~~N-1-7~~

Aransas COUNTY ROLLED SKETCH NO. 17

3-Field Books - Survey of Lagoon at Causeway Near Bayside

SURVEYED March 1953 J. S. Boyles

11N80W FILED 3-1-76

~~ROLL № 7~~

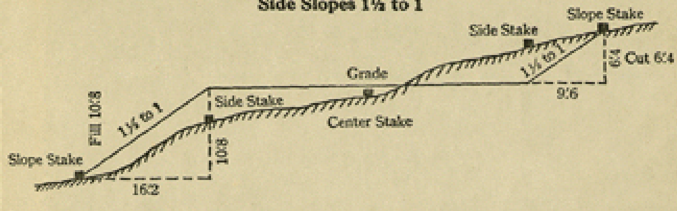
(FLAT FOLDER)

3 FIELD BOOKS (U-10) OF A SURVEY MADE BY J.S. BOYLES OF LAGOON AT CAUSEWAY NEAR BAYSIDE, INCLUDING LEVELS RUN FROM TIDAL BENCH MARK AT ROCKPORT, MARSH INCLOSED BY COPANO BAY & WM. STEELE SURVEY № 2, ARANSAS CO.

~~Pine Cabinet Miscellaneous~~

counter 42819

## DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING
**Roadway of any Width**
**Side Slopes 1½ to 1**




In the figure above: Opposite 6 under "Cut or Fill" and under .4 read 9.6 the distance from the side stake to the slope stake at right. Opposite 10 under "Cut or Fill" and under .8 read 16.2, the distance from the side stake to the slope stake at the left.

| Cut or Fill | 0 | .1 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | .9 | Cut or Fill |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Distance out from Side or Shoulder Stake | | | | | | | | | | |
| 0 | 0.0 | 0.2 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 0 |
| 1 | 1.5 | 1.7 | 1.8 | 2.0 | 2.1 | 2.3 | 2.4 | 2.6 | 2.7 | 2.9 | 1 |
| 2 | 3.0 | 3.2 | 3.3 | 3.5 | 3.6 | 3.8 | 3.9 | 4.1 | 4.2 | 4.4 | 2 |
| 3 | 4.5 | 4.7 | 4.8 | 5.0 | 5.1 | 5.3 | 5.4 | 5.6 | 5.7 | 5.9 | 3 |
| 4 | 6.0 | 6.2 | 6.3 | 6.5 | 6.6 | 6.8 | 6.9 | 7.1 | 7.2 | 7.4 | 4 |
| 5 | 7.5 | 7.7 | 7.8 | 8.0 | 8.1 | 8.3 | 8.4 | 8.6 | 8.7 | 8.9 | 5 |
| 6 | 9.0 | 9.2 | 9.3 | 9.5 | 9.6 | 9.8 | 9.9 | 10.1 | 10.2 | 10.4 | 6 |
| 7 | 10.5 | 10.7 | 10.8 | 11.0 | 11.1 | 11.3 | 11.4 | 11.6 | 11.7 | 11.9 | 7 |
| 8 | 12.0 | 12.2 | 12.3 | 12.5 | 12.6 | 12.8 | 12.9 | 13.1 | 13.2 | 13.4 | 8 |
| 9 | 13.5 | 13.7 | 13.8 | 14.0 | 14.1 | 14.3 | 14.4 | 14.6 | 14.7 | 14.9 | 9 |
| 10 | 15.0 | 15.2 | 15.3 | 15.5 | 15.6 | 15.8 | 15.9 | 16.1 | 16.2 | 16.4 | 10 |
| 11 | 16.5 | 16.7 | 16.8 | 17.0 | 17.1 | 17.3 | 17.4 | 17.6 | 17.7 | 17.9 | 11 |
| 12 | 18.0 | 18.2 | 18.3 | 18.5 | 18.6 | 18.8 | 18.9 | 19.1 | 19.2 | 19.4 | 12 |
| 13 | 19.5 | 19.7 | 19.8 | 20.0 | 20.1 | 20.3 | 20.4 | 20.6 | 20.7 | 20.9 | 13 |
| 14 | 21.0 | 21.2 | 21.3 | 21.5 | 21.6 | 21.8 | 21.9 | 22.1 | 22.2 | 22.4 | 14 |
| 15 | 22.5 | 22.7 | 22.8 | 23.0 | 23.1 | 23.3 | 23.4 | 23.6 | 23.7 | 23.9 | 15 |
| 16 | 24.0 | 24.2 | 24.3 | 24.5 | 24.6 | 24.8 | 24.9 | 25.1 | 25.2 | 25.4 | 16 |
| 17 | 25.5 | 25.7 | 25.8 | 26.0 | 26.1 | 26.3 | 26.4 | 26.6 | 26.7 | 26.9 | 17 |
| 18 | 27.0 | 27.2 | 27.3 | 27.5 | 27.6 | 27.8 | 27.9 | 28.1 | 28.2 | 28.4 | 18 |
| 19 | 28.5 | 28.7 | 28.8 | 29.0 | 29.1 | 29.3 | 29.4 | 29.6 | 29.7 | 29.9 | 19 |
| 20 | 30.0 | 30.2 | 30.3 | 30.5 | 30.6 | 30.8 | 30.9 | 31.1 | 31.2 | 31.4 | 20 |
| 21 | 31.5 | 31.7 | 31.8 | 32.0 | 32.1 | 32.3 | 32.4 | 32.6 | 32.7 | 32.9 | 21 |
| 22 | 33.0 | 33.2 | 33.3 | 33.5 | 33.6 | 33.8 | 33.9 | 34.1 | 34.2 | 34.4 | 22 |
| 23 | 34.5 | 34.7 | 34.8 | 35.0 | 35.1 | 35.3 | 35.4 | 35.6 | 35.7 | 35.9 | 23 |
| 24 | 36.0 | 36.2 | 36.3 | 36.5 | 36.6 | 36.8 | 36.9 | 37.1 | 37.2 | 37.4 | 24 |
| 25 | 37.5 | 37.7 | 37.8 | 38.0 | 38.1 | 38.3 | 38.4 | 38.6 | 38.7 | 38.9 | 25 |
| 26 | 39.0 | 39.2 | 39.3 | 39.5 | 39.6 | 39.8 | 39.9 | 40.1 | 40.2 | 40.4 | 26 |
| 27 | 40.5 | 40.7 | 40.8 | 41.0 | 41.1 | 41.3 | 41.4 | 41.6 | 41.7 | 41.9 | 27 |
| 28 | 42.0 | 42.2 | 42.3 | 42.5 | 42.6 | 42.8 | 42.9 | 43.1 | 43.2 | 43.4 | 28 |
| 29 | 43.5 | 43.7 | 43.8 | 44.0 | 44.1 | 44.3 | 44.4 | 44.6 | 44.7 | 44.9 | 29 |
| 30 | 45.0 | 45.2 | 45.3 | 45.5 | 45.6 | 45.8 | 45.9 | 46.1 | 46.2 | 46.4 | 30 |
| 31 | 46.5 | 46.7 | 46.8 | 47.0 | 47.1 | 47.3 | 47.4 | 47.6 | 47.7 | 47.9 | 31 |
| 32 | 48.0 | 48.2 | 48.3 | 48.5 | 48.6 | 48.8 | 48.9 | 49.1 | 49.2 | 49.4 | 32 |
| 33 | 49.5 | 49.7 | 49.8 | 50.0 | 50.1 | 50.3 | 50.4 | 50.6 | 50.7 | 50.9 | 33 |
| 34 | 51.0 | 51.2 | 51.3 | 51.5 | 51.6 | 51.8 | 51.9 | 52.1 | 52.2 | 52.4 | 34 |
| 35 | 52.5 | 52.7 | 52.8 | 53.0 | 53.1 | 53.3 | 53.4 | 53.6 | 53.7 | 53.9 | 35 |
| 36 | 54.0 | 54.2 | 54.3 | 54.5 | 54.6 | 54.8 | 54.9 | 55.1 | 55.2 | 55.4 | 36 |
| 37 | 55.5 | 55.7 | 55.8 | 56.0 | 56.1 | 56.3 | 56.4 | 56.6 | 56.7 | 56.9 | 37 |
| 38 | 57.0 | 57.2 | 57.3 | 57.5 | 57.6 | 57.8 | 57.9 | 58.1 | 58.2 | 58.4 | 38 |
| 39 | 58.5 | 58.7 | 58.8 | 59.0 | 59.1 | 59.3 | 59.4 | 59.6 | 59.7 | 59.9 | 39 |
| 40 | 60.0 | 60.2 | 60.3 | 60.5 | 60.6 | 60.8 | 60.9 | 61.1 | 61.2 | 61.4 | 40 |

EUGENE DIETZGEN CO.

ARANSAS Co. RLD. SK. #17

U-10

This Field Book is manufactured of a High Grade **50%** Rag Paper having a **WATER RESISTING SURFACE,** and is sewed with Bing Special Enamel Waterproof thread.

**Made in U. S. A.**

counter 42220

| | + | HI | - | Elev. |
|---|---|---|---|---|
| BM.5 C&G | | | | 5.69 |
| ⊼ | 3.671 | 9.361 | | |
| ⊙ | | | 5.068 | 4.293 |
| ⊼ | 4.852 | 9.145 | | |
| ⊙ | | | 14.605 | -5.460 = 0.0 on tidegauge staff. |
| ⊼ | 14.526 | 9.066 | | |
| ⊙ | | | 4.784 | 4.282 |
| ⊼ | 5.088 | 9.370 | | |
| ⊙ | | | 3.680 | 5.690 |
| ⊼ | 3.770 | 9.460 | | |
| ⊙ | | | 4.240 | 5.220 |
| ⊼ | 4.003 | 9.223 | | |
| ⊙ | | | 2.491 | 6.732 |
| ⊼ | 5.118 | 11.850 | | |
| ⊙ | | | 4.410 | 7.440 |
| ⊼ | 4.988 | 12.428 | | |
| ⊙ | | | 5.213 | 7.215 |
| ⊼ | 4.524 | 11.739 | | |
| ⊙ | | | 3.940 | 7.799 |
| ⊼ | 4.760 | 12.559 | | |
| ⊙ | | | 3.170 | 9.389 |
| ⊼ | 4.633 | 14.022 | | |
| ⊙ | | | 5.008 | 9.014 |
| ⊼ | 5.200 | 14.214 | | |



2/17/1953 Cold and Windy
H.C. Wellman ⊼, Haddick, Lyerly - Gates.
Rod men and stakeman -

Checking Elev. of tidegauge 0.0 on staff and U.S.C.&G. B.M. Nº X604 on Copano Bay -

Elev. of U.S.C.&G. B.M. #5, 1948 5.68 above M.L.W. or according to letter and enclosure from Robert W. Knox acting Director U.S.C&G. dated 1/19/1953 addressed to J.S. Boyles - the elev. of said B.M. Nº 5 - would be 5.465 above M.S.L.

5.915

counter 42221

| | + | H.I | - | Elev |
|---|---|---|---|---|
| Fwd. | | 14.214 | | ~~[illegible]~~ |
| ⊙ | | | 4.016 | 10.198 |
| ⊼ | 5.263 | 15.461 | | |
| ⊙ | | | 2.582 | 12.879 |
| ⊼ | 4.952 | 17.831 | | |
| ⊙ | | | 3.751 | 14.080 |
| ⊼ | 6.318 | 20.398 | | |
| ⊙ | | | 3.895 | 16.503 |
| ⊼ | 5.243 | 21.746 | | |
| ⊙ | | | 3.224 | 18.522 |
| ⊼ | 3.731 | 22.253 | | |
| ⊙ | | | 3.800 | 18.453 |
| ⊼ | 4.650 | 23.103 | | |
| ⊙ | | | 6.400 | 16.703 |
| ⊼ | 5.704 | 22.407 | | |
| ⊙ | | | 4.003 | 18.404 |
| ⊼ | 6.172 | 24.576 | | |
| ⊙ | | | 3.032 | 21.544 |
| ⊼ | 6.183 | 27.727 | | |
| ⊙ | | | 4.650 | 23.077 |
| ⊼ | 4.950 | 28.027 | | |
| ⊙ | | | 5.970 | 22.057 |
| ⊼ | 3.902 | 25.959 | | |
| ⊙ | | | 5.400 | 20.559 |
| ⊼ | 3.787 | 24.346 | | |

2/17/53 

Loop 1. North
Our BM. No 1, + on top brick headwall over pipe across road on S.S. Hyway 881 about 1 mile west of Highway No 35
2/18/1953 Same party
Cloudy - Cool.

3

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| | | 24.346 | | |
| ⊙ | | | 5.193 | 19.153 |
| ⊼ | 1.722 | 20.875 | | |
| ⊙ | | | 6.300 | 14.575 |
| ⊼ | 1.373 | 15.948 | | |
| B ⊙ M | | | 4.413 | 11.535 |
| ⊙ | | | 6.271 | 9.677 |
| ⊼ | 4.490 | 14.167 | | |
| ⊙ | | | 3.830 | 10.337 |
| ⊼ | 4.890 | 15.227 | | |
| ⊙ | | | 4.276 | 10.951 |
| ⊼ | 4.066 | 15.017 | | |
| ⊙ | | | 6.008 | 9.009 |
| ⊼ | 4.355 | 13.364 | | |
| ⊙ | | | 5.930 | 7.434 |
| ⊼ | 4.520 | 11.954 | | |
| ⊙ | | | 4.444 | 7.510 |
| ⊼ | 4.505 | 12.015 | | |
| ⊙ | | | 5.423 | 6.592 |
| ⊼ | 4.226 | 10.818 | | |
| O | | | 4.900 | 5.918 |
| ⊼ | 3.500 | 9.418 | | |
| B O M | | | 3.588 | 5.830 |
| ⊼ | 3.320 | 9.150 | | |
| ⊙ | | | 3.180 | 5.970 |

3

2/18/53

U.S.G&G.S. B.M. X601-1942 at bend in Hyway No 881 about 2.2 mi. E. of Hyway No 35

No 2

⊞ cut in Conc. head wall - 2' from S.W. Cor. same on West side Culvert across Hyway 881, about 3.3 mi. from its intersection with Hyway No 35

| | + | H.I | − | Elev. |
|---|---|---|---|---|
| Fwd. | | | | 5.970 |
| ⊼ | 4.990 | 10.960 | | |
| ⊙ | | | 3.040 | 7.920 |
| ⊼ | 4.130 | 12.050 | | |
| ⊙ | | | 3.470 | 8.580 |
| ⊼ | 3.845 | 12.425 | | |
| ⊙ | | | 2.890 | 9.535 |
| ⊼ | 2.433 | 11.968 | | |
| ⊙ | | | 5.390 | 6.578 |
| ⊼ | 3.800 | 10.378 | | |
| ⊙ | | | 6.363 | 4.015 |
| ⊼ | 4.124 | 8.139 | | |
| ⊙ | | | 2.870 | 5.269 |
| ⊼ | 6.220 | 11.489 | | |
| ⊙ | | | 3.423 | 8.066 |
| ⊼ | 4.874 | 12.940 | | |
| ⊙ | | | 3.080 | 9.860 |
| ⊼ | 3.520 | 13.380 | | |
| ⊙ | | | 4.424 | 8.956 |
| ⊼ | 4.430 | 13.386 | | |
| ⊙ | | | 4.250 | 9.136 |
| ⊼ | 4.030 | 13.160 | | |
| ⊙ | | | 4.330 | 8.836 |
| ⊼ | 3.927 | 12.763 | | |
| ⊙ | | | 3.770 | 8.993 |



2/19/53 Same party
Cloudy & Windy.

Quit account of hard rain

| | + | H.I | - | Elev. |
|---|---|---|---|---|
| Fwd | | | | 8.993 |
| ⊼ | 4.427 | 13.420 | | |
| ⊙ | | | 4.366 | 9.054 |
| ⊼ | 3.900 | 12.954 | | |
| ⊙ | | | 3.300 | 9.654 |
| ⊼ | 3.780 | 14.434 | | |
| ⊙ | | | 4.117 | 9.317 |
| ⊼ | 4.326 | 13.643 | | |
| B⊙M | | | 4.973 | 8.670 |
| ⊼ | 4.650 | 13.320 | | |
| ⊙ | | | 4.130 | 9.190 |
| ⊼ | 5.010 | 14.200 | | |
| ⊙ | | | 4.470 | 9.730 |
| ⊼ | 2.570 | 12.300 | | |
| ⊙ | | | 6.410 | 5.890 |
| ⊼ | 3.760 | 9.650 | | |
| B⊙M | | | 4.880 | 4.770 |
| Ⓐ | | | 4.580 | 5.070 |
| ⊼ | 4.540 | 9.610 | | |
| ⊙ | | | 3.770 | 5.840 |
| ⊼ | 4.490 | 10.330 | | |
| ⊙ | | | 2.990 | 7.340 |
| ⊼ | 5.150 | 12.490 | | |
| ⊙ | | | 3.350 | 9.140 |
| ⊼ | 3.760 | 12.900 | | |



2/19/53

No. 3 ⊞ Cut in stone headwall over Concrete pipe culvert across Hyway 881 about 5.8 miles from its intersection with Hyway No. 35. Head wall on N.E. side of road.

U.S. C&G.S. B.M. B603 Reset 1950

| | + | H.I | - | Elev. |
|---|---|---|---|---|
| Fwd | | 12.900 | | |
| ⊙ | | | 4.304 | 8.596 |
| ⊼ | 5.960 | 14.556 | | |
| ⊙ | | | 3.500 | 11.056 |
| ⊼ | 4.262 | 15.318 | | |
| ⊙ | | | 1.523 | 13.795 |
| ⊼ | 6.390 | 20.185 | | |
| ⊙ | | | 3.365 | 16.820 |
| ⊼ | 3.530 | 20.350 | | |
| ⊙ | | | 4.130 | 16.220 |
| ⊼ | 2.913 | 19.133 | | |
| ⊙ | | | 5.760 | 13.373 |
| ⊼ | 4.470 | 17.843 | | |
| ⊙ | | | 5.260 | 12.583 |
| ⊼ | 2.957 | 15.540 | | |
| ⊙ | | | 4.683 | 10.857 |
| ⊼ | 4.793 | 15.650 | | |
| ⊙ | | | 4.730 | 10.920 |
| ⊼ | 3.750 | 14.670 | | |
| B⊙M. | | | 5.513 | 9.157 |
| ⊼ | 4.070 | 13.227 | | |
| ⊙ | | | 4.530 | 8.697 |
| ⊼ | 4.470 | 13.167 | | |
| ⊙ | | | 4.553 | 8.614 |
| ⊼ | 4.300 | 12.914 | | |



2/20/1953 Same Crew
Cloudy & misting rain 7.40 A.M.
Norther blew in at 9.00 A.M.

No 4 = U.S.C&G.S. B.M. "D-603"-1942
about 8.2 miles from intersection of
Hyways No 881 & No 35 about 0.5 mi.
East of Central Light & Power Co. Sub-
Station. Mon. on South side of Hyway 881.

| | + | H.I | - | Elev |
|---|---|---|---|---|
| Fwd. | | 12.914 | | |
| ⊙ | | | 4.844 | 8.070 |
| ⊼ | 4.200 | 12.270 | | |
| ⊙ | | | 3.920 | 8.350 |
| ⊼ | 5.100 | 13.450 | | |
| ⊙ | | | 4.720 | 8.730 |
| ⊼ | 4.440 | 13.170 | | |
| ⊙ | | | 4.680 | 8.490 |
| ⊼ | 4.607 | 13.097 | | |
| ⊙ | | | 4.754 | 8.343 |
| ⊼ | 4.150 | 12.493 | | |
| B⊙M | | | 6.203 | 6.290 |
| ⊼ | 5.470 | 11.760 | | |
| ⊙ | | | 4.040 | 7.720 |
| ⊼ | 4.620 | 12.340 | | |
| ⊙ | | | 4.520 | 7.820 |
| ⊼ | 4.470 | 12.290 | | |
| ⊙ | | | 4.680 | 7.610 |
| ⊼ | 4.040 | 11.650 | | |
| ⊙ | | | 4.680 | 6.970 |
| ⊼ | 5.190 | 12.160 | | |
| ⊙ | | | 4.000 | 8.160 |
| ⊼ | 5.000 | 13.160 | | |
| B⊙M | | | 5.245 | 7.915 |
| ⊼ | 4.880 | 12.795 | | |



2/20/1953

Windy in P.M.

U.S.C.&G.S. B.M. "E-603" 1942

No. 5 - U.S.C.&G. B.M. 'F-603' reset in 1950.

| | + | H.I | − | Elev. |
|---|---|---|---|---|
| Fwd | | 12.795 | | |
| ⊙ | | | 4.760 | 8.035 |
| ⊼ | 4.510 | 12.545 | | |
| ⊙ | | | 4.655 | 7.890 |
| ⊼ | 5.000 | 12.890 | | |
| ⊙ | | | 4.680 | 8.210 |
| ⊼ | 4.345 | 12.555 | | |
| ⊙ | | | 4.330 | 8.225 |
| ⊼ | 4.755 | 12.980 | | |
| ⊙ | | | 3.820 | 9.160 |
| ⊼ | 4.940 | 14.100 | | |
| ⊙ | | | 3.870 | 10.230 |
| ⊼ | 4.150 | 14.380 | | |
| ⊙ | | | 4.085 | 10.295 |
| ⊼ | 5.075 | 15.370 | | |
| ⊙ | | | 5.210 | 10.160 |
| ⊼ | 5.180 | 15.340 | | |
| ⊙ | | | 4.675 | 10.665 |
| ⊼ | 4.820 | 15.485 | | |
| ⊙ | | | 4.900 | 10.585 |
| ⊼ | 4.550 | 15.135 | | |
| ⊙ | | | 5.335 | 9.800 |
| ⊼ | 5.200 | 15.000 | | |
| ⊙ | | | 5.080 | 9.920 |
| ⊼ | 3.895 | 13.815 | | |



2/21/1953 Same party

Cold- near freezing.

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| Fwd | | 13.815 | | |
| ⊙ | | | 5.500 | 8.315 |
| ⊼ | 4.060 | 12.375 | | |
| ⊙ | | | 4.430 | 7.945 |
| ⊼ | 4.610 | 12.555 | | |
| ⊙ | | | 4.665 | 7.890 |
| ⊼ | 4.920 | 12.810 | | |
| ⊙ | | | 4.425 | 8.385 |
| ⊼ | 5.725 | 14.110 | | |
| ⊙ | | | 3.755 | 10.355 |
| ⊼ | 6.040 | 16.395 | | |
| B⊙M | | | 4.940 | 11.455 |
| ⊼ | 5.010 | 16.465 | | |
| ⊙ | | | 4.170 | 12.235 |
| ⊼ | 4.800 | 17.095 | | |
| ⊙ | | | 4.290 | 12.805 |
| ⊼ | 4.895 | 17.700 | | |
| ⊙ | | | 5.195 | 12.505 |
| ⊼ | 4.770 | 17.275 | | |
| ⊙ | | | 4.420 | 12.855 |
| ⊼ | 4.700 | 17.555 | | |
| ⊙ | | | 4.880 | 12.675 |
| ⊼ | 4.980 | 17.655 | | |
| ⊙ | | | 5.095 | 12.560 |
| ⊼ | 5.095 | 17.565 | | |



2/22/1953 Same Crew

Cold near freezing.

N° 6. Spike in light pole on North side Hyway N° 881 about 2.3 miles eastly from intersection of Hyways 881 & 136

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| Fwd. | | 17.565 | | |
| ⊙ | | | 4.770 | 12.885 |
| ⊼ | 4.940 | 17.825 | | |
| ⊙ | | | 4.120 | 13.705 |
| ⊼ | 4.345 | 18.050 | | |
| ⊙ | | | 4.450 | 13.600 |
| ⊼ | 4.950 | 18.550 | | |
| ⊙ | | | 5.060 | 13.490 |
| ⊼ | 4.880 | 18.370 | | |
| ⊙ | | | 5.000 | 13.370 |
| ⊼ | 4.880 | 18.250 | | |
| ⊙ | | | 4.680 | 13.570 |
| ⊼ | 4.650 | 18.220 | | |
| ⊙ | | | 4.450 | 13.770 |
| ⊼ | 5.435 | 19.205 | | |
| ⊙ | | | 4.050 | 15.155 |
| ⊼ | 5.700 | 20.855 | | |
| ⊙ | | | 4.425 | 16.430 |
| ⊼ | 5.730 | 22.160 | | |
| B ⊙ M | | | 3.870 | 18.290 |
| ⊼ | 6.250 | 24.540 | | |
| ⊙ | | | 3.490 | 21.050 |
| ⊼ | 5.100 | 26.150 | | |
| ⊙ | | | 4.325 | 21.825 |
| ⊼ | 4.590 | 26.415 | | |

2/23/1953 Same party
Cold and rainy.



Nº7. Center of top of Concrete monument with bronze disc in side marked Texas S-1234. At Southeast Cor. of intersection of Hyways Nºs 136 & 881

| | + | H.I. | - | Elev |
|---|---|---|---|---|
| Fwd. | | 26.415 | | |
| ⊙ | | | 4.690 | 21.725 |
| ⊼ | 5.520 | 27.245 | | |
| ⊙ | | | 4.680 | 22.565 |
| ⊼ | 4.760 | 27.325 | | |
| ⊙ | | | 4.670 | 22.655 |
| ⊼ | 4.230 | 26.885 | | |
| ⊙ | | | 4.730 | 22.155 |
| ⊼ | 3.990 | 26.145 | | |
| ⊙ | | | 5.990 | 20.155 |
| ⊼ | 4.830 | 24.985 | | |
| ⊙ | | | 5.820 | 19.165 |
| ⊼ | 4.425 | 23.590 | | |
| ⊙ | | | 4.900 | 18.690 |
| ⊼ | 5.290 | 23.980 | | |
| ⊙ | | | 4.885 | 19.095 |
| ⊼ | 4.500 | 23.595 | | |
| ⊙ | | | 5.000 | 18.595 |
| ⊼ | 4.300 | 22.895 | | |
| ⊙ | | | 4.470 | 18.425 |
| ⊼ | 4.290 | 22.715 | | |
| ⊙ | | | 4.950 | 17.765 |
| ⊼ | 3.290 | 21.055 | | |
| ⊙ | | | 4.985 | 16.070 |
| ⊼ | 1.345 | 17.415 | | |



2/24/1953 Same party

Cold and misting rain.

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| Fwd | | 17.415 | | |
| ⊙ | | | 6.160 | 11.255 |
| ⊼ | 1.290 | 12.545 | | |
| ⊙ | | | 5.840 | 6.705 |
| ⊼ | 1.700 | 8.405 | | |
| ⊙ | | | 4.925 | 3.480 |
| ⊼ | 4.660 | 8.140 | | |
| ⊙ | | | 4.370 | 3.770 |
| ⊼ | 4.440 | 8.210 | | |
| ⊙ | | | 4.850 | 3.360 |
| ⊼ | 4.170 | 7.530 | | |
| B⊙M | | | 4.950 | 2.580 → |
| | | | 7.18 | 0.35 = Elev. |

top water Feb. 24, 1953 at 12.05 P.M.-

Return Loops. (No 8)

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| B.M. | | | | 2.580 |
| ⊼ | 5.060 | 7.64 | | |
| | | | 7.38 | 0.26 |
| ⊙ | | | 4.660 | 2.980 |
| ⊼ | 5.100 | 8.080 | | |
| ⊙ | | | 4.400 | 3.680 |
| ⊼ | 4.990 | 8.670 | | |
| ⊙ | | | 3.225 | 5.445 |
| ⊼ | 6.410 | 11.855 | | |



U.S. C&G.S. B.M. No "X-604" - 1942
The published elevation of same is
above sea level ~~low water~~ ~~2.779~~ 2.799 -

Top of water Copano Bay - 2/24/53 - 1:00 pm

| | + | H.I | − | Elev |
|---|---|---|---|---|
| Fwd | | 11.855 | | |
| ⊙ | | | 1.000 | 10.855 |
| ⊼ | 6.445 | 17.300 | | |
| ⊙ | | | 2.480 | 14.820 |
| ⊼ | 6.435 | 21.255 | | |
| ⊙ | | | 3.990 | 17.265 |
| ⊼ | 4.190 | 22.175 | | |
| ⊙ | | | 4.330 | 17.845 |
| ⊼ | 4.845 | 22.690 | | |
| ⊙ | | | 4.215 | 18.475 |
| ⊼ | 4.330 | 22.805 | | |
| ⊙ | | | 4.545 | 18.260 |
| ⊼ | 5.100 | 23.360 | | |
| ⊙ | | | 4.235 | 19.125 |
| ⊼ | 4.790 | 23.915 | | |
| ⊙ | | | 4.945 | 18.970 |
| ⊼ | 4.650 | 23.620 | | |
| ⊙ | | | 4.590 | 19.030 |
| ⊼ | 4.815 | 23.845 | | |
| ⊙ | | | 3.720 | 20.125 |
| ⊼ | 5.060 | 25.185 | | |
| ⊙ | | | 3.630 | 21.555 |
| ⊼ | 5.280 | 26.835 | | |
| ⊙ | | | 4.750 | 22.085 |
| ⊼ | 5.380 | 27.465 | | |

2/24/1953

| | + | H.I. | − | Elev |
|---|---|---|---|---|
| Fwd | | 27.465 | | |
| ⊙ | | | 4.990 | 22.475 |
| ⊼ | 4.820 | 27.295 | | |
| ⊙ | | | 4.930 | 22.365 |
| ⊼ | 4.030 | 26.395 | | |
| ⊙ | | | 4.480 | 21.915 |
| ⊼ | 4.610 | 26.525 | | |
| ⊙ | | | 5.110 | 21.415 |
| ⊼ | 3.170 | 24.585 | | |
| ⊙ | | | 6.290 | 18.295 |
| ⊼ | 3.650 | 21.945 | | |
| ⊙ | | | 5.480 | 16.465 |
| ⊼ | 4.430 | 20.895 | | |
| ⊙ | | | 5.690 | 15.205 |
| ⊼ | 4.210 | 19.415 | | |
| ⊙ | | | 5.620 | 13.795 |
| ⊼ | 4.600 | 18.395 | | |
| ⊙ | | | 4.895 | 13.500 |
| ⊼ | 4.830 | 18.330 | | |
| ⊙ | | | 4.890 | 13.440 |
| ⊼ | 5.000 | 18.440 | | |
| ⊙ | | | 4.900 | 13.540 |
| ⊼ | 5.220 | 18.760 | | |
| ⊙ | | | 5.170 | 13.590 |
| ⊼ | 4.690 | 18.280 | | |

2/24/53



= B.M. H 7 - 18.290 or Close 0.005 high

counter 42234

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| Fwd | | 18.280 | | |
| ⊙ | | | 4.480 | 13.800 |
| ⊼ | 4.170 | 17.970 | | |
| ⊙ | | | 5.120 | 12.850 |
| ⊼ | 4.980 | 17.830 | | |
| ⊙ | | | 4.920 | 12.910 |
| ⊼ | 4.720 | 17.630 | | |
| ⊙ | | | 4.920 | 12.710 |
| ⊼ | 4.870 | 17.580 | | |
| ⊙ | | | 4.670 | 12.910 |
| ⊼ | 4.600 | 17.510 | | |
| ⊙ | | | 4.930 | 12.580 |
| ⊼ | 5.350 | 17.930 | | |
| ⊙ | | | 5.120 | 12.810 |
| ⊼ | 4.720 | 17.530 | | |
| ⊙ | | | 5.220 | 12.310 |
| ⊼ | 4.570 | 16.880 | | |
| B.⊙M. | | | 5.400 | 11.480 |
| ⊼ | 4.880 | 16.360 | | |
| ⊙ | | | 6.055 | 10.305 |
| ⊼ | 3.710 | 14.015 | | |
| ⊙ | | | 5.940 | 8.075 |
| ⊼ | 4.520 | 12.595 | | |
| ⊙ | | | 4.910 | 7.685 |
| ⊼ | 4.865 | 12.550 | | |



= B.M. No. 6 pg. 9 = 11.455 or 0.025 high

| | + | H.I | - | Elev |
|---|---|---|---|---|
| Fwd. | | 12.550 | | |
| ⊙ | | | 4.800 | 7.750 |
| ⊼ | 4.800 | 12.550 | | |
| ⊙ | | [illegible] | 4.160 | 8.390 |
| ⊼ | 5.600 | 13.990 | | |
| ⊙ | | | 3.950 | 10.040 |
| ⊼ | 4.790 | 14.830 | | |
| ⊙ | | | 5.000 | 9.830 |
| ⊼ | 5.275 | 15.105 | | |
| ⊙ | | | 4.205 | 10.900 |
| ⊼ | 4.800 | 15.700 | | |
| ⊙ | | | 5.010 | 10.690 |
| ⊼ | 4.730 ~~4.370~~ | 15.420 ~~15.060~~ | | |
| ⊙ | | | 5.140 | 10.280 |
| ⊼ | 5.110 | 15.390 | | |
| ⊙ | | | 5.050 | 10.340 |
| ⊼ | 4.230 | 14.570 | | |
| ⊙ | | | 4.700 | 9.870 |
| ⊼ | 4.475 | 14.345 | | |
| ⊙ | | | 5.150 | 9.195 |
| ⊼ | 3.890 | 13.085 | | |
| ⊙ | | | 4.910 | 8.175 |
| ⊼ | 4.530 | 12.705 | | |
| ⊙ | | | 4.490 | 8.215 |
| ⊼ | 4.635 | 12.850 | | |

2/22/53



counter 42236

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| Fwd | | 12.850 | | |
| ⊙ | | | 4.700 | 8.150 |
| ⊼ | 4.750 | 12.900 | | |
| ⊙ | | | 4.930 | 7.970 |
| ⊼ | 5.000 | 12.970 | | |
| B⊙M. | | | 5.040 | 7.930 |
| ⊼ | 5.245 | 13.175 | | |
| ⊙ | | | 4.990 | 8.185 |
| ⊼ | 4.150 | 12.335 | | |
| ⊙ | | | 5.435 | 6.900 |
| ⊼ | 4.920 | 11.820 | | |
| ⊙ | | | 1.510 | 10.310 |
| ⊼ | 1.700 | 12.010 | | |
| ⊙ | | | 3.905 | 8.105 |
| ⊼ | 4.590 | 12.695 | | |
| ⊙ | | | 4.720 | 7.975 |
| ⊼ | 3.430 | 11.405 | | |
| ⊙ | | | 5.120 | 6.285 |
| ⊼ | 5.830 | 12.115 | | |
| ⊙ | | | 3.790 ~~3.290~~ | 8.325 |
| ⊼ | 4.410 | 12.735 | | |
| ⊙ | | | 4.190 | 8.545 ~~7.335~~ |
| ⊼ | 4.450 | 12.995 | | |
| ⊙ | | | 4.310 | 8.685 |
| ⊼ | 4.350 | 13.035 | | |



2/22/53

BM. No 5 pg. 7. = 7.915 or 0.015 high.

counter +2237

| | + | H.I. | − | Elev. | |
|---|---|---|---|---|---|
| Fwd. | | 13.035 | | | |
| ⊙ | | | 4.500 | 8.535 | |
| ⊼ | 3.490 | 12.025 | | | |
| ⊙ | | | 4.240 | 7.785 | |
| ⊼ | 4.290 | 12.075 | | | |
| ⊙ | | | 3.440 | 8.635 | |
| ⊼ | 4.240 | 12.875 | | | |
| ⊙ | | | 4.520 | 8.355 | |
| ⊼ | 4.830 | 13.185 | | | |
| B⊙M | | | 4.030 | 9.155 | = B.M. No. 4 pg. 6 - 9.157 = or. 0.002 Low |
| ⊙⊼ | 5.268 | 14.423 | | | |
| ⊼⊙ | | | 3.825 | 10.598 | |
| ⊙⊼ | 4.235 | 14.833 | | | |
| C⊼⊙ | | | 3.710 | 11.123 | |
| ⊼⊙ | 4.105 | 15.228 | | | |
| ⊙⊼ | | | 2.732 | 12.496 | |
| ⊙⊼ | 4.234 | 16.730 | | | |
| ⊙⊼ | | | 3.225 | 13.505 | |
| ⊙⊼ | 4.990 | 18.495 | | | |
| ⊙⊼ | | | 1.952 | 16.543 | |
| ⊙⊼ | 3.710 | 20.253 | | | |
| ⊙⊼ | | | 3.825 | 16.428 | |
| ⊙⊼ | 5.010 | 21.438 | | | |
| C⊼ | | | 4.780 | 16.658 | |
| ⊙ | 0.650 | 17.308 | | | |

18

counter 42238

| | + | H.I | - | Elev. |
|---|---|---|---|---|
| Fwd. | | 17.308 | | |
| ⊙ | | | 6.320 | 10.988 |
| ⊼ | 4.300 | 15.288 | | |
| ⊙ | | | 5.420 | 9.868. |
| ⊼ | 3.210 | 13.078. | | |
| ⊙ | | | 4.690 | 8.388. |
| ⊼ | 4.060 | 12.448 | | |
| ⊙ | | | 3.300 | 9.148 |
| ⊼ | 2.080 | 11.228 | | |
| ⊙ | | | 4.830 | 6.398 |
| ⊼ | 3.510 | 9.908 | | |
| ⊙ | | | 4.750 | 5.158 |
| ⊼ | 4.380 | 9.538 | | |
| ⊙ | | | 4.760 | 4.778 |
| ⊼ | 4.500 | 9.278 | | |
| ⊙ | | | 2.180 | 7.098 |
| ⊼ | 5.850 | 12.948 | | |
| ⊙ | | | 3.000 | 9.948 |
| ⊼ | 3.340 | 13.288 | | |
| ⊙ | | | 4.630 | 8.658 |
| ⊼ | 5.170 | 13.828 | | |
| ⊙ | | | 5.037 | 8.791 |
| | 5.150 | 13.941 | | |
| ⊼ | 5.150 | 13.941 | | |
| | | | 4.830 | 9.111 |
| ⊙ | | | 4.830 | 9.111 |
| ⊼ | 4.510 | 13.621 | | |



U.S.C.&G.S. BM. "B-603" reset 1950.

B.M. No 3 = 8.670 pg 5. = 0.012 Low.

| | + | H.I | − | Elev. |
|---|---|---|---|---|
| Fwd | | 13.621 | | |
| ⊙ | | | 4.343 | 9.278 |
| ⊼ | 4.420 | 13.698 | | |
| ⊙ | | | 5.200 | 8.498 |
| ⊼ | 5.070 | 13.568 | | |
| ⊙ | | | 4.820 | 8.748 |
| ⊼ | 4.775 | 13.523 | | |
| ⊙ | | | 4.195 | 9.328 |
| ⊼ | 4.260 | 13.588 | | |
| ⊙ | | | 4.400 | 9.188 |
| ⊼ | 4.585 | 13.773 | | |
| ⊙ | | | 4.270 | 9.503 |
| ⊼ | 4.700 | 14.203 | | |
| ⊙ | | | 6.090 | 8.113 |
| ⊼ | 4.210 | 12.323 | | |
| ⊙ | | | 5.980 | 6.343 |
| ⊼ | 3.380 | 9.723 | | |
| ⊙ | | | 5.493 | 4.230 |
| ⊼ | 5.010 | 9.240 | | |
| B⊙M | | | 4.560 | 4.68 |
| o⊼o | | | 3.920 | 5.320 |
| ⊼ | 6.355 | 11.675 | | |
| ⊙ | | | 2.740 | 8.935 |
| ⊼ | 4.424 | 13.359 | | |
| ⊙ | | | 4.810 | 8.549 |



l

U.S.C&G.S. B.M. Z-601* 1942 NE Cor. Head wall on culvert across Hyway No 881 abt. 4.2 miles NEly. of intersection of Hyways Nos 881 & 35

| | + | H.I | - | Elev |
|---|---|---|---|---|
| Fwd. | | | | 8.549 |
| ⊼ | 4.670 | 13.219 | | |
| ⊙ | | | 5.110 | 8.109 |
| ⊼ | 4.570 | 12.679 | | |
| ⊙ | | | 5.711 | 6.968 |
| ⊼ | 2.910 | 9.878 | | |
| ⊙ | | | 4.050 | 5.828 |
| ⊼ | 3.458 ~~3.220~~ | 9.286 ~~9.148~~ | | |
| ⊙ | | | 3.480 ~~3.180~~ | 5.806 ~~5.968~~ |
| ⊼ | 5.160 ~~4.990~~ | 10.966 ~~10.958~~ | | |
| ⊙ | | | 4.302 ~~3.040~~ | 6.664 ~~7.918~~ |
| ⊼ | 5.00 ~~4.130~~ | 11.664 ~~12.048~~ | | |
| ⊙ | | | 3.980 ~~3.470~~ | 7.684 ~~8.578~~ |
| ⊼ | 3.510 ~~3.845~~ | 11.194 ~~12.423~~ | | |
| ⊙ | | | 3.100 ~~2.890~~ | 8.094 ~~9.533~~ |
| ⊼ | 5.505 ~~2.433~~ | 13.599 ~~11.966~~ | | |
| ⊙ | | | 4.247 ~~5.390~~ | 9.352 ~~6.576~~ |
| ⊼ | 6.260 ~~3.800~~ | 15.612 ~~10.376~~ | | |
| ⊙ | | | 5.187 ~~6.363~~ | 10.425 ~~4.013~~ |
| ⊼ | 4.806 ~~4.124~~ | 15.231 ~~8.137~~ | | |
| ⊙ | | | 5.232 ~~2.870~~ | 9.999 ~~5.267~~ |
| ⊼ | 4.835 ~~6.220~~ | 14.834 ~~11.487~~ | | |
| ⊙ | | | 3.310 3.423 | 11.524 8.064 |
| ⊼ | 6.500 ~~[illegible]~~ | 18.024 ~~[illegible]~~ | | |
| ⊙ | | | 2.340 | 15.684 |

Copied wrong from field



= B.M. No 2 on pg. 3 = 5.830. = 0.002 low

U.S.C.&G.S. B.M "X-601" – 1942

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| Fwd | 6.100 | 21.784 | | ~~9.858~~ 15.684 |
| ⊼ | ~~3.520~~ | ~~13.378~~ | 3.083 | 18.701 |
| ⊙ | 5.780 | 24.481 | ~~4.424~~ | ~~8.954~~ |
| ⊼ | ~~4.430~~ | ~~13.384~~ | 4.080 | 20.401 |
| ⊙ | | | 4.250 | ~~9.134~~ |
| ⊼ | 4.244 | 24.645 | | |
| ⊙ | | | 3.340 | 21.305 |
| ⊼ | 5.373 | 26.678 | | |
| ⊙ | | | 2.930 | 23.748 |
| ⊼ | 4.550 | 28.298 | | |
| ⊙ | | | 5.000 | 23.298 |
| ⊼ | 4.065 | 27.363 | | |
| ⊙ | | | 5.900 | 21.463 |
| ⊼ | 2.520 | 23.983 | | |
| ⊙ | | | 5.370 | 18.613 |
| ⊼ | 3.880 | 22.493 | | |
| B⊙M. | | | 5.780 | 16.713 |
| ⊼ | 6.320 | 23.033 | | |
| ⊙ | | | 4.522 | 18.511 |
| ⊼ | 3.810 | 22.321 | | |
| ⊙ | | | 3.906 | 18.421 |
| ⊼ | 3.297 | 21.718 | | |
| ⊙ | | | 5.585 | 16.133 |
| ⊼ | 4280 | 20.413 | | |
| ⊙ | | | 5.880 | 14.533 |



BM.No1 pg = 16.703 on pg 2 = 0.010 high

counter 42242

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| Fwd. | | | | 14.533 |
| ⊼ | 3.214 | 17.747 | | |
| ⊙ | | | 5.220 | 12.527 |
| ⊼ | 2.922 | 15.449 | | |
| ⊙ | | | 5.180 | 10.269 |
| ⊼ | 3.830 | 14.099 | | |
| ⊙ | | | 4.740 | 9.359 |
| ⊼ | 4.550 | 13.909 | | |
| ⊙ | | | 4.626 | 9.283 |
| ⊼ | 3.320 | 12.603 | | |
| ⊙ | | | 5.073 | 7.530 |
| ⊼ | 4.520 | 12.050 | | |
| ⊙ | | | 4.646 | 7.404 |
| ⊼ | 4.520 | 11.924 | | |
| ⊙ | | | 5.093 | 6.831 |
| ⊼ | 3.150 | 9.981 | | |
| ⊙ | | | 5.111 | 4.870 |
| ⊼ | 4.865 | 9.735 | | |
| B⊙M | | | 4.055 | 5.680 |



= Beg. pg. 1 - U.S.C.&G.S. B.M. №5.
Elev. 5.69 or 0.010 Low in
40 mi. loop.

| Sta. | + | H.I. | − | Elev | |
|---|---|---|---|---|---|
| 0+0 | +2.72 | 5.30 | | 2.58 | |
| 0+19 | | | 1.87 | 3.43 | ℄ Paving |
| 0+37.5 | | | | | hub |
| 0+45.6 | | | 2.74 | 2.56 | E. Head wall |
| 0+47 | | | 7.10 | -1.80 | Flow line pipe |
| 2+00 | | | 4.60 | 0.70 | stk |
| 4+00 | | | 4.70 | 0.60 | " |
| 6+00 | | | 4.90 | 0.40 | " |
| 8+00 | | | 4.90 | 0.40 | " |
| TOP | | | 4.32 | 0.98 | Top stk 8+00 |
| ⊼ | 3.93 | 4.91 | | | |
| 10+00 | | | 4.50 | 0.41 | stk |
| 12+00 | | ~~4.1~~ | 4.60 | 0.31 | " |
| 14+00 | | | 4.50 | 0.41 | " |
| 16+00 | | | 4.50 | 0.41 | " |
| TOP | | | 3.84 | 1.07 | Top stk 16+00 |
| ⊼ | 3.83 | 4.90 | | | |
| 18+00 | | | 4.60 | 0.30 | stk. |
| 20+00 | | | 4.80 | 0.10 | |
| 22+00 | | | 4.60 | 0.30 | |
| 24+00 | | | 4.60 | 0.30 | |
| T.O.P. | | | 3.94 | 0.96 | Top stk 24+00 |
| ⊼ | 4.06 | 5.02 | | | |
| 26+00 | | | 4.6 | 0.42 | |



2/27/1953 Wicklund - Parks - Corpus
Cold and Cloudy - Var. 9°45' E. Dietzgen 7868
We set Var. on N30°E on ℄ Farm Road No 136 and on division line of A.B. Van Benthuysen and lower part Wm. Steele Surv. No 2-Abst. 191

0+00 = U.S.C.&G.S. B.M. No X-664-1942 on South end of culvert headwall on West side Hyway No. 136 on first Culvert South of Causeway over Copano Bay
Line brs. N82°46'E. from 0+00

B.M. published elevation ~~2.779~~ 2.799 above ~~low water~~ sea level - Short observation actul elev. as run from Rockport which is tied to Galveston net is 2.58 above mean low water.

4+00 on Line N82°46'E = hub "A"
12+42 x fence - wire insulated - no current on

counter 42244

| Sta. | + | H.I. | − | Elev. | |
|---|---|---|---|---|---|
| | | 5.02 | | | |
| 28+00 | | | 4.8 | 0.22 | Stk |
| 30+00 | | | 4.8 | 0.22 | " |
| 32+00 | | | 4.8 | 0.22 | " |
| T.O.P. | | | 4.16 | 0.86 | |
| ⊼ | 4.20 | 5.06 | | | |
| 34+00 | | | 4.8 | 0.26 | " |
| 36+00 | | | 4.9 | 0.16 | " |
| 38+00 | | | 4.7 | 0.36 | " |
| 39+86 | | | | | |
| 40+00 | | | 4.7 | 0.36 | " |
| T.O.P | | | 4.05 | 1.01 | |
| ⊼ | 4.36 | 5.37 | | | |
| 42+00 | | | 4.9 | 0.47 | " |
| 44+00 | | | 4.9 | 0.47 | " |
| 46+00 | | | 4.8 | 0.57 | " |
| 48+00 | | | 4.7 | 0.67 | " |
| T.O.P | | | 4.05 | 1.32 | |
| ⊼ | 5.02 | 6.34 | | | |
| 50+00 | | | 5.7 | 0.64 | |
| 52+00 | | | 5.3 | 1.04 | |
| 54+00 | | | 5.7 | 0.64 | |
| 54+58 | | | 5.5 | 0.84 | |
| 54+87 | | | 1.6 | 4.74 | Stk |
| 55+25 | | | 1.6 | 4.74 | |



Top Stk 32+00

X power line pole line & 1 wire insulated fence

Top Stk 4+00

Top Stk 48+00

Toe slope of road fill – 18' wide
on west shoulder of road fill
East " " "

counter 42245

| Sta. | + | H.I | − | Elev. |
|---|---|---|---|---|
| | | 6.34 | | |
| 55+56 | | | 4.9 | 1.44 |
| 55+80 | | | 5.6 | 0.74 |
| | | | 5.9 | 0.44 |
| Tem. B.M. | | | 2.98 | 3.36 |

Line running S 24° W from
Sta 4+00 on preceeding notes

| Sta. | + | H.I | − | Elev. |
|---|---|---|---|---|
| B.M | 2.61 | 5.19 | | 2.58 |
| 0+0 | | | | 0.60 |
| 2+00 | | | 4.6 | 0.59 |
| 2+60 | | | 3.8 | 1.39 |
| 2+90 | | | 6.2 | −1.01 |
| 3+23 | | | 3.9 | 1.29 |
| 4+00 | | | 4.5 | 0.69 |
| 6+00 | | | 4.8 | 0.39 |
| 8+00 | | | 4.5 | 0.69 |
| T.O.P. | | | 3.96 | 1.23 |
| T | 4.48 | 5.71 | | |
| 10+00 | | | 5.0 | 0.71 |

2-18-19-20-1953 Same party 

Toe slope east side levee
about line of vegitation

Top of water in Copano Bay $8^{25}$ A.M.
2/20/1953 Very Calm and Still- No waves
top of 2" I.P. in bank 150± Left from
Sta 54+00

Norther blew in at $8.^{30}$ A.M.
2/20/1953

U.S.C.&G.S. "X-604"-1942
= 4+00 line "A" S 82° 46' E.

N. Bank Channel- Top water $4\bar{3}^{0}$ = 0.49
S. " " "

counter +2246

| Sta | + | H.I | - | Elev | |
|---|---|---|---|---|---|
| | | 5.71 | | | |
| 11+06 | | | | | Telephone line NTS. |
| 12+00 | | | 4.7 | 1.01 | |
| 12+27 | | | 4.7 | 1.01 | H. bank Channel |
| 12+27 | | | 5.17 | 0.54 | water level (top) |
| 13+40 | | | 6.40 | -0.69 | ℄ Channel |
| 14+57 | | | 4.70 | 1.01 | H. bank Channel |
| 16+00 | | | 5.00 | 0.71 | Top of stk 16+00 |
| T.O.P. | | | 4.50 | 1.21 | |
| ⊼ | 4.08 | 5.29 | | | |
| 18+00 | | | 4.4 | 0.89 | |
| 20+00 | | | 4.6 | 0.69 | |
| 22+00 | | | 4.7 | 0.59 | |
| 24+00 | | | 4.8 | 0.49 | |
| T.O.P. | | | 4.28 | 1.01 | Top stk 24+00 |
| ⊼ | 4.13 | 5.14 | | | |
| 26+00 | | | 4.30 | 0.84 | |
| 28+00 | | | 4.60 | 0.54 | |
| 30+00 | | | 4.70 | 0.44 | |
| 32+00 | | | 4.70 | 0.44 | |
| T.O.P. | | | 4.18 | 0.96 | Top stk - 32+00 |
| ⊼ | 5.35 | 6.31 | | | |
| 34+00 | | | 5.7 | 0.61 | |
| 34+83 | | | 5.2 | 1.11 | line ~~station~~ toe of Slope. |

counter 42247

| Sta | + | H.I. | − | Elev |
|---|---|---|---|---|
| | | 6.31 | | |
| 36+00 | | | -4.20 | 2.11 |
| 37+00 | | | +1.00 | 7.31 |
| T.O.P. | | | -2.91 | 3.40 |
| ⊼ | 3.10 | 6.50 | | |
| Tem. B.M. | | | 3.18 | 3.32 |
| ⊼ | 4.42 | 7.74 | | |
| ⊙ | | | 4.22 | 3.52 |
| ⊼ | 4.35 | 7.87 | | |
| ⊙ | | | 4.01 | 3.86 |
| ⊼ | 3.64 | 7.50 | | |
| ⊙ | | | 3.69 | 3.81 |
| ⊼ | 4.86 | 8.67 | | |
| ⊙ | | | 6.09 | 2.58 |
| | | | 8.59 | 0.08 |
| | Line Running | | S82°46W from X 604 | |
| 0+0 | 3.01 | 5.59 | | 2+58 |
| 0+01 | | | 4.90 | 0.69 |
| 0+15 | | | 7.50 | -1.91 |
| 2+00 | | | 4.6 | 0.99 |
| 2+50 | | | 7.50 | -1.91 |
| 4+00 | | | 4.6 | 0.99 |
| 5+58 | | | 4.9 | 0.69 |
| 5+59³ | | | 5.0 | 0.59 |



Top of Con. R. of W. marker about 80'± N. of Toe of Slope and on East side Hy. 136

B.M. X 604

Top water Copano Bay 2/21/53.

BM

Top water 5.81* − 0.22

℄ channel of bayou

Top of water

counter 42248

| Sta | + | H.I | - | Elev | |
|---|---|---|---|---|---|
| 0+0 | 2.52 | 5.10 | | 2.58 | BM x604 |
| 2+00 | | | 4.7 | 0.40 | |
| 4+00 | | | 4.7 | 0.40 | |
| T.O.P. | | | 4.18 | 0.92 | |
| ⊼ | 4.03 | 4.95 | | | |
| 6+00 | | | 4.4 | 0.55 | |
| 8+00 | | | 4.5 | 0.45 | |
| 10+00 | | | 4.5 | 0.45 | |
| 12+00 | | | 4.6 | 0.35 | |
| T.O.P. | | | 4.11 | 0.84 | |
| ⊼ | 4.10 | 4.94 | | | |
| 14+00 | | | 4.6 | 0.34 | |
| 16+00 | | | 4.8 | 0.14 | |
| 16+66 | | | | | |
| 18+00 | | | 4.5 | 0.44 | |
| 20+00 | | | 4.4 | 0.54 | |
| T.O.P | | | 3.90 | 1.04 | |
| ⊼ | 9.42 | 10.46 | | | |
| 22+00 | | | 9.5 | 0.96 | |
| 22+20 | | | 8.2 | 2.26 | |
| 22+74$^{5}$ | | | 4.8 | 5.66 | |
| T.O.P. | | | 3.16 | 7.30 | |
| ⊼ | 1.29 | 8.59 | | | |
| 24+00 | | | 3.4 | 5.19 | |
| 26+00 | | | 6.6 | 1.99 | |



Line from Hub A = 4+00 ∡ 58°46' Lt
N 24°E . 0+0 = 4+00

Top Stk 4+00

Top Stk. 12+00

℄ powerline tang. to 39+86 on line N 82°46 E

Vegation line
bank

Temp. B.M. top of 5" x 5" pyramid mon

| Sta | + | H.I | − | Elev |
|---|---|---|---|---|
| | | 8.59 | | |
| 26+67 | | | 5.00 | 3.59 |
| 26+87 | | | 4.80 | 3.79 |
| 27+48 | | | 7.40 | 1.19 |
| 27+52 | | | 8.00 | 0.59 |
| T.O.P. | | | 3.58 | 5.01 |
| ⊼ | 4.90 | 9.91 | | |
| ⊙ | | | 5.81 | 4.10 |
| ⊼ | 4.67 | 8.77 | | |
| ⊙ | | | 3.49 | 5.28 |
| ⊼ | 5.89 | 11.17 | | |
| ⊙ | | | 6.04 | 5.13 |
| ⊼ | 5.98 | 11.11 | | |
| ⊙ | | | 6.28 | 4.83 |
| ⊼ | 6.21 | 11.04 | | |
| ⊙ | | | 6.80 | 4.24 |
| ⊼ | 3.80 | 8.04 | | |
| T.B.M | | | 4.69 | 3.35. |



℄ Road along bay Shore
Top bank point Egry Island.
line vegitation
Water edge - water high & Rough.

