SIGHT DISTANCE
DRIVEWAYS

403N

DIETZGEN

CHAPTER 112
PRIMARY ROAD ACCESS CONTROL

[Prior to 6/3/87, Transportation Department(820)—(06,C)Ch 1]

761—112.1(306A) Statement of policy. The efficiency and safety of a highway depend to a large extent upon the amount and character of interruptions to the movement of traffic. The primary cause of these interruptions is vehicular movements to and from businesses, residences, and other developments along the highway. Regulation and overall control of highway access are necessary to provide efficient and safe highway operation and to utilize the full potential of the highway investment.

Accordingly, the department hereby establishes rules for control of access to primary roads.

112.1(1) When applying these rules to a particular access situation, the department shall consider the following:

a. Safety to the traveling public.

b. Perpetuation of the traffic-carrying capacity of the highway.

c. The impact upon the economy of the state.

d. Protection of the rights of the traveling public and of property owners, including the rights of abutting property owners.

112.1(2) The department reserves the right to make exceptions to these rules where the exercise of sound and reasonable judgment indicates that the literal enforcement of the rules would cause an undue hardship to any interested party, the community or the state.

761—112.2(306A) Definitions. The following terms, when used in this chapter of rules, shall have the following meanings unless the context otherwise requires:

112.2(1) *Access.* A means of ingress or egress between a primary highway and abutting property or an intersecting local public road or street.

112.2(2) *Acquisition.* To receive title by gift, purchase or condemnation.

112.2(3) *Built-up area.* An area adjacent to a primary road that meets the following general criteria:

a. The lots or area abutting the primary road does not have sufficient setback for the construction of a frontage road, and the development in depth precludes the establishment of a frontage-type road to the rear of the lots or area.

b. When a "built-up area" exists on one side of a primary road, the other side of the road is also considered to be "built-up" for the purpose of determining access requirements.

112.2(4) *Controlled access highway.* All primary highways are controlled access facilities.

112.2(5) *Department.* The Iowa department of transportation. The following organizational entities within the department direct or administer the rules contained within this chapter, or have some decision-making capacity in the application of these rules to a particular access situation:

a. The office of maintenance.

b. The office of right of way.

c. The office of road design.

d. The director of the bureau of operations.

e. The bureau of transportation safety.

f. The resident maintenance engineer, resident construction engineer, or district engineer in charge of the geographical area in which these rules are being applied to a particular situation.

g. The director/chief engineer of the highway division.

h. The director of transportation.

112.2(6) *Entrance.* A physical connection between a primary highway and abutting property or an intersecting local public road or street.

112.2(7) *Entrance type.* Entrances are divided into the following three classes according to their normal usage:

eye ht. - 3.5 ft. object ht. (approaching vehicle) - 4.25 ft.

b. An access location should be established where desirable sight distance is available and shall not be authorized in a location providing less than minimum sight distance, as shown below.

POSTED DAYTIME SPEED LIMIT (mph)	DESIRABLE SIGHT DISTANCE (feet)	MINIMUM SIGHT DISTANCE (feet)
60	850	650
55	725	550
50	650	475
45	550	400
40	475	325
35	400	250
30	325	200

This table is based on values used in Table No. III-1, 1984 AASHTO Green Book.

c. On a four-lane divided primary highway where access is proposed at a location not to be served by a median crossover, sight distance shall be required only in the direction of the flow of traffic.

112.2(29) *Special access connection.* An access location authorized to the primary road system in an area where access rights were previously acquired. Special access connections shall be constructed in compliance with the rules for entrances.

112.2(30) *Turning lane.* An auxiliary lane, including taper areas, primarily for the deceleration or storage of vehicles leaving the through traffic lanes.

112.2(31) *Urban-designed area.* A built-up or fringe area in which the predominant cross section accommodates roadway surface drainage by means of a curbed roadway.

761—112.3(306A) General requirements for control of access.

112.3(1) *Establishment of controlled access highway.* Access locations necessary for free and convenient access that exist at the time a primary highway is established are hereby approved if the department deems they are reasonably located.

112.3(2) *Frontage roads.* If a frontage road is open to public travel, access from the abutting property shall be to the frontage road.

a. Access to frontage roads maintained by the department shall be authorized in accordance with rules 112.4(306A), 112.8(306A) and 112.9(306A).

b. Access to frontage roads maintained by other governmental agencies shall conform to those agencies' access requirements.

112.3(3) *Enforcement of access control.*

a. Fences. The department may construct and maintain fences or other appropriate physical separations within the primary highway right-of-way to effectively enforce and control access to the highway.

b. Unauthorized construction or modification of entrances. If an entrance is constructed or altered without the approval of the department or if the work is not completed in conformity with an approved permit or agreement, the department may notify the owner by certified mail of the violation and the need to restore the area to the standards which existed immediately prior to construction or alteration or advise of the changes necessary to conform. If after 20 days the changes have not been made, the department may make the necessary changes and immediately send a statement of the cost to the property owner. If within 30 days after sending the statement the cost is not paid, the department may institute proceedings in the district court system to collect the cost.

c. Written permission—right to inspect. A person must have written permission from the department via the specified permit or agreement before the person may construct or alter an entrance.

(1) The department reserves the right to inspect and approve any work performed within the right-of-way.

ing one or two tracks, rural speeds, agricultural land areas, etc. Municipal crossings frequently involve a more complex group of study variables than rural crossings such as higher vehicle volumes, lower and more variable vehicle and train speeds, groups of switch and mainline tracks and the associated mixture of switching and through train movements, and closely adjacent buildings. Such crossings require individual study and analysis by an engineer with special attention directed to the unique group of safety related elements present at each crossing.

These rules are intended to implement section 307.26, The Code.

[Filed 8/10/79, Notice 6/13/79—published 9/5/79, effective 10/10/79]

ARTICLE B
Reserved

CHAPTER 1
Rescinded, effective 8/29/79, See IAB 7/25/79

ARTICLE C
DEVELOPMENT SUPPORT

CHAPTER 1*
PRIMARY ROAD ACCESS CONTROL

820—[06,C]1.1(306A) Statement of policy. The department hereby establishes the following rules for control of access to primary roads.

1.1(1) The department shall at all times recognize that no property owner shall be deprived of the right to reasonable, free and convenient access to the owner's property without just compensation therefor.

1.1(2) In connection with each application of access rules to a particular situation, the department shall at all times consider the following:

a. Safety to the traveling public.

b. Perpetuation of the traffic-carrying capacity of the highway.

c. The impact upon the economy of the state.

d. Protection of the rights of property owners, including the rights of abutting property owners.

e. The rights and convenience of the traveling public and of property owners to have access to homes and business facilities.

