



July 3, 2008

Ref. 2469

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Mr. Kevin Hajos
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Re: Rapp Road Landfill Expansion: Back-up Alarm Noise Analysis

Dear Mr. Hajos:

This letter describes a noise impact evaluation of back-up alarms for the Rapp Road Landfill expansion in Albany, NY. Existing sound levels were measured at community locations surrounding the landfill during periods when a back-up alarm was operating. Two separate alarms were also measured at a close-in distance of 50 feet away, so as to determine alarm reference sound levels. The alarm reference sound levels were then used to conduct predictive noise modeling, to determine the alarm sound levels in the community after the landfill expansion. The predicted sound levels were then compared against existing alarm sound levels. A determination was also made as to whether the landfill expansion could result in "prominent discrete tone" conditions in the community.

Impact Assessment Criteria

Overall Sound Level Increases

The NYS DEC has published a guidance document for assessing noise impacts (NYS DEC, 2001). The guidance document states that the addition of any noise source, in a non-industrial setting, should not raise the ambient noise level above a maximum of 65 dBA. Ambient sound levels in industrial or commercial areas may exceed 65 dBA with a high end of approximately 79 dBA. In these instances, mitigation measures utilizing best management practices should be used in an effort to ensure minimum impacts.

This guidance document also states that sound level increases from 0-3 dBA should have no appreciable effect on receptors, increases from 3-6 dBA may have potential for adverse noise impact only in cases where the most sensitive of receptors are present, and increases of more than 6 dBA may require a closer analysis of impact

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potential depending on existing sound levels and the character of surrounding land use and receptors. An increase of 10 dBA deserves consideration of avoidance and mitigation measures in most cases. The typical ability of an individual to perceive changes in noise levels is summarized in Table 1. These guidelines allow direct estimation of an individual's probable perception of a change in community noise levels.

Table 1 **Thresholds for Sound Pressure Level Increases**

Increase in Sound Pressure (dBA)	Reaction
0-3	No appreciable effect
3-6	Potential effect for sensitive receptors
Over 6	Closer analysis required

Source: NYS DEC, "Assessing and Mitigating Noise Impacts", Division of Environmental Permits, February 2, 2001.

Tonal Noise Considerations

The other impact criterion relates to the tonal nature (i.e., frequency content) of the noise in question. The NYS DEC Noise Policy does not address tonal noise, so it is necessary to cite an American National Standards Institute (ANSI) Standard¹. In the high-frequency noise region (above 450-500 hertz) a "prominent discrete tone" exists when the noise level within any one-third-octave band is 5 dB above the arithmetic average of the sound levels in the two adjacent one-third-octave bands. Many environmental standards have used the threshold of "prominence" as an indicator of annoyance, because a tone may be audible but not necessarily annoying. The "prominent discrete tone" concept provides an objective means of determining the likelihood that a tonal noise may be annoying.

The "prominent discrete tone" definition is best explained with an image. Figure 1 (attached) shows a bar graph of one-third-octave band sound levels. The red bar represents a "prominent discrete tone", and the blue bars represent the background sound level when the tone source is off. The sound level in the 1,000 hertz band

¹ American National Standards Institute (ANSI) S12.9 Part 3, "Quantities and Procedures For Description and Measurement of Environmental Sound. Part 3: Short-term Measurements With An Observer Present"

(the red section of the bar) is 76 dB, and the arithmetic average in the two adjacent bands (800 Hz and 1,250 Hz) is 62 dB. This is a clear example of a “prominent discrete tone”.

Community Sound Level Measurements

Sound level measurements were conducted on Wednesday June 25, 2008 at six (6) locations in the vicinity surrounding the landfill. The measurements occurred while the back-up alarm for a mobile crusher was activated (constantly on). The crusher stayed in the same location during the community measurements. The locations are very similar to locations cited in the April 2008 Clough Harbour report (the fourth Supplemental DEIS). However, a new location within the Fox Run Estates called “Location A” was measured.

