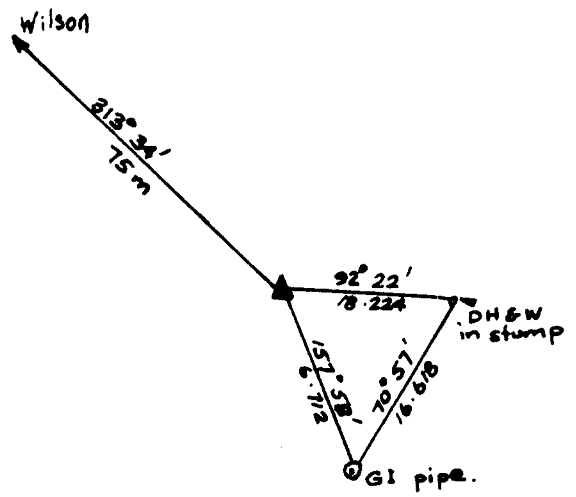


STATION	DIRECTION
Hackney	26° 44′
Perth	101° 57′
Shell	122° 16′
Backostani88	177° 43′
Boundary	215° 53′

NOTE: G.I.Pipe o 40mm with centred (hexagonal) Brass Bolt. 0.31 m below ground.

NOT TO SCALE

'CHERRY TREE T.S.'

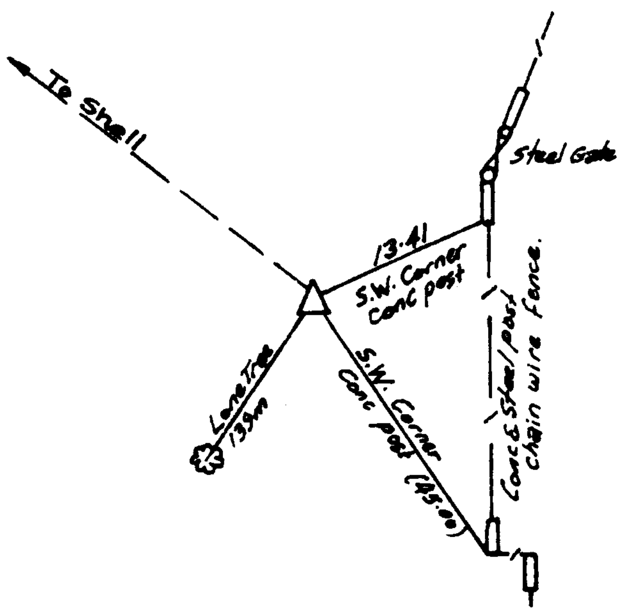


STATION	DIRN
Tarella	34° 20'
Peel	60° 29'
St Stanislaus	83° 11'
Humby	88° 08'
MacPhillamy	94° 51'
Bayliss	118° 27'
Panorama	88°
Perth Pillar	158° 11'
Bald	168° 22'
Everden	174° 17'
Williams	183° 58'
Lenehan	195° 05'
Bushranger	212° 33'
Wilson	331° 34'

'HACKNEY T.S.'

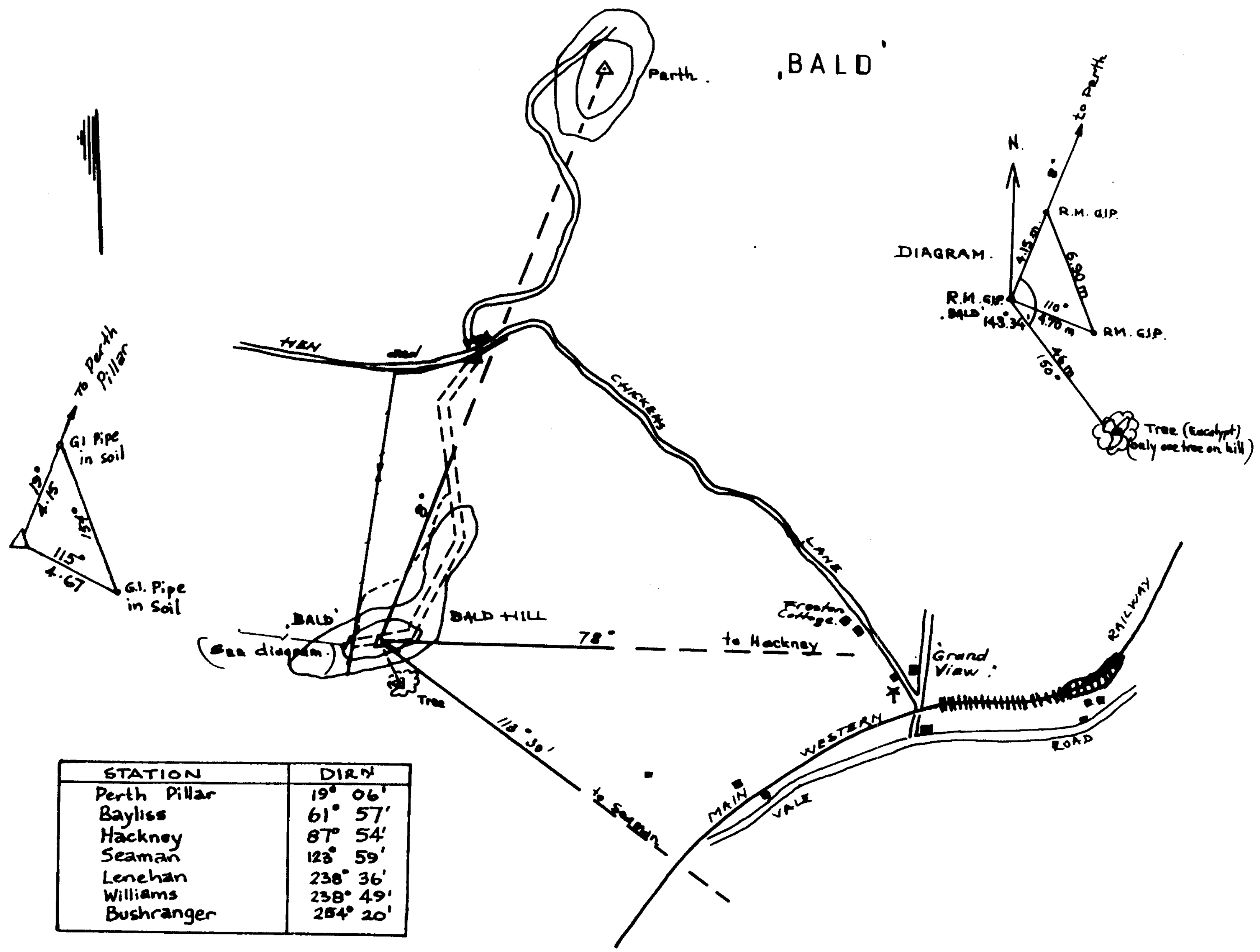
STATION	DIRN
Shell Tower	0° 00'
St. stanislaus	38° 10'
Bayliss	53° 10'
McPhillamy	57° 42'
Seaman	287° 04'
Williams	311° 36'
Bald	319° 57'
Perth	339 37'

Access on foot from Goremans Hill Road. For car access in exceptional circumstances: Get key for padlock on gate on Goremans Hill road from the manager of WONALABEE. Phone 313922.



A 6/1

'BALD'

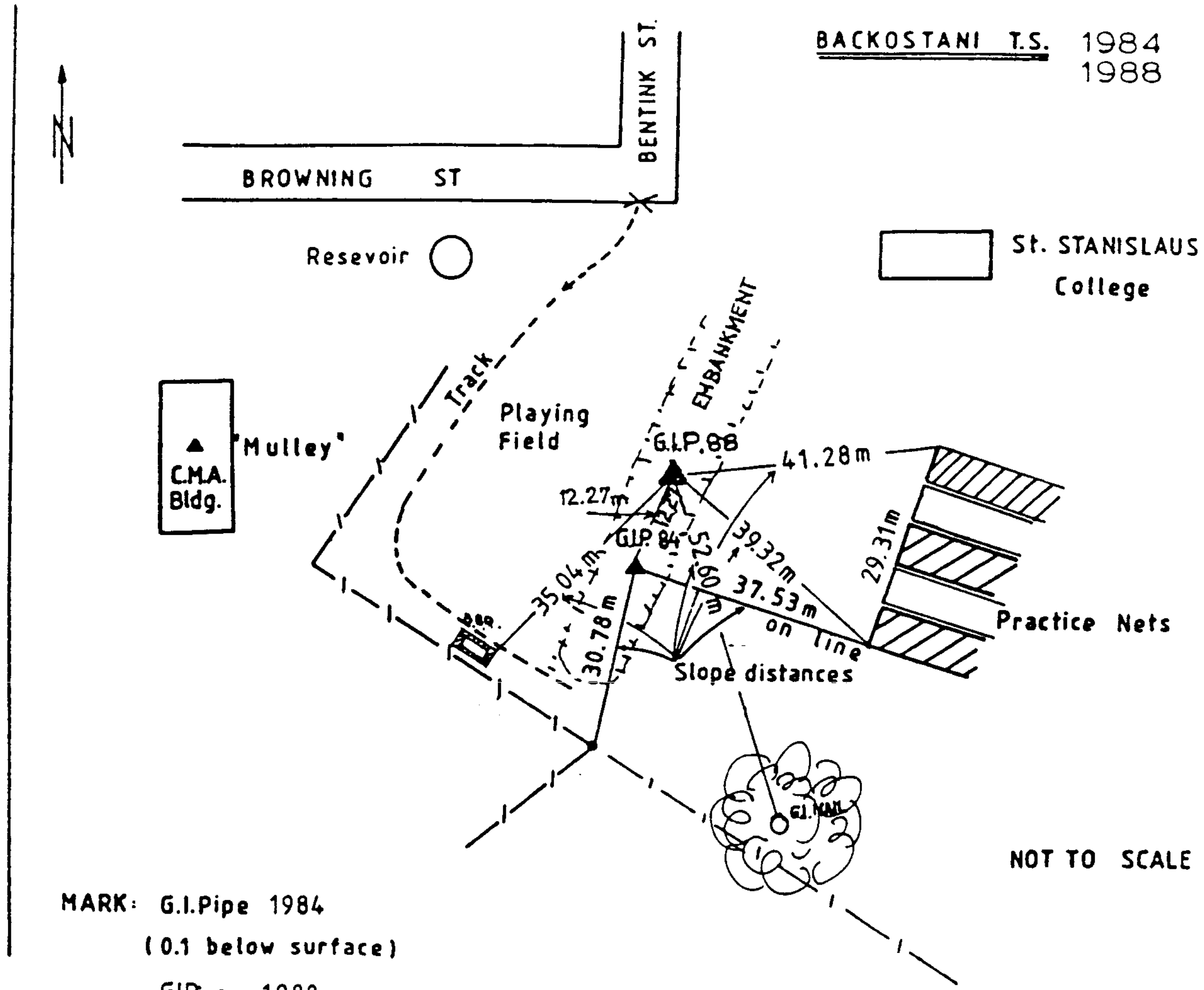


STATION	DIRN
Perth Pillar	19° 06'
Bayliss	61° 57'
Hackney	87° 54'
Seaman	123° 59'
Lenehan	238° 36'
Williams	238° 49'
Bushranger	254° 20'

BATHURST

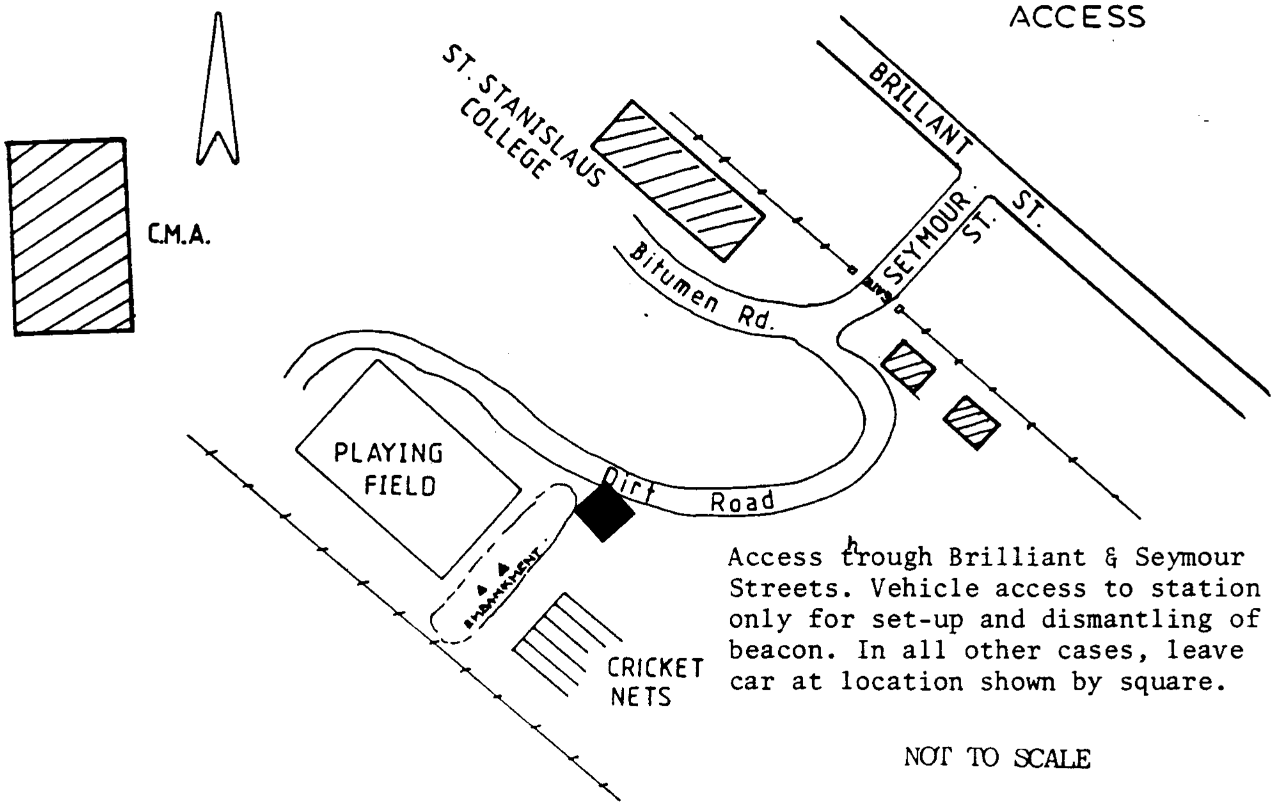
2 Oct. 1984

BACKOSTANI T.S. 1984 1988



MARK: G.I.Pipe 1984
(0.1 below surface)
G.I.Pipe 1988
(0.14 below surface)

