



September 2, 2010

To: Mr. Michael R. Hobbs mhobbs@sugarlandtx.gov
Director of Public Works 281-275-2450 (tel.)
City of Sugar Land 281-275-2355 (dir.)
P.O. Box 110 281-642-1720 (cell)
Sugar Land, Texas 77487 281-275-2465 (fax)

From: Ashton Taylor
HFP Acoustical Consultants Inc.

Re: Predicted Sound Levels for the new
Minor League Ballpark, Sugar Land, Texas
HFP File No. 7126-1

TECHNICAL MEMORANDUM

This Technical Memorandum presents the results of acoustical modeling of predicted sound levels in nearby neighborhoods due to crowd noise, stadium public address system, and concert sound systems from the proposed minor league ballpark. The baseball stadium will be located near U.S. Highway 90A and State Highway 6.

MEASURED BACKGROUND SOUND LEVELS

To determine existing background sound levels, sound monitors were placed at three locations in the vicinity of the proposed ballpark. The monitors were in place from Thursday, August 12, 2010 through Monday, August 16, 2010. The three monitor locations are shown in Figure 1 and are as follows:

- Location 1: 2700 ft E of Ballpark by park (29° 37' 25.10" N, 95° 38' 17.45" W)
- Location 2: 2900 ft NE of Ballpark by residence (29° 37' 41.20", 95° 38' 19.70" W)
- Location 3: 1200 ft S of Ballpark by old bridge (29° 37' 13.50", 95° 38' 51.00" W)

The following sounds were heard during the sound monitor set-up:

- Location 1: Include insects (cicadas), traffic on Ulrich St., trains, and aircraft
- Location 2: Lawn maintenance equipment and aircraft
- Location 3: Vehicle traffic on State Highway 6 and insects

6001 Savoy Drive, Suite 115
Phone: 713.789.9400

Houston, Texas 77036
Fax: 713.789.5493

#1140, 10201 Southport Road S.W.
Phone: 403.259.6600

Calgary, Alberta, Canada T2W 4X9
Fax: 403.259.6611



Figure 1 – Sound Monitor Locations

During the sound monitoring period, the temperature ranged from 79° F to 100° F, the relative humidity ranged from 48% to 91%, the wind ranged from 0 mph (calm) to 8 mph mostly from the south, and the sky was partly cloudy to overcast.

The hourly A-weighted average background sound levels (L_{eq}) for each location are as follows:

<u>DATE</u>	<u>HOURLY</u>	<u>HOURLY L_{eq}</u>	<u>HOURLY L_{eq}</u>	<u>HOURLY L_{eq}</u>
		<u>LOC-1</u>	<u>LOC-2</u>	<u>LOC-3</u>
Aug 12	12:00	51.1	51.1	55.7
	13:00	50.3	51.5	55.2
	14:00	47.6	49.4	50.7
	15:00	48.5	50.3	55.1
	16:00	49.8	53.8	54.2
	17:00	51.9	53.0	51.7
	18:00	51.1	50.4	53.3
	19:00	55.0	53.5	56.7
	20:00	50.9	52.6	59.1
	21:00	52.2	55.9	57.6
	22:00	49.2	60.4	56.4
	23:00	47.7	58.6	55.1

<u>DATE</u>	<u>HOUR</u>	<u>HOURLY L_{eq}</u> <u>LOC-1</u>	<u>HOURLY L_{eq}</u> <u>LOC-2</u>	<u>HOURLY L_{eq}</u> <u>LOC-3</u>
Aug 13	0:00	46.5	56.2	54.8
	1:00	50.8	55.5	57.4
	2:00	49.4	56.1	53.9
	3:00	47.0	56.4	53.1
	4:00	48.6	56.1	54.2
	5:00	54.1	56.4	58.3
	6:00	52.7	55.1	55.2
	7:00	53.8	57.3	55.5
	8:00	54.0	56.0	53.3
	9:00	51.1	59.1	53.5
	10:00	49.3	53.1	54.7
	11:00	50.9	53.1	56.0
	12:00	52.2	52.3	56.2
	13:00	50.0	49.7	52.9
	14:00	52.6	49.3	55.7
	15:00	52.0	48.5	56.3
	16:00	52.3	50.5	56.1
	17:00	53.9	55.5	57.7
	18:00	54.5	67.0	56.7
	19:00	51.8	65.5	57.8
	20:00	51.9	52.2	58.7
	21:00	54.3	55.4	57.5
	22:00	51.5	59.4	56.1
23:00	56.3	60.0	57.1	
Aug 14	0:00	58.2	56.3	60.4
	1:00	52.1	55.8	55.4
	2:00	47.5	55.7	59.4
	3:00	51.7	56.7	58.1
	4:00	48.0	55.7	59.6
	5:00	46.8	54.7	55.6
	6:00	51.6	56.1	55.8
	7:00	50.6	56.9	55.0
	8:00	51.4	54.9	54.0
	9:00	51.9	54.4	55.2
	10:00	51.9	53.4	56.3
	11:00	53.3	54.3	56.8
	12:00	51.1	54.5	55.4
	13:00	50.1	50.9	55.5
	14:00	50.5	47.3	55.2
	15:00	54.2	52.0	56.5
	16:00	50.5	53.6	54.4
	17:00	49.6	53.4	55.0
	18:00	51.6	54.8	55.0
	19:00	56.4	53.3	56.2
	20:00	55.2	50.8	57.0
	21:00	51.9	53.5	56.8
	22:00	51.0	58.3	58.2
23:00	50.6	59.8	56.2	

<u>DATE</u>	<u>HOUR</u>	<u>HOURLY L_{eq}</u>		
		<u>LOC-1</u>	<u>LOC-2</u>	<u>LOC-3</u>
Aug 15	0:00	51.1	57.8	57.3
	1:00	47.3	56.5	53.7
	2:00	49.4	57.0	55.2
	3:00	50.2	57.3	56.3
	4:00	49.0	56.7	55.7
	5:00	50.5	56.1	64.8
	6:00	49.6	54.8	59.7
	7:00	48.8	55.2	50.8
	8:00	49.4	55.9	52.1
	9:00	48.4	53.1	53.3
	10:00	48.4	54.1	53.6
	11:00	49.1	51.5	53.6
	12:00	50.5	52.5	53.7
	13:00	55.6	49.3	56.7
	14:00	48.5	47.7	53.4
	15:00	51.3	48.5	53.3
	16:00	51.2	51.6	57.4
	17:00	48.5	52.0	52.8
	18:00	64.0	51.0	54.2
	19:00	49.7	52.6	55.2
	20:00	48.8	52.1	57.3
	21:00	47.7	54.2	56.5
	22:00	45.4	58.8	62.1
23:00	47.1	60.5	60.1	
Aug 16	0:00	50.6	57.3	54.3
	1:00	45.4	55.3	53.3
	2:00	44.1	55.6	52.6
	3:00	41.9	55.4	51.3
	4:00	44.1	55.5	53.8
	5:00	49.0	57.1	58.8
	6:00	47.6	56.6	59.9
	7:00	48.5	57.3	56.4
	8:00	47.5	57.0	58.5
	9:00	46.9	53.5	---
	10:00	48.0	---	---
11:00	47.8	---	---	

At Location 1 on August 15 during the 18:00 hour, the sound monitor equipment was tampered with and vandalized. The microphone support pole and microphone windscreen were stolen. The rest of the system was left intact and it continued to record data. However, from that point on, the data at that location is suspect, even though it shows similar levels to the previous days.

