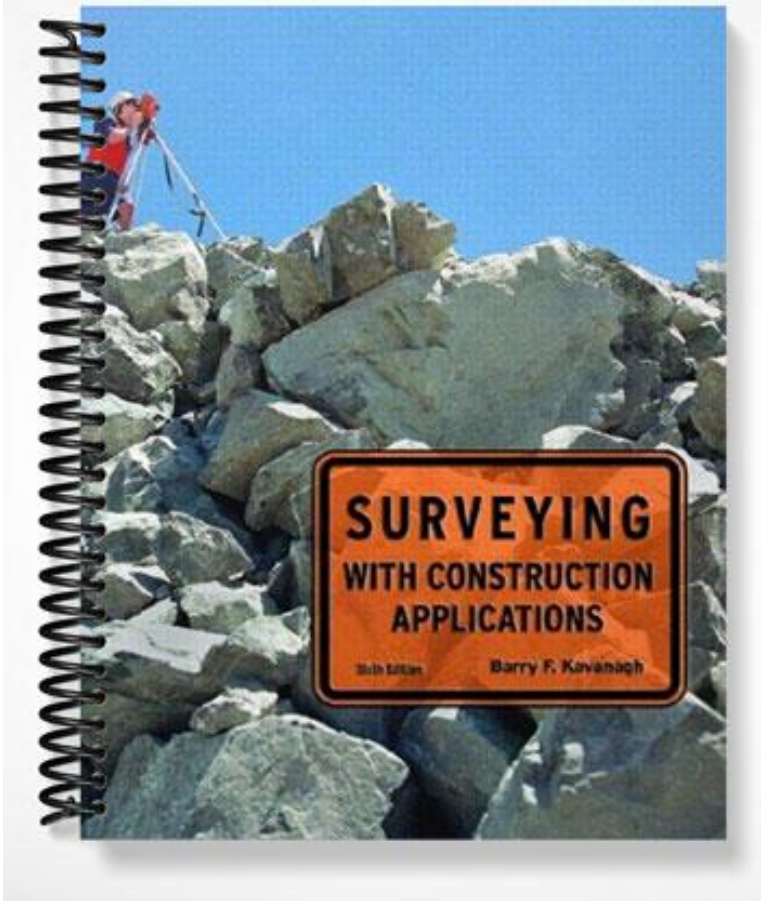
SOLUTIONS MANUAL



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Instructor's Manual
to accompany

SURVEYING

With Construction Applications

Sixth Edition

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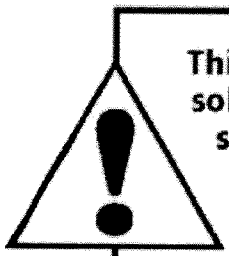
Upper Saddle River, New Jersey
Columbus, Ohio



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Preface

A publication of this type seems to always retain a few mistakes that have eluded detection through a number of checks. If you find any mistakes in the manual and forward the information to me at **[barry_kavanagh@sympatico.ca]**, I will ensure that the corrections are sent to the publisher.

Any comments, corrections and/or suggestions about this Instructors' Manual or about the text *Surveying With Construction Applications*, 6th edition, will also be appreciated.

Barry Kavanagh,

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SECTION A

SOLUTIONS TO TEXT PROBLEMS

SOLUTIONS

CHAPTER 2

2.2 a) - when looking for survey evidence to begin a survey
- when rough-checking a construction layout

b) - auto: identifying rural fence corners
- wheel: frontage measurements for assessment purposes
- wheel: measurements for accident surveys

c) - when taking a baseline measurement
- when measuring over long distances, or difficult terrain

d) - when measuring across a busy highway
- when setting a calibration baseline for industrial use

e) - when doing quantity measurements on a construction site
- when measuring less important detail

f) - when measuring control lines for any small-area survey
- when measuring key components in a structural layout.

2.3 a) 23.92x66 = 1,578.72 ft. x.3048 = 481.19 m
b) 48.71x66 = 3,214.86 ft. x.3048 = 979.89 m
c) 12.22x66 = 806.52 ft. x.3048 = 245.83 m
d) 8.31x66 = 548.46 ft. x.3048 = 167.17 m

2.4 Clearance = 61.5 + 4.3 = 65.8 ft. (Tan 45^o = 1.00)

2.5 Distance = 42.00 - 0.33 = 41.67 ft.

2.6 Distance = 47.00 +0.62 = 47.62 ft.

2.7 H = 22.745 Cos $1^o42'$ = 22.735 m

2.8 $H = \sqrt{73.79^2 - 8.45^2}$ = 73.30 ft.

