October 11, 2022

Devens Enterprise Commission
c/o Mr. Neil Angus, AICP CEP, LEED AP
Environmental Planner
33 Andrews Parkway
Devens, MA 01434

RE: Proposed Industrial/Warehouse Building
35 Saratoga Boulevard, Devens, MA

Dear Mr. Angus,

Bayside Engineering is in receipt of Nitsch Engineering's (Nitsch) Peer Review letter dated August 26, 2022 review of the Sight Distance materials prepared for the proposed warehouse to be located at 35 Saratoga Boulevard in Devens, MA. The purpose of this letter is to respond to the comments raised on the Bayside materials. The Nitsch comments requiring additional response are addressed below.

Comment No. 20

The report states the sight distance calculations are attached, but they appear to be missing. Please provide any relevant sight distance calculations.

Applicant Response (05/31/2022): The sight distance worksheets are attached.

Nitsch Response (06/07/2022): Are Figures 1-4 the "sight distance worksheets"? Still no calculations found.

Applicant Response (08/22/2022): <None provided>

Nitsch Response (08/25/2022): Please respond to this comment.

Applicant Response: *The sight distance calculations are attached.*

Comment No. 21

For the required minimum sight distances in Table 1, please use the Design values from the AASHTO Green Book (2018) Tables 3-1 and 9-7 (rounded-up values, as are standard), or as adjusted for grade. Please ensure the value for SSD for Saratoga Boulevard approaching from the south at 30 MPH is corrected, as well.

Applicant Response (05/31/2022): Summarized in Table 1 are the sight distances using the

Design values from the AASHTO *A Policy on Geometric Design of Highways and Streets*[1].

TABLE 1
SIGHT DISTANCE SUMMARY

	Required Minimum 30 MPH (Feet)[a]	Required Minimum 35 MPH (Feet)[b]	Required Minimum 40 MPH (Feet)[c]	Measured (Feet)
Saratoga Boulevard and Site Driveway				
Stopping Sight Distance:				
Saratoga Boulevard approaching from the north	200	250	305	500+
Saratoga Boulevard approaching from the south	200	250	305	500+
Intersection Sight Distance:				
Driveway looking to the north	287[d]/331[e]	334[d]/386[e]	382[d]/441[e]	500+
Driveway looking to the south	287[d]/331[e]	334[d]/386[e]	382[d]/441[e]	500+
Barnum Road and Site Driveway				
Stopping Sight Distance:				
Barnum Road approaching from the east[f]	--	234	285	400
Barnum Road approaching from the west[f]	--	234	285	500+
Intersection Sight Distance:				
Driveway looking to the east	--	334[d]/386[e]	382[d]/441[e]	400+
Driveway looking to the west	--	334[d]/386[e]	382[d]/441[e]	500+

[b]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2010, and based on a 30 mph speed (Posted Speed Limit) on Saratoga Boulevard.
[b]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2010, and based on a 35 mph speed on Saratoga Boulevard.
[c]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2010, and based on a 40 mph speed on Saratoga Boulevard.
[d]Recommended minimum value for vehicles turning right exiting a roadway under STOP-sign control.
[e]Recommended minimum value for vehicles turning left exiting a roadway under STOP-sign control.
[f]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2010, and based on a 35 or 40 mph speed on Barnum Road, adjusted for 4% grade.

On May 18, 2022 and May 19, 2022, automatic traffic recorder counts were performed to determine the speed of vehicles on Barnum Road and Saratoga Boulevard. The Barnum Road ATR was placed west of Saratoga Boulevard (which is east of the proposed Barnum Road site driveway). The 85th percentile speed was found to be 38 mph on May 18, 2022 and 39 mph on May 19, 2022 in the westbound direction. This indicates using a 40 mph speed for assessing the sight distances at the Barnum Road driveway would be appropriate.

The Saratoga Boulevard ATR was placed west of the driveway to 35 Saratoga Boulevard (which is west of the 35 Saratoga Boulevard site driveway). The 85th percentile speed was found to be 36 mph on May 18, 2022 and 35 mph on May 19, 2022 in the eastbound direction. This indicates using a 35 mph speed for assessing the sight distances at the Saratoga Boulevard driveway would be appropriate.

1 *A Policy on Geometric Design of Highways and Streets;* American Association of State Highway and Transportation Officials; Washington, D.C.; 2018.

The ATR data is attached.

In the comments from Mass Development, they recommended using the design speed of 45 mph as the posted speed limit on Barnum Road is 35 mph. However, as there is now actual speed data, collected over a two-day period, for Barnum Road, the sight distances were evaluated based on a 40 mph speed, adjusting for grade as appropriate.

Nitsch Response (06/07/2022): Please update *all* required minimum sight distances in Table 1 to their rounded-up values, including the Saratoga Boulevard and Site Driveway ISD and the Barnum Road and Site Driveway SSD and ISD. Change the year of the AASHTO publication in the table footnotes to 2018 for consistency.

Applicant Response (08/22/2022): <None provided>

Nitsch Response (08/25/2022): Please respond to this comment.

Applicant Response: *All required minimum sight distances in Table 1R on the following page have been rounded-up to the values in the AASHTO tables, including the Saratoga Boulevard and Site Driveway ISD and the Barnum Road and Site Driveway SSD and ISD. The year of the AASHTO publication in the table footnotes has been updated 2018.*

At the meeting with the DEC on August 29, 2022, it was requested that sight distance graphics be provided for the site driveway to Saratoga Boulevard. Figures 1S through 4S in the Appendix show the stopping sight distances and intersection sight distances at this driveway.

TABLE 1R
SIGHT DISTANCE SUMMARY

	Required Minimum 30 MPH (Feet)[a]	*Required Minimum 35 MPH (Feet)[b]*	*Required Minimum 40 MPH (Feet)[c]*	*Measured (Feet)*
Saratoga Boulevard and Site Driveway				
Stopping Sight Distance:				
Saratoga Boulevard approaching from the north	*200*	*250*	*305*	*400*
Saratoga Boulevard approaching from the south	*200*	*250*	*305*	*400*
Intersection Sight Distance:				
Driveway looking to the north	*290[d]335[e]*	*335[d]/390[e]*	*385[d]/445[e]*	*450*
Driveway looking to the south	*290[d]/335[e]*	*335[d]/390[e]*	*385[d]/445[e]*	*450*
Barnum Road and Site Driveway				
Stopping Sight Distance:				
Barnum Road approaching from the east[f]	*--*	*235*	*285*	*275*
Intersection Sight Distance:				
Driveway looking to the east[f]	*--*	*335[d]/390[e]*	*385[d]/445[e]*	*300*

[a]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2018, and based on a 30 mph speed (Posted Speed Limit) on Saratoga Boulevard.
[b]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2018, and based on a 35 mph speed on Saratoga Boulevard.
[c]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2018, and based on a 40 mph speed on Saratoga Boulevard.
[d]Recommended minimum value for vehicles turning right exiting a roadway under STOP-sign control.
[e]Recommended minimum value for vehicles turning left exiting a roadway under STOP-sign control.
[f]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2018, and based on a 35 or 40 mph speed on Barnum Road, adjusted for 4% grade on Barnum Road.

Comment No. 22

If either of these roadways has a grade affecting the sight distance (3% or greater), please describe it in the Sight Distance Assessment section and ensure that any calculations provided reflect those grades.

Applicant Response (05/31/2022): Based on available grading data from the site plans, Barnum Road rises a four (4) percent grade approaching the proposed Barnum Road site driveway from both directions. These four (4) percent grades are reflected in the calculations shown above in Table 1.

Nitsch Response (06/07/2022): In footnote "f" of Table 1, specify that it is a 4% *up*grade in both directions. Were the required minimum ISDs for Barnum Road and Site Driveway also adjusted for grade? If so, please provide a footnote to explain. If not, please make those adjustments.

Applicant Response (08/22/2022): <None provided>

Nitsch Response (08/25/2022): Please respond to this comment.