1.1(3) The department shall at all times reserve the right to make exceptions to any and all rules where the exercise of sound and reasonable judgment indicates that the literal enforcement of any such rules would cause an undue hardship to any interested party, and the department shall in the enforcement thereof use extraordinary care so that no undue hardship or injustice results to any affected party, the community or the state.

820—[06,C]1.2(306A) Definitions. The following terms when used in this chapter of rules shall have the following meanings:

1.2(1) *Department.* The Iowa department of transportation. The following organizational entities within the department direct or administer the rules contained within this chapter, or have some decisionmaking capacity in the application of these rules to particular situations:

a. The office of development support.

b. The office of right-of-way.

c. The director of the bureau of development.

d. The resident maintenance engineer, resident construction engineer, or district engineer in charge of the geographical area in which these rules are being applied to a particular situation.

e. The director of the highway division.

f. The director of the department.

g. The transportation commission.

1.2(2) *Acquisition.* To receive title by gift, purchase or condemnation.

*Effective date delayed by administrative rules review committee seventy days. Delay lifted by committee on March 13, 1980.

1.2(3) Reserved.

1.2(4) *Controlled access highway.* A highway or street especially designed for through traffic, and over, from or to which owners or occupants of abutting land or other persons have no right or easement of access, or only a controlled right or easement of access, by reason of the fact that their property abuts upon such controlled access facility or for any other reason. All primary highways are controlled access highways.

1.2(5) Reserved.

1.2(6) Reserved.

1.2(7) *Access.* A means of ingress or egress between a primary highway and abutting property or a public road.

1.2(8) *Frontage.* The length along the highway right-of-way line of a single property tract. Corner property at a public road intersection has a separate frontage along each roadway.

1.2(9) *Frontage road.* A public street or road auxiliary to and usually located alongside and parallel to a primary highway for purposes of maintaining local road continuity and for control of access.

1.2(10) *Entrance.* A physical driveway between a primary road and abutting property, or an access from a public road to a primary highway. Entrances are divided into the following three types according to their normal peak hour potential traffic during an average day:

a. Type "A" entrance. An entrance developed to carry one hundred fifty vehicles or more per hour. It may have up to five 12-foot traffic lanes with a median of approved design. Possible examples: Sporadic, heavy concentration of vehicles to or from drive-in theaters, race tracks, or large industrial plants, or continuous heavy traffic to or from shopping centers, subdivisions, or amusement parks.

b. Type "B" entrance. An entrance developed to carry at least twenty vehicles but less than one hundred fifty vehicles per hour. The entrance shall be no more than forty-five feet in width. Possible examples: Vehicles entering or exiting service stations, small businesses, drive-in food stands and banks, light industrial plants, small drive-in theaters, cemeteries, airports, golf parks, etc.

c. Type "C" entrance. An entrance developed to carry less than twenty vehicles per hour. The entrance shall be no more than thirty-five feet in width. Possible examples: Field, farm or residential entrances that serve not more than three dwellings, or any other entrance which generates less than twenty vehicles per hour.

1.2(11) *Sight distance.* The distance of clear vision along the primary highway in each direction from any given point of access where a vehicle must stop before entering the primary highway. Sight distance is determined by measuring from a point 3.75 feet above the entrance surface to a point 4.5 feet above the primary highway surface.

a. The minimum stopping sight distances and the desirable sight distances for various posted daytime speed limits shall be as listed below.

POSTED DAYTIME SPEED LIMIT (mph)	DESIRABLE SIGHT DISTANCE (feet)	MINIMUM STOPPING SIGHT DISTANCE (feet)
55	650	415
50	550	350
40	450	275
30	350	200

VOID VOID

b. On a four-lane divided primary highway when an entrance is proposed at a location not to be served by a median crossover, sight distance shall be required as set out in paragraph 1.2(11) *"a"* above only in the direction opposing the flow of traffic.

1.2(12) *Built-up area.* The area adjacent to the primary road or primary road extension which meets the following general criteria:

a. The lots or area abutting the primary road or primary road extension are presently developed with insufficient setback for the construction of a frontage road, and the development in depth precludes the establishment of a frontage road to the rear of the lots or area.

INSTRUCTIONAL MEMORANDUM

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
OFFICE OF MAINTENANCE

CHAPTER: TRAFFIC SERVICES NO: 9.101
TITLE: SCHOOL BUS STOP AHEAD SIGNS

APPROVED: EFFECTIVE DATE: February 1, 1985
REVISION DATE:

I. Purpose:

To provide guidance to District Office Personnel and Resident Maintenance Engineers on the procedure to be used to evaluate requests for placing "School Bus Stop Ahead" signs.

II. References:

A. Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), 1978 edition adopted by the Iowa Department of Transportation on October 10, 1979.

B. Standard Highway Signs, 1979 edition.

C. A Policy on Geometric Design of Highways and Streets, 1984 edition published by the American Association of State Highway and Transportation Officials. (AASHTO)

III. General Guidelines:

A. Requests for placement of "School Bus Stop Ahead" signs submitted by school or law enforcement officials should be evaluated as provided herein. Requests received from other sources should be reviewed with the appropriate school officials to verify bus travel patterns and operations, and recommendations.

B. The MUTCD states that a School Bus Stop Ahead sign is justified where a school bus is not visible from a distance of 500 feet in advance of the point where it stops to pick up or discharge passengers. It is not to be used at all locations, but only where terrain and vertical or horizontal geometry of the roadway limit approach sight distance and there is no opportunity to relocate the stop to a point where visibility is adequate.

C. In lieu of using the specified 500 feet in all situations, a procedure has been developed to compute the stopping sight distance for each location under study and compare it with available sight distance. If the stopping sight distance exceeds the available sight distance, a School Bus Stop Ahead sign is justified. If the stopping sight distance is less than the available sight distance, a sign is not to be installed.

IV. Procedures:

A. Determining Available Sight Distance.

The available sight distance (SD) is determined by making observations at each site under study. Assumptions and criteria used for this part of the study are as follows.

1. The driver's eye height is 3.50 feet.

2. The height of the target used at the driveway where passengers are picked up or discharged is 4.0 feet. This is approximately 1/2 the height of a school bus and would include the flashing lights and a substantial portion of the bus itself.

3. The observation point is positioned on the roadway at approximately the same lateral location as the driver's eye.

By using the above assumptions and criteria, the available sight distance is determined.

B. Determining The Stopping Sight Distance.

The method of computing stopping sight distance is taken from the 1984 edition of A Policy on Geometric Design of Highways and Streets published by AASHTO. Stopping sight distance is composed of two parts. First is the distance traveled during perception and reaction and second is the actual distance to brake to a stop. The following formula is used.

$$d = V(1.47)(t) + \frac{V^2}{30(f+g)}$$

The terms in this equation are defined as follows.

d = The total stopping sight distance in feet.

