Appendix D

Environmental Noise Assessment

Environmental Noise Assessment

Oak Creek Canyon 6-Lot Subdivision

Clayton, California

BAC Job # 2017-163

Prepared For:

Raney Planning & Management, Inc.

Attn: Mr. Nick Pappani
1501 Sports Drive
Sacramento, CA 95834

Prepared By:

Bollard Acoustical Consultants, Inc.

Paul Bollard, President

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BOLLARD
Acoustical Consultants

3551 Bankhead Road • Loomis, CA 95650 • Phone: (916) 663-0500 • Fax: (916) 663-0501 • BACNOISE.COM

Introduction

The Oak Creek Canyon 6-Lot Subdivision (project) proposes to construct 6 single-family residential lots in Clayton, California. The project area and site plan are presented as Figures 1 and 2, respectively.

This analysis focuses on future exterior and interior traffic noise levels at the proposed residential lots, off-site traffic noise generation, and construction activity noise generation. Specific noise mitigation recommendations are provided in this analysis to mitigate project noise impacts.

Noise Fundamentals and Terminology

Noise is often described as unwanted sound. Sound is defined as any pressure variation in air that the human ear can detect. If the pressure variations occur frequently enough (at least 20 times per second), they can be heard, and thus are called sound. Measuring sound directly in terms of pressure would require a very large and awkward range of numbers. To avoid this, the decibel scale was devised. The decibel scale allows a million-fold increase in pressure to be expressed as 120 dB. Another useful aspect of the decibel scale is that changes in levels (dB) correspond closely to human perception of relative loudness. Appendix A contains definitions of Acoustical Terminology. Figure 3 shows common noise levels associated with various sources.

The perceived loudness of sounds is dependent upon many factors, including sound pressure level and frequency content. However, within the usual range of environmental noise levels, perception of loudness is relatively predictable, and can be approximated by weighing the frequency response of a sound level meter by means of the standardized A-weighing network. There is a strong correlation between A-weighted sound levels (expressed as dBA) and community response to noise. For this reason, the A-weighted sound level has become the standard tool of environmental noise assessment. All noise levels reported in this section are in terms of A-weighted levels in decibels.

Community noise is commonly described in terms of the “ambient” noise level, which is defined as the all-encompassing noise level associated with a given noise environment. A common statistical tool to measure the ambient noise level is the average, or equivalent, sound level (L_{eq}) over a given time period (usually one hour). The L_{eq} is the foundation of the Day-Night Average Level noise descriptor, L_{dn}, and shows very good correlation with community response to noise.

Legend

Traffic Noise Measurement Location

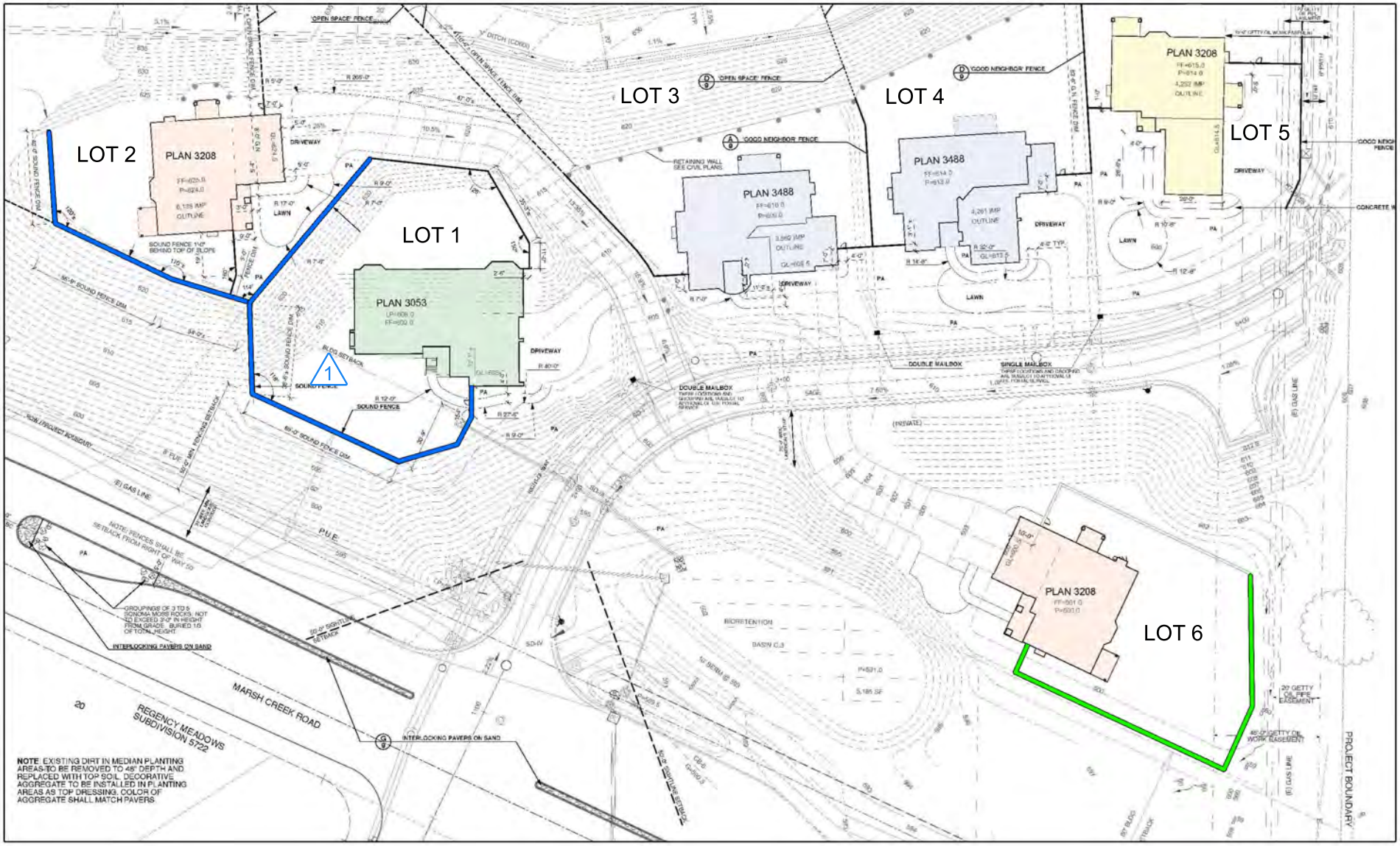
N

Scale (feet)

