MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

PRINCIPALS
Robert J. Michaud, P.E.
Daniel J. Mills, P.E., PTOE

# MEMORANDUM

**DATE:** April 26, 2021

**TO:** Mr. Glenn Clancy, PE
Director of Community Development Town of Belmont
19 Moore Street
Belmont, Massachusetts 02478

**FROM:** Robert J. Michaud, P.E. – Managing Principal
Daniel A. Dumais, P.E. – Senior Project Manager

**RE:** **Response to Comments – BSC Group**
Proposed 40B Residential Development
91 Beatrice Circle – Belmont, MA

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MDM Transportation Consultants, Inc. (MDM) has prepared the following responses to transportation-related comments as issued in a letter by BSC Group (BSC) dated March 25, 2021 and subsequent email correspondence of April 8, 2021 from BSC to the ZBA (paraphrased herein). To facilitate review, specific comments are paraphrased with corresponding responses.

## September 2020 Traffic Impact Memorandum

Comment 1: *"The study methodology is generally consistent with the requirements of the Town of Belmont and the Massachusetts Department of Transportation (MassDOT) guidelines for traffic impact assessment with the exception of the evaluation of the Design Year (2020). Traffic impact analyses that follow MassDOT guidelines typically project traffic volumes seven years into the future to evaluate a future "Build" condition scenario that incorporates general traffic growth and any additional traffic volumes from planned projects. BSC requests that the Applicant provide their reasoning for not including a future conditions scenario in the analysis and how this would impact the overall conclusions and findings of memo."*

**Response**: The small project size (12 total units) and nominal trip generation characteristics of the project do not warrant the standard seven-year future year evaluation as relative project impacts are de-minimus. However, formal response includes a 2027 Build condition traffic volume network that reflects increasing the Baseline traffic volumes by 1% over 7-years and then adding the site generate trips - see **Attachments**. Capacity analysis for the 2027 Build condition indicates that the proposed driveway approach to the Frontage Road will operate with minimal delay at LOS A during the peak hours consistent with findings of the submitted traffic impact memorandum.

Comment 2: *"The ATR data was collected during the summer of 2020 during typical weekday commuter peak periods. BSC agrees with the methods of data collection. We also agree that adjustment factors should be applied to the 2020 volumes to represent pre-2020 conditions. However, after reviewing the continuous count station data, the adjustment factors are not high enough to represent the pre-2020 conditions. The following table explains the discrepancy in the adjustment factors:*

| | **MassDOT Count Data (Station 4013)** | | | |
|---|---|---|---|---|
| Time Period | Tuesday June 18, 2019 Traffic Volumes | Tuesday June 23, 2020 Traffic Volumes | Adjustment Factor Used in Analysis | BSC's Calculated Adjustment Factor |
| Daily | 58,987 | 36,721 | 1.41 | 1.61 |
| Morning Peak | 9,387 | 5,030 | 1.46 | 1.87 |
| Evening Peak | 8,452 | 5,637 | 1.33 | 1.50 |

*The Applicant developed adjustment factors based on a nearby count station that were applied to the 2020 ATR data to represent volumes from 2019. As shown in the above table, the factors the Applicant used were lower than required to adjust the 2020 volumes upward to match the 2019 volumes (e.g. the daily volume of 36,721 needs to be multiplied by 1.61 and not 1.41 to match the 2019 volumes).*

*The following table shows how the adjustment factors affect the overall traffic volumes that were reported in the memorandum:*

| Time Period | Frontage Road June 30, 2020 ATR Counts | Adjusted Traffic Volumes used in Analysis | Adjusted Traffic Volumes (based on updated factors) |
|---|---|---|---|
| Daily | 2,327 | 3,280 | 3,746 |
| Morning Peak | 182 | 266 | 340 |
| Evening Peak | 164 | 219 | 246 |

*Based on our independent evaluation, the traffic volumes reported in the memo for Frontage Road that were used in the analysis are expected to be lower than the pre-2020 volumes. BSC requests that the Applicant provide an update on whether this discrepancy will have an impact on the overall conclusions derived from the analyses presented in the memo."*

**Response**: MDM acknowledges the calculation discrepancy and the pandemic adjustments have been revised per above. The updated traffic volume networks are provided in the **Attachments** and the revised daily traffic volumes on the Frontage Road are summarized below in **Table R1**. Updated analysis results are essentially identical to the submitted traffic impact memorandum as described under response to Comment 6.

**TABLE R1**
**BASELINE TRAFFIC VOLUME SUMMARY**
**FRONTAGE ROAD WEST OF 91 BEATRICE CIRLCE**

| Time Period | Daily Volume (vpd)[1] | Peak Hour Volume (vph)[2] | Percent Daily Traffic[3] |
|---|---|---|---|
| *Weekday Morning Peak Hour* | 3,746 | 340 | 9% |
| *Weekday Evening Peak Hour* | 3,746 | 246 | 7% |

[1]Two-way daily traffic expressed in vehicles per day adjusted by1.61 to reflect pre-pandemic conditions.
[2]Two-way peak-hour volume expressed in vehicles per hour adjusted by 1.87 (AM) and 1.50 (PM) to reflect pre-pandemic conditions.
[3]The percent of daily traffic that occurs during the peak hour.

As summarized in **Table R1**, the Frontage Road when adjusted to pre-Pandemic conditions carries approximately 3,746 vehicles per day (vpd) with approximately 340 vehicles during the weekday morning peak hour and 246 vehicles during the weekday evening peak hour. The peak hour traffic volumes represent approximately 7 to 9 percent of the daily traffic volumes.

The results and conclusions of the memo remain valid in that the relative traffic increases for the proposed project represents an inconsequential change in area roadway volumes - a level of change that falls well within normal day-to-day fluctuations in traffic entering and exiting the study area and is immaterial to traffic operations along the Frontage Road.

Comment 3: *"BSC verified the information provided in the traffic study. There were no reported crashes between the years 2017 – 2019. According to MassDOT guidelines, a three-year review period is the minimum and a five-year review period is preferred. We recommend that the Applicant determine if there are any crashes that occurred within a five-year timeframe (add two years to the data)."*

**Response**: Review of the latest available 5-year crash database (2016 to 2020) indicate that no crashes were reported at the roadway segment along Frontage Road between Beatrice Circle and Clifton Street. Likewise, no HSIP locations are listed for the study area; therefore, no immediate safety countermeasures are warranted based on the crash history.

Comment 4: *"The ITE LUCs that were used are appropriate for the proposed land uses. BSC agrees with the trip generation methodology used in the memo."*

**Response**: MDM concurs; no response required.

Comment 5: *"BSC conducted a visit to the Project site to verify sight distances and to observe travel speeds along Frontage Road. Our site visit indicates that available sight distance is approximately 435 feet. BSC also observed vehicles to travel at or above 40 mph. We request that the Applicant determine the required SSD and recommended ISD for speeds of 45 mph.*

*BSC has concerns about the safety related to the location of the driveway and crosswalk. We request that the Applicant investigate additional measures to ensure safety at the driveway and crosswalk beyond the proposed crosswalk treatments."*

**Response**:

Requested sight line analysis is provided below concluding that applicable AASHTO criteria are met for measured (ambient) 85th percentile travel speeds that range from 43 to 46 mph.

As a point of reference MDM obtained the Special Speed Regulation for the Frontage Road from MassDOT (see **Attachments**) which indicates a regulatory speed limit of 40 mph for this section of the roadway. MDM also collected supplemental speed data along Frontage Road for each travel lane at the intersection with Beatrice Circle on February 24, 2021 using a radar device with the speed data summarized in **Table R2**. We note that the speed data were collected at a location approximately 450 feet west of the site driveway to correspond to the appropriate approaching vehicle sight line position relative to the driveway, included between 100 and 124 individual speed observations for each travel lane (to ensure a statistically significant sampling) and were collected using a radar device that was not visible to oncoming traffic. Likewise, speed data for vehicles turning onto or exiting Beatrice Circle or that were in any way influenced by these turning vehicles were excluded from the database.

**TABLE R2**
**SPEED STUDY RESULTS – FRONTAGE ROAD**

| | Travel Speed | | |
|---|---|---|---|
| **Travel Direction** | **Regulatory**[1] | **Mean**[1] | **85th Percentile**[2] |
| Travel Lane | 40 | 38 | 43 |
| Passing Lane | 40 | 40 | 46 |

[1]Regulatory Speed (in mph)
[1]Arithmetic mean (in mph)
[2]The speed at or below which 85 percent of the vehicles are traveling (in mph)

As summarized in **Table R2**, the mean (average) travel speed on Frontage Road was observed to be 38 mph and the 85th percentile travel speeds were observed to be 43 mph in the near travel lane and 40 mph and 85th percentile travel speed of 46 in the passing lane. While no posted speed limit was observed in the immediate study area, the observed speed data is consistent with the regulatory speed limit of 40 mph along the Frontage Road. The speed data is provided in the **Attachments**.

<u>Supplemental Speed Data</u>

Subsequent to collection of the above speed data by MDM, the Town peer review consultant was directed to collect supplemental speed data at a point just west of Beatrice Circle (approximately 450 feet west of the driveway) by an independent third party vendor (PDI) between Tuesday April 13 and Friday April 16, 2021. This measurement location corresponds to the available sight line for vehicles approaching the site driveway and is consistent with the measurement position used for the MDM speed measurements referenced above. These supplemental data indicate average speeds or 42 mph or less and $85^{th}$ percentile travel speeds of 48 mph or less.