The six locations are described below. Figure 2 shows the measurement locations overlaid upon an aerial photograph. To maintain consistency and continuity, the numbering system used in the DEIS will be used in this letter. The measurement locations are described as follows:

- Location 1/15: On Br'er Fox Boulevard within the Fox Run Estates, located approximately between the Locations 1 and 15 cited in the April 2008 Fourth Supplemental DEIS. The back-up alarm was audible here, but not much louder than the truck engine noise coming from the landfill.
- Location A: This location was not used in the DEIS, but it was deemed representative of sound levels in that section of Fox Run Estates. It is along Tallyho Drive. Back-up alarms were audible at this location, but they were intermittent (not constant).
- Location 2: Residence/Horse Farm along Rapp Road/Lincoln Avenue. Landfill activity was audible here, and the back-up alarm was also audible. The June 25 measurement location used was 300 feet closer to the main house than the DEIS Location 2. The original location was not accessible at the time of the June 25 measurements.
- Location 14: Along Rapp Road, approximately 300 feet southwest of the DEIS Location 14. Landfill activity was audible here, but the back-up alarm was not clearly audible. The primary source of noise here was vehicular traffic along Rapp Road (one vehicle every 10 to 15 seconds). The original location was not used because of a utility crew working very close by.

- Location 4/5: Practically identical to the DEIS locations, 200 feet northwest of the landfill along a trail within the Pine Bush. The back-up alarm was audible at this location, but it was not much louder than truck engine noise coming from the landfill. Because Locations 4 and 5 are so close together, they are considered here as one.
- Location 6: Approximately 700 feet west of the landfill. Landfill activity (including the back-up alarm) was practically inaudible at this location. The primary sources of noise here were the New York State Thruway and birds.

Sound levels were measured at each location with a Norsonic Model Nor140 precision sound analyzer, equipped with a Norsonic-1209 Type 1 Preamplifier, a Norsonic-1225 half-inch microphone and a foam windscreen. The instrumentation meets the "Type 1 - Precision" requirements set forth in American National Standards Institute (ANSI) S1.4 for acoustical measuring devices. The microphone was tripod-mounted at a height of five feet above ground. The measurements included simultaneous collection of broadband (A-weighted) and one-third-octave band data (25 hertz to 10,000 hertz). Each measurement lasted between 1 and 3 minutes.

The measured L_{eq} sound levels at each location are presented in Table 2, attached. The data indicate that sound levels in the back-up alarm frequency region (1,000 hertz, 1,250 hertz, and 1,600 hertz) did not exhibit any "prominent discrete tones". Sound levels in that frequency range were between 32 and 36 dB within the Pine Bush, while sound levels at other locations ranged between 39 and 47 dB in that frequency range. Overall A-weighted sound levels ranged from 47 dBA to 57 dBA for all locations.

Reference Sound Levels

One-third-octave band measurements were conducted for two back-up alarms during the same visit to the landfill (June 25). Measurements were taken fifty (50) feet from the rear and side of a mobile crusher, and fifty feet from a water truck. Both measurements confirmed that the back-up alarm noise occurs within the 1,000 to 2,000 hertz region. The water truck was equipped with a Preco Model 270 Type B alarm, with a rated sound level of 107 dBA at a distance of 4 feet from the alarm (+/- 4 dBA). The 107 dBA level can vary depending upon voltage. At fifty feet away, the Model 270 alarm was measured to be 78 dB in the 1,000 hertz band. Noise from the Model 270 was non-existent in all other frequency bands.

It was not possible to easily determine the manufacturer and model of the crusher alarm, because it was difficult to access. Sound levels for the crusher alarm were measured to be 75 dB in the 1,250-hertz band and 80 dB in the 1,600 hertz band. Crusher alarm noise was non-existent in all other frequency bands. Table 3 summarizes the measurements. The background sound levels (with the alarms off) are also provided, to show that the alarms were considerably louder in those particular frequency bands.

Table 3: Close-In Alarm Measurements, A-Weighted L_{eq} Sound Levels

Measurement	Distance (feet)	Direction	One-Third-Octave Band (Center Frequency, hertz)		
			1,000 Hz (dB)	1,250 Hz (dB)	1,600 Hz (dB)
Water Truck Alarm	50	On-Axis (directly behind)	78	NA	NA
Water Truck Alarm	50	<u>90 degrees to side</u>	63	NA	NA
Alarm Off	50	-	48	NA	NA
Crusher Alarm	50	On-Axis (directly behind)	NA	75	80
Crusher Alarm	50	<u>90 degrees to side</u>	NA	65	67
Alarm Off	50	-	NA	61	59

NA – Negligible sound levels

Note that the alarm noise is very directional. As Table 3 shows, the measurements taken 90 degrees off-axis from the rear of each vehicle are considerably quieter than the straight on-axis measurements. The alarms primarily emit noise in one direction, not omni-directionally.

