Glenn McConnell Parkway

Highway Traffic Noise

Technical Memorandum

April 2020

Charleston County

Transportation Development

CHARLESTON COUNTY SOUTH CAROLINA

DAVIS & FLOYD

SINCE 1954

HIGHWAY TRAFFIC NOISE

TECHNICAL MEMORANDUM

for the

GLENN MCCONNELL PARKWAY

(SC-461 FROM MAGWOOD DRIVE TO BEES FERRY ROAD)

Prepared for: Charleston County

Prepared by: Davis & Floyd, Inc.

April 28, 2020

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for

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Charleston County, South Carolina

April 28, 2020

Introduction

PURPOSE OF STUDY

The purpose of this study is to determine existing noise levels and assess the potential traffic and construction noise impacts resulting from the proposed widening and transportation improvements to SC Route 461 (Glenn McConnell Parkway) from Magwood Drive (S-1863) to Bees Ferry Road (S-57) in Charleston County, South Carolina. The procedures for this study follow Title 23: Highways – Part 772 (23 CFR 772) – "Procedures for the Abatement of Highway Traffic Noise and Construction Noise, U.S. Department of Transportation, Federal Highway Administration". This project is classified as a Type I project under 23 CFR 772. A "Type I project" is defined as a proposed project for the construction of a new highway or the physical alteration of an existing highway that significantly changes either the horizontal or the vertical alignment or increases the number of through-traffic lanes. As a Type I project, it is evaluated for the need of constructing noise barriers.

PROJECT DESCRIPTION

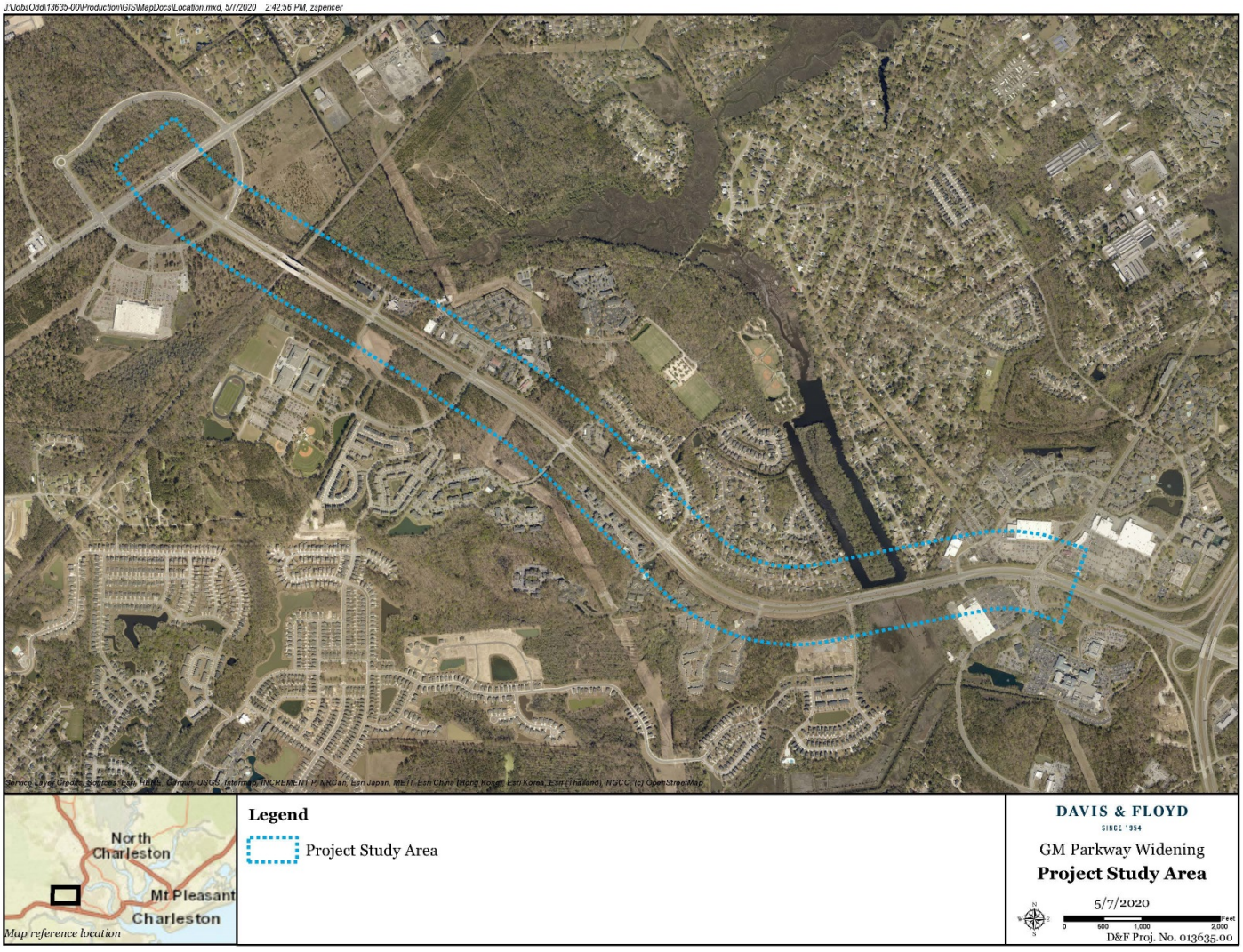
The proposed improvements include widening the Glenn McConnell Parkway (Parkway) to accommodate existing and future forecast traffic volumes. An additional travel lane would be added in each direction for the length of the corridor. Intersection improvements including turning lanes are proposed along the corridor to improve roadway geometry and to facilitate traffic flow through intersections. An eight to 12-foot shared use path for bicycles and pedestrians is proposed along the corridor.

The right-of-way along the corridor is transitional in areas and varies greatly along the corridor from 100 feet each side out to over 150+ feet each side nearest the Bees Ferry Road intersection. As currently proposed no new right-of-way would be required to implement and construct the planned transportation improvements and no displacement of residences or businesses are anticipated.

PROJECT PURPOSE AND NEED

The purpose and need for the project is to relieve traffic congestion on the Parkway by widening the roadway from four to six lanes. One additional travel lane will be added in each direction of travel. A shared use path will also be constructed to improve and provide alternate transportation options to bicyclists and pedestrians with a safer means to travel within the Parkway corridor and over the CSX railway. Existing (2018) average daily traffic (ADT) volumes along the Parkway are 34,900 vehicles per day and is expected to increase to 62,840 vehicles per day by the year 2040.

Exhibit 1: Glenn McConnell Parkway Location Map



Noise Fundamentals

NOISE

Noise is comprised of three characteristics: frequency (or pitch), amplitude (or loudness), and intensity. Frequency relates to whether noise has a high pitch, low pitch, or contains a combination of pitches ranging from low (rumble) to high (squeal) and is measured in cycles per seconds, or Hertz (Hz) units. The human ear is capable of discerning noise in the range of 20 Hz to 20,000 Hz. Various frequencies of noise allow identification of the source. For example, a door slamming shut will produce noise identified with the action. A car pass-by is identified because the motor (and vehicle exhaust) generates similar frequencies that are identified with all cars. Heavy-duty trucks carry a signature of frequencies that distinguish them from cars or motorcycles. Cars tend to generate noise emitted closer to the ground, higher in frequencies, and less in intensity than trucks.

The intensity of noise is a measure of the magnitude of the sound pressure level (SPL). The ear is responsive to sounds having a tremendous range in intensity. For this reason, and because the sensitivity of the ear is more logarithmic than linear in its response, sound levels are expressed on a logarithmic scale. Using a base 10 logarithm to measure relative sound pressure, the range is compressed to a scale of 0 to 9. Thus, this is a system based on the number of tenfold increases, rather than on the actual number itself. The numbers 0 to 9 represent relative quantities, and the quantity measured on this scale is referred to as a level. The unit on this scale is called a bel. The bel has been divided into 10 smaller units known as decibels (dB), so that the range of sound pressures from the approximate threshold of hearing to rocket noise runs from 0 to 180 decibels. The decibel is the common term used for noise density. Human hearing is less sensitive at low and high frequencies than in the frequency mid-range; therefore, the A-weighted system favoring mid-range frequencies is used to determine how frequencies impact human hearing. The use of this system is denoted as dBA.