MDM has prepared plan and profile exhibits for the site plan based on supplemental ground survey along the Frontage Road and the proposed driveway grading. Calculated sight line requirements are based on the supplemental speed data collected under the direction of BSC that include a 48 mph $85^{th}$ percentile travel speed. Following AASHTO methodology the calculated minimum required stopping sight distance (SSD) for the eastbound vehicle approach is 455 feet based on an $85^{th}$ percentile speed of 48 mph and an average approach downgrade grade of 7.2 percent as measured along an available sight line distance of 475 feet from the proposed driveway. Available Intersection sight distance (ISD) of 475 feet is also confirmed from ground survey, exceeding the minimum ISD requirement of 455 feet as well as corresponding "ideal" ISD for the eastbound Frontage Road approach.

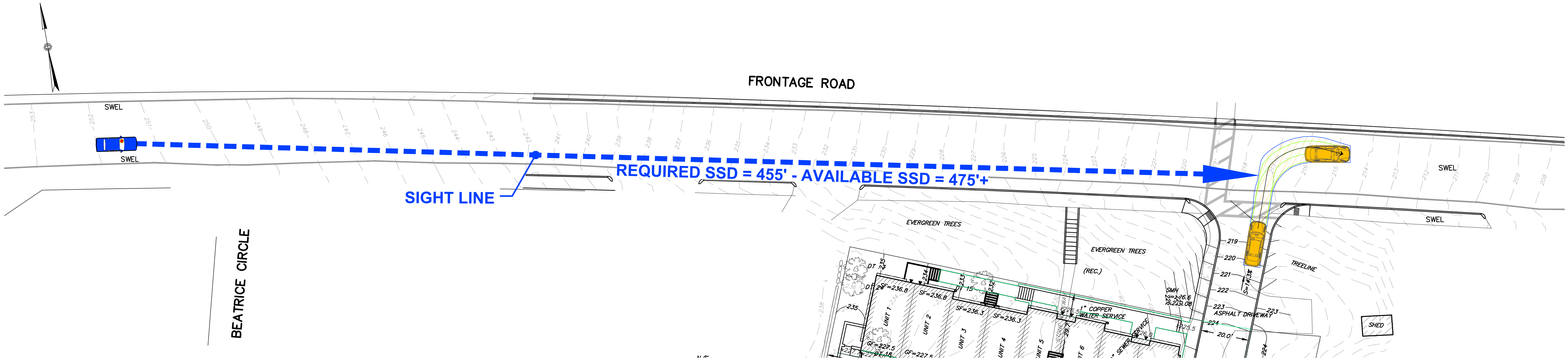
**Exhibit 1** and **Exhibit 2** indicate that the stopping sight distances (SSD) are exceeded for both travel lanes for the observed $85^{th}$ percentile travel speeds along the Frontage Road. Likewise, **Exhibit 3** and **Exhibit 4** present the intersection sight lines (ISD) for the proposed site driveway indicating that criteria for ideal ISD are also met or exceeded for the observed $85^{th}$ percentile travel speeds along the Frontage Road.

The sight triangle areas for the Project site driveway intersections will be provided on the final site plan set by DeCelle-Burke-Sala & Associates.

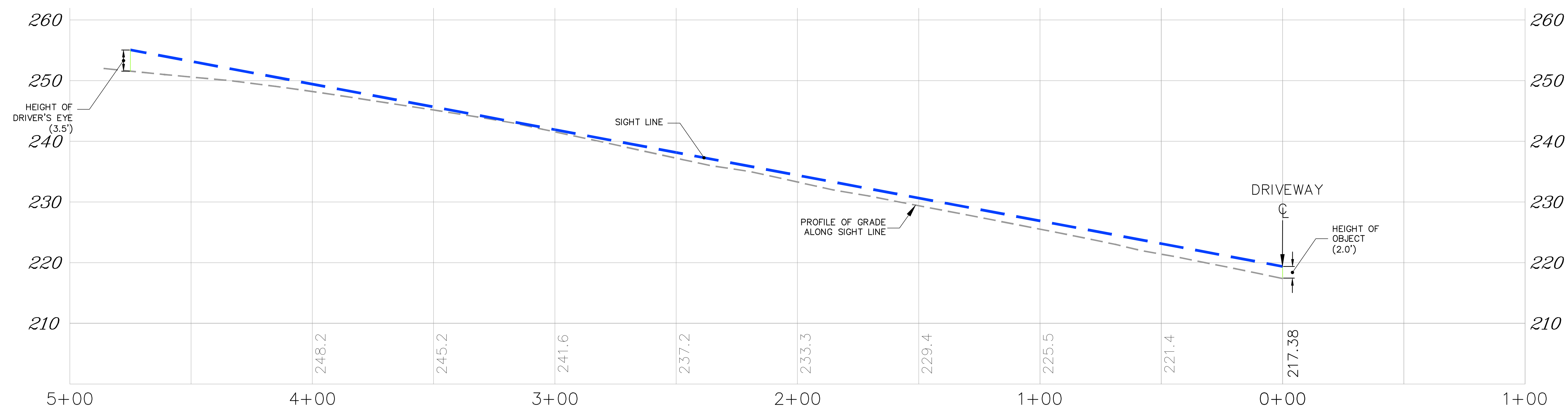
Comment 6: *"The traffic operations analysis was conducted in accordance with traffic engineering standards. BSC agrees with the operations analysis methodology and the reported results.*

*As previously mentioned in Comment #1, the analysis did not consider future traffic conditions that incorporate growth and other potential developments in the area."*

**Response**: Revised capacity analysis is presented in **Table R3** with updated the level of service for the 2020 Baseline, 2020 Design Year, and provided a supplemental 2027 Build condition all adjusted to reflect the appropriate Pandemic adjustment factors.




## Plan View




## Profile View

NOTES

1. THIS PLAN INTENDED FOR DISCUSSION PURPOSES ONLY; IT IS NOT INTENDED FOR CONSTRUCTION.
2. SIGHT DISTANCES ARE MEASURED DOWN THE CENTERLINE OF THE DRIVEWAY AND PROFILES ARE DRAWN ALONG THE LINE OF SIGHT.
3. BASE PLANS PROVIDED BY DeCELLE-BURKE SALA & ASSOCIATES, INC.

Site Plan Source: DeCelle-Burke Sala & Associates, Inc.

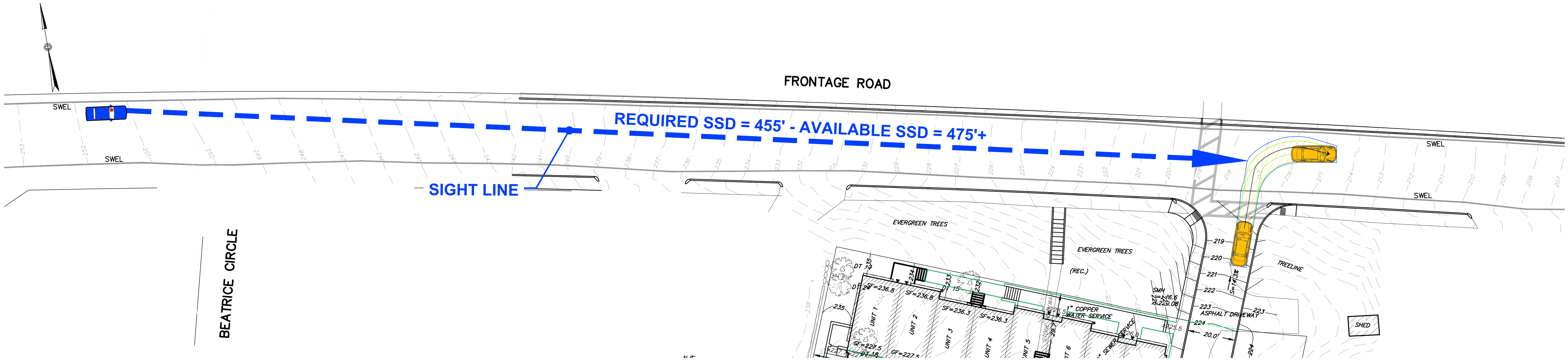
MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers
28 Lord Road, Suite 280
Marlborough, MA 01752

*Proposed Residential Development*
Belmont, Massachusetts

GRAPHIC SCALE
HORIZ. SCALE IN FEET: 0 10 20 40 80
VERT. SCALE IN FEET: 0 4 8 16 32

*Exhibit 1*
*Stopping Sight Distance Evaluation*
*Site Driveway to Near Lane*

Scale: As Noted
DWG No. 1088 Sight Line Profile (4-22-2021).dwg
Date: April 2021
Project No. 1088

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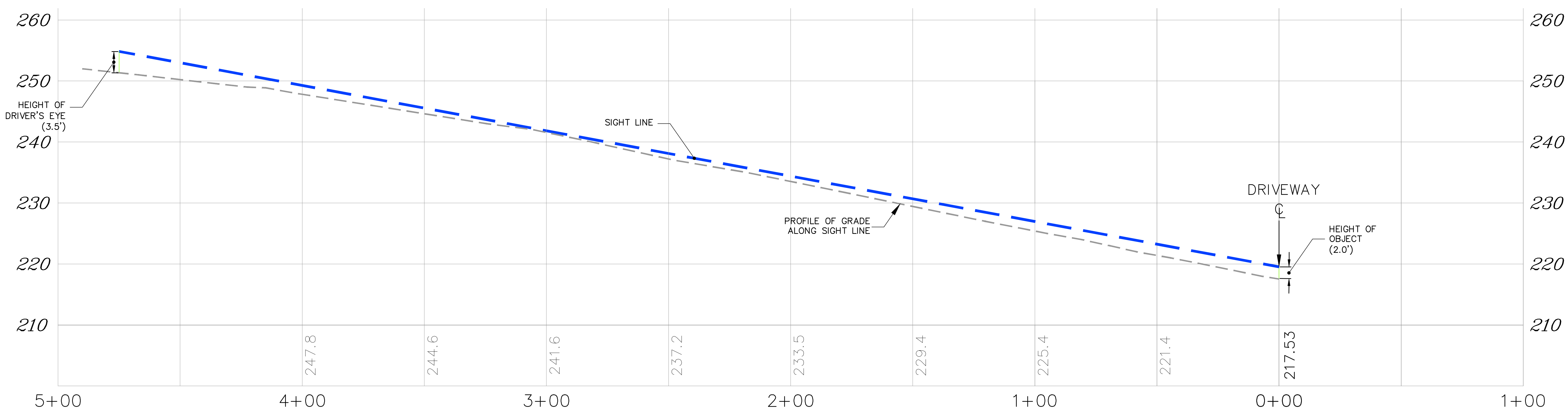