0 125 200

Figure 1

Traffic Noise Monitoring Location
Oak Creek Canyon 6 Lot Subdivision
Clayton, California



Legend

- Traffic Noise Measurement Location
- Proposed 6-Foot Tall Sound Wall
- Recommended 6-Foot Tall Sound Wall

N

Scale (feet)

0 40 80

Figure 2

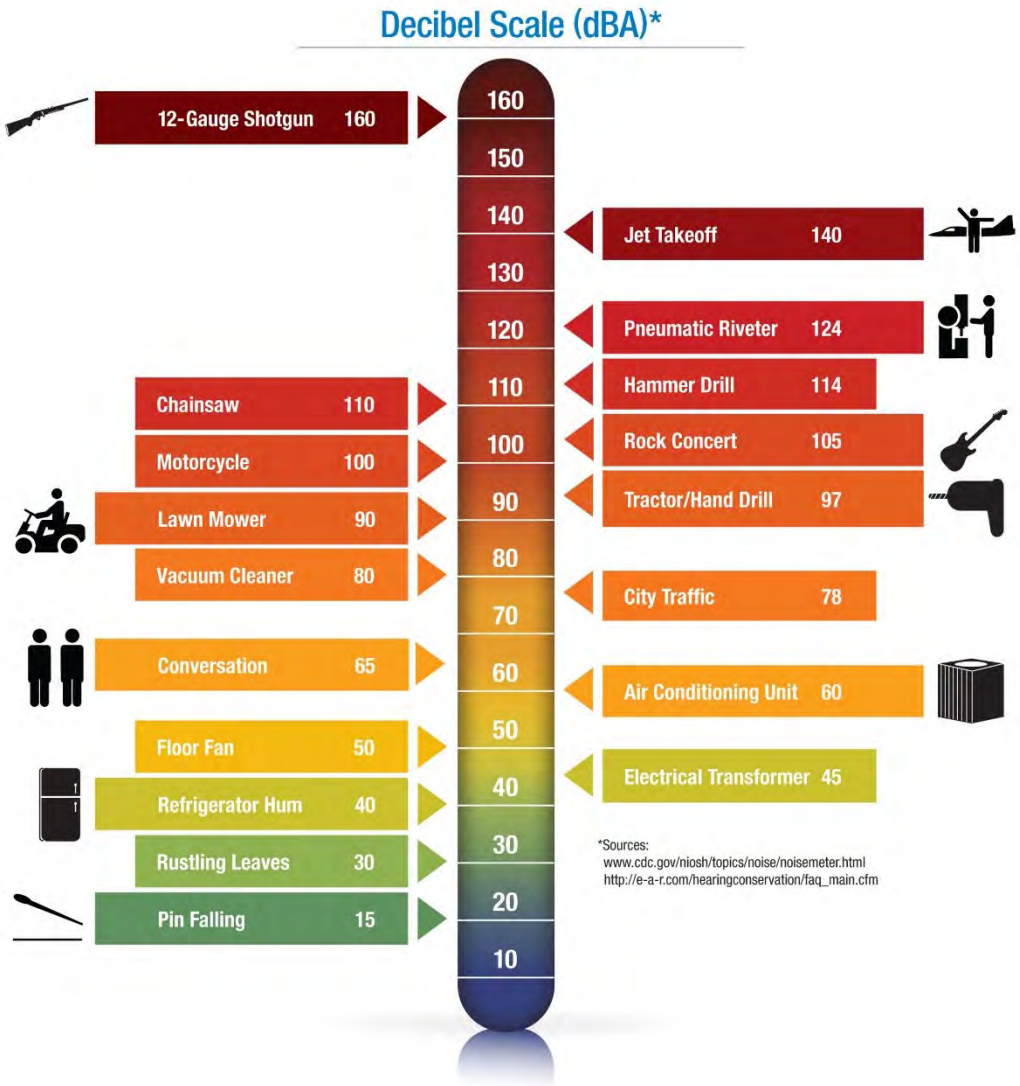
Proposed Site Plan

Oak Creek Canyon 6 Lot Subdivision

Clayton, California

The Day-Night Average Level (L_{dn}) is based upon the average noise level over a 24-hour day, with a +10 decibel weighing applied to noise occurring during nighttime (10:00 p.m. to 7:00 a.m.) hours. The nighttime penalty is based upon the assumption that people react to nighttime noise exposures as though they were twice as loud as daytime exposures. Because L_{dn} represents a 24-hour average, it tends to disguise short-term variations in the noise environment. L_{dn}-based noise standards are commonly used to assess noise impacts associated with traffic, railroad and aircraft noise sources.

Figure 3
Typical A-Weighted Sound Levels of Common Noise Sources



Criteria for Acceptable Noise Exposure

City of Clayton General Plan

For transportation noise sources (traffic, rail, aircraft) affecting new residential land uses, the Noise Element of the City of Clayton General Plan establishes an exterior noise level standard of 60 dB L_{dn}, applied at outdoor activity areas of the residential uses. The intent of this standard is to provide an acceptable exterior noise environment for outdoor activities. Additionally, the City of Clayton utilizes an interior transportation noise level standard of 45 dB L_{dn} or less within noise-sensitive residential dwellings. The intent of this interior noise limit is to provide a suitable environment for indoor communication and sleep.

Existing Ambient Noise Environment at the Project Site

The existing ambient noise environment at the project site is primarily defined by traffic on Marsh Creek Road. To generally quantify existing noise levels at the project site, BAC conducted a long-term (48-hour) noise level survey on the project site from September 13 to September 15, 2017. The ambient noise level measurement location, identified as Site 1 on Figure 1, was selected to quantify existing traffic noise exposure from Marsh Creek Road.