Nine graphs that show the minute-by-minute sound levels throughout the day are attached to this document. For each location, there are three graphs, each covering a time period of 24 hours beginning at noon. The three time periods are as follows:

12:00 noon August 12 through 12:00 noon August 13
12:00 noon August 13 through 12:00 noon August 14
12:00 noon August 14 through 12:00 noon August 15

Because the data was possibly corrupt at Location 1, the graphs do not cover the final period.

The background sound levels during evening baseball games were determined by averaging the sound levels from the first three days during the evening hours from 6:00 P.M. until 10:00 P.M. This resulted in an average background sound level during evening game times of 53 dB(A).

PREDICTED SOUND LEVELS IN NEIGHBORHOOD DUE TO BALLPARK ACTIVITIES

To determine the sound levels in the closest neighborhood, a three-dimensional computer noise model was constructed to analyze the noise contributions expected from activities in the ballpark. The model was developed using CadnaA, version 4.0.135, a commercial noise modeling package developed by DataKustik GmbH. The software takes into account spreading losses, ground and atmospheric effects, shielding from barriers and buildings, reflections from surfaces, and other sound propagation properties. The software is based on published engineering standards. The ISO 9613 standard was used for air absorption and other noise propagation calculations. A neutral atmosphere (typical of evening game times) with a slight downwind was assumed in the model.

The sounds modeled were from the following activities:

- 7500 fans cheering or shouting at the same time
- The ballpark permanent public address system making announcements
- A large sound reinforcement system in operation for a concert event

There are standard sound levels for talker vocal efforts. These vocal effort ranges are rated (low to high) as Casual, Normal, Raised, Loud, and Shout. The levels and spectra are different for male and female talkers. For the acoustical model, the Shout vocal effort was assumed from 7500 people, half of whom were women and the other half men (we do not have children sound data). Of course, this sound level will only happen a few times each game, and in some games, it is never reached. Figure 1, attached to this document, is an aerial view of the site with the ballpark superimposed. The A-weighted sound level contour lines show the levels during crowd cheering or shouting. Each contour line represents a 1-decibel reduction in level with increasing distance from the ballpark. The contours at 75 dB(A), 65 dB(A), and 55 dB(A) are shown bold and are labeled. The nearest residential property line is at 62 dB(A) during crowd cheering.

The ballpark public address system is assumed to be a distributed sound system capable of full-range sound. The system is assumed to have no subwoofers. The loudspeakers in the model were mounted at/under the eaves of the roof above the sky boxes. This resulted in some sound reflecting off the glass of the sky boxes. Also, to cover the lower stands, the loudspeakers had to

be aimed outward in the direction of the neighborhood. The sound levels in the stands were assumed to be 100 dB(A) during P.A. System announcements. This resulted in a predicted sound level of 75 dB(A) at the nearest residential property line. It is quite possible that the P.A. system can be operated at a lower level, say 90 dB(A) in the stands. If that is the case, the P.A. system sound level contribution in the neighborhood would be 65 dB(A). While the P.A. system will operate frequently, it is mostly expected to be short announcements at speech frequencies with pauses between.

Using the ballpark for concert events will undoubtedly result in disturbances for the residences of the nearest neighborhood. Each touring musical act will bring powerful sound systems which usually have large line array loudspeaker systems with subwoofers. For the acoustical model, the stage is assumed to be in the vicinity of second base with the loudspeakers aimed to cover the seating which is mostly in the opposite direction of the neighborhood. Even though the loudspeakers are oriented away from the neighborhood, line arrays have strong low frequency emission off the rear of the array and subwoofers are usually omnidirectional. This results in a sound in the neighborhood that is mostly low frequency in nature. If the sound level is 105 dB(A) in the ballpark seating, the level in the neighborhood is expected to be 76 dB(A). Unlike the baseball game P.A. system, the concert sound will be almost continuous for significant time periods. Additionally, buildings and houses do not provide good sound isolation for the low frequency sounds transmitted by the concert sound system.

A fourth sound source was considered, but not run through the Cadna-A model: fireworks displays. The firework shows are expected to last 8 – 10 minutes and they will occur 18 – 25 times per year. In the initial show description, 2000 shells are expected to be used. The following quantities of shells by size are as follows:

1500	1-inch to 2-inch shells
140	2.5-inch shells
300	3-inch shells
60	4-inch shells

In recent discussions, we understand the 4-inch shells will not be used because of concerns regarding the nearby airport. For these calculations, we modeled 360 3-inch shells. To arrive at a model, we assume that the firework shells are approximately spherical and that the volumes of the spheres correspond to the shell “firepower” and hence relative acoustical power. The approximate interior volumes of the shells are as follows:

1-inch shell:	0.3 cubic inch	Base dB level
2-inch shell:	3 cubic inches	+10 dB over base level
2.5-inch shell:	6 cubic inches	+13 dB over base level
3-inch shell:	11 cubic inches	+16 dB over base level

For a 10-minute fireworks show, there are 600 seconds of total time. If 2000 shells are used, the average time between shells is $600/2000 = 0.3$ second, or 3.33 shells per second. The ANSI standard rise time for impulse response is 35 ms (0.035 s). The background sound is assumed to be 53 dB(A). If the largest (3-inch) shell results in an impulse sound level of 80 dB(A) at the

nearest neighborhood, then the levels of the other shells would be 64 dB(A) (1-inch), 74 dB(A) (2-inch), and 77 dB(A) (3-inch). The following table gives the quantity, size, assumed dB(A) level in the neighborhood, the time of each shot, and the total time for each shell type. The last line is the background sound level which occurs in between each shot.

<u>Quan.</u>	<u>Size</u>	<u>Level</u>	<u>Time per Shot</u>	<u>Total Time</u>
750	1-inch shells	64 dB(A)	0.035 s	26.25 s
750	2-inch shells	74 dB(A)	0.035 s	26.25 s
140	2.5-inch shells	77 dB(A)	0.035 s	4.90 s
360	3-inch shells	80 dB(A)	0.035 s	12.60 s
---	none (bkgnd)	53 dB(A)		530.00 s

The average sound level with these estimated shot sound levels will be 66 dB(A), or 14 dB(A) lower than the loudest shells. We do not anticipate noise complaint problems with fireworks shows. This is because the average sound levels are not too high and the duration of the show is short.