See pg. 26 - Should be 3.36 - 0.01 error.

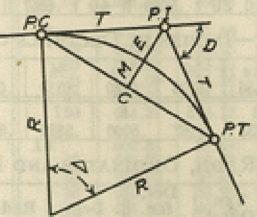
J. Baylis
Licensed Land Surveyor
3/16/1953

J. Baylis

counter 42250

# DIETZGEN'S RAILROAD CURVE AND REDUCTION TABLES






## CURVE FORMULAS

Radius$=R=\frac{50}{\sin. D/2}$(1) Degree of Curve$=D$ and $\sin. \frac{D}{2}=\frac{50}{R}$ (2)

Tangent$=T=R\tan\frac{\Delta}{2}$ (3) Length of Curve$=L=100\frac{\Delta}{D}$ (4)

Middle ordinate$=M=R(1-\cos. \frac{\Delta}{2})$ (5)$=R\text{vers}\frac{\Delta}{2}$ (6)

External$=E=T\tan\frac{\Delta}{4}$-(7)$=R\div\cos.\frac{\Delta}{2}-R$(8)$=R\text{exsec}\frac{\Delta}{2}$(9)

Long Chord$=C=2R\sin.\frac{\Delta}{2}$ (10) $\Delta$=Central Angle

## EXPLANATION AND USE OF TABLES

**Stations.**—Given P. I.=Sta. 161+60.35 to find Sta. of P. C. and P. T. $\Delta$=62° 10′ D=8° 20′. From Table IV for 1° curve T=3454.1 and ÷8⅓=414.49 ft. From Table V correction=.36 or T=414.85 ft. P. C.=Sta. P.I.—T=157 +45.50. Also from (4) L=746.00 and P. T.=Sta. P. C.+L=164+91.50.

**Offsets.**—Tangent offsets vary (approximately) directly with D and with square of the distance. Thus tangent offset for Sta. 158 on above curve is 2.16 ft. found as follows. From Table III tangent offset for 100 ft.=7.27 ft. Distance=158—Sta. P. C.=54.50, hence offset=7.27 $(54.50\div100)^2$=2.16 ft. Also square of any distance divided by twice the radius equals (approximately) the distance from tangent to curve. Thus $(54.50)^2\div(2 \times 688.26)$=2.16 ft.

**Deflections.**—Deflection angle=½ D for 100 ft., ¼ D for 50 ft., etc. For c ft.=(in minutes) .3 x C x D° or=defl. for 1 ft. from Table III x C. For Sta. 158 of above curve=.3 x 54.5 x 8⅓=136.2′ or 2° 16.2′, or=2.50 x 54.5=136.2′ from Table III. For Sta. 159 deflection angle=2° 16.2′ +8° 20′ ÷2=6° 26.2′, etc.

**Externals.**—May be found in similar manner to tangents. Thus E for curve above is 115.37. For from Table IV for 1° curve E=960.6 for 8° 20′=960.6÷8⅓=115.27 and from Table V correction=.10 or E=115.37 ft. Or suppose $\Delta$=32° and E is measured and found to be 42 ft. What is D? From Table IV E=230.9 and ÷42=5.5 or D=5° 30′.

## Table I.—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 |

## Table II.—Inches in Decimals of a Foot.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1/16 | 3/32 | 1/8 | 3/16 | 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 |

## Table III.—Radii, Ordinates and Deflections.

| Deg. | Radius | Mid. Ord. | Tan Offset | Def. for 1 Foot |
|---|---|---|---|---|
| 0° 10′ | 34377.5 | .036 | .145 | 0.05′ |
| 20 | 17188.8 | .073 | .291 | 0.10 |
| 30 | 11459.2 | .109 | .436 | 0.15 |
| 40 | 8594.42 | .145 | .582 | 0.20 |
| 50 | 6875.55 | .182 | .727 | 0.25 |
| 1 | 5729.65 | .218 | .873 | 0.30 |
| 10 | 4911.15 | .255 | 1.018 | 0.35 |
| 20 | 4297.28 | .291 | 1.164 | 0.40 |
| 30 | 3819.83 | .327 | 1.309 | 0.45 |
| 40 | 3437.87 | .364 | 1.454 | 0.50 |
| 50 | 3125.36 | .400 | 1.600 | 0.55 |
| 2 | 2864.93 | .436 | 1.745 | 0.60 |
| 10 | 2644.58 | .473 | 1.891 | 0.65 |
| 20 | 2455.70 | .509 | 2.036 | 0.70 |
| 30 | 2292.01 | .545 | 2.181 | 0.75 |
| 40 | 2148.79 | .582 | 2.327 | 0.80 |
| 50 | 2022.41 | .618 | 2.472 | 0.85 |
| 3 | 1910.08 | .655 | 2.618 | 0.90 |
| 10 | 1809.57 | .691 | 2.763 | 0.95 |
| 20 | 1719.12 | .727 | 2.908 | 1.00 |
| 30 | 1637.28 | .764 | 3.054 | 1.05 |
| 40 | 1562.88 | .800 | 3.199 | 1.10 |
| 50 | 1494.95 | .836 | 3.345 | 1.15 |
| 4 | 1432.69 | .873 | 3.490 | 1.20 |
| 10 | 1375.40 | .909 | 3.635 | 1.25 |
| 20 | 1322.53 | .945 | 3.718 | 1.30 |
| 30 | 1273.57 | .982 | 3.926 | 1.35 |
| 40 | 1228.11 | 1.018 | 4.071 | 1.40 |
| 50 | 1185.78 | 1.055 | 4.217 | 1.45 |
| 5 | 1146.28 | 1.091 | 4.362 | 1.50 |
| 10 | 1109.33 | 1.127 | 4.507 | 1.55 |
| 20 | 1074.68 | 1.164 | 4.653 | 1.60 |
| 30 | 1042.14 | 1.200 | 4.798 | 1.65 |
| 40 | 1011.51 | 1.237 | 4.943 | 1.70 |
| 50 | 982.64 | 1.273 | 5.088 | 1.75 |
| 6 | 955.37 | 1.309 | 5.234 | 1.80 |
| 10 | 929.57 | 1.346 | 5.379 | 1.85 |
| 20 | 905.13 | 1.382 | 5.524 | 1.90 |
| 30 | 881.95 | 1.418 | 5.669 | 1.95 |
| 40 | 859.92 | 1.455 | 5.814 | 2.00 |

| Deg. | Radius | Mid. Ord. | Tan Offset | Def. for 1 Foot |
|---|---|---|---|---|
| 7° | 819.02 | 1.528 | 6.105 | 2.10′ |
| 20 | 781.84 | 1.600 | 6.395 | 2.20 |
| 30 | 764.49 | 1.637 | 6.540 | 2.25 |
| 40 | 747.89 | 1.673 | 6.685 | 2.30 |
| 8 | 716.78 | 1.746 | 6.976 | 2.40 |
| 20 | 688.16 | 1.819 | 7.266 | 2.50 |
| 30 | 674.69 | 1.855 | 7.411 | 2.55 |
| 40 | 661.74 | 1.892 | 7.556 | 2.60 |
| 9 | 637.28 | 1.965 | 7.846 | 2.70 |
| 20 | 614.56 | 2.037 | 8.136 | 2.80 |
| 30 | 603.80 | 2.074 | 8.281 | 2.85 |
| 40 | 593.42 | 2.110 | 8.426 | 2.90 |
| 10 | 573.69 | 2.183 | 8.716 | 3.00 |
| 30 | 546.44 | 2.292 | 9.150 | 3.15 |
| 11 | 521.67 | 2.402 | 9.585 | 3.30 |
| 30 | 499.06 | 2.511 | 10.02 | 3.45 |
| 12 | 478.34 | 2.620 | 10.45 | 3.60 |
| 30 | 459.28 | 2.730 | 10.89 | 3.75 |
| 13 | 441.68 | 2.839 | 11.32 | 3.90 |
| 30 | 425.40 | 2.949 | 11.75 | 4.05 |
| 14 | 410.28 | 3.058 | 12.18 | 4.20 |
| 30 | 396.20 | 3.168 | 12.62 | 4.35 |
| 15 | 383.07 | 3.277 | 13.05 | 4.50 |
| 30 | 370.78 | 3.387 | 13.49 | 4.65 |
| 16 | 359.27 | 3.496 | 13.92 | 4.80 |
| 30 | 348.45 | 3.606 | 14.35 | 4.95 |
| 17 | 338.27 | 3.716 | 14.78 | 5.10 |
| 18 | 319.62 | 3.935 | 15.64 | 5.40 |
| 19 | 302.94 | 4.155 | 16.51 | 5.70 |
| 20 | 287.94 | 4.374 | 17.37 | 6.00 |
| 21 | 274.37 | 4.594 | 18.22 | 6.30 |
| 22 | 262.04 | 4.814 | 19.08 | 6.60 |
| 23 | 250.79 | 5.035 | 19.94 | 6.90 |
| 24 | 240.49 | 5.255 | 20.79 | 7.20 |
| 25 | 231.01 | 5.476 | 21.64 | 7.50 |
| 26 | 222.27 | 5.697 | 22.50 | 7.80 |
| 27 | 214.18 | 5.918 | 23.35 | 8.10 |
| 28 | 206.68 | 6.139 | 24.19 | 8.40 |
| 29 | 199.70 | 6.360 | 25.04 | 8.70 |
| 30 | 193.18 | 6.583 | 25.88 | 9.00 |

Note. Chord Deflection=2 times tangent deflection.



## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 1° | 50.00 | .22 | 11° | 551.70 | 26.50 | 21° | 1061.9 | 97.57 |
| 10′ | 58.34 | .30 | 10′ | 560.11 | 27.31 | 10′ | 1070.6 | 99.16 |
| 20 | 66.67 | .39 | 20 | 568.53 | 28.14 | 20 | 1079.2 | 100.75 |
| 30 | 75.01 | .49 | 30 | 576.95 | 28.97 | 30 | 1087.8 | 102.35 |
| 40 | 83.34 | .61 | 40 | 585.36 | 29.82 | 40 | 1096.4 | 103.97 |
| 50 | 91.68 | .73 | 50 | 593.79 | 30.68 | 50 | 1105.1 | 105.60 |
| 2 | 100.01 | .87 | 12 | 602.21 | 31.56 | 22 | 1113.7 | 107.24 |
| 10 | 108.35 | 1.02 | 10 | 610.64 | 32.45 | 10 | 1122.4 | 108.90 |
| 20 | 116.68 | 1.19 | 20 | 619.07 | 33.35 | 20 | 1131.0 | 110.57 |
| 30 | 125.02 | 1.36 | 30 | 627.50 | 34.26 | 30 | 1139.7 | 112.25 |
| 40 | 133.36 | 1.55 | 40 | 635.93 | 35.18 | 40 | 1148.4 | 113.95 |
| 50 | 141.70 | 1.75 | 50 | 644.37 | 36.12 | 50 | 1157.0 | 115.66 |
| 3 | 150.04 | 1.96 | 13 | 652.81 | 37.07 | 23 | 1165.7 | 117.38 |
| 10 | 158.38 | 2.19 | 10 | 661.25 | 38.03 | 10 | 1174.4 | 119.12 |
| 20 | 166.72 | 2.43 | 20 | 669.70 | 39.01 | 20 | 1183.1 | 120.87 |
| 30 | 175.06 | 2.67 | 30 | 678.15 | 39.99 | 30 | 1191.8 | 122.63 |
| 40 | 183.40 | 2.93 | 40 | 686.60 | 40.99 | 40 | 1200.5 | 124.41 |
| 50 | 191.74 | 3.21 | 50 | 695.06 | 42.00 | 50 | 1209.2 | 126.20 |
| 4 | 200.08 | 3.49 | 14 | 703.51 | 43.03 | 24 | 1217.9 | 128.00 |
| 10 | 208.43 | 3.79 | 10 | 711.97 | 44.07 | 10 | 1226.6 | 129.82 |
| 20 | 216.77 | 4.10 | 20 | 720.44 | 45.12 | 20 | 1235.3 | 131.65 |
| 30 | 225.12 | 4.42 | 30 | 728.90 | 46.18 | 30 | 1244.0 | 133.50 |
| 40 | 233.47 | 4.76 | 40 | 737.37 | 47.25 | 40 | 1252.8 | 135.35 |
| 50 | 241.81 | 5.10 | 50 | 745.85 | 48.34 | 50 | 1261.5 | 137.23 |
| 5 | 250.16 | 5.46 | 15 | 754.32 | 49.44 | 25 | 1270.2 | 139.11 |
| 10 | 258.51 | 5.83 | 10 | 762.80 | 50.55 | 10 | 1279.0 | 141.01 |
| 20 | 266.86 | 6.21 | 20 | 771.29 | 51.68 | 20 | 1287.7 | 142.93 |
| 30 | 275.21 | 6.61 | 30 | 779.77 | 52.89 | 30 | 1296.5 | 144.85 |
| 40 | 283.57 | 7.01 | 40 | 788.26 | 53.97 | 40 | 1305.3 | 146.79 |
| 50 | 291.92 | 7.43 | 50 | 796.75 | 55.13 | 50 | 1314.0 | 148.75 |
| 6 | 300.28 | 7.86 | 16 | 805.25 | 56.31 | 26 | 1322.8 | 150.71 |
| 10 | 308.64 | 8.31 | 10 | 813.75 | 57.50 | 10 | 1331.6 | 152.69 |
| 20 | 316.99 | 8.76 | 20 | 822.25 | 58.70 | 20 | 1340.4 | 154.69 |
| 30 | 325.35 | 9.23 | 30 | 830.76 | 59.91 | 30 | 1349.2 | 156.70 |
| 40 | 333.71 | 9.71 | 40 | 839.27 | 61.14 | 40 | 1358.0 | 158.72 |
| 50 | 342.08 | 10.20 | 50 | 847.78 | 62.38 | 50 | 1366.8 | 160.76 |
| 7 | 350.44 | 10.71 | 17 | 856.30 | 63.63 | 27 | 1375.6 | 162.81 |
| 10 | 358.81 | 11.22 | 10 | 864.82 | 64.90 | 10 | 1384.4 | 164.86 |
| 20 | 367.17 | 11.75 | 20 | 873.35 | 66.18 | 20 | 1393.2 | 166.95 |
| 30 | 375.54 | 12.29 | 30 | 881.88 | 67.47 | 30 | 1402.0 | 169.04 |
| 40 | 383.91 | 12.85 | 40 | 890.41 | 68.77 | 40 | 1410.9 | 171.15 |
| 50 | 392.28 | 13.41 | 50 | 898.95 | 70.09 | 50 | 1419.7 | 173.27 |
| 8 | 400.66 | 13.99 | 18 | 907.49 | 71.42 | 28 | 1428.6 | 175.41 |
| 10 | 409.03 | 14.58 | 10 | 916.03 | 72.76 | 10 | 1437.4 | 177.55 |
| 20 | 417.41 | 15.18 | 20 | 924.58 | 74.12 | 20 | 1446.3 | 179.72 |
| 30 | 425.79 | 15.80 | 30 | 933.13 | 75.49 | 30 | 1455.1 | 181.89 |
| 40 | 434.17 | 16.43 | 40 | 941.69 | 76.86 | 40 | 1464.0 | 184.08 |
| 50 | 442.55 | 17.07 | 50 | 950.25 | 78.26 | 50 | 1472.9 | 186.29 |
| 9 | 450.93 | 17.72 | 19 | 958.81 | 79.67 | 29 | 1481.8 | 188.51 |
| 10 | 459.32 | 18.38 | 10 | 967.38 | 81.09 | 10 | 1490.7 | 190.74 |
| 20 | 467.71 | 19.06 | 20 | 975.96 | 82.53 | 20 | 1499.6 | 192.99 |
| 30 | 476.10 | 19.75 | 30 | 984.53 | 83.97 | 30 | 1508.5 | 195.25 |
| 40 | 484.49 | 20.45 | 40 | 993.12 | 85.43 | 40 | 1517.4 | 197.53 |
| 50 | 492.88 | 21.16 | 50 | 1001.7 | 86.90 | 50 | 1526.3 | 199.82 |
| 10 | 501.28 | 21.89 | 20 | 1010.3 | 88.39 | 30 | 1535.3 | 202.12 |
| 10 | 509.68 | 22.62 | 10 | 1018.9 | 89.89 | 10 | 1544.2 | 204.44 |
| 20 | 518.08 | 23.38 | 20 | 1027.5 | 91.40 | 20 | 1553.1 | 206.77 |
| 30 | 526.48 | 24.14 | 30 | 1036.1 | 92.92 | 30 | 1562.1 | 209.12 |
| 40 | 534.89 | 24.91 | 40 | 1044.7 | 94.46 | 40 | 1571.0 | 211.48 |
| 50 | 543.29 | 25.70 | 50 | 1053.3 | 96.01 | 50 | 1580.0 | 213.86 |

counter 42252

## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 31° | 1589.0 | 216.3 | 41° | 2142.2 | 387.4 | 51° | 2732.9 | 618.4 |
| 10′ | 1598.0 | 218.7 | 10′ | 2151.7 | 390.7 | 10 | 2743.1 | 622.8 |
| 20 | 1606.9 | 221.1 | 20 | 2161.2 | 394.1 | 20 | 2753.4 | 627.2 |
| 30 | 1615.9 | 223.5 | 30 | 2170.8 | 397.4 | 30 | 2763.7 | 631.7 |
| 40 | 1624.9 | 226.0 | 40 | 2180.3 | 400.8 | 40 | 2773.9 | 636.2 |
| 50 | 1633.9 | 228.4 | 50 | 2189.9 | 404.2 | 50 | 2784.2 | 640.7 |
| 32 | 1643.0 | 230.9 | 42 | 2199.4 | 407.6 | 52 | 2794.5 | 645.2 |
| 10 | 1652.0 | 233.4 | 10 | 2209.0 | 411.1 | 10 | 2804.9 | 649.7 |
| 20 | 1661.0 | 235.9 | 20 | 2218.6 | 414.5 | 20 | 2815.2 | 654.3 |
| 30 | 1670.0 | 238.4 | 30 | 2228.1 | 418.0 | 30 | 2825.6 | 658.8 |
| 40 | 1679.1 | 241.0 | 40 | 2237.7 | 421.4 | 40 | 2835.9 | 663.4 |
| 50 | 1688.1 | 243.5 | 50 | 2247.3 | 425.0 | 50 | 2846.3 | 668.0 |
| 33 | 1697.2 | 246.1 | 43 | 2257.0 | 428.5 | 53 | 2856.7 | 672.7 |
| 10 | 1706.3 | 248.7 | 10 | 2266.6 | 432.0 | 10 | 2867.1 | 677.3 |
| 20 | 1715.3 | 251.3 | 20 | 2276.2 | 435.6 | 20 | 2877.5 | 682.0 |
| 30 | 1724.4 | 253.9 | 30 | 2285.9 | 439.2 | 30 | 2888.0 | 686.7 |
| 40 | 1733.5 | 256.5 | 40 | 2295.6 | 442.8 | 40 | 2898.4 | 691.4 |
| 50 | 1742.6 | 259.1 | 50 | 2305.2 | 446.4 | 50 | 2908.9 | 696.1 |
| 34 | 1751.7 | 261.8 | 44 | 2314.9 | 450.0 | 54 | 2919.4 | 700.9 |
| 10 | 1760.8 | 264.5 | 10 | 2324.6 | 453.6 | 10 | 2929.9 | 705.7 |
| 20 | 1770.0 | 267.2 | 20 | 2334.3 | 457.3 | 20 | 2940.4 | 710.5 |
| 30 | 1779.1 | 269.9 | 30 | 2344.1 | 461.0 | 30 | 2951.0 | 715.3 |
| 40 | 1788.2 | 272.6 | 40 | 2353.8 | 464.6 | 40 | 2961.5 | 720.1 |
| 50 | 1797.4 | 275.3 | 50 | 2363.5 | 468.4 | 50 | 2972.1 | 725.0 |
| 35 | 1806.6 | 278.1 | 45 | 2373.3 | 472.1 | 55 | 2982.7 | 729.9 |
| 10 | 1815.7 | 280.8 | 10 | 2383.1 | 475.8 | 10 | 2993.3 | 734.8 |
| 20 | 1824.9 | 283.6 | 20 | 2392.8 | 479.6 | 20 | 3003.9 | 739.7 |
| 30 | 1834.1 | 286.4 | 30 | 2402.6 | 483.8 | 30 | 3014.5 | 744.6 |
| 40 | 1843.3 | 289.2 | 40 | 2412.4 | 487.2 | 40 | 3025.2 | 749.6 |
| 50 | 1852.5 | 292.0 | 50 | 2422.3 | 491.0 | 50 | 3035.8 | 754.6 |
| 36 | 1861.7 | 294.9 | 46 | 2432.1 | 494.8 | 56 | 3046.5 | 759.6 |
| 10 | 1870.9 | 297.7 | 10 | 2441.9 | 498.7 | 10 | 3057.2 | 764.6 |
| 20 | 1880.1 | 300.6 | 20 | 2451.8 | 502.5 | 20 | 3067.9 | 769.7 |
| 30 | 1889.4 | 303.5 | 30 | 2461.7 | 506.4 | 30 | 3078.7 | 774.7 |
| 40 | 1898.6 | 306.4 | 40 | 2471.5 | 510.3 | 40 | 3089.4 | 779.8 |
| 50 | 1907.9 | 309.3 | 50 | 2481.4 | 514.3 | 50 | 3100.2 | 784.9 |
| 37 | 1917.1 | 312.2 | 47 | 2491.3 | 518.2 | 57 | 3110.9 | 790.1 |
| 10 | 1926.4 | 315.2 | 10 | 2501.2 | 522.2 | 10 | 3121.7 | 795.2 |
| 20 | 1935.7 | 318.1 | 20 | 2511.2 | 526.1 | 20 | 3132.6 | 800.4 |
| 30 | 1945.0 | 321.1 | 30 | 2521.1 | 530.1 | 30 | 3143.4 | 805.6 |
| 40 | 1954.3 | 324.1 | 40 | 2531.1 | 534.2 | 40 | 3154.2 | 810.9 |
| 50 | 1963.6 | 327.1 | 50 | 2541.0 | 538.2 | 50 | 3165.1 | 816.1 |
| 38 | 1972.9 | 330.2 | 48 | 2551.0 | 542.2 | 58 | 3176.0 | 821.4 |
| 10 | 1982.2 | 333.2 | 10 | 2561.0 | 546.3 | 10 | 3186.9 | 826.7 |
| 20 | 1991.5 | 336.3 | 20 | 2571.0 | 550.4 | 20 | 3197.8 | 832.0 |
| 30 | 2000.9 | 339.3 | 30 | 2581.0 | 554.5 | 30 | 3208.8 | 837.3 |
| 40 | 2010.2 | 342.4 | 40 | 2591.0 | 558.6 | 40 | 3219.7 | 842.7 |
| 50 | 2019.6 | 345.5 | 50 | 2601.1 | 562.8 | 50 | 3230.7 | 848.1 |
| 39 | 2029.0 | 348.6 | 49 | 2611.2 | 566.9 | 59 | 3241.7 | 853.5 |
| 10 | 2038.4 | 351.8 | 10 | 2621.2 | 571.1 | 10 | 3252.7 | 858.9 |
| 20 | 2047.8 | 354.9 | 20 | 2631.3 | 575.3 | 20 | 3263.7 | 864.3 |
| 30 | 2057.2 | 358.1 | 30 | 2641.4 | 579.5 | 30 | 3274.8 | 869.8 |
| 40 | 2066.6 | 361.3 | 40 | 2651.5 | 583.8 | 40 | 3285.8 | 875.3 |
| 50 | 2076.0 | 364.5 | 50 | 2661.6 | 588.0 | 50 | 3296.9 | 880.8 |
| 40 | 2085.4 | 367.7 | 50 | 2671.8 | 592.3 | 60 | 3308.0 | 886.4 |
| 10 | 2094.9 | 371.0 | 10 | 2681.9 | 596.6 | 10 | 3319.1 | 892.0 |
| 20 | 2104.3 | 374.2 | 20 | 2692.1 | 600.9 | 20 | 3330.3 | 897.5 |
| 30 | 2113.8 | 377.5 | 30 | 2702.3 | 605.3 | 30 | 3341.4 | 903.2 |
| 40 | 2123.3 | 380.8 | 40 | 2712.5 | 609.6 | 40 | 3352.6 | 908.8 |
| 50 | 2132.7 | 384.1 | 50 | 2722.7 | 614.0 | 50 | 3363.8 | 914.5 |



## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 61° | 3375.0 | 920.2 | 71° | 4086.9 | 1308.2 | 81° | 4893.6 | 1805.3 |
| 10′ | 3386.3 | 925.9 | 10′ | 4099.5 | 1315.6 | 10′ | 4908.0 | 1814.7 |
| 20 | 3397.5 | 931.6 | 20 | 4112.1 | 1322.5 | 20 | 4922.5 | 1824.1 |
| 30 | 3408.8 | 937.3 | 30 | 4124.8 | 1330.3 | 30 | 4937.0 | 1833.6 |
| 40 | 3420.1 | 943.1 | 40 | 4137.4 | 1337.7 | 40 | 4951.5 | 1843.1 |
| 50 | 3431.4 | 948.9 | 50 | 4150.1 | 1345.1 | 50 | 4966.1 | 1852.6 |
| 62 | 3442.7 | 954.8 | 72 | 4162.8 | 1352.6 | 82 | 4980.7 | 1862.2 |
| 10 | 3454.1 | 960.6 | 10 | 4175.6 | 1360.1 | 10 | 4995.4 | 1871.8 |
| 20 | 3465.4 | 966.5 | 20 | 4188.5 | 1367.6 | 20 | 5010.0 | 1881.5 |
| 30 | 3476.8 | 972.4 | 30 | 4201.2 | 1375.2 | 30 | 5024.8 | 1891.2 |
| 40 | 3488.3 | 978.3 | 40 | 4214.0 | 1382.8 | 40 | 5039.5 | 1900.9 |
| 50 | 3499.7 | 984.3 | 50 | 4226.8 | 1390.4 | 50 | 5054.3 | 1910.7 |
| 63 | 3511.1 | 990.2 | 73 | 4239.7 | 1398.0 | 83 | 5069.2 | 1920.5 |
| 10 | 3522.6 | 996.2 | 10 | 4252.6 | 1405.7 | 10 | 5084.0 | 1930.4 |
| 20 | 3534.1 | 1002.3 | 20 | 4265.6 | 1413.5 | 20 | 5099.0 | 1940.3 |
| 30 | 3545.6 | 1008.3 | 30 | 4278.5 | 1421.2 | 30 | 5113.9 | 1950.3 |
| 40 | 3557.2 | 1014.4 | 40 | 4291.5 | 1429.0 | 40 | 5128.9 | 1960.2 |
| 50 | 3568.7 | 1020.5 | 50 | 4304.6 | 1436.8 | 50 | 5143.9 | 1970.3 |
| 64 | 3580.3 | 1026.6 | 74 | 4317.6 | 1444.6 | 84 | 5159.0 | 1980.4 |
| 10 | 3591.9 | 1032.8 | 10 | 4330.7 | 1452.5 | 10 | 5174.1 | 1990.5 |
| 20 | 3603.5 | 1039.0 | 20 | 4343.8 | 1460.4 | 20 | 5189.3 | 2000.6 |
| 30 | 3615.1 | 1045.2 | 30 | 4356.9 | 1468.4 | 30 | 5204.4 | 2010.8 |
| 40 | 3626.8 | 1051.4 | 40 | 4370.1 | 1476.4 | 40 | 5219.7 | 2021.1 |
| 50 | 3638.5 | 1057.7 | 50 | 4383.3 | 1484.4 | 50 | 5234.9 | 2031.4 |
| 65 | 3650.2 | 1063.9 | 75 | 4396.5 | 1492.4 | 85 | 5250.3 | 2041.7 |
| 10 | 3661.9 | 1070.2 | 10 | 4409.8 | 1500.5 | 10 | 5265.6 | 2052.1 |
| 20 | 3673.7 | 1076.6 | 20 | 4423.1 | 1508.6 | 20 | 5281.0 | 2062.5 |
| 30 | 3685.4 | 1082.9 | 30 | 4436.4 | 1516.7 | 30 | 5296.4 | 2073.0 |
| 40 | 3697.2 | 1089.3 | 40 | 4449.7 | 1524.9 | 40 | 5311.9 | 2083.5 |
| 50 | 3709.0 | 1095.7 | 50 | 4463.1 | 1533.1 | 50 | 5327.4 | 2094.1 |
| 66 | 3720.9 | 1102.2 | 76 | 4476.5 | 1541.4 | 86 | 5343.0 | 2104.7 |
| 10 | 3732.7 | 1108.6 | 10 | 4489.9 | 1549.7 | 10 | 5358.6 | 2115.3 |
| 20 | 3744.6 | 1115.1 | 20 | 4503.4 | 1558.0 | 20 | 5374.2 | 2126.0 |
| 30 | 3756.5 | 1121.7 | 30 | 4516.9 | 1566.3 | 30 | 5389.9 | 2136.7 |
| 40 | 3768.5 | 1128.2 | 40 | 4530.4 | 1574.7 | 40 | 5405.6 | 2147.5 |
| 50 | 3780.4 | 1134.8 | 50 | 4544.0 | 1583.1 | 50 | 5421.4 | 2158.4 |
| 67 | 3792.4 | 1141.4 | 77 | 4557.6 | 1591.6 | 87 | 5437.2 | 2169.2 |
| 10 | 3804.4 | 1148.0 | 10 | 4571.2 | 1600.1 | 10 | 5453.1 | 2180.2 |
| 20 | 3816.4 | 1154.7 | 20 | 4584.8 | 1608.6 | 20 | 5469.0 | 2191.1 |
| 30 | 3828.4 | 1161.3 | 30 | 4598.5 | 1617.1 | 30 | 5484.9 | 2202.2 |
| 40 | 3840.5 | 1168.1 | 40 | 4612.2 | 1625.7 | 40 | 5500.9 | 2213.2 |
| 50 | 3852.6 | 1174.8 | 50 | 4626.0 | 1634.4 | 50 | 5517.0 | 2224.3 |
| 68 | 3864.7 | 1181.6 | 78 | 4639.8 | 1643.0 | 88 | 5533.1 | 2235.5 |
| 10 | 3876.8 | 1188.4 | 10 | 4653.6 | 1651.7 | 10 | 5549.2 | 2246.7 |
| 20 | 3889.0 | 1195.2 | 20 | 4667.4 | 1660.5 | 20 | 5565.4 | 2258.0 |
| 30 | 3901.2 | 1202.0 | 30 | 4681.3 | 1669.2 | 30 | 5581.6 | 2269.3 |
| 40 | 3913.4 | 1208.9 | 40 | 4695.2 | 1678.1 | 40 | 5597.8 | 2280.6 |
| 50 | 3925.6 | 1215.8 | 50 | 4709.2 | 1686.9 | 50 | 5614.2 | 2292.0 |
| 69 | 3937.9 | 1222.7 | 79 | 4723.2 | 1695.8 | 89 | 5630.5 | 2303.5 |
| 10 | 3950.2 | 1229.7 | 10 | 4737.2 | 1704.7 | 10 | 5646.9 | 2315.0 |
| 20 | 3962.5 | 1236.7 | 20 | 4751.2 | 1713.7 | 20 | 5663.4 | 2326.6 |
| 30 | 3974.8 | 1243.7 | 30 | 4765.3 | 1722.7 | 30 | 5679.9 | 2338.2 |
| 40 | 3987.2 | 1250.8 | 40 | 4779.4 | 1731.7 | 40 | 5696.4 | 2349.8 |
| 50 | 3999.5 | 1257.9 | 50 | 4793.6 | 1740.8 | 50 | 5713.0 | 2361.5 |
| 70 | 4011.9 | 1265.0 | 80 | 4807.7 | 1749.9 | 90 | 5729.7 | 2373.3 |
| 10 | 4024.4 | 1272.1 | 10 | 4822.0 | 1759.0 | 10 | 5746.3 | 2385.1 |
| 20 | 4036.8 | 1279.3 | 20 | 4836.2 | 1768.2 | 20 | 5763.1 | 2397.0 |
| 30 | 4049.3 | 1286.5 | 30 | 4850.5 | 1777.4 | 30 | 5779.9 | 2408.9 |
| 40 | 4061.8 | 1293.6 | 40 | 4864.8 | 1786.7 | 40 | 5796.7 | 2420.9 |
| 50 | 4074.4 | 1300.9 | 50 | 4879.2 | 1796.0 | 50 | 5813.6 | 2432.9 |

counter 42253

## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 91° | 5830.5 | 2444.9 | 101° | 6950.6 | 3278.1 | 111° | 8336.7 | 4386.1 |
| 10′ | 5847.5 | 2457.1 | 10′ | 6971.3 | 3294.1 | 10′ | 8362.7 | 4407.6 |
| 20 | 5864.6 | 2469.3 | 20 | 6992.0 | 3310.1 | 20 | 8388.9 | 4429.2 |
| 30 | 5881.7 | 2481.5 | 30 | 7012.7 | 3326.1 | 30 | 8415.1 | 4450.9 |
| 40 | 5898.8 | 2493.8 | 40 | 7033.6 | 3342.3 | 40 | 8441.5 | 4472.7 |
| 50 | 5916.0 | 2506.1 | 50 | 7054.5 | 3358.5 | 50 | 8468.0 | 4494.6 |
| 92 | 5933.2 | 2518.5 | 102 | 7075.5 | 3374.9 | 112 | 8494.6 | 4516.6 |
| 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 | 103 | 7203.2 | 3474.4 | 113 | 8656.6 | 4651.3 |
| 10 | 6055.4 | 2606.8 | 10 | 7224.7 | 3491.3 | 10 | 8684.0 | 4674.2 |
| 20 | 6073.1 | 2619.7 | 20 | 7246.3 | 3508.2 | 20 | 8711.5 | 4697.2 |
| 30 | 6090.8 | 2632.6 | 30 | 7268.0 | 3525.2 | 30 | 8739.2 | 4720.3 |
| 40 | 6108.6 | 2645.5 | 40 | 7289.8 | 3542.4 | 40 | 8767.0 | 4743.6 |
| 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 | 6162.6 | 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 | 50 | 7444.6 | 3664.5 | 50 | 8965.0 | 4909.9 |
| 95 | 6252.8 | 2751.3 | 105 | 7467.0 | 3682.3 | 115 | 8993.8 | 4934.1 |
| 10 | 6271.1 | 2764.8 | 10 | 7489.6 | 3700.2 | 10 | 9022.7 | 4958.6 |
| 20 | 6289.4 | 2778.3 | 20 | 7512.2 | 3718.2 | 20 | 9051.7 | 4983.1 |
| 30 | 6307.9 | 2792.0 | 30 | 7534.9 | 3736.2 | 30 | 9080.9 | 5007.8 |
| 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 | 40 | 7696.3 | 3865.2 | 40 | 9289.2 | 5184.5 |
| 50 | 6457.3 | 2903.1 | 50 | 7719.7 | 3884.0 | 50 | 9319.5 | 5210.3 |
| 97 | 6476.2 | 2917.3 | 107 | 7743.2 | 3902.9 | 117 | 9349.9 | 5236.2 |
| 10 | 6495.2 | 2931.6 | 10 | 7766.8 | 3921.9 | 10 | 9380.5 | 5262.3 |
| 20 | 6514.3 | 2945.9 | 20 | 7790.5 | 3940.9 | 20 | 9411.3 | 5288.6 |
| 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 | 10 | 7910.4 | 4037.8 | 10 | 9567.2 | 5422.1 |
| 20 | 6630.1 | 3033.1 | 20 | 7934.6 | 4057.4 | 20 | 9598.9 | 5449.2 |
| 30 | 6649.6 | 3047.9 | 30 | 7959.0 | 4077.2 | 30 | 9630.7 | 5476.5 |
| 40 | 6669.2 | 3062.8 | 40 | 7983.5 | 4097.1 | 40 | 9662.6 | 5504.0 |
| 50 | 6688.8 | 3077.7 | 50 | 8008.0 | 4117.0 | 50 | 9694.7 | 5531.7 |
| 99 | 6708.6 | 3092.7 | 109 | 8032.7 | 4137.1 | 119 | 9727.0 | 5559.4 |
| 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 | 110 | 8182.8 | 4259.7 | 120 | 9924.0 | 5729.7 |
| 10 | 6848.5 | 3199.6 | 10 | 8208.2 | 4280.5 | 10 | 9957.5 | 5758.6 |
| 20 | 6868.8 | 3215.1 | 20 | 8233.7 | 4301.4 | 20 | 9991.0 | 5787.7 |
| 30 | 6889.2 | 3230.8 | 30 | 8259.3 | 4322.4 | 30 | 10025.0 | 5817.0 |
| 40 | 6909.6 | 3246.5 | 40 | 8285.0 | 4343.6 | 40 | 10059.0 | 5846.5 |
| 50 | 6930.1 | 3262.3 | 50 | 8310.8 | 4364.8 | 50 | 10093.0 | 5876.1 |



## Table V.—Corrections for Tangents and Externals.

These corrections are to be added to the approximate values, found by dividing the tangent, or external, for a 1° curve (Table IV) by the degree of curve, in order to obtain the true tangents, or externals. Intermediate values may be obtained by interpolation.

### For Tangents Add

| Central Angle | Degree of Curve | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° |
| 10° | .03 | .06 | .09 | .13 | .16 | .19 | .22 | .25 | .28 | .31 | .34 | .38 | .42 | .46 |
| 15° | .04 | .10 | .14 | .19 | .24 | .29 | .34 | .39 | .45 | .51 | .53 | .58 | .63 | .68 |
| 20° | .06 | .13 | .19 | .26 | .32 | .39 | .45 | .51 | .58 | .65 | .72 | .79 | .84 | .90 |
| 25° | .08 | .16 | .24 | .33 | .40 | .49 | .58 | .67 | .75 | .83 | .90 | .99 | 1.06 | 1.14 |
| 30° | .10 | .19 | .29 | .39 | .49 | .59 | .69 | .79 | .89 | .99 | 1.09 | 1.20 | 1.29 | 1.39 |
| 35° | .11 | .22 | .34 | .47 | .58 | .69 | .70 | .81 | .92 | 1.04 | 1.29 | 1.42 | 1.54 | 1.66 |
| 40° | .13 | .26 | .40 | .53 | .67 | .80 | .93 | 1.06 | 1.20 | 1.34 | 1.49 | 1.64 | 1.79 | 1.94 |
| 45° | .15 | .30 | .44 | .60 | .76 | .91 | 1.06 | 1.21 | 1.37 | 1.52 | 1.70 | 1.87 | 2.04 | 2.21 |
| 50° | .17 | .34 | .51 | .68 | .85 | 1.02 | 1.19 | 1.36 | 1.54 | 1.72 | 1.91 | 2.10 | 2.29 | 2.48 |
| 55° | .19 | .38 | .57 | .76 | .95 | 1.14 | 1.32 | 1.52 | 1.72 | 1.92 | 2.14 | 2.35 | 2.56 | 2.77 |
| 60° | .21 | .42 | .63 | .84 | 1.05 | 1.27 | 1.49 | 1.71 | 1.94 | 2.17 | 2.38 | 2.60 | 2.83 | 3.07 |
| 65° | .23 | .46 | .69 | .93 | 1.16 | 1.40 | 1.64 | 1.88 | 2.13 | 2.38 | 2.63 | 2.88 | 3.13 | 3.39 |
| 70° | .25 | .51 | .76 | 1.02 | 1.28 | 1.54 | 1.80 | 2.06 | 2.33 | 2.60 | 2.88 | 3.16 | 3.44 | 3.72 |
| 75° | .27 | .56 | .83 | 1.12 | 1.40 | 1.69 | 1.98 | 2.27 | 2.57 | 2.87 | 3.16 | 3.47 | 3.78 | 4.09 |
| 80° | .30 | .61 | .91 | 1.22 | 1.53 | 1.84 | 2.15 | 2.46 | 2.78 | 3.10 | 3.44 | 3.78 | 4.12 | 4.46 |
| 85° | .33 | .66 | 1.00 | 1.33 | 1.68 | 2.02 | 2.36 | 2.70 | 3.05 | 3.40 | 3.77 | 4.14 | 4.55 | 4.89 |
| 90° | .36 | .72 | 1.09 | 1.45 | 1.83 | 2.20 | 2.57 | 2.94 | 3.32 | 3.70 | 4.10 | 4.50 | 4.91 | 5.32 |
| 95° | .39 | .79 | 1.19 | 1.55 | 2.00 | 2.40 | 2.80 | 3.20 | 3.61 | 4.02 | 4.40 | 4.98 | 5.38 | 5.83 |
| 100° | .43 | .86 | 1.30 | 1.74 | 2.18 | 2.62 | 3.06 | 3.50 | 3.95 | 4.40 | 4.88 | 5.37 | 5.85 | 6.34 |
| 110° | .51 | 1.03 | 1.56 | 2.08 | 2.61 | 3.14 | 3.67 | 4.21 | 4.76 | 5.31 | 5.86 | 6.43 | 7.01 | 7.60 |
| 120° | .62 | 1.25 | 1.93 | 2.52 | 3.16 | 3.81 | 4.45 | 5.11 | 5.77 | 6.44 | 7.12 | 7.80 | 8.50 | 9.22 |

### For Externals Add

| Central Angle | Degree of Curve | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° |
| 10° | .001 | .003 | .004 | .006 | .007 | .008 | .009 | .011 | .012 | .014 | .015 | .017 | .018 | .020 |
| 15° | .003 | .007 | .010 | .014 | .018 | .023 | .027 | .029 | .032 | .035 | .039 | .043 | .047 | .051 |
| 20° | .006 | .011 | .017 | .022 | .028 | .034 | .038 | .045 | .051 | .057 | .063 | .070 | .076 | .083 |
| 25° | .009 | .018 | .027 | .036 | .046 | .056 | .065 | .074 | .083 | .093 | .106 | .120 | .127 | .135 |
| 30° | .013 | .025 | .038 | .051 | .065 | .078 | .090 | .103 | .116 | .129 | .149 | .170 | .179 | .188 |
| 35° | .018 | .035 | .054 | .072 | .086 | .109 | .131 | .153 | .175 | .197 | .213 | .230 | .247 | .264 |
| 40° | .023 | .046 | .070 | .093 | .117 | .141 | .172 | .203 | .234 | .265 | .277 | .290 | .315 | .341 |
| 45° | .030 | .060 | .093 | .119 | .153 | .184 | .216 | .254 | .289 | .325 | .351 | .378 | .411 | .445 |
| 50° | .037 | .075 | .116 | .151 | .189 | .227 | .266 | .305 | .345 | .384 | .425 | .467 | .508 | .550 |
| 55° | .046 | .093 | .142 | .188 | .236 | .283 | .332 | .381 | .420 | .479 | .530 | .582 | .641 | .700 |
| 60° | .056 | .112 | .168 | .225 | .283 | .340 | .398 | .457 | .516 | .575 | .636 | .697 | .774 | .851 |
| 65° | .067 | .135 | .204 | .273 | .343 | .412 | .483 | .554 | .625 | .697 | .711 | .845 | .922 | 1.01 |
| 70° | .080 | .159 | .240 | .321 | .403 | .485 | .568 | .652 | .735 | .819 | .906 | .994 | 1.08 | 1.17 |
| 75° | .095 | .182 | .286 | .383 | .480 | .578 | .678 | .777 | .877 | .977 | 1.07 | 1.18 | 1.29 | 1.39 |
| 80° | .110 | .220 | .332 | .445 | .558 | .671 | .787 | .903 | 1.02 | 1.13 | 1.25 | 1.38 | 1.50 | 1.62 |
| 85° | .128 | .259 | .391 | .524 | .657 | .790 | .926 | 1.06 | 1.20 | 1.34 | 1.47 | 1.62 | 1.76 | 1.91 |
| 90° | .149 | .299 | .450 | .603 | .756 | .910 | 1.07 | 1.22 | 1.38 | 1.54 | 1.70 | 1.87 | 2.03 | 2.20 |
| 95° | .174 | .350 | .522 | .706 | .985 | 1.06 | 1.25 | 1.43 | 1.62 | 1.80 | 1.99 | 2.18 | 2.38 | 2.53 |
| 100° | .200 | .401 | .604 | .809 | 1.01 | 1.22 | 1.43 | 1.64 | 1.85 | 2.06 | 2.28 | 2.50 | 2.73 | 2.96 |
| 110° | .268 | .536 | .806 | 1.08 | 1.35 | 1.63 | 1.91 | 2.20 | 2.48 | 2.76 | 3.05 | 3.35 | 3.66 | 3.96 |
| 120° | .360 | .721 | 1.08 | 1.45 | 1.82 | 2.19 | 2.57 | 2.95 | 3.33 | 3.72 | 4.11 | 4.50 | 4.91 | 5.32 |

## Table VI.—Corrections for Sub-Chords and Long Chords.

| For Sub-Chords Add | | | | | | | | | | Excess of arc per 100 ft. | Long Chords | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | | D | 200 | 300 | 400 | 500 |
| 4° | .00 | .00 | .01 | .01 | .01 | .01 | .01 | .01 | .00 | .02 | 1 | 199.99 | 299.97 | 399.92 | 499.85 |
| 6 | .00 | .01 | .01 | .02 | .02 | .02 | .02 | .01 | .01 | .05 | 2 | 199.97 | 299.88 | 399.70 | 499.39 |
| 8 | .01 | .02 | .02 | .03 | .03 | .03 | .03 | .02 | .01 | .08 | 3 | 199.93 | 299.73 | 399.32 | 498.63 |
| 10 | .01 | .02 | .03 | .04 | .05 | .05 | .05 | .04 | .02 | .13 | 4 | 199.88 | 299.51 | 398.78 | 497.57 |
| 12 | .02 | .04 | .05 | .06 | .07 | .07 | .07 | .05 | .03 | .18 | 5 | 199.81 | 299.24 | 398.10 | 496.20 |
| 14 | .02 | .05 | .07 | .08 | .09 | .10 | .09 | .07 | .04 | .25 | 6 | 199.73 | 298.90 | 397.26 | 494.53 |
| 16 | .03 | .06 | .09 | .11 | .12 | .12 | .12 | .09 | .05 | .33 | 7 | 199.63 | 298.51 | 396.28 | 492.57 |
| 18 | .04 | .08 | .11 | .14 | .15 | .16 | .15 | .12 | .07 | .41 | 8 | 199.51 | 298.05 | 395.14 | 490.31 |
| 20 | .05 | .10 | .14 | .17 | .19 | .20 | .18 | .15 | .09 | .51 | 9 | 199.38 | 297.54 | 393.86 | 487.75 |
| 22 | .06 | .12 | .17 | .21 | .23 | .24 | .22 | .18 | .10 | .62 | 10 | 199.24 | 296.96 | 392.42 | 484.90 |
| 24 | .07 | .14 | .20 | .25 | .28 | .28 | .26 | .21 | .12 | .74 | 12 | 198.90 | 295.63 | 389.12 | 478.34 |
| 26 | .09 | .17 | .24 | .29 | .32 | .33 | .31 | .25 | .15 | .86 | 14 | 198.51 | 294.06 | 385.22 | 470.65 |
| 28 | .10 | .19 | .27 | .34 | .37 | .38 | .36 | .29 | .17 | 1.00 | 16 | 198.05 | 292.25 | 380.76 | 461.86 |
| 30 | .11 | 22 | .31 | .39 | .43 | .44 | .41 | .33 | .19 | 1.15 | 18 | 197.54 | 290.21 | 375.74 | 452.02 |
| 32 | .13 | .25 | .36 | .44 | .49 | .50 | .47 | .38 | .22 | 1.31 | 20 | 196.90 | 287.94 | 370.17 | 441.15 |
| 34 | .15 | .28 | .40 | .50 | .55 | .57 | .53 | .43 | .25 | 1.48 | 22 | 196.32 | 285.44 | 364.06 | 429.30 |
| 36 | .17 | .32 | .45 | .56 | .62 | .64 | .59 | .48 | .28 | 1.66 | 24 | 195.63 | 282.71 | 357.43 | 416.53 |
| 38 | .18 | .36 | .51 | .62 | .70 | .71 | .66 | .53 | .31 | 1.86 | 26 | 194.87 | 279.76 | 350.30 | 402.89 |
| 40 | .21 | .40 | .56 | .69 | .77 | .79 | .73 | .59 | .35 | 2.06 | 28 | 194.06 | 276.59 | 342.69 | 388.42 |
| 42 | .23 | .44 | .62 | .76 | .85 | .87 | .81 | .65 | .38 | 2.28 | 30 | 193.18 | 273.20 | 334.61 | 373.20 |
| 44 | .25 | .48 | .68 | .84 | .94 | .96 | .89 | .72 | .42 | 2.50 | 32 | 192.25 | 269.61 | 326.08 | 357.28 |
| 46 | .27 | .52 | .75 | .92 | 1.02 | 1.05 | .98 | .78 | .46 | 2.74 | 34 | 191.26 | 265.81 | 317.12 | 340.73 |
| 48 | .30 | .57 | .81 | 1.00 | 1.12 | 1.14 | 1.06 | .86 | .50 | 2.99 | 36 | 190.21 | 261.80 | 307.77 | 323.61 |
| 50 | .32 | .62 | .89 | 1.09 | 1.21 | 1.24 | 1.15 | .93 | .55 | 3.24 | 38 | 189.10 | 257.60 | 298.03 | 305.99 |
| 52 | .35 | .67 | .96 | 1.18 | 1.31 | 1.35 | 1.25 | 1.01 | .59 | 3.52 | 40 | 187.94 | 253.21 | 287.94 | 287.94 |
| 54 | .38 | .73 | 1.04 | 1.28 | 1.42 | 1.46 | 1.35 | 1.09 | .64 | 3.80 | 42 | 186.72 | 248.63 | 277.51 | 269.54 |
| 56 | .41 | .78 | 1.12 | 1.38 | 1.53 | 1.57 | 1.46 | 1.17 | .69 | 4.09 | 44 | 185.44 | 243.87 | 266.78 | 250.85 |
| 58 | .44 | .84 | 1.20 | 1.48 | 1.65 | 1.69 | 1.57 | 1.20 | .74 | 4.40 | 46 | 184.10 | 239.93 | 255.78 | 231.95 |
| 60 | .47 | .91 | 1.29 | 1.59 | 1.76 | 1.81 | 1.68 | 1.35 | .80 | 4.72 | 48 | 182.71 | 233.83 | 244.51 | 212.92 |

Note.—When a chord of less than 100 ft. is used the corrections given in the above table should be added to the nominal length of chord to get the length which should be used in order that the 100 ft. points will check with those obtained by using the standard 100 ft. chord. Thus in locating a 14° curve by 25 ft. chords measure 25′.06 for each chord. Long chords are useful in passing obstacles.

## Table VII.—Middle Ordinates for Rails in Feet.

| Deg. of Curve | Length of Rails | | | | | | | Deg. of Curve | Length of Rails | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 32 | 30 | 28 | 26 | 24 | 22 | 20 | | 32 | 30 | 28 | 26 | 24 | 22 | 20 |
| 1° | .022 | .020 | .016 | .013 | .011 | .009 | .008 | 16° | .356 | .313 | .273 | .236 | .200 | .170 | .139 |
| 2 | .045 | .038 | .034 | .029 | .025 | .021 | .017 | 17 | .378 | .333 | .290 | .252 | .213 | .180 | .148 |
| 3 | .067 | .058 | .051 | .044 | .037 | .031 | .026 | 18 | .400 | .351 | .306 | .265 | .225 | .190 | .156 |
| 4 | .089 | .079 | .069 | .060 | .050 | .042 | .035 | 19 | .423 | .371 | .324 | .280 | .238 | .201 | .165 |
| 5 | .112 | .099 | .086 | .074 | .063 | .053 | .044 | 20 | .445 | .392 | .341 | .296 | .250 | .212 | .174 |
| 6 | .134 | .117 | .102 | .088 | .076 | .064 | .052 | 21 | .466 | .410 | .357 | .309 | .262 | .222 | .182 |
| 7 | .156 | .137 | .120 | .104 | .088 | .074 | .061 | 22 | .487 | .430 | .375 | .325 | .275 | .233 | .191 |
| 8 | .179 | .158 | .137 | .119 | .100 | .085 | .070 | 23 | .509 | .450 | .390 | .338 | .287 | .243 | .199 |
| 9 | .201 | .175 | .153 | .133 | .112 | .095 | .078 | 24 | .531 | .469 | .408 | .354 | .299 | .253 | .208 |
| 10 | .223 | .196 | .171 | .148 | .125 | .106 | .087 | 25 | .552 | .486 | .424 | .367 | .311 | .263 | .216 |
| 11 | .245 | .216 | .188 | .163 | .139 | .117 | .096 | 26 | .573 | .506 | .441 | .382 | .323 | .274 | .225 |
| 12 | .268 | .236 | .206 | .179 | .151 | .128 | .105 | 27 | .594 | .524 | .457 | .396 | .335 | .284 | .233 |
| 13 | .290 | .254 | .222 | .192 | .163 | .138 | .113 | 28 | .618 | .545 | .475 | .411 | .348 | .294 | .242 |
| 14 | .312 | .275 | .239 | .207 | .175 | .148 | .122 | 29 | .638 | .564 | .491 | .424 | .361 | .303 | .250 |
| 15 | .334 | .295 | .257 | .223 | .188 | .159 | .131 | 30 | .660 | .583 | .508 | .438 | .374 | .313 | .259 |



## SLOPE REDUCTIONS.

When distances are measured on a slope that may be reduced to the equivalent horizontal distance by the following approximate rule:—subtract from the slope distance the square of the rise divided by twice the slope distance. Thus for a slope distance of 250.3 ft. and a rise of 15 ft. correction$=15^2\div2\times250.3=.45$ (by slide rule) or horizontal distance$=250.3-.45=249.85$. When vertical angle=V. A. is measured horizontal distance=slope distance—slope distance (1—Cos. V. A.). Thus for slope distance of 248.7 ft. and V. A. of 4° 20′ from Table VIII Cos=.99714 and correction$=1-.99714=.00286$ per foot or total of $.286\times2\frac{1}{2}$ (near enough)=.57 and horizontal distance$=248.7-.57=248.13$ ft.

## TRIGONOMETRICAL FORMULAS.

See fig. (a).

sin. $A=\frac{a}{c}$

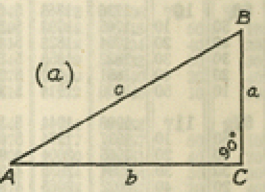
cos. $A=\frac{b}{c}$

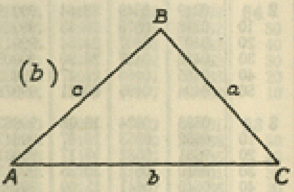
tan. $A=\frac{a}{b}$

cot. $A=\frac{b}{a}$

sec. $A=\frac{c}{b}$

cosec. $A=\frac{c}{a}$




### Formula for Solving Triangles.

| Given | Sought. | Right triangles. See fig. (a). |
|---|---|---|
| $a, c$ | $A, B, b$ | sin. $A=\frac{a}{c}$, cos. $B=\frac{a}{c}$, $b=\sqrt{(c+a)\ (c-a)}$ |
| $a, b$ | $A, B, c$ | tan. $A=\frac{a}{b}$, cot. $B=\frac{a}{b}$, $c=\sqrt{a^2+b^2}$ |
| $A, a$ | $B, b, c$ | $B=90°-A$, $b=a$ cot. $A$, $c=\frac{a}{\sin. A^\circ}$ |
| $A, b$ | $B, a, c$ | $B=90°-A$, $a=b$ tan. $A$, $c=\frac{b}{\cos. A^\circ}$ |
| $A, c$ | $B, a, b$ | $B=90°-A$, $a=c$ sin. $A$, $b=c$ cos. $A$ |
| **Given** | **Sought.** | **Oblique triangles. See fig. (b)** |
| $A, B, a$ | $b$ | $b=\frac{a \sin. B}{\sin. A}$ |
| $A, a, b$ | $B$ | sin. $B=\frac{b \sin. A}{a}$ |
| $a, b, C$ | $A - B$ | tan. ½ $(A-B)=\frac{a-b \tan. \frac{1}{2}\ (A+B)}{a+b}$ |
| $c, b, c$ | $A$ | If $s=\frac{1}{2}(a+b+c)$, sin. ½ $A=\sqrt{\frac{(s-b)\ (s-c)}{b\,c}}$<br>cos. ½ $A=\sqrt{\frac{s\ (s-a)}{b\,c}}$, tan. ½ $A=\sqrt{\frac{(s-b)\ (s-c)}{s\ (s-a)}}$,<br>sin. $A=\frac{2\sqrt{(s-a)\ (s-b)\ (s-c)\ s}}{b\,c}$ |
| $A, B, C, a$ | area | area$=\frac{a^2 \sin. B \sin. C}{2 \sin. A}$ |
| $A, b, c$ | area | area$=\frac{1}{2}\,b\,c$ sin. $A$ |
| $a, b, c$ | area | $s=\frac{1}{2}(a+b+c)$, area$=\sqrt{s\ (s-a)(s-b)(s-c)}$ |

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## TABLE VIII.—NATURAL TRIGONOMETRICAL FUNCTIONS.