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Date: April 2021
Project No. 1088

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Belmont, Massachusetts

GRAPHIC SCALE

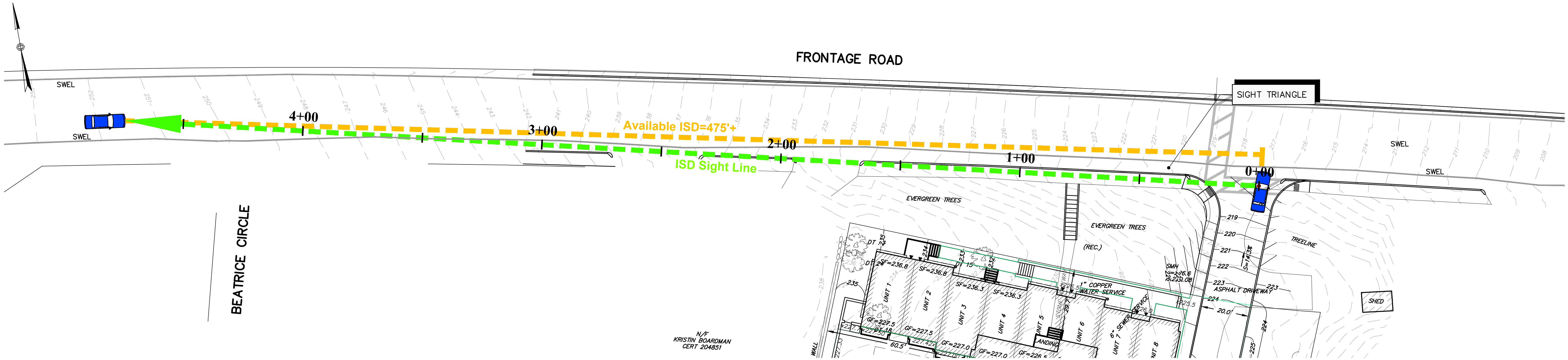
HORIZ. SCALE IN FEET: 0, 10, 20, 40, 80

VERT. SCALE IN FEET: 0, 4, 8, 16, 32

*Exhibit 2*

*Stopping Sight Distance Evaluation*

*Site Driveway to Far Lane*

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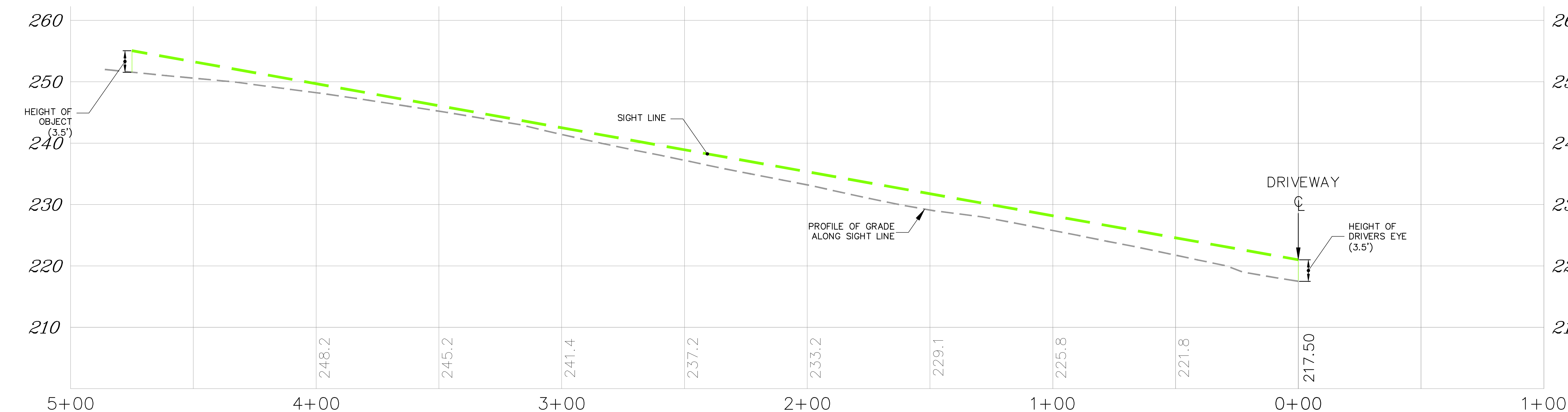


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Belmont, Massachusetts

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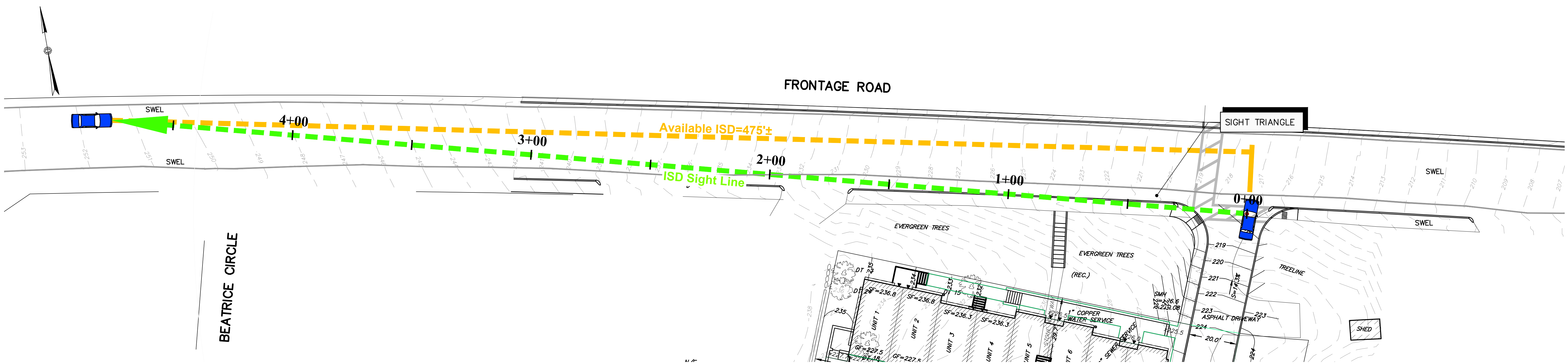
*Exhibit 3*
*Intersection Sight Distance Evaluation*
*Site Driveway to Near Lane*

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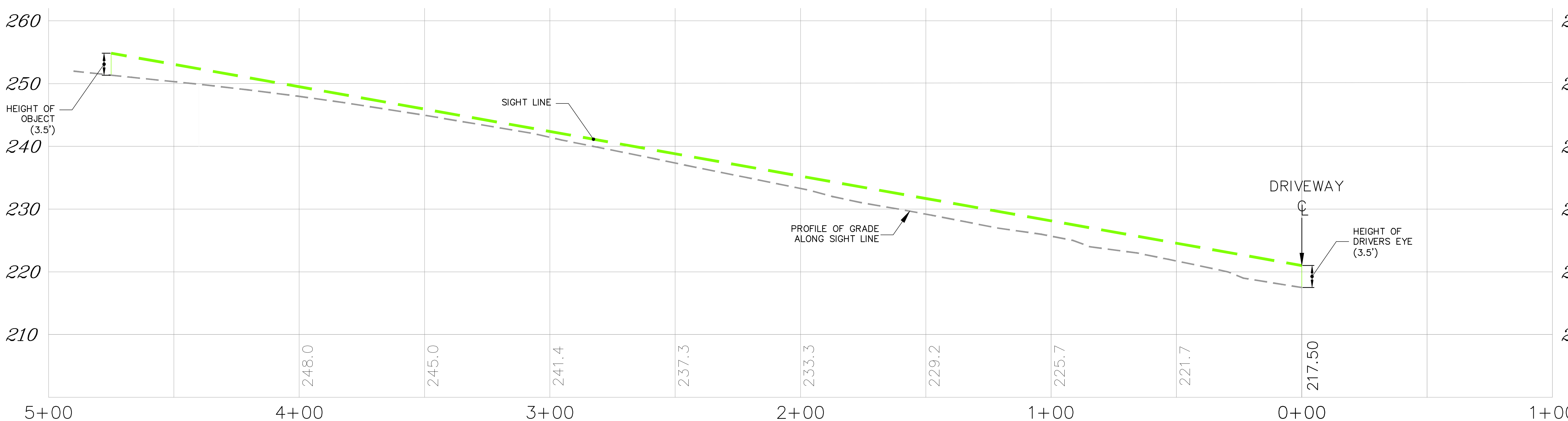


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Date: April 2021
Project No. 1088

*Proposed Residential Development*

Belmont, Massachusetts

GRAPHIC SCALE
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VERT. SCALE IN FEET: 0, 4, 8, 16, 32

*Exhibit 4*
*Intersection Sight Distance Evaluation*
*Site Driveway to Far Lane*

**TABLE R3**
**INTERSECTION CAPACITY ANALYSIS RESULTS**
**FRONTAGE ROAD AT SITE DRIVEWAY**

| | | 2020 Baseline | | | 2020 Design Year | | | 2027 Build | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Period | Approach | v/c[1] | Delay[2] | LOS[3] | v/c | Delay | LOS | v/c | Delay | LOS |
| *Weekday Morning* | Eastbound | 0.00 | <5 | A | 0.00 | <5 | A | 0.00 | <5 | A |
| *Peak Hour* | NB Exit | 0.00 | <5 | A | 0.01 | 9 | A | 0.01 | 10 | A |
| *Weekday Evening* | Eastbound | 0.00 | <5 | A | 0.00 | <5 | A | 0.00 | <5 | A |
| *Peak Hour* | NB Exit | 0.00 | 9 | A | 0.00 | 9 | A | 0.00 | 9 | A |

[1]Volume-to-capacity ratio; [2]Average control delay per vehicle (in seconds); [3]Level of service

As summarized in **Table R3,** under 2020 Design Year conditions and projected 2027 Build conditions, capacity analyses indicate that the unsignalized Site Driveway approach to the Frontage Road will continue to operate below capacity at level of service (LOS) A during peak hours. The project will result in a nominal change to traffic operations for mainline travel along the Frontage Road. The results and conclusions of the September 23, 2020 traffic study remain valid.

