Sam Houston Tollway
Traffic Noise Analysis

From US 290 to SH 249
Harris County, Texas

Prepared for:

HARRIS COUNTY TOLL ROAD AUTHORITY

Prepared by:

KBR

May 2008

Contents

Tables

1.0 SUMMARY

This document discusses and describes the potential for noise effects from the Sam Houston Tollway from United States Highway (US) 290 to State Highway (SH) 249. The Harris County Toll Road Authority (HCTRA) received comments from the residents of the area concerning the existing noise levels. As a result of the public comments, HCTRA is completing this study to determine actual noise levels, model future noise levels, and to suggest additional traffic noise mitigation measures. This report does not include final design and engineering of traffic noise mitigation, including noise barriers.

Sound level measurements were taken to establish existing noise levels and to calibrate the model results. The Federal Highway Administration (FHWA) approved Traffic Noise Model (TNM 2.5 computer model) was used to predict potential noise impacts based on 2008 and 2028 traffic volumes.

Existing and predicted traffic noise levels were modeled at adjacent receiver locations. These receiver locations represent the land use activity areas adjacent to the facility that might be impacted by traffic noise and could potentially benefit from feasible and reasonable noise abatement. After analyzing the data, including the addition of one lane in each direction, the facility is not expected to produce a perceptible change in traffic noise levels that a typical person would hear; nonetheless, noise abatement consideration was still investigated.

Before any noise abatement measure can be incorporated, it must be both feasible and reasonable. Feasibility issues were considered in proposed mitigation; however, a full evaluation of the feasibility and reasonableness is not included in this report.

2.0 INTRODUCTION

This document discusses and describes the potential for noise effects from the Sam Houston Tollway from US 290 to SH 249 in Harris County, Texas.

Noise is often defined as unwanted sound. Highway vehicle noise is primarily composed of engine exhaust, drive train, tire-roadway interaction and vehicle aerodynamics. Sound is a very subjective concept, and degrees of sound disturbance depend on several things; the amount and nature of the intruding noise, the relationship between the background noise and intruding noise, the type of activity where the noise is heard, and the time of day.

The traffic noise modeling conforms to the FHWA Regulation 23 CFR 772.17, *Procedures for Abatement of Highway Traffic Noise and Construction Noise: Traffic Noise Prediction*.

3.0 BACKGROUND AND CURRENT STATUS

Development of the Sam Houston Tollway/Beltway 8 facility was planned and designed by the HCTRA and Texas Department of Transportation (TxDOT). A traffic noise analysis was completed by TxDOT during the planning and design process that met the requirements of the Nation Environmental Policy Act. The traffic noise mitigation recommended in that analysis included the traffic noise barriers in their current location for Jersey Village and Windfern Forest traffic noise receivers. A copy of this traffic noise analysis was made available to the public to ensure, to the maximum extent possible, that future developments near the project were planned, designed, and programmed in a manner that would avoid traffic noise impacts.

HCTRA received comments from the residents of the area concerning the traffic noise levels from the Sam Houston Tollway. As a result of the public comments, HCTRA is completing this study to determine actual noise levels in the area and to analyze additional traffic noise mitigation that could provide a benefit to residents. HCTRA will use this report to efficiently and effectively plan traffic noise mitigation for residents of the area. This report does not include final design and engineering of traffic noise mitigation, including noise barriers.

4.0 FUNDAMENTALS OF SOUND AND NOISE

Sound is created when an object moves; the rustling of leaves as the wind blows, the air passing through our vocal cords, the almost invisible movement of the speakers on a stereo. These movements cause vibrations of the molecules in the air to move in waves like ripples on water. When the vibrations reach our ears, we hear what we call sound.

Sound pressure levels are used to measure the intensity of sound and are described in terms of decibels. The decibel (dB) is a logarithmic unit which expresses the ratio of the sound pressure level being measured to a standard reference measure. Sound is composed of various frequencies, but the human ear does not respond to all frequencies. Frequencies to which the human ear does not respond must be filtered out when measuring highway noise levels, so an adjustment or weighting of high-pitched and low-pitched sounds is made to approximate average human perception. When such adjustments are made to the sound levels, they are called “A-weighted levels” and are labeled as “dBA”. Table 1 illustrates some of the more common A-weighted noise levels one might typically experience.

Table 1: Common Sound and Noise Levels

Outdoor	dBA	Indoor
Pneumatic hammer	100	Subway Train
Gas lawn mower at 3 ft		
	90	Food blender at 3 ft
Downtown (large city)	80	Garbage disposal at 3 ft
Lawn mower at 100 ft	70	Vacuum cleaner at 10 ft
		Normal speech at 3 ft
Air conditioning unit	60	Clothes dryer at 3 ft
Babbling brook		Large business office
Quiet urban (daytime)	50	Dishwasher (next room)
Quiet urban (nighttime)	40	Library

Source: TxDOT Guidelines for Analysis ans Abatement of Highway and Traffic Noise (Rev. 1997)

The dBA scale for measuring the intensity of sound is based on the logarithm or sound level pressure relative to a reference sound level pressure. Logarithmic scales are based on powers of ten, and are not linear. Because of this, sound level changes are hard to define. For example, if a sound of 60 dBA is added to another sound of 60 dBA, the result is 63 dBA and not 120 dBA.