V = The initial speed in miles per hour.

t = The perception/reaction time in seconds.

f = The coefficient of friction between the tires and the roadway.

g = The grade expressed as a decimal.

Assumptions made in computing the stopping sight distance are as follows.

1. The initial speed is 60 MPH for a rural location which allows for a factor of safety over the posted 55 MPH speed limit. If the location is in a reduced speed zone, use the actual posted speed limit.

2. Perception time is 1.5 seconds.

3. Reaction time is 1.0 seconds.

4. Total perception - reaction time (t) equals 2.5 seconds.

5. The coefficient of friction (f) is 0.30 which is representative of wet pavement conditions.

6. The grade used is the actual percent divided by 100 or the average grade if the approach is on a vertical curve.

The following is an example showing how the stopping sight distance should be computed. Data to be used is as follows.

V = 60 MPH

t = 2.5 seconds

f = 0.300 (wet pavement)

g = -4.50% or 4.50/100 = 0.045

$$d = V(1.47)(t) + \frac{V^2}{30(f \pm g)}$$

$$d = 60(1.47)(2.5) + \frac{(60)^2}{30(0.300 - 0.045)}$$

$$d = 220.5 + \frac{3600}{30(0.255)}$$ D= 220.5 + 120/0.3± Gr.

$$d = 220.5 + 470.6$$

d = 691.1, rounded to 690 ft.

C. Determination of Signing Needs.

The available sight distance (SD) needs to be compared with the stopping sight distance (d) to determine if a School Bus Stop Ahead sign is needed.

When the situation involves approaching the front of a stopped school bus, 10 feet should be added for a passenger crosswalk and 25 feet for a clear zone. The analysis would be as follows.

(1a) If SD is greater than d + 10 + 25, a School Bus Stop Ahead sign is not justified.

(1b) If SD is equal to or less than d + 10 + 25, a School Bus Stop Ahead sign is justified.

When the situation involves approaching the rear of a stopped school bus, 35 feet should be added for the bus and 25 feet for a clear zone. The analysis is as follows.

(2a) If SD is greater than d + 35 + 25, a School Bus Stop Ahead sign is not justified.

(2b) If SD is equal to or less than d + 35 + 25, a School Bus Stop Ahead sign is justified.

D. Installation of a Sign.

If a School Bus Stop Ahead sign is justified under 1b or 2b in Section C above, a standard 30" x 30" warning sign should be used. It should be installed approximately 500 feet in advance of the point where 1/2 of the school bus is visible, i.e., SD + 500 feet.

2. At congested locations where the roadway will accommodate more lanes of traffic than would be the case without the use of lane lines.

Lane lines are usually normal broken white lines which permit lane changing with care.

A normal solid white line may be used as the lane line in critical areas where it is advisable to discourage lane changing. Typical locations for such applications are tunnels or bridges having width restrictions and interchange areas where lane changing disrupts traffic flow.

A solid white line may be used to separate through-traffic lanes from special secondary lanes, such as uphill truck lanes, left-or right-turn lanes and transit bus lanes.

A double solid white line shall be used when lane changing is prohibited.

Applications of lane lines are illustrated in figures 3-1, 3-2, 3-4, 3-5, and 3-6.

3B-3 No-Passing Zone Markings

Where center lines are installed, no-passing zones shall be established at vertical and horizontal curves and elsewhere on two- and three-lane highways where an engineering study indicates passing must be prohibited because of inadequate sight distances or other special conditions. Specific reference is made to section 11-307 UVC Revised 1968.

A no-passing zone shall be marked by either a one direction, no-passing marking (#5, sec. 3A-7) or a two direction, no-passing marking (#6, sec. 3A-7) as illustrated in figure 3-2b.

3B-4 Application of No-Passing Zone Markings

On a two-or three-lane highway, the no-passing marking shall be parallel to and extended along the center line throughout the no-passing zone.

On a three-lane highway where the single lane is being moved from one side of the road to the opposite side, a no-passing buffer zone shall be provided by transitioning the centerline markings diagonally across the center lane to the beginning of the no-passing buffer zone, and thence along this location to the end of the buffer zone (fig. 3-7a). An alternate method of marking this condition is illustrated in figure 3-7b. The markings shall extend across the center lane on a diagonal for a distance (taper length) computed by the formula $L = WS$ for all roadways having a posted speed of 45 m.p.h. or greater. For urban, residential, and other streets having posted speeds of 40 m.p.h. or less, taper length should be computed by the formula $L = WS^2/60$. Under both formulas, L equals the taper length in feet, W the width of the center lane in feet, and S the off-peak 85 percentile speed in miles per hour.

shoulders or refuge areas of lesser structural strength than adjacent pavement. Edge lines shall not be continued through intersections and should not be broken for driveways.

Edge lines shall be provided on all Interstate highways, on rural multilane divided highways, and may be used on other classes of roads. The lines shall be white except that on the left edge of each roadway of divided streets and highways, and one-way roadways in the direction of travel, they shall be yellow.

III-6 (c) Rev. 1

3B-7 Pavement Marking Extensions Through Intersections or Interchanges

Where road design or reduced visibility conditions make it desirable to provide control or to guide vehicles through an interchange or intersection, (such as at offset, skewed, complex multi-legged intersections or where multiple turn lanes are used) a dotted line may be used to extend markings as necessary through the interchange or intersection area (figs. 3-9a, 3-11). Where a greater degree of restriction is required, solid lane lines or channelizing lines may be continued through intersections. A frequent use for the channelizing line is to separate turning movements (figs. 3-9b, 3-9c).

3B-8 Lane Reduction Transitions

Where pavement markings are used, lane reduction markings shall be used to guide traffic at points where the pavement width changes to a lesser number of through lanes. No-passing markings shall be used to prohibit passing in the direction of the convergence, throughout the transition area. The length of transition (taper length) for a lane reduction should be computed by the formula L = WS for freeways, expressways, and all other roadways having a posted speed of 45 m.p.h. or greater. Formula $L = WS^2/60$ should be used to compute taper length on urban, residential, and other streets where the posted speeds are 40 m.p.h. or less. Under both formulas, L equals the taper length in feet, W the offset distance in feet, and S the off-peak 85 percentile speed in miles per hour. On new construction, where no 85 percentile speed is established, the design speed may be used.

A number of situations are possible, as illustrated in figure 3-10, depending on which lanes must be offset or terminated and the amount of offset. One or more lane lines must be connected in such a way as to merge traffic into the reduced number of lanes.

Lane lines should be discontinued one-quarter of the distance between the Pavement Width Transition sign (sec. 2C-19) and the point of convergence. Edge lines should be installed from the location of the warning sign, past the beginning of the narrower roadway (fig. 3-10).

