NAUNI VALLEY DRIVE

MCDONALD DRIVE

LOT 12
APN 169-44-012
BH NAUNI VALLEY LLC

SPLIT OF NAUNI VALLEY
RANCH LOT 13B
APN 169-44-029
ELSIE MY LIPNER 1996
LIVING TRUST

405' SIGHT DISTANCE TRIANGLE
AASHTO CASE B2/B3

465' SIGHT DISTANCE TRIANGLE
AASHTO CASE B1

N

SIGHT
DISTANCE
FIGURE 01
CONCEPTUAL

Intersection of Nauni Valley Drive and McDonald Drive

Paradise Valley, Arizona

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April 11, 2016

Cullum Homes, Inc.
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8408 E Shea Blvd, Suite 100
Scottsdale, Arizona 85260
Phone: (602) 955-6370
Fax: (602) 955-7217
Email: rod@cullumhomes.com

Registered Professional Engineer (Civil)
CERTIFICATE
53396
ERICA RAE
EGGEN
Date Signed 4-11-16
ARIZONA, U.S.A.
Expires 6-30-18

RE: *Nauni Valley Drive and McDonald Drive Intersection Stopping Sight Distance Requirements, Paradise Valley, AZ*

Dear Mr. Cullum:

Civtech has been retained to prepare a sight distance analysis for the existing intersection of Nauni Valley Drive and McDonald Drive in the Town of Paradise Valley, Arizona. The purpose of this letter is to address the minimum sight distances required at this intersection to ensure proper safety.

To maintain intersection safety and operation, there must be sufficient unobstructed sight distance along both approaches of an intersection and across their included corners to allow operators of vehicles to detect approaching vehicles in order to prevent a collision. The sight triangle is the area encompassed by the line of sight from a stopped vehicle on the minor roadway to the approaching vehicle on the major roadway.

The Town has classified McDonald Drive as a minor arterial. The posted speed limit along McDonald Drive is 35 mph. It consists of one (1) lane in each direction, separated by a raised center median. McDonald Drive begins to the west at Tatum Boulevard, continuing east to Loop 101(Pima Freeway).

The American Association of State and Highway Transportation Officials (AASHTO) provides sight distance requirements in the 2011 publication *A Policy on Geometric Design of Highways and Streets.* AASHTO uses a standard set of equations for the case of a minor road stopping at a major road. These calculations provide the sight distance requirements for vehicles making a left-hand turn (Case B1), a right-hand turn and for crossing the roadway (Cases B2 and B3). These calculations assume a stopped position for the vehicle attempting to enter the roadway and are dependent upon the major roadway typical section and design speed. The "decision point" of each sight triangle is desired 18-feet from the edge of the major-road traveled way. Cases B2 and B3 calculate the length of the shorter leg as the distance from the decision point to the center of the width of approaching lanes to the left. Case B1 calculates the shorter leg of the sight distance triangle as the distance from the decision point to the center of the width of approaching lanes to the right. Using this methodology, Case B2/B3 utilizes a shorter leg distance of 24 feet (18 feet + 6 feet) and Case B1 utilizes a shorter leg distance of 45 feet (18 feet + 12 feet + 9 feet + 6 feet).

An intersection site distance analysis was performed to set guidelines for establishing line of sight for the intersection of Nauni Valley Drive and McDonald Drive. Using the guidelines set forth by AASHTO, **Table 1** was generated for the existing intersection. Vehicle travel speed is a primary factor in calculating sight distance. The posted speed limit along McDonald Drive is 35 miles per hour (mph) and a design speed of 40 mph was applied. For the purposes of sight distance calculations, the cross section of McDonald Road was assumed to consist of a 12-foot travel lane and a 9-foot median. **Table 1** below summarizes the length of the longer leg in the sight distance triangles required for this intersection.

Table 1 – Intersection Sight Distance Analysis

Intersection	Design Speed (mph)	Required Sight Distance	
		Case B2/B3-Left (ft)	Case B1-Right (ft)
Nauni Valley Drive and McDonald Drive	40	465	405

In summary, the required sight distance for vehicles stopped on Nauni Valley Drive is 465 feet to the left (east) of the intersection and 405 feet to the right (west) of the intersection.