The term loudness is used to describe the manner in which people perceive the intensity of sound. The loudness level is based on a subjective comparison of different sounds under controlled laboratory conditions. The human ear is a far better detector of relative (comparative) differences in sound levels than absolute levels. Table 2 depicts the relationship between changes in sound levels and the perceived changes in loudness. It has also been found by testing large numbers of people that a 10 dBA increase in the sound level is equivalent to a doubling of the sound level as heard by the human ear. This means that a sound level of 60 dBA sounds twice as loud as a sound level of 50 dBA.

Table 2: Sound Level Change vs. Loudness

Sound Level Change	Relative Loudness
2 dBA	No Perceptible Change
3 dBA	Barely Perceptible Change
5 dBA	Readily Perceptible Change
10 dBA	Perceived as Twice as Loud

The level of highway traffic noise is never constant; therefore, it is necessary to use a statistical descriptor to describe the varying traffic noise levels. The equivalent continuous sound level (Leq) is the statistical descriptor used in this report. The Leq sound level is the steady A-weighted sound energy, which would produce the same A-weighted sound energy over a stated period of time as a specified time-varying sound.

5.0 NOISE ABATEMENT CRITERIA

Title 23 of the Code of Federal Regulations Part 772 (23 CFR 772) defines traffic noise impacts as those "impacts which occur when predicted traffic noise levels approach or exceed the Noise Abatement Criteria, or when the predicted traffic noise levels substantially exceed the existing noise levels."

The FHWA has established Noise Abatement Criteria (NAC) for various land use activity areas that are used as one of two means to determine when a traffic noise impact would occur, as shown in Table 3.

Table 3: Noise Abatement Criteria

Activity Category	dBA Leq	Description of Land Use Activity Areas
A	57 (exterior)	Lands on which serenity and quiet are of extra-ordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries and hospitals.
C	72 (exterior)	Developed lands, properties or activities not included in categories A or B above.
D	--	Undeveloped lands.
E	52 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals and auditoriums.

Source: FHWA 23 CFR 772.
Note: Primary consideration is given to exterior areas (Category A, B or C) where frequent human activity occurs. However, interior areas (Category E) are used if exterior areas are physically shielded from the roadway or if there is little or no human activity in exterior areas adjacent to the roadway.

A noise impact occurs when either the absolute or substantial increase criterion is met. These criteria are as follows:

- Absolute criterion - the predicted noise level at a receiver approaches, equals, or exceeds the NAC. "Approach" is defined as 1 dBA below the NAC. For example, a noise impact would occur at a Category B residence if the noise level is predicted to be 66 dBA or above.
- Relative criterion - the predicted noise level substantially exceeds the existing noise level at a receiver even though the predicted noise level does not approach, equal, or exceed the NAC. "Substantially exceeds" is defined as more than 10 dBA. For example, a noise impact would occur at a Category B residence if the existing level is 54 dBA and the predicted level is 65 dBA (11 dBA increase).

According to FHWA, when a traffic noise impact occurs, noise abatement measures must be considered. A noise abatement measure is any positive reasonable and feasible action taken to reduce the impact of traffic noise on an activity area.

6.0 METHODOLOGY

6.1 Sound Level Measurements

Short-term peak (15 minute) sound level measurements were taken at four daily times; AM peak, PM peak, day off-peak, and evening off-peak, to calibrate the TNM 2.5 model results. The measurements were taken with a Quest 2300 ANSI Type II sound level meter. A log was kept noting the time of day, meteorological conditions, calibration results and any unusual ambient sound sources experienced during each measurement. Twelve representative sites were chosen at noise sensitive land uses along the corridor. Commercial business and industrial sites were not measured because they are not typically considered to be sensitive to noise. Table 4 identifies the location of the measurement sites, the land use(s) in the area, the dominant noise source, and the recorded measurements.

Table 4: Peak Period Existing Sound Level Measurements

Measurement Site Number	Land Use – Site Identification	Measured Sound Level (Leq dBA)			
		AM Peak[1]	PM Peak[2]	Day Off-Peak	Evening Off-Peak
1	Post Elementary School	**70**[3]	69	66	**70**
2	Jersey Village Single Family Homes	63	**68**	65	66
3	Jersey Village Single Family Homes	63	59	**65**	64
4	Jersey Village Single Family Homes	63	**66**	64	63
5	Windfern Forest Single Family Homes	67	55	**69**	67
6	Windfern Forest Single Family Homes	65	59	**69**	66
7	Windfern Forest Single Family Homes	66	56	**67**	65
8	West Bridge Single Family Homes	**68**	62	67	66
9	Gleason Elementary School	**65**	61	60	62
10	Willow Lake Single Family Homes	67	61	**69**	62
11	Willow Lake Single Family Homes	**71**	65	68	67
12	Villages at Harvest Bend	59	55	59	**61**

1. AM peak is between 6 AM -9 AM based on TranStar Speed Data and visual observation.
2. PM peak is between 4 PM -6:30 PM based on TranStar Speed Data and visual observation.
3. Bold sound levels are the highest daily recorded sound level.