Pavement markings at pavement-width transitions supplement the standard signs.

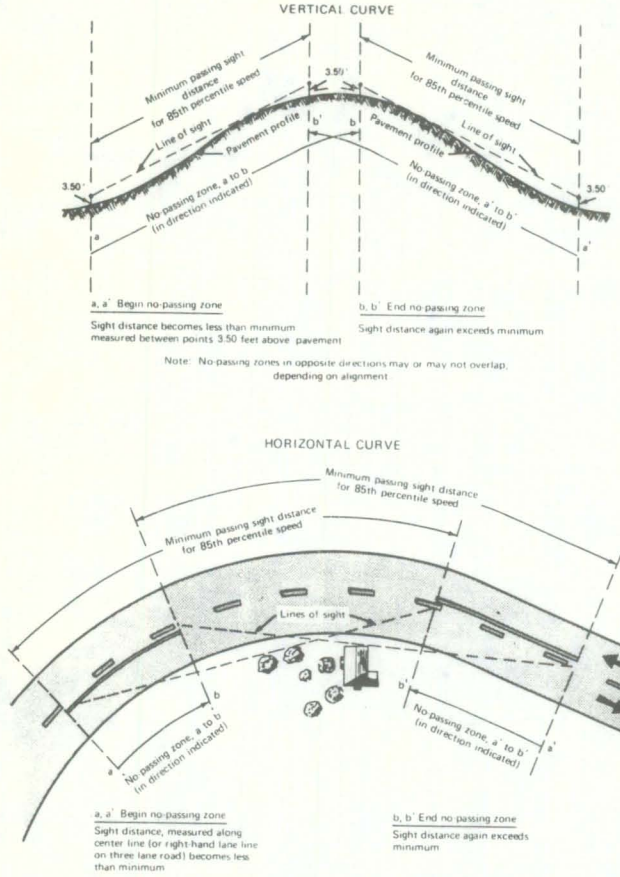


Figure 3-8. Method of locating and determining the limits of no-passing zones at vertical and horizontal curves.

III-4 (c) Rev. 3

In addition to the pavement markings here prescribed, no-passing zone signs (secs. 2B-21, 2B-22 and 2C-38) may be used to emphasize the existence and extent of a no-passing zone.

Where the distance between successive no-passing zones is less than 400 feet, the appropriate no-passing marking (one direction or two direction) should connect the zones.

The no-passing marking is also used on two-way roadways at pavement width transitions (sec. 3B-8) and on approaches to obstructions which must be passed on the right (sec. 3B-13). It may also be used on approaches to railroad grade crossings and other locations where passing should be prohibited.

3B-5 Warrants for No-Passing Zones at Curves

A no-passing zone at a horizontal or vertical curve is warranted where the sight distance, as defined below, is less than the minimum necessary for safe passing at the prevailing speed of traffic. Passing sight distance on a vertical curve is the distance at which an object 3.50 feet above the pavement surface can just be seen from a point 3.50 feet above the pavement (fig. 3-8a). Similarly, passing sight distance on a horizontal curve is the distance measured along the center line (or right hand lane line of a three-lane highway) between two points 3.50 feet above the pavement on a line tangent to the embankment or other obstruction that cuts off the view on the inside of the curve (fig. 3-8b). Where center lines are installed and a curve warrants a no-passing zone, it should be so marked where the sight distance is equal to or less than that listed below for the prevailing off-peak 85 percentile speed:

III-4 (c) Rev. 3

85 Percentile Speed (MPH)	Minimum Passing Sight Distance (Feet)
30	500
40	600
50	800
60	1000
70	1200

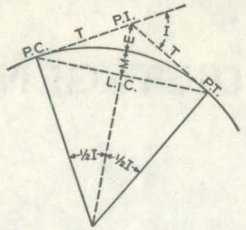
The beginning of a no-passing zone (point "a," fig. 3-8) is that point at which the sight distance first becomes less than that specified in the above table. The end of the zone (point "b") is that point at which the sight distance again becomes greater than the minimum specified.

3B-6 Pavement Edge Lines

Pavement edge line markings provide an edge of pavement guide for drivers. They have a unique value as a visual reference for the guidance of drivers during adverse weather and visibility conditions. They also may be used where edge delineation is desirable to reduce driving on paved

CURVE AND REDUCTION TABLES

Published by Eugene Dietzgen Co.



CURVE FORMULAS

1. Radius : $R = \frac{50}{\sin D/2}$
2. Degree of Curve: $D = 100\frac{I}{L}$. Also, $\sin D/2 = \frac{50}{R}$
3. Tangent : $T = R \tan \frac{1}{2} I$. Also, $T = \frac{T \text{ for } 1° \text{ curve}}{D} + C.$
4. Length of Curve: $L = 100\frac{I}{D}$
5. Long Chord : $L.C. = 2R \sin \frac{1}{2} I.$
6. Middle Ordinate: $M = R\,(1 - \cos \frac{1}{2} I)$
7. External : $E = \frac{R}{\cos \frac{1}{2} I} - R.$ Also, $E = T \tan \frac{1}{4} I.$

EXPLANATION AND USE OF TABLES

Given P.I. Sta. 83+40.7, I = 45° 20′ and D = 6°30′ find:

Stations—P.C. = P.I. − T. $T = \frac{T \text{ for } 1° \text{ Curve}}{D} +$ C. From Tables V and VI $T = \frac{2392.8}{6.5} + .197 = 368.32 = 3+68.32$. Sta. P. C. = 83+40.7 − (3+68.32) = 79+72.38. P. T. = P. C. + L, and $L = 100\frac{I}{D} = 100\frac{45.33}{6.5} = 697.38$ Therefore, P. T. = (79+72.38) + (6+97.38) = 86+69.76.

Offsets—Tangent offsets vary (approximately) directly with D and with the square of the distance. From Table III Tangent Offset for 100 feet = 5.669 feet. Distance = 80 − Sta. P. C. = 27.62. Hence offset $= 5.66 \times \left(\frac{27.62}{100}\right)^2 = .432$ ft. Also, square of any distance, divided by twice the radius equals (approximately) the distance from tangent to curve. Thus $(27.62)^2 \div (2 \times 881.95) = .432$ ft.

Deflections—Deflection angle = ½ D for 100 ft., ¼ D for 50 ft., etc. For "X" ft., Deflection Angle (in minutes) = .3 × X × D. For Sta. 80 of above curve Deflection Angle = .3 × 27.62 × 6.5 = 53.86′. Also Deflection Angle = dfl. for 1 ft. from Table III × X = 1.95 × 27.62 = 53.86′. For Sta. 181 Deflection Angle $= 53.86' + \frac{6°\,30'}{2} = 4°\,8.86'$.