Comment 7: *"The site plan is designed to allow emergency vehicle access to the building and provides a parking ratio of 1.66 spaces per unit. The parking ratio is below the zoning requirements of 2 spaces per unit. We request that the Applicant provide further explanation of the determination of the proposed parking supply."*

**Response**: The Applicant is evaluating options that may increase the number of parking spaces provided and/or reduce bedroom counts. The originally proposed parking supply ratio of 1.66 spaces per unit represents a net shortfall of only 4 spaces relative to Town zoning requirements of 2 spaces per unit for 12 units. Accordingly, on-site parking supply is being reviewed in tandem with alternative options to add additional capacity to bring parking supply closer to standards that would otherwise be required under local zoning.

Peak parking generation rates for residential land uses, including multi-family residential complexes, are also published by the Institute of Transportation Engineers (ITE) in *Parking Generation*[1] which provides a basis for identifying parking demand characteristics for residential developments. **Table R4** provides a summary of unadjusted peak parking demands for the multi-family low rise residential use. The ratios provided also account for average visitor parking activity with detailed data sheets provided in the **Attachments**.

[1] *Parking Generation, 5th Edition*, Institute of Transportation Engineers, Washington D.C. 2019

**TABLE R4**
**PEAK PARKING DEMAND**
**ITE Rates for Low-Rise Multi-Family land use category – Suburban Locations**

| Source | Peak Parking Rate (spaces per dwelling unit) | Peak Parking Demand |
|---|---|---|
| ITE Average Peak Demand[1] | 1.21 | 15 |
| ITE 95% Confidence Demand[2] | 1.26 | 15 |
| ITE 85th Percentile Peak Demand[3] | 1.52 | 18 |

[1]Average peak period demand per Land Use Code – LUC 220 (Low-Rise Multi-Family Unit) for a suburban location.
[2] 95% Confidence Interval for ITE LUC 220 peak parking generation rate.
[3] 85th Percentile peak period demand per Land Use Code – LUC 220 (Low-Rise Multi-Family Unit) for a suburban location.

As summarized in **Table R4**, residential peak parking demand for 12 occupied units ranges from 15 to 18 vehicles based on ITE parking generation rates with peak demands occurring during the overnight hours (12:00 – 5:00 AM). The projected demand based on ITE remains below the proposed parking supply of 20 marked spaces. While proposed parking supply is consistent with demands estimated using ITE per-unit peak demand rates, the Applicant is evaluating building layout options that may increase the number of parking spaces provided and/or reduce bedroom counts as described above in response to concerns raised by neighbors regarding increased parking demand based on a higher bedroom count.

Unit leases will limit parking to one (1) space per unit with the remaining eight (8) surface spaces available on a first-come/first served and/or reservation basis through the leasing office. In this way, the Proponent will clearly articulate limitation on parking to prospective tenants and will rely on the market to "self-select" tenants who opt to own fewer vehicles and that deem the property as adequate from a parking supply perspective.

Comment 8: *"The proposed relocation of the crosswalk will require a new curb ramp on the opposite side of Frontage Road to access the pedestrian bridge. Due to the lack of sidewalk on the opposite side of Frontage Road, the entire roadway will be narrowed to accommodate the width needed for the ramp installation. The crosswalk also does not align with pedestrian desire lines to/from the bridge, especially to access the MBTA bus stop to the east of the driveway.*

*The Applicant is also proposing the installation of an RRFB at the crosswalk location. We agree with this treatment and recommend that the Applicant continue to work with the Town on the design of this measure. Appropriate signage should be provided at and in advance of the crosswalk.*

*We request that the Applicant explore a design of the driveway that retains the existing location of the crosswalk across Frontage Road. This concept should include an ADA accessible ramp at the bridge and the driveway may need to be shifted a few feet to the east."*

**Response**: The Proponent will continue to work with the Town to design an enhanced ADA-compliant pedestrian crossing across the Frontage Road. The pedestrian bridge abutments and substructure preclude construction of a more direct ADA-compliant ramp system at the bridge. The provided conceptual pedestrian crossing plan will satisfy ADA accessibility standards, is specifically oriented to eliminate conflicts between right-turn driveway volumes and crossings and includes design elements (curbline adjustments) that are common to pedestrian crossings and reduce pedestrian crossing length. The Proponent will evaluate relocation of the MBTA bus stop to a location that corresponds to the proposed crossing location to consolidate pedestrian activity.

While the proposed location of the crosswalk exceeds sight line criteria for approaching vehicle speeds of 48 mph, MDM notes that the improved pedestrian crossing will also incorporate Rapid Rectangular Flashing Beacons (RRFBs) that have beacons mounted at 7' minimum clear height above sidewalk grade, allowing clear visibility of the beacons to oncoming vehicles that far exceeds sight line requirements for measured 85$^{th}$ percentile travel speeds on the Frontage Road. The crosswalk design will also incorporate a walkway railing system that will provide a positive pedestrian guidance feature/barrier to ensure pedestrian crossings to/from the overpass use the designated walkway and sidewalk. Similar design treatment at the pedestrian crossing on the Arlington side of the overpass will be designed and implemented by the Proponent to ensure compliance with ADA requirements.

Comment 9: *"The Applicant should ensure that sight lines at the driveway are maintained at all times. Town of Belmont bylaws require driveways to have clear sight triangles set ten feet back from the back of sidewalk, with vegetation and obstructions no higher than three feet in height (Section 4.3.7 of the Zoning Bylaws). The Applicant should confirm that these dimensions will be met and maintained."*

**Response**: The sight line as described above will be shown on the final site plan set by DeCelle-Burke-Sala & Associates. A note to "maintain vegetation and obstructions no higher than three feet in height" within the sight lines triangle will also be provided.

**Exhibit 5** presents a sight line evaluation of the Town sight triangle area as defined under Section 4.3.7 of the Zoning Bylaw and confirms that adequate sight line will be available within that area subject to clearing and maintenance of vegetation within the sight line triangle area.

**<u>Email Correspondence BSC to ZBA April 8, 2021</u>**

Comment E1. *The issue of sight distance at the driveway was discussed during the April 5, 2021 ZBA hearing. BSC recommends that the Town authorize us to conduct an independent speed study along Frontage Road. Speeds will be measured at a point approximately 425 feet to the west of the proposed site driveway and at the site driveway. This study should be conducted over the course of a minimum of 72* *hours (three days). Both the Applicant and a member of the public provided speed studies that had different results that affect the required sight distance. The speed study methodology should be vetted by both the Town and the Applicant so that there are no issues or questions that can arise during the next ZBA hearing about how it was conducted. We propose to use a third-party vendor (e.g. Accurate Counts or PDI) to collect the speed data using automatic traffic recorder tubes.*

**Response:** The Town peer review consultant was directed by the ZBA to collect supplemental speed data at a point just west of Beatrice Circle (approximately 450 feet west of the driveway) by an independent third party vendor (PDI) between Tuesday April 13 and Friday April 16, 2021. This measurement location corresponds to the available sight line for vehicles approaching the site driveway and is consistent with the measurement position used for the MDM speed measurements referenced above. These supplemental data indicate average speeds or 42 mph or less and 85th percentile travel speeds of 48 mph or less.

MDM has prepared plan and profile exhibits for the site plan based on supplemental ground survey along the Frontage Road and the proposed driveway grading. These exhibits demonstrate that applicable sight line criteria for the driveway meet or exceed minimum requirements per AASHTO guidelines as discussed in more detail in response to Comment No. 5 above.

Comment E2. *The issue of the crosswalk improvements was discussed during the April 5, 2021 ZBA hearing. The issue with the existing location is that the pedestrian bridge is not ADA-accessible and any modifications will require the addition of curb ramps. BSC recommends the following:*

a) *We recommend the Applicant describe alternatives for crosswalk design that were evaluated. This should include but not limited to retaining the existing alignment and providing a raised crosswalk.*

**Response:** Crosswalk locations east and west of the driveway were considered; the selection of a crosswalk west of the driveway minimizes vehicle conflicts by aligning the crosswalk beyond the right-turn vehicle movements from the driveway and in direct alignment of the driver view looking left upon exiting the driveway which is a preferred (safer) design practice. The placement of the crosswalk on the west side of the driveway is also compliant with the AASHTO sight line criteria required for an approaching 85th percentile vehicle speed of 48 mph (455 feet). Provision of RRFB equipment at this crossing will further improve driver awareness and visibility for pedestrian crossings – vastly improving the visibility of the crossing relative to existing conditions. The crosswalk design will also incorporate a walkway railing system that will provide a positive pedestrian guidance feature/barrier to ensure pedestrian crossings to/from the overpass use the designated walkway and sidewalk. Similar design treatment at the pedestrian crossing on the Arlington side of the overpass will be designed and implemented by the Proponent to ensure compliance with ADA requirements.