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **0** | 0 | 0 | 00 | 1 | **90** |
| 10 | .0029 | .0029 | 343.8 | 1 | 50 |
| 20 | .0058 | .0058 | 171.9 | .99998 | 40 |
| 30 | .0087 | .0087 | 114.6 | .99996 | 30 |
| 40 | .0116 | .0116 | 85.94 | .99993 | 20 |
| 50 | .0145 | .0145 | 68.75 | .99989 | 10 |
| **1** | .0175 | .0175 | 57.29 | .99985 | **89** |
| 10 | .0204 | .0204 | 49.10 | .99979 | 50 |
| 20 | .0233 | .0233 | 42.96 | .99973 | 40 |
| 30 | .0262 | .0262 | 38.19 | .99966 | 30 |
| 40 | .0291 | .0291 | 34.37 | .99958 | 20 |
| 50 | .0320 | .0320 | 31.24 | .99949 | 10 |
| **2** | .0349 | .0349 | 28.64 | .99939 | **88** |
| 10 | .0378 | .0378 | 26.43 | .99929 | 50 |
| 20 | .0407 | .0407 | 24.54 | .99917 | 40 |
| 30 | .0436 | .0437 | 22.90 | .99905 | 30 |
| 40 | .0465 | .0466 | 21.47 | .99892 | 20 |
| 50 | .0494 | .0495 | 20.21 | .99878 | 10 |
| **3** | .0523 | .0524 | 19.08 | .99863 | **87** |
| 10 | .0552 | .0553 | 18.07 | .99847 | 50 |
| 20 | .0581 | .0582 | 17.17 | .99831 | 40 |
| 30 | .0610 | .0612 | 16.35 | .99813 | 30 |
| 40 | .0640 | .0641 | 15.60 | .99795 | 20 |
| 50 | .0669 | .0670 | 14.92 | .99776 | 10 |
| **4** | .0698 | .0699 | 14.30 | .99756 | **86** |
| 10 | .0727 | .0729 | 13.73 | .99736 | 50 |
| 20 | .0756 | .0758 | 13.20 | .99714 | 40 |
| 30 | .0785 | .0787 | 12.71 | .99692 | 30 |
| 40 | .0814 | .0816 | 12.25 | .99668 | 20 |
| 50 | .0843 | .0846 | 11.83 | .99644 | 10 |
| **5** | .0872 | .0875 | 11.43 | .99619 | **85** |
| 10 | .0901 | .0904 | 11.06 | .99594 | 50 |
| 20 | .0929 | .0934 | 10.71 | .99567 | 40 |
| 30 | .0958 | .0963 | 10.39 | .99540 | 30 |
| 40 | .0987 | .0992 | 10.08 | .99511 | 20 |
| 50 | .1016 | .1022 | 9.788 | .99482 | 10 |
| **6** | .1045 | .1051 | 9.514 | .99452 | **84** |
| 10 | .1074 | .1080 | 9.255 | .99421 | 50 |
| 20 | .1103 | .1110 | 9.010 | .99390 | 40 |
| 30 | .1132 | .1139 | 8.777 | .99357 | 30 |
| 40 | .1161 | .1169 | 8.556 | .99324 | 20 |
| 50 | .1190 | .1198 | 8.345 | .99290 | 10 |
| **7** | .1219 | .1228 | 8.144 | .99255 | **83** |
| 10 | .1248 | .1257 | 7.953 | .99219 | 50 |
| 20 | .1276 | .1287 | 7.770 | .99182 | 40 |
| 30 | .1305 | .1317 | 7.596 | .99144 | 30 |
| 40 | .1334 | .1346 | 7.429 | .99106 | 20 |
| 50 | .1363 | .1376 | 7.269 | .99067 | 10 |
| | | | | | **82** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **8** | .1392 | .1405 | 7.115 | .99027 | **82** |
| 10 | .1421 | .1435 | 6.968 | .98986 | 50 |
| 20 | .1449 | .1465 | 6.827 | .98944 | 40 |
| 30 | .1478 | .1495 | 6.691 | .98902 | 30 |
| 40 | .1507 | .1524 | 6.561 | .98858 | 20 |
| 50 | .1536 | .1554 | 6.435 | .98814 | 10 |
| **9** | .1564 | .1584 | 6.314 | .98769 | **81** |
| 10 | .1593 | .1614 | 6.197 | .98723 | 50 |
| 20 | .1622 | .1644 | 6.084 | .98676 | 40 |
| 30 | .1650 | .1673 | 5.976 | .98629 | 30 |
| 40 | .1679 | .1703 | 5.871 | .98580 | 20 |
| 50 | .1708 | .1733 | 5.769 | .98531 | 10 |
| **10** | .1736 | .1763 | 5.671 | .98481 | **80** |
| 10 | .1765 | .1793 | 5.576 | .98430 | 50 |
| 20 | .1794 | .1823 | 5.485 | .98378 | 40 |
| 30 | .1822 | .1853 | 5.396 | .98325 | 30 |
| 40 | .1851 | .1883 | 5.309 | .98272 | 20 |
| 50 | .1880 | .1914 | 5.226 | .98218 | 10 |
| **11** | .1908 | .1944 | 5.145 | .98163 | **79** |
| 10 | .1937 | .1974 | 5.066 | .98107 | 50 |
| 20 | .1965 | .2004 | 4.989 | .98050 | 40 |
| 30 | .1994 | .2035 | 4.915 | .97992 | 30 |
| 40 | .2022 | .2065 | 4.843 | .97934 | 20 |
| 50 | .2051 | .2095 | 4.773 | .97875 | 10 |
| **12** | .2079 | .2126 | 4.705 | .97815 | **78** |
| 10 | .2108 | .2156 | 4.638 | .97754 | 50 |
| 20 | .2136 | .2186 | 4.574 | .97692 | 40 |
| 30 | .2164 | .2217 | 4.511 | .97630 | 30 |
| 40 | .2193 | .2247 | 4.449 | .97566 | 20 |
| 50 | .2221 | .2278 | 4.390 | .97502 | 10 |
| **13** | .2250 | .2309 | 4.331 | .97437 | **77** |
| 10 | .2278 | .2339 | 4.275 | .97371 | 50 |
| 20 | .2306 | .2370 | 4.219 | .97304 | 40 |
| 30 | .2334 | .2401 | 4.165 | .97237 | 30 |
| 40 | .2363 | .2432 | 4.113 | .97169 | 20 |
| 50 | .2391 | .2462 | 4.061 | .97100 | 10 |
| **14** | .2419 | .2493 | 4.011 | .97030 | **76** |
| 10 | .2447 | .2524 | 3.962 | .96959 | 50 |
| 20 | .2476 | .2555 | 3.914 | .96887 | 40 |
| 30 | .2504 | .2586 | 3.867 | .96815 | 30 |
| 40 | .2532 | .2617 | 3.821 | .96742 | 20 |
| 50 | .2560 | .2648 | 3.776 | .96667 | 10 |
| **15** | .2588 | .2679 | 3.732 | .96593 | **75** |
| 10 | .2616 | .2711 | 3.689 | .96517 | 50 |
| 20 | .2644 | .2742 | 3.647 | .96440 | 40 |
| 30 | .2672 | .2773 | 3.606 | .96363 | 30 |
| 40 | .2700 | .2805 | 3.566 | .96285 | 20 |
| 50 | .2728 | .2836 | 3.526 | .96206 | 10 |
| | | | | | **74** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

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## TABLE VIII.—NATURAL TRIGONOMETRICAL FUNCTIONS.

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **16** | .2756 | .2867 | 3.487 | .96126 | **74** |
| 10 | .2784 | .2899 | 3.450 | .96046 | 50 |
| 20 | .2812 | .2931 | 3.412 | .95964 | 40 |
| 30 | .2840 | .2962 | 3.376 | .95882 | 30 |
| 40 | .2868 | .2994 | 3.340 | .95799 | 20 |
| 50 | .2896 | .3026 | 3.305 | .95715 | 10 |
| **17** | .2924 | .3057 | 3.271 | .95615 | **73** |
| 10 | .2952 | .3089 | 3.237 | .95545 | 50 |
| 20 | .2979 | .3121 | 3.204 | .95459 | 40 |
| 30 | .3007 | .3153 | 3.172 | .95372 | 30 |
| 40 | .3035 | .3185 | 3.140 | .95284 | 20 |
| 50 | .3062 | .3217 | 3.108 | .95195 | 10 |
| **18** | .3090 | .3249 | 3.078 | .95106 | **72** |
| 10 | .3118 | .3281 | 3.048 | .95015 | 50 |
| 20 | .3145 | .3314 | 3.018 | .94924 | 40 |
| 30 | .3173 | .3346 | 2.989 | .94832 | 30 |
| 40 | .3201 | .3378 | 2.960 | .94740 | 20 |
| 50 | .3228 | .3411 | 2.932 | .94646 | 10 |
| **19** | .3256 | .3443 | 2.904 | .94552 | **71** |
| 10 | .3283 | .3476 | 2.877 | .94457 | 50 |
| 20 | .3311 | .3508 | 2.850 | .94361 | 40 |
| 30 | .3338 | .3541 | 2.824 | .94264 | 30 |
| 40 | .3365 | .3574 | 2.798 | .94167 | 20 |
| 50 | .3393 | .3607 | 2.773 | .94068 | 10 |
| **20** | .3420 | .3640 | 2.747 | .93969 | **70** |
| 10 | .3448 | .3673 | 2.723 | .93869 | 50 |
| 20 | .3475 | .3706 | 2.699 | .93769 | 40 |
| 30 | .3502 | .3739 | 2.675 | .93667 | 30 |
| 40 | .3529 | .3772 | 2.651 | .93565 | 20 |
| 50 | .3557 | .3805 | 2.628 | .93462 | 10 |
| **21** | .3584 | .3839 | 2.605 | .93358 | **69** |
| 10 | .3611 | .3872 | 2.583 | .93253 | 50 |
| 20 | .3638 | .3906 | 2.560 | .93148 | 40 |
| 30 | .3665 | .3939 | 2.539 | .93042 | 30 |
| 40 | .3692 | .3973 | 2.517 | .92935 | 20 |
| 50 | .3719 | .4006 | 2.496 | .92827 | 10 |
| **22** | .3746 | .4040 | 2.475 | .92718 | **68** |
| 10 | .3773 | .4074 | 2.455 | .92609 | 50 |
| 20 | .3800 | .4108 | 2.434 | .92499 | 40 |
| 30 | .3827 | .4142 | 2.414 | .92388 | 30 |
| 40 | .3854 | .4176 | 2.394 | .92276 | 20 |
| 50 | .3881 | .4210 | 2.375 | .92164 | 10 |
| **23** | .3907 | .4245 | 2.356 | .92050 | **67** |
| 10 | .3934 | .4279 | 2.337 | .91936 | 50 |
| 20 | .3961 | .4314 | 2.318 | .91822 | 40 |
| 30 | .3987 | .4348 | 2.300 | .91706 | 30 |
| 40 | .4014 | .4383 | 2.282 | .91590 | 20 |
| 50 | .4041 | .4417 | 2.264 | .91472 | 10 |
| | | | | | **66** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **24** | .4067 | .4452 | 2.246 | .91355 | **66** |
| 10 | .4094 | .4487 | 2.229 | .91236 | 50 |
| 20 | .4120 | .4522 | 2.211 | .91116 | 40 |
| 30 | .4147 | .4557 | 2.194 | .90996 | 30 |
| 40 | .4173 | .4592 | 2.177 | .90875 | 20 |
| 50 | .4200 | .4628 | 2.161 | .90753 | 10 |
| **25** | .4226 | .4663 | 2.145 | .90631 | **65** |
| 10 | .4253 | .4699 | 2.128 | .90507 | 50 |
| 20 | .4279 | .4734 | 2.112 | .90383 | 40 |
| 30 | .4305 | .4770 | 2.097 | .90259 | 30 |
| 40 | .4331 | .4806 | 2.081 | .90133 | 20 |
| 50 | .4358 | .4841 | 2.066 | .90007 | 10 |
| **26** | .4384 | .4877 | 2.050 | .89879 | **64** |
| 10 | .4410 | .4913 | 2.035 | .89752 | 50 |
| 20 | .4436 | .4950 | 2.020 | .89623 | 40 |
| 30 | .4462 | .4986 | 2.006 | .89493 | 30 |
| 40 | .4488 | .5022 | 1.991 | .89363 | 20 |
| 50 | .4514 | .5059 | 1.977 | .89232 | 10 |
| **27** | .4540 | .5095 | 1.963 | .89101 | **63** |
| 10 | .4566 | .5132 | 1.949 | .88968 | 50 |
| 20 | .4592 | .5169 | 1.935 | .88835 | 40 |
| 30 | .4617 | .5206 | 1.921 | .88701 | 30 |
| 40 | .4643 | .5243 | 1.907 | .88566 | 20 |
| 50 | .4669 | .5280 | 1.894 | .88431 | 10 |
| **28** | .4695 | .5317 | 1.881 | .88295 | **62** |
| 10 | .4720 | .5354 | 1.868 | .88158 | 50 |
| 20 | .4746 | .5392 | 1.855 | .88020 | 40 |
| 30 | .4772 | .5430 | 1.842 | .87882 | 30 |
| 40 | .4797 | .5467 | 1.829 | .87743 | 20 |
| 50 | .4823 | .5505 | 1.816 | .87603 | 10 |
| **29** | .4848 | .5543 | 1.804 | .87462 | **61** |
| 10 | .4874 | .5581 | 1.792 | .87321 | 50 |
| 20 | .4899 | .5619 | 1.780 | .87178 | 40 |
| 30 | .4924 | .5658 | 1.767 | .87036 | 30 |
| 40 | .4950 | .5696 | 1.756 | .86892 | 20 |
| 50 | .4975 | .5735 | 1.744 | .86748 | 10 |
| **30** | .5000 | .5774 | 1.732 | .86603 | **60** |
| 10 | .5025 | .5812 | 1.720 | .86457 | 50 |
| 20 | .5050 | .5851 | 1.709 | .86310 | 40 |
| 30 | .5075 | .5890 | 1.698 | .86163 | 30 |
| 40 | .5100 | .5930 | 1.686 | .86015 | 20 |
| 50 | .5125 | .5969 | 1.675 | .85866 | 10 |
| **31** | .5150 | .6009 | 1.664 | .85717 | **59** |
| 10 | .5175 | .6048 | 1.653 | .85567 | 50 |
| 20 | .5200 | .6088 | 1.643 | .85416 | 40 |
| 30 | .5225 | .6128 | 1.632 | .85264 | 30 |
| 40 | .5250 | .6168 | 1.621 | .85112 | 20 |
| 50 | .5275 | .6208 | 1.611 | .84959 | 10 |
| | | | | | **58** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

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### Table VIII.—Natural Trigonometrical Functions.

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| 32 | .5299 | .6249 | 1.600 | .84805 | 58 |
| 10 | .5324 | .6289 | 1.590 | .84650 | 50 |
| 20 | .5348 | .6330 | 1.580 | .84495 | 40 |
| 30 | .5373 | .6371 | 1.570 | .84339 | 30 |
| 40 | .5398 | .6412 | 1.560 | .84182 | 20 |
| 50 | .5422 | .6453 | 1.550 | .84025 | 10 |
| 33 | .5446 | .6494 | 1.540 | .83867 | 57 |
| 10 | .5471 | .6536 | 1.530 | .83708 | 50 |
| 20 | .5495 | .6577 | 1.520 | .83549 | 40 |
| 30 | .5519 | .6619 | 1.511 | .83389 | 30 |
| 40 | .5544 | .6661 | 1.501 | .83228 | 20 |
| 50 | .5568 | .6703 | 1.492 | .83066 | 10 |
| 34 | .5592 | .6745 | 1.483 | .82904 | 56 |
| 10 | .5616 | .6787 | 1.473 | .82741 | 50 |
| 20 | .5640 | .6830 | 1.464 | .82577 | 40 |
| 30 | .5664 | .6873 | 1.455 | .82413 | 30 |
| 40 | .5688 | .6916 | 1.446 | .82248 | 20 |
| 50 | .5712 | .6959 | 1.437 | .82082 | 10 |
| 35 | .5736 | .7002 | 1.428 | .81915 | 55 |
| 10 | .5760 | .7046 | 1.419 | .81748 | 50 |
| 20 | .5783 | .7089 | 1.411 | .81580 | 40 |
| 30 | .5807 | .7133 | 1.402 | .81412 | 30 |
| 40 | .5831 | .7177 | 1.393 | .81242 | 20 |
| 50 | .5854 | .7221 | 1.385 | .81072 | 10 |
| 36 | .5878 | .7265 | 1.376 | .80902 | 54 |
| 10 | .5901 | .7310 | 1.368 | .80730 | 50 |
| 20 | .5925 | .7355 | 1.360 | .80558 | 40 |
| 30 | .5948 | .7400 | 1.351 | .80386 | 30 |
| 40 | .5972 | .7445 | 1.343 | .80212 | 20 |
| 50 | .5995 | .7490 | 1.335 | .80038 | 10 |
| 37 | .6018 | .7536 | 1.327 | .79864 | 53 |
| 10 | .6041 | .7581 | 1.319 | .79688 | 50 |
| 20 | .6065 | .7627 | 1.311 | .79512 | 40 |
| 30 | .6088 | .7673 | 1.303 | .79335 | 30 |
| 40 | .6111 | .7720 | 1.295 | .79158 | 20 |
| 50 | .6134 | .7766 | 1.288 | .78980 | 10 |
| 38 | .6157 | .7813 | 1.280 | .78801 | 52 |
| 10 | .6180 | .7860 | 1.272 | .78622 | 50 |
| 20 | .6202 | .7907 | 1.265 | .78442 | 40 |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| 30 | .6225 | .7954 | 1.257 | .78261 | 30 |
| 40 | .6248 | .8002 | 1.250 | .78079 | 20 |
| 50 | .6271 | .8050 | 1.242 | .77897 | 10 |
| 39 | .6293 | .8098 | 1.235 | .77715 | 51 |
| 10 | .6316 | .8146 | 1.228 | .77531 | 50 |
| 20 | .6338 | .8195 | 1.220 | .77347 | 40 |
| 30 | .6361 | .8243 | 1.213 | .77162 | 30 |
| 40 | .6383 | .8292 | 1.206 | .76977 | 20 |
| 50 | .6406 | .8342 | 1.199 | .76791 | 10 |
| 40 | .6428 | .8391 | 1.192 | .76604 | 50 |
| 10 | .6450 | .8441 | 1.185 | .76417 | 50 |
| 20 | .6472 | .8491 | 1.178 | .76229 | 40 |
| 30 | .6494 | .8541 | 1.171 | .76041 | 30 |
| 40 | .6517 | .8591 | 1.164 | .75851 | 20 |
| 50 | .6539 | .8642 | 1.157 | .75661 | 10 |
| 41 | .6561 | .8693 | 1.150 | .75471 | 49 |
| 10 | .6583 | .8744 | 1.144 | .75280 | 50 |
| 20 | .6604 | .8796 | 1.137 | .75088 | 40 |
| 30 | .6626 | .8847 | 1.130 | .74896 | 30 |
| 40 | .6648 | .8899 | 1.124 | .74703 | 20 |
| 50 | .6670 | .8952 | 1.117 | .74509 | 10 |
| 42 | .6691 | .9004 | 1.111 | .74314 | 48 |
| 10 | .6713 | .9057 | 1.104 | .74120 | 50 |
| 20 | .6734 | .9110 | 1.098 | .73924 | 40 |
| 30 | .6756 | .9163 | 1.091 | .73728 | 30 |
| 40 | .6777 | .9217 | 1.085 | .73531 | 20 |
| 50 | .6799 | .9271 | 1.079 | .73333 | 10 |
| 43 | .6820 | .9325 | 1.072 | .73135 | 47 |
| 10 | .6841 | .9380 | 1.066 | .72937 | 50 |
| 20 | .6862 | .9435 | 1.060 | .72737 | 40 |
| 30 | .6884 | .9490 | 1.054 | .72537 | 30 |
| 40 | .6905 | .9545 | 1.048 | .72337 | 20 |
| 50 | .6926 | .9601 | 1.042 | .72136 | 10 |
| 44 | .6947 | .9657 | 1.036 | .71934 | 46 |
| 10 | .6967 | .9713 | 1.030 | .71732 | 50 |
| 20 | .6988 | .9770 | 1.024 | .71529 | 40 |
| 30 | .7009 | .9827 | 1.018 | .71325 | 30 |
| 40 | .7030 | .9884 | 1.012 | .71121 | 20 |
| 50 | .7050 | .9942 | 1.006 | .70916 | 10 |
| | .7071 | .1 | 1. | .70711 | 45 |
| | | | | | ° ′ |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |



### Table IX.—Calculation of Earthwork.

| Width | Height 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .02 | .04 | .06 | .07 | .09 | .11 | .13 | .15 | .17 | .18 | .20 | .22 | .24 | .26 | .28 |
| 2 | .04 | .07 | .11 | .15 | .18 | .22 | .26 | .30 | .33 | .37 | .41 | .44 | .48 | .52 | .56 |
| 3 | .06 | .11 | .17 | .22 | .28 | .33 | .39 | .44 | .50 | .56 | .61 | .67 | .72 | .78 | .83 |
| 4 | .07 | .15 | .22 | .30 | .37 | .44 | .52 | .59 | .67 | .74 | .81 | .89 | .96 | 1.04 | 1.11 |
| 5 | .09 | .19 | .28 | .37 | .46 | .56 | .65 | .74 | .83 | .93 | 1.02 | 1.11 | 1.20 | 1.30 | 1.39 |
| 6 | .11 | .22 | .33 | .44 | .56 | .67 | .78 | .89 | 1.00 | 1.11 | 1.22 | 1.33 | 1.44 | 1.55 | 1.67 |
| 7 | .13 | .26 | .39 | .52 | .65 | .78 | .91 | 1.04 | 1.16 | 1.30 | 1.42 | 1.55 | 1.68 | 1.81 | 1.94 |
| 8 | .15 | .30 | .44 | .59 | .74 | .89 | 1.04 | 1.19 | 1.33 | 1.48 | 1.63 | 1.78 | 1.92 | 2.08 | 2.22 |
| 9 | .17 | .33 | .50 | .67 | .83 | 1.00 | 1.17 | 1.33 | 1.50 | 1.67 | 1.83 | 2.00 | 2.17 | 2.33 | 2.50 |
| 10 | .18 | .37 | .56 | .74 | .93 | 1.11 | 1.30 | 1.48 | 1.67 | 1.85 | 2.04 | 2.22 | 2.41 | 2.59 | 2.78 |
| 11 | .20 | .41 | .61 | .82 | 1.02 | 1.22 | 1.43 | 1.63 | 1.83 | 2.04 | 2.24 | 2.44 | 2.65 | 2.85 | 3.06 |
| 12 | .22 | .44 | .67 | .89 | 1.11 | 1.33 | 1.56 | 1.78 | 2.00 | 2.22 | 2.44 | 2.67 | 2.89 | 3.11 | 3.33 |
| 13 | .24 | .48 | .72 | .96 | 1.20 | 1.44 | 1.68 | 1.92 | 2.16 | 2.41 | 2.65 | 2.89 | 3.13 | 3.37 | 3.61 |
| 14 | .26 | .52 | .78 | 1.04 | 1.30 | 1.55 | 1.81 | 2.08 | 2.33 | 2.59 | 2.85 | 3.11 | 3.37 | 3.63 | 3.89 |
| 15 | .28 | .56 | .83 | 1.11 | 1.39 | 1.67 | 1.94 | 2.22 | 2.50 | 2.78 | 3.06 | 3.33 | 3.61 | 3.89 | 4.17 |
| 16 | .30 | .59 | .89 | 1.18 | 1.48 | 1.78 | 2.07 | 2.37 | 2.67 | 2.96 | 3.26 | 3.56 | 3.85 | 4.15 | 4.44 |
| 17 | .31 | .63 | .94 | 1.26 | 1.57 | 1.89 | 2.20 | 2.52 | 2.83 | 3.15 | 3.46 | 3.78 | 4.09 | 4.41 | 4.72 |
| 18 | .33 | .67 | 1.00 | 1.33 | 1.67 | 2.00 | 2.33 | 2.67 | 3.00 | 3.33 | 3.67 | 4.00 | 4.33 | 4.67 | 5.00 |
| 19 | .35 | .70 | 1.06 | 1.41 | 1.76 | 2.11 | 2.46 | 2.82 | 3.17 | 3.52 | 3.87 | 4.22 | 4.57 | 4.92 | 5.28 |
| 20 | .37 | .74 | 1.11 | 1.48 | 1.85 | 2.22 | 2.59 | 2.96 | 3.33 | 3.70 | 4.07 | 4.44 | 4.81 | 5.18 | 5.56 |
| 21 | .39 | .78 | 1.17 | 1.55 | 1.94 | 2.33 | 2.72 | 3.11 | 3.50 | 3.89 | 4.28 | 4.67 | 5.06 | 5.44 | 5.83 |
| 22 | .41 | .81 | 1.22 | 1.63 | 2.04 | 2.44 | 2.85 | 3.26 | 3.67 | 4.07 | 4.48 | 4.89 | 5.30 | 5.70 | 6.11 |
| 23 | .43 | .85 | 1.28 | 1.70 | 2.13 | 2.56 | 2.98 | 3.41 | 3.83 | 4.26 | 4.68 | 5.11 | 5.54 | 5.96 | 6.39 |
| 24 | .44 | .89 | 1.33 | 1.78 | 2.22 | 2.67 | 3.11 | 3.56 | 4.00 | 4.44 | 4.89 | 5.33 | 5.78 | 6.22 | 6.67 |
| 25 | .46 | .92 | 1.39 | 1.85 | 2.31 | 2.78 | 3.24 | 3.70 | 4.17 | 4.63 | 5.09 | 5.56 | 6.02 | 6.48 | 6.94 |
| 26 | .48 | .96 | 1.44 | 1.92 | 2.41 | 2.89 | 3.37 | 3.85 | 4.33 | 4.82 | 5.30 | 5.78 | 6.26 | 6.74 | 7.24 |
| 27 | .50 | 1.00 | 1.50 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 |
| 28 | .52 | 1.04 | 1.55 | 2.07 | 2.59 | 3.11 | 3.63 | 4.15 | 4.67 | 5.18 | 5.70 | 6.22 | 6.74 | 7.26 | 7.78 |
| 29 | .54 | 1.07 | 1.61 | 2.15 | 2.68 | 3.22 | 3.76 | 4.30 | 4.83 | 5.37 | 5.91 | 6.44 | 6.98 | 7.52 | 8.06 |
| 30 | .56 | 1.11 | 1.67 | 2.22 | 2.78 | 3.33 | 3.89 | 4.44 | 5.00 | 5.55 | 6.11 | 6.67 | 7.22 | 7.78 | 8.33 |
| 31 | .57 | 1.15 | 1.72 | 2.30 | 2.87 | 3.44 | 4.02 | 4.59 | 5.17 | 5.74 | 6.32 | 6.89 | 7.46 | 8.04 | 8.61 |
| 32 | .59 | 1.18 | 1.78 | 2.37 | 2.96 | 3.56 | 4.15 | 4.74 | 5.33 | 5.92 | 6.52 | 7.11 | 7.70 | 8.30 | 8.89 |
| 33 | .61 | 1.22 | 1.83 | 2.44 | 3.05 | 3.67 | 4.28 | 4.89 | 5.50 | 6.11 | 6.72 | 7.33 | 7.94 | 8.55 | 9.17 |
| 34 | .63 | 1.26 | 1.89 | 2.52 | 3.15 | 3.78 | 4.40 | 5.04 | 5.67 | 6.29 | 6.93 | 7.56 | 8.18 | 8.81 | 9.44 |
| 35 | .65 | 1.30 | 1.94 | 2.59 | 3.24 | 3.89 | 4.53 | 5.18 | 5.83 | 6.48 | 7.13 | 7.78 | 8.42 | 9.08 | 9.72 |
| 36 | .67 | 1.33 | 2.00 | 2.67 | 3.33 | 4.00 | 4.66 | 5.33 | 6.00 | 6.67 | 7.33 | 8.00 | 8.67 | 9.33 | 10.00 |
| 37 | .68 | 1.37 | 2.06 | 2.74 | 3.42 | 4.11 | 4.79 | 5.48 | 6.17 | 6.85 | 7.54 | 8.22 | 8.91 | 9.59 | 10.28 |
| 38 | .70 | 1.41 | 2.11 | 2.82 | 3.52 | 4.22 | 4.92 | 5.63 | 6.33 | 7.03 | 7.74 | 8.44 | 9.15 | 9.85 | 10.56 |
| 39 | .72 | 1.44 | 2.17 | 2.89 | 3.61 | 4.33 | 5.05 | 5.78 | 6.50 | 7.22 | 7.95 | 8.67 | 9.39 | 10.11 | 10.83 |
| 40 | .74 | 1.48 | 2.22 | 2.96 | 3.70 | 4.44 | 5.18 | 5.92 | 6.67 | 7.41 | 8.15 | 8.89 | 9.63 | 10.37 | 11.11 |

Table gives cu. yds. in 1 ft. of a triangle of given width and height. Corrections for tenths of width are one tenth the values found under each height considering the widths from 1 to 9 as tenths and similarly the corrections for tenths of height are one tenth the figures opposite width considering the heights from 1 to 9 as tenths. Thus if w=16.2 and h=5.3, cu. yds.=1.48+.018+.089=1.587 cu. yds. or practically 159 cu. yds. per 100 ft. If w exceeds 40 ft., use one half and multiply result by 2, if both w and h are large use one half of each and multiply result by 4. Any cross-section may be divided into triangles by the following rule. To the triangle of the sum of the outside cuts (or fills) =h, and ½ the roadbed =w, add the triangles formed by taking the distance out to each break in turn (=w's) by the difference between the cuts (or fills) on each side of it (=h's) always subtracting the outer from the inner.

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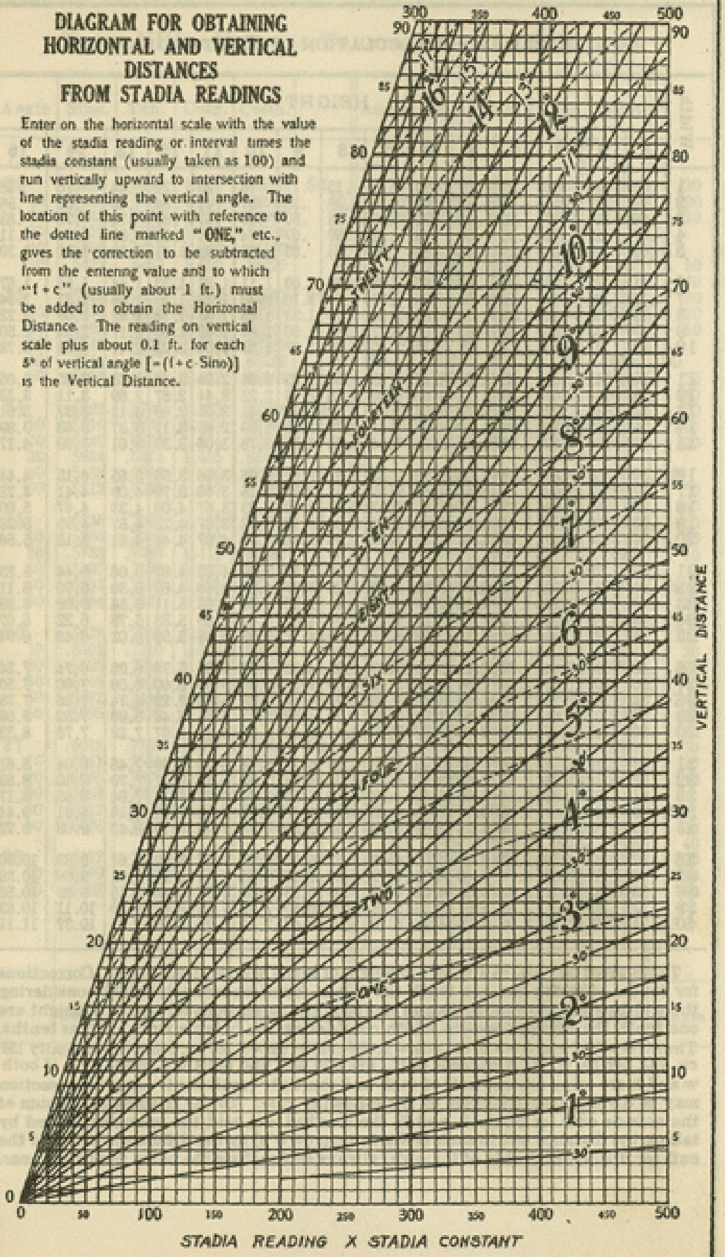
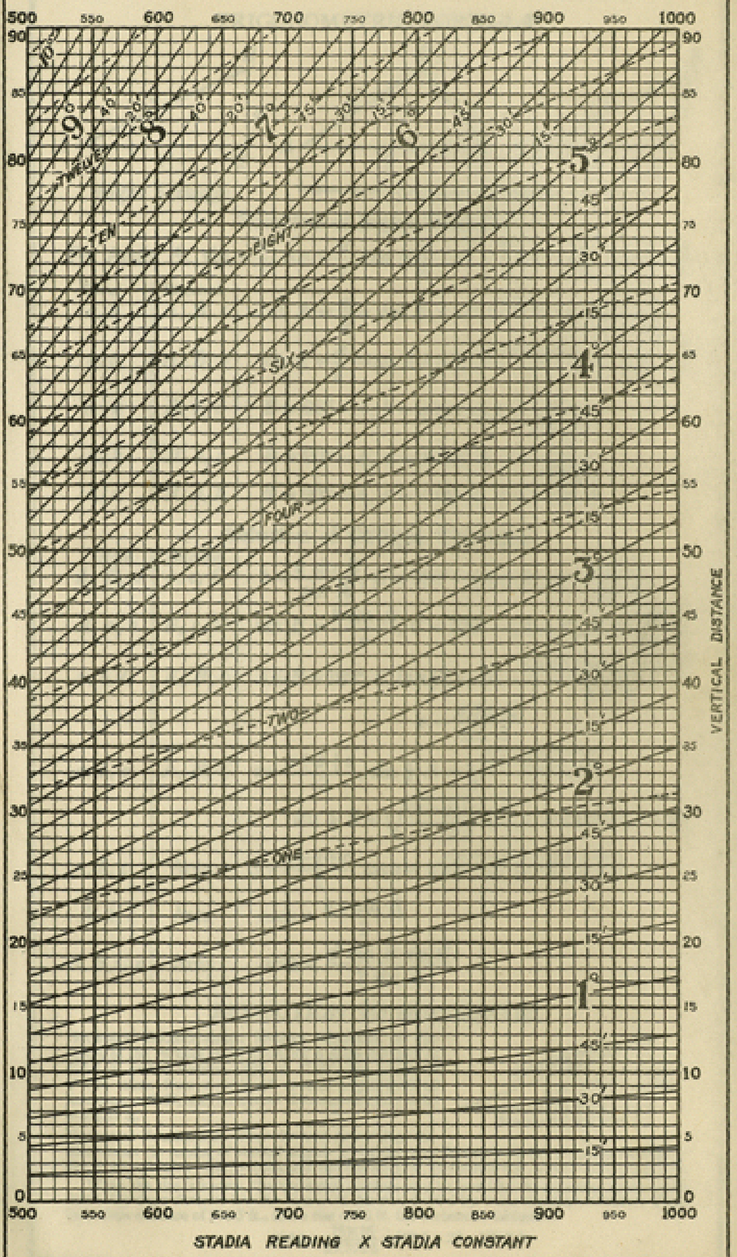
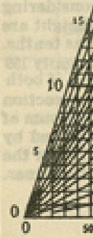
## DIAGRAM FOR OBTAINING HORIZONTAL AND VERTICAL DISTANCES FROM STADIA READINGS

Enter on the horizontal scale with the value of the stadia reading or interval times the stadia constant (usually taken as 100) and run vertically upward to intersection with line representing the vertical angle. The location of this point with reference to the dotted line marked "ONE," etc., gives the correction to be subtracted from the entering value and to which "f + c" (usually about 1 ft.) must be added to obtain the Horizontal Distance. The reading on vertical scale plus about 0.1 ft. for each 5° of vertical angle [= (f + c·Sinα)] is the Vertical Distance.

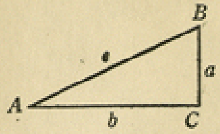


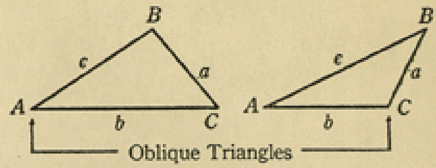

counter 42258



## TRIGONOMETRIC FORMULÆ




Right Triangle




Oblique Triangles

### Solution of Right Triangles

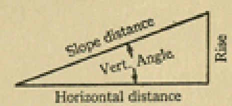
For Angle $A$. $\sin = \frac{a}{c}$, $\cos = \frac{b}{c}$, $\tan = \frac{a}{b}$, $\cot = \frac{b}{a}$, $\sec = \frac{c}{b}$, $\operatorname{cosec} = \frac{c}{a}$

| 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 | |
|---|---|---|
| $A, B, a$ | $b, c, C$ | $b = \frac{a \sin B}{\sin A},\ C = 180° - (A+B),\ c = \frac{a \sin C}{\sin A}$ |
| $A, a, b$ | $B, c, C$ | $\sin B = \frac{b \sin A}{a},\ C = 180° - (A+B),\ c = \frac{a \sin C}{\sin A}$ |
| $a, b, C$ | $A, B, c$ | $A+B = 180° - C, \tan\frac{1}{2}(A-B) = \frac{(a-b)\tan\frac{1}{2}(A+B)}{a+b}$; $c = \frac{a \sin C}{\sin A}$ |
| $a, b, c$ | $A, B, C$ | $s = \frac{a+b+c}{2},\ \sin\frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{bc}},$ $\sin\frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{ac}},\ C = 180° - (A+B)$ |
| $a, b, c$ | Area | $s = \frac{a+b+c}{2}$, area $= \sqrt{s(s-a)\,(s-b)\,(s-c)}$ |
| $A, b, c$ | Area | area $= \frac{b\,c \sin A}{2}$ |
| $A, B, C, a$ | Area | 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, for a slope distance of 403.6 ft. and a vertical angle of 4° 40′—the cosine of 4° 40′, taken from a table of natural trigonometrical functions, = .9967, and horizontal distance = 403.6 x .9967 = 402.27 ft.

Horizontal distance also = Slope distance minus slope distance times (1—cosine of vertical angle). Using the same figures as in the preceding example—Cos. 4° 40′ = .9967. 1−.9967 = .0033. 403.6 x .0033 = 1.33 ft. Horizontal dist. = 403.6 − 1.33 = 402.27 ft.

When the rise is known, the horizontal distance may be found by the following approximate rule:— the slope distance less the square of the rise divided by twice the slope distance. Thus, for a slope distance of 372.5 ft., and a rise of 15 ft. the horizontal distance =

$$372.5 - \frac{15 \times 15}{2 \times 372.5} = 372.5 - .30 = 372.2 \text{ ft.}$$

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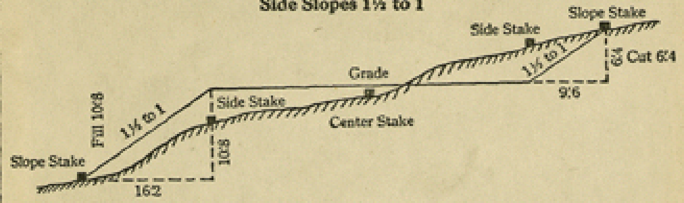
**DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING**
**Roadway of any Width**
**Side Slopes 1½ to 1**




In the figure above: Opposite 6 under "Cut or Fill" and under .4 read 9.6 the distance from the side stake to the slope stake at right. Opposite 10 under "Cut or Fill" and under .8 read 16.2, the distance from the side stake to the slope stake at the left.

| Cut or Fill | 0 | .1 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | .9 | Cut or Fill |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Distance out from Side or Shoulder Stake | | | | | | | | | | |
| 0 | 0.0 | 0.2 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 0 |
| 1 | 1.5 | 1.7 | 1.8 | 2.0 | 2.1 | 2.3 | 2.4 | 2.6 | 2.7 | 2.9 | 1 |
| 2 | 3.0 | 3.2 | 3.3 | 3.5 | 3.6 | 3.8 | 3.9 | 4.1 | 4.2 | 4.4 | 2 |
| 3 | 4.5 | 4.7 | 4.8 | 5.0 | 5.1 | 5.3 | 5.4 | 5.6 | 5.7 | 5.9 | 3 |
| 4 | 6.0 | 6.2 | 6.3 | 6.5 | 6.6 | 6.8 | 6.9 | 7.1 | 7.2 | 7.4 | 4 |
| 5 | 7.5 | 7.7 | 7.8 | 8.0 | 8.1 | 8.3 | 8.4 | 8.6 | 8.7 | 8.9 | 5 |
| 6 | 9.0 | 9.2 | 9.3 | 9.5 | 9.6 | 9.8 | 9.9 | 10.1 | 10.2 | 10.4 | 6 |
| 7 | 10.5 | 10.7 | 10.8 | 11.0 | 11.1 | 11.3 | 11.4 | 11.6 | 11.7 | 11.9 | 7 |
| 8 | 12.0 | 12.2 | 12.3 | 12.5 | 12.6 | 12.8 | 12.9 | 13.1 | 13.2 | 13.4 | 8 |
| 9 | 13.5 | 13.7 | 13.8 | 14.0 | 14.1 | 14.3 | 14.4 | 14.6 | 14.7 | 14.9 | 9 |
| 10 | 15.0 | 15.2 | 15.3 | 15.5 | 15.6 | 15.8 | 15.9 | 16.1 | 16.2 | 16.4 | 10 |
| 11 | 16.5 | 16.7 | 16.8 | 17.0 | 17.1 | 17.3 | 17.4 | 17.6 | 17.7 | 17.9 | 11 |
| 12 | 18.0 | 18.2 | 18.3 | 18.5 | 18.6 | 18.8 | 18.9 | 19.1 | 19.2 | 19.4 | 12 |
| 13 | 19.5 | 19.7 | 19.8 | 20.0 | 20.1 | 20.3 | 20.4 | 20.6 | 20.7 | 20.9 | 13 |
| 14 | 21.0 | 21.2 | 21.3 | 21.5 | 21.6 | 21.8 | 21.9 | 22.1 | 22.2 | 22.4 | 14 |
| 15 | 22.5 | 22.7 | 22.8 | 23.0 | 23.1 | 23.3 | 23.4 | 23.6 | 23.7 | 23.9 | 15 |
| 16 | 24.0 | 24.2 | 24.3 | 24.5 | 24.6 | 24.8 | 24.9 | 25.1 | 25.2 | 25.4 | 16 |
| 17 | 25.5 | 25.7 | 25.8 | 26.0 | 26.1 | 26.3 | 26.4 | 26.6 | 26.7 | 26.9 | 17 |
| 18 | 27.0 | 27.2 | 27.3 | 27.5 | 27.6 | 27.8 | 27.9 | 28.1 | 28.2 | 28.4 | 18 |
| 19 | 28.5 | 28.7 | 28.8 | 29.0 | 29.1 | 29.3 | 29.4 | 29.6 | 29.7 | 29.9 | 19 |
| 20 | 30.0 | 30.2 | 30.3 | 30.5 | 30.6 | 30.8 | 30.9 | 31.1 | 31.2 | 31.4 | 20 |
| 21 | 31.5 | 31.7 | 31.8 | 32.0 | 32.1 | 32.3 | 32.4 | 32.6 | 32.7 | 32.9 | 21 |
| 22 | 33.0 | 33.2 | 33.3 | 33.5 | 33.6 | 33.8 | 33.9 | 34.1 | 34.2 | 34.4 | 22 |
| 23 | 34.5 | 34.7 | 34.8 | 35.0 | 35.1 | 35.3 | 35.4 | 35.6 | 35.7 | 35.9 | 23 |
| 24 | 36.0 | 36.2 | 36.3 | 36.5 | 36.6 | 36.8 | 36.9 | 37.1 | 37.2 | 37.4 | 24 |
| 25 | 37.5 | 37.7 | 37.8 | 38.0 | 38.1 | 38.3 | 38.4 | 38.6 | 38.7 | 38.9 | 25 |
| 26 | 39.0 | 39.2 | 39.3 | 39.5 | 39.6 | 39.8 | 39.9 | 40.1 | 40.2 | 40.4 | 26 |
| 27 | 40.5 | 40.7 | 40.8 | 41.0 | 41.1 | 41.3 | 41.4 | 41.6 | 41.7 | 41.9 | 27 |
| 28 | 42.0 | 42.2 | 42.3 | 42.5 | 42.6 | 42.8 | 42.9 | 43.1 | 43.2 | 43.4 | 28 |
| 29 | 43.5 | 43.7 | 43.8 | 44.0 | 44.1 | 44.3 | 44.4 | 44.6 | 44.7 | 44.9 | 29 |
| 30 | 45.0 | 45.2 | 45.3 | 45.5 | 45.6 | 45.8 | 45.9 | 46.1 | 46.2 | 46.4 | 30 |
| 31 | 46.5 | 46.7 | 46.8 | 47.0 | 47.1 | 47.3 | 47.4 | 47.6 | 47.7 | 47.9 | 31 |
| 32 | 48.0 | 48.2 | 48.3 | 48.5 | 48.6 | 48.8 | 48.9 | 49.1 | 49.2 | 49.4 | 32 |
| 33 | 49.5 | 49.7 | 49.8 | 50.0 | 50.1 | 50.3 | 50.4 | 50.6 | 50.7 | 50.9 | 33 |
| 34 | 51.0 | 51.2 | 51.3 | 51.5 | 51.6 | 51.8 | 51.9 | 52.1 | 52.2 | 52.4 | 34 |
| 35 | 52.5 | 52.7 | 52.8 | 53.0 | 53.1 | 53.3 | 53.4 | 53.6 | 53.7 | 53.9 | 35 |
| 36 | 54.0 | 54.2 | 54.3 | 54.5 | 54.6 | 54.8 | 54.9 | 55.1 | 55.2 | 55.4 | 36 |
| 37 | 55.5 | 55.7 | 55.8 | 56.0 | 56.1 | 56.3 | 56.4 | 56.6 | 56.7 | 56.9 | 37 |
| 38 | 57.0 | 57.2 | 57.3 | 57.5 | 57.6 | 57.8 | 57.9 | 58.1 | 58.2 | 58.4 | 38 |
| 39 | 58.5 | 58.7 | 58.8 | 59.0 | 59.1 | 59.3 | 59.4 | 59.6 | 59.7 | 59.9 | 39 |
| 40 | 60.0 | 60.2 | 60.3 | 60.5 | 60.6 | 60.8 | 60.9 | 61.1 | 61.2 | 61.4 | 40 |

EUGENE DIETZGEN CO.

ARANSAS CO. RLD. SK. #17

8246
502
8748

U-10

U-10-1

3/16 Lv. Ho. Speed 9375

N57°11'E
5671
1230
N4441E

14923 or 22
5711
9212

17960
9212
N8748E
4307
4441

This Field Book is manufactured of a High Grade 50% Rag Paper having a WATER RESISTING SURFACE, and is sewed with Bing Special Enamel Waterproof thread.

Made in U. S. A.

counter 12263

Survey of Marsh Inclosed by
Copano Bay & Wm. Steele
Survey No. 2 Aransas Co. Texas
For - State of Texas

Beg at U.S.C. & G.S. B.M. X-604
See Notes Vol. U-10 Pg. 1 fac.
Hub 548.70' N82°46' E

Th. ∠ 0°00'
N82°46' E
at 37.5 Found Hub Set By Me
on 2/17/53 for Triangulation
Point "A" of This Survey. See
Pg. 2 this Vol. for Triangulation

Th. ∠ 85°02' Lt.
N2°16' W Mag N2°10' W
at 497.8 Set Hub. fen. on E.S. Hwy 30.0 Lt.
℄ Tarvia on Hwy. # 136 - 34.2 Lt.
Hwy is on Curve Here

Th ∠ 91°26' Rt.
N89°10' E
to Δ Hub "B"



3/16/53 Wicklund - McKay
Ptly Cloudy & Warm
Var. 9°45' E - Dietzgen 9868 - 100' Tape.
Arrived on Job 3:00 P.M.
Spent Rest of Day Setting Δ Pts.

Note.
1.1 El. = Points of 1.1' Elev.
0.7 = " " 0.7 "
Veg. = Vegation Line
T.S. = Toe Slope.
T.B. = Top Bank.

3/17/53 Wicklund - McKay - Corpus
High Wind - Ptly - Cloudy.

Met Mr. Wheeler on Ground and
Rec'd Permission to go thru His
Property.

9126
216
8910

8462
8246
216

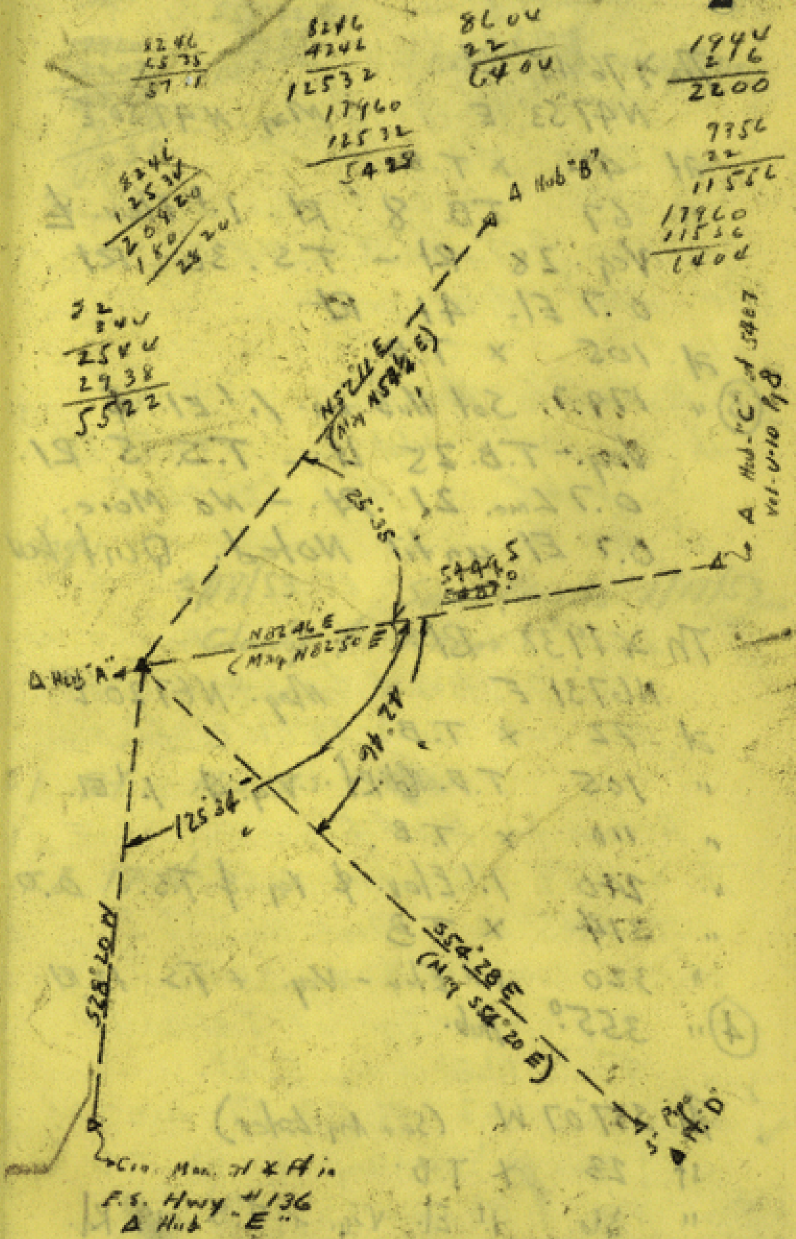
counter 42264

Return to 497.8 Hub Pg. 1
Th ∡ 19°44' Lt. fac. N 2°16 W
N22°00' W  Mag. N22°00' W
at 377.55 Set Hub at About P.T.
of Hwy. 136 ℄ Tarvia on Same
13.3 Lt. Con. Mon in fen. on (N64°04' E)
E.S. Hwy. Brs. ∡ 86°04' Rt. 50.1 ft.
Another Conc. Mon on W.S. Hwy
Brs. ∡ 93°56' Lt. (S64°04' W). 69.9 ft.

Th ∡ 3°44' Lt.
N25°44' W  Mag. N25°40' W
(1) 864.15 Set Hub ℄ Tarvia on Hwy.
No 136 - 12.6 Lt

Th. ∡ 29°38' Lt fac. S25°44' E
S55°22' E  Mag. S55°20' E
at 98.5 × fen. on E.S. Hwy.
" 127 Hit 1.' El. - Also Veg.
T.S. ℄ 0.7 El. 16' Rt. - T.B.
20 Lt.
at 230 1.' El. 56 Lt. T.S. 71 Lt
T.B. ℄ Veg. 91 Lt - 0.7 El. 9' Rt
(2) at 323.75 Hub. on 1.' El. ℄ Veg. T.B.
30 Lt 0.' El. ℄ T.S. 0' Rt





Th ∡ 76°45' Lt.
N47°53' E     Mag. N47°30' E
at 42 × T.B
" 67 T.B. 8' Rt. 1.' Elev. ℄
" Veg. 28 Rt – T.S. 30 Rt
0.7 El. 41 Rt
at 105 × T.B.
(3) " 179.7 Set Hub on 1.' El. ℄
Veg. – T.B. 25 Lt. – T.S. 5 Rt.
0.7 Lme. 21 Rt. – No More.
0.7 El. until Noted. Quit for day.

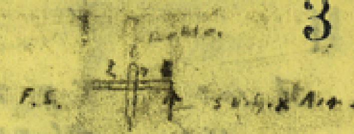
Th ∡ 19°38' Rt.
N67°31' E     Mag. N67°20' E
at 72 × T.B.
" 105 T.B. 16 Rt. Veg. & 1.' El. 21 Rt. Also T.S.
" 110 × T.B.
" 240 1.' Elev. & Veg & T.S. 0.0 T.B. 17 Lt.
" 314 × T.B
" 320 1.' Elev – Veg. + T.S. 12 Rt.
(4) " 355.0 Hub.

Th S37°07' W (See Ang. Later)
at 23 × T.B.
" 36 1.' El. Veg. + T.S. 1 Rt.



S55°22' E
76 45
132 07

179 60
132 07
47 53
19 38
67 31




3/18/53     Same Crew as 3/17/53
Cloudy & Warm

at 100 T.B. 20 Lt
" 166 1.' El. ¢ Veg. 0.0
" 240 T.B. 0.0
" 288 1.' El. ¢ Veg. 4 Rt.
" 330 Tip of T.B. 18 Lt.
5 " 401.5 Hub.