ACCESS

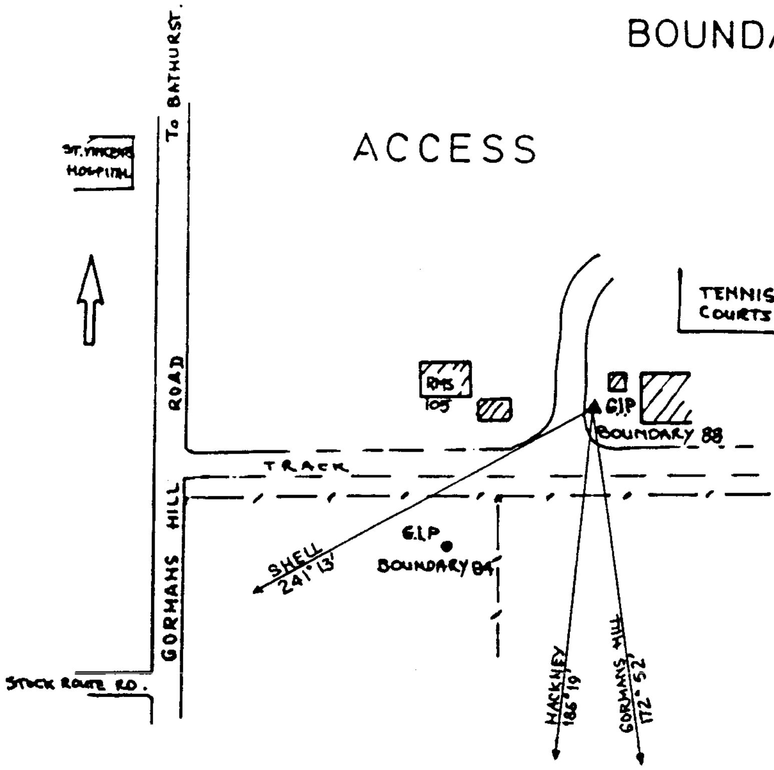


Access trough Brilliant & Seymour Streets. Vehicle access to station only for set-up and dismantling of beacon. In all other cases, leave car at location shown by square.

NOT TO SCALE

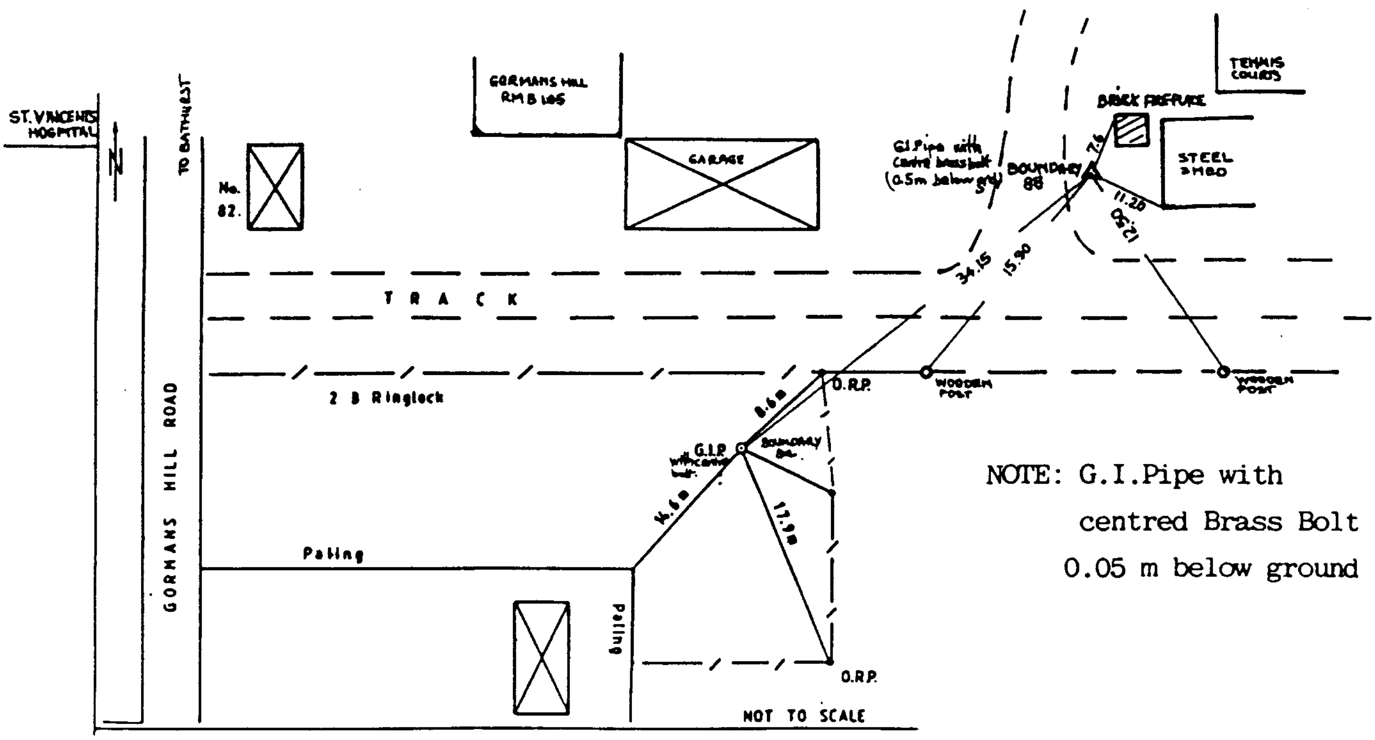
BOUNDARY 1984
1988

ACCESS



NOT TO SCALE

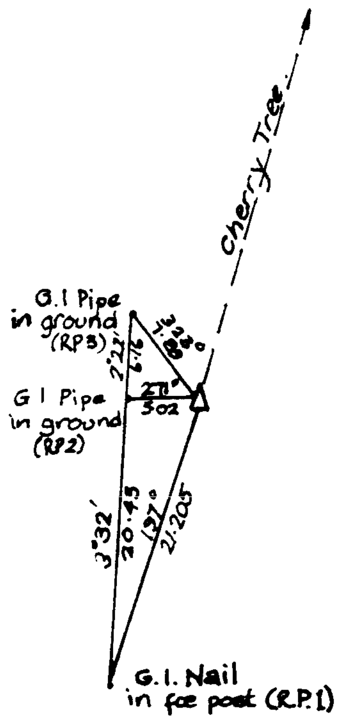
BOUNDARY



NOTE: G.I.Pipe with centred Brass Bolt 0.05 m below ground

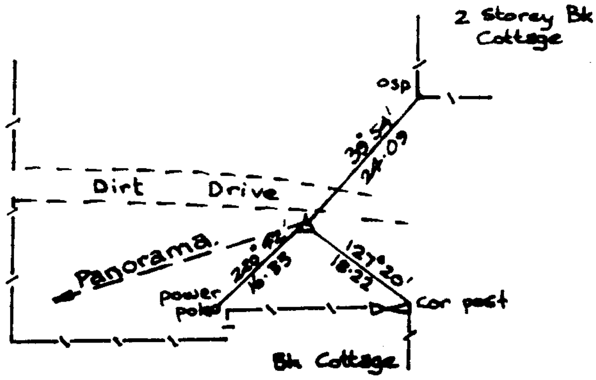
A.8

'LENEHAN T.S.'



'Mc PHILLAMY T.S.'

STATION	DIRN
Cherry Tree	0°00'00"
Perth Pillar	32°13'
Bald	43°31'
Bushranger	262°11'

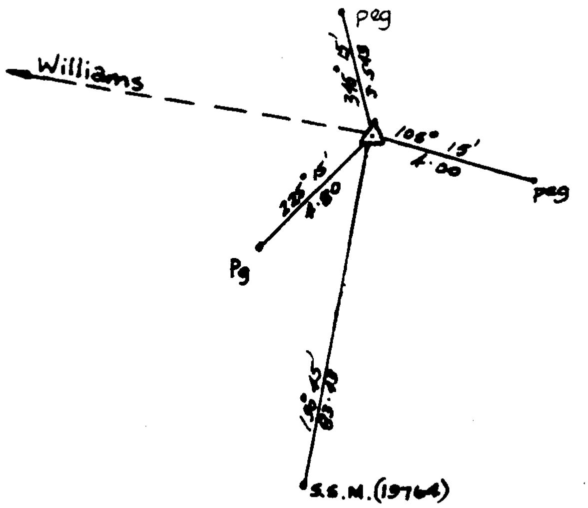


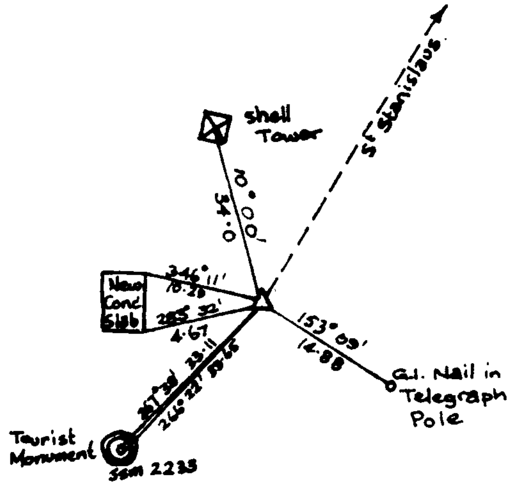
STATION	DIRN
Hackney	185°37'
Perth Pillar	231°37'
Shell	240°56'
Panorama	251°06'
Cherry Tree	274°51'
Humby	277°10'
St Stanislaus	297°57'
Tarella	17°08'

A.9

'SEAMAN T.S.'

'SHELL T.S.'



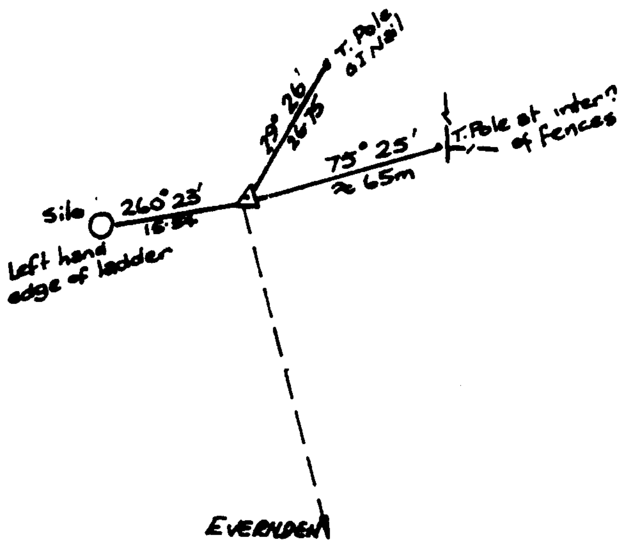


STATION	DIRN
Lenehan	265° 13'
Williams	277° 44'
Bald	303° 59'
Perth	329° 56'
Shell	345° 48'
Hackney	55° 01'
Three Brothers	223° 15'