MDM acknowledges that the Frontage Road provides excessive capacity for the peak hour volumes it carries (a single lane would provide sufficient capacity for two to three times the current volumes). As the Frontage Road is under local (Town) jurisdiction the Town may at its election and subject to proper engineering study and design reduce the existing two-lane cross section to a single lane with turning lanes provided at major intersections. Such design would allow for curb extensions in the vicinity of the Route 2 pedestrian overpass, in which case ADA ramp grading would be feasible for a more direct alignment of the pedestrian crossing at the overpass. However, such improvements are beyond the scope of the project; the Proponent's proposed crossing design would satisfy ADA design requirements and present a vast improvement in visibility and safety relative to current conditions.

b) *We recommend that the Applicant review the feasibility of raising the profile of the roadway through a gradual change so that the crosswalk is at grade with the pedestrian bridge. This option may allow the current location to be ADA accessible.*

**Response:** Options to retain a crossing in direct alignment with the overpass are not feasible as the roadway elevation would itself need to be raised approximately one foot to eliminate the need for accessible ramps or would require structural modification of the Route 2 abutment and overpass substructure to accommodate ADA ramps. Raising the roadway elevation is not practical or viable as doing so would reduce the effective barrier height for the Route 2 retaining wall – a necessary roadside crash barrier - and is not necessary given the Proponent's alternative design which will comply with applicable ADA design requirements.

c) *We recommend that any modifications to the crosswalk also include modifications on the northern side of the pedestrian bridge to provide ADA accessibility.*

**Response:** Similar design treatment at the pedestrian crossing on the Arlington side of the overpass will be designed and implemented by the Proponent to ensure compliance with ADA requirements.

d) *If the proposed concept is selected that shows the crosswalk being offset from the pedestrian bridge, we recommend that the Applicant show and describe design elements that will funnel pedestrians to the crosswalk to prevent them from crossing at the current location.*

**Response:** The crosswalk design will also incorporate a walkway railing system that will provide a positive pedestrian guidance feature/barrier to ensure pedestrian crossings to/from the overpass use the designated walkway and sidewalk.

e) *We recommend that the Applicant work with the MBTA to determine the most appropriate location for the existing bus stop, which is currently located east of the crosswalk.*

**Response:** The Applicant will work with the MBTA bus stop coordinator to relocate the existing stop located to the east of the driveway to coincide with the proposed crosswalk location on the west side of the driveway. Such a consolidation is not only practical by more directly accommodating the pedestrian "desire line" to/from the overpass but also more directly accommodates the future tenants of the proposed development. We note that relocation of the bus stop from its current location (60 feet east of the pedestrian overpass) is also more consistent with the existing bus stop along the Frontage Road in Arlington which is in the immediate proximity of the pedestrian overpass.

> Comment E3. *The issue of on-site parking was discussed during the April 5, 2021 ZBA hearing. The project is proposing a total of 12 4-bedroom units (a total of 48 bedrooms on the site). We recommend that the Applicant provide a description of the level of impact to on-street parking in the vicinity of the site, specifically along Beatrice Circle, Clifton Road, and on neighborhood streets in Arlington on the north side of Route 2.*

**Response:** The Applicant is evaluating options that may increase the number of parking spaces provided and/or reduce bedroom counts. The originally proposed parking supply ratio of 1.66 spaces per unit represents a net shortfall of only 4 spaces relative to Town zoning requirements of 2 spaces per unit for 12 units. Accordingly, on-site parking supply is being reviewed in tandem with options to add additional capacity to bring parking supply closer to standards that would otherwise be required under local zoning.

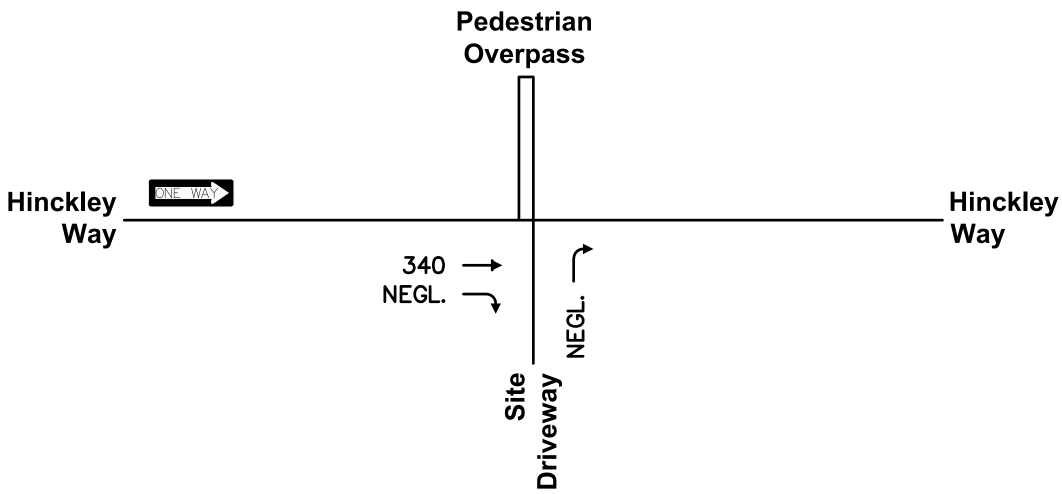
Unit leases will limit parking to one (1) space per unit with the remaining eight (8) surface spaces available on a first-come/first served and/or reservation basis through the leasing office. In this way, the Proponent will clearly articulate limitation on parking to prospective tenants and will rely on the market to "self-select" tenants who opt to own fewer vehicles and that deem the property as adequate from a parking supply perspective.

MDM is not aware of any formal restriction on the use of public curbside parking on the cited public streets by residents of those streets or potential tenants or visitors of the proposed development.

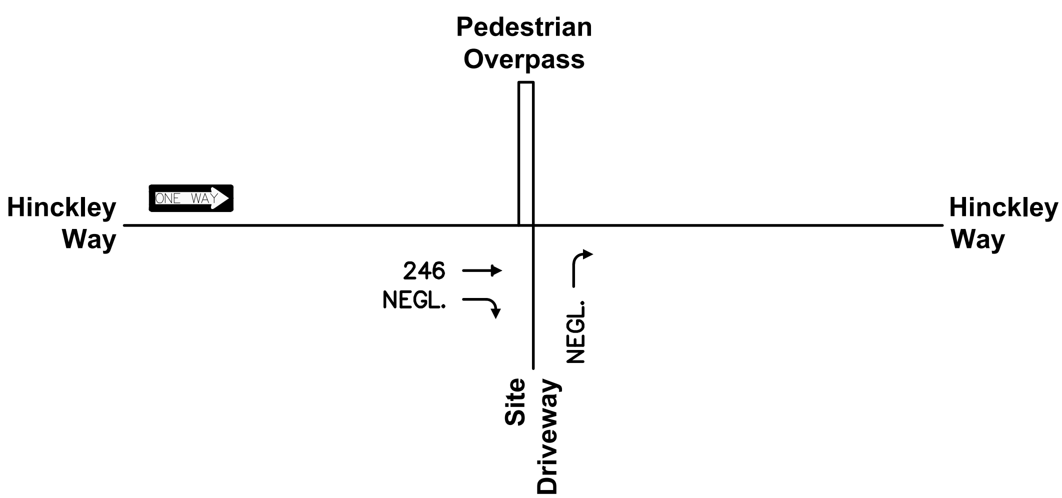
# ATTACHMENTS

- □ Updated Traffic Report Figures
- □ Special Speed Regulation - MassDOT
- □ Speed Data – February 2021
- □ Sight Distance Calculations
- □ Capacity Analysis
- □ Parking Analysis