The sound pressure levels were then converted into sound power levels for use in the noise prediction model (described in the next section). A calibration model was created, and it was determined that the worst-case sound power level in the 1,000-hertz frequency band was approximately 110 dB, which would correspond to the Preco 107 dBA alarm. The worst-case sound power level in the 1,250-hertz band

was determined to be approximately 107 dB. The worst-case sound power level for the 1,600-hertz band was determined to be 112 dB. The 1,250-hertz and 1,600-hertz sound power levels correspond to the mobile crusher back-up alarm.

Predictive Modeling Methodology

A site-wide noise model was developed, and alarm noise impacts associated with the proposed landfill expansion were predicted using the Cadna/A (Computer Aided Noise Abatement) noise calculation model (DataKustik Corporation, 2005). This model uses the ISO 9613-2 industrial standard for sound propagation (Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation). The benefits of this modeling are a more refined set of computations as compared to spreadsheet calculations due to the inclusion of topography, ground attenuation, multiple building reflections, drop-off with distance, and atmospheric absorption.

The Cadna/A model allows for octave band calculation of noise from multiple noise sources, as well as computation of diffraction, and multiple reflections off parallel buildings and solid ground areas. The landfill layout and terrain height contour elevations were imported into Cadna/A using an electronic AutoCAD drawing provided by Clough, Harbour & Associates. This allowed for consideration of terrain shielding where appropriate. In this manner, all significant geometric propagation effects are accounted for in the noise modeling. Ground attenuation credit was taken by the model where appropriate in accordance with ISO 9613-2. No shielding credit was taken for trees, which would make the Pine Bush predictions conservative.

The AutoCAD drawing also made it possible to identify the limits of the proposed landfill expansion. With this information, a back-up alarm was modeled at various locations within the new expansion region. The intention was to model worst-case conditions, so that the alarms would be as close as possible to the community locations in question. The alarms were modeled at an elevation of approximately 400 feet, which is 10 feet above the landfill's highest possible future ground elevation.

Figure 3 shows the Cadna/A predictive-modeling "receptor" locations, the approximate limits of the expansion, and the three different modeling locations for the back-up alarm. The Cadna/A modeled locations are identical to those cited in the DEIS. Note that the Cadna/A (i.e., DEIS) locations are not identical to the June 25, 2008 measurement locations shown in Figure 2. This was primarily because the

exact DEIS location were not accessible on June 25. However, for the purposes of the predictive modeling and noise impact determination, the slight differences between the Figure 2 and Figure 3 locations do not negate the overall findings.

Specific Noise Model Assumptions

Community noise studies rarely determine noise impact on the basis of an absolute worst-case (i.e., loudest) sound level that might occur for some brief period of time. Noise studies typically use the "average hourly sound level" to determine noise impact. For intermittent noise sources (such as a back-up alarm), the noise impact is determined by considering the amount of time the device is expected to operate over the course of any given hour. Back-up alarms do not operate for all 60 minutes within an hour. Furthermore, because the alarm noise is very directional (90 degrees versus on-axis), a given listener in the community is not always going to hear the alarm, even when the alarm is on. This is because the vehicle will make frequent turns as it operates.

The Cadna/A modeling utilized the following assumptions for determining alarm noise impact for any given hour:

- The alarm was modeled as an omni-directional point source. This is a very conservative assumption, since the alarm is actually very directional. This was shown earlier.
- Within any given hour, an alarm was assumed to operate constantly for 20 minutes at each of the three "alarm source locations" shown in Figure 3. 20 minutes was also considered to be a conservative assumption.
- The alarm was modeled at the maximum future height (400 feet) of the proposed expansion. The actual ground elevation will be 390 feet, but the alarm will sit approximately 10 feet above ground while on the vehicle. This results in worst-case sound exposure conditions for the community receptors. In reality, it will take several years for the landfill to reach its final height.

