SOKKIA™

TRANSIT FIELD BOOK

No. 8152-00

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INDEX

Yorkshire 9/20/92

Scalby Ness Rocks at Scalby Beck.

SE 0320 9145

Sheet 101 Ordnance Survey - Scarboro

Loc. 9201

w Chris Hill Geff Hickey

David Taylor

Scalby Fm - Bajocian

Long Nab Mbr (Upper)

Scarboro Fm.

Cloughton Fm. { Gristhorpe Mbr
Lebberston Mbr
Sycharnam Mbr.
Blow Hill m.

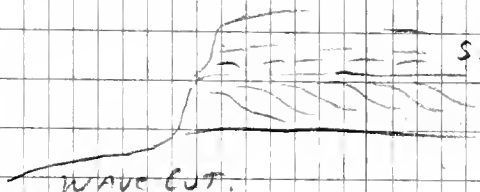
Ellerbeck Fm.

Saltwick fm ← Deltaic

Conl. Bs

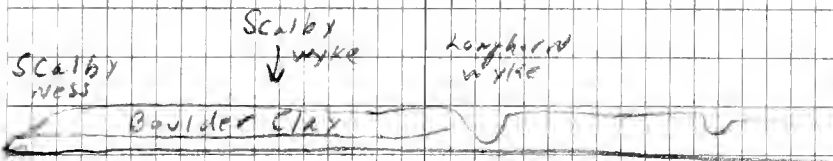
Dogger

See P. 42 of Brit. Geol. Survey
Guide To Geol of Eastern
England ~~for~~ 3rd Fig from
top of page for section



Meander channels w inclined, Sigmoidal Strata

Upper Scalby Carb. ss + lenses of muddy ss.



Scalby Fm. - Lateral accretion
- Channels w/ intervening clays + silts

Locality in Long Nab Mbr of Scalby fm.

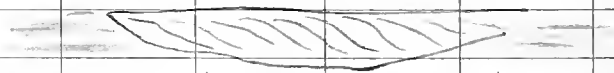
Loc. 9201 (CONT.) 5/20/92

Ginkgo huttonii
Araucarian roots w/ nodules
Cyparissidium
Lateral accretion = ITST. beds in a grey SH.

→ Olenekian sample
Ginkgo cuticle sampled

→ 9201 Ol. sample from Ginkgo bed. Tight, very f.gr. SS to SLTS.

→ 9201C Ol. sample - From slumped but tight dark grey clays of Long Draw mbr. of Scolby A. Molstine



Lenses of INT. accumulation SS. interspersed w/ med grey mud/LT. w/ Thin layers of up to 1 cm of LT. grey SLTST.

- Tops of SS. channels

Frequently leached w/ vert. roots & limonite below on joint cracks & bedding planes.

FACIES – meander belt sands & flood basin shs.

Locality is on Ord Survey Map No 101 Scarborough / Bridlington 3.2 x 91.5

Loc. 9206 5/20/92

CAYTON BAY ON The point
To The S.E. Called Yon's Nab.

ON. Ord. Survey Map 101 at.
~~0~~ 8.5 W x 84.5N

Caytonia beds from Scarham beds

SECTION Calc. grit
Oxford Clay
Hackness
Kellaways
Cornbrash

Hebberston Mbr.
Sycarhams Fm.

Sycarham Mbr of The Claughton Fm. is Non-marine.

Hebberston Mbr
A. Calcareous Arenite
Shows x-bedding but This is very small scale
X-bedding flat
Tidal.

9203a 5/20/92

CAYTON BAY - S. Side

Base of Gristhorpe Mbr. of Claughton Fm.
Lt. Grey silty clay of supposed non-marine middle deltaic Fm.

Some ironstone nodules present
From 1 m. above Top of marine Lebberston Mbr.

9203b Classic Caytonia beds in Middle Gristhorpe Mbr of Claughton Fm.

Visited 5/20/92
+ again 5/22/92

92036

Taeniopteris small & large
Willsonia
Nilssoniopteris
Cladophlebis denticulata
Caytonia fruits
Brachyphyllum
Gelnitzia
Sagenopteris
Equisetum
Conifers.

Took Overbank Bulk and Taxon Bulk samples

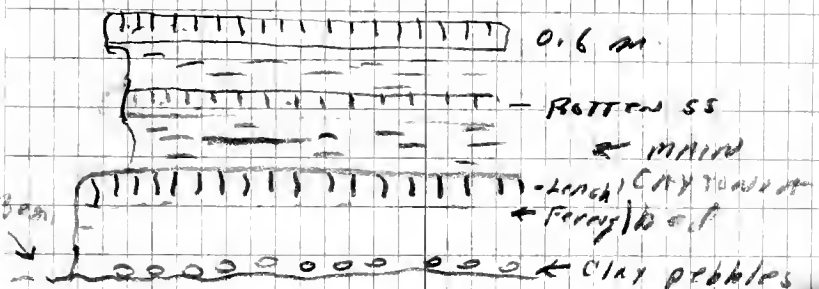
Fine grained w/ carb laminae (probably back swamp deposit
Laterally probably Channel ss units. as it is interbedded w/ them

Channel ss & Tops w/ leaching to 0.5 m + roots (vertical) leaching to dead white.

9203C 5/20/92

Caytonia bed about
300 m S. of MAIN CAYTONIA
loc
ON N side of Yons Nab

Broad FLAT CHANNEL SSS
up TO 1 m 1.5 m THICK



Osmundaceae
Geinitzia appears more
abundant

Revisited 5/23/92

1 m.

/// - ROOTS

o o o o - Fe STONE
CONCS

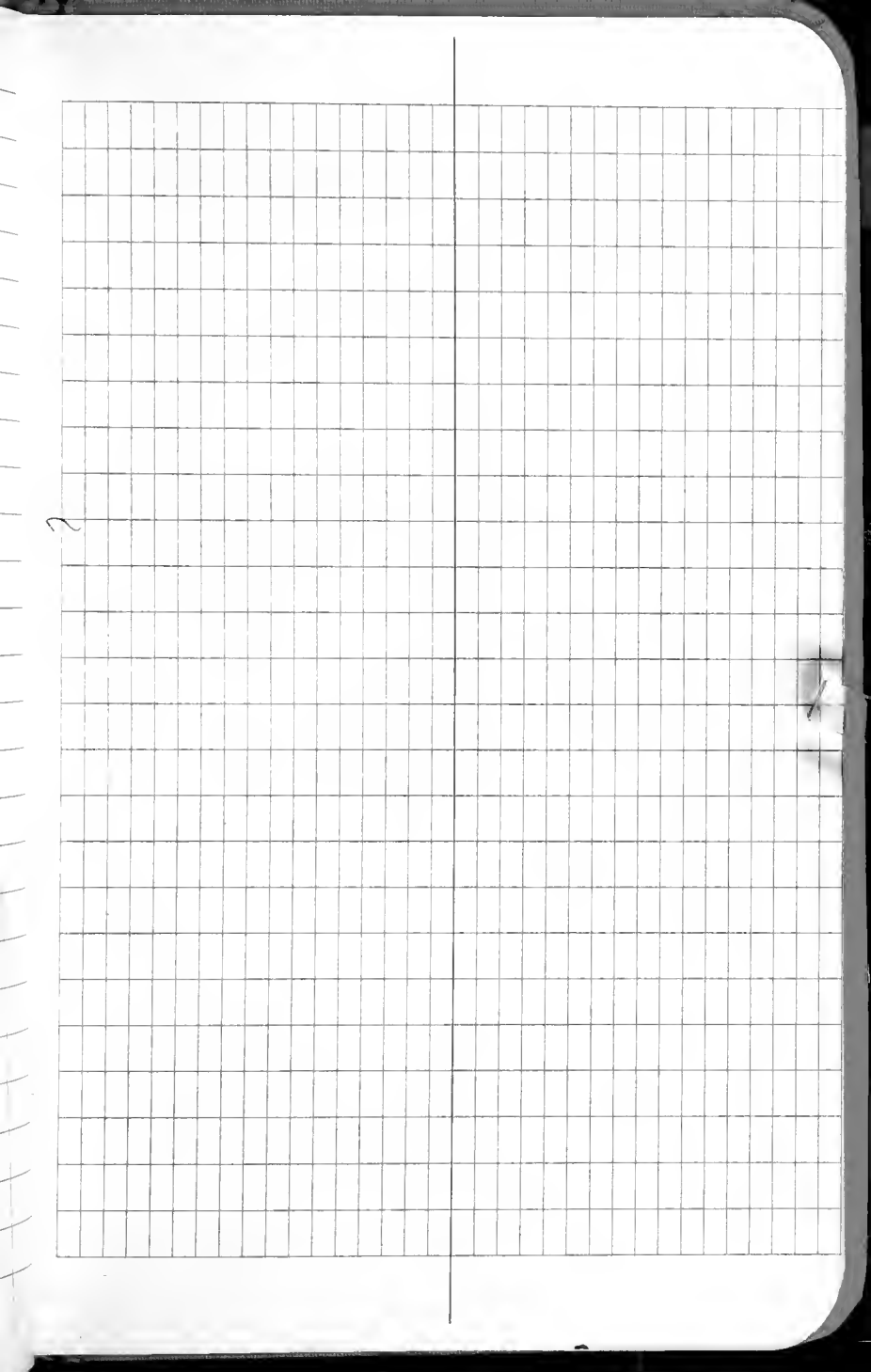
9204

Oxford Clay
From the top of a slump
block that is about
1/4 mi in length

Good tight sample
but a silt
not a clay
NOT carbonaceous.

Yorkshire middle & Upper Jurassic Sequence

	Stages.
Kimmeridge Clay	Kimm.
V. Calcareous Grit	
Coral Rag	Oxf
Oxford Clay	
Hackness Rock	
Kellaways Rock	Call.
Cornbrash	
~~	
Scalby Fm	
Scarborough Fm	
Gristhorpe Mbr ≤ Clay.	
Yons Nab Fm } Habbers-Ton Mbr at Yons Nab	Bnj
Millepore bed }	
Sycarham Mbr	
Ellerbeck Fm	
Saltwick Fm	
Ravenscar Gp. (Deltaic Series)	
	Aal



5/21/92

Loc 9205
Hasty Bank
Chris Hills Dissertation.
Sect D.

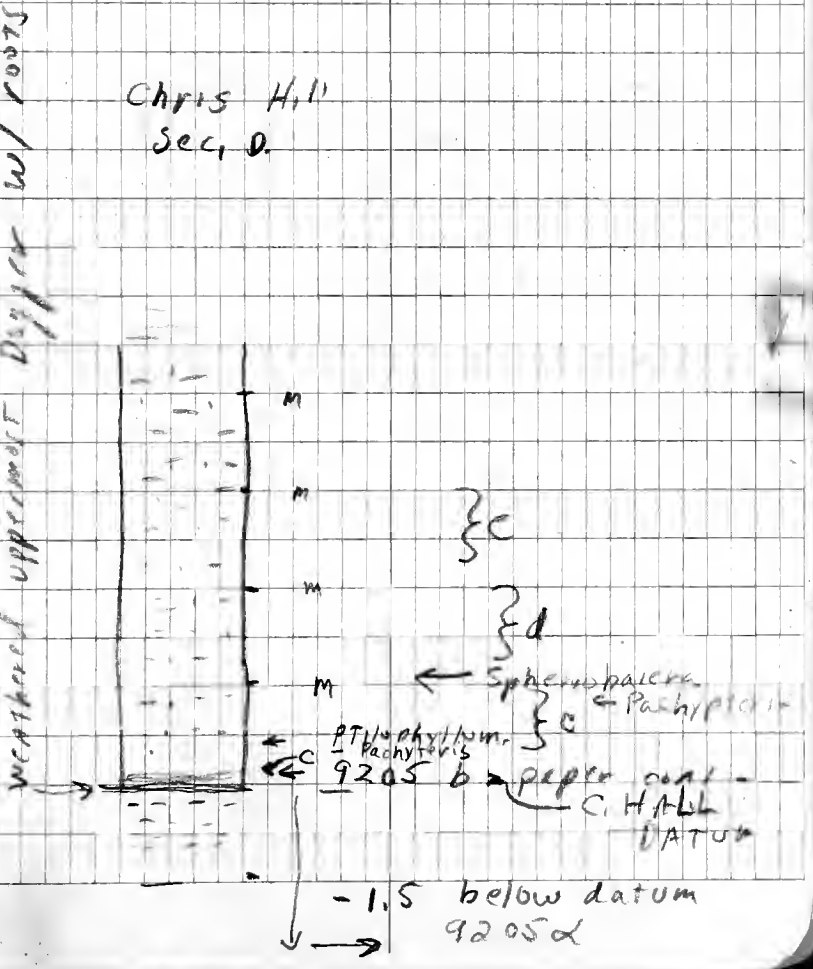
Saltwick Fm. Aalenian

Equisetum
Coryssispems.
Pteroma
Dacypteris
Pachypteris has regular
pinnate leaf.

Paleoecology
Lower Delta plain
5% microplankton

Pachypteris
Sagenopteris colpoides
Sphenobaiera gyron
Equisetum
Ptilophyllum pectinoides.

Chris Hill
Sec. D.



c. Ptilophyllum
- Pach.

9205c - Oleanane
Sample in coal

9206 Whitby EAST Cliff

Sycarsdale Mbr of Cleveland
dark grey
Ellerbeck Fm. Ferruginous ss

SALTWICK Fm
Xbedded Channels, Shales sh
1m Dogger Thin marine ss

ALUM Shales of Lias

Army module

5/22/92

9207 Roger Trail (N. side)

9207a Ixcharras Fm.
0.3 m above the
Highest ledge of
Ellerbeck SS.

Ferruginous SS w
burrows & shells
some siderite nodules
Rooted & limonite
yellow weathered.
SS. becomes more massive
upward.

This Ellerbeck interval is a
marine/deltaic interfingered
sequence
w ~~xx~~ cycles of SS
lobes that grow swamps
and are then inundated

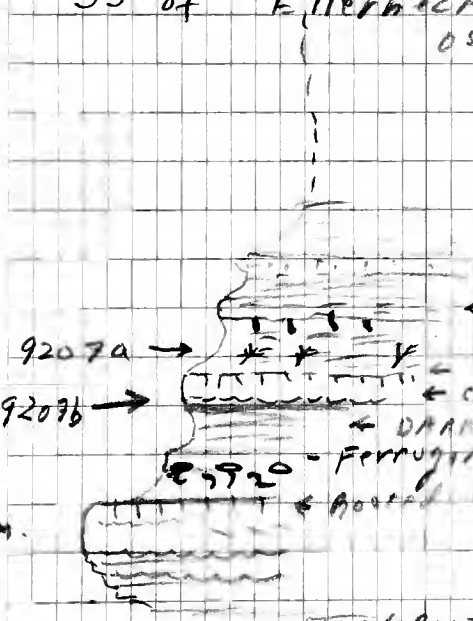
by marine conditions until filled by next thin SS sheet.

Sheet SS / Swamp muds

Lower Delta Plain

to slightly offshore

SS of Ellerbeck w/ oscillation & interference ripp



9207 (CONTd.)