A Larson Davis Laboratories (LDL) Model 820 precision integrating sound level meter was used to conduct the noise level survey. The meter was calibrated before use with an LDL Model CAL200 acoustical calibrator to ensure the accuracy of the measurements. The equipment used meets all pertinent specifications of the American National Standards Institute for Type 1 sound level meters (ANSI S1.4).

A summary of the continuous noise level measurement results are shown in Table 1. Detailed monitoring results are provided numerically in Appendix B and graphically in Appendix C. The Table 1 data indicate that measured ambient day-night average noise levels at the project site exceeded the City of Clayton 60 dB L_{dn} exterior noise level standard.

Table 1
Summary of Long-Term Ambient Noise Monitoring Results[1]
Oak Creek Canyon 6-Lot Subdivision – Clayton, California

Date	L_{dn}, dB	Average Measured Hourly Noise Levels (dB)					
		Daytime (7 a.m. to 10 p.m.)			Nighttime (10 p.m. to 7 a.m.)		
		L_{eq}	L_{50}	L_{max}	L_{eq}	L_{50}	L_{max}
Site 1 – Approximately 100 feet from centerline of Marsh Creek Road							
September 13-14, 2017	66	62	56	77	59	46	73
September 14-15, 2017	64	61	55	74	57	37	70

Notes:
[1] The long-term ambient noise monitoring location is identified on Figures 1 and 2.
Source: Bollard Acoustical Consultants, Inc. (2017)

Evaluation of Future Traffic Noise Levels at Proposed Residences

Traffic Noise Prediction Methodology

The Federal Highway Administration Highway Traffic Noise Prediction Model (FHWA-RD-77-108) was used to predict traffic noise levels at the project site. The model is based upon the CALVENO noise emission factors for automobiles, medium trucks and heavy trucks, with consideration given to vehicle volume, speed, roadway configuration, distance to the receiver, and the acoustical characteristics of the site. The FHWA Model was developed to predict hourly L_{eq} values for free flowing traffic conditions, and is considered to be accurate within 1.5 dB in most situations.

Traffic Noise Prediction Model Calibration

According to the City of Clayton planning staff, the segment of Marsh Creek Road adjacent to the project site currently experiences an average daily traffic (ADT) volume of 8,154. Assuming vehicle speeds of 50 MPH, medium- and heavy-truck mix of 2%/2%, and an existing volume of 8,154, the FHWA Model predicts a roadway noise level of 64 dB L_{dn}, 100 feet from the centerline of Marsh Creek Road. The traffic noise level measurement results presented in Table 1, conducted 100 feet from the centerline of Marsh Creek Road, indicate existing traffic noise levels ranged from 64 to 66 dB L_{dn} during the monitoring period. Because the measured traffic noise levels are within 0-2 dB of the predicted FHWA Model traffic noise levels, no model calibration adjustment would be warranted.

Predicted Future Traffic Noise Levels at the Project Site

The FHWA Model was used with future traffic data to predict future traffic noise levels at the proposed noise outdoor activity areas of the development. Future average daily traffic was conservatively estimated by assuming a doubling of traffic volumes relative to existing conditions. As mentioned previously, existing traffic counts for Marsh Creek Road were obtained from the City of Clayton planning staff. The FHWA Model inputs and predicted future traffic noise levels at the project site are shown in Appendix D. The predicted future traffic noise levels at the project lots are summarized below in Table 2. The predicted future traffic noise levels presented below take into account the proposed traffic noise barrier at Lots 1 and 2. The location of the proposed barrier is shown on Figure 2.

Table 2
Predicted Future Exterior Traffic Noise Levels[1]
Oak Creek Canyon 6-Lot Subdivision – Clayton, California

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
Setbacks distances from centerline of Marsh Creek Road (feet)[2]						
Backyard Area	110	140	260	330	410	140
Building Facade	130	140	210	260	330	140
Predicted Future Exterior Traffic Noise Levels, L_{dn} (dB)[3,4]						
Backyard Area	58	55	56	54	53	65
1st Floor Facades	57	55	62	61	59	65
2nd Floor Facades	68	68	65	64	62	68

Notes:
1 Detailed FHWA Model inputs and results are provided in Appendix D.
2 Distances were measured from the centerline of Marsh Creek Road to the nearest outdoor activity areas and building facades.
3 At the backyards and 1st floor facades of Lots 1 and 2, the predicted traffic noise levels include the attenuation provided by the proposed property line 6-foot tall CMU noise barriers. Project topography was accounted for in the noise barrier calculations, provided as Appendix E. No noise barrier offsets were applied at elevated, unshielded upper floor facades.
4 A +3 dB offset was applied to the 2nd floor facades due to reduced ground absorption at elevated floor levels.

Source: Bollard Acoustical Consultants, Inc. (2017)

With the exception of Lot 6, the Table 2 data indicate that future traffic noise levels at the proposed outdoor activity areas of the development are predicted to satisfy the City of Clayton 60 dB L_{dn} exterior noise level standard. Therefore, additional analysis is required to ensure compliance with the City's exterior traffic noise level standard at Lot 6.

At the nearest proposed 2nd floor building façades (Lots 1, 2, 6) the Table 2 data indicate that predicted future traffic noise exposure would be approximately 68 dB L_{dn}. This information is used in a subsequent section of this report to assess compliance with the City's interior traffic noise level standard.

Exterior Traffic Noise Mitigation

As shown in Table 2, future Marsh Creek Road traffic noise levels are predicted to be 65 dB L_{dn} within the backyard of Lot 6, exceeding the City of Clayton exterior noise level standard of 60 dB L_{dn} by 5 dB. An analysis of noise barrier effectiveness was conducted for Lot 6 to determine the required noise barrier height to sufficiently reduce traffic noise levels below the city's exterior criteria. The noise barrier effectiveness prediction worksheet is provided as Appendix E. According to the worksheet, which account for the project grading, a 6-foot noise barrier would reduce to Marsh Creek Road traffic noise levels to 58 dB L_{dn}, satisfying the 60 dB L_{dn} standard. The location of the recommended noise barrier is shown on Figure 2. No further consideration of exterior traffic noise mitigation measures would be warranted for the development.