CONCLUSION

In summary, we do not anticipate that crowd noise, the ballpark P.A. system, or the fireworks shows will result in many complaints. If high-energy concert events are planned for the ballpark, neighborhood complaints will probably be lodged. A spectrum graph of the sounds of the crowd, P.A. system, concert sound system, and background sound is attached to this document. Please call if you have any questions.

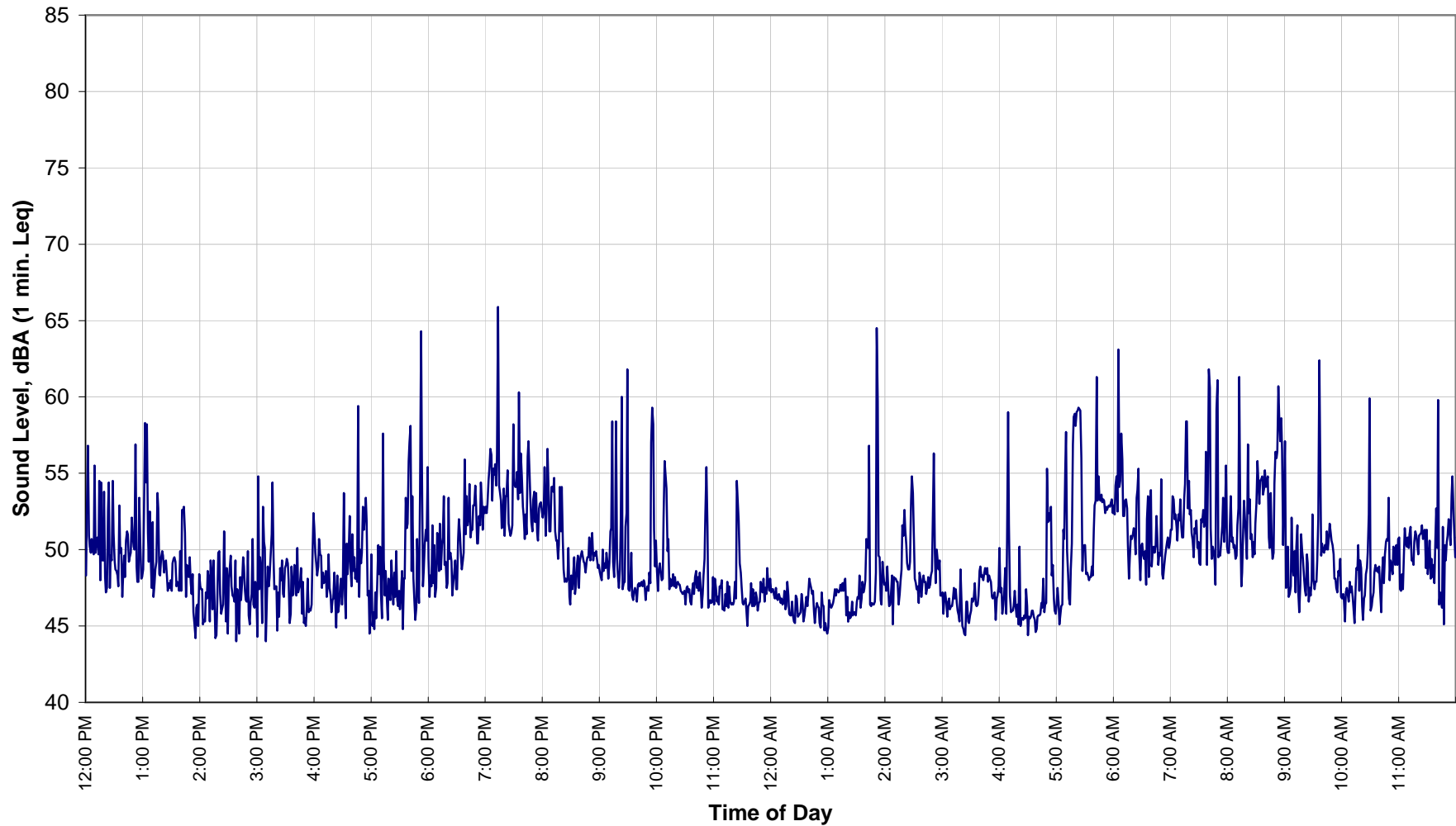
Sincerely,
HFP Acoustical Consultants Inc.