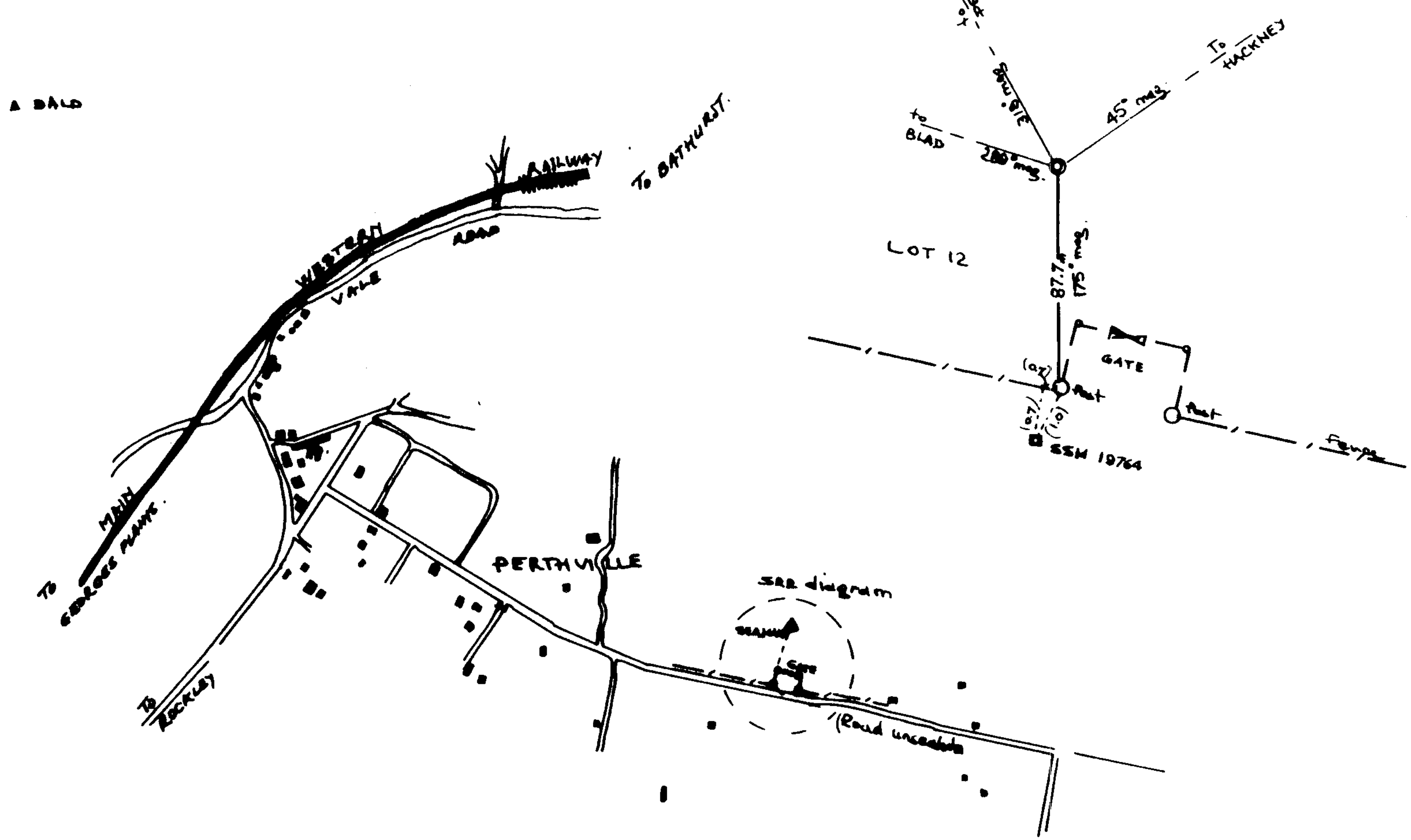
STATION	DIRN
Panorama	334° 45'
Humby	346° 52'
St Stanislaus	31° 45'
McPhillamy	60° 56'
Bayliss	96° 35'
Hackney	127° 53'
Perth Pillar	205° 08'

'WILLIAMS. T.S.'

STATION	DIRN
Evenden	0° 00'
Three Brothers	48° 38'
Lenehan	71° 16'
Cherry Tree	136° 52'
Perth Pillar	283° 52'
Seaman	290° 37'



"SEAMAN"



BATHURST

Oct. 1984.
Drawing. C. RUSU.

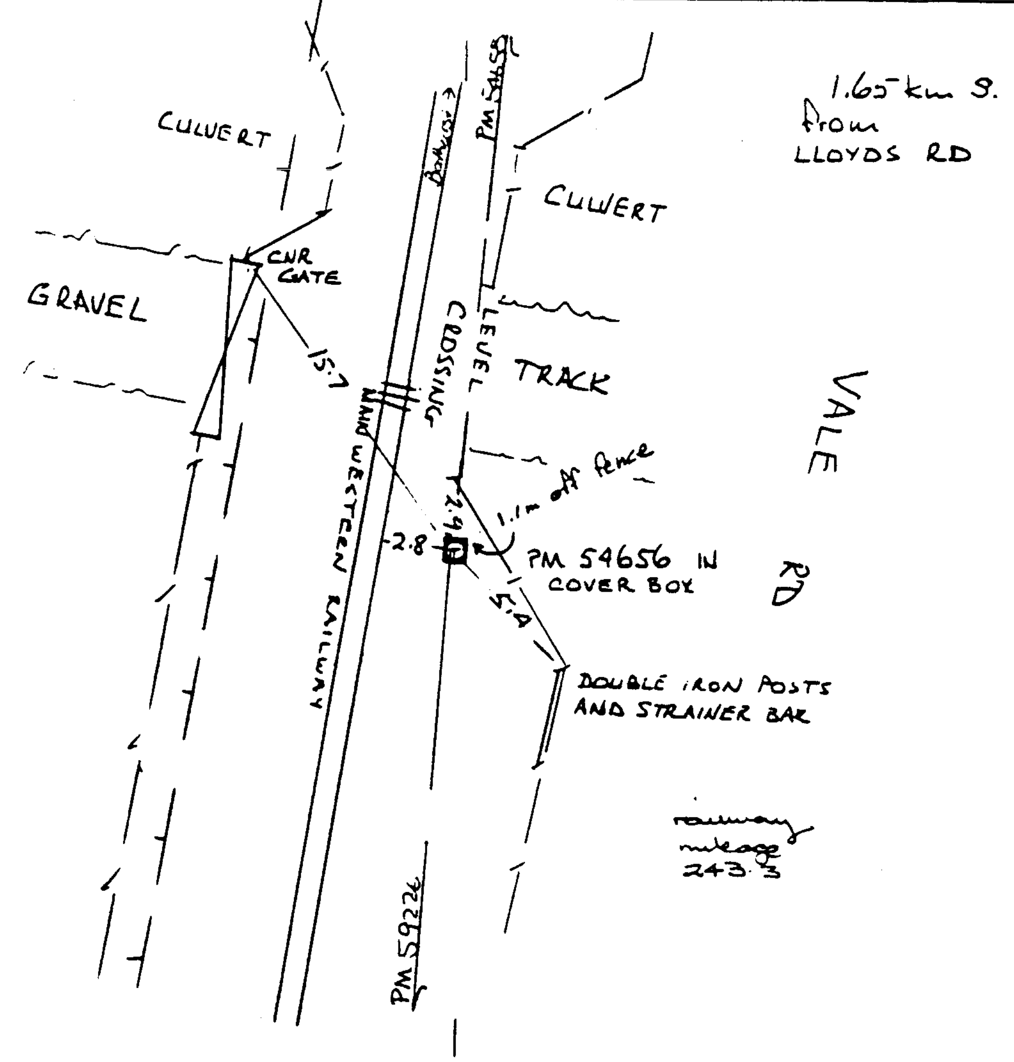
PM 54656
SSM
MsM

LOCALITY SKETCH PLAN

Parish BATHURST County ROXBURGH NEAREST City or Town BATHURST

Municipality or Shire BATHURST C.M.A. Map Sheet BATHURST 8831-3-S

Measurements are in metres Zone 55/3



Organization placing Marks CMA Ref.

Mark placed / /19

Note: Replaces PM SSM

Locality Sketch Book No. Fol.

Plan Register noted / /19

PM 54656
SSM
MsM

I certify that the Mark or Marks have been placed and numbered as detailed hereon.

Designation

Date 16/ 6/ 1987

S.O. 2019 D. West, Government Printer

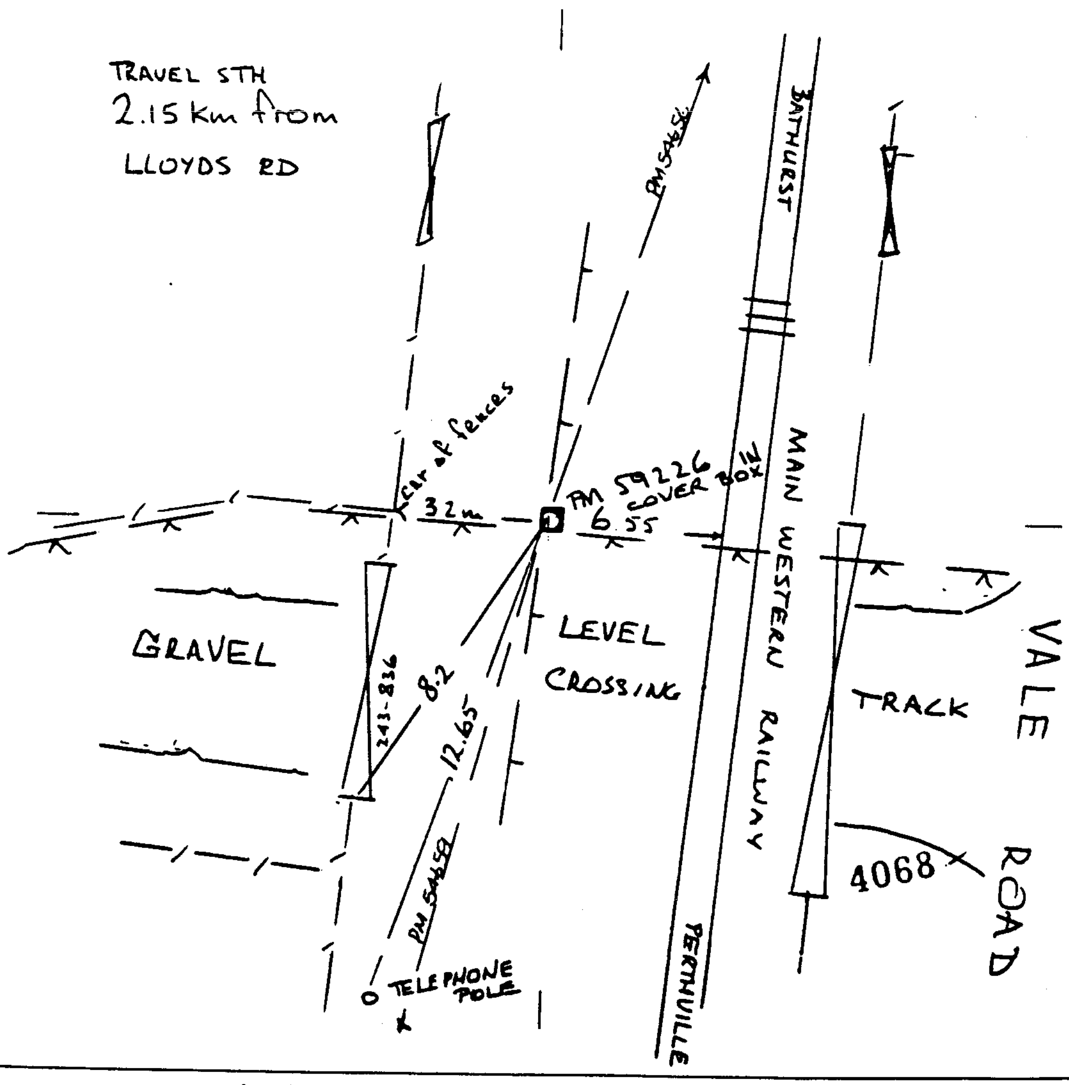
PM 59226
SSM
M:M

LOCALITY SKETCH PLAN

Parish BATHURST County ROXBURGH NEAREST City or Town BATHURST

Municipality or Shire BATHURST C.M.A. Map Sheet BATHURST 8831-3-S

Measurements are in metres Zone 55 / 3



Organization placing Marks CMA Ref. ....

Mark placed / /19

Note: Replaces PM .... SSM ....

Locality Sketch Book No. .... Fol. ....

Plan Register noted / /19

PM 59226
SSM
M:M

I certify that the Mark or Marks have been placed and numbered as detailed hereon.

Designation ....