Results and Comparison with Criteria

The Cadna/A sound model predicts sound levels within octave bands. However, Cadna/A can be used to predict one-third-octave band sound levels in certain cases,

such as when the sound in question is very tonal. Recall that an octave band can be “split up” into three individual one-third-octave bands. Consider a situation were the sound energy within the 1,000-Hz octave band is entirely due to sound energy centered within the 1,000-Hz one-third-octave band. In this case, the Cadna/A results are still valid, because the octave-band sound levels are essentially the same at the one-third-octave band levels.

Predicted worst-case alarm sound levels within the 1,600-Hz band are shown in Table 4. Those levels are compared with the “Existing L_{eq} Sound Levels” in the 1,600-Hz band, which were measured on June 25, 2008. The predicted levels reflect the contribution from the mobile crusher alarm, which was considerably louder than the water truck. Predictions are only provided for the locations that were measured on June 25, 2008. Note that the existing levels reflect the contribution of all sound sources: trucks, public-road vehicular traffic, etc. The “Future Alarm-Only L_{eq} Sound Levels” only reflect the contribution of the alarm.

Table 4: Predicted Future Worst-Case Alarm Sound Levels – Crusher Alarm within 1,600-Hz Band

Location	Future Alarm-Only L_{eq} Sound Level (dB)	Existing L_{eq} Sound Level with Alarm On, (dBA)	Increase Over Existing (dB)
Near 1 and 15 (Fox Run Estates)	47	44	3
A (Fox Run Estates)	46	43	3
2 (Horse Farm)	47	36	11
14 (Rapp Road)	40	41	0
4/5 (Pine Bush Closer to Landfill)	38	32	6
6 (Pine Bush – 700 Feet West)	40	35	5

The modeling results indicate that crusher alarm sound levels within the 1,600-Hz band are predicted to exceed the existing “alarm on” sound levels at five of the six measured locations.

Table 5 shows prediction modeling results for the water truck alarm. Recall that the Preco Model 270 alarm (water truck) only emitted sound in the 1,000-Hz band. Table 5 shows that the water truck alarm levels are predicted to be considerably lower than the crusher alarm levels. The largest increase (of 5 dB) is predicted at Location 2.

Table 5: Predicted Future Worst-Case Alarm Sound Levels – Preco Model 270 Alarm within 1,000-hertz Band

Location	Future Alarm-Only Leq Sound Level (dB)	Existing Leq Sound Level with Alarm On, (dBA)	Increase Over Existing (dB)
Near 1 and 15 (Fox Run Estates)	45	47	0
A (Fox Run Estates)	44	47	0
2 (Horse Farm)	45	40	5
14 (Rapp Road)	38	47	0
4/5 (Pine Bush Closer to Landfill)	36	35	1
6 (Pine Bush – 700 Feet West)	38	36	2

“Prominent Discrete Tone” Determination

The Cadna/A results were used to estimate the likelihood of “prominent discrete tones”. Table 6 (attached) shows the worst-case predicted sound levels in the 1,000-Hz, 1,250-Hz, and 1,600-Hz one-third-octave bands. For each one-third-octave band, the predicted sound levels are shown side-by-side with the sound

levels measured on June 25, 2008. The likelihood of a “prominent discrete tone” is also shown.

1,000-Hz One-Third-Octave Band:

At Location 2, there is a possibility that a “prominent discrete tone” condition could arise within the 1,000-hertz one-third-octave band, provided that the water truck operates near the limits of the proposed expansion. This would only occur if the water truck were to operate frequently near the far corner of the expansion limits (closest to Location 2). Of course, the water truck is probably very unlikely to back-up with such frequency, so the “prominent discrete tone” prediction for Location 2 within the 1,000-hertz one-third-octave band is unlikely. The prediction is representative of absolute worst-case conditions. This will probably not be the norm.

1,250-Hz One-Third-Octave Band:

There were no “prominent discrete tones” predicted within the 1,250-hz one-third-octave band.

