Traffic Impact Study

Paragon Dunes Mixed-Use Development

197 Nantasket Avenue
Hull, MA

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INTRODUCTION

McMahon, a Bowman company, has completed a review of the existing traffic operations and potential traffic impacts associated with the proposed mixed-use development to be located at 197 Nantasket Avenue in Hull, Massachusetts. The purpose of this traffic impact study is to evaluate existing and projected traffic operations and safety conditions associated with the proposed development within the study area.

The assessment documented in this traffic impact study is based on a review of existing traffic volumes, recent crash data, and the anticipated traffic generating characteristics of the proposed project. The study examines existing and projected traffic operations (both without and with the proposed redevelopment) within the vicinity of the project site. The study area was selected based on a review of the surrounding roadway network and the estimated trip generating characteristics of the proposed project. This study provides an analysis of traffic operations during the weekday morning, weekday afternoon, and Saturday midday peak hours, when the combination of adjacent roadway volumes and project trips would be expected to be the greatest.

Based on the analysis presented in this study, the traffic estimated to be generated by the proposed redevelopment is not projected to have a significant impact on the area roadways and intersections.

Project Description

The proposed mixed-use development would be located on the site of an existing arcade and mini golf course and is bounded by Nantasket Avenue to the east, George Washington Boulevard to the west, the Paragon Carousel to the north, and an existing parking lot operated by the Department of Conservation and Recreation (DCR) to the south, as shown in Figure 1 below. The proposed project would raze the existing on-site structures and construct a 132-unit residential building and approximately 7,000square feet of ground floor retail space divided amongst two spaces.

Access to the site would be provided via three driveways on George Washington Boulevard and one on Rockland Circle. The driveways on George Washington Boulevard would include a full-access driveway and a right-in only driveway accessing a small parking lot and loading area north of the proposed building, and a full-access-in, right-out only driveway located to the south of the building. The Rockland Circle driveway would be full-access. All vehicular access to and from the project site would be through George Washington Boulevard or Rockland Circle. An internal connection to the existing DCR parking lot would be provided at the location of the south site driveway, in the approximate current location of the DCR parking lot’s exit onto George Washington Boulevard, and would allow exit-only traffic from the DCR parking lot as is the case under existing conditions. Pedestrian access would be provided on both the George Washington Boulevard and Nantasket Avenue sides of the site.

The proposed project would build a new surface parking lot adjacent to the existing DCR parking lot located on George Washington Boulevard northwest of Rockland Circle, a parking garage located underneath the proposed residential building, and a small parking lot/loading area on George Washington Boulevard to the north of the proposed building. A total of approximately 178 parking spaces would be provided on-site.

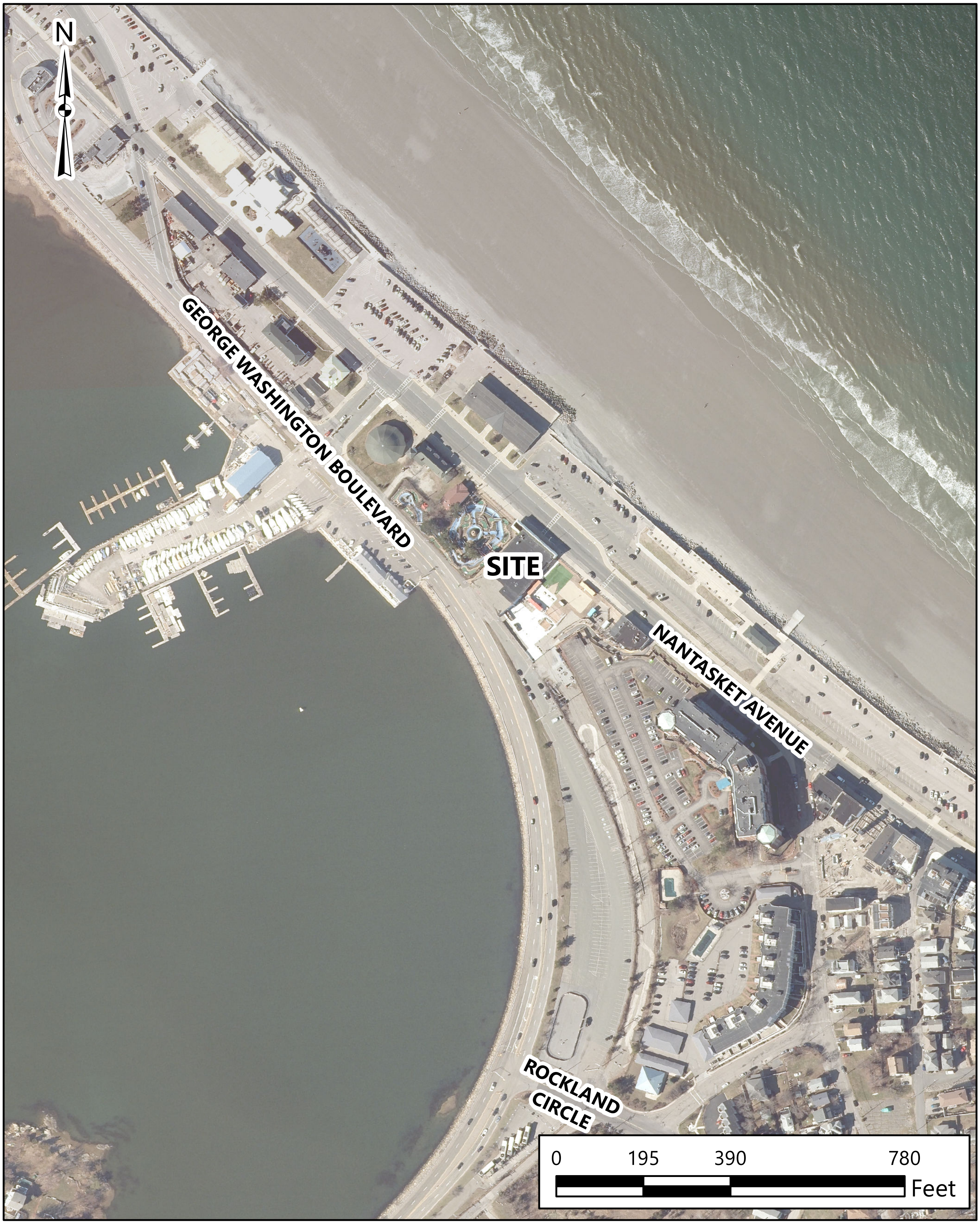

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Figure 1
Site Location
Paragon Dunes Mixed-Use Development
Hull, MA

Study Methodology

This traffic impact study evaluates existing and projected traffic operations at the study area intersections during the weekday morning, weekday afternoon, and Saturday midday peak hour traffic conditions, when the combination of the adjacent roadway volumes and estimated project trips would be expected to be the greatest.

The study was conducted in three steps. The first step consisted of an inventory of existing traffic conditions within the project study area. As part of this inventory, turning movement counts were collected at the study area intersections during the weekday morning, weekday afternoon, and Saturday midday peak periods. A field visit was completed to document intersection and roadway geometries and review the available sight distances at the site driveways. Crash data for the study area intersection was obtained from the Massachusetts Department of Transportation (MassDOT) to establish if the study area intersections have existing traffic safety deficiencies.

The second step of the study built upon the data collected in the first step to establish the basis for evaluating potential transportation impacts associated with the projected future conditions. During this second step, the projected traffic demands associated with planned future developments that could influence traffic volumes at the study area intersection were assessed. Consistent with MassDOT traffic study guidelines, 2023 Existing traffic volumes were forecasted over a seven-year project horizon, to the future year 2030 to establish 2030 No Build (without project) conditions and 2030 Build (with project) conditions. An additional sensitivity analysis was also conducted to model peak summer conditions at the study area intersections. Traffic volume comparisons of nearby continuous count locations and of the MassDOT seasonal adjustment information were conducted to understand how to adjust the traffic volume counts collected for the project upwards to summer conditions.

The third step of this study determined if measures are necessary to improve future traffic operations, minimize potential traffic impacts, and provide efficient access to the site with the proposed project in place.

Study Area

Based on a review of the anticipated traffic generating characteristics of the proposed project and a review of the adjacent roadways serving the project site, the following study area intersections were selected for analysis:

- George Washington Boulevard at Rockland Circle
- Rockland Circle at the site driveway
- George Washington Boulevard at the south site driveway
- George Washington Boulevard at the north site driveway

The traffic impact study presented in this report documents existing and future traffic conditions for the study area intersections noted above.

EXISTING CONDITIONS

An assessment of the potential traffic impacts associated with the proposed redevelopment requires an understanding of the existing traffic conditions within the project study area. The existing conditions assessment included in this study consists of an inventory of intersection and roadway geometries, an inventory of traffic control devices, the collection of peak period traffic volumes, and a review of recent crash data. The existing conditions in the vicinity of the project site are summarized below.

Roadway Network

A brief description of the principal roadways providing access to the project site is presented below.

George Washington Boulevard
George Washington Boulevard provides a connection to Route 3A and runs along the western coast of the Hull peninsula in the vicinity of the study area. George Washington Boulevard is classified as an urban minor arterial and is under MassDOT jurisdiction. Two vehicle travel lanes are provided in each direction, with sidewalks provided on both sides of the roadway in the vicinity of the site. A speed limit of 45 miles per hour (mph) is posted in both directions along George Washington Boulevard.

Rockland Circle
Rockland Circle is an urban connector which generally runs in the east/west direction and is under Town of Hull jurisdiction. Rockland Circle provides for two-way vehicle traffic. In the vicinity of the site driveway location, the roadway is approximately 42 feet wide, with noncontinuous segments of sidewalk provided in several locations. No speed limit is posted on Rockland Circle near the project site.

Existing Traffic Volumes

Existing Peak Hour Traffic Volumes
To assess average peak hour traffic conditions, turning movement counts were conducted at the study area intersections during the weekday morning, weekday afternoon, and Saturday midday peak periods.

Counts were conducted on Thursday, October 27, 2022, from 7:00 AM to 9:00 AM and from 4:00 PM to 6:00 PM, and on Saturday, October 29, 2022, from 11:00 AM to 2:00 PM. The results of the turning movement counts are tabulated by 15-minute periods and are provided in Appendix A. The four highest consecutive 15-minute intervals during each of these count periods constitute the peak hours that are the basis of the traffic analysis provided in this report. Based on a review of the peak period traffic data, the weekday morning peak hour at the study area intersections is shown to occur between 7:30 AM and 8:30 AM, the weekday afternoon peak hour is shown to occur between 4:00 PM and 5:00 PM, and the Saturday midday peak hour is shown to occur between 12:30 PM and 1:30 PM.

Automatic traffic recorder (ATR) counts were also conducted on George Washington Boulevard south of the existing DCR parking lot driveway from Thursday, October 27, 2022, through Saturday, October 29, 2022. The results of the ATR counts are provided in Appendix A of the report and summarized Table 1 in below.