Applicant Response: *As shown on the attached sight distance calculations for the Barnum Road site driveway, the SSD and ISD calculations were adjusted to account for the 4% grades. Footnote f in Table 1R describes the 4% grade used in the adjustment.*

Comment No. 23

In Figures 1 and 2, what is the visual obstruction between driver and object used to determine the sight line?

Applicant Response (05/31/2022): The stopping sight distance (SSD) was measured from the height of the truck driver's eye (7.75 feet average) to a two (2) foot tall object at the edge of the travelled way (Barnum Road). Additional sight lines were prepared using automobiles exiting the proposed Barnum Road site driveway. These are shown on Figures 3 and 4, attached.

As noted on Figure 3, with a lower profile and lower eye height, automobiles will have less stopping sight distance. It is recommended that an Intersection Ahead (W2-2) sign be installed on Barnum Road westbound. This sign can be supplemented with a W10-11 (Truck) sign.

Nitsch Response (06/07/2022): See Comment No. 26. If actual measurements were taken from the CAD drawings in Figures 1-4, is the crest curve of the roadway itself the visual obstruction between driver and object that was used to determine the sight line? Separately, on the grade charts in Figures 1-4, are the grades along the roadway centerline or along the sight lines shown?

Applicant Response (08/22/2022): The stopping sight distance (SSD) was measured from the height of the truck driver's eye (7.75 feet average) to a two (2) foot tall object at the edge of the travelled way (Barnum Road). Additional sight lines were prepared using automobiles exiting the proposed Barnum Road site driveway. These are shown on Figures 3 and 4, attached.

The visual obstructions would have been the existing topography. Photos showing the sight lines are included in the response to Comment No. 26 below.

As noted on Figure 3, with a lower profile and lower eye height, automobiles will have less

stopping sight distance. It is recommended that an Intersection Ahead (W2-2) sign be installed on Barnum Road westbound. This sign can be supplemented with a W10-11 (Truck) sign.

Nitsch Response (08/25/2022): No new Figures 3 and 4 were provided, so we assume this is referring to the Figures 3 and 4 included in the applicant response from May 31, 2022. However, Figures 1 and 2 were updated in the interim and still have questions that are outstanding – see Comment 30. There have been inconsistencies between figures and changes that could affect sight distance measurements. Please provide updated Figures 1-4 with all relevant comments incorporated, and please label the visual obstruction along the sight line, be it a roadside slope, the roadway itself within the vertical curve, or otherwise. In other words, show how the sight line vector was constructed such that it was then measured in CAD. As shown currently, it looks like the vehicle on the roadway is placed at an arbitrary distance from the driveway and a line is drawn between the two vehicles. Show how that line was made. If the visual obstruction is the roadway itself, is that the purpose of the profile view, and if so, is the existing grade for the roadway centerline or does it follow the sight lines? This distinction is particularly important for the sight lines that cross over the roadside.

Applicant Response: *The original sight distance graphics are no longer valid as the Barnum Road driveway location has changed slightly and the driveway now will permit right turns in/out only. As such, the only sight lines that come into play are approaching from the east for the SSD and looking to the east for the ISD. Updated sight line graphics, Figure 1B and 2B, are included in the Appendix.*

For the SSD graphics, the height of driver's eye recommended by AASHTO is 3.5 feet above grade. The height of object at the edge of travelled way is 2.0 feet. Using the proposed driveway as the point of reference, a vehicle was placed in the exiting lane with its bumper on the edge of travelled way. From this point, starting at a height of 2.0 feet above grade, a line was drawn to the east just over the topographical features along the property frontage and Barnum Road driveway, just above the associated grade until the line was 3.5 feet above grade, representing the driver's eye height. All grades, existing and proposed, for the sight distance graphics were obtained from site planes prepared by Eugene T. Sullivan, Inc.

For the ISD graphics, the driver's eye location is placed 14.5 back from the edge of the travelled way. The height of the driver's eye, for an automobile is 3.5 feet above grade. From this point, a line is drawn to the center of the approaching lane and a height of 3.5 feet above grade. This line is just above the existing grade.

All of the sight distance graphics were prepared using CAD. The profile line shown is along the driver's eye toward the site driveway or from the driver's eye to the approaching vehicle. The resulting sight distances are tabulated in Table 1R.

A second sight distance analysis was performed for the Barnum Road driveway by shifting the

Barnum Road driveway to the east to optimize the potential sight distances. These sight distances are shown on Figures 3B and 4B in the Appendix. Table 2R summarizes the sight distances for the relocated Barnum Road site driveway.

TABLE 2R
SIGHT DISTANCE SUMMARY Relocated Barnum Road Site Driveway

	Required Minimum 30 MPH (Feet)[a]	*Required Minimum 35 MPH (Feet)[b]*	*Required Minimum 40 MPH (Feet)[c]*	*Measured (Feet)*
Barnum Road and Site Driveway				
Stopping Sight Distance:				
Barnum Road approaching from the east[f]	--	*235*	*285*	*400*
Intersection Sight Distance:				
Driveway looking to the east[f]	--	*335[d]/390[e]*	*385[d]/445[e]*	*400*

[a]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2018, and based on a 30 mph speed (Posted Speed Limit) on Saratoga Boulevard.
[b]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2018, and based on a 35 mph speed on Saratoga Boulevard.
[c]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2018, and based on a 40 mph speed on Saratoga Boulevard.
[d]Recommended minimum value for vehicles turning right exiting a roadway under STOP-sign control.
[e]Recommended minimum value for vehicles turning left exiting a roadway under STOP-sign control.
[f]Recommended minimum values obtained from A Policy on Geometric Design of Highways and Streets; American Association of State Highway and Transportation Officials (AASHTO); 2018, and based on a 35 or 40 mph speed on Barnum Road, adjusted for 4% grade on Barnum Road.

As shown in Table 2R, with the driveway shifted, the SSD and ISD improve to 400 feet.

Comment No. 26

Describe whether these measurements all done in CAD, or if there were any field measurements. Please provide figures showing all SSD and ISD measurements done in CAD. For any field measurements, provide the date(s) taken. Also, describe any considerations for change in foliage/vegetation levels for different times of year, especially if taken when there was little or no foliage/vegetation.

Applicant Response (05/31/2022): The measurements were done in CAD for Figures 1 and 2. Field observations were made for both the Saratoga Boulevard and Barnum Road driveways. The site visits were performed on March 3, 2022 and March 8, 2022. Looking to the east out of the proposed Barnum Road site driveway, the area is sloped and grassed only. There are no trees, shrubs, or signage that would impede sight lines (relative to foliage and vegetation) as seen in the photo to the right.

Looking to the west out of the proposed Barnum Road site driveway, the area is also sloped and grassed only. The tree line to the west is closer to Barnum Road. The photograph to the right shows the view measured 14.5 from the edge of travelled way. While it is the end of winter, the leaves from the previous Fall are still on the tree and do not block sight lines.

Nitsch Response (06/07/2022): Both pictures provided appear to be looking to the right from one or the other of the driveways, but the narrative describes only the Barnum Road site driveway looking east (left) and west (right). Please clarify. Also, please clarify whether the measured sight distances in Table 1 are all from field measurements or the ones looking east on Barnum Road are from the measurements done in CAD and shown in Figures 1-4. If they were all from field measurements, please clarify the purpose of Figures 1-4. Depending on that purpose, consider providing figures showing sight distances looking west on Barnum Road and looking both ways on Saratoga Road as well.

Applicant Response (08/22/2022): The measurements were done in CAD for Figures 1 and 2. Field observations were made for both the Saratoga Boulevard and Barnum Road driveways. The site visits were performed on March 3, 2022 and March 8, 2022. Looking to the east out of the proposed Barnum Road site driveway, the area is sloped and grassed only. There are no trees, shrubs, or signage that would impede sight lines (relative to foliage and vegetation) as seen in the photo to the right.

Looking to the west out of the proposed Barnum Road site driveway, the area is also sloped and grassed only. The tree line to the west is closer to Barnum Road. The photograph to the right shows the view measured 14.5 from the edge of travelled way. While it is the end of winter, the leaves from the previous Fall are still on the tree and do not block sight lines.