Externals—From Table V for 1° curve, with central angle of 45° 20′, E = 479.6. Therefore, for 6° 30′ curve, $E = \frac{479.6}{6.5} +$ Correction from Table VI = 7.378 + .039 = 7.417.

Asphalt patch on Elk Run road see back Page

SIGHT DISTANCE FOR PROPOSED DRIVE SOUTH OF BUILDING SITE AT 7334 NORTH RAYMOND RD.

TARGET HEIGHT = 3.75'
OBSERVER HEIGHT = 4.5'

SIGHT DIST. NORTH = 910 ft.
" " SOUTH = 2000 + ft.

April 7, 1992 — WL, BS

℄ RAYMOND RD.

100 N. $\frac{7^{5}}{35}$

4^{7} $\frac{5^{1}}{11}$ $\frac{5^{4}}{15}$ $\frac{9^{0}}{28}$ $\frac{9^{4}}{42}$ $\frac{7^{1}}{50}$ $\frac{7^{0}}{100}$

100 S. $\frac{12^{7}}{35}$

SIGHT DISTANCE FOR PROPOSED DRIVE West of INT Schrock & KIMBALL

TARGET HEIGHT = 3.75'
OBSERVER HEIGHT = 4.5'

SIGHT DIST. WEST = 904 ft
" " East = Unrestricted

April 23, 1992 — WL, BS

SIGHT DISTANCE FOR PROPOSED DRIVE
E. of Bldg. Sight @ 11930 E. Airline

TARGET HEIGHT = 3.75'
OBSERVER HEIGHT = 4.5'

SIGHT DIST. WEST = 647 ft
" " EAST = Unrestricted

JUNE 26, 1992 WL, JS

$\frac{11^{6}}{25}$ F_L DITCH 100' E.

5^{0} $\frac{5^{6}}{12}$ $\frac{8^{8}}{20}$ $\frac{8^{8}}{25}$ $\frac{5^{4}}{33}$

$\frac{6^{2}}{25}$ F_L DITCH 100' W.

40' pipe
Recommend 18" ϕ

SIGHT DISTANCE FOR PROPOSED DRIVE
SW 1/4 Sec 35·90·12

Target Height = 3.75'
Observer Height = 4.5'

SIGHT DIST. East = 1755'
" " West = 637'

Marked location with orange painted lath.

F_L DITCH 100' East $\frac{7^{8}}{21}$

$\frac{4^{6}}{32}$ $\frac{8^{9}}{26}$ $\frac{9^{0}}{20}$ $\frac{5^{4}}{13}$ 5^{0}

Recommended 30" ϕ
50' pipe

F_L DITCH 100' West $\frac{8^{6}}{21}$

Final approved location = Approx. 950' east of Crane Creek Rd. west side of rdwy curb. - 585' S.D. to west and good S.D. to east 18"ϕ x 38' ~~RCP~~ (See p.10)

SIGHT SURVEY FOR DRIVE INDIAN CR. RD.
1 mile East of Jesup Rd.

Target Height = 3.75
Observer Height = 4.5

Sight Distance East = 653 ft.
" " West = 1100 ft.

7-10-92

Recommend 18" x 36' Culvert

0.6 SHO. 4.0 DITCH 1.3 B.S.

SIGHT SURVEY FOR DRIVE W. Reinbeck Rd.
E. of Intersection Hwy #21

7-10-92

Target Height = 3.75'
Observer Height = 4.5'

Sight Distance East = 2400'
" " West = 2600'

Note: Hwy 21 ℄ is 123' West of proposed drive location.

Recommend Dry Fill w/ 10:1 side slopes

Sight Survey for Drive @ Pilot Grove R
½ mile North of Dubuque Rd on
West Side of Rd

Target Height = 3.75
Observer Height = 4.5

Sight Distance South = unlimited
Sight Distance North = 561 ft

Sight Survey for Fld Ent on Fox Rd
Approx. 730' West of Spring Creek Rd
on South Side of Rd.

Target Height = 3.75
Observer Height = 4.5

Sight Distance West = 433'
East = Unrestricted

SIGHT SURVEY FOR DRIVE ON WASHBURN RD.
West of Dysart Rd. on North side
of Rd., for David Weber, 6940 Dysart Rd.

Target Ht. = 3.75'
Observer Ht. = 4.5'

Sight Distance East = 240' to ℄ Dysart
Sight Distance West = 1700'+

℄ Washburn

$\frac{10^{0}}{48}$

E_L 100' East

$\frac{10^{7}}{65}$ $\frac{11^{8}}{56}$ $\frac{12^{6}}{47}$ $\frac{5^{0}}{18}$ $\frac{4^{77}}{11}$ $\frac{4^{103}}{\quad}$

℄ Proposed Dr.

$\frac{12^{3}}{48}$

E_L 100' West

recommend 50' x 18" pipe
WL

Sight Survey For FLD. Ent Acker @ Orange Rd
And 300' North on Acker @ Orange Int.

Sight Distance - Unlimited South For Both
Sight Distance @ Intersection. ~~715' North~~ 715 —
Sight Distance @ 300' N. 650' North —
Sight Distance @ 600' N. of Orange - good south good north 700+
Target Ht. = ~~3.75~~' 3.5
Observer Ht = ~~4.5~~' 4.25
Ditch Depth = 3.3'

Ditch Depth = 3.3' — 18" Ø culv.
— Dry Fill (? snow filled ditch) 3.5' depth ditch

Sight Survey For FLD. Ent Quarry Rd
between Acker & Holmes @ ¼ corr.

	3/4/97
Target Ht. = 3.75'	3.5
Observer Ht. = 4.5	4.25

Sight Distance East = Unlimited unlimited
Sight Distance West = Unlimited unlimited