1,600-Hz One-Third-Octave Band:

“Prominent Discrete Tones” were predicted in the 1,600-Hz one-third-octave band for all locations. This is because the crusher back-up alarm was considerably louder than the water truck alarm. Table 6 shows a 5-dB discrete tone for locations within Fox Run Estates and for the residence near Location 14 along Rapp Road. Location 2, located very close to the limits of the expansion, is predicted to have a 9-dB discrete tone. Locations within the Pine Bush are predicted to have 6 to 7-dB discrete tones due to the crusher alarm.

These worst-case conditions only apply if the crusher alarm were to operate constantly, for 20 minutes within a given hour at a single location.

Conclusion

Existing noise levels at the nearest residences were surveyed while a mobile-crusher back-up alarm operated within the landfill. For the proposed landfill expansion, predicted sound levels for the crusher alarm are predicted to be 3 to 11 dB higher than existing alarm sound levels. Sound levels from the crusher alarm would not exceed the NYS DEC guidance maximum of 65 dBA. However, the crusher alarm

Mr. Kevin Hajos
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July 3, 2008

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could result in an increase above existing levels that could create a noise impact. Furthermore, "prominent discrete tone" conditions are predicted to arise during operation of the current mobile crusher alarm within the proposed expansion.

A mitigation option would be to equip the crusher with a Preco Model 270 alarm, which is currently used on the water truck. Sound levels for the water truck alarm are predicted to be 0 to 2 dB higher than existing alarm sound levels for all locations except Location 2. The Location 2 increase is predicted to be 5 dB. The 5-dB prediction is based on extremely conservative, worst-case modeling assumptions. The actual increase would probably be considerably less.

The analysis also shows that "prominent discrete tone" conditions could be avoided at five of the six measurement locations, provided that the mobile crusher is equipped with a Preco Model 270 alarm. Although Location 2 might still experience "prominent discrete tone" conditions, it is likely that actual operating conditions would likely avoid this outcome. It is very unlikely that the alarm would point directly towards Location 2 for more than 20 minutes within an hour.

If you have any questions about this letter, please call me at (978) 461-6265.

Sincerely,
EPSILON ASSOCIATES, Inc.



