OSTERGAARD ACOUSTICAL ASSOCIATES

EVALUATION OF SITE SOUND EMISSIONS

PROPOSED WAREHOUSE
Randolph, MA

Prepared for: **Bluewater Property Group**

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INTRODUCTION

Ostergaard Acoustical Associates (OAA) was asked to assist with evaluation of potential sound emissions from a speculative warehouse to be located on multiple parcels off of Randolph Road in the Town of Randolph, Norfolk County, Massachusetts. The site is currently undeveloped and will be developed to accommodate a 24-hour operation warehouse building. The vicinity of the site is mixed-use in nature, commercial uses and undeveloped land are to the north and east, respectively, and residential receptors are to the south and west. This report addresses the onsite noise radiated off-site to nearby potentially noise-sensitive receptors.

The purpose of this sound study is to analyze future site sound emissions for comparison with applicable State and local noise code limits and to evaluate compatibility of the proposed use with the surroundings. Such ordinances regulate site sound relative to existing ambient sound levels in order to minimize the potential acoustical impact of new noise sources. The site will contribute steady sound from rooftop HVAC equipment. The site will also produce intermittent sound from truck and car[1] movements.

Since future tenants are not known, the extent of heavy trucking activity was conservatively estimated, assuming the potential for nighttime activity. Traditional use of such buildings will primarily see activity during daytime hours; nighttime activity, if any, is expected to be lower in quantity and sporadic. Nevertheless, potential nighttime operations are of most interest since residential receptors are potentially more sensitive during this period.

Work by OAA was overseen by Benjamin C. Mueller, P.E., with assistance from OAA Staff. The representative at Bluewater Property Group coordinating the project is Alexandra Escamilla.

SITE AND VICINITY

Figure 1 is an aerial image obtained from Google Earth outlining the site in red. Figure 1 also shows ambient survey locations, which are discussed in a subsequent section.

[1] Note that throughout this report, the term "car" collectively refers to personal passenger vehicles including automobiles, vans, pick-ups, or SUVs. The term "truck" refers to heavy trucks such as over-the-road or line-haul trucks.

The site is located southwest of the Richardi Reservoir, at the terminus of Randolph Road in the Town of Randolph, Norfolk County, Massachusetts. The developed portion of the site is along Randolph Road and comprises a gym and construction equipment storage. The surrounding area is mixed-use in nature. The site and properties north and east of the site are in the Industrial District. Specifically, to the north is a large self-storage facility; wooded land and an extension of the reservoir abut the site to the east. An active adult condo community is immediately south of the project in the Residential Multi-Family 55+ District. Further south, beyond the condo community, are more industrial uses including a large Stacy's Pita Chip manufacturing facility, which utilizes heavy trucks. Lastly, single-family residences front on North Street to the west in the Residential Single-Family High-Density District. Nearby residences to the south and west are of most concern acoustically given their potential noise sensitivity and proximity to the site.

Plans call for the developed areas of the site to remain; deeper into the site will accommodate the construction of an approximately 120,000 ft^2 building to be located in the western portion of the irregularly shaped parcel. Access will be provided via Randolph Road for all vehicles, and the onsite driveway will circle the building. The road on the eastern side of the building is for emergency access use only. Heavy truck docks are located along the northeast façade of the building, with ancillary trailer parking areas provided outboard of the docks. Personnel vehicles have dedicated parking areas along the southwest side of the building. The site layout is acoustically beneficial as the truck yard is located away from residences and shielded by the building.

Specific traffic counts depend on the end user tenant. While the extent of onsite traffic and the hours of operation are unknown, the sound study has followed the same conservative assumptions made in the traffic study. A review of the traffic study and discussion with the traffic engineer indicates that 72 truck trips are expected daily at this site. This equates to 36 trucks daily, or about 1.5 trucks per hour if they were equally distributed. Professional experience, and information from the Institute of Transportation Engineers (ITE), indicates that while typical warehouses operate 24/7, the majority of their activity occurs during the daytime hours; nighttime operations are generally used to prepare for the next day. The ITE trip generation manual shows that for Land Use Code 150: Warehouse, approximately 87% of all truck traffic occurs during the daytime hours. For this site, this means around 5 trucks are expected across the nighttime hours. While low in volume, the focus of this study is to analyze this potential nighttime activity as this is generally when residential receptors are most sensitive.

