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Memorandum

To: Ms. Ann Remus
Superintendent of Schools
SAU #25
103 County Road
Bedford, NH 03110

Date: February 9, 2005

Project No.: 51646

From: Robin Bousa
Senior Project Manager

Re: Traffic Impact Assessment -
Proposed High School and Middle School
Nashua Road - Bedford, NH

Vanasse Hangen Brustlin, Inc. (VHIB) has been retained to conduct a traffic impact assessment for the proposed Bedford High School and Middle School Project to be located off Nashua Road in Bedford, NH. This study has been prepared in accordance with the New Hampshire Department of Transportation (NHDOT) guidelines and standards for the preparation of traffic studies. The study was conducted based on enrollment projections developed by the School District and information provided by the Bedford High School Traffic Study Subcommittee. This memorandum provides the following:

- The study area limits for the project;
- A description of the existing roadway network surrounding the site;
- A summary of the proposed enrollment projections;
- A trip generation estimate for the schools;
- An evaluation of traffic impacts and site access issues associated with the projects;
- Recommended roadway and intersection improvements needed to provide safe and efficient access to the site; and
- Preliminary cost estimates for the recommended improvements.

It is important to note that this study was performed with the understanding that roadway and intersection improvements recommended in the NH Route 101 Corridor Study would be implemented in the future. At a Bedford Town Council meeting held on December 8, 2004, the Council members and representatives from the NHDOT reaffirmed that both parties still support the recommendations of the NH Route 101 study and were committed to the implementation of those improvements through the State's Ten Year Plan. Specific recommendations in the NH Route 101 Corridor Study that affect traffic flow and travel patterns within the project study area include:

- The implementation of access management measures on NH Route 101. Under the future plan, NH Route 101 would become a median divided roadway with left-turn movements allowed only at

specified locations, such as the Wallace Road signalized intersection. The intersection of Nashua Road and NH Route 101 would be restricted to right-turns only.

- The construction of a service or connector road behind the retail and commercial properties located along NH Route 101 running from Nashua Road to Wallace Road. The connector road would allow vehicles traveling to and from the businesses to access Wallace Road and its signalized intersection with NH Route 101 to make left-turn movements.
- The construction of a motor vehicle and pedestrian bridge over NH Route 101 extending from Bell Hill Road on the north side of NH Route 101 to Nashua Road on the south side.

At the December 8, 2004 meeting, Town Council members expressed their desire to accelerate the implementation of these improvements, which are very much needed today. The NHDOT suggested that the Town consider implementing the improvements through phasing, which could help expedite funding for portions of the corridor improvements. The State also agreed that if the Town chose to build phases of the improvements in the near future (opposed to waiting for the State funding), that the project would be eligible for State reimbursement when the funding became available in the future.

It is important to point out that the Traffic Study Subcommittee recommended that this study assume that the local connector road described above would be constructed along the north side of the school property to the greatest extent possible. The intent of this assumption was to minimize the need to acquire private property to construct the connector road. Placing the connector road on the school site would have the least amount of impact on the abutters surrounding the school property and the businesses along NH Route 101 (who will use the connector road to make left-turn movements to/from NH Route 101), and would be the most cost effective solution for the Town.

STUDY AREA LIMITS

The 3.72-acre site for the proposed school facilities is located on the west side of Nashua Road, across from County Road. The study area for this assessment is generally limited to NH Route 101 from Nashua Road to Wallace Road, Nashua Road from NH Route 101 to Wallace Road, Wallace Road from NH Route 101 to Nashua Road, and County Road from Nashua Road to Liberty Hill Road/Gault Road. Intersections included in this study for detailed traffic analyses include:

- NH Route 101 and Nashua Road;
- NH Route 101 and Wallace Road;
- Nashua Road and County Road;
- County Liberty, Liberty Hill Road, and Gault Road; and
- Proposed site access locations.

In addition to these locations, the need to assess traffic operations at the intersection of Nashua Road and Wallace Road was discussed at one of the Transportation Infrastructure Subcommittee meetings. In order to address these concerns, a limited data collection effort and analysis was conducted for the intersection.

EXISTING CONDITIONS

Nashua Road

In the vicinity of the site, Nashua Road is approximately 22 feet wide with one 11-foot travel lane in each direction and a posted speed limit of 30 miles per hour. Field observations revealed that the pavement on Nashua Road is in relatively poor condition. Data collected by the Southern New Hampshire Planning Commission (SNHPC) in 2003 indicates that this segment of Nashua Road carries approximately 2,200 vehicles per day (vpd) with peak hour flows of approximately 200 to 250 vehicles per hour (vph).