2.9 Tan slope angle = .02; slope angle = 1.1457628^o
H = 162.102 Cos 1.1457628^o = 162.069 m

2.10 *Prism constant* = EG-EF-FG
= 566.711-238.778-327.963 = -0.030m

2.11 H = 3,964.37 Cos $+2^o45'30"$ = 3,959.78 ft.
V = 3,964.37 Sin $+2^o45'30"$ = 190.78 ft.
Elevation of target station = 285.69+190.78 = 476.47 ft.

2.12 Inst. @ A, H = 1,458.777 Cos $1^o26'50"$ = 1,458.312m
Elevation difference = 1,458.777 Sin $1^o26'50"$ = 36.843m
Inst.@ B, H = 1,458.757 Cos $1^o26'38"$ = 1,458.294m

Elevation difference = 1,458.757 Sin 1°26'38" = 36.758m
a)Horizontal distance = (1,458.312+1,458.294)/2 = 1,458.303m
b)Elev. B = 211.841 - (36.843+36.758)/2 = 175.041m

2.13 LL^1 = 3,000.00 Sin 3°30' = +183.15 ft.
c+r = .0206 x 3^2 = +0.19 ft.
Elevation difference, K to L, = +183.34 ft
Elevation of L = 232.47+183.34 = 415.81 ft.

MM^1 = 3000.00 Sin -1°30' = -78.53 ft.
c+r = .0206 x 3^2 = +0.19 ft.
Elevation difference, K to M, = -78.34 ft.
Elevation of M = 232.47- 78.34 = 154.13 ft.

c+r = .0206 x 2^2 = +0.08 ft.
Elevation difference, K to N, = +0.08 ft.
Elevation of N = 232.47 + 0.08 = 232.55 ft.

2.14 ΔHR - Δhi = 0.150 - 0.100 = 0.050m
SinΔα = (0.050 Cos 4°18'30")/387.603
Δα = 0°00'27"
α_K = 0°00'27"+4°18'30" = 4°18'57"
H = 387.603 Cos 4°18'57" = 386.504m
Elevation of B = 110.222+1.601+ (387.603 Sin 4°18'57") - 1.915
= 139.077m.

2.15 ΔHR-Δhi = 0.39-0.31 = 0.08 ft.
SinΔα = (0.08 Cos 3°14'30")/536.88
Δα = 0°00'31"
α_K = 0°00'31"+3°14'30" = 3°15'01"
H = 536.88 Cos 3°15'01" = 536.02 ft.
Elevation B = 531.49+5.21 + (536.88 Sin 3°15'01") - 5.78
=561.36 ft.

CHAPTER 3

3.1 **a)** c+r = .0206 x $(700/1000)^2$ = 0.010 ft.
b) c+r = .0206 x 3^2 = 0.19 ft.
c) c+r = .0675 x $(500/1000)^2$ = 0.017 m
d) c+r = .574 x 1.75^2 = 1.76 ft.
e) c+r = .0675 x 3.5^2 = 0.827 m
f) c+r = .0675 x 5^2 = 1.688 m

3.2a)	**b)**	**c)**	**d)**	**e)**	**f)**
i 2.09	i 1.185	i 1.90	i 1.097	i 3.06	i 1.145
ii 1.86	ii 1.150	ii 1.74 (.73)	ii 1.055	ii 2.85	ii 1.065
iii 1.52	iii 1.040	iii 1.57	iii 0.987	iii 2.57	iii 1.000
iv 1.10	iv 1.000	iv 1.21	iv 0.950	iv 2.22 (.21)	iv 0.935
v 0.95	v 0.925	v 1.04	v 0.910	v 1.92	v 0.880

3.3 5.75 = 0.574 K_1^2, $K_1 = \sqrt{5.75/0.574}$ = 3.165 miles
310 = 0.574 K_2^2, $K_2 = \sqrt{310/0.574}$ = 23.239 miles
Maximum visibility distance (K_1+K_2) = 26.40 miles.