Date 16 / 6 / 1987

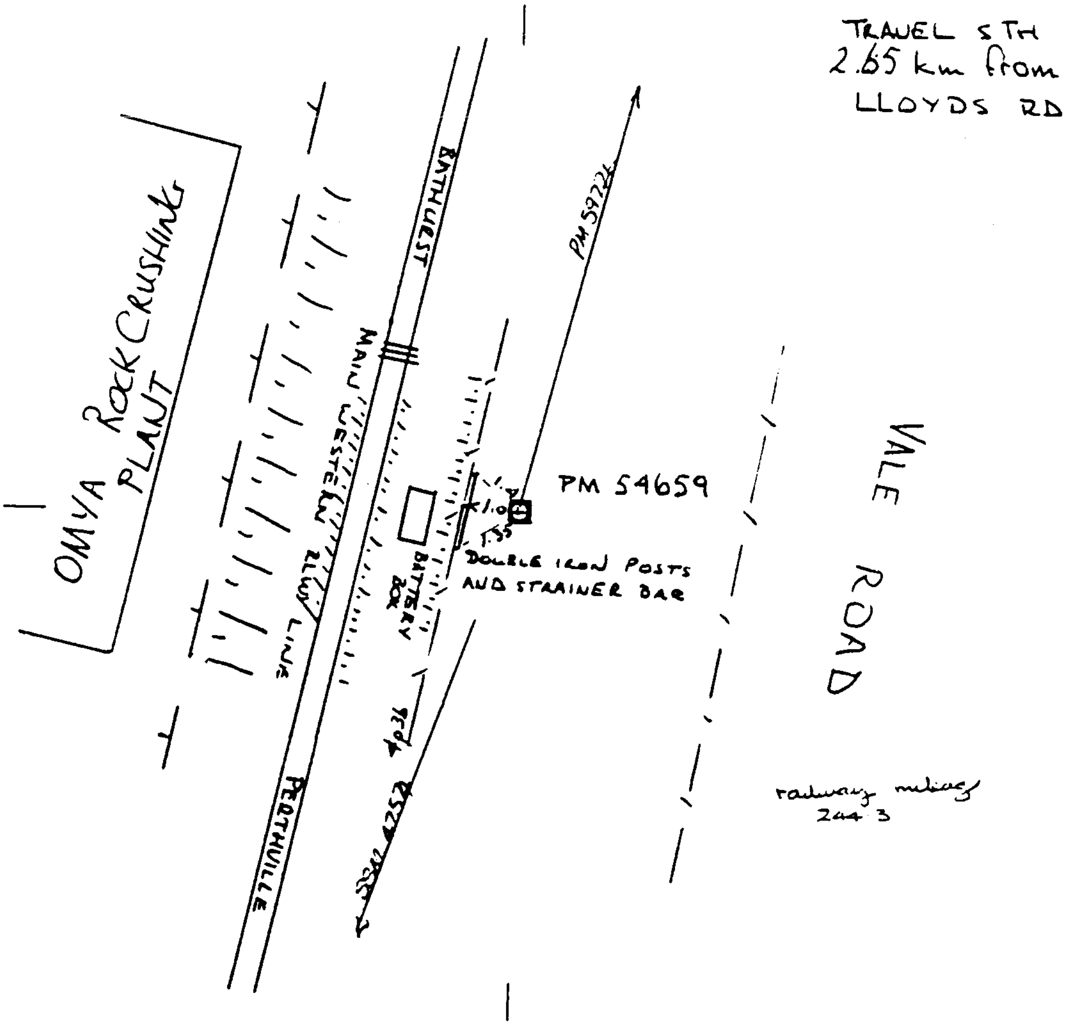
PM 54659
SSM
MsM

LOCALITY SKETCH PLAN

Parish BATHURST County ROXBURGH NEAREST City or Town BATHURST

Municipality or Shire BATHURST C.M.A. Map Sheet BATHURST 8831-3-S

Measurements are in metres Zone 55/3



Organization placing Marks CMA Ref.

Mark placed / / 19

Note: Replaces PM ... SSM ...

Locality Sketch Book No. ... Fol. ...

Plan Register noted / / 19

PM 54659
SSM
MsM

I certify that the Mark or Marks have been placed and numbered as detailed hereon.

Designation

Date 16 / 6 / 1987

S.O. 2019 D. West, Government Printer

Appendix B

COMPENDIUM OF FORMULAE
for the
LEAST SQUARES ADJUSTMENT
of
CONTROL NETWORKS

1. NOTATION AND BACKGROUND

A set of n linearized observation equations is given by:

$$v = Bx + T$$

where v is the vector of residuals of the n observations p_i

B is the matrix of coefficients b_{ij} (calculated from approximate values of parameters $\overline{x}$),

x is the vector of u independent parameters, and

T is the vector of absolute terms.

The vector of absolute terms is calculated from

$$T = p^o - p$$

where p is the vector of observed values, and

p^o is the vector of constant terms, calculated from approximate values of parameters $\overline{x}$.

The degree of freedom, f, is given by

$$f = n - u$$

The population variance σ_i^2 of each observation p_i can be expressed by a variance estimator S_i^2 :

$$S_i^2 = S^2 . g_{ii} ,$$

where S^2 is the a priori (dimensionless) variance factor, and

g_{ii} is the weight coefficient of the particular observation.

The weight coefficients g_{ii} form a matrix G, which is a diagonal matrix for the case of uncorrelated observations.

2. SOLUTION

The most probable values for the parameters x are found according to the Principle of Least Squares by minimizing the quadratic form M by variation of the parameters.

$$M = v^T G^{-1} v = \Sigma(\frac{vv}{g})$$

This minimization leads to the normal equation system:

$$N x + C = 0 ,$$

which can be solved by suitable methods. The matrix of normal equation coefficients N and vector of constant terms C are given by:

$$N = B^T G^{-1} B$$

$$C = B^T G^{-1} T$$

The solution for the parameters is found by

$$\Delta X = -N^{-1} B^T G^{-1} T$$

$$= -N^{-1} C.$$

Values of final parameters x are calculated from

$$x = \overline{x} + \Delta x.$$

3. CHECK CALCULATIONS

Values for the adjusted observations p_i are calculated from the final parameters x . Hence the residuals are found as the difference between p_i^a and the original observations p_i:

$$v_i = p_i^a - p_i . \qquad i = 1, \ldots n$$

i) As an important check calculation the individual residuals v_i also may be calculated by substitution of the parameters x into the observation equations:

$$v = B.\Delta x + T .$$

ii)

$$\Sigma \left(\frac{B_{ij} v_i}{g_{ii}}\right) = 0 \qquad \text{for all} \quad j = 1, \ldots. u.$$

iii) The minimum (least squares) is found by the equation

$$M = (B^T G^{-1} T)^T \Delta X + T^T G^{-1} T ,$$

and is compared as a check calculation with

$$M = \Sigma \left(\frac{v_i v_i}{g_{ii}}\right) ,$$

calculated from individual residuals v_i.

4. INVESTIGATION OF PRECISION

4.1 A posteriori Variance factor

An a posteriori estimate $\bar{S}^2$ for the variance factor may be obtained from the minimum M:

$$\bar{S}^2 = \frac{M}{f}$$

The null hypothesis that both variance factors (a priori and a posteriori) belong to the same population, can be tested using the F-distribution. If the variance ratio

$$\frac{\bar{S}^2}{S^2} < F\,(1-\alpha,\ f_1,\ f_2),$$

the null hypothesis has to be accepted at the α significance level, and for f_1 and f_2 as the number of degrees of freedom used in determining $\bar{S}^2$ and S^2 respectively.

4.2 Precision of adjusted parameters

An estimate of the variance -covariance matrix of the adjusted parameters (S_x) is found by application of the general law of propagation of variances as:

$$(S_x) = \bar{S}^2\ Q_{xx}\ ,$$

where the cofactor matrix Q_{xx} is the inverse of N:

$$Q_{xx} = N^{-1}\ .$$

and where $\bar{S}^2$ is the aposteriori variance factor.

5. OBSERVATION EQUATIONS FOR A CONTROL NETWORK

i) Direction from station P to station Q , D_{PQ} :

P to Q : $v_D = a_{PQ}\,dN_P + b_{PQ}\,dE_P - a_{PQ}\,dN_Q - b_{PQ}\,dE_Q - dO_P + T_D$

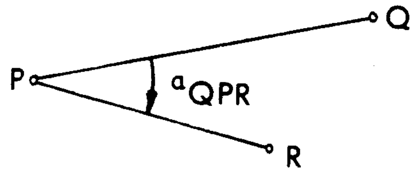
$T_D = \Theta_{PQ} - (D^{\cdot}_{PQ} + \bar{O}_P)$

ii) Distance between stations P and Q, d_{PQ} :

P to Q: $v_d = -\cos\Theta_{PQ}\,dN_P - \sin\Theta_{PQ}\,dE_P + \cos\Theta_{PQ}\,dN_Q + \sin\Theta_{PQ}\,dE_Q + T_d$

$T_d = d_{PQ}^{calc.} - d_{PQ}^{observ.}$

iii) Angle at station P between stations Q and R, α_{QPR} :



$$v_\alpha = (a_{PR} - a_{PQ})\ dN_p + (b_{PR} - b_{PQ})\ dE_p + a_{PQ}dN_Q + b_{PQ}dE_Q$$

$$- a_{PR}\ dN_R - b_{PR}dE_R + l_\alpha$$

$$l_\alpha = (\Theta_{PR} - \Theta_{PQ}) - \alpha_{QPR}$$

NOTATION

For these observation equations the following notation has been adopted:

$\overline{E}$, $\overline{N}$: are approximate coordinates of stations

dE , dN : are the least squares parameters for the unknown coordinates

$E = \overline{E} + dE$, and

$N = \overline{N} + dN$: are the adjusted final coordinates

$\overline{O}_p$: is the approximate orientation of the direction observations at station P, with respect to the coordinate system.

dO_p : is the least squares parameter for the orientation at station P.

$O_p = \overline{O}_p + dO_p$: is the adjusted final orientation at station P.

D , d , α : are the observed values for direction, distance and angle respectively.

V_D , d_d , v_α : are the corrections (residuals) to these observed values

T_D , T_d , T_α : are the absolute terms

Θ , S : are the preliminary bearing and distance, calculated from approximate coordinates $\overline{E}$, $\overline{N}$.

a , b : are the direction coefficients, calculated according to the equations

$$a_{PQ} = \frac{\rho'' \sin \Theta_{PQ}}{S_{PQ}} \quad , \quad b_{PQ} = -\frac{\rho'' \cos \Theta_{PQ}}{S_{PQ}}$$

$$\rho'' = 206\ 264.81''$$

Attention: Dimensions.

6. CALCULATION OF POINT ERROR ELLIPSES AND 95% CONFIDENCE ELLIPSES

The weight coefficient Q_{xx} of the adjusted parameters dN_i , dE_i and dO_i is of the general form:

$$Q_{xx} = \begin{bmatrix} Q_{N_1N_1} & Q_{N_1E_1} & \cdots & & & \cdot \\ Q_{E_1N_1} & Q_{E_1E_1} & & & & \cdot \\ \cdot & & Q_{N_iN_i} & Q_{N_iE_i} & & \cdot \\ \cdot & & Q_{E_iN_i} & Q_{E_iE_i} & & \cdot \\ \cdot & & & & \ddots & \cdot \\ \cdot & \cdots & & & & Q_{O_jO_j} \end{bmatrix}$$

The basic parameters of the error ellipse at the station i are calculated from the following equations:

i) The a posteriori variance factor $\bar{s}^2$

(Refer to Section 4.1 for details)

ii) The eigen values $\lambda_{1,2}$ of the cofactor matrix for the station i :

$$\lambda_{1,2} = \tfrac{1}{2}(Q_{N_iN_i} + Q_{E_iE_i}) \pm \tfrac{1}{2}\sqrt{(Q_{N_iN_i} - Q_{E_iE_i})^2 + 4Q^2_{N_iE_i}}$$

(positive sign for λ_1)

iii) Semi major and minor axis of the point error ellipse:

Semi major axis : $\sqrt{\bar{s}^2 \lambda_1}$

Semi minor axis : $\sqrt{\bar{s}^2 \lambda_2}$

iv) Orientation of semi major axis Θ_i :

$$\Theta_i = \tfrac{1}{2} \arctan \frac{2\, Q_{N_iE_i}}{Q_{N_iN_i} - Q_{E_iE_i}}$$

v) Semi major and minor axis of the 95% (point) confidence ellipse computes from:

Semi major axis: $(F_{2,f,\ 0.05}\ \bar{s}^2\lambda_1)^{0.5}$

Semi minor axis: $(F_{2,f,\ 0.05}\ \bar{s}^2\lambda_2)^{0.5}$

where the values for the Fisher - distribution refer to the two - tailed test.