Nashua Road intersects NH Route 101 from the south forming a three-way unsignalized intersection. Nashua Road provides a single lane approach to the intersection where vehicles operate under stop control, which is reinforced with a flashing red beacon. At this location, Nashua Road provides a single travel lane in each direction with 10-foot wide shoulders. Nashua Road approaches have a flashing yellow beacon to warn on-coming traffic of the intersection. Traffic operations and safety at this intersection are complicated by Bell Hill Road, which intersects NH Route 101 from the north just east of Nashua Road.

County Road intersects Nashua Road from the east, directly across from the school property. All three legs to this unsignalized intersection have a single approach lane. Vehicles exiting from County Road operate under stop controlled.

Wallace Road

Wallace Road, between Nashua Road and NH Route 101, is a two lane roadway with one 10-foot travel lane in each direction and 1 to 2 foot shoulders. Wallace Road widens as it approaches its signalized intersection with NH Route 101 to provide separate turn lanes. The posted speed limit on Wallace Road is 30 miles per hour. Wallace Road carries approximately 3,300 vpd with peak hour flows of 250 to 350 vph.

Wallace Road approaches NH Route 101 from the north and south, forming a four-way signalized intersection. Both Wallace Road approaches provide a shared left-turn/through lane and a separate right-turn lane. At this location, NH Route 101 provides a separate left-turn lane, and two through lanes in each direction. A separate right-turn lane is provided on NH Route 101 westbound. The traffic signal operates with three phases: eastbound/ westbound protected left-turns, eastbound/ westbound throughs and rights, and northbound/ southbound all movements.

South of the school property, Nashua Road intersects Wallace Road from the east forming a three-way unsignalized intersection. All three approaches to the intersection provide a single travel lane. Vehicles exiting from Nashua Road are stop controlled. Nashua Road is signed for "No Thru Trucks" at this location.

NH Route 101

As described above, NH Route 101 has a variable width within the study area ranging from one travel lane in each direction to multiple lanes at signalized intersections. The posted speed limit on NH Route 101 is 70 miles per hour. Counts conducted by the NHDOT in 2003 show that NH Route 101 carries approximately 28,000 vehicles per day.

Other Locations

The intersection of County Road, Liberty Hill Road, and Gault Road is located east of the Nashua Road/County Road intersection. At this five-way intersection, County Road runs east/west and intersects Liberty Hill Road, which runs north/south. Gault Road intersects Liberty Hill Road in the

north east corner of the intersection. Each roadway provides one travel lane in each direction. The County Road and Gault Road approaches operate under stop control. Traffic operations are complicated at this intersection due to the five leg configuration. In addition, field observations noted that sight distances on the side street approaches were restricted as a result of the intersection geometry.

PROPOSED ENROLLMENT PROJECTIONS

Enrollment projections prepared by the School District assume that the proposed facilities will accommodate approximately 2,020 students by the year 2013 with 760 students attending the Middle School and 1,260 students attending the High School. The schools are anticipated to open in 2007 and may include phasing for the high school enrollment. For analysis purposes, this study assumes full enrollment of both schools for the opening year (2007) and future year (2013) conditions.

TRIP GENERATION

A trip generation estimate was prepared for the project using rates published by the Institute of Transportation Engineers (ITE) in *Trip Generation*¹. Calculations to support the estimates have been provided in the Appendix. Table 1 summarizes the weekday morning, mid-afternoon, and evening peak hour trip generation for the proposed schools.

TABLE 1
TRIP GENERATION ESTIMATE

<u>Period</u>	<u>High School Trips</u>	<u>Middle School Trips</u>	<u>Total Trips</u>
Weekday AM Peak Hour (vph)*			
In	360	220	580
Out	<u>160</u>	<u>180</u>	340
Total	520	400	920
Weekday Mid-Noon Peak Hour			
In	115	105	220
Out	<u>245</u>	<u>125</u>	<u>370</u>
Total	360	230	590
Weekday PM Peak Hour			
In	80	60	140
Out	<u>95</u>	<u>55</u>	<u>150</u>
Total	175	115	290

* vph = vehicles per hour.

¹ Trip Generation, 7th Edition, Institute of Transportation Engineers, Washington, DC, 2003.

TRAFFIC ANALYSES

Traffic Volume Network Development

Traffic volume networks for the study area intersections were developed based on traffic data collected in July 2001 for the NH Route 101 Corridor Study and December 2001 for the preliminary traffic assessment conducted by VHB for the School District. Turn movement data was collected for the weekday morning, mid-afternoon, and evening peak hours. Supplemental data for the critical condition (weekday morning peak hour) was collected at the intersection of Wallace Road and Nashua Road in November 2004 as requested by the Traffic Study Subcommittee. Copies of the traffic count data are provided in the Appendix.