Sight Survey on Young Rd 88-12-11 340' W of N¼ Cor

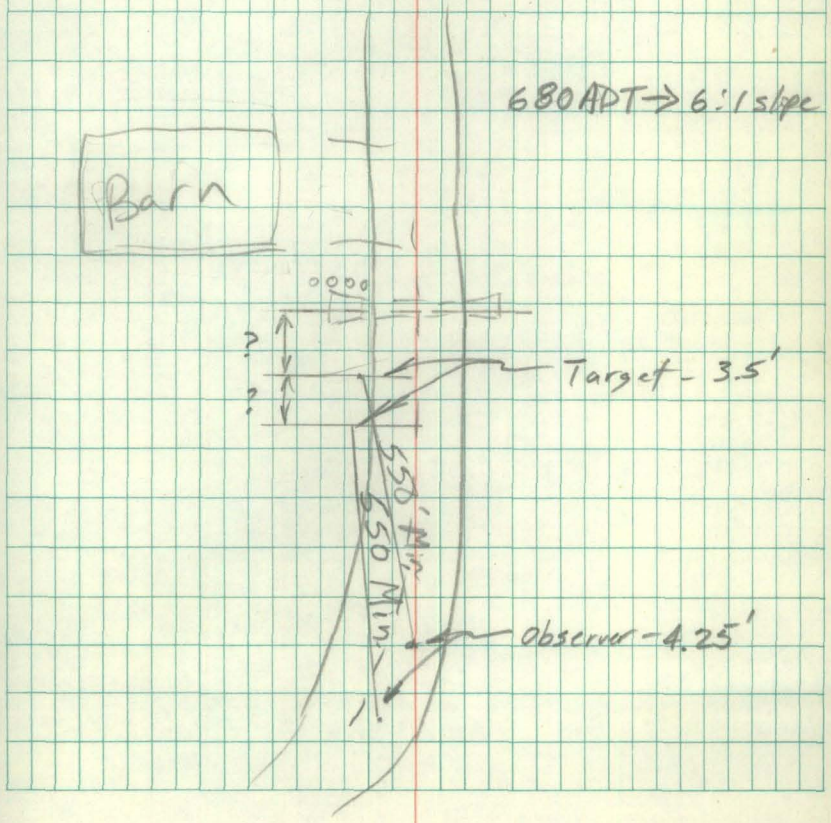
Target HT = 3.75' —	3.5'
Observer HT = 4.50' —	4.25'
Sight Distance East = 803' —	823
Sight Distance West = 1135' —	1158

Ditch Depth = 3.8'

2-26-93 Sight Survey -(Thru Sec. 3-90-14)
Taylor Rd. — Stan Buhrmaster
Target Ht. 3.75 S.D. North - 1000' plus
Observer Ht. = 4.5' S.D. South - 580'

3- -93 Sight Survey
Target - 3.5'
Observ. - 4.25'

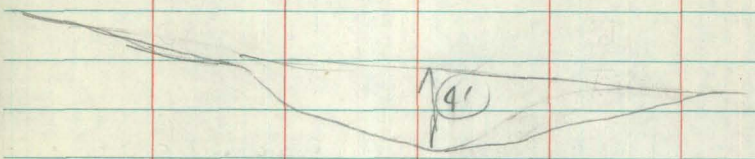
Fill Depth (Ditch)
Drainage Area
Culvert ø
Culvert Length (6:1)



SIGHT SURVEY UNION Rd
for Kevin Cross N. Turkey Foot

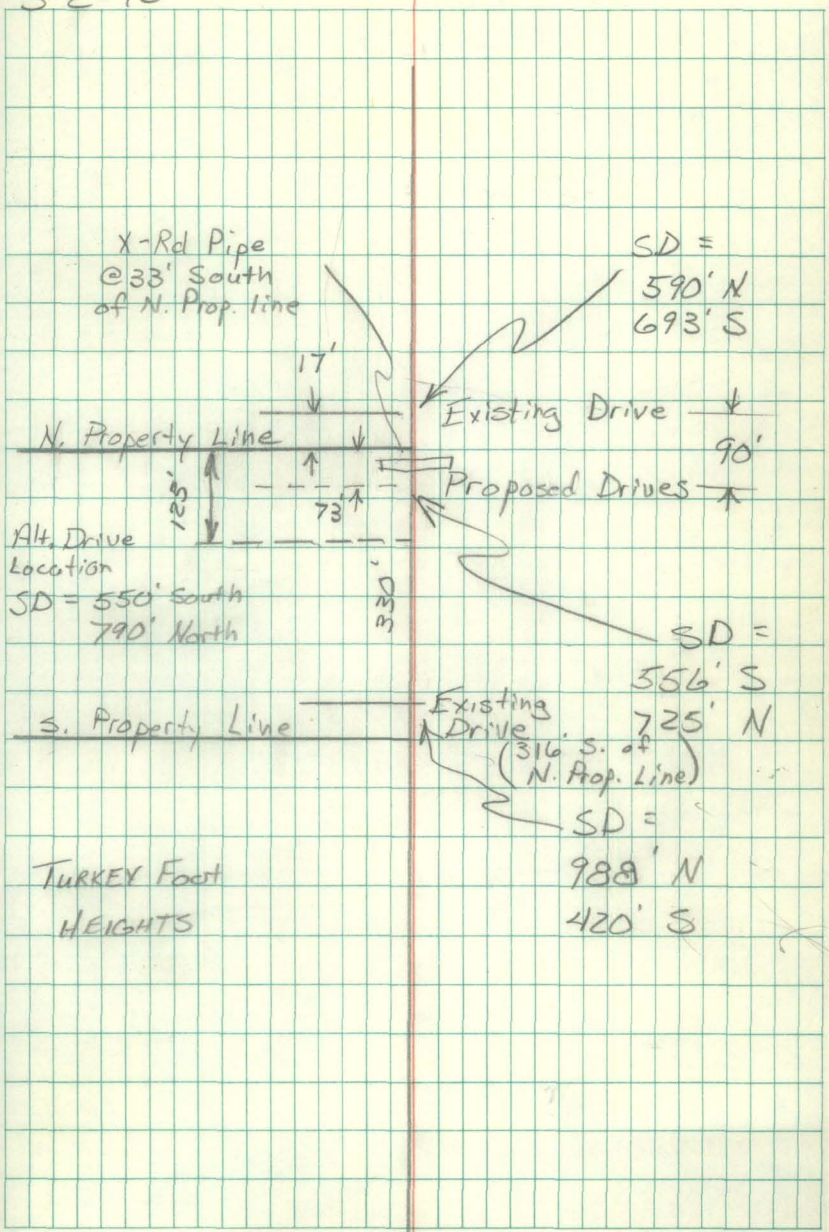
Target Ht = 3.5 ft
Observer Ht = 4.25 ft

Depth Ditch: 9'