□ Updated Traffic Report Figures




Weekday Morning Peak Hour




North
Scale: Not to Scale

**NOTES:**
**NEGL. = Negligible**
**= Signalized Intersection**

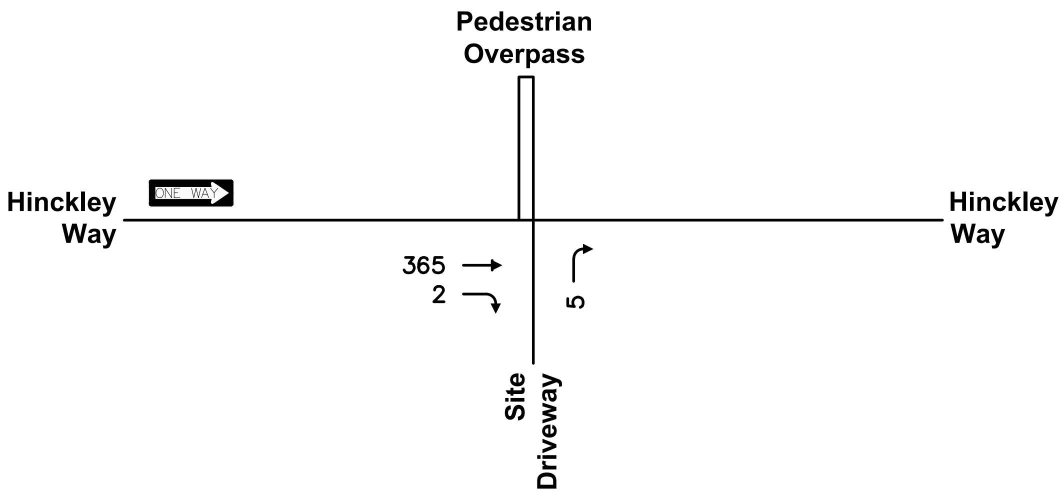
Weekday Evening Peak Hour

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

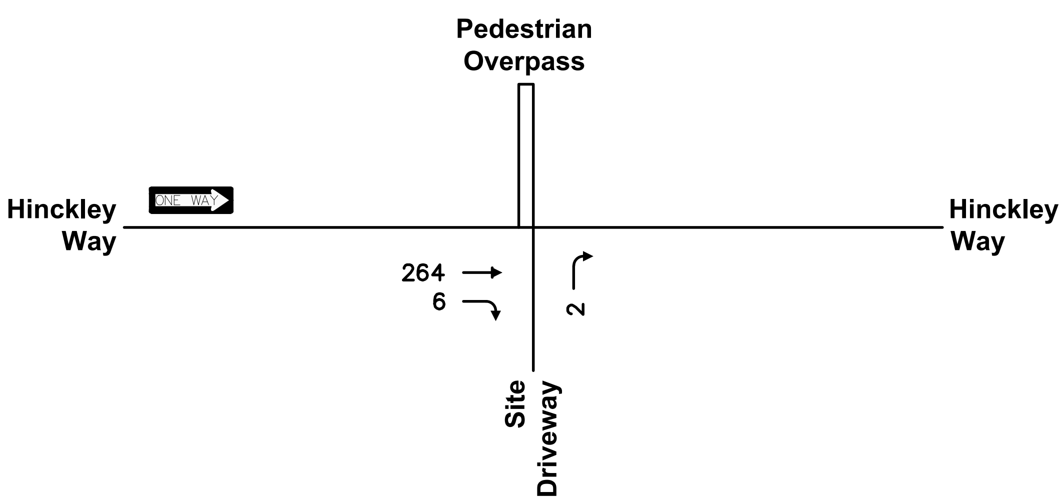
# Figure R3

## 2020 Baseline Conditions
## Weekday Traffic Volumes

Date: April 2021
Dwg No. 1088 Response to Comments.dwg




Weekday Morning Peak Hour




North
Scale: Not to Scale

**NOTES:**
**NEGL. = Negligible**
**S = Signalized Intersection**

Weekday Evening Peak Hour

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

**Figure R5**

**2027 Design Year Condition Weekday Traffic Volumes**

Date: April 2021
Dwg No. 1088 Response to Comments.dwg

□ Special Speed Regulation - MassDOT

March 20, 1973

THE COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS

SPECIAL SPEED REGULATION NO. 793

| | |
|---|---|
| Highway Location: | LEXINGTON - BELMONT |
| Authority in Control: | COMMONWEALTH OF MASSACHUSETTS<br>DEPARTMENT OF PUBLIC WORKS |
| Name of Highway: | LEXINGTON - Frontage Road - Misc. State Hwy.<br>ARLINGTON - " " " " "<br>BELMONT - " " " " " |

In accordance with the provisions of Section 18 Chapter 90 of the General Laws (Ter. Ed.) the following Special Speed Regulation is hereby promulgated:

The following designated speed limits are established at which motor vehicles may be operated in the areas described.

EASTBOUND - FRONTAGE ROAD

Beginning in Lexington at a point 70 feet east of Watertown Street Thence easterly on Frontage Road
0.18 miles at 25 miles per hour to the Arlington line.

Thence easterly in Arlington
0.04 miles at 25 miles per hour
0.23 " " 40 " " "
0.02 " " 30 " " " to the Belmont line.

Thence easterly in Belmont
0.16 miles at 30 miles per hour
0.50 " " 40 " " "
0.18 " " 25 " " "
0.80 " " 40 " " "
0.08 " " 25 " " " ending at Pleasant Street; the total distance being 2.19 miles.

WESTBOUND - FRONTAGE ROAD

Beginning in Arlington at a point 150 feet West of Pleasant Street Thence westerly on Frontage Road
0.85 miles at 40 miles per hour
0.16 " " 25 " " "
0.59 " " 40 " " "
0.10 " " 30 " " "
0.28 " " 40 " " " to the Lexington line.

Thence Westerly in Lexington

0.04 miles at 40 miles per hour

0.30 " " 25 " " " ending at Watertown Street; the total distance being 2.32 miles.

Operation of a motor vehicle at a rate of speed in excess of these limits shall be prima facie evidence that such speed is greater than is reasonable and proper.

The provisions of this regulation shall not, however, abrogate in any sense, Section 14 of Chapter 90.

The Department of Public Works and the Registrar of Motor Vehicles, acting jointly do hereby certify in writing, that this regulation is consistent with the public interest.

Standard signs must be erected at the beginning of each zone.

DATE: March 20, 1973

FOR THE DEPARTMENT OF PUBLIC WORKS

BY: V J Cantore
Traffic Engineer

David J Lucey
Registrar of Motor Vehicles

- □ Speed Data – February 2021

# MDM Transportation Consultants, Inc.

28 Lord Road, Suite 280
Marlborough, MA, 01752

EB: Frontage Road
West of Site Driveway
Just West of Beatrice Circle
Belmont, MA

File Name : 1088 Frontage Road Speeds at Beatrice
Site Code : 1088
Start Date : 2/25/2021
Count Time: 7:00 AM to 8:00AM


| # | Near Lane | Far Lane |
|---|---|---|
| 1 | 54 | 45 |
| 2 | 42 | 46 |
| 3 | 32 | 29 |
| 4 | 37 | 41 |
| 5 | 36 | 38 |
| 6 | 49 | 38 |
| 7 | 36 | 37 |
| 8 | 44 | 39 |
| 9 | 32 | 36 |
| 10 | 34 | 38 |
| 11 | 41 | 36 |
| 12 | 39 | 34 |
| 13 | 33 | 51 |
| 14 | 43 | 33 |
| 15 | 39 | 48 |
| 16 | 40 | 30 |
| 17 | 36 | 35 |
| 18 | 36 | 40 |
| 19 | 30 | 44 |
| 20 | 36 | 42 |
| 21 | 39 | 35 |
| 22 | 31 | 36 |
| 23 | 45 | 43 |
| 24 | 38 | 48 |
| 25 | 52 | 41 |
| 26 | 33 | 53 |
| 27 | 37 | 42 |
| 28 | 40 | 45 |
| 29 | 33 | 38 |
| 30 | 32 | 34 |
| 31 | 44 | 38 |
| 32 | 41 | 41 |
| 33 | 34 | 39 |
| 34 | 34 | 33 |
| 35 | 40 | 38 |
| 36 | 36 | 30 |
| 37 | 37 | 37 |
| 38 | 42 | 39 |
| 39 | 36 | 49 |
| 40 | 27 | 36 |
| 41 | 38 | 39 |
| 42 | 29 | 39 |
| 43 | 44 | 42 |
| 44 | 43 | 44 |
| 45 | 36 | 47 |
| 46 | 39 | 38 |
| 47 | 33 | 42 |
| 48 | 41 | 36 |
| 49 | 30 | 41 |
| 50 | 43 | 36 |
| 51 | 35 | 39 |
| 52 | 38 | 51 |
| 53 | 34 | 45 |
| 54 | 39 | 40 |
| 55 | 33 | 41 |
| 56 | 38 | 33 |
| 57 | 41 | 38 |
| 58 | 43 | 40 |
| 59 | 41 | 42 |

# MDM Transportation Consultants, Inc.

28 Lord Road, Suite 280
Marlborough, MA, 01752

EB: Frontage Road
West of Site Driveway
Just West of Beatrice Circle
Belmont, MA

File Name : 1088 Frontage Road Speeds at Beatrice
Site Code : 1088
Start Date : 2/25/2021
Count Time: 7:00 AM to 8:00AM


| # | Near Lane | Far Lane |
|---|---|---|
| 60 | 37 | 39 |
| 61 | 30 | 43 |
| 62 | 41 | 39 |
| 63 | 43 | 50 |
| 64 | 37 | 41 |
| 65 | 37 | 36 |
| 66 | 34 | 36 |
| 67 | 42 | 36 |
| 68 | 36 | 38 |
| 69 | 35 | 50 |
| 70 | 38 | 38 |
| 71 | 47 | 37 |
| 72 | 42 | 49 |
| 73 | 37 | 41 |
| 74 | 41 | 41 |
| 75 | 36 | 44 |
| 76 | 38 | 43 |
| 77 | 42 | 42 |
| 78 | 35 | 42 |
| 79 | 38 | 46 |
| 80 | 31 | 43 |
| 81 | 37 | 38 |
| 82 | 30 | 36 |
| 83 | 31 | 44 |
| 84 | 38 | 37 |
| 85 | 34 | 38 |
| 86 | 34 | 41 |
| 87 | 52 | 45 |
| 88 | 40 | 36 |
| 89 | 36 | 45 |
| 90 | 44 | 38 |
| 91 | 49 | 41 |
| 92 | 33 | 39 |
| 93 | 35 | 39 |
| 94 | 39 | 38 |
| 95 | 42 | 43 |
| 96 | 48 | 37 |
| 97 | 38 | 45 |
| 98 | 30 | 36 |
| 99 | 42 | 35 |
| 100 | 34 | 36 |
| 101 | | 50 |
| 102 | | 41 |
| 103 | | 49 |
| 104 | | 42 |
| 105 | | 39 |
| 106 | | 50 |
| 107 | | 48 |
| 108 | | 34 |
| 109 | | 37 |
| 110 | | 38 |
| 111 | | 50 |
| 112 | | 38 |
| 113 | | 33 |
| 114 | | 47 |
| 115 | | 40 |
| 116 | | 41 |
| 117 | | 38 |
| 118 | | 33 |
| 119 | | 38 |
| 120 | | 46 |