DIRECTION OBSERVATIONS

STATION Alpha	DATE 1/4/55 TIME 1600 to 1700	WEATHER Clear	OBSERVER J. Jones BOOKER W. Smith THEOD. T2 # 36487

ARC	STATION	F.L.	F.R.	DIFF "	MEAN	RED. MEAN	q	V	VV	COMMENTS
	BETA	0 00 05	180 00 22	+ 17	0 00 13.5	0 00 00	0.00	+0.17	0.03	
	GAMMA	74 39 55	254 40 19	+ 24	74 40 07.0	74 39 53.5	1.62	1.79	3.20	
	DELTA	99 01 04	279 01 19	+ 15	99 01 11.5	99 00 58.0	-2.12	-1.95	3.80	
							-0.50	+0.01		
	BETA	45 02 29	225 02 52	+ 23	45 02 40.5	0 00 00	0.00	-0.50	0.25	
	GAMMA	119 42 22	319 42 42	+ 20	119 42 32.0	74 39 51.5	-0.38	-0.88	0.77	
	DELTA	144 03 32	364 03 53	+ 21	144 03 42.5	99 01 02.0	+1.88	+1.38	1.90	
							+1.50	0.00		
	BETA	90 04 57	270 05 18	+ 21	90 05 07.5	0 00 00	0.00	0.00	0.00	
	GAMMA	164 44 49	344 45 09	+ 20	164 44 59.0	74 39 51.5	-0.38	-0.38	0.14	
	DELTA	189 06 00	9 06 16	+ 16	189 06 08.0	99 01 00.5	+0.38	+0.38	0.14	
							0.00	0.00		
	BETA	135 07 28	315 07 42	+ 14	135 07 35.0	0 00 00	0.00	-0.25	0.06	
	GAMMA	209 47 21	29 47 31	+ 10	209 47 26.0	74 39 51.0	+0.88	+0.63	0.40	
	DELTA	234 08 26	54 08 44	+ 18	234 08 35.0	99 01 00.0	-0.12	-0.37	0.14	
							+0.76	+0.01	10.85	
		GRAND MEANS								
		BETA	0 00 00							
		GAMMA	74 39 51.88							
		DELTA	99 01 00.12							

$s^2_{SD} = \frac{10.85}{6} = 1.81$

$s^2_{GM} = \frac{1.81}{4} = 0.45$

$\therefore S_{SD} = \pm 1{\cdot}35''$

$S_{GM} = \pm 0{\cdot}67''$

n = No. of Arcs ...... i = 1,n

k = No. of Stations .. j = 1,k

q_{ij} = (Red. Mean)$_{ij}$ - (Grand Mean)$_j$

$V = q_{ij} - \left(\frac{\sum_{j=1}^{k} q_{ij}}{k}\right)$

VARIANCE ESTIMATES.

single direction: $s^2_{SD} = \frac{[VV]}{(n-1)(k-1)}$

grand mean direction: $s^2_{GM} = \frac{s^2_{SD}}{n}$

B. 7

ZENITH DISTANCE MEASUREMENT (3 HAIR TECHNIQUE)

Station: Pillar 6 G.A.S
Height of Instrument: 0.251 m
Target: T.S 103
Height of Target: Top of Pillar

Observer: G.J. Bowlar
Instrument: Wild T2 S/N° 22940
Date: 21st October 1986
Time: 0910 hrs
Weather: Sunny No Wind

Set	Hair	Face	Vertical Circle Reading	Zenith Distance $z=\frac{1}{2}(360+L-R)$	v	Error Calculation
	Upper	Left	86 29 30			
		Right	274 05 40	z_u: 86 11 55.0	+0.17	Σv^2 = 0.17
		360+L-R	172 23 50			
	Centre	Left	86 12 20			
		Right	273 48 30	z_c: 86 11 55.0	+0.17	$s_z = \sqrt{\frac{\Sigma v^2}{2}}$
		360+L-R	172 23 50			$= \pm 0.29''$
	Lower	Left	85 55 05			
		Right	273 31 14	z_l: 86 11 55.5	-0.33	$s_{\bar{z}} = \frac{s}{\sqrt{3}}$
		360+L-R	172 23 51			
Mean Zenith Distance				$\bar{z}$: 86 11 55.17	[v] 0	$= \pm 0.17''$

Remarks:

Station: Pillar 6 G.A.S
Height of Instrument: 0.251 m
Target: T.S 103
Height of Targets: Top of Pillar

Observer: G.J. Bowlar
Instrument: Wild T2 S/N° 22940
Date: 21st October 1986
Time: 0920 hrs
Weather: Sunny N° Wind

Set	Hair	Face	Vertical Circle Reading	Zenith Distance $z=\frac{1}{2}(360+L-R)$	v	Error Calculation
	Upper	Left	86 29 29			
		Right	274 05 43	z_u: 86 11 53.0	+0.17	Σv^2 = 1.17
		360+L-R	172 23 46			
	Centre	Left	86 12 16			
		Right	273 48 28	z_c: 86 11 54.0	-0.83	$s_z = \sqrt{\frac{\Sigma v^2}{2}}$
		360+L-R	172 23 48			$= \pm 0.76''$
	Lower	Left	85 55 04			
		Right	273 31 19	z_l: 86 11 52.5	+0.67	$s_{\bar{z}} = \frac{s}{\sqrt{3}}$
		360+L-R	172 23 45			
Mean Zenith Distance				$\bar{z}$: 86 11 53.17	[v] 0	$= \pm 0.44''$

Remarks:

Prepared by J.M. RÜEGER, Dec. 1982

APPENDIX C1

Photogrammetric Control

The following sketches illustrate a selection of suitable and unsuitable points to be considered during photo-identification for planimetric and height control. They should be used as a general guide only, as the selection of suitable points will depend on the photo scale. For small scale photography points marked "Bad" in these sketches may prove to be satisfactory.

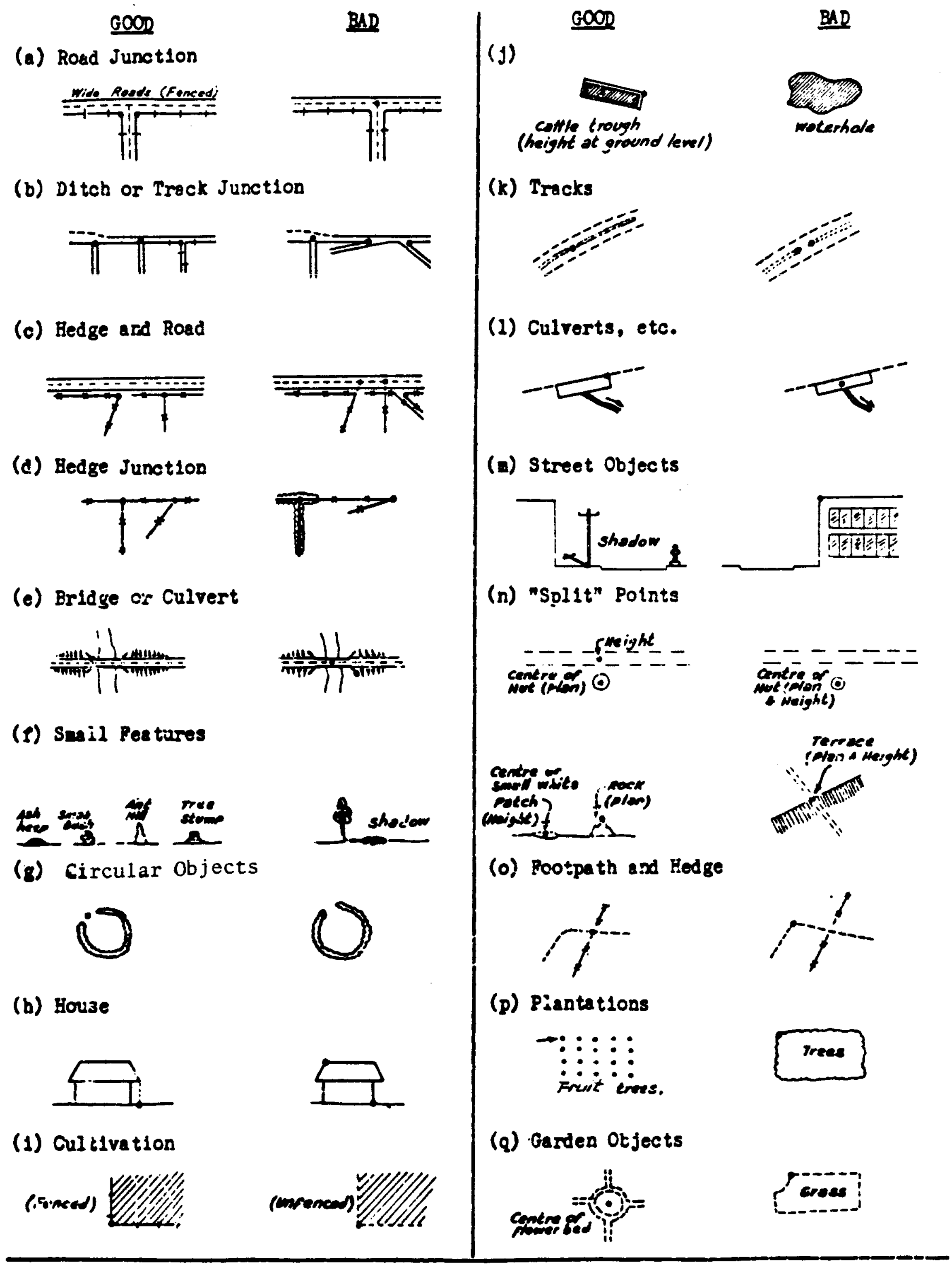


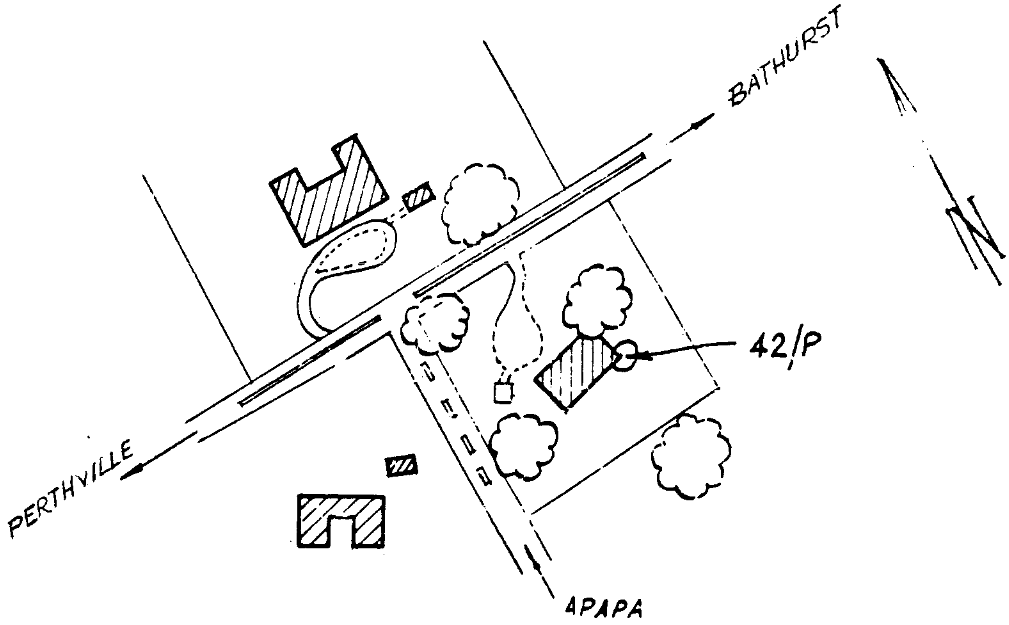
PHOTO POINT DESCRIPTION

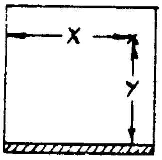
SPECIMEN

Survey: BATHURST 1:10.000   Page 7

Job no. 1961/2

Station 42/P





Circled on photograph no. 261

Photograph co-ordinates X 17·8 mm

Y 18·4 mm

Description of mark: Corner of house

Location of station: S.E. Corner of house south of BATHURST-PERTVILLE Road

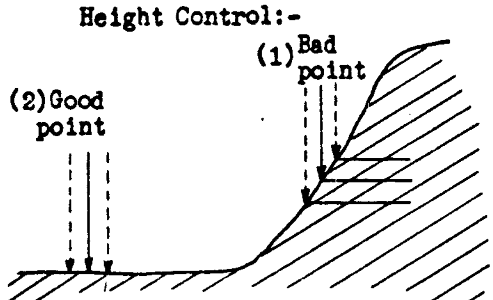
Co-ordinates: E 364 210·71   Drawn by E.X. PERT

N 241 365·81   Date 3-6-61

Height: —

Signed O.B. SERVER

Height Control:-



Section through hillside

It can be seen clearly that any slight error in field identification or in placing the floating mark during the plotting process, will cause considerable height error in (1), but will have no appreciable effect in (2).

APPENDIX D

Cadastral Project

PURPOSE

The assumed purpose of the survey is for a primary application to convert land held under the old system title to a Torrens title, i.e. to bring the land under the provisions of the Real Property Act. This survey should include not only the land held under the old system title but also any easements that may be appurtenant to the land.

BACKGROUND

The properties you will survey front College Road, Bathurst. The three parcels of land are shown on page D.3 and defined as:

Parcel	Plan Description	Title Description
U	DP 535178	Reg. Conv. No. 576 Bk. 2927
V	Pt. Lot 18 DP 609975	Pt. Reg. Conv. No. 288 Bk. 3198
W	Pt. Lot 18 DP 609975	Pt. Reg. Conv. No. 288 Bk. 3198

Please note the reference to easements which form part of the title.

Regarding your particular land, a number of other surveys defining the lots surrounding the land survey all have a bearing on the redefinition of the boundary of the subject land.

Copies of the most important documents will be issued to students at the survey camp. Other plans of lesser importance, which nevertheless should still be examined, will also be available but just for your inspection.

BASIC CONSIDERATIONS

The Castral Survey Exercise is not calculated on ISG. The survey land resulting plan are carried out and prepared to the requirements of the SURVEY PRACTICE REGULATIONS and the Registrar General's Office. The survey is carried out assuming it is in a Proclaimed Survey Area.

A number of considerations will determine what survey information is most necessary and what boundary adoptions should be made.