Increases in noise levels produce varying effects. For example, a 1-dBA increase, except in controlled laboratory conditions, cannot be perceived, a 3-dBA increase is considered barely noticeable in exterior environments, and a 5-dBA increase is considered noticeable in exterior environments. Exhibit 2 shows a listing of common noise levels.

Since noise varies over time, a statistical parameter, known as the equivalent sound level, $L_{(eq)}$ has been developed to quantify the time varying pattern of noise, or the intensity of the noise. Noise levels are based on a $L_{(eq)}$ descriptor, which refers to the steady-state (constant sound) A-weighted sound level. Therefore, the fluctuating sound levels of traffic noise over a period of time are represented in terms of a constant noise level with the same energy content. The time period used corresponds with the peak-hour traffic period. The Federal Highway Administration (FHWA) in traffic noise analyses commonly uses the $L_{(eq)}$ noise descriptor. The $L_{(eq)}$ descriptor has been used to quantify the noise levels in this analysis.

Exhibit 2: Common Noise Sources and Levels

OUTDOOR SOUND LEVELS	SOUND LEVEL (DBA)	INDOOR SOUND LEVELS
	110	Rock Band at 5 m (16 feet)
Jet Over-Flight at 300 m (1,000 feet)	105	
	100	Inside New York Subway Train
Gas Lawn Mower at 1m (3 feet)	95	
	90	Food Blender at 1 m (3 feet)
Diesel Truck at 15 m (50 feet)	85	
Noisy Urban Area-Daytime	80	Garbage Disposal at 1 m (3 feet)
	75	Shouting at 1 m (3 feet)
Gas Lawn Mower at 30 m (100 feet)	70	Vacuum Cleaner at 3 m (10 feet)
Suburban Commercial Area	65	Normal Speech at 1 m (3 feet)
	60	
Quiet Urban Area-Daytime	55	Quiet Conversation at 1 m (3 feet)
	50	Dishwasher in Next Room
Quiet Urban Area at Night	45	
	40	Empty Theater or Library
Quiet Suburb at Night	35	
	30	Quiet Bedroom at Night
Quiet Rural Area at Night	25	Empty Concert Hall
Rustling Leaves	20	
	15	Broadcast and Recording Studios
	10	
	5	
Reference Pressure Level	0	Threshold of Hearing
Source: Highway Noise Fundamentals, Federal Highway Administration, September 1980.		

TRAFFIC NOISE

Traffic noise is dependent on the following variables: the volume of vehicles, speed of the traffic, and the number and size of the trucks in the traffic flow. The higher the number of cars or trucks, the faster the traffic is traveling, and the larger their size, the louder the traffic noise. For example, traffic traveling at 65 miles per hour (mph) will sound twice as loud as traffic traveling at 30 mph. Tire and pavement interaction is the predominant noise source from autos traveling at highway speeds,

with engine noise contributing a smaller amount of noise. The combination of the tire and pavement interaction and exhaust are the primary source of noise for heavy trucks at highway speeds. One truck at 55 miles per hour (mph) can create as much noise as 10 cars at 55 mph.[1] In addition to noise emitted from tire design and pavement surface, the area of the engine and exhaust contribute to noise coming from motor vehicles. Cars are relatively quiet when found in small numbers while a single tractor-trailer pass-by can sound much louder at close distances.

Traffic noise can follow four paths: Direct, Diffracted, Reflected, and Transmitted. Direct refers to the noise following a straight path from the roadway to the receiver whereas diffracted is when the noise follows a path from the roadway to the top of a barrier and then bends toward the receiver. Reflected paths occur when noise bounces off a barrier and is reflected toward the receiver on the opposite side of the roadway from the barrier and transmitted paths occur when the noise is transmitted through the barrier.[2]

The FHWA publication, "Highway Traffic Noise Analysis and Abatement Policy and Guidance", June 1995, describes several general relationships that affect sound generation and dispersion (propagation). The decibel scale is extremely useful; however, it could be puzzling since decibels are logarithmic units, sound levels cannot be added arithmetically. On a linear scale, the total sound generated by two identical noise sources would be twice the sound of one of the sources operating alone. For example, two vehicles that each produces 70 dB of noise would combine to produce 73 dB, rather than 140 dB. Thus, two noise sources of the same intensity or loudness would combine to produce a 3 dB increase in the sound pressure level. Furthermore, an increase or decrease of 10 dB in the sound pressure level would be perceived by an observer as a doubling or halving of the sound. For example, an 80 dB sound would be perceived as twice as loud as a 70 dB sound. If two sound sources whose levels differ by more than 10 dBA are added together, the resulting level would be less than 0.5 dBA higher than the level produced by the greater source operating alone.

The general relationship is that sound intensity decreases in proportion with the square of the distance from the source. Therefore, sound levels for a point source would decrease by approximately 6 dB for each doubling of distance. Sound levels for a highway line source vary differently with distance, since sound pressure waves are propagated or dispersed all along the roadway and overlap at the point of measurement. A long, closely spaced continuous line of vehicles along a roadway (hard surface) would produce a 3 dB decrease in sound level for each doubling of distance. However, evidence has shown that where sound from a highway propagates close to "soft" ground, such as yards, pastures and cultivated areas, a drop-off rate of 4.5 dB per doubling of distance is more suitable in estimating the drop-off rate in traffic noise analyses. Thus, if a stream of traffic moving at 60 miles per hour produces 78 dBA over a soft, grassy surface at a distance of 50 feet, the sound level at 100 feet would be 73.5 dBA, and the sound level would be 68.5 dBA at 200 feet.

[1] USDOT and FHWA. Environment. Highway Traffic Noise. URL: < http://www.fhwa.dot.gov/environment/htnoise.htm>

[2] FHWA Planning, Environment, and Realty. Highway Traffic Noise. URL: <http://www.fhwa.dot.gov/environment/htnoise.htm>

NOISE IMPACTS

Noise will impact people differently depending on their environment and other considerations. The sounds generated by vehicular traffic constitute noise to people and could interfere with normal activities when they reach uncomfortable levels. The type of noise source determines the general frequencies present in noise measurements. The noise source is important in determining impacts and so is the number of sources. The number and distance (of vehicles) to the receiver determines the intensity or loudness. Time of day also affects the determination of impact to receptors.

To determine if highway noise levels are compatible with various land uses, the FHWA has developed noise abatement criteria and procedures to be used in the planning and design of highways. These abatement criteria and procedures are in accordance with 23 CFR, Part 772; Procedures for Noise Abatement of Highway Traffic Noise and Construction Noise. One factor in determining whether a noise impact occurs is when the projected future noise level at a receiver either approaches or exceeds the criteria level for the respective activity category. When dBA levels reach the point where it creates a disruption to the activity, it is considered an impact. Areas receiving noise levels above the designated Noise Abatement Criteria (NAC) require further study to determine if noise abatement procedures are warranted and justified.[3] A noise impact can also occur if the predicted future noise levels exceed the existing noise levels for a receiver by more than 15 dBA, which is referred to as a "substantial increase." The NAC found in Exhibit 3 identifies land use categories in which the criteria or standard has been set in determining impact.

[3] 23 CFR PART 772 Procedure for Abatement of Highway Traffic Noise and Construction Noise.

Exhibit 3: NAC for Land Use Categories

Activity Category	Leq (h)\1,2\	L10 (h) \1,2\	Evaluation Location	Description of Activity Category
A	57	60	Exterior	Lands on which serenity and quiet are of extraordinary 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\3\	67	70	Exterior	Residential.
C\3\	67	70	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	55	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E\3\	72	75	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	--	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	--	--	--	Undeveloped lands that are not permitted.