6.2 Modeling

The FHWA approved Traffic Noise Model (TNM 2.5 computer model) was used to predict potential noise impacts based on 2008 and 2028 traffic volumes. The model primarily considers the number, type and speed of vehicles; highway alignment and grade; applicable cuts, fills, and natural berms; surrounding terrain features; tree zones; building row shielding; and the locations of activity areas (receivers) likely to be impacted by the associated traffic noise. These receivers represent approximately 381 single family homes (dwelling units), three schools, one apartment complex, and one park. These receivers also represent locations that might be impacted by traffic noise and that may potentially benefit from reduced noise levels.

Adjacent Activity Category C receivers (commercial or industrial) were not included in this study. Nearly all of these sites had direct access to the frontage roads. These sites were comprised of gas stations, strip malls, restaurants, office buildings, storage facilities, and various independent proprietors.

None of these commercial or industrial sites had visible exterior people activity areas and none of these sites would potentially benefit from reduced noise levels. Furthermore, 23 CFR 772.11(a) states that in determining and abating traffic noise impacts, primary consideration is to be given to exterior areas. Abatement will usually be necessary only where frequent human use occurs and a lowered noise level would be of benefit. Additionally, line-of-sight safety issues would further restrict barrier placement because of the gaps required for safe egress. Finally, professional experience suggests that public visibility is typically an important variable for business owners. Therefore, it is not likely that these owners would desire a solid structure hiding them from their potential clients.

7.0 TRAFFIC NOISE LEVEL RESULTS

7.1 Noise Environment

Existing and predicted traffic noise levels for the current year (2008) on the existing facility and 2028 on the improved facility, which includes the addition of one lane in each direction, were modeled at the sensitive receivers. These receivers represent the sites that might be impacted by traffic noise and that may potentially benefit from reduced noise levels.

Traffic data was developed using Houston-Galveston Area Council's (H-GAC) 2001, 24-Hour saturation counts. Existing and predicted traffic noise levels for 167,700 vehicles per day (vpd) in existing year (2008) and 237,500 vehicles per day in (2028)[1] were used for this study. During the peak hour, the Sam Houston Tollway/Beltway 8 facility currently carries approximately 13,100 vehicles and is projected to carry 18,500 vehicles by 2028. The peak hour vehicle fleet mix is 95% autos/light duty vehicles, 2% medium trucks, and 3% heavy trucks. The directional split is 53/47.

Existing and predicted traffic noise levels were modeled (with calibration) at adjacent receiver locations (Table 5 and Exhibit 1). These receiver locations represent the land use activity areas adjacent to the facility that might be impacted by traffic noise and could potentially benefit from feasible and reasonable noise abatement.

Table 5: Traffic Noise Levels (dBA Leq)

Receiver	NAC Category	NAC Level	Existing 2008	Predicted 2028	Change (+/-)	Noise Impact
1 Post Elementary School**	E	52	40	42	+2	No
1a. Clark Henry Park	B	67	65	67	+2	Yes
2 Jersey Village SFH*	B	67	62	64	+2	No
3 Jersey Village SFH	B	67	64	66	+2	Yes
4 Jersey Village SFH	B	67	64	65	+1	No
5 Jersey Village SFH	B	67	67	68	+1	Yes
6 Jersey Village SFH	B	67	66	68	+2	Yes
7 Jersey Village SFH	B	67	63	65	+2	No
8 Jersey Village SFH	B	67	64	66	+2	Yes
9 Bellagio Apartments**	E	52	48	50	+2	No

[1] A growth factor of 1.4% annual increased was used to develop the existing and design year vpd.