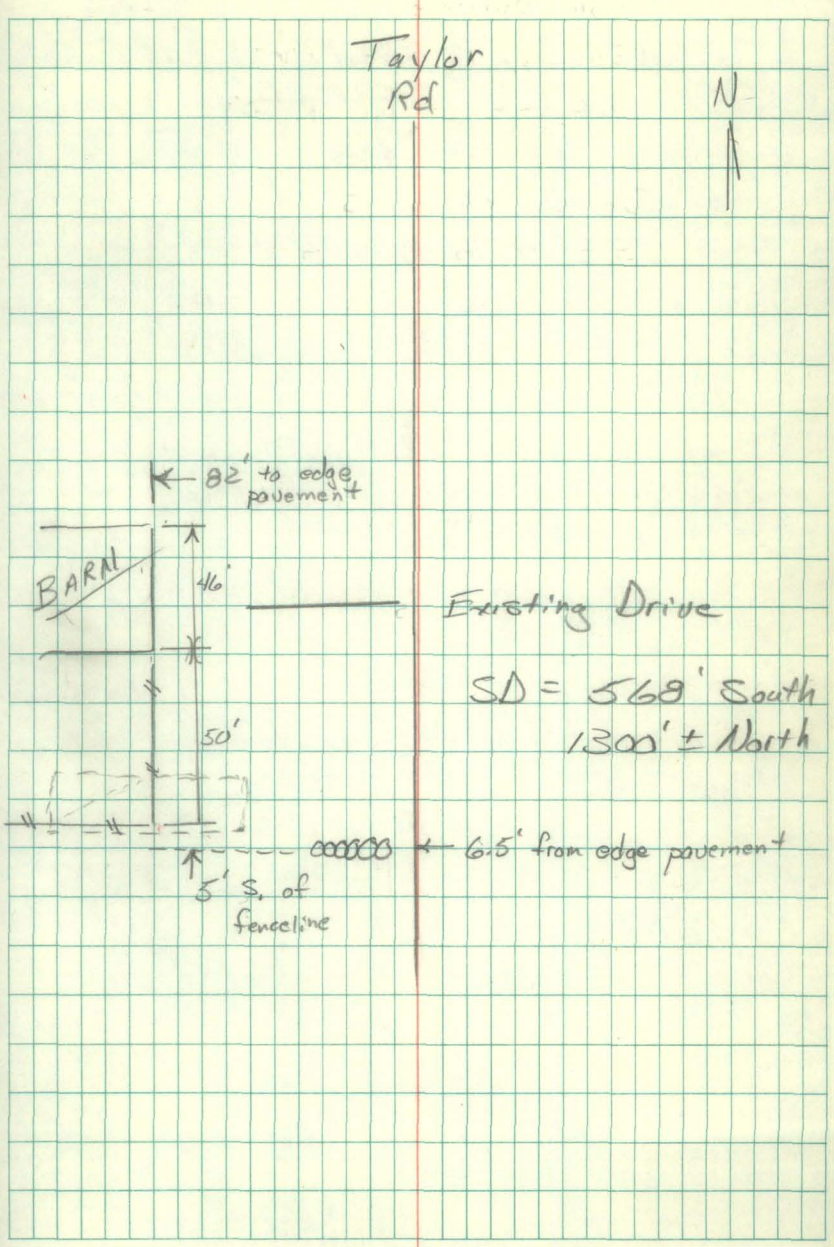
N. Union

3-2-93



SIGHT SURVEY Taylor Rd for
Stan Buhrmaster 9607 Taylor Rd
WL, BS 3-2-93

Target Ht. = 3.5 ft
Observer Ht = 4.25



Sight Survey

Douglas Dr. / Kimball Ave.

Dennis Edgar 4/14/93

Ht. Object (Hwy) - 4.25'

Ht. Eye (Drive) - 3.5'

S.D. to South - 619'

" " North - ¼ mile

Sight Survey - 4/14/93 Dennis Edgar

9443 Kimball - Casey Vandenberg

S.D. to South - 375'

SD to North - good ¼ mile

(S.D. to south improved to 400' sight distance if driver stops 30' from edge of pavement and sight through ditch to south)