# MDM Transportation Consultants, Inc.

28 Lord Road, Suite 280
Marlborough, MA, 01752

EB: Frontage Road
West of Site Driveway
Just West of Beatrice Circle
Belmont, MA

File Name : 1088 Frontage Road Speeds at Beatrice
Site Code : 1088
Start Date : 2/25/2021
Count Time: 7:00 AM to 8:00AM


| # | Near Lane | Far Lane |
|---|---|---|
| 121 | | 46 |
| 122 | | 37 |
| 123 | | 43 |
| 124 | | 43 |
| 125 | | |

| Class | Vehicle Count | 85 Percentile | 10 MPH Pace Speed | Number in Pace | Percent in Pace | Number of Vehicles Over 40 MPH | Percent of Vehicles Over 40 MPH | Average Speed | Number of Vehicles Over 40 MPH | Percent of Vehicles Over 40 MPH |
|---|---|---|---|---|---|---|---|---|---|---|
| Near Lane | 100 | 43 | 33 - 42 | 70 | 70 | 31 | 31 | 38 | 31 | 31 |
| Far Lane | 124 | 46 | 36 - 45 | 90 | 73 | 57 | 46 | 40 | 57 | 46 |
| Summary | 224 | 44 | 34 - 43 | 155 | 69 | 88 | 39 | 39 | 88 | 39 |

- Sight Distance Calculations

## *Stopping Sight Distance - Average*

Frontage Road EB approach to Site Driveway; average grade taken at 475' west of driveway (available sight line)

| | | SPEED (MPH) | BRAKE REACTION DISTANCE (FT) | BRAKING DISTANCE (FT) | CALCULATED STOPPING SIGHT DISTANCE (FT) |
|---|---|---|---|---|---|
| | | | | | |
| **Direction 1** | EB | 42 | 154.35 | 213.2 | 367.5 |

| INPUTS | Direction 1 | |
|---|---|---|
| Travel Direction | EB | |
| Speed | 42 | (Per PDI Speed Survey) |
| Grade | -0.072 | |
| t | 2.5 | |
| a | 11.2 | |

**Stopping Sight Distance (SSD) - Source: AASHTO**

SSD = Reaction Distance + Brake Distance

Reaction Distance = 1.47 x t x V

Brake Distance = V^2 / (30 x ((a/32.2)+G))

Where:
t = reaction time (sec)
V = travel speed (mph)
G= roadway grade
a - deceleration rate (ft/sec^2)

## *Stopping Sight Distance - 85th Percentile*

Frontage Road EB approach to Site Driveway; average grade taken at 475' west of driveway (available sight line)

| | | SPEED (MPH) | BRAKE REACTION DISTANCE (FT) | BRAKING DISTANCE (FT) | CALCULATED STOPPING SIGHT DISTANCE (FT) |
|---|---|---|---|---|---|
| | | | | | |
| **Direction 1** | EB | 48 | 176.4 | 278.4 | 454.8 |

| INPUTS | Direction 1 | |
|---|---|---|
| Travel Direction | EB | |
| Speed | 48 | (Per PDI Speed Survey) |
| Grade | -0.072 | |
| t | 2.5 | |
| a | 11.2 | |

**Stopping Sight Distance (SSD) - Source: AASHTO**

SSD = Reaction Distance + Brake Distance

Reaction Distance = 1.47 x t x V

Brake Distance = V^2 / (30 x ((a/32.2)+G))

Where:
t = reaction time (sec)
V = travel speed (mph)
G= roadway grade
a - deceleration rate (ft/sec^2)

# Intersection Sight Distance Calculations

Source: *A Policy on Geometric Design of Highways and Street, 6th Edition;* AASHTO; 2011.

ISD = 1.47 * V * t

V = speed
t = time gap

t = 7.5 s for a passenger car for Left Turn from a Stop
t = 6.5 s for a passenger car for Right Turn from a Stop

**<u>Frontage Road</u>**

ISD = 1.47 * 42 * 6.5 = 411 ft **SAY 415 ft**
(right-turn from a stop)

# Intersection Sight Distance Calculations

Source: *A Policy on Geometric Design of Highways and Street, 6th Edition;* AASHTO; 2011.

ISD = 1.47 * V * t

V = speed
t = time gap

t = 7.5 s for a passenger car for Left Turn from a Stop
t = 6.5 s for a passenger car for Right Turn from a Stop

**Frontage Road**

ISD = 1.47 * 48 * 6.5 = 440 ft **SAY 440 ft**
(right-turn from a stop)

- Capacity Analysis

| Intersection | | | | | | |
|---|---|---|---|---|---|---|
| Int Delay, s/veh | 0 | | | | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | ↑↱ | | | | | ↱ |
| Traffic Vol, veh/h | 340 | 0 | 0 | 0 | 0 | 0 |
| Future Vol, veh/h | 340 | 0 | 0 | 0 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Stop | Stop | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | - | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 91 | 91 | 91 | 91 | 91 | 91 |
| Heavy Vehicles, % | 4 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 374 | 0 | 0 | 0 | 0 | 0 |

| Major/Minor | Major1 | | | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | | | - | 187 |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |
| Critical Hdwy | - | - | | | - | 6.9 |
| Critical Hdwy Stg 1 | - | - | | | - | - |
| Critical Hdwy Stg 2 | - | - | | | - | - |
| Follow-up Hdwy | - | - | | | - | 3.3 |
| Pot Cap-1 Maneuver | - | - | | | 0 | 830 |
| Stage 1 | - | - | | | 0 | - |
| Stage 2 | - | - | | | 0 | - |
| Platoon blocked, % | - | - | | | | |
| Mov Cap-1 Maneuver | - | - | | | - | 830 |
| Mov Cap-2 Maneuver | - | - | | | - | - |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |

| Approach | EB | | | | NB |
|---|---|---|---|---|---|
| HCM Control Delay, s | 0 | | | | 0 |
| HCM LOS | | | | | A |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR |
|---|---|---|---|
| Capacity (veh/h) | - | - | - |
| HCM Lane V/C Ratio | - | - | - |
| HCM Control Delay (s) | 0 | - | - |
| HCM Lane LOS | A | - | - |
| HCM 95th %tile Q(veh) | - | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 246 | 1 | 0 | 0 | 0 | 1 |
| Future Vol, veh/h | 246 | 1 | 0 | 0 | 0 | 1 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Stop | Stop | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | - | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 78 | 78 | 78 | 78 | 78 | 78 |
| Heavy Vehicles, % | 6 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 315 | 1 | 0 | 0 | 0 | 1 |

| Major/Minor | Major1 | | | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | | | - | 158 |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |
| Critical Hdwy | - | - | | | - | 6.9 |
| Critical Hdwy Stg 1 | - | - | | | - | - |
| Critical Hdwy Stg 2 | - | - | | | - | - |
| Follow-up Hdwy | - | - | | | - | 3.3 |
| Pot Cap-1 Maneuver | - | - | | | 0 | 866 |
| Stage 1 | - | - | | | 0 | - |
| Stage 2 | - | - | | | 0 | - |
| Platoon blocked, % | - | - | | | | |
| Mov Cap-1 Maneuver | - | - | | | - | 866 |
| Mov Cap-2 Maneuver | - | - | | | - | - |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |

| Approach | EB | | | | NB |
|---|---|---|---|---|---|
| HCM Control Delay, s | 0 | | | | 9.2 |
| HCM LOS | | | | | A |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR |
|---|---|---|---|
| Capacity (veh/h) | 866 | - | - |
| HCM Lane V/C Ratio | 0.001 | - | - |
| HCM Control Delay (s) | 9.2 | - | - |
| HCM Lane LOS | A | - | - |
| HCM 95th %tile Q(veh) | 0 | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.1 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 340 | 2 | 0 | 0 | 0 | 5 |
| Future Vol, veh/h | 340 | 2 | 0 | 0 | 0 | 5 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Stop | Stop | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | - | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 91 | 91 | 91 | 91 | 91 | 91 |
| Heavy Vehicles, % | 4 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 374 | 2 | 0 | 0 | 0 | 5 |

| Major/Minor | Major1 | | | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | | | - | 188 |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |
| Critical Hdwy | - | - | | | - | 6.9 |
| Critical Hdwy Stg 1 | - | - | | | - | - |
| Critical Hdwy Stg 2 | - | - | | | - | - |
| Follow-up Hdwy | - | - | | | - | 3.3 |
| Pot Cap-1 Maneuver | - | - | | | 0 | 828 |
| Stage 1 | - | - | | | 0 | - |
| Stage 2 | - | - | | | 0 | - |
| Platoon blocked, % | - | - | | | | |
| Mov Cap-1 Maneuver | - | - | | | - | 828 |
| Mov Cap-2 Maneuver | - | - | | | - | - |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |

| Approach | EB | | | | NB |
|---|---|---|---|---|---|
| HCM Control Delay, s | 0 | | | | 9.4 |
| HCM LOS | | | | | A |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR |
|---|---|---|---|
| Capacity (veh/h) | 828 | - | - |
| HCM Lane V/C Ratio | 0.007 | - | - |
| HCM Control Delay (s) | 9.4 | - | - |
| HCM Lane LOS | A | - | - |
| HCM 95th %tile Q(veh) | 0 | - | - |

