EXHIBITS TO CITY OF SARATOGA DETAILED COMMENTS ON THE STATE ROUTE 85 EXPRESS LANES PROJECT INITIAL STUDY

FEBRUARY 25, 2014

Exhibit A

TO CITY OF SARATOGA DETAILED COMMENTS
ON THE STATE ROUTE 85 EXPRESS LANES PROJECT INITIAL STUDY
FEBRUARY 25, 2014

EXHIBIT

Exhibit A

TO CITY OF SARATOGA DETAILED COMMENTS
ON THE STATE ROUTE 85 EXPRESS LANES PROJECT INITIAL STUDY
FEBRUARY 25, 2014

Report on the Status of Rubberized Asphalt Traffic Noise Reduction in Sacramento County

Prepared For:

Sacramento County
Public Works Agency - Transportation Division

Prepared by:

Sacramento County
Department of Environmental Review and Assessment

And

Bollard & Brennan, Inc.
Consultants in Acoustics and Noise Control Engineering

November 1999

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

INTRODUCTION 2

HISTORY OF NOISE REDUCING PAVEMENT 3

THE PROCESS OF PRODUCING RUBBERIZED ASPHALT 4
- Wet Process 4
- Dry Process 5

CURRENT USES OF RUBBERIZED ASPHALT 5

STUDIES OF RUBBERIZED ASPHALT OUTSIDE OF SACRAMENTO COUNTY 10
- Rubberized Asphalt Studies in Other California Counties 10
- National Rubberized Asphalt Studies 10
- Global Studies 11

SACRAMENTO COUNTY RUBBERIZED ASPHALT NOISE STUDIES 13
- Overview of Noise and Rationale for Rubberized Asphalt Noise Studies 13
- How Traffic Noise is Generated and the Implications for Rubberized Asphalt 13
- Traffic Noise Prediction Model 14
- Traffic Noise Prediction Model Calibration 15
- Traffic Noise Prediction Model Inputs 15
- Specific Rubberized Asphalt Test Procedure 15
- Test Roadways Evaluated in the Sacramento County Studies 16
  - Elapsed Time Between Measurements 16
  - Asphalt Compaction 17
  - Noise Measurement Duration, Equipment Locations and Configurations 17
  - Atmospheric Conditions 18
  - Traffic Volume, Speed and Heavy Truck Usage 18
- Specific Sacramento County Rubberized Asphalt Test Results 19

CONCLUSIONS OF THE STUDIES CONDUCTED IN SACRAMENTO COUNTY 20

Appendix A ..... Acoustical Terminology

Appendix B ..... Noise Standards Commonly Applied in Sacramento County

Appendix C ..... References Consulted

ACKNOWLEDGEMENTS

Sacramento County Public Works Agency

Transportation Division
906 G. Street, Suite 510
Sacramento, California 95814
(916) 874-6291
Chief: Thomas Zlotkowski
Senior Engineer: Theron Roschen

Sacramento County Department of Environmental Review and Assessment

Public Projects Division
827 7th Street, Room 220
Sacramento, California 95814
(916) 874-7914
Environmental Coordinator: Dennis Yeast
Division Manager: Bob Caikoski
Project Leader: Antonia Barry
Student Intern: Melinda Coy

Bollard & Brennan, Inc.

Consultants in Acoustics and Noise Control Engineering
3805 Taylor Road, Suite 2
Loomis, California 95650
(916) 660-0191
President: Paul Bollard

EXECUTIVE SUMMARY

This report is a joint study prepared for the Sacramento County Public Works Agency, Transportation Division by the Sacramento County Department of Environmental Review and Assessment and Bollard and Brennan, Inc., consultants in acoustics and noise control engineering.

The purpose of this report is to document the effectiveness of rubberized asphalt as a traffic noise mitigation measure. Rubberized asphalt is a bituminous mix, consisting of blended aggregates, recycled rubber and binding agents. The rubber is often obtained from used tires. Studies conducted locally, nationally, and internationally, have shown that rubberized asphalt can reduce the noise pollution that is associated with roadway traffic.