Return to Hub #3
Th ∡ 107°13' Rt. fac. N47°53 E
S24°54 E Mag. S25°05 E
at 21 " 0.7 El. 2 Rt.
" 182 " " 65 " "
6 " 203.35 Hub. on 1.' El. ¢ Veg. 0.7 El.
66' ft. S13¾ W. ¢ 54 ft. S27¼ E Both T.S. - Also
Hub. No 4 Bis. ∡ 62°01 Rt fac N24°54 W - N37°07 E

Return to Hub #5
Th. ∡ 88°59' Rt fac. N24°54 W
N64°05' E Mag. N63°55 E
at 15 1.' El. ¢ Veg. 23 Rt
" 75 Wly. Tip of T.B. 20 Lt.
" 92 1.' El. + Veg. 5 Rt
" 190 0.7 El. 144' Rt. Also T.S.
" 131 1.' El. + Veg. 9 Rt T.B. 30 Lt
" 370 0.7 El + T.S. 133' Rt



N 47 53 E
107 13
155 06

179 60
155 06
24 54

61 61
24 54
37 07

88 59
24 54
64 05

at Wly - Pt of Same.

at 345 Veg + 1.' El. 0.0 T.B.
" 520 1.' El. & Veg. 0.0 T.B.
6 " 579.9 Hub. 1.' El. & Veg. 6' Rt
T.B. 23 Lt. T.B. 30 Lt. —
B.B. Also 115' N35°E T.B. Also
118 N35°E 0.7 El. 148 A S5½W

Th ∢ 55°12' Rt.
S60°43' ~~Rt~~ Mag. S60 3/4°E
at 36 W El. & Veg. 6 Rt
" 80 " " " " 32 "
" 126 " " " " 41 " 0.7
" 126 × B.B.
" 127 × T.B.
" 167 T.B. 16 Rt. 1.' El. 44 Rt
" 200 T.B. 0.0 - 1.' El. Veg.
7 " 284.8 Hub on 1.' El. & Veg. - 0.7

Th ∢ 89°15' Lt
N30°02' E Mag. N30°0' E
at. 30 1.' El. + Veg. 25 Rt. 0.7
" 70 " " " " 12 " "
" 153 1.' El. + Veg. 0.0 0.7 El.
" 183 × Power Line
" 200 1.' El. + Veg. 5 Rt. 0.7 El.



N64°05' E
55 12
119 17

33 Lt.
15 Lt

6.3
17960
11917
6043

Note:- To Here ~~B.B. Point 115' Toward~~ Low Ground for Toe Slope or From Here on Designated as Bottom of Bank or B.B.

B.B. El. at #6 = ~~1.3~~ El. T.B. = 3.0

6.25
3.75
2.50

5.55
7
6.25
3.75
1.5

6043
8915
14958

17960
14958
3002

El. 119 Rt

240 20 T.B.
40 Lt. 0.7 El. 57 Rt
El. 14 Rt - B.B. 38 Lt T.B. 40 Lt.
at #7. B.B. 1.5 El. T.B. 2.3 El.

El. 38 Rt.
" 19 " B.B. 12 Lt. T.B. 25 Lt
11 Rt. " " 10 " " " 20 "

20 Rt - B.B. 12 Lt. T.B. 20 Lt

counter 42268

at. 232 X B.B.
" 242 X T.B.
" 245 1.' El. + Vg. 45 Rt. 0.7 El.
" 320 T.B. 7 Rt. B.B. 10 Rt. 1.' El.
8 " 381.85 Hub. T.B. 10 Rt. B.B. 15 Rt.
Con. Mon. Near S.E. Cor. Borrow Pit
Brs. X 26°48 Rt. for. S30°02 W
S56°50 W 170.' ft.

Th X 21°31 Rt.
N51°33 E Mag. N51½ E
at 30 X T.B.
" 42 X B.B. - T.B. 5 Lt. - 1.' El. + Vg.
" 170 1.' El + Vg. 0.0 B.B. 6 Lt.
" 283 B.B. 6 Lt T.B. 10 Lt. 1.' El. & Vg.
" 354 X B.B. T.B. 5 Lt. 1.' El. & Vg.
" 375 X T.B.
" 430 T.B. 24 Rt. B.B. 27 Rt. 1.' El. &
9 " 479.8 Fnd Con. Mon. Near N.E. Cor.
Borrow Pit - Con. Mon. Placed at
22+74.5 V. 1. U. 10 Pg. 24 -
T.B. 50 Lt B.B. 52 Rt. 1.' El & Vg 61 Rt
S24°00 W Ln. Brs. X 27°30 Lt. for
S51°33 W - S24°03 W - 0°03 Error



30°02
26 48
56 50

N30°02 E
X 21 31 Rt.
51 33

55 Rt.
& Vg. 22 Rt. 0.7 El. 34 Rt.
1.' El. & Vg. 23 Rt. 0.7 El. 35 Rt.

B.B. at 48 = 1.4 El. T.B. = 1.9 El.

11 Rt. 0.7 El. 25 Rt.
T.B. 12 Lt. 0.7 El. 15 Rt.
3 Rt. 0.7 El. 14 Rt.
12 Rt. 0.7 " 53 Lt.

Vg. 37 Rt. 0.7 El. 65 Rt.

at A 9 BB = 1.3 El T.B = 2.4 El.

0.7 El. 88 Rt.

7

Th ∡ 31 42 Rt.
N 83 15 E    Mag. N 13 20 E

| | | |
|---|---|---|
| at | 175 | T.B. 27 Rt. B.B. 28 Rt. 1.1 El. |
| " | 300 | X T.B. " " 8 " " " |
| " | 400 | B.B. 41 Lt. T.B. 42 Lt. |
| " | 412 | X 1.1 El. ¢ Veg. Line. |
| " | 482 | 1.1 El. 37 Lt. Veg. 33 Lt. |
| " | 547 | X 1.1 El. Line |
| (10) " | 576.5 | Hub. |

Side Shot -
From H. 10
Th N. 76¼° E

| | | |
|---|---|---|
| at | 0.0 | Veg. 37 Lt. B.B. 62 Lt. |
| " | 100 | " 20 " " " 35 " |
| " | 200 | B.B. & Veg. Line 39 Lt. T.B. |
| " | 242 | X Veg. Line |
| " | 255 | B.B. 32 Lt. T.B. 37 Lt. |
| " | 264 | X B.B. |
| " | 267 | T.B. |

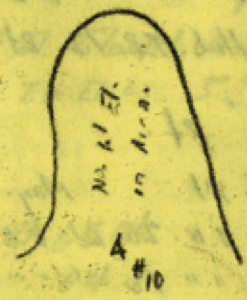
Th ∡ 69 44 Lt. for S 83 15 W from
S 13 31 W    Mag. S 13½° W

| | | |
|---|---|---|
| at | 72 | X Veg. Line 1.1 El. 4 Rt. |
| " | 175 | 1.1 El. ¢ Veg. 13 Rt. 0.7 El. |

N 51 33 E
31 42
83 15

82 75
69 44
13 31

¢ Veg. 44 Rt. 0.7 El. 84 Rt.
" " 30 " " " 65 "
1.2 ¢ Veg. 5 Rt. 0.7 El. 48 Rt.
Note. No More 0.7 Pts. until Noted.
B.B. 74 Lt. T.B. 75 Lt.




T.B. 65 Lt.
" " 40 " Veg. 42 Rt. B.B. 125 Rt. T.B. 130
44 Lt. " 17 " " " 54 " " " 55

B.B. 25 Rt. T.B. 30 Rt.

at #10. B.B. El = 1.5 T.B. El. = 2.7

#10

117 Rt. (Runs to Last Pt. on 0.7) B.B. 58 Lt. TB. 60 Lt.

counter 42270

at 275 1.' El. 15 El. Veg. 72 Rt. 0.7
" 400 1.1 " 30 " " ¢ 0.7
" 430 X B.B.
" 431 X T.B. 9 End Veg. in Flat
" 445 T.B. 27 Rt B.B. 30 Rt
" 500 T.B. 9 Veg. 63 Rt. B.B. 68 Rt
" 580 " " " " 80 " " " 82 "
" 720 " " " " 62 " " " 64 "
(11) " 818.! Hub. T.B. 12 Rt. B.B. 18 Rt.

Th. ∡ 31°15' Rt.
S44°46'W Mag. S44 3/4°W
at 125 T.B. 20 Rt. B.B. 21 Rt. 1.' El. ¢
" 240 " " 12 " " " 15 " " " "
" 340 " " 21 " " " 26 " " " "
" 410 " " 12 " " " 20 " " " "
" 520 " " 22 " " " 25 " " " "
" 630 " " 4 " " " 7 " " " "
" 750 " " 7 " " " 10 " " " "
" 875 X T.B
" 878 X B.B.
" 900 B.B. 2 Lt. T.B. 5 Lt. 1.' El. ¢
" 916 X B.B
" 919 X TB.
" 1030 T.B. 14 Rt. B.B. 15 Rt. 1.' El.



S13°31'W
31 15
R44°46'

El. 116 Rt. B.B. 50 Lt. T.B. 51 Lt.
El. 110 Rt. B.B. 31 Lt. T.B. 32 Lt

Veg on T.B.
1.' El 68 Rt. 0.7 El. 124 Rt.
1.' " 98 " " " " 132 "
" " " 100 " " " " 121 "
" " " 76 " " " " 96 "
Veg. 28 Rt. 1.' El. 56 Rt. 0.7 El. 92 Rt
B.B. El. 1.7 T.B. El. = 5.0 at # 11

Veg. 30 Rt. 0.7 El. 65 Rt
" 46 " " " " 64 "
" 32 " " " " 56 "
" 28 " " " " 52 "
" 30 " " " " 48 "
" 21 " " " " 55 "
" 13 " " " " 70 "

Veg. 5 Rt. 0.7 El. 65 Rt

¢ Veg. 21 Rt. 0.7 El. 56 Rt

at 11.60 T.B. 9 Rt. B.B. Veg. & 1.' El.
" 11 80 × T.B. at S.W. Tip
"B" " 1246.45 Δ Hub. "B" 1.' El. &
Veg. 13 Rt × Rt. 0.7 El. 34 Rt × Rt
1.' El. & Veg. 7 S44°46 W. 0.7 El.
15' S44°46 W Quit for day.

Th ∠12°30' Rt.
~~S57°16~~ W to Δ Pt "A"
Should Be S57°11 W or 0°05 Error
in Traverse Just Closed.
Used This Line Now as S57°11 W

From "B"
Th ∠21°42' Lt. for N87°48 E
N66°06 E Mag. N66°05 E
at 0.0 1.' El. & Veg. 12 Rt. 0.7 El 23 Rt
" 55 " " " " 15 " " " " 25 "
" 65 B.B. 15 Lt. T.B. 22 Lt.
" 128 × Ono 1.' El. 0.7 El. 42 Rt
" 170 1.' El. & Veg. 8 Lt. B.B. 23 Lt.
T.B. 24 Lt — 1.' El. Also 39
& 62 Rt. at west End Peninsula.
0.7 El. 67 Rt.
See Sketch on Pg. 10.



544°46'
12 30
57 16

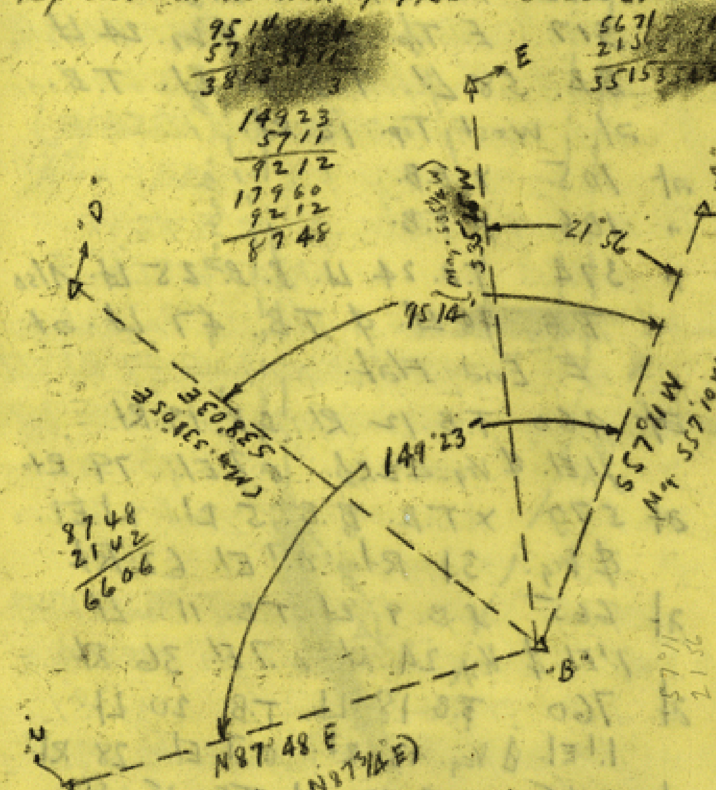
2.58
2.35
.23

27 Rt. 0.7 El. 55 Rt

→ 1185 × B.B.

at B. B.B. El = 1.6 T.B. El = 2.0
3/19/53 Same Crew as 3/18/53
Cloudy & Warm.

Top water at 7:30 AM. 3/19/53: 0.23 El.




Triangulation at "B"

at 220 1.' El & Veg. 18 Lt. B.B.
37 Lt. T.B. 42 Lt -- 1.' Elev.
Also 26 Rt.

at 275 1.' El & Veg. 23 Lt. B.B. 52 Lt
T.B. 55 Lt - Also 1.' El. & Veg.
9 ~~6~~ 6.8 Rt 0.7 El. 80 Rt

at 292 Rd. X 1.' El. & Veg.
" 317 E. Tip. 1.' El. & Veg. 24 Lt
B.B. 58 Lt. T.B. 61 Lt. T.B.
at West Tip 12 Rt.

at 105 X B.B.
" 106 X T.B.
" 374 T.B. 24 Lt. B.B. 25 Lt. Also
B.B. 46 Lt. & T.B. 47 Lt. at
E. End Flat.

at 460 T.B. 12 Rt.; B.B. 13 Rt.
1.' El. & Veg. 42 Rt. 0.7 El. 79 Rt

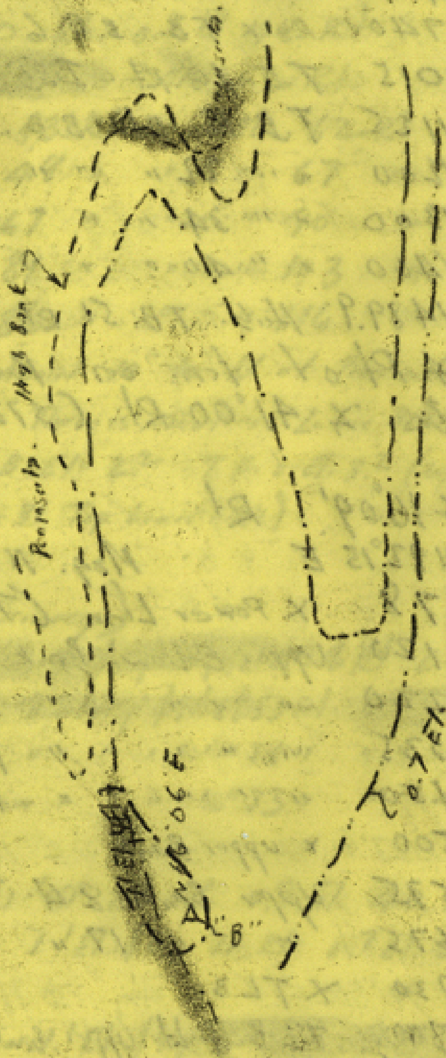
at 570 X T.B. B.B. 5 Rt. 1.' El.
& Veg. 31 Rt. 0.7 El. 62 Rt

at 665 B.B. 9 Lt. T.B. 11 Lt
1.' El. & Veg. 24 Rt. 0.7 El. 36 Rt

at 760 T.B. 18 Lt. T.B. 20 Lt
1.' El. & Veg. 13 Rt. 0.7 El. 28 Rt

at 845 B.B. 10 Lt. T.B. 15 Lt.
1.' El. & Veg. 21 Rt. 0.7 El. 33 Rt.





@ 900 X B.B.
" 940 R.x T.B. B.B. 6 Rt. 1.'El.
" 1015 T.B. ~~20~~ Rt. ~~[illegible]~~
" 1125 T.B. 16 Rt. B.B. 21 Rt
" 1200 " " 22 " " " 28 "
" 1300 " " 34 " " " 35 "
" 1400 " " 40 " " " 43 "
12 " 1489.9 Hub. T.B. 51 Rt. B.B. 53 Rt
∡ Pt of Tan. on Power Line
Bs. ∡ 41°00' Rt. (S72°54' E)

Th. ∡ 16°09' Rt.
N82°15 E Mag. N82°4' E
@ 78 X Power Line (Tangent
" 120 Upper & Low. Bank 37 Rt T.B
" 220 " " " " " 25 "
" 335 " " " " " 13 "
" 450 " " " " " 4 "
" 500 X upper Bank
" 575 Upper Bank 8 Lt. T.L.B. 17 Rt
" 675 " " 17 " " " " 4 "
" 730 X T.L.B.
" ~~840~~ ~~T.L.B. 4 Lt.~~ Upper Bank 30 Lt.
" 865 " " 3 " " " 29 "
" 955 X T.L.B. (Upper Bank Joins line) B.B. 21

1'

N66°06 E
16 09
82 15

₵ Veg. 30 Rt 0.7 El. 48 Rt
1.' El. ₵ Veg. 40 Rt 0.7 El. 52 Rt.
1.' El ₵ Veg. 43 Rt. 0.7 El. 62 Rt.
" " " " 48 " " " " 67 "
" " " " 67 " " " " 90 "
" " " " 81 " " " " 103 "
" " " " 86 " " " " 116 "
Note. About 10' to Lt of Preceding Plusses
of 1.' El. There is another Lower Bank or Ledge.
at 12 - B.B. El = 2.2 T.B. = El. 3.2 (Upper Bank)
(T.L.B. Top Lower bank)

6606
4
10706

17960
10706
7254

Xross Survey)
69 Lt ~~[illegible]~~ 1.' El. 74 Rt. 0.7 El. 95 Rt.
~~T.B.B. 50 Rt. B.B. Veg. ₵ 1.' El. 53 Rt. 0.7 El. 73 Rt~~
" " 33 " " " " " " " 38 " " " " 61 "
" " 26 " " " " " " " 33 " " " " 46 "

B.B. Veg. ₵ 1.' El. 28 Rt 0.7 El. 40 Rt
B.B. 6 Rt 1.' El. ₵ Veg. 11 Rt 0.7 El. 34 Rt

B.B. 3 Rt 1.' El. ₵ Veg. 6 Rt. 0.7 El 32 Rt
" " 4 " " " " " 5 " " " " 41 "
Rt. 1.' El. ₵ Veg. 31 Rt 0.7 El. 60 Rt

counter 42274

(13) at 1020.5 Hub T.B. 39 Rt. B.B. 45 Rt.
Alig. Pt. of Tan. on Power Line
Brs. ∡ 3149 Lt. for S82 15W (S50 26 W)

Th ∡14 57 Rt.
S82 48 E Mag. S82 50 E
at 85 T.B. 26 Rt B.B. 30 Rt
" 200 " " 17 " " " " 21 "
" 300 " " 22 " " " 27 "
" 355 " " 28 " " " 38 "
" 400 " " 36 " " " 46 "
" 470 " " 19 " " " 23 "
" 528 × T.B.
" 530 × B.B.
" 550 B.B. 2 Lt T.B. 4 Lt ℄ Veg. 1.' El
" 630 B.B. 6 " " " " ℄ Veg. 11 Lt
" 720 " " 10 " " " " " 15 "
" 796 × B.B.
(14) " 837.4 [illegible] B. ℄ Veg Line BB 10 Lt. 1.' El.

Th ∡10 50 + Rt
S71 58 E Mag. S71 55 E
at 0.0 Lv. T.B.
" 40 × B.B.
" 75 B.B. 8 Lt T.B. 20 Lt



8175
3149
5026

N82 15 E

1.' El. ℄ Veg. 71 Rt. 0.7 El. 77 Rt

17960
9712
8248

8215
1457
9702

at 13 B.B. El = 1.4 T.B. El = 2.2

81108
10 50
71 58

1.' El. ℄ Veg. 36 Rt. 0.7 El. 62 Rt
" " " " 27 " " " 67 "
" " " " 38 " " " 80 "
" " " " 76 " " " 83 "
" " " " 61 " " " 74 "
" " " " 28 " " " 55 "

7 Rt. 0.7 El. 51 Rt.
1.' El. 7 Rt. 0.7 El. 61 Rt.
1.' " 10 " " 77 "

34 Rt 0.7 El. 140 Rt.
at 14 B.B. El = 1.6 T.B. El = 3.5

1.' El 41 Rt 0.7 El. 154 Rt

| | | | | |
|---|---|---|---|---|
| at | 170 | B.B. 32 Lt. | T.B. 42 Lt. | |
| " | 250 | " " 34 " | " " 44 " | |
| " | 350 | " " 33 " | " " 38 " | |
| " | 435 | " " 26 " | " " 36 " | |
| " | 500 | " " 30 " | " " 35 " | |
| " | 600 | " " 28 " | " " 33 " | |
| " | 700 | " " 35 " | " " 40 " | |
| " | 800 | " " 27 " | " " 32 " | |
| " | 900 | " " 22 " | " " 28 " | |
| " | 1010 | " " 52 " | " " 57 " | |

" 1050 ⊀ 1.' El. Line

" 1070 1.' El. 4' Lt. B.B. 83 Lt.

" 1126 Ro.x. 1.' El.

" 1190 1.' El. 5 Rt B.B. 67 Lt.

"C" " 1484° Hub. A. Pt "C" on Wly. Berm of Levee used for Road. or is. Hub Plussed at 54+87 Vol V-10 Pg. 8 - 2" Jack @ Pipe on Wly. Bank of Copano Bay Br. ⊀ 28°29' Rt. for. N71°58 W N43°29 W 165.4 A

Th Δ 15°16' Lt from "C" for. N71°58 W S82°46 W to. Δ Pt "A" of Angles



Note. Veg. on T.B. until further Noted

| | | | |
|---|---|---|---|
| 1.' El. 56 Rt | | 0.7 El. 176 Rt. | |
| " " 49 " | | " " 165 " | |
| " " 40 " | | " " 165 " | |
| " " 24 " | | " " 146 " | |
| " " 22 " | | " " 143 " | |
| " " 37 " | | " " 153 " | |
| " " 42 " | | " " 163 " | |
| " " 53 " | | " " 196 " | |
| " " 30 " | | " " 203 " | |
| " " 11 " | | " " 144 " | |

T.B. 89 Lt. 0.7 El. 145 Rt

1430.0
54
1484.0

T.B. 72 Lt. (on Levee)

71 58
28 29
43 29

71 58
25 16
97 14

179 60
97 14
82 46

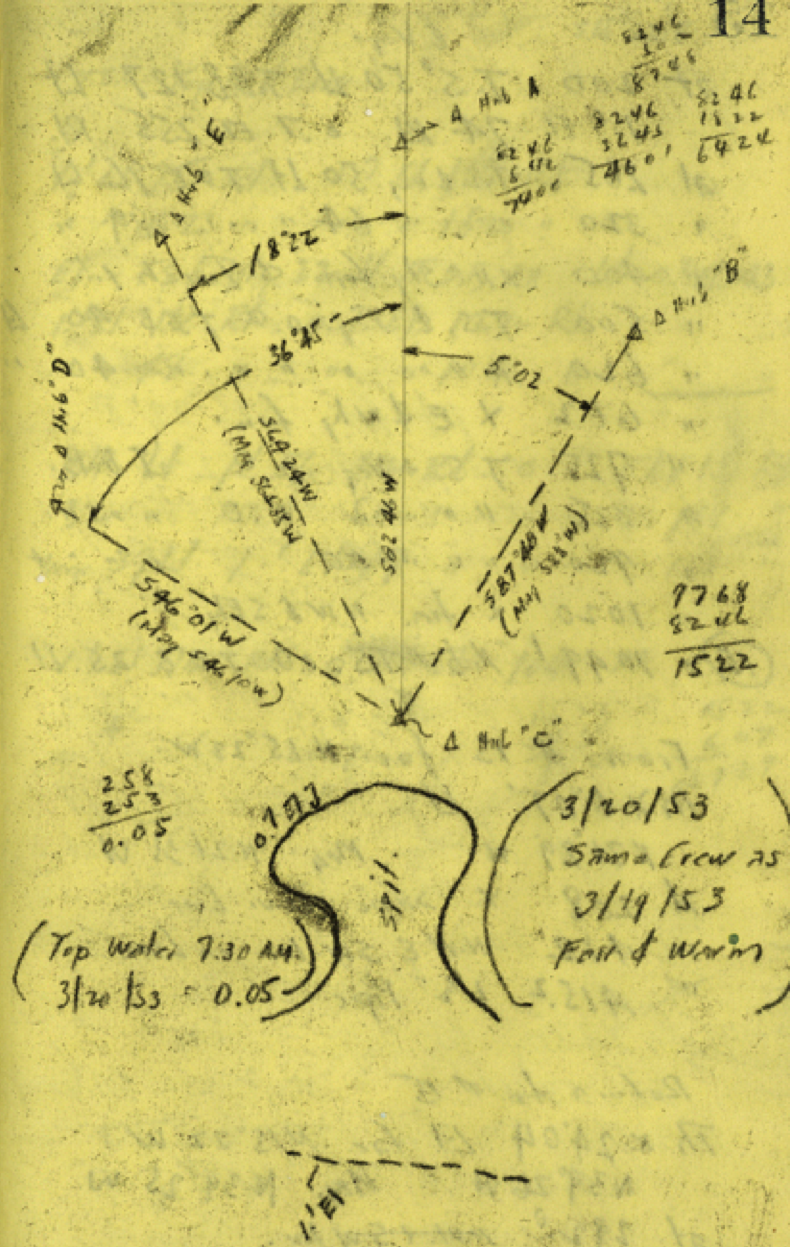
on this Traverse Close

Side Shot along Spit From
Δ Hub "C"

Th ∡ 8°46' Lt for S82°46'W
S74°00'W Mag. S74°05'W
at 218 × 1.1' El.
" 276 0.7 El. 55 Lt
" 327 " " " 11 "
" 390 " " " 20 "
" 425 " " " 63 Rt
" 433 " " " 33 Lt
" 483 " " " 26 Rt Also
33 Lt. C 70 Lt.
at 525 0.7 El. 20 Rt E 77 Lt.
" 565 0.7 El. at W. Tip of Spit
Quit for day.

Th ∡ 98°08' Lt From "C" for S82°46'W
S15°22'E Mag. S15°20'E
at 15 Toe of Slope of Levee.
" 105 Axis Ht. for to sly E N Ely
52 Lt T.S. of Veg. 68 Lt T.B.
(Bluff) 145 Lt Runs Nly to
Bay - 1.1 El 164 Rt 0.7 El.
292 Rt.






3/20/53
Same Crew as
3/19/53
Fair & Warm

(Top Water 7:30 A.M.
3/20/53 = 0.05)

2.58
2.53
0.05

97 68
82 46
15 22

& Veg.

at 200 T.S. 50 Lt. T.B.B. 127 Lt
1.' El. 74 Rt. 0.7 El. 255 Rt.
at 265 T.S. & Veg. 50 Lt. T.B.B. 96 Lt
" 320 " " " " 64 " " " 89 "
" 400 X N.E. Sly. fen. & Trench 1.'
" 500 T.S. & Veg. 0.0 T.B.B. 40 Lt
" 620 " " " " " " " " 40 "
" 662 X E & Wly fen.
" 725 T.S. & Veg. 0.0 T.B.B.
" 835 " " " " 0.0 " " "
" 920 " " " 0.0. " " "
" 1020 X fen. N.W. & SEly.
15 " 1049.! Hub ~~T.S.~~ 0.0. T.B.B. 25 Lt

From # 15 for. N 15°22' W
Th ∠ 6°07' Lt
N 21°29' W Mag. N 21°35' W
at 208 X Some Power Line
" 412 N.W. & SW. Inc. on Line
" 415.2 1½" Pipe

Return to # 15
Th ∠ 24°04' Lt for. N 15°22' W
N 39°26' W Mag. N 39°25' W
at 292.0 ~~N.W. & SW~~ Inc.
NE & E



T.B.B. = Top Bluff Bank

1.' El. 75 Rt. 0.7 El. 167 Rt.
" " 62 " " " 152 "
El. - T.S. & Veg. 22 Lt. T.B.B. 68 Lt. 0.7 El. 143 Rt.
1.' El. 18 Rt. 0.7 El. 127 Rt.
" " 48 " " " 104 "

34 Lt 1.' El. 22 Rt. 0.7 El. 118 Rt.
32 " " " 54 " " " " 118 "
Max 39 Lt. 1.' El. 49 " " " " 113 "

1.' El. 70 Rt. 0.7 El. 104 Rt.

+ 15
2 0 7
2 0
15 22 / 24 04 / 39 26
15 22 / 6 07 / 21 29

From # 15
Th. ∢ 44°42' Lt fac. N13°22' W.
N60°04' W. Mag. N60°05' W.
at 240 NW ℄ S.R. Int.

Return to # 15

Th ∢ 17°25' Rt fac. S15°22' E
S2°03' W Mag. S2°05' W
at 141 T.S. 27 Lt. T.B.B. 50 Lt
" 245 " " 59 " " " 75 "
" 360 " " 60 " " " 75 "
" 560 " " 60 " " " 80 "
" 600 " " 42 " " " " 52 "
" 641.5 X another Power Line
" 710 T.S. 52 Lt T.B.B. 62 Lt
(16) " 843.8 Hub on T.S. T.B.B. Lt
From # 16 S.E. ℄ Swly. Int. Brg.
∢ 51°54' Rt. (S53°57' W) Mag. [redacted]

Th. ∢ 24°50' Rt
S26°53' W Mag. S26°50' W
at 135 T.S. 4 Lt. T.B. 60 Lt
" 260 " " 30 " " " 15.0 "
" 345 " " 40 " " " 95 "



1.1 13°22'
6.6 44°42'
7.7 60°04'
S15°22' E
17°25
15°22
2°03

Mr. Boyles Appeared on Ground
9:45 A.M.
Note. Veg. [redacted] unless.
Noted Otherwise
at # 15 T.S. El. = 2.6

2°03
24°30
26°53

1.1 El 10 Rt. 0.7 El 75 Rt
" " 4 " " " 77 "
" " 37 " " " 89 "
" " 11 " " " 93 "
" " 5 " " " 79 "
SW ℄ NE¼
1.1 El. 29 Rt. 0.7 El 72 Rt
" " " " " " " "

2°03
51°54
53°57

at # 16 T.S. El. = 1.6

1.1 El 23 Lt. 0.7 El 96 Rt
" " 6 " " " 60 "
" " 14 " " " 109 "
Veg. Begs 161 T.S.

counter 42279

at 386 X E of Alty few. 2 Vrg.
" 455 T.S. Lt T.B. 7.0 Lt
" 555 " " & Vrg. 6 Lt T.B. 7.6 Lt
" 670 1.' El. + T.S. 0.0 LowBank & Vrg.
(17) " 857.15 Hub-Vrg. T.S. 3.0 Lt. T.B. 3.5 Lt
at # 17 SE & SW. Inc. Bus. ∡ 37°14' Lt.
for. N26°53'E (N10°21'W) Mag. N10°4'W

Th. ∡ 30°17' Rt. for. S26°53'W.
S57°10' W. Mag. S57°4'W.
at 80 1.' El. 0.0.
" 116 " " " T.S. & Vrg. 1.5 Lt
T.B. 5.5 Lt. 0.7 El. 7.8 Rt.
at 210 1.' El. 0.0 T.S. & Vrg. 1.5 Lt.
T.B. 3.0 Lt 0.7 El. 6.7 Rt.
at 335 T.S. & Vrg. 0.0 T.S. 1.5 Lt.
1.' El 2.2 Rt. 0.7 El. 5.6 Rt.
at 460 T.S. & Vrg. 0.0 T.B. 2.0 Lt
1.' El. 1.0 Rt. 0.7 El. 5.4 Rt.
(18) at 518.45 Hub ~~[illegible]~~ T.S. &
Vrg. .5 Lt T.B. 2.0 Lt. 0.7 El.
5.2 Rt.

Th. ∡ 19°48 Lt.
S37°22 W. Mag. S37°25 W



S26°53 W

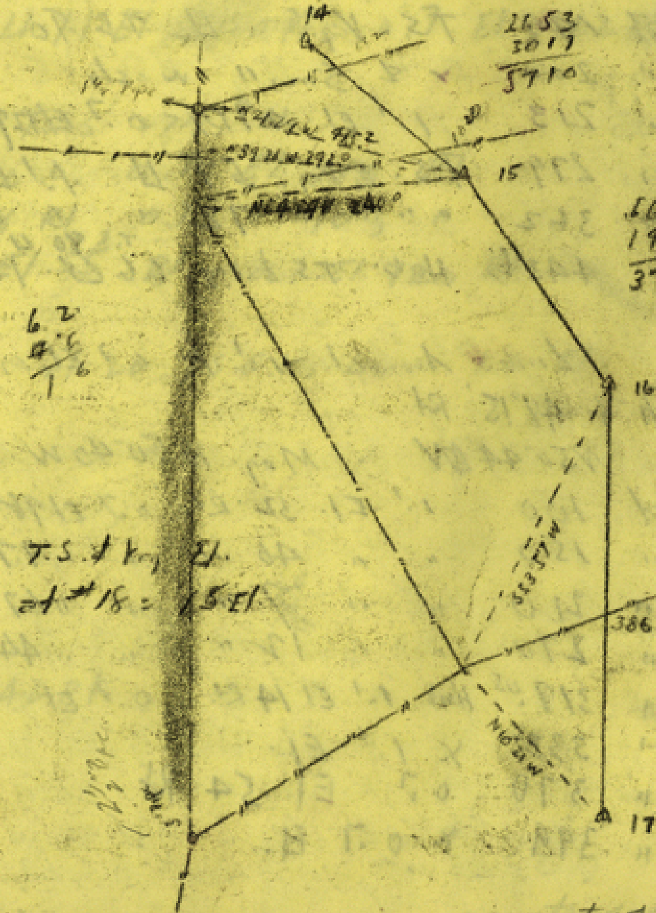
High Bank Narrow Long Slope

1.' El. 5 Rt 0.7 El 13.8 Rt
" " 3 " " " " 9.7 "
10 Lt. 0.7 El. 9.0 Rt
1.' El. 4.2 Rt 0.7 El. 11.8 Rt

at #17 T.S. & Vrg. Lt = 2.1

6.2
4.6
1.6

T.S. & Vrg. El.
at #18 = 1.5 El.




17 43 21

36 74 21 53 15 21

26 53 30 17 57 10

56 70 19 48 37 22

*also 1.1 El.

at 50 T.S. & Veg 0.0 T.B
" 105 X Pow Line S.W C.
" 155 T.S. E. Veg. 29 Lt T.B 20
(19) " 274.6 Hub. on T.S. Veg. T.B.

MR B. Helped.

Th. ∡ 43°39' Rt
S81°01' W Mag
at 149 T.S. Veg. Lt T.B To
" 200 X & Small wash
" 213 1.1 El 49 Rt. 0.7 El. 127 Rt
" 279 T.S. E Veg. 57 Lt 1.1 El.
" 362 " " " " 72 " " "
(20) 443.6 Hub. T.S. E Veg. 66 Lt. 1.1 T.S. 90 Lt

Lines Around 1.1 & 0.7 El. only.
Th ∡ 48°15' Rt
N50°44' W Mag N50°40W
at 100 1.1 El. 32 Rt 0.7 El 98 Rt
" 150 " " 40 " " " 97 "
" 210 " " 27 " " " 67 "
" 270 " " 12 " " " 44 "
(21) " 319.05 Hub 1.1 El 14 Rt. 0.7 El
" 333 X 1.1 El.
" 370 0.7 El 54 Rt
" 399 X 0.7 El.



S37°22'W
43 39
81 01

20 Lt 0.7 El. 68.5 Rt
NE¼

Lt 1.1 El 0.0 0.7 El 102 Rt
35 Lt 1.1 El. 85 Rt 0.7 El 186 Rt

179 60 | 81 01
129 16 | 48 15
50 44 | 129 16

Lt 1.1 El 50 Rt 0.7 El 142 Rt

5.5
1.1
6.6
6.1
1.5

T.S 279 Lt
0.0 0.7 El 110 Rt
8 Rt 0.7 " 103 "
El. 55 Rt 0.7 El 120 Rt

at 20 T.S. E Veg. bar = 1.8 El.

42 Rt.

Return to No. 20

Th. ∠19°10' Rt. fr. S81°01'W

N79°49'W Mag. 79°40'W

at 200 T.S. & Veg. 16 Lt T.B. 45

" 300 " " " 25 " " " 60

(22) " 440.7 - P.O.T. Hub T.S. & Veg. 6 Lt

Th ∠136°15' Rt

N56°26'E Mag. N56½°E

at 47 1.' El. 0.0 0.7 El.

" 110 " " 14 Lt. 0.7 El.

" 175 " " 0.0 " " "

" 224.2 Hub #21

Return to # 22

Th. N79°49'W Cont. Ch.

at 475 T.S. & Veg. 4 Lt. T.B. 70 Lt.

" 540 " " " 4 " " 20 "

" 600 " " " 7 " " " 25 "

" 650 × T.S. & Veg.

" 685 T.B. 0.0 T.S. ~~1.1~~ El. & Veg.

" 740 Rd × T.S. & Veg.

" 770 T.S. & Veg. 6 Lt. T.B. 20 Lt.

" 850 " " " 19 " " " 30 "

" 940 " " " 38 " " " 50 "



S81°01'W
19 10
100 11

135 75 179 60
77 49 100 11
56 26 79 49

Lt

"

T.B. 25 Lt.

78 Lt

68 Lt.

81 "

1.' El. 33 Rt 0.7 El. 83 Rt

" " 31 " " " 73 "

" " 12 " " " 64 "

Veg. 19 Rt 0.7 El. 67 Rt

1.' El. 5 Rt 0.7 El. 79 Rt

1.' " 5 " " 87 "

" " 0.0 " " 99 "

Bank Ceases to Be long slope Here and Begins to B. Bluff Bank.

at 1035 x T.S. & Veg
" 1040 T.S. & Veg. 10 Rt 1.1 El. =
(23) " 1176.0 Hub T.B. 40 Lt T.S.E

Th x 44°22' Rt
~~N35°22 W~~ N35°27 W
~~N55 49~~ W Mag. N35 20 W
at 128 x 1.1 El. 0.7 El. 159 Rt
" 200 1.1 El. 19 Lt T.S. & Veg
" 250 1.1 " 28 " T.S. & Veg
" 275 0.7 El 44 Rt
(24) " 323.5 Hub on 1.1 El. 0.7 El.

Th x 28°49' - Lt
~~N64 11 W~~ N64 16 W Mag. N64 05 W
at 70 T.S. & Veg. 15 Lt T.B. 55 Lt.
" 128 " " " 10 " " " 50 "
" 165 " " " 10 " " " 50 "
" 220 " " " 16 " " " 36 "
" 236 x 1.1 El.
" 261 x fence
285 Angle in fence 2.5 Lt
"D" " 267.9 Set Hub = A Pt. "D" on N Edge
old R.R. cut 2½" Pipe ~~set~~
on 0.7 El 1.1 El 22 Lt T.S. & Veg 40 Lt
T.B. 45 Lt Gate for Ang.



N79°49 W
20 Rt. 0.7 El. 109 Rt
Veg. 25 Rt 1.1 El. 53 Rt 0.7 El. 164 Rt
T.S. & Veg. at #23 = 1.4 El.

N79 49 W
44 22
35 22

179 60
144 11
35 49

28 49
44 22
124 11

T.S. & Veg. 10 Lt T.B. 60 Lt.
25 Lt. Bank 35 Lt. 0.7 El. 113 Rt.
36 Lt T.B. 45 Lt. 0.7 El. 75 Rt.

13 Rt. T.S. & Veg. 24 Lt. T.B. 50 Lt.
at #23 T.S. & Veg. El = 1.3

35 22
28 49
64 11

1.1 El. 4 Rt 0.7 El. 58 Rt
" " 19 " " " 61 "
" " 18 " " " 64 "
" " 11 " " " 36 "

T.S. & Veg. at D = El 1.8

See Pg. 21 for Triangulation

Th. ∠ 9°50' Rt to "A"

~~N54° Lt~~ W Should Be N54 28 W

N54°26'W

From "D" fac. N54°28 W

Th ∠ 102°37' Lt Mag. S25°Wt

~~at~~ ~~S23°02 W~~ S22°55'W

at 31 X fen. Meandering Marsh

" 50 X 1.' El. 0.7 El. 27 Rt

T.S. Veg. 22 Lt. T.B. 35 "

at 100 Touch T.S.E Veg.

" 120 T.S. ℄ Veg. 0.0 T.B. 2 Lt.

1.' El. 4 Rt. 0.7 El. 54 Rt

at 139 X 1.' El. T.S. ℄ Veg.

" 190 1.' El. 9 Lt. T.S.E Veg.

16 Lt - T.B. 20 Lt. 0.7 El 78 Rt

at 265 1.' El. 7 Lt T.S.E Veg.

24 Lt. T.B. 30 Lt 0.7 El. 68 Rt

at 330 1.' El. - T.S. ℄ Veg 5 Lt.

T.B 22 Lt. - 0.7 El. 50 Rt.

at 372 X 1.' El. T.S. ℄ Veg.

" 400 1.' El. T.S. ℄ Veg 3 Rt

" 475 1.' El T.S. ℄ Veg 17 Rt

" 550 Ro X 1.' El. T.S. ℄ Veg.

" 610 1.' El T.S.E Veg 31 Lt

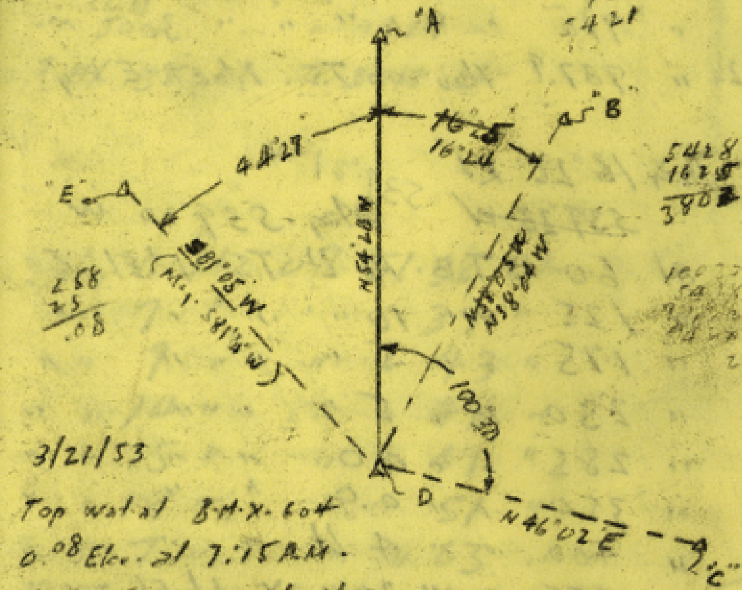
" 700 " " " " " 63 "



5428 / 6427 / 9855   17460 / 9833 / 8105   N64°11 W / 951

0°07 Error

3371 / 950 / 5421




5428 / 1628 / 3800

3/21/53

Top wat. at B.M. X 604

0.08 Elev. at 7:15 A.M.

Same Crew as 3/20/53

Cool. Cloudy.

5421 / 102 37 / 15658   17960 / 15658 / 2302

T.B. 4 Lt 0.7 El 38 Rt

0.7 El. 35 Rt. T.B. 10 Lt.

T.B 10 Lt. 0.7 El. 22 Rt

T.B. 55 Lt. 0.7 El. 39 Rt

" 100 " " " 44 "

at 775 1.' El. T.S. ∮ Vg. 59 Lt
" 845 " " " " " 51 "
" 910 " " " " " 30 "
2 " 987.9 Hub on T.S. 1.' El. E Vg.

Th. ∡ 16°26' Rt
~~S39 28 W~~ S39°21' W Mag. S39°20 W
at 60 T.B. 12 Lt T.S. 1.' El. E
" 125 " " 10 " " " "
" 175 " " 5 " " " "
" 230 " " 5 " " " "
" 285 " " 0.0 " " "
" 350 " " 0.0 " " "
" 400 " " 4 Lt " " "
" 455 " " 20 " X 1.' El. T.S.
" 459 X fen.
" 520 1.' El. T.S. ∮ Vg. 29 Lt
" 550.0 0.7 El. 81 Rt. W Cor. Vg. 18
fen. 48.3 Lt T.B. + S ∮ E
at 600 0.7 El. 93 Rt. 1.' El. 42 Lt
" 650 " " 90 " " " 34 "
" 700 " " 46 " " " 40 "
" 775 " " 90 " " " 34 "
" 850 " " 90 " " " 21 "
" 925 " " 100 " " " 39 "



(Bluff)
S23°02' W
16 26
39 28

T.B. 110 Lt 0.7 El. 61 Rt.
(T.B.B.) " " 120 " " " 56 "
(L.B.) " " 50 " " " 19 "
0.7 El. 38 Rt T.B. 16 Lt

Vg. 6 Rt. 0.7 El. 38 Rt
" 7 " " " 39 "
" 9 " " " 43 "
" 14 " " " 48 "
" 15 " " " 49 "
" 18 " " " 51 "
" 7 " " " 63 "
∮ Vg. " " 45 "

T.B. 39 Lt 0.7 El. 47 Rt
4 1.' El. 33 Lt. T.S. ∮ Vg. E Cor. Mon. 17
Cor. fen. 56 Lt
T.S. ∮ Vg. 68 Lt T.B. 98 Lt (T.B.B.)
" " " 100 " " " 140 " "
" " " 120 " " " 125 " "
" " " 130 " " " 140 " "
" " " 120 " " " 130 "
" " " 90 " " " 92 "

counter 12285

at 978 0.7 El 88 Rt 1.1 El 30 Lt
" 1045 " " 92 " " " 24 "
" 1086 Re X Fen.
(26) " 1119.05 Hub on T.S. 1.1 El E Veg-

Th. 440°28 Rt
~~579°56 W~~ 579°49 W Mag 579°50 W
at 57 1.1 El 7 Rt 0.7 El 88 Rt
" 73 X fen to S Ely. N.E & NWlly line.
" 100 X fen along Marsh.
" 135 0.7 El 64 Rt 1.1 El TS
" 190 " " 38 " " " "
" 275 " " 17 " " " "
" 340 " " 16 " " " 36 "
" 415 " " 12 " 1.1 El 33 Lt
" 500 " " 19 " " " 24 "
" 575 " " 26 " " " 4 "
" 603 X 1.1 El
" 655 X T.S. & Veg. 1.1 El 7 Rt
" 668 X fen along Marsh
(27) " 718.5 Hub on T.B. - T.S & Veg. 8 Rt

Th 21°03 Rt
~~N79°01 W~~ N79°08 W Mag N79°03 W
at 28 X fen along Marsh



X H fen 64 Lt T.S. & Veg. 74 Lt. T.B. 90 Lt
T.S. & Veg. 43 Lt T.B. 50 Lt

0.7 El 11 Rt T.B. 4 Lt

0+80 X 1.1 El.
T.S. & Veg. 15 Lt. T.B. 20 Lt.
1.0 Rt

& Veg. 20 Lt T.B. 30 Lt.
" " 29 " " 39 "
" " 42 " " 52 "

H fen 39 Lt T.S. & Veg. 50 Lt T.B. 60 Lt
T.S. & Veg 43 Lt T.B. 45 Lt
" " " 30 " " " 33 "
" " " 24 " " " 34 "

0.7 El 36 Rt TB 6 Lt

1.1 El 14 Rt 0.7 El 48 Rt
T.S. & Veg. El. at #27 = 1.8

39 28
40 24
79 56
21 03
100 59
179 60
100 59
79 01

Sta. 85 x T.S. & Veg. T.B. 40 Lt
" 73 NWly. 14r. 15 Lt
" 114 x 1.1 El.
" 152 1.1 El. T.S. & Veg. 8 Lt
" 240 " " " " " 7 "
" 315 " " " " " 12 "
" 390 " " " " " 14 "
" 470 " " " " " 17 "
" 540 " " " " " 8 "
" 595 " " " " " 4 "
" 655 " " " " " 2 "
" 705 " " " " " 4 "
" 713 x 1.1 El.
" 750 Veg. 0.0 T.S. El. 18 Rt
" 810 T.S. & Veg. 11 Lt T.B.
" 809.5 x Telep. Line following
" 843 R.x. 1.1 El.
" 870 1.1 El T.S. & Veg. 17 Lt
" 935 0.7 El 23 Rt & 66 Rt
" 950 ~~Rt El. 17 El~~ Veg. 29 Lt
" 962 R.x. 1.1 El.
" 995 1.1 El 26 Rt. 0.7 El 85
" 1030 & Small Drain 1.1 El 43 Rt
" 1090 1.1 El 39 Rt 0.7 El 63 Rt
" 1155 " " " " " 72 "



N 79 01 W

1.1 El. 6' Rt 0.7 El. 37 Rt

0.7 El 22 Rt T.B. 20 Lt
T.B. 15 Lt. 0.7 El. 11 Rt
" " 25 " " " 10 "
" " 25 " " " 5 "
" " 25 " " " 2 "
" " 18 " " " 24 "
" " 25 " " " 40 "
" " 12 " " " 41 "
" " 15 " " " 37 "

0.7 El. 35 Lt T.B. 12 Lt
20 Lt. 1.1 El. 23 Rt 0.7 El. 65 Rt
Pipe Line

T.B. 25 Lt 0.7 El. 21 Rt

T.B. 50 Lt

Rt. T.S. & Veg. 40 Lt. T.B. 55 Lt
0.7 El. 63 Rt. T.S. & Veg. 50 Lt T.B. 70 Lt
T.S. & Veg. 73 Lt T.B. 83 Lt
" " " 82 " " " 83 " 23

at 1205 x 1.' El.
" 1205 0.7 El 82 Rt. 1.' El 12 Lt
" 1250 " " 120 " " " 14 "
" 1310 [illegible] " " " 8 "
" 1360 " " 79 " " " 29 "
" 1440 1.' El. 0.0 0.7 El 49 Rt
" 1510 " " 0.0 " " 38 "
" 1512 x 1.' El.
" 1537 x T.S. & Veg.
" 1582 1.' El. 14 Rt 0.7 El 52 Rt
28 " 1709.0 Hub on. T.B.

Th. N 26°44' E 30 x T.S. & Veg.
at 81 x 1.' El ~~Lt~~
" 140 Re-ent. Cor. 0.7 El.
" 201 x 0.7 El

Return to #28

Th ~~x~~ 46°42' Rt.
~~N32°19 W~~ N32°26 W Mag. N 32°20 W
at 43 x T.S. & Veg.
" 80 1.' El 64 Rt (Re-ent Cor.
" 115 " " 54 " 0.7 El 134 Rt
" 180 " " 75 " " " 133 "



7861
4642
3219

T.S. & Veg. 84 Lt. T.B. 114 Lt.
" " " 91 " " 95 "
" " " 91 " " 100 "
" " " 80 " " 92 "
" " " 53 " " 80 "
" " " 6 " " 70 "

T.B. 35 Lt

Note. Between 1.' E.L. & T.S. There is Scattered Vegetation

0.7 El 120 Rt. T.S. & Veg. 30 Lt. T.B. 40 Lt.
Veg & T.S. 41 Lt. T.B. 65 Lt.
90 " " 120 "

at 225 1.' El. 52 Rt Road Cor. 0.7
" El. 84 Rt. N.E. Cor 0.7 El. 131 Rt
T.S. 110 Lt. T.B. 145 Lt
at 270 1.' El. 29 Rt. 0.7 El. 57 Rt
" 305 X 1.' El
" 310 0.7 El 22 Rt 1.' El 4 Lt
" 380 " " 31 " " " 17 "
" 420 " " 77 " " " 24 "
" 445 " " 31 " " " 26 "
" 476 X 0.7 El.
" 480 0.7 El. 4 Lt. 1.' El. 47 Lt
" 500 Rx 0.7 El.
" 545 0.7 El 8 Rt.
" 595 1.' El 44 Lt T.S. E. Veg
" 610 X 1.' El.
" 630 1.' El. 7 Rt. 0.7 El 33 Rt.
" 685 " " 70 " " " 93 "
" 780 " " 110 " " " 170 "
" 835 " " 103 " " " 153 "
" 920 " " 97 " " " 168 "
"E" 11.14.8 Conc. Mon. "For A Pt "E"
T.S. E Veg. 50 Lt.
Side Shot from "E"

Th. N33 30 E From E.

N32°14' W 

T.S. E Veg 135 Lt T.B. 165 Lt

T.S. E Veg 145 Lt T.B. 185 Lt
" " 140 " " " 190 "
" " 150 " " " 200 "
" " 150 " " " 190 "

Note: Between 1.' El. E T.S. all along. This Shot is Scattered Veg.

190 Lt. T.B. 200 Lt.

T.S. 160 Lt T.B. 165 Lt.
" " 130 " " " 170 "

T.S. E Veg 140 Lt. T.B. 150 Lt.
Quit for day
3/22/53 Same Crew as 3/21/53
Ptly Cloudy & Warm

counter 42289

| | | | | | | |
|---|---|---|---|---|---|---|
| at | 0.0 | 1.1' El. | 113 Rt | 0.7 El | 125 Rt | |
| " | 165 | " " | 35 " | " " | 49 " | |
| " | 205 | " " | 56 " | " | 77 " | |
| " | 250 | " " | 40 " | " | 55 " | |
| " | 290 | × 1.1' El. | 0.7 El. 104 Rt | | | |
| " | 315 | × 0.7 " | | | | |

Return to "E"

Th. ∢60°48' Rt for N32°19' W

N28°29' E to "A" Should be N28°20' E

Return to "E"

Th ∢45°22' Lt for N28°20' E

N17°02' W Mag.

| | | | | | | |
|---|---|---|---|---|---|---|
| at | 127 | × ℄ Tarvia on Hwy #13 | | | | |
| " | 265 | × Fence N.S. Hwy. | | | | |
| " | 312 | Ang Pt Fence 58.5 Rt. | | | | |
| " | 420 | T.S. 15 Lt | T.S. 35 Lt | | | |
| " | 465 | " " 10 " | " " 35 " | | | |
| " | 565 | " " 0.0 | " " 30 " | | | |
| " | 610 | " " 0.0 | " " 25 | | | |
| " | 690 | " " 15 Lt | " " 30 " | | | |
| " | 730 | " " 25 " | " " 35 " | | | |
| " | 790 | " " 44 " | " " 50 " | | | |
| " | 850 | " " 80 " | " " 90 " | | | |

N32°19' W 

1.1' El. on this Shot follows a ledge with Scattered Vegetation

60 49
32 19
28 29

113 34
32 19
81 15

31 79
6 55
25 24

N28°20' E
6 55
N35°15' E

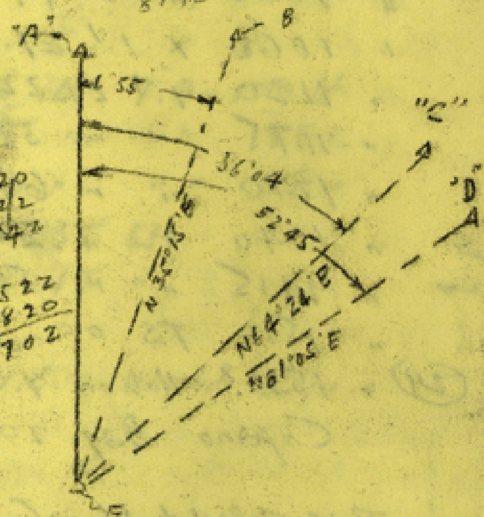
28 20
36 04
64 24

28 20
45 22
73 42

64 20

45 22
28 20
17 02

26 20
32 45
58 65




Veg.: T.S. on this Shot.