PLANTS IN Shales WT 9207

a. /

Equisetum

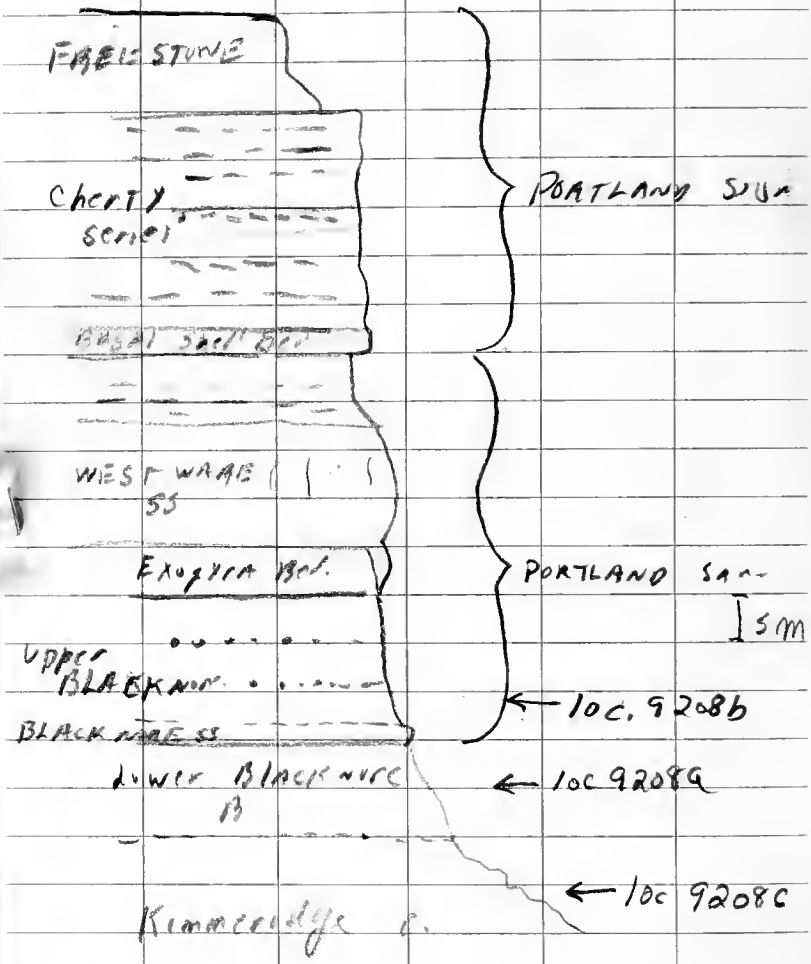
Fern & Cycad.

5/22/92

9203b CAYTON'A Bch
again -

9203c FURTHEST S. ON
CAYTON BAY at Vows
WAB

C/ADO
Willsonia
Taeniopteris
Sphenobriera
Geinitzia
~~Cycad~~


FABLE STONE
Cherty series
PORTLAND SAN
BASAL SHELL BED
WEST WARE SS
EXOGYRA BED
PORTLAND SAN
5m
UPPER BLACKNOR
BLACKNORE SS
loc. 9208b
LOWER BLACKNORE B
loc 9208a
loc 9208c
Kimmeridge c.

Dorset

CRETACEOUS

Cinder Beds

60 m Lulworth Beds

26.7 Portland Stone — Portlandian

36.8 Portland Sand

500 Kimmeridge Clay — Kimmeridgian

c 65 Corallian — Oxfordian

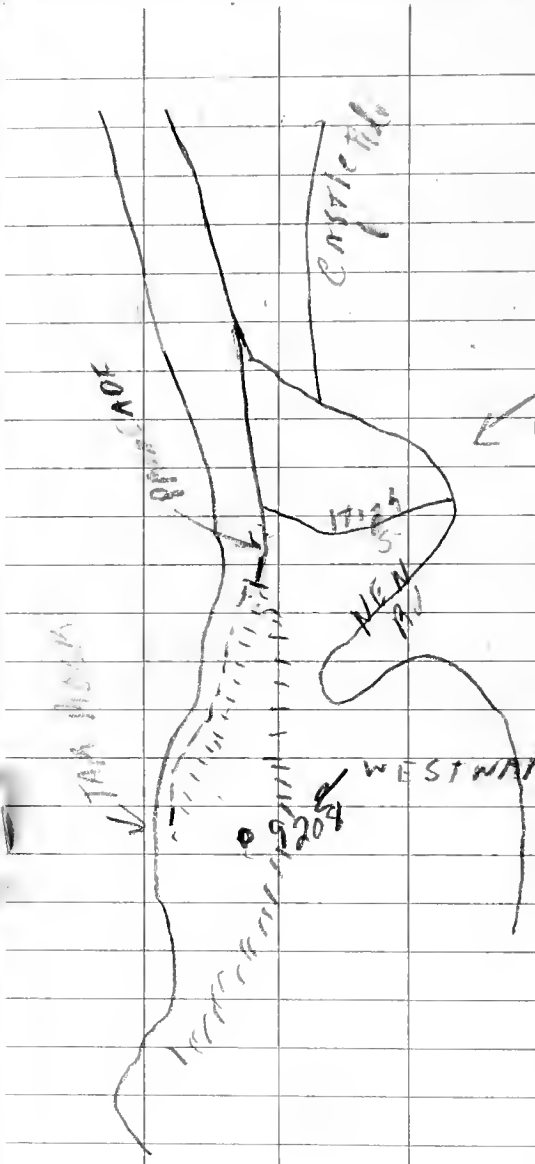
42 Upper Oxford Clay

8 Middle } Oxford Clay

19 Lower } — Callovian

3.2 Kellaways Rock } Clay

5 Upper Cornbrash


Castle Rd
Chiswell
WESTWARD CLIFFS
9204

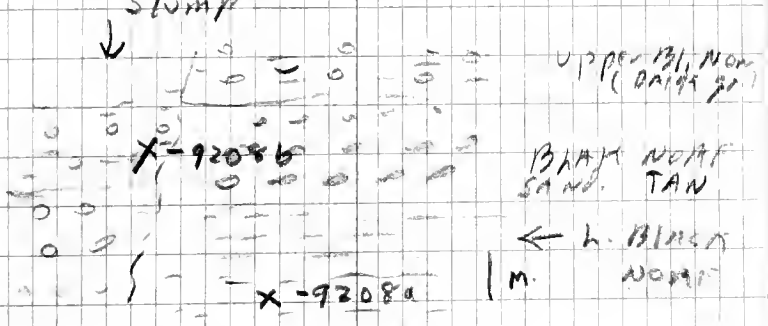
5/24/95

9208 West Ware Cliffs Loc.
Loc. 11A of Geol Dorset Coast
SY 6810 7248

9208a Lower Black Nodule Mbr
of Portland Sand
Near Shore Marine.

2 Samples TAKEN

9208b Upper Black Nodule Mbr
of Portland Sand
w Clam Shells
- From slump



Lower Black Nodule
& Greenish Black prob.

glauconitic ss.
w pecten shells.

9208C Kimmeridge clay

- Dark grey unctuous clay at base of the TAR Rocks slump block.

On the toe of the slump just above berm of loose rock.

5/24/95

9209 Furzy Cliff loc.

Map ref. SY 69.981.8

Dorchester Sheet 194

0.33 m Below Red Nodule Bed of Bowlhaze Clay Mbr. of Upper Oxford Clay

Gryphaea from same level

→ 92-09 Olennane Samples

5/24/92

9210 East of Bowlense Cove

Map Ref. SY 70.7 81.8

No The Clay of Corallian

2 m below The Bench ff Gr. 7.

→ Samp 9210 for Oleanan

Env. Near Shore Subtidal.

5/24/92

9211 Peveril Point

From Corbula beds of Durlston beds ——————→ the Durlston beds of the Purbeck Fm.
At type area of Purbeck on Durlston Bay, N. of Swanage

Sig. consists of 20 cm to 1 m thick laminated broken shell ls w interbedded laminated unctuous dark grey clays w shell hash.

→ Sample 9211 about 300 m SW of tip of Peveril Point. in Corbula Oleaginae Beds.

– Middle Purbeck. in lowermost 15.

5/24/92

92116

Cinder beds 5 m above
sea Level
ON Durlston BAY

-

Pure CLAY w Shells in
it DARK grey Carbon

-

- ON. Durlston Bay 5 m
above S.L.

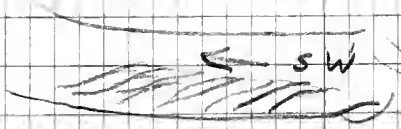
5/25/92

9212a Swanage Bay, North limb
Swanage BGS Sheet 343
(part 342)
Sheet 343 of Geol Survey
OB.5 80.5

Dorsetshire.
Wealden Fm.

Carbonaceous s/t w
comminuted plant matter
in med. grey, ferruginous
stained lams. of s/s.

Wealden Seq. here consists
of x bedded ss tan color
Flat & Trough x-bedded
Some sm wave



ss. interbedded at 4.5 m.
intervals w/ maroon to
reddish mudstones w/
ped. & rhizomorph str's
indicating gley soils

This is a Terrestrial sequence on a low flood plain (prob. meander belt) w/ a seasonal sub Tropical climate

Bell 2 Px {18-19 / 20-21
Loc 9212a

Loc

5/25/92

Loc. 92126 Sunnyside BAY
at an access gully just S. of
N. most groin
Sheet 343 03.380.4.
X bedded f to m. gr. SS
w comminted PLANT
MATTER
App 3 m exposed in cliff

Current dir. to SW

Probably 20 m below 92127

5/25/92

92/3 Studland Bay
BGS Sheet 343 4.482.4

Dx 27-28 K / Eocene
Chalk / Reading bed.
unconf. w fissure
filling

5/25/92

9214 STUDLAND.

Reclend Sand.
Bagshot Beds Eocene
BGS Sheet 343 3.7582.8

BLACK ~~Plant~~ CARBONACEOUS
CLAY IN a red TO
BROWN Ferruginous
F.g. SS. w X-beds.
Some MANGANESE STAINING

→ Sample 9214.

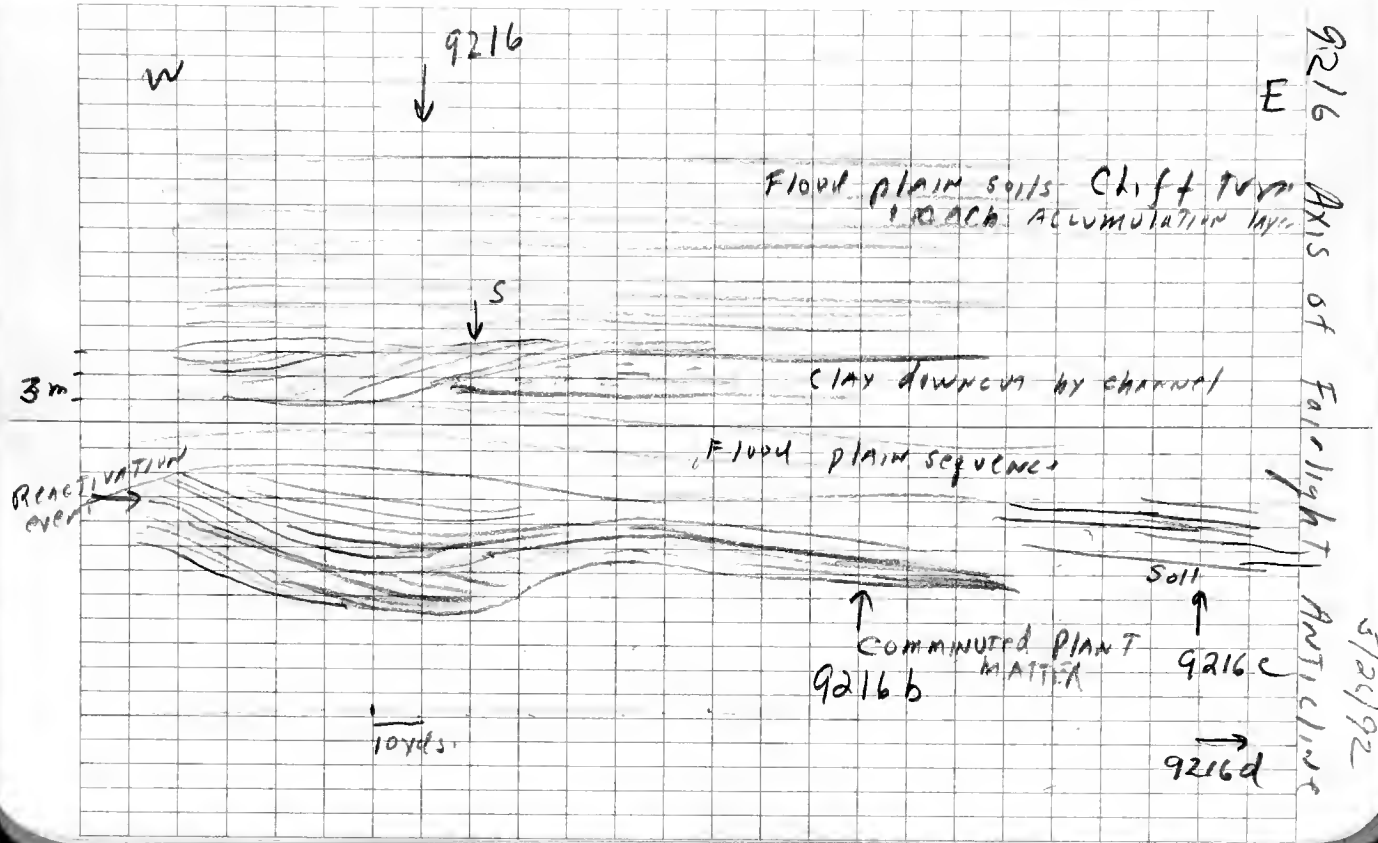
5/26/92

9215 Fairlight Head.

Carb c/A Y 1/2 WAY down
cliff.
Ashdown

9215 b ON Beach Below
9215

Trough CHANNEL pointing
S W Arifts of PIANO
MATTER in Bedding
PLANES.


W
9216
E
9216 Axis of Fairlight Anticline
5/24/92
Flood plain soils Cliff tur
Leach accumulation lay
S
3m
clay dikes by channel
Flood plain sequence
Reactivation event
Soil
Comminuted plant matter
9216b
9216c
9216d
10 yds.

May 26

9216 (CONT)

LOOKS like sequence of meander belt ss channels + flood basin soils. Some glexing mostly pod sized

9216 b CRAVASSE SPLAY deposit or DISTAL levee. About 100 yds e. of View point 9216

9216 c. "B" or accumulation horizon (HUMATE) of flood plain sequence

9216 d PLANT bed in WEALDEN DISTAL SPLAY at same level as 9216 c Onychiopsis ferrilo Brachyphyllum ponderatum Ruffordia"?

Sphenolepis

TAX. Codes

Pseudocycas.

—

SAme or level of distal splay unit

5/26/92

9217 Buried early
recent forest of
stumps and snags

Map ref:

Geol. Survey 1:50,000
Sheet 320/321
c680 1282

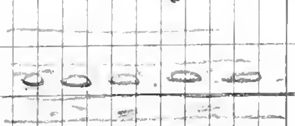
~~Pleist~~
Early holocene
at 5,000 yrs b.p.

MAY 27, 1992

9218 Ockley Brick Pit at
Smokejacks Farm
TQ 11.2 37.5 Quad. 187
Dorking.

Hauterivian / Barremian Bdy
Extensive parallel bedded
Carb & Ferruginous
weathering Shale
20 m Thick w lt grey
siderite nodules about
12 m above base of
Pit

One Trydoloid core
Ockley mystery plant
- Beetles
Fish fragments
About 10 m Higher
a Baryonyx walkerii
- and Iguanadon



3m

PX 14-15

92 19 LAYBROOK BRICK WORKS

Upper Barremian

– Wealden Clay

Ibstock Brick Pits

TQ 11.6 18.9 Sheet 182.

