Memorandum

To: Ms. Susan C. Ryan
Spaulding Youth Center
72 Spaulding Road
Northfield, NH 03276

Date: September 7, 2017

Project #: 52455.00

From: Robin Bousa
Director of Transportation Systems

Evan Drew, PE
Project Engineer

Re: Spaulding Youth Center
Northfield, NH Property

Traffic Impact Study

VHB has completed a traffic impact study for a proposed medical office park to be located on the Spaulding Youth Center (SYC) property, west of Shaker Road in Northfield, New Hampshire. VHB previously completed a preliminary site access assessment for the proposed project on July 18, 2017, which was submitted to the Town of Northfield Planning Board and the New Hampshire Department of Transportation (NHDOT). The site access assessment was prepared to determine how access will be provided to the site. The scope of work for the preliminary site access evaluation was limited to Shaker Road at NH 140 (Tilton Road) and the site driveway. Comments from the NHDOT on the site access assessment were received by VHB on Wednesday, August 9, 2017 and are included in this memorandum as an Appendix item along with a response to comments by VHB.

This formal traffic impact study is intended to build upon the preliminary site access assessment by expanding the study area, evaluating project impacts, and identifying possible mitigation for the SYC development program on the local transportation system. At a scoping session with the NHDOT and Town officials, the study area for this assessment was determined to include: US 3 at the intersections of NH 132/Shaw's Plaza, I-93 Exit 20 Northbound Ramps/NH 140, and I-93 Exit 20 Southbound Ramps; NH 132 at the intersections of I-93 Exit 19 Northbound Off-Ramp and I-93 Exit 19 Southbound On-Ramp; and the local intersections of Elm Street/Bay Street at Summer Street/Granite Street and Bay Street/Shedd Road at Bay Hill Road. It is important to note that the I-93 Exit 19 interchange and the local intersections were included in the study area at the scoping because, at that time, the SYC development program was contemplating a secondary site access via Shedd Road. This secondary access has since been eliminated from the development program as requested by the Town, except for a possible gated emergency access.

This memorandum includes the following:

- A description of the existing local roadway network near the site beyond the site access;
- A description of the planned development program;
- Trip generation and distribution estimates for the proposed use;
- A description of the traffic volume network development;
- An evaluation of No Build and Build traffic operations at the study area intersections;
- Potential mitigation measures; and
- Conclusions.

2 Bedford Farms Drive
Suite 200
Bedford, NH 03110-6532
P 603.391.3900

Development Program

The nearly 470-acre site is located in Northfield, NH and is bound by Shaker Road, Shedd Road, and Bay Hill Road to the east and south. The Winnipesaukee River and Interstate 93 (I-93) border the site to the north and west. The proposed development program calls for constructing one million square feet of medical facilities and other supporting ancillary uses. The master plan shows multiple buildings throughout the site concentrated on the north and east edges of the property. As the site planning process progresses, the number and locations of the buildings will be refined. A preliminary concept of a potential site buildout is shown in Figure 1. Per the request of the Northfield Planning Board, primary access to the site has been limited to Shaker Road to the east. Potential emergency access could be provided along Shedd Road to the west. The location of the site in relation to the local roadway system is shown in Figure 2.

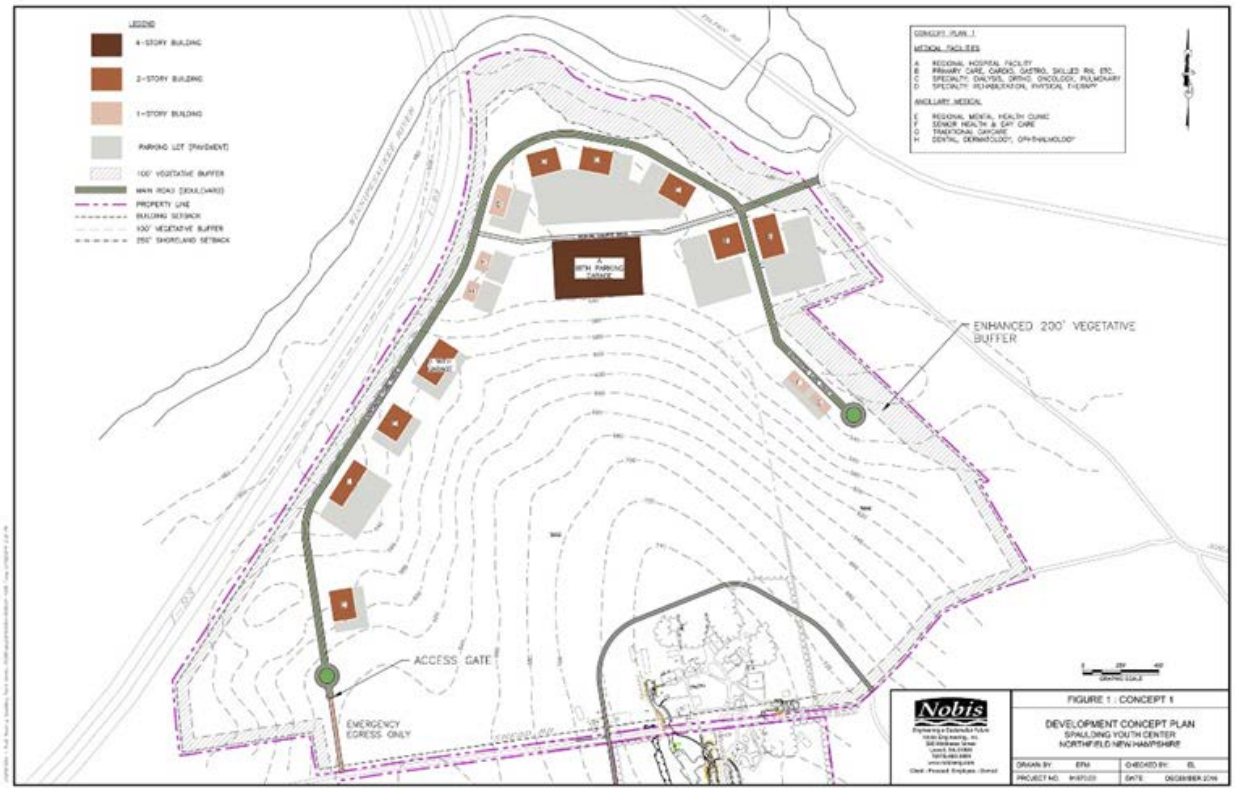
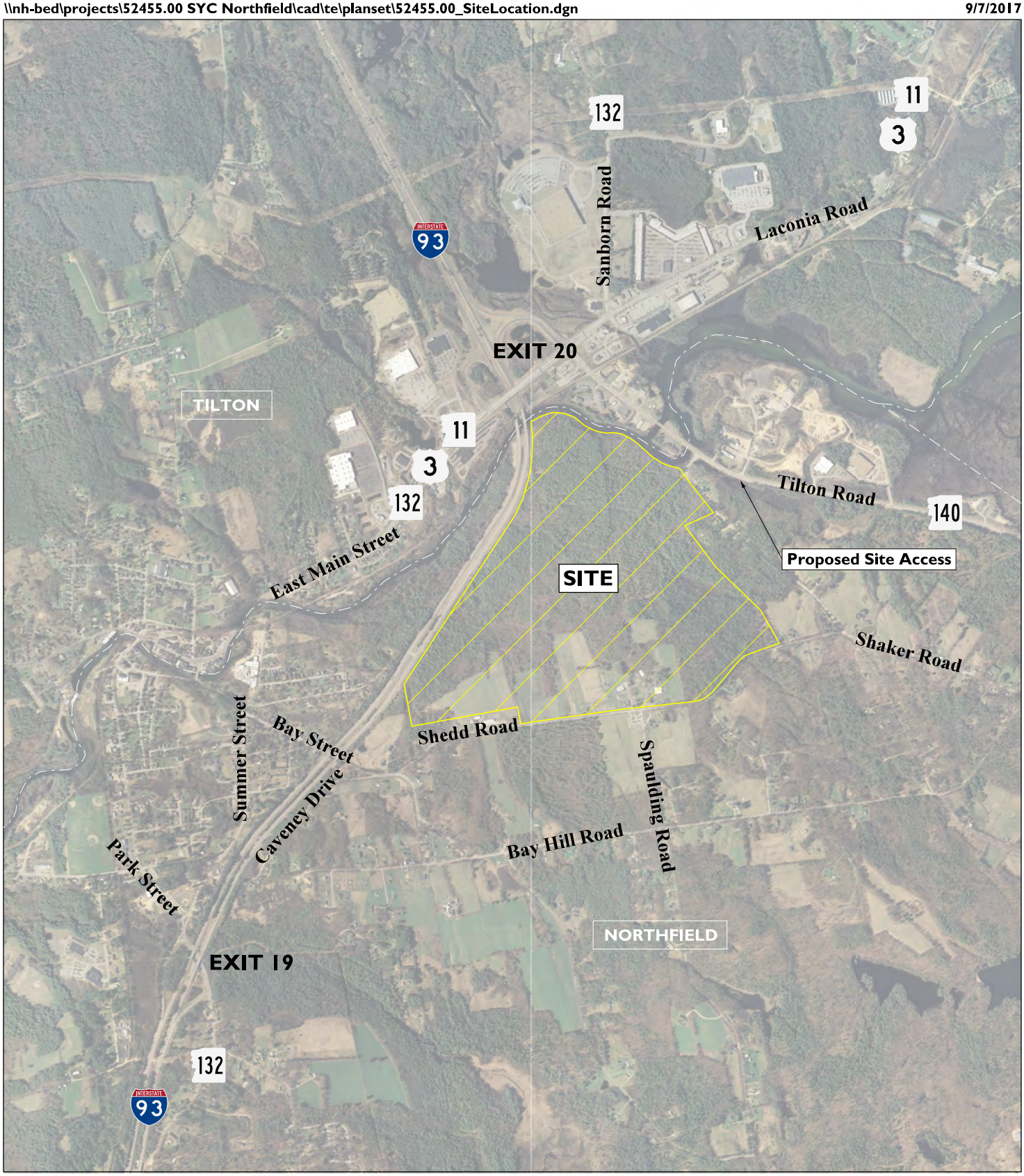


Figure 1: Preliminary Site Buildout Concept



0 2000 4000 FEET

vhb

Figure 2
Site Location Map

Study Area Intersections

The following section provides an overview of the study area intersections with regard to location, traffic control, pedestrian amenities and posted limited. Figure 3 shows the existing specific lane geometry at each location.

US 3 / NH 132 (Laconia Road) at NH 140 (Tilton Road) and I-93 Exit 20 Northbound Ramps

Approximately one half mile northwest of the existing unsignalized intersection of NH 140 and Shaker Road is the signalized intersection of NH 140, US 3 / NH 132 and the I-93 Exit 20 Northbound Ramps. Sidewalk and a signalized pedestrian crosswalk are provided across the south approach (NH 140). The speed limit along US 3 is 35 miles per hour and NH 140 is posted at 35 miles per hour approaching the intersection.

US 3 (Laconia Road) at NH 132 (Sanborn Road) and Shaw's Plaza

US 3 / NH 132 runs east and splits at approximately 0.15 miles at a signalized intersection, where US 3 continues east and NH 132 continues north. The Shaw's Plaza entrance approaches from the south. Sidewalks are available on the northwest and southwest quadrants of the intersection, with no signalized pedestrian crossings provided. NH 132 is posted at 40 miles per hour.

US 3 (Laconia Road) at I-93 Exit 20 Southbound Ramps

Over a quarter of a mile west of the US 3 intersection with NH 140 and I-93 Exit 20 Northbound Ramps is the signalized intersection of US 3 at I-93 Exit 20 Southbound Ramps. This intersection has three approaches and sidewalk available along the south side of US 3.