No Build traffic volume networks were developed by factoring the 2001 traffic data to reflect 2007 conditions for the opening year of the schools and 2013 for future conditions. Forecasting calculations were performed using an average annual growth rate of 1.7 percent per year, which was established based on historical count data within the Town. Growth rate calculations are provided in the Appendix. Build traffic volume networks were developed by adding the trips generated by the schools to the No Build networks. No Build and Build traffic volume networks are shown in the Appendix.

It is important to note again the assumptions that were made in conducting this study. As discussed previously herein, the traffic analysis was performed in a manner that remains consistent with the improvements associated with the NH Route 101 Corridor Study. Therefore, it was assumed that NH Route 101 will be a median divided road in the vicinity of the proposed schools with Wallace Road providing signalized access to/from the corridor. The intersection of NH Route 101 and Nashua Road would prohibit left-turn movements. This is important to note from an analysis perspective as it affects the assignment of school related trips to the surrounding roadways. Left-turns traveling to/from NH Route 101 and the school were assumed to travel via the signalized intersection of Wallace Road and the future local connector road. This assignment scenario provides the safest condition for motorists (and particularly students) traveling to and from the schools whereas the left-turn movements to/from NH Route 101 are protected by the traffic signal.

Traffic Operations and Improvement Measures

Traffic analyses were conducted using the methodology and procedures found in the *Highway Capacity Manual*². Level of service (LOS) analyses were calculated for each of the study area intersections for the 2007 No Build, 2013 No Build, 2007 Build and 2013 Build scenarios. 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 detailed analysis results are provided in the Appendix.

The following describes traffic operations under the Build scenario with the completion of the proposed schools and recommends measures to improve traffic flow and safety within the study area. It is important to point out that some of the improvements discussed below are needed independent of the proposed school project (specifically those identified previously in the NH Route 101 Corridor Study). Graphics conceptually depicting the recommended roadway and intersection improvements, and associated cost estimates are provided in the Appendix.

NH Route 101 and Wallace Road

The 2007 Build analyses indicate that additional capacity is needed at the signalized intersection of NH Route 101 and Wallace Road in order to accommodate traffic volume demands during the weekday

² Highway Capacity Manual, Transportation Research Board, Washington, DC, 2000.

morning and evening peak hours. Assuming full occupancy of the schools under the opening year scenario, the intersection is expected to operate at LOS F in the morning and LOS E in the evening with the existing geometrics. Traffic operations during the mid-afternoon peak hour (when the school would be releasing students) are anticipated to be an acceptable LOS C.

In order to achieve improved traffic operations at this location, it is recommended that the Wallace Road approaches to the NH Route 101 intersection be widened to accommodate an additional lane. Each Wallace Road approach should provide a left-turn lane, a through lane, and a right-turn lane. A field investigation revealed that this widening could be accomplished with the least amount of impact by widening toward the east on both approaches. A preliminary cost for the recommended widening and associated signal/equipment modifications was estimated to be \$350,000 (exclusive of any potential right-of-way impacts). It is important to keep in mind that this cost estimate is based on a conceptual layout of the improvement only; formal engineering design is needed to better determine construction costs and right-of-way impacts. Under this scenario the intersection is projected to operate at LOS D or better through the year 2013 with full occupancy of the schools.

NH Route 101 and Nashua Road

The intersection of NH Route 101 and Nashua Road is anticipated to operate at acceptable levels of service under the assumed condition of right-turn movements only. Right-turns entering Nashua Road from NH Route 101 are expected to operate at LOS A through the year 2013 with the full occupancy of the schools. Right-turns exiting from Nashua Road are expected to operate at LOS B.

A conceptual improvement plan depicting an interim solution for the intersections of NH Route 101/Nashua Road and NH Route 101/Bell Hill Road with left-turn movements prohibited was developed as part of this study. The plan calls for the construction of median islands that channelize or force right-turn movements at the intersections. The plan also calls for the construction of a widened 12 foot shoulder to provide a deceleration lane for right-turn from NH Route 101. These improvements could be constructed prior to the implementation of the median on NH Route 101 to restrict left-turns. The Nashua Road intersection improvements were developed in a manner that would be reusable as part of the long-term solution (with the median on NH Route 101 and the bridge from Bell Hill Road to Nashua Road). The Bell Hill Road intersection improvements would be removed under the long term plan, where as Bell Hill Road will no longer intersect NH Route 101 and become an overpass to Nashua Road. An estimated cost of this interim improvement is approximately \$380,000 with the majority of that cost associated with the Nashua Road portion of the project. It is important to keep in mind that this is a preliminary cost estimate based on a concept plan only. Formal engineering design of the plan is needed in order to develop a more detailed estimate of the costs and to determine any right-of-way impacts.