SOURCE: SCDOT Traffic Noise Abatement Policy, October 2019.

\1\ Either Leq(h) or L10(h) (but not both) may be used on a project.
\2\ The Leq(h) and L10(h) Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.
\3\ Includes undeveloped lands permitted for this activity category.

NOISE ANALYSIS METHODOLOGY

The procedures and requirements contained in the Federal-Aid Policy Guide, Subchapter H, Part 772 (23 CFR 772), “Procedures for the Abatement of Highway Traffic Noise and Construction Noise” were followed in conducting the noise analysis for this project. The following methods are used to determine existing noise levels, predict future noise levels, and assess impacts on the project's adjacent environment:

- Existing land uses for the project area were established.
- Existing (ambient) noise levels were determined by obtaining noise measurements at selected representative locations along the proposed project.
- The proposed and existing systems were modeled utilizing the FHWA Traffic Noise Model 2.5 (TNM 2.5).
- The noise levels modeled for the existing conditions were compared to the actual field measurements in order to verify the accuracy of the inputs for the noise model.
- Predicted noise levels were compared to the existing noise levels to determine the extent of the noise impact caused by the proposed project.
- Where an impact is expected to occur, noise abatement measures were examined and evaluated.

LAND USE

Existing land uses within the project area were identified. Following 23 CFR 722, the activity categories were identified and the corresponding FHWA NAC was assigned to each land use. The NAC represents the upper limit of acceptable highway traffic noise and is a compromise between noise levels that are desirable and those that are achievable. Land uses in the project study area include less developed areas, residential communities, undeveloped land, offices, retail stores and other commercial/industrial areas.

It was determined that Land Use Categories B, C and E occur along the project corridor; therefore, existing and future noise levels were determined for each category and the noise abatement criteria applied to determine effect. Noise abatement measures, such as the construction of noise barriers, must be considered when traffic noise impacts occur. The feasibility of barriers is based on several factors including cost, wall height, amount of land needed and ability to construct, land use changes, and number of impacted receptors benefiting from the barrier.

Existing Noise Levels

AMBIENT NOISE MEASUREMENTS

Using land use surveys and aerial photographs, the study team identified areas to take noise level readings that typically represent noise levels throughout that area and for that land use. These existing or “ambient” noise levels were used to calibrate the model and to determine if there will be any substantial increases in noise levels when the project is constructed.

Ambient noise measurements were taken on February 11, 2019 at multiple locations along the project corridor. Measurements were taken during peak traffic hours (morning, midday and afternoon) using a Quest Technologies Sound Pro SE/DL Sound Level Datalogger at selected locations determined using aerial photographs and field verified visits. Measurements with traffic counts were taken at two locations along the corridor. In addition, ambient measurements were taken at 5 locations within adjacent neighborhoods to the Parkway. As the roadway could not be viewed from these locations no traffic data was collected. Noise levels recorded were the $L_{(eq)}$ and these measurements were then utilized as ambient existing noise levels along the project corridor.

The noise meter was placed five feet above the ground and approximately 50 feet from the edge-of-pavement (EOP) at each sampling site. Sampling periods were taken for 15 minutes and traffic counts were conducted simultaneously at each location. Traffic characteristics such as the number of automobiles, motorcycles, medium trucks, and heavy trucks were noted. Medium trucks are those with two axles and six wheels and a gross vehicle weight of over five tons while heavy trucks are those with three or more axles and a gross vehicle weight of over 13 tons. Observations of temperature, humidity, precipitation, and vehicle speed in miles per hour were estimated at each location as well as any events that could affect the noise measurements such as the passing by of an ambulance with siren or an airplane or helicopter flyover.

EXISTING NOISE PREDICTIONS AND NOISE MODEL VALIDATION

The FHWA-developed Traffic Noise Model (TNM 2.5) was used in predicting existing traffic noise. TNM 2.5 was developed and tested extensively under the auspices of the Federal Highway Administration against previously collected field data and results from other traffic noise models.[4] To ensure applicability of model output to traffic flow conditions in this study area, the existing traffic noise measurements taken in the field were used for comparison to the TNM predicted noise levels. Noise levels (L_{eq}) measured in the field along the Parkway ranged from 69.1 dBA to 74.1 dBA. The model developed for the corridor reflects close agreement (within +/- 2.3 dBA) for these four sets of field measurements. These results show that the TNM should be useful in predicting values in areas where traffic is the predominate source of noise and actual field measurements are not taken. It should be noted that it takes an approximately 3 dBA change in noise level to be barely perceptible to the human ear; therefore, the model accuracy of within 1.3 to 2.3 dBA is sufficient for these studies.

[4] FHWA Traffic Noise Model Technical Manual, Final Report February 1998, USDOT, Research and Special Programs Administration, John A. Volpe NTSC Acoustics Facility, Cambridge, MA 02142-1093.

Exhibit 4: Ambient Noise Measurements and FHWA TNM Model Validation

Field Receiver Location	Field Measurement	TNM Measurement	Difference (+/-)
Field Measurement 1	74.1	71.8	2.3
Field Measurement 2	73.5	71.9	1.6
Field Measurement 3	73.4	72.1	1.3
Field Measurement 4	73.9	71.7	2.2

Existing ambient noise measurements were also taken at five locations within the adjacent neighborhoods to the Parkway. Consecutive sets of two five-minute grab samples were taken for ambient noise level measurements. These samples were taken along Egret Crest Lane, Eagle View Drive, Emerald Forest Parkway, Arrow Wind Terrace, and Wayah Drive. Noise levels (Leq) measured at these locations measured from 57.2 dBA to 66.7 dBA.

Predicted Noise Levels

The TNM was also used to predict future traffic noise levels in terms of $L_{(eq)}$ both with and without implementation of the proposed project. The three-dimensional noise model can predict existing and future traffic noise depending on a variety of input parameters that include traffic volume, vehicle mix, vehicle speed, roadway grades, traffic flow, and receiver location and elevation. Using these inputs, TNM was run to predict the worst-case traffic noise levels for existing conditions, the No-build Alternative, and the Build Alternative along the project corridor.

Predicted peak hour traffic volumes for the 2018 existing and 2040 No-build and Build Alternatives were used in the model to predict traffic noise to adjacent receivers. These projections were performed for the existing conditions, No-build Alternative, and Build Alternative and then compared to existing noise levels to determine if there would be a substantial increase (over 15 dBA) in noise levels.

Exhibit 5: GMP Traffic Date – Peak Hour Volume for Existing and Design Year

Road	Traffic Station*	Existing AADT	Peak Hour Volume	Build AADT	Peak Hour Volume
Glenn McConnell Parkway	684	34,900	3,929	62,840	5,872

In addition to the identification of residential and commercial noise receptors within the project area, large tracts of undeveloped lands were also present along the corridor. Representative receptors were modeled at 50 and 100-foot increments from the edge of pavement to predict future noise levels at these locations. These receptors were modeled in the same manner as each of the proposed alternatives and elevations are the same for this analysis, this group of discrete receptors is assumed to be representative of all areas along each proposed alignment. A summary of this information is provided in Exhibit 6.

Exhibit 6: Approximate Distances (feet) to NAC for Undeveloped Lands

Distance from Edge of Pavement	dBA (L_{eq})
50-feet	74.3
100-feet	71.1
150-feet	68.4
200-feet	66.2
300-feet	62.7
400-feet	60.2
500-feet	58.2
600-feet	56.5

Potential Noise Impacts

Impact analysis was conducted for the proposed project using the requirements of FHWA's 23 CFR 772, "Procedures for Abatement of Highway Traffic Noise and Construction Noise". Under these guidelines, impact can occur under either of two conditions; either when future predicted noise levels approach or exceed the NAC for the particular land use in question or when there is a substantial increase of future build levels over existing levels. The SCDOT defines "approach" as 1 dBA below the specified FHWA NAC for each of the land use types. In South Carolina, a substantial increase is defined as being 15 decibels over existing noise levels.