3.4

STATION	BS	HI	FS	ELEVATION
BM 50	1.27	183.95		182.68
TP 1	2.33	181.37	4.91	197.04
TP 2			6.17	175.20
	Σ BS = 3.60		Σ FS = 11.08	

182.68 +3.60 -11.08 = 175.20 ***check***

3.5

STATION	BS	HI	IS	FS	ELEVATION
BM 61	4.72	218.44			213.72
0+00			4.42		214.02
0+50			4.30		214.14
TP 1	5.11	221.54		2.01	216.43
1+00			4.66		216.88
1+50			3.98		217.56
1+75			1.20		220.34
TP 2				1.80	219.74
	Σ BS = 9.83			Σ FS = 3.81	

213.72 +9.83 -3.81 = 219.74 ***check***

3.6

STATION	BS	HI	FS	ELEVATION
BM 3	1.613	150.233		148.610
TP 1	1.425	149.721	1.927	148.296
TP 2	1.307	149.318	1.710	148.011
TP 3	1.340	149.385	1.273	148.045
BM 3			0.780	148.605
	Σ BS = 5.685		Σ FS = 5.690	

148.610 +5.685 -5.690 = 148.605 ***check***

3.7 Error = 148.610 – 148.605 = 0.005m
2nd order Class 1 (U.S.) = 6mm $\sqrt{K}$ = .006 $\sqrt{0.7}$ = .005
2nd order (Canada) = 8mm$\sqrt{K}$ = .008$\sqrt{.7}$ = .007. The error qualifies for 2nd order in both countries.

3.8

STATION	BS	HI	FS	ELEVATION
BM 100	2.71	269.80		267.09
TP 1	3.62	268.54	4.88	264.92
TP 2	3.51	268.080	3.97	264.57
TP 3	3.17	268.44	2.81	265.27
TP 4	1.47	268.29	1.62	266.82
BM 100			1.21	267.08
	Σ BS = 14.48		Σ FS = 14.49	

267.09 +14.48 -14.49 = 267.08 ***check***

3.9 Error = 267.09-267.08 = 0.01 ft. 2nd order allowable error = $.035\sqrt{1000/5280} = 0.015$
Therefore the results qualify for second order – according to Table 3.2.

3.10

STATION	BS	HI	IS	FS	ELEVATION
BM S101	0.475	160.462			159.987
0+000			0.02		160.44
0+020			0.41		160.05
0+040			0.73		159.73
0+060			0.70		159.76
0+066.28			0.726		159.736
0+080			1.38		159.08
0+100			1.75		158.71
0+120			2.47		157.99
TP 1	0.666	158.135		2.993	157.469
0+140			0.57		157.57
0+143.78			0.634		157.501
0+147.02			0.681		157.454
0+160			0.71		157.43
0+180			0.69		157.45
0+200			1.37		156.77
TP 2	0.033	156.463		1.705	156.430
BM S102				2.891	153.572
	Σ BS = 1.174			Σ FS = 7.589	

159.987 +1.174 -7.589 = 153.572 ***check***

3.11

STATION	BS	HI	IS	FS	ELEVATION
BM 41	6.21	419.54			413.33
TP 13	4.10	422.75		0.89	418.65
12+00					
50 ft. left			3.9		418.9
18.3 ft. left			4.6		418.2
℄			6.33		416.42
20.1 ft. right			7.9		414.9
50 ft. right			8.2		414.6
13+00					
50 ft. left			5.0		417.8

19.6 ft. left			5.7		417.1
℄			7.54		415.21
20.7 ft. right			7.9		414.9
50 ft. right			8.4		414.4
TP 14	7.39	429.02		1.12	421.63
BM S22				2.41	426.61
	Σ BS = 17.70		Σ FS = 4.42		

13.33+17.70-4.42=426.61 ***check***

3.12

Station	BS	HI	FS	Elevation	Left		℄	Right	
BM 107	7.71	264.42		256.71					
					60'	28'	0'	32	60'
80+50					9.7	8.0	5.7	4.3	4.0
					254.7	256.4	258.7	260.1	260.4
					60'	25'	0'	30'	60'
81+00					10.1	9.7	6.8	6.0	5.3
					254.3	254.7	257.6	258.4	259.1
					60'	27'	0'	33'	60'
81+50					11.7	11.0	9.2	8.3	8.0
					252.7	253.4	255.2	256.1	256.4
TP 1			10.17	254.25					

3.13 a) Correct difference in elevation = 8.72-5.61 = 3.11 ft.
b) Correct reading @ A would have been 5.42+3.11 = 8.53 ft.
c) Error is (8.57- 8.53) = +0.04 ft. in 300 ft.
d) Upper/lower reticle capstan screws are loosened/tightened until the cross hair falls on 8.53 on the rod @ A.