ON Brighton Sheet 198

Weald Clay

Parallel bedded & laminated w bioturbation on some surfaces

Anoxic clay dark grey but this is rare Mostly mottled and shows some signs of at least some disturbation.

Worm tubes on horizontal surfaces below ironstone

9220 WADHURST CLAY of.
Weald Fm
in old lower pit of
Freshlands Brick Co

Shales laminated w silt
layers w some slicks
and vertical Equisetum

Paludal flood basin on
lower delta plain.

Laminated, no bioturbation
anoxic (semi) w freshw
intervals

9221 NEW PIT of Freshlane Brick Co.

- Grinsted CLAY & Upper Tunbridge Wells Sand.

UTS is a series of shallow EVULSION CHANNELS 3 m THICK & ABOUT 100-200 m broad. LATERAL to These is a sequence of Typical Red & Green to BLACK MOTTLED SOILS beds (CATAPSCO) making the CLAYS NON-CARBONACEOUS & SO NOT Sample.

FOUND "pebble bed" AT TOP OF Lower Tunbridge Wells SANDS.

NOT SUITABLE for SAMPLING

9222 - 9230 Used

Dazil Used
9 7 30

START at 9240 6/19

BCR SITE 23.

Washingtonites
Araucarites long. Co 7
Fruiting axis 0
IND 10
DN 20 BCR Scrambler

SUNNY, HOT, & STILL.

6/25

AT BCR SOUTH end.
PLOTTED POSITION of
SITES 42-47 on
Aerial Photograph.

122.3 from nut hole to
nut hole

Loc. 38A 6/26/92

Large Palm leaf of WASHINGTONIES is 15 cm above soil layer PX by SCOTT leaf is TWISTED COUNTER CLOCKWISE ~~to~~ on left side. Especially at base

7/3/92

Meet at ERSE Dump w
Kay Behrens meyer
Brian
Scott
Robyn Burnham

Soils not leached
should return for
extra collecting

9241 7/3/22

Revisited loc 9133 & 9134

BCR 7/6/92

Just 20' N of Site #36

Substrate of soil related,
sandy c/sr
Almost no soil develop-
ment below ash.

PLANTS Acer Cret. very
Impt.

7/8/92

Site 36.3

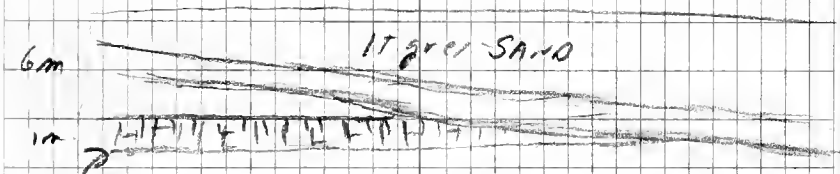
VRm 20 cm across w sheathing nearly circular leaves that fill w/ sediment

7/7/92

BCR N of Site 10
looking for placement
of Site 9

S
10

N



NO ~~recognizable~~ identifiable PLANTS in
"PLANT bed" N. of SITE 10

7/8/92

Discussion

Standing water only in pond at 50 -

Densly organic soil w clay laminae

A Scenario:

High water table not flooded but soften forest.

Reducing substrate

Dies Frac

Tuft flowing upwards always in first 6 cm

Fig 55 to 57.

PLANT HASH at 10-20 cm

level.
Plant ash possibly
mostly water lain
& from then up to top
of bentonite it is laminar.

Press board still water
laminated

- One eruption
- (Air)
- Ponding
- Burial of remaining plants.
-

- Air fall for original
event. 2

7/9/62

SITE 18 Redigging

This was right down to the soil horizon and below the pressboard

7/10/92

BCR

AT SITE 18.1

Censusing 1, 2

NO pressboard at This SITE

Also Almost NO Anemia fremontii

Although This is Dominant at 19T 18 8m to The North.

7/14/92

Site 18.3

- Soil here is bedded with beds of mcl. to ~~cscr~~ ss interbedded w/ carb silt.
layers of unreworked plant ~~life~~ incl.
Palm fronds &.
Araucarites found here
much fusain in soil
Tuff is sharply based w only scraps of plant material incl.
palms & inlet fern
frags. very rarely found.

Some convolutions noted in Tuff.

SITE Abandoned for plant census.

7/4/92

SITE 16.4

SITE Abandoned for lack of fossils.

INITES recorded on data capture sheets given to A.K. Behrensmeyer.

7/15/92

Meeteetse Section

3 Bentonites at base of Section

1st. Just Above PMAG MTE 41

2nd. ~1m below MTE 42

3rd. Just below MTE 44

poor Thin bey MTE 45

Above MTE 46 poor

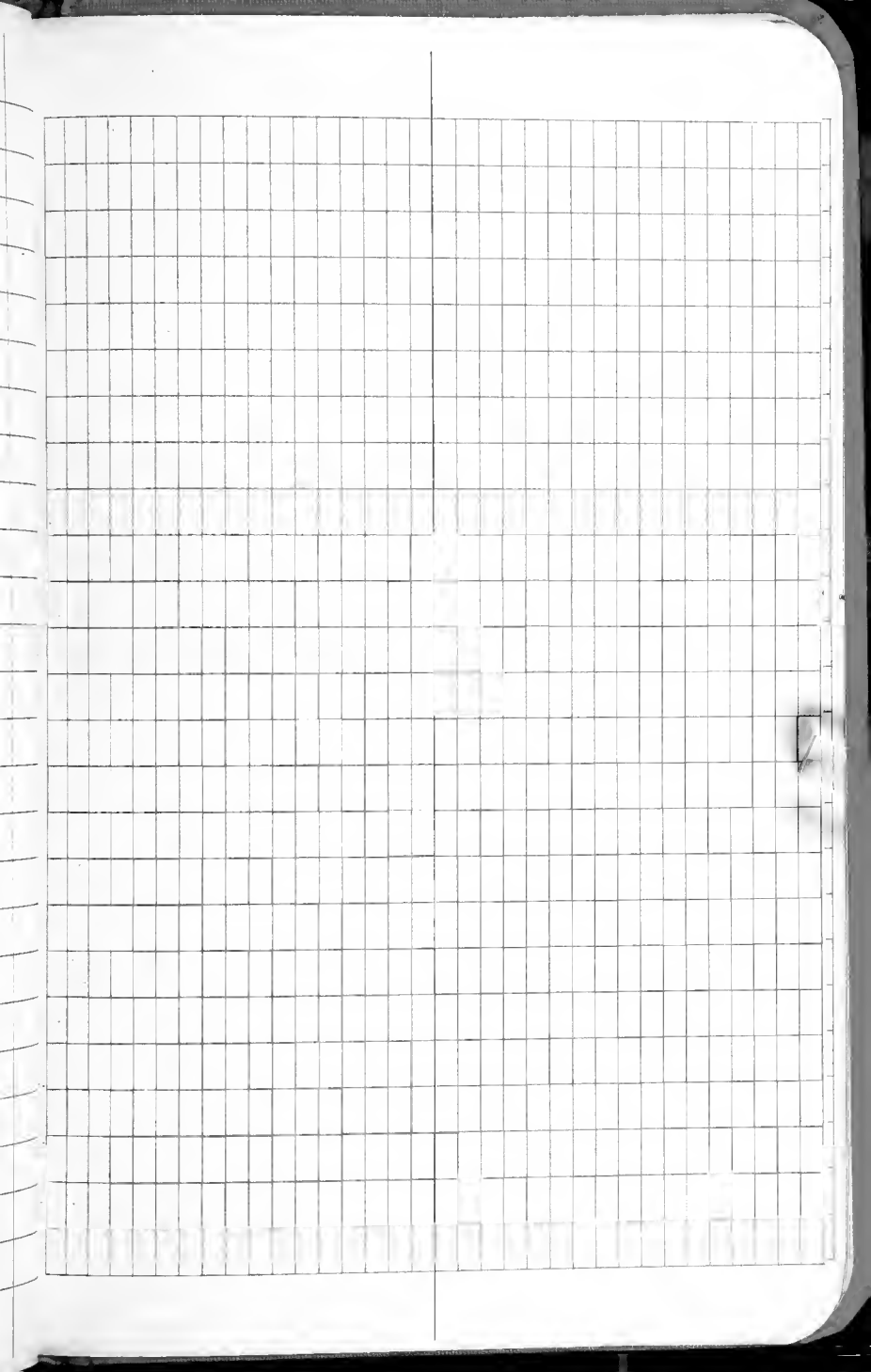
2 in Lance at Road Intersection to Farm

1} Above MTE 51
2} 3-4m below prom carb line

~~... of Farm pond~~

between MTE 52-53

Farm pond below MTE 54



7/18/92

9242 = MO-1

Survey of MAIN fossil plant site on prominent nose in Meeteetse Quad.

Census completed at 4:50 p.m. as thunderstorm approached

Thujites CRETACEA (SLW (3.2)) overwhelmingly dominant - more than 99%

MANY STICKS of charred & petrified wood. Dense masses of Thujites. Occurrence of fossil plants

Area of pit

1.5 X 2.5 x 3 m.

2.5

7/19/92

RAIN DAY no field work.

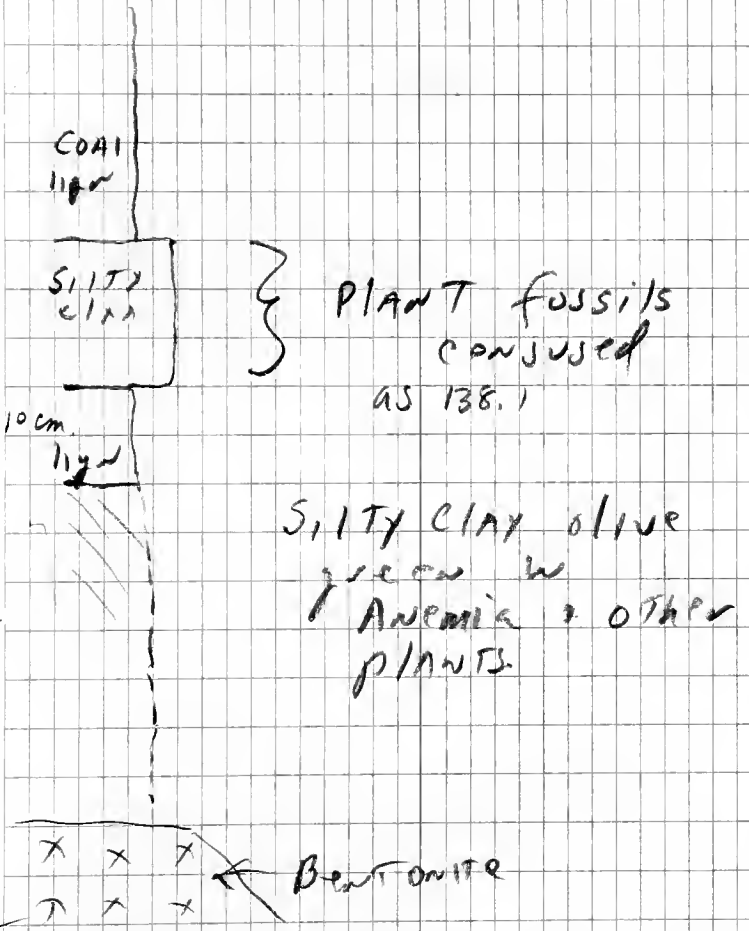
7/20/92

Loc. 135.6
Censused. This is mainly
an Araucarian-Palm
dominated ss app a
crevasse or distal
levee filling near a
flood basin contact

Start section on census
sheet

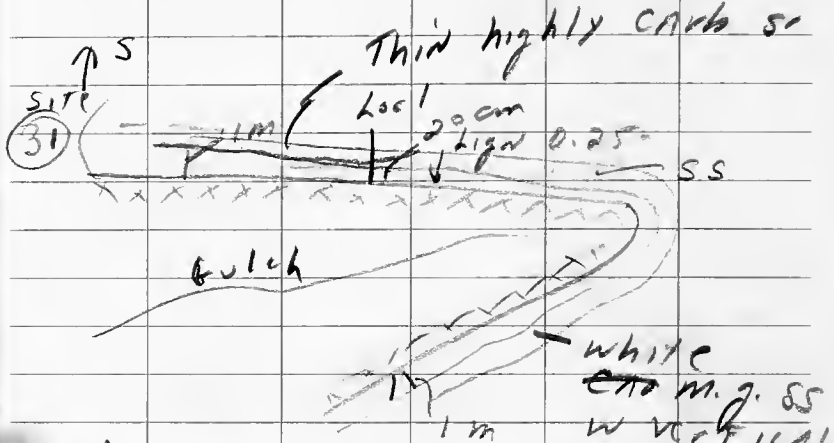
7/20/92

Loc 138.1



7/21/92

100' Level between
30 - 31
~~A white~~



Site
30

AT loc 1
PLANTS in base of
SS
Indet dicot frags
Nelumbo frags
Cladophlebis virg.

AT 2
Araucarites frags

7/22/92

AT SITE 24.2

PIT SIZE 2 X 3 m

FOSSILS SPARSE

SED. OBSERVATIONS MADE ON STANDARD SHEET.

Site at BCK
16.4 7/23/92

Palm leaf found at
12 cm above soil
dipping down to 8 cm
on distal portion

Also found is Anemia
fremontii
and fragments.

Press board layer at
about 15 cm
above soil layer

SITE 14.4 7/23/92

- Press board at 25cm above base soil

Found mud sclia 40cm above soil.

No fossils to base of bentonite except for palms right at base.

7/25/92 SITE (-)16

Clinker developed from prominent 2m lignite & lignitic shale

PLANTS found

Eodicranopteris

Indet monocot

CO3

Indet dicot lf ~ 12 cm long

Anemia fremontii

Vertical rooted mono

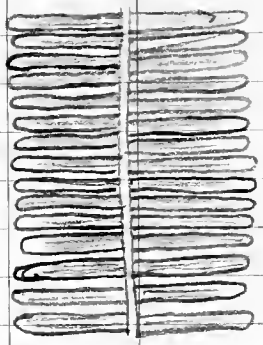
7/29/92
AT Base of Jason
Hicks Big Cedar
Bridge Section

STARTING on The highest
Lcdy/ Ferruginous SS
THAT forms The Top of
The Fox Hills Fm

0 Top of Brown Indurated
flat bedded con-
cretionary SS of Fox
Hills Fm
UNIT

0 1 Mecteetse Fm
Friable poorly exposed
VF, SA, SS THAT
IS Flat or planar
bedded but poorly
exposed. Forms
base of Mecteetse Fm
[WAVE Dominated]

2m Base STAKE of JH Sect.
SAME IT. grey SS-



~125%

Pterophyllum

BENNETTITALEAN

Brighton
Steyning
Shoreh.

Pass

Outlook from White
Frame

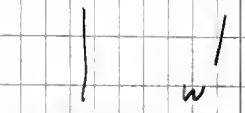
— Formed +

to P

Fairfield Lane — Dane Hill
Broadwaters
Bottom Rd — Hobhurst

Storrington By. Hike
Hardley

S	M	T	W	T
24	25	26	27	28
PORT.	Prince	COASTAL	OCK.	WTAKD.



COASTAL LOCS. ON ROUTE.

Meet Chris at 9:30
at Smoke Jacks Brick-
works. in Ockley

O.S. Map. 187 (1:50,000 Sc)
Grid Ref TQ 116372

Chris - Mus. 071 938 9423
Hm 081 940 6643

JASON HICKS
To Acknowledge Chevin
in his papers.