Interior Traffic Noise Mitigation

Future exterior noise levels at the first-floor facades nearest to the adjacent roadways are predicted to be 55-62 dB L_{dn}. Due to reduced ground absorption at elevated positions and lack of shielding by the proposed and recommended noise barriers, noise levels at the second-floor facades of residences are predicted to be 62-68 dB L_{dn}. In order to satisfy the City of Clayton 45 dB L_{dn} interior noise level standard, minimum noise reductions of 17 and 23 dB would be required of the first- and upper-floor building facades, respectively.

Standard residential construction (stucco siding, STC-27 windows, door weather-stripping, exterior wall insulation, composition plywood roof) typically results in an exterior to interior noise reduction of about 25 dB with windows closed, and approximately 15 dB with windows open. Therefore, standard construction practices would be adequate for both first-floor and elevated upper-floor facades of all residences in the development. Mechanical ventilation (air conditioning) should be provided for all residences within this development to allow the occupants to close doors and windows as desired for additional acoustical isolation. No further consideration of interior traffic noise mitigation measures would be warranted for the development.

Evaluation of Off-Site Traffic Noise Level Increases

To assess noise impacts due to project-related traffic increases on the local roadway network, BAC utilized Institute of Transportation Engineers (ITE) trip generation rates in conjunction with the measured existing traffic noise exposure on Marsh Creek Road. According to ITE, a single-family residential unit generates approximately 10 trips per day. Assuming the 6 proposed residential units generate 10 trips per day, the project would result in an additional 60 vehicle trips on Marsh Creek Road during an annual average day. Assuming a vehicle speed of 50 mph, 60 vehicle trips, and a distance of 100 feet from the centerline of Marsh Creek Road, the predicted traffic noise level from the project alone would be 41 dB L_{dn}. As mentioned previously, existing Marsh Creek traffic noise levels were measured to be 64-66 dB L_{dn}. As a result, the additional trips would result in a traffic noise level of increase of less than 0.1 dB L_{dn}.

Therefore, no significant noise impacts due to project-generated traffic are identified for this project.

Evaluation of Construction Noise at Nearest Existing Residences

During project construction, heavy equipment would be used for grading excavation, paving, and building construction, which would increase ambient noise levels when in use. Noise levels would vary depending on the type of equipment used, how it is operated, and how well it is maintained. Noise exposure at any single point outside the project site would also vary depending on the proximity of construction activities to that point. Standard construction equipment, such as graders, backhoes, loaders, and trucks, would likely be used for this work.

The range of maximum noise levels for various types of construction equipment at a distance of 50 feet is depicted in Table 3. The noise values represent maximum noise generation, or full-power operation of the equipment. As one increases the distance between equipment, or increases separation of areas with simultaneous construction activity, dispersion and distance attenuation reduce the effects of combining separate noise sources.

Table 3
Construction Equipment Noise Emission Levels

Equipment	Typical Sound Level (dBA) 50 Feet from Source
Air compressor	81
Backhoe	80
Compactor	82
Concrete mixer	85
Concrete pump	82
Concrete vibrator	76
Crane, mobile	83
Dozer	85
Generator	81
Grader	85
Impact wrench	85
Jackhammer	88
Loader	85
Paver	89
Pneumatic tool	85
Pump	76
Roller	74
Saw	76

Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration, Table 12-1. (May 2006)

The nearest sensitive receptors to the proposed project are single-family residences located immediately south of the project site. The nearest sensitive land uses are located at least 100 feet from construction activities which would occur on the project site. As shown in Table 3, construction activities typically generate noise levels ranging from approximately 75 to 90 dB L_{max} at a reference distance of 50 feet from the construction activities. The noise levels from construction operations decrease at a rate of approximately 6 dB per doubling of distance from the source. As a result, maximum construction noise levels would range from 69 to 84 dB L_{max} at the nearest existing residences. In addition, typical residential construction provides a noise level reduction of approximately 25 dBA with the windows closed, which would reduce the maximum noise levels within residences to approximately 44 to 59 dB L_{max}.

Noise generated by project construction could exceed the City's standards for short duration events near residential areas, but such noise would be short-term in duration and would not likely substantially exceed existing ambient noise levels cause by local traffic on Marsh Creek Road. Nonetheless, the following construction noise mitigation measures should be utilized to the extent practical to minimize the potential for adverse public reaction to project construction noise.

- Project construction activities should be limited to daytime hours unless conditions warrant that certain construction activities occur during evening or early morning hours (i.e. extreme heat).
- All noise-producing project equipment and vehicles using internal-combustion engines shall be equipped with manufacturers-recommended mufflers and be maintained in good working condition.
- All mobile or fixed noise-producing equipment used on the project site that are regulated for noise output by a federal, state, or local agency shall comply with such regulations while in the course of project activity.
- Electrically powered equipment shall be used instead of pneumatic or internal-combustion-powered equipment, where feasible.
- Material stockpiles and mobile equipment staging, parking, and maintenance areas shall be located as far as practicable from noise-sensitive receptors.
- Construction site and access road speed limits shall be established and enforced during the construction period.

Conclusions and Recommendations

The preceding analysis focused on exterior and interior traffic noise levels at the proposed residences, off-site traffic noise generation, and construction activity noise generation. In order to ensure compliance with the City of Clayton General Plan noise level standards, the following activity-specific mitigation measures are recommended:

Residential Lots:

1) The construction, as proposed, of a 6-foot tall CMU wall providing shielding of traffic noise for Lots 1 and 2. The location of the proposed noise barrier is shown on Figure 2.

2) The construction of a recommended 6-foot tall CMU wall providing shielding of traffic noise for Lot 6. The location of the recommended noise barrier is shown on Figure 2.