All receivers within 400 feet of each side of the centerline were imported into the model to determine the noise level at those receivers and verify impacts. These included 92 residential and 16 commercial receptors. Receptors beyond 400 feet each side of the centerline were not modeled since the greatest distance for a noise impact to occur is approximately 250 feet. In all, 108 receivers were analyzed using TNM. The table below shows the potential noise impacts for residential and commercial receivers in the existing, future no build and future build conditions.

Exhibit 7: Predicted Noise Impacts to Receivers

CONDITION	CATEGORY B (66 DBA) RESIDENTIAL	CATEGORY C (71 DBA) COMMERCIAL, INDUSTRIAL, OFFICE	TOTAL IMPACTS
Existing (2018)	33	0	33
No-build (2040)	41	3	44
Build (2040)	52	7	59
Source: D&F Inc., 2019.			

NOISE ABATEMENT MEASURES

When noise impacts occur, consideration of abatement measures is required. Abatement measures to be considered may include the construction of noise barriers, change in horizontal and/or vertical roadway alignment and truck lane designation. An initial consideration in minimizing noise impacts is to place the roadway in uninhabited or sparsely populated areas, where possible, consistent with the project's intended purpose and need and logical termini. The No-build Alternative must also be considered.[5] While noise impacts are currently occurring and are expected to occur in the future, further efforts to mitigate or reduce these impacts remain. The following considerations will be undertaken in further development of the project:

HORIZONTAL AND VERTICAL ALIGNMENT

Change in project alignment will be carefully considered during the public involvement process and will consider noise impacts and other factors when exploring further alignment shifts. While horizontal shifts remain challenging due to the right of way limits, lowering of grades sufficiently to reduce noise levels to adjacent receptors is not possible because of the area's slightly above sea level ground elevation.

[5] Highway Traffic Noise Analysis and Abatement Policy and Guidance. USDOT FHWA Office of Environmental and Planning Noise and Air Quality Branch. Washington D.C. June 1995.

NOISE BARRIERS

Noise barriers are solid obstructions placed between the roadway and impacted receivers to reduce highway traffic noise. The SCDOT's noise abatement policy requires a rigorous analysis be completed to determine if a barrier meets both the feasible and reasonable criteria established by the policy. A proposed noise barrier must meet both the feasibility and reasonableness criteria to be considered a viable noise abatement measure.

Feasibility refers to whether a barrier can be built at a modeled and evaluated location. The modeled noise barrier must reduce highway traffic noise and be free of conflicts within its surroundings. Examples of these potential engineering feasibility conflicts and considerations include the topography, safety, drainage, utility, maintenance, and access to the modeled location. Subsequently, a constructability review should be conducted during this phase to determine if any engineering considerations, such as seismic or hurricane specifications, would increase the overall cost of the barrier. Noise barriers are considered feasible if a substantial noise reduction can be obtained through the implementation of this noise abatement measure. For a barrier to be feasible the barrier must be less than 25 feet in height and must provide at least a 5 dBA reduction to at least 75 percent of the impacted receivers. This 5 dBA reduction is the minimum needed to ensure the receiver can discern a noticeable difference in the noise levels.

The reasonableness criteria are determined through the evaluation of three reasonable factors: the noise reduction design goal, cost effectiveness, and the viewpoints of the property owners and residents of the benefitted receptors. For a potential noise barrier to be considered reasonable under the noise reduction design criteria it must reduce noise levels by a minimum of 8 dBA for 80 percent or more of the benefited receivers in the first two rows of buildings. A noise barrier must cost less than $30,000 per benefitted receiver to meet the cost effectiveness factor. Finally, if the first two reasonable factors are met then the viewpoints of the property owners and residents who desire and do not desire a noise barrier must be taken into consideration.

For this project four clusters of three or more impacted receivers were identified along the Parkway corridor and evaluated to determine if noise abatement measures could be implemented. A detailed noise barrier analysis was conducted for each group of receivers and a SCDOT Feasibility and Reasonableness Worksheet was completed for each modeled barrier (included in the Appendix) . Areas along the corridor where impacted receivers numbered less than three or were scattered over a larger distance were considered isolated and were not included in the barrier analysis. These modeled barriers were labeled barriers one through four and are summarized in the following paragraphs.

Barrier 1

Barrier 1 was modeled between Mary Ader Avenue and Baird's Cove on the north side of the Parkway. A cul-de-sac and neighborhood along Wayah Drive was evaluated within the project study area and included five residences that would receive noise levels above their NAC. A barrier approximately 360 feet long was modeled for these and the adjacent residences. Engineering and constructability concerns included an overhead power line that crosses the Parkway at this location and then extends to the west paralleling the Parkway and a large wetland area immediately west of this

neighborhood. A barrier at this location would benefit only the two receivers closest to the roadway by reducing noise levels by at least 5 dBA. As less than 50 percent of the receivers (2 of 5 or 40 percent) would only be benefitted by the barrier, the barrier at this location does not meet the feasibility criteria and is not considered a viable noise abatement measure. A copy of the SCDOT Feasibility and Reasonableness Worksheet is included in the Appendix.

Barrier 2

Barrier 2 was modeled on the north side of the Parkway between Mary Ader Avenue and Baird's Cove near its intersection with the Parkway. A cul-de-sac and neighborhood along Fox Ridge Court was evaluated within the project study area and included six residences that would receive noise levels above their NAC. A barrier approximately 500 feet long was modeled for these and the adjacent residences. Engineering and constructability concerns included the barrier's proximity to the intersection of the Parkway with Baird's Cove. The barrier could not be extended to the intersection due to safety concerns from a potential reduction in vehicle sight distances. Due to this restriction a barrier at this location would benefit the two receivers closest to the roadway by reducing noise levels by at least 5 dBA. As less than 50 percent of the receivers (2 of 6 or 33 percent) would only be benefitted by the barrier, the barrier at this location does not meet the feasibility criteria and is not considered a viable noise abatement measure. A copy of the SCDOT Feasibility and Reasonableness Worksheet is included in the Appendix.

Barrier 3

Barrier 3 was modeled between Baird's Cove and Charlie Hall Blvd along the north side of the Parkway. Emerald Forest Parkway runs parallel with the Glenn McConnell Parkway with a row of single-family residences along each side of the street. This neighborhood was evaluated within the project study area and included 33 residences that would receive noise levels above their NAC. A barrier approximately 1,100 feet long was modeled for these and the adjacent residences. Engineering and constructability concerns included the barrier's proximity to the intersection of the Parkway with Baird's Cove. The barrier could not be extended to the intersection due to safety concerns from a potential reduction in vehicle sight distances. In addition, the Parkway's right of way limits are substantially reduced along this section of the Parkway. The modeled noise barrier at this location would benefit 11 receivers by reducing noise levels by at least 5 dBA. As less than 50 percent of the receivers (11 of 33 or 33 percent) would only be benefitted by the barrier, the barrier at this location does not meet the feasibility criteria and is not considered a viable noise abatement measure. A copy of the SCDOT Feasibility and Reasonableness Worksheet is included in the Appendix.

Barrier 4

Barrier 4 was modeled between Lochaven Drive and Waterstone Lane on the south side of the Parkway. Eight multi-family buildings of 16 units each and a community swimming pool are along Egret Crest Lane. Each building (considered a receiver) has six units on the first floor, six units on the second floor and 4 units on the third floor (16 dwelling units per receiver). This neighborhood was evaluated within the project study area and included 122 residences (dwelling units) that would receive noise levels above their NAC. A barrier approximately 1,100 feet long was modeled for these and the adjacent

multi-family buildings and the community swimming pool. Engineering and constructability concerns included the barrier's proximity to the intersection of the Parkway with Egret Crest Lane. The barrier could not be extended to the intersection due to safety concerns from a potential reduction in vehicle sight distances. In addition, an overhead power line parallels the Parkway to the west and then crosses the Parkway at perpendicularly and a large wetland area is present in front of an immediately west of the westernmost multi-family residential building in this neighborhood. The modeled noise barrier at this location would benefit 113 receivers by reducing noise levels by at least 5 dBA. This corresponds to 93 percent of the receivers (113 of 122) being benefitted by the barrier, thus meeting the feasibility criteria at this location. However, a barrier at this location would be in conflict with the overhead powerlines and could not be constructed. A copy of the SCDOT Feasibility and Reasonableness Worksheet is included in the Appendix.