Receiver	NAC Category	NAC Level	Existing 2008	Predicted 2028	Change (+/-)	Noise Impact
10 Windfern Forest SFH	B	67	67	68	+1	Yes
11 Windfern Forest SFH	B	67	68	69	+1	Yes
12 Windfern Forest SFH	B	67	64	66	+2	Yes
13 Windfern Forest SFH	B	67	69	70	+1	Yes
14 Windfern Forest SFH	B	67	65	66	+1	Yes
15 Windfern Forest SFH	B	67	69	70	+1	Yes
16 Windfern Forest SFH	B	67	60	62	+2	No
17 Windfern Forest SFH	B	67	68	70	+2	Yes
18 Windfern Forest SFH	B	67	62	63	+1	No
19 West Bridge SFH	B	67	61	63	+2	No
20 West Bridge SFH	B	67	59	61	+2	No
21 West Bridge SFH	B	67	63	65	+2	No
22 West Bridge SFH	B	67	66	68	+2	Yes
23 West Bridge SFH	B	67	65	67	+2	Yes
24 West Bridge SFH	B	67	57	59	+2	No
25 Gleason Elementary School**	E	52	39	40	+1	No
26 Willow Lake SFH	B	67	65	67	+2	Yes
27 Willow Lake SFH	B	67	67	69	+2	Yes
28 Willow Lake SFH	B	67	63	65	+2	No
29 Willow Lake SFH	B	67	62	63	+1	No
30 Willow Lake SFH	B	67	68	70	+2	Yes
31 Willow Lake SFH	B	67	69	70	+1	Yes
32 Willow Lake SFH	B	67	68	69	+1	Yes
33 Willow Lake SFH	B	67	62	64	+2	No
34 Willow Lake SFH	B	67	62	64	+2	No
35 Willow Lake SFH	B	67	64	65	+1	No
36 Willow Lake SFH	B	67	66	67	+1	Yes
37 Willbern Elementary**	E	52	28	30	+2	No
38 Villages at Harvest Bend SFH	B	67	60	62	+2	No
39 Heron Lakes Estates SFH	B	67	66	67	+1	Yes
40 Silver Oaks Trails SFH	B	67	62	64	+2	No
41 Silver Oaks Trails SFH	B	67	63	65	+2	No
42 Blue Creek SFH	B	67	65	66	+1	Yes
43 Blue Creek SFH	B	67	69	69	0	Yes

* Single Family Homes
** Category E calculated by subtracting 25 dBA from exterior numbers: the average noise reduction achieved within a residence

7.1.1 Existing Condition

Forty-four receivers were analyzed, which represent 381 individual dwelling units, three school sites, one apartment complex, and one park. Fifteen of these receivers have existing noise levels approaching, equaling, or exceeding the criteria. Table 5 shows the existing sound levels for each receiver site.

7.1.2 2028 Conditions

The noise levels at year 2028 on the improved facility in the study area are predicted to increase between 1 dBA and 2 dBA. A 1 to 2 dBA increase is not a perceptible increase over existing conditions. Twenty-three receivers are predicted to have noise levels approaching, equaling, or exceeding the criteria by year 2028. Table 5 shows the predicted sound levels for each receiver site.

8.0 POTENTIAL MITIGATION

8.1 Feasible and Reasonable Mitigation Measures

HCTRA is committed to incorporate all reasonable and feasible mitigation measures into projects to minimize noise impacts and enhance the surrounding noise environment. This commitment to minimize noise impacts and enhance the noise environment must be fulfilled through prudent application of Federal Highway Administration's (FHWA) noise regulations. HCTRA shall identify noise abatement measures which are reasonable and feasible and which are likely to be incorporated into the project when noise impacts are identified. Also, HCTRA will identify noise impacts for which no apparent solution is available. The basis for any noise abatement decisions will be made available to local officials for future planning. The purpose of this policy statement is to establish criteria that identify what is feasible and reasonable in the decision to construct or provide noise abatement measures adjacent to proposed transportation facilities.

As indicated in Table 5, predicted noise levels exceed existing levels by a maximum of 2 dBA; however, the NAC was approached, equaled, or exceeded at 23 of the 44 modeled representative receivers. The 2028 traffic noise conditions would result in an impact and the following noise abatement measures could be considered: traffic management, alteration of the horizontal and/or vertical alignments, acquisition of undeveloped property to act as a buffer zone, utilization of rubberized asphalt, and the construction of noise barriers.

Per TxDOT guidelines, before any abatement measure can be proposed for incorporation into the project, it must be both feasible and reasonable. In order to be feasible, the abatement measure must be able to reduce the noise level at an impacted receiver by at least 5 dBA; and to be reasonable, it must not exceed the cost-effectiveness criterion of $25,000 for each receiver that would benefit by a reduction of at least 5 dBA.

8.1.1 Traffic Management Measures

Control devices could be used to reduce the speed of the traffic; however, the minor benefit of 1 dBA per 5 mph reduction probably does not outweigh the potential associated increase in congestion and additional air quality impacts. Additionally, a typical person can first perceive a difference in the sound level environment when a 3 dBA change occurs; therefore, it would take a minimum 15 mph reduction to achieve a perceived lowering in the sound levels. Furthermore, the lower speeds would be difficult to enforce. Other measures such as time or use restrictions for certain vehicles are prohibited on state highways.

8.1.2 Horizontal/Vertical Realignment

Reasonable horizontal and/or vertical realignments were investigated as a possible way to minimize impacts. However, these changes are bound by engineering limitations of interchanges, intersection approaches, acceptable curve/turning radii and the dense development in many areas of the facility. The existing toll road facility was developed to minimize and/or avoid impacts to potentially sensitive areas, to reduce right-of-way acquisition, to maintain acceptable cross-street connections, and to minimize/avoid other environmentally sensitive impacts.