   Suitable materials for the traffic noise barriers include masonry and precast concrete panels. Other materials may be acceptable but should be reviewed by an acoustical consultant prior to use.

3) Standard residential construction practices (stucco siding, STC-27 windows, door weather-stripping, exterior wall insulation, composition plywood roof) would be adequate for all proposed residences.

4) Mechanical ventilation (air conditioning) should be provided for all residences in this development to allow the occupants to close doors and windows as desired to achieve compliance with the applicable interior noise level criteria.

Project Construction:

1) All construction activities must adhere to the City's requirements with respect to hours of construction.

2) Construction equipment must have appropriate sound muffling devices, which shall be properly maintained and used at all times such equipment is in operation.

3) The construction contractor shall locate on-site equipment staging areas so as to maximize the distance between construction-related noise sources and noise-sensitive receptors nearest the project construction areas.

These conclusions are based on the collected noise level data at the project site, the site plan shown on Figure 2, and on noise reduction data for standard residential dwellings and for typical STC rated window data. Deviations from the project site plan shown on Figure 2, could cause future traffic noise levels to differ from those predicted in this analysis. In addition, Bollard Acoustical Consultants, Inc. is not responsible for degradation in acoustic performance of the

building construction due to poor construction practices, failure to comply with applicable building code requirements, or for failure to adhere to the minimum building practices cited in this report.

This concludes BAC's traffic noise assessment for the proposed Oak Creek Canyon 6-Lot Subdivision in Clayton, California. Please contact BAC at (916) 663-0500 or paulb@bacnoise.com with any questions regarding this assessment.

Appendix A

Acoustical Terminology

Acoustics	The science of sound.
Ambient Noise	The distinctive acoustical characteristics of a given space consisting of all noise sources audible at that location. In many cases, the term ambient is used to describe an existing or pre-project condition such as the setting in an environmental noise study.
Attenuation	The reduction of an acoustic signal.
A-Weighting	A frequency-response adjustment of a sound level meter that conditions the output signal to approximate human response.
Decibel or dB	Fundamental unit of sound, A Bell is defined as the logarithm of the ratio of the sound pressure squared over the reference pressure squared. A Decibel is one-tenth of a Bell.
CNEL	Community Noise Equivalent Level. Defined as the 24-hour average noise level with noise occurring during evening hours (7 - 10 p.m.) weighted by a factor of three and nighttime hours weighted by a factor of 10 prior to averaging.
Frequency	The measure of the rapidity of alterations of a periodic signal, expressed in cycles per second or hertz.
Ldn	Day/Night Average Sound Level. Similar to CNEL but with no evening weighting.
Leq	Equivalent or energy-averaged sound level.
Lmax	The highest root-mean-square (RMS) sound level measured over a given period of time.
Loudness	A subjective term for the sensation of the magnitude of sound.
Masking	The amount (or the process) by which the threshold of audibility is for one sound is raised by the presence of another (masking) sound.
Noise	Unwanted sound.
Peak Noise	The level corresponding to the highest (not RMS) sound pressure measured over a given period of time. This term is often confused with the Maximum level, which is the highest RMS level.
RT_{60}	The time it takes reverberant sound to decay by 60 dB once the source has been removed.
Sabin	The unit of sound absorption. One square foot of material absorbing 100% of incident sound has an absorption of 1 sabin.
SEL	A rating, in decibels, of a discrete event, such as an aircraft flyover or train passby, that compresses the total sound energy of the event into a 1-s time period.
Threshold of Hearing	The lowest sound that can be perceived by the human auditory system, generally considered to be 0 dB for persons with perfect hearing.
Threshold of Pain	Approximately 120 dB above the threshold of hearing.

Appendix B-1
Oak Creek Canyon 6-Lot Subdivision
Ambient Noise Monitoring Results - Site 1
September 13-14, 2017

Hour	Leq	Lmax	L50	L90
12:00	60	76	52	43
13:00	60	76	54	45
14:00	61	77	55	46
15:00	62	80	59	45
16:00	64	82	61	46
17:00	63	74	61	47
18:00	63	76	60	47
19:00	61	79	54	42
20:00	57	73	51	46
21:00	57	71	53	49
22:00	56	73	52	49
23:00	51	70	46	43
0:00	56	91	46	42
1:00	49	66	46	33
2:00	48	68	34	32
3:00	48	67	36	30
4:00	54	73	36	30
5:00	62	76	50	32
6:00	65	77	65	41
7:00	66	77	66	54
8:00	64	80	61	49
9:00	61	75	55	40
10:00	59	77	49	36
11:00	60	80	52	39

	Statistical Summary					
	Daytime (7 a.m. - 10 p.m.)			Nighttime (10 p.m. - 7 a.m.)		
	High	Low	Average	High	Low	Average
Leq (Average)	66	57	62	65	48	59
Lmax (Maximum)	82	71	77	91	66	73
L50 (Median)	66	49	56	65	34	46
L90 (Background)	54	36	45	49	30	37

Computed Ldn, dB	66
% Daytime Energy	78%
% Nighttime Energy	22%

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Appendix B-2
Oak Creek Canyon 6-Lot Subdivision
Ambient Noise Monitoring Results - Site 1
September 14-15, 2017

Hour	Leq	Lmax	L50	L90
12:00	59	77	54	41
13:00	59	75	52	41
14:00	60	74	54	43
15:00	61	72	58	43
16:00	62	75	60	47
17:00	62	77	60	45
18:00	61	75	58	42
19:00	59	72	53	40
20:00	58	70	54	50
21:00	56	75	51	43
22:00	52	72	38	34
23:00	50	69	37	31
0:00	45	68	31	28
1:00	46	67	29	27
2:00	44	63	29	26
3:00	46	68	29	26
4:00	55	75	31	26
5:00	61	74	48	35
6:00	64	76	61	40
7:00	65	77	63	46
8:00	62	74	56	38
9:00	59	73	51	35
10:00	58	73	50	35
11:00	59	71	51	33