Table 1: ATR Data Summary

		ADT[1]			85th %[3]
Roadway	**Direction**	**Weekday**	**Saturday**	**HV%[2]**	**Speed**
George Washington	Northbound	6,210	5,780	2%	38
Boulevard	Southbound	6,690	6,140	2%	41
	Combined	12,900	11,920	2%	39

1 Average daily traffic in vehicles per day
2 Weekday heavy vehicle percentage
3 Weekday 85th percentile speed in miles per hour

As shown in Table 1, the daily traffic volume on Washington Street south in the vicinity of the project site was measured to be approximately 12,900 vehicles per day during the Thursday and approximately 11,920 vehicles per day during the Saturday. Approximately two percent of weekday daily traffic was observed to be heavy vehicles. The 85th percentile speeds on Washington Street were measured to be 38 mph in the northbound direction and 41 mph in the southbound direction.

Seasonal Variation
Normal variation in traffic volumes is expected to occur throughout the year. To determine whether any seasonal adjustment of the counted traffic volumes was necessary, the MassDOT weekday seasonal factors were reviewed. As George Washington Boulevard is an urban minor arterial, MassDOT seasonal factors show that vehicle volumes collected during the month of October are typically greater than those of an average month. However, in order to provide a more conservative average month analysis and to better reflect the recreational nature of travel demand in Hull, the October MassDOT seasonal adjustment factor for the Recreational – East group were utilized. This factor is based on vehicle volumes collected on Cape Cod including Martha's Vineyard and Nantucket. The MassDOT data for the Recreational – East group indicate that vehicular volumes in the month of October are approximately two percent lower than during an average month. Therefore, the counted vehicle volumes were adjusted upward by two percent. The MassDOT seasonal factors are provided in Appendix B of this report.

It is understood that the study area experiences peak traffic conditions during the summer months of July and August and that the analysis presented in this report is reflective of average conditions. Additional discussion and analysis is included in later sections to describe the methodology to increase the October volumes to peak summer traffic conditions within the study area for review.

Background Traffic Growth
Based on conversations with the Central Transportation Planning Staff (CTPS), Hull experiences an annual growth of approximately 0.455 percent. To provide a conservative analysis, the 2022 counted volumes were grown by 0.5 percent to establish the 2023 Existing traffic volumes.

The calculated peak hourly traffic flows for the 2023 Existing conditions are depicted in Figure 2 for the weekday morning peak hour, Figure 3 for the weekday afternoon peak hour, and Figure 4 for the Saturday midday peak hour.

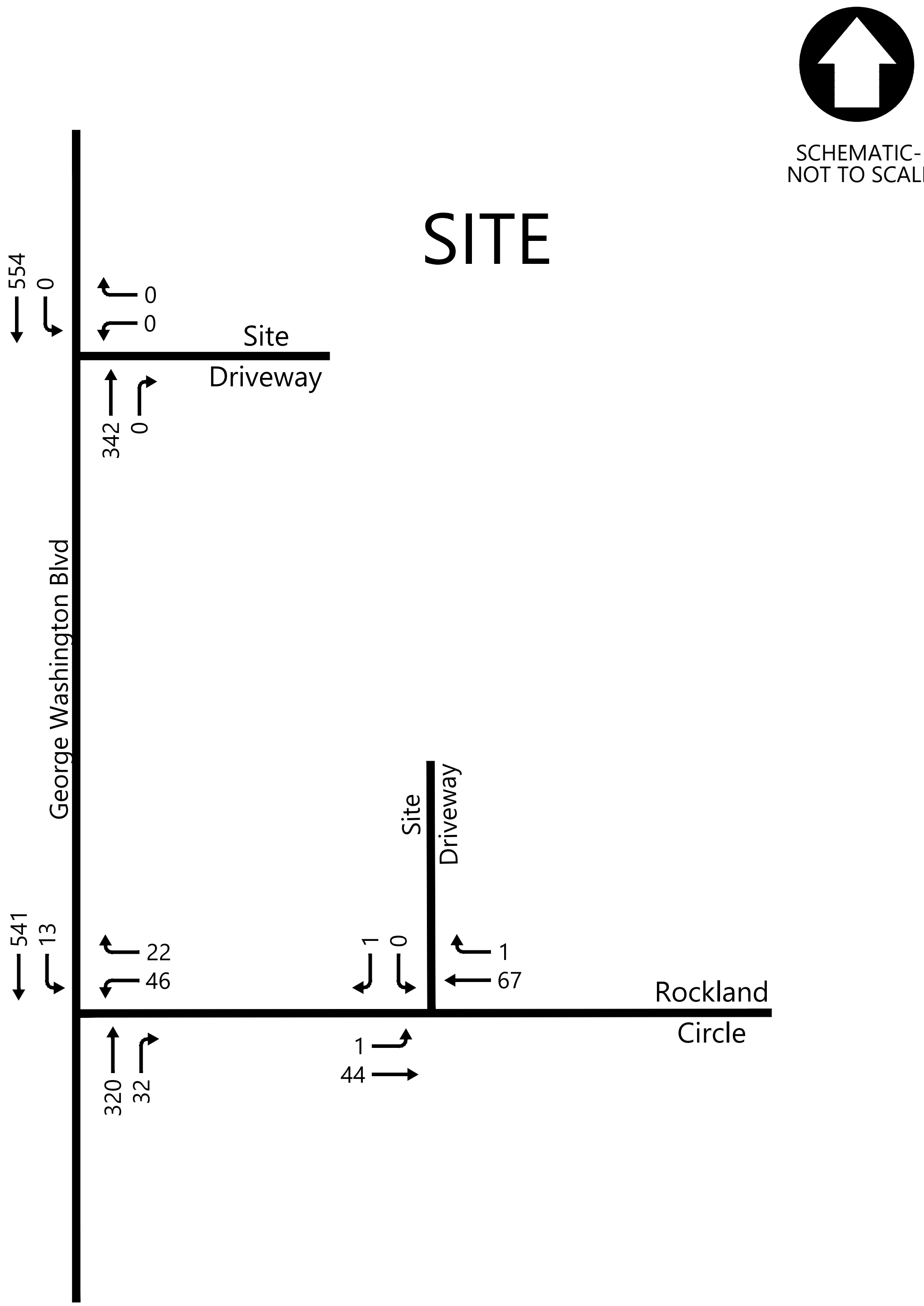

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Figure 2
2023 Existing Weekday Morning
Peak Hour Traffic Volumes
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

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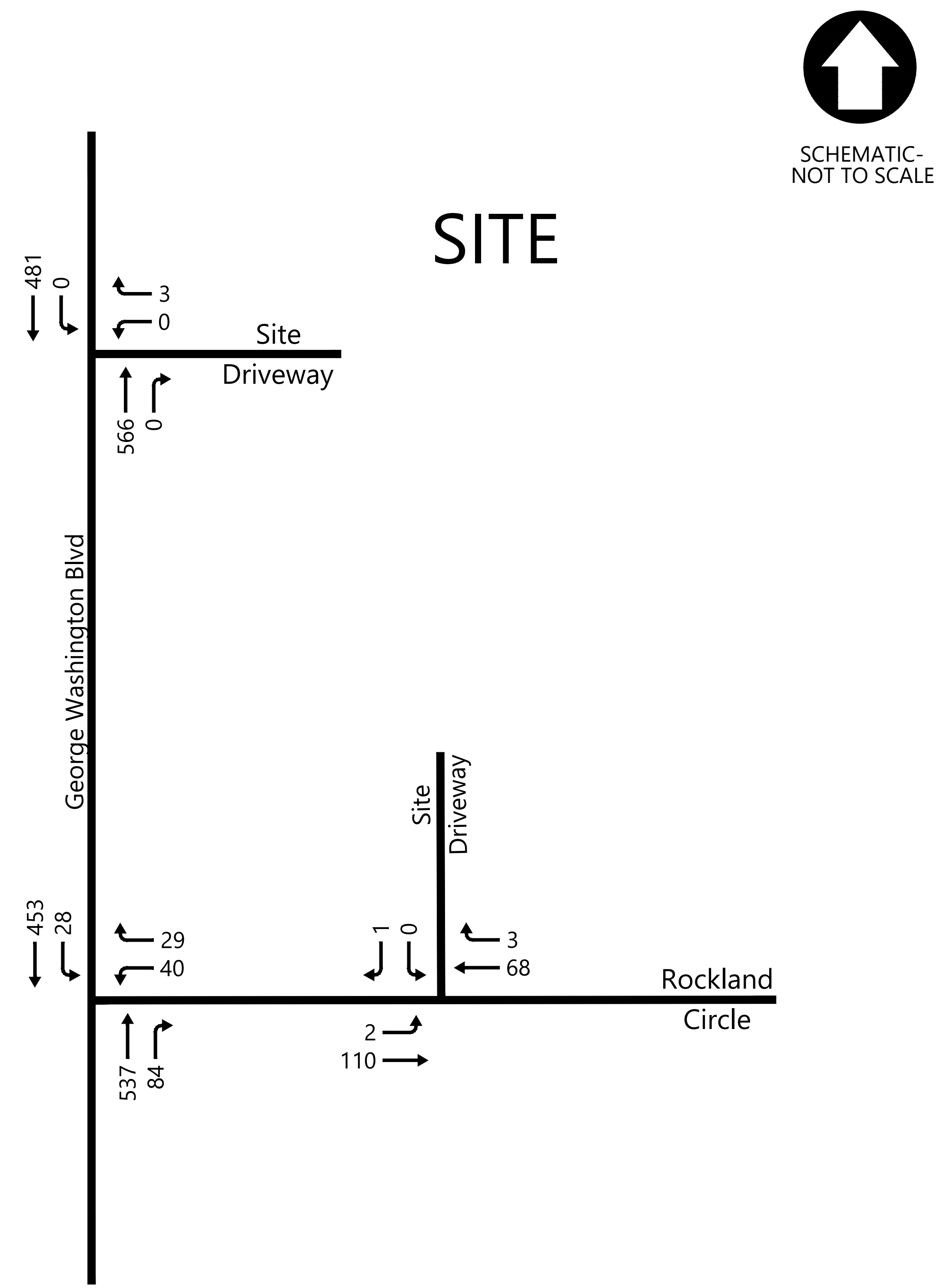

Figure 3
2023 Existing Weekday Afternoon
Peak Hour Traffic Volumes
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