8.1.3 Buffer Zones

Preliminary indications are that the acquisition of sufficient undeveloped land adjacent to the facility to preclude future development that could be impacted by highway traffic noise could not be cost effective/reasonable.

8.1.4 Rubberized Asphalt

Studies have indicated that rubberized asphalt may provide acoustical benefits; however, final conclusions of the benefits are still pending. Studies from the Arizona Department of Transportation have indicated that noise reduction of 3 to 5 dBA from tire noise sources, one of the two main sources of traffic noise, may be achieved. Traffic noise modeling techniques have not been released for rubberized asphalt.

8.1.5 Noise Barriers

Noise barriers are the most commonly used noise abatement measure. A preliminary analysis was performed for the areas warranting noise abatement.

Receiver 1a: Clark Henry Park

This receiver is a separate, individual receiver. A noise barrier that would achieve the minimum feasible reduction of 5 dBA at this receiver would have a minimum cost of $171,264, which would exceed the reasonable, cost-effective criteria of $25,000.

Receivers 2-8 - Jersey Village

These receivers represent 43 single family homes, which are a part of the City of Jersey Village. Two potential noise mitigation scenarios were analyzed for these receivers. The two barrier mitigation scenarios include constructing new barriers and supplementing existing barriers.

A combination of adding 4 feet to the existing 16-foot barriers and adding structure barriers adjacent to the main lanes would reduce traffic noise levels by a maximum of 3 dBA, which would not achieve the minimum feasible reduction of 5 dBA.

A second scenario was considered based on comments from the Jersey Village Tollroad Noise Abatement Committee. This second scenario extends the length of the barriers previously analyzed. This scenario also includes adding a wrap-around barrier to the west from the north end of the existing Jersey Village barrier. This scenario would reduce traffic noise levels by a maximum of 3 dBA, which would not achieve the minimum feasible reduction of 5 dBA.

Receivers 10-18 – Windfern Forest

These receivers represent 44 single family homes that are a part of the Windfern Forest Subdivision. Potential noise mitigation includes constructing new barriers and supplementing existing barriers. A combination of adding 4 feet to the existing 16-foot barriers and adding structure barriers adjacent to the main lanes would reduce traffic noise levels by a maximum of 3 dBA, which would not achieve the minimum feasible reduction of 5 dBA.

Receivers 19-24 – West Bridge

These receivers represent 42 single family homes that are a part of the West Bridge Subdivision. A continuous noise barrier with sufficient length would restrict access to the commercial areas flanking these receivers. A barrier which would not restrict access to the commercial areas would not be sufficient to achieve the minimum, feasible reduction of 5 dBA. Adding a structure barrier adjacent to the main lanes would reduce traffic noise levels by a maximum of 3 dBA, which would not achieve the minimum feasible reduction of 5 dBA.

Receiver 26-36 – Willow Lake

These receivers represent 81 single family homes that are a part of the Willow Lake Subdivision. A continuous noise barrier with sufficient length would restrict access to the commercial areas flanking these receivers. A barrier which would not restrict access to the commercial areas would not be sufficient to achieve the minimum, feasible reduction of 5 dBA. Adding a structure barrier adjacent to the main lanes would reduce traffic noise levels by a maximum of 2 dBA, which would not achieve the minimum feasible reduction of 5 dBA.

Receiver 39 – Heron Lakes Estates

This receiver represents four single family homes that are a part of the Heron Lakes Estates Subdivision. Based on preliminary calculations, a noise barrier 750 feet in length and 12 feet in height would reduce noise levels by at least 5 dBA for four benefited residences at a total cost of $144,000 or $36,000 per each benefited receiver. The proposed barrier would not meet the minimum reasonable requirement of $25,000 per benefited residence.

Receiver 40-43 – Silver Oaks Trails and Blue Creek

These receivers represent 55 single family homes that are part of the Silver Oaks Trails and Blue Creek Subdivision. A continuous noise barrier with sufficient length would restrict access to the commercial areas flanking these receivers. A barrier which would not restrict access to the commercial areas would not be sufficient to achieve the minimum, feasible reduction of 5 dBA. Adding a structure barrier adjacent to the main lanes would reduce traffic noise levels by a maximum of 3 dBA, which would not achieve the minimum feasible reduction of 5 dBA.

9.0 CONCLUSION

For the year 2028, the FHWA absolute criterion was approached, equaled or exceeded for 23 sensitive receiver locations. Many sensitive receivers that were located farther away and behind the commercial building rows and existing barriers were not impacted. There were no relative criterion (substantial increase) impacts at any site.