The Town of Paradise Valley provides a 50'x50' corner visibility triangle requirement in Section 8-1-13B of the Paradise Valley Town Code, and is provided in **Attachment A**. Although the Town of Paradise Valley requires a conservative standard traffic safety triangle, it is our recommendation to utilize the sight distance requirements documented by AASHTO. Sight distance calculations are provided in **Attachment B**. Within designated sight visibility triangles, landscaping should be maintained at a maximum of two (2) feet in height or as otherwise specified by the Town of Paradise Valley. Tree branches lower than eight (8) feet should be trimmed and maintained to meet current acceptable landscape requirements. Improvements can be constructed within the 50'x50' corner visibility requirement without impeding sight distance. Any improvements planned in this area should be staked in the field and gain concurrence by the Town Engineer on location and height.

Should there be any questions regarding the sight distance recommendations for this intersection, please contact me at 480-659-4250.

Sincerely,

Erica Eggen, P.E.
Project Manager

Attachments:

A - Paradise Valley Sight Distance Requirements
B - AASHTO Sight Distance Calculations

CivTech

swimming pools, spas, ponds, fountains, sprinklers, hoses, pipes, ditches, standpipes, berms, irrigation structures or equipment, valves or gates.

Section 8-1-11   Obstruction of Watercourses (Repealed 418 6/13/96)

Section 8-1-12   Weeds

A.   Every person owning, occupying, or controlling any premises fronting on any street, alley, or public place in the Town shall cut or cause to be cut all grass and weeds growing on such frontage as often as the same may require cutting, to the end that said grasses or weeds shall not attain a height of over six inches, and every person who shall permit grass or weeds to grow to a height exceeding six inches between the property line of such property and the street shall be guilty of a violation of this Code.

B.   Every person owning, occupying, or controlling any lot or lots within the Town shall cause all weeds and other noxious growths to be cut thereon as often as the same may require cutting to prevent the same from attaining a height of over six inches, and every person owning, occupying or controlling any lot or lots within the Town who shall permit on such lot or lots weeds or other noxious growth to grow to a height exceeding six inches, or who shall permit any rubbish, dirt, debris, or other matter to accumulate upon such lot or lots, shall be guilty of a violation of this Code.

Section 8-1-13 Corner Vision [369] [456]

As an aid to safe movement of vehicles at and near street intersections and in order to promote more adequate protection for the safety of children, pedestrians, and operators of vehicles, there shall be limitations on the height of fences, walls, gateways, ornamental structures, hedges, shrubbery and other fixtures, construction and planting on all corner lots.

A. Such barriers to clear, unobstructed vision at corners of intersecting streets shall be limited to a height of not over two (2) feet above the street elevation of the nearest edge of pavement, for a distance of fifty (50) feet along both the front and side lot lines, measured as indicated below.

B. Within the triangle formed by connecting the ends of the respective fifty (50) foot distances as illustrated in figure 8-1-13, all the structures, fixtures, construction, hedges, shrubbery and other plantings shall be limited to a height of two (2) feet above the elevation of the nearest edge of pavement at the said intersecting streets.

C. Paragraphs A and B of this Section notwithstanding, trees may be located within the fifty (50) foot clear distance if their trunks are no more than eight (8) inches in diameter at a height of twelve (12) inches from the ground, and the foliage is cleared to a height of eight (8) feet above the ground. [456]

D. In interpreting this ordinance, the diagrams shown in Figure 8-1-13 shall be utilized to determine the fifty (50) foot segments and the triangle within which structures are limited in height. In any situation not specifically covered in these diagrams, this Section shall be interpreted in a manner to provide maximum sight distance at the intersection.

E. This Section is applicable to that area within the property, but the property owner is also responsible for that area between the property line and the curb, and to the pavement where no curb exists. [456]

F. A sight distance triangle shall be eligible for modification by the Town Engineer if one or both of the intersecting streets are controlled by stop signs or traffic signals and no decrease in sight distance would occur as a result of the modification. [456]

Section 8-1-14 Landscaping [369] Repealed by Ordinance #448, 1/22/98

Section 8-1-15 Public Utility Walls [396]

A. Contrary to any terms in the Paradise Valley Zoning Ordinance, it is permissible for electric utility companies to surround electrical substations with walls eight feet high, measured from finished grade.