Bay Hill Road and Bay Street at Shedd Road

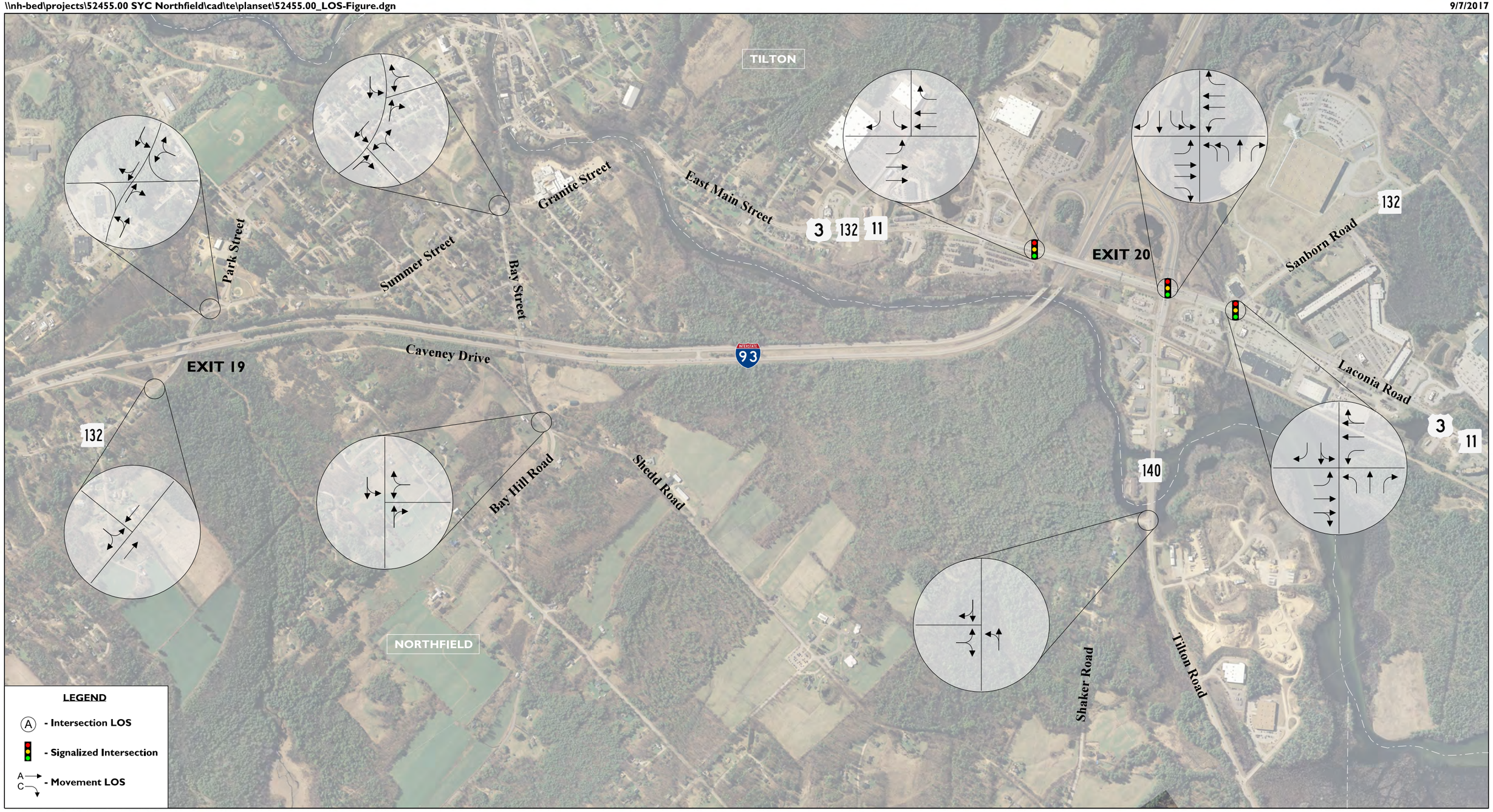
About three quarters of a mile west of the Spaulding Youth Center is the unsignalized intersection of Shedd Road with Bay Hill Road and Bay Street. Bay Street approaches from the west and continues uncontrolled as the name changes to Bay Hill Road and the roadway curves to the south. Shedd Road approaches Bay Street / Bay Hill Road from the northeast and is stop-controlled. No pedestrian facilities or parking facilities exist at this location. Shedd Road, Bay Street and Bay Hill Road are posted at 30 miles per hour.

Elm Street and Summer Street at Bay Street and Granite Street

About a mile and a quarter west of the Spaulding Youth Center and less than a quarter mile south from downtown Tilton is the unsignalized intersection of Elm Street and Summer Street with Bay Street and Granite Street. Elm Street approaches from the northwest and continues uncontrolled as the name changes to Summer Street to the South. Bay Street approaches from the east and is stop controlled. Granite Street is a dead-end roadway that approaches from the north and is stop-controlled. Sidewalk exists along the east side of the intersection. Elm Street, Summer Street, and Bay Street are posted at 30 miles per hour and Granite Street is posted at 25 miles per hour.

NH 132 (Park Street) at Summer Street and I-93 Exit 19 Southbound On-Ramp

Approximately a mile south of downtown Tilton is the unsignalized intersection of NH 132 with Summer Street and the I-93 Exit 19 Southbound On-Ramp. NH 132 runs north-south, with a skewed stop-controlled approach from the northeast (Summer Street) and yield-controlled, one-way on-ramps to I-93 Southbound. Sidewalks are available on the southeast corner of the intersection but there are no crosswalks. NH 132 and Summer Street are posted at 30 miles per hour.



vhb

Figure 3
Existing and No Build Conditions
Lane Use Geometries

NH 132 (Park Street) at I-93 Exit 19 Northbound Off-Ramp

Approximately a quarter mile south of the intersection of NH 132 at Summer Street and I-93 Exit 19 Southbound On-Ramp is the intersection of NH 132 with the I-93 Exit 19 Northbound Off-Ramp. NH 132 runs north-south, with a skewed stop-controlled I-93 Northbound Off-Ramp approach. A sidewalk continues from the intersection to the north, but ends at this location with no existing crosswalks. NH 132 is posted at 30 miles per hour.

Trip Generation

As presented in the previous site access evaluation memorandum, site-generated trips have been estimated based on a combination of rates published by the Institute of Transportation Engineers (ITE) and other local data. Unfortunately, there are no ITE Land Use Codes (LUC) that accurately represent the proposed development program. The ITE LUC of 720, Medical-Dental Office Building is not appropriate as this LUC is based on individual buildings that are much smaller (less than 120,000 sf) than the proposed campus. Use of LUC 720 also would not incorporate the potential for internal shared trips between the facilities within a campus setting.

Therefore, the proposed trip generation estimates have been prepared using ITE LUC 610, Hospital combined with local data collected at the Robert G. Dodge Business Park located in Biddeford, ME. ITE LUC 610, Hospital has been assumed for half of the potential development (500,000 sf). The Hospital ITE data base includes facilities ranging in size from 100,000 sf to 1,800,000 sf – with 5 sites similar in size to the proposed one million square foot development program. Since this data base includes several very large hospitals, it is assumed that internal capture between uses within the facility is accounted for (which could be similar in nature to the proposed site).

The trip estimates for the remaining 500,000 sf are based on rates observed at a local medical office park in Biddeford, ME. Traffic counts collected at this site were used to develop weekday morning and weekday evening trip generation rates for this 193,000-sf park consisting of nine different buildings. Businesses within the park vary from general health care to dentists, dermatology, eye care, counseling services and a hotel. The trip generation rates developed from this location result in 2.23 trips per 1,000 sf during the weekday morning peak period and 1.89 trips per 1,000 sf during the weekday evening peak period. The weekday morning rate calculated is similar to ITE LUC 720, but the weekday evening calculated rate is lower than ITE. A technical memorandum documenting the detailed trip generation methodology dated March 20, 2017 was previously submitted to and reviewed by the NHDOT as part of the preliminary site access evaluation.

As seen in the following table, the trip generation estimate proposed for the Spaulding Youth Center property is expected to generate approximately 1,590 trips (1,125 entering, 465 exiting) during the weekday morning peak period and 1,410 trips (375 entering, 1,035 exiting) during the weekday evening peak period.

Table 1 - Trip Generation Estimate

		Weekday Morning Peak Hour			Weekday Evening Peak Hour		
Land Use Type	**Square Footage**	**Total**	**Enter**	**Exit**	**Total**	**Enter**	**Exit**
Hospital*	500,000	475	300	175	465	175	290
Business Park**	500,000	1,115	825	290	945	200	745
Total	1,000,000	1,590	1,125	465	1,410	375	1,035

* ITE Trip Generation Manual 9th Edition

** Robert G Dodge Business Park Trip Rates

Trip Distribution Gravity Model

A population-based gravity model was prepared to estimate a potential trip distribution for the proposed development. The detailed methodology and approach to the distribution model was also documented in the previously submitted site access evaluation; however, a brief overview is provided herein.

For planning purposes, populations within 15, 30, and 45 mile radii were compiled and considered to represent the core or primary business area of the model. Due to the proximity to I-93, the 15, 30, and 45-mile radius delineations would generally follow an estimated travel time window of 15, 30, and 45 minutes for communities that have access to I-93. Community populations were weighted based on proximity to the site, as well as proximity to other potential competing medical facilities offering specialty medicine and in a large campus environment. These two factors were used to determine the likelihood of the population to work at or visit the site. Overall, the distribution model estimates the following:

- 54 percent to/from the northwest of Shaker Road via NH 140 towards Tilton and I-93 Exit 20
    - 15 percent to/from the south via I-93, using Exit 20
    - 13 percent to/from the north via I-93, using Exit 20
    - 13 percent to/from the west via US 3 / NH 11
    - 8 percent to/from the east via US 3 / NH 11 (Lakes Region)
    - 2 percent to/from the north via NH 132
    - 2 percent to/from the south via I-93 Exit 19
    - 1 percent to/from the south via NH 132
- 37 percent to/from the southeast of Shaker Road via NH 140 towards Belmont
- 9 percent via Shaker Road internal to Northfield

Trip assignments for the site-generated traffic are provided in Figures 4 and 5 for the weekday morning and evening peak hours respectively.

Traffic Network Development

Weekday morning and weekday evening are the peak periods selected as the critical hours for analysis purposes. As such, weekday morning and evening peak hour turning movement counts conducted in February 2017 were used as a basis for the previously submitted preliminary site access evaluation study. The count data revealed that the peak hours for the Shaker Road intersection with NH 140 occur at 6:45 AM to 7:45 AM for the weekday morning and 3:45 PM to 4:45 PM for the weekday evening. During the same traffic count collection, counts at the intersection of Bay Street and Bay Hill Road with Shedd Road were also recorded with similar peak periods.

Additional traffic count data was recorded in April and May 2017 for the other study area intersections. The peak hours for the US 3 / NH 11 corridor occur at 7:00 AM to 8:00 AM for the weekday morning and 3:45 PM to 4:45 PM for the weekday evening and for the Exit 19 corridor at 7:00 AM to 8:00 AM for the weekday morning and 4:30 PM to 5:30 PM for the weekday evening. The other intersections identified for this study had similar peak hours, but are far enough away from the corridors that they do not share common peak hours.

Copies of the traffic counts are provided in the Appendix. As for the site access study, it was assumed for this traffic impact study that the opening year of the project would be 2027 and the 10-year forecast horizon would be 2037.

Seasonal Variation

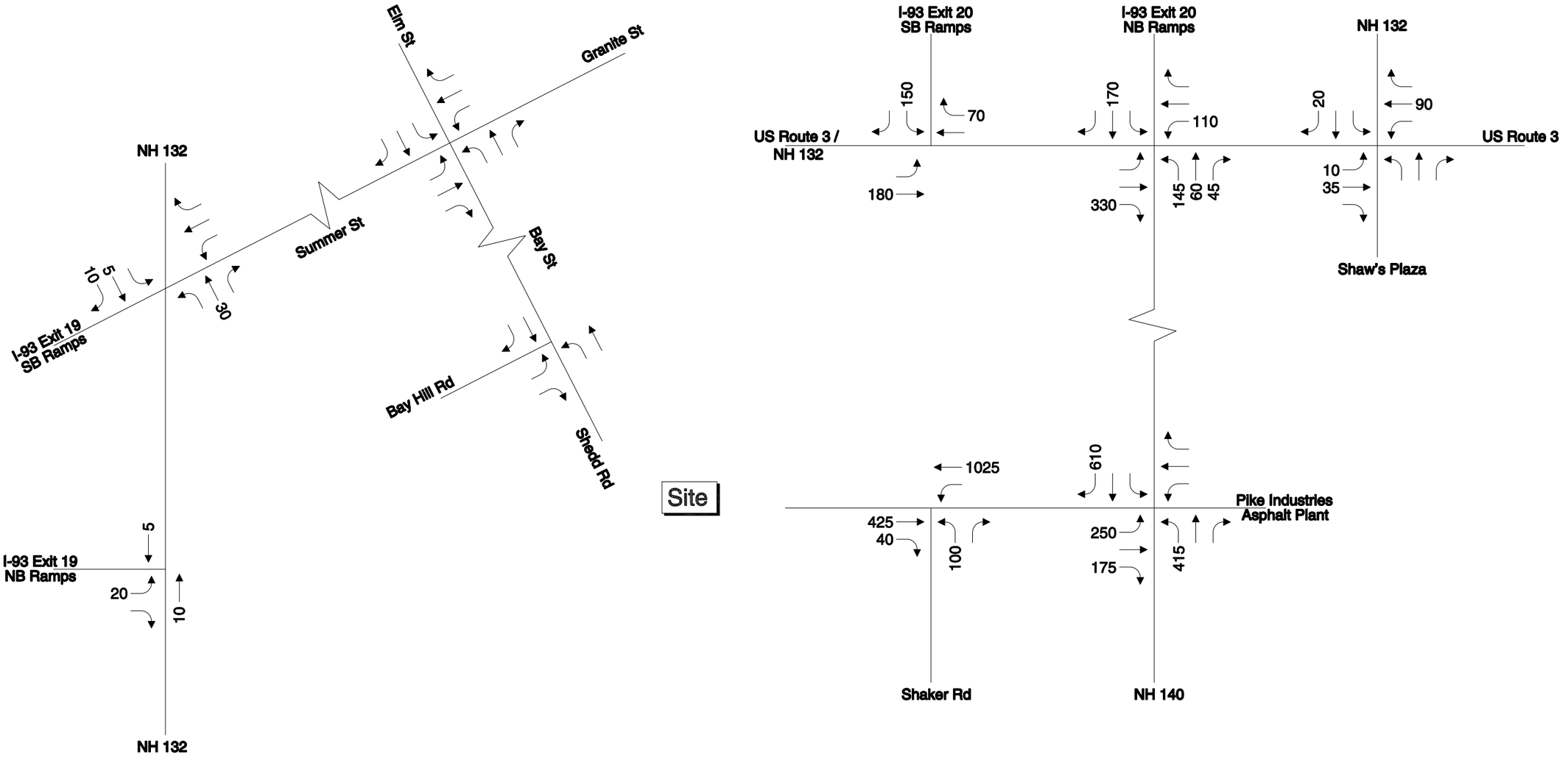
NHDOT guidelines require that private development traffic impact studies consider traffic operations based on "peak month" conditions. The most recent traffic data (2013-2015) from the NHDOT Urban Highway (Group 4) Averages, NHDOT Recreational Highway (Group 5) and the closest permanent count station (Count Station #039022 – Belmont, US 3 and NH 11 near Mosquito Bridge) averages were compared when evaluating seasonal adjustments required for the February, April and May 2017 counts. Based on the data, seasonal adjustment factors of 1.21, 1.09, and 1.05 were used for the weekday morning peak hour factors and 1.24, 1.16, and 1.11 for the weekday evening peak hour factors for February, April, and May traffic data respectively. Back-up calculations to support these adjustments factors are provided in the Appendix.