Damien Bell
Project Engineer

Figure 1: Prominent Discrete Tone

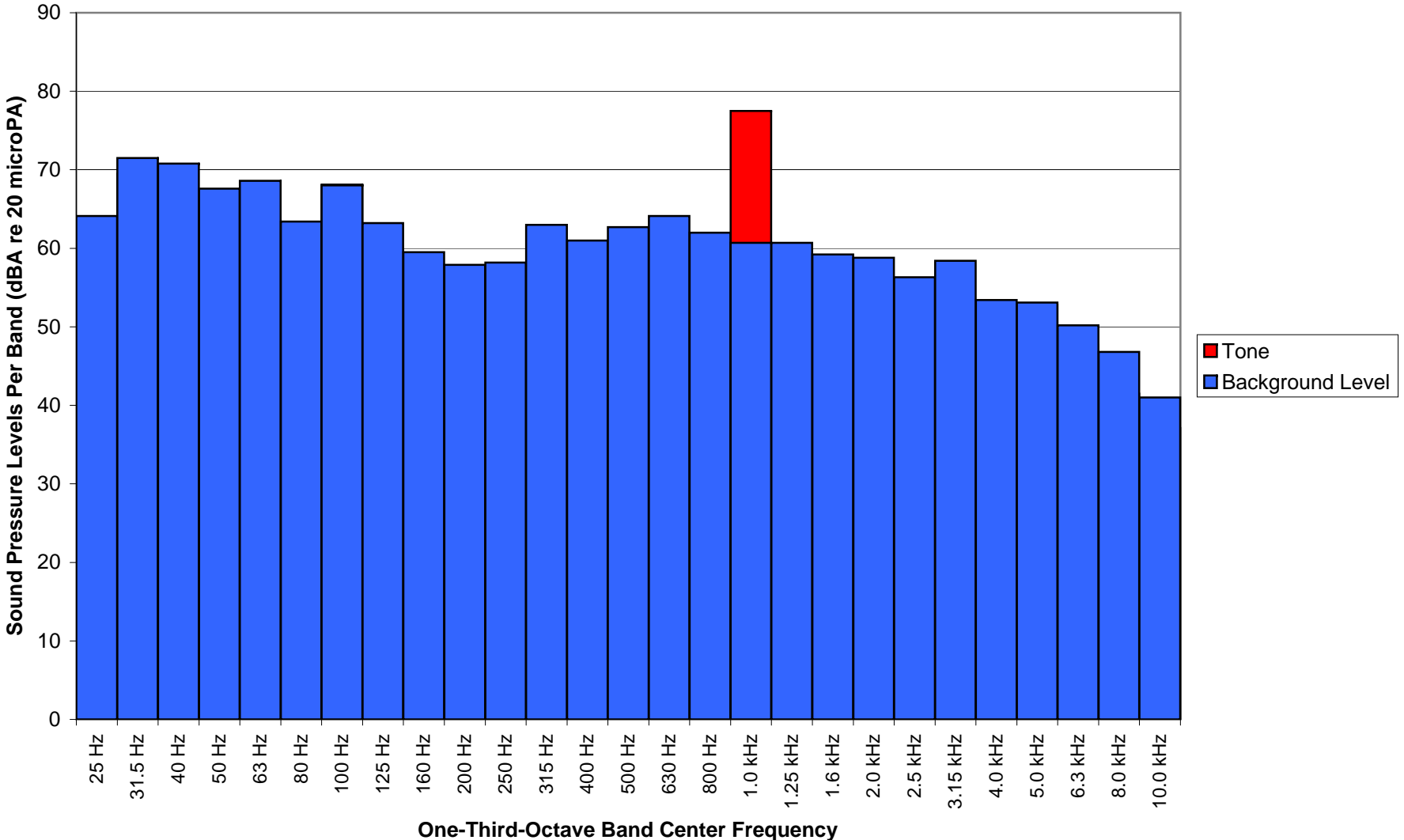
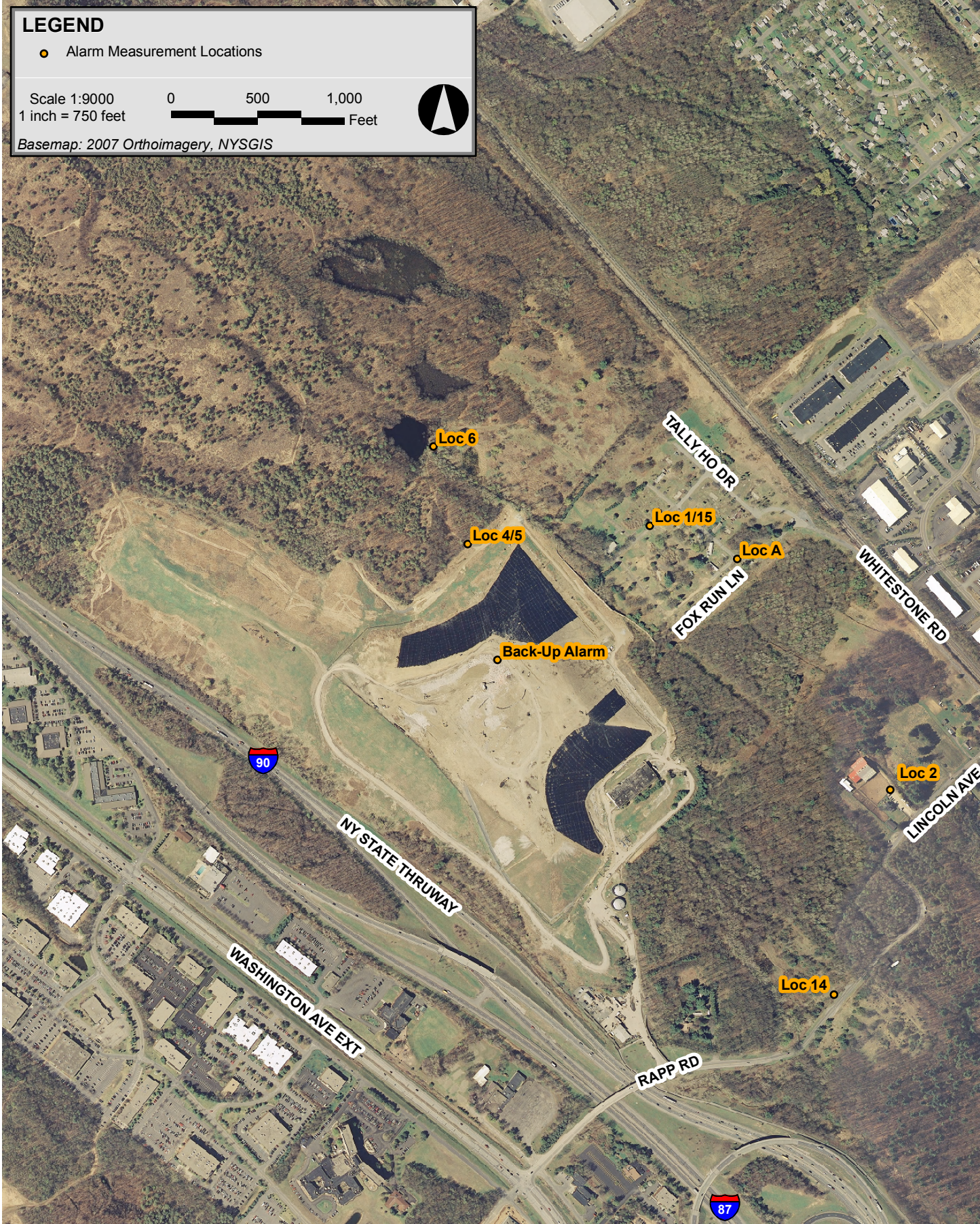