Nitsch Response (08/25/2022): The top picture has now been flipped (mirror image) relative to the one provided in the earlier response with no note about that change. Please confirm that this is now the correct orientation for this picture. Also, please clarify whether the measured sight distances in Table 1 are all from field measurements or the ones looking east on Barnum Road are from the measurements done in CAD and shown in Figures 1-4. If they were all from field measurements, please clarify the purpose of Figures 1-4. If the measurements are all from CAD, please provide figures showing sight distances looking west on Barnum Road and looking both ways on Saratoga Road as well.

Applicant Response: *The set of photos on Page 8 represent the actual views based on photos taken from the site visits. The original sight distance graphics, as well as those enclosed with this response were all generated based on CAD. Included with the response to Comment No. 21 are the sight line graphics for the Saratoga Boulevard driveway. Included in the response to Comment No. 23 are the updated sight line graphics for the proposed Barnum Road driveway.*

Comment No. 29

On page 6, it says the measured ISD at the proposed site driveway is 550+ feet. Please clarify whether this referring to one (1) of the driveways or both. Either way, the measured ISDs in Table 1 do not match. Please correct the table and/or the narrative.

Applicant Response (05/31/2022): The statement was to refer to the SSD, not the ISD. The SSD for the proposed driveways exceeds the minimum AASHTO requirements.

Nitsch Response (06/07/2022): We note that the measured SSDs for both proposed driveways exceed the minimum AASHTO requirements, as shown in Table 1, no matter whether the measured SSDs are 400/500+ feet as shown in the Table or 550+ feet as stated in the report paragraph. Nevertheless, the updated report should either drop the stated value from the paragraph or state values consistent with the table.

Applicant Response (08/22/2022): <None provided>

Nitsch Response (08/25/2022): Please respond to this comment.

Applicant Response: *The distances in Table 1R coincide with the sight distance graphics contained with this response letter.*

Comment No. 30

New Nitsch Comment in response to new Figure 1 & Figure 2 received the day prior (07/26/2022): They have sent us a revised version of their Figures 1 and 2, which show a revised driveway configuration on Barnum Road having a raised triangular island, consistent with the accompanying plans. But also:

- Figure 1 has changed from a truck spotting a truck to a car spotting a car, which presents a more conservative sight distance analysis, which is good, but somehow the measured distance is the same. There is no explanation given.
- Figure 2 remains a truck spotting a car, but the height of the truck driver's eye has dropped from 7.75' (appropriate for a truck) to 4.00' (appropriate for a car), which doesn't make sense. Also, the height of the car being spotted has changed from 3.50' to 4.00' and no explanation is given.

I would like to know what the proponent is trying to show with these revised figures. The revised figures do not directly address any of the comments, though Comments No. 23 & 26 ask questions of these figures. They still need to respond to those comments as well as the others in the email sent to Peter Lowitt on June 7, 2022. And if they have revised the report itself, I would like to see it.

Applicant Response (08/22/2022): <None provided>

Nitsch Response (08/25/2022): Please respond to this comment.

Applicant Response: *The sight distance graphics referenced were prepared in response to a verbal request for a 4.0 foot sight line. These graphics are now considered moot and have no bearing on the sight distance assessment.*

Comment No. 31

New Nitsch Comment (08/25/2022): Please respond to all unresolved comments and submit revised Sight Distance Assessment report.

Applicant Response: *All comments have been addressed and summarized within this letter.*

Please do not hesitate to contact me if you have any questions or require additional information.

Sincerely,

BAYSIDE ENGINEERING, INC.

Kenneth P. Cram, P.E.
Director, Traffic Engineering

Appendix

Sight Distance Worksheets

Saratoga Boulevard Driveway Sight Distance Graphics

Barnum Road Driveway Sight Distance Graphics

Sight Distance Worksheets

Sight Distance Calculations

Proposed Warehouse, Devens, MA

Inputs

Posted Speed Limit = 30 mph EB and 30 mph WB

Direction 1 =	Saratoga Boulevard EB	85% Speed =	30	mph	Grade =	0	t=	2.5	s	a=	11.2 ft/s^2
Direction 2 =	Saratoga Boulevard WB	85% Speed =	30	mph	Grade =	0	t=	2.5	s	a=	11.2 ft/s^2
						Left:	t_g =	7.5	s		
						Right:	t_g =	6.5	s		

SSD = Reaction Distance + Braking Distance

Reaction Distance = 1.47 x V x t

Braking Distance = $V^2/(30 \times ((a/32.2) + G))$

ISD = 1.47 x V x t_g

Where t = reaction time (sec)

t_g = time gap for minor road vehicle to enter the major road

V= travel speed (mph)

G= roadway grade

a= deceleration rate (ft/s^2)

Calculations

	Reaction Distance (ft)	Brake Distance (ft)	SSD (ft)
Saratoga Boulevard EB	110.3	86.3	197
Saratoga Boulevard WB	110.3	86.3	197

For 30 mph:		
Left Turn ISD =	331	ft
Right Turn ISD =	287	ft

For 30 mph:		
Left Turn ISD =	331	ft
Right Turn ISD =	287	ft

Source: AASHTO Geometric Design of Highways and Streets; FHWA; Washington, D.C.; 2018

Sight Distance Calculations

Proposed Warehouse, Devens, MA

Inputs

Posted Speed Limit = 30 mph EB and 30 mph WB

Direction 1 =	Saratoga Boulevard EB	85% Speed =	35	mph	Grade =	0	t=	2.5 s	a=	11.2	ft/s^2
Direction 2 =	Saratoga Boulevard WB	85% Speed =	35	mph	Grade =	0	t=	2.5 s	a=	11.2	ft/s^2
						Left:	t_g =	7.5 s			
						Right:	t_g =	6.5 s			

SSD = Reaction Distance + Braking Distance

Reaction Distance = 1.47 x V x t

Braking Distance = $V^2/(30 \times ((a/32.2) + G))$

ISD = 1.47 x V x t_g

Where t = reaction time (sec)

t_g = time gap for minor road vehicle to enter the major road

V= travel speed (mph)

G= roadway grade

a= deceleration rate (ft/s^2)

Calculations

	Reaction Distance (ft)	Brake Distance (ft)	SSD (ft)
Saratoga Boulevard EB	128.6	117.4	246
Saratoga Boulevard WB	128.6	117.4	246

For	35 mph:		
Left Turn ISD =	386	ft	
Right Turn ISD =	334	ft	

For	35 mph:		
Left Turn ISD =	386	ft	
Right Turn ISD =	334	ft	

Source: AASHTO Geometric Design of Highways and Streets; FHWA; Washington, D.C.; 2018

Sight Distance Calculations

Proposed Warehouse, Devens, MA

Inputs

Posted Speed Limit = 30 mph EB and 30 mph WB

Direction 1 =	Saratoga Boulevard EB	85% Speed =	40	mph	Grade =	0	t=	2.5	s	a=	11.2 ft/s^2
Direction 2 =	Saratoga Boulevard WB	85% Speed =	40	mph	Grade =	0	t=	2.5	s	a=	11.2 ft/s^2
						Left:	t_g =	7.5	s		
						Right:	t_g =	6.5	s		

SSD = Reaction Distance + Braking Distance

Reaction Distance = 1.47 x V x t

Braking Distance = $V^2/(30 \times ((a/32.2) + G))$

ISD = 1.47 x V x t_g

Where t = reaction time (sec)
t_g = time gap for minor road vehicle to enter the major road
V= travel speed (mph)
G= roadway grade
a= deceleration rate (ft/s^2)

Calculations

	Reaction Distance (ft)	Brake Distance (ft)	SSD (ft)
Saratoga Boulevard EB	147.0	153.3	300
Saratoga Boulevard WB	147.0	153.3	300

For	40 mph:		
Left Turn ISD =	441	ft	
Right Turn ISD =	382	ft	

For	40 mph:		
Left Turn ISD =	441	ft	
Right Turn ISD =	382	ft	

Source: AASHTO Geometric Design of Highways and Streets; FHWA; Washington, D.C.; 2018