T.S. 30 Lt

| | | | | |
|---|---|---|---|---|
| 1.1' | ~~640~~ 109 | El. | 0.7 El. 151 Rt | |
| " | 98 | " | " " 115 " | |
| " | 74 | " | " " 101 " | |
| " | 96 | " | " " 132 " | |
| " | 93 | " | " " 132 " | |
| " | 30 | " | " " 54 " | Also 112 Rt |
| " | 34 | " | " " 40 " | |
| " | 20 | " | " " 34 " | |

counter 42290

at 881 × 1.1 El.
" 690 1.1 El 7 Lt. T.S. 81 Lt
" 950 " " 35 " " 100 "
" 1000 " " 17 " " 105 "
" 1060 × 1.1 El.
" 1130 1.1 El. 22 Rt 0.7 El.
" 1175 " " 37 " 46 "
" 1210 " " 68 " 0.7 "
" 1340 " " 55 " ℄ 238 Rt
" 1435 " " 56 " 245 "
" 1510 T.S. 0.0. T.B. 25 Lt.
(29) " 1533.8 Hub on 1.1 El. of Shore of Copano Bay 20 from W.E

Th ∡ 72°08' Lt for S17°02' E
S89°10' E Mag. S89°10' E
at 10.3 × fen.
" 35 W.E. 45 Lt.
" 190 " " 3 "
" 300 " " 54 "
" 400 " " 49 "
" 580 " " 30 "
" 770 " " 150 "
" 1000 " " 26 "
" 1140 Touch W.E



N17°02' W
72 08
89 10

T.B. 91 Lt 0.7 El 26 Rt
" 120 " " " 12 "
" 110 " " " 12 "

29 Rt T.S. 72 Lt T.B. 100 Lt.
46 " " 55 " " " 85 "
160 " " 50 " " " 85 "
T.S. 20 Lt T.B. 35 Lt
" " 4 " " " 15 "

Note W.E. = Waters Edge.

counter 42291

at 1220 W.E. 18 Lt
(30) " 1295.5 Set Hub on E. Edge Hwy.

Th. 37 09 Lt
N33°46 E Mag. N33 1/4° E
at 0.0 W.E. 42 Lt ¢ Traverse
" 135 " " 10
" 250 " " 31 "
" 350 " " 10 "
" 449.5 ¢ + W. End Culvert on
(31) " 470.5 Hub

Th. 47 33 Lt
N15 47 W Mag. N11 W
at 00.0 W.E. 90 Lt
" 180 W.E. 82 Lt
" 360 " " 75 "
" 575 " " 74 "
" 700 " " 124 " to E. Bank
" 804 X W.E. Small Bayou
" 810 W.E. (Copano) Bay 325 Lt
" 874 Lv. W.E. Small Bayou
" 900 W.E. Copano Bay 270 Lt
" 1150 " " " " 95 "
" 1360 " " " " 32 "



33 46
23 15
57 01
(5744 W)

48 61
33 46
15 15

179 60
146 14
33 46

S89°10 E
57 09
146 19

N33 46 E

19.6 Lt

48 93
33 46
15 47

Small Bayou 1.1 Lt

From 31 Tac. S33°46 W 80.9
X 23 15 Rt (S57 01 W) C.M. at P.O.C. Hwy (W.S.)
" 47 01 Lt (S15 13 E) " " " " " (S.S.)
116.6 ft.

Small Bayou

Note:- A Mr. Winland Showed up - Pretty Hostile about Going into Property West of Hwy - Says we Left Gate Hinge out - Finally Cooled off & was Very Nice - Says See Him if You want to go in Property and He will give You gate Keys.

" 1620 W.E. Copano 22 ft
" 1900 " " " 41 "
" 2008 X W.E Smith Bryan W.E
" 2061 [illegible] " "
(32) " 2066.9 H.b.

Th. 5554 Ft.
N40°07 E Mag. N39°35 E
" 120 X 0.7 Ft
" 190 0.7 Ft. 176 ft
" 240 " " " 180 1'
" 380 " " " 44 "
" 476.2 H.b. # 1 Pg 2 This Vol.



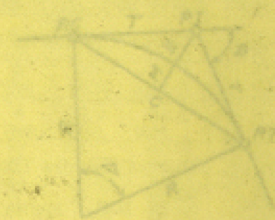
N15 47 W

# DIETZGEN'S RAILROAD CURVE AND REDUCTION TABLES

5554
1547
4007

Copano Bay 70 ft






## CURVE FORMULAS

Radius=R=$\frac{50}{\sin. D/2}$ (1) Degree of Curve=D and sin. [illegible] (2)

B. 60 ft

Tangent=T=R tan $\frac{\Delta}{2}$ (3) Length of Curve=L=[illegible] (4)

" 78 "

Middle ordinate=M=R(1—cos. $\frac{\Delta}{2}$) (5)=R vers. $\frac{\Delta}{2}$ (6)

External=E=T tan $\frac{\Delta}{4}$ (7)=R ÷ cos. $\frac{\Delta}{2}$—R (8)=R exsec. $\frac{\Delta}{2}$ (9)

Long Chord=C=2 R sin. $\frac{\Delta}{2}$ (10) Δ=Central Angle

## EXPLANATION AND USE OF TABLES

**Stations.**—Given P. I.=Sta. 161+60.35 to find Sta. of P. C. and P. T. Δ=62° 10′ D=8° 20′. From Table IV for 1° curve T=3454.1 and ÷8⅓=414.49 ft. From Table V correction=.26 or T=414.85 ft. P. C.=Sta. P. I.—T=157 +45.50. Also from (4) L=[illegible] and P. T.=Sta. P. C. + L=16[illegible]+91.[illegible]

J Boulson

**Offsets.**—Tangent offsets vary (approximately) directly with D and with square of the distance. Thus tangent offset for Sta. [illegible] above curve is 2.1[illegible] ft. as follows. From Table III tangent offset for 100 ft.=7.27 [illegible] distance=158—Sta. P. C.=54.50. Hence offset=7.27 (54.5[illegible])[illegible]=2.16 ft. Also square of any distance divided by twice the radius equals (approximately) the distance from tangent to curve. Thus (54.50)² ÷ (2 x 688.26)=2.16 ft.

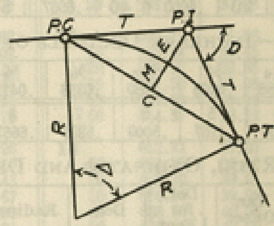
**Deflections.**—Deflection angle=½ D for 100 ft., ¼ D for 50 ft. etc. For c ft.=(in minutes) .3 x C x D° or=defl. for 1 ft. from Table III x C. For Sta. 158 of above curve=.3 x 54.5 x 8⅓=136.2′ or 2° 16.2′, or=2.50 x 54.5=136.2′ from Table III. For Sta. 159 deflection angle=2° 16.2′ + 8° 20′ ÷ 2=6° 26.2′, etc.

**Externals.**—May be found in similar manner to tangents. Thus E for curve above is 115.37. For from Table IV for 1° curve E=960.6 for 8° 20′=960.6÷8⅓=115.27 and from Table V correction=.10 or E=115.37 ft. Or suppose Δ=32° and E is measured and found to be 42 ft. What is D? From Table IV E=230.9 and ÷42=5.5 or D=5° 30′.

counter 42293

# DIETZGEN'S RAILROAD CURVE AND REDUCTION TABLES






## CURVE FORMULAS

Radius=R=$\frac{50}{\sin. D/2}$(1) Degree of Curve=D and sin. $\frac{D}{2}=\frac{50}{R}$ (2)

Tangent=T=R$\tan\frac{\Delta}{2}$ (3) Length of Curve=L=100$\frac{\Delta}{D}$ (4)

Middle ordinate=M=R(1—cos. $\frac{\Delta}{2}$) (5)=Rvers $\frac{\Delta}{2}$ (6)

External=E=T$\tan\frac{\Delta}{4}$-(7)=R ÷ cos.$\frac{\Delta}{2}$—R(8)=Rexsec$\frac{\Delta}{2}$(9)

Long Chord=C=2 R sin.$\frac{\Delta}{2}$ (10) Δ=Central Angle

## EXPLANATION AND USE OF TABLES

**Stations.**—Given P. I.=Sta. 161+60.35 to find Sta. of P. C. and P. T. Δ=62° 10′ D=8° 20′. From Table IV for 1° curve T=3454.1 and ÷8⅓=414.49 ft. From Table V correction=.36 or T=414.85 ft. P. C.=Sta. P.I.—T=157 +45.50. Also from (4) L=746.00 and P. T.=Sta. P. C.+L=164+91.50.

**Offsets.**—Tangent offsets vary (approximately) directly with D and with square of the distance. Thus tangent offset for Sta. 158 on above curve is 2.16 ft. found as follows. From Table III tangent offset for 100 ft.=7.27 ft. Distance=158—Sta. P. C.=54.50, hence offset=7.27 $(54.50 \div 100)^2$=2.16 ft. Also square of any distance divided by twice the radius equals (approximately) the distance from tangent to curve. Thus $(54.50)^2 \div (2 \times 688.26)$=2.16 ft.

**Deflections.**—Deflection angle=½ D for 100 ft., ¼ D for 50 ft., etc. For c ft.=(in minutes) .3 x C x D° or=defl. for 1 ft. from Table III x C. For Sta. 158 of above curve=.3 x 54.5 x 8⅓=136.2′ or 2° 16.2′, or=2.50 x 54.5=136.2′ from Table III. For Sta. 159 deflection angle=2° 16.2′ +8° 20′ ÷2=6° 26.2′, etc.

**Externals.**—May be found in similar manner to tangents. Thus E for curve above is 115.37. For from Table IV for 1° curve E=960.6 for 8° 20′=960.6÷8⅓=115.27 and from Table V correction=.10 or E=115.37 ft. Or suppose Δ=32° and E is measured and found to be 42 ft. What is D? From Table IV E=230.9 and ÷42=5.5 or D=5° 30′.

### TABLE I.—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 |

### TABLE II.—INCHES IN DECIMALS OF A FOOT.

| 1/16 | 3/32 | 1/8 | 3/16 | 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 |

### TABLE III.—RADII, ORDINATES AND DEFLECTIONS.

| Deg. | Radius | Mid. Ord. | Tan Offset | Def. for 1 Foot | Deg. | Radius | Mid. Ord. | Tan Offset | Def. for 1 Foot |
|---|---|---|---|---|---|---|---|---|---|
| 0° 10′ | 34377.5 | .036 | .145 | 0.05′ | 7° | 819.02 | 1.528 | 6.105 | 2.10′ |
| 20 | 17188.8 | .073 | .291 | 0.10 | 20 | 781.84 | 1.600 | 6.395 | 2.20 |
| 30 | 11459.2 | .109 | .436 | 0.15 | 30 | 764.49 | 1.637 | 6.540 | 2.25 |
| 40 | 8594.42 | .145 | .582 | 0.20 | 40 | 747.89 | 1.673 | 6.685 | 2.30 |
| 50 | 6875.55 | .182 | .727 | 0.25 | 8 | 716.78 | 1.746 | 6.976 | 2.40 |
| 1 | 5729.65 | .218 | .873 | 0.30 | 20 | 688.16 | 1.819 | 7.266 | 2.50 |
| 10 | 4911.15 | .255 | 1.018 | 0.35 | 30 | 674.69 | 1.855 | 7.411 | 2.55 |
| 20 | 4297.28 | .291 | 1.164 | 0.40 | 40 | 661.74 | 1.892 | 7.556 | 2.60 |
| 30 | 3819.83 | .327 | 1.309 | 0.45 | 9 | 637.28 | 1.965 | 7.846 | 2.70 |
| 40 | 3437.87 | .364 | 1.454 | 0.50 | 20 | 614.56 | 2.037 | 8.136 | 2.80 |
| 50 | 3125.36 | .400 | 1.600 | 0.55 | 30 | 603.80 | 2.074 | 8.281 | 2.85 |
| 2 | 2864.93 | .436 | 1.745 | 0.60 | 40 | 593.42 | 2.110 | 8.426 | 2.90 |
| 10 | 2644.58 | .473 | 1.891 | 0.65 | 10 | 573.69 | 2.183 | 8.716 | 3.00 |
| 20 | 2455.70 | .509 | 2.036 | 0.70 | 30 | 546.44 | 2.292 | 9.150 | 3.15 |
| 30 | 2292.01 | .545 | 2.181 | 0.75 | 11 | 521.67 | 2.402 | 9.585 | 3.30 |
| 40 | 2148.79 | .582 | 2.327 | 0.80 | 30 | 499.06 | 2.511 | 10.02 | 3.45 |
| 50 | 2022.41 | .618 | 2.472 | 0.85 | 12 | 478.34 | 2.620 | 10.45 | 3.60 |
| 3 | 1910.08 | .655 | 2.618 | 0.90 | 30 | 459.28 | 2.730 | 10.89 | 3.75 |
| 10 | 1809.57 | .691 | 2.763 | 0.95 | 13 | 441.68 | 2.839 | 11.32 | 3.90 |
| 20 | 1719.12 | .727 | 2.908 | 1.00 | 30 | 425.40 | 2.949 | 11.75 | 4.05 |
| 30 | 1637.28 | .764 | 3.054 | 1.05 | 14 | 410.28 | 3.058 | 12.18 | 4.20 |
| 40 | 1562.88 | .800 | 3.199 | 1.10 | 30 | 396.20 | 3.168 | 12.62 | 4.35 |
| 50 | 1494.95 | .836 | 3.345 | 1.15 | 15 | 383.07 | 3.277 | 13.05 | 4.50 |
| 4 | 1432.69 | .873 | 3.490 | 1.20 | 30 | 370.78 | 3.387 | 13.49 | 4.65 |
| 10 | 1375.40 | .909 | 3.635 | 1.25 | 16 | 359.27 | 3.496 | 13.92 | 4.80 |
| 20 | 1322.53 | .945 | 3.718 | 1.30 | 30 | 348.45 | 3.606 | 14.35 | 4.95 |
| 30 | 1273.57 | .982 | 3.926 | 1.35 | 17 | 338.27 | 3.716 | 14.78 | 5.10 |
| 40 | 1228.11 | 1.018 | 4.071 | 1.40 | 18 | 319.62 | 3.935 | 15.64 | 5.40 |
| 50 | 1185.78 | 1.055 | 4.217 | 1.45 | 19 | 302.94 | 4.155 | 16.51 | 5.70 |
| 5 | 1146.28 | 1.091 | 4.362 | 1.50 | 20 | 287.94 | 4.374 | 17.37 | 6.00 |
| 10 | 1109.33 | 1.127 | 4.507 | 1.55 | 21 | 274.37 | 4.594 | 18.22 | 6.30 |
| 20 | 1074.68 | 1.164 | 4.653 | 1.60 | 22 | 262.04 | 4.814 | 19.08 | 6.60 |
| 30 | 1042.14 | 1.200 | 4.798 | 1.65 | 23 | 250.79 | 5.035 | 19.94 | 6.90 |
| 40 | 1011.51 | 1.237 | 4.943 | 1.70 | 24 | 240.49 | 5.255 | 20.79 | 7.20 |
| 50 | 982.64 | 1.273 | 5.088 | 1.75 | 25 | 231.01 | 5.476 | 21.64 | 7.50 |
| 6 | 955.37 | 1.309 | 5.234 | 1.80 | 26 | 222.27 | 5.697 | 22.50 | 7.80 |
| 10 | 929.57 | 1.346 | 5.379 | 1.85 | 27 | 214.18 | 5.918 | 23.35 | 8.10 |
| 20 | 905.13 | 1.382 | 5.524 | 1.90 | 28 | 206.68 | 6.139 | 24.19 | 8.40 |
| 30 | 881.95 | 1.418 | 5.669 | 1.95 | 29 | 199.70 | 6.360 | 25.04 | 8.70 |
| 40 | 859.92 | 1.455 | 5.814 | 2.00 | 30 | 193.18 | 6.583 | 25.88 | 9.00 |

NOTE. Chord Deflection = 2 times tangent deflection.



### TABLE IV.—TANGENTS AND EXTERNALS TO A 1° CURVE.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 1° | 50.00 | .22 | 11° | 551.70 | 26.50 | 21° | 1061.9 | 97.57 |
| 10′ | 58.34 | .30 | 10′ | 560.11 | 27.31 | 10′ | 1070.6 | 99.16 |
| 20 | 66.67 | .39 | 20 | 568.53 | 28.14 | 20 | 1079.2 | 100.75 |
| 30 | 75.01 | .49 | 30 | 576.95 | 28.97 | 30 | 1087.8 | 102.35 |
| 40 | 83.34 | .61 | 40 | 585.36 | 29.82 | 40 | 1096.4 | 103.97 |
| 50 | 91.68 | .73 | 50 | 593.79 | 30.68 | 50 | 1105.1 | 105.60 |
| 2 | 100.01 | .87 | 12 | 602.21 | 31.56 | 22 | 1113.7 | 107.24 |
| 10 | 108.35 | 1.02 | 10 | 610.64 | 32.45 | 10 | 1122.4 | 108.90 |
| 20 | 116.68 | 1.19 | 20 | 619.07 | 33.35 | 20 | 1131.0 | 110.57 |
| 30 | 125.02 | 1.36 | 30 | 627.50 | 34.26 | 30 | 1139.7 | 112.25 |
| 40 | 133.36 | 1.55 | 40 | 635.93 | 35.18 | 40 | 1148.4 | 113.95 |
| 50 | 141.70 | 1.75 | 50 | 644.37 | 36.12 | 50 | 1157.0 | 115.66 |
| 3 | 150.04 | 1.96 | 13 | 652.81 | 37.07 | 23 | 1165.7 | 117.38 |
| 10 | 158.38 | 2.19 | 10 | 661.25 | 38.03 | 10 | 1174.4 | 119.12 |
| 20 | 166.72 | 2.43 | 20 | 669.70 | 39.01 | 20 | 1183.1 | 120.87 |
| 30 | 175.06 | 2.67 | 30 | 678.15 | 39.99 | 30 | 1191.8 | 122.63 |
| 40 | 183.40 | 2.93 | 40 | 686.60 | 40.99 | 40 | 1200.5 | 124.41 |
| 50 | 191.74 | 3.21 | 50 | 695.06 | 42.00 | 50 | 1209.2 | 126.20 |
| 4 | 200.08 | 3.49 | 14 | 703.51 | 43.03 | 24 | 1217.9 | 128.00 |
| 10 | 208.43 | 3.79 | 10 | 711.97 | 44.07 | 10 | 1226.6 | 129.82 |
| 20 | 216.77 | 4.10 | 20 | 720.44 | 45.12 | 20 | 1235.3 | 131.65 |
| 30 | 225.12 | 4.42 | 30 | 728.90 | 46.18 | 30 | 1244.0 | 133.50 |
| 40 | 233.47 | 4.76 | 40 | 737.37 | 47.25 | 40 | 1252.8 | 135.35 |
| 50 | 241.81 | 5.10 | 50 | 745.85 | 48.34 | 50 | 1261.5 | 137.23 |
| 5 | 250.16 | 5.46 | 15 | 754.32 | 49.44 | 25 | 1270.2 | 139.11 |
| 10 | 258.51 | 5.83 | 10 | 762.80 | 50.55 | 10 | 1279.0 | 141.01 |
| 20 | 266.86 | 6.21 | 20 | 771.29 | 51.68 | 20 | 1287.7 | 142.93 |
| 30 | 275.21 | 6.61 | 30 | 779.77 | 52.89 | 30 | 1296.5 | 144.85 |
| 40 | 283.57 | 7.01 | 40 | 788.26 | 53.97 | 40 | 1305.3 | 146.79 |
| 50 | 291.92 | 7.43 | 50 | 796.75 | 55.13 | 50 | 1314.0 | 148.75 |
| 6 | 300.28 | 7.86 | 16 | 805.25 | 56.31 | 26 | 1322.8 | 150.71 |
| 10 | 308.64 | 8.31 | 10 | 813.75 | 57.50 | 10 | 1331.6 | 152.69 |
| 20 | 316.99 | 8.76 | 20 | 822.25 | 58.70 | 20 | 1340.4 | 154.69 |
| 30 | 325.35 | 9.23 | 30 | 830.76 | 59.91 | 30 | 1349.2 | 156.70 |
| 40 | 333.71 | 9.71 | 40 | 839.27 | 61.14 | 40 | 1358.0 | 158.72 |
| 50 | 342.08 | 10.20 | 50 | 847.78 | 62.38 | 50 | 1366.8 | 160.76 |
| 7 | 350.44 | 10.71 | 17 | 856.30 | 63.63 | 27 | 1375.6 | 162.81 |
| 10 | 358.81 | 11.22 | 10 | 864.82 | 64.90 | 10 | 1384.4 | 164.86 |
| 20 | 367.17 | 11.75 | 20 | 873.35 | 66.18 | 20 | 1393.2 | 166.95 |
| 30 | 375.54 | 12.29 | 30 | 881.88 | 67.47 | 30 | 1402.0 | 169.04 |
| 40 | 383.91 | 12.85 | 40 | 890.41 | 68.77 | 40 | 1410.9 | 171.15 |
| 50 | 392.28 | 13.41 | 50 | 898.95 | 70.09 | 50 | 1419.7 | 173.27 |
| 8 | 400.66 | 13.99 | 18 | 907.49 | 71.42 | 28 | 1428.6 | 175.41 |
| 10 | 409.03 | 14.58 | 10 | 916.03 | 72.76 | 10 | 1437.4 | 177.55 |
| 20 | 417.41 | 15.18 | 20 | 924.58 | 74.12 | 20 | 1446.3 | 179.72 |
| 30 | 425.79 | 15.80 | 30 | 933.13 | 75.49 | 30 | 1455.1 | 181.89 |
| 40 | 434.17 | 16.43 | 40 | 941.69 | 76.86 | 40 | 1464.0 | 184.08 |
| 50 | 442.55 | 17.07 | 50 | 950.25 | 78.26 | 50 | 1472.9 | 186.29 |
| 9 | 450.93 | 17.72 | 19 | 958.81 | 79.67 | 29 | 1481.8 | 188.51 |
| 10 | 459.32 | 18.38 | 10 | 967.38 | 81.09 | 10 | 1490.7 | 190.74 |
| 20 | 467.71 | 19.06 | 20 | 975.96 | 82.53 | 20 | 1499.6 | 192.99 |
| 30 | 476.10 | 19.75 | 30 | 984.53 | 83.97 | 30 | 1508.5 | 195.25 |
| 40 | 484.49 | 20.45 | 40 | 993.12 | 85.43 | 40 | 1517.4 | 197.53 |
| 50 | 492.88 | 21.16 | 50 | 1001.7 | 86.90 | 50 | 1526.3 | 199.82 |
| 10 | 501.28 | 21.89 | 20 | 1010.3 | 88.39 | 30 | 1535.3 | 202.12 |
| 10 | 509.68 | 22.62 | 10 | 1018.9 | 89.89 | 10 | 1544.2 | 204.44 |
| 20 | 518.08 | 23.38 | 20 | 1027.5 | 91.40 | 20 | 1553.1 | 206.77 |
| 30 | 526.48 | 24.14 | 30 | 1036.1 | 92.92 | 30 | 1562.1 | 209.12 |
| 40 | 534.89 | 24.91 | 40 | 1044.7 | 94.46 | 40 | 1571.0 | 211.48 |
| 50 | 543.29 | 25.70 | 50 | 1053.3 | 96.01 | 50 | 1580.0 | 213.86 |

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## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 31° | 1589.0 | 216.3 | 41° | 2142.2 | 387.4 | 51° | 2732.9 | 618.4 |
| 10′ | 1598.0 | 218.7 | 10′ | 2151.7 | 390.7 | 10 | 2743.1 | 622.8 |
| 20 | 1606.9 | 221.1 | 20 | 2161.2 | 394.1 | 20 | 2753.4 | 627.2 |
| 30 | 1615.9 | 223.5 | 30 | 2170.8 | 397.4 | 30 | 2763.7 | 631.7 |
| 40 | 1624.9 | 226.0 | 40 | 2180.3 | 400.8 | 40 | 2773.9 | 636.2 |
| 50 | 1633.9 | 228.4 | 50 | 2189.9 | 404.2 | 50 | 2784.2 | 640.7 |
| 32 | 1643.0 | 230.9 | 42 | 2199.4 | 407.6 | 52 | 2794.5 | 645.2 |
| 10 | 1652.0 | 233.4 | 10 | 2209.0 | 411.1 | 10 | 2804.9 | 649.7 |
| 20 | 1661.0 | 235.9 | 20 | 2218.6 | 414.5 | 20 | 2815.2 | 654.3 |
| 30 | 1670.0 | 238.4 | 30 | 2228.1 | 418.0 | 30 | 2825.6 | 658.8 |
| 40 | 1679.1 | 241.0 | 40 | 2237.7 | 421.4 | 40 | 2835.9 | 663.4 |
| 50 | 1688.1 | 243.5 | 50 | 2247.3 | 425.0 | 50 | 2846.3 | 668.0 |
| 33 | 1697.2 | 246.1 | 43 | 2257.0 | 428.5 | 53 | 2856.7 | 672.7 |
| 10 | 1706.3 | 248.7 | 10 | 2266.6 | 432.0 | 10 | 2867.1 | 677.3 |
| 20 | 1715.3 | 251.3 | 20 | 2276.2 | 435.6 | 20 | 2877.5 | 682.0 |
| 30 | 1724.4 | 253.9 | 30 | 2285.9 | 439.2 | 30 | 2888.0 | 686.7 |
| 40 | 1733.5 | 256.5 | 40 | 2295.6 | 442.8 | 40 | 2898.4 | 691.4 |
| 50 | 1742.6 | 259.1 | 50 | 2305.2 | 446.4 | 50 | 2908.9 | 696.1 |
| 34 | 1751.7 | 261.8 | 44 | 2314.9 | 450.0 | 54 | 2919.4 | 700.9 |
| 10 | 1760.8 | 264.5 | 10 | 2324.6 | 453.6 | 10 | 2929.9 | 705.7 |
| 20 | 1770.0 | 267.2 | 20 | 2334.3 | 457.3 | 20 | 2940.4 | 710.5 |
| 30 | 1779.1 | 269.9 | 30 | 2344.1 | 461.0 | 30 | 2951.0 | 715.3 |
| 40 | 1788.2 | 272.6 | 40 | 2353.8 | 464.6 | 40 | 2961.5 | 720.1 |
| 50 | 1797.4 | 275.3 | 50 | 2363.5 | 468.4 | 50 | 2972.1 | 725.0 |
| 35 | 1806.6 | 278.1 | 45 | 2373.3 | 472.1 | 55 | 2982.7 | 729.9 |
| 10 | 1815.7 | 280.8 | 10 | 2383.1 | 475.8 | 10 | 2993.3 | 734.8 |
| 20 | 1824.9 | 283.6 | 20 | 2392.8 | 479.6 | 20 | 3003.9 | 739.7 |
| 30 | 1834.1 | 286.4 | 30 | 2402.6 | 483.8 | 30 | 3014.5 | 744.6 |
| 40 | 1843.3 | 289.2 | 40 | 2412.4 | 487.2 | 40 | 3025.2 | 749.6 |
| 50 | 1852.5 | 292.0 | 50 | 2422.3 | 491.0 | 50 | 3035.8 | 754.6 |
| 36 | 1861.7 | 294.9 | 46 | 2432.1 | 494.8 | 56 | 3046.5 | 759.6 |
| 10 | 1870.9 | 297.7 | 10 | 2441.9 | 498.7 | 10 | 3057.2 | 764.6 |
| 20 | 1880.1 | 300.6 | 20 | 2451.8 | 502.5 | 20 | 3067.9 | 769.7 |
| 30 | 1889.4 | 303.5 | 30 | 2461.7 | 506.4 | 30 | 3078.7 | 774.7 |
| 40 | 1898.6 | 306.4 | 40 | 2471.5 | 510.3 | 40 | 3089.4 | 779.8 |
| 50 | 1907.9 | 309.3 | 50 | 2481.4 | 514.3 | 50 | 3100.2 | 784.9 |
| 37 | 1917.1 | 312.2 | 47 | 2491.3 | 518.2 | 57 | 3110.9 | 790.1 |
| 10 | 1926.4 | 315.2 | 10 | 2501.2 | 522.2 | 10 | 3121.7 | 795.2 |
| 20 | 1935.7 | 318.1 | 20 | 2511.2 | 526.1 | 20 | 3132.6 | 800.4 |
| 30 | 1945.0 | 321.1 | 30 | 2521.1 | 530.1 | 30 | 3143.4 | 805.6 |
| 40 | 1954.3 | 324.1 | 40 | 2531.1 | 534.2 | 40 | 3154.2 | 810.9 |
| 50 | 1963.6 | 327.1 | 50 | 2541.0 | 538.2 | 50 | 3165.1 | 816.1 |
| 38 | 1972.9 | 330.2 | 48 | 2551.0 | 542.2 | 58 | 3176.0 | 821.4 |
| 10 | 1982.2 | 333.2 | 10 | 2561.0 | 546.3 | 10 | 3186.9 | 826.7 |
| 20 | 1991.5 | 336.3 | 20 | 2571.0 | 550.4 | 20 | 3197.8 | 832.0 |
| 30 | 2000.9 | 339.3 | 30 | 2581.0 | 554.5 | 30 | 3208.8 | 837.3 |
| 40 | 2010.2 | 342.4 | 40 | 2591.0 | 558.6 | 40 | 3219.7 | 842.7 |
| 50 | 2019.6 | 345.5 | 50 | 2601.1 | 562.8 | 50 | 3230.7 | 848.1 |
| 39 | 2029.0 | 348.6 | 49 | 2611.2 | 566.9 | 59 | 3241.7 | 853.5 |
| 10 | 2038.4 | 351.8 | 10 | 2621.2 | 571.1 | 10 | 3252.7 | 858.9 |
| 20 | 2047.8 | 354.9 | 20 | 2631.3 | 575.3 | 20 | 3263.7 | 864.3 |
| 30 | 2057.2 | 358.1 | 30 | 2641.4 | 579.5 | 30 | 3274.8 | 869.8 |
| 40 | 2066.6 | 361.3 | 40 | 2651.5 | 583.8 | 40 | 3285.8 | 875.3 |
| 50 | 2076.0 | 364.5 | 50 | 2661.6 | 588.0 | 50 | 3296.9 | 880.8 |
| 40 | 2085.4 | 367.7 | 50 | 2671.8 | 592.3 | 60 | 3308.0 | 886.4 |
| 10 | 2094.9 | 371.0 | 10 | 2681.9 | 596.6 | 10 | 3319.1 | 892.0 |
| 20 | 2104.3 | 374.2 | 20 | 2692.1 | 600.9 | 20 | 3330.3 | 897.5 |
| 30 | 2113.8 | 377.5 | 30 | 2702.3 | 605.3 | 30 | 3341.4 | 903.2 |
| 40 | 2123.3 | 380.8 | 40 | 2712.5 | 609.6 | 40 | 3352.6 | 908.8 |
| 50 | 2132.7 | 384.1 | 50 | 2722.7 | 614.0 | 50 | 3363.8 | 914.5 |



## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 61° | 3375.0 | 920.2 | 71° | 4086.9 | 1308.2 | 81° | 4893.6 | 1805.3 |
| 10′ | 3386.3 | 925.9 | 10′ | 4099.5 | 1315.6 | 10′ | 4908.0 | 1814.7 |
| 20 | 3397.5 | 931.6 | 20 | 4112.1 | 1322.9 | 20 | 4922.5 | 1824.1 |
| 30 | 3408.8 | 937.3 | 30 | 4124.8 | 1330.3 | 30 | 4937.0 | 1833.6 |
| 40 | 3420.1 | 943.1 | 40 | 4137.4 | 1337.7 | 40 | 4951.5 | 1843.1 |
| 50 | 3431.4 | 948.9 | 50 | 4150.1 | 1345.1 | 50 | 4966.1 | 1852.6 |
| 62 | 3442.7 | 954.8 | 72 | 4162.8 | 1352.6 | 82 | 4980.7 | 1862.2 |
| 10 | 3454.1 | 960.6 | 10 | 4175.6 | 1360.1 | 10 | 4995.4 | 1871.8 |
| 20 | 3465.4 | 966.5 | 20 | 4188.5 | 1367.6 | 20 | 5010.0 | 1881.5 |
| 30 | 3476.8 | 972.4 | 30 | 4201.2 | 1375.2 | 30 | 5024.8 | 1891.2 |
| 40 | 3488.3 | 978.3 | 40 | 4214.0 | 1382.8 | 40 | 5039.5 | 1900.9 |
| 50 | 3499.7 | 984.3 | 50 | 4226.8 | 1390.4 | 50 | 5054.3 | 1910.7 |
| 63 | 3511.1 | 990.2 | 73 | 4239.7 | 1398.0 | 83 | 5069.2 | 1920.5 |
| 10 | 3522.6 | 996.2 | 10 | 4252.6 | 1405.7 | 10 | 5084.0 | 1930.4 |
| 20 | 3534.1 | 1002.3 | 20 | 4265.6 | 1413.5 | 20 | 5099.0 | 1940.3 |
| 30 | 3545.6 | 1008.3 | 30 | 4278.5 | 1421.2 | 30 | 5113.9 | 1950.3 |
| 40 | 3557.2 | 1014.4 | 40 | 4291.5 | 1429.0 | 40 | 5128.9 | 1960.2 |
| 50 | 3568.7 | 1020.5 | 50 | 4304.6 | 1436.8 | 50 | 5143.9 | 1970.3 |
| 64 | 3580.3 | 1026.6 | 74 | 4317.6 | 1444.6 | 84 | 5159.0 | 1980.4 |
| 10 | 3591.9 | 1032.8 | 10 | 4330.7 | 1452.5 | 10 | 5174.1 | 1990.5 |
| 20 | 3603.5 | 1039.0 | 20 | 4343.8 | 1460.4 | 20 | 5189.3 | 2000.6 |
| 30 | 3615.1 | 1045.2 | 30 | 4356.9 | 1468.4 | 30 | 5204.4 | 2010.8 |
| 40 | 3626.8 | 1051.4 | 40 | 4370.1 | 1476.4 | 40 | 5219.7 | 2021.1 |
| 50 | 3638.5 | 1057.7 | 50 | 4383.3 | 1484.4 | 50 | 5234.9 | 2031.4 |
| 65 | 3650.2 | 1063.9 | 75 | 4396.5 | 1492.4 | 85 | 5250.3 | 2041.7 |
| 10 | 3661.9 | 1070.2 | 10 | 4409.8 | 1500.5 | 10 | 5265.6 | 2052.1 |
| 20 | 3673.7 | 1076.6 | 20 | 4423.1 | 1508.6 | 20 | 5281.0 | 2062.5 |
| 30 | 3685.4 | 1082.9 | 30 | 4436.4 | 1516.7 | 30 | 5296.4 | 2073.0 |
| 40 | 3697.2 | 1089.3 | 40 | 4449.7 | 1524.9 | 40 | 5311.9 | 2083.5 |
| 50 | 3709.0 | 1095.7 | 50 | 4463.1 | 1533.1 | 50 | 5327.4 | 2094.1 |
| 66 | 3720.9 | 1102.2 | 76 | 4476.5 | 1541.4 | 86 | 5343.0 | 2104.7 |
| 10 | 3732.7 | 1108.6 | 10 | 4489.9 | 1549.7 | 10 | 5358.6 | 2115.3 |
| 20 | 3744.6 | 1115.1 | 20 | 4503.4 | 1558.0 | 20 | 5374.2 | 2126.0 |
| 30 | 3756.5 | 1121.7 | 30 | 4516.9 | 1566.3 | 30 | 5389.9 | 2136.7 |
| 40 | 3768.5 | 1128.2 | 40 | 4530.4 | 1574.7 | 40 | 5405.6 | 2147.5 |
| 50 | 3780.4 | 1134.8 | 50 | 4544.0 | 1583.1 | 50 | 5421.4 | 2158.4 |
| 67 | 3792.4 | 1141.4 | 77 | 4557.6 | 1591.6 | 87 | 5437.2 | 2169.2 |
| 10 | 3804.4 | 1148.0 | 10 | 4571.2 | 1600.1 | 10 | 5453.1 | 2180.2 |
| 20 | 3816.4 | 1154.7 | 20 | 4584.8 | 1608.6 | 20 | 5469.0 | 2191.1 |
| 30 | 3828.4 | 1161.3 | 30 | 4598.5 | 1617.1 | 30 | 5484.9 | 2202.2 |
| 40 | 3840.5 | 1168.1 | 40 | 4612.2 | 1625.7 | 40 | 5500.9 | 2213.2 |
| 50 | 3852.6 | 1174.8 | 50 | 4626.0 | 1634.4 | 50 | 5517.0 | 2224.3 |
| 68 | 3864.7 | 1181.6 | 78 | 4639.8 | 1643.0 | 88 | 5533.1 | 2235.5 |
| 10 | 3876.8 | 1188.4 | 10 | 4653.6 | 1651.7 | 10 | 5549.2 | 2246.7 |
| 20 | 3889.0 | 1195.2 | 20 | 4667.4 | 1660.5 | 20 | 5565.4 | 2258.0 |
| 30 | 3901.2 | 1202.0 | 30 | 4681.3 | 1669.2 | 30 | 5581.6 | 2269.3 |
| 40 | 3913.4 | 1208.9 | 40 | 4695.2 | 1678.1 | 40 | 5597.8 | 2280.6 |
| 50 | 3925.6 | 1215.8 | 50 | 4709.2 | 1686.9 | 50 | 5614.2 | 2292.0 |
| 69 | 3937.9 | 1222.7 | 79 | 4723.2 | 1695.8 | 89 | 5630.5 | 2303.5 |
| 10 | 3950.2 | 1229.7 | 10 | 4737.2 | 1704.7 | 10 | 5646.9 | 2315.0 |
| 20 | 3962.5 | 1236.7 | 20 | 4751.2 | 1713.7 | 20 | 5663.4 | 2326.6 |
| 30 | 3974.8 | 1243.7 | 30 | 4765.3 | 1722.7 | 30 | 5679.9 | 2338.2 |
| 40 | 3987.2 | 1250.8 | 40 | 4779.4 | 1731.7 | 40 | 5696.4 | 2349.8 |
| 50 | 3999.5 | 1257.9 | 50 | 4793.6 | 1740.8 | 50 | 5713.0 | 2361.5 |
| 70 | 4011.9 | 1265.0 | 80 | 4807.7 | 1749.9 | 90 | 5729.7 | 2373.3 |
| 10 | 4024.4 | 1272.1 | 10 | 4822.0 | 1759.0 | 10 | 5746.3 | 2385.1 |
| 20 | 4036.8 | 1279.3 | 20 | 4836.2 | 1768.2 | 20 | 5763.1 | 2397.0 |
| 30 | 4049.3 | 1286.5 | 30 | 4850.5 | 1777.4 | 30 | 5779.9 | 2408.9 |
| 40 | 4061.8 | 1293.6 | 40 | 4864.8 | 1786.7 | 40 | 5796.7 | 2420.9 |
| 50 | 4074.4 | 1300.9 | 50 | 4879.2 | 1796.0 | 50 | 5813.6 | 2432.9 |

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## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 91° | 5830.5 | 2444.9 | 101° | 6950.6 | 3278.1 | 111° | 8336.7 | 4386.1 |
| 10′ | 5847.5 | 2457.1 | 10′ | 6971.3 | 3294.1 | 10′ | 8362.7 | 4407.6 |
| 20 | 5864.6 | 2469.3 | 20 | 6992.0 | 3310.1 | 20 | 8388.9 | 4429.2 |
| 30 | 5881.7 | 2481.5 | 30 | 7012.7 | 3326.1 | 30 | 8415.1 | 4450.9 |
| 40 | 5898.8 | 2493.8 | 40 | 7033.6 | 3342.3 | 40 | 8441.5 | 4472.7 |
| 50 | 5916.0 | 2506.1 | 50 | 7054.5 | 3358.5 | 50 | 8468.0 | 4494.6 |
| 92 | 5933.2 | 2518.5 | 102 | 7075.5 | 3374.9 | 112 | 8494.6 | 4516.6 |
| 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 | 103 | 7203.2 | 3474.4 | 113 | 8656.6 | 4651.3 |
| 10 | 6055 4 | 2606.8 | 10 | 7224.7 | 3491.3 | 10 | 8684.0 | 4674.2 |
| 20 | 6073.1 | 2619.7 | 20 | 7246.3 | 3508.2 | 20 | 8711.5 | 4697.2 |
| 30 | 6090.8 | 2637.6 | 30 | 7268.0 | 3525.2 | 30 | 8739.2 | 4720.3 |
| 40 | 6108.6 | 2645.5 | 40 | 7289.8 | 3542.4 | 40 | 8767.0 | 4743.6 |
| 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 | 6162.6 | 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 | 50 | 7444.6 | 3664.5 | 50 | 8965.0 | 4909.9 |
| 95 | 6252.8 | 2751.3 | 105 | 7467.0 | 3682.3 | 115 | 8993.8 | 4934.1 |
| 10 | 6271.1 | 2764.8 | 10 | 7489.6 | 3700.2 | 10 | 9022.7 | 4958.6 |
| 20 | 6289.4 | 2778.3 | 20 | 7512.2 | 3718.2 | 20 | 9051.7 | 4983.1 |
| 30 | 6307.9 | 2792.0 | 30 | 7534.9 | 3736.2 | 30 | 9080.9 | 5007.8 |
| 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 | 40 | 7696.3 | 3865.2 | 40 | 9289.2 | 5184.5 |
| 50 | 6457.3 | 2903.1 | 50 | 7719.7 | 3884.0 | 50 | 9319.5 | 5210.3 |
| 97 | 6476.2 | 2917.3 | 107 | 7743.2 | 3902.9 | 117 | 9349.9 | 5236.2 |
| 10 | 6495.2 | 2931.6 | 10 | 7766.8 | 3921.9 | 10 | 9380.5 | 5262.3 |
| 20 | 6514.3 | 2945.9 | 20 | 7790.5 | 3940.9 | 20 | 9411.3 | 5288.6 |
| 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 | 10 | 7910.4 | 4037.8 | 10 | 9567.2 | 5422.1 |
| 20 | 6630.1 | 3033.1 | 20 | 7934.6 | 4057.4 | 20 | 9598.9 | 5449.2 |
| 30 | 6649.6 | 3047.9 | 30 | 7959.0 | 4077.2 | 30 | 9630.7 | 5476.5 |
| 40 | 6669.2 | 3062.8 | 40 | 7983.5 | 4097.1 | 40 | 9662.6 | 5504.0 |
| 50 | 6688.8 | 3077.7 | 50 | 8008.0 | 4117.0 | 50 | 9694.7 | 5531.7 |
| 99 | 6708.6 | 3092.7 | 109 | 8032.7 | 4137.1 | 119 | 9727.0 | 5559.4 |
| 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 | 110 | 8182.8 | 4259.7 | 120 | 9924.0 | 5729.7 |
| 10 | 6848.5 | 3199.6 | 10 | 8208.2 | 4280.5 | 10 | 9957.5 | 5758.6 |
| 20 | 6868.8 | 3215.1 | 20 | 8233.7 | 4301.4 | 20 | 9991.0 | 5787.7 |
| 30 | 6889.2 | 3230.8 | 30 | 8259.3 | 4322.4 | 30 | 10025.0 | 5817.0 |
| 40 | 6909.6 | 3246.5 | 40 | 8285.0 | 4343.6 | 40 | 10059.0 | 5846.5 |
| 50 | 6930.1 | 3262.3 | 50 | 8310.8 | 4364.8 | 50 | 10093.0 | 5876.1 |



## Table V.—Corrections for Tangents and Externals.

These corrections are to be added to the approximate values, found by dividing the tangent, or external, for a 1° curve (Table IV) by the degree of curve, in order to obtain the true tangents, or externals. Intermediate values may be obtained by interpolation.

### For Tangents Add

| Central Angle | Degree of Curve | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° |
| 10° | .03 | .06 | .09 | .13 | .16 | .19 | .22 | .25 | .28 | .31 | .34 | .38 | .42 | .46 |
| 15° | .04 | .10 | .14 | .19 | .24 | .29 | .34 | .39 | .45 | .51 | .53 | .58 | .63 | .68 |
| 20° | .06 | .13 | .19 | .26 | .32 | .39 | .45 | .51 | .58 | .65 | .72 | .79 | .84 | .90 |
| 25° | .08 | .16 | .24 | .33 | .40 | .49 | .58 | .67 | .75 | .83 | .90 | .99 | 1.06 | 1.14 |
| 30° | .10 | .19 | .29 | .39 | .49 | .59 | .69 | .79 | .89 | .99 | 1.09 | 1.20 | 1.29 | 1.39 |
| 35° | .11 | .22 | .34 | .47 | .58 | .69 | .70 | .81 | .92 | 1.04 | 1.29 | 1.42 | 1.54 | 1.66 |
| 40° | .13 | .26 | .40 | .53 | .67 | .80 | .93 | 1.06 | 1.20 | 1.34 | 1.49 | 1.64 | 1.79 | 1.94 |
| 45° | .15 | .30 | .44 | .60 | .76 | .91 | 1.06 | 1.21 | 1.37 | 1.52 | 1.70 | 1.87 | 2.04 | 2.21 |
| 50° | .17 | .34 | .51 | .68 | .85 | 1.02 | 1.19 | 1.36 | 1.54 | 1.72 | 1.91 | 2.10 | 2.29 | 2.48 |
| 55° | .19 | .38 | .57 | .76 | .95 | 1.14 | 1.32 | 1.52 | 1.72 | 1.92 | 2.14 | 2.35 | 2.56 | 2.77 |
| 60° | .21 | .42 | .63 | .84 | 1.05 | 1.27 | 1.49 | 1.71 | 1.94 | 2.17 | 2.38 | 2.60 | 2.83 | 3.07 |
| 65° | .23 | .46 | .69 | .93 | 1.16 | 1.40 | 1.64 | 1.88 | 2.13 | 2.38 | 2.63 | 2.88 | 3.13 | 3.39 |
| 70° | .25 | .51 | .76 | 1.02 | 1.28 | 1.54 | 1.80 | 2.06 | 2.33 | 2.60 | 2.88 | 3.16 | 3.44 | 3.72 |
| 75° | .27 | .56 | .83 | 1.12 | 1.40 | 1.69 | 1.98 | 2.27 | 2.57 | 2.87 | 3.16 | 3.47 | 3.78 | 4.09 |
| 80° | .30 | .61 | .91 | 1.22 | 1.53 | 1.84 | 2.15 | 2.46 | 2.78 | 3.10 | 3.44 | 3.78 | 4.12 | 4.46 |
| 85° | .33 | .66 | 1.00 | 1.33 | 1.68 | 2.02 | 2.36 | 2.70 | 3.05 | 3.40 | 3.77 | 4.14 | 4.55 | 4.89 |
| 90° | .36 | .72 | 1.09 | 1.45 | 1.83 | 2.20 | 2.57 | 2.94 | 3.32 | 3.70 | 4.10 | 4.50 | 4.91 | 5.32 |
| 95° | .39 | .79 | 1.19 | 1.55 | 2.00 | 2.40 | 2.80 | 3.20 | 3.61 | 4.02 | 4.40 | 4.98 | 5.38 | 5.83 |
| 100° | .43 | .86 | 1.30 | 1.74 | 2.18 | 2.62 | 3.06 | 3.50 | 3.95 | 4.40 | 4.88 | 5.37 | 5.85 | 6.34 |
| 110° | .51 | 1.03 | 1.56 | 2.08 | 2.61 | 3.14 | 3.67 | 4.21 | 4.76 | 5.31 | 5.86 | 6.43 | 7.01 | 7.60 |
| 120° | .62 | 1.25 | 1.93 | 2.52 | 3.16 | 3.81 | 4.45 | 5.11 | 5.77 | 6.44 | 7.12 | 7.80 | 8.50 | 9.22 |

### For Externals Add

| Central Angle | Degree of Curve | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° |
| 10° | .001 | .003 | .004 | .006 | .007 | .008 | .009 | .011 | .012 | .014 | .015 | .017 | .018 | .020 |
| 15° | .003 | .007 | .010 | .014 | .018 | .023 | .027 | .029 | .032 | .035 | .039 | .043 | .047 | .051 |
| 20° | .006 | .011 | .017 | .022 | .028 | .034 | .038 | .045 | .051 | .057 | .063 | .070 | .076 | .083 |
| 25° | .009 | .018 | .027 | .036 | .046 | .056 | .065 | .074 | .083 | .093 | .106 | .120 | .127 | .135 |
| 30° | .013 | .025 | .038 | .051 | .065 | .078 | .090 | .103 | .116 | .129 | .149 | .170 | .179 | .188 |
| 35° | .018 | .035 | .054 | .072 | .086 | .109 | .131 | .153 | .175 | .197 | .213 | .230 | .247 | .264 |
| 40° | .023 | .046 | .070 | .093 | .117 | .141 | .172 | .203 | .234 | .265 | .277 | .290 | .315 | .341 |
| 45° | .030 | .060 | .093 | .119 | .153 | .184 | .216 | .254 | .289 | .325 | .351 | .378 | .411 | .445 |
| 50° | .037 | .075 | .116 | .151 | .189 | .227 | .266 | .305 | .345 | .384 | .425 | .467 | .508 | .550 |
| 55° | .046 | .093 | .142 | .188 | .236 | .283 | .332 | .381 | .420 | .479 | .530 | .582 | .641 | .700 |
| 60° | .056 | .112 | .168 | .225 | .283 | .340 | .398 | .457 | .516 | .575 | .636 | .697 | .774 | .851 |
| 65° | .067 | .135 | .204 | .273 | .343 | .412 | .483 | .554 | .625 | .697 | .711 | .845 | .922 | 1.01 |
| 70° | .080 | .159 | .240 | .321 | .403 | .485 | .568 | .652 | .735 | .819 | .906 | .994 | 1.08 | 1.17 |
| 75° | .095 | .182 | .286 | .383 | .480 | .578 | .678 | .777 | .877 | .977 | 1.07 | 1.18 | 1.29 | 1.39 |
| 80° | .110 | .220 | .332 | .445 | .558 | .671 | .787 | .903 | 1.02 | 1.13 | 1.25 | 1.38 | 1.50 | 1.62 |
| 85° | .128 | .259 | .391 | .524 | .657 | .790 | .926 | 1.06 | 1.20 | 1.34 | 1.47 | 1.62 | 1.76 | 1.91 |
| 90° | .149 | .299 | .450 | .603 | .756 | .910 | 1.07 | 1.22 | 1.38 | 1.54 | 1.70 | 1.87 | 2.03 | 2.20 |
| 95° | .174 | .350 | .522 | .706 | .985 | 1.06 | 1.25 | 1.43 | 1.62 | 1.80 | 1.99 | 2.18 | 2.38 | 2.53 |
| 100° | .200 | .401 | .604 | .809 | 1.01 | 1.22 | 1.43 | 1.64 | 1.85 | 2.06 | 2.28 | 2.50 | 2.73 | 2.96 |
| 110° | .268 | .536 | .806 | 1.08 | 1.35 | 1.63 | 1.91 | 2.20 | 2.48 | 2.76 | 3.05 | 3.35 | 3.66 | 3.96 |
| 120° | .360 | .721 | 1.08 | 1.45 | 1.82 | 2.19 | 2.57 | 2.95 | 3.33 | 3.72 | 4.11 | 4.50 | 4.91 | 5.32 |

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### TABLE VI.—CORRECTIONS FOR SUB-CHORDS AND LONG CHORDS.

| FOR SUB-CHORDS ADD | | | | | | | | | | Excess of arc per 100 ft. | LONG CHORDS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | | D | 200 | 300 | 400 | 500 |
| 4° | .00 | .00 | .01 | .01 | .01 | .01 | .01 | .01 | .00 | .02 | 1 | 199.99 | 299.97 | 399.92 | 499.85 |
| 6 | .00 | .01 | .01 | .02 | .02 | .02 | .02 | .01 | .01 | .05 | 2 | 199.97 | 299.88 | 399.70 | 499.39 |
| 8 | .01 | .02 | .02 | .03 | .03 | .03 | .03 | .02 | .01 | .08 | 3 | 199.93 | 299.73 | 399.32 | 498.63 |
| 10 | .01 | .02 | .03 | .04 | .05 | .05 | .05 | .04 | .02 | .13 | 4 | 199.88 | 299.51 | 398.78 | 497.57 |
| 12 | .02 | .04 | .05 | .06 | .07 | .07 | .07 | .05 | .03 | .18 | 5 | 199.81 | 299.24 | 398.10 | 496.20 |
| 14 | .02 | .05 | .07 | .08 | .09 | .10 | .09 | .07 | .04 | .25 | 6 | 199.73 | 298.90 | 397.26 | 494.53 |
| 16 | .03 | .06 | .09 | .11 | .12 | .12 | .12 | .09 | .05 | .33 | 7 | 199.63 | 298.51 | 396.28 | 492.57 |
| 18 | .04 | .08 | .11 | .14 | .15 | .16 | .15 | .12 | .07 | .41 | 8 | 199.51 | 298.05 | 395.14 | 490.31 |
| 20 | .05 | .10 | .14 | .17 | .19 | .20 | .18 | .15 | .09 | .51 | 9 | 199.38 | 297.54 | 393.86 | 487.75 |
| 22 | .06 | .12 | .17 | .21 | .23 | .24 | .22 | .18 | .10 | .62 | 10 | 199.24 | 296.96 | 392.42 | 484.90 |
| 24 | .07 | .14 | .20 | .25 | .28 | .28 | .26 | .21 | .12 | .74 | 12 | 198.90 | 295.63 | 389.12 | 478.34 |
| 26 | .09 | .17 | .24 | .29 | .32 | .33 | .31 | .25 | .15 | .86 | 14 | 198.51 | 294.06 | 385.22 | 470.65 |
| 28 | .10 | .19 | .27 | .34 | .37 | .38 | .36 | .29 | .17 | 1.00 | 16 | 198.05 | 292.25 | 380.76 | 461.86 |
| 30 | .11 | .22 | .31 | .39 | .43 | .44 | .41 | .33 | .19 | 1.15 | 18 | 197.54 | 290.21 | 375.74 | 452.02 |
| 32 | .13 | .25 | .36 | .44 | .49 | .50 | .47 | .38 | .22 | 1.31 | 20 | 196.90 | 287.94 | 370.17 | 441.15 |
| 34 | .15 | .28 | .40 | .50 | .55 | .57 | .53 | .43 | .25 | 1.48 | 22 | 196.32 | 285.44 | 364.06 | 429.30 |
| 36 | .17 | .32 | .45 | .56 | .62 | .64 | .59 | .48 | .28 | 1.66 | 24 | 195.63 | 282.71 | 357.43 | 416.53 |
| 38 | .18 | .36 | .51 | .62 | .70 | .71 | .66 | .53 | .31 | 1.86 | 26 | 194.87 | 279.76 | 350.30 | 402.89 |
| 40 | .21 | .40 | .56 | .69 | .77 | .79 | .73 | .59 | .35 | 2.06 | 28 | 194.06 | 276.59 | 342.69 | 388.42 |
| 42 | .23 | .44 | .62 | .76 | .85 | .87 | .81 | .65 | .38 | 2.28 | 30 | 193.18 | 273.20 | 334.61 | 373.20 |
| 44 | .25 | .48 | .68 | .84 | .94 | .96 | .89 | .72 | .42 | 2.50 | 32 | 192.25 | 269.61 | 326.08 | 357.28 |
| 46 | .27 | .52 | .75 | .92 | 1.02 | 1.05 | .98 | .78 | .46 | 2.74 | 34 | 191.26 | 265.81 | 317.12 | 340.73 |
| 48 | .30 | .57 | .81 | 1.00 | 1.12 | 1.14 | 1.06 | .86 | .50 | 2.99 | 36 | 190.21 | 261.80 | 307.77 | 323.61 |
| 50 | .32 | .62 | .89 | 1.09 | 1.21 | 1.24 | 1.15 | .93 | .55 | 3.24 | 38 | 189.10 | 257.60 | 298.03 | 305.99 |
| 52 | .35 | .67 | .96 | 1.18 | 1.31 | 1.35 | 1.25 | 1.01 | .59 | 3.52 | 40 | 187.94 | 253.21 | 287.94 | 287.94 |
| 54 | .38 | .73 | 1.04 | 1.28 | 1.42 | 1.46 | 1.35 | 1.09 | .64 | 3.80 | 42 | 186.72 | 248.63 | 277.51 | 269.54 |
| 56 | .41 | .78 | 1.12 | 1.38 | 1.53 | 1.57 | 1.46 | 1.17 | .69 | 4.09 | 44 | 185.44 | 243.87 | 266.78 | 250.85 |
| 58 | .44 | .84 | 1.20 | 1.48 | 1.65 | 1.69 | 1.57 | 1.20 | .74 | 4.40 | 46 | 184.10 | 239.93 | 255.78 | 231.95 |
| 60 | .47 | .91 | 1.29 | 1.59 | 1.76 | 1.81 | 1.68 | 1.35 | .80 | 4.72 | 48 | 182.71 | 233.83 | 244.51 | 212.92 |

NOTE.—When a chord of less than 100 ft. is used the corrections given in the above table should be added to the nominal length of chord to get the length which should be used in order that the 100 ft. points will check with those obtained by using the standard 100 ft. chord. Thus in locating a 14° curve by 25 ft. chords measure 25'.06 for each chord. Long chords are useful in passing obstacles.