Figure 1 — Google Earth image showing the proposed warehouse site and vicinity in Randolph, MA. The site property line is approximated in red.

REGULATIONS/GOALS

When developing a site of this type, it is appropriate to consider how sound from the facility will likely be received, especially by potentially noise-sensitive receptors. Sound produced by a typical warehouse is characterized by car and truck parking lot activity, such as idling and vehicle movement, as well as steady HVAC equipment. The noise from these sources was evaluated and compared to applicable noise code limits as well as acoustical goals based on professional experience. As a general practice, when motor vehicles are onsite, they are considered part of a site's sound emissions; when vehicles are on public roads, they are not.

State, county, and local noise codes were reviewed. The State of Massachusetts code, Division of Air Quality Control Policy 90-001, requires sound emissions to not exceed background ambient sound levels at the nearest residence by 10 dB(A). The background sound level is defined as the level present 90% of the time during a measurement period when equipment is in operation. In addition, sound from the site is not to produce a "pure tone" condition where once octave band sound pressure level exceeds adjacent bands by 3 dB or more. The Town of Randolph's noise ordinance is found in Chapter 141 *Unreasonable Noise*. This ordinance prohibits the creation of unreasonable noise, which is defined as noise in excess of 50 dB(A) during the nighttime hours from 2300 and 0700 hours and 70 dB(A) during the complementary daytime hours. In the absence of an applicable noise level standard, unreasonable noise is also defined as "any noise plainly audible at a distance of three hundred (300) feet or, in the case of loud amplification devices or similar equipment, noise plainly audible at a distance of one hundred (100) feet from its source by a person of normal hearing". Lastly, there are no Norfolk County noise codes that could be found.

A discussion of relevant codes is warranted. The Randolph noise ordinance provides fixed noise limits. OAA agrees with the nighttime noise limit of 50 dB(A) as being appropriate for protecting residential receptors. Of note is that New Jersey also uses 50 dB(A) for their nighttime noise limit; similarly, Connecticut uses 51 dB(A) for their nighttime code limit. When 50 dB(A) occurs at a residential window, an open window will provide 10 dB of attenuation and result in a bedroom sound level of 40 dB(A); a closed window provides even more attenuation. Having intermittent maximum bedroom sound levels below 40 dB(A) minimizes disruption of sleep according to studies by the World Health Organization. Chapter 141 does not clearly indicate where the code limit should be applied, nor does it provide any adjustments for type of receiver. Some interpretation is therefore necessary. OAA generally selects the façade of dwellings to evaluate nighttime sound emissions and an area of outdoor repose (such as a deck, patio, pool, or other similar area) where an affected party would exist to evaluate daytime sound emissions.

Lastly, while the local code discusses audibility, OAA recommends relying on tangible metrics, such as the 50 dB(A) nighttime limit, to provide a clear and scientifically backed direction for noise evaluation and enforcement.

The Massachusetts noise code takes the approach to compare new sound to existing, which is appropriate for minimizing the acoustical impact of new noise sources. The local nighttime noise code limit of 50 dB(A) would essentially assume a background sound level of 40 dB(A), which is typical for a rural suburb area. The State code is traditionally applied to stationary noise sources. The code language unfortunately does not specify a measurement period or provide details on how to address the inherent variability of ambient sound; background sound levels are themselves dynamic and constantly changing in the area. The State code is more complicated to evaluate and enforce given this variability. While there is little question that the State noise code regulates stationary noise sources, it is less clear on whether it includes mobile noise sources; motor vehicles can travel off-site and produce variable sound themselves.

OAA finds in practice that receptors are more tolerant of short duration excursions than a steady sound of the same magnitude. In other words, the public would be less tolerant of a steady sound that was 10 dB higher than existing sound levels than for an occasional intermittent one. OAA agrees with allowing intermittent site sounds to approach 10 dB higher than existing sounds in the area provided they are in line with other maximum sound levels that might occur. Steady HVAC sound on the other hand, should generally be well below applicable maximum code limits and more aligned with existing ambient background sound levels in the area to minimize the potential for any acoustical impact.