It is important to note that, if the schools are proposed to open prior to the construction of the NH Route 101 access management plan and associated local connector road, additional measures will likely be required at the intersection of Nashua Road for operational and safety reasons. Under the existing geometric conditions, left-turn movements to/from Nashua Road operate at very poor levels of services due to the high peak hour traffic volumes and lack of adequate gaps in the NH Route 101 through traffic stream. If left-turn movements are allowed to occur at this location with the opening of the schools, additional improvement measures to be considered at the intersection include the construction of a separate center left-turn lane on NH Route 101, construction of separate left and right-turn lanes on Nashua Road, and potentially the installation of a traffic signal. Since none of these measures are consistent with the NH Route 101 improvement plan, the intersection improvements would only act as an interim solution and would eventually be removed. The interim intersection improvements described are considered substantial construction and would be a costly temporary solution.

Nashua Road from New Connector Road to County Road/Proposed School Driveway

As previously discussed herein, for the purpose of this study it was assumed that the local connector road would be constructed along the north limit of the school property. Therefore, in order to promote safe and efficient traffic operations along Nashua Road, it is recommended that a consistent three-lane cross section (one through lane in each direction and a center turn lane) be constructed extending from the new local connector road intersection through the County Road intersection. The center turn lane would remove the left-turns from the through travel lanes, reducing delays along Nashua Road. In addition a right-turn deceleration lane or widen shoulder should be provided for vehicles turning into the school driveway. It is recommended that Nashua Road be widened to the west (onto the school property) to the greatest extent possible in order to minimize potential right-of-way impacts and related costs.

With regard to the placement of the proposed school driveway on Nashua Road, the access should be constructed to align with County Road, forming a four-way intersection. It is recommended that separate left and through/right-turn lanes be constructed on the site driveway to minimize delays and vehicle queuing. Similarly, if sufficient right-of-way is available or obtainable, a separate left-turn lane could be constructed on the County Road approach to reduce delays at the intersection. With the implementation of these improvements, all movements at the intersection will operate at acceptable levels of service (LOS D or better) through 2013 with the full occupancy of the schools.

Based on the conceptual layout of these improvements, it has been estimated that this project will cost approximately \$870,000 (exclusive of right-of-way). Final engineering design is required to better estimate the construction costs and potential right-of-way impacts.

Wallace Road and Connector Road

There are several options being considered for proposed location of the connector road as it intersects with Wallace Road. It is recommended that the new intersection be kept a minimum of 600 feet (preferably 800 feet) south of NH Route 101 to provide clear separation between the two intersections. At the new intersection, Wallace Road should be widened to provide separate left and right-turn lanes into the new connector road to minimize delays to the through traffic. Separate left and right-turn lanes exiting from the connector road should also be provided. The conceptual cost estimate for this improvement is \$410,000 (exclusive of right-of-way impacts).

Connector Road

It is recommended that the local connector road as described in the NH Route 101 Corridor Study be constructed as soon as possible and prior to the opening of the schools. As discussed in the corridor study, the connector road provides a key role in access management plan and is badly needed today. The connector will eliminate the need for left-turn movements from unsignalized driveways and side streets along NH Route 101 between Wallace Road and Nashua Road, which will dramatically improve the safety along the corridor. The connector road will provide this same level of safety for vehicles traveling to/from the proposed schools by gaining access from the school property to the NH Route 101/Wallace Road traffic signal for left-turn movements.

It is recommended that the local connector road be constructed to meet the Town's urban roadway standards. The road would provide one travel lane in each direction with sidewalk on both sides. A connection to the local businesses along NH Route 101 is recommended via Chestnut Drive. At the intersections of the connector road with Wallace Road and Nashua Road, the roadway should widen to provide separate left and right-turn lanes for approximately 200 feet. In addition, a bridge is required for the roadway to cross Riddle Brook, which will require the project to go through wetlands permitting with the State. Based on a conceptual layout, the estimate length of the connector road is approximately 3,700 feet and is anticipated to cost approximately \$2,600,000 (exclusive of right-of-way cost). Formal engineering design is required to develop a more detailed cost estimate.

Nashua Road/Bell Hill Road Overpass

The NH Route 101 Corridor Study recommended the construction of a bridge extending from Bell Hill Road to Nashua Road over NH Route 101. This bridge is an important part of the overall NH Route 101 corridor plan whereas it provides a local connection for vehicles, pedestrians, and bicycles between the north and south sides of the community that does not exist today. The Town should continue to pursue this element of the NH Route 101 improvement plan as soon as possible. However, it is important to note that the bridge does not need to be in place upon the opening of the schools.