B. all walls built under the terms of Section 8-1-15 must comply with the terms of Section 8-1-13.

C. These facilities, although necessary for the health, safety and welfare of the citizens, are a hazard to the citizens and especially the children of the community, and are considered by most to be unsightly.

Figure 8-1-13

A

B

C

D
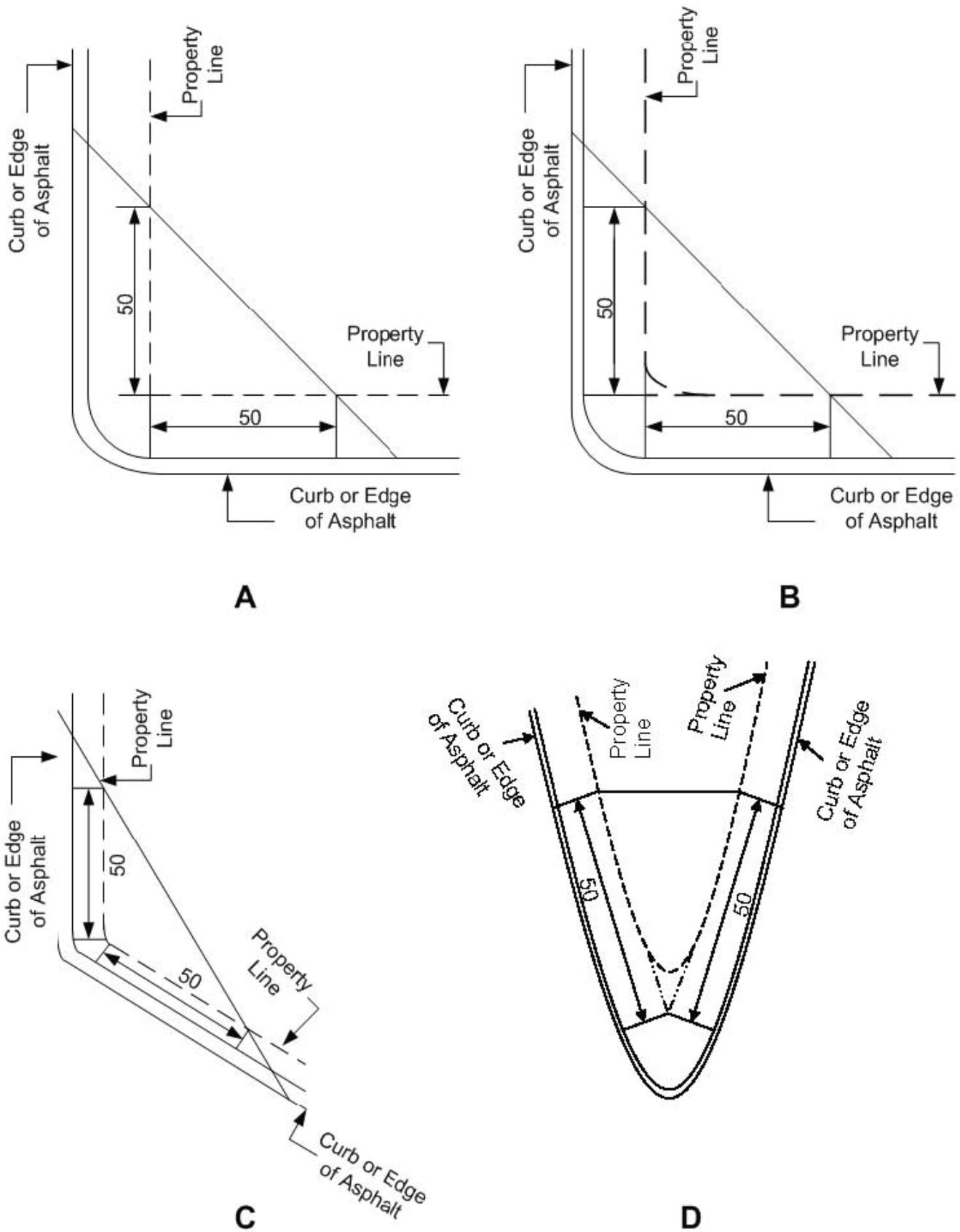
Assumptions and/or Givens

Elements of Design from AASHTO	*6th*	*Edition*	*AASHTO Ref*
Driver Eye Height			
Passenger Vehicle		3.50 ft	§3.2.6, p 3-14
Truck		7.60 ft	§3.2.6, p 3-14
Object Height			
Stopping Sight Distance		2.00 ft	§3.2.6, p 3-14
Passing Sight Distance		3.50 ft	§3.2.6, p 3-14
Vehicle Height		4.25 ft	§3.2.6, p 3-14
Driver Eye Location			
From Edge of Major Rd Traveled Way		14.50 ft	9.5.3, B1
Deceleration Rate (a)			
Passenger Vehicle		11.20 ft/sec^2	§3.2.2, p 3-3
Truck		N/A ft	
Brake reaction time (t)		2.50 sec	§3.2.2, p 3-4

Site Specific Data

Major Street Design Speed (V_{major})		40 MPH	
Grades - Approaching Minor Street from: (— = approaching downhill)			
Left (G_L)		0.00 %	
Right (G_R)		0.00 %	
Approach Grade Adjustment Factor	Left	1.0	Tbl 9-4, p 9-35
	Right	1.0	
Major Road Through Lanes on Each Approach		1.0	
Median Width (in "Lane Equivalents")		0.75	
Bicycle Lane Width (in "Lane Equivalents")		0.0	
Minor Road Approach Upgrade, if >3%		0.00 %	
Minor Road Access (check restricted)			

LI   LO/Th   RO

Stopping Sight Distance = Brake Reaction Distance + Braking Distance