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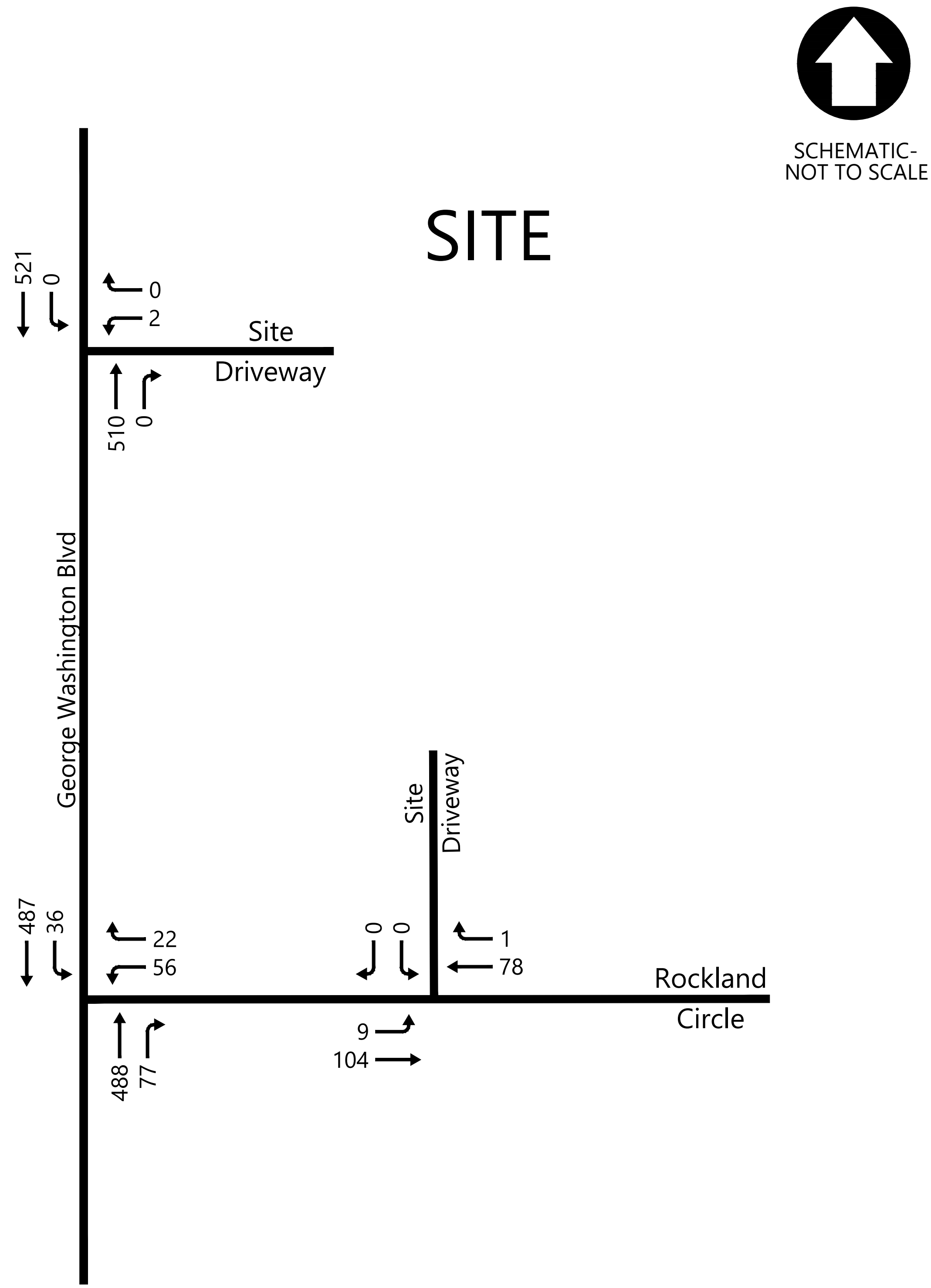

Figure 4
2023 Existing Saturday Midday
Peak Hour Traffic Volumes
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

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Crash Summary

Crash data was obtained from MassDOT for the most recent five-year period available (2016 to 2020) to understand the existing safety operations of the study area intersection. A summary of the crash data analyzed is presented in Appendix C.

The MassDOT Crash Rate Worksheet calculations were used to determine whether the crash frequencies at the study area intersection was unusually high given the travel demands. The MassDOT Crash Rate Worksheet calculates a crash rate expressed in crashes per million entering vehicles (MEV). The calculated rate is then compared to the average rate for signalized and unsignalized intersections statewide and within MassDOT District 5. For signalized intersections, the statewide average crash rate is 0.78 crashes per MEV, and the MassDOT District 5 crash rate is 0.75 crashes per MEV. For unsignalized intersections, the statewide and Districtwide average crash rates are 0.57 crashes per MEV.

George Washington Boulevard at Rockland Circle

The signalized intersection of George Washington Boulevard at Rockland Circle is reported to have experienced a total of eight crashes during the five-year period reviewed, resulting in a crash rate of 0.29 crashes per MEV. Of the crashes reviewed at the intersection, three crashes were rear-end collisions, one crash was a sideswipe, one crash was a head-on collision, and three crashes were single vehicle collisions. Two crashes resulted in personal injury, and six crashes resulted in property damage only.

George Washington Boulevard at the South Site Driveway

The unsignalized intersection of George Washington Boulevard at south site driveway was reported to have experienced one crash during the five-year period reviewed, resulting in a crash rate of 0.04 crashes per MEV. The reported crash was a rear-end collision resulting in property damage only.

The intersections of Rockland Circle at the site driveway and George Washington Boulevard at the north site driveway are not reported to have experienced any crashes during the five-year period reviewed.

FUTURE CONDITIONS

To establish future traffic demands on the study area roadways and intersections, the 2023 Existing traffic volumes were projected to the future-year 2030. Traffic volumes on the study area roadways in 2030 are considered to include existing traffic, as well as new traffic resulting from general growth in the study area and from other planned development projects, independent of the proposed project. The potential background traffic growth, unrelated to the proposed project, was considered in the development of the 2030 No Build (without project) peak hour traffic volumes. The estimated traffic increases associated with the proposed project were then added to the 2030 No Build volumes to reflect the 2030 Build (with project) traffic conditions. A more detailed description of the development of the 2030 No Build and 2030 Build traffic volume networks is presented below.

Future Roadway Improvements

Planned roadway improvement projects can impact travel patterns and future traffic operations. Based on information available from the MassDOT project database, no roadway improvement projects are planned in the vicinity of the study area which are anticipated to impact existing travel patterns or traffic operations.

Background Traffic Growth

Traffic growth is generally a function of changes in motor vehicle use and expected land development within the area. To establish the rate at which traffic on the study area roadways can be anticipated to grow during the seven-year forecast period (2023 to 2030), both planned area developments and historic traffic growth were reviewed.

Historic Traffic Growth
As described above, a growth rate of 0.455 percent per year was provided by the Central Transportation Planning Staff (CTPS). In order to provide a conservative estimate of future growth, a background growth rate of 0.5 percent, compounded annually, was utilized to capture traffic growth associated with general changes in population, smaller developments, and future developments which may not be known at this time.

Site-Specific Growth
Based on discussions with the Town of Hull and available information on the Town of Hull website, there are no additional developments in the area that would be anticipated to impact traffic volumes within the study area.

2030 No Build Traffic Volumes

The 2023 Existing peak hour traffic volumes were grown by 0.5 percent per year (compounded annually) over the seven-year study horizon (2023 to 2030) in order to establish the 2030 No Build weekday morning, weekday afternoon, and Saturday midday peak hour traffic volumes. The resulting 2030 No Build traffic volumes are documented in the traffic projection model presented in Appendix D and are presented in Figure 5 for the weekday morning peak hour, Figure 6 for the weekday afternoon peak hour, and Figure 7 for the Saturday midday peak hour.

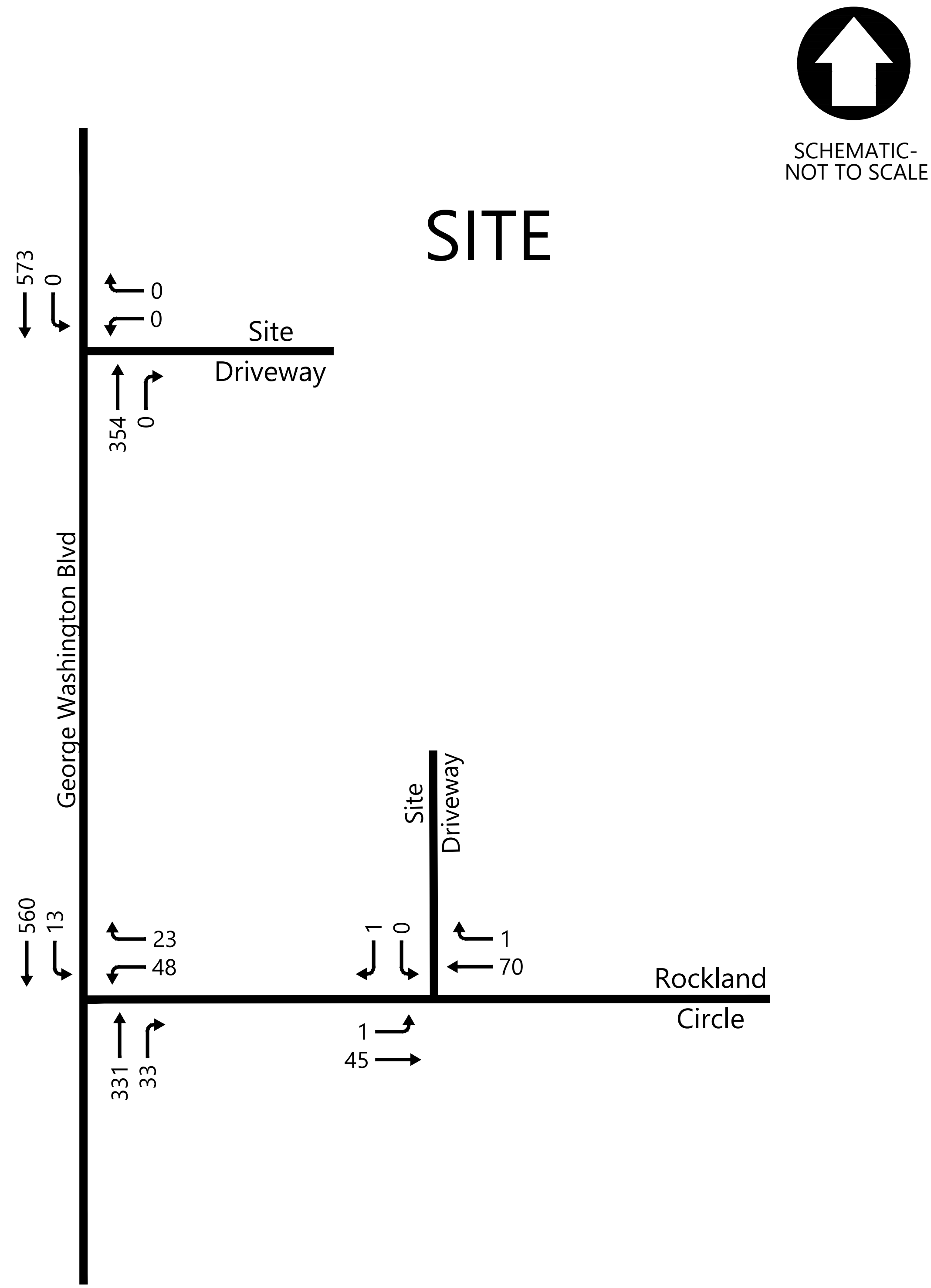

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Figure 5
2030 No Build Weekday Morning
Peak Hour Traffic Volumes
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