Sight Distance Calculations

Proposed Warehouse, Devens, MA

Inputs

Posted Speed Limit = 35 mph NB and 35 mph SB

Direction 1 =	Barnum Road EB	85% Speed =	35	mph	Grade =	4	t=	2.5	s	a=	11.2 ft/s^2
Direction 2 =	Barnum Road WB	85% Speed =	35	mph	Grade =	4	t=	2.5	s	a=	11.2 ft/s^2
						Left:	t_g =	7.5	s		
						Right:	t_g =	6.5	s		

SSD = Reaction Distance + Braking Distance

Reaction Distance = 1.47 x V x t

Braking Distance = $V^2/(30 \times ((a/32.2) + G))$

ISD = 1.47 x V x t_g

Where t = reaction time (sec)

t_g = time gap for minor road vehicle to enter the major road

V= travel speed (mph)

G= roadway grade

a= deceleration rate (ft/s^2)

Calculations

	Reaction Distance (ft)	Brake Distance (ft)	SSD (ft)
Barnum Road EB	128.6	105.3	234
Barnum Road WB	128.6	105.3	234

For 35 mph:

Left Turn ISD = 386 ft

Right Turn ISD = 334 ft

For 35 mph:

Left Turn ISD = 386 ft

Right Turn ISD = 334 ft

Source: AASHTO Geometric Design of Highways and Streets; FHWA; Washington, D.C.; 2018

Sight Distance Calculations

Proposed Warehouse, Devens, MA

Inputs

Posted Speed Limit = 35 mph NB and 35 mph SB

Direction 1 =	Barnum Road EB	85% Speed =	35	mph	Grade =	4	t=	2.5	s	a=	11.2 ft/s^2
Direction 2 =	Barnum Road WB	85% Speed =	35	mph	Grade =	4	t=	2.5	s	a=	11.2 ft/s^2
						Left:	t_g =	7.5	s		
						Right:	t_g =	6.5	s		

SSD = Reaction Distance + Braking Distance

Reaction Distance = 1.47 x V x t

Braking Distance = $V^2/(30 \times ((a/32.2) + G))$

ISD = 1.47 x V x t_g

Where t = reaction time (sec)

t_g = time gap for minor road vehicle to enter the major road

V= travel speed (mph)

G= roadway grade

a= deceleration rate (ft/s^2)

Calculations

	Reaction Distance (ft)	Brake Distance (ft)	SSD (ft)
Barnum Road EB	128.6	105.3	234
Barnum Road WB	128.6	105.3	234

For 35 mph:

Left Turn ISD = 386 ft

Right Turn ISD = 334 ft

For 35 mph:

Left Turn ISD = 386 ft

Right Turn ISD = 334 ft

Source: AASHTO Geometric Design of Highways and Streets; FHWA; Washington, D.C.; 2018

Sight Distance Calculations

Proposed Warehouse, Devens, MA

Inputs

Posted Speed Limit = 35 mph NB and 35 mph SB

Direction 1 =	Barnum Road EB	85% Speed =	40	mph	Grade =	4	t=	2.5	s	a=	11.2 ft/s^2
Direction 2 =	Barnum Road WB	85% Speed =	40	mph	Grade =	4	t=	2.5	s	a=	11.2 ft/s^2
						Left:	t_g =	7.5	s		
						Right:	t_g =	6.5	s		

SSD = Reaction Distance + Braking Distance

Reaction Distance = 1.47 x V x t

Braking Distance = $V^2/(30 \times ((a/32.2) + G))$

ISD = 1.47 x V x t_g

Where t = reaction time (sec)
t_g = time gap for minor road vehicle to enter the major road
V= travel speed (mph)
G= roadway grade
a= deceleration rate (ft/s^2)

Calculations

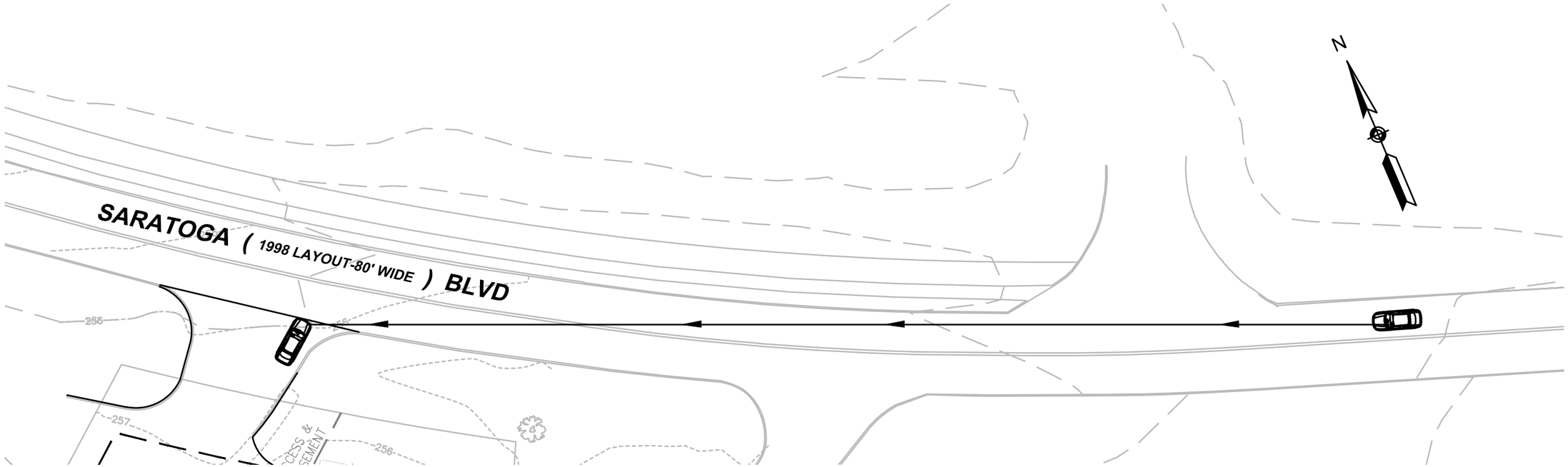
	Reaction Distance (ft)	Brake Distance (ft)	SSD (ft)
Barnum Road EB	147.0	137.5	285
Barnum Road WB	147.0	137.5	285

For 40 mph:
Left Turn ISD = 441 ft
Right Turn ISD = 382 ft

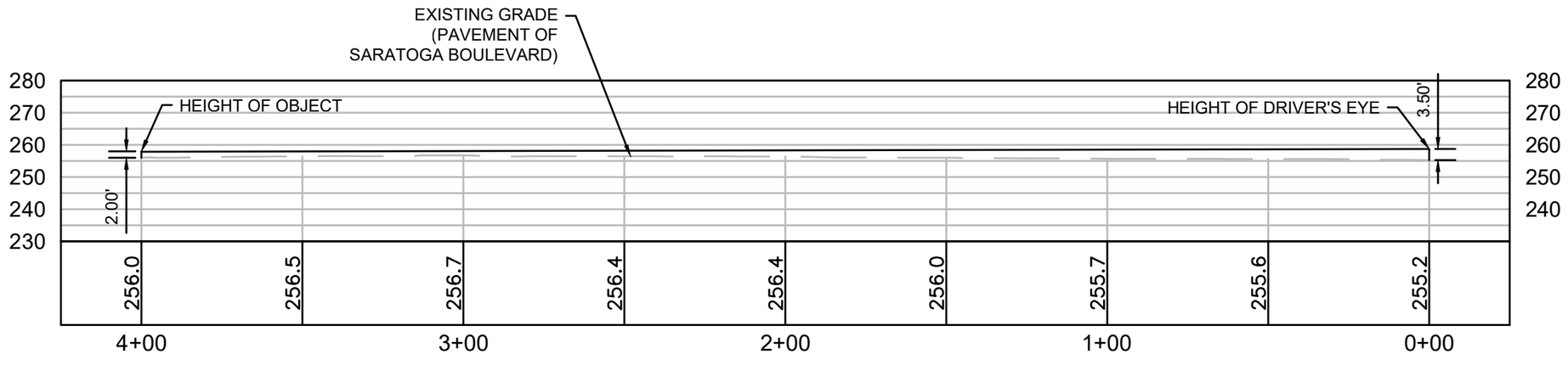
For 40 mph:
Left Turn ISD = 441 ft
Right Turn ISD = 382 ft