Norton Villa - Hastings Odd T.
0424 428 168

Ph Hicks
07988 72348

Table
Table
Table
Table
Table
Table
Table
Table VI
Table IX
Table X
Table XI

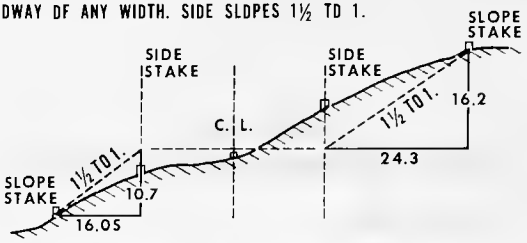
INDEX OF
CURVE AND REDUCTION TABLES

left blan
left Hand pa
left

TABLE I. SLOPE STAKE

DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING

RDADWAY DF ANY WIDTH. SIDE SLDPES 1½ TD 1.



Cut or Fill	Distance out from Side or Shoulder Stake.										Cut or Fill
	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
0	0 00	0 15	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	0
1	1 50	1 65	1 80	1.95	2.10	2.25	2.40	2.55	2.70	2.85	1
2	3.00	3.15	3.30	3 45	3.60	3 75	3.90	4.05	4.20	4 35	2
3	4.50	4 65	4.80	4.95	5 10	5 25	5 40	5.55	5.70	5.85	3
4	6.00	6 15	6.30	6.45	6.60	6 75	6.90	7.05	7.20	7.35	4
5	7 50	7.65	7.80	7.95	8 10	8.25	8.40	8.55	8.70	8.85	5
6	9 00	9 15	9.30	9.45	9.60	9 75	9.90	10.05	10.20	10 35	6
7	10.50	10 65	10 80	10.95	11.10	11.25	11.40	11 55	11 70	11.85	7
8	12.00	12 15	12.30	12.45	12 60	12.75	12.90	13 05	13.20	13.35	8
9	13 50	13 65	13 80	13 95	14.10	14.25	14.40	14 55	14.70	14.85	9
10	15.00	15 15	15 30	15 45	15.60	15.75	15.90	16.05	16.20	16 35	10
11	16 50	16 65	16 80	16.95	17 10	17.25	17.40	17.55	17.70	17.85	11
12	18 00	18 15	18.30	18 45	18 60	18 75	18.90	19.05	19.20	19 35	12
13	19 50	19 65	19.80	19.95	20.10	20.25	20 40	20.55	20.70	20.85	13
14	21.00	21 15	21.30	21.45	21 60	21.75	21.90	22 05	22 20	22 35	14
15	22 50	22 65	22 60	22 95	23.10	23.25	23.40	23 55	23.70	23.85	15
16	24.00	24 15	24 30	24 45	24 60	24.75	24 90	25 05	25.20	25.35	16
17	25.50	25 65	25.80	25 95	26.10	26 25	26 40	26.55	26.70	26.85	17
18	27.00	27 15	27.30	27 45	27.60	27.75	27.90	28.05	28 20	28.35	18
19	28 50	28 65	28 80	28.95	29.10	29.25	29 40	29.55	29.70	29.85	19
20	30 00	30 15	30.30	30.45	30.60	30.75	30.90	81.05	31.20	31.85	20
21	31 50	31 65	31.80	31.95	32 10	32 25	32.40	32.55	32 70	32 85	21
22	33 00	33 15	33 30	33 45	33.60	33 75	33.90	34.05	34.20	34.35	22
23	34 50	34 65	34.80	34.95	35.10	35 25	35 40	35.55	35.70	35 85	23
24	86 00	86 15	36.30	36 45	36.60	36.75	36.90	37.05	37.20	37.35	24
25	37 50	37.65	37 80	37.95	38.10	38.25	38.40	38 55	38.70	38.85	25
26	39 00	39 15	39 80	39 45	39 60	39 75	39.90	40 05	40.20	40.35	26
27	40 50	40 65	40 80	40.95	41.10	41.25	41 40	41.55	41.70	41.85	27
28	42 00	42 15	42.30	42.45	42.60	42 75	42.90	43.05	43.20	43.35	28
29	43 50	43 65	43.80	43 95	44.10	44 25	44 40	44.55	44.70	44 85	29
30	45 00	45 15	45.30	45 45	45.60	45.75	45.90	46.05	46 20	46.35	30
31	46.50	46.65	46.80	46 95	47.10	47.25	47.40	47.55	47.70	47.85	31
32	48 00	48.15	48.30	48 45	48.60	48 75	48.90	49.05	49 20	49.35	32
33	49.50	49 65	49.80	49.95	50.10	50.25	50.40	50.55	50 70	50.85	33
34	51 00	51.15	51.30	51.45	51.60	51.75	51.90	52.05	52.20	52.35	34
35	52 50	52.65	52.80	52.95	53.10	53.25	53.40	53.55	53.70	53.85	35
36	54 00	54.15	54 30	54 45	54.60	54.75	54.90	55.05	55.20	55.35	36
37	55 50	55 65	55.80	55.95	56.10	56.25	56.40	56.55	56.70	56.85	37
38	57.00	57.15	57.30	57 45	57.60	57 75	57.90	58.05	58.20	58 35	38
39	58 50	58.65	58 80	58.95	59.10	59 25	59.40	59 55	59.70	59.85	39
40	60 00	60 15	60 30	60 45	60 60	60.75	60 90	61.05	61 20	61.35	40

TABLE II. STADIA CORRECTION AND HORIZONTAL DISTANCES

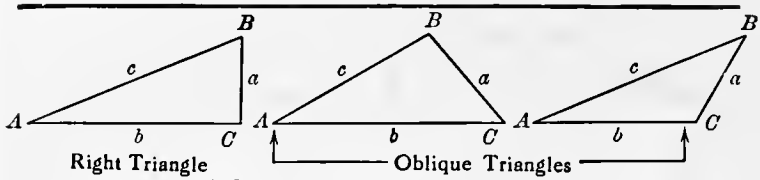
STADIA REDUCTIONS FOR READING 100

Vertical Angle	Horizontal Correction	Difference in Elevation	Vertical Angle	Horizontal Correction	Difference in Elevation
2°—00′	0.1	3.5	18°—30′	10.1	30.1
3°—00′	0.3	5.3	19°—00′	10.6	30.8
4°—00′	0.5	7.0	19°—30′	11.2	31.5
5°—00′	0.8	8.7	20°—00′	11.7	32.1
6°—00′	1.1	10.4	20°—30′	12.3	32.8
7°—00′	1.5	12.1	21°—00′	12.8	33.5
8°—00′	1.9	13.8	21°—30′	13.4	34.1
9°—00′	2.5	15.5	22°—00′	14.0	34.7
10°—00′	3.0	17.10	22°—30′	14.7	35.4
10°—30′	3.3	17.9	23°—00′	15.3	36.0
11°—00′	3.6	18.7	23°—30′	15.9	36.6
11°—30′	4.0	19.5	24°—00′	16.5	37.2
12°—00′	4.3	20.3	24°—30′	17.2	37.7
12°—30′	4.7	21.1	25°—00′	17.9	38.3
13°—00′	5.1	21.9	25°—30′	18.6	39.0
13°—30′	5.5	22.7	26°—00′	19.2	39.4
14°—00′	5.9	23.4	26°—30′	19.9	39.9
14°—30′	6.3	24.2	27°—00′	20.6	40.5
15°—00′	6.7	25.0	27°—30′	21.3	41.0
15°—30′	7.2	25.8	28°—00′	22.0	42.0
16°—00′	7.6	26.5	28°—30′	22.8	41.9
16°—30′	8.1	27.2	29°—00′	23.5	42.4
17°—00′	8.5	28.0	29°—30′	24.3	42.9
17°—30′	9.0	28.7	30°—00′	25.0	43.3
18°—00′	9.5	29.4			

Chains to Feet	
1	66
2	132
3	198
4	264
5	330
6	396
7	462
8	528
9	594
10	660

Feet to Chains	
100	1.515
200	3.030
300	4.545
400	6.060
500	7.575
600	9.090
700	10.606
800	12.121
900	13.636
1,000	15.151

TABLE III. TRIGONOMETRIC FORMULAE



Solution of Right Triangles

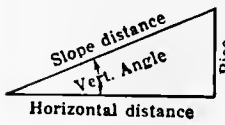
For Angle A. $\sin = \frac{a}{c}$, $\cos = \frac{b}{c}$, $\tan = \frac{a}{b}$, $\cot = \frac{b}{a}$, $\sec = \frac{c}{b}$, $\operatorname{cosec} = \frac{c}{a}$

Given	Required	
a, b	A, B, c	$\tan A = \frac{a}{b} = \cot B,\ c = \sqrt{a^2 + b^2} = a\sqrt{1 + \frac{b^2}{a^2}}$
a, c	A, B, b	$\sin A = \frac{a}{c} = \cos B,\ b = \sqrt{(c+a)(c-a)} = c\sqrt{1 - \frac{a^2}{c^2}}$
A, a	B, b, c	$B = 90° - A,\ b = a \cot A,\ c = \frac{a}{\sin A}$
A, b	B, a, c	$B = 90° - A,\ a = b \tan A,\ c = \frac{b}{\cos A}$
A, c	B, a, b	$B = 90° - A,\ a = c \sin A,\ b = c \cos A,$

Solution of Oblique Triangles

Given	Required	
A, B, a	b, c, C	$b = \frac{a \sin B}{\sin A},\ C = 180° - (A + B),\ c = \frac{a \sin C}{\sin A}$
A, a, b	B, c, C	$\sin B = \frac{b \sin A}{a},\ C = 180° - (A + B),\ c = \frac{a \sin C}{\sin A}$
a, b, C	A, B, c	$A + B = 180° - C,\ \tan \frac{1}{2}(A - B) = \frac{(a-b)\tan \frac{1}{2}(A+B)}{a+b}.$ $c = \frac{a \sin C}{\sin A}$
a, b, c	A, B, C	$s = \frac{a+b+c}{2},\ \sin \frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{b\,c}},$ $\sin \frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{a\,c}},\ C = 180° - (A+B)$
a, b, c	Area	$s = \frac{a+b+c}{2},\ \text{area} = \sqrt{s(s-a)(s-b)(s-c)}$
A, b, c	Area	$\text{area} = \frac{b\,c \sin A}{2}$
A, B, C, a	Area	$\text{area} = \frac{a^2 \sin B \sin C}{2 \sin A}$

REDUCTION TO HORIZONTAL



Horizontal distance = Slope distance multiplied by the cosine of the vertical angle. Thus: slope distance = 319.4 ft. Vert. angle = 5° 0′. From Table, IV, cos 5° 0′ = .9959. Horizontal distance = 319.4 × .9959 = 318.09 ft.

Horizontal distance also = Slope distance minus slope distance times (1 − cosine of vertical angle). With the same figures as in the preceding example, the following result is obtained. Cosine 5° 10′ = .9959. 1 − .9959 = .0041. 319.4 × .0041 = 1.31. 319.4 − 1.31 = 318.09 ft.

When the rise is known, the horizontal distance is approximately:—the slope distance less the square of the rise divided by twice the slope distance. Thus: rise = 14 ft., slope distance = 302.6 ft. Horizontal distance $= 302.6 - \frac{14 \times 14}{2 \times 302.6} = 302.6 - 0.32 = 302.28$ ft.

TABLE IV. NATURAL TRIGONOMETRICAL FUNCTIONS

Angle	Sin	Tan.	Sec.	Cosec.	Catg.	Cosin.		Angle	Sin.	Tan.	Sec.	Cosec.	Catg.	Cosin.	
° ′								° ′							
0	0	0	1.	∞	∞	1.	90	8	.1392	.1405	1.0098	7.185	7.115	.99027	82
10	.0029	.0029		343.8	343.8	1.	50	10	.1421	.1435	1.0102	7.040	6.968	.98986	50
20	.0058	.0058		171.9	171 9	.99998	40	20	.1449	.1465	1.0107	6.900	6.827	.98944	40
30	.0087	.0087		114.6	114.6	.99996	30	30	.1478	.1495	1.0111	6.766	6.691	.98902	30
40	.0116	.0116	1.0001	85.94	85.94	.99993	20	40	.1507	.1524	1.0115	6.636	6.561	.98858	20
50	.0145	.0145	1.0001	68.76	68.75	.99989	10	50	.1536	.1554	1.0120	6.512	6.435	.98814	10
1	.0175	.0175	1.0002	57.30	57.29	.99985	89	9	.1564	.1584	1.0125	6.394	6.314	.98769	81
10	.0204	.0204	1.0002	49.11	49.10	.99979	50	10	.1593	.1614	1.0129	6.277	6.197	.98723	50
20	.0233	.0233	1.0003	42.98	42.96	.99973	40	20	.1622	.1644	1.0134	6.166	6.084	.98676	40
30	.0262	.0262	1.0003	38.20	38.19	.99966	30	30	.1650	.1673	1.0139	6.059	5.976	.98629	30
40	.0291	.0291	1.0004	34.38	34.37	.99958	20	40	.1679	.1703	1.0144	5.955	5.871	.98580	20
50	.0320	.0320	1.0005	31.26	31.24	.99949	10	50	.1708	.1733	1.0149	5.855	5.769	.98531	10
2	.0349	.0349	1.0006	28.65	28.64	.99939	88	10	.1736	.1763	1.0154	5.759	5.671	.98481	80
10	.0378	.0378	1.0007	26 45	26.43	.99929	50	10	.1765	.1793	1.0160	5.665	5.576	.98430	50
20	.0407	.0407	1.0008	24.56	24.54	.99917	40	20	.1794	.1823	1.0165	5.575	5.485	.98378	40
30	.0436	.0437	1.0010	22.93	22.90	.99905	30	30	.1822	.1853	1.0170	5.488	5.396	.98325	30
40	.0465	.0466	1.0011	21.49	21.47	.99892	20	40	.1851	.1883	1.0176	5.403	5.309	.98272	20
50	.0494	.0495	1.0012	20.23	20.21	.99878	10	50	.1880	.1914	1.0181	5.320	5.226	.98218	10
3	.0523	.0524	1.0014	19.11	19.08	.99863	87	11	.1908	.1944	1.0187	5.241	5.145	.98163	79
10	.0552	.0553	1.0015	18.10	18.07	.99847	50	10	.1937	.1974	1.0193	5.164	5.066	.98107	50
20	.0581	.0582	1.0017	17.20	17.17	.99831	40	20	.1965	.2004	1.0199	5.089	4.989	.98050	40
30	.0610	.0612	1.0019	16 38	16.35	.99813	30	30	.1994	.2035	1.0205	5.016	4.915	.97992	30
40	.0640	.0641	1.0020	15.64	15.60	.99795	20	40	.2022	.2065	1.0211	4.945	4.843	.97934	20
50	.0669	.0670	1.0022	14.96	14.92	.99776	10	50	.2051	.2095	1.0217	4.877	4.773	.97875	10
4	.0698	.0699	1.0024	14.34	14.30	.99756	86	12	.2079	.2126	1.0223	4.810	4.705	.97815	78
10	.0727	.0729	1.0027	13.76	13.73	.99736	50	10	.2108	.2156	1.0230	4.745	4.638	.97754	50
20	.0756	.0758	1.0029	13.23	13 20	.99714	40	20	.2136	.2186	1.0236	4.682	4.574	.97692	40
30	.0785	.0787	1.0031	12.75	12.71	.99692	30	30	.2164	.2217	1.0243	4.620	4.511	.97630	30
40	.0814	.0816	1.0033	12.29	12.25	.99668	20	40	.2193	.2247	1.0249	4.560	4.449	.97566	20
50	.0843	.0846	1.0036	11.87	11.83	.99644	10	50	.2221	.2278	1.0256	4.502	4.390	.97502	10
5	.0872	.0875	1.0038	11.47	11.43	.99619	85	13	.2250	.2309	1.0263	4.445	4.331	.97437	77
10	.0901	.0904	1.0041	11.10	11.06	.99594	50	10	.2278	.2339	1.0270	4.390	4.275	.97371	50
20	.0929	.0934	1.0043	10.76	10.71	.99567	40	20	.2306	.2370	1.0277	4.336	4.219	.97304	40
30	.0958	.0963	1.0046	10.43	10.39	.99540	30	30	.2334	.2401	1.0284	4.284	4.165	.97237	30
40	.0987	.0992	1.0049	10.13	10.08	.99511	20	40	.2363	.2432	1.0291	4.232	4.113	.97169	20
50	.1016	.1022	1.0052	9.839	9.788	.99482	10	50	.2391	.2462	1.0299	4.182	4.061	.97100	10
6	.1045	.1051	1.0055	9.567	9.514	.99452	84	14	.2419	.2493	1.0306	4.133	4.011	.97030	76
10	.1074	.1080	1.0058	9.309	9.255	.99421	50	10	.2447	.2524	1.0314	4.086	3.962	.96959	50
20	.1103	.1110	1.0061	9.065	9.010	.99390	40	20	.2476	.2555	1.0321	4.039	3.914	.96887	40
30	.1132	.1139	1.0065	8.834	8.777	.99357	30	30	.2504	.2586	1.0329	3.994	3.867	.96815	30
40	.1161	.1169	1.0068	8.614	8.556	.99324	20	40	.2532	.2617	1.0337	3.949	3.821	.96742	20
50	.1190	.1198	1.0072	8.405	8.345	.99290	10	50	.2560	.2648	1.0345	3.906	3.776	.96667	10
7	.1219	.1228	1.0075	8.206	8.144	.99255	83	15	.2588	.2679	1.0353	3.864	3.732	.96593	75
10	.1248	.1257	1.0079	8.016	7.953	.99219	50	10	.2616	.2711	1.0361	3.822	3.689	.96517	50
20	.1276	.1287	1.0082	7.834	7.770	.99182	40	20	.2644	.2742	1.0369	3.782	3.647	.96440	40
30	.1305	.1317	1.0086	7.661	7.596	.99144	30	30	.2672	.2773	1.0377	3.742	3.606	.96363	30
40	.1334	.1346	1.0090	7.496	7.429	.99106	20	40	.2700	.2805	1.0386	3.703	3.566	.96285	20
50	.1363	.1376	1.0094	7.337	7.269	.99067	10	50	.2728	.2836	1.0394	3.665	3.526	.96206	10
							82								74
							° ′								° ′
	Cosin	Catg.	Casec.	Sec.	Tan.	Sin.	Angle		Cosin.	Catg.	Casec.	Sec.	Tan.	Sin.	Angle