<u>Neglecting Effect of Grade</u>

$$d=1.47Vt+1.075\frac{V^2}{a} \qquad \text{Eq 3-2, p 3-4}$$

Calculated d=   300.6 ft
Design d=   305 ft

<u>With Effect of Grade</u>

$$d=1.47Vt+\frac{V^2}{30\left(\left(\frac{a}{32.2}\right)\pm G\right)} \qquad \text{Eq 3-3, p 3-5}$$

Calculated d=   300.3 ft - left
         305 ft - right
Design d=   300.3 ft - left
         305 ft - right

SSD's do not consider design for truck operations, since better visibility is considered to offset longer braking distance.   §3.2.2, p 3-6

Intersection Sight Distances

		AASHTO Ref
Case B—Intersections with Stop Control on the Minor Road		§9.5.3, p 9-36

<u>Case B1—Left Turn from the Minor Road</u>   §9.5.3, p 9-36

Design Vehicle	Time Gap (t_g)	
Passenger Car	7.5 sec	Tbl 9-5, p 9-37
Single-Unit Tuck	9.5 sec	Tbl 9-5, p 9-37
Combination Truck	11.5 sec	Tbl 9-5, p 9-37

Time gap adjustments		
Add'l lanes to cross (1st is assumed)		
Passenger Car	0.5 sec	See Notes
Trucks	0.7 sec	below
Minor Approach Upgrade (Per each 1%>3%)	0.2 sec	Tbl 9-5, p 9-37

Site data		
Major Road + Bike Lanes on Left Approach	1.0	§9.5.3, p 9-37
Minor Road Approach Upgrade, if >3%	0 %	§9.5.3, p 9-37

Time Gap based on site data
Design Vehicle Gap+Adj for Approach Grade>3%+Adjs for Add'l Lanes & Median

Passenger Car	7.9 sec
Single-Unit Tuck	10.0 sec
Combination Truck	12.0 sec

ISD to left & right along Major Road   ISD=1.47$V_{major}t_g$ (ft)   Eq 9-1, p 9-37