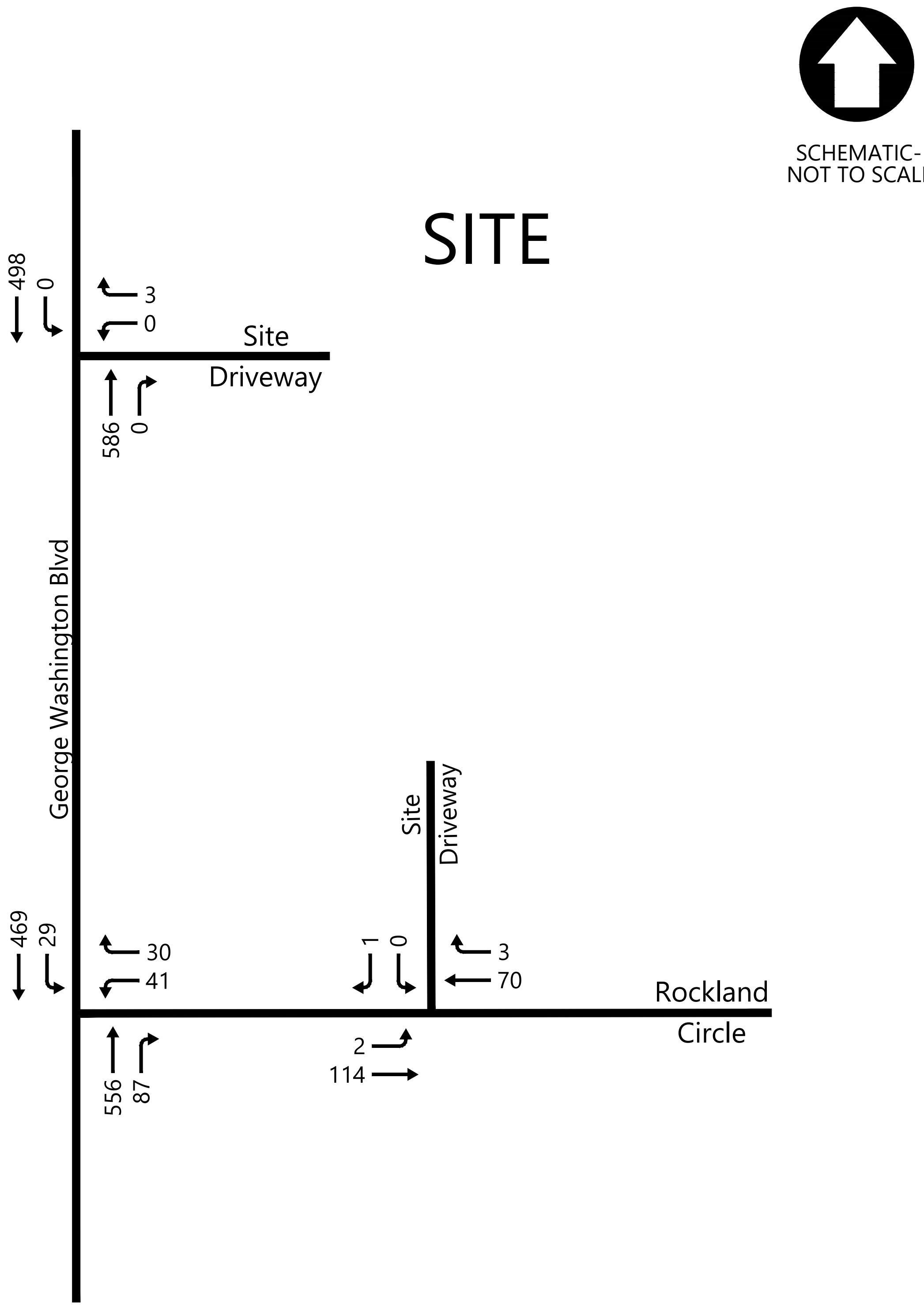

Figure 6
2030 No Build Weekday Afternoon
Peak Hour Traffic Volumes
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

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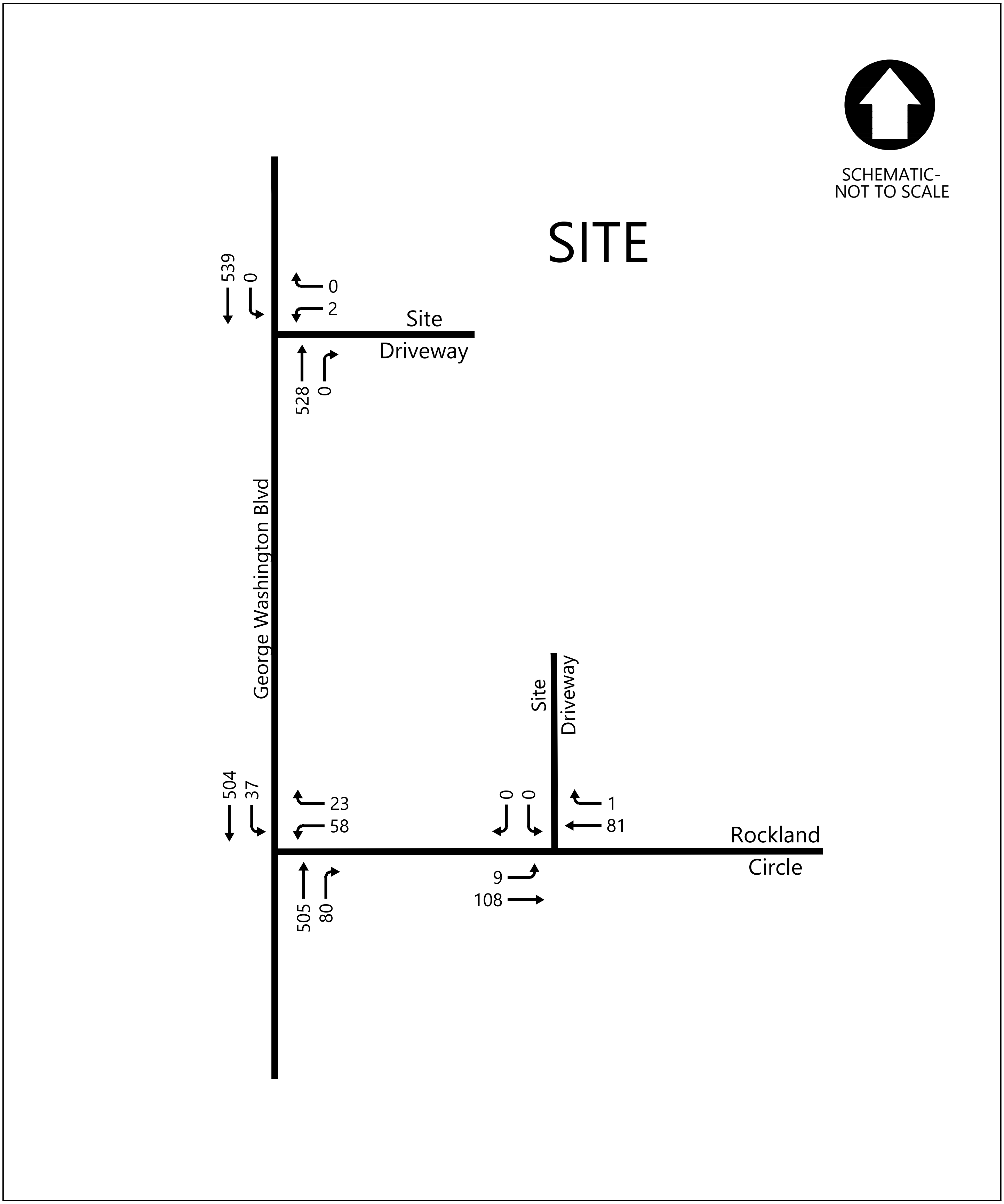

Figure 7
2030 No Build Saturday Midday
Peak Hour Traffic Volumes
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

Site-Generated Traffic

To estimate the number of vehicle trips associated with the proposed mixed-use development, the Institute of Transportation Engineers' (ITE) publication, *Trip Generation Manual*, *11th Edition*, was referenced. ITE is a national research organization of transportation professionals, and the *Trip Generation Manual* provides traffic generation information for various land uses compiled from studies conducted by members nationwide. This reference establishes vehicle trip rates (in this case expressed in trips per square foot and trips per dwelling unit) based on actual traffic counts conducted at similar types of existing land uses.

Vehicle trip estimates for the residential portion of the proposed mixed-use development were developed based on data presented for Land Use Code (LUC) 221 (Multifamily Housing (Mid-Rise)). The exact nature of the retail portion of the sites has not yet been determined, though it is considered possible that at least one and potentially both could be occupied by restaurant uses, which typically generate more trips than other types of retail uses. In order to present a conservative analysis, the retail portion of the site was modeled using LUC 932 (High-Turnover Sit-Down Restaurant). The resulting trips estimated to be generated by the proposed mixed-use development are displayed in Table 2 below.

Table 2: Proposed Trip Generation

		Weekday AM Peak Hour			Weekday PM Peak Hour			Saturday Midday Peak Hour		
Description	**Size**	**In**	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Proposed Residential Trips[1]	132 d.u.	11	36	47	32	20	52	27	26	53
Proposed Restaurant Trips[2]	7,000 s.f.	37	30	67	39	25	64	40	38	78
Proposed Site Trips		**48**	**66**	**114**	**71**	**45**	**116**	**67**	**64**	**131**

1 ITE Land Use Code 221 (Multifamily Housing (Mid-Rise)) based on 132 dwelling units.
2 ITE Land Use Code 932 (High-Turnover (Sit-Down) Restaurant) based on 7,000 square feet.

As shown in Table 2, the proposed mixed-use development is shown to generate approximately 114 trips (48 entering vehicles and 66 exiting vehicles) during the weekday morning peak hour, approximately 116 trips (71 entering vehicles and 45 exiting vehicles) during the weekday afternoon peak hour, and approximately 131 trips (67 entering vehicles and 64 exiting vehicles) during the Saturday midday peak hour.

Not all trips to restaurant land uses are new trips. In fact, a significant portion of the total trips attracted to such land uses are pass-by trips. Since pass-by traffic is already on the adjacent roadways, this portion of the total development traffic is reflected in the existing traffic volumes and does not represent additional traffic on the roadway network. Therefore, the total traffic volume associated with the proposed development is reduced by the pass-by volume to estimate the "new" traffic generated by the project.

For the retail portions of the site, ITE data for LUC 932 shows a pass-by trip rate of 43% during the weekday afternoon peak hour. ITE data does not include pass-by trip rates for LUC 932 during the weekday morning or Saturday midday peak hours. The weekday afternoon pass-by rate of 43% was applied to the Saturday midday peak hour vehicle trips. No pass-by adjustment was applied to the weekday morning peak hour.

A summary of the total trips, pass-by trips, and new trips estimated to be generated by the proposed redevelopment are presented below in Table 3.

Table 3: Pass-by Trip Generation

	Weekday AM Peak Hour			Weekday PM Peak Hour			Saturday Midday Peak Hour		
Description	**In**	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Proposed Site Trips	48	66	114	71	45	116	67	64	131
- Restaurant Pass-by Trips [1]	*0*	*0*	*0*	*-14*	*-14*	*-28*	*-17*	*-17*	*-34*
New Site Trips	**48**	**66**	**114**	**57**	**31**	**88**	**50**	**47**	**97**

[1] Based on ITE Land Use Code 932 (High-Turnover (Sit-Down) Restaurant), 43% of weekday PM peak hour trips are attributed to pass-by trips. No data are provided for the Saturday midday peak hour, so the weekday PM pass-by rate was utilized for Saturday midday. No pass-by reduction was applied to the weekday AM peak hour.