Growth

Historical growth trends were obtained from five NHDOT Count Stations: #039022 (Belmont – US 3 / NH 11 West of Union Road), #039053 (Belmont – NH 140 at Gilmanton Town Line), #163051 (Franklin – US 3 / NH 11 at Tilton Town Line), #343002 (Northfield – I-93 Between Exits 18 and 19), and #451001 (Tilton – I-93 Between Exits 19 and 20). The annual growth rates from all five local count stations average to about one percent, annually. No site-specific developments in Northfield or the other surround communities that would have a regional impact were identified.

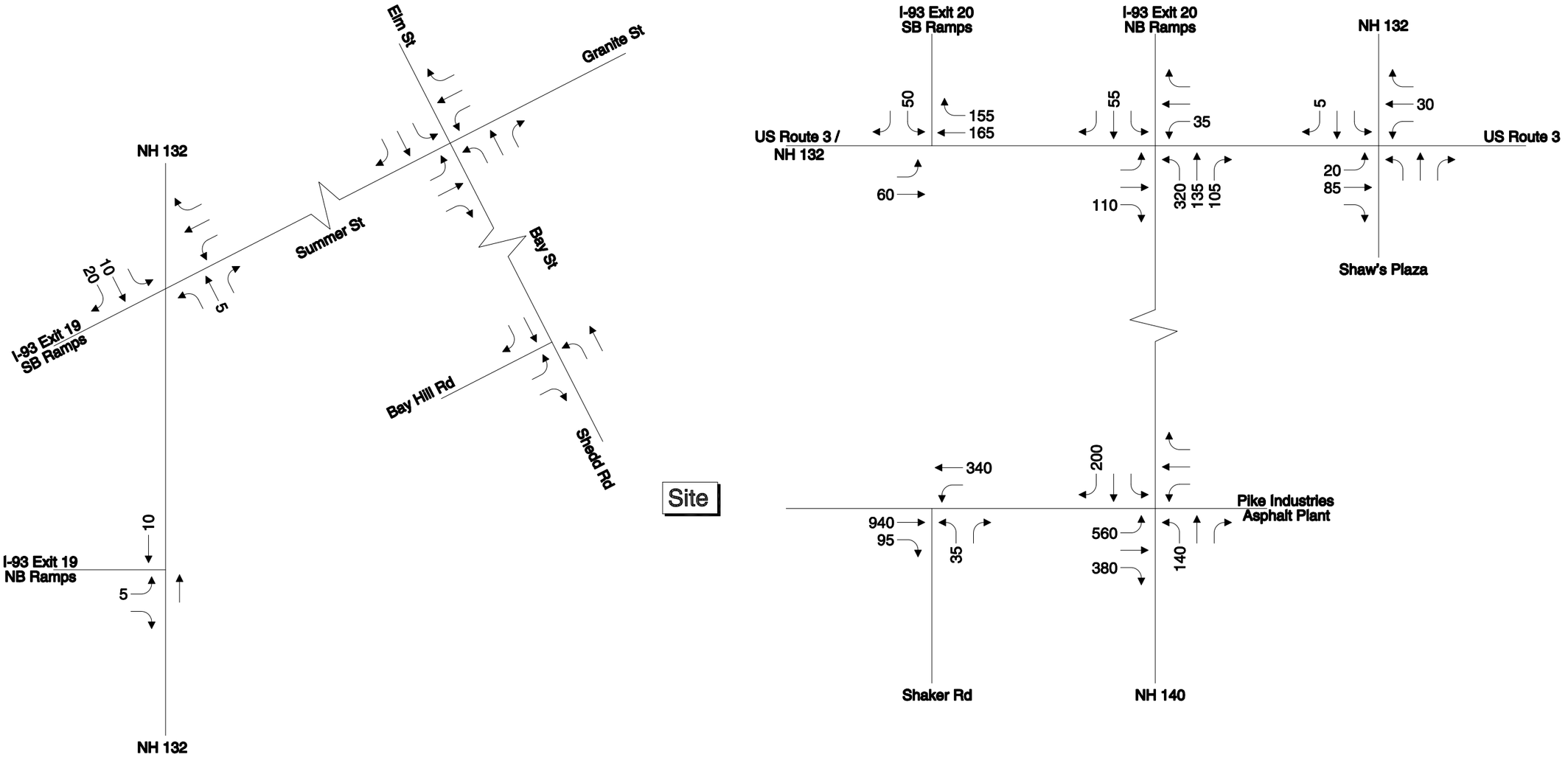
Traffic Networks

The existing raw data weekday morning and evening peak hour traffic, pedestrian, and truck volumes counted in February, April, and May 2017 are provided in Figures 6 through 9. Intersections were seasonally adjusted as described above to their respective peak month conditions with adjustments as necessary to balance flows. These base volumes