Overall, there were approximately 381 single family homes (dwelling units), three schools, one apartment complex, and one park sensitive receptor locations identified in the corridor. Forty-four representative receivers were selected for modeling purposes. As indicated in Table 5, predicted noise levels exceeded existing levels by a maximum of only 2 dBA; however the NAC was approached, equaled or exceeded at 23 of the 44 modeled receivers.

Many of the receivers in the area immediately abutting the Sam Houston Tollway and its frontage roads currently have an exterior sound level environment in the mid to high 60’s dBA.

Receivers farther from the immediate roadway have existing exterior sound levels in the low 60's dBA. Many of the sensitive receivers are located behind commercial areas.

The existing and future noise levels were measured and modeled for future traffic conditions. The future noise levels will increase above the existing conditions, but not by a perceptible level. Although sound is a very subjective concept, the results of this study found that 23 sensitive receiver locations approached, equaled, or exceeded FHWA absolute criteria for noise mitigation, clearly indicating that noise is an issue.

State and federal guidelines were met during the planning, design, and implementation of noise mitigation measures during the original construction of Sam Houston Tollway. However, HCTRA recognizes the impact of Sam Houston Tollway to the adjacent residential areas and intends to further investigate the suggested mitigation measures contained herein.

LEGEND

- RIGHT OF WAY
- EXISTING NOISE BARRIER
- RECEIVER LOCATION
- MONITORING SITE LOCATION

0 50 100 200
SCALE IN FEET

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EXHIBIT 1
SAM HOUSTON TOLLWAY
US 290 TO SH 249
TRAFFIC NOISE STUDY

SHEET 1 OF 8

FED. RD. DIV. NO.	STATE PROJECT NO.	SHEET NO.

STATE	DIST.	COUNTY	
TEXAS			
CONT.	SECT.	JOB	HIGHWAY NO.
			CF 0119

NOTE: RECEIVER 26, RECEIVER 27, AND MEASUREMENT LOCATION 9 NOT SHOWN, DUE TO DISTANCE FROM PROJECT.

LEGEND

RIGHT OF WAY

EXISTING NOISE BARRIER

RECEIVER LOCATION

MONITORING SITE LOCATION

0 50 100 200
SCALE IN FEET

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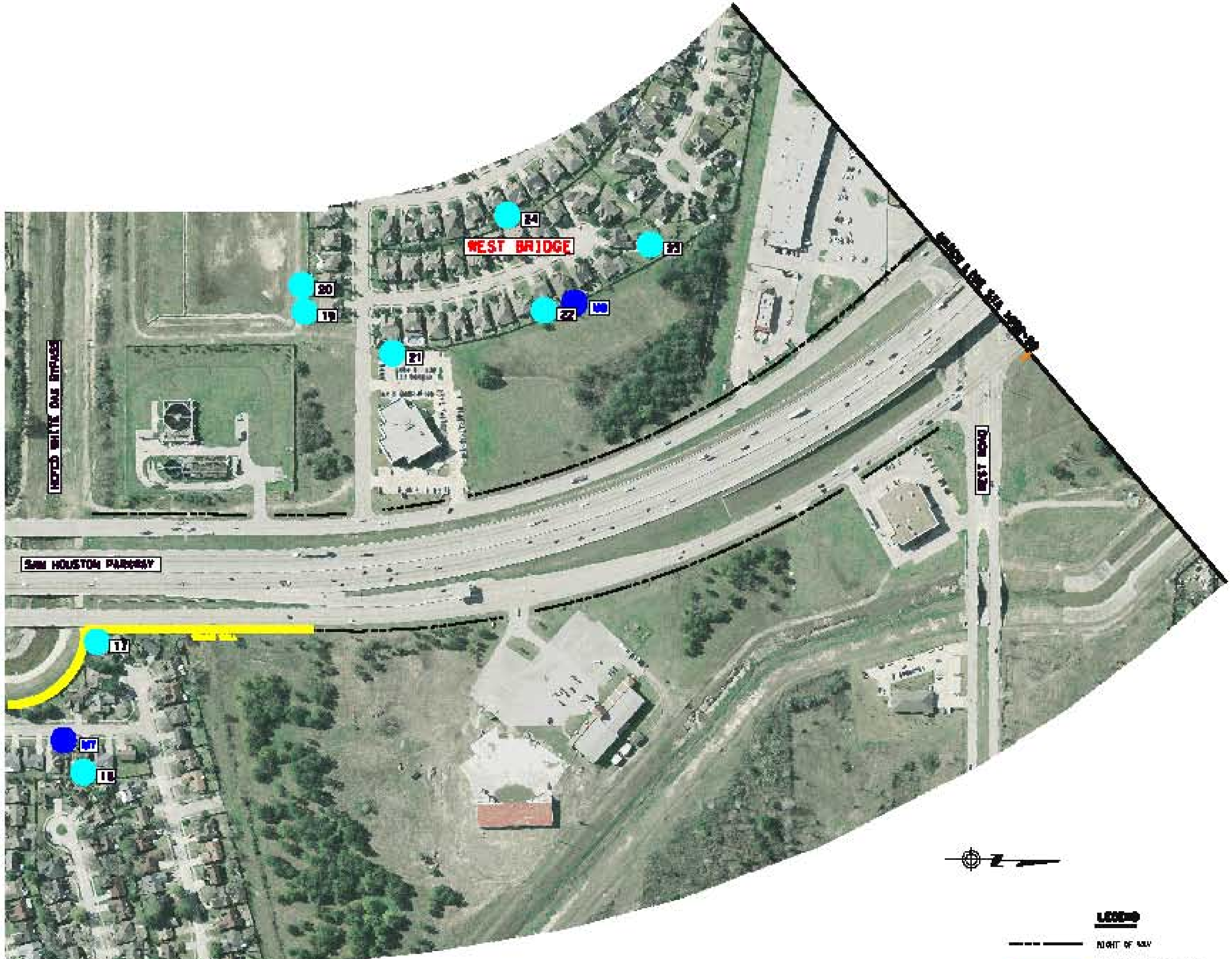
EXHIBIT 1
SAM HOUSTON TOLLWAY US 290 TO SH 249 TRAFFIC NOISE STUDY