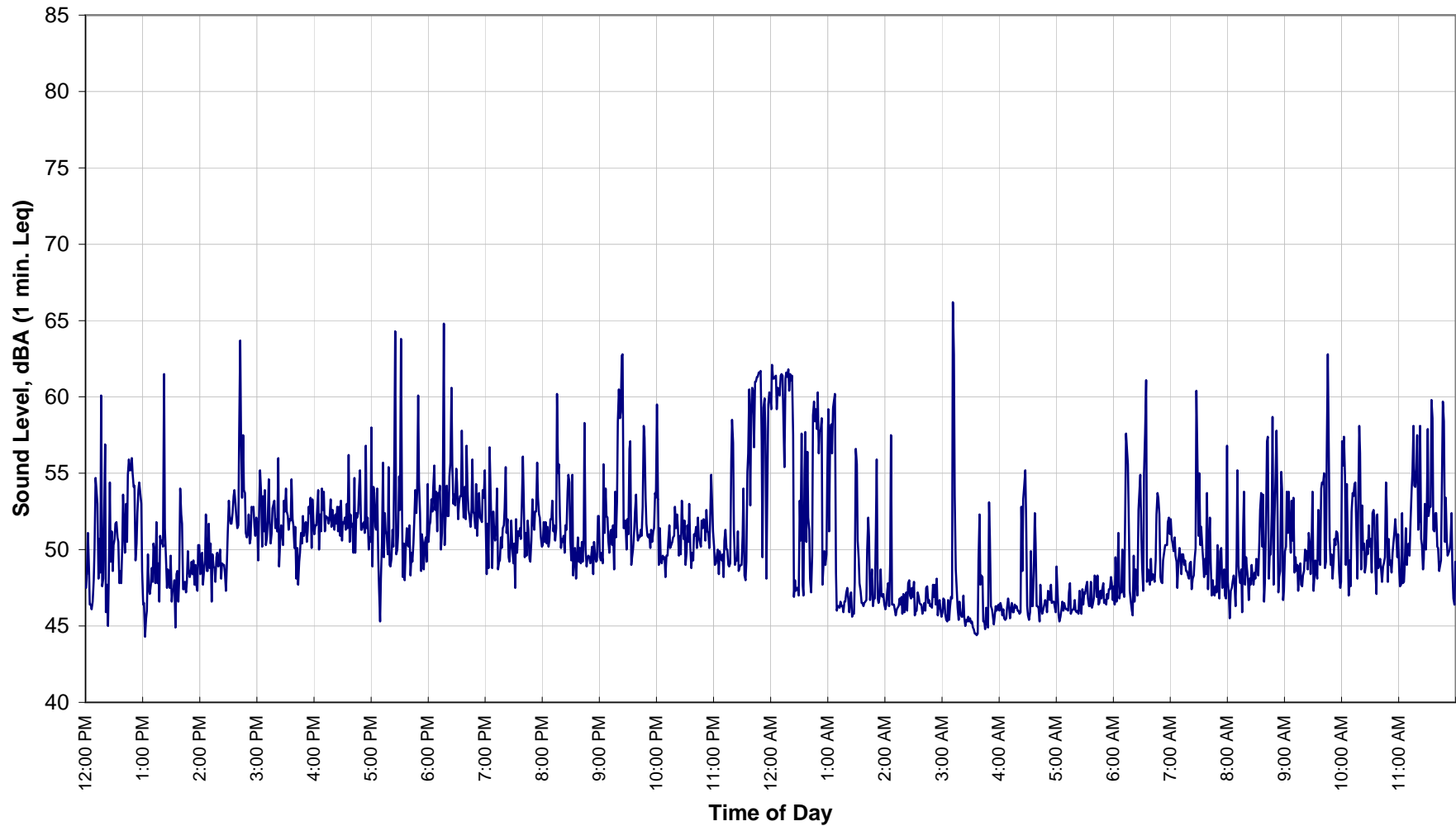
Ashton Taylor
Senior Project Consultant

Attachments: Sound Level By Time Graphs (9 pages)
 Figure 1 – Cadna-A Model Sound Level Contour Map
 Spectrum Graph of Sound Levels

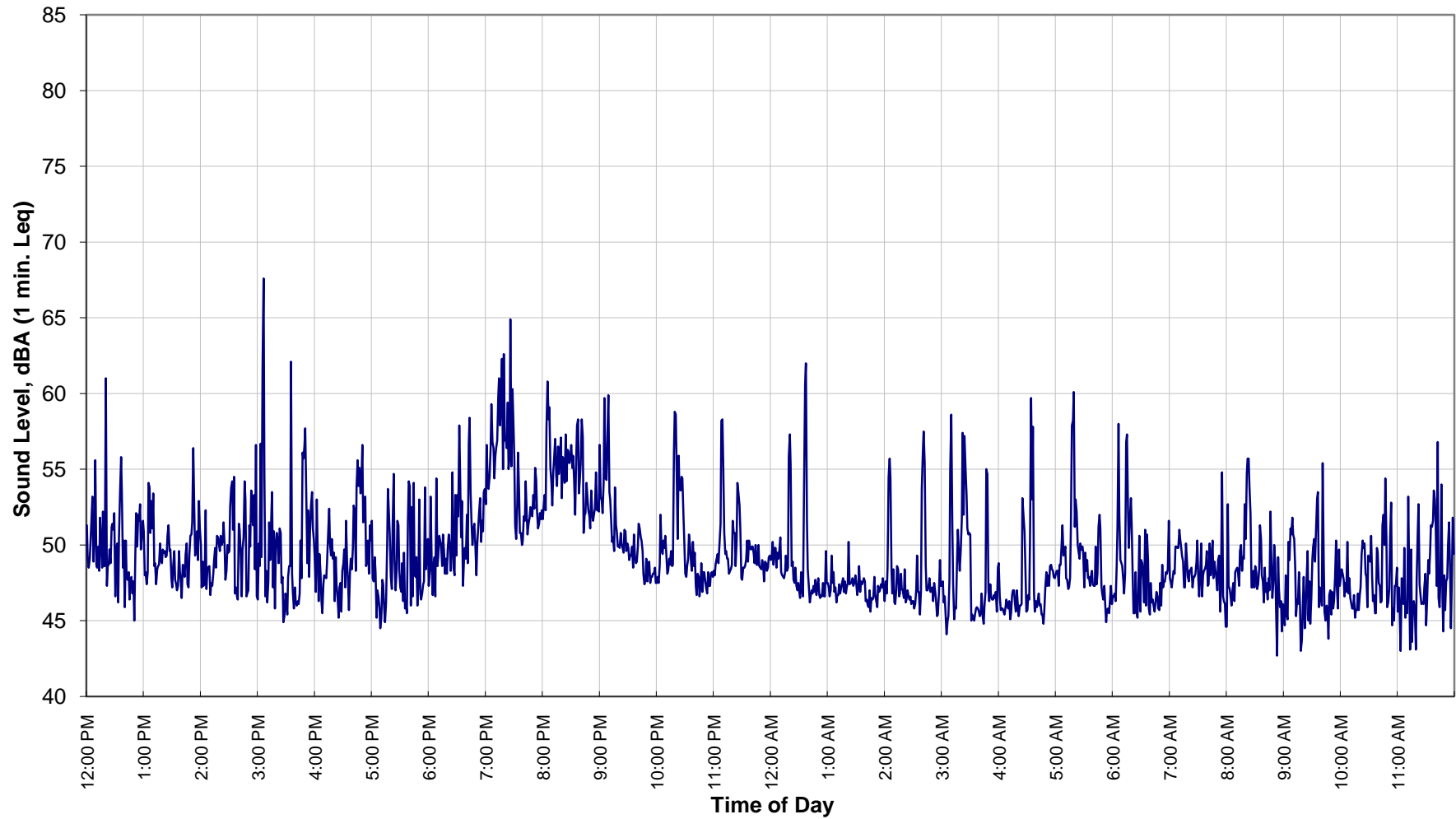
City of Sugarland
Minor League Baseball Stadium
Location 1 - **(Day 1)** August 12, 2010 through August 13, 2010