Not to Scale

Figure 4
Weekday Morning Trip Distribution
Peak Hour Traffic Volumes



Not to Scale

Figure 5
Weekday Evening Trip Distribution
Peak Hour Traffic Volumes

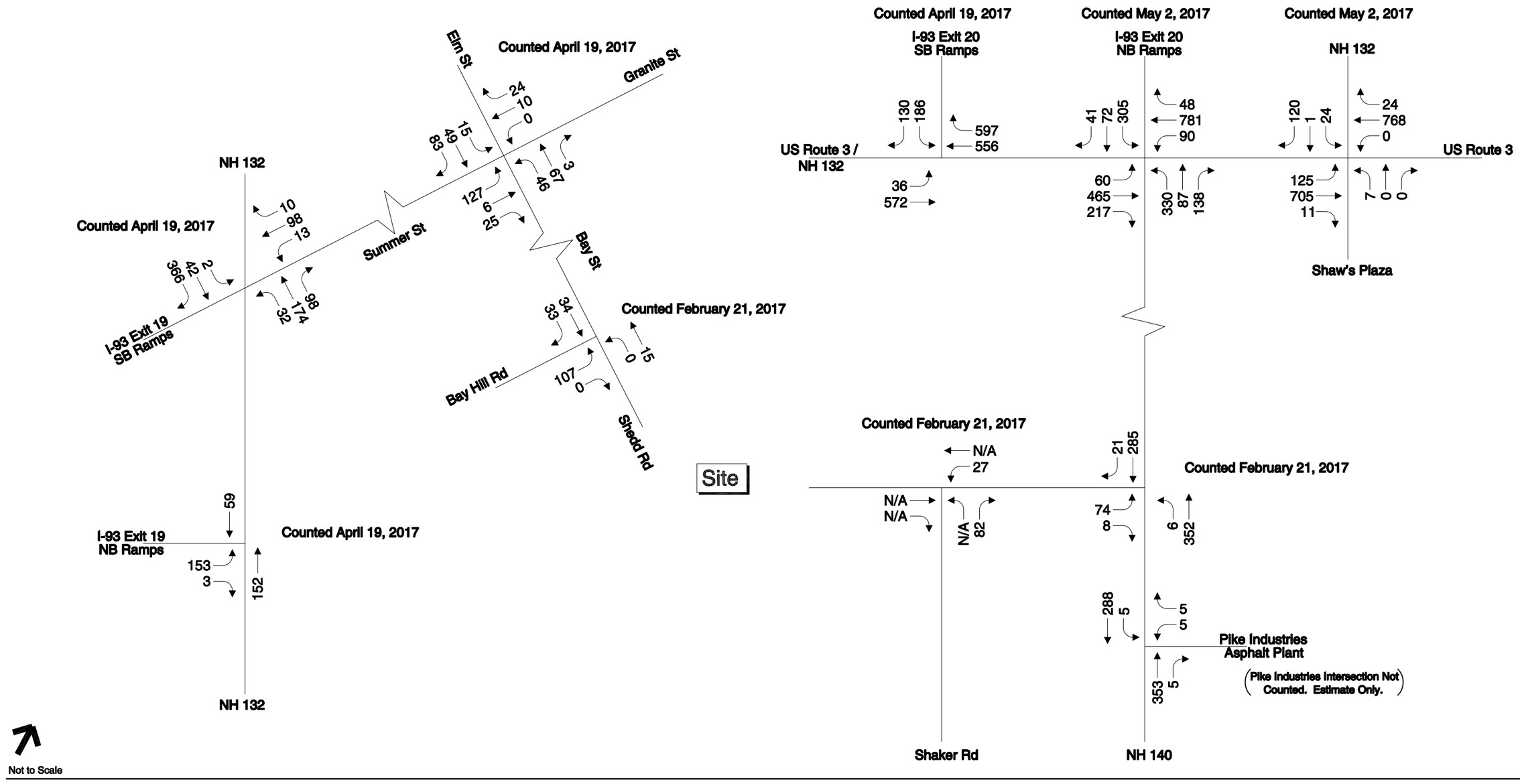


Figure 6
2017 Raw Volumes
Weekday Morning

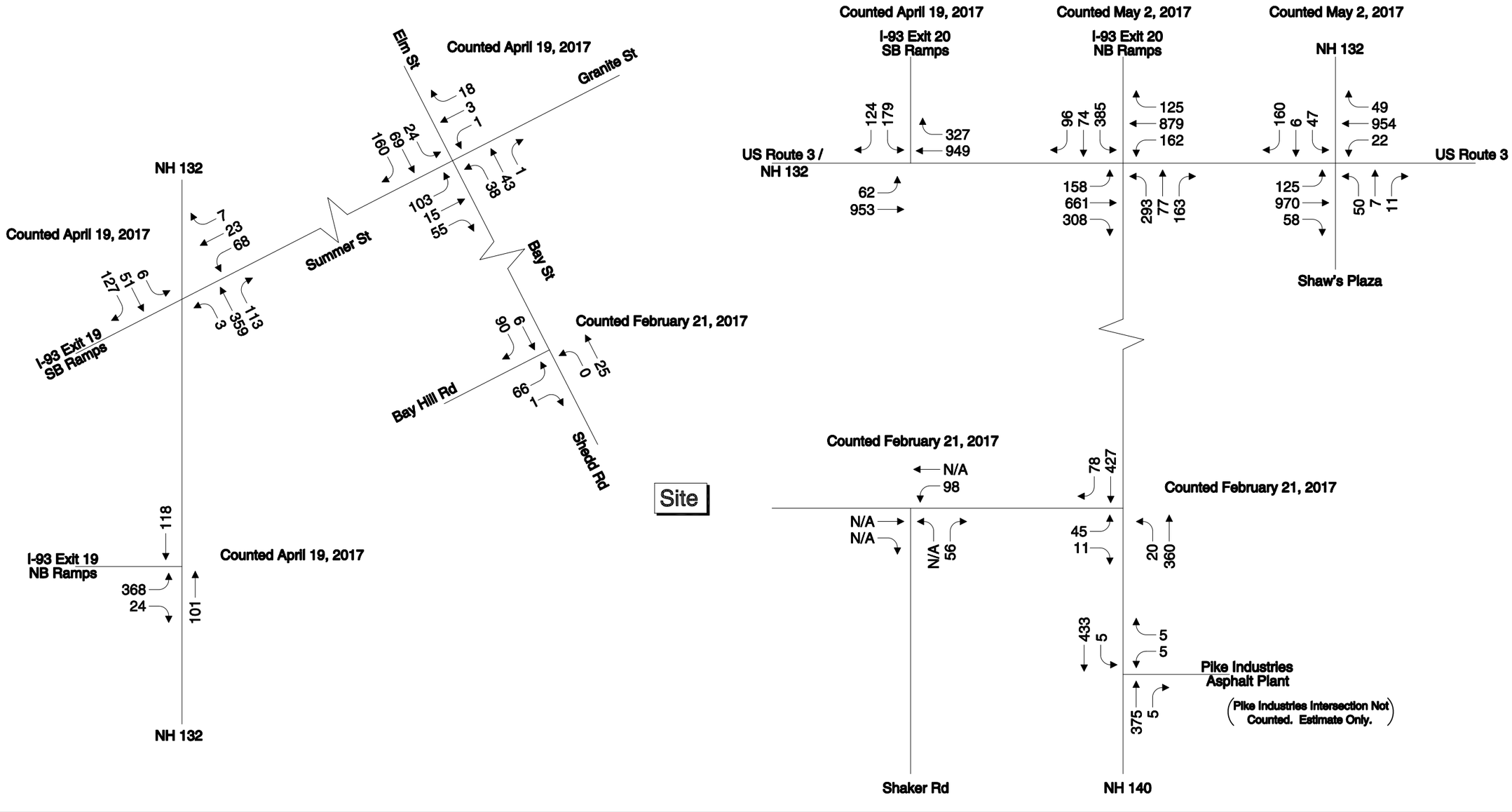


Figure 7
2017 Raw Volumes
Weekday Evening

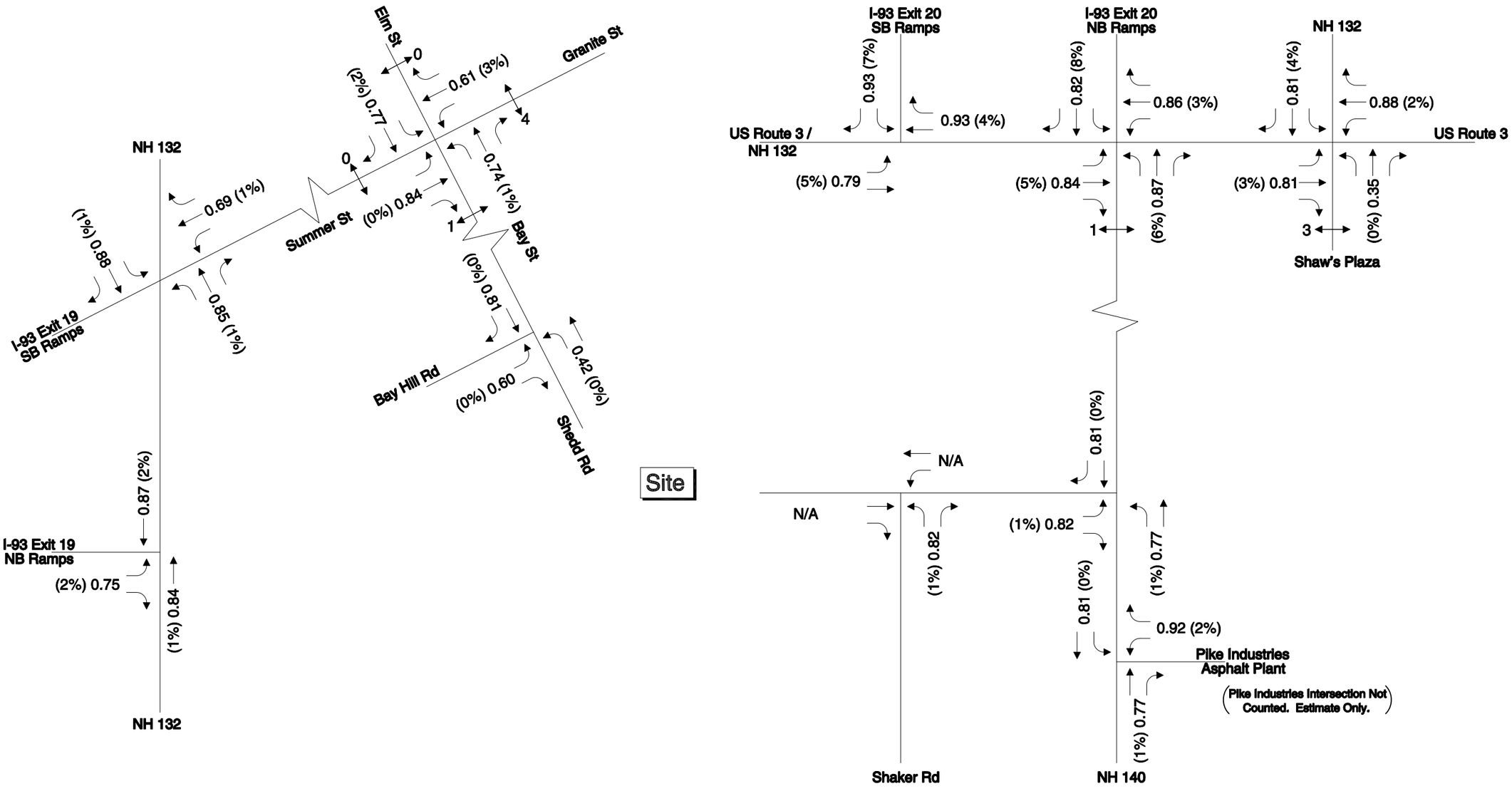


Figure 8
Weekday Morning
Pedestrian, Peak Hour
Factors, and Trucks

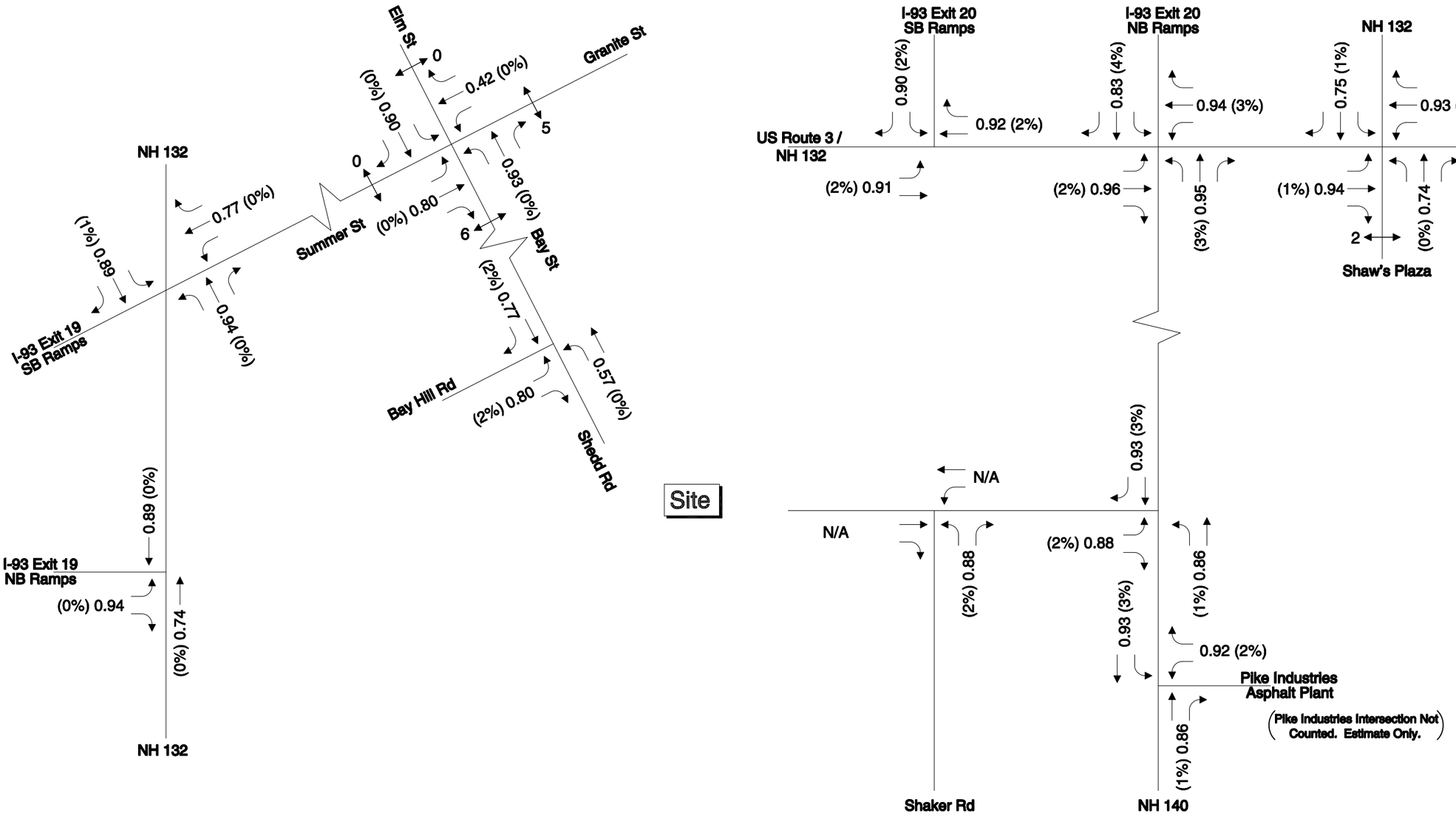


Figure 9
Weekday Evening
Pedestrian, Peak Hour
Factors, and Trucks

were factored for growth to reflect the opening year (2027) and 10-year forecast (2037) traffic volumes. The 2027 and 2037 No Build traffic volume networks are provided in Figures 10 through 13.

The trips generated by the proposed development were added to the 2027 and 2037 No Build peak hour traffic volumes to establish the Build networks. The 2027 and 2037 Build traffic volume networks are shown in Figures 14 through 17.

Traffic Analyses

Signalized and unsignalized intersection capacity analyses were performed for the study area intersections. Levels of service (LOS) were calculated based on the criteria published in the 2000 Highway Capacity Manual[1]. Level of service is the term that defines the conditions that may occur on a given roadway or at an intersection when accommodating various traffic volume loads. Levels of service range from A to F with LOS A representing the best operating conditions and LOS F representing the worst. Copies of the level of service calculations have been provided in the Appendix.

Unsignalized Intersections

Table 2 summarizes the intersection level of service results for the No Build and the Build conditions for the unsignalized intersections. It is important to note that the project is not anticipated to have a measurable impact on the unsignalized study area intersections since the Shedd Road access has been eliminated from the development program. While a small number of trips was assigned to the Exit 19 interchange for analysis purposes, it is not likely that motorists will choose this exit to travel to/from the site as the Exit 20 interchange will provide a quicker and more convenient travel route. The intersections were included in the study to meet the scoping requirements.

Elm Street and Summer Street at Bay Street and Granite Street

The Bay Street approach to the intersection with Elm Street and Summer Street is projected to operate at LOS B through the year 2037 with average delays approximating 14 seconds per vehicle during the weekday morning and evening peak hours. The 95th percentile queue exiting from Bay Street is anticipated to be 35 feet or less (approximating 1 vehicle).

The Granite Street approach to the intersection with Elm Street and Summer Street is projected to operate at LOS B through 2037 with average delays approximating 11 seconds per vehicle during the weekday morning and evening peak hours. The 95th percentile queue exiting from Granite Street is anticipated to be less than a car length.

Bay Hill Road and Bay Street at Shedd Road

The Shedd Road approach to the intersection with Bay Street and Bay Hill Road is projected to operate at LOS A through 2037 with average delays approximately 9 to 10 seconds per vehicle during the weekday morning and evening peak hours.

[1] Highway Capacity Manual, Federal Highway Administration, Transportation Research Board, 2000.