Source: AASHTO Geometric Design of Highways and Streets; FHWA; Washington, D.C.; 2018

Saratoga Boulevard Driveway Sight Distance Graphics



SCALE 1" = 40'



HORIZONTAL SCALE 1" = 40'
VERTICAL SCALE 1' = 1'

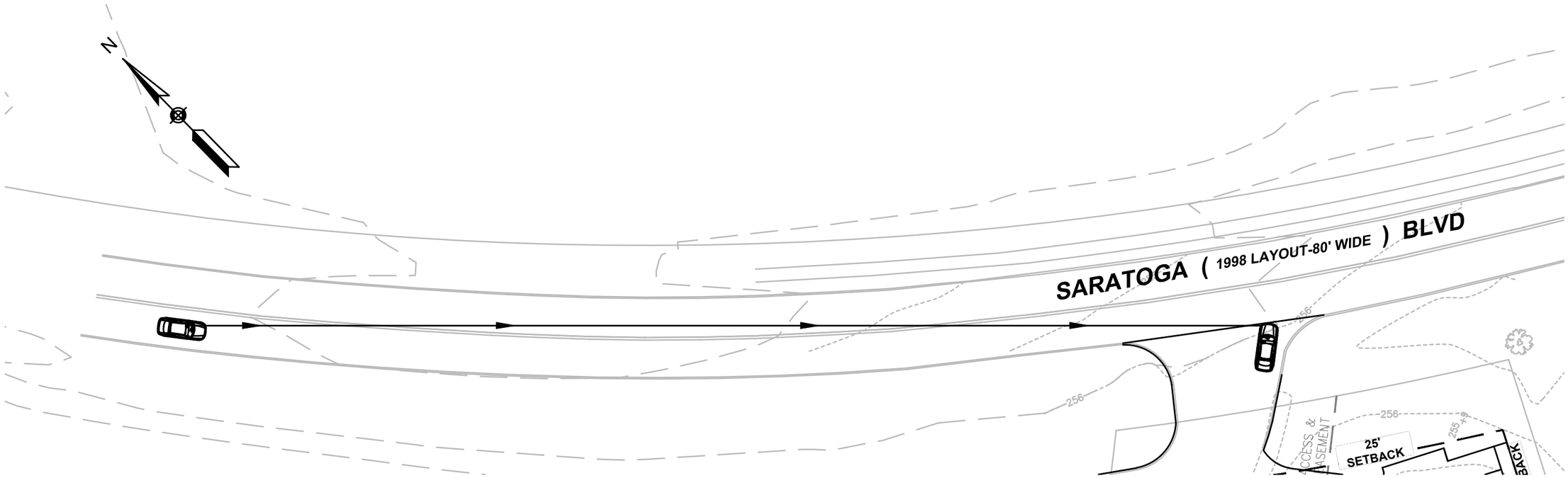
Note: Existing grades taken from site plans prepared by Eugene T. Sullivan Inc.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

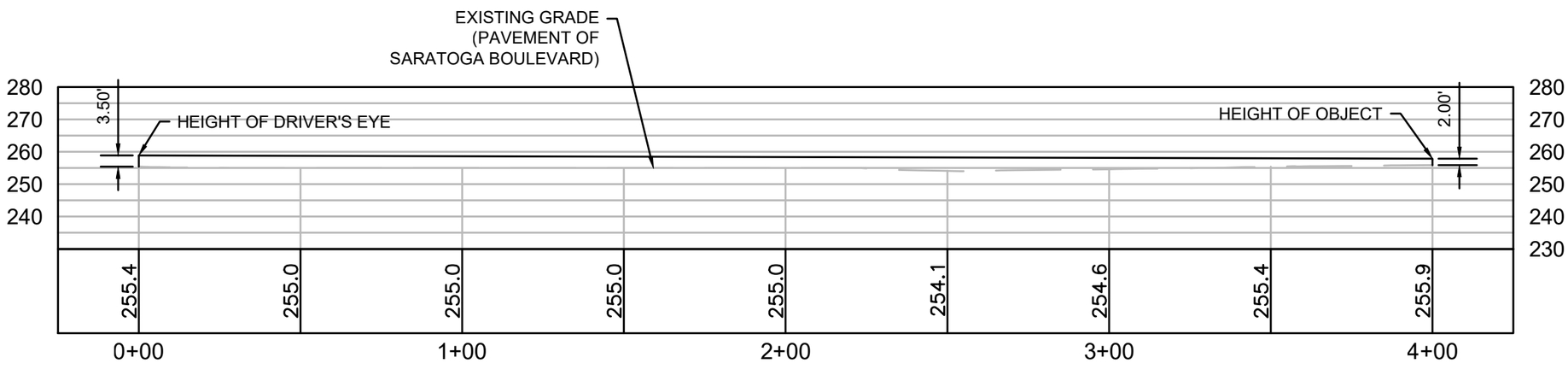
Proposed Warehouse
35 Saratoga Boulevard
Devens, MA

Figure 1S

Stopping Sight Distance
Approaching From East
35 Saratoga Boulevard Driveway



SCALE 1" = 40'



HORIZONTAL SCALE 1" = 40'
VERTICAL SCALE 1' = 1'

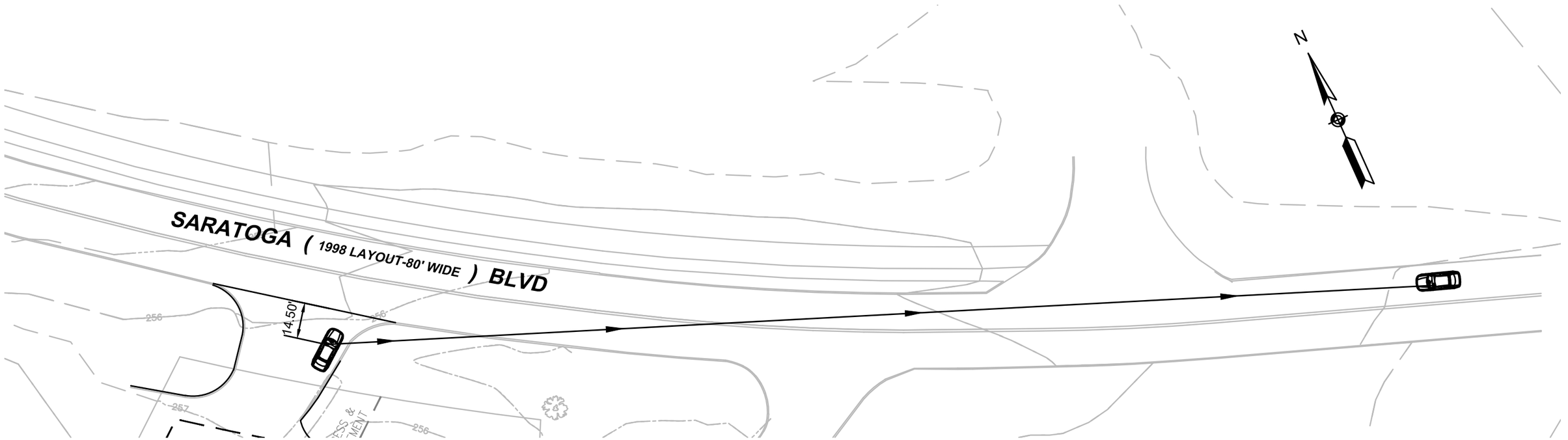
Note: Existing grades taken from site plans prepared by Eugene T. Sullivan Inc.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