TABLE IV CONTD. NATURAL TRIGONOMETRICAL FUNCTIONS

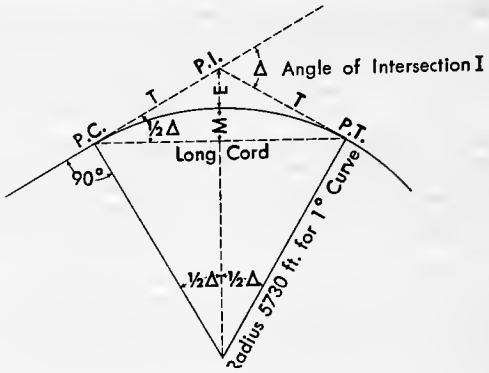
Angle	Sin.	Tan.	Sec.	Cosec.	Cotg.	Cosin.		Angle	Sin.	Tan.	Sec.	Cosec.	Cotg.	Cosin.	
° ′								° ′							
16	.2756	.2867	1.0403	3.628	3.487	.96126	74	24	.4067	.4452	1.0946	2.459	2.246	.91355	66
10	.2784	.2899	1.0412	3.592	3.450	96046	50	10	.4094	.4487	1 0961	2.443	2.229	.91236	50
20	.2812	2931	1.0423	3.556	3.412	.95964	40	20	.4120	.4522	1.0975	2.427	2.211	.91116	40
30	.2840	.2962	1.0429	3.521	3.376	.95882	30	30	.4147	.4557	1.0989	2.411	2.194	90996	30
40	.2868	2994	1.0438	3.487	3.340	.95799	20	40	.4173	4592	1.1004	2.396	2.177	.90875	20
50	.2896	.3026	1.0448	3.453	3.305	.95715	10	50	.4200	.4628	1.1019	2.381	2.161	90753	10
17	.2924	.3057	1.0457	3.420	3.271	.95630	73	25	.4226	.4663	1.1034	2.366	2.145	.90631	65
10	.2952	.3089	1 0466	3.388	3.237	95545	50	10	.4253	.4699	1.1049	2.351	2.128	.90507	50
20	.2979	.3121	1.0476	3.357	3.204	.95459	40	20	.4279	4734	1.1064	2.337	2.112	.90383	40
30	.3007	.3153	1.0485	3.326	3.172	95372	30	30	.4305	.4770	1.1079	2.323	2.097	.90259	30
40	.3035	3185	1.0495	3 295	3.140	.95284	20	40	.4331	.4806	1.1095	2.309	2.081	.90133	20
50	.3062	.3217	1.0505	3.265	3.108	.95195	10	50	.4358	.4841	1.1110	2.295	2.066	90007	10
18	.3090	.3249	1.0515	3.236	3.078	.95106	72	26	.4384	.4877	1.1126	2.281	2.050	.89879	64
10	.3118	.3281	1.0525	3.207	3.048	95015	50	10	.4410	.4913	1 1142	2.268	2.035	.89752	50
20	.3145	.3314	1.0535	3.179	3 018	.94924	40	20	.4436	.4950	1.1158	2.254	2.020	.89623	40
30	.3173	.3346	1.0545	3.152	2.989	.94832	30	30	.4462	4986	1.1174	2.241	2.006	.89493	30
40	.3201	.3378	1.0555	3.124	2.960	.94740	20	40	.4488	.5022	1.1190	2.228	1.991	.89363	20
50	.3228	.3411	1.0566	3.098	2.932	.94646	10	50	.4514	.5059	1.1207	2.215	1.977	.89232	10
19	.3256	.3443	1.0576	3.072	2.904	.94552	71	27	.4540	.5095	1.1223	2.203	1.963	.89101	63
10	.3283	.3476	1.0587	3.046	2.877	.94457	50	10	.4566	.5132	1.1240	2.190	1.949	88968	50
20	.3311	.3508	1.0598	3.020	2.850	.94361	40	20	.4592	.5169	1.1257	2.178	1.935	.88835	40
30	.3338	.3541	1.0608	2.996	2.824	.94264	30	30	.4617	.5206	1.1274	2.166	1.921	.88701	30
40	.3365	.3574	1.0619	2.971	2.798	.94167	20	40	.4643	.5243	1.1291	2.154	1.907	.88566	20
50	.3393	.3607	1.0631	2.947	2.773	.94068	10	50	.4669	.5280	1.1308	2.142	1.894	.88431	10
20	.3420	.3640	1.0642	2.924	2.747	.93969	70	28	.4695	.5317	1.1326	2.130	1.881	.88295	62
10	.3448	3673	1.0653	2 900	2.723	.93869	50	10	.4720	.5354	1,1343	2.119	1.868	.88158	50
20	.3475	3706	1.0665	2.878	2.699	93769	40	20	.4746	.5392	1.1361	2.107	1.855	.88020	40
30	.3502	.3739	1.0676	2 856	2.675	93667	30	30	.4772	.5430	1.1379	2.096	1.842	.87882	30
40	.3529	.3772	1.0688	2.833	2.651	.93565	20	40	.4797	.5467	1.1397	2.085	1.829	.87743	20
50	.3557	.3805	1.0700	2.811	2.628	.93462	10	50	.4823	.5505	1.1415	2.073	1.816	.87603	10
21	.3584	.3839	1.0711	2.790	2.605	.93358	69	29	.4848	.5543	1 1434	2.063	1.804	.87462	61
10	.3611	.3872	1.0723	2.769	2.583	93253	50	10	.4874	.5581	1.1452	2.052	1.792	87321	50
20	.3638	.3906	1.0736	2.749	2.560	.93148	40	20	.4899	.5619	1.1471	2.041	1.780	.87178	40
30	.3665	.3939	1.0748	2.729	2.539	.93042	30	30	.4924	.5658	1.1490	2.031	1.767	.87036	30
40	.3692	.3973	1.0760	2.709	2.517	.92935	20	40	.4950	.5696	1.1509	2.020	1.756	.86892	20
50	.3719	.4006	1.0773	2.689	2.496	.92827	10	50	.4975	.5735	1 1528	2.010	1.744	.86748	10
22	.3746	.4040	1.0785	2.670	2.475	.92718	68	30	.5000	.5774	1 1547	2.000	1.732	.86603	60
10	.3773	.4074	1.0798	2.650	2.455	.92609	50	10	.5025	.5812	1.1566	1.990	1.720	.86457	50
20	.3800	.4108	1.0811	2.632	2.434	.92499	40	20	.5050	.5851	1.1586	1.980	1.709	.86310	40
30	.3827	.4142	1.0824	2.613	2.414	.92388	30	30	.5075	.5890	1.1606	1.970	1.698	.86163	30
40	.3854	.4176	1.0837	2.595	2.394	.92276	20	40	.5100	.5930	1.1626	1.961	1.686	.86015	20
50	.3881	.4210	1.0850	2.577	2.375	.92164	10	50	.5125	.5969	1.1646	1.951	1.675	.85866	10
23	.3907	.4245	1.0864	2.559	2.356	.92050	67	31	.5150	.6009	1.1666	1.924	1.664	.85717	59
10	.3934	.4279	1.0877	2.542	2.337	.91936	50	10	.5175	.6048	1.1687	1.932	1.653	.85567	50
20	.3961	.4314	1.0891	2.525	2.318	.91822	40	20	.5200	.6088	1.1707	1.923	1.643	.85416	40
30	.3987	.4348	1.0904	2.508	2.300	.91706	30	30	.5225	.6128	1.1728	1.914	1.632	.85264	30
40	.4014	.4383	1.0918	2.491	2.282	.91590	20	40	.5250	.6168	1.1749	1.905	1.621	.85112	20
50	.4041	.4417	1.0932	2.475	2.264	.91472	10	50	.5275	.6208	1.1770	1.896	1.611	.84959	10
							66								58
							° ′								° ′
	Cosin.	Cotg.	Cosec.	Sec.	Tan.	Sin.	Angle		Cosin.	Cotg.	Cosec.	Sec.	Tan.	Sin.	Angle

TABLE IV CONTD. NATURAL TRIGONOMETRICAL FUNCTIONS

Angle	Sin.	Tan.	Sec.	Cosec.	Cotg.	Cosin.		Angle	Sin.	Tan	Sec.	Cosec.	Cotg.	Cosin.	
° ′							° ′	° ′							° ′
32	.5299	.6249	1.1792	1.887	1.600	.84805	58	39	.6293	.8098	1.2868	1.589	1.235	.77715	51
10	.5324	.6289	1.1813	1.878	1.590	84650	50	10	.6316	.8146	1.2898	1.583	1.228	.77531	50
20	.5348	.6330	1.1835	1.870	1.580	84495	40	20	.6338	.8195	1.2929	1.578	1.220	.77347	40
30	.5373	.6371	1.1857	1.861	1.570	.84339	30	30	.6361	.8243	1.2959	1.572	1.213	.77162	30
40	.5398	.6412	1.1879	1.853	1.560	.84182	20	40	.6383	.8292	1.2991	1.567	1.206	.76977	20
50	.5422	.6453	1.1901	1.844	1.550	.84025	10	50	.6406	.8342	1.3022	1.561	1.199	.76791	10
33	.5446	.6494	1.1924	1.836	1.540	.83867	57	40	.6428	.8391	1.3054	1.556	1.192	.76604	50
10	.5471	.6536	1 1946	1.828	1.530	.83708	50	10	.6450	.8441	1.3086	1.550	1.185	.76417	50
20	.5495	.6577	1.1969	1.820	1.520	.83549	40	20	.6472	.8491	1.3118	1.545	1.178	.76229	40
30	.5519	.6619	1.1992	1.812	1.511	83389	30	30	.6494	.8541	1.3151	1.540	1.171	.76041	30
40	.5544	.6661	1.2015	1.804	1.501	.83228	20	40	.6517	.8591	1.3184	1.535	1.164	.75851	20
50	.5568	.6703	1 2039	1.796	1.492	.83066	10	50	.6539	.8642	1.3217	1.529	1.157	.75661	10
34	.5592	.6745	1.2062	1.788	1.483	.82904	56	41	.6561	.8693	1.3251	1.524	1.150	.75471	49
10	.5616	.6787	1.2086	1.781	1.473	.82741	50	10	.6583	.8744	1.3284	1.519	1.144	.75280	50
20	.5640	.6830	1.2110	1.773	1.464	.82577	40	20	.6604	.8796	1.3318	1.514	1.137	.75088	40
30	.5664	.6873	1 2134	1.766	1.455	.82413	30	30	.6626	.8847	1.3352	1.509	1.130	.74896	30
40	.5688	.6916	1.2158	1.758	1.446	.82248	20	40	.6648	8899	1.3386	1.504	1.124	.74703	20
50	.5712	.6959	1.2183	1.751	1.437	.82082	10	50	.6670	.8952	1.3421	1.499	1.117	.74509	10
35	.5736	.7002	1.2208	1.743	1.428	.81915	55	42	.6691	.9004	1.3456	1.494	1.111	.74314	48
10	.5760	.7046	1.2233	1.736	1.419	.81748	50	10	.6713	.9057	1.3492	1.490	1.104	.74120	50
20	.5783	.7089	1.2258	1.729	1.411	.81580	40	20	.6734	.9110	1.3527	1.485	1.098	.73924	40
30	.5807	.7133	1.2283	1.722	1.402	.81412	30	30	.6756	.9163	1.3563	1.480	1.091	.73728	30
40	.5831	.7177	1.2309	1.715	1.393	.81242	20	40	.6777	.9217	1.3600	1.476	1.085	.73531	20
50	.5854	.7221	1.2335	1.708	1.385	81072	10	50	.6799	.9271	1.3636	1.471	1.079	.73333	10
36	.5878	.7265	1.2361	1.701	1.376	.80902	54	43	.6820	.9325	1.3673	1.466	1.072	.73135	47
10	.5901	.7310	1.2387	1.695	1.368	.80730	50	10	.6841	.9380	1.3711	1.462	1.066	.72937	50
20	.5925	.7355	1.2413	1.688	1.360	.80558	40	20	.6862	.9435	1.3748	1.457	1.060	.72737	40
30	.5948	.7400	1 2440	1.681	1.351	80386	30	30	.6884	.9490	1.3786	1 453	1.054	.72537	30
40	.5972	.7445	1.2466	1.675	1.343	.80212	20	40	.6905	.9545	1.3824	1.448	1.048	.72337	20
50	.5995	.7490	1.2494	1.668	1.335	.80038	10	50	.6926	.9601	1.3863	1.444	1.042	.72136	10
37	.6018	.7536	1.2521	1.662	1.327	.79864	53	44	.6947	.9657	1.3902	1.440	1.036	.71934	46
10	.6041	.7581	1 2549	1.655	1.319	.79688	50	10	.6967	.9713	1 3941	1.435	1.030	.71732	50
20	.6065	.7627	1.2577	1.649	1.311	.79512	40	20	.6988	.9770	1.3980	1 431	1.024	.71529	40
30	.6088	.7673	1.2605	1.643	1.303	.79335	30	30	.7009	.9827	1.4020	1.427	1.018	.71325	30
40	.6111	.7720	1.2633	1.636	1.295	.79158	20	40	.7030	.9884	1.4061	1.422	1.012	.71121	20
50	.6134	.7766	1.2661	1.630	1.288	.78980	10	50	.7050	.9942	1.4101	1.418	1.006	.70916	10
38	.6157	.7813	1.2690	1.624	1.280	.78801	52		.7071	1.	1.414	1.414	1.	.70711	45
10	.6180	.7860	1.2719	1.618	1.272	.78622	50								
20	.6202	.7907	1.2748	1.612	1.265	.78442	40								
30	.6225	.7954	1.2778	1.606	1.257	.78261	30								
40	.6248	.8002	1.2808	1.601	1.250	.78079	20								
50	.6271	.8050	1.2838	1.595	1.242	.77897	10								
	Cosin.	Cotg.	Cosec.	Sec.	Tan.	Sin.	Angle		Cosin.	Cotg.	Cosec.	Sec.	Tan.	Sin.	Angle

CURVE TABLE

Table of Tangent and External to a 1° Curve



To find Tangent and External for curve of any other degree, divide by degree of curve and add correction found in column of corrections.