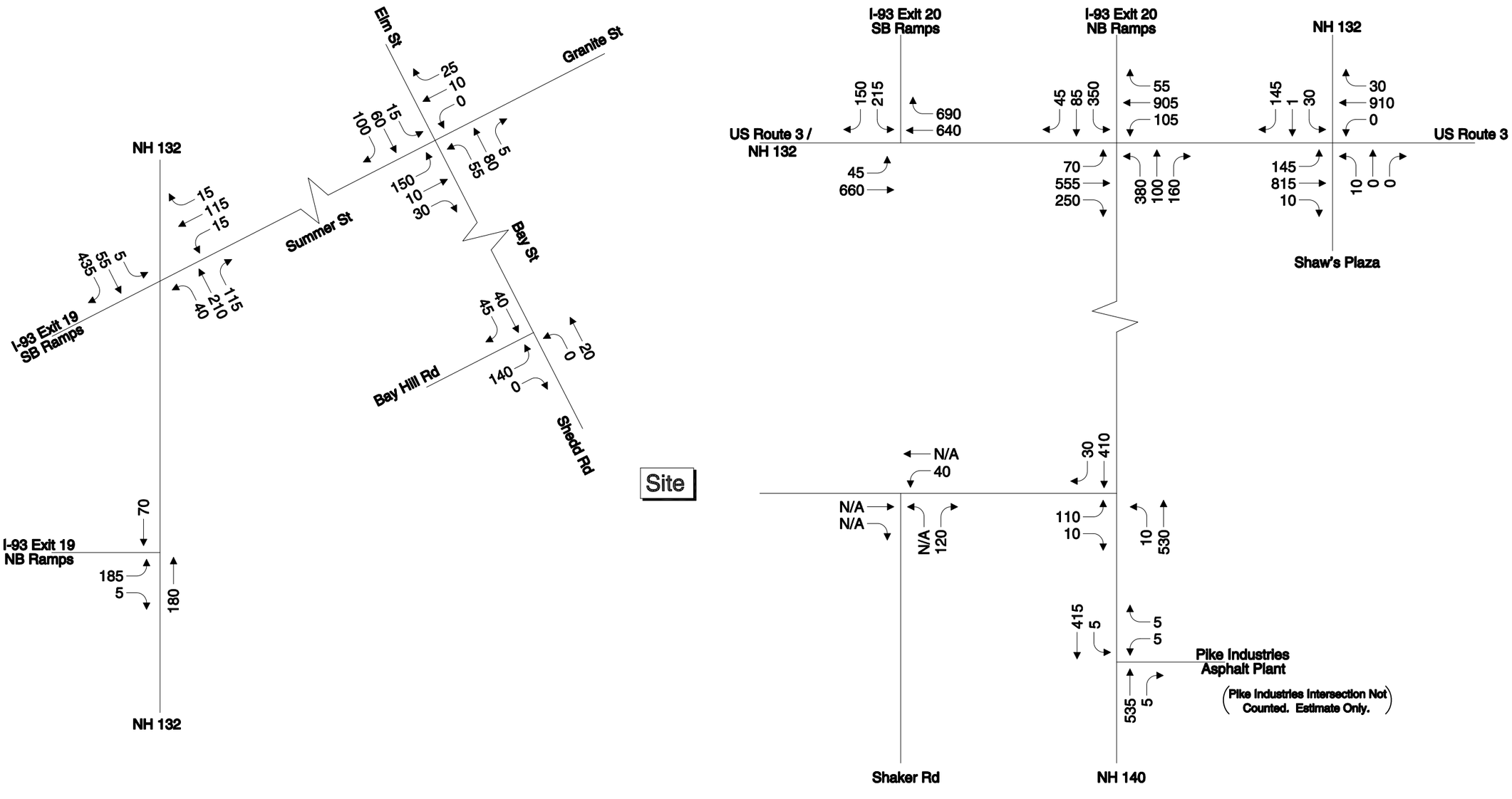


Figure 10
2027 No Build Weekday Morning
Peak Hour Traffic Volumes

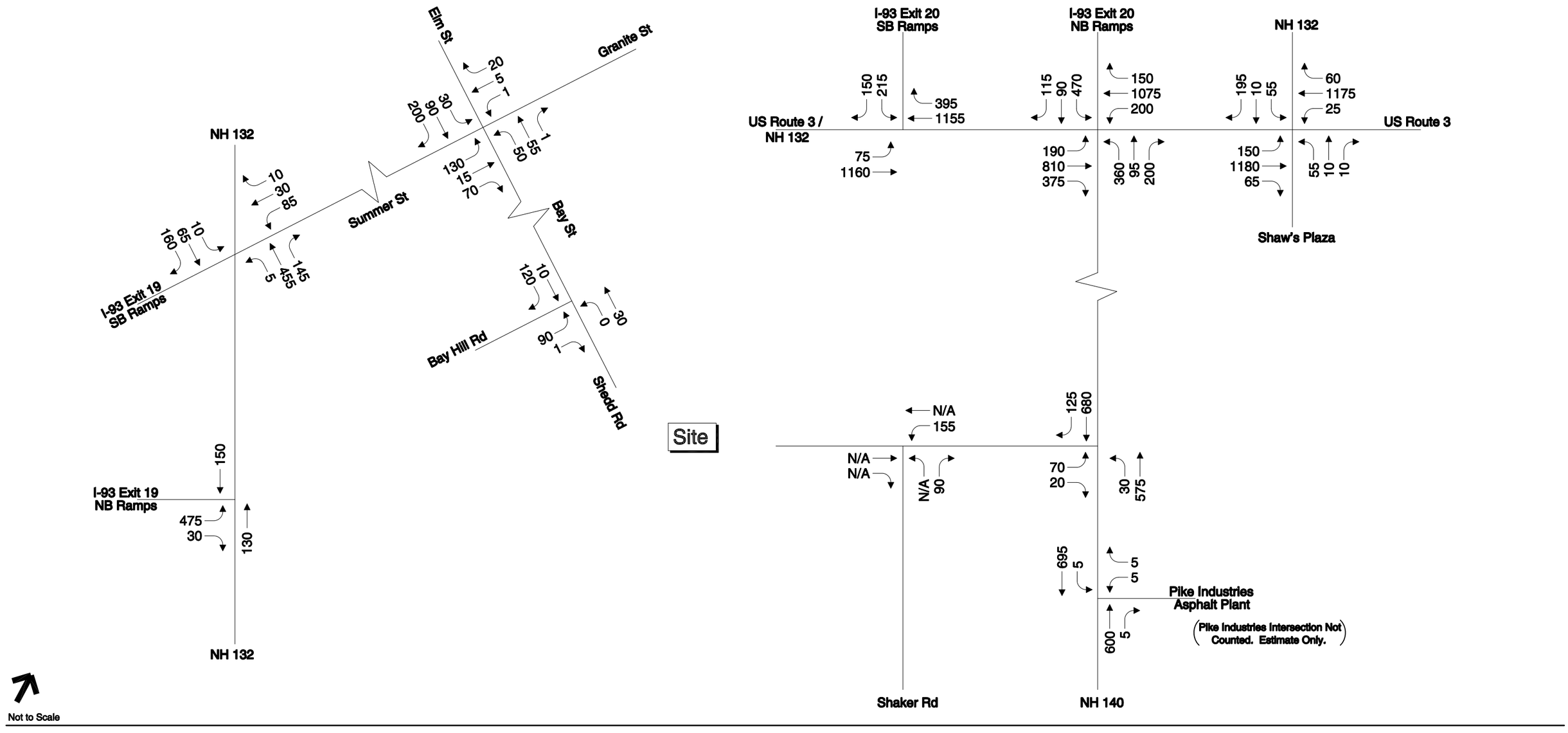


Figure 11
2027 No Build Weekday Evening
Peak Hour Traffic Volumes

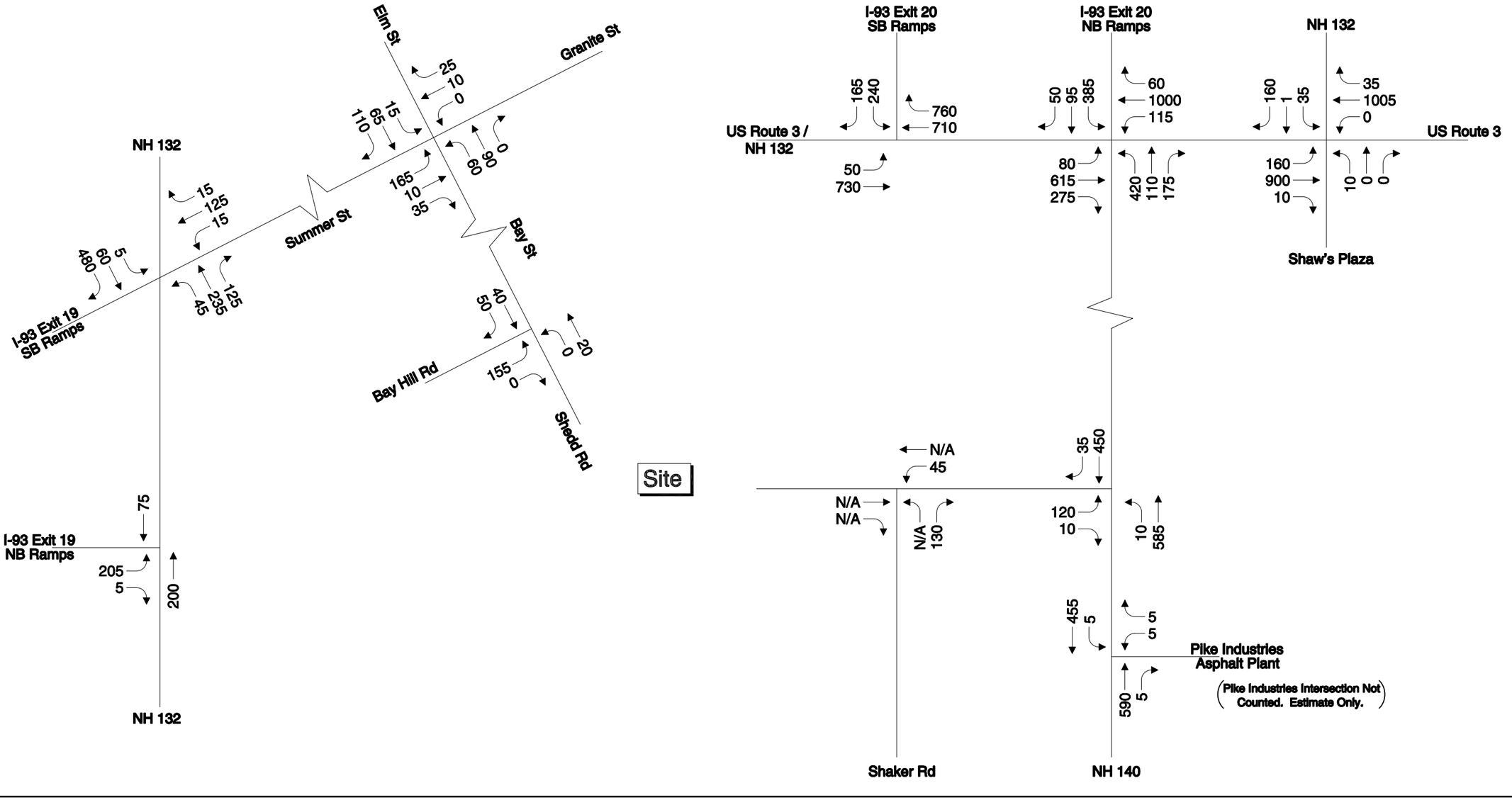


Figure 12
2037 No Build Weekday Morning
Peak Hour Traffic Volumes

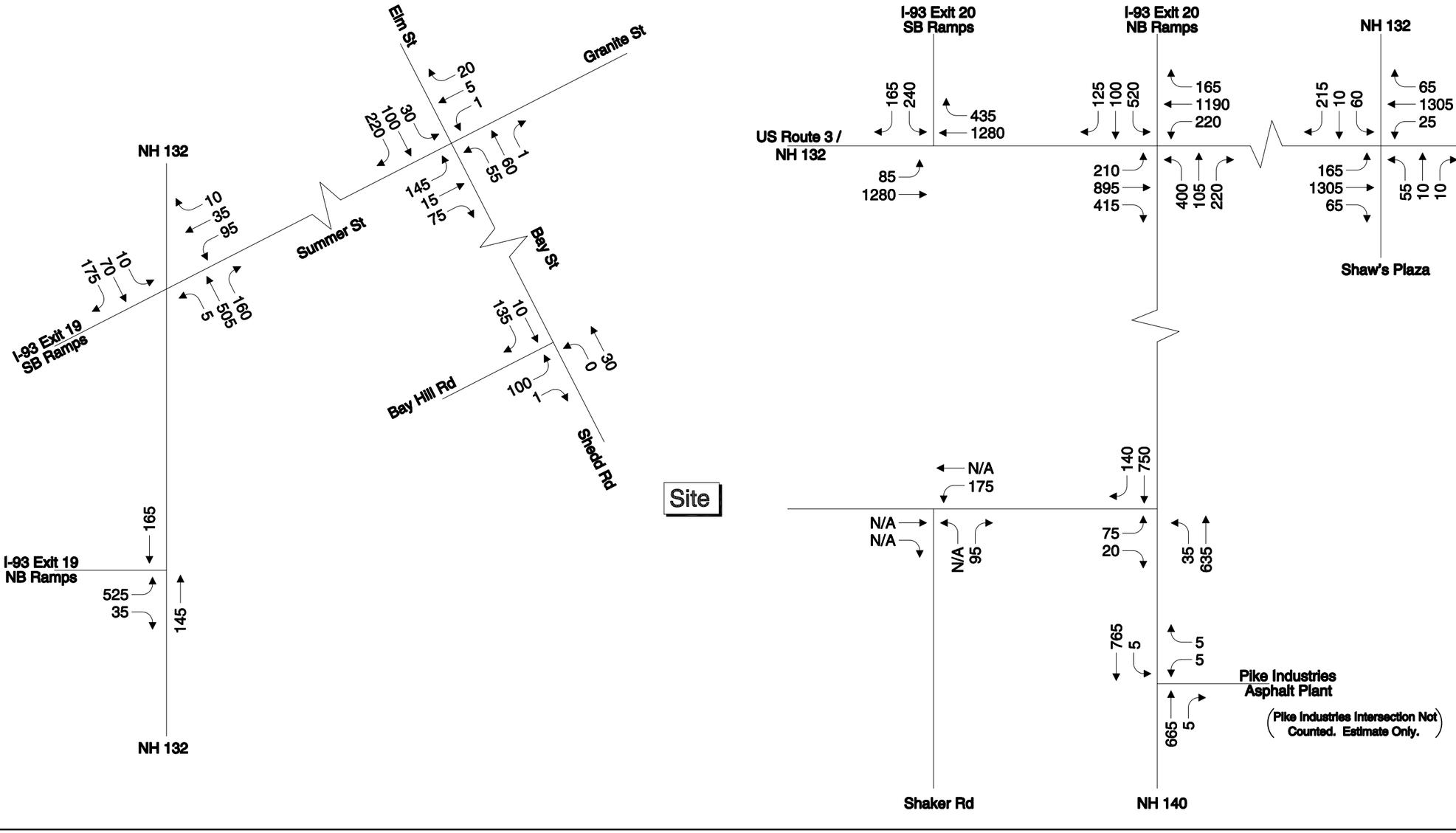


Figure 13
2037 No Build Weekday Evening
Peak Hour Traffic Volumes

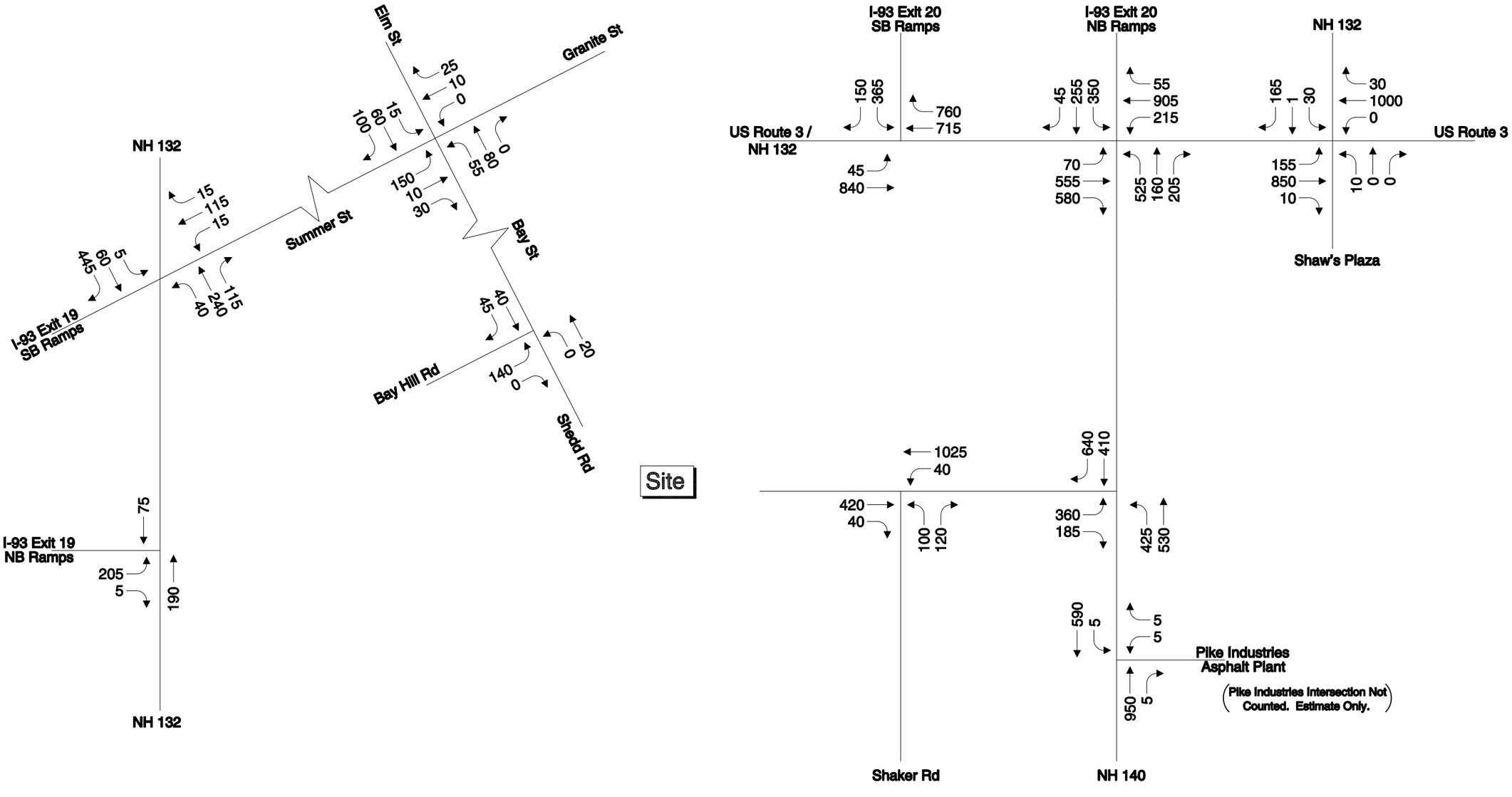


Figure 14
2027 Build Weekday Morning
Peak Hour Traffic Volumes

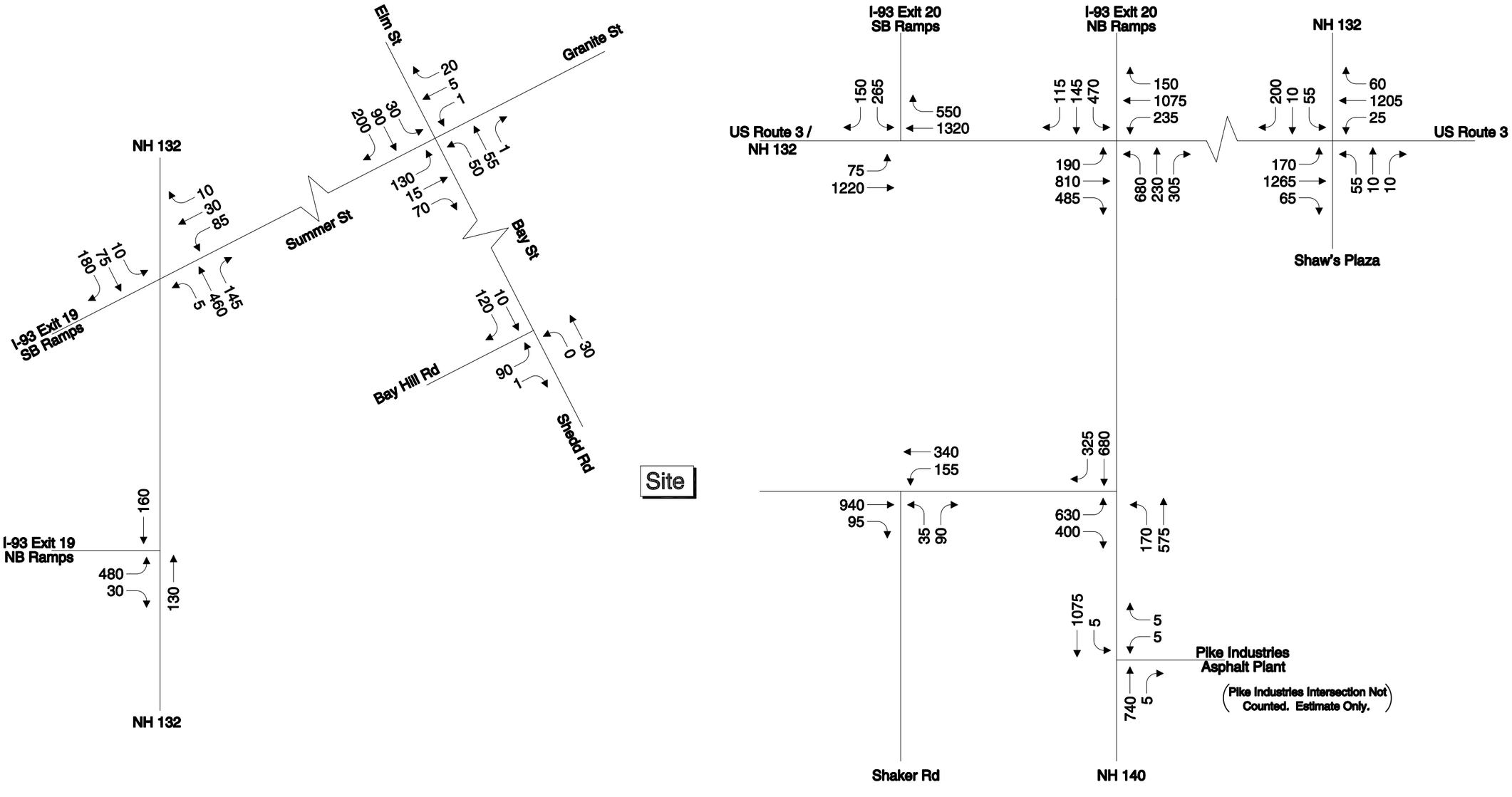


Figure 15
2027 Build Weekday Evening
Peak Hour Traffic Volumes

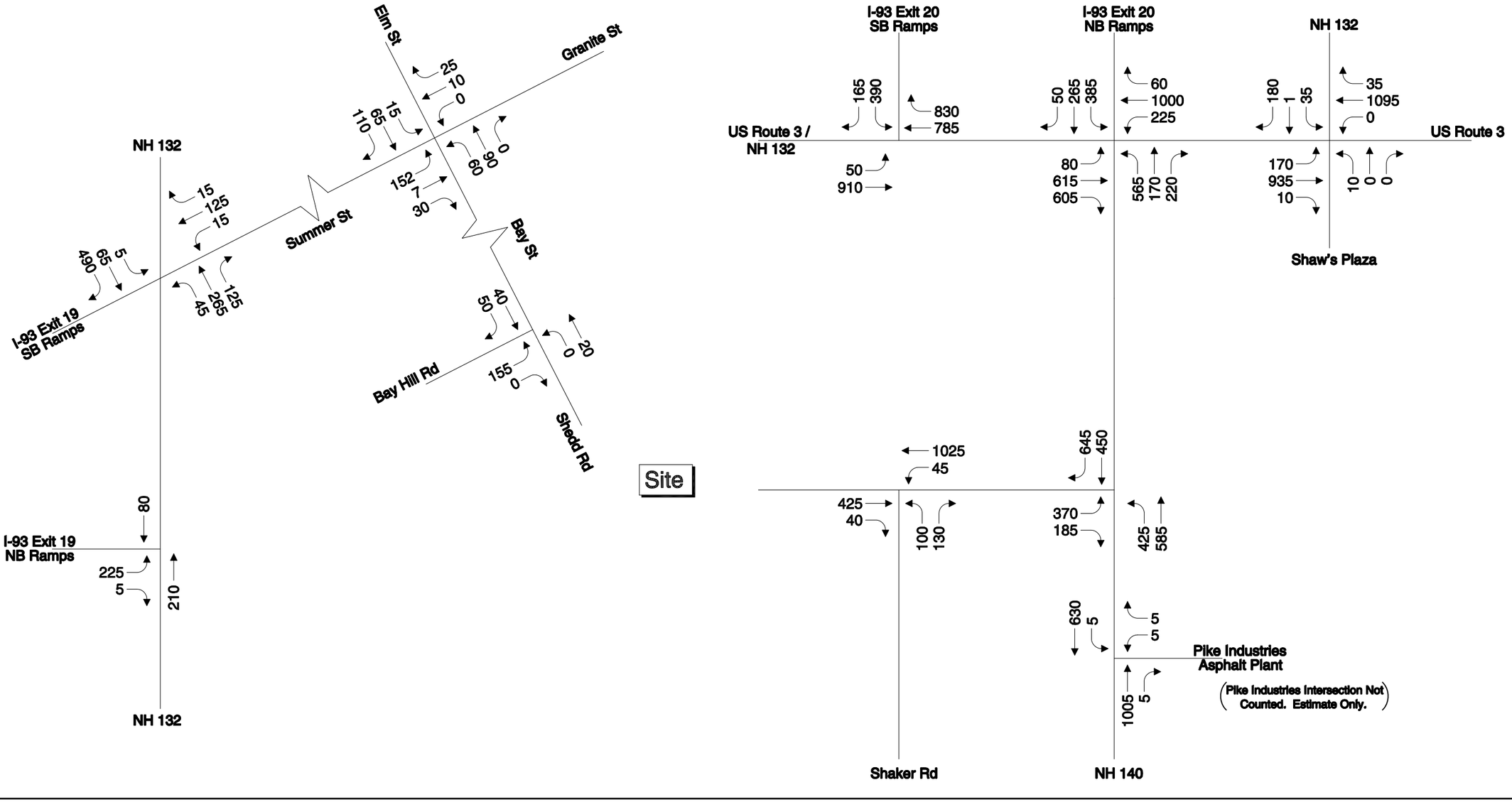


Figure 16
2037 Build Weekday Morning
Peak Hour Traffic Volumes

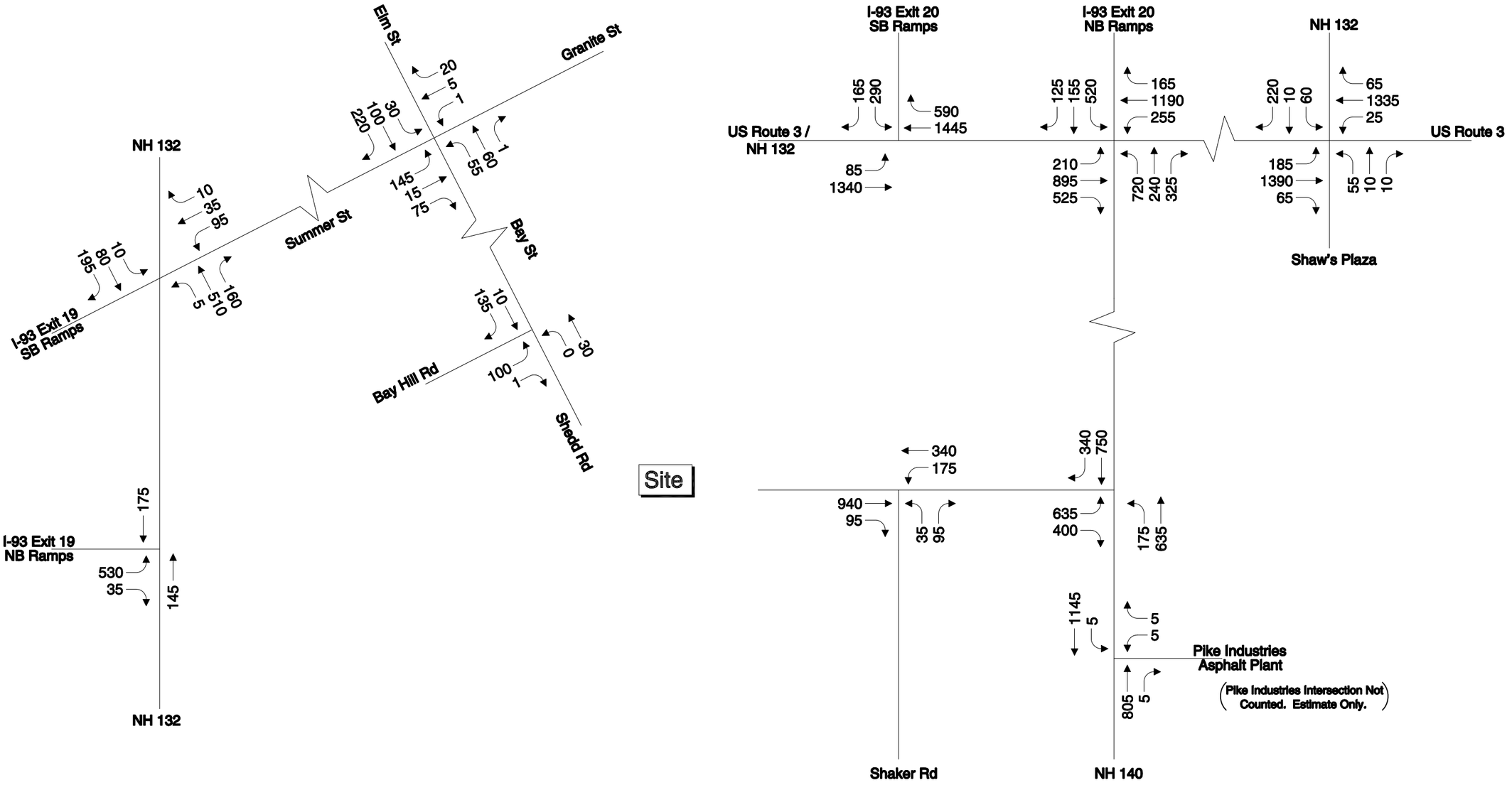


Figure 17
2037 Build Weekday Evening
Peak Hour Traffic Volumes

Table 2 – Unsignalized Intersection Capacity Analysis Summary

INTERSECTION AND APPROACH	Peak Period	2027 No Build			2027 Build		
		Demand*	Delay^	LOS+	Demand	Delay	LOS
Elm Street and Summer Street at Bay Street and Granite Street							
Left/right turn from Granite St	AM	35	11	B	35	11	B
Left/right turn from Bay St	AM	135	13	B	135	13	B
Left/right turn from Granite St	PM	25	11	B	25	11	B
Left/right turn from Bay St	PM	115	13	B	115	13	B
Bay Hill Road and Bay Street at Shedd Road							
Left/right turn from Shedd Rd	AM	20	10	A	20	10	A
Left/right turn from Shedd Rd	PM	30	9	A	30	9	A
NH 132 at Summer Street							
Left/right turn from Summer St	AM	145	27	D	145	31	D
Left/right turn from Summer St	PM	125	21	C	125	22	C
NH 132 at I-93 Exit 19 Northbound Off-Ramp							
Left/right turn from Off-Ramp	AM	190	13	B	210	14	B
Left/right turn from Off-Ramp	PM	505	29	D	510	31	D

* Demand in vehicles per hour.
^ Delay in seconds per vehicle.
+ Level of service.

Table 2 Continued -Unsignalized Intersection Capacity Analysis Summary

INTERSECTION AND APPROACH	Peak Period	2037 No Build			2037 Build		
		Demand*	Delay^	LOS+	Demand	Delay	LOS
Elm Street and Summer Street at Bay Street and Granite Street							
Left/right turn from Granite St	AM	35	11	B	35	11	B
Left/right turn from Bay St	AM	150	14	B	150	14	B
Left/right turn from Granite St	PM	25	11	B	25	11	B
Left/right turn from Bay St	PM	115	15	B	115	15	B
Bay Hill Road and Bay Street at Shedd Road							
Left/right turn from Shedd Rd	AM	20	10	A	20	10	A
Left/right turn from Shedd Rd	PM	30	9	A	30	9	A
NH 132 at Summer Street							
Left/right turn from Summer St	AM	155	37	E	155	43	E
Left/right turn from Summer St	PM	140	26	D	140	29	D
NH 132 at I-93 Exit 19 Northbound Off-Ramp							
Left/right turn from Off-Ramp	AM	210	14	B	230	15	C
Left/right turn from Off-Ramp	PM	560	47	E	565	52	F

* Demand in vehicles per hour.
^ Delay in seconds per vehicle.
+ Level of service.

NH 132 at Summer Street