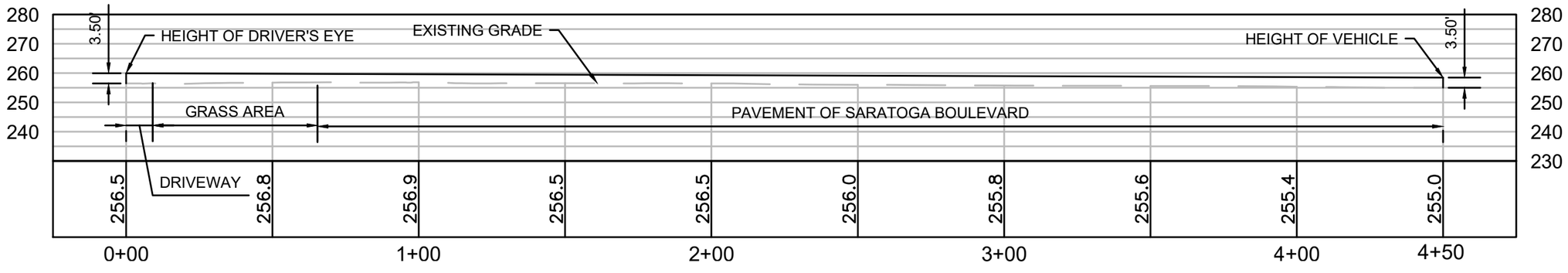
Proposed Warehouse
35 Saratoga Boulevard
Devens, MA

Figure 2S

Stopping Sight Distance
Approaching from West
35 Saratoga Boulevard Driveway



SCALE 1" = 40'



HORIZONTAL SCALE 1" = 40'
VERTICAL SCALE 1' = 1'

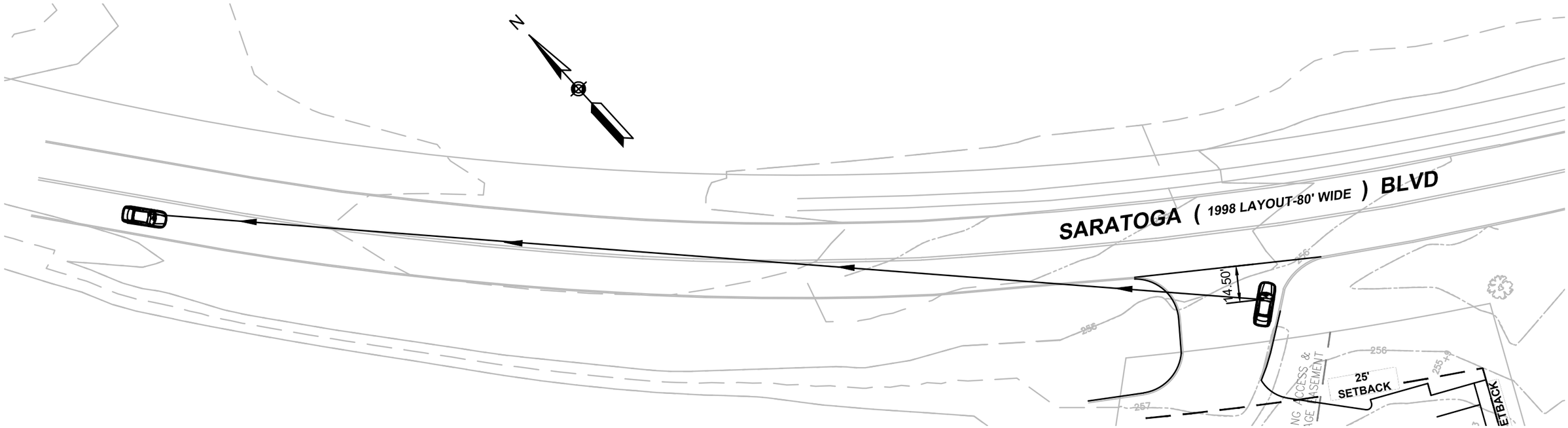
Note: Existing grades taken from site plans prepared by Eugene T. Sullivan Inc.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

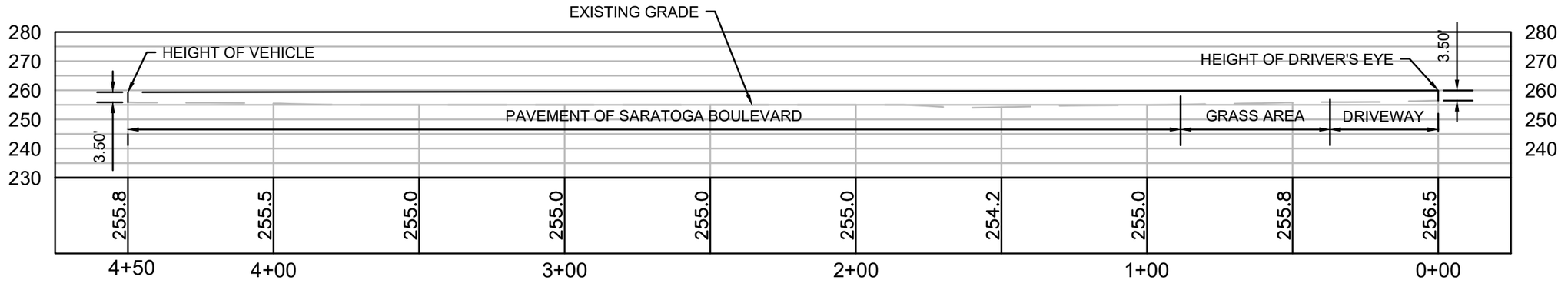
Proposed Warehouse
35 Saratoga Boulevard
Devens, MA

Figure 3S

Intersection Sight Distance
Driveway Looking East From
35 Saratoga Boulevard Driveway



SCALE 1" = 40'



HORIZONTAL SCALE 1" = 40'
VERTICAL SCALE 1' = 1'

Note: Existing grades taken from site plans prepared by Eugene T. Sullivan Inc.

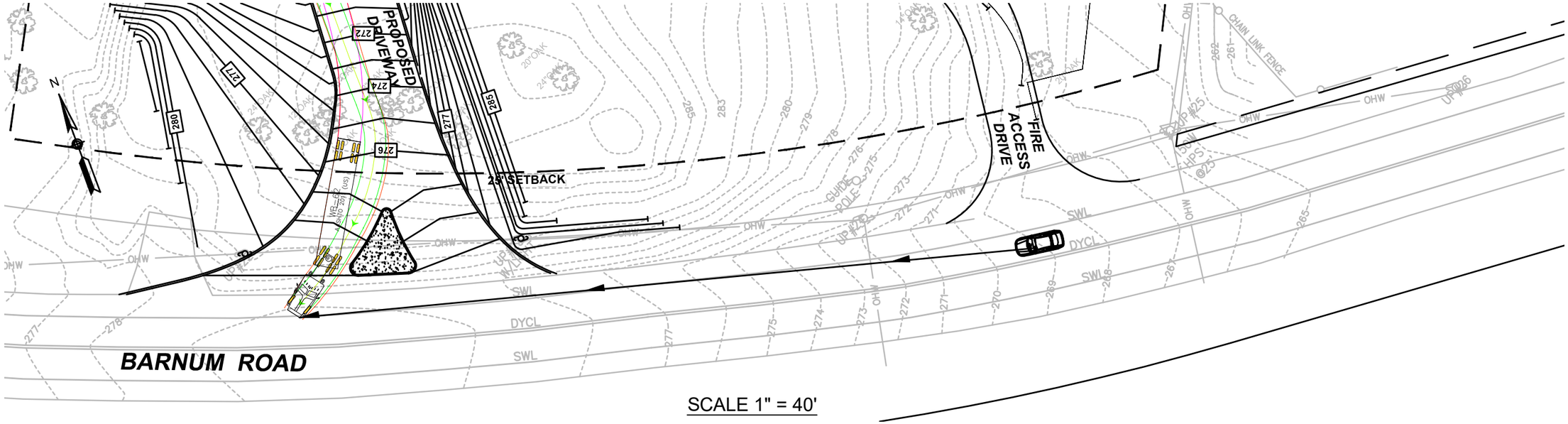
BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Warehouse
35 Saratoga Boulevard
Devens, MA