(1) Where the land is surrounded by other old system land, attention should be given to the position and age of existing occupations as this will help to indicate the position of the boundaries as originally surveyed.

(2) Where the land is surrounded by land held under Torrens title, greatest consideration should be given to preserving those titles, the balance then going to the land which is the subject of the primary application. If substantial differences with occupations exist, consideration would need to be given to an application based on adverse possession.

(3) When the land in question has been the subject of a previous survey or surveys that have been accepted by the Land Titles Office, greatest weight should be given to any marks established or monuments fixed under those previous surveys.

(4) Where a number of previous surveys relating to the same boundaries are in existence, some minor disagreement in dimensions will usually be found. While always considering the pre-eminence of marks (where by measurement they can be shown not to have moved), the survey that has redefined the boundaries by interpolation from surrounding information, as compared to one which has extrapolated from information to the subject land, should be given greatest weight.

(5) In most surveys, the road alignment (if any) should be given particular consideration. This alignment should be such that sufficient dimensions exist between it and the boundaries forming the opposite side of the road.

(6) When examining the primary application, the Land Titles Office is only concerned with the re-established external boundaries of the land in question (and in the position of any easements) and not with the position of any internal boundaries created by parcels that are part of the total application. There must be a one to one relationship between the parcel of land and easements defined by survey and the ensuing title that issues.

SURVEY HINTS AND REQUIREMENTS

(1) The traverse legs which form the framework from which the boundary evidence is measured should, where possible, clearly parallel the occupation. Long radiations from instrument stations to pegs, corner posts, etc., should be kept to a minimum.

(2) All marks measured from the basic traverse framework must have in addition at least one redundant measurement for checking purposes. Note that whilst the traverse surround can be checked by closure, the measurements to any marks connected to this traverse by radiation or offset are not checked as part of the total closure.

(3) Where short boundaries are traversed, an extended backsight should be provided for the transfer of azimuth to the subsequent traverse leg.

(4) The bearings and distances shown on any old plans that are to be utilised in the survey must be checked by calculation prior to any final adopted boundaries being determined. Errors in old plans are not without precedent.

(5) Measurements to, and description of, occupation (particularly corner posts) should be made, as these can act in future years as monuments. Measurements are usually made to the centre base of the post, the position of which should be projected onto the top or face of the post. Where the centre base obviously does not represent the true corner position, the intersection of the line of fences can be taken.

(6) Field notes should be clear and concise, indicating all measurements and the sketched relationships between all marks measured. Information must be immediately entered into the field book. All pages should be cross-referenced, indexed, refer to a master diagram, be signed and dated by the group and the supervisor.

(7) All surveys shall be made in accordance with the Survey Practice Regulations.

See ss 8-13 Survey Practice
ss 21 Country Surveys
ss 25-29 Redetermination of Boundaries
ss 41, 42A-44 Accuracy
ss 47-48, 50-53 Field Notes
ss 54-57 Plans
ss 12 Connection of Isolated Survey to State Control Survey.
Reference should also be made to the N.S.W. Crown Lands Office Survey Directions, 1981.

(8) Check all equipment before commencing survey. In particular, check the operation of your particular EDM instrument and that each tribrach is in adjustment.

(9) You are required to standardise your steel band on both baselines (AA & BB) located at Mitchell College. (See page D-4)

(10) Traverse closures and adjusted coordinates, in a nominated system, of boundary corners should be approved by the supervisor before traverse marks are removed.

(11) Every mark shown on a plan which refers to the boundaries of the subject property must be shown as either "found", "found (disturbed)", or "gone".

(12) Connection of Isolated Survey to State Control Survey: You are required to connect your survey to one of the "permanent marks" Cadastral 3, 4 or 5 and to measure an angle on said station to a coordinated Survey Control Mark to enable late redefinition of the survey.

SUBMISSIONS AND ORAL EXAM

The report is to be a group submission, comprising:

(1) Field notes - final adjusted bearings and distances of all observations must be shown in the field notes, preferably in a different colour.

(2) Calculations and report: This will include the calibration of the steel band, the traverse misclosures and adjustments, the calculation of boundaries, the comparisons, the connection to cadastral 3 or 4 or 5 and the bearing to State Survey Mark.

(3) A neat sketch of the survey is to be submitted. It should contain such complete information that a survey draftsman could compile a plan suitable for submission to the Land Titles Officer from it. It should include parcel identifiers of the parcel under survey as well as for adjacent parcels.

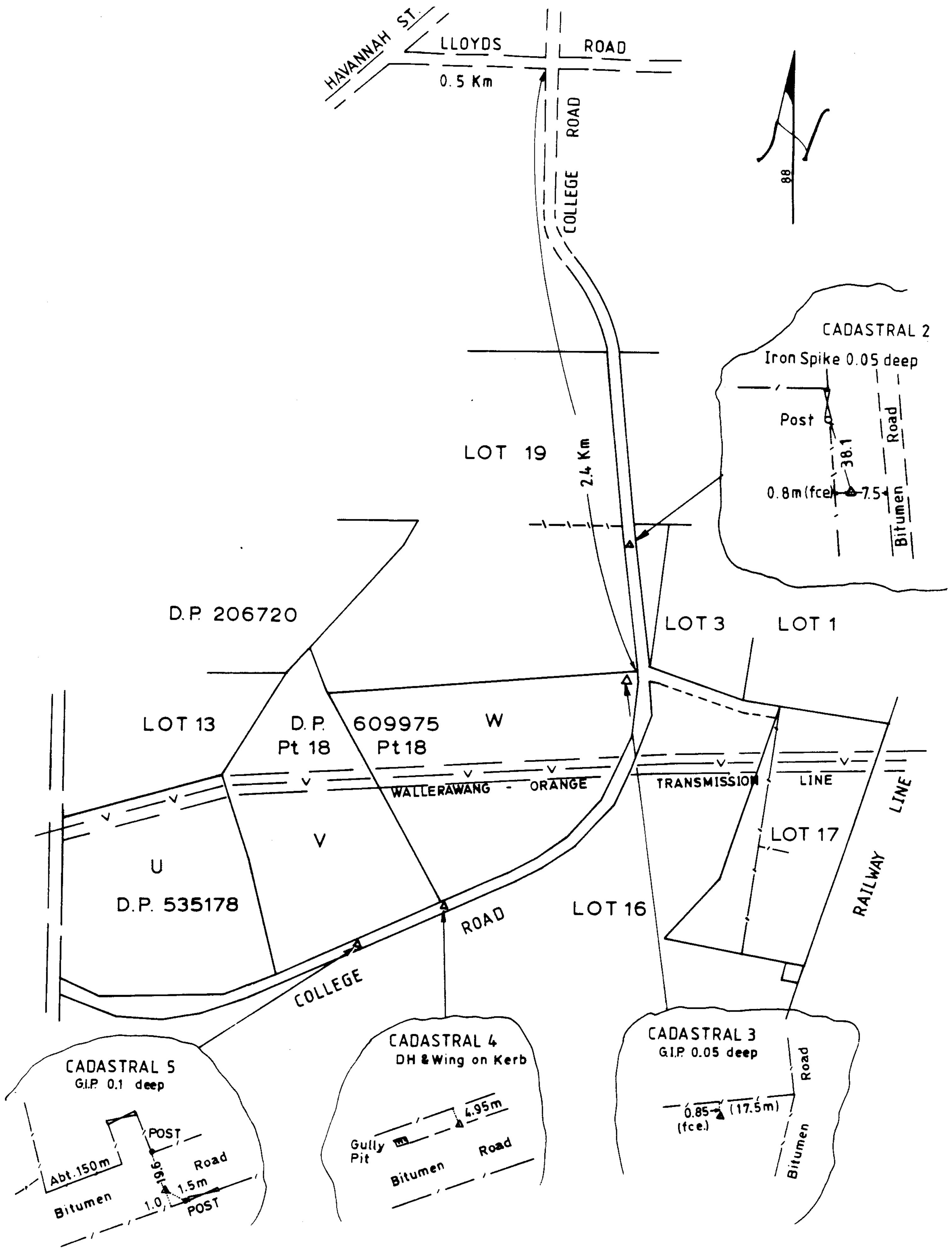
A brief oral exam will cover (amongst other things) the following aspects relating to the survey:

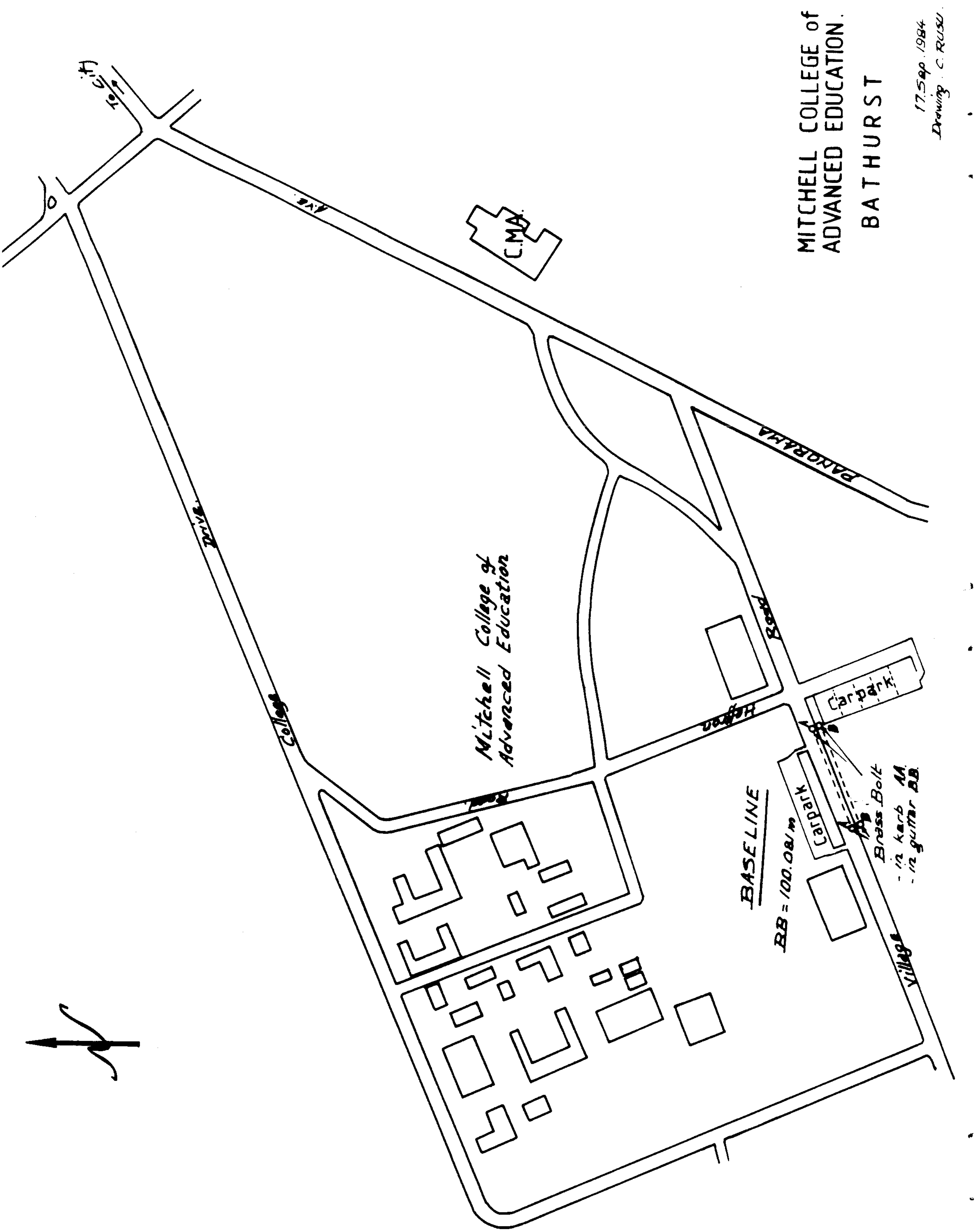
(a) method of survey, incl. connection to permanent mark and state control survey,

(b) any problems in interpreting the old system description or any of the plans of survey,

(c) a discussion on any differences between various plans of survey and the measured values,

(d) the method of fixation of boundaries and any problems confronted in the boundary definition.