3.14 a) V = 148.61 Sin 21°26' = 54.30 ft.
Elevation of lower station = 324.28 + 4.66-54.30 - 4.88 = 269.76 ft.
b) H = 148.61 Cos 21°26' = 138.33 ft.
Lower station = 110+71.25 + 138.33 = 112+09.58

3.15 a) First elevation difference = 2.417-0.673 = 1.744
Second elevation difference = 2.992 - 1.252 = 1.740
Average elevation difference = 1.742
Elevation of B = 187.298-1.742 = 185.556m
b) Levelling error = 0.004m

3.16 a) Error = 167.174 – 167.185 = - 0.011m

Accuracy limit for 2nd order = .007 $\sqrt{.8}$ = .006

Accuracy limit for 3rd order = .012 $\sqrt{.8}$ = .011 (U.S.)

or = .024 $\sqrt{.8}$ = .021 (Canada)

(See Tables 3.1 and 3.2)

Therefore the error of - 0.011 satisfies the requirements for 3rd order accuracy in both the U.S. and Canada.

3.16 b)

Station	Cumulative Distance	Elevation	Correction	Adjusted Elevation
BM 130		168.213		168.213
TP 1	130	167.804	130/780 x.011 = +.002	167.806
TP 2	260	168.095	260/780 x.011 = +.004	168.099
TP 3	390	165.874	390/780 x.011 = +.006	165.880
BM K110	520	165.950	520/780 x.011 = +.007	**165.957**
TP 4	650	166.135	650/780 x.011 = +.009	166.144
BM 132	780	167.174	780/780 x.011 = +.011	167.185

C = 167.174 – 167.185 = - 0.011

The adjusted elevation of BM K110 is 165.957m

CHAPTER 6

6.1 E = 116° 38'

6.2

A 75°10'30" +30 = 75°11'00"
B 137°43'00" +30 = 137°43'30"
C 88°49'30" +30 = 88°50'00"
D 113°27'30" +30 = 113°28'00"
E 124°47'00" +30 = 124°47'30"
539°57'30" 150" 537°179'60" = 540°00'00"

6.3

a) S 8°23'W
b) S12°08'E
c) N29°50'10"W
d) N 29°33E
e) S81°50'W
f) S 13°01'E

6.4

a) 352°09'
b) 76°14'
c) 146°27'
d) 184°39'
e) 322°42'
f) 179°22'

6.5

a) 8°23'
b) 347 °52'
c) 150°09'50"
d) 209°33'
e) 81°50'
f) 346°59'

6.6

a) S7°51'E
b) S76°14'W
c) N33°33'W
d) N 4°39'E
e) S 37°18'E
f) N 0°38'W

6.7

AB = N19°24'E
B + 1°03
BC = N20°27'E
C +2°58'
CD = N23°25'E
D - 7°24'
DE = N16°01'E
E - 6°31'
EF = N 9°30'E
F +1°31'
FG = N 11°01'E
G - 8°09'
GH = N 2°52'W

6.8

A 51°05'
B 134°33'
C 102°04'
D 72°18'
359°60'
= 360°00'

6.9 CLOCKWISE

Bearing BC 102°11'
-53°55'
= S48°16E

Bearing CD 179°60'
- (48°16'+104°42')
= S27°02'W

Bearing DE 113°05'
-27°02'
= N86°03W

Bearing EA 86°03'
+ 118°34'
204°37'
- 180°
= N24°37'W

Bearing AB 179°60'
- (24°37'+101°28')
= N53°55'E **CHECK**

COUNTER-CLOCKWISE

Bearing AE 179°60'
- (53°55'+101°28')
= S24°37'E

Bearing ED 118°34'
- 24°37'
93°57'
179°60'
= S86°03'E

Bearing DC 113°05'
- 86°03'
= N27°02'E

Bearing CB 179°60'
- (27°02'+104°42')
= N48°16'W

Bearing BA 102°11'
- 48°16'
= S53°55'W **CHECK**

6.10 CLOCKWISE

Az AB = 63°22'
Az BA = 243°22'
-B 102°11'
Az BC = 141°11'
Az CB = 321°11'
-C 104°42'
Az CD = 216°29'
Az DC = 396°29'
-D 113°05'
Az DE = 283°24'
Az ED = 463°24'
-E 118°34'
Az EA = 344°50'
Az AE = 164°50'
-A 101°28'
Az AB = 63°22' **CHECK**

COUNTER-CLOCKWISE

Az AB = 63°22'
+A 101°28'
Az AE= 164°50'
Az EA = 344°50'
+E 118°34'
AZ ED= 463°24'
AZ ED =103°24'
Az DE =283°24'
+D 113°05'
Az DC = 396°29'
Az DC = 36°29'
Az CD = 216°29'
+C 104°42'
Az CB = 321°11'
Az BC = 141°11'
+B 102°11'
Az BA = 243°22'
Az AB = 63°22' **CHECK**