Given all of this, OAA finds the Randolph nighttime code limit of 50 dB(A) appropriate to protect nearby residential receptors. On-site truck activity in the dock area should strive to meet this recognizing that typical traffic passby sound levels are expected to routinely exceed 60 dB(A) along the North Street corridor. To ensure that steady HVAC sound has no negative impact, a project noise goal of 45 dB(A) is recommended for these sources. Meeting these sound level limits will ensure that the intent of the local code is met and will minimize the potential for complaints. Using nighttime noise code limits as a project goal will also ensure compliance during the daytime hours, where the code limit is 70 dB(A).

Based on experience, OAA believes that local noise ordinances would prevail over State codes. However, OAA is currently in the process of surveying ambient sound levels for comparison of sound emissions to State criteria; results are expected to align with local code limits.

EXPECTED SOUND EMISSIONS

Acoustical modelling software, specifically CadnaA, was used to create and analyze site sound emissions for the site. The model takes into account relevant parameters between the noise source and receptor positions of interest to predict how sound will propagate. In addition to distance attenuation, the model accounts for the effects of terrain, various types of ground cover, shielding by structures, and reflections from buildings. In all models the buildings are white, elevation contour lines are teal, and the site property line is outlined in red. North is pointing up in all Figures. All models include a proposed 10-foot tall sound barrier, shown in light blue, designed to reduce off-site sound emissions from the truck court area. Elevation changes exterior to the site were obtained from MassGIS and incorporated into the model. Model results show only the sound emissions of the site, which are directly comparable to the project noise goal and code limits; ambient sound is not included in the model. The numbers around the perimeter each figure represent the scale in feet.

To evaluate nighttime site conditions, it is logical to apply noise code limits at the area of repose of sleeping residences. For this reason, site sound emissions were scrutinized at the upper-story façade of residential dwellings, where complaints are most likely to occur. Evaluation of daytime noise code limits would occur at ear height at vantage points on the receiver's property where repose would occur, for example a patio, porch, or other usable area of a yard. This study focuses on the nighttime noise code as it is the most stringent metric to meet.

The acoustical model shows the results graphically as A-weighted sound level contours, in 1 dB increments, and tabulates the summed A-weighted sound levels at six discrete locations, labeled Locations A through F, typifying nearby residential receptors of interest. Sound level contours are at ear height, 5 feet above grade. All discrete Locations are at the façade of nearby residences. All Locations are at a height of 15 feet above grade, representing a second story receptor.

Rooftop HVAC Sound

Rooftop HVAC equipment produces noise that is nominally steady in nature, and hence will not vary significantly over time. Information from the project team indicates that four HVAC units will serve this building. Each unit is based on an AAON 25,000 cfm gas unit, with a case-radiated sound power level of 90 dB(A) per manufacturer's sound data. The noise from the four rooftop units was included in the HVAC sound model. Rooftop units are shown as blue +'s and were placed 4 feet above the rooftop. Figure 2 shows the results of HVAC sound emissions graphically and tabulates the summed A-weighted sound levels of all equipment operating simultaneously at their maximum sound level at the nearby receptor locations of concern.