The intersection of NH 132 with Summer Street is projected to operate at same level of service with and without the development program. Vehicles exiting form Summer Street are projected to operate at LOS D or better in 2027, but degrade to slightly to a LOS E in 2037 during the morning peak hour. The primary movement exiting from Summer Street is the traffic accessing the I-93 southbound on-ramp. Delays and queues for vehicles exiting from Summer Street are not projected to be excessive. Average delays are projected to be 43 seconds per vehicle. The 95th percentile queue exiting from Summer Street is anticipated to be approximately 100 feet during the 2027 morning peak hour (approximately 4 vehicles) and 125 feet during the 2037 morning hour (approximately 5 vehicles).

NH 132 at I-93 Exit 19 Northbound Off-Ramp

The I-93 Exit 19 Northbound Off-Ramp approach to the intersection with NH 132 is projected to operate at LOS C or better through the year 2037 during the morning peak hour. The 95th percentile queue is approximated to be 60 feet (2 vehicles) for the off-ramp. During the 2027 opening year, the off-ramp is projected to operate at LOS D during the weekday evening peak hour, but degrading to the LOS E/F threshold by the year 2037 with delays ranging between 47

seconds (No Build) and 52 seconds (Build) per vehicle. The 95th percentile queue for the off-ramp is projected to be approximately 325 feet (No Build) to 335 feet (Build) during the 2037 evening peak hour. While the analysis results show minimal impact on the intersection's operations, it is important to restate that with the elimination of the Shedd Road site access, it is not anticipated that the small number of trips that were assigned to Exit 19 will materialize as a result of the project.

Signalized Intersections

Tables 3 and 4 summarize the intersection level of service results for the 2027 and 2037 No Build conditions for the signalized intersections and Tables 5 and 6 summarize the results the 2027 and 2037 Build conditions.

US 3 at I-93 Exit 20 Southbound Ramps

This intersection is projected to operate at LOS B in the weekday morning peak hour and LOS C in the weekday evening peak hour under both the 2027 and 2037 No-Build conditions. The maximum queue is anticipated to occur during the evening peak hour when the worst case 95th percentile queue is expected to be 24 vehicles for the US 3 / NH 11 westbound approach for these conditions.

Under the 2027 and 2037 Build conditions operations will degrade one to two levels of service. The intersection is projected to operate at LOS C for both weekday morning peak hour conditions and LOS D in 2027 and LOS E in the 2037 Build weekday evening peak hour conditions. The maximum queue is anticipated to occur during the evening peak hour when the 95th percentile queue is expected to be 25 vehicles for the US 3 / NH 11 westbound approach in 2027 and 29 vehicles in 2037.

US 3 / NH 132 at NH 140 and I-93 Exit 20 Northbound Ramps

This intersection is projected to operate at LOS D in the 2027 and 2037 No Build weekday morning peak hour and LOS E in the weekday evening peak hour. Under the existing timings, the westbound approach is anticipated to operate near or over capacity during the peak hours in 2037. The maximum queue is anticipated to occur during the evening peak hour when the 95th percentile queue is expected to be 47 vehicles for the US 3 / NH 11 westbound approach. Under the 2037 Build conditions, the intersection is projected to further degrade and operate at LOS E in the weekday morning peak hour and LOS F in the weekday evening peak hour.