### TABLE VII.—MIDDLE ORDINATES FOR RAILS IN FEET.

| Deg. of Curve | LENGTH OF RAILS | | | | | | | Deg. of Curve | LENGTH OF RAILS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 32 | 30 | 28 | 26 | 24 | 22 | 20 | | 32 | 30 | 28 | 26 | 24 | 22 | 20 |
| 1° | .022 | .020 | .016 | .013 | .011 | .009 | .008 | 16° | .356 | .313 | .273 | .236 | .200 | .170 | .139 |
| 2 | .045 | .038 | .034 | .029 | .025 | .021 | .017 | 17 | .378 | .333 | .290 | .252 | .213 | .180 | .148 |
| 3 | .067 | .058 | .051 | .044 | .037 | .031 | .026 | 18 | .400 | .351 | .306 | .265 | .225 | .190 | .156 |
| 4 | .089 | .079 | .069 | .060 | .050 | .042 | .035 | 19 | .423 | .371 | .324 | .280 | .238 | .201 | .165 |
| 5 | .112 | .099 | .086 | .074 | .063 | .053 | .044 | 20 | .445 | .392 | .341 | .296 | .250 | .212 | .174 |
| 6 | .134 | .117 | .102 | .088 | .076 | .064 | .052 | 21 | .466 | .410 | .357 | .309 | .262 | .222 | .182 |
| 7 | .156 | .137 | .120 | .104 | .088 | .074 | .061 | 22 | .487 | .430 | .375 | .325 | .275 | .233 | .191 |
| 8 | .179 | .158 | .137 | .119 | .100 | .085 | .070 | 23 | .509 | .450 | .390 | .338 | .287 | .243 | .199 |
| 9 | .201 | .175 | .153 | .133 | .112 | .095 | .078 | 24 | .531 | .469 | .408 | .354 | .299 | .253 | .208 |
| 10 | .223 | .196 | .171 | .148 | .125 | .106 | .087 | 25 | .552 | .486 | .424 | .367 | .311 | .263 | .216 |
| 11 | .245 | .216 | .188 | .163 | .139 | .117 | .096 | 26 | .573 | .506 | .441 | .382 | .323 | .274 | .225 |
| 12 | .268 | .236 | .206 | .179 | .151 | .128 | .105 | 27 | .594 | .524 | .457 | .396 | .335 | .284 | .233 |
| 13 | .290 | .254 | .222 | .192 | .163 | .138 | .113 | 28 | .618 | .545 | .475 | .411 | .348 | .294 | .242 |
| 14 | .312 | .275 | .239 | .207 | .175 | .148 | .122 | 29 | .638 | .564 | .491 | .424 | .361 | .303 | .250 |
| 15 | .334 | .295 | .257 | .223 | .188 | .159 | .131 | 30 | .660 | .583 | .508 | .438 | .374 | .313 | .259 |



## SLOPE REDUCTIONS.

When distances are measured on a slope that may be reduced to the equivalent horizontal distance by the following approximate rule:—subtract from the slope distance the square of the rise divided by twice the slope distance. Thus for a slope distance of 250.3 ft. and a rise of 15 ft. correction $=15^2 \div 2 \times 250.3 = .45$ (by slide rule) or horizontal distance $= 250.3 - .45 = 249.85$. When vertical angle = V. A. is measured horizontal distance = slope distance — slope distance (1 — Cos. V. A.). Thus for slope distance of 248.7 ft. and V. A. of 4° 20′ from Table VIII Cos = .99714 and correction $= 1 - .99714 = .00286$ per foot or total of $.286 \times 2\frac{1}{2}$ (near enough) $= .57$ and horizontal distance $= 248.7 - .57 = 248.13$ ft.

## TRIGONOMETRICAL FORMULAS.

See fig. (a).

sin. $A = \frac{a}{c}$

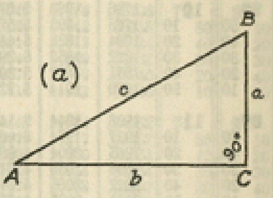
cos. $A = \frac{b}{c}$

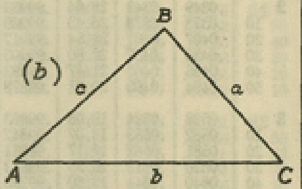
tan. $A = \frac{a}{b}$

cot. $A = \frac{b}{a}$

sec. $A = \frac{c}{b}$

cosec. $A = \frac{c}{a}$




### FORMULA FOR SOLVING TRIANGLES.

| Given | Sought. | Right triangles. See fig. (a). |
|---|---|---|
| $a, c$ | $A, B, b$ | sin. $A = \frac{a}{c}$, cos. $B = \frac{a}{c}$, $b = \sqrt{(c+a)(c-a)}$ |
| $a, b$ | $A, B, c$ | tan. $A = \frac{a}{b}$, cot. $B = \frac{a}{b}$, $c = \sqrt{a^2+b^2}$ |
| $A, a$ | $B, b, c$ | $B = 90° - A$, $b = a$ cot. $A$, $c = \frac{a}{\text{sin. } A}$ |
| $A, b$ | $B, a, c$ | $B = 90° - A$, $a = b$ tan. $A$, $c = \frac{b}{\text{cos. } A}$ |
| $A, c$ | $B, a, b$ | $B = 90° - A$, $a = c$ sin. $A$, $b = c$ cos. $A$ |
| **Given** | **Sought.** | **Oblique triangles. See fig. (b)** |
| $A, B, a$ | $b$ | $b = \frac{a \text{ sin. } B}{\text{sin. } A}$ |
| $A, a, b$ | $B$ | sin. $B = \frac{b \text{ sin. } A}{a}$ |
| $a, b, C$ | $A - B$ | tan. $\frac{1}{2}(A-B) = \frac{a-b \text{ tan. } \frac{1}{2}(A+B)}{a+b}$ |
| $c, b, c$ | $A$ | If $s = \frac{1}{2}(a+b+c)$, sin. $\frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{bc}}$<br>cos. $\frac{1}{2} A = \sqrt{\frac{s(s-a)}{bc}}$, tan. $\frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$,<br>sin. $A = \frac{2\sqrt{(s-a)(s-b)(s-c)s}}{bc}$ |
| $A, B, C, a$ | area | area $= \frac{a^2 \text{ sin. } B \text{ sin. } C}{2 \text{ sin. } A}$ |
| $A, b, c$ | area | area $= \frac{1}{2} b c$ sin. $A$ |
| $a, b, c$ | area | $s = \frac{1}{2}(a+b+c)$, area $= \sqrt{s(s-a)(s-b)(s-c)}$ |

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## Table VIII.—Natural Trigonometrical Functions.

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **0** | 0 | 0 | 00 | 1 | **90** |
| 10 | .0029 | .0029 | 343.8 | 1 | 50 |
| 20 | .0058 | .0058 | 171.9 | .99998 | 40 |
| 30 | .0087 | .0087 | 114.6 | .99996 | 30 |
| 40 | .0116 | .0116 | 85.94 | .99993 | 20 |
| 50 | .0145 | .0145 | 68.75 | .99989 | 10 |
| **1** | .0175 | .0175 | 57.29 | .99985 | **89** |
| 10 | .0204 | .0204 | 49.10 | .99979 | 50 |
| 20 | .0233 | .0233 | 42.96 | .99973 | 40 |
| 30 | .0262 | .0262 | 38.19 | .99966 | 30 |
| 40 | .0291 | .0291 | 34.37 | .99958 | 20 |
| 50 | .0320 | .0320 | 31.24 | .99949 | 10 |
| **2** | .0349 | .0349 | 28.64 | .99939 | **88** |
| 10 | .0378 | .0378 | 26.43 | .99929 | 50 |
| 20 | .0407 | .0407 | 24.54 | .99917 | 40 |
| 30 | .0436 | .0437 | 22.90 | .99905 | 30 |
| 40 | .0465 | .0466 | 21.47 | .99892 | 20 |
| 50 | .0494 | .0495 | 20.21 | .99878 | 10 |
| **3** | .0523 | .0524 | 19.08 | .99863 | **87** |
| 10 | .0552 | .0553 | 18.07 | .99847 | 50 |
| 20 | .0581 | .0582 | 17.17 | .99831 | 40 |
| 30 | .0610 | .0612 | 16.35 | .99813 | 30 |
| 40 | .0640 | .0641 | 15.60 | .99795 | 20 |
| 50 | .0669 | .0670 | 14.92 | .99776 | 10 |
| **4** | .0698 | .0699 | 14.30 | .99756 | **86** |
| 10 | .0727 | .0729 | 13.73 | .99736 | 50 |
| 20 | .0756 | .0758 | 13.20 | .99714 | 40 |
| 30 | .0785 | .0787 | 12.71 | .99692 | 30 |
| 40 | .0814 | .0816 | 12.25 | .99668 | 20 |
| 50 | .0843 | .0846 | 11.83 | .99644 | 10 |
| **5** | .0872 | .0875 | 11.43 | .99619 | **85** |
| 10 | .0901 | .0904 | 11.06 | .99594 | 50 |
| 20 | .0929 | .0934 | 10.71 | .99567 | 40 |
| 30 | .0958 | .0963 | 10.39 | .99540 | 30 |
| 40 | .0987 | .0992 | 10.08 | .99511 | 20 |
| 50 | .1016 | .1022 | 9.788 | .99482 | 10 |
| **6** | .1045 | .1051 | 9.514 | .99452 | **84** |
| 10 | .1074 | .1080 | 9.255 | .99421 | 50 |
| 20 | .1103 | .1110 | 9.010 | .99390 | 40 |
| 30 | .1132 | .1139 | 8.777 | .99357 | 30 |
| 40 | .1161 | .1169 | 8.556 | .99324 | 20 |
| 50 | .1190 | .1198 | 8.345 | .99290 | 10 |
| **7** | .1219 | .1228 | 8.144 | .99255 | **83** |
| 10 | .1248 | .1257 | 7.953 | .99219 | 50 |
| 20 | .1276 | .1287 | 7.770 | .99182 | 40 |
| 30 | .1305 | .1317 | 7.596 | .99144 | 30 |
| 40 | .1334 | .1346 | 7.429 | .99106 | 20 |
| 50 | .1363 | .1376 | 7.269 | .99067 | 10 |
| | | | | | **82** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **8** | .1392 | .1405 | 7.115 | .99027 | **82** |
| 10 | .1421 | .1435 | 6.968 | .98986 | 50 |
| 20 | .1449 | .1465 | 6.827 | .98944 | 40 |
| 30 | .1478 | .1495 | 6.691 | .98902 | 30 |
| 40 | .1507 | .1524 | 6.561 | .98858 | 20 |
| 50 | .1536 | .1554 | 6.435 | .98814 | 10 |
| **9** | .1564 | .1584 | 6.314 | .98769 | **81** |
| 10 | .1593 | .1614 | 6.197 | .98723 | 50 |
| 20 | .1622 | .1644 | 6.084 | .98676 | 40 |
| 30 | .1650 | .1673 | 5.976 | .98629 | 30 |
| 40 | .1679 | .1703 | 5.871 | .98580 | 20 |
| 50 | .1708 | .1733 | 5.769 | .98531 | 10 |
| **10** | .1736 | .1763 | 5.671 | .98481 | **80** |
| 10 | .1765 | .1793 | 5.576 | .98430 | 50 |
| 20 | .1794 | .1823 | 5.485 | .98378 | 40 |
| 30 | .1822 | .1853 | 5.396 | .98325 | 30 |
| 40 | .1851 | .1883 | 5.309 | .98272 | 20 |
| 50 | .1880 | .1914 | 5.226 | .98218 | 10 |
| **11** | .1908 | .1944 | 5.145 | .98163 | **79** |
| 10 | .1937 | .1974 | 5.066 | .98107 | 50 |
| 20 | .1965 | .2004 | 4.989 | .98050 | 40 |
| 30 | .1994 | .2035 | 4.915 | .97992 | 30 |
| 40 | .2022 | .2065 | 4.843 | .97934 | 20 |
| 50 | .2051 | .2095 | 4.773 | .97875 | 10 |
| **12** | .2079 | .2126 | 4.705 | .97815 | **78** |
| 10 | .2108 | .2156 | 4.638 | .97754 | 50 |
| 20 | .2136 | .2186 | 4.574 | .97692 | 40 |
| 30 | .2164 | .2217 | 4.511 | .97630 | 30 |
| 40 | .2193 | .2247 | 4.449 | .97566 | 20 |
| 50 | .2221 | .2278 | 4.390 | .97502 | 10 |
| **13** | .2250 | .2309 | 4.331 | .97437 | **77** |
| 10 | .2278 | .2339 | 4.275 | .97371 | 50 |
| 20 | .2306 | .2370 | 4.219 | .97304 | 40 |
| 30 | .2334 | .2401 | 4.165 | .97237 | 30 |
| 40 | .2363 | .2432 | 4.113 | .97169 | 20 |
| 50 | .2391 | .2462 | 4.061 | .97100 | 10 |
| **14** | .2419 | .2493 | 4.011 | .97030 | **76** |
| 10 | .2447 | .2524 | 3.962 | .96959 | 50 |
| 20 | .2476 | .2555 | 3.914 | .96887 | 40 |
| 30 | .2504 | .2586 | 3.867 | .96815 | 30 |
| 40 | .2532 | .2617 | 3.821 | .96742 | 20 |
| 50 | .2560 | .2648 | 3.776 | .96667 | 10 |
| **15** | .2588 | .2679 | 3.732 | .96593 | **75** |
| 10 | .2616 | .2711 | 3.689 | .96517 | 50 |
| 20 | .2644 | .2742 | 8.647 | .96440 | 40 |
| 30 | .2672 | .2773 | 3.606 | .96363 | 30 |
| 40 | .2700 | .2805 | 3.566 | .96285 | 20 |
| 50 | .2728 | .2836 | 3.526 | .96206 | 10 |
| | | | | | **74** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |



## Table VIII.—Natural Trigonometrical Functions.

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **16** | .2756 | .2867 | 3.487 | .96126 | **74** |
| 10 | .2784 | .2899 | 3.450 | .96046 | 50 |
| 20 | .2812 | .2931 | 3.412 | .95964 | 40 |
| 30 | .2840 | .2962 | 3.376 | .95882 | 30 |
| 40 | .2868 | .2994 | 3.340 | .95799 | 20 |
| 50 | .2896 | .3026 | 3.305 | .95715 | 10 |
| **17** | .2924 | .3057 | 3.271 | .95615 | **73** |
| 10 | .2952 | .3089 | 3.237 | .95545 | 50 |
| 20 | .2979 | .3121 | 3.204 | .95459 | 40 |
| 30 | .3007 | .3153 | 3.172 | .95372 | 30 |
| 40 | .3035 | .3185 | 3.140 | .95284 | 20 |
| 50 | .3062 | .3217 | 3.108 | .95196 | 10 |
| **18** | .3090 | .3249 | 3.078 | .95106 | **72** |
| 10 | .3118 | .3281 | 3.048 | .95015 | 50 |
| 20 | .3145 | .3314 | 3.018 | .94924 | 40 |
| 30 | .3173 | .3346 | 2.989 | .94832 | 30 |
| 40 | .3201 | .3378 | 2.960 | .94740 | 20 |
| 50 | .3228 | .3411 | 2.932 | .94646 | 10 |
| **19** | .3256 | .3443 | 2.904 | .94552 | **71** |
| 10 | .3283 | .3476 | 2.877 | .94457 | 50 |
| 20 | .3311 | .3508 | 2.850 | .94361 | 40 |
| 30 | .3338 | .3541 | 2.824 | .94264 | 30 |
| 40 | .3365 | .3574 | 2.798 | .94167 | 20 |
| 50 | .3393 | .3607 | 2.773 | .94068 | 10 |
| **20** | .3420 | .3640 | 2.747 | .93969 | **70** |
| 10 | .3448 | .3673 | 2.723 | .93869 | 50 |
| 20 | .3475 | .3706 | 2.699 | .93769 | 40 |
| 30 | .3502 | .3739 | 2.675 | .93667 | 30 |
| 40 | .3529 | .3772 | 2.651 | .93565 | 20 |
| 50 | .3557 | .3805 | 2.628 | .93462 | 10 |
| **21** | .3584 | .3839 | 2.606 | .93358 | **69** |
| 10 | .3611 | .3872 | 2.583 | .93253 | 50 |
| 20 | .3638 | .3906 | 2.560 | .93148 | 40 |
| 30 | .3665 | .3939 | 2.539 | .93042 | 30 |
| 40 | .3692 | .3973 | 2.517 | .92935 | 20 |
| 50 | .3719 | .4006 | 2.496 | .92827 | 10 |
| **22** | .3746 | .4040 | 2.475 | .92718 | **68** |
| 10 | .3773 | .4074 | 2.455 | .92609 | 50 |
| 20 | .3800 | .4108 | 2.434 | .92499 | 40 |
| 30 | .3827 | .4142 | 2.414 | .92388 | 30 |
| 40 | .3854 | .4176 | 2.394 | .92276 | 20 |
| 50 | .3881 | .4210 | 2.375 | .92164 | 10 |
| **23** | .3907 | .4245 | 2.356 | .92050 | **67** |
| 10 | .3934 | .4279 | 2.337 | .91936 | 50 |
| 20 | .3961 | .4314 | 2.318 | .91822 | 40 |
| 30 | .3987 | .4348 | 2.300 | .91706 | 30 |
| 40 | .4014 | .4383 | 2.282 | .91590 | 20 |
| 50 | .4041 | .4417 | 2.264 | .91472 | 10 |
| | | | | | **66** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **24** | .4067 | .4452 | 2.246 | .91355 | **66** |
| 10 | .4094 | .4487 | 2.229 | .91236 | 50 |
| 20 | .4120 | .4522 | 2.211 | .91116 | 40 |
| 30 | .4147 | .4557 | 2.194 | .90996 | 30 |
| 40 | .4173 | .4592 | 2.177 | .90875 | 20 |
| 50 | .4200 | .4628 | 2.161 | .90753 | 10 |
| **25** | .4226 | .4663 | 2.145 | .90631 | **65** |
| 10 | .4253 | .4699 | 2.128 | .90507 | 50 |
| 20 | .4279 | .4734 | 2.112 | .90383 | 40 |
| 30 | .4305 | .4770 | 2.097 | .90259 | 30 |
| 40 | .4331 | .4806 | 2.081 | .90133 | 20 |
| 50 | .4358 | .4841 | 2.066 | .90007 | 10 |
| **26** | .4384 | .4877 | 2.050 | .89879 | **64** |
| 10 | .4410 | .4913 | 2.035 | .89752 | 50 |
| 20 | .4436 | .4950 | 2.020 | .89623 | 40 |
| 30 | .4462 | .4986 | 2.006 | .89493 | 30 |
| 40 | .4488 | .5022 | 1.991 | .89363 | 20 |
| 50 | .4514 | .5059 | 1.977 | .89232 | 10 |
| **27** | .4540 | .5095 | 1.963 | .89101 | **63** |
| 10 | .4566 | .5132 | 1.949 | .88968 | 50 |
| 20 | .4592 | .5169 | 1.935 | .88835 | 40 |
| 30 | .4617 | .5206 | 1.921 | .88701 | 30 |
| 40 | .4643 | .5243 | 1.907 | .88566 | 20 |
| 50 | .4669 | .5280 | 1.894 | .88431 | 10 |
| **28** | .4695 | .5317 | 1.881 | .88295 | **62** |
| 10 | .4720 | .5354 | 1.868 | .88158 | 50 |
| 20 | .4746 | .5392 | 1.855 | .88020 | 40 |
| 30 | .4772 | .5430 | 1.842 | .87882 | 30 |
| 40 | .4797 | .5467 | 1.829 | .87743 | 20 |
| 50 | .4823 | .5505 | 1.816 | .87603 | 10 |
| **29** | .4848 | .5543 | 1.804 | .87462 | **61** |
| 10 | .4874 | .5581 | 1.792 | .87321 | 50 |
| 20 | .4899 | .5619 | 1.780 | .87178 | 40 |
| 30 | .4924 | .5658 | 1.767 | .87036 | 30 |
| 40 | .4950 | .5696 | 1.756 | .86892 | 20 |
| 50 | .4975 | .5735 | 1.744 | .86748 | 10 |
| **30** | .5000 | .5774 | 1.732 | .86603 | **60** |
| 10 | .5025 | .5812 | 1.720 | .86457 | 50 |
| 20 | .5050 | .5851 | 1.709 | .86310 | 40 |
| 30 | .5075 | .5890 | 1.698 | .86163 | 30 |
| 40 | .5100 | .5930 | 1.686 | .86015 | 20 |
| 50 | .5125 | .5969 | 1.675 | .85866 | 10 |
| **31** | .5150 | .6009 | 1.664 | .85717 | **59** |
| 10 | .5175 | .6048 | 1.653 | .85567 | 50 |
| 20 | .5200 | .6088 | 1.643 | .85416 | 40 |
| 30 | .5225 | .6128 | 1.632 | .85264 | 30 |
| 40 | .5250 | .6168 | 1.621 | .85112 | 20 |
| 50 | .5275 | .6208 | 1.611 | .84959 | 10 |
| | | | | | **58** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

## Table VIII.—Natural Trigonometrical Functions.

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **32** | .5299 | .6249 | 1.600 | .84805 | **58** |
| 10 | .5324 | .6289 | 1.590 | .84650 | 50 |
| 20 | .5348 | .6330 | 1.580 | .84495 | 40 |
| 30 | .5373 | .6371 | 1.570 | .84339 | 30 |
| 40 | .5398 | .6412 | 1.560 | .84182 | 20 |
| 50 | .5422 | .6453 | 1.550 | .84025 | 10 |
| **33** | .5446 | .6494 | 1.540 | .83867 | **57** |
| 10 | .5471 | .6536 | 1.530 | .83708 | 50 |
| 20 | .5495 | .6577 | 1.520 | .83549 | 40 |
| 30 | .5519 | .6619 | 1.511 | .83389 | 30 |
| 40 | .5544 | .6661 | 1.501 | .83228 | 20 |
| 50 | .5568 | .6703 | 1.492 | .83066 | 10 |
| **34** | .5592 | .6745 | 1.483 | .82904 | **56** |
| 10 | .5616 | .6787 | 1.473 | .82741 | 50 |
| 20 | .5640 | .6830 | 1.464 | .82577 | 40 |
| 30 | .5664 | .6873 | 1.455 | .82413 | 30 |
| 40 | .5688 | .6916 | 1 446 | .82248 | 20 |
| 50 | .5712 | .6959 | 1.437 | .82082 | 10 |
| **35** | .5736 | .7002 | 1.428 | .81915 | **55** |
| 10 | .5760 | .7046 | 1.419 | .81748 | 50 |
| 20 | .5783 | .7089 | 1.411 | .81580 | 40 |
| 30 | .5807 | .7133 | 1.402 | .81412 | 30 |
| 40 | .5831 | .7177 | 1.393 | .81242 | 20 |
| 50 | .5854 | .7221 | 1.385 | .81072 | 10 |
| **36** | .5878 | .7265 | 1.376 | .80902 | **54** |
| 10 | .5901 | .7310 | 1.368 | .80730 | 50 |
| 20 | .5925 | .7355 | 1.360 | .80558 | 40 |
| 30 | .5948 | .7400 | 1.351 | .80386 | 30 |
| 40 | .5972 | .7445 | 1.343 | .80212 | 20 |
| 50 | .5995 | .7490 | 1.335 | .80038 | 10 |
| **37** | .6018 | .7536 | 1.327 | .79864 | **53** |
| 10 | .6041 | .7581 | 1.319 | .79688 | 50 |
| 20 | .6065 | .7627 | 1.311 | .79512 | 40 |
| 30 | .6088 | .7673 | 1.303 | .79335 | 30 |
| 40 | .6111 | .7720 | 1.295 | .79158 | 20 |
| 50 | .6134 | .7766 | 1.288 | .78980 | 10 |
| **38** | .6157 | .7813 | 1.280 | .78801 | **52** |
| 10 | .6180 | .7860 | 1.272 | .78622 | 50 |
| 20 | .6202 | .7907 | 1.265 | .78442 | 40 |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| 30 | .6225 | .7954 | 1.257 | .78261 | 30 |
| 40 | .6248 | .8002 | 1.250 | .78079 | 20 |
| 50 | .6271 | .8050 | 1.242 | .77897 | 10 |
| **39** | .6293 | .8098 | 1.235 | .77715 | **51** |
| 10 | .6316 | .8146 | 1.228 | .77531 | 50 |
| 20 | .6338 | .8195 | 1.220 | .77347 | 40 |
| 30 | .6361 | .8243 | 1.213 | .77162 | 30 |
| 40 | .6383 | .8292 | 1.206 | .76977 | 20 |
| 50 | .6406 | .8342 | 1.199 | .76791 | 10 |
| **40** | .6428 | .8391 | 1.192 | .76604 | **50** |
| 10 | .6450 | .8441 | 1.185 | .76417 | 50 |
| 20 | .6472 | .8491 | 1.178 | .76229 | 40 |
| 30 | .6494 | .8541 | 1.171 | .76041 | 30 |
| 40 | .6517 | .8591 | 1.164 | .75851 | 20 |
| 50 | .6539 | .8642 | 1.157 | .75661 | 10 |
| **41** | .6561 | .8693 | 1.150 | .75471 | **49** |
| 10 | .6583 | .8744 | 1.144 | .75280 | 50 |
| 20 | .6604 | .8796 | 1.137 | .75088 | 40 |
| 30 | .6626 | .8847 | 1.130 | .74896 | 30 |
| 40 | .6648 | .8899 | 1.124 | .74703 | 20 |
| 50 | .6670 | .8952 | 1.117 | .74509 | 10 |
| **42** | .6691 | .9004 | 1.111 | .74314 | **48** |
| 10 | .6713 | .9057 | 1.104 | .74120 | 50 |
| 20 | .6734 | .9110 | 1.098 | .73924 | 40 |
| 30 | .6756 | .9163 | 1.091 | .73728 | 30 |
| 40 | .6777 | .9217 | 1.085 | .73531 | 20 |
| 50 | .6799 | .9271 | 1.079 | .73333 | 10 |
| **43** | .6820 | .9325 | 1.072 | .73135 | **47** |
| 10 | .6841 | .9380 | 1.066 | .72937 | 50 |
| 20 | .6862 | .9435 | 1.060 | .72737 | 40 |
| 30 | .6884 | .9490 | 1.054 | .72537 | 30 |
| 40 | .6905 | .9545 | 1.048 | .72337 | 20 |
| 50 | .6926 | .9601 | 1.042 | .72136 | 10 |
| **44** | .6947 | .9657 | 1.036 | .71934 | **46** |
| 10 | .6967 | .9713 | 1.030 | .71732 | 50 |
| 20 | .6988 | .9770 | 1.024 | .71529 | 40 |
| 30 | .7009 | .9827 | 1.018 | .71325 | 30 |
| 40 | .7030 | .9884 | 1.012 | .71121 | 20 |
| 50 | .7050 | .9942 | 1.006 | .70916 | 10 |
| | .7071 | .1 | 1. | .70711 | **45** |
| | | | | | ° ′ |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |



## Table IX.—Calculation of Earthwork.

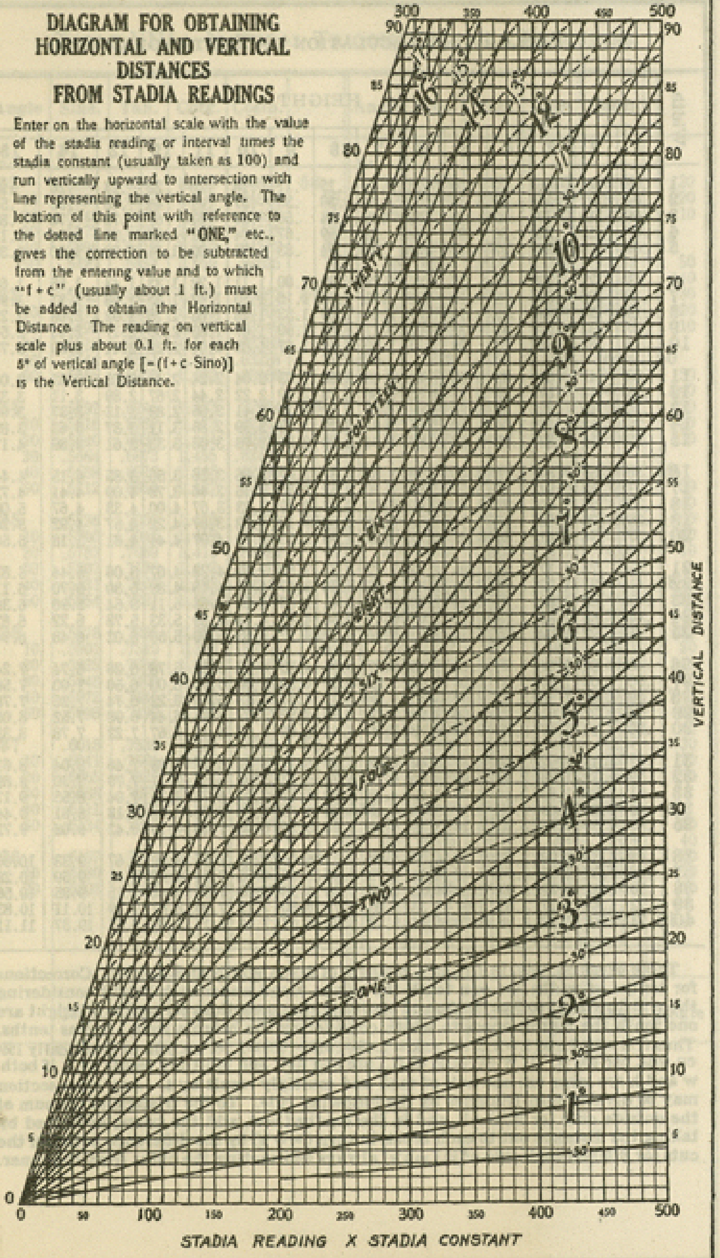
| Width | HEIGHT | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **1** | .02 | .04 | .06 | .07 | .09 | .11 | .13 | .15 | .17 | .18 | .20 | .22 | .24 | .26 | .28 |
| **2** | .04 | .07 | .11 | .15 | .18 | .22 | .26 | .30 | .33 | .37 | .41 | .44 | .48 | .52 | .56 |
| **3** | .06 | .11 | .17 | .22 | .28 | .33 | .39 | .44 | .50 | .56 | .61 | .67 | .72 | .78 | .83 |
| **4** | .07 | .15 | .22 | .30 | .37 | .44 | .52 | .59 | .67 | .74 | .81 | .89 | .96 | 1.04 | 1.11 |
| **5** | .09 | .19 | .28 | .37 | .46 | .56 | .65 | .74 | .83 | .93 | 1.02 | 1.11 | 1.20 | 1.30 | 1.39 |
| **6** | .11 | .22 | .33 | .44 | .56 | .67 | .78 | .89 | 1.00 | 1.11 | 1.22 | 1.33 | 1.44 | 1.55 | 1.67 |
| **7** | .13 | .26 | .39 | .52 | .65 | .78 | .91 | 1.04 | 1.16 | 1.30 | 1.42 | 1.55 | 1.68 | 1.81 | 1.94 |
| **8** | .15 | .30 | .44 | .59 | .74 | .89 | 1.04 | 1.19 | 1.33 | 1.48 | 1.63 | 1.78 | 1.92 | 2.08 | 2.22 |
| **9** | .17 | .33 | .50 | .67 | .83 | 1.00 | 1.17 | 1.33 | 1.50 | 1.67 | 1.83 | 2.00 | 2.17 | 2.33 | 2.50 |
| **10** | .18 | .37 | .56 | .74 | .93 | 1.11 | 1.30 | 1.48 | 1.67 | 1.85 | 2.04 | 2.22 | 2.41 | 2.59 | 2.78 |
| **11** | .20 | .41 | .61 | .82 | 1.02 | 1.22 | 1.43 | 1.63 | 1.83 | 2.04 | 2.24 | 2.44 | 2.65 | 2.85 | 3.06 |
| **12** | .22 | .44 | .67 | .89 | 1.11 | 1.33 | 1.56 | 1.78 | 2.00 | 2.22 | 2.44 | 2.67 | 2.89 | 3.11 | 3.33 |
| **13** | .24 | .48 | .72 | .96 | 1.20 | 1.44 | 1.68 | 1.92 | 2.16 | 2.41 | 2.65 | 2.89 | 3.13 | 3.37 | 3.61 |
| **14** | .26 | .52 | .78 | 1.04 | 1.30 | 1.55 | 1.81 | 2.08 | 2.33 | 2.59 | 2.85 | 3.11 | 3.37 | 3.63 | 3.89 |
| **15** | .28 | .56 | .83 | 1.11 | 1.39 | 1.67 | 1.94 | 2.22 | 2.50 | 2.78 | 3.06 | 3.33 | 3.61 | 3.89 | 4.17 |
| **16** | .30 | .59 | .89 | 1.18 | 1.48 | 1.78 | 2.07 | 2.37 | 2.67 | 2.96 | 3.26 | 3.56 | 3.85 | 4.15 | 4.44 |
| **17** | .31 | .63 | .94 | 1.26 | 1.57 | 1.89 | 2.20 | 2.52 | 2.83 | 3.15 | 3.46 | 3.78 | 4.09 | 4.41 | 4.72 |
| **18** | .33 | .67 | 1.00 | 1.33 | 1.67 | 2.00 | 2.33 | 2.67 | 3.00 | 3.33 | 3.67 | 4.00 | 4.33 | 4.67 | 5.00 |
| **19** | .35 | .70 | 1.06 | 1.41 | 1.76 | 2.11 | 2.46 | 2.82 | 3.17 | 3.52 | 3.87 | 4.22 | 4.57 | 4.92 | 5.28 |
| **20** | .37 | .74 | 1.11 | 1.48 | 1.85 | 2.22 | 2.59 | 2.96 | 3.33 | 3.70 | 4.07 | 4.44 | 4.81 | 5.18 | 5.56 |
| **21** | .39 | .78 | 1.17 | 1.55 | 1.94 | 2.33 | 2.72 | 3.11 | 3.50 | 3.89 | 4.28 | 4.67 | 5.06 | 5.44 | 5.83 |
| **22** | .41 | .81 | 1.22 | 1.63 | 2.04 | 2.44 | 2.85 | 3.26 | 3.67 | 4.07 | 4.48 | 4.89 | 5.30 | 5.70 | 6.11 |
| **23** | .43 | .85 | 1.28 | 1.70 | 2.13 | 2.56 | 2.98 | 3.41 | 3.83 | 4.26 | 4.68 | 5.11 | 5.54 | 5.96 | 6.39 |
| **24** | .44 | .89 | 1.33 | 1.78 | 2.22 | 2.67 | 3.11 | 3.56 | 4.00 | 4.44 | 4.89 | 5.33 | 5.78 | 6.22 | 6.67 |
| **25** | .46 | .92 | 1.39 | 1.85 | 2.31 | 2.78 | 3.24 | 3.70 | 4.17 | 4.63 | 5.09 | 5.56 | 6.02 | 6.48 | 6.94 |
| **26** | .48 | .96 | 1.44 | 1.92 | 2.41 | 2.89 | 3.37 | 3.85 | 4.33 | 4.82 | 5.30 | 5.78 | 6.26 | 6.74 | 7.24 |
| **27** | .50 | 1.00 | 1.50 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 |
| **28** | .52 | 1.04 | 1.55 | 2.07 | 2.59 | 3.11 | 3.63 | 4.15 | 4.67 | 5.18 | 5.70 | 6.22 | 6.74 | 7.26 | 7.78 |
| **29** | .54 | 1.07 | 1.61 | 2.15 | 2.68 | 3.22 | 3.76 | 4.30 | 4.83 | 5.37 | 5.91 | 6.44 | 6.98 | 7.52 | 8.06 |
| **30** | .56 | 1.11 | 1.67 | 2.22 | 2.78 | 3.33 | 3.89 | 4.44 | 5.00 | 5.55 | 6.11 | 6.67 | 7.22 | 7.78 | 8.33 |
| **31** | .57 | 1.15 | 1.72 | 2.30 | 2.87 | 3.44 | 4.02 | 4.59 | 5.17 | 5.74 | 6.32 | 6.89 | 7.46 | 8.04 | 8.61 |
| **32** | .59 | 1.18 | 1.78 | 2.37 | 2.96 | 3.56 | 4.15 | 4.74 | 5.33 | 5.92 | 6.52 | 7.11 | 7.70 | 8.30 | 8.89 |
| **33** | .61 | 1.22 | 1.83 | 2.44 | 3.06 | 3.67 | 4.28 | 4.89 | 5.50 | 6.11 | 6.72 | 7.33 | 7.94 | 8.55 | 9.17 |
| **34** | .63 | 1.26 | 1.89 | 2.52 | 3.15 | 3.78 | 4.40 | 5.04 | 5.67 | 6.29 | 6.93 | 7.56 | 8.18 | 8.81 | 9.44 |
| **35** | .65 | 1.30 | 1.94 | 2.59 | 3.24 | 3.89 | 4.53 | 5.18 | 5.83 | 6.48 | 7.13 | 7.78 | 8.42 | 9.08 | 9.72 |
| **36** | .67 | 1.33 | 2.00 | 2.67 | 3.33 | 4.00 | 4.66 | 5.33 | 6.00 | 6.67 | 7.33 | 8.00 | 8.67 | 9.33 | 10.00 |
| **37** | .68 | 1.37 | 2.06 | 2.74 | 3.42 | 4.11 | 4.79 | 5.48 | 6.17 | 6.85 | 7.54 | 8.22 | 8.91 | 9.59 | 10.28 |
| **38** | .70 | 1.41 | 2.11 | 2.82 | 3.52 | 4.22 | 4.92 | 5.63 | 6.33 | 7.03 | 7.74 | 8.44 | 9.15 | 9.85 | 10.56 |
| **39** | .72 | 1.44 | 2.17 | 2.89 | 3.61 | 4.33 | 5.05 | 5.78 | 6.50 | 7.22 | 7.95 | 8.67 | 9.39 | 10.11 | 10.83 |
| **40** | .74 | 1.48 | 2.22 | 2.96 | 3.70 | 4.44 | 5.18 | 5.92 | 6.67 | 7.41 | 8.15 | 8.89 | 9.63 | 10.37 | 11.11 |

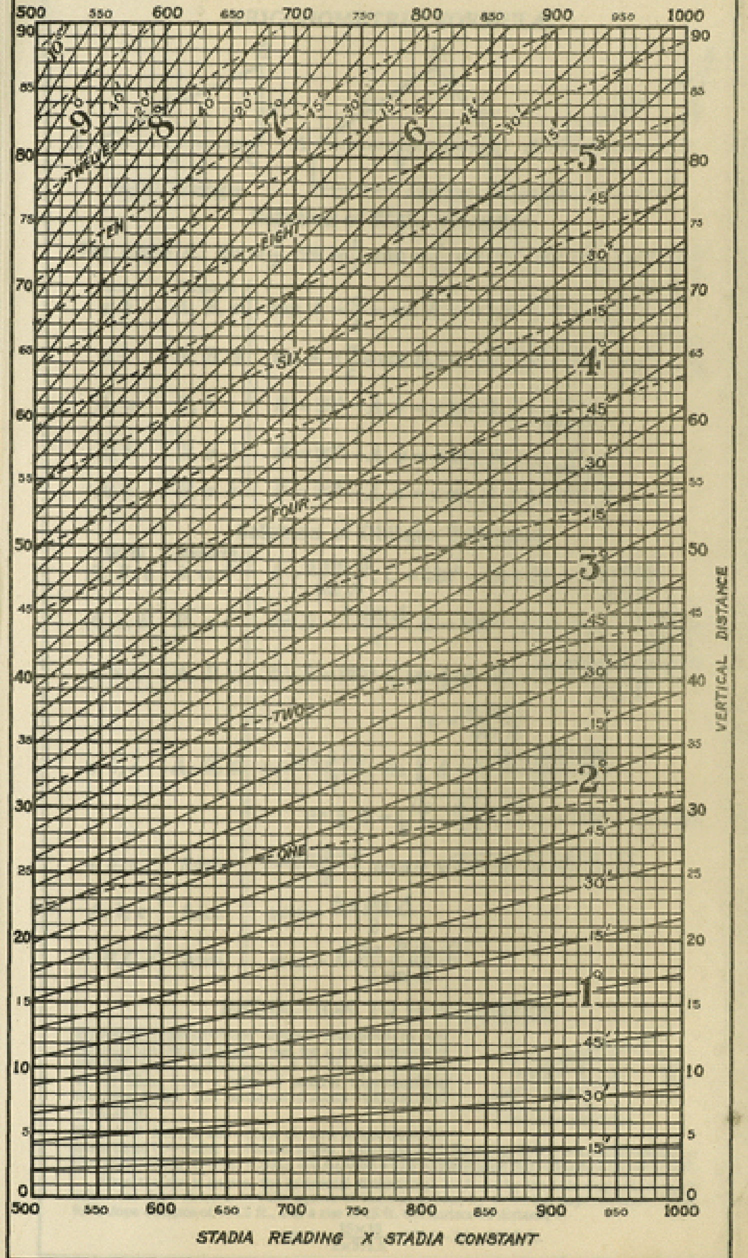
Table gives cu. yds. in 1 ft. of a triangle of given width and height. Corrections for tenths of width are one tenth the values found under each height considering the widths from 1 to 9 as tenths and similarly the corrections for tenths of height are one tenth the figures opposite width considering the heights from 1 to 9 as tenths. Thus if w = 16.2 and h = 5.3, cu. yds. = 1.48 + .018 + .089 = 1.587 cu. yds. or practically 159 cu. yds. per 100 ft. If w exceeds 40 ft., use one half and multiply result by 2, if both w and h are large use one half of each and multiply result by 4. Any cross-section may be divided into triangles by the following rule. To the triangle of the sum of the outside cuts (or fills) = h, and ½ the roadbed = w, add the triangles formed by taking the distance out to each break in turn ( = w's) by the difference between the cuts (or fills) on each side of it ( = h's) always subtracting the outer from the inner.

counter 42300

## DIAGRAM FOR OBTAINING HORIZONTAL AND VERTICAL DISTANCES FROM STADIA READINGS

Enter on the horizontal scale with the value of the stadia reading or interval times the stadia constant (usually taken as 100) and run vertically upward to intersection with line representing the vertical angle. The location of this point with reference to the dotted line marked "ONE," etc., gives the correction to be subtracted from the entering value and to which "f + c" (usually about 1 ft.) must be added to obtain the Horizontal Distance. The reading on vertical scale plus about 0.1 ft. for each 5° of vertical angle [= (f + c · Sin α)] is the Vertical Distance.

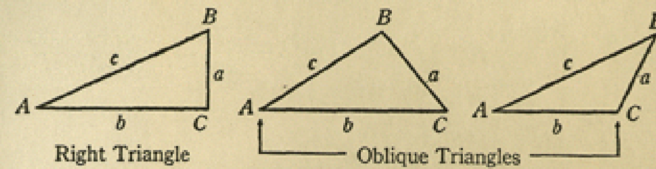



counter 42301

DIAG
HORIZ
FROM
Enter on th
of the stac
stadia cons
run vertica
line repres
location of
the dotted
gives the
from the
"f + c"
be added
Distance
scale plu
5° of vert
is the Ve

# TRIGONOMETRIC FORMULÆ




## Solution of Right Triangles

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

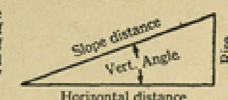
| Given | Required | |
|---|---|---|
| $a, b$ | $A, B, c$ | $\tan A=\frac{a}{b}=\cot B,\ c=\sqrt{a^2+b^2}=a\sqrt{1+\frac{b^2}{a^2}}$ |
| $a, c$ | $A, B, b$ | $\sin A=\frac{a}{c}=\cos B,\ b=\sqrt{(c+a)(c-a)}=c\sqrt{1-\frac{a^2}{c^2}}$ |
| $A, a$ | $B, b, c$ | $B=90°-A,\ b=a\cot A,\ c=\frac{a}{\sin A.}$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

## Solution of Oblique Triangles

| Given | Required | |
|---|---|---|
| $A, B, a$ | $b, c, C$ | $b=\frac{a\sin B}{\sin A},\ C=180°-(A+B),\ c=\frac{a\sin C}{\sin A}$ |
| $A, a, b$ | $B, c, C$ | $\sin B=\frac{b\sin A}{a},\ C=180°-(A+B),\ c=\frac{a\sin C}{\sin A}$ |
| $a, b, C$ | $A, B, c$ | $A+B=180°-C,\ \tan\frac{1}{2}(A-B)=\frac{(a-b)\tan\frac{1}{2}(A+B)}{a+b}$, $c=\frac{a\sin C}{\sin A}$ |
| $a, b, c$ | $A, B, C$ | $s=\frac{a+b+c}{2},\ \sin\frac{1}{2}A=\sqrt{\frac{(s-b)(s-c)}{bc}},$ $\sin\frac{1}{2}B=\sqrt{\frac{(s-a)(s-c)}{ac}},\ C=180°-(A+B)$ |
| $a, b, c$ | Area | $s=\frac{a+b+c}{2},\ \text{area}=\sqrt{s(s-a)(s-b)(s-c)}$ |
| $A, b, c$ | Area | $\text{area}=\frac{bc\sin A}{2}$ |
| $A, B, C, a$ | 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, for a slope distance of 403.6 ft. and a vertical angle of 4° 40′—the cosine of 4° 40′, taken from a table of natural trigonometrical functions, = .9967, and horizontal distance = 403.6 x .9967 = 402.27 ft.




Horizontal distance also = Slope distance minus slope distance times (1— cosine of vertical angle). Using the same figures as in the preceding example—Cos. 4° 40′ = .9967. 1—.9967 = .0033. 403.6 x .0033 = 1.33 ft. Horizontal dist. = 403.6 − 1.33 = 402.27 ft.

When the rise is known, the horizontal distance may be found by the following approximate rule:— the slope distance less the square of the rise divided by twice the slope distance. Thus, for a slope distance of 372.5 ft., and a rise of 15 ft. the horizontal distance =

$$372.5-\frac{15\times15}{2\times372.5}=372.5-.30=372.2 \text{ ft.}$$

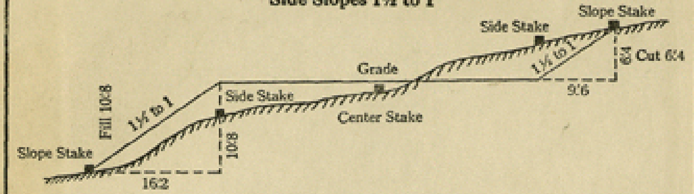


counter 42302

U-10

## DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING

### Roadway of any Width
### Side Slopes 1½ to 1




In the figure above: Opposite 6 under "Cut or Fill" and under .4 read 9.6 the distance from the side stake to the slope stake at right. Opposite 10 under "Cut or Fill" and under .8 read 16.2, the distance from the side stake to the slope stake at the left.

| Cut or Fill | 0 | .1 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | .9 | Cut or Fill |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Distance out from Side or Shoulder Stake | | | | | | | | | | |
| 0 | 0.0 | 0.2 | 0.3 | 0.5 | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 0 |
| 1 | 1.5 | 1.7 | 1.8 | 2.0 | 2.1 | 2.3 | 2.4 | 2.6 | 2.7 | 2.9 | 1 |
| 2 | 3.0 | 3.2 | 3.3 | 3.5 | 3.6 | 3.8 | 3.9 | 4.1 | 4.2 | 4.4 | 2 |
| 3 | 4.5 | 4.7 | 4.8 | 5.0 | 5.1 | 5.3 | 5.4 | 5.6 | 5.7 | 5.9 | 3 |
| 4 | 6.0 | 6.2 | 6.3 | 6.5 | 6.6 | 6.8 | 6.9 | 7.1 | 7.2 | 7.4 | 4 |
| 5 | 7.5 | 7.7 | 7.8 | 8.0 | 8.1 | 8.3 | 8.4 | 8.6 | 8.7 | 8.9 | 5 |
| 6 | 9.0 | 9.2 | 9.3 | 9.5 | 9.6 | 9.8 | 9.9 | 10.1 | 10.2 | 10.4 | 6 |
| 7 | 10.5 | 10.7 | 10.8 | 11.0 | 11.1 | 11.3 | 11.4 | 11.6 | 11.7 | 11.9 | 7 |
| 8 | 12.0 | 12.2 | 12.3 | 12.5 | 12.6 | 12.8 | 12.9 | 13.1 | 13.2 | 13.4 | 8 |
| 9 | 13.5 | 13.7 | 13.8 | 14.0 | 14.1 | 14.3 | 14.4 | 14.6 | 14.7 | 14.9 | 9 |
| 10 | 15.0 | 15.2 | 15.3 | 15.5 | 15.6 | 15.8 | 15.9 | 16.1 | 16.2 | 16.4 | 10 |
| 11 | 16.5 | 16.7 | 16.8 | 17.0 | 17.1 | 17.3 | 17.4 | 17.6 | 17.7 | 17.9 | 11 |
| 12 | 18.0 | 18.2 | 18.3 | 18.5 | 18.6 | 18.8 | 18.9 | 19.1 | 19.2 | 19.4 | 12 |
| 13 | 19.5 | 19.7 | 19.8 | 20.0 | 20.1 | 20.3 | 20.4 | 20.6 | 20.7 | 20.9 | 13 |
| 14 | 21.0 | 21.2 | 21.3 | 21.5 | 21.6 | 21.8 | 21.9 | 22.1 | 22.2 | 22.4 | 14 |
| 15 | 22.5 | 22.7 | 22.8 | 23.0 | 23.1 | 23.3 | 23.4 | 23.6 | 23.7 | 23.9 | 15 |
| 16 | 24.0 | 24.2 | 24.3 | 24.5 | 24.6 | 24.8 | 24.9 | 25.1 | 25.2 | 25.4 | 16 |
| 17 | 25.5 | 25.7 | 25.8 | 26.0 | 26.1 | 26.3 | 26.4 | 26.6 | 26.7 | 26.9 | 17 |
| 18 | 27.0 | 27.2 | 27.3 | 27.5 | 27.6 | 27.8 | 27.9 | 28.1 | 28.2 | 28.4 | 18 |
| 19 | 28.5 | 28.7 | 28.8 | 29.0 | 29.1 | 29.3 | 29.4 | 29.6 | 29.7 | 29.9 | 19 |
| 20 | 30.0 | 30.2 | 30.3 | 30.5 | 30.6 | 30.8 | 30.9 | 31.1 | 31.2 | 31.4 | 20 |
| 21 | 31.5 | 31.7 | 31.8 | 32.0 | 32.1 | 32.3 | 32.4 | 32.6 | 32.7 | 32.9 | 21 |
| 22 | 33.0 | 33.2 | 33.3 | 33.5 | 33.6 | 33.8 | 33.9 | 34.1 | 34.2 | 34.4 | 22 |
| 23 | 34.5 | 34.7 | 34.8 | 35.0 | 35.1 | 35.3 | 35.4 | 35.6 | 35.7 | 35.9 | 23 |
| 24 | 36.0 | 36.2 | 36.3 | 36.5 | 36.6 | 36.8 | 36.9 | 37.1 | 37.2 | 37.4 | 24 |
| 25 | 37.5 | 37.7 | 37.8 | 38.0 | 38.1 | 38.3 | 38.4 | 38.6 | 38.7 | 38.9 | 25 |
| 26 | 39.0 | 39.2 | 39.3 | 39.5 | 39.6 | 39.8 | 39.9 | 40.1 | 40.2 | 40.4 | 26 |
| 27 | 40.5 | 40.7 | 40.8 | 41.0 | 41.1 | 41.3 | 41.4 | 41.6 | 41.7 | 41.9 | 27 |
| 28 | 42.0 | 42.2 | 42.3 | 42.5 | 42.6 | 42.8 | 42.9 | 43.1 | 43.2 | 43.4 | 28 |
| 29 | 43.5 | 43.7 | 43.8 | 44.0 | 44.1 | 44.3 | 44.4 | 44.6 | 44.7 | 44.9 | 29 |
| 30 | 45.0 | 45.2 | 45.3 | 45.5 | 45.6 | 45.8 | 45.9 | 46.1 | 46.2 | 46.4 | 30 |
| 31 | 46.5 | 46.7 | 46.8 | 47.0 | 47.1 | 47.3 | 47.4 | 47.6 | 47.7 | 47.9 | 31 |
| 32 | 48.0 | 48.2 | 48.3 | 48.5 | 48.6 | 48.8 | 48.9 | 49.1 | 49.2 | 49.4 | 32 |
| 33 | 49.5 | 49.7 | 49.8 | 50.0 | 50.1 | 50.3 | 50.4 | 50.6 | 50.7 | 50.9 | 33 |
| 34 | 51.0 | 51.2 | 51.3 | 51.5 | 51.6 | 51.8 | 51.9 | 52.1 | 52.2 | 52.4 | 34 |
| 35 | 52.5 | 52.7 | 52.8 | 53.0 | 53.1 | 53.3 | 53.4 | 53.6 | 53.7 | 53.9 | 35 |
| 36 | 54.0 | 54.2 | 54.3 | 54.5 | 54.6 | 54.8 | 54.9 | 55.1 | 55.2 | 55.4 | 36 |
| 37 | 55.5 | 55.7 | 55.8 | 56.0 | 56.1 | 56.3 | 56.4 | 56.6 | 56.7 | 56.9 | 37 |
| 38 | 57.0 | 57.2 | 57.3 | 57.5 | 57.6 | 57.8 | 57.9 | 58.1 | 58.2 | 58.4 | 38 |
| 39 | 58.5 | 58.7 | 58.8 | 59.0 | 59.1 | 59.3 | 59.4 | 59.6 | 59.7 | 59.9 | 39 |
| 40 | 60.0 | 60.2 | 60.3 | 60.5 | 60.6 | 60.8 | 60.9 | 61.1 | 61.2 | 61.4 | 40 |

ARANSAS CO. RLD. SK. #17

EUGENE DIETZGEN CO.

U-10

U-10-2



counter 42303

Copano Bay Aransas Co.
Cont
State of Texas

From Hub #32 for. N15°52 W
Th ∡ 38°43 Lt.
∡ N54°35 W Mag. N54°55 W
at 0.0. W.E. Copano Bay 89 Lt.
" 10 x W.E. Bayou
" 162 [illegible] "
" 258 Re Ent Small Bayou
" 210 Lv. " " W. E.
" 300 Mouth Bayou. 45 Lt. [illegible]
" 400 W.E. Bay 16 Lt.
" 600 " " " 40 "
" 680 " " " 50 "
33 " 761.0 Hub W.E. 12 Lt.

Th ∡ 59°35 Lt. for. S54°35 E
N65°50 E Mag. N65°55 E
at 0.0 W.E. 100 Lt. ∡ Lt.
" 380 " " 10 Lt.
" 482 S.S. Boat Ways.
" 526 N.S. " Bulkhead
" 625 W.E. ~~15~~ 5 Lt.
" 700 " " 16 "



3/22/53
Same Crew Joined By
Henrys Crew.