Degree of curve with a given I may be found by dividing tangent, (or external), opposite I by given tangent, (or external).

The distance from a point on the tangent to the curve is very nearly the square of the tangent length divided by twice the radius.

CURVE FORMULAS

Radius: $R = \frac{50}{\sin \frac{1}{2} D}$

Length of Curve: $L = 100 \frac{\Delta}{D}$

also $L = .0174533 \times \Delta \times R$

Degree of Curve: $D = 100 \frac{\Delta}{L}$

Tangent: $T = R \tan \frac{1}{2} \Delta$

Long Cord: $LC = 2R \sin \frac{1}{2} \Delta$

Middle Ordinate: $M = R\ (1 - \text{Cos}\ \frac{1}{2}\ \Delta)$

External: $E = T \tan \frac{1}{4} \Delta$

TABLE V. TANGENTS AND EXTERNALS TO A 1° CURVE

I	T	E	I=10°
1°	50.00	.218	+
10′	58.34	.297	5° C.
20′	66.67	.388	T
30′	75.01	.491	.03
40′	83.34	.606	E
50′	91.68	.733	
2°	100.01	.873	.001
10′	108.35	1.024	
20′	116.68	1.188	
30′	125.02	1.364	
40′	133.36	1.552	
50′	141.70	1.752	
3°	150.04	1.964	10° C.
10′	158.38	2.188	T
20′	166.72	2.425	.06
30′	175.06	2.674	E
40′	183.40	2.934	.003
50′	191.74	3.207	
4°	200.08	3.492	
10′	208.43	3.790	
20′	216.77	4.099	
30′	225.12	4.421	
40′	233.47	4.755	
50′	241.81	5.100	15° C.
5°	250.16	5.459	T
10′	258.51	5.829	.09
20′	266.86	6.211	E
30′	275.21	6.606	.004
40′	283.57	7.013	
50′	291.92	7.432	
6°	300.28	7.863	
10′	308.64	8.307	
20′	316.99	8.762	
30′	325.35	9.230	
40′	333.71	9.710	20° C.
50′	342.08	10.202	T
7°	350.44	10.707	.13
10′	358.81	11.224	E
20′	367.17	11.753	.006
30′	375.54	12.294	
40′	383.91	12.847	
50′	392.28	13.413	
8°	400.66	13.991	
10′	409.03	14.582	
20′	417.41	15.184	25° C.
30′	425.79	15.799	T
40′	434.17	16.426	.16
50′	442.55	17.065	E
9°	450.93	17.717	.007
10′	459.32	18.381	
20′	467.71	19.058	
30′	476.10	19.746	
40′	484.49	20.447	
50′	492.88	21.161	
10°	501.28	21.887	30° C.
10′	509.68	22.624	T
20′	518.08	23.375	.19
30′	526.48	24.138	E
40′	534.89	24.913	.008
50′	543.29	25.700	

I	T	E	I=20°
11°	551.70	26.500	+
10′	560.11	27.313	5° C.
20′	568.53	28.137	T
30′	576.95	28.974	.06
40′	585.36	29.824	E
50′	593.79	30.686	
12°	602.21	31.561	.006
10′	610.64	32.447	
20′	619.07	33.347	
30′	627.50	34.259	
40′	635.93	35.183	
50′	644.37	36.120	
13°	652.81	37.070	10° C.
10′	661.25	38.031	T
20′	669.70	39.006	.13
30′	678.15	39.993	E
40′	686.60	40.992	.011
50′	695.06	42.004	
14°	703.51	43.029	
10′	711.97	44.066	
20′	720.44	45.116	
30′	728.90	46.178	
40′	737.37	47.253	
50′	745.85	48.341	15° C.
15°	754.32	49.441	T
10′	762.80	50.554	.19
20′	771.29	51.679	E
30′	779.77	52.818	.017
40′	788.26	53.969	
50′	796.75	55.132	
16°	805.25	56.309	
10′	813.75	57.498	
20′	822.25	58.699	
30′	830.76	59.914	
40′	839.27	61.141	20° C.
50′	847.78	62.381	T
17°	856.30	63.634	.26
10′	864.82	64.900	E
20′	873.35	66.178	.022
30′	881.88	67.470	
40′	890.41	68.774	
50′	898.95	70.091	
18°	907.49	71.421	
10′	916.03	72.764	
20′	924.58	74.119	25° C.
30′	933.13	75.488	T
40′	941.69	76.869	.32
50′	950.25	78.264	E
19°	958.81	79.671	.028
10′	967.38	81.092	
20′	975.96	82.525	
30′	984.53	83.972	
40′	993.12	85.431	
50′	1001.7	86.904	
20°	1010.3	88.389	30° C.
10′	1018.9	89.888	T
20′	1027.5	91.399	.39
30′	1036.1	92.924	E
40′	1044.7	94.462	.034
50′	1053.3	96.013	

I	T	E	I=30°
21°	1061.9	97.577	+
10′	1070.6	99.155	5° C.
20′	1079.2	100.75	T
30′	1087.8	102.35	.10
40′	1096.4	103.97	E
50′	1105.1	105.60	
22°	1113.7	107.24	.013
10′	1122.4	108.90	
20′	1131.0	110.57	
30′	1139.7	112.25	
40′	1148.4	113.95	
50′	1157.0	115.66	
23°	1165.7	117.38	10° C.
10′	1174.4	119.12	T
20′	1183.1	120.87	.19
30′	1191.8	122.63	E
40′	1200.5	124.41	.025
50′	1209.2	126.20	
24°	1217.9	128.00	
10′	1226.6	129.82	
20′	1235.3	131.65	
30′	1244.0	133.50	
40′	1252.8	135.35	
50′	1261.5	137.23	15° C.
25°	1270.2	139.11	T
10′	1279.0	141.01	.29
20′	1287.7	142.93	E
30′	1296.5	144.85	.038
40′	1305.3	146.79	
50′	1314.0	148.75	
26°	1322.8	150.71	
10′	1331.6	152.69	
20′	1340.4	154.69	
30′	1349.2	156.70	
40′	1358.0	158.72	20° C.
50′	1366.8	160.76	T
27°	1375.6	162.81	.39
10′	1384.4	164.86	E
20′	1393.2	166.95	.051
30′	1402.0	169.04	
40′	1410.9	171.15	
50′	1419.7	173.27	
28°	1428.6	175.41	
10′	1437.4	177.55	
20′	1446.3	179.72	25° C.
30′	1455.1	181.89	T
40′	1464.0	184.08	.49
50′	1472.9	186.29	E
29°	1481.8	188.51	.065
10′	1490.7	190.74	
20′	1499.6	192.99	
30′	1508.5	195.25	
40′	1517.4	197.53	
50′	1526.3	199.82	
30°	1535.3	202.12	30° C.
10′	1544.2	204.44	T
20′	1553.1	206.77	.59
30′	1562.1	209.12	E
40′	1571.0	211.48	.078
50′	1580.0	213.86	

$T = R \tan \frac{1}{2}I$ $\quad E = R \operatorname{exsec} \frac{1}{2}I$

TABLE V CONTD. TANGENTS AND EXTERNALS TO A 1° CURVE

I	T	E	I=40°
31°	1589.0	216.3	+
10′	1598.0	218.7	5° C.
20′	1606.9	221.1	T
30′	1615.9	223.5	.13
40′	1624.9	226.0	E
50′	1633.9	228.4	
32°	1643.0	230.9	.023
10′	1652.0	233.4	
20′	1661.0	235.9	
30′	1670.0	238.4	
40′	1679.1	241.0	
50′	1688.1	243.5	
33°	1697.2	246.1	10° C.
10′	1706.3	248.7	T
20′	1715.3	251.3	.26
30′	1724.4	253.9	E
40′	1733.5	256.5	.046
50′	1742.6	259.1	
34°	1751 7	261.8	
10′	1760.8	264.5	
20′	1770.0	267.2	
30′	1779.1	269.9	
40′	1788.2	272.6	
50′	1797.4	275.3	15° C.
35°	1806.6	278.1	T
10′	1815.7	280.8	.40
20′	1824.9	283.6	E
30′	1834.1	286.4	.070
40′	1843.3	289 2	
50′	1852.5	292.0	
36°	1861.7	294.9	
10′	1870.9	297.7	
20′	1880.1	300.6	
30′	1889.4	303.5	
40′	1898.6	306.4	
50′	1907.9	309.3	20° C.
37°	1917.1	312.2	T
10′	1926.4	315.2	.53
20′	1935.7	318.1	E
30′	1945.0	321.1	.093
40′	1954.3	324.1	
50′	1963.6	327.1	
38°	1972.9	330.2	
10′	1982.2	333 2	
20′	1991.5	336.3	25° C.
30′	2000.9	339.3	T
40′	2010.2	342.4	.67
50′	2019.6	345.5	E
39°	2029.0	348.6	.117
10′	2038.4	351.8	
20′	2047.8	354.9	
30′	2057.2	358.1	
40′	2066.6	361.3	
50′	2076.0	364.5	
40°	2085.4	367.7	30° C.
10′	2094.9	371.0	T
20′	2104.3	374.2	.80
30′	2113.8	377.5	E
40′	2123.3	380.8	141
50′	2132.7	384.1	

I	T	E	I=50°
41°	2142.2	387.4	+
10′	2151.7	390.7	5° C.
20′	2161.2	394.1	T
30′	2170.8	397.4	.17
40′	2180.3	400,8	E
50′	2189.9	404.2	
42°	2199.4	407.6	.037
10′	2209.0	411.1	
20′	2218.6	414.5	
30′	2228.1	418.0	
40′	2237.7	421.4	
50′	2247.3	425.0	
43°	2257.0	428.5	10° C.
10′	2266.6	432.0	T
20′	2276 2	435.6	.34
30′	2285,9	439.2	E
40′	2295.6	442.8	.075
50′	2305 2	446.4	
44°	2314.9	450.0	
10′	2324.6	453.6	
20′	2334.3	457.3	
30′	2344.1	461.0	
40′	2353.8	464.6	
50′	2363.5	468.4	15° C.
45°	2373.3	472.1	T
10′	2383.1	475.8	.51
20′	2392.8	479.6	E
30′	2402.6	483.4	.116
40′	2412.4	487.2	
50′	2422.3	491.0	
46°	2432.1	494.8	
10′	2441.9	498.7	
20′	2451,8	502.5	
30′	2461.7	506.4	
40′	2471,5	510.3	20° C.
50′	2481,4	514.3	T
47°	2491 3	518.2	.68
10′	2501.2	522.2	E
20′	2511.2	526.1	.151
30′	2521.1	530.1	
40′	2531.1	534.2	
50′	2541.0	538.2	
48°	2551.0	542.2	
10′	2561.0	546.3	
20′	2571,0	550.4	25° C.
30′	2581.0	554.5	T
40′	2591.0	558.6	.85
50′	2601,1	562.8	E
49°	2611 2	566.9	.189
10′	2621.2	571.1	
20′	2631.3	575 3	
30′	2641.4	579 5	
40′	2651.5	583.8	
50′	2661.6	588 0	
50°	2671.8	592.3	30° C.
10′	2681.9	596 6	T
20′	2692.1	600.9	1.02
30′	2702.3	605.3	E
40′	2712.5	609 6	.227
50′	2722.7	614.0	

I	T	E	I=60°
51°	2732.9	618.4	+
10′	2743.1	622.8	5° C.
20′	2753.4	627.2	T
30′	2763.7	631.7	.21
40′	2773.9	636.2	E
50′	2784.2	640.7	
52°	2794.5	645.2	.056
10′	2804.9	649.7	
20′	2815.2	654.3	
30′	2825.6	658.8	
40′	2835.9	663.4	
50′	2846.3	668.0	
53°	2856.7	672.7	10° C.
10′	2867.1	677.3	T
20′	2877.5	682.0	.42
30′	2888.0	686.7	E
40′	2898.4	691.4	.112
50′	2908.9	696.1	
54°	2919.4	700.9	
10′	2929.9	705.7	
20′	2940.4	710.5	
30′	2951.0	715.3	
40′	2961.5	720.1	
50′	2972.1	725.0	15° C.
55°	2982.7	729.9	T
10′	2993.3	734.8	.63
20′	3003.9	739.7	E
30′	3014.5	744.6	.168
40′	3025.2	749.6	
50′	3035.8	754.6	
56°	3046.5	759.6	
10′	3057.2	764.6	
20′	3067.9	769.7	
30′	3078.7	774.7	20° C.
40′	3089.4	779.8	T
50′	3100.2	784.9	.84
57°	3110.9	790.1	E
10′	3121.7	795.2	.225
20′	3132.6	800.4	
30′	3143.4	805 6	
40′	3154.2	810.9	
50′	3165.1	816.1	
58°	3176.0	821.4	
10′	3186.9	826.7	
20′	3197.8	832.0	25° C.
30′	3208.8	837.3	T
40′	3219 7	842.7	1.05
50′	3230.7	848.1	E
59°	3241.7	853.5	.283
10′	3252.7	858.9	
20′	3263.7	864.3	
30′	3274.8	869.8	
40′	3285.8	875.3	
50′	3296.9	880.8	
60°	3308.0	886.4	30 C.
10′	3319.1	892.0	T
20′	3330.3	897.5	1,27
30′	3341.4	903.2	E
40′	3352.6	908.8	
50′	3363.8	914.5	.340