	Statistical Summary					
	Daytime (7 a.m. - 10 p.m.)			Nighttime (10 p.m. - 7 a.m.)		
	High	Low	Average	High	Low	Average
Leq (Average)	65	56	61	64	44	57
Lmax (Maximum)	77	70	74	76	63	70
L50 (Median)	63	50	55	61	29	37
L90 (Background)	50	33	41	40	26	31

Computed Ldn, dB	64
% Daytime Energy	79%
% Nighttime Energy	21%

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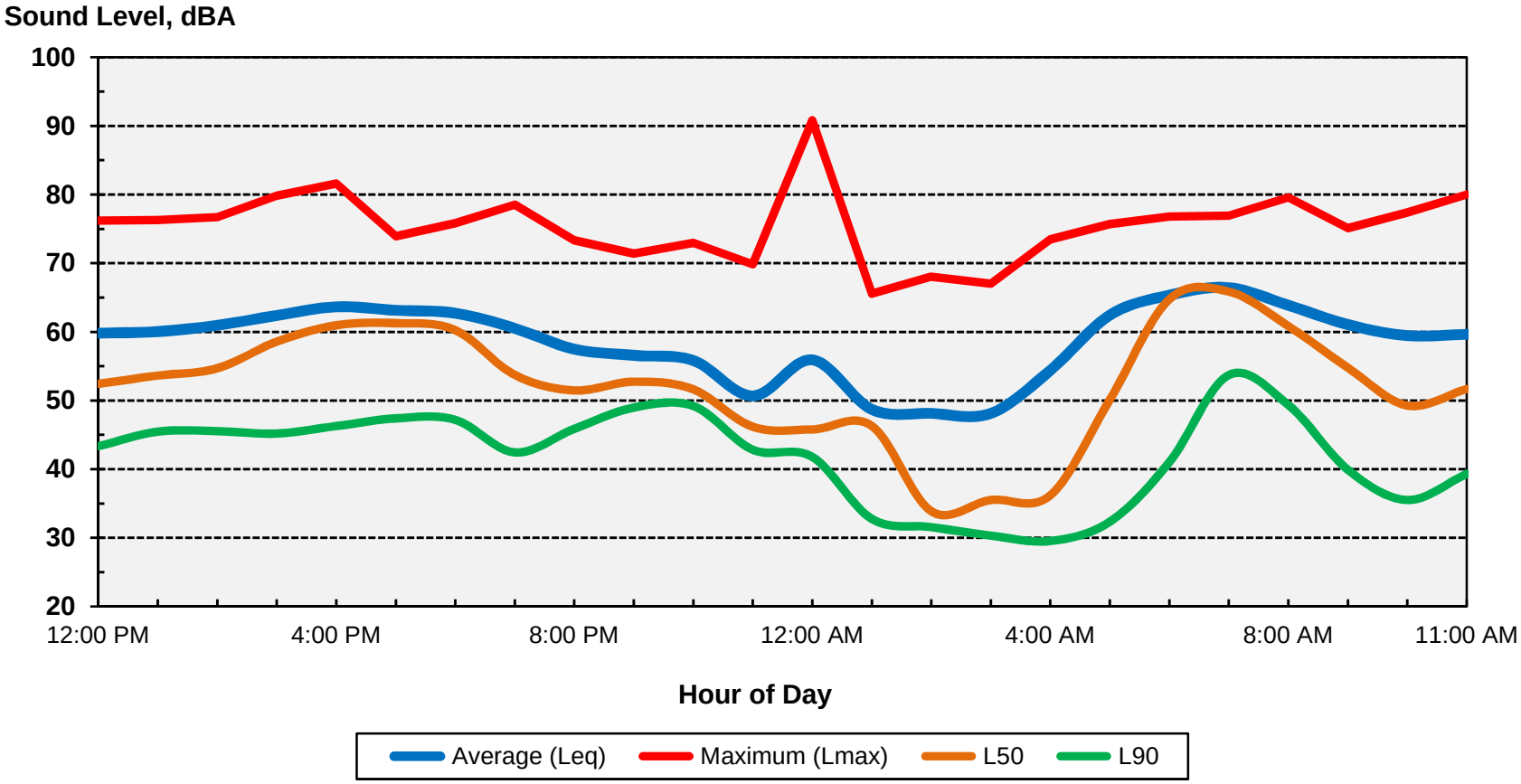
Appendix C-1
Oak Creek Canyon 6-Lot Subdivision
Ambient Noise Monitoring Results - Site 1
September 13-14, 2017