			ISD to Left and Right
Passenger Car	calculated	ISD=	463.1 ft
	design	ISD=	465 ft
Single-Unit Tuck	calculated	ISD=	589.5 ft
	design	ISD=	590 ft
Combination Truck	calculated	ISD=	707.1 ft
	design	ISD=	710 ft

Intersection Sight Distances (cont'd)

	AASHTO Ref
Case B2—Right Turn from the Minor Road	§9.5.3, p 9-40
&	
Case B3—Crossing Maneuver from the Minor Road	§9.5.3, p 9-43

Design Vehicle	Time Gap (t_g)	
Passenger Car	6.5 sec	Tbl 9-7, p 9-40
Single-Unit Tuck	8.5 sec	Tbl 9-7, p 9-40
Combination Truck	10.5 sec	Tbl 9-7, p 9-40

Time gap adjustments - Case B-3 Only*
Add'l lanes to cross (1st is assumed)

Passenger Car	0.5 sec	See Notes
Trucks	0.7 sec	below
Minor Approach Upgrade (Per each 1%>3%)	0.1 sec	Tbl 9-7, p 9-40

Site data

Major Road + Bike Lanes on Left Approach	1.0	§9.5.3, p 9-40
Minor Road Approach Upgrade, if >3%	0 %	§9.5.3, p 9-40

Time Gap based on site data (sec)	B2 & B3	B3 Only

Design Vehicle Gap+Adj for Approach Grade>3%(+Adjs for Add'l Lanes & Median for B3)

	B2 & B3	B3 Only
Passenger Car	6.9	6.9
Single-Unit Tuck	9.0	9.0
Combination Truck	11.0	11.0

ISD to left (B2/B3) & right (B3) along Major Rd ISD=$1.47V_{major}t_g$ (ft) Eq 9-1, p 9-37

		ISD to Left (B2 & B3)	ISD to right (B3 Only)
Passenger Car	calculated ISD=	404.3	404.3
	design ISD=	405	405
Single-Unit Tuck	calculated ISD=	530.7	530.7
	design ISD=	535	535
Combination Truck	calculated ISD=	648.3	648.3
	design ISD=	650	650

*Number of major road lanes is irrelevant in Case B2.

The differences between Case B1 and Cases B2 & B3 are reduced
time gaps and time gap adjustment for the minor approach upgrade. §9.5.3, p 9-43

Intersection Sight Distances (cont'd)

	AASHTO Ref
Case F—Left Turns from the Major Road	§9.5.3, p 9-51

Design Vehicle	Time Gap (t_g)	
Passenger Car	5.5 sec	bl 9-13, p 9-51
Single-Unit Tuck	6.5 sec	bl 9-13, p 9-51
Combination Truck	7.5 sec	bl 9-13, p 9-51

Time gap adjustments
Add'l lanes to cross (1 assumed)

Passenger Car	0.5 sec	See Notes to
Trucks	0.7 sec	bl 9-13, p 9-51

Site data

Opposing Lanes (adj'd for x-wide median)	0.8	

Time Gap based on site data
Design Vehicle Gap+Adj for Add'l Opposing Lanes

Passenger Car	5.9 sec
Single-Unit Tuck	7.0 sec
Combination Truck	8.0 sec

ISD to front along Major Road ISD=$1.47V_{major}t_g$ (ft) Eq 9-1, p 9-37

Passenger Car	calculated ISD=	345.5 ft
	design ISD=	350 ft
Single-Unit Tuck	calculated ISD=	413.1 ft
	design ISD=	415 ft
Combination Truck	calculated ISD=	471.9 ft
	design ISD=	475 ft

The differences between Case F and Cases B1, B2 & B3 are reduced
time gaps and no time gap adjustment for any minor approach upgrade. §9.5.3, p 9-43

SIGHT DISTANCE SUMMARY

Sight Distance Type	Governing Case	Car	SU Truck	Combo Truck
Stopping				
Without effect of grade		305	N/A	N/A
With effect of grade on left		305	N/A	N/A
With effect of grade on right		305	N/A	N/A
Intersection				
To Right	B1	465	590	710
To Left	B2/B3	405	535	650
On Major Road	F	350	415	475