CONSTRUCTION NOISE CONSIDERATIONS

A key element of a highway traffic noise study is the consideration of construction noise. 23 CFR 772 requires the evaluation of construction noise and the possible mitigation of impacts if they should occur. Construction noise is defined like that of noise in general, being any unwanted or undesirable sound that can adversely affect the quality of people's lives. In addition, construction noise can be perceived as any loud, disruptive, impulsive and uncontrollable sound occurring unexpectedly and/or at undesirable times of day. Depending on the construction site location, noise can be unwelcomed during nighttime hours or daytime hours. Loud noises may interfere with speech and activities of humans and other species. Construction noise may affect species such as domestic and wild animals in terms of mating, nesting, feeding activities and migration.[6]

The purpose of construction noise assessments is to obtain information on impacts and evaluate possible mitigation strategies if impacts occur. General construction noise criteria include identifying and determining the following factors:

- Areas of potential impact (direct and indirect)
- Existing noise levels
- Construction operations
- Time of operations (day, night, holidays, weekends)
- Adjacent land uses (residential, commercial, rural)
- Duration and frequency of noise
- Assessment methods
- Any differences in existing and expected noise levels
- Impacts and mitigation (if necessary)

Areas along the project corridor may be affected by construction noise. It is expected that those individuals living and working near the project area will experience construction noise impacts. Impacts may also affect wildlife and domestic animals living near the project. Possible noise generating construction activities may include earth moving, hauling of debris and paving. To mitigate any expected construction noise, low-cost, easy-to-implement measures can be implemented.

[6] Federal Highway Administration Highway Construction Noise Handbook.

These include choosing work hours and locations of haul roads that least impact the area, requiring mufflers on equipment, and elimination of unnecessary noises such as “tail gate banging”.[7] However, impacts are not expected to be substantial since project work hours should occur during normal weekday work hours.

SUMMARY

A detailed traffic noise analysis was conducted for the existing, future no build and future build scenarios for the Parkway. In all, 108 receivers were analyzed using TNM 2.5 (Traffic Noise Model) software. The analysis determined potential noise impacts would occur for some receivers adjacent to the proposed project corridor. Noise abatement measures were considered and evaluated where noise impacts occurred. Four noise barriers were considered and analyzed along the project corridor. Utilizing the SCDOT noise abatement policy (effective date 10/10/19) these four barriers did not meet the established feasibility criteria and their construction was determined not to be feasible.

[7] Highway Traffic Noise Analysis and Abatement Policy and Guidance. USDOT FHWA Office of Environmental and Planning Noise and Air Quality Branch. Washington D.C. June 1995.

APPENDIX

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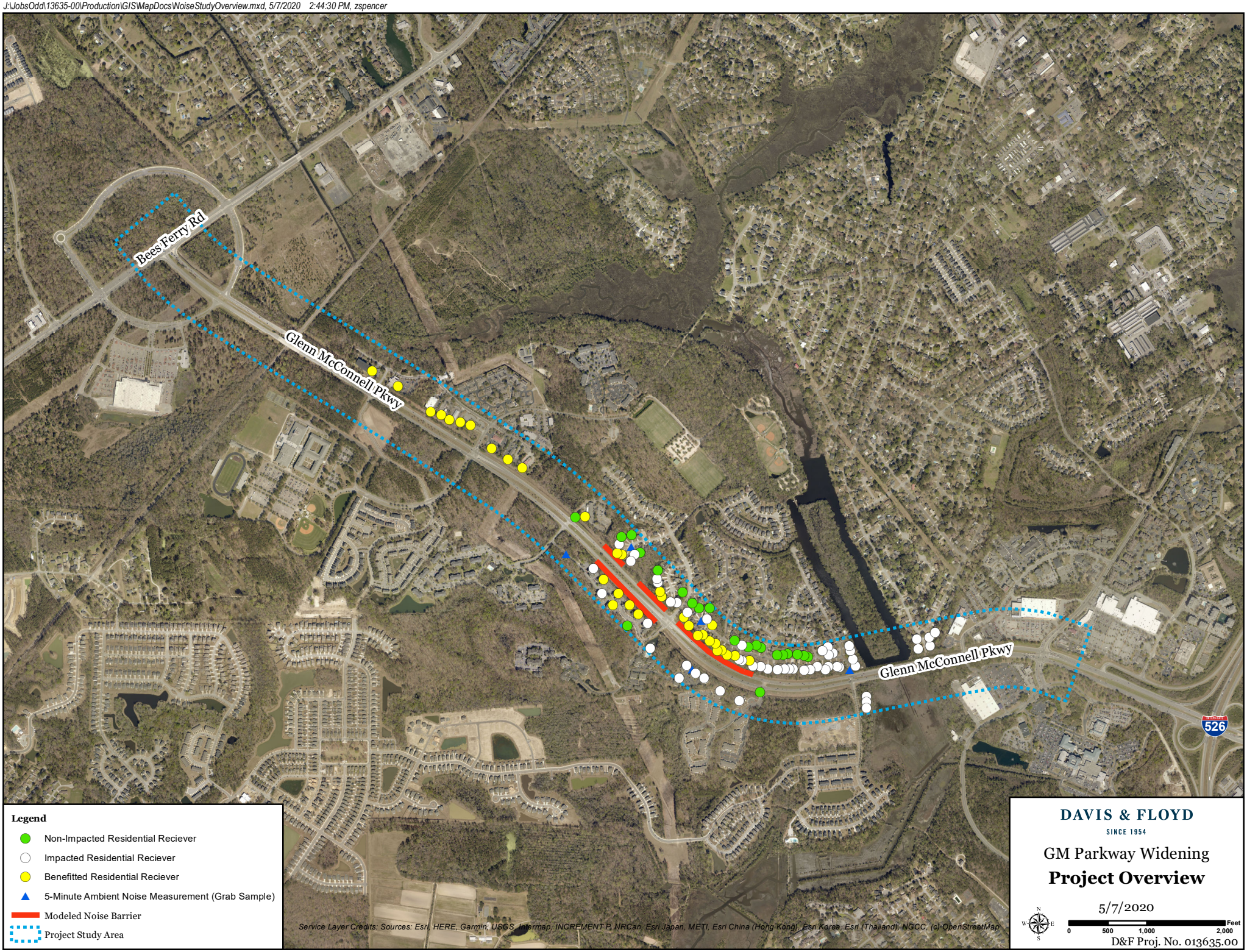