Ldn: 66 dB

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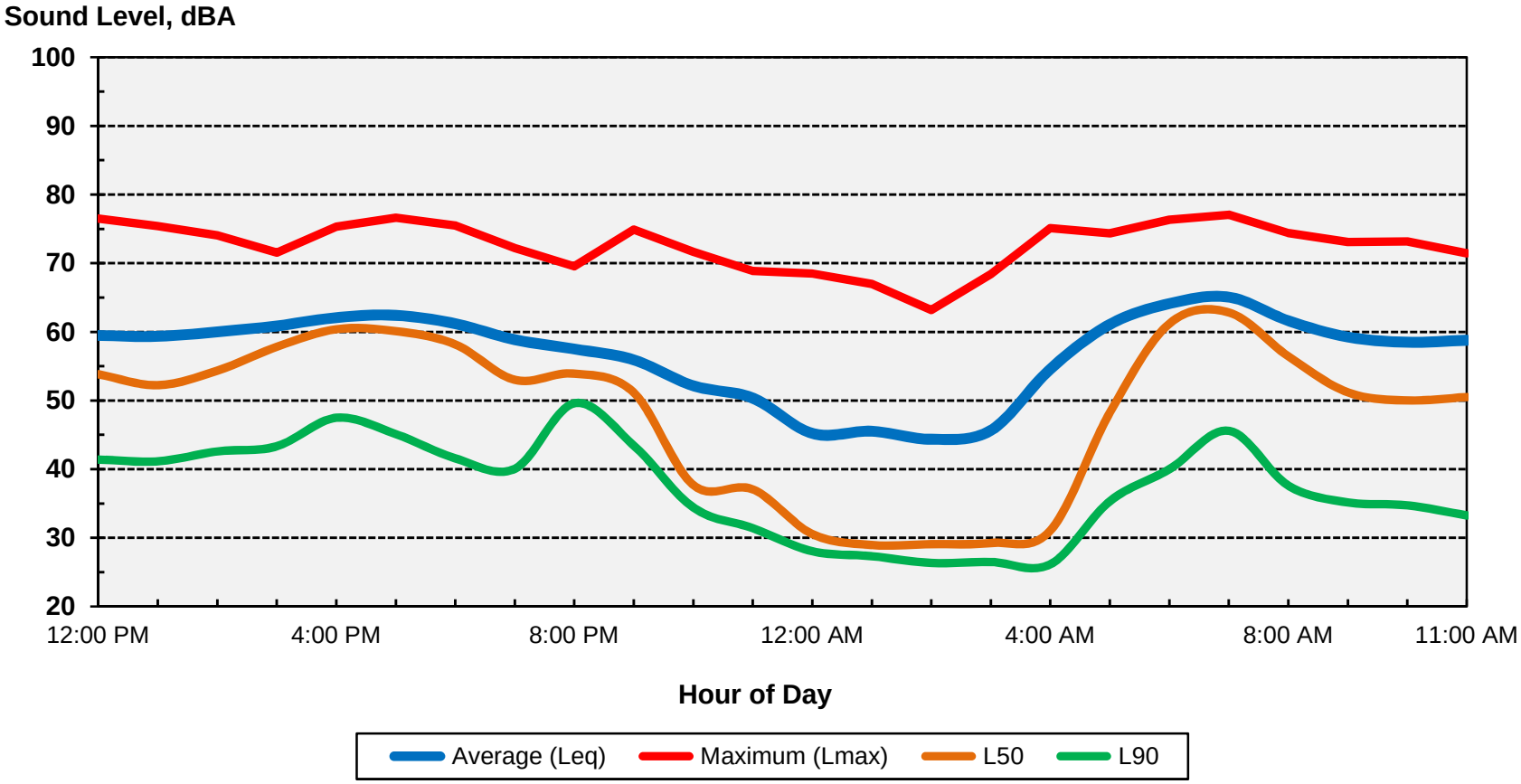
Appendix C-2
Oak Creek Canyon 6-Lot Subdivision
Ambient Noise Monitoring Results - Site 1
September 14-15, 2017



Ldn: 64 dB

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Appendix D-1

FHWA Traffic Noise Prediction Model (FHWA-RD-77-108)
Noise Prediction Worksheet

Project Information:

Job Number: 2017-163
Project Name: Oak Creek Canyon 6-Lot Subdivision
Roadway Name: Marsh Creek Road

Traffic Data:

Year:	Future
Average Daily Traffic Volume[1]:	16,308
Percent Daytime Traffic:	83
Percent Nighttime Traffic:	17
Percent Medium Trucks (2 axle):	2
Percent Heavy Trucks (3+ axle):	2
Assumed Vehicle Speed (mph):	50
Intervening Ground Type (hard/soft):	**Soft**

Traffic Noise Levels:

				----------L_{dn}, dB----------			
Lot	**Description**	**Distance**	**Offset (dB)[2]**	**Autos**	**Medium Trucks**	**Heavy Trucks**	**Total**
1	Lot 1 Backyard	110	0	65	55	60	66
2	Lot 2 Backyard	140	0	63	54	58	65
3	Lot 3 Backyard	260	-5	54	45	49	56
4	Lot 4 Backyard	330	-5	52	43	47	54
5	Lot 5 Backyard	410	-5	51	42	46	53
6	Lot 6 Backyard	140	0	63	54	58	65

Traffic Noise Contours (No Calibration Offset):

L_{dn} Contour, dB	Distance from Centerline, (ft)
75	28
70	61
65	131
60	283

Notes: 1. Average Daily Traffic Volume was conservatively estimated by doubling existing traffic volumes obtained from the City of Clayton planning staff (Date: February 2015; ADT: 8154).
2. Conservative offsets of -5 dB were applied at the backyards of Lots 3-5 to account for the shielding of traffic noise provided by the intervening residential building structures.

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Appendix D-2

FHWA Traffic Noise Prediction Model (FHWA-RD-77-108)
Noise Prediction Worksheet

Project Information:

Job Number: 2017-163
Project Name: Oak Creek Canyon 6-Lot Subdivision
Roadway Name: Marsh Creek Road

Traffic Data:

Year:	Future
Average Daily Traffic Volume[1]:	16,308
Percent Daytime Traffic:	83
Percent Nighttime Traffic:	17
Percent Medium Trucks (2 axle):	2
Percent Heavy Trucks (3+ axle):	2
Assumed Vehicle Speed (mph):	50
Intervening Ground Type (hard/soft):	**Soft**

Traffic Noise Levels:

				----------L_{dn}, dB----------			
Lot	**Description**	**Distance**	**Offset (dB)[2]**	**Autos**	**Medium Trucks**	**Heavy Trucks**	**Total**
1	Lot 1 - 2nd Floor Façade	130	3	66	57	62	68
2	Lot 2 - 2nd Floor Façade	140	3	66	57	61	68
3	Lot 3 - 2nd Floor Façade	210	3	63	54	58	65
4	Lot 4 - 2nd Floor Façade	260	3	62	53	57	64
5	Lot 5 - 2nd Floor Façade	330	3	60	51	55	62
6	Lot 6 - 2nd Floor Façade	140	3	66	57	61	68

Traffic Noise Contours (No Calibration Offset):

L_{dn} Contour, dB	Distance from Centerline, (ft)
75	28
70	61
65	131
60	283

Notes: 1. Average Daily Traffic Volume was conservatively estimated by doubling existing traffic volumes obtained from the City of Clayton planning staff (Date: February 2015; ADT: 8154).
2. A +3 dB offset was applied to the 2nd floor facades due to reduced ground absorption at elevated facades.