As shown in Table 3 above, with pass-by adjustments applied the proposed project is estimated to generate approximately 88 new vehicle trips during the weekday afternoon peak hour (57 entering vehicles and 31 exiting vehicles) and approximately 97 new vehicle trips during the Saturday midday peak hour (50 entering vehicles and 47 exiting vehicles).

The trip generation presented above is considered to be conservative as it does not account for the trips generated by the existing/previous uses on the site or for trips which would occur between the uses on the site. Additionally, the trip generation does not account for trips taken via walking or biking from nearby attractions. Inclusion of these elements would be expected to further reduce the number of new vehicles trips traveling to and from the project site on the adjacent roadways.

Project Trip Distribution and Assignment

In order to understand the potential travel patterns of the vehicle trips related to the proposed redevelopment, U.S. Census Journey-to-Work data for the Town of Hull was reviewed and is provided in Appendix E of this report. The overall distribution patterns identified using the U.S. Census data were applied to both the residential and retail components of the project.

It is expected that vehicle trips associated with the retail portions of the site will utilize the existing Department of Conservation and Recreation parking lot along George Washington Boulevard, while residents of the proposed mixed-use development will utilize the proposed parking garage underneath the residential portion of the site and the proposed on-site parking area to the south. It is anticipated that some portion of the vehicle trips to the retail portion of the site would utilize parking areas other than the DCR lot on George Washington Boulevard, such as the DCR parking lot on Nantasket Avenue or on-street parking along Nantasket Avenue. In order to present a conservative estimate of the impact of the project trips on the study area intersections, all vehicle trips associated with the retail portion of the proposed development are assigned to utilize the DCR parking lot on George Washington Boulevard. Additionally, in order to further provide a conservative estimate of the vehicle operations at the proposed site driveways on George Washington Boulevard, the site access points on George Washington Boulevard have been modeled as a single full-access-in, right-out only driveway.

The resulting arrival and departure patterns for the proposed project are presented in Figure 8.

The new vehicle trips associated with the project were then assigned to the surrounding roadway network based on the project trip distribution patterns presented in Figure 8. The resulting distributed new project trips are shown in Figure 9 for the weekday morning peak hour, Figure 10 for the weekday afternoon peak hour, and Figure 11 for the Saturday midday peak hour. The pass-by vehicle trips are assigned based on existing traffic patterns. The new and pass-by trip assignments are documented in the traffic projection model found in Appendix D.

2030 Build Traffic Volumes

To establish the 2030 Build peak hour traffic volumes, the distributed new and pass-by project trips were added to the 2030 No Build peak hour traffic volumes. The resulting 2030 Build weekday traffic volumes are presented in Figure 12 for the weekday morning peak hour, Figure 13 for the weekday afternoon peak hour, and Figure 14 for the Saturday midday peak hour, and are documented in the traffic projection model presented in Appendix D.

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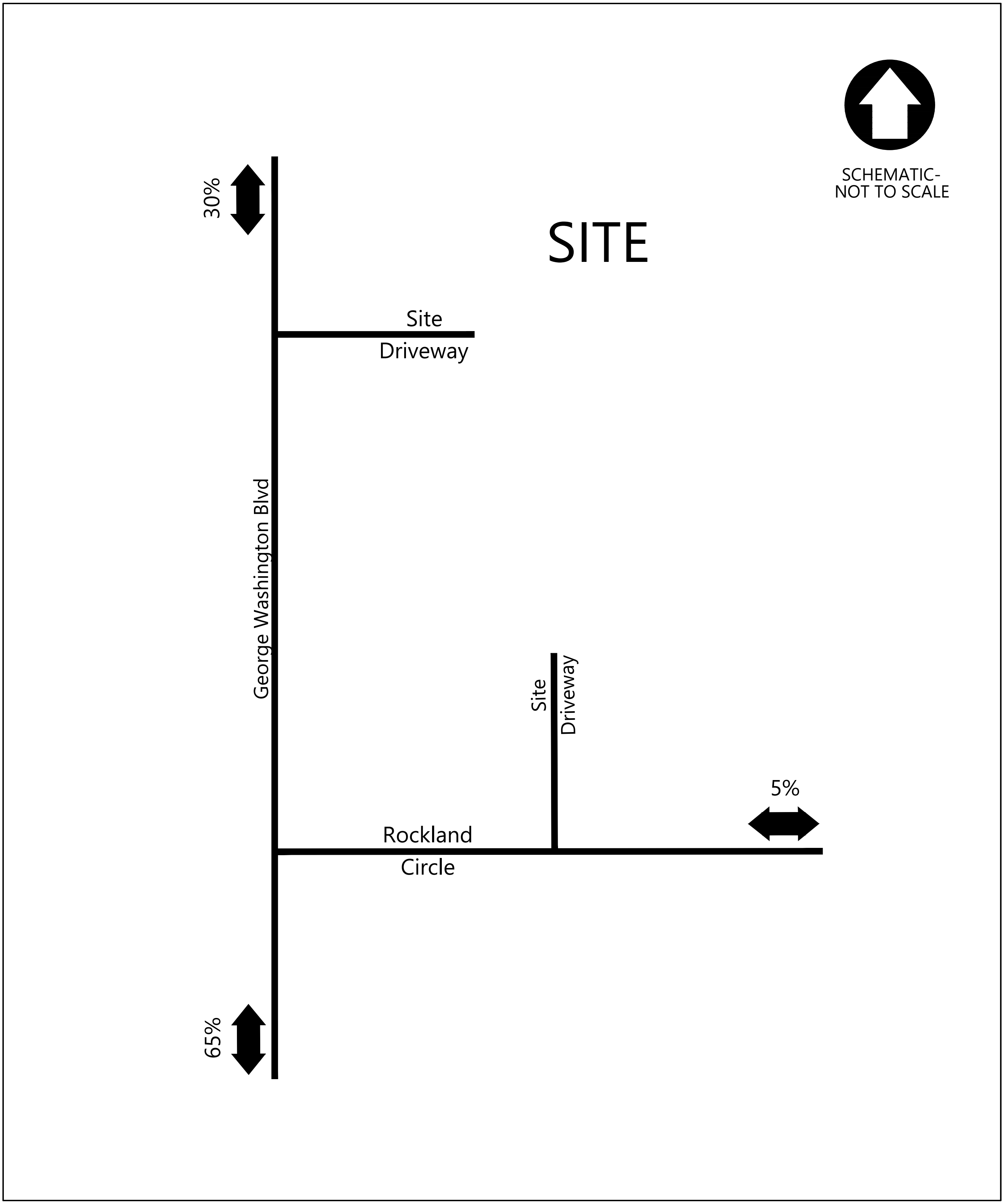

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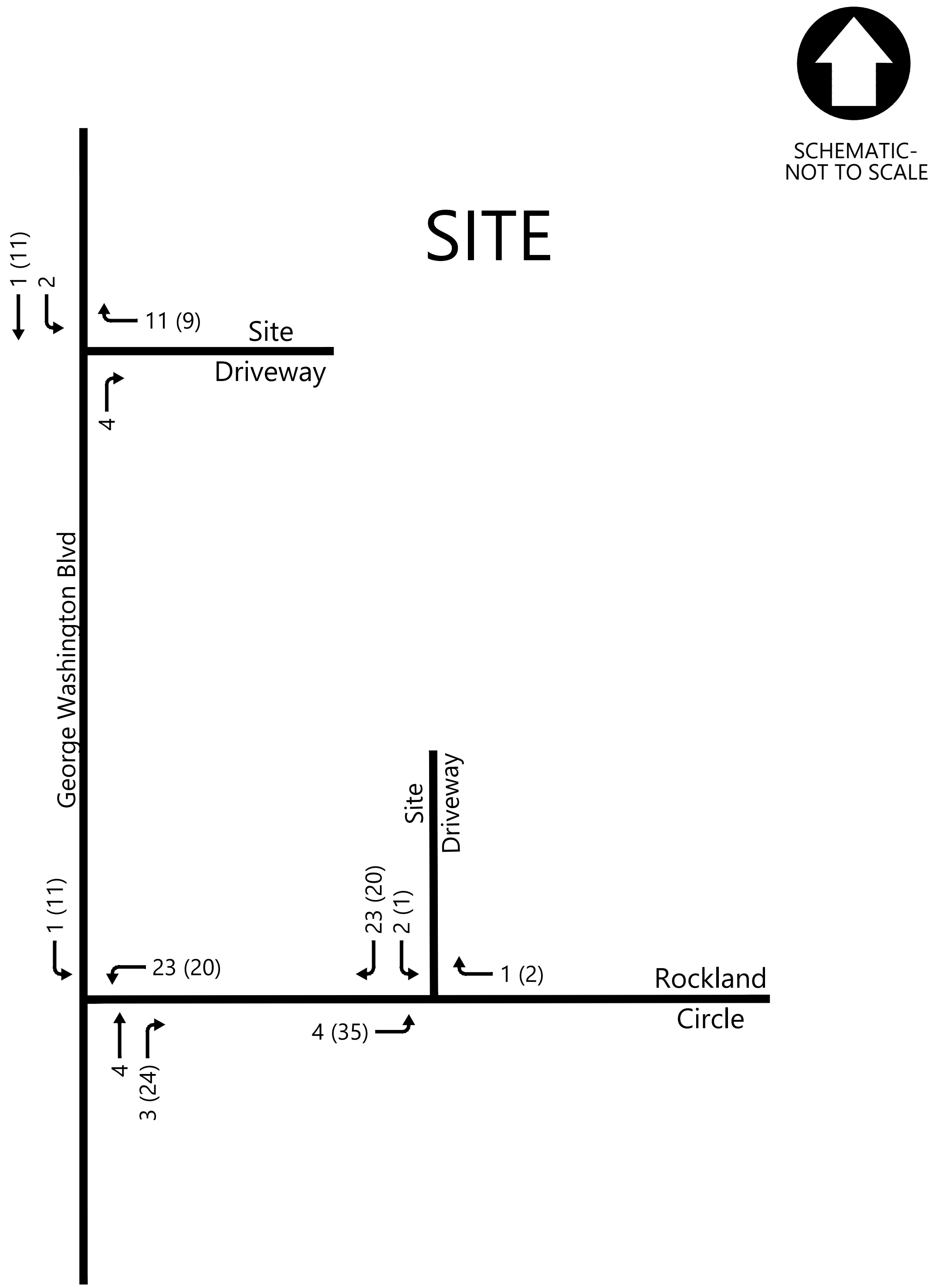
Figure 8
Direction of Arrivals and Departures
Paragon Dunes Mixed-Use Development
Hull, Massachusetts



LEGEND

Residential (Retail)

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Figure 9
Weekday Morning Peak Hour
New Project Trips
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