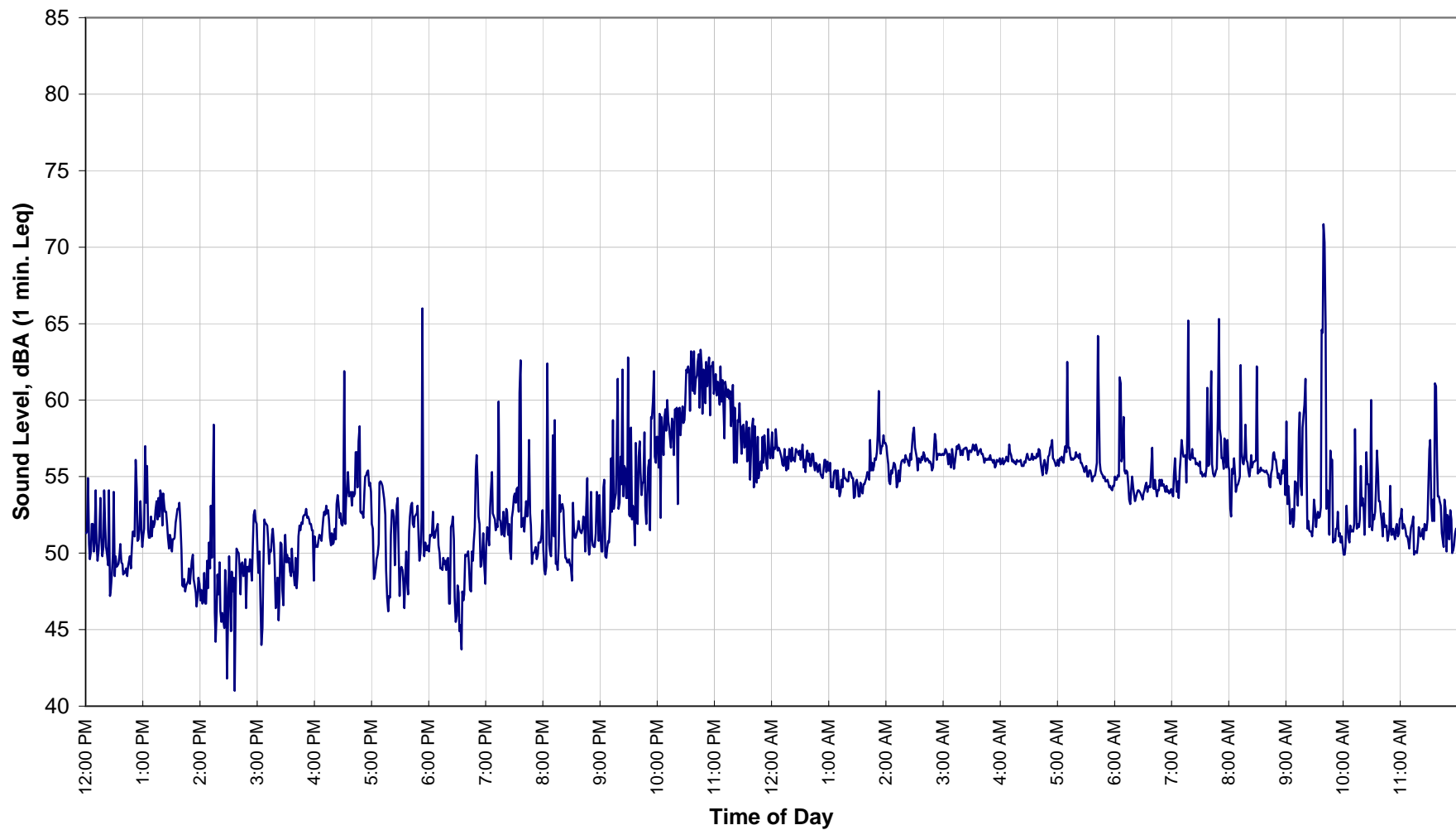
City of Sugarland
Minor League Baseball Stadium
Location 1 - **(Day 2)** August 13, 2010 through August 14, 2010



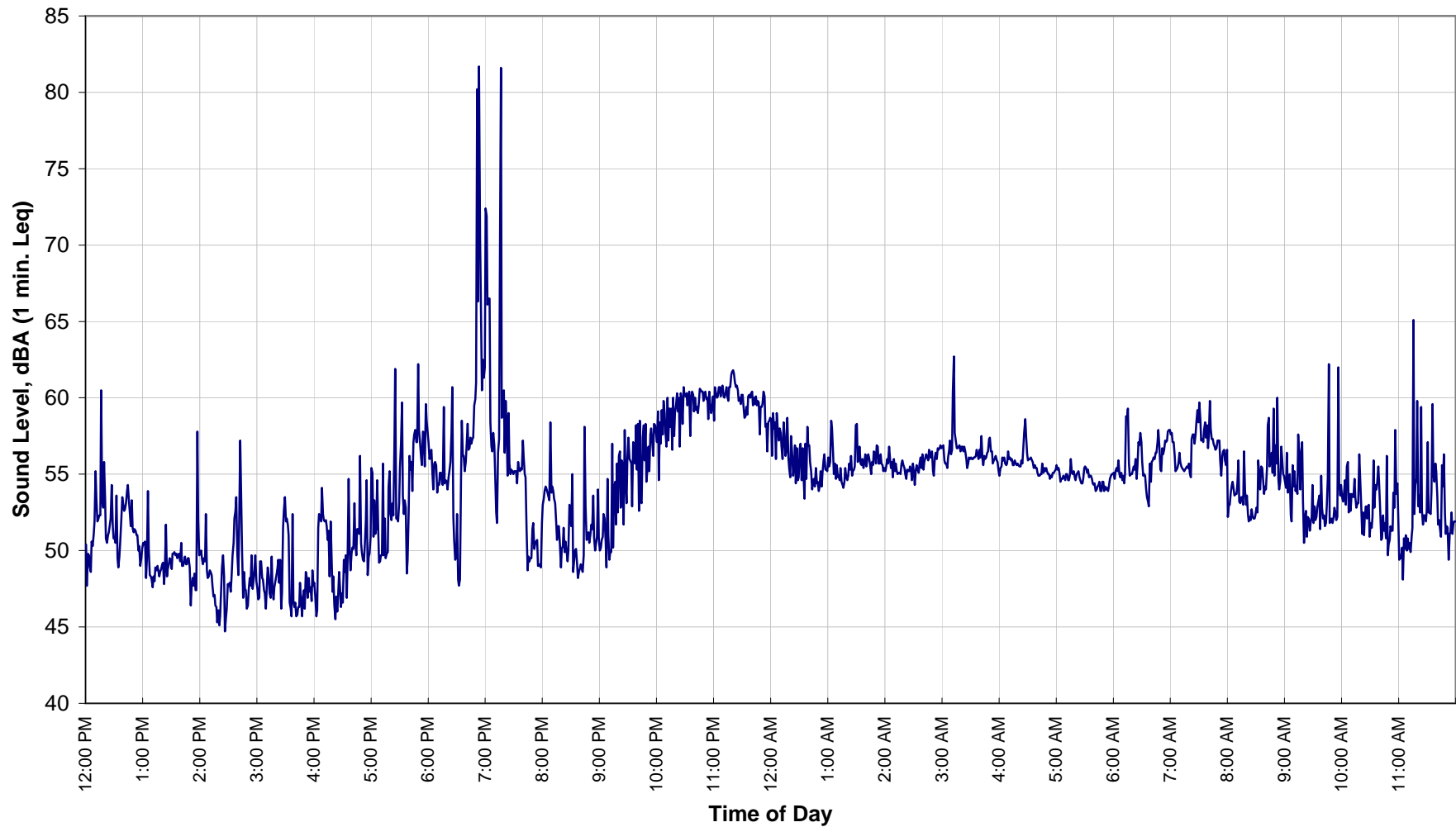
City of Sugarland
Minor League Baseball Stadium
Location 1 - **(Day 3)** August 14, 2010 through August 15, 2010