$T = R \tan \frac{1}{2}I$ $E = R \operatorname{exsec} \frac{1}{2}I$

TABLE V CONTD. TANGENTS AND EXTERNALS TO A 1° CURVE

I	T	E	I=70°
61°	3375.0	920.2	+
10′	3386.3	925.9	5° C.
20′	3397.5	931.6	T
30′	3408.8	937.3	.25
40′	3420.1	943.1	E
50′	3431.4	948.9	
62°	3442.7	954.8	.080
10′	3454.1	960.6	
20′	3465.4	966.5	
30′	3476.8	972.4	
40′	3488.3	978.3	
50′	3499.7	984.3	
63°	3511.1	990.2	10° C.
10′	3522.6	996.2	T
20′	3534.1	1002.3	.51
30′	3545.6	1008.3	E
40′	3557.2	1014.4	.159
50′	3568.7	1020.5	
64°	3580.3	1026.6	
10′	3591.9	1032.8	
20′	3603.5	1039.0	
30′	3615.1	1045.2	
40′	3626.8	1051.4	
50′	3638.5	1057.7	15° C.
65°	3650.2	1063.9	T
10′	3661.9	1070.2	.76
20′	3673.7	1076.6	E
30′	3685.4	1082.9	.240
40′	3697.2	1089.3	
50′	3709.0	1095.7	
66°	3720.9	1102.2	
10′	3732.7	1108.6	
20′	3744.6	1115.1	
30′	3756.5	1121.7	20° C.
40′	3768.5	1128.2	T
50′	3780.4	1134.8	1.02
67°	3792.4	1141.4	E
10′	3804.4	1148.0	.321
20′	3816.4	1154.7	
30′	3828.4	1161.3	
40′	3840.5	1168.1	
50′	3852.6	1174.8	
68°	3864.7	1181.6	
10′	3876.8	1188.4	
20′	3889.0	1195.2	25° C.
30′	3901.2	1202.0	T
40′	3913.4	1208.9	1.28
50′	3925.6	1215.8	E
69°	3937.9	1222.7	.403
10′	3950.2	1229.7	
20′	3962.5	1236.7	
30′	3974.8	1243.7	
40′	3987.2	1250.8	
50′	3999.5	1257.9	
70°	4011.9	1265.0	30° C.
10′	4024.4	1272.1	T
20′	4036.8	1279.3	1.54
30′	4049.3	1286.5	E
40′	4061.8	1293.6	.485
50′	4074.4	1300.9	

I	T	E	I=80°
71°	4086.9	1308.2	+
10′	4099.5	1315.6	5° C.
20′	4112.1	1322.9	T
30′	4124.8	1330.3	.30
40′	4137.4	1337.7	E
50′	4150.1	1345.1	
72°	4162.8	1352.6	.110
10′	4175.6	1360.1	
20′	4188.5	1367.6	
30′	4201.2	1375.2	
40′	4214.0	1382.8	
50′	4226.8	1390.4	
73°	4239.7	1398.0	10° C.
10′	4252.6	1405.7	T
20′	4265.6	1413.5	.61
30′	4278.5	1421.2	E
40′	4291.5	1429.0	.220
50′	4304.6	1436.8	
74°	4317.6	1444.6	
10′	4330.7	1452.5	
20′	4343.8	1460.4	
30′	4356.9	1468.4	
40′	4370.1	1476.4	
50′	4383.3	1484.4	15° C.
75°	4396.5	1492.4	T
10′	4409.8	1500.5	.91
20′	4423.1	1508.6	E
30′	4436.4	1516.7	.332
40′	4449.7	1524.9	
50′	4463.1	1533.1	
76°	4476.5	1541.4	
10′	4489.9	1549.7	
20′	4503.4	1558.0	
30′	4516.9	1566.3	20° C.
40′	4530.4	1574.7	T
50′	4544.0	1583.1	1.22
77°	4557.6	1591.6	E
10′	4571.2	1600.1	.445
20′	4584.8	1608.6	
30′	4598.5	1617.1	
40′	4612.2	1625.7	
50′	4626.0	1634.4	
78°	4639.8	1643.0	
10′	4653.6	1651.7	
20′	4667.4	1660.5	25° C.
30′	4681.3	1669.2	T
40′	4695.2	1678.1	1.53
50′	4709.2	1686.9	E
79°	4723.2	1695.8	.558
10′	4737.2	1704.7	
20′	4751.2	1713.7	
30′	4765 3	1722.7	
40′	4779.4	1731.7	
50′	4793.6	1740.8	
80°	4807.7	1749.9	30° C.
10′	4822.0	1759.0	T
20′	4836.2	1768.2	1.84
30′	4850.5	1777.4	E
40′	4864.8	1786.7	.671
50′	4879.2	1796.0	

I	T	E	I=90°
81°	4893.6	1805.3	+
10′	4908.0	1814.7	5° C.
20′	4922.5	1824.1	T
30′	4937.0	1833.6	.36
40′	4951.5	1843.1	E
50′	4966.1	1852.6	
82°	4980.7	1862.2	.149
10′	4995.4	1871.8	
20′	5010.0	1881.5	
30′	5024.8	1891.2	
40′	5039.5	1900.9	
50′	5054.3	1910.7	
83°	5069.2	1920.5	10° C.
10′	5084.0	1930.4	T
20′	5099.0	1940.3	.72
30′	5113.9	1950.3	E
40′	5128.9	1960.2	.299
50′	5143.9	1970.3	
84°	5159.0	1980.4	
10′	5174.1	1990.5	
20′	5189.3	2000.6	
30′	5204.4	2010.8	
40′	5219.7	2021.1	
50′	5234.9	2031.4	15° C.
85°	5250.3	2041.7	T
10′	5265.6	2052.1	1.09
20′	5281.0	2062.5	E
30′	5296.4	2073.0	.450
40′	5311.9	2083.5	
50′	5327.4	2094.1	
86°	5343.0	2104.7	
10′	5358.6	2115.3	
20′	5374.2	2126.0	
30′	5389.9	2136.7	20° C.
40′	5405.6	2147.5	T
50′	5421.4	2158.4	1.45
87°	5437.2	2169 2	E
10′	5453.1	2180.2	.603
20′	5469.0	2191.1	
30′	5484.9	2202.2	
40′	5500.9	2213.2	
50′	5517.0	2224.3	
88°	5533.1	2235.5	
10′	5549.2	2246.7	
20′	5565.4	2258.0	25° C.
30′	5581.6	2269.3	T
40′	5597.8	2280.6	1.83
50′	5614.2	2292.0	E
89°	5630.5	2303.5	.756
10′	5646.9	2315.0	
20′	5663.4	2326.6	
30′	5679.9	2338.2	
40′	5696.4	2349.8	
50′	5713.0	2361.5	
90°	5729.7	2373.3	30° C.
10′	5746.3	2385.1	T
20′	5763.1	2397.0	2.20
30′	5779.9	2408.9	E
40′	5796.7	2420.9	.910
50′	5813.6	2432.9	

$T = R \tan \frac{1}{2}I$ $E = R \operatorname{exsec} \frac{1}{2}I$

TABLE V CONTD. TANGENTS AND EXTERNALS TO A 1° CURVE

I	T	E	I=100°	I	T	E	I=110°	I	T	E	I=120°
91°	5830.5	2444.9	+	101°	6950.6	3278.1	+	111°	8336.7	4386.1	+
10′	5847.5	2457.1	5° C.	10′	6971.3	3294.1	5° C.	10′	8362.7	4407.6	5° C.
20′	5864.6	2469.3	T	20′	6992.0	3310.1	T	20′	8388.9	4429.2	T
30′	5881.7	2481.5	.43	30′	7012.7	3326.1	.51	30′	8415.1	4450.9	.62
40′	5898.8	2493.8	E	40′	7033.6	3342.3	E	40′	8441.5	4472.7	E
50′	5916.0	2506.1		50′	7054.5	3358.5		50′	8468.0	4494.6	
92°	5933.2	2518.5	.200	102°	7075.5	3374.9	.268	112°	8494.6	4516.6	.360
10′	5950.5	2531.0		10′	7096.6	3391.2		10′	8521.3	4538.8	
20′	5967.9	2543.5		20′	7117.8	3407.7		20′	8548.1	4561.1	
30′	5985.3	2556.0		30′	7139.0	3424.3		30′	8575.0	4583.4	
40′	6002.7	2568.6		40′	7160.3	3440.9		40′	8602.1	4606.0	
50′	6020.2	2581.3		50′	7181.7	3457.6		50′	8629.3	4628.6	
93°	6037.8	2594.0	10° C.	103°	7203.2	3474.4	10° C.	113°	8656.6	4651.3	10° C.
10′	6055.4	2606.8	T	10′	7224.7	3491.3	T	10′	8684.0	4674.2	T
20′	6073.1	2619.7	.86	20′	7246.3	3508.2	.103	20′	8711.5	4697.2	1.25
30′	6090.8	2632.6	E	30′	7268.0	3525.2	E	30′	8739.2	4720.3	E
40′	6108.6	2645.5	.401	40′	7289.8	3542.4	.536	40′	8767.0	4743.6	.721
50′	6126.4	2658.5		50′	7311.7	3559.6		50′	8794.9	4766.9	
94°	6144.3	2671.6		104°	7333.6	3576.8		114°	8822.9	4790.4	
10′	6162.2	2684.7		10′	7355.6	3594.2		10′	8851.0	4814.1	
20′	6180.2	2697.9		20′	7377.8	3611.7		20′	8879.3	4837.8	
30′	6198.3	2711.2		30′	7399.9	3629.2		30′	8907.7	4861.7	
40′	6216.4	2724.5		40′	7422.2	3646.8		40′	8936.3	4885.7	
50′	6234.6	2737.9	15° C.	50′	7444.6	3664.5	15° C.	50′	8965.0	4909.9	15° C.
95°	6252.8	2751.3	T	105°	7467.0	3682.3	T	115°	8993.8	4934.1	T
10′	6271.1	2764.8	1.30	10′	7489.6	3700.2	1.56	10′	9022.7	4958.6	1.93
20′	6289.4	2778.3	E	20′	7512.2	3718.2	E	20′	9051.7	4983.1	E
30′	6307.9	2792.0	.604	30′	7534.9	3736.2	.806	30′	9080.9	5007.8	1.09
40′	6326.3	2805.6		40′	7557.7	3754.4		40′	9110.3	5032.6	
50′	6344.8	2819.4		50′	7580.5	3772.6		50′	9139.8	5057.6	
96°	6363.4	2833.2		106°	7603.5	3791.0		116°	9169.4	5082.7	
10′	6382.1	2847.0		10′	7626.6	3809.4		10′	9199.1	5107.9	
20′	6400.8	2861.0		20′	7649.7	3827.9		20′	9229.0	5133.3	
30′	6419.5	2875.0		30′	7672.9	3846.5		30′	9259.0	5158.8	
40′	6438.4	2889.0	20° C.	40′	7696.3	3865.2	20° C.	40′	9289.2	5184.5	20° C.
50′	6457.3	2903.1	T	50′	7719.7	3884.0	T	50′	9319.5	5210.3	T
97°	6476.2	2917.3	1.74	107°	7743.2	3902.9	2.08	117°	9349.9	5236.2	2.52
10′	6495.2	2931.6	E	10′	7766.8	3921.9	E	10′	9380.5	5262.3	E
20′	6514.3	2945.9	.809	20′	7790.5	3940.9	1.08	20′	9411.3	5288.6	1.46
30′	6533.4	2960.3		30′	7814.3	3960.1		30′	9442.2	5315.0	
40′	6552.6	2974.7		40′	7838.1	3979.4		40′	9473.2	5341.5	
50′	6571.9	2989.2		50′	7862.1	3998.7		50′	9504.4	5368.2	
98°	6591.2	3003.8		108°	7886.2	4018.2		118°	9535.7	5395.1	
10′	6610.6	3018.4	25° C.	10′	7910.4	4037.8	25° C.	10′	9567.2	5422.1	25° C.
20′	6630.1	3033.1	T	20′	7934.6	4057.4	T	20′	9598.9	5449.2	T
30′	6649.6	3047.9	2.18	30′	7959.0	4077.2	2.61	30′	9630.7	5476.5	3.16
40′	6669.2	3062.8	E	40′	7983.5	4097.1	E	40′	9662.6	5504.0	E
50′	6688.8	3077.7		50′	8008.0	4117.0		50′	9694.7	5531.7	
99°	6708.6	3092.7	1.02	109°	8032.7	4137.1	1.36	119°	9727.0	5559.4	1.83
10′	6728.4	3107.7		10′	8057.4	4157.3		10′	9759.4	5587.4	
20′	6748.2	3122.9		20′	8082.3	4177.5		20′	9792.0	5615.5	
30′	6768.1	3138.1		30′	8107.3	4197.9		30′	9824.8	5643.8	
40′	6788.1	3153.3		40′	8132.3	4218.4		40′	9857.7	5672.3	
50′	6808.2	3168.7		50′	8157.5	4239.0		50′	9890.8	5700.9	
100°	6828.3	3184.1	30° C.	110°	8182.8	4259.7	30° C.	120°	9924.0	5729.7	30° C.
10′	6848.5	3199.6	T	10′	8208.2	4280.5	T	10′	9957.5	5758.6	T
20′	6868.8	3215.1	2.62	20′	8233.7	4301.4	3.14	20′	9991.0	5787.7	3.81
30′	6889.2	3230.8	E	30′	8259.3	4322.4	E	30′	10025.0	5817.0	E
40′	6909.6	3246.5		40′	8285.0	4343.6		40′	10059.0	5846.5	
50′	6930.1	3262.3	1.22	50′	8310.8	4364.8	1.63	50′	10093.0	5876.1	2.20

$T = R \tan \frac{1}{2} I$ $E = R \operatorname{exsec} \frac{1}{2} I$

USEFUL RELATIONS

Lineal feet	×.00019	=	miles
Lineal yards	×.0006	=	miles
Square inches	×.007	=	square feet
Square feet	×.111	=	square yards
Square yards	×.0002067	=	acres
Acres	×4840	=	square yards
Cubic inches	×.00058	=	cubic feet
Cubic feet	×.03704	=	cubic yards
Links	×.22	=	yards
Links	×.66	=	feet
Feet	×1.5	=	links

360° = 21600′ = 1296000″

Radius = arc of 57.2957790°

Arc of 1° (radius = 1) = .017453292

Arc of 1′ (radius = 1) = .000290888

Arc of 1″ (radius = 1) = .000004848

Curvature of Earth's surface = about 0.7 feet in 1 mile

Curvature in feet = 0.667 (Dist. in miles)^2

Difference between arc and chord length, 0.05 feet in 11½ miles

Probable error of a single observation = $0.6754\sqrt{\frac{\Sigma v^2}{n-1}}$

Error in chaining of 0.01 feet in 100 feet:

Due to—

1. Length of tape error of 0.01 feet
2. Alignment. One end 1.4 feet out of line
3. Sag of tape at center of 0.61 feet.
4. Temperature difference of 15°
5. Difference of pull of 15 lbs.

SQUARE MEASURE

144 sq. inches = 1 sq. ft.
9 sq. ft. = 1 sq. yard
30¼ sq. yds. = 1 sq. rd.
40 sq. rds. = 1 rood.
4 roods = 1 acre
640 acres = 1 sq. mile.

SURVEYORS' MEASURE

7.92 inches = 1 link.
25 links = 1 rod.
4 rds. = 1 chain.
10 sq. chains or 160 sq. rods = 1 acre.
640 acres = 1 sq. mile.
36 sq. miles (6 miles sq.) = 1 township.