HAVANNAH ST.
LLOYDS ROAD
0.5 Km
COLLEGE ROAD
88
CADASTRAL 2
Iron Spike 0.05 deep
Post
38.1
0.8m(fce)
7.5
Road
Bitumen
LOT 19
2.4 Km
D.P. 206720
LOT 3
LOT 1
LOT 13
D.P. 609975
Pt 18
Pt 18
W
WALLERAWANG - ORANGE TRANSMISSION LINE
V
U
D.P. 535178
LOT 17
RAILWAY LINE
LOT 16
ROAD
COLLEGE
CADASTRAL 5
G.I.P. 0.1 deep
POST
Abt. 150m
19.6
Road
1.5m
1.0
Bitumen
POST
CADASTRAL 4
DH & Wing on Kerb
4.95m
Gully Pit
Road
Bitumen
CADASTRAL 3
G.I.P. 0.05 deep
Road
0.85
(17.5m)
(fce.)
Bitumen


MITCHELL COLLEGE of
ADVANCED EDUCATION.
BATHURST
17 Sep 1984
Drawing C. RUSU
To city
C.M.A.
Ave
PANORAMA
Drive
College
Mitchell College of
Advanced Education
Road
Village
Carpark
Carpark
BASELINE
BB = 100.08 m
Brass Bolt
- in kerb AA
- in gutter BB

APPENDIX E

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

APPENDIX F.1

Additive Constants of EDM Instruments and Reflectors

INSTRUMENT	SERIAL NUMBER	ADD. CONST.	σ ADD CONST.	DATE OF CALIBRATION	REFLECTOR TO WITH ADD. CONST. REFERS
AGA 14	14075	-4 mm	± 0.9 mm	15.8.81	New AGA
HP 3820A	1650A00131	-1 mm	±1.5 mm	23.4.83	HP/Old AGA
KERN DM501	250942	(SEE NEXT PAGE)			KERN
TELLUROMETER CA 1000	6249-E, 6250-E	-23 m	±11 mm	16.8.80	N.A.
TOPCON DM-C2	911266	+4 mm	±0.4 mm	9.8.80	New AGA
TOPCON GTS-2	B45056	-4 mm*	±1.0 mm	Aug. 88	Topcon
PENTAX PX-06D	532238	-6 mm**	±0.7 mm	Aug. 88	WILD GPR-1
NIKON NTD-3	310444	-2 mm***	±0.4 mm	1.9.86	WILD GPR-1
SOKKISHA SDM-3ER	76359	-5 mm****	±0.7 mm	Aug. 88	WILD GPR-1
WILD DI 3000	62961	-1 mm+	±0.3 mm	5.8.87	WILD GPR-1
WILD TC 1600	331519	-1.2 mm+	±0.2 mm	7.7.88	WILD GPR-1

* Internal additive constant setting = -07 (mm). As for tiltable TOPCON prism (in triple prism holder).

** Reflector constant set to '30' and instrument correction to '-48'.

*** Reflector constant set to '0.030' and instrument constant to '37'.

**** Reflector constant set to '30'

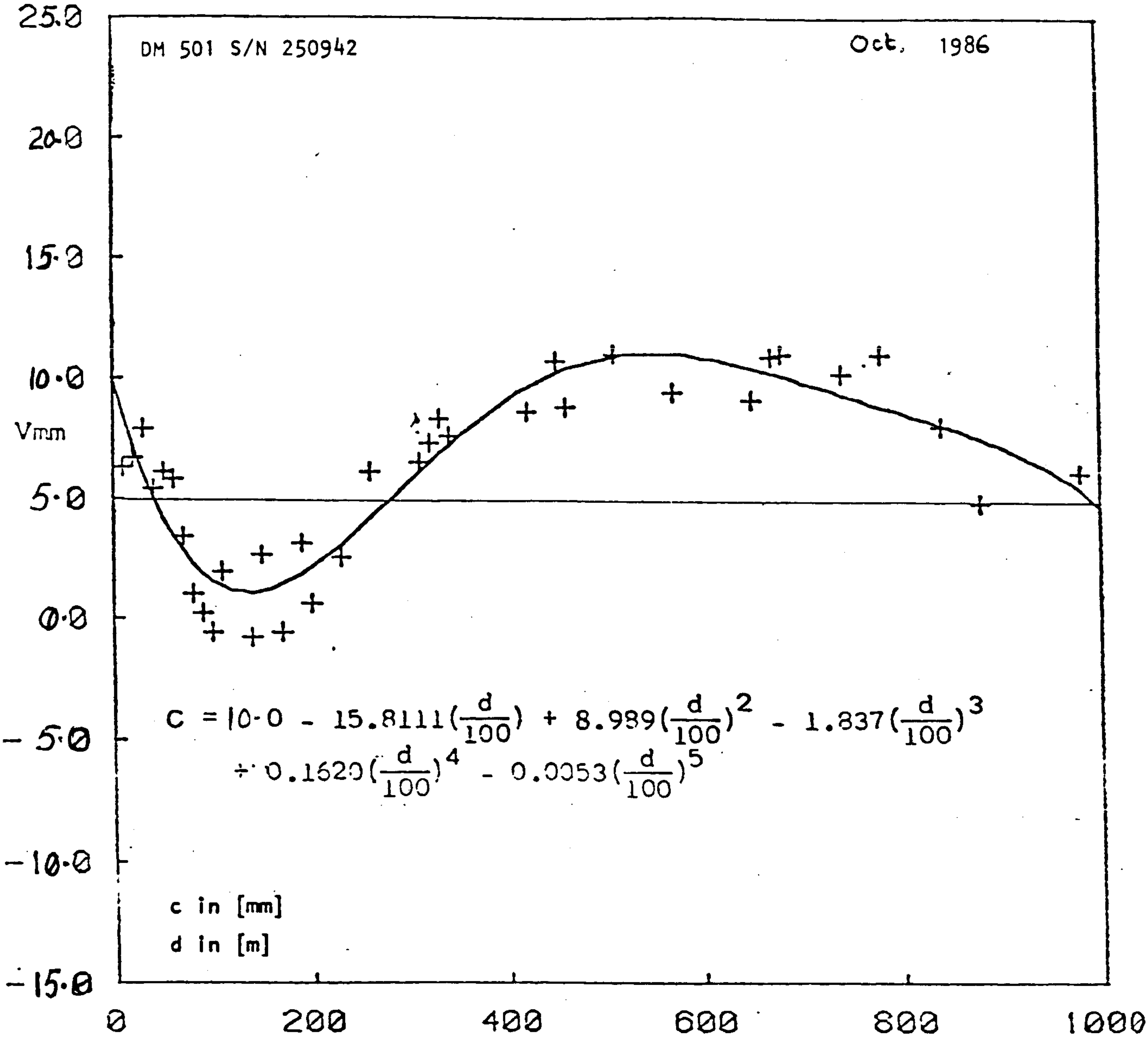
\+ Reflector constant set to '00 mm'.

INSTRUMENT CORRECTION FOR DM 501:

→ EITHER: SCALE OFF DIAGRAM BELOW OR COMPUTE FROM EQ. USING ALL TERMS!

DISTANCES < 100 m → CLOSED DIAPHRAGM

> 100 m → OPEN DIAPHRAGM



$$C = 10.0 - 15.8111\left(\frac{d}{100}\right) + 8.989\left(\frac{d}{100}\right)^2 - 1.837\left(\frac{d}{100}\right)^3 + 0.1620\left(\frac{d}{100}\right)^4 - 0.0053\left(\frac{d}{100}\right)^5$$

c in [mm]

d in [m]

Curve fitted to residuals from Regents Park and 100m Baseline. (Valid with built-in constant '999.058'.)

APPENDIX F.3

UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF SURVEYING

ADDITIVE CONSTANTS OF BAROMETERS

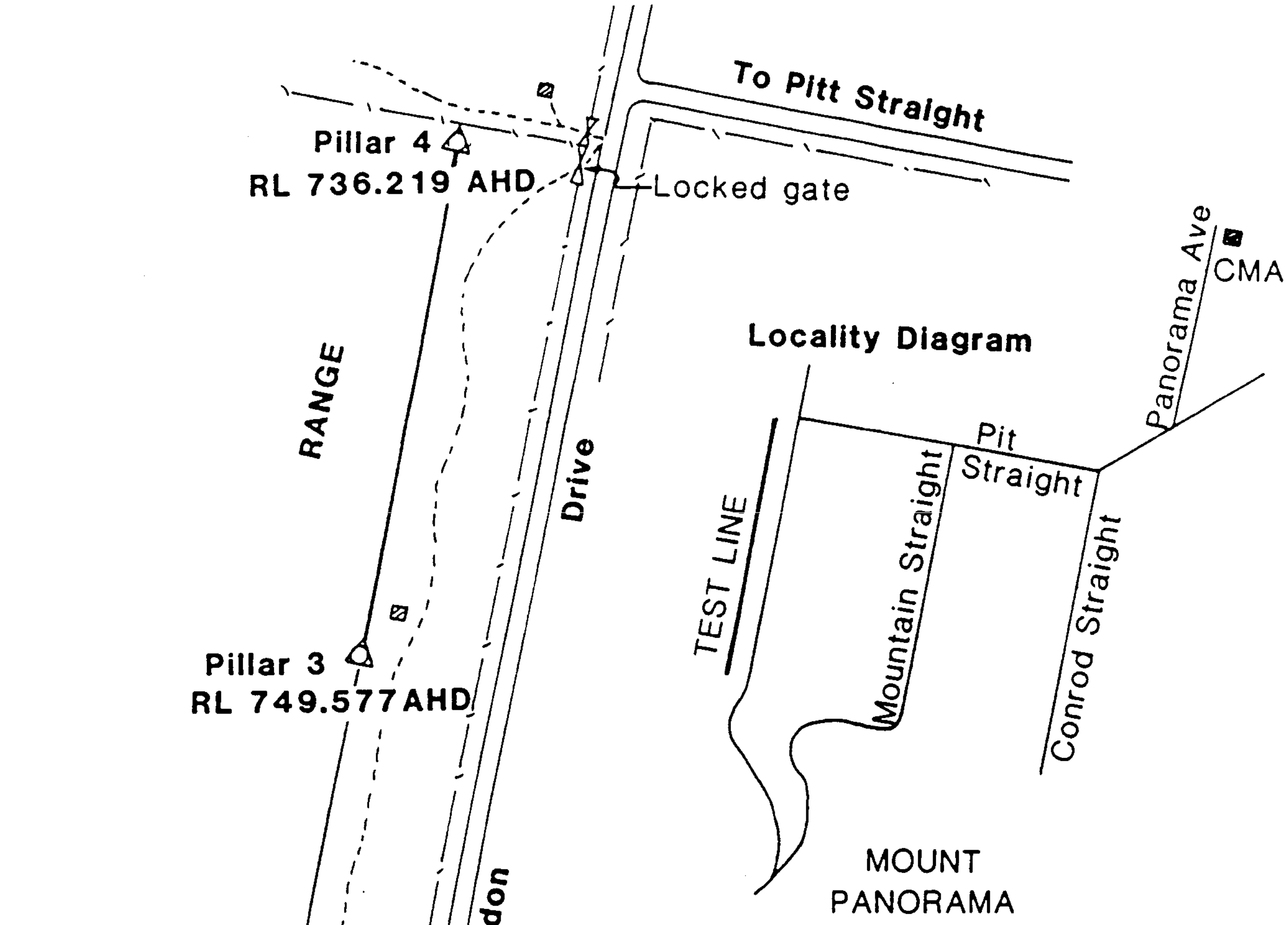
Make / Type	S/N	2.80	2.83	2/3.87	3.88	12.88
Mechanism 2016/A	271/61	+ 4.0 mm	+ 4.2 mm	+ 4.0 mm	+ 3.9 mm	-
" 2016/A	302/62	- 3.2 mm	- 3.6 mm	- 3.2 mm	- 3.4 mm	**- 3.6 mm
" 2016/A	655/65	- 3.7 mm	- 3.7 mm	- 3.5 mm	- 3.7 mm	-
" 2016/A	656/65	- 2.0 mm	- 1.9 mm	- 1.6 mm	- 2.0 mm	**- 1.8 mm
" 2016/A	657/65	- 2.3 mm	- 2.2 mm	- 2.3 mm	- 2.4 mm	**- 2.1 mm
Thommen 2A4	25294	- 6.4 mb	- 2.1 mb	- 2.1 mb	- 2.0 mb	- 2.4 mb
" 2A2.511.02	234619	- 2.0 mb	+ 0.1 mb	**- 2.2 mb	- 2.4 mb	- 0.5 mb
" 2A4.611.02	235745	- 2.1 mb	- 4.2 mb	- 4.9 mb	- 5.4 mb	- 5.7 mb
" 2A2.511.02	220459	+ 1.1 mb	- 2.2 mb	**- 0.6 mb	- 0.8 mb	- 0.4 mb
Dobbie	685	- 0.02 in	-	- 0.27 in	-	-
"	2531	- 0.04 in	-	- 0.33 in	-	-
"	688	- 0.03 in	-	- 0.03 in	-	-
"	686	+ 0.05 in	-	- 0.07 in	-	-
"	691	+ 0.06 in	-	+ 1.25 in	-	-
Esdaile	52/155	- 0.03 in	-	+ 0.00 in	-	-
		7.80				
Thommen (Everest)	416441	- 0.4 mb	- 5.8 mb	- 4.8 mb	- 3.9 mb	- 4.5 mb
" (6000m)	416452	+ 0.6 mb	- 7.0 mb	- 14.5 mb	- 15.6 mb	- 15.7 mb
"	417701	+ 0.2 mb	- 17.6 mb	- 17.7 mb	- 17.6 mb	- 18.1 mb
"	417728	+ 0.1 mb	+ 0.3 mb	- 0.2 mb	+ 0.7 mb	-
"	418885	-	- 4.2 mb	**- 3.3 mb	- 1.8 mb	- 2.2 mb
"	419048	± 0.0 mb	+ 1.6 mb	- 15.7 mb	- 16.5 mb	- 15.7 mb
"	416394	+ 0.6 mb	- 3.4 mb	- 6.3 mb	- 5.1 mb	- 9.8 mb
					5.88	
AIR AIR - HB - 1A	0223	-	-	-	+ 2.8	+ 2.9 mb
" AIR - HB - 1A	0551	-	-	-	- 0.8	- 1.0 mb
" AIR - HB - 1A	0716	-	-	-	- 0.6	- 0.7 mb

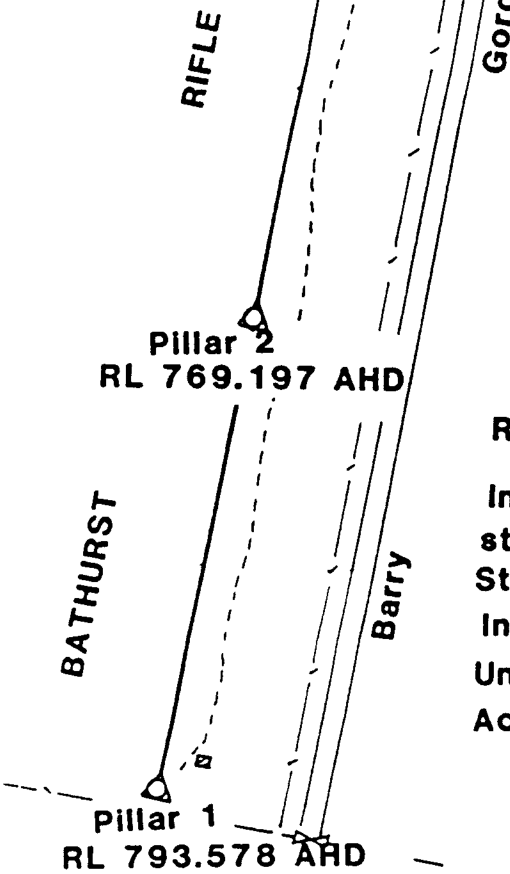
IMPORTANT: Use only the latest additive constants for the reduction of measurements.