For the purpose of this study, a conceptual cost estimate was developed for the construction of the bridge and its associated improvements. The overpass was assumed to be constructed to Town standards with a bridge span of about 128 feet. In addition, it was assumed that Nashua Road would be relocated to the west to accommodate the overpass and that Bell Hill Road and North Amherst Road would also require reconstruction. The estimated length of the project is 2,100 feet with a cost approximately \$3,800,000 (exclusive of right-of-way).

County Road, Liberty Hill Road, and Gault Road

As previously described in this memo, traffic operations at the intersection of Country Road, Liberty Hill Road, and Gault Road are complicated by the geometry at this location. In fact, the standard methodologies provided in the *Highway Capacity Manual* do not allow for analysis of the geometric conditions at this intersection. Modified analyses were conducted, in conjunction with field observations, to determine that this intersection experiences poor levels of services for the stop controlled approaches on County Road and Gault Road during the existing peak hour conditions.

Minor to moderate improvements (such as additional stop signs or traffic signals) would not improve traffic operations or safety at this location. Therefore, it was concluded that a major improvement project would be required to correct the problems that exist at this intersection. Some potential improvement scenarios discussed with the Traffic Study Subcommittee include the construction of a five-leg roundabout or the relocation of Gault Road to a point north on Liberty Hill Road (forming a new three way intersection clearly separated from County Road). Both of these improvement scenarios would require partial and/or full acquisition of private properties in the vicinity of the intersection. Therefore, it was concluded that the existing problems at this intersection go beyond the means of the school project to address. It was recommended that the intersection be studied in more detail and addressed through a Town project in the future. In the interim, traffic operations at this intersection could be improved through the use of a uniformed police officer directing traffic during the peak hour conditions.

Wallace Road and Nashua Road

A limited traffic analysis was conducted for the intersection of Wallace Road and Nashua Road as requested by the Traffic Study Subcommittee. The analysis results indicate that the intersection will continue to operate at acceptable levels of service with the full occupancy of the schools through 2013. No improvements are required at this location.

CONCLUSIONS AND RECOMMENDATIONS

Table 2 briefly summarizes the recommended roadway infrastructure improvements that should be constructed and in place upon the opening of the proposed Bedford High School and Middle School. The table also provides cost estimates that have been developed based on conceptual level improvement plans. The estimates should be used for planning purposes only and do not include costs associated with right-of-way acquisition. Formal engineering design is required to establish more detailed estimates. The table also indicates which improvements are associated with the NH Route 101 Corridor

Study and which are required without the school. The figures titled "Conceptual Roadway Improvements" and "Conceptual Roadway Improvements Descriptions and Cross Sections" should be consulted for more detail.

TABLE 2
SUMMARY OF RECOMMENDATIONS

<u>Recommended Improvement</u>	<u>Estimated Cost</u>	<u>Part of NH 101 Study?</u>	<u>Needed Without School Project?</u>
Wallace Road at NH 101 Intersection Improvements: Add one approach lane NB on Wallace Road Add one approach lane SB on Wallace Road Modify signals	\$350,000	No	No
Wallace Road at New Connector Road: Add SB left-turn lane on Wallace Road Add NB left-turn lane on Wallace Road	\$410,000	No	Yes
New Connector Road: Two lane road from Wallace Road to Nashua Road Widened approaches at Wallace & Nashua for turn lanes Bridge over Riddle Brook	\$2,800,000	Yes	Yes
Nashua Road from Connector Road to County Road: Add center turn lane for entire segment Add SB right turn lane at proposed school driveway Reconstruct County Road approach	\$870,000	Partial	Partial
Nashua Road/Bell Hill Road Left-turn Restrictions: Widen NH 101 to provide right-turn deceleration lane Relocate and reconstruct Nashua Road approach Reconstruct Bell Hill Road approach Install raised islands to prohibit left-turns	\$380,000	Partial	Potential Interim Solution
Nashua Road/Bell Hill Road Overpass: Construct two lane overpass with sidewalk Bridge span approximately 128 feet Reconstruction of Bell Hill Road and North Amherst Road Relocation/reconstruction of Nashua Road (included above)	\$3,800,000	Yes	Yes, but not needed immediately.

Notes:

1. Estimates do not include costs associated with right-of-way acquisition.
2. All improvements may be eligible for financial reimbursement through State funding with the exception of intersection improvements at Nashua Road, County Road, and the proposed school driveway.