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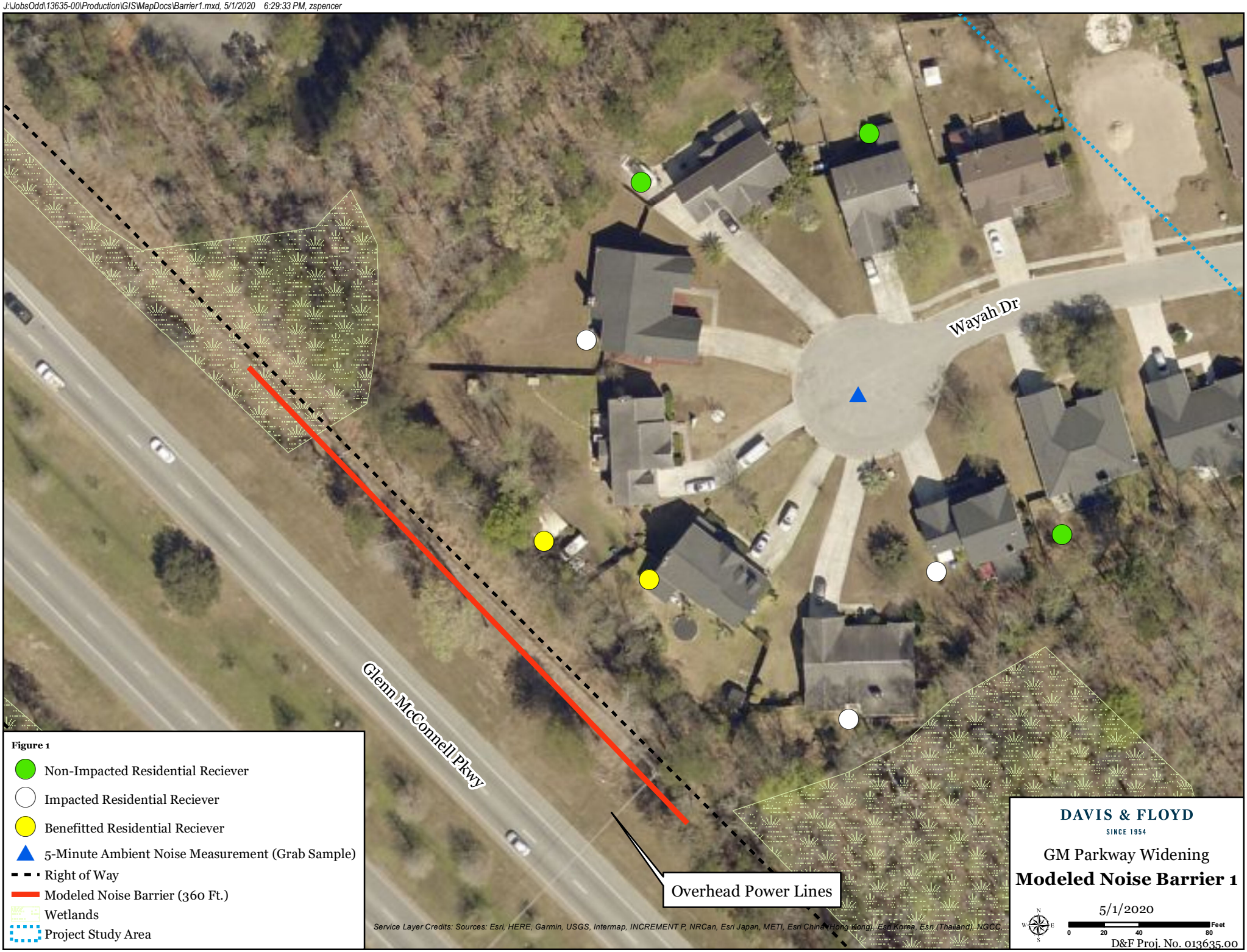

Figure 1

- Non-Impacted Residential Reciever
- Impacted Residential Reciever
- Benefitted Residential Reciever
- 5-Minute Ambient Noise Measurement (Grab Sample)
- Right of Way
- Modeled Noise Barrier (360 Ft.)
- Wetlands
- Project Study Area

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC,

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SINCE 1954

GM Parkway Widening

Modeled Noise Barrier 1

5/1/2020

0 20 40 80 Feet

D&F Proj. No. 013635.00

SCDOT Feasibility and Reasonableness Worksheet

Date: Apr 28, 2020

Project Name Glenn McConnell Parkway

Highway Traffic Noise Abatement Measure Noise Barrier #1

Feasibility

Number of Impacted Receivers: 5

Number of Benefited Receivers: 2

Percentage of Impacted Receivers that would achieve a 5 dBA reduction from the proposed noise abatement measure: 40

Is the proposed noise abatement measure acoustically feasible?
NOTE:SCDOT Policy indicates that 75% of the impacted receivers must achieve at least a 5 dBA reduction for it to be acoustically feasible.

☐ Yes ☒ No

Would any of the following issues limit the ability of the abatement measure to achieve the noise reduction goal?

Topography	☐ Yes	☒ No
Safety	☐ Yes	☒ No
Drainage	☐ Yes	☒ No
Utilities	☒ Yes	☐ No
Maintenance	☐ Yes	☒ No
Access	☐ Yes	☒ No
Exposed Height of Wall	☐ Yes	☒ No

If "Yes" was marked for any of the questions above, please explain below.

Detailed Description

Barrier 1 would be in conflict with an existing overhead power line that runs across the Parkway at this location and then turns and parallels the west bound lanes of the Parkway. In addition, there is a wetland located at the west end of the wall prohibiting the barrier from being lengthened any farther.

Reasonableness

According to 23 CFR 772.13(d)(2)(iv) the abatement measure must collectively achieve each of these criteria to be reasonable. Therefore if any of the three mandatory reasonable factors are not achieved, then the abatement measure is determined NOT to be reasonable. When completing the form it is not necessary to detail each of the criteria if one was determined not to be reasonable.

#1: Noise Reduction Design Goal

Number of Benefited Receivers: 2

Number of Benefited Receivers that achieve at least an 8 dBA reduction: 1

Percentage of Benefited Receivers in the first two building rows that would achieve at least a 8 dBA reduction from the proposed noise abatement measure. NOTE: SCDOT Policy indicates that 80% of the benefited receivers in the first two building rows must achieve at least a 8 dBA reduction for it to be reasonable.: 50

Does the proposed noise abatement measure meet the noise reduction design goal? ☐ Yes ☒ No

If "Yes" is marked, continue to #2. If "No" is marked, then abatement is determined NOT to be reasonable.

#2: Cost Effectiveness

Estimated cost per square foot for noise abatement measure:

Estimated construction cost for noise abatement measure:

Estimated cost per Benefited Receiver:

Based on the SCDOT policy of $30,000 per Benefited Receiver, would the abatement measure be reasonable? NOTE: SCDOT Policy states that the preliminary noise analysis is based on $35.00 per square foot and a more project-specific construction cost should be applied at a cost per square foot basis during the detailed noise abatement evaluation. ☐ Yes ☐ No

If "Yes" is marked, continue to #3. If "No" is marked, then abatement is determined NOT to be reasonable.

#3: Viewpoints of the property owners and residents of the benefitted receivers

Number of Benefited Receivers (same as above):

Number of Benefited Receivers in **support** of noise abatement measure:

Percentage of Benefited Receivers in **support** of noise abatement measure:

Number of Benefited Receivers **opposed** to noise abatement measure:

Percentage of Benefited Receivers **opposed** to noise abatement measure:

Number of Benefited Receivers **that did not respond** to solicitation on noise abatement measure:

Percentage of Benefited Receivers **that did not respond** to solicitation on noise abatement measure:

Based on the viewpoints of the property owners and residents of the Benefited Receivers, would the abatement measure be reasonable? NOTE: SCDOT Policy indicates that the noise abatement shall be constructed unless greater than 50% of the benefited receptors are opposed to noise abatement. ☐ Yes ☐ No

Final Determination for Noise Abatement Measure

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Figure 2

- Non-Impacted Residential Reciever
- Impacted Residential Reciever
- Benefitted Residential Reciever
- 5-Minute Ambient Noise Measurement (Grab Sample)
- Right of Way
- Modeled Noise Barrier (500 Ft.)
- Wetlands
- Project Study Area

DAVIS & FLOYD
SINCE 1954

GM Parkway Widening

Modeled Noise Barrier 2

4/30/2020

0 25 50 100 Feet

D&F Proj. No. 013635.00

SCDOT Feasibility and Reasonableness Worksheet

Date: Apr 28, 2020

Project Name Glenn McConnell Parkway

Highway Traffic Noise Abatement Measure Noise Barrier #2

Feasibility

Number of Impacted Receivers: 6

Number of Benefited Receivers: 2

Percentage of Impacted Receivers that would achieve a 5 dBA reduction from the proposed noise abatement measure: 33

Is the proposed noise abatement measure acoustically feasible?
NOTE:SCDOT Policy indicates that 75% of the impacted receivers must achieve at least a 5 dBA reduction for it to be acoustically feasible.