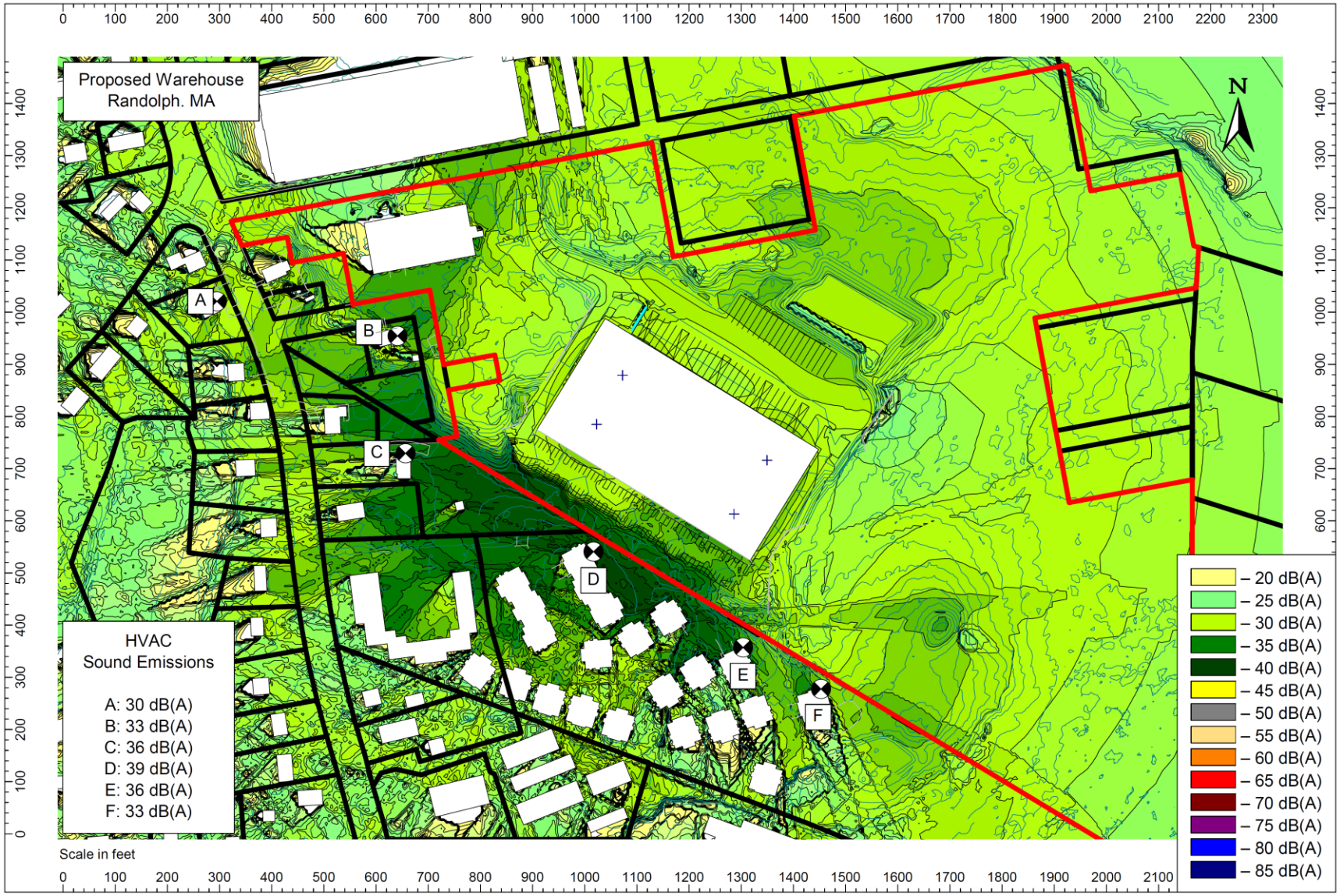

Figure 2 — Maximum A-weighted sound emission contours, 5 feet above grade, from all rooftop HVAC equipment operating. Rooftop equipment shown as blue +'s. Buildings shown in white; site property line outlined in red. A-weighted sound emissions tabulated at 15 feet above grade for all Locations.

This analysis shows that there is little concern about HVAC sound. The results show that with all rooftop units operating, HVAC sound levels at off-site residential receptors are in the 30-to-39 dB(A) range. HVAC sound is sufficiently controlled via distance and roof shielding effects so that this noise is well below the 45 dB(A) project limit by a wide margin. Levels of this magnitude comply with the local daytime and nighttime noise limit by even wider margins. Note that for these model results to be realized, acoustical performance of HVAC equipment must be aligned with what was modelled.

Heavy Truck Activity

OAA has had the opportunity to visit various warehouse facilities and industrial parks over the years to survey and document the sounds of truck activity. The warehouse will have over-the-road line-haul trucks and potentially have terminal tractors (yard tractors) active on site. From an acoustical aspect, terminal tractors and line-haul trucks are acoustically equivalent.

Truck noise in a typical dock area can routinely produce maximum sound levels of 79 dB(A) when measured at a distance of 50 feet from the source. This sound level was determined by looking at a wide variety of truck activity, such as truck movement, air brakes, back-up alarms, and coupling/decoupling, and distilling it to a single conservative maximum level and spectrum for use in acoustical studies such as this. A driving truck exhibits slightly lower maximum sound levels of 74 dB(A) when measured 50 feet from the source. The height of a truck source for all truck activity is modelled at a conservative height of 8 feet above grade. OAA has found that using these maximum sound levels at this height ensures a conservative approach to evaluating truck sound within the truck court. When specific individual activities are modelled at their actual height and sound level, results are typically lower in level than predicted below. For example, many of the high sound level activities, such as back-up alarms and air brakes, occur at a height of 4 feet above grade, not 8 feet. This is a critical detail when evaluating the effectiveness of a sound barrier or berm and when considering intervening topography. It is also important to recognize that all truck noise is dynamic in nature. Maximum sound levels only occur for a short duration and are not representative of the constant sound level produced by on-site trucks.