**Asterisks indicate repair work between calibrations.

Dr. J.M. Rüeger
Senior Lecturer
December 1988

DETAILS OF EDM BASELINE IN BATHURST





NOMINAL DISTANCES AT MEAN ELEVATION

FROM	TO	DISTANCE
Pillar 1	Pillar 2	268.732
Pillar 1	Pillar 3	592.133
Pillar 1	Pillar 4	888.390

Resolved distances by Dept. of Lands July 1986

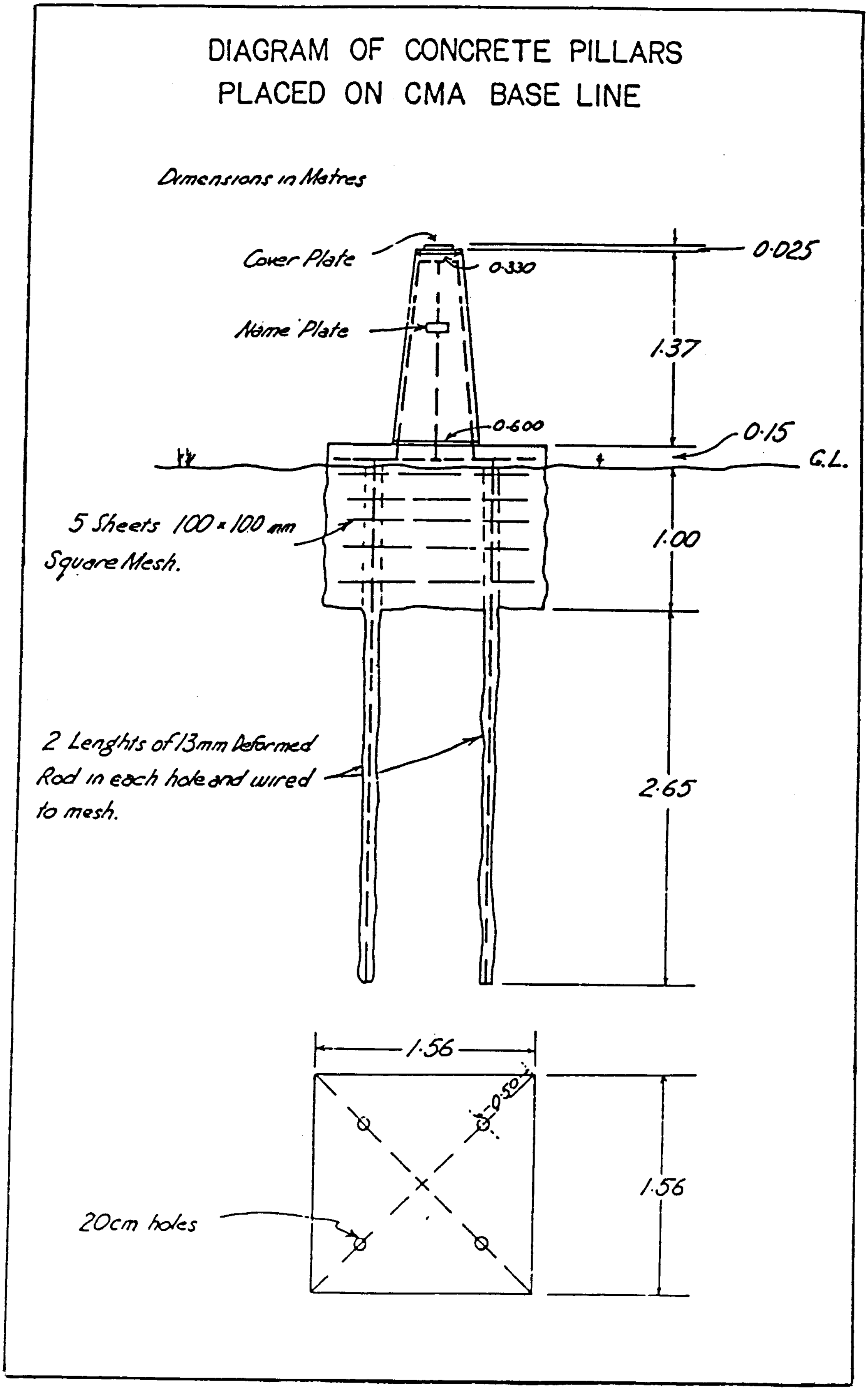
In accordance with the measurement of subsidiary standards of length as prescribed by The National Standards Commission.

Instrument used: Com-Rad Geomensor S/N 003

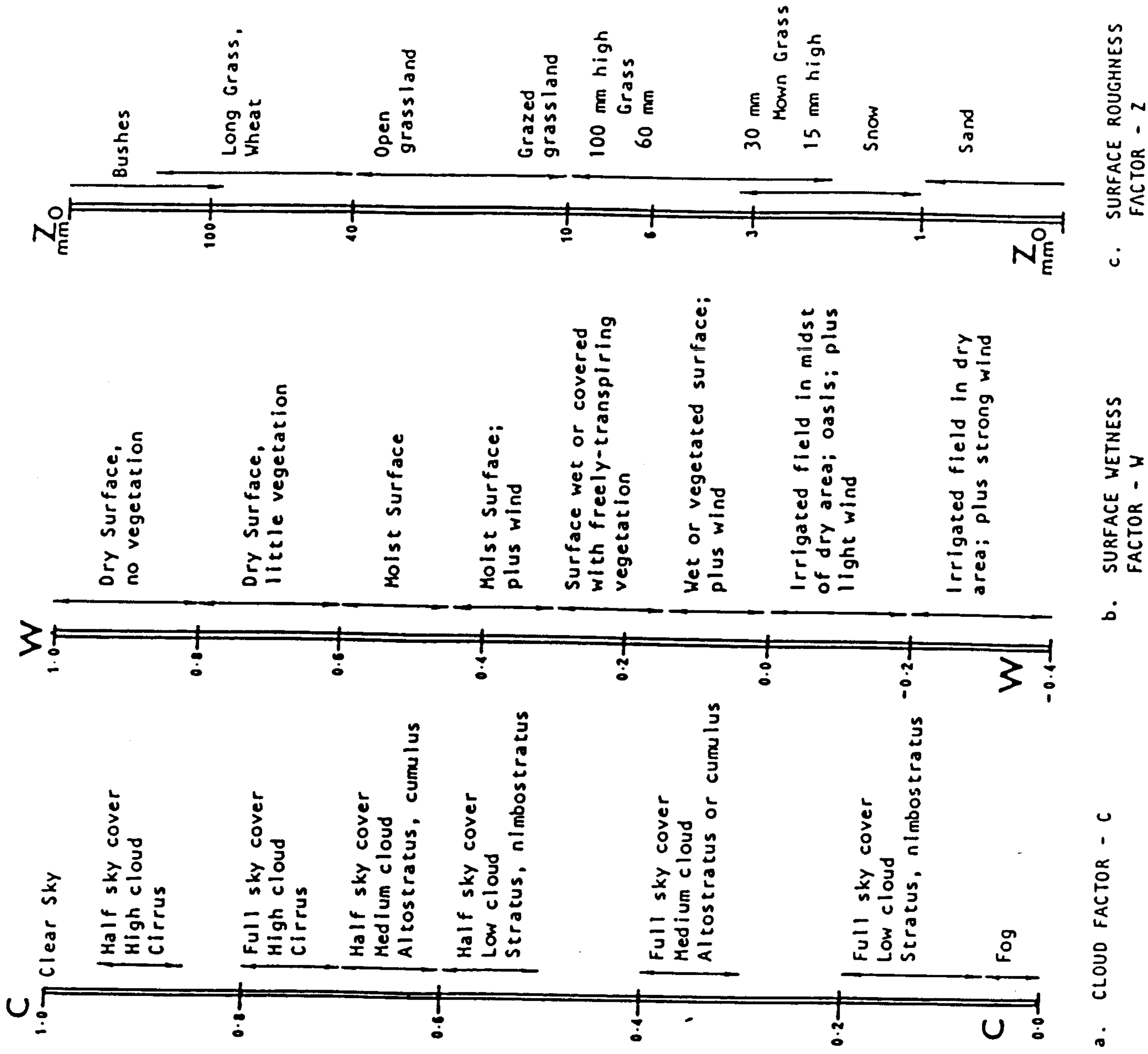
Uncertainty Level 2mm at 99% confidence level.

Access: Key to locked gate from Chief Surveyor, CMA, Panorama Ave Bathurst.

DESIGN DETAILS OF EDM BASELINE PILLARS



METEOROLOGICAL PARAMETERS FOR ATMOSPHERIC MODELS IN EDM



ESTIMATION OF WINDSPEEDS

Description	Wind speed equivalent at a standard height of 10 metres above open flat ground*		Specifications for estimating speed over land
	Knots	Kilometres per hour	
Calm	< 1	< 1	Calm; smoke rises vertically.
Light air	1-3	1-5	Direction of wind shown by smoke-drift but not by wind vanes.
Light breeze	4-6	6-11	Wind felt on face; leaves rustle; ordinary vanes moved by wind.
Gentle breeze	7-10	12-19	Leaves and small twigs in constant motion; wind extends light flag.
Moderate breeze	11-16	20-28	Raises dust and loose paper; small branches are moved.
Fresh breeze	17-21	29-38	Small trees in leaf begin to sway; crested wavelets form on inland waters.
Strong breeze	22-27	39-49	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
Near gale	28-33	50-61	Whole trees in motion; inconvenience felt when walking against the wind.
Gale	34-40	62-74	Breaks twigs off trees; generally impedes progress.
Strong gale	41-47	75-88	Slight structural damage occurs (roof tiles removed).
Storm	48-55	89-102	Seldom experienced inland; trees uprooted; considerable structural damage occurs.
Violent storm	56-63	103-117	Very rarely experienced; accompanied by widespread damage.
Hurricane	64 and over	118 and over	

* The scales in the two sets of units are not exact conversions; the difference arises from historically different conventions.

Analysis of Measurements on

4 Station EDM Baselines

The unknown parameters compute as:

$$c = -\frac{1}{2}(S_{12} + S_{23} + S_{34} - S_{14})$$

$$X_{12} = +\frac{1}{4}(2c + 2S_{12} + S_{13} - S_{23} + S_{14} - S_{24})$$

$$X_{13} = +\frac{1}{4}(4c + 2S_{13} + S_{12} + S_{23} + S_{14} - S_{34})$$

$$X_{14} = +\frac{1}{4}(6c + 2S_{14} + S_{12} + S_{24} + S_{13} + S_{34})$$

Where

S_{ij} = observed distances between i and j corrected for slope

V_{ij} = residual for S_{ij} ($= X_{ij} - S_{ij} - c$)

c = additive constant of EDM instrument

X_{ij} = unknown distances between pillars. Any three independent distances can be chosen, here:
X_{12}, X_{13}, X_{14}.

The standard deviation of a distance measurements follows from

$$S_0 = + \left(\frac{\Sigma v^2}{6-4}\right)^{0.5}$$

and the standard deviations of the unknowns

$$S_c = (0.182)^{0.5}\, S_o$$

$$S_{x_{12}} = (0.386)^{0.5}\, S_o = S_{x_{13}} = S_{x_{14}}$$