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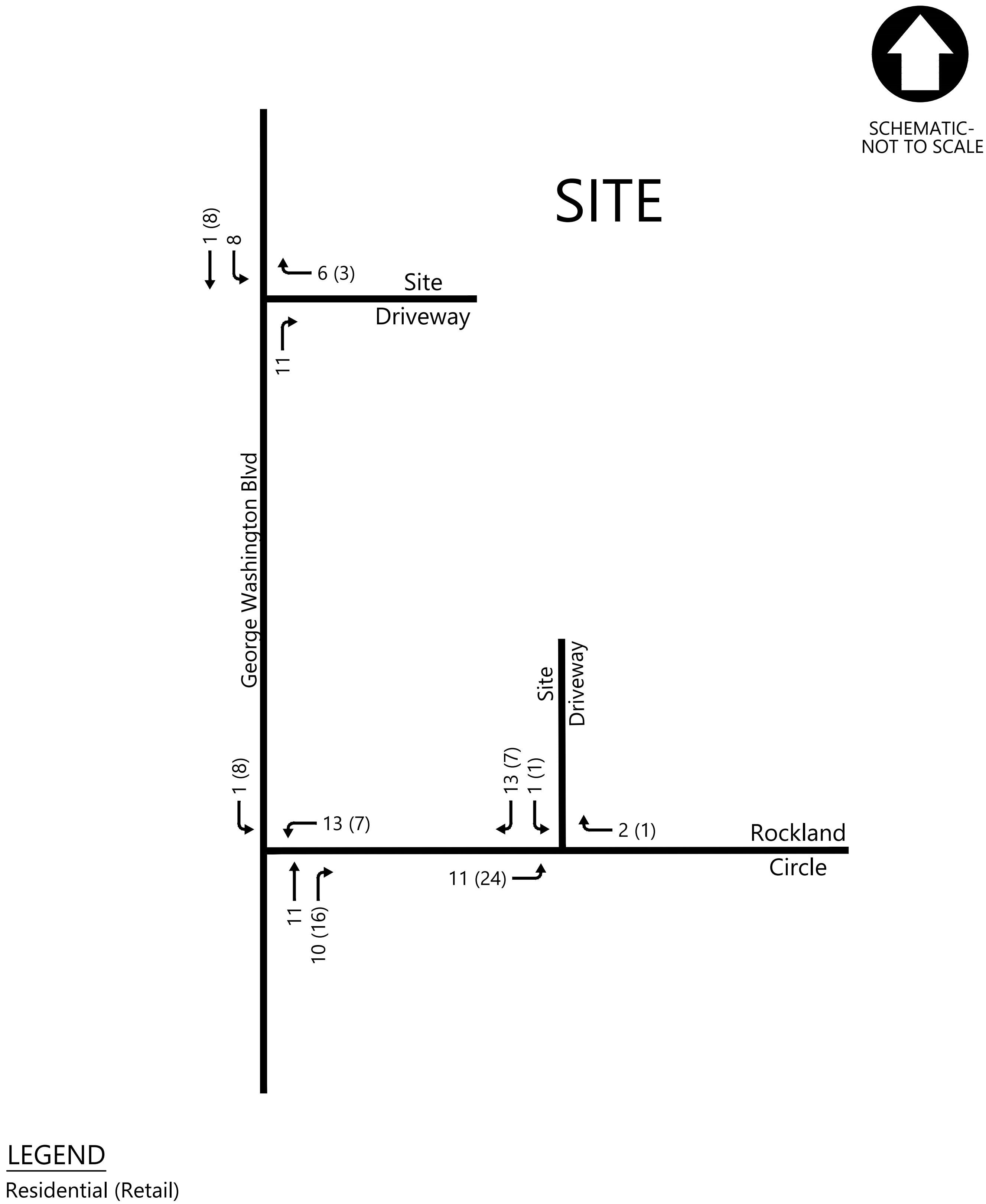

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Figure 10
Weekday Afternoon Peak Hour
New Project Trips
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

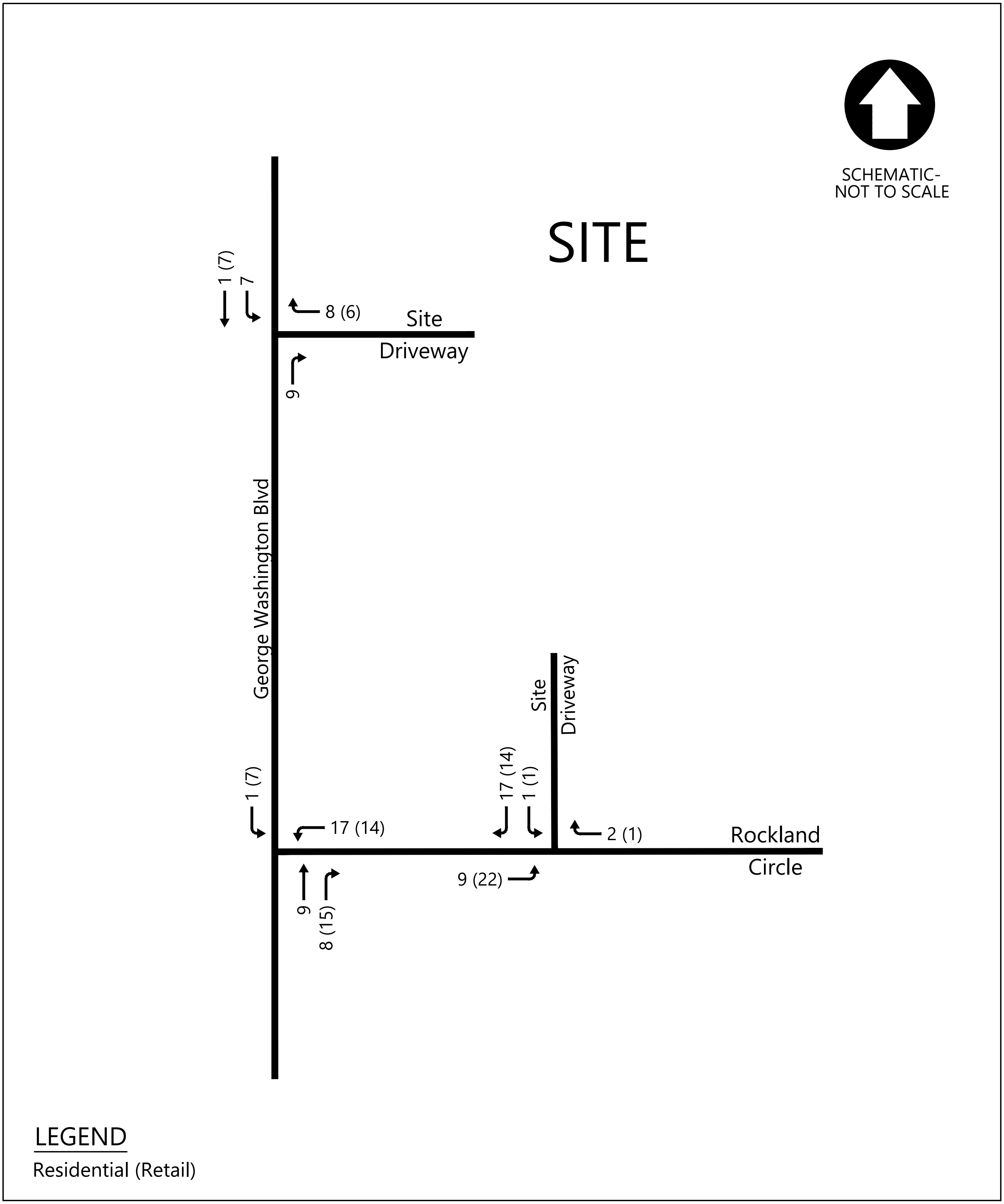

Figure 11
Saturday Midday Peak Hour
New Project Trips
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

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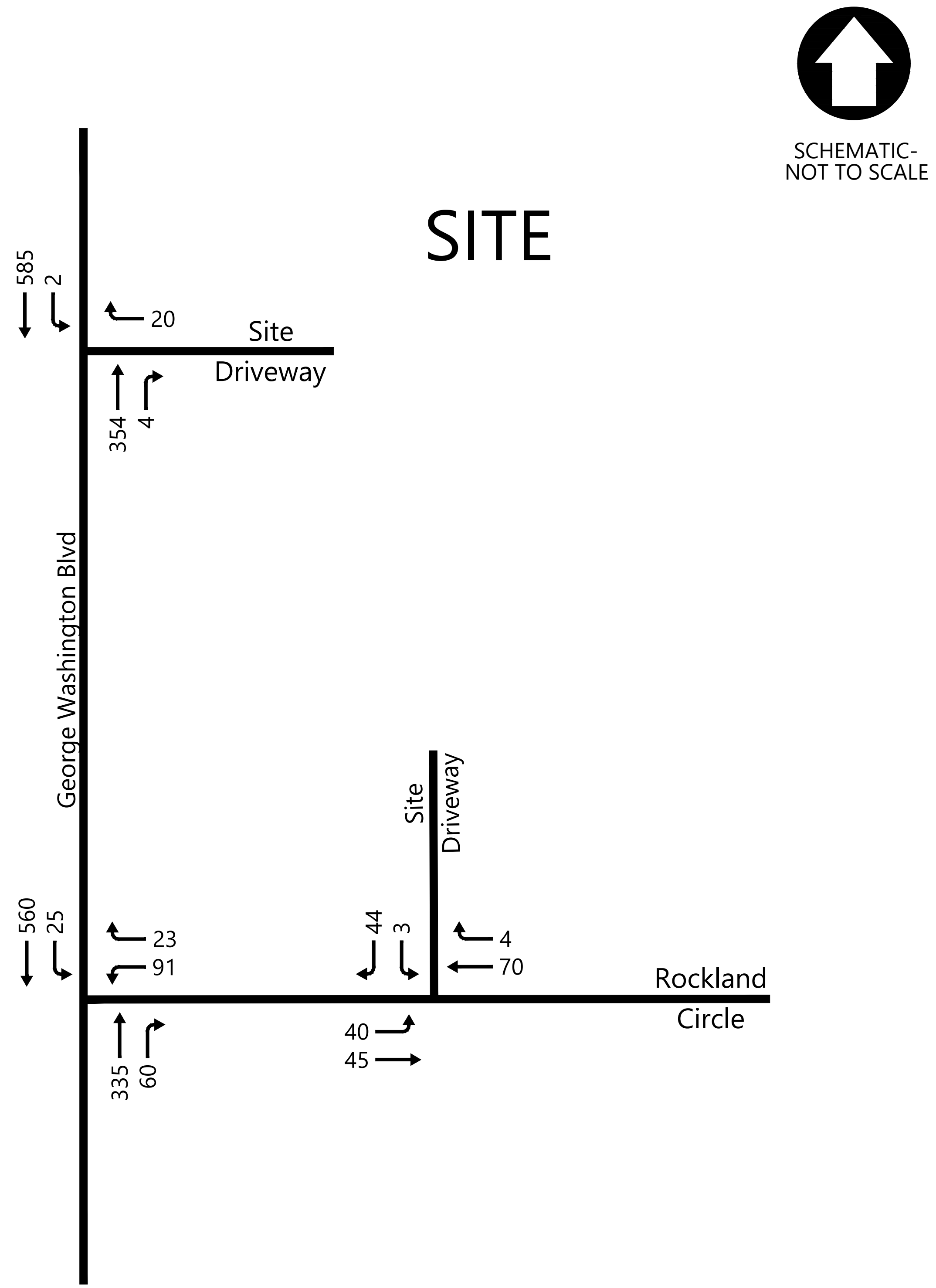