While there will certainly be multiple trucks onsite at any given time, it is generally appropriate to evaluate maximum sound from an individual truck. Several factors support this. Because maximum levels are dynamic and short in duration, it is unlikely that multiple truck sound level maximums will occur at exactly the same time and location. In addition, safe practices restrict more than one truck from operating in proximity to each other in the same vicinity. Hence, off-

site maximum sound levels will be driven by individual truck sources. In the unlikely event that two truck sources would contribute the same level in the same location at the exact same time, maximum emissions would only be 3 dB higher due to the logarithmic nature of sound pressure level addition. The above rationale is echoed by ITE data which shows that at most, the site expects 1 or 2 trucks in a given nighttime hour. For comparison, ITE data show that 8 trucks would come and go during the busiest daytime hour period. Even with this higher volume the likelihood of multiple maximum sound levels happening at the same time is extremely small.

Maximum sound levels from dock activity were modelled at various on-site locations. Of most concern are activities that occur at the easternmost and westernmost docks as these are closest to off-site receptors. Truck sources were placed in truck court areas at locations where sound emissions were worst-case. Truck yard activity noise sources are shown as white "+"s. HVAC noise sources from Figure 2 were also included in the model to represent worst-case condition.

Figure 3 shows truck yard activity in the westernmost dock. Maximum off-site emissions are 44 dB(A) due to the proposed wing wall that screens sound in this direction. Levels of this magnitude fully comply with local noise code limits. The handful events that might occur in a given hour is expected to be far lower than sound produced by intermittent local traffic travelling along North Street. This applies during both the daytime as well as nighttime hours.

Figure 4 shows a similar condition when there is truck yard activity in the easternmost dock. The truck source was placed in the middle of the truck court to account for use of either the easternmost dock or the easternmost trailer parking. Results show that maximum off-site emissions are 50 dB(A) at Location F. Results at all other locations are 41 dB(A) or below. Results comply with the local noise code limit. The few occurrences of this magnitude that might occur during the night are not expected to generate any noise complaints or have any negative acoustical impact on the surrounding residential receptors. During the daytime, this activity is expected to be difficult to distinguish from other noise sources in the area.

These results show that anticipated for worst-case modelling condition, maximum site sound levels will comply with the 50 dB(A) nighttime code limit and, by default, the 70 dB(A) daytime code limit. This is achieved via site layout, distance, and the proposed sound barrier. Lastly, the low truck trip generation counts expected at this site ensures that these maximum sound level events will be kept to a minimum and not regularly occur. No negative acoustical impact is expected from site operations.