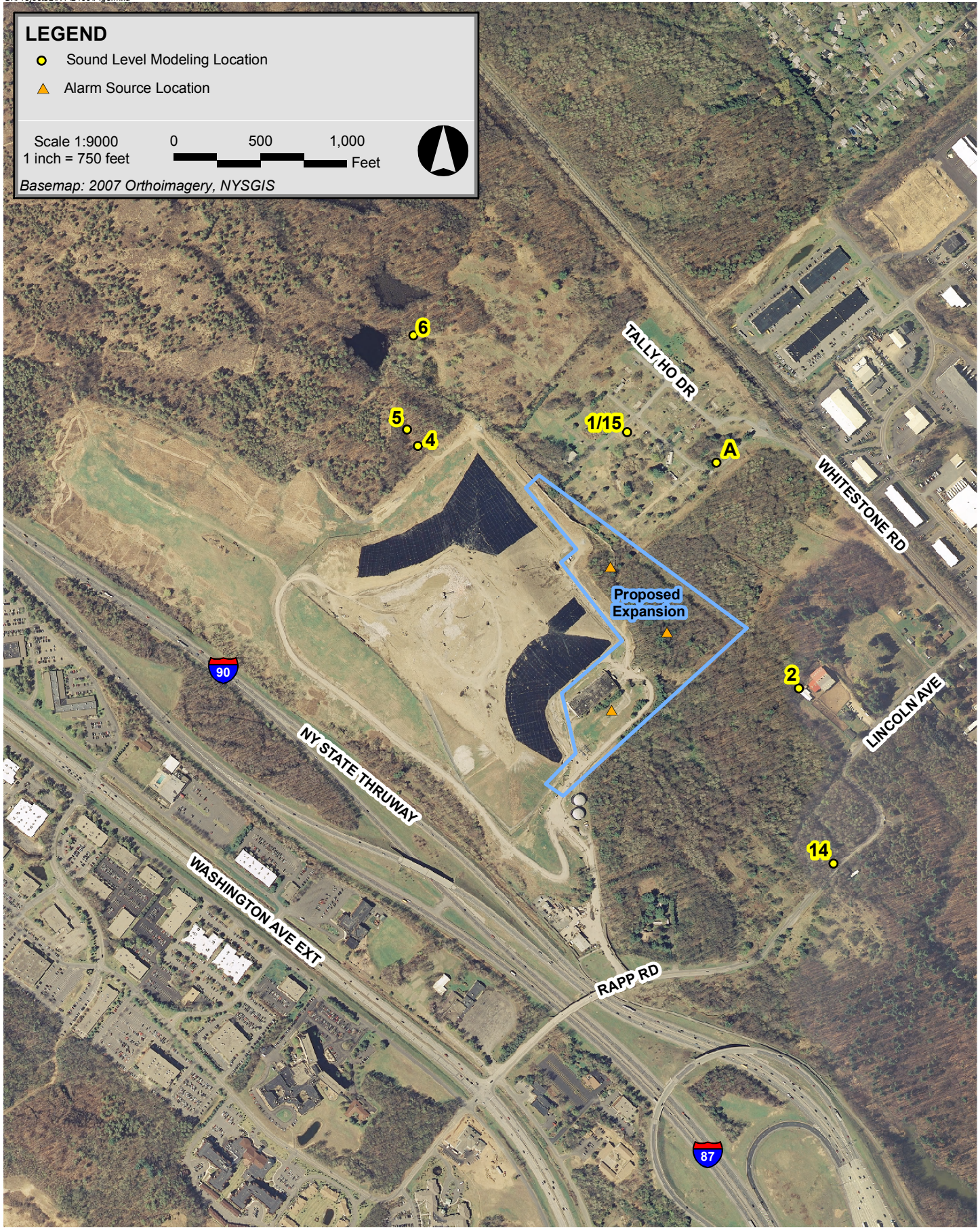
Table 2
Rapp Road Landfill Back-Up Alarm Measurements
Albany, NY
25-Jun-08