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Figure 12
2030 Build Weekday Morning
Peak Hour Traffic Volumes
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

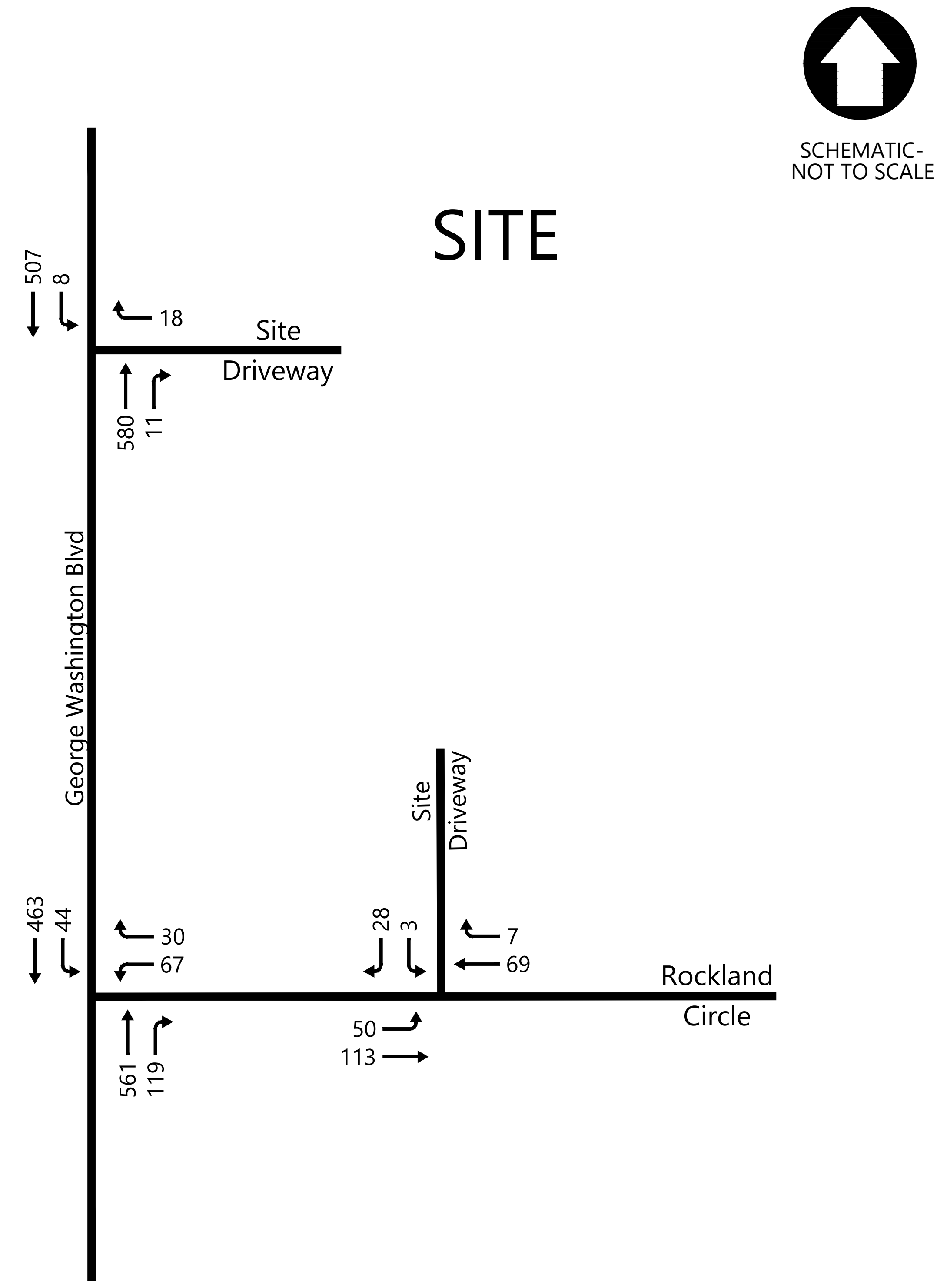

Figure 13
2030 Build Weekday Afternoon
Peak Hour Traffic Volumes
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

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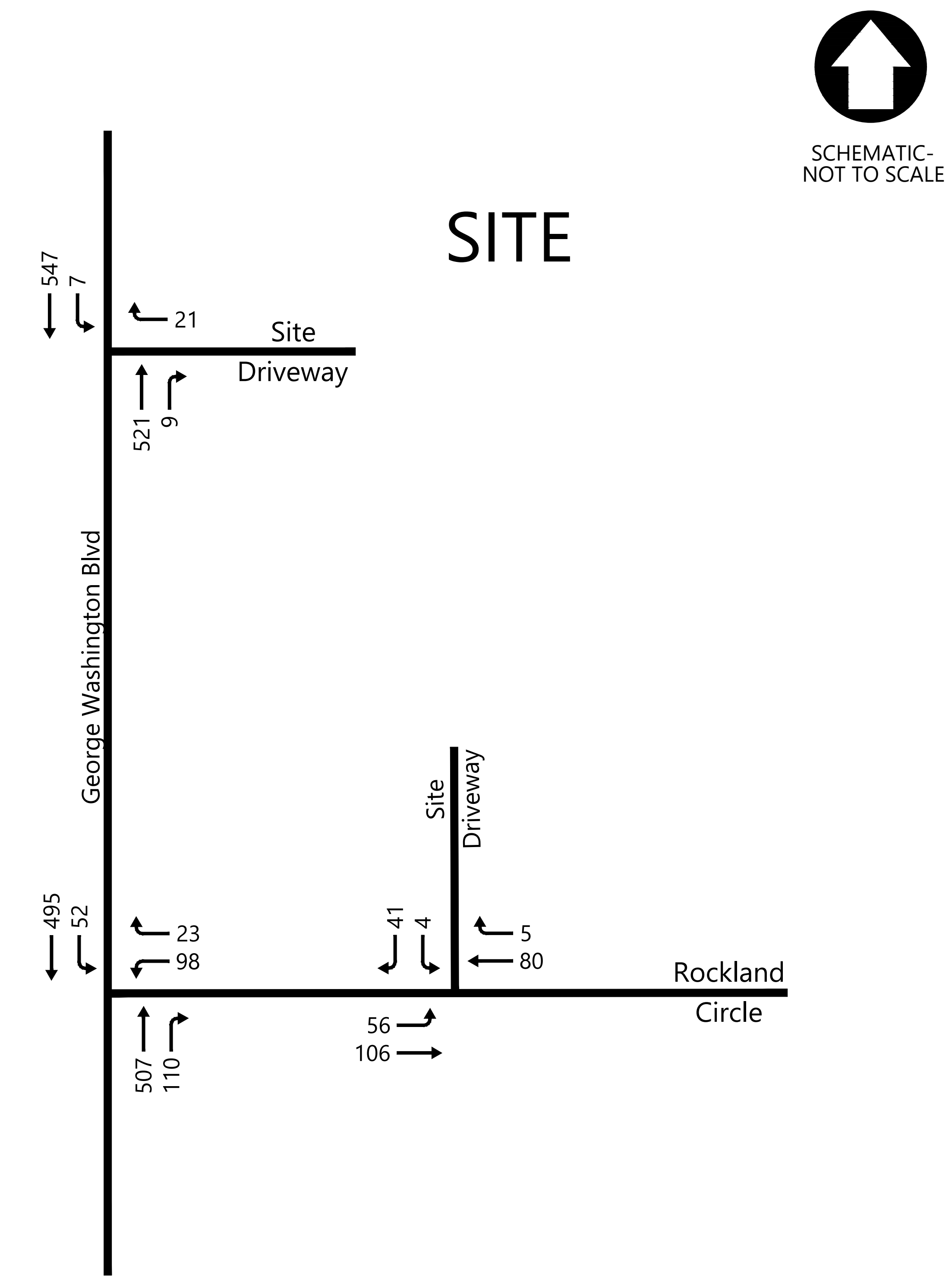

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Figure 14
2030 Build Saturday Midday
Peak Hour Traffic Volumes
Paragon Dunes Mixed-Use Development
Hull, Massachusetts

TRAFFIC OPERATIONS ANALYSIS

In previous sections of this report, the quantity of traffic at the study area intersections has been discussed. This section describes the overall quality of the traffic flow at the study area intersections during the weekday morning, weekday afternoon, and Saturday peak hours. As a basis for this assessment, intersection capacity analysis was conducted using Synchro capacity analysis software at the study area intersections under the 2023 Existing, 2030 No Build, and 2030 Build peak hour traffic conditions. The analysis is based on Synchro capacity analysis methodologies and procedures contained in the *Highway Capacity Manual, 6th Edition* (HCM), which are summarized in Appendix F. In accordance with MassDOT Transportation Impact Assessment Guidelines, under future-year 2030 No Build and 2030 Build conditions, a default peak hour factor of 0.92 is utilized for all movements at the study area intersections.

A discussion of the evaluation criteria and a summary of the results of the capacity analysis are presented below.

Level-of-Service Criteria

Average total vehicle delay is reported as level-of-service (LOS) on a scale of A to F. At signalized intersections, LOS A represents delays of 10 seconds or less and LOS F represents delays in excess of 80 seconds. At unsignalized intersections, LOS A represents delays of 10 seconds or less and LOS F represents delays in excess of 50 seconds. A more detailed description of the LOS criteria is provided in Appendix F.

Capacity Analysis Results

Intersection capacity analyses were conducted using Synchro capacity analysis software for the study area intersection to evaluate the 2023 Existing, 2030 No Build, and 2030 Build traffic conditions during the weekday morning and weekday afternoon peak hours. The peak hour traffic volumes utilized as part of this analysis are provided in the traffic projection model, attached in Appendix D.

As discussed previously, in order to present a conservative analysis the three site driveways located on George Washington Boulevard have been modeled as a single full-access driveway, serving entering and exiting vehicle trips using the proposed site parking and exiting vehicle trips from the DCR parking lot. Additionally, the DCR and site parking lot exits on Rockland Circle have been modeled as a single combined driveway.

The Synchro capacity analysis worksheets for the 2023 Existing, 2030 No Build, and 2030 Build traffic conditions are presented in Appendix G, Appendix H, and Appendix I, respectively. The overall results for the signalized study area intersection and the stop-controlled site driveway approaches are presented in Table 3. A more detailed summary of the capacity analysis for the study area intersections is provided in Appendix J. The results of the specific capacity analysis at the study area intersections are discussed below.