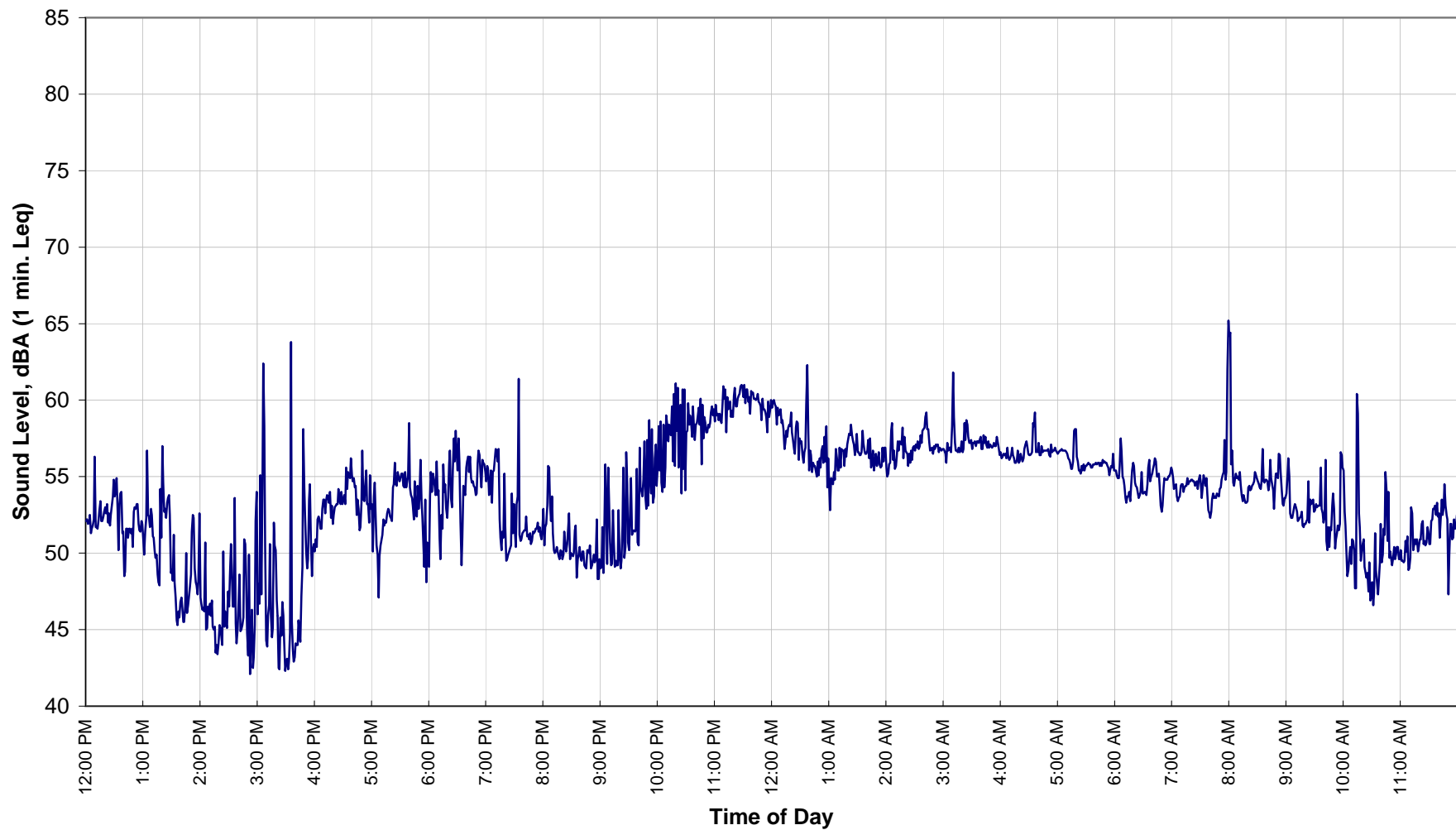
City of Sugarland
Minor League Baseball Stadium
Location 2 - **(Day 1)** August 12, 2010 through August 13, 2010



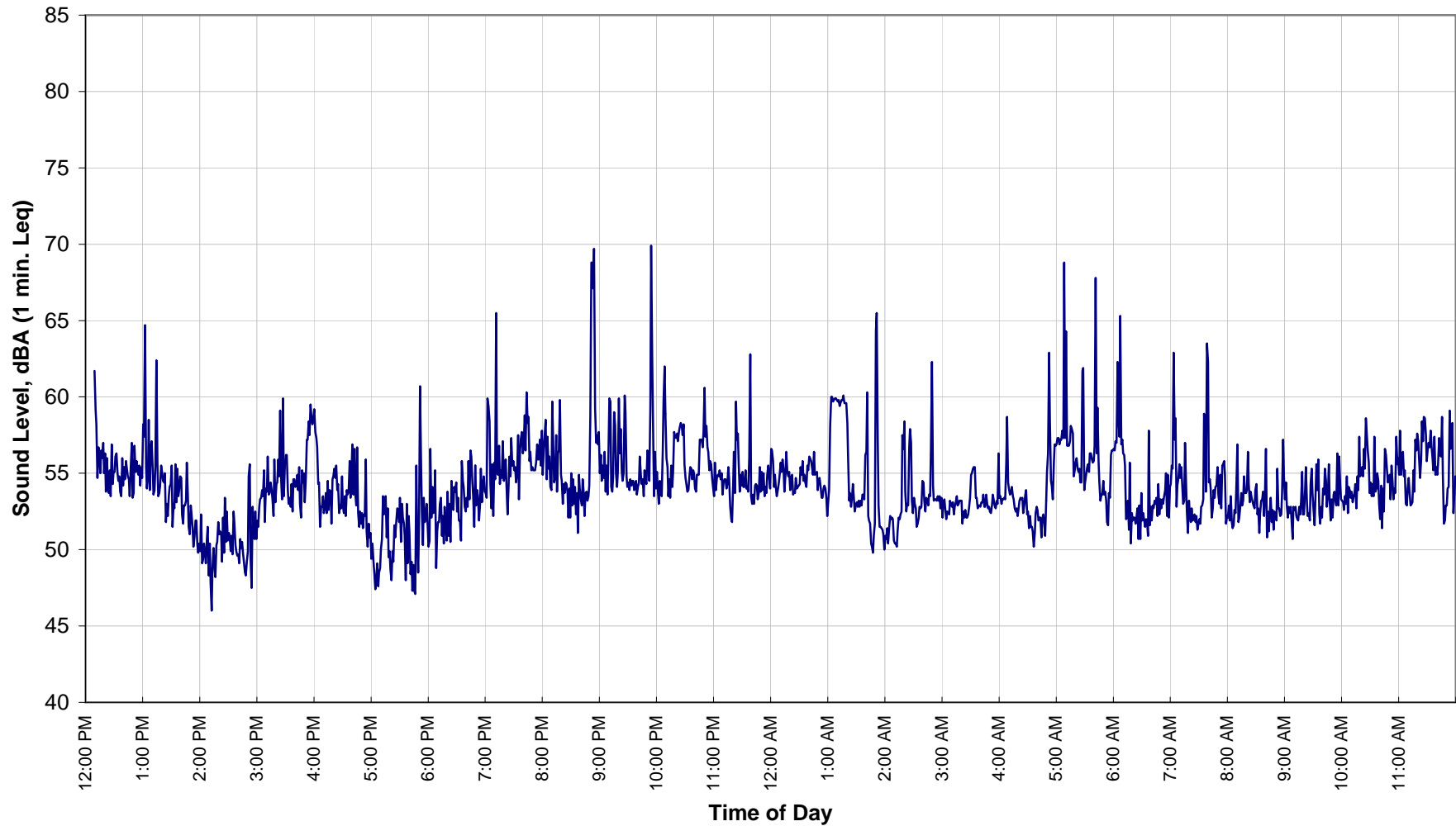
City of Sugarland
Minor League Baseball Stadium
Location 2 - **(Day 2)** August 13, 2010 through August 14, 2010