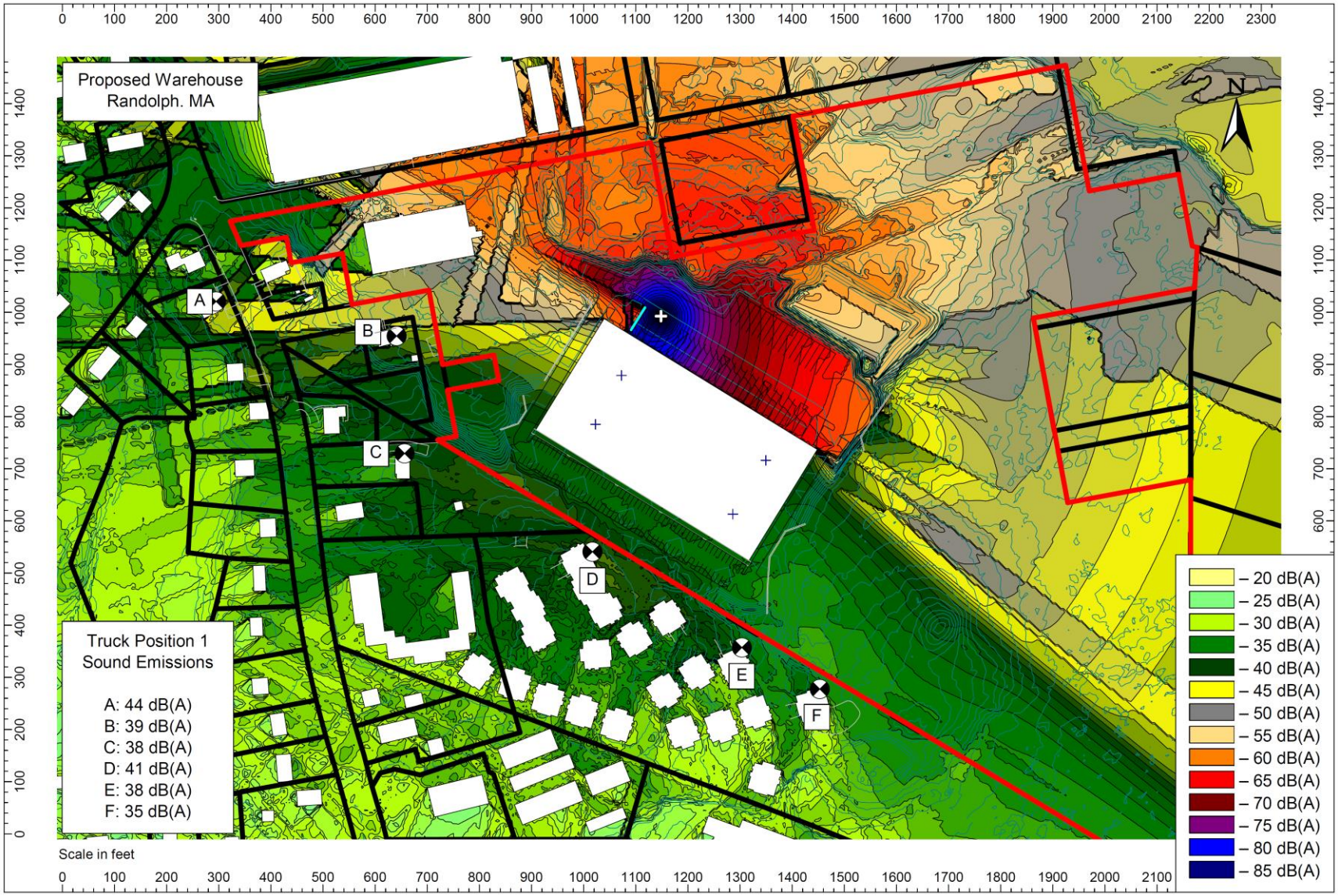

Figure 3 — A-weighted sound level contours, 5 feet above grade, expected for a truck contributing yard activity at Truck Position 1, shown with a white +. Rooftop equipment shown as blue +'s. Buildings shown in white; site property line outlined in red. A-weighted sound emissions tabulated at 15 feet above grade for all Locations.