SHEET 2 OF 8

FED. RD. DIV. NO.	STATE PROJECT NO.		SHEET NO.
STATE	DIST.	COUNTY	
TEXAS			
CONT.	SECT.	JOB	HIGHWAY NO.
			CF D119

NOTE: RECEIVER 25, RECEIVER 37, AND MEASUREMENT LOCATION 9 NOT SHOWN, DUE TO DISTANCE FROM PROJECT.



LEGEND

- RIGHT OF WAY
- EXISTING NOISE BARRIER
- RECEIVER LOCATION
- MONITORING SITE LOCATION

0 50 100 200
SCALE IN FEET

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EXHIBIT 1
SAM HOUSTON TOLLWAY
US 290 TO SH 249
TRAFFIC NOISE STUDY

SHEET 3 OF 8

FED. RD. DIV. NO.	STATE PROJECT NO.	SHEET NO.

STATE	DIST.	COUNTY	
TEXAS			
CONT.	SECT.	JOB	HIGHWAY NO.
			CF D119

NOTE: RECEIVER 26, RECEIVER 27, AND MEASUREMENT LOCATION 9 NOT SHOWN, DUE TO DISTANCE FROM PROJECT.

LEGEND

RIGHT OF WAY

EXISTING NOISE BARRIER

RECEIVER LOCATION

MONITORING SITE LOCATION

0 50 100 200
SCALE IN FEET

NOTE: RECEIVER 25, RECEIVER 37, AND MEASUREMENT LOCATION 9 NOT SHOWN, DUE TO DISTANCE FROM PROJECT.

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EXHIBIT 1
SAM HOUSTON TOLLWAY
US 290 TO SH 249
TRAFFIC NOISE STUDY

SHEET 4 OF 8

FED.RD. DIV.NO.	STATE PROJECT NO.	SHEET NO.

STATE	DIST.	COUNTY	
TEXAS			
CONT.	SECT.	JOB	HIGHWAY NO.
			CF 0119

LEGEND

RIGHT OF WAY

EXISTING NOISE BARRIER

RECEIVER LOCATION

MONITORING SITE LOCATION

0 50 100 200

SCALE IN FEET

NOTE: RECEIVER 25, RECEIVER 27, AND MEASUREMENT LOCATION 9 NOT SHOWN, DUE TO DISTANCE FROM PROJECT.