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Appendix E-1

FHWA Traffic Noise Prediction Model (FHWA-RD-77-108)
Noise Barrier Effectiveness Prediction Worksheet

Project Information:

Job Number: 2017-163
Project Name: Oak Creek Canyon 6-Lot Subdivision
Roadway Name: Marsh Creek Road
Location(s): Lot 1 Backyard

Noise Level Data:

Year: Future
Auto L_{dn}, dB: 65
Medium Truck L_{dn}, dB: 55
Heavy Truck L_{dn}, dB: 60

Site Geometry:

Receiver Description: Lot 1 Backyard
Centerline to Barrier Distance (C_1): 90
Barrier to Receiver Distance (C_2): 20
Automobile Elevation: 595
Medium Truck Elevation: 597
Heavy Truck Elevation: 603
Pad/Ground Elevation at Receiver: 608
Receiver Elevation[1]: 613
Base of Barrier Elevation: 608
Starting Barrier Height 6

Barrier Effectiveness:

Top of Barrier Elevation (ft)	Barrier Height[2] (ft)	---------- L_{dn}, dB ---------- Autos	Medium Trucks	Heavy Trucks	Total	Barrier Breaks Line of Sight to… Autos?	Medium Trucks?	Heavy Trucks?
614	6	56	47	53	**58**	Yes	Yes	Yes
615	7	55	46	52	**57**	Yes	Yes	Yes
616	8	54	45	50	**56**	Yes	Yes	Yes
617	9	53	44	49	**55**	Yes	Yes	Yes
618	10	52	44	49	**54**	Yes	Yes	Yes
619	11	52	43	48	**53**	Yes	Yes	Yes
620	12	51	42	47	**53**	Yes	Yes	Yes
621	13	50	41	46	**52**	Yes	Yes	Yes
622	14	50	41	46	**52**	Yes	Yes	Yes

Notes: 1.Standard receiver elevation is five feet above grade/pad elevations at the receiver location(s)

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Appendix E-2

FHWA Traffic Noise Prediction Model (FHWA-RD-77-108)
Noise Barrier Effectiveness Prediction Worksheet

Project Information:

Job Number: 2017-163
Project Name: Oak Creek Canyon 6-Lot Subdivision
Roadway Name: Marsh Creek Road
Location(s): Lot 2 Backyard

Noise Level Data:

Year: Future
Auto L_{dn}, dB: 63
Medium Truck L_{dn}, dB: 54
Heavy Truck L_{dn}, dB: 58

Site Geometry:

Receiver Description: Lot 2 Backyard
Centerline to Barrier Distance (C_1): 120
Barrier to Receiver Distance (C_2): 20
Automobile Elevation: 598
Medium Truck Elevation: 600
Heavy Truck Elevation: 606
Pad/Ground Elevation at Receiver: 625
Receiver Elevation[1]: 630
Base of Barrier Elevation: 625
Starting Barrier Height 6

Barrier Effectiveness:

Top of Barrier Elevation (ft)	Barrier Height[2] (ft)	---------- L_{dn}, dB ---------- Autos	Medium Trucks	Heavy Trucks	Total	Barrier Breaks Line of Sight to… Autos?	Medium Trucks?	Heavy Trucks?
631	6	53	44	49	**55**	Yes	Yes	Yes
632	7	53	44	48	**54**	Yes	Yes	Yes
633	8	52	43	48	**53**	Yes	Yes	Yes
634	9	51	42	47	**53**	Yes	Yes	Yes
635	10	50	41	46	**52**	Yes	Yes	Yes
636	11	49	40	45	**51**	Yes	Yes	Yes
637	12	49	40	44	**51**	Yes	Yes	Yes
638	13	48	39	44	**50**	Yes	Yes	Yes
639	14	48	39	43	**50**	Yes	Yes	Yes

Notes: 1.Standard receiver elevation is five feet above grade/pad elevations at the receiver location(s)

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Appendix E-3

FHWA Traffic Noise Prediction Model (FHWA-RD-77-108)
Noise Barrier Effectiveness Prediction Worksheet

Project Information:

Job Number: 2017-163
Project Name: Oak Creek Canyon 6-Lot Subdivision
Roadway Name: Marsh Creek Road
Location(s): Lot 6 Backyard

Noise Level Data:

Year: Future
Auto L_{dn}, dB: 63
Medium Truck L_{dn}, dB: 54
Heavy Truck L_{dn}, dB: 58

Site Geometry:

Receiver Description: Lot 6 Backyard
Centerline to Barrier Distance (C_1): 120
Barrier to Receiver Distance (C_2): 20
Automobile Elevation: 595
Medium Truck Elevation: 597
Heavy Truck Elevation: 603
Pad/Ground Elevation at Receiver: 600
Receiver Elevation[1]: 605
Base of Barrier Elevation: 600
Starting Barrier Height 6

Barrier Effectiveness:

Top of Barrier Elevation (ft)	Barrier Height[2] (ft)	---------- L_{dn}, dB ---------- Autos	Medium Trucks	Heavy Trucks	Total	Barrier Breaks Line of Sight to… Autos?	Medium Trucks?	Heavy Trucks?
606	6	56	48	53	**58**	Yes	Yes	Yes
607	7	55	46	52	**57**	Yes	Yes	Yes
608	8	54	45	51	**56**	Yes	Yes	Yes
609	9	53	44	50	**55**	Yes	Yes	Yes
610	10	53	44	48	**54**	Yes	Yes	Yes
611	11	52	43	48	**53**	Yes	Yes	Yes
612	12	51	42	47	**53**	Yes	Yes	Yes
613	13	50	41	46	**52**	Yes	Yes	Yes
614	14	49	40	45	**51**	Yes	Yes	Yes

Notes: 1.Standard receiver elevation is five feet above grade/pad elevations at the receiver location(s)

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