US 3 at NH 132 and Shaw's Plaza

This intersection is projected to operate at LOS C or better through the year 2037 under the No Build condition. The maximum queue is anticipated to occur during the evening peak hour when the 95th percentile queue is expected to be 21 vehicles for the US 3 / NH 11 westbound approach. Under the future Build condition, the intersection is projected to operate at degrade to LOS C in the weekday evening peak hour. The maximum queue is anticipated to be 24 vehicles for the US 3 / NH 11 westbound approach.

Table 3 – 2027 No Build Signalized Intersection Capacity Analysis Summary

INTERSECTION AND APPROACH	AM Peak Hour				PM Peak Hour			
	v/c*	Delay^	LOS+	Max 95th% Queue~	v/c	Delay	LOS	Max 95th% Queue~
US 3 / NH 132 at I-93 Exit 20 Southbound Ramps	**0.49**	**16**	**B**		**0.73**	**22**	**C**	
US 3 Eastbound	0.36	7	A	125 (Thru)	0.52	8	A	225 (Thru)
US 3 Westbound	0.51	18	B	225 (Thru)	0.94	33	C	525 (Thru)
I-93 Exit 20 SB Off-Ramp Southbound	0.55	28	C	200 (Left)	0.56	30	C	200 (Left)
US 3 / NH 132 at I-93 Exit 20 Northbound Ramps and NH 140	**0.69**	**43**	**D**		**0.79**	**56**	**E**	
US 3 Eastbound	0.57	35	D	400 (Thru)	0.74	43	D	575 (Thru)
US 3 Westbound	0.87	44	D	775 (Thru)	1.02	71	E	1025 (Thru)
NH 140 Northbound	0.69	50	D	325 (Left)	0.66	54	D	275 (Left)
I-93 Exit 20 NB Off-Ramp Southbound	0.66	48	D	275 (Left)	0.82	53	D	425 (Left)
US 3 / NH 132 at NH 132 and Shaw's Plaza	**0.53**	**14**	**B**		**0.63**	**18**	**B**	
US 3 Eastbound	0.59	8	A	150 (Left)	0.59	13	B	375 (Thru)
US 3 Westbound	0.59	15	B	275 (Thru)	0.71	19	B	450 (Thru)
Shaw's Plaza Northbound	0.14	32	C	25 (Left)	0.35	36	D	75 (Left)
NH 132 Southbound	0.20	32	C	50 (Thru)	0.39	35	D	75 (Thru)

* Volume demand to capacity ratio.

^ Delay in seconds per vehicle.

+ Level of service. ~ Queue measured in feet.

Table 4 – 2037 No Build Signalized Intersection Capacity Analysis Summary

INTERSECTION AND APPROACH	AM Peak Hour				PM Peak Hour			
	v/c*	Delay^	LOS+	Max 95th% Queue~	v/c	Delay	LOS	Max 95th% Queue~
US 3 / NH 132 at I-93 Exit 20 Southbound Ramps	**0.54**	**17**	**B**		**0.81**	**34**	**C**	
US 3 Eastbound	0.40	7	A	125 (Thru)	0.58	8	A	275 (Thru)
US 3 Westbound	0.57	20	C	250 (Thru)	1.06	55	E	600 (Thru)
I-93 Exit 20 SB Off-Ramp Southbound	0.60	29	C	200 (Left)	0.61	30	C	200 (Left)
US 3 / NH 132 at I-93 Exit 20 Northbound Ramps and NH 140	**0.75**	**51**	**D**		**0.89**	**71**	**E**	
US 3 Eastbound	0.65	38	D	450 (Thru)	0.78	44	D	675 (Thru)
US 3 Westbound	0.98	60	E	925 (Thru)	1.14	106	F	1175 (Thru)
NH 140 Northbound	0.73	52	D	375 (Left)	0.71	56	E	325 (Left)
I-93 Exit 20 NB Off-Ramp Southbound	0.71	51	D	325 (Left)	0.93	64	E	500 (Left)
US 3 / NH 132 at NH 132 and Shaw's Plaza	**0.58**	**15**	**B**		**0.69**	**20**	**B**	
US 3 Eastbound	0.65	9	A	175 (Left)	0.64	14	B	450 (Thru)
US 3 Westbound	0.65	16	B	325 (Thru)	0.80	21	C	525 (Thru)
Shaw's Plaza Northbound	0.15	33	C	25 (Left)	0.35	36	D	75 (Left)
NH 132 Southbound	0.23	33	C	50 (Thru)	0.42	35	D	75 (Thru)

* Volume demand to capacity ratio.

^ Delay in seconds per vehicle.

+ Level of service. ~ Queue measured in feet.