☐ Yes ☒ No

Would any of the following issues limit the ability of the abatement measure to achieve the noise reduction goal?

Topography	☐ Yes	☒ No
Safety	☒ Yes	☐ No
Drainage	☐ Yes	☒ No
Utilities	☐ Yes	☒ No
Maintenance	☐ Yes	☒ No
Access	☐ Yes	☒ No
Exposed Height of Wall	☐ Yes	☒ No

If "Yes" was marked for any of the questions above, please explain below.

Detailed Description

Barrier 2 would be in conflict with an existing intersection (Baird's Cove @ Glenn McConnell Parkway) and could not be extended any farther to the east. A barrier too close to the intersection could reduce driver sight distance and safety.

Reasonableness

According to 23 CFR 772.13(d)(2)(iv) the abatement measure must collectively achieve each of these criteria to be reasonable. Therefore if any of the three mandatory reasonable factors are not achieved, then the abatement measure is determined NOT to be reasonable. When completing the form it is not necessary to detail each of the criteria if one was determined not to be reasonable.

#1: Noise Reduction Design Goal

Number of Benefited Receivers: 2

Number of Benefited Receivers that achieve at least an 8 dBA reduction: 0

Percentage of Benefited Receivers in the first two building rows that would achieve at least a 8 dBA reduction from the proposed noise abatement measure. NOTE: SCDOT Policy indicates that 80% of the benefited receivers in the first two building rows must achieve at least a 8 dBA reduction for it to be reasonable.: 0

Does the proposed noise abatement measure meet the noise reduction design goal? ☐ Yes ☒ No

If "Yes" is marked, continue to #2. If "No" is marked, then abatement is determined NOT to be reasonable.

#2: Cost Effectiveness

Estimated cost per square foot for noise abatement measure:

Estimated construction cost for noise abatement measure:

Estimated cost per Benefited Receiver:

Based on the SCDOT policy of $30,000 per Benefited Receiver, would the abatement measure be reasonable? NOTE: SCDOT Policy states that the preliminary noise analysis is based on $35.00 per square foot and a more project-specific construction cost should be applied at a cost per square foot basis during the detailed noise abatement evaluation. ☐ Yes ☐ No

If "Yes" is marked, continue to #3. If "No" is marked, then abatement is determined NOT to be reasonable.

#3: Viewpoints of the property owners and residents of the benefitted receivers

Number of Benefited Receivers (same as above):

Number of Benefited Receivers in **support** of noise abatement measure:

Percentage of Benefited Receivers in **support** of noise abatement measure:

Number of Benefited Receivers **opposed** to noise abatement measure:

Percentage of Benefited Receivers **opposed** to noise abatement measure:

Number of Benefited Receivers **that did not respond** to solicitation on noise abatement measure:

Percentage of Benefited Receivers **that did not respond** to solicitation on noise abatement measure:

Based on the viewpoints of the property owners and residents of the Benefited Receivers, would the abatement measure be reasonable? NOTE: SCDOT Policy indicates that the noise abatement shall be constructed unless greater than 50% of the benefited receptors are opposed to noise abatement. ☐ Yes ☐ No

Final Determination for Noise Abatement Measure

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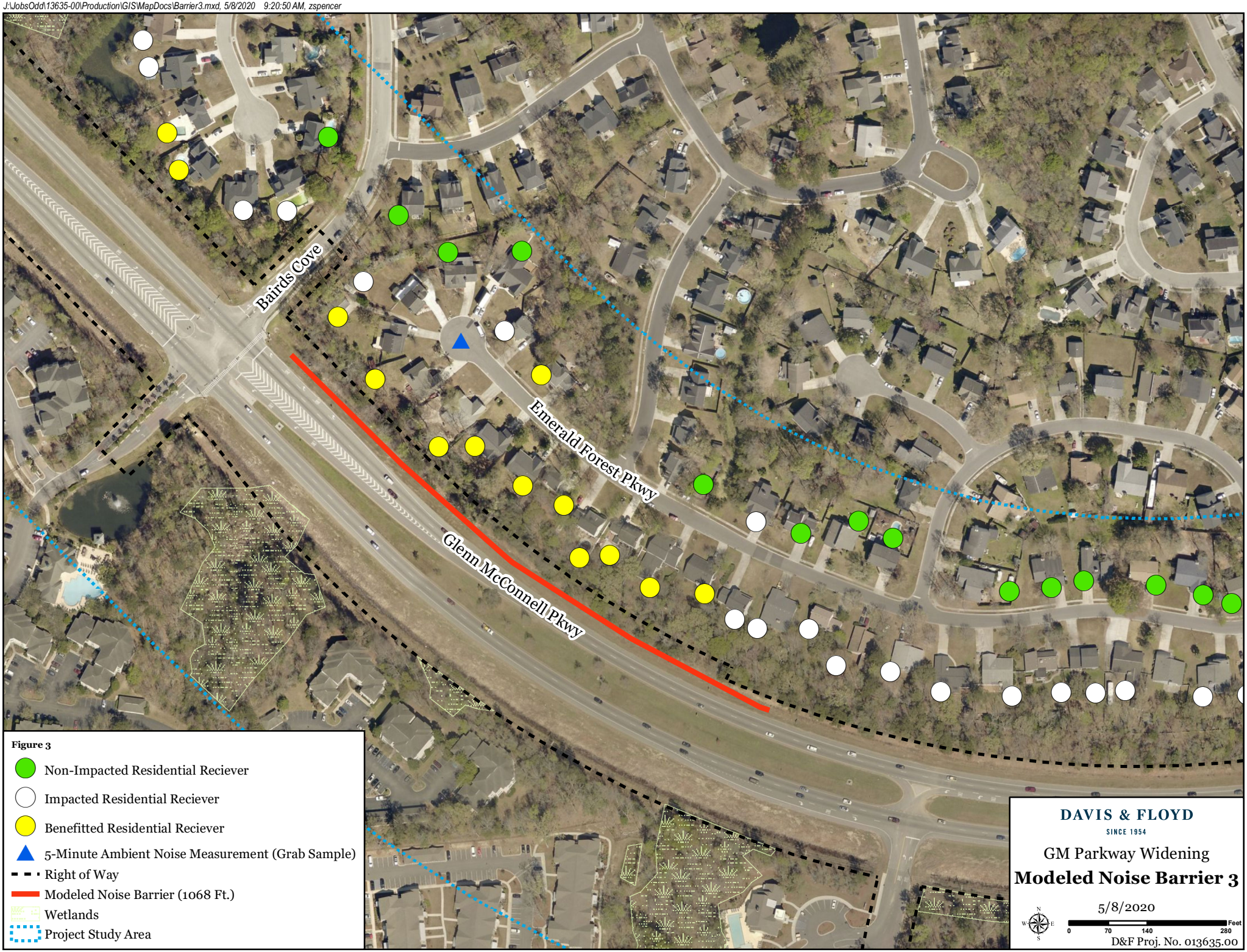

Figure 3

- Non-Impacted Residential Reciever
- Impacted Residential Reciever
- Benefitted Residential Reciever
- 5-Minute Ambient Noise Measurement (Grab Sample)
- Right of Way
- Modeled Noise Barrier (1068 Ft.)
- Wetlands
- Project Study Area

DAVIS & FLOYD
SINCE 1954

GM Parkway Widening

Modeled Noise Barrier 3

5/8/2020

0 70 140 280 Feet

D&F Proj. No. 013635.00

SCDOT Feasibility and Reasonableness Worksheet

Date: Apr 28, 2020

Project Name Glenn McConnell Parkway

Highway Traffic Noise Abatement Measure Noise Barrier #3

Feasibility

Number of Impacted Receivers: 33

Number of Benefited Receivers: 11

Percentage of Impacted Receivers that would achieve a 5 dBA reduction from the proposed noise abatement measure: 33

Is the proposed noise abatement measure acoustically feasible?
NOTE:SCDOT Policy indicates that 75% of the impacted receivers must achieve at least a 5 dBA reduction for it to be acoustically feasible.