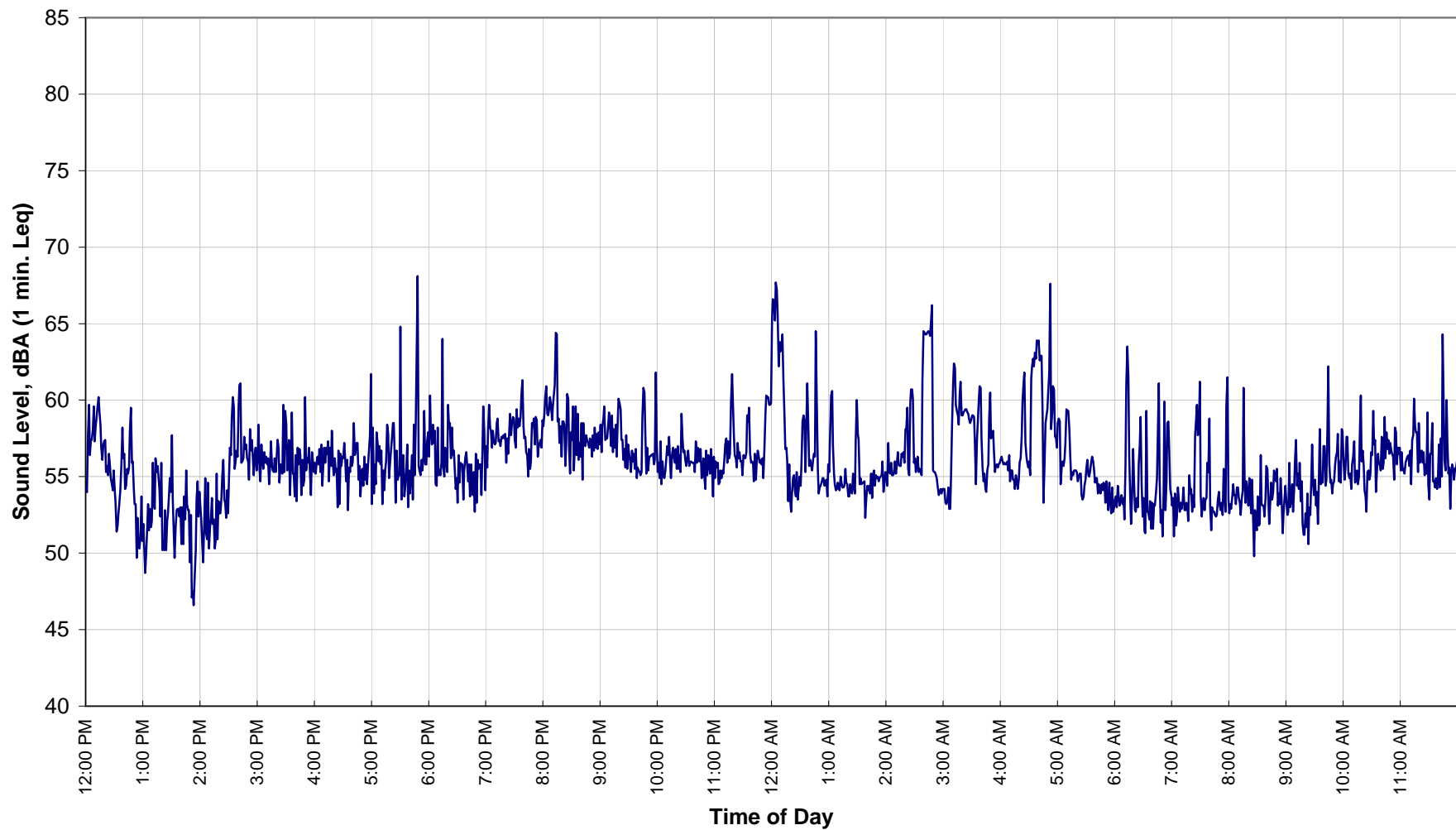
City of Sugarland
Minor League Baseball Stadium
Location 2 - **(Day 3)** August 14, 2010 through August 15, 2010



City of Sugarland
Minor League Baseball Stadium
Location 3 - **(Day 1)** August 12, 2010 through August 13, 2010



City of Sugarland
Minor League Baseball Stadium
Location 3 - **(Day 2)** August 13, 2010 through August 14, 2010



City of Sugarland
Minor League Baseball Stadium
Location 3 - **(Day 3)** August 14, 2010 through August 15, 2010