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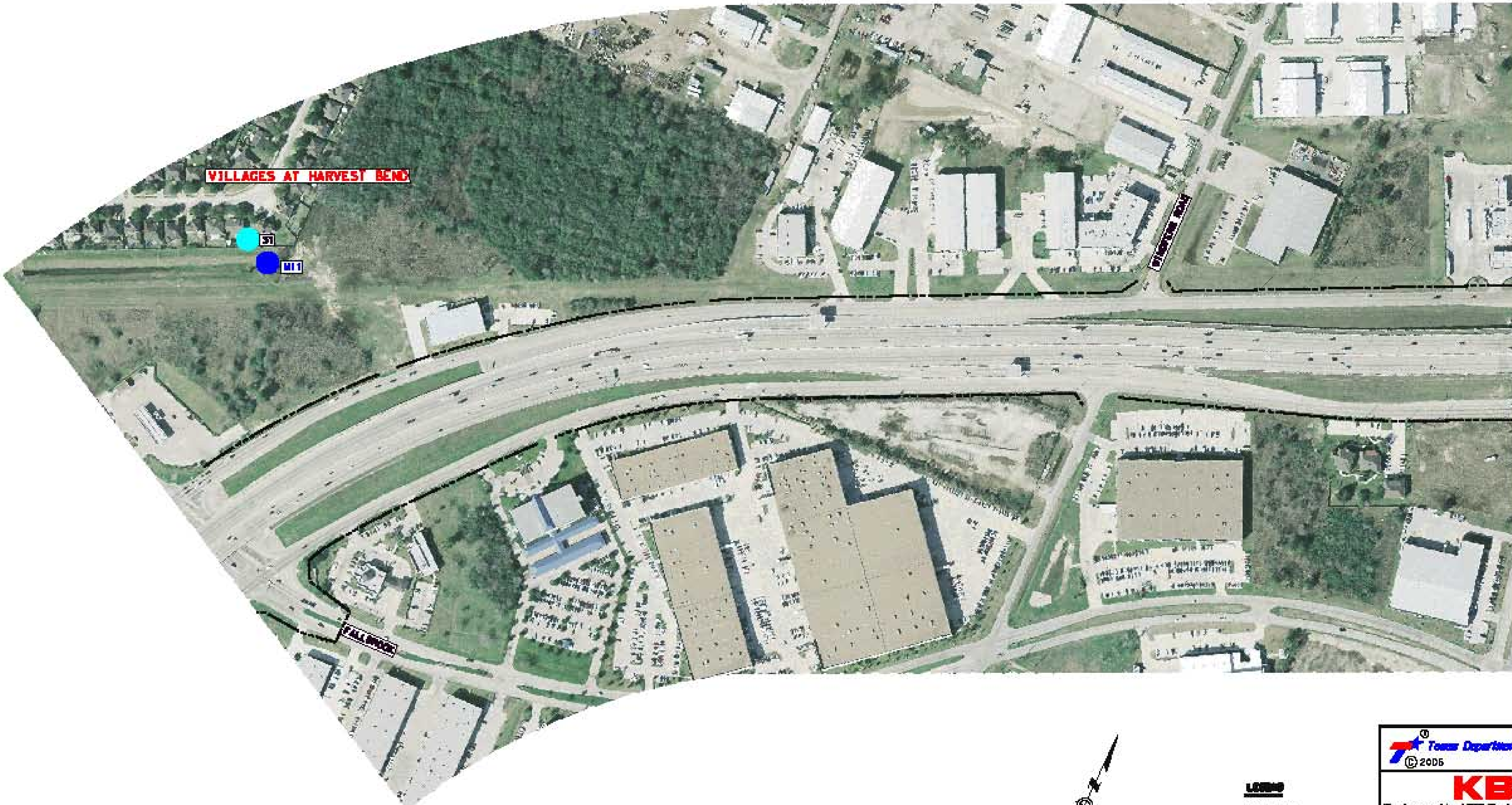
EXHIBIT 1
SAM HOUSTON TOLLWAY
US 290 TO SH 249
TRAFFIC NOISE STUDY

SHEET 5 OF 6

FED. RD. DIV. NO.	STATE PROJECT NO.		SHEET NO.
STATE	DIST.	COUNTY	
TEXAS			
CONT.	SECT.	JOB	HIGHWAY NO.
			CF 0119



LEGEND

- RIGHT OF WAY
- EXISTING NOISE BARRIER
- RECEIVER LOCATION
- MONITORING SITE LOCATION

0 80 160 240
SCALE IN FEET

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EXHIBIT 1
SAM HOUSTON TOLLWAY
US 290 TO SH 249
TRAFFIC NOISE STUDY

SHEET 6 OF 8

FED. RD. DIV. NO.	STATE PROJECT NO.			SHEET NO.
STATE	DIST.	COUNTY		
TEXAS				
CONT.	SECT.	JOB	HIGHWAY NO.	
			CF 0119	

NOTE: RECEIVER 35, RECEIVER 37, AND MEASUREMENT LOCATION 9 NOT SHOWN, DUE TO DISTANCE FROM PROJECT.

LEGEND

- RIGHT OF WAY
- EXISTING NOISE BARRIER
- RECEIVER LOCATION
- MONITORING SITE LOCATION

SCALE IN FEET

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EXHIBIT 1
SAM HOUSTON TOLLWAY
US 290 TO SH 249
TRAFFIC NOISE STUDY

SHEET 7 OF 8

FED. RD. DIV. NO.	STATE PROJECT NO.		SHEET NO.
STATE	DIST.	COUNTY	
TEXAS			
CONT.	SECT.	JOB	HIGHWAY NO.
			CF 0119

NOTE: RECEIVER 25, RECEIVER 37, AND MEASUREMENT LOCATION 9 NOT SHOWN, DUE TO DISTANCE FROM PROJECT.

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LEGEND

- RIGHT OF WAY
- EXISTING NOISE BARRIER
- RECEIVER LOCATION
- MONITORING SITE LOCATION

0 80 160 240
SCALE IN FEET

Texas Department of Transportation
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EXHIBIT 1
SAN HOUSTON TOLLWAY
US 290 TO SH 249
TRAFFIC NOISE STUDY

SHEET 8 OF 8

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