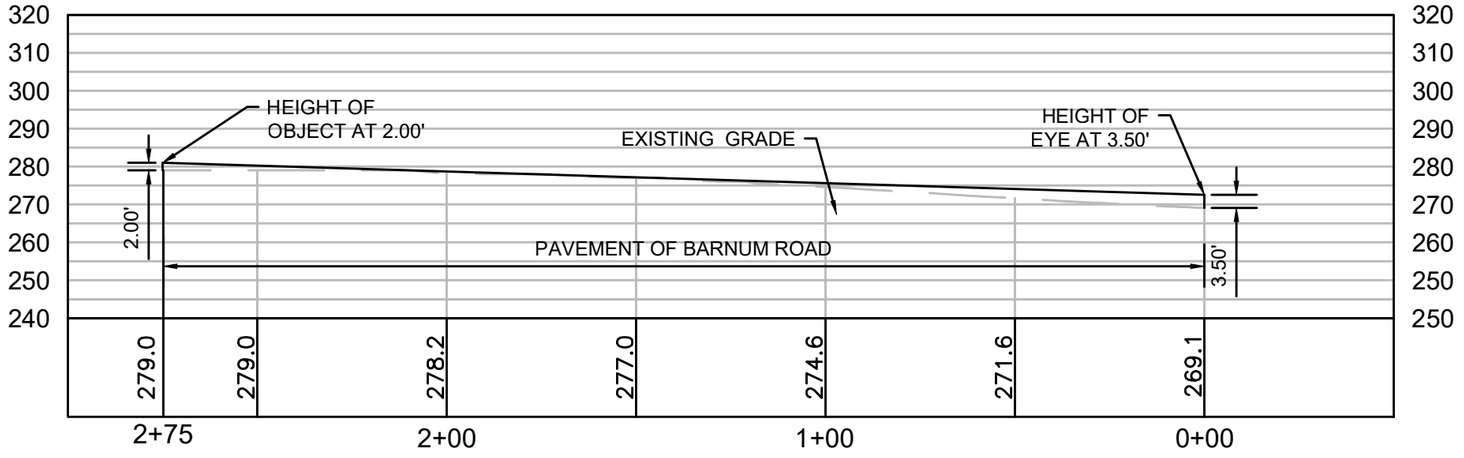
Figure 4S

Intersection Sight Distance
Driveway Looking West From
35 Saratoga Boulevard Driveway

Barnum Road Driveway Sight Distance Graphics



SCALE 1" = 40'



HORIZONTAL SCALE 1" = 40'
VERTICAL SCALE 1' = 1'

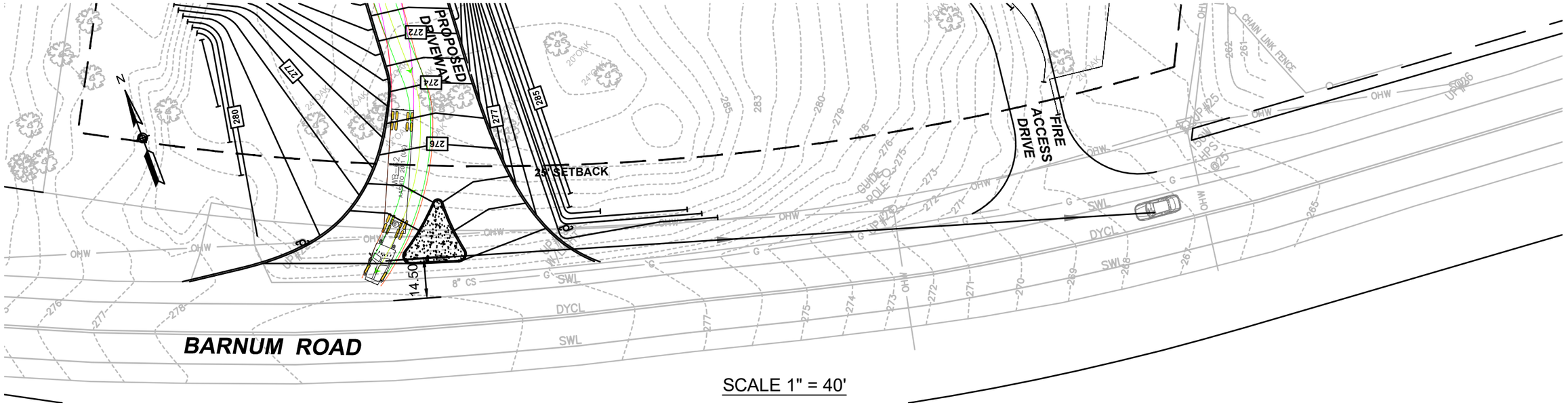
Note: Existing and proposed grades taken from site plans prepared by Eugene T. Sullivan Inc.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

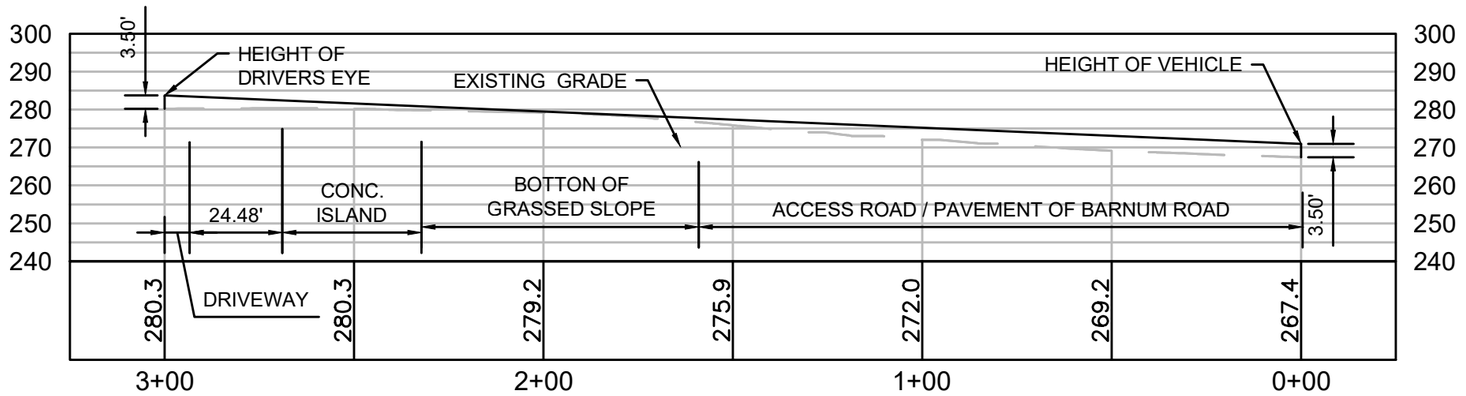
Proposed Warehouse
35 Saratoga Boulevard
Devens, MA

Figure 1B

Stopping Sight Distance Approaching from East Barnum Road Driveway



SCALE 1" = 40'



HORIZONTAL SCALE 1" = 40'
VERTICAL SCALE 1' = 1'

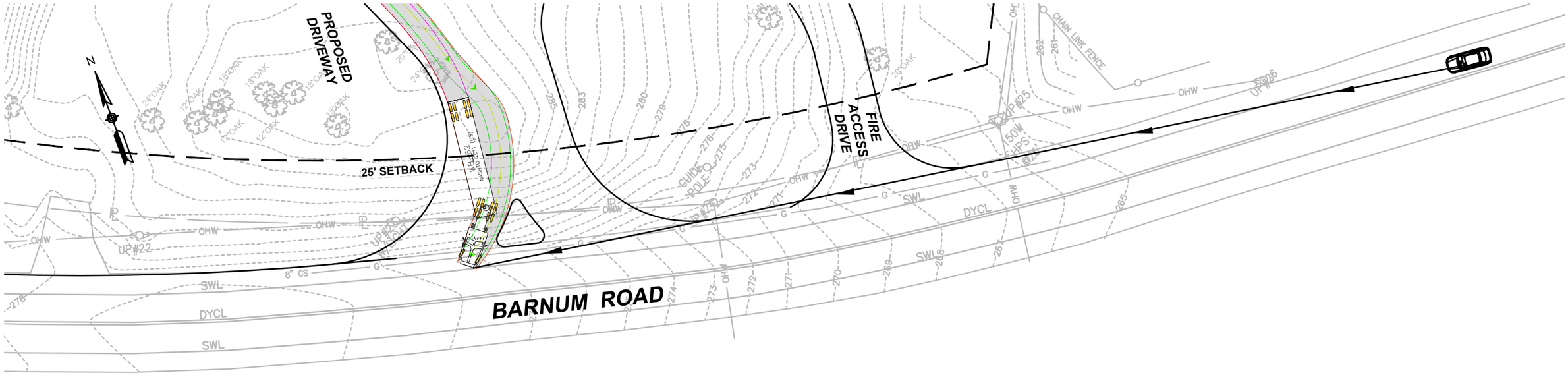
Note: Existing grade taken from site plans prepared by Eugene T. Sullivan Inc.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