| Intersection | | | | | | |
|---|---|---|---|---|---|---|
| Int Delay, s/veh | 0.1 | | | | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | ↑↱ | | | | | ↱ |
| Traffic Vol, veh/h | 246 | 6 | 0 | 0 | 0 | 2 |
| Future Vol, veh/h | 246 | 6 | 0 | 0 | 0 | 2 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Stop | Stop | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | - | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 78 | 78 | 78 | 78 | 78 | 78 |
| Heavy Vehicles, % | 6 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 315 | 8 | 0 | 0 | 0 | 3 |

| Major/Minor | Major1 | | | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | | | - | 162 |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |
| Critical Hdwy | - | - | | | - | 6.9 |
| Critical Hdwy Stg 1 | - | - | | | - | - |
| Critical Hdwy Stg 2 | - | - | | | - | - |
| Follow-up Hdwy | - | - | | | - | 3.3 |
| Pot Cap-1 Maneuver | - | - | | | 0 | 861 |
| Stage 1 | - | - | | | 0 | - |
| Stage 2 | - | - | | | 0 | - |
| Platoon blocked, % | - | - | | | | |
| Mov Cap-1 Maneuver | - | - | | | - | 861 |
| Mov Cap-2 Maneuver | - | - | | | - | - |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |

| Approach | EB | | | | NB | |
|---|---|---|---|---|---|---|
| HCM Control Delay, s | 0 | | | | 9.2 | |
| HCM LOS | | | | | A | |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR |
|---|---|---|---|
| Capacity (veh/h) | 861 | - | - |
| HCM Lane V/C Ratio | 0.003 | - | - |
| HCM Control Delay (s) | 9.2 | - | - |
| HCM Lane LOS | A | - | - |
| HCM 95th %tile Q(veh) | 0 | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.1 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 365 | 2 | 0 | 0 | 0 | 5 |
| Future Vol, veh/h | 365 | 2 | 0 | 0 | 0 | 5 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Stop | Stop | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | - | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 91 | 91 | 91 | 91 | 91 | 91 |
| Heavy Vehicles, % | 4 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 401 | 2 | 0 | 0 | 0 | 5 |

| Major/Minor | Major1 | | | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | | | - | 202 |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |
| Critical Hdwy | - | - | | | - | 6.9 |
| Critical Hdwy Stg 1 | - | - | | | - | - |
| Critical Hdwy Stg 2 | - | - | | | - | - |
| Follow-up Hdwy | - | - | | | - | 3.3 |
| Pot Cap-1 Maneuver | - | - | | | 0 | 811 |
| Stage 1 | - | - | | | 0 | - |
| Stage 2 | - | - | | | 0 | - |
| Platoon blocked, % | - | - | | | | |
| Mov Cap-1 Maneuver | - | - | | | - | 811 |
| Mov Cap-2 Maneuver | - | - | | | - | - |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |

| Approach | EB | | | | NB |
|---|---|---|---|---|---|
| HCM Control Delay, s | 0 | | | | 9.5 |
| HCM LOS | | | | | A |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR |
|---|---|---|---|
| Capacity (veh/h) | 811 | - | - |
| HCM Lane V/C Ratio | 0.007 | - | - |
| HCM Control Delay (s) | 9.5 | - | - |
| HCM Lane LOS | A | - | - |
| HCM 95th %tile Q(veh) | 0 | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.1 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 264 | 6 | 0 | 0 | 0 | 2 |
| Future Vol, veh/h | 264 | 6 | 0 | 0 | 0 | 2 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Stop | Stop | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | - | 0 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 78 | 78 | 78 | 78 | 78 | 78 |
| Heavy Vehicles, % | 6 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 338 | 8 | 0 | 0 | 0 | 3 |

| Major/Minor | Major1 | | | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | | | - | 173 |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |
| Critical Hdwy | - | - | | | - | 6.9 |
| Critical Hdwy Stg 1 | - | - | | | - | - |
| Critical Hdwy Stg 2 | - | - | | | - | - |
| Follow-up Hdwy | - | - | | | - | 3.3 |
| Pot Cap-1 Maneuver | - | - | | | 0 | 847 |
| Stage 1 | - | - | | | 0 | - |
| Stage 2 | - | - | | | 0 | - |
| Platoon blocked, % | - | - | | | | |
| Mov Cap-1 Maneuver | - | - | | | - | 847 |
| Mov Cap-2 Maneuver | - | - | | | - | - |
| Stage 1 | - | - | | | - | - |
| Stage 2 | - | - | | | - | - |

| Approach | EB | NB |
|---|---|---|
| HCM Control Delay, s | 0 | 9.3 |
| HCM LOS | | A |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR |
|---|---|---|---|
| Capacity (veh/h) | 847 | - | - |
| HCM Lane V/C Ratio | 0.003 | - | - |
| HCM Control Delay (s) | 9.3 | - | - |
| HCM Lane LOS | A | - | - |
| HCM 95th %tile Q(veh) | 0 | - | - |

- □ Parking Analysis

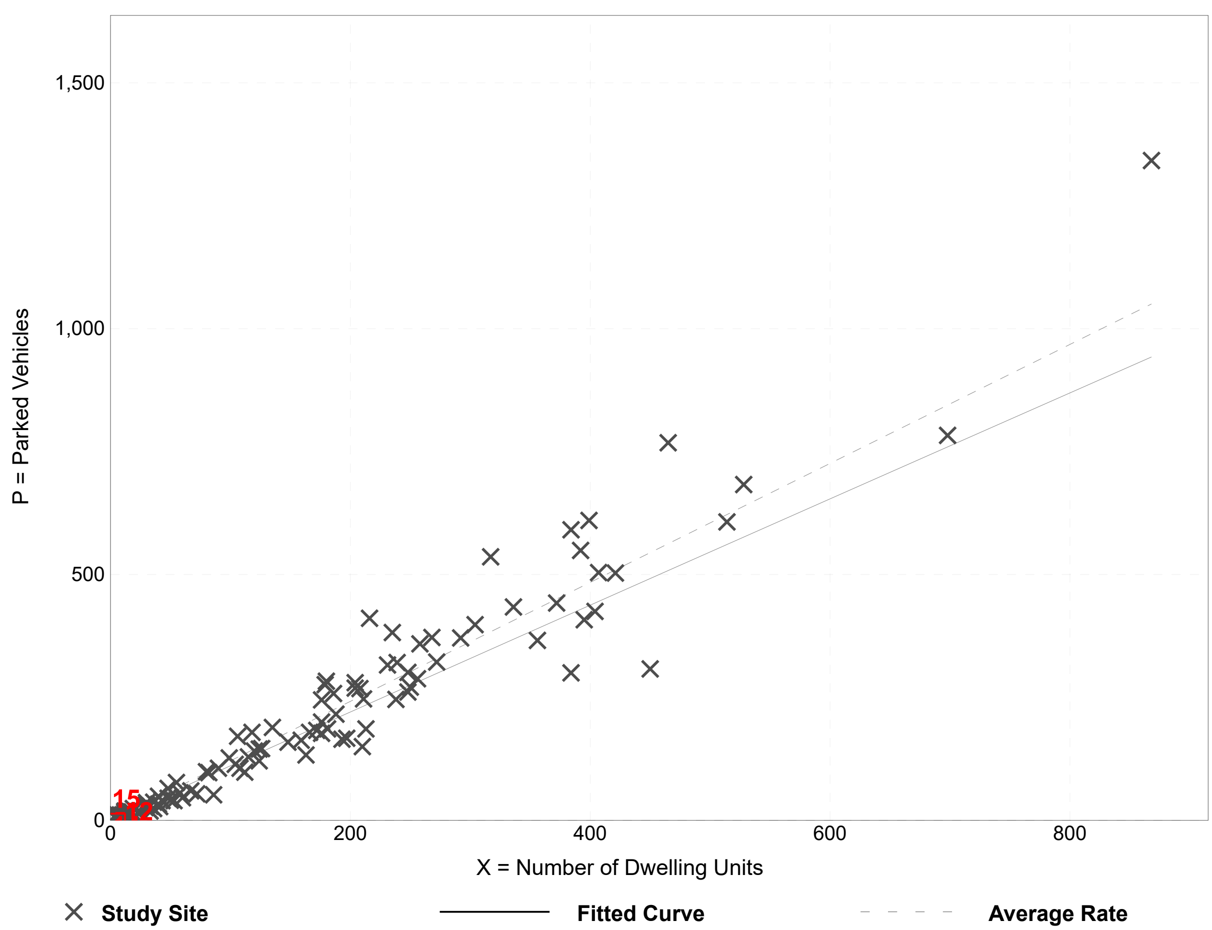
# Multifamily Housing (Low-Rise)
(220)

| | |
|---|---|
| **Peak Period Parking Demand vs:** | **Dwelling Units** |
| **On a:** | **Weekday (Monday - Friday)** |
| **Setting/Location:** | **General Urban/Suburban (no nearby rail transit)** |
| **Peak Period of Parking Demand:** | **11:00 p.m. - 6:00 a.m.** |
| Number of Studies: | 119 |
| Avg. Num. of Dwelling Units: | 156 |

## Peak Period Parking Demand per Dwelling Unit

| Average Rate | Range of Rates | 33rd / 85th Percentile | 95% Confidence Interval | Standard Deviation (Coeff. of Variation) |
|---|---|---|---|---|
| 1.21 | 0.58 - 2.50 | 1.03 / 1.52 | 1.16 - 1.26 | 0.27 (22%) |

## Data Plot and Equation




**Fitted Curve Equation: $Ln(P) = 0.99\ Ln(X) + 0.15$** **$R^2 = 0.96$**