Table 5 – 2027 Build Signalized Intersection Capacity Analysis Summary

INTERSECTION AND APPROACH	AM Peak Hour				PM Peak Hour			
	v/c*	Delay^	LOS+	Max 95th% Queue~	v/c	Delay	LOS	Max 95th% Queue~
US 3 / NH 132 at I-93 Exit 20 Southbound Ramps	**0.63**	**21**	**C**		**0.82**	**40**	**D**	
US 3 Eastbound	0.40	8	A	150 (Thru)	0.55	8	A	250 (Thru)
US 3 Westbound	0.61	22	C	250 (Thru)	1.09	63	E	625 (Thru)
I-93 Exit 20 SB Off-Ramp Southbound	0.84	38	D	375 (Left)	0.64	31	C	225 (Left)
US 3 / NH 132 at I-93 Exit 20 Northbound Ramps and NH 140	**0.85**	**54**	**D**		**1.00**	**80**	**E**	
US 3 Eastbound	0.63	43	D	400 (Thru)	0.77	46	D	600 (Thru)
US 3 Westbound	0.86	52	D	750 (Thru)	1.08	95	F	1050 (Thru)
NH 140 Northbound	0.88	58	E	525 (Left)	1.19	118	F	725 (Left)
I-93 Exit 20 NB Off-Ramp Southbound	0.97	70	E	600 (Thru)	0.78	56	E	425 (Left)
US 3 / NH 132 at NH 132 and Shaw's Plaza	**0.54**	**14**	**B**		**0.66**	**19**	**B**	
US 3 Eastbound	0.57	8	A	175 (Left)	0.66	14	B	425 (Thru)
US 3 Westbound	0.62	15	B	325 (Thru)	0.74	20	B	475 (Thru)
Shaw's Plaza Northbound	0.14	32	C	25 (Left)	0.35	36	D	75 (Left)
NH 132 Southbound	0.20	32	C	50 (Thru)	0.40	35	D	75 (Thru)

* Volume demand to capacity ratio.

^ Delay in seconds per vehicle.

+ Level of service. ~ Queue measured in feet.

Table 6 – 2037 Build Signalized Intersection Capacity Analysis Summary

INTERSECTION AND APPROACH	AM Peak Hour				PM Peak Hour			
	v/c*	Delay^	LOS+	Max 95th% Queue~	v/c	Delay	LOS	Max 95th% Queue~
US 3 / NH 132 at I-93 Exit 20 Southbound Ramps	**0.68**	**22**	**C**		**0.90**	**58**	**E**	
US 3 Eastbound	0.44	8	A	175 (Thru)	0.61	9	A	275 (Thru)
US 3 Westbound	0.68	24	C	275 (Thru)	1.21	98	F	725 (Thru)
I-93 Exit 20 SB Off-Ramp Southbound	0.89	42	D	400 (Left)	0.68	32	C	250 (Left)
US 3 / NH 132 at I-93 Exit 20 Northbound Ramps and NH 140	**0.93**	**60**	**E**		**1.08**	**99**	**F**	
US 3 Eastbound	0.67	44	D	425 (Thru)	0.82	48	D	725 (Thru)
US 3 Westbound	0.93	60	E	900 (Thru)	1.19	132	F	1200 (Thru)
NH 140 Northbound	0.97	69	E	575 (Left)	1.29	145	F	775 (Left)
I-93 Exit 20 NB Off-Ramp Southbound	1.02	76	E	625 (Thru)	0.89	63	E	475 (Left)
US 3 / NH 132 at NH 132 and Shaw's Plaza	**0.59**	**15**	**B**		**0.73**	**21**	**C**	
US 3 Eastbound	0.63	9	A	175 (Left)	0.71	16	B	500 (Thru)
US 3 Westbound	0.67	17	B	375 (Thru)	0.83	23	C	600 (Thru)
Shaw's Plaza Northbound	0.14	33	C	25 (Left)	0.35	36	D	75 (Left)
NH 132 Southbound	0.23	33	C	50 (Thru)	0.42	35	D	75 (Thru)

* Volume demand to capacity ratio.

^ Delay in seconds per vehicle.

+ Level of service. ~ Queue measured in feet.

Proposed Mitigation

As mentioned previously, the US 3 corridor signals are not currently operating in a coordinated signal system. Previous NHDOT projects laid the framework so that the US 3 corridor could be coordinated using time of day plans for the signalized intersections. Installation of a signal system upgrade to provide modern technology could greatly improve traffic flow and assist in managing congestion and queues between intersections where problems exist today, as well as mitigate the impact of the proposed project. As presented in Tables 7 and 8, providing new signal technology to the corridor will restore capacity, reduce queues and return the level of service for the Build condition back to No Build levels.

The signal system upgrade proposed to mitigate project-related impacts would extend beyond the three signalized intersections on US 3 evaluated in this study. In order for the corridor to work effectively the system upgrade would include the signalized intersections at Sherwood Drive, Exit 20, NH 132/Shaw's, Tanger Outlets/BJ's Wholesale Club, and Home Depot. Although final design of the system has not been completed at this time, the components are anticipated to include items such as TS2-1 controllers (including a new master controller), video detection, wireless communications, new signal heads, and new pedestrian equipment at the Exit 20 Northbound Ramps/NH 140 intersection. A planning level (conceptual) cost estimate suggests that the cost of this upgrade would be approximately $250,000.

US 3 at I-93 Exit 20 Southbound Ramps

This intersection was retimed and the coordination offset revised for both the morning and evening peak hours at half the cycle lengths used for the US 3 / NH 11 at NH 140 and I-93 Exit 20 Northbound Ramps intersection. No physical modifications were introduced into the mitigation analysis.

With the new signal timings, this intersection is projected to operate at LOS C or better through 2037. Most notably, the proposed mitigation greatly reduces the 95th percentile queue for the westbound through critical movement for the 2037 Build condition to a level that is 4 vehicles (100 feet) less than the 2037 No Build (evening) condition. Likewise, the improvements also reduce the volume to capacity ratio for the westbound approach so that it remains under capacity.

US 3 / NH 132 (Laconia Road) at NH 140 (Tilton Road) and I-93 Exit 20 Northbound Ramps

This intersection was retimed and the coordination offset revised for both the AM and PM peak hour periods. Phase overlaps were introduced for right-turn only lanes for the NH 140 northbound and US 3 / NH 11 eastbound approaches; this would require the furnishing and installing two new 4-section bimodal or 5-section signal heads.

This intersection has one signalized pedestrian crossing across the NH 140 Northbound approach. Part of the mitigation analysis calls for changing the signalized pedestrian crossing from an exclusive phase, where each pedestrian call is serviced in an exclusive pedestrian phase for 36 seconds, to a concurrent phase with right turn on red movements from US 3 / NH 11 eastbound prohibited during the walk phase of the pedestrian crossing.

With the new signal timings, phase overlaps, and signal modifications, this intersection is projected to operate at LOS D during the 2037 weekday morning peak hour and LOS E during the 2037 weekday evening peak hour. The mitigation reduces the Build intersection delay to less than the No Build condition and keeps the individual intersection approaches under capacity. In addition, the 2037 westbound queue during the Build weekday evening is substantially reduced to approximately 500 feet less than the No Build condition.

US 3 (Laconia Road) at NH 132 (Sanborn Road) and Shaw's Plaza

This intersection was retimed and the coordination offset revised for both the AM and PM Peak Hour periods. No physical modifications were introduced into the mitigation analysis. With the new signal timings, this intersection is projected to operate at LOS C or better through the 2037 peak hours. Retiming and coordination offset adjustments did not provide a substantial improvement to this intersection, but they were necessary in coordination with the US 3 / NH 11 at I-93 Exit 20 Northbound Ramps and NH 140 intersection.

Table 7 – 2027 Build with Mitigation Signalized Intersection Capacity Analysis Summary

INTERSECTION AND APPROACH	AM Peak Hour				PM Peak Hour			
	v/c*	Delay^	LOS+	Max 95th% Queue~	v/c	Delay	LOS	Max 95th% Queue~
US 3 / NH 132 at I-93 Exit 20 Southbound Ramps	**0.67**	**19**	**B**		**0.80**	**16**	**B**	
US 3 Eastbound	0.49	8	A	125 (Thru)	0.55	7	A	175 (Thru)
US 3 Westbound	0.59	14	B	200 (Thru)	0.87	19	B	425 (Thru)
I-93 Exit 20 SB Off-Ramp Southbound	0.72	22	C	225 (Left)	0.72	28	C	225 (Left)
US 3 / NH 132 at I-93 Exit 20 Northbound Ramps and NH 140	**0.82**	**38**	**D**		**0.90**	**47**	**D**	
US 3 Eastbound	0.76	30	C	250 (Thru)	0.87	41	D	425 (Thru)
US 3 Westbound	0.77	29	C	450 (Thru)	0.89	43	D	550 (Thru)
NH 140 Northbound	0.85	46	D	325 (Left)	0.91	51	D	400 (Left)
I-93 Exit 20 NB Off-Ramp Southbound	0.90	58	E	375 (Thru)	0.90	63	E	300 (Left)
US 3 / NH 132 at NH 132 and Shaw's Plaza	**0.51**	**15**	**B**		**0.64**	**22**	**C**	
US 3 Eastbound	0.60	8	A	175 (Left)	0.68	15	B	450 (Thru)
US 3 Westbound	0.53	14	B	400 (Thru)	0.66	19	B	550 (Thru)
Shaw's Plaza Northbound	0.19	50	D	25 (Left)	0.46	54	D	100 (Left)
NH 132 Southbound	0.26	49	D	75 (Thru)	0.48	53	D	100 (Thru)

* Volume demand to capacity ratio.

^ Delay in seconds per vehicle.

+ Level of service. ~ Queue measured in feet.

Table 8 – 2037 Build with Mitigation Signalized Intersection Capacity Analysis Summary

INTERSECTION AND APPROACH	AM Peak Hour				PM Peak Hour			
	v/c*	Delay^	LOS+	Max 95th% Queue~	v/c	Delay	LOS	Max 95th% Queue~
US 3 / NH 132 at I-93 Exit 20 Southbound Ramps	**0.67**	**19**	**B**		**0.87**	**20**	**C**	
US 3 Eastbound	0.49	8	A	150 (Thru)	0.61	8	A	200 (Thru)
US 3 Westbound	0.79	19	B	225 (Thru)	0.97	21	C	500 (Thru)
I-93 Exit 20 SB Off-Ramp Southbound	0.80	25	C	275 (Left)	0.79	30	C	250 (Left)
US 3 / NH 132 at I-93 Exit 20 Northbound Ramps and NH 140	**0.88**	**41**	**D**		**0.98**	**55**	**E**	
US 3 Eastbound	0.80	31	C	275 (Thru)	0.95	46	D	500 (Thru)
US 3 Westbound	0.86	33	C	475 (Thru)	0.98	53	D	675 (Thru)
NH 140 Northbound	0.91	50	D	375 (Left)	0.98	60	E	450 (Left)
I-93 Exit 20 NB Off-Ramp Southbound	0.92	60	E	400 (Thru)	0.96	76	E	350 (Left)
US 3 / NH 132 at NH 132 and Shaw's Plaza	**0.56**	**16**	**B**		**0.70**	**24**	**C**	
US 3 Eastbound	0.64	9	A	200 (Left)	0.71	17	B	525 (Thru)
US 3 Westbound	0.59	16	B	450 (Thru)	0.75	22	C	650 (Thru)
Shaw's Plaza Northbound	0.19	50	D	25 (Left)	0.46	54	D	100 (Left)
NH 132 Southbound	0.30	49	D	75 (Thru)	0.50	55	D	100 (Thru)

* Volume demand to capacity ratio.

^ Delay in seconds per vehicle.

+ Level of service. ~ Queue measured in feet.

Conclusion

The proposed development program calls for constructing a one million square foot medical business park on 470 acres in Northfield, NH. Trip generation estimates indicate that the proposed development will generate approximately 1,590 trips (1,125 entering and 1,035 exiting) during the weekday morning peak hour and 1,410 trips (375 entering and 1,035 exiting) during the weekday evening peak hour. As detailed in the site access study from July 18, 2017, the primary access to the development is proposed via a new four-legged, signalized intersection on NH 140 by relocating Shaker Road to align with the existing Pike Industries driveway. This impact study analyzed critical intersections, including three signalized intersections and four unsignalized intersections in Tilton and Northfield, NH.

With most of the predicted traffic using I-93 Exit 20, as outlined in the Trip Generation and Distribution memorandum dated March 20, 2017, the Build impact on the unsignalized intersections identified in the Town of Northfield, including I-93 Exit 19, are predicted to be minor and mitigation analysis was not pursued. Expected increases in delay per vehicle from No-Build to Build conditions on the I-93 Exit 19 Southbound On-Ramp intersection from Summer Street are 5 seconds for the weekday morning peak hour and 3 seconds for the weekday evening peak hour. Expected increases in delay per vehicle from No-Build to Build conditions on the I-93 Exit 19 Northbound Off-Ramp intersection are 1 second for the weekday morning peak hour and 5 seconds for the weekday evening peak hour.

Without the need of highway geometry changes or additional lanes to the US 3 / NH 11 corridor (I-93 Exit 20), the proposed mitigation to the existing signalized system not only manages, but improves upon the No-Build conditions of the area. For the 2037 Build analysis, the mitigation at the existing signalized intersections of I-93 Exit 20 includes overlap phasing, retiming, coordination, and equipment modifications to accommodate the additional Spaulding Youth Center Development trips. Introducing additional traffic signal technologies, such as video detection, updated traffic signal controllers, and signal interconnect will not only allow for the one million square foot development to be accommodated on the regional transportation system, but will substantially improve traffic operations for all roadway users that use the US 3 / NH 11 corridor through the area.