☐ Yes ☒ No

Would any of the following issues limit the ability of the abatement measure to achieve the noise reduction goal?

Topography	☐ Yes	☒ No
Safety	☒ Yes	☐ No
Drainage	☐ Yes	☒ No
Utilities	☐ Yes	☒ No
Maintenance	☐ Yes	☒ No
Access	☒ Yes	☐ No
Exposed Height of Wall	☐ Yes	☒ No

If "Yes" was marked for any of the questions above, please explain below.

Detailed Description

Barrier 3 would be in conflict with an existing intersection (Baird's Cove @ Glenn McConnell Parkway) and could not be extended any farther to the west. A barrier too close to the intersection could reduce driver sight distance and safety. A barrier could not be extended farther to the east as the SCDOT right of way is substantially reduced and there would not be enough right of way to be able to construct a barrier.

Reasonableness

According to 23 CFR 772.13(d)(2)(iv) the abatement measure must collectively achieve each of these criteria to be reasonable. Therefore if any of the three mandatory reasonable factors are not achieved, then the abatement measure is determined NOT to be reasonable. When completing the form it is not necessary to detail each of the criteria if one was determined not to be reasonable.

#1: Noise Reduction Design Goal

Number of Benefited Receivers: 11

Number of Benefited Receivers that achieve at least an 8 dBA reduction: 8

Percentage of Benefited Receivers in the first two building rows that would achieve at least a 8 dBA reduction from the proposed noise abatement measure. NOTE: SCDOT Policy indicates that 80% of the benefited receivers in the first two building rows must achieve at least a 8 dBA reduction for it to be reasonable.: 73

Does the proposed noise abatement measure meet the noise reduction design goal? ☐ Yes ☒ No

If "Yes" is marked, continue to #2. If "No" is marked, then abatement is determined NOT to be reasonable.

#2: Cost Effectiveness

Estimated cost per square foot for noise abatement measure:

Estimated construction cost for noise abatement measure:

Estimated cost per Benefited Receiver:

Based on the SCDOT policy of $30,000 per Benefited Receiver, would the abatement measure be reasonable? NOTE: SCDOT Policy states that the preliminary noise analysis is based on $35.00 per square foot and a more project-specific construction cost should be applied at a cost per square foot basis during the detailed noise abatement evaluation. ☐ Yes ☐ No

If "Yes" is marked, continue to #3. If "No" is marked, then abatement is determined NOT to be reasonable.

#3: Viewpoints of the property owners and residents of the benefitted receivers

Number of Benefited Receivers (same as above):

Number of Benefited Receivers in **support** of noise abatement measure:

Percentage of Benefited Receivers in **support** of noise abatement measure:

Number of Benefited Receivers **opposed** to noise abatement measure:

Percentage of Benefited Receivers **opposed** to noise abatement measure:

Number of Benefited Receivers **that did not respond** to solicitation on noise abatement measure:

Percentage of Benefited Receivers **that did not respond** to solicitation on noise abatement measure:

Based on the viewpoints of the property owners and residents of the Benefited Receivers, would the abatement measure be reasonable? NOTE: SCDOT Policy indicates that the noise abatement shall be constructed unless greater than 50% of the benefited receptors are opposed to noise abatement. ☐ Yes ☐ No

Final Determination for Noise Abatement Measure

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Figure 4

- Non-Impacted Residential Reciever
- Impacted Residential Reciever
- Benefitted Residential Reciever
- 5-Minute Ambient Noise Measurement (Grab Sample)
- Right of Way
- Modeled Noise Barrier (1094 Ft.)
- Wetlands
- Project Study Area

DAVIS & FLOYD
SINCE 1954

GM Parkway Widening

Modeled Noise Barrier 4

5/1/2020

0 55 110 220 Feet

D&F Proj. No. 013635.00

SCDOT Feasibility and Reasonableness Worksheet

Date: Apr 28, 2020

Project Name Glenn McConnell Parkway

Highway Traffic Noise Abatement Measure Noise Barrier #4

Feasibility

Number of Impacted Receivers: 122

Number of Benefited Receivers: 113

Percentage of Impacted Receivers that would achieve a 5 dBA reduction from the proposed noise abatement measure: 93

Is the proposed noise abatement measure acoustically feasible?
NOTE:SCDOT Policy indicates that 75% of the impacted receivers must achieve at least a 5 dBA reduction for it to be acoustically feasible.

☒ Yes ☐ No

Would any of the following issues limit the ability of the abatement measure to achieve the noise reduction goal?

Topography	☐ Yes	☒ No
Safety	☒ Yes	☐ No
Drainage	☐ Yes	☒ No
Utilities	☒ Yes	☐ No
Maintenance	☐ Yes	☒ No
Access	☐ Yes	☒ No
Exposed Height of Wall	☐ Yes	☒ No

If "Yes" was marked for any of the questions above, please explain below.

Detailed Description

Barrier 4 would be in conflict with an existing intersection (Water Stone Lane @ Glenn McConnell Parkway) and could not be extended any farther to the east. A barrier too close to the intersection could reduce driver sight distance and safety. A barrier could not be extended farther to the west as an overhead power line parallels the Parkway and crosses the parkway preventing a wall from being constructed.

Reasonableness

According to 23 CFR 772.13(d)(2)(iv) the abatement measure must collectively achieve each of these criteria to be reasonable. Therefore if any of the three mandatory reasonable factors are not achieved, then the abatement measure is determined NOT to be reasonable. When completing the form it is not necessary to detail each of the criteria if one was determined not to be reasonable.

#1: Noise Reduction Design Goal

Number of Benefited Receivers: 113

Number of Benefited Receivers that achieve at least an 8 dBA reduction: 64

Percentage of Benefited Receivers in the first two building rows that would achieve at least a 8 dBA reduction from the proposed noise abatement measure. NOTE: SCDOT Policy indicates that 80% of the benefited receivers in the first two building rows must achieve at least a 8 dBA reduction for it to be reasonable.: 57

Does the proposed noise abatement measure meet the noise reduction design goal? ☐ Yes ☒ No

If "Yes" is marked, continue to #2. If "No" is marked, then abatement is determined NOT to be reasonable.

#2: Cost Effectiveness

Estimated cost per square foot for noise abatement measure:

Estimated construction cost for noise abatement measure:

Estimated cost per Benefited Receiver:

Based on the SCDOT policy of $30,000 per Benefited Receiver, would the abatement measure be reasonable? NOTE: SCDOT Policy states that the preliminary noise analysis is based on $35.00 per square foot and a more project-specific construction cost should be applied at a cost per square foot basis during the detailed noise abatement evaluation. ☐ Yes ☐ No

If "Yes" is marked, continue to #3. If "No" is marked, then abatement is determined NOT to be reasonable.

#3: Viewpoints of the property owners and residents of the benefitted receivers

Number of Benefited Receivers (same as above):

Number of Benefited Receivers in **support** of noise abatement measure:

Percentage of Benefited Receivers in **support** of noise abatement measure:

Number of Benefited Receivers **opposed** to noise abatement measure:

Percentage of Benefited Receivers **opposed** to noise abatement measure:

Number of Benefited Receivers **that did not respond** to solicitation on noise abatement measure:

Percentage of Benefited Receivers **that did not respond** to solicitation on noise abatement measure:

Based on the viewpoints of the property owners and residents of the Benefited Receivers, would the abatement measure be reasonable? NOTE: SCDOT Policy indicates that the noise abatement shall be constructed unless greater than 50% of the benefited receptors are opposed to noise abatement. ☐ Yes ☐ No

Final Determination for Noise Abatement Measure


Glenn McConnell
Parkway Widening