Loc.	Overall L _{eq} Sound Level	25 Hz	31.5 Hz	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1.0 kHz	1.25 kHz	1.6 kHz	2.0 kHz	2.5 kHz	3.15 kHz	4.0 kHz	5.0 kHz	6.3 kHz	8.0 kHz	10.0 kHz
	(dBA)	(dB)	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
1/15	57	59	59	57	56	62	53	55	58	65	54	46	51	48	50	48	48	47	46	44	42	39	37	35	33	29	26	23
A	55	53	54	52	51	54	50	52	56	60	51	45	50	46	48	46	46	47	46	43	40	37	33	31	34	26	19	16
2	52	56	56	55	56	56	56	57	57	59	49	43	44	43	44	45	41	40	39	36	33	33	34	33	29	26	23	19
14	54	60	61	60	58	58	61	54	51	49	47	45	46	47	48	46	47	47	44	41	36	32	28	25	25	20	16	20
4/5	48	52	56	56	54	61	50	50	48	48	42	39	41	37	37	35	36	35	33	32	31	31	34	32	42	31	25	24
6	47	53	52	50	47	52	46	48	41	42	39	34	39	37	40	39	36	36	36	35	31	32	34	34	32	30	28	25



Albany Landfill Albany, NY

Figure 2
Rapp Road Landfill Back-Up
Alarm Measurements



Albany Landfill Albany, NY

Table 6

"Prominent Discrete Tone" Calculation for Three One-Third-Octave Bands

Loc.	800 Hz	1.0 kHz	1.25 kHz	1.6 kHz	2.0 kHz	Sound Level Relative to Adjacent Bands	Prominent Discrete Tone?
	dB	dB	dB	dB	dB		
1/15	48	45	46	44	42	-1	No
A	46	44	46	43	40	-2	No
2	41	45	39	36	33	5	Yes
14	47	38	44	41	36	-7	No
4/5	36	36	33	32	31	1	No
6	36	38	36	35	31	1	No

Loc.	800 Hz	1.0 kHz	1.25 kHz	1.6 kHz	2.0 kHz	Sound Level Relative to Adjacent Bands	Prominent Discrete Tone?
	dB	dB	dB	dB	dB		
1/15	48	47	42	47	42	-5	No
A	46	47	41	46	40	-6	No
2	41	40	42	47	33	-2	No
14	47	47	35	40	36	-8	No
4/5	36	35	33	38	31	-3	No
6	36	36	35	40	31	-3	No

Loc.	800 Hz	1.0 kHz	1.25 kHz	1.6 kHz	2.0 kHz	Sound Level Relative to Adjacent Bands	Prominent Discrete Tone?
	dB	dB	dB	dB	dB		
1/15	48	47	42	47	42	5	Yes
A	46	47	41	46	40	5	Yes
2	41	40	42	47	33	9	Yes
14	47	47	35	40	36	5	Yes
4/5	36	35	33	38	31	6	Yes
6	36	36	35	40	31	7	Yes