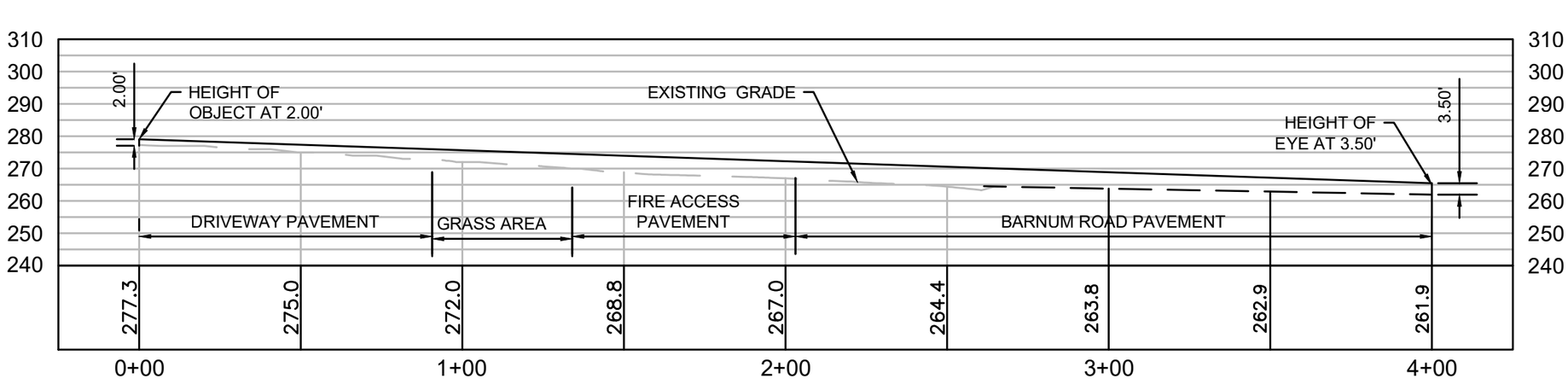
Proposed Warehouse
35 Saratoga Boulevard
Devens, MA

Figure 2B

Intersection Sight Distance
Looking East From
Barnum Road Driveway



SCALE 1" = 40'



HORIZONTAL SCALE 1" = 40'
VERTICAL SCALE 1' = 1'

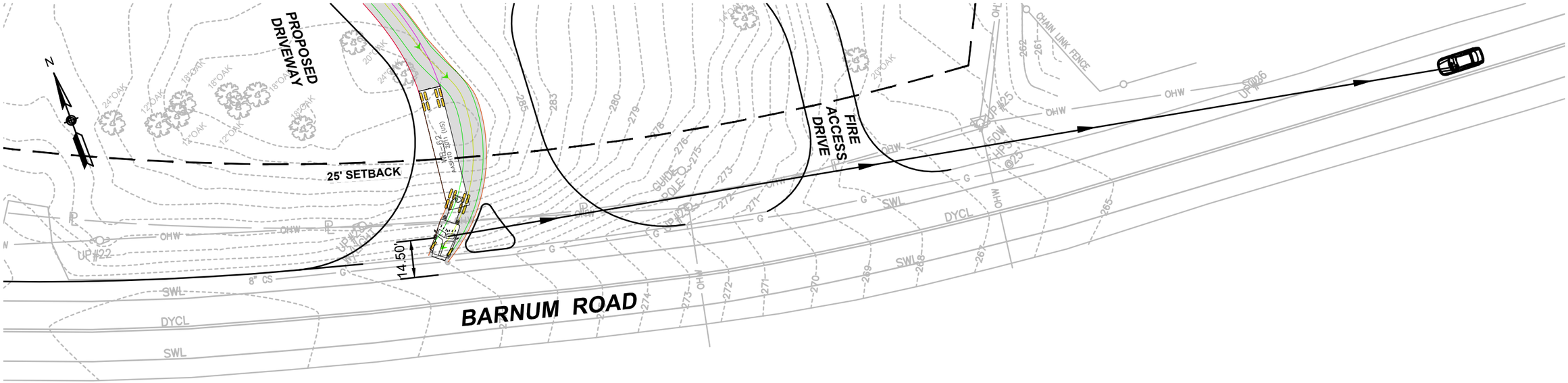
Note: Existing and proposed grades taken from site plans prepared by Eugene T. Sullivan Inc.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

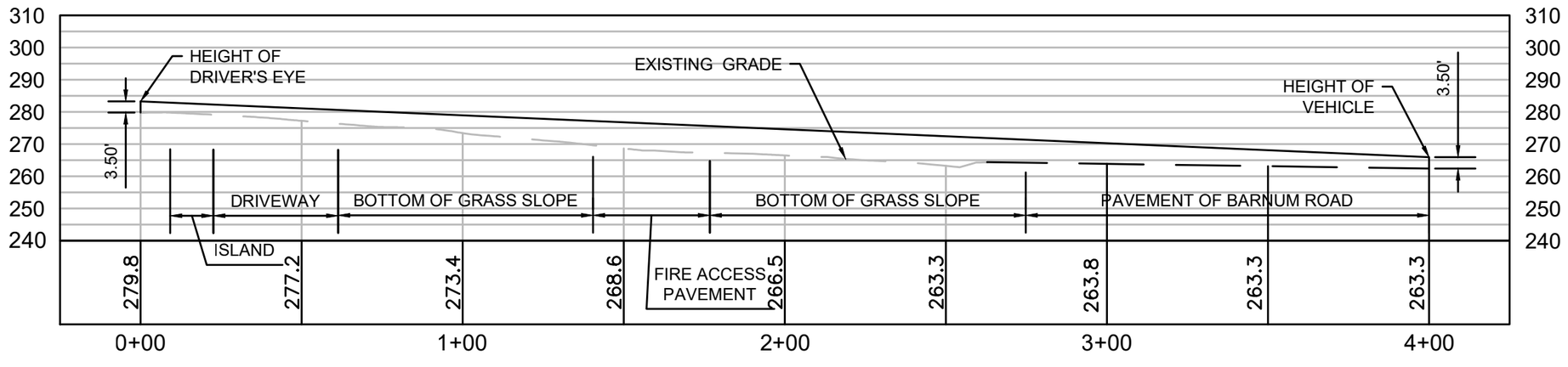
Proposed Warehouse
35 Saratoga Boulevard
Devens, MA

Figure 3B

Stopping Sight Distance
Driveway Approaching East
Barnum Road Driveway
Driveway Shifted to East



SCALE 1" = 40'



HORIZONTAL SCALE 1" = 40'
VERTICAL SCALE 1' = 1'

Note: Existing and proposed grades taken from site plans prepared by Eugene T. Sullivan Inc.

BAYSIDE ENGINEERING
600 Unicorn Park Drive ▲ Woburn, MA 01801
Phone: 781.932.3201 ▲ Fax: 781.932.3413
www.baysideengineering.com

Proposed Warehouse
35 Saratoga Boulevard
Devens, MA

Figure 4B

Intersection Sight Distance
Driveway Looking East From
Barnum Road Driveway
Driveway Shifted to East