212 BC– 467 567 33 / 60.0

1552
3843
5435
3973
11410

17960
11410
6550

Bay. 55 Lt.
W.E. Bay 30 Lt.

at 750 W.E. 60 Lt
" 787.5 x ℄ Trv'l on Hwy # 136
" 800 W.E. 175 Lt
" 965 " " 60 "
(34) " 1033.6 Hub W.E 48 Lt

Th ∡ 11°16' Rt.
N77°06'E Mag. N77°05'E
at 36 x Pow. Line.
" 450 W.E. 210 Lt
" 650 " " 135 "
800 " " 170 "
(35) " 1052.7 Hub W.E. 53 Lt.

Th ∡ 4°59' Rt
N82°05' E Mag N82°05'E
at 200 W.E 58 Lt
" 450 " " 75 "
" 600 " " 120 "
" 900 " " 40 "
(36) " 980.5 Hub WE 66 Lt

Th ∡ 20°45' Rt
S77°10'E Mag. S77°10'E
at 100 W.E. 80 Lt



563
150

565
100
665
700
765
35
800

N15°50'E
11 16
77 06
4 59
82 05
20 45
102 50
179 60
102 50
77 10

at 500 WE 63 Lt.
37 " 668.0 Hub W.E. 24 Lt.

Th 43°01' + Lt. for N77°10 W
S59°49 W Mag. S59°55 W
at 313.3 Hub #10

Th. ~~+~~23°26' Rt
S83°15 W to S83°15 W

Fill across N End of Wm
Steele No. 2

Beg. at Hub "C" at 5487 Vol. U-10
Pg. 8 also Δ Pt. "C" on Pg.
2 1st Vol These Notes.

Th + 47°12 Rt for S82°50 W
N49°58 W Mag. N49°55 W
at 0.0 Top Fill 2 Lt. Toe Fill
WE 45 Rt. (Bay Coppano)
at 25 x Road.
" 100 ~~100~~ WE 34 Rt Toe
Top Fill 23 Lt. Toe Fill 28 Lt.
at 200 WE Rt ℄ Road 43



S77°10 E
43 01
120 11

179 60
120 11
59 49
23 26
83 15

Quit for day.

179 60
130 02
49 58

52 50
47 12
130 02

3/23/53 Cool & Clear
Wicklund - H. Wellman Hadelike
Lyerly - McKain.

8 Lt - Top Fill 14 Rt. toe fill 17 Rt.

Fill 0.0 Top Fill 4 Lt. ℄ Road 13 Lt

Lt ℄ Road 35 Lt. Top Fill 44 Lt. Toe Fill 49 Lt

at 270 W.E. 64 Rt. ℄ Rd. 38 Lt
" 335 " " 76 " " " 25 "
" 378 × ℄ Road
" 445 End of Fill (About)

Return to "C"

Th ∡ 12°28' Rt fac N82°50 E
S84°32' E Mag. S84°35' E

at 40 × ℄ Road. Top Fill 9 Lt
Toe Fill 12 Lt. W.E. 49 Lt. - Top
Fill 9 Rt. Toe Fill 16 Rt

at 100 Top Fill 4 Lt Toe Fill 7 Lt.
11 Rt Toe Fill 15 Rt.

at 140 End of Fill ℄ Road 0.0
Top Fill 5 Rt. Toe Fill 7 Rt

at 310.6 Hub W.E. 90. Lt

Th ∡ 22°24' Rt
S62°08' E Mag. S62°20' E

at 300 W.E. 108 Lt.
" ~~328.6~~ Fnd 2×2 Hub W. E ~~108~~
" ~~628.6~~

Th ∡ 58°25' Lt. Mag. N59¼° E

N59°27' E to Large Yellow Flag -



Top Fill 46 Lt Toe Fill 48 Lt
" " 32 " " " 35 "

℄ Road 41 Rt W.E. 91 Rt

N39°E

5250
1228
19518

17960
19528
8432
2228
6208

W.E. 22 Lt. ℄ Road 4. Rt Top Fill

Top Fill 8 Lt. Toe Fill 12 Lt. W.E. 30 Lt

6208
5825
12033

17960
12033
5927

98 Lt

at 628.6 - N39°E Hits on E Point
of Land Far away on Bay.

Far Away Across Bay.

counter 4 -10

Level Notes to Determine
1.' Elev. Line & 0.7 Elev. Line
Around Marsh Inclosed By
Copano Bay & Wm. Steele
Survey No. 2 Aransas Co. Tex.
for State of Texas.

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| B.M. | 5.06 | 7.64 | | |
| ⊙ | | | 3.11 | 4.53 |
| ⊼ | 2.52 | 7.05 | | |
| ⊙ | | | 3.35 | 3.70 |
| ⊼ | 2.61 | 6.31 | | |
| ⊙ T.P. 2 | | | 5.06 | 1.25 |
| ⊼ | 4.90 | 6.15 | | |
| ⊙ | | | 4.90 | 1.25 |
| ⊼ | 5.81 | 7.06 | | |
| | Rod for 0.7 Cont. 6.36 | | | |
| | " " 1.' " 5.96 | | | |
| ⊙ | | | 5.71 | 1.35 |
| ⊼ | 5.05 | 6.40 | | |
| | Rod for 0.7 Cont. 5.70 | | | |
| | " " 1.1 " 5.30 | | | |
| ⊙ | | | 5.07 | 1.33 |
| ⊼ | 5.85 | 7.18 | | |



U.S.C. & G.S. B.M. X-604 Elev. 2.58

T.P. No. 1
Rod for 0.7 Cont. 5.45
" " 1.' " 5.05

| + | H.I. | − | Elev. |
|---|---|---|---|
| | | | 1.33 |
| Rod for. 0.7 Contour | | | 6.48 |
| " " 1.1 " | | | 6.08 |
| ⊙ | | 5.92 | 1.26 |
| ⊼ 6.20 | 7.46 | | |
| Rod for. 0.7 Contour | | 6.76 | |
| " " 1.1 " | | 6.36 | |
| ⊙ | | 6.52 | 0.84 |
| ⊼ 5.78 | 6.62 | | |
| Rod for. 0.7 Contour. | | 5.92 | |
| " " 1.1 " | | 5.52 | |
| ⊙ | | 5.49 | 1.13 |
| ⊼ 5.77 | 6.90 | | |
| Rod for. 0.7 Contour. | | 6.20 | |
| " " 1.1 " | | 5.80 | |
| ⊙ | | 5.56 | 1.34 |
| 5.29 | 6.63 | | |
| Rod for. 0.7 Cont. 5.93 | | | |
| " " 1.1 " 5.53 | | | |
| ⊙ | | 5.29 | 1.34 |
| ⊼ 4.77 | 6.11 | | |
| Rod for. 0.7 Cont. 5.41 | | | |
| " " 1.1 " 5.01 | | | |
| ⊙ | | 4.67 | 1.44 |



Quit for day 3/17/53

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| | | | | 1.44 |
| ⊼ | 5.00 | 6.44 | | |
| Rod for 0.7 Cont. | | | 5.74 | |
| " " 1.1 " | | | 5.34 | |
| ⊙ | | | 5.11 | 1.33 |
| ⊼ | 4.50 | 5.83 | | |
| Rod for 0.7 Cont. | | | 5.13 | |
| " " 1.1 " | | | 4.73 | |
| T.P.1 | | | 2.51 | 3.32 |
| ⊼ | 2.23 | 5.55 | | |
| Rod for 0.7 Contour | | | 4.85 | |
| " " 1.' " | | | 4.45 | |
| ⊙ | | | 3.98 | 1.57 |
| ⊼ | 4.02 | 5.59 | | |
| Rod for 0.7 Cont. | | | 4.89 | |
| " " 1.1 " | | | 4.49 | |
| ⊙ | | | 4.34 | 1.25 |
| ⊼ | 4.19 | 5.44 | | |
| Rod for 0.7 Cont. | | | 4.74 | |
| " " 1.1 " | | | 4.34 | |
| ⊙ | | | 4.23 | 1.21 |
| | 4.42 | 5.63 | | |
| Rod for 0.7 Cont. | | | 4.93 | |
| " " 1.1 " | | | 4.53 | |



= 2" Pipe that Noble Took Turn on
Nobles Elev. is 3.33 Above Sea Level

| | + | H.I. | - | Elev. |
|---|---|---|---|---|
| | | 5.63 | | |
| ⊙ | | | 4.46 | 1.17 |
| ⊼ | 4.55 | 5.72 | | |
| Rod for. 0.7 Cont. | | | 5.02 | |
| " " 1.1 " | | | 4.62 | |
| ⊙ | | | 4.40 | 1.32 |
| ⊼ | 5.36 | 6.68 | | |
| Rod for. 0.7 Cont. | | | 5.98 | |
| " " 1.1 " | | | 5.58 | |
| ⊙ | | | 4.62 | 2.06 |
| ⊼ | 3.70 | 5.76 | | |
| Rod for. 0.7 Cont. | | | 5.06 | |
| " " 1.1 " | | | 4.66 | |
| ⊙ | | | 4.21 | 1.55 |
| ⊼ | 4.17 | 5.72 | | |
| Rod for. 0.7 Cont. | | | 5.02 | |
| " " 1.1 " | | | 4.62 | |
| ⊙ | | | 4.41 | 1.31 |
| ⊼ | 4.50 | 5.81 | | |
| Rod for. 0.7 Cont. | | | 5.11 | |
| " " 1.1 " | | | 4.71 | |
| ⊙ | | | 4.29 | 1.52 |
| ⊼ | 4.55 | 6.07 | | |
| Rod for. 0.7 Cont. | | | 5.37 | |
| " " 1.1 " | | | 4.97 | |



Quit for day 3/19/53

| | + | H.I. | - | Elev. |
|---|---|---|---|---|
| | | 6.07 | | |
| ⊙ | | | 4.57 | 1.50 |
| A | 4.19 | 5.69 | | |
| Rod for 0.7 Cont. | | | 4.99 | |
| " " 1.1 " | | | 4.59 | |
| ⊙ | | | 4.17 | 1.52 |
| A | 4.08 | 5.60 | | |
| Rod for. 0.7 Cont. | | | 4.90 | |
| " " 1.1 " | | | 4.50 | |
| ⊙ | | | 3.47 | 2.13 |
| A | 3.80 | 5.93 | | |
| Rod for. 0.7 Cont. | | | 5.23 | |
| " " 1.1 " | | | 4.83 | |
| ⊙ | | | 4.34 | 1.59 |
| A | 4.43 | 6.02 | | |
| Rod for. 0.7 Cont. | | | 5.32 | |
| " " 1.1 " | | | 4.92 | |
| ⊙ | | | 4.06 | 2.02 |
| A | 4.64 | 6.66 | | |
| Rod for 0.7 Cont. | | | 5.96 | |
| " " 1.1 " | | | 5.56 | |
| ⊙ | | | 4.25 | 2.41 |
| A | 4.26 | 6.67 | | |
| Rod for 0.7 Cont. | | | 5.97 | |
| " " 1.1 " | | | 5.57 | |



Quit for day 3/20/53

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| | | 6.67 | | |
| ⊙ | | | 5.63 | 1.04 |
| A | 4.97 | 6.01 | | |
| Rod for 0.7 Cont. | | | 5.31 | |
| " " 1.1 " | | | 4.91 | |
| ⊙ | | | 4.70 | 1.31 |
| A | 4.72 | 6.03 | | |
| Rod for 0.7 Cont. | | | 5.33 | |
| " " 1.1 " | | | 4.93 | |
| Top Water 1:00 P.M. 3/21/53 | | | 5.66 | 0.37 |
| " " 1:50 " " 3/21/53 | | | 5.57 | 0.46 |
| " " 3:20 " " 3/21/53 | | | 5.52 | 0.51 |
| T.P.#2 | | | | 1.25 |
| A | 4.38 | 5.63 | | |
| Rod for 0.7 Cont. | | | 4.93 | |
| " " 1.1 " | | | 5.53 | |
| OT.P.#3 | | | 4.03 | 1.60 |

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| T.P.#2 | | | | 1.25 |
| | 5.05 | 6.30 | | |
| Top Water at 7:50 A.M. 3/22/53 | | | 5.95 | 0.35 |
| ⊙ | | | 0.96 | 5.34 |
| ⊼ | 8.28 | 13.62 | | |
| ⊙ | | | 0.79 | 12.83 |
| ⊼ | 1.84 | 14.67 | | |
| ⊙ | | | 11.38 | 3.29 |
| ⊼ | 6.16 | 9.45 | | |
| ⊙ | | | 4.70 | 4.75 |
| ⊼ | 3.50 | 8.25 | | |
| ⊙ | | | 4.60 | 3.65 |
| ⊼ | 3.95 | 7.60 | | |
| | | | 7.15 | 0.45 |
| | | | 7.10 | 0.50 |



3/23/53
Same Crew
Cloudy & Windy

{Top of Water in Lake about ½ Mile
N.E. of Copano Bay.
Nat. Grd. 100' S.W. of Lake.

counter 42315

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| B.M. | | | | 2.58 |
| ⊼ | 4.68 | 7.26 | | |
| ⊙ 1 | | | 4.67 | 2.59 |
| ⊼ | 4.195 | 6.785 | | |
| ⊙ 2 | | | 3.845 | 2.940 |
| ⊼ | 4.49 | 7.43 | | |
| ⊙ 3 | | | 4.66 | 2.77 |
| ⊼ | 5.32 | 8.09 | | |
| ⊙ 4 | | | 5.68 | 2.41 |
| ⊼ | 4.72 | 7.13 | | |
| ⊙ 5 | | | 5.11 | 2.02 |
| ⊼ | 4.30 | 6.32 | | |
| ⊙ 6 | | | 4.73 | 1.59 |
| ⊼ | 4.34 | 5.93 | | |
| ⊙ 7 | | | 3.80 | 2.13 |
| ⊼ | 3.61 | 5.74 | | |
| ⊙ 8 | | | 4.22 | 1.52 |
| ⊼ | 4.13 | 5.65 | | |
| ⊙ 9 | | | 4.15 | 1.50 |
| ⊼ | 4.43 | 5.93 | | |
| ⊙ 10 | | | 4.41 | 1.52 |
| ⊼ | 4.47 | 5.99 | | |
| ⊙ 11 | | | 4.68 | 1.31 |
| ⊼ | 4.41 | 5.72 | | |
| ⊙ 12 | | | 4.17 | 1.55 |



Quit for day 3/18/53

3/19/53 Same Crew
Cloudy & Windy

| | + | H.I. | − | Elev. |
|---|---|---|---|---|
| | | | | 1.55 |
| ⊼ | 4.17 | 5.72 | | |
| ⊙ 13 | | | 3.66 | 2.06 |
| ⊼ | 4.67 | 6.73 | | |
| ⊙ 14 | | | 5.41 | 1.32 |
| ⊼ | 4.32 | 5.64 | | |
| ⊙ 15 | | | 4.48 | 1.16 |
| ⊼ | 4.59 | 5.75 | | |
| ⊙ 16 | | | 4.54 | 1.21 |
| ⊼ | 4.77 | 5.98 | | |
| ⊙ 17 | | | 4.73 | 1.25 |
| ⊼ | 4.30 | 5.55 | | |
| T.P.# 1 | | | 2.21 | 3.34 |

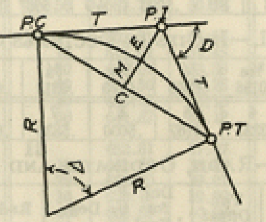


= 3.32 on Line # 1 or 0.02' Error.

Bayliss
Licensed State Land
Surveyor.

# DIETZGEN'S RAILROAD CURVE AND REDUCTION TABLES






## CURVE FORMULAS

Radius $= R = \frac{50}{\sin.\ D/2}$ (1) Degree of Curve $= D$ and $\sin.\ \frac{D}{2} = \frac{50}{R}$ (2)

Tangent $= T = R\tan\frac{\Delta}{2}$ (3) Length of Curve $= L = 100\frac{\Delta}{D}$ (4)

Middle ordinate $= M = R(1 - \cos.\ \frac{\Delta}{2})$ (5) $= R\,\mathrm{vers}\,\frac{\Delta}{2}$ (6)

External $= E = T\tan\frac{\Delta}{4}$ (7) $= R \div \cos.\frac{\Delta}{2} - R$ (8) $= R\,\mathrm{exsec}\frac{\Delta}{2}$ (9)

Long Chord $= C = 2\ R\ \sin.\frac{\Delta}{2}$ (10) $\Delta =$ Central Angle

## EXPLANATION AND USE OF TABLES

**Stations.**—Given P. I.=Sta. 161+60.35 to find Sta. of P. C. and P. T. $\Delta = 62°\ 10'$ $D = 8°\ 20'$. From Table IV for 1° curve T=3454.1 and ÷8⅓=414.49 ft. From Table V correction=.36 or T=414.85 ft. P. C.=Sta. P.I.—T=157 +45.50. Also from (4) L=746.00 and P. T.=Sta. P. C.+L=164+91.50.

**Offsets.**—Tangent offsets vary (approximately) directly with D and with square of the distance. Thus tangent offset for Sta. 158 on above curve is 2.16 ft. found as follows. From Table III tangent offset for 100 ft.=7.27 ft. Distance=158—Sta. P. C.=54.50, hence offset=7.27 $(54.50 \div 100)^2$=2.16 ft. Also square of any distance divided by twice the radius equals (approximately) the distance from tangent to curve. Thus $(54.50)^2 \div (2 \times 688.26)$=2.16 ft.

**Deflections.**—Deflection angle=½ D for 100 ft., ¼ D for 50 ft., etc. For c ft.=(in minutes) .3 x C x D° or=defl. for 1 ft. from Table III x C. For Sta. 158 of above curve=.3 x 54.5 x 8⅓=136.2′ or 2° 16.2′, or=2.50 x 54.5=136.2′ from Table III. For Sta. 159 deflection angle=2° 16.2′ +8° 20′ ÷2=6° 26.2′, etc.

**Externals.**—May be found in similar manner to tangents. Thus E for curve above is 115.37. For from Table IV for 1° curve E=960.6 for 8° 20′=960.6÷8⅓=115.27 and from Table V correction=.10 or E=115.37 ft. Or suppose $\Delta = 32°$ and E is measured and found to be 42 ft. What is D? From Table IV E=230.9 and ÷42=5.5 or D=5° 30′.

## Table I.—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 |

## Table II.—Inches in Decimals of a Foot.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1/16 | 3/32 | 1/8 | 3/16 | 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 |

## Table III.—Radii, Ordinates and Deflections.

| Deg. | Radius | Mid. Ord. | Tan Offset | Def. for 1 Foot |
|---|---|---|---|---|
| 0° 10′ | 34377.5 | .036 | .145 | 0.05′ |
| 20 | 17188.8 | .073 | .291 | 0.10 |
| 30 | 11459.2 | .109 | .436 | 0.15 |
| 40 | 8594.42 | .145 | .582 | 0.20 |
| 50 | 6875.55 | .182 | .727 | 0.25 |
| 1 | 5729.65 | .218 | .873 | 0.30 |
| 10 | 4911.15 | .255 | 1.018 | 0.35 |
| 20 | 4297.28 | .291 | 1.164 | 0.40 |
| 30 | 3819.83 | .327 | 1.309 | 0.45 |
| 40 | 3437.87 | .364 | 1.454 | 0.50 |
| 50 | 3125.36 | .400 | 1.600 | 0.55 |
| 2 | 2864.93 | .436 | 1.745 | 0.60 |
| 10 | 2644.58 | .473 | 1.891 | 0.65 |
| 20 | 2455.70 | .509 | 2.036 | 0.70 |
| 30 | 2292.01 | .545 | 2.181 | 0.75 |
| 40 | 2148.79 | .582 | 2.327 | 0.80 |
| 50 | 2022.41 | .618 | 2.472 | 0.85 |
| 3 | 1910.08 | .655 | 2.618 | 0.90 |
| 10 | 1809.57 | .691 | 2.763 | 0.95 |
| 20 | 1719.12 | .727 | 2.908 | 1.00 |
| 30 | 1637.28 | .764 | 3.054 | 1.05 |
| 40 | 1562.88 | .800 | 3.199 | 1.10 |
| 50 | 1494.95 | .836 | 3.345 | 1.15 |
| 4 | 1432.69 | .873 | 3.490 | 1.20 |
| 10 | 1375.40 | .909 | 3.635 | 1.25 |
| 20 | 1322.53 | .945 | 3.718 | 1.30 |
| 30 | 1273.57 | .982 | 3.926 | 1.35 |
| 40 | 1228.11 | 1.018 | 4.071 | 1.40 |
| 50 | 1185.78 | 1.055 | 4.217 | 1.45 |
| 5 | 1146.28 | 1.091 | 4.362 | 1.50 |
| 10 | 1109.33 | 1.127 | 4.507 | 1.55 |
| 20 | 1074.68 | 1.164 | 4.653 | 1.60 |
| 30 | 1042.14 | 1.200 | 4.798 | 1.65 |
| 40 | 1011.51 | 1.237 | 4.943 | 1.70 |
| 50 | 982.64 | 1.273 | 5.088 | 1.75 |
| 6 | 955.37 | 1.309 | 5.234 | 1.80 |
| 10 | 929.57 | 1.346 | 5.379 | 1.85 |
| 20 | 906.13 | 1.382 | 5.524 | 1.90 |
| 30 | 881.95 | 1.418 | 5.669 | 1.95 |
| 40 | 859.92 | 1.455 | 5.814 | 2.00 |
| 7° | 819.02 | 1.528 | 6.105 | 2.10′ |
| 20 | 781.84 | 1.600 | 6.395 | 2.20 |
| 30 | 764.49 | 1.637 | 6.540 | 2.25 |
| 40 | 747.89 | 1.673 | 6.685 | 2.30 |
| 8 | 716.78 | 1.746 | 6.976 | 2.40 |
| 20 | 688.16 | 1.819 | 7.266 | 2.50 |
| 30 | 674.69 | 1.855 | 7.411 | 2.55 |
| 40 | 661.74 | 1.892 | 7.556 | 2.60 |
| 9 | 637.28 | 1.965 | 7.846 | 2.70 |
| 20 | 614.56 | 2.037 | 8.136 | 2.80 |
| 30 | 603.80 | 2.074 | 8.281 | 2.85 |
| 40 | 593.42 | 2.110 | 8.426 | 2.90 |
| 10 | 573.69 | 2.183 | 8.716 | 3.00 |
| 30 | 546.44 | 2.292 | 9.150 | 3.15 |
| 11 | 521.67 | 2.402 | 9.585 | 3.30 |
| 30 | 499.06 | 2.511 | 10.02 | 3.45 |
| 12 | 478.34 | 2.620 | 10.45 | 3.60 |
| 30 | 459.28 | 2.730 | 10.89 | 3.75 |
| 13 | 441.68 | 2.839 | 11.32 | 3.90 |
| 30 | 425.40 | 2.949 | 11.75 | 4.05 |
| 14 | 410.28 | 3.058 | 12.18 | 4.20 |
| 30 | 396.20 | 3.168 | 12.62 | 4.35 |
| 15 | 383.07 | 3.277 | 13.05 | 4.50 |
| 30 | 370.78 | 3.387 | 13.49 | 4.65 |
| 16 | 359.27 | 3.496 | 13.92 | 4.80 |
| 30 | 348.45 | 3.606 | 14.35 | 4.95 |
| 17 | 338.27 | 3.716 | 14.78 | 5.10 |
| 18 | 319.62 | 3.935 | 15.64 | 5.40 |
| 19 | 302.94 | 4.155 | 16.51 | 5.70 |
| 20 | 287.94 | 4.374 | 17.37 | 6.00 |
| 21 | 274.37 | 4.594 | 18.22 | 6.30 |
| 22 | 262.04 | 4.814 | 19.08 | 6.60 |
| 23 | 250.79 | 5.035 | 19.94 | 6.90 |
| 24 | 240.49 | 5.255 | 20.79 | 7.20 |
| 25 | 231.01 | 5.476 | 21.64 | 7.50 |
| 26 | 222.27 | 5.697 | 22.50 | 7.80 |
| 27 | 214.18 | 5.918 | 23.35 | 8.10 |
| 28 | 206.68 | 6.139 | 24.19 | 8.40 |
| 29 | 199.70 | 6.360 | 25.04 | 8.70 |
| 30 | 193.18 | 6.583 | 25.88 | 9.00 |

Note. Chord Deflection=2 times tangent deflection.



## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 1° | 50.00 | .22 | 11° | 551.70 | 26.50 | 21° | 1061.9 | 97.57 |
| 10′ | 58.34 | .30 | 10′ | 560.11 | 27.31 | 10′ | 1070.6 | 99.16 |
| 20 | 66.67 | .39 | 20 | 568.53 | 28.14 | 20 | 1079.2 | 100.75 |
| 30 | 75.01 | .49 | 30 | 576.95 | 28.97 | 30 | 1087.8 | 102.35 |
| 40 | 83.34 | .61 | 40 | 585.36 | 29.82 | 40 | 1096.4 | 103.97 |
| 50 | 91.68 | .73 | 50 | 593.79 | 30.68 | 50 | 1105.1 | 105.60 |
| 2 | 100.01 | .87 | 12 | 602.21 | 31.56 | 22 | 1113.7 | 107.24 |
| 10 | 108.35 | 1.02 | 10 | 610.64 | 32.45 | 10 | 1122.4 | 108.90 |
| 20 | 116.68 | 1.19 | 20 | 619.07 | 33.35 | 20 | 1131.0 | 110.57 |
| 30 | 125.02 | 1.36 | 30 | 627.50 | 34.26 | 30 | 1139.7 | 112.25 |
| 40 | 133.36 | 1.55 | 40 | 635.93 | 35.18 | 40 | 1148.4 | 113.95 |
| 50 | 141.70 | 1.75 | 50 | 644.37 | 36.12 | 50 | 1157.0 | 115.66 |
| 3 | 150.04 | 1.96 | 13 | 652.81 | 37.07 | 23 | 1165.7 | 117.38 |
| 10 | 158.38 | 2.19 | 10 | 661.25 | 38.03 | 10 | 1174.4 | 119.12 |
| 20 | 166.72 | 2.43 | 20 | 669.70 | 39.01 | 20 | 1183.1 | 120.87 |
| 30 | 175.06 | 2.67 | 30 | 678.15 | 39.99 | 30 | 1191.8 | 122.63 |
| 40 | 183.40 | 2.93 | 40 | 686.60 | 40.99 | 40 | 1200.5 | 124.41 |
| 50 | 191.74 | 3.21 | 50 | 695.06 | 42.00 | 50 | 1209.2 | 126.20 |
| 4 | 200.08 | 3.49 | 14 | 703.51 | 43.03 | 24 | 1217.9 | 128.00 |
| 10 | 208.43 | 3.79 | 10 | 711.97 | 44.07 | 10 | 1226.6 | 129.82 |
| 20 | 216.77 | 4.10 | 20 | 720.44 | 45.12 | 20 | 1235.3 | 131.65 |
| 30 | 225.12 | 4.42 | 30 | 728.90 | 46.18 | 30 | 1244.0 | 133.50 |
| 40 | 233.47 | 4.76 | 40 | 737.37 | 47.25 | 40 | 1252.8 | 135.35 |
| 50 | 241.81 | 5.10 | 50 | 745.85 | 48.34 | 50 | 1261.5 | 137.23 |
| 5 | 250.16 | 5.46 | 15 | 754.32 | 49.44 | 25 | 1270.2 | 139.11 |
| 10 | 258.51 | 5.83 | 10 | 762.80 | 50.55 | 10 | 1279.0 | 141.01 |
| 20 | 266.86 | 6.21 | 20 | 771.29 | 51.68 | 20 | 1287.7 | 142.93 |
| 30 | 275.21 | 6.61 | 30 | 779.77 | 52.89 | 30 | 1296.5 | 144.85 |
| 40 | 283.57 | 7.01 | 40 | 788.26 | 53.97 | 40 | 1305.3 | 146.79 |
| 50 | 291.92 | 7.43 | 50 | 796.75 | 55.13 | 50 | 1314.0 | 148.75 |
| 6 | 300.28 | 7.86 | 16 | 805.25 | 56.31 | 26 | 1322.8 | 150.71 |
| 10 | 308.64 | 8.31 | 10 | 813.75 | 57.50 | 10 | 1331.6 | 152.69 |
| 20 | 316.99 | 8.76 | 20 | 822.25 | 58.70 | 20 | 1340.4 | 154.69 |
| 30 | 325.35 | 9.23 | 30 | 830.76 | 59.91 | 30 | 1349.2 | 156.70 |
| 40 | 333.71 | 9.71 | 40 | 839.27 | 61.14 | 40 | 1358.0 | 158.72 |
| 50 | 342.08 | 10.20 | 50 | 847.78 | 62.38 | 50 | 1366.8 | 160.76 |
| 7 | 350.44 | 10.71 | 17 | 856.30 | 63.63 | 27 | 1375.6 | 162.81 |
| 10 | 358.81 | 11.22 | 10 | 864.82 | 64.90 | 10 | 1384.4 | 164.86 |
| 20 | 367.17 | 11.75 | 20 | 873.35 | 66.18 | 20 | 1393.2 | 166.95 |
| 30 | 375.54 | 12.29 | 30 | 881.88 | 67.47 | 30 | 1402.0 | 169.04 |
| 40 | 383.91 | 12.85 | 40 | 890.41 | 68.77 | 40 | 1410.9 | 171.15 |
| 50 | 392.28 | 13.41 | 50 | 898.95 | 70.09 | 50 | 1419.7 | 173.27 |
| 8 | 400.66 | 13.99 | 18 | 907.49 | 71.42 | 28 | 1428.6 | 175.41 |
| 10 | 409.03 | 14.58 | 10 | 916.03 | 72.76 | 10 | 1437.4 | 177.55 |
| 20 | 417.41 | 15.18 | 20 | 924.58 | 74.12 | 20 | 1446.3 | 179.72 |
| 30 | 425.79 | 15.80 | 30 | 933.13 | 75.49 | 30 | 1455.1 | 181.89 |
| 40 | 434.17 | 16.43 | 40 | 941.69 | 76.86 | 40 | 1464.0 | 184.08 |
| 50 | 442.55 | 17.07 | 50 | 950.25 | 78.26 | 50 | 1472.9 | 186.29 |
| 9 | 450.93 | 17.72 | 19 | 958.81 | 79.67 | 29 | 1481.8 | 188.51 |
| 10 | 459.32 | 18.38 | 10 | 967.38 | 81.09 | 10 | 1490.7 | 190.74 |
| 20 | 467.71 | 19.06 | 20 | 975.96 | 82.53 | 20 | 1499.6 | 192.99 |
| 30 | 476.10 | 19.75 | 30 | 984.53 | 83.97 | 30 | 1508.5 | 195.25 |
| 40 | 484.49 | 20.45 | 40 | 993.12 | 85.43 | 40 | 1517.4 | 197.53 |
| 50 | 492.88 | 21.16 | 50 | 1001.7 | 86.90 | 50 | 1526.3 | 199.82 |
| 10 | 501.28 | 21.89 | 20 | 1010.3 | 88.39 | 30 | 1535.3 | 202.12 |
| 10 | 509.68 | 22.62 | 10 | 1018.9 | 89.89 | 10 | 1544.2 | 204.44 |
| 20 | 518.08 | 23.38 | 20 | 1027.5 | 91.40 | 20 | 1553.1 | 206.77 |
| 30 | 526.48 | 24.14 | 30 | 1036.1 | 92.92 | 30 | 1562.1 | 209.12 |
| 40 | 534.89 | 24.91 | 40 | 1044.7 | 94.46 | 40 | 1571.0 | 211.48 |
| 50 | 543.29 | 25.70 | 50 | 1053.3 | 96.01 | 50 | 1580.0 | 213.86 |

counter 42319

## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 31° | 1589.0 | 216.3 | 41° | 2142.2 | 387.4 | 51° | 2732.9 | 618.4 |
| 10′ | 1598.0 | 218.7 | 10′ | 2151.7 | 390.7 | 10 | 2743.1 | 622.8 |
| 20 | 1606.9 | 221.1 | 20 | 2161.2 | 394.1 | 20 | 2753.4 | 627.2 |
| 30 | 1615.9 | 223.5 | 30 | 2170.8 | 397.4 | 30 | 2763.7 | 631.7 |
| 40 | 1624.9 | 226.0 | 40 | 2180.3 | 400.8 | 40 | 2773.9 | 636.2 |
| 50 | 1633.9 | 228.4 | 50 | 2189.9 | 404.2 | 50 | 2784.2 | 640.7 |
| 32 | 1643.0 | 230.9 | 42 | 2199.4 | 407.6 | 52 | 2794.5 | 645.2 |
| 10 | 1652.0 | 233.4 | 10 | 2209.0 | 411.1 | 10 | 2804.9 | 649.7 |
| 20 | 1661.0 | 235.9 | 20 | 2218.6 | 414.5 | 20 | 2815.2 | 654.3 |
| 30 | 1670.0 | 238.4 | 30 | 2228.1 | 418.0 | 30 | 2825.6 | 658.8 |
| 40 | 1679.1 | 241.0 | 40 | 2237.7 | 421.4 | 40 | 2835.9 | 663.4 |
| 50 | 1688.1 | 243.5 | 50 | 2247.3 | 425.0 | 50 | 2846.3 | 668.0 |
| 33 | 1697.2 | 246.1 | 43 | 2257.0 | 428.5 | 53 | 2856.7 | 672.7 |
| 10 | 1706.3 | 248.7 | 10 | 2266.6 | 432.0 | 10 | 2867.1 | 677.3 |
| 20 | 1715.3 | 251.3 | 20 | 2276.2 | 435.6 | 20 | 2877.5 | 682.0 |
| 30 | 1724.4 | 253.9 | 30 | 2285.9 | 439.2 | 30 | 2888.0 | 686.7 |
| 40 | 1733.5 | 256.5 | 40 | 2295.6 | 442.8 | 40 | 2898.4 | 691.4 |
| 50 | 1742.6 | 259.1 | 50 | 2305.2 | 446.4 | 50 | 2908.9 | 696.1 |
| 34 | 1751.7 | 261.8 | 44 | 2314.9 | 450.0 | 54 | 2919.4 | 700.9 |
| 10 | 1760.8 | 264.5 | 10 | 2324.6 | 453.6 | 10 | 2929.9 | 705.7 |
| 20 | 1770.0 | 267.2 | 20 | 2334.3 | 457.3 | 20 | 2940.4 | 710.5 |
| 30 | 1779.1 | 269.9 | 30 | 2344.1 | 461.0 | 30 | 2951.0 | 715.3 |
| 40 | 1788.2 | 272.6 | 40 | 2353.8 | 464.6 | 40 | 2961.5 | 720.1 |
| 50 | 1797.4 | 275.3 | 50 | 2363.5 | 468.4 | 50 | 2972.1 | 725.0 |
| 35 | 1806.6 | 278.1 | 45 | 2373.3 | 472.1 | 55 | 2982.7 | 729.9 |
| 10 | 1815.7 | 280.8 | 10 | 2383.1 | 475.8 | 10 | 2993.3 | 734.8 |
| 20 | 1824.9 | 283.6 | 20 | 2392.8 | 479.6 | 20 | 3003.9 | 739.7 |
| 30 | 1834.1 | 286.4 | 30 | 2402.6 | 483.8 | 30 | 3014.5 | 744.6 |
| 40 | 1843.3 | 289.2 | 40 | 2412.4 | 487.2 | 40 | 3025.2 | 749.6 |
| 50 | 1852.5 | 292.0 | 50 | 2422.3 | 491.0 | 50 | 3035.8 | 754.6 |
| 36 | 1861.7 | 294.9 | 46 | 2432.1 | 494.8 | 56 | 3046.5 | 759.6 |
| 10 | 1870.9 | 297.7 | 10 | 2441.9 | 498.7 | 10 | 3057.2 | 764.6 |
| 20 | 1880.1 | 300.6 | 20 | 2451.8 | 502.5 | 20 | 3067.9 | 769.7 |
| 30 | 1889.4 | 303.5 | 30 | 2461.7 | 506.4 | 30 | 3078.7 | 774.7 |
| 40 | 1898.6 | 306.4 | 40 | 2471.5 | 510.3 | 40 | 3089.4 | 779.8 |
| 50 | 1907.9 | 309.3 | 50 | 2481.4 | 514.3 | 50 | 3100.2 | 784.9 |
| 37 | 1917.1 | 312.2 | 47 | 2491.3 | 518.2 | 57 | 3110.9 | 790.1 |
| 10 | 1926.4 | 315.2 | 10 | 2501.2 | 522.2 | 10 | 3121.7 | 795.2 |
| 20 | 1935.7 | 318.1 | 20 | 2511.2 | 526.1 | 20 | 3132.6 | 800.4 |
| 30 | 1945.0 | 321.1 | 30 | 2521.1 | 530.1 | 30 | 3143.4 | 805.6 |
| 40 | 1954.3 | 324.1 | 40 | 2531.1 | 534.2 | 40 | 3154.2 | 810.9 |
| 50 | 1963.6 | 327.1 | 50 | 2541.0 | 538.2 | 50 | 3165.1 | 816.1 |
| 38 | 1972.9 | 330.2 | 48 | 2551.0 | 542.2 | 58 | 3176.0 | 821.4 |
| 10 | 1982.2 | 333.2 | 10 | 2561.0 | 546.3 | 10 | 3186.9 | 826.7 |
| 20 | 1991.5 | 336.3 | 20 | 2571.0 | 550.4 | 20 | 3197.8 | 832.0 |
| 30 | 2000.9 | 339.3 | 30 | 2581.0 | 554.5 | 30 | 3208.8 | 837.3 |
| 40 | 2010.2 | 342.4 | 40 | 2591.0 | 558.6 | 40 | 3219.7 | 842.7 |
| 50 | 2019.6 | 345.5 | 50 | 2601.1 | 562.8 | 50 | 3230.7 | 848.1 |
| 39 | 2029.0 | 348.6 | 49 | 2611.2 | 566.9 | 59 | 3241.7 | 853.5 |
| 10 | 2038.4 | 351.8 | 10 | 2621.2 | 571.1 | 10 | 3252.7 | 858.9 |
| 20 | 2047.8 | 354.9 | 20 | 2631.3 | 575.3 | 20 | 3263.7 | 864.3 |
| 30 | 2057.2 | 358.1 | 30 | 2641.4 | 579.5 | 30 | 3274.8 | 869.8 |
| 40 | 2066.6 | 361.3 | 40 | 2651.5 | 583.8 | 40 | 3285.8 | 875.3 |
| 50 | 2076.0 | 364.5 | 50 | 2661.6 | 588.0 | 50 | 3296.9 | 880.8 |
| 40 | 2085.4 | 367.7 | 50 | 2671.8 | 592.3 | 60 | 3308.0 | 886.4 |
| 10 | 2094.9 | 371.0 | 10 | 2681.9 | 596.6 | 10 | 3319.1 | 892.0 |
| 20 | 2104.3 | 374.2 | 20 | 2692.1 | 600.9 | 20 | 3330.3 | 897.5 |
| 30 | 2113.8 | 377.5 | 30 | 2702.3 | 605.3 | 30 | 3341.4 | 903.2 |
| 40 | 2123.3 | 380.8 | 40 | 2712.5 | 609.6 | 40 | 3352.6 | 908.8 |
| 50 | 2132.7 | 384.1 | 50 | 2722.7 | 614.0 | 50 | 3363.8 | 914.5 |



## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 61° | 3375.0 | 920.2 | 71° | 4086.9 | 1308.2 | 81° | 4893.6 | 1805.3 |
| 10′ | 3386.3 | 925.9 | 10′ | 4099.5 | 1315.6 | 10′ | 4908.0 | 1814.7 |
| 20 | 3397.5 | 931.6 | 20 | 4112.1 | 1322.9 | 20 | 4922.5 | 1824.1 |
| 30 | 3408.8 | 937.3 | 30 | 4124.8 | 1330.3 | 30 | 4937.0 | 1833.6 |
| 40 | 3420.1 | 943.1 | 40 | 4137.4 | 1337.7 | 40 | 4951.5 | 1843.1 |
| 50 | 3431.4 | 948.9 | 50 | 4150.1 | 1345.1 | 50 | 4966.1 | 1852.6 |
| 62 | 3442.7 | 954.8 | 72 | 4162.8 | 1352.6 | 82 | 4980.7 | 1862.2 |
| 10 | 3454.1 | 960.6 | 10 | 4175.6 | 1360.1 | 10 | 4995.4 | 1871.8 |
| 20 | 3465.4 | 966.5 | 20 | 4188.5 | 1367.6 | 20 | 5010.0 | 1881.5 |
| 30 | 3476.8 | 972.4 | 30 | 4201.2 | 1375.2 | 30 | 5024.8 | 1891.2 |
| 40 | 3488.3 | 978.3 | 40 | 4214.0 | 1382.8 | 40 | 5039.5 | 1900.9 |
| 50 | 3499.7 | 984.3 | 50 | 4226.8 | 1390.4 | 50 | 5054.3 | 1910.7 |
| 63 | 3511.1 | 990.2 | 73 | 4239.7 | 1398.0 | 83 | 5069.2 | 1920.5 |
| 10 | 3522.6 | 996.2 | 10 | 4252.6 | 1405.7 | 10 | 5084.0 | 1930.4 |
| 20 | 3534.1 | 1002.3 | 20 | 4265.6 | 1413.5 | 20 | 5099.0 | 1940.3 |
| 30 | 3545.6 | 1008.3 | 30 | 4278.5 | 1421.2 | 30 | 5113.9 | 1950.3 |
| 40 | 3557.2 | 1014.4 | 40 | 4291.5 | 1429.0 | 40 | 5128.9 | 1960.2 |
| 50 | 3568.7 | 1020.5 | 50 | 4304.6 | 1436.8 | 50 | 5143.9 | 1970.3 |
| 64 | 3580.3 | 1026.6 | 74 | 4317.6 | 1444.6 | 84 | 5159.0 | 1980.4 |
| 10 | 3591.9 | 1032.8 | 10 | 4330.7 | 1452.5 | 10 | 5174.1 | 1990.5 |
| 20 | 3603.5 | 1039.0 | 20 | 4343.8 | 1460.4 | 20 | 5189.3 | 2000.6 |
| 30 | 3615.1 | 1045.2 | 30 | 4356.9 | 1468.4 | 30 | 5204.4 | 2010.8 |
| 40 | 3626.8 | 1051.4 | 40 | 4370.1 | 1476.4 | 40 | 5219.7 | 2021.1 |
| 50 | 3638.5 | 1057.7 | 50 | 4383.3 | 1484.4 | 50 | 5234.9 | 2031.4 |
| 65 | 3650.2 | 1063.9 | 75 | 4396.5 | 1492.4 | 85 | 5250.3 | 2041.7 |
| 10 | 3661.9 | 1070.2 | 10 | 4409.8 | 1500.5 | 10 | 5265.6 | 2052.1 |
| 20 | 3673.7 | 1076.6 | 20 | 4423.1 | 1508.6 | 20 | 5281.0 | 2062.5 |
| 30 | 3685.4 | 1082.9 | 30 | 4436.4 | 1516.7 | 30 | 5296.4 | 2073.0 |
| 40 | 3697.2 | 1089.3 | 40 | 4449.7 | 1524.9 | 40 | 5311.9 | 2083.5 |
| 50 | 3709.0 | 1095.7 | 50 | 4463.1 | 1533.1 | 50 | 5327.4 | 2094.1 |
| 66 | 3720.9 | 1102.2 | 76 | 4476.5 | 1541.4 | 86 | 5343.0 | 2104.7 |
| 10 | 3732.7 | 1108.6 | 10 | 4489.9 | 1549.7 | 10 | 5358.6 | 2115.3 |
| 20 | 3744.6 | 1115.1 | 20 | 4503.4 | 1558.0 | 20 | 5374.2 | 2126.0 |
| 30 | 3756.5 | 1121.7 | 30 | 4516.9 | 1566.3 | 30 | 5389.9 | 2136.7 |
| 40 | 3768.5 | 1128.2 | 40 | 4530.4 | 1574.7 | 40 | 5405.6 | 2147.5 |
| 50 | 3780.4 | 1134.8 | 50 | 4544.0 | 1583.1 | 50 | 5421.4 | 2158.4 |
| 67 | 3792.4 | 1141.4 | 77 | 4557.6 | 1591.6 | 87 | 5437.2 | 2169.2 |
| 10 | 3804.4 | 1148.0 | 10 | 4571.2 | 1600.1 | 10 | 5453.1 | 2180.2 |
| 20 | 3816.4 | 1154.7 | 20 | 4584.8 | 1608.6 | 20 | 5469.0 | 2191.1 |
| 30 | 3828.4 | 1161.3 | 30 | 4598.5 | 1617.1 | 30 | 5484.9 | 2202.2 |
| 40 | 3840.5 | 1168.1 | 40 | 4612.2 | 1625.7 | 40 | 5500.9 | 2213.2 |
| 50 | 3852.6 | 1174.8 | 50 | 4626.0 | 1634.4 | 50 | 5517.0 | 2224.3 |
| 68 | 3864.7 | 1181.6 | 78 | 4639.8 | 1643.0 | 88 | 5533.1 | 2235.5 |
| 10 | 3876.8 | 1188.4 | 10 | 4653.6 | 1651.7 | 10 | 5549.2 | 2246.7 |
| 20 | 3889.0 | 1195.2 | 20 | 4667.4 | 1660.5 | 20 | 5565.4 | 2258.0 |
| 30 | 3901.2 | 1202.0 | 30 | 4681.3 | 1669.2 | 30 | 5581.6 | 2269.3 |
| 40 | 3913.4 | 1208.9 | 40 | 4695.2 | 1678.1 | 40 | 5597.8 | 2280.6 |
| 50 | 3925.6 | 1215.8 | 50 | 4709.2 | 1686.9 | 50 | 5614.2 | 2292.0 |
| 69 | 3937.9 | 1222.7 | 79 | 4723.2 | 1695.8 | 89 | 5630.5 | 2303.5 |
| 10 | 3950.2 | 1229.7 | 10 | 4737.2 | 1704.7 | 10 | 5646.9 | 2315.0 |
| 20 | 3962.5 | 1236.7 | 20 | 4751.2 | 1713.7 | 20 | 5663.4 | 2326.6 |
| 30 | 3974.8 | 1243.7 | 30 | 4765.3 | 1722.7 | 30 | 5679.9 | 2338.2 |
| 40 | 3987.2 | 1250.8 | 40 | 4779.4 | 1731.7 | 40 | 5696.4 | 2349.8 |
| 50 | 3999.5 | 1257.9 | 50 | 4793.6 | 1740.8 | 50 | 5713.0 | 2361.5 |
| 70 | 4011.9 | 1265.0 | 80 | 4807.7 | 1749.9 | 90 | 5729.7 | 2373.3 |
| 10 | 4024.4 | 1272.1 | 10 | 4822.0 | 1759.0 | 10 | 5746.3 | 2385.1 |
| 20 | 4036.8 | 1279.3 | 20 | 4836.2 | 1768.2 | 20 | 5763.1 | 2397.0 |
| 30 | 4049.3 | 1286.5 | 30 | 4850.5 | 1777.4 | 30 | 5779.9 | 2408.9 |
| 40 | 4061.8 | 1293.6 | 40 | 4864.8 | 1786.7 | 40 | 5796.7 | 2420.9 |
| 50 | 4074.4 | 1300.9 | 50 | 4879.2 | 1796.0 | 50 | 5813.6 | 2432.9 |

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## Table IV.—Tangents and Externals to a 1° Curve.

| Central Angle | Tangent | External | Central Angle | Tangent | External | Central Angle | Tangent | External |
|---|---|---|---|---|---|---|---|---|
| 91° | 5830.5 | 2444.9 | 101° | 6950.6 | 3278.1 | 111° | 8336.7 | 4386.1 |
| 10′ | 5847.5 | 2457.1 | 10′ | 6971.3 | 3294.1 | 10′ | 8362.7 | 4407.6 |
| 20 | 5864.6 | 2469.3 | 20 | 6992.0 | 3310.1 | 20 | 8388.9 | 4429.2 |
| 30 | 5881.7 | 2481.5 | 30 | 7012.7 | 3326.1 | 30 | 8415.1 | 4450.9 |
| 40 | 5898.8 | 2493.8 | 40 | 7033.6 | 3342.3 | 40 | 8441.5 | 4472.7 |
| 50 | 5916.0 | 2506.1 | 50 | 7054.5 | 3358.5 | 50 | 8468.0 | 4494.6 |
| 92 | 5933.2 | 2518.5 | 102 | 7075.5 | 3374.9 | 112 | 8494.6 | 4516.6 |
| 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 | 103 | 7203.2 | 3474.4 | 113 | 8656.6 | 4651.3 |
| 10 | 6055 4 | 2606.8 | 10 | 7224.7 | 3491.3 | 10 | 8684.0 | 4674.2 |
| 20 | 6073.1 | 2619.7 | 20 | 7246.3 | 3508.2 | 20 | 8711.5 | 4697.2 |
| 30 | 6090.8 | 2632.6 | 30 | 7268.0 | 3525.2 | 30 | 8739.2 | 4720.3 |
| 40 | 6108.6 | 2645.5 | 40 | 7289.8 | 3542.4 | 40 | 8767.0 | 4743.6 |
| 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 | 6162.6 | 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 | 50 | 7444.6 | 3664.5 | 50 | 8965.0 | 4909.9 |
| 95 | 6252.8 | 2751.3 | 105 | 7467.0 | 3682.3 | 115 | 8993.8 | 4934.1 |
| 10 | 6271.1 | 2764.8 | 10 | 7489.6 | 3700.2 | 10 | 9022.7 | 4958.6 |
| 20 | 6289.4 | 2778.3 | 20 | 7512.2 | 3718.2 | 20 | 9051.7 | 4983.1 |
| 30 | 6307.9 | 2792.0 | 30 | 7534.9 | 3736.2 | 30 | 9080.9 | 5007.8 |
| 40 | 6326.3 | 2806.6 | 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 | 40 | 7696.3 | 3865.2 | 40 | 9289.2 | 5184.5 |
| 50 | 6457.3 | 2903.1 | 50 | 7719.7 | 3884.0 | 50 | 9319.5 | 5210.3 |
| 97 | 6476.2 | 2917.3 | 107 | 7743.2 | 3902.9 | 117 | 9349.9 | 5236.2 |
| 10 | 6495.2 | 2931.6 | 10 | 7766.8 | 3921.9 | 10 | 9380.5 | 5262.3 |
| 20 | 6514.3 | 2945.9 | 20 | 7790.5 | 3940.9 | 20 | 9411.3 | 5288.6 |
| 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 | 10 | 7910.4 | 4037.8 | 10 | 9567.2 | 5422.1 |
| 20 | 6630.1 | 3033.1 | 20 | 7934.6 | 4057.4 | 20 | 9598.9 | 5449.2 |
| 30 | 6649.6 | 3047.9 | 30 | 7959.0 | 4077.2 | 30 | 9630.7 | 5476.5 |
| 40 | 6669.2 | 3062.8 | 40 | 7983.5 | 4097.1 | 40 | 9662.6 | 5504.0 |
| 50 | 6688.8 | 3077.7 | 50 | 8008.0 | 4117.0 | 50 | 9694.7 | 5531.7 |
| 99 | 6708.6 | 3092.7 | 109 | 8032.7 | 4137.1 | 119 | 9727.0 | 5559.4 |
| 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 | 110 | 8182.8 | 4259.7 | 120 | 9924.0 | 5729.7 |
| 10 | 6848.5 | 3199.6 | 10 | 8208.2 | 4280.5 | 10 | 9957.5 | 5758.6 |
| 20 | 6868.8 | 3215.1 | 20 | 8233.7 | 4301.4 | 20 | 9991.0 | 5787.7 |
| 30 | 6889.2 | 3230.8 | 30 | 8259.3 | 4322.4 | 30 | 10025.0 | 5817.0 |
| 40 | 6909.6 | 3246.5 | 40 | 8285.0 | 4343.6 | 40 | 10059.0 | 5846.5 |
| 50 | 6930.1 | 3262.3 | 50 | 8310.8 | 4364.8 | 50 | 10093.0 | 5876.1 |



## Table V.—Corrections for Tangents and Externals.

These corrections are to be added to the approximate values, found by dividing the tangent, or external, for a 1° curve (Table IV) by the degree of curve, in order to obtain the true tangents, or externals. Intermediate values may be obtained by interpolation.