Table 4: Capacity Analysis Results

		Peak	2023 Existing			2030 No Build			2030 Build		
Intersection	Movement	Hour	LOS[1]	Delay[2]	V/C[3]	LOS	Delay	V/C	LOS	Delay	V/C
George Washington Boulevard at Site Driveway	WB LR/R	AM	n/a	n/a	n/a	n/a	n/a	n/a	A	9.6	0.03
		PM	B	10.3	0.01	B	10.3	0.01	B	10.6	0.03
		SAT	C	16.9	0.01	C	17.3	0.01	B	10.3	0.03
George Washington Boulevard at Rockland Circle	Overall	AM	A	6.1	0.49	A	6.0	0.49	A	8.0	0.49
		PM	A	7.2	0.49	A	6.9	0.49	A	8.0	0.51
		SAT	A	6.9	0.49	A	7.1	0.49	A	8.9	0.58
Rockland Circle at Site Driveway	SB LR	AM	A	8.7	0.00	A	8.6	0.00	A	8.9	0.05
		PM	A	8.7	0.00	A	8.7	0.00	A	9.0	0.04
		SAT	n/a	n/a	n/a	n/a	n/a	n/a	A	9.1	0.05

1 Level-of-Service
2 Average vehicle delay, in seconds
3 Volume to capacity ratio; intersection capacity utilization reported for signal
n/a Not applicable

As shown in Table 4, the signalized intersection of George Washington Boulevard at Rockland Circle is shown to currently operate at overall LOS A during the weekday morning, weekday afternoon, and Saturday midday peak hours. Under future conditions, without and with the proposed project, the intersection is projected to continue to operate at overall LOS A during all peak hours analyzed. Relative to 2030 No Build conditions, average overall vehicle delay at the signal is not projected to increase by more than two seconds with the additional traffic associated with the proposed redevelopment on the study area roadways. All movements at the intersection are projected to operate at LOS C or better during all peak hours analyzed.

Exiting traffic at the existing DCR parking lot driveway on George Washington Boulevard at the location of the proposed site driveway is shown to currently operate at LOS B during the weekday afternoon peak hour and at LOS C during the Saturday midday peak hour. Under 2030 No Build conditions, the driveway is projected to continue operating at LOS B and LOS C during the weekday afternoon and Saturday midday peak hours, respectively. No vehicles were counted entering or exiting the existing driveway during the weekday morning peak hour, so no capacity analysis results are provided for the weekday morning peak hour under 2023 Existing or 2030 No Build conditions. With the proposed project in place, the George Washington Boulevard site driveway is projected to operate at LOS A during the weekday morning peak hour and LOS B during the weekday afternoon and Saturday midday peak hours. It should be noted that the average vehicle delay exiting at the driveway is reported to decrease during the Saturday midday peak hour between 2030 No Build and 2030 Build conditions as left turns experience greater delay than right turns, and left turns out of site driveway on George Washington Boulevard would be prohibited under 2030 Build conditions.

The exiting movements at the existing DCR/site driveway on Rockland Circle are projected to operate at LOS A during all peak hours and under all conditions analyzed, with a negligible increase in average vehicle delay with the proposed project in place.

Sensitivity Analysis

The turning movement counts which form the basis of the capacity analysis presented in this report were taken in October. Seasonal adjustments were made based on MassDOT-provided factors for Cape Cod for the average month, and the resulting 2023 Existing vehicle volumes are expected to reflect a conservative estimate of vehicle volumes during a typical month. However, in order to assess the potential impacts of the proposed project during the peak summertime conditions in Hull, an additional sensitivity analysis was performed.

Historic traffic count data on Hull Street south of Rockland Street available from the MassDOT Transportation Data Management System database were referenced. Daily vehicle volume data collected on a typical weekday in mid-July 2022 were compared to data collected in late September 2019. Based on this comparison, the July vehicle volumes were found to be approximately 46% greater than vehicle volumes in September. The MassDOT factors for the Recreational – East group were also reviewed. The peak monthly vehicle volumes of the MassDOT factors were shown to occur in July, and are shown to be approximately 30% greater than an average month. Combined with October traffic being slightly below average, the resulting peak July vehicle volumes would be approximately 32% greater than October volumes.

To reflect the higher volumes on the study area roadways, the volumes at the study area intersections were increased by 50% as part of the sensitivity analysis during each of the peak hours analyzed.

In order to assess the potential impacts related to seasonal use of the DCR parking lot, the volume of exiting traffic from the lot was increased above what was counted in October. The capacity of the parking lot was identified to be approximately 203 parked vehicles. A vehicle volume equal to approximately half of the parking lot capacity, 102 vehicles, was then distributed to the site driveway exiting movements and the westbound left turn movement at the intersection of George Washington Boulevard at Rockland Circle in order to account for a peak exiting volume from the DCR parking lot.

With the 50% increase in roadway volume and the addition of the 102 exiting vehicles exiting the DCR lot, the sensitivity analysis found that all movements at the study area intersections would be projected to operate at LOS D or better during all peak hours analyzed. Exiting movements at the site driveways would be projected to operate at LOS C or better, and the signalized intersection of George Washington Boulevard at Rockland Circle would be projected to operate at overall LOS B. Overall, the sensitivity analysis suggests that the project would not be expected to have significant impact on vehicle operations at the study area intersections, even under peak summertime conditions.

Site Access and Circulation

Access to the proposed redevelopment would be provided via a total of four driveways. One full-access and one right-in only driveway on George Washington Boulevard would provide access to the trash collection area and a small parking lot located to the north of the proposed building. An additional full-access-in, right-out only driveway on George Washington Boulevard would provide access to the parking garage and to the primary outdoor parking lot of the site. Additionally, an internal connection near this driveway would allow for exit-only vehicle traffic from the DCR parking lot. A final full-access driveway connects the proposed parking lot to Rockland Circle.

Internal sidewalks on the site would connect to the existing Art Walk, providing pedestrian access from the parking lots on the site to Nantasket Avenue and the proposed retail buildings.

Overall, the site layout is expected to allow for safe and efficient access to and within the site.

Sight Distance

A field review of the available sight distance was conducted at the proposed site driveway locations. The American Association of State Highway and Transportation Officials (AASHTO) publication, *A Policy on Geometric Design, 2018 Edition*, defines minimum sight distances at intersections. The minimum sight distance is based on the required stopping sight distance (SSD) for vehicles traveling along the main road. According to AASHTO, "If the available sight distance for an entering or crossing vehicle is at least equal to the appropriate stopping sight distance for the major road, then drivers have sufficient time to anticipate and avoid collisions. Table 5 summarizes the stopping sight distance standards for the roadway speeds, and the available sight distance on George Washington Boulevard and Rockland Circle approaching the existing site driveway locations. In order to present a conservative analysis, the posted speed limit of 45 miles per hour (mph) was utilized for George Washington Boulevard. No speed limit is posted on Rockland Circle. In order to assess sight distance requirements along Rockland Circle, a speed limit of 25 mph was assumed.

Table 5: Stopping Sight Distances

Site Driveway Location	Approaching	Speed Limit (mph)	85th % Speed (mph)	SSD[1] Required	SSD Measured (ft)	Meets Required SSD?
George Washington Boulevard	Northbound	45	38	360	> 1,000	Yes
North Site Driveway	Southbound	45	41	360	> 1,000	Yes
George Washington Boulevard	Northbound	45	38	360	> 1,000	Yes
South Site Driveway	Southbound	45	41	360	> 1,000	Yes
Rockland Circle	Eastbound	25	-	155	55[2]	Yes
	Westbound	25	-	155	435	Yes

1 Stopping sight distance (see AASHTO equations 3-2 and 3-3) for the posted speed limits, in feet.
2 Sight distance extends to the terminus of Rockland Circle at its intersection with George Washington Boulevard.

As shown in Table 5 above, the available stopping sight distances for vehicles approaching the site driveways on George Washington Boulevard and Rockland Circle exceed the AASHTO required stopping sight distance for the operating vehicle speeds on each of the roadways.

In addition to the required stopping sight distance, *A Policy on Geometric Design* also defines desirable sight distance. The desirable sight distance allows vehicles to enter the main street traffic flow without requiring the mainline traffic to slow to less than 70 percent of its speed and is referred to as intersection sight distance (ISD). Table 6 summarizes the standards for intersection sight distance for the posted speed limits, and the available sight distances at the proposed site driveway locations.

Table 6: Intersection Sight Distances

Site Driveway Location	Looking	Speed Limit (mph)	85th % Speed (mph)	ISD[1] Recommended	ISD Measured (ft)	Meets Recommended ISD?
George Washington Boulevard	Left (South)	45	38	430	>1,000	Yes
North Site Driveway	Right (North)	45	41	530	>800	Yes
George Washington Boulevard	Left (South)	45	38	430	>1,000	Yes
South Site Driveway	Right (North)	45	41	530	>1,000	Yes
Rockland Circle	Left (East)	25	-	240	360	Yes
	Right (West)	25	-	280	105[2]	Yes

1 Intersection sight distance (see AASHTO equations 9-1 and 9-2) for the posted speed limits, in feet.
2 Sight distance extends to the terminus of Rockland Circle at its intersection with George Washington Boulevard.

As shown in Table 6, the available intersection sight distances at the proposed site driveways exceed the AASHTO-recommended intersection sight distances for the operating vehicle speeds.

CONCLUSION

The proposed project would redevelop the existing arcade and mini golf course located on the site and construct a mixed-use development consisting of a 132-unit residential building and approximately 7,000 square feet of retail space divided amongst two spaces.

Based on trip generation data published by the Institute of Transportation Engineers, the proposed redevelopment is estimated to generate approximately 114 new vehicle trips (48 entering vehicles and 66 exiting vehicles) during the weekday morning peak hour, 88 new vehicle trips during the weekday afternoon peak hour (57 entering vehicles and 31 exiting vehicles), and 97 new vehicle trips during the Saturday midday peak hour (50 entering vehicles and 47 exiting vehicles). This estimated trip generation does not account for vehicle trips to the existing or previous uses on the site, or for the proportion of trips which may arrive by walking or biking, including those traveling from one use on the site to another. As such, the trip generation estimates are expected to provide a conservative estimate of the total vehicle trips to the proposed site.

Capacity analysis at the study area intersections indicates that the proposed redevelopment would have a minimal impact on operations at the study area intersections. The signalized intersection of George Washington Boulevard at Rockland Circle is projected to operate at overall LOS A during all peak hours analyzed under 2023 Existing, 2030 No Build, and 2030 Build conditions. All movements at the study area intersections are projected to operate at LOS C or better. A sensitivity analysis performed found that even with a 50 increase in traffic and over half of the existing DCR parking lot capacity exiting the site, all movements would continue to be projected to operate at LOS D or better, with movements exiting the site operating at LOS C or better and the signalized intersection of George Washington Boulevard at Rockland Circle at overall LOS B.

The available sight distances at the site driveways on George Washington Boulevard and Rockland Circle exceed the AASHTO stopping sight distance requirements and intersection sight distance recommendations for the speed limits on each roadway.

Based on the evaluation documented within this traffic impact study, the proposed mixed-use redevelopment is shown to have a minimal impact on the overall traffic operations of the study area roadways and intersections.