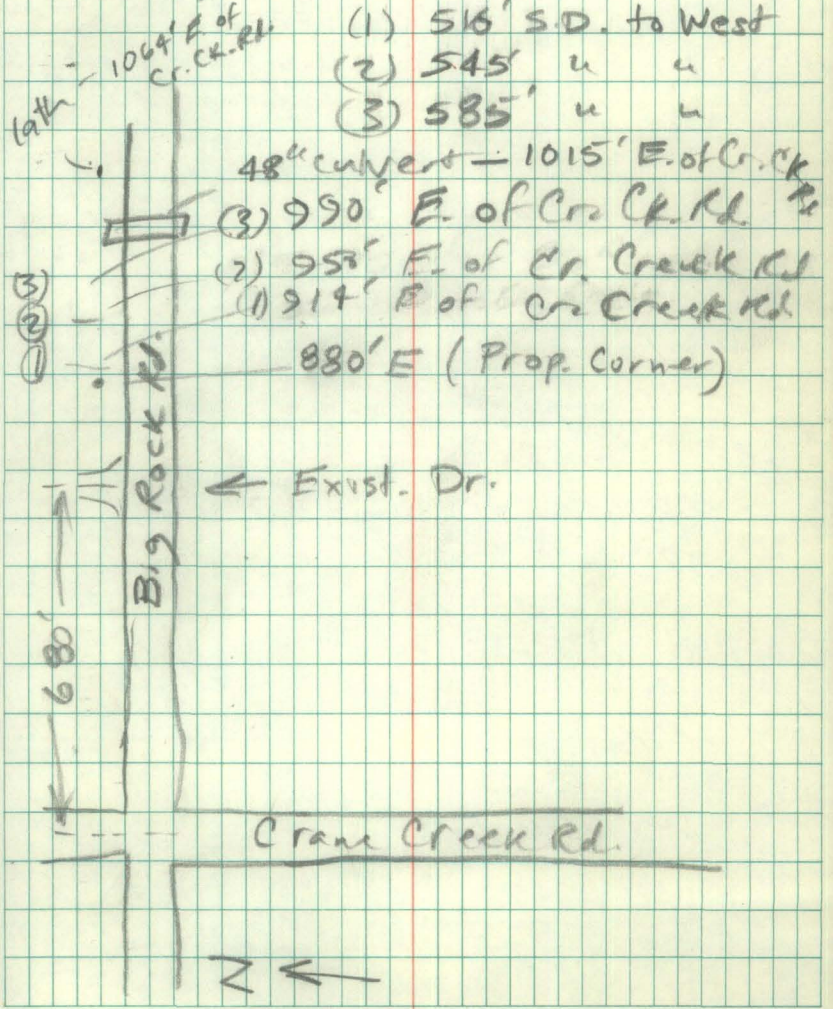
Sight Survey 5/93

Sec 35-90-12

Steve Riley - (w) 233-9911

Scott Reynolds - 236-0371

E. Big Rock Rd.

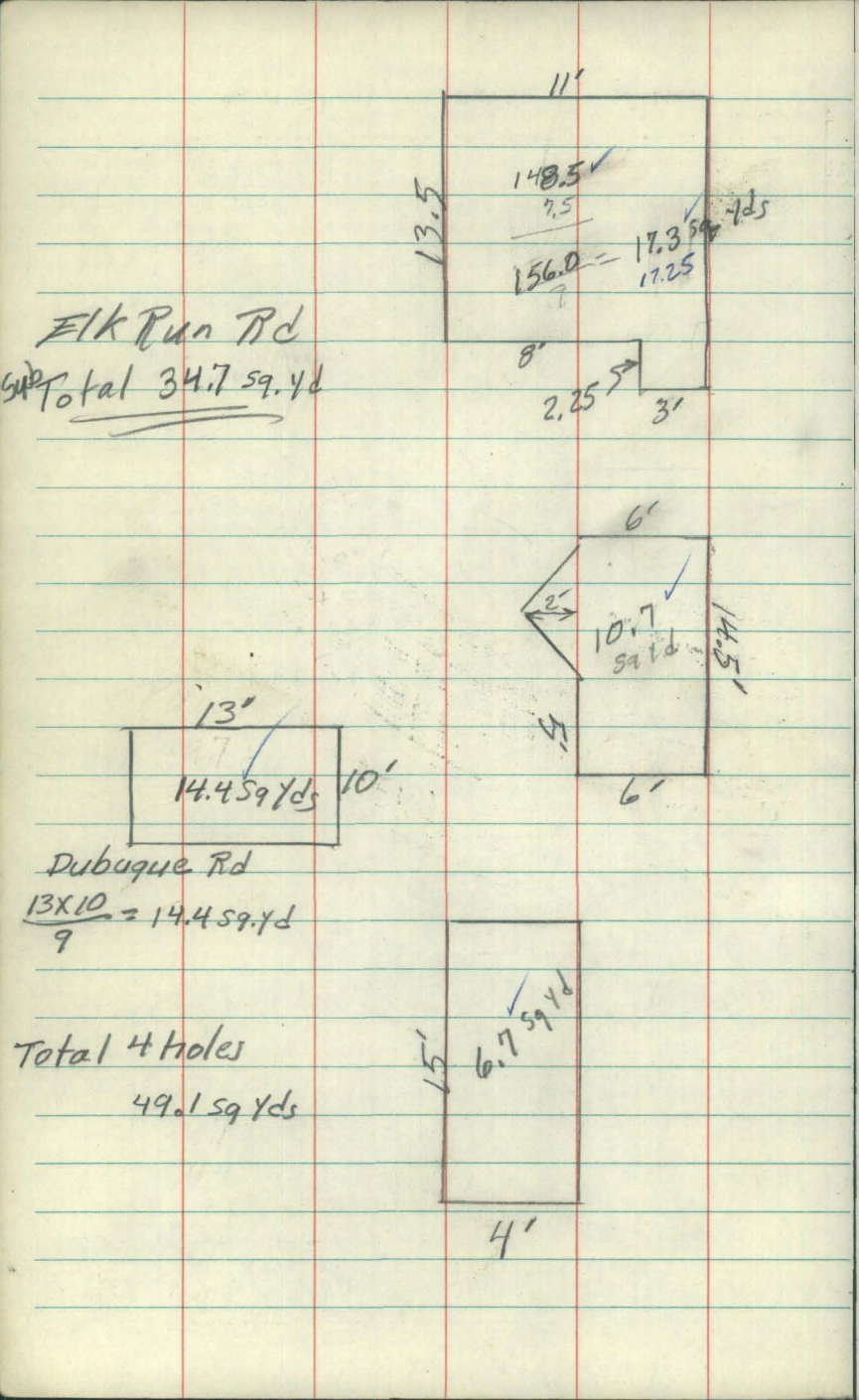


Sight Survey -
James Bosier, 9527 Kimball Ave, W'loo

Object Ht. (observer) - 4.25'
Ht. Eye (driver) - 3.5'

S.D. - North - good ¼ mi ±
S.D. - South - 571'

Note: Const. of this drive may reduce
S.D. of drive @ 9443 Kimball (see p.10)
Const. of this drive should not
affect S.D. at exist. drive (238' ± south)
S.D @ exist. dr. - good to south
S.D " - 391' to north



General Equations and Useful Data

	Symbol on Equation	Numerical Value
Area of circle	$\frac{\pi d^2}{4}$	
Area of Sector of Circle (Length of arc = l)	1/2 lr	
Area of Segment of Parabola (app.) (c = chord; m = mid. ord.)	2/3 cm	
Area of Segment of Circle	2/3 cm	
Cubic Feet in 1 Cubic Meter		35.3145
Cubic Inches in 1 Imperial Gallon		277.274
Cubic Inches in 1 U.S. Gallon		231
Feet in 1 Meter		3.2808
Feet in 1 Mile		5280
Gallons (Imperial) in 1 Cubic Foot		6.2321
Gallons (U.S.) in 1 Cubic Foot		7.48
Miles in 1 Kilometer		0.6213
Pounds (Av.) in 1 Kilogram		2.2046
Ratio of Circumference to Diameter	π	3.14159
Reciprocal of π		0.31831
Square Feet in 1 Acre		43,560
Volume of Sphere	$4/3\ \pi r^3$	

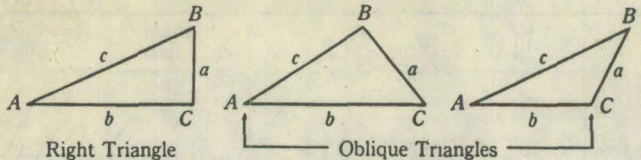
Table I.—Minutes in Decimals of a Degree.

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 .0052	3/32 .0078	1/8 .0104	3/16 .0156	1/4 .0208	5/16 .0260	3/8 .0313	1/2 .0417	5/8 .0521	3/4 .0625	7/8 .0729
1 .0833	2 .1667	3 .2500	4 .3333	5 .4167	6 .5000	7 .5833	8 .6667	9 .7500	10 .8333	11 .9167

TRIGONOMETRIC FORMULÆ



Right Triangle — Oblique Triangles

Solution of Right Triangles

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

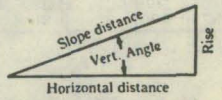
Given	Required	
a, b	A, B, c	$\tan A = \frac{a}{b} = \cot B, c = \sqrt{a^2+b^2} = a\sqrt{1+\frac{b^2}{a^2}}$
a, c	A, B, b	$\sin A = \frac{a}{c} = \cos B, b = \sqrt{(c+a)\,c-a)} = c\sqrt{1-\frac{a^2}{c^2}}$
A, a	B, b, c	$B = 90° - A, b = a \cot A, c = \frac{a}{\sin A}$
A, b	B, a, c	$B = 90° - A, a = b \tan A, c = \frac{b}{\cos A}$
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	$s = \frac{a+b+c}{2}, \sin \frac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{b\,c}}$; $\sin \frac{1}{2} B = \sqrt{\frac{(s-a)(s-c)}{a\,c}}, C = 180° - (A+B)$
a, b, c	Area	$s = \frac{a+b+c}{2}$, 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 =

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