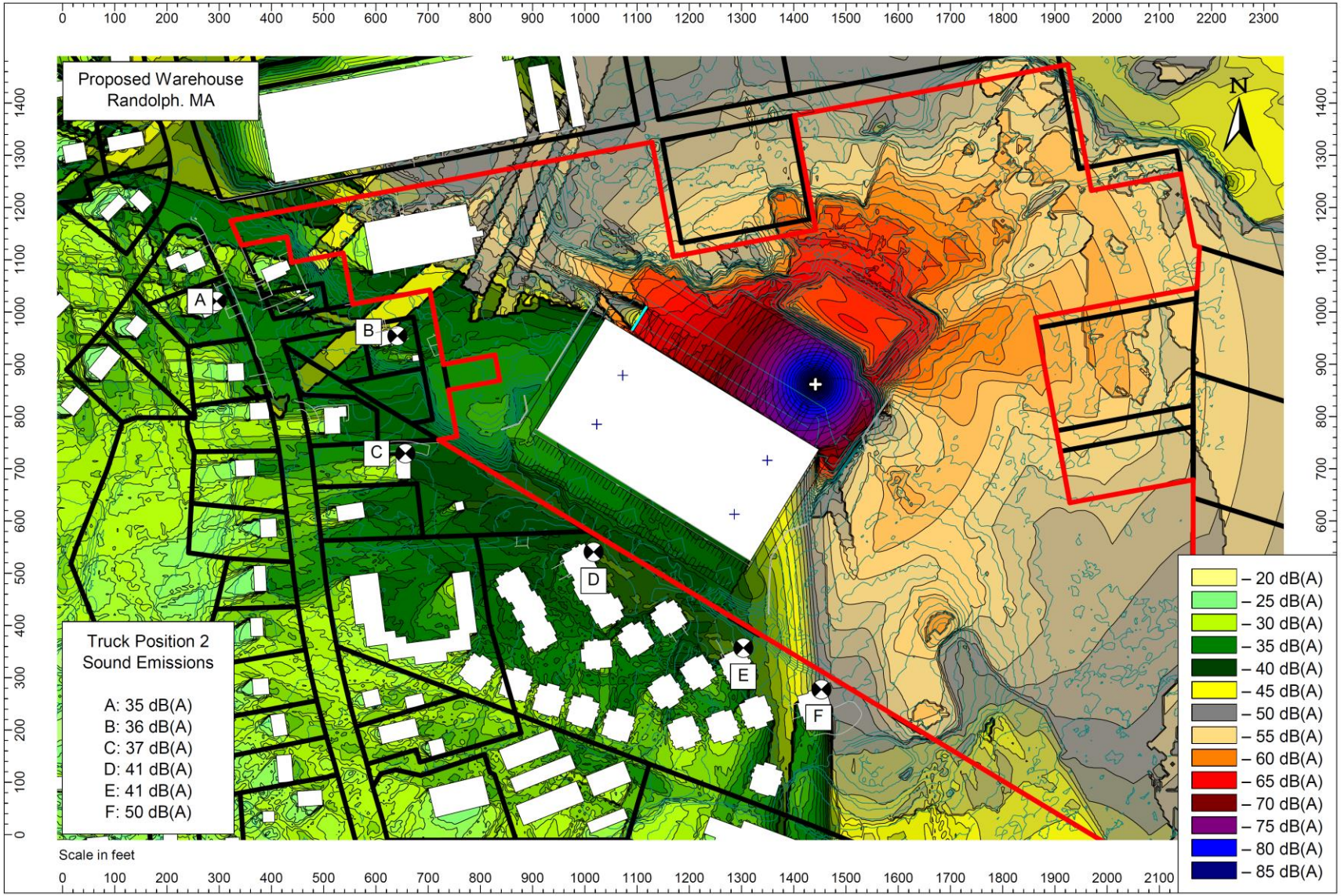

Figure 4 — A-weighted sound level contours, 5 feet above grade, expected for a truck contributing yard activity at Truck Position 2, shown with a white +. Rooftop equipment shown as blue +'s. Buildings shown in white; site property line outlined in red. A-weighted sound emissions tabulated at 15 feet above grade for all Locations.

CONCLUSION

A warehouse is planned in an industrial district in Randolph, MA. Despite having similar uses in the area, there are residential receptors bordering the site to the south and west. Non-noise-sensitive commercial uses border the site to the north and undeveloped land abuts the site to the east. An acoustical evaluation was carried out to ensure that site sound emissions meet the intent of the local noise code and minimize the potential for noise complaints. More stringent project goals were established for steady sound producing HVAC equipment. Meeting these local code limits and recommended project goals will ensure there is no negative acoustical impact at potentially noise sensitive receptors. While local noise code is expected to prevail, an ambient sound survey is currently being conducted to also ensure that the State noise code limits are also met.

Based on results of analyses, steady HVAC site noise is expected to fall well below project noise goals and have an even greater margin of compliance with the allowable nighttime noise code limit of 50 dB(A). HVAC sound is expected to blend in with existing sounds in the area and be difficult to discern from off-site vantage points. Proposed HVAC equipment arrangements can proceed; however, keep in mind that any modification to the arrangement may affect site sound emissions. Similarly, heavy truck activity in the truck court was shown to fully comply with local noise code limits with the inclusion of a 10-foot-tall sound barrier. The sound barrier will block line-of-sight of intermittent dock activity to residences to the west and minimize potential impacts. A sound barrier is not needed to the south as there is sufficient distance and screening provided by the building.

The site layout represents good acoustical planning, which will put the site in the best position to be a good neighbor. No negative acoustical impact is anticipated from 24-hour site operations, and results support that site sound will comply with the daytime and nighttime noise code limits and not generate noise complaints from the surrounding area.