### For Tangents Add

| Central Angle | Degree of Curve | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° |
| 10° | .03 | .06 | .09 | .13 | .16 | .19 | .22 | .25 | .28 | .31 | .34 | .38 | .42 | .46 |
| 15° | .04 | .10 | .14 | .19 | .24 | .29 | .34 | .39 | .45 | .51 | .53 | .58 | .63 | .68 |
| 20° | .06 | .13 | .19 | .26 | .32 | .39 | .45 | .51 | .58 | .65 | .72 | .79 | .84 | .90 |
| 25° | .08 | .16 | .24 | .33 | .40 | .49 | .58 | .67 | .75 | .83 | .90 | .99 | 1.06 | 1.14 |
| 30° | .10 | .19 | .29 | .39 | .49 | .59 | .69 | .79 | .89 | .99 | 1.09 | 1.20 | 1.29 | 1.39 |
| 35° | .11 | .22 | .34 | .47 | .58 | .69 | .70 | .81 | .92 | 1.04 | 1.29 | 1.42 | 1.54 | 1.66 |
| 40° | .13 | .26 | .40 | .53 | .67 | .80 | .93 | 1.06 | 1.20 | 1.34 | 1.49 | 1.64 | 1.79 | 1.94 |
| 45° | .15 | .30 | .44 | .60 | .76 | .91 | 1.06 | 1.21 | 1.37 | 1.52 | 1.70 | 1.87 | 2.04 | 2.21 |
| 50° | .17 | .34 | .51 | .68 | .85 | 1.02 | 1.19 | 1.36 | 1.54 | 1.72 | 1.91 | 2.10 | 2.29 | 2.48 |
| 55° | .19 | .38 | .57 | .76 | .95 | 1.14 | 1.32 | 1.52 | 1.72 | 1.92 | 2.14 | 2.35 | 2.56 | 2.77 |
| 60° | .21 | .42 | .63 | .84 | 1.05 | 1.27 | 1.49 | 1.71 | 1.94 | 2.17 | 2.38 | 2.60 | 2.83 | 3.07 |
| 65° | .23 | .46 | .69 | .93 | 1.16 | 1.40 | 1.64 | 1.88 | 2.13 | 2.38 | 2.63 | 2.88 | 3.13 | 3.39 |
| 70° | .25 | .51 | .76 | 1.02 | 1.28 | 1.54 | 1.80 | 2.06 | 2.33 | 2.60 | 2.88 | 3.16 | 3.44 | 3.72 |
| 75° | .27 | .56 | .83 | 1.12 | 1.40 | 1.69 | 1.98 | 2.27 | 2.57 | 2.87 | 3.16 | 3.47 | 3.78 | 4.09 |
| 80° | .30 | .61 | .91 | 1.22 | 1.53 | 1.84 | 2.15 | 2.46 | 2.78 | 3.10 | 3.44 | 3.78 | 4.12 | 4.46 |
| 85° | .33 | .66 | 1.00 | 1.33 | 1.68 | 2.02 | 2.36 | 2.70 | 3.05 | 3.40 | 3.77 | 4.14 | 4.55 | 4.89 |
| 90° | .36 | .72 | 1.09 | 1.45 | 1.83 | 2.20 | 2.57 | 2.94 | 3.32 | 3.70 | 4.10 | 4.50 | 4.91 | 5.32 |
| 95° | .39 | .79 | 1.19 | 1.55 | 2.00 | 2.40 | 2.80 | 3.20 | 3.61 | 4.02 | 4.40 | 4.98 | 5.38 | 5.83 |
| 100° | .43 | .86 | 1.30 | 1.74 | 2.18 | 2.62 | 3.06 | 3.50 | 3.95 | 4.40 | 4.88 | 5.37 | 5.85 | 6.34 |
| 110° | .51 | 1.03 | 1.56 | 2.08 | 2.61 | 3.14 | 3.67 | 4.21 | 4.76 | 5.31 | 5.86 | 6.43 | 7.01 | 7.60 |
| 120° | .62 | 1.25 | 1.93 | 2.52 | 3.16 | 3.81 | 4.45 | 5.11 | 5.77 | 6.44 | 7.12 | 7.80 | 8.50 | 9.22 |

### For Externals Add

| Central Angle | Degree of Curve | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° |
| 10° | .001 | .003 | .004 | .006 | .007 | .008 | .009 | .011 | .012 | .014 | .015 | .017 | .018 | .020 |
| 15° | .003 | .007 | .010 | .014 | .018 | .023 | .027 | .029 | .032 | .035 | .039 | .043 | .047 | .051 |
| 20° | .006 | .011 | .017 | .022 | .028 | .034 | .038 | .045 | .051 | .057 | .063 | .070 | .076 | .083 |
| 25° | .009 | .018 | .027 | .036 | .046 | .056 | .065 | .074 | .083 | .093 | .106 | .120 | .127 | .135 |
| 30° | .013 | .025 | .038 | .051 | .065 | .078 | .090 | .103 | .116 | .129 | .149 | .170 | .179 | .188 |
| 35° | .018 | .035 | .054 | .072 | .086 | .109 | .131 | .153 | .175 | .197 | .213 | .230 | .247 | .264 |
| 40° | .023 | .046 | .070 | .093 | .117 | .141 | .172 | .203 | .234 | .265 | .277 | .290 | .315 | .341 |
| 45° | .030 | .060 | .093 | .119 | .153 | .184 | .216 | .254 | .289 | .325 | .351 | .378 | .411 | .445 |
| 50° | .037 | .075 | .116 | .151 | .189 | .227 | .266 | .305 | .345 | .384 | .425 | .467 | .508 | .550 |
| 55° | .046 | .093 | .142 | .188 | .236 | .283 | .332 | .381 | .420 | .479 | .530 | .582 | .641 | .700 |
| 60° | .056 | .112 | .168 | .225 | .283 | .340 | .398 | .457 | .516 | .575 | .636 | .697 | .774 | .851 |
| 65° | .067 | .135 | .204 | .273 | .343 | .412 | .483 | .554 | .625 | .697 | .711 | .845 | .922 | 1.01 |
| 70° | .080 | .159 | .240 | .321 | .403 | .485 | .568 | .652 | .735 | .819 | .906 | .994 | 1.08 | 1.17 |
| 75° | .095 | .182 | .286 | .383 | .480 | .578 | .678 | .777 | .877 | .977 | 1.07 | 1.18 | 1.29 | 1.39 |
| 80° | .110 | .220 | .332 | .445 | .558 | .671 | .787 | .903 | 1.02 | 1.13 | 1.25 | 1.38 | 1.50 | 1.62 |
| 85° | .128 | .259 | .391 | .524 | .657 | .790 | .926 | 1.06 | 1.20 | 1.34 | 1.47 | 1.62 | 1.76 | 1.91 |
| 90° | .149 | .299 | .450 | .603 | .756 | .910 | 1.07 | 1.22 | 1.38 | 1.54 | 1.70 | 1.87 | 2.03 | 2.20 |
| 95° | .174 | .350 | .522 | .706 | .985 | 1.06 | 1.25 | 1.43 | 1.62 | 1.80 | 1.99 | 2.18 | 2.38 | 2.53 |
| 100° | .200 | .401 | .604 | .809 | 1.01 | 1.22 | 1.43 | 1.64 | 1.85 | 2.06 | 2.28 | 2.50 | 2.73 | 2.96 |
| 110° | .268 | .536 | .806 | 1.08 | 1.35 | 1.63 | 1.91 | 2.20 | 2.48 | 2.76 | 3.05 | 3.35 | 3.66 | 3.96 |
| 120° | .360 | .721 | 1.08 | 1.45 | 1.82 | 2.19 | 2.57 | 2.95 | 3.33 | 3.72 | 4.11 | 4.50 | 4.91 | 5.32 |

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## Table VI.—Corrections for Sub-Chords and Long Chords.

| | For Sub-Chords Add | | | | | | | | | Excess of arc per 100 ft. | Long Chords | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | | D | 200 | 300 | 400 | 500 |
| 4° | .00 | .00 | .01 | .01 | .01 | .01 | .01 | .01 | .00 | .02 | 1 | 199.99 | 299.97 | 399.92 | 499.85 |
| 6 | .00 | .01 | .01 | .02 | .02 | .02 | .02 | .01 | .01 | .05 | 2 | 199.97 | 299.88 | 399.70 | 499.39 |
| 8 | .01 | .02 | .02 | .03 | .03 | .03 | .03 | .02 | .01 | .08 | 3 | 199.93 | 299.73 | 399.32 | 498.63 |
| 10 | .01 | .02 | .03 | .04 | .05 | .06 | .06 | .04 | .02 | .13 | 4 | 199.88 | 299.51 | 398.78 | 497.57 |
| 12 | .02 | .04 | .05 | .06 | .07 | .07 | .07 | .05 | .03 | .18 | 5 | 199.81 | 299.24 | 398.10 | 496.20 |
| 14 | .02 | .05 | .07 | .08 | .09 | .10 | .09 | .07 | .04 | .25 | 6 | 199.73 | 298.90 | 397.26 | 494.53 |
| 16 | .03 | .06 | .09 | .11 | .12 | .12 | .12 | .09 | .05 | .33 | 7 | 199.63 | 298.51 | 396.28 | 492.57 |
| 18 | .04 | .08 | .11 | .14 | .15 | .16 | .15 | .12 | .07 | .41 | 8 | 199.51 | 298.05 | 395.14 | 490.31 |
| 20 | .05 | .10 | .14 | .17 | .19 | .20 | .18 | .15 | .09 | .51 | 9 | 199.38 | 297.54 | 393.86 | 487.75 |
| 22 | .06 | .12 | .17 | .21 | .23 | .24 | .22 | .18 | .10 | .62 | 10 | 199.24 | 296.96 | 392.42 | 484.90 |
| 24 | .07 | .14 | .20 | .25 | .28 | .28 | .26 | .21 | .12 | .74 | 12 | 198.90 | 295.63 | 389.12 | 478.34 |
| 26 | .09 | .17 | .24 | .29 | .32 | .33 | .31 | .25 | .15 | .86 | 14 | 198.51 | 294.06 | 385.22 | 470.65 |
| 28 | .10 | .19 | .27 | .34 | .37 | .38 | .36 | .29 | .17 | 1.00 | 16 | 198.05 | 292.25 | 380.76 | 461.86 |
| 30 | .11 | 22 | .31 | .39 | .43 | .44 | .41 | .33 | .19 | 1.15 | 18 | 197.54 | 290.21 | 375.74 | 452.02 |
| 32 | .13 | .25 | .36 | .44 | .49 | .50 | .47 | .38 | .22 | 1.31 | 20 | 196.90 | 287.94 | 370.17 | 441.15 |
| 34 | .15 | .28 | .40 | .50 | .55 | .57 | .53 | .43 | .25 | 1.48 | 22 | 196.32 | 285.44 | 364.06 | 429.30 |
| 36 | .17 | .32 | .45 | .56 | .62 | .64 | .59 | .48 | .28 | 1.66 | 24 | 195.63 | 282.71 | 357.43 | 416.53 |
| 38 | .18 | .36 | .51 | .62 | .70 | .71 | .66 | .53 | .31 | 1.86 | 26 | 194.87 | 279.76 | 350.30 | 402.89 |
| 40 | .21 | .40 | .56 | .69 | .77 | .79 | .73 | .59 | .35 | 2.06 | 28 | 194.06 | 276.59 | 342.69 | 388.42 |
| 42 | .23 | .44 | .62 | .76 | .85 | .87 | .81 | .65 | .38 | 2.28 | 30 | 193.18 | 273.20 | 334.61 | 373.20 |
| 44 | .25 | .48 | .68 | .84 | .94 | .96 | .89 | .72 | .42 | 2.50 | 32 | 192.25 | 269.61 | 326.08 | 357.28 |
| 46 | .27 | .52 | .75 | .92 | 1.02 | 1.05 | .98 | .78 | .46 | 2.74 | 34 | 191.26 | 265.81 | 317.12 | 340.73 |
| 48 | .30 | .57 | .81 | 1.00 | 1.12 | 1.14 | 1.06 | .86 | .50 | 2.99 | 36 | 190.21 | 261.80 | 307.77 | 323.61 |
| 50 | .32 | .62 | .89 | 1.09 | 1.21 | 1.24 | 1.15 | .93 | .55 | 3.24 | 38 | 189.10 | 257.60 | 298.03 | 305.99 |
| 52 | .35 | .67 | .96 | 1.18 | 1.31 | 1.35 | 1.25 | 1.01 | .59 | 3.52 | 40 | 187.94 | 253.21 | 287.94 | 287.94 |
| 54 | .38 | .73 | 1.04 | 1.28 | 1.42 | 1.46 | 1.35 | 1.09 | .64 | 3.80 | 42 | 186.72 | 248.63 | 277.51 | 269.54 |
| 56 | .41 | .78 | 1.12 | 1.38 | 1.53 | 1.57 | 1.46 | 1.17 | .69 | 4.09 | 44 | 185.44 | 243.87 | 266.78 | 250.85 |
| 58 | .44 | .84 | 1.20 | 1.48 | 1.65 | 1.69 | 1.57 | 1.20 | .74 | 4.40 | 46 | 184.10 | 239.93 | 255.78 | 231.95 |
| 60 | .47 | .91 | 1.29 | 1.59 | 1.76 | 1.81 | 1.68 | 1.35 | .80 | 4.72 | 48 | 182.71 | 233.83 | 244.51 | 212.92 |

Note.—When a chord of less than 100 ft. is used the corrections given in the above table should be added to the nominal length of chord to get the length which should be used in order that the 100 ft. points will check with those obtained by using the standard 100 ft. chord. Thus in locating a 14° curve by 25 ft. chords measure 25'.06 for each chord. Long chords are useful in passing obstacles.

## Table VII.—Middle Ordinates for Rails in Feet.

| Deg. of Curve | Length of Rails | | | | | | | Deg. of Curve | Length of Rails | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 32 | 30 | 28 | 26 | 24 | 22 | 20 | | 32 | 30 | 28 | 26 | 24 | 22 | 20 |
| 1° | .022 | .020 | .016 | .013 | .011 | .009 | .008 | 16° | .356 | .313 | .273 | .236 | .200 | .170 | .139 |
| 2 | .045 | .038 | .034 | .029 | .025 | .021 | .017 | 17 | .378 | .333 | .290 | .252 | .213 | .180 | .148 |
| 3 | .067 | .058 | .051 | .044 | .037 | .031 | .026 | 18 | .400 | .351 | .306 | .265 | .225 | .190 | .156 |
| 4 | .089 | .079 | .069 | .060 | .050 | .042 | .035 | 19 | .423 | .371 | .324 | .280 | .238 | .201 | .165 |
| 5 | .112 | .099 | .086 | .074 | .063 | .053 | .044 | 20 | .445 | .392 | .341 | .296 | .250 | .212 | .174 |
| 6 | .134 | .117 | .102 | .088 | .076 | .064 | .052 | 21 | .466 | .410 | .357 | .309 | .262 | .222 | .182 |
| 7 | .156 | .137 | .120 | .104 | .088 | .074 | .061 | 22 | .487 | .430 | .375 | .325 | .275 | .233 | .191 |
| 8 | .179 | .158 | .137 | .119 | .100 | .085 | .070 | 23 | .509 | .450 | .390 | .338 | .287 | .243 | .199 |
| 9 | .201 | .175 | .153 | .133 | .112 | .096 | .078 | 24 | .531 | .469 | .408 | .354 | .299 | .253 | .208 |
| 10 | .223 | .196 | .171 | .148 | .125 | .106 | .087 | 25 | .552 | .486 | .424 | .367 | .311 | .263 | .216 |
| 11 | .245 | .216 | .188 | .163 | .139 | .117 | .096 | 26 | .573 | .506 | .441 | .382 | .323 | .274 | .225 |
| 12 | .268 | .236 | .206 | .179 | .151 | .128 | .105 | 27 | .594 | .524 | .457 | .396 | .335 | .284 | .233 |
| 13 | .290 | .254 | .222 | .192 | .163 | .138 | .113 | 28 | .618 | .545 | .475 | .411 | .348 | .294 | .242 |
| 14 | .312 | .275 | .239 | .207 | .175 | .148 | .122 | 29 | .638 | .564 | .491 | .424 | .361 | .303 | .250 |
| 15 | .334 | .295 | .257 | .223 | .188 | .159 | .131 | 30 | .660 | .583 | .508 | .438 | .374 | .313 | .259 |



## SLOPE REDUCTIONS.

When distances are measured on a slope that may be reduced to the equivalent horizontal distance by the following approximate rule:—subtract from the slope distance the square of the rise divided by twice the slope distance. Thus for a slope distance of 250.3 ft. and a rise of 15 ft. correction$=15^2 \div 2\times 250.3=.45$ (by slide rule) or horizontal distance$=250.3-.45=249.85$. When vertical angle=V. A. is measured horizontal distance=slope distance—slope distance (1—Cos. V. A.). Thus for slope distance of 248.7 ft. and V. A. of 4° 20′ from Table VIII Cos=.99714 and correction$=1-.99714=.00286$ per foot or total of $.286\times 2\tfrac{1}{2}$ (near enough)=.57 and horizontal distance$=248.7-.57=248.13$ ft.

## TRIGONOMETRICAL FORMULAS.

See fig. (a).

sin. $A=\frac{a}{c}$

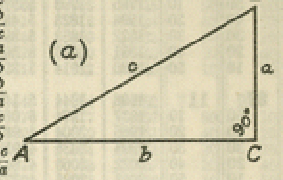
cos. $A=\frac{b}{c}$

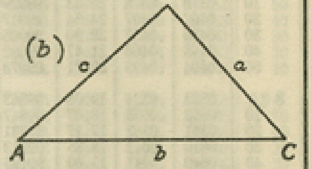
tan. $A=\frac{a}{b}$

cot. $A=\frac{b}{a}$

sec. $A=\frac{c}{b}$

cosec. $A=\frac{c}{a}$




### Formula for Solving Triangles.

| Given | Sought. | Right triangles. See fig. (a). |
|---|---|---|
| $a, c$ | $A, B, b$ | sin. $A=\frac{a}{c}$, cos. $B=\frac{a}{c}$, $b=\sqrt{(c+a)(c-a)}$ |
| $a, b$ | $A, B, c$ | tan. $A=\frac{a}{b}$, cot. $B=\frac{a}{b}$, $c=\sqrt{a^2+b^2}$ |
| $A, a$ | $B, b, c$ | $B=90°-A$, $b=a$ cot. $A$, $c=\frac{a}{\text{sin. } A}$ |
| $A, b$ | $B, a, c$ | $B=90°-A$, $a=b$ tan. $A$, $c=\frac{b}{\text{cos. } A}$ |
| $A, c$ | $B, a, b$ | $B=90°-A$, $a=c$ sin. $A$, $b=c$ cos. $A$ |
| **Given** | **Sought.** | **Oblique triangles. See fig. (b)** |
| $A, B, a$ | $b$ | $b=\frac{a \text{ sin. } B}{\text{sin. } A}$ |
| $A, a, b$ | $B$ | sin. $B=\frac{b \text{ sin. } A}{a}$ |
| $a, b, C$ | $A-B$ | tan. $\tfrac{1}{2}(A-B)=\frac{a-b \text{ tan. } \frac{1}{2}(A+B)}{a+b}$ |
| $c, b, c$ | $A$ | If $s=\tfrac{1}{2}(a+b+c)$, sin. $\tfrac{1}{2}A=\sqrt{\frac{(s-b)(s-c)}{bc}}$, cos. $\tfrac{1}{2}A=\sqrt{\frac{s(s-a)}{bc}}$, tan. $\tfrac{1}{2}A=\sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$, sin. $A=\frac{2\sqrt{(s-a)(s-b)(s-c)s}}{bc}$ |
| $A, B, C, a$ | area | area$=\frac{a^2 \text{ sin. } B \text{ sin. } C}{2 \text{ sin. } A}$ |
| $A, b, c$ | area | area$=\tfrac{1}{2} bc$ sin. $A$ |
| $a, b, c$ | area | $s=\tfrac{1}{2}(a+b+c)$, area$=\sqrt{s(s-a)(s-b)(s-c)}$ |

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## Table VIII.—Natural Trigonometrical Functions.

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **0** | 0 | 0 | 00 | 1 | **90** |
| 10 | .0029 | .0029 | 343.8 | I | 50 |
| 20 | .0058 | .0058 | 171.9 | .99998 | 40 |
| 30 | .0087 | .0087 | 114.6 | .99996 | 30 |
| 40 | .0116 | .0116 | 85.94 | .99993 | 20 |
| 50 | .0145 | .0145 | 68.75 | .99989 | 10 |
| **1** | .0175 | .0175 | 57.29 | .99985 | **89** |
| 10 | .0204 | .0204 | 49.10 | .99979 | 50 |
| 20 | .0233 | .0233 | 42.96 | .99973 | 40 |
| 30 | .0262 | .0262 | 38.19 | .99966 | 30 |
| 40 | .0291 | .0291 | 34.37 | .99958 | 20 |
| 50 | .0320 | .0320 | 31.24 | .99949 | 10 |
| **2** | .0349 | .0349 | 28.64 | .99939 | **88** |
| 10 | .0378 | .0378 | 26.43 | .99929 | 50 |
| 20 | .0407 | .0407 | 24.54 | .99917 | 40 |
| 30 | .0436 | .0437 | 22.90 | .99905 | 30 |
| 40 | .0465 | .0466 | 21.47 | .99892 | 20 |
| 50 | .0494 | .0495 | 20.21 | .99878 | 10 |
| **3** | .0523 | .0524 | 19.08 | .99863 | **87** |
| 10 | .0552 | .0553 | 18.07 | .99847 | 50 |
| 20 | .0581 | .0582 | 17.17 | .99831 | 40 |
| 30 | .0610 | .0612 | 16.35 | .99813 | 30 |
| 40 | .0640 | .0641 | 15.60 | .99795 | 20 |
| 50 | .0669 | .0670 | 14.92 | .99776 | 10 |
| **4** | .0698 | .0699 | 14.30 | .99756 | **86** |
| 10 | .0727 | .0729 | 13.73 | .99736 | 50 |
| 20 | .0756 | .0758 | 13.20 | .99714 | 40 |
| 30 | .0785 | .0787 | 12.71 | .99692 | 30 |
| 40 | .0814 | .0816 | 12.25 | .99668 | 20 |
| 50 | .0843 | .0846 | 11.83 | .99644 | 10 |
| **5** | .0872 | .0875 | 11.43 | .99619 | **85** |
| 10 | .0901 | .0904 | 11.06 | .99594 | 50 |
| 20 | .0929 | .0934 | 10.71 | .99567 | 40 |
| 30 | .0958 | .0963 | 10.39 | .99540 | 30 |
| 40 | .0987 | .0992 | 10.08 | .99511 | 20 |
| 50 | .1016 | .1022 | 9.788 | .99482 | 10 |
| **6** | .1045 | .1051 | 9.514 | .99452 | **84** |
| 10 | .1074 | .1080 | 9.255 | .99421 | 50 |
| 20 | .1103 | .1110 | 9.010 | .99390 | 40 |
| 30 | .1132 | .1139 | 8.777 | .99357 | 30 |
| 40 | .1161 | .1169 | 8.556 | .99324 | 20 |
| 50 | .1190 | .1198 | 8.345 | .99290 | 10 |
| **7** | .1219 | .1228 | 8.144 | .99255 | **83** |
| 10 | .1248 | .1257 | 7.953 | .99219 | 50 |
| 20 | .1276 | .1287 | 7.770 | .99182 | 40 |
| 30 | .1305 | .1317 | 7.596 | .99144 | 30 |
| 40 | .1334 | .1346 | 7.429 | .99106 | 20 |
| 50 | .1363 | .1376 | 7.269 | .99067 | 10 |
| | | | | | **82** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **8** | .1392 | .1405 | 7.115 | .99027 | **82** |
| 10 | .1421 | .1435 | 6.968 | .98986 | 50 |
| 20 | .1449 | .1465 | 6.827 | .98944 | 40 |
| 30 | .1478 | .1495 | 6.691 | .98902 | 30 |
| 40 | .1507 | .1524 | 6.561 | .98858 | 20 |
| 50 | .1536 | .1554 | 6.435 | .98814 | 10 |
| **9** | .1564 | .1584 | 6.314 | .98769 | **81** |
| 10 | .1593 | .1614 | 6.197 | .98723 | 50 |
| 20 | .1622 | .1644 | 6.084 | .98676 | 40 |
| 30 | .1650 | .1673 | 5.976 | .98629 | 30 |
| 40 | .1679 | .1703 | 5.871 | .98580 | 20 |
| 50 | .1708 | .1733 | 5.769 | .98531 | 10 |
| **10** | .1736 | .1763 | 5.671 | .98481 | **80** |
| 10 | .1765 | .1793 | 5.576 | .98430 | 50 |
| 20 | .1794 | .1823 | 5.485 | .98378 | 40 |
| 30 | .1822 | .1853 | 5.396 | .98325 | 30 |
| 40 | .1851 | .1883 | 5.309 | .98272 | 20 |
| 50 | .1880 | .1914 | 5.226 | .98218 | 10 |
| **11** | .1908 | .1944 | 5.145 | .98163 | **79** |
| 10 | .1937 | .1974 | 5.066 | .98107 | 50 |
| 20 | .1965 | .2004 | 4.989 | .98050 | 40 |
| 30 | .1994 | .2035 | 4.915 | .97992 | 30 |
| 40 | .2022 | .2065 | 4.843 | .97934 | 20 |
| 50 | .2051 | .2095 | 4.773 | .97875 | 10 |
| **12** | .2079 | .2126 | 4.705 | .97815 | **78** |
| 10 | .2108 | .2156 | 4.638 | .97754 | 50 |
| 20 | .2136 | .2186 | 4.574 | .97692 | 40 |
| 30 | .2164 | .2217 | 4.511 | .97630 | 30 |
| 40 | .2193 | .2247 | 4.449 | .97566 | 20 |
| 50 | .2221 | .2278 | 4.390 | .97502 | 10 |
| **13** | .2250 | .2309 | 4.331 | .97437 | **77** |
| 10 | .2278 | .2339 | 4.275 | .97371 | 50 |
| 20 | .2306 | .2370 | 4.219 | .97304 | 40 |
| 30 | .2334 | .2401 | 4.165 | .97237 | 30 |
| 40 | .2363 | .2432 | 4.113 | .97169 | 20 |
| 50 | .2391 | .2462 | 4.061 | .97100 | 10 |
| **14** | .2419 | .2493 | 4.011 | .97030 | **76** |
| 10 | .2447 | .2524 | 3.962 | .96959 | 50 |
| 20 | .2476 | .2555 | 3.914 | .96887 | 40 |
| 30 | .2504 | .2586 | 3.867 | .96815 | 30 |
| 40 | .2532 | .2617 | 3.821 | .96742 | 20 |
| 50 | .2560 | .2648 | 3.776 | .96667 | 10 |
| **15** | .2588 | .2679 | 3.732 | .96593 | **75** |
| 10 | .2616 | .2711 | 3.689 | .96517 | 50 |
| 20 | .2644 | .2742 | 8.647 | .96440 | 40 |
| 30 | .2672 | .2773 | 3.606 | .96363 | 30 |
| 40 | .2700 | .2805 | 3.566 | .96285 | 20 |
| 50 | .2728 | .2836 | 3.526 | .96206 | 10 |
| | | | | | **74** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |



## Table VIII.—Natural Trigonometrical Functions.

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **16** | .2756 | .2867 | 3.487 | .96126 | **74** |
| 10 | .2784 | .2899 | 3.450 | .96046 | 50 |
| 20 | .2812 | .2931 | 3.412 | .95964 | 40 |
| 30 | .2840 | .2962 | 3.376 | .95882 | 30 |
| 40 | .2868 | .2994 | 3.340 | .95799 | 20 |
| 50 | .2896 | .3026 | 3.305 | .95715 | 10 |
| **17** | .2924 | .3057 | 3.271 | .95615 | **73** |
| 10 | .2952 | .3089 | 3.237 | .95545 | 50 |
| 20 | .2979 | .3121 | 3.204 | .95459 | 40 |
| 30 | .3007 | .3153 | 3.172 | .95372 | 30 |
| 40 | .3035 | .3185 | 3.140 | .95284 | 20 |
| 50 | .3062 | .3217 | 3.108 | .95195 | 10 |
| **18** | .3090 | .3249 | 3.078 | .95106 | **72** |
| 10 | .3118 | .3281 | 3.048 | .95015 | 50 |
| 20 | .3145 | .3314 | 3.018 | .94924 | 40 |
| 30 | .3173 | .3346 | 2.989 | .94832 | 30 |
| 40 | .3201 | .3378 | 2.960 | .94740 | 20 |
| 50 | .3228 | .3411 | 2.932 | .94646 | 10 |
| **19** | .3256 | .3443 | 2.904 | .94552 | **71** |
| 10 | .3283 | .3476 | 2.877 | .94457 | 50 |
| 20 | .3311 | .3508 | 2.850 | .94361 | 40 |
| 30 | .3338 | .3541 | 2.824 | .94264 | 30 |
| 40 | .3365 | .3574 | 2.798 | .94167 | 20 |
| 50 | .3393 | .3607 | 2.773 | .94068 | 10 |
| **20** | .3420 | .3640 | 2.747 | .93969 | **70** |
| 10 | .3448 | .3673 | 2.723 | .93869 | 50 |
| 20 | .3475 | .3706 | 2.699 | .93769 | 40 |
| 30 | .3502 | .3739 | 2.675 | .93667 | 30 |
| 40 | .3529 | .3772 | 2.651 | .93565 | 20 |
| 50 | .3557 | .3805 | 2.628 | .93462 | 10 |
| **21** | .3584 | .3839 | 2.605 | .93358 | **69** |
| 10 | .3611 | .3872 | 2.583 | .93253 | 50 |
| 20 | .3638 | .3906 | 2.560 | .93148 | 40 |
| 30 | .3665 | .3939 | 2.539 | .93042 | 30 |
| 40 | .3692 | .3973 | 2.517 | .92935 | 20 |
| 50 | .3719 | .4006 | 2.496 | .92827 | 10 |
| **22** | .3746 | .4040 | 2.475 | .92718 | **68** |
| 10 | .3773 | .4074 | 2.455 | .92609 | 50 |
| 20 | .3800 | .4108 | 2.434 | .92499 | 40 |
| 30 | .3827 | .4142 | 2.414 | .92388 | 30 |
| 40 | .3854 | .4176 | 2.394 | .92276 | 20 |
| 50 | .3881 | .4210 | 2.375 | .92164 | 10 |
| **23** | .3907 | .4245 | 2.356 | .92050 | **67** |
| 10 | .3934 | .4279 | 2.337 | .91936 | 50 |
| 20 | .3961 | .4314 | 2.318 | .91822 | 40 |
| 30 | .3987 | .4348 | 2.300 | .91706 | 30 |
| 40 | .4014 | .4383 | 2.282 | .91590 | 20 |
| 50 | .4041 | .4417 | 2.264 | .91472 | 10 |
| | | | | | **66** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **24** | .4067 | .4452 | 2.246 | .91355 | **66** |
| 10 | .4094 | .4487 | 2.229 | .91236 | 50 |
| 20 | .4120 | .4522 | 2.211 | .91116 | 40 |
| 30 | .4147 | .4557 | 2.194 | .90996 | 30 |
| 40 | .4173 | .4592 | 2.177 | .90875 | 20 |
| 50 | .4200 | .4628 | 2.161 | .90753 | 10 |
| **25** | .4226 | .4663 | 2.145 | .90631 | **65** |
| 10 | .4253 | .4699 | 2.128 | .90507 | 50 |
| 20 | .4279 | .4734 | 2.112 | .90383 | 40 |
| 30 | .4305 | .4770 | 2.097 | .90259 | 30 |
| 40 | .4331 | .4806 | 2.081 | .90133 | 20 |
| 50 | .4358 | .4841 | 2.066 | .90007 | 10 |
| **26** | .4384 | .4877 | 2.050 | .89879 | **64** |
| 10 | .4410 | .4913 | 2.035 | .89752 | 50 |
| 20 | .4436 | .4950 | 2.020 | .89623 | 40 |
| 30 | .4462 | .4986 | 2.006 | .89493 | 30 |
| 40 | .4488 | .5022 | 1.991 | .89363 | 20 |
| 50 | .4514 | .5059 | 1.977 | .89232 | 10 |
| **27** | .4540 | .5095 | 1.963 | .89101 | **63** |
| 10 | .4566 | .5132 | 1.949 | .88968 | 50 |
| 20 | .4592 | .5169 | 1.935 | .88835 | 40 |
| 30 | .4617 | .5206 | 1.921 | .88701 | 30 |
| 40 | .4643 | .5243 | 1.907 | .88566 | 20 |
| 50 | .4669 | .5280 | 1.894 | .88431 | 10 |
| **28** | .4695 | .5317 | 1.881 | .88295 | **62** |
| 10 | .4720 | .5354 | 1.868 | .88158 | 50 |
| 20 | .4746 | .5392 | 1.855 | .88020 | 40 |
| 30 | .4772 | .5430 | 1.842 | .87882 | 30 |
| 40 | .4797 | .5467 | 1.829 | .87743 | 20 |
| 50 | .4823 | .5505 | 1.816 | .87603 | 10 |
| **29** | .4848 | .5543 | 1.804 | .87462 | **61** |
| 10 | .4874 | .5581 | 1.792 | .87321 | 50 |
| 20 | .4899 | .5619 | 1.780 | .87178 | 40 |
| 30 | .4924 | .5658 | 1.767 | .87036 | 30 |
| 40 | .4950 | .5696 | 1.756 | .86892 | 20 |
| 50 | .4975 | .5735 | 1.744 | .86748 | 10 |
| **30** | .5000 | .5774 | 1.732 | .86603 | **60** |
| 10 | .5025 | .5812 | 1.720 | .86457 | 50 |
| 20 | .5050 | .5851 | 1.709 | .86310 | 40 |
| 30 | .5075 | .5890 | 1.698 | .86163 | 30 |
| 40 | .5100 | .5930 | 1.686 | .86015 | 20 |
| 50 | .5125 | .5969 | 1.675 | .85866 | 10 |
| **31** | .5150 | .6009 | 1.664 | .85717 | **59** |
| 10 | .5175 | .6048 | 1.653 | .85567 | 50 |
| 20 | .5200 | .6088 | 1.643 | .85416 | 40 |
| 30 | .5225 | .6128 | 1.632 | .85264 | 30 |
| 40 | .5250 | .6168 | 1.621 | .85112 | 20 |
| 50 | .5275 | .6208 | 1.611 | .84959 | 10 |
| | | | | | **58** |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

## Table VIII.—Natural Trigonometrical Functions.

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| **32** | .5299 | .6249 | 1.600 | .84805 | **58** |
| 10 | .5324 | .6289 | 1.590 | .84650 | 50 |
| 20 | .5348 | .6330 | 1.580 | .84495 | 40 |
| 30 | .5373 | .6371 | 1.570 | .84339 | 30 |
| 40 | .5398 | .6412 | 1.560 | .84182 | 20 |
| 50 | .5422 | .6453 | 1.550 | .84025 | 10 |
| **33** | .5446 | .6494 | 1.540 | .83867 | **57** |
| 10 | .5471 | .6536 | 1.530 | .83708 | 50 |
| 20 | .5495 | .6577 | 1.520 | .83549 | 40 |
| 30 | .5519 | .6619 | 1.511 | .83389 | 30 |
| 40 | .5544 | .6661 | 1.501 | .83228 | 20 |
| 50 | .5568 | .6703 | 1.492 | .83066 | 10 |
| **34** | .5592 | .6745 | 1.483 | .82904 | **56** |
| 10 | .5616 | .6787 | 1.473 | .82741 | 50 |
| 20 | .5640 | .6830 | 1.464 | .82577 | 40 |
| 30 | .5664 | .6873 | 1.455 | .82413 | 30 |
| 40 | .5688 | .6916 | 1.446 | .82248 | 20 |
| 50 | .5712 | .6959 | 1.437 | .82082 | 10 |
| **35** | .5736 | .7002 | 1.428 | .81915 | **55** |
| 10 | .5760 | .7046 | 1.419 | .81748 | 50 |
| 20 | .5783 | .7089 | 1.411 | .81580 | 40 |
| 30 | .5807 | .7133 | 1.402 | .81412 | 30 |
| 40 | .5831 | .7177 | 1.393 | .81242 | 20 |
| 50 | .5854 | .7221 | 1.385 | .81072 | 10 |
| **36** | .5878 | .7265 | 1.376 | .80902 | **54** |
| 10 | .5901 | .7310 | 1.368 | .80730 | 50 |
| 20 | .5925 | .7355 | 1.360 | .80558 | 40 |
| 30 | .5948 | .7400 | 1.351 | .80386 | 30 |
| 40 | .5972 | .7445 | 1.343 | .80212 | 20 |
| 50 | .5995 | .7490 | 1.335 | .80038 | 10 |
| **37** | .6018 | .7536 | 1.327 | .79864 | **53** |
| 10 | .6041 | .7581 | 1.319 | .79688 | 50 |
| 20 | .6065 | .7627 | 1.311 | .79512 | 40 |
| 30 | .6088 | .7673 | 1.303 | .79335 | 30 |
| 40 | .6111 | .7720 | 1.295 | .79158 | 20 |
| 50 | .6134 | .7766 | 1.288 | .78980 | 10 |
| **38** | .6157 | .7813 | 1.280 | .78801 | **52** |
| 10 | .6180 | .7860 | 1.272 | .78622 | 50 |
| 20 | .6202 | .7907 | 1.265 | .78442 | 40 |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |

| Angle | Sine. | Tan. | Cotg. | Cosin. | |
|---|---|---|---|---|---|
| ° ′ | | | | | |
| 30 | .6225 | .7954 | 1.257 | .78261 | 30 |
| 40 | .6248 | .8002 | 1.250 | .78079 | 20 |
| 50 | .6271 | .8050 | 1.242 | .77897 | 10 |
| **39** | .6293 | .8098 | 1.235 | .77715 | **51** |
| 10 | .6316 | .8146 | 1.228 | .77531 | 50 |
| 20 | .6338 | .8195 | 1.220 | .77347 | 40 |
| 30 | .6361 | .8243 | 1.213 | .77162 | 30 |
| 40 | .6383 | .8292 | 1.206 | .76977 | 20 |
| 50 | .6406 | .8342 | 1.199 | .76791 | 10 |
| **40** | .6428 | .8391 | 1.192 | .76604 | **50** |
| 10 | .6450 | .8441 | 1.185 | .76417 | 50 |
| 20 | .6472 | .8491 | 1.178 | .76229 | 40 |
| 30 | .6494 | .8541 | 1.171 | .76041 | 30 |
| 40 | .6517 | .8591 | 1.164 | .75851 | 20 |
| 50 | .6539 | .8642 | 1.157 | .75661 | 10 |
| **41** | .6561 | .8693 | 1.150 | .75471 | **49** |
| 10 | .6583 | .8744 | 1.144 | .75280 | 50 |
| 20 | .6604 | .8796 | 1.137 | .75088 | 40 |
| 30 | .6626 | .8847 | 1.130 | .74896 | 30 |
| 40 | .6648 | .8899 | 1.124 | .74703 | 20 |
| 50 | .6670 | .8952 | 1.117 | .74509 | 10 |
| **42** | .6691 | .9004 | 1.111 | .74314 | **48** |
| 10 | .6713 | .9057 | 1.104 | .74120 | 50 |
| 20 | .6734 | .9110 | 1.098 | .73924 | 40 |
| 30 | .6756 | .9163 | 1.091 | .73728 | 30 |
| 40 | .6777 | .9217 | 1.085 | .73531 | 20 |
| 50 | .6799 | .9271 | 1.079 | .73333 | 10 |
| **43** | .6820 | .9325 | 1.072 | .73135 | **47** |
| 10 | .6841 | .9380 | 1.066 | .72937 | 50 |
| 20 | .6862 | .9435 | 1.060 | .72737 | 40 |
| 30 | .6884 | .9490 | 1.054 | .72537 | 30 |
| 40 | .6905 | .9545 | 1.048 | .72337 | 20 |
| 50 | .6926 | .9601 | 1.042 | .72136 | 10 |
| **44** | .6947 | .9657 | 1.036 | .71934 | **46** |
| 10 | .6967 | .9713 | 1.030 | .71732 | 50 |
| 20 | .6988 | .9770 | 1.024 | .71529 | 40 |
| 30 | .7009 | .9827 | 1.018 | .71325 | 30 |
| 40 | .7030 | .9884 | 1.012 | .71121 | 20 |
| 50 | .7050 | .9942 | 1.006 | .70916 | 10 |
| | .7071 | .1 | 1. | .70711 | **45** |
| | | | | | ° ′ |
| | Cosin. | Cotg. | Tan. | Sine. | Angle |



## Table IX.—Calculation of Earthwork.

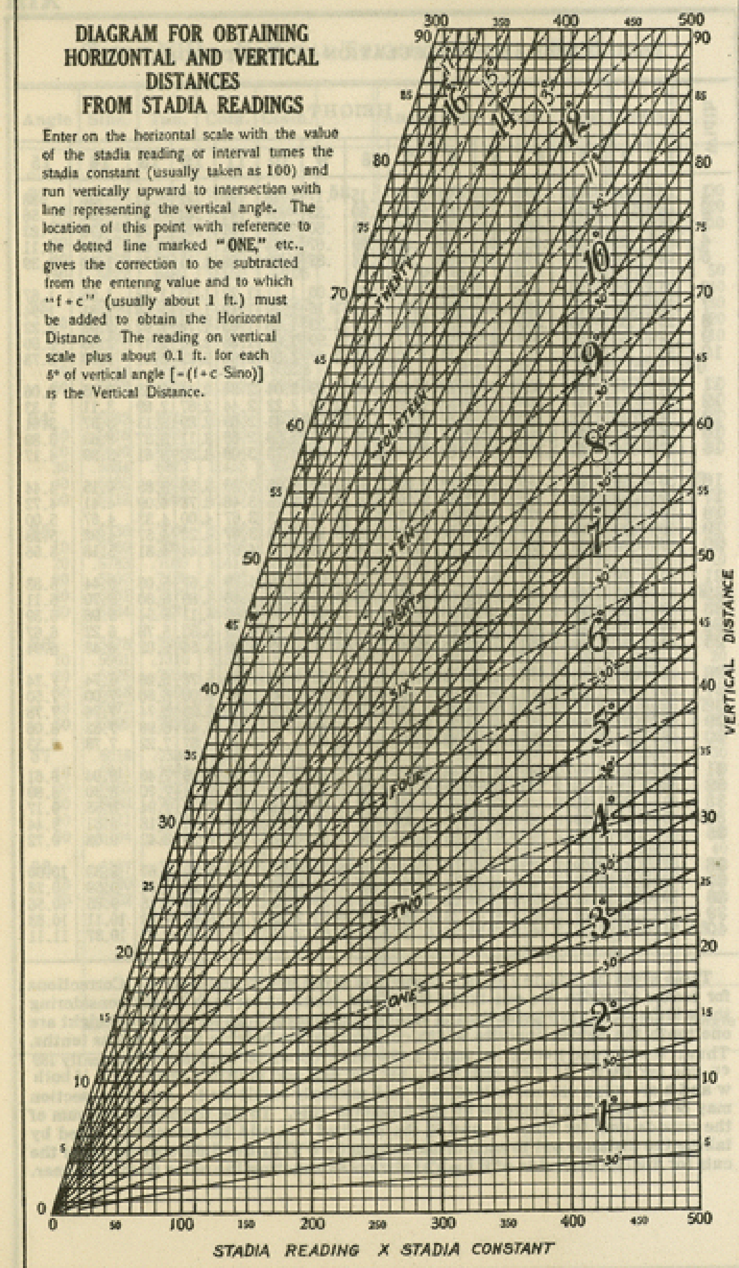
| Width | HEIGHT | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| **1** | .02 | .04 | .06 | .07 | .09 | .11 | .13 | .15 | .17 | .18 | .20 | .22 | .24 | .26 | .28 |
| **2** | .04 | .07 | .11 | .15 | .18 | .22 | .26 | .30 | .33 | .37 | .41 | .44 | .48 | .52 | .56 |
| **3** | .06 | .11 | .17 | .22 | .28 | .33 | .39 | .44 | .50 | .56 | .61 | .67 | .72 | .78 | .83 |
| **4** | .07 | .15 | .22 | .30 | .37 | .44 | .52 | .59 | .67 | .74 | .81 | .89 | .96 | 1.04 | 1.11 |
| **5** | .09 | .19 | .28 | .37 | .46 | .56 | .65 | .74 | .83 | .93 | 1.02 | 1.11 | 1.20 | 1.30 | 1.39 |
| **6** | .11 | .22 | .33 | .44 | .56 | .67 | .78 | .89 | 1.00 | 1.11 | 1.22 | 1.33 | 1.44 | 1.55 | 1.67 |
| **7** | .13 | .26 | .39 | .52 | .65 | .78 | .91 | 1.04 | 1.16 | 1.30 | 1.42 | 1.55 | 1.68 | 1.81 | 1.94 |
| **8** | .15 | .30 | .44 | .59 | .74 | .89 | 1.04 | 1.19 | 1.33 | 1.48 | 1.63 | 1.78 | 1.92 | 2.08 | 2.22 |
| **9** | .17 | .33 | .50 | .67 | .83 | 1.00 | 1.17 | 1.33 | 1.50 | 1.67 | 1.83 | 2.00 | 2.17 | 2.33 | 2.50 |
| **10** | .18 | .37 | .56 | .74 | .93 | 1.11 | 1.30 | 1.48 | 1.67 | 1.85 | 2.04 | 2.22 | 2.41 | 2.59 | 2.78 |
| **11** | .20 | .41 | .61 | .82 | 1.02 | 1.22 | 1.43 | 1.63 | 1.83 | 2.04 | 2.24 | 2.44 | 2.65 | 2.85 | 3.06 |
| **12** | .22 | .44 | .67 | .89 | 1.11 | 1.33 | 1.56 | 1.78 | 2.00 | 2.22 | 2.44 | 2.67 | 2.89 | 3.11 | 3.33 |
| **13** | .24 | .48 | .72 | .96 | 1.20 | 1.44 | 1.68 | 1.92 | 2.16 | 2.41 | 2.65 | 2.89 | 3.13 | 3.37 | 3.61 |
| **14** | .26 | .52 | .78 | 1.04 | 1.30 | 1.55 | 1.81 | 2.08 | 2.33 | 2.59 | 2.85 | 3.11 | 3.37 | 3.63 | 3.89 |
| **15** | .28 | .56 | .83 | 1.11 | 1.39 | 1.67 | 1.94 | 2.22 | 2.50 | 2.78 | 3.06 | 3.33 | 3.61 | 3.89 | 4.17 |
| **16** | .30 | .59 | .89 | 1.18 | 1.48 | 1.78 | 2.07 | 2.37 | 2.67 | 2.96 | 3.26 | 3.56 | 3.85 | 4.15 | 4.44 |
| **17** | .31 | .63 | .94 | 1.26 | 1.57 | 1.89 | 2.20 | 2.52 | 2.83 | 3.15 | 3.46 | 3.78 | 4.09 | 4.41 | 4.72 |
| **18** | .33 | .67 | 1.00 | 1.33 | 1.67 | 2.00 | 2.33 | 2.67 | 3.00 | 3.33 | 3.67 | 4.00 | 4.33 | 4.67 | 5.00 |
| **19** | .35 | .70 | 1.06 | 1.41 | 1.76 | 2.11 | 2.46 | 2.82 | 3.17 | 3.52 | 3.87 | 4.22 | 4.57 | 4.92 | 5.28 |
| **20** | .37 | .74 | 1.11 | 1.48 | 1.85 | 2.22 | 2.59 | 2.96 | 3.33 | 3.70 | 4.07 | 4.44 | 4.81 | 5.18 | 5.56 |
| **21** | .39 | .78 | 1.17 | 1.55 | 1.94 | 2.33 | 2.72 | 3.11 | 3.50 | 3.89 | 4.28 | 4.67 | 5.06 | 5.44 | 5.83 |
| **22** | .41 | .81 | 1.22 | 1.63 | 2.04 | 2.44 | 2.85 | 3.26 | 3.67 | 4.07 | 4.48 | 4.89 | 5.30 | 5.70 | 6.11 |
| **23** | .43 | .85 | 1.28 | 1.70 | 2.13 | 2.56 | 2.98 | 3.41 | 3.83 | 4.26 | 4.68 | 5.11 | 5.54 | 5.96 | 6.39 |
| **24** | .44 | .89 | 1.33 | 1.78 | 2.22 | 2.67 | 3.11 | 3.56 | 4.00 | 4.44 | 4.89 | 5.33 | 5.78 | 6.22 | 6.67 |
| **25** | .46 | .92 | 1.39 | 1.85 | 2.31 | 2.78 | 3.24 | 3.70 | 4.17 | 4.63 | 5.09 | 5.56 | 6.02 | 6.48 | 6.94 |
| **26** | .48 | .96 | 1.44 | 1.92 | 2.41 | 2.89 | 3.37 | 3.85 | 4.33 | 4.82 | 5.30 | 5.78 | 6.26 | 6.74 | 7.24 |
| **27** | .50 | 1.00 | 1.50 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 |
| **28** | .52 | 1.04 | 1.55 | 2.07 | 2.59 | 3.11 | 3.63 | 4.15 | 4.67 | 5.18 | 5.70 | 6.22 | 6.74 | 7.26 | 7.78 |
| **29** | .54 | 1.07 | 1.61 | 2.15 | 2.68 | 3.22 | 3.76 | 4.30 | 4.83 | 5.37 | 5.91 | 6.44 | 6.98 | 7.52 | 8.06 |
| **30** | .56 | 1.11 | 1.67 | 2.22 | 2.78 | 3.33 | 3.89 | 4.44 | 5.00 | 5.55 | 6.11 | 6.67 | 7.22 | 7.78 | 8.33 |
| **31** | .57 | 1.15 | 1.72 | 2.30 | 2.87 | 3.44 | 4.02 | 4.59 | 5.17 | 5.74 | 6.32 | 6.89 | 7.46 | 8.04 | 8.61 |
| **32** | .59 | 1.18 | 1.78 | 2.37 | 2.96 | 3.56 | 4.15 | 4.74 | 5.33 | 5.92 | 6.52 | 7.11 | 7.70 | 8.30 | 8.89 |
| **33** | .61 | 1.22 | 1.83 | 2.44 | 3.05 | 3.67 | 4.28 | 4.89 | 5.50 | 6.11 | 6.72 | 7.33 | 7.94 | 8.55 | 9.17 |
| **34** | .63 | 1.26 | 1.89 | 2.52 | 3.15 | 3.78 | 4.40 | 5.04 | 5.67 | 6.29 | 6.93 | 7.56 | 8.18 | 8.81 | 9.44 |
| **35** | .65 | 1.30 | 1.94 | 2.59 | 3.24 | 3.89 | 4.53 | 5.18 | 5.83 | 6.48 | 7.13 | 7.78 | 8.42 | 9.08 | 9.72 |
| **36** | .67 | 1.33 | 2.00 | 2.67 | 3.33 | 4.00 | 4.66 | 5.33 | 6.00 | 6.67 | 7.33 | 8.00 | 8.67 | 9.33 | 10.00 |
| **37** | .68 | 1.37 | 2.06 | 2.74 | 3.42 | 4.11 | 4.79 | 5.48 | 6.17 | 6.85 | 7.54 | 8.22 | 8.91 | 9.59 | 10.28 |
| **38** | .70 | 1.41 | 2.11 | 2.82 | 3.52 | 4.22 | 4.92 | 5.63 | 6.33 | 7.03 | 7.74 | 8.44 | 9.15 | 9.85 | 10.56 |
| **39** | .72 | 1.44 | 2.17 | 2.89 | 3.61 | 4.33 | 5.05 | 5.78 | 6.50 | 7.22 | 7.95 | 8.67 | 9.39 | 10.11 | 10.83 |
| **40** | .74 | 1.48 | 2.22 | 2.96 | 3.70 | 4.44 | 5.18 | 5.92 | 6.67 | 7.41 | 8.15 | 8.89 | 9.63 | 10.37 | 11.11 |

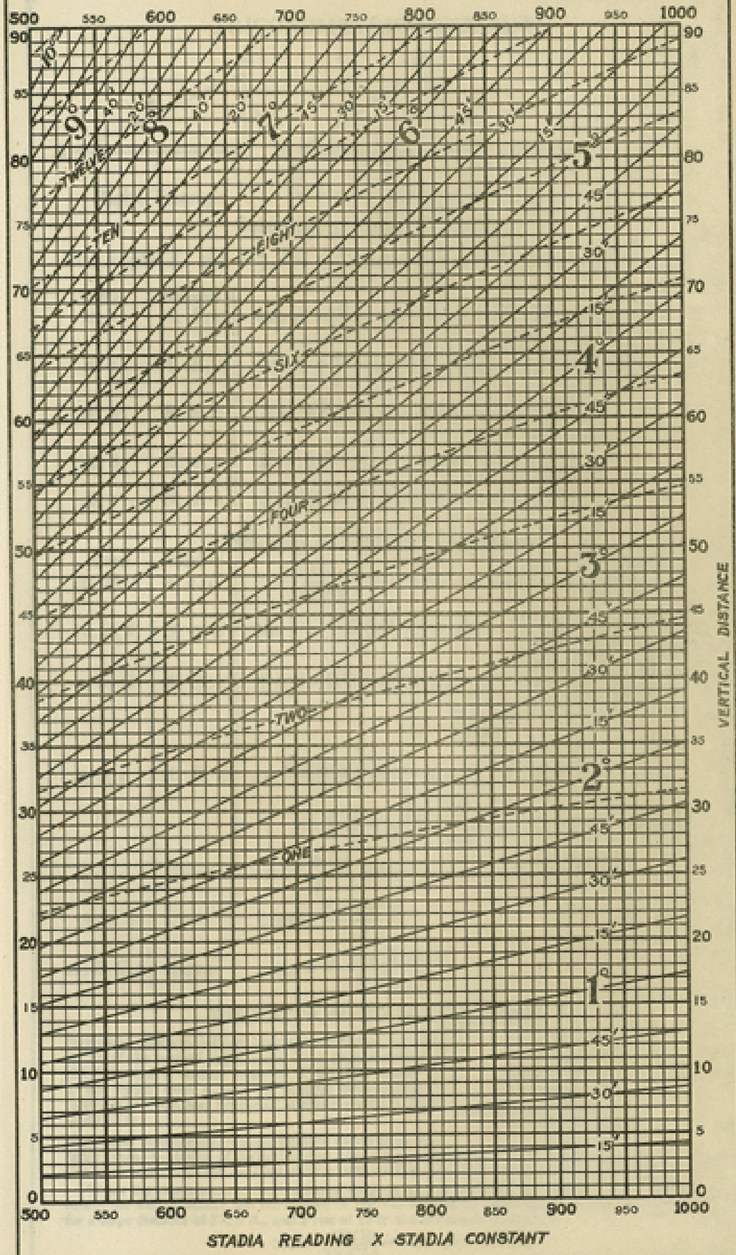
**Table gives cu. yds. in 1 ft. of a triangle of given width and height. Corrections for tenths of width are one tenth the values found under each height considering the widths from 1 to 9 as tenths and similarly the corrections for tenths of height are one tenth the figures opposite width considering the heights from 1 to 9 as tenths. Thus if w = 16.2 and h = 5.3, cu. yds. = 1.48 + .018 + .089 = 1.587 cu. yds. or practically 159 cu. yds. per 100 ft. If w exceeds 40 ft., use one half and multiply result by 2, if both w and h are large use one half of each and multiply result by 4. Any cross-section may be divided into triangles by the following rule. To the triangle of the sum of the outside cuts (or fills) = h, and ½ the roadbed = w, add the triangles formed by taking the distance out to each break in turn ( = w's) by the difference between the cuts (or fills) on each side of it ( = h's) always subtracting the outer from the inner.**

counter 42324

## DIAGRAM FOR OBTAINING HORIZONTAL AND VERTICAL DISTANCES FROM STADIA READINGS

Enter on the horizontal scale with the value of the stadia reading or interval times the stadia constant (usually taken as 100) and run vertically upward to intersection with line representing the vertical angle. The location of this point with reference to the dotted line marked "ONE," etc., gives the correction to be subtracted from the entering value and to which "f + c" (usually about 1 ft.) must be added to obtain the Horizontal Distance. The reading on vertical scale plus about 0.1 ft. for each 5° of vertical angle [= (f + c Sinα)] is the Vertical Distance.

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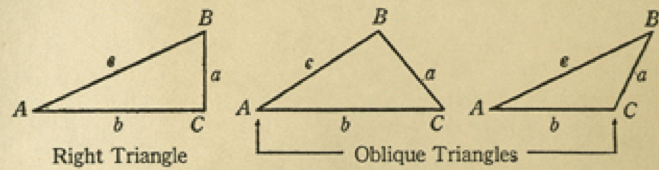
# TRIGONOMETRIC FORMULÆ




## Solution of Right Triangles

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

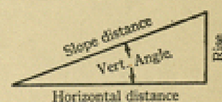
| Given | Required | |
|---|---|---|
| $a, b$ | $A, B, c$ | $\tan A = \frac{a}{b} = \cot B$, $c = \sqrt{a^2+b^2} = a\sqrt{1+\frac{b^2}{a^2}}$ |
| $a, c$ | $A, B, b$ | $\sin A = \frac{a}{c} = \cos B$, $b = \sqrt{(c+a)(c-a)} = c\sqrt{1-\frac{a^2}{c^2}}$ |
| $A, a$ | $B, b, c$ | $B = 90° - A$, $b = a \cot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

## Solution of Oblique Triangles

| Given | Required | |
|---|---|---|
| $A, B, a$ | $b, c, C$ | $b = \frac{a \sin B}{\sin A}$, $C = 180° - (A+B)$, $c = \frac{a \sin C}{\sin A}$ |
| $A, a, b$ | $B, c, C$ | $\sin B = \frac{b \sin A}{a}$, $C = 180° - (A+B)$, $c = \frac{a \sin C}{\sin A}$ |
| $a, b, C$ | $A, B, c$ | $A+B = 180° - C$, $\tan \frac{1}{2}(A-B) = \frac{(a-b)\tan\frac{1}{2}(A+B)}{a+b}$, $c = \frac{a \sin C}{\sin A}$ |
| $a, b, c$ | $A, B, C$ | $s = \frac{a+b+c}{2}$, $\sin \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{bc}}$, $\sin \frac{1}{2} B = \sqrt{\frac{(s-a)(s-c)}{ac}}$, $C = 180° - (A+B)$ |
| $a, b, c$ | Area | $s = \frac{a+b+c}{2}$, $\text{area} = \sqrt{s(s-a)(s-b)(s-c)}$ |
| $A, b, c$ | Area | $\text{area} = \frac{bc \sin A}{2}$ |
| $A, B, C, a$ | 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, for a slope distance of 403.6 ft. and a vertical angle of 4° 40′—the cosine of 4° 40′, taken from a table of natural trigonometrical functions, = .9967, and horizontal distance = 403.6 x .9967 = 402.27 ft.




Horizontal distance also = Slope distance minus slope distance times (1 − cosine of vertical angle). Using the same figures as in the preceding example — Cos. 4° 40′ = .9967. 1 − .9967 = .0033. 403.6 x .0033 = 1.33 ft. Horizontal dist. = 403.6 − 1.33 = 402.27 ft.

When the rise is known, the horizontal distance may be found by the following approximate rule:— the slope distance less the square of the rise divided by twice the slope distance. Thus, for a slope distance of 372.5 ft., and a rise of 15 ft. the horizontal distance =

$$372.5 - \frac{15 \times 15}{2 \times 372.5} = 372.5 - .30 = 372.2 \text{ ft.}$$



counter 42326

19
15
95
19
285

counter 42327