TABLE VI. INCHES TO DECIMALS OF A FOOT

In.	0	1	2	3	4	5	6	7	8	9	10	11	In.
0	Foot	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167	0
1–32	.0026	.0859	.1693	.2526	.3359	.4193	.5026	.5859	.6693	.7526	.8359	.9193	1–32
1–16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219	1–16
3–32	.0078	.0911	.1745	.2578	.3411	.4245	.5078	.5911	.6745	.7578	.8411	.9245	3–32
1–8	.0104	.0938	.1771	.2604	.3438	.4271	.5104	.5938	.6771	.7604	.8438	.9271	1–8
5–32	.0130	.0964	.1797	.2630	.3464	.4297	.5130	.5964	.6797	.7630	.8464	.9297	5–32
3–16	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323	3–16
7–32	.0182	.1016	.1849	.2682	.3516	.4349	.5182	.6016	.6849	.7682	.8516	.9349	7–32
1–4	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.5875	.7708	.8542	.9375	1–4
9–32	.0234	.1068	.1901	.2734	.3568	.4401	.5234	.6068	.6901	.7734	.8568	.9401	9–32
5–16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427	5–16
11–32	.0286	.1120	.1953	.2786	.3620	.4453	.5286	.6120	.6953	.7786	.8620	.9453	11–32
3–8	.0313	.1146	.1979	.2813	.3646	.4479	.5313	.6146	.6979	.7813	.8646	.9479	3–8
13–32	.0339	.1172	.2005	.2839	.3672	.4505	.5339	.6172	.7005	.7839	.8672	.9505	13–32
7–16	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531	7–16
15–32	.0391	.1224	.2057	.2891	.3724	.4557	.5391	.6224	.7057	.7891	.8724	.9557	15–32
1–2	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583	1–2
17–32	.0443	.1276	.2109	.2943	.3776	.4609	.5443	.6276	.7109	.7943	.8776	.9609	17–32
9–16	.0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9635	9–16
19–32	.0495	.1328	.2161	.2995	.3828	.4661	.5495	.6328	.7161	.7995	.8828	.9661	19–32
5–8	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688	5–8
21–32	.0547	.1380	.2214	.3047	.3880	.4714	.5547	.6380	.7214	.8047	.8880	.9714	21–32
11–16	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740	11–16
23–32	.0599	.1432	.2266	.3099	.3932	.4766	.5599	.6432	.7266	.8099	.8932	.9766	23–32
3–4	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792	3–4
25–32	.0651	.1484	.2318	.3151	.3984	.4818	.5651	.6484	.7318	.8151	.8984	.9818	25–32
13–16	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844	13–16
27–32	.0703	.1536	.2370	.3203	.4036	.4870	.5703	.6536	.7370	.8203	.9036	.9870	27–32
7–8	.0729	.1563	.2396	.3229	.4063	.4896	.5729	.6563	.7396	.8229	.9063	.9896	7–8
29–32	.0755	.1589	.2422	.3255	.4089	.4922	.5755	.6589	.7422	.8255	.9089	.9922	29–32
15–16	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948	15–16
31–32	.0807	.1641	.2474	.3307	.4141	.4974	.5807	.6641	.7474	.8307	.9141	.9974	31–32
	0	1	2	3	4	5	6	7	8	9	10	11	

TABLE VII. MINUTES IN DECIMALS OF A DEGREE

0′ 30″	.00833	10′ 30″	.17500	20′ 30″	.34167	30′ 30″	.50833	40′ 30″	.67500	50′ 30″	.84167
1 00	.01667	11 00	.18333	21 00	.35000	31 00	.51667	41 00	.68333	51 00	.85000
30	.02500	30	.19167	30	.35833	30	.52500	30	.69167	30	.85833
2 00	.03333	12 00	.20000	22 00	.36667	32 00	.53333	42 00	.70000	52 00	.86667
30	.04167	30	.20833	30	.37500	30	.54167	30	.70833	30	.87500
3 00	.05000	13 00	.21667	23 00	.38333	33 00	.55000	43 00	.71667	53 00	.88333
30	.05833	30	.22500	30	.39167	30	.55833	30	.72500	30	.89167
4 00	.06667	14 00	.23333	24 00	.40000	34 00	.56667	44 00	.73333	54 00	.90000
30	.07500	30	.24167	30	.40833	30	.57500	30	.74167	30	.90833
5 00	.08333	15 00	.25000	25 00	.41667	35 00	.58333	45 00	.75000	55 00	.91667
30	.09167	30	.25833	30	.42500	30	.59167	30	.75833	30	.92500
6 00	.10000	16 00	.26667	26 00	.43333	36 00	.60000	46 00	.76667	56 00	.93333
30	.10833	30	.27500	30	.44167	30	.60833	30	.77500	30	.94167
7 00	.11667	17 00	.28333	27 00	.45000	37 00	.61667	47 00	.78333	57 00	.95000
30	.12500	30	.29167	30	.45833	30	.62500	30	.79167	30	.95833
8 00	.13333	18 00	.30000	28 00	.46667	38 00	.63333	48 00	.80000	58 00	.96667
30	.14167	30	.30833	30	.47500	30	.64167	30	.80833	30	.97500
9 00	.15000	19 00	.31667	29 00	.48333	39 00	.65000	49 00	.81667	59 00	.98333
30	.15833	30	.32500	30	.49167	30	.65833	30	.82500	30	.99167
10 00	.16667	20 00	.33333	30 00	.500000	40 00	.66667	50 00	.83333	60 00	1.00000

TABLE VIII. MIDDLE ORDINATES OF RAILS

Length of Rail (feet)

C ° ′	R Feet	30 Inch	28 Inch	26 Inch	24 Inch	22 Inch	20 Inch	C °	R Feet	30 Inch	28 Inch	26 Inch	24 Inch	22 Inch	20 Inch
0–20	17189	.08	.07	.06	.05	.04	.03	8	716.8	1.88	1.64	1.42	1.20	1.01	.84
0–40	8594	.16	.14	.12	.10	.08	.07	9	637.3	2.12	1.84	1.60	1.35	1.14	.94
1–0	5730	.24	.20	.18	.15	.13	.10	10	573.7	2.36	2.05	1.78	1.50	1.27	1.04
1–20	4297	.31	.27	.23	.20	.17	.13	11	521.7	2.59	2.26	1.95	1.65	1.39	1.15
1–40	3438	.39	.34	.29	.25	.21	.17	12	478.3	3.83	2.47	2.15	1.81	1.54	1.26
2–0	2865	.47	.41	.35	.30	.25	.20	13	441.7	3.05	2.66	2.30	1.96	1.66	1.36
2–20	2456	.55	.48	.41	.35	.29	.23	14	410.3	3.30	2.87	2.48	2.10	1.78	1.46
2–40	2149	.63	.55	.47	.40	.33	.27	15	383.1	3.54	3.08	2.68	2.26	1.91	1.57
3–0	1910	.71	.62	.53	.45	.38	.31	16	359.3	3.76	3.28	2.83	2.40	2.04	1.67
3–20	1719	.78	.68	.59	.50	.42	.35	17	338.3	4.00	3.48	3.02	2.57	2.16	1.78
3–40	1563	.86	.75	.65	.55	.46	.38	18	319.6	4.21	3.67	3.18	2.70	2.28	1.87
4–0	1433	.94	.82	.71	.60	.50	.42	19	302.9	4.45	3.89	3.36	2.86	2.41	1.98
4–20	1323	1.02	.89	.77	.65	.55	.45	20	287.9	4.70	4.09	3.55	3.00	2.54	2.09
4–40	1228	1.10	.96	.83	.70	.59	.48	22	262.0	5.16	4.44	3.84	3.30	2.80	2.29
5	1146	1.18	1.03	.89	.75	.63	.52	24	240.5	5.64	4.92	4.20	3.59	3.04	2.50
6	955.3	1.41	1.23	1.06	.90	.76	.62	26	222.3	6.07	5.29	4.58	3.88	3.29	2.70
7	819.0	1.65	1.44	1.24	1.05	.89	.73								

TABLE IX. SHORT RADIUS CURVES

Radius Feet	Chord Feet	Central Angle	Deflection Angle	Deflection for 1 Foot
35	10	16-26	8-13	49.3
45	10	12-46	6-23	38.3
50	15	17-16	8-38	34.5
60	15	14-22	7-11	28.8
75	15	11-30	5-45	23.0
100	20	11-30	5-45	17.3
120	20	9-34	4-47	14.3
150	20	7-39	3-49	11.5
190	25	7-32	3-46	9.15
200	25	7-10	3-35	8.6
225	25	6-25	3-12	7.7
240	25	5-58	2-59	7.2
250	25	5-44	2-52	6.9
275	25	5-12	2-36	6.2
288	50	9-58	4-59	6.0
300	50	9-32	4-46	5.7
350	50	8-12	4-06	4.9
376	50	7-40	3-50	4.6
400	50	7-10	3-35	4.3
410	50	7-00	3-30	4.2

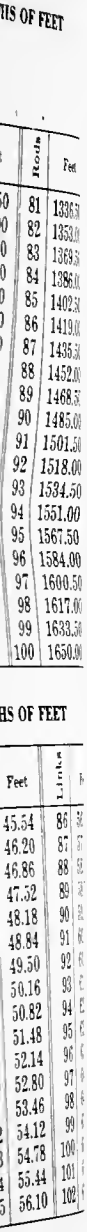
To find length of curve divide angle from P. C. to P. T. by central angle of chord, and multiply by length of chord.

TABLE X. RODS IN FEET, 10THS AND 100THS OF FEET

Rods	Feet	Rods	Feet	Rods	Feet	Rods	Feet	Rods	Feet
1	16.50	21	346.50	41	676.50	61	1006.50	81	1336.50
2	33.00	22	363.00	42	693.00	62	1023.00	82	1353.00
3	49.50	23	379.50	43	709.50	63	1039.50	83	1369.50
4	66.00	24	396.00	44	726.00	64	1056.00	84	1386.00
5	82.50	25	412.50	45	742.50	65	1072.50	85	1402.50
6	99.00	26	429.00	46	759.00	66	1089.00	86	1419.00
7	115.50	27	445.50	47	775.50	67	1105.50	87	1435.50
8	132.00	28	462.00	48	792.00	68	1122.00	88	1452.00
9	148.50	29	478.50	49	808.50	69	1138.50	89	1468.50
10	165.00	30	495.00	50	825.00	70	1155.00	90	1485.00
11	181.50	31	511.50	51	841.50	71	1171.50	91	1501.50
12	198.00	32	528.00	52	858.00	72	1188.00	92	1518.00
13	214.50	33	544.50	53	874.50	73	1204.50	93	1534.50
14	231.00	34	561.00	54	891.00	74	1221.00	94	1551.00
15	247.50	35	577.50	55	907.50	75	1237.50	95	1567.50
16	264.00	36	594.00	56	924.00	76	1254.00	96	1584.00
17	280.50	37	610.50	57	940.50	77	1270.50	97	1600.50
18	297.00	38	627.00	58	957.00	78	1287.00	98	1617.00
19	313.50	39	643.50	59	973.50	79	1303.50	99	1633.50
20	330.00	40	660.00	60	990.00	80	1320.00	100	1650.00

TABLE XI. LINKS IN FEET, 10THS AND 100THS OF FEET

Links	Feet	Links	Feet	Links	Feet	Links	Feet	Links	Feet	Links	Feet
1	0.66	18	11.88	35	23.10	52	34.32	69	45.54	86	56.76
2	1.32	19	12.54	36	23.76	53	34.98	70	46.20	87	57.42
3	1.98	20	13.20	37	24.42	54	35.64	71	46.86	88	58.08
4	2.64	21	13.86	38	25.08	55	36.30	72	47.52	89	58.74
5	3.30	22	14.52	39	25.74	56	36.96	73	48.18	90	59.40
6	3.96	23	15.18	40	26.40	57	37.62	74	48.84	91	60.06
7	4.62	24	15.84	41	27.06	58	38.28	75	49.50	92	60.72
8	5.28	25	16.50	42	27.72	59	38.94	76	50.16	93	61.38
9	5.94	26	17.16	43	28.38	60	39.60	77	50.82	94	62.04
10	6.60	27	17.82	44	29.04	61	40.26	78	51.48	95	62.70
11	7.26	28	18.48	45	29.70	62	40.92	79	52.14	96	63.36
12	7.92	29	19.14	46	30.36	63	41.58	80	52.80	97	64.02
13	8.58	30	19.80	47	31.02	64	42.24	81	53.46	98	64.68
14	9.24	31	20.46	48	31.68	65	42.90	82	54.12	99	65.34
15	9.90	32	21.12	49	32.34	66	43.56	83	54.78	100	66.00
16	10.56	33	21.78	50	33.00	67	44.22	84	55.44	101	66.66
17	11.22	34	22.44	51	33.66	68	44.88	85	56.10	102	67.32



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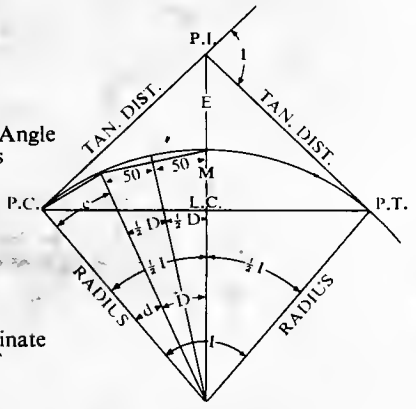
CURVE FORMULAE

D = Degree of Curve
1° = 1-Degree of Curve
2° = 2-Degree of Curve
P.C. = Point of Curve
P.T. = Point of Tangent
P.I. = Point of Intersection
I = Intersection of Angle, Angle between Two Tangents
L = Length of Curve, from P.C. to P.T.
T = Tangent Distance
E = External Distance
R = Radius
L.C. = Length of Chord
M = Length of Middle Ordinate
c = Length of Sub-Chord
d = Angle of Sub-Chord



$$R = \frac{L.C.}{2 \sin \frac{1}{2} I} \quad T = R \tan \tfrac{1}{2} I = \frac{L.C.}{2 \cos \frac{1}{2} I}$$

$$\frac{L.C.}{2} = R \sin \frac{I}{2}, \quad D\,1° = R = 5730, \quad D\,2° = \frac{5730}{2}, \quad D = \frac{5730}{R}$$

$$M = R (1 - \cos \tfrac{1}{2} I), = R - R \cos \frac{I}{2}$$

$$\frac{E + R}{R} = \sec \frac{I}{2}, \quad \frac{R - M}{R} = \cos \frac{I}{2}$$

$$c = 2 R \sin \tfrac{1}{2} d, \quad d = \frac{c}{2R}$$

$$L.C. = 2 R \sin \tfrac{1}{2} I, \quad E = R (\sec \tfrac{1}{2} I - 1), = R \sec \frac{I}{2} - R$$

Minutes in Decimals of a Degree

1′	·0167	11′	·1833	21′	·3500	31′	·5167	41′	·6833	51′	·8500
2	·0333	12	·2000	22	·3667	32	·5333	42	·7000	52	·8667
3	·0500	13	·2167	23	·3833	33	·5500	43	·7167	53	·8833
4	·0667	14	·2333	24	·4000	34	·5667	44	·7333	54	·9000
5	·0833	15	·2500	25	·4167	35	·5833	45	·7500	55	·9167
6	·1000	16	·2667	26	·4333	36	·6000	46	·7667	56	·9333
7	·1167	17	·2833	27	·4500	37	·6167	47	·7833	57	·9500
8	·1333	18	·3000	28	·4667	38	·6333	48	·8000	58	·9667
9	·1500	19	·3167	29	·4833	39	·6500	49	·8167	59	·9833
10	·1667	20	·3333	30	·5000	40	·6667	50	·8333	60	1·0000

Inches in Decimals of a Foot

1/16	3/32	1/8	5/16	1/4	5/16	3/8	1/2	5/8	3/4	7/8
·0052	·0078	·0104	·0156	·0208	·0260	·0313	·0417	·0521	·0625	·0729

1	2	3	4	5	6	7	8	9	10	11
·0833	·1667	·2500	·3333	·4167	·5000	·5833	·6667	·7500	·8333	·9167

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