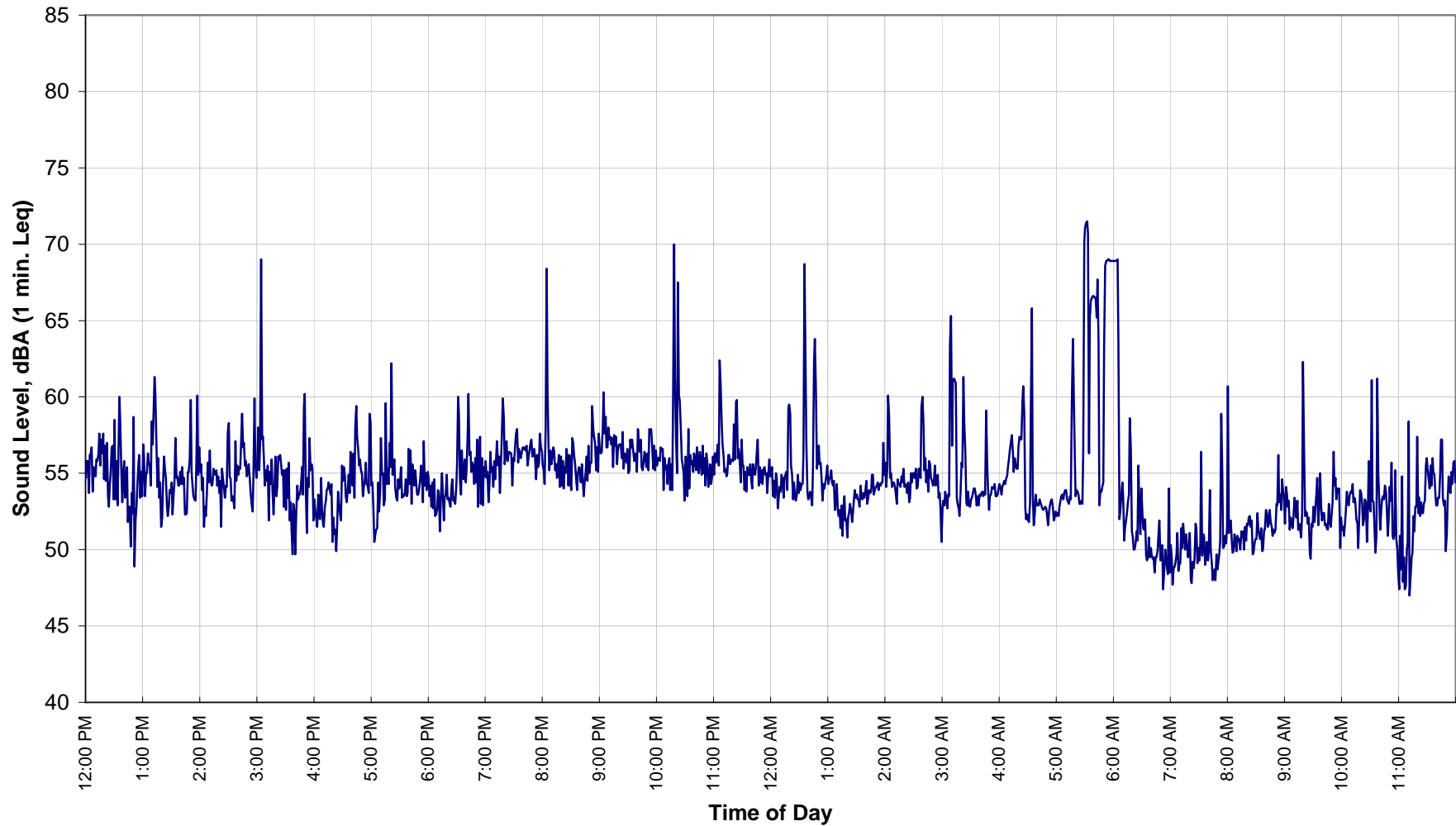
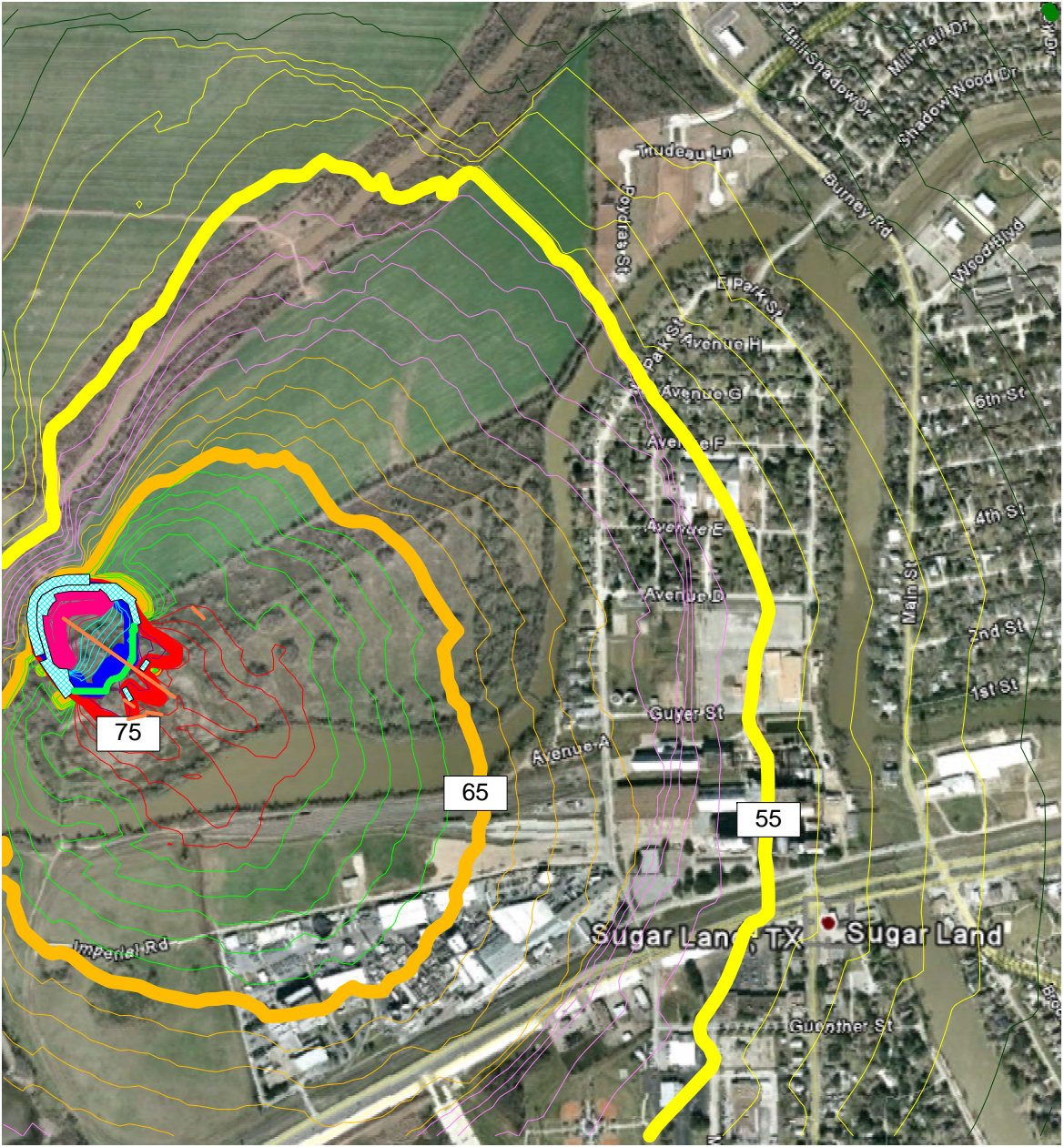


FIGURE 1: Planned Sugar Land Baseball Stadium Preliminary Sound Level Model



[Lightest color swatch]	> 40.0 dB(A)
[Light color swatch]	> 45.0 dB(A)
[Lighter color swatch]	> 50.0 dB(A)
[Light yellow color swatch]	> 55.0 dB(A)
[Yellow color swatch]	> 60.0 dB(A)
[Orange color swatch]	> 65.0 dB(A)
[Red-orange color swatch]	> 70.0 dB(A)
[Red color swatch]	> 75.0 dB(A)
[Dark red color swatch]	> 80.0 dB(A)
[Dark red color swatch]	> 85.0 dB(A)
[Darkest color swatch]	> 90.0 dB(A)

Color Scale in dB(A)

Predicted Sound Levels at Nearest Residences