The specific findings of this analysis are based primarily on a series of traffic noise level measurements conducted along the Alta Arden Expressway, between Howe and Watt Avenues, from 1993 to the present. Although similar noise measurements have been conducted along a segment of Antelope Road, the smaller number of variables affecting the measured traffic noise levels along the Alta Arden Expressway before and after paving with rubberized asphalt made that roadway a more statistically reliable test subject. Therefore, this analysis focuses on the series of test results for Alta Arden Expressway.

Bond Road between Stockton Boulevard and Florin Road, was used as the control site for conventional (non-rubberized) paving. Although the Bond Road test segment was widened at the time of paving with conventional asphalt, the relationship of the roadway to the noise measurement site remained relatively unchanged.

The conclusions of the 6-year study indicate that the use of rubberized asphalt on Alta Arden Expressway resulted in an average four (4) decibel reduction in traffic noise levels as compared to the conventional asphalt overlay used on Bond Road. This noise reduction continued to occur six (6) years after the paving with rubberized asphalt. This degree of noise attenuation is significant, as it represents a 60% reduction in traffic noise energy, and a clearly perceptible decrease in traffic noise. This traffic noise attenuation from rubberized paving is similar to the results documented in several non-related studies conducted in recent years at other locations, both nationally and internationally.

The conclusions of this study are based on tests conducted in Sacramento County on the Alta Arden Expressway and Bond Road. Attenuation provided by rubberized asphalt may vary in other locations with different climates and different percentages of medium duty and

heavyduty trucks.

INTRODUCTION

The main theme of this report is the effectiveness of rubberized asphalt as a traffic noise mitigation measure. Locally collected noise information is supplemented with general noise test results from various locations, both nationally and internationally, where other jurisdictions are exploring the use of rubberized asphalt. However, this report does not attempt to reproduce the result of those other studies herein. The interested reader is encouraged to contact those entities or jurisdictions where other studies were performed for further information. This report is primarily meant to provide information on the studies conducted in Sacramento County.

In addition to the various noise test results, this report offers an overview of the factors that contribute to traffic noise generation. The report also contains the Sacramento County, State and Federal noise standards, which mandate the consideration of noise abatement measures in cases where traffic noise levels exceed acceptable limits. The noise standards are provided to illustrate the importance that is given to traffic noise impacts in Sacramento County, which in turn has led to substantial requirements for traffic noise abatement.

In recent years, Sacramento County has relied upon noise barriers as the primary noise mitigation option, and often times the only viable noise mitigation option, for roadway improvement projects in the County. As a result, a substantial number of noise barriers have, and continue to be, constructed in areas where traffic noise is determined to be excessive. Concerns regarding the proliferation of noise barriers has resulted in the investigation of rubberized asphalt paving as a viable noise mitigation alternative. This investigation has been ongoing since the paving of Alta Arden Expressway with rubberized asphalt in October of 1993. This report summarizes the results of Sacramento County's ongoing investigation to date.

HISTORY OF NOISE REDUCING PAVEMENT

The history of adding recycled tire rubber to asphalt paving material can be traced back to the 1940's when the U.S. Rubber Reclaiming Company began marketing a devulcanized recycled rubber product, called Ramflex ™, as a dry particle additive to asphalt paving mixture. In the mid-1960's, Charles McDonald began developing a modified asphalt binder using crumb rubber. This product was marketed by Sahuaro Petroleum and Asphalt Company as Overflex ™.

The Arizona Refining Company Inc., created the second modified binder in the mid-1970's, replacing a portion of the crumb rubber with devulcanized recycled rubber and marketing it under the name Arm-R-Shield ™. Both Overflex ™ and Arm-R-shield ™ were patented and eventually brought under single ownership. The companies marketing these two products founded a trade association known as the Asphalt Rubber Producer Group in the mid-1980's. Ramflex ™ disappeared from the market when its parent corporation sold the U.S. Rubber Reclaiming Company.

In addition to the US, Sweden also made tremendous contributions to the development of rubberized asphalt. In the 1960's, two Swedish companies began developing an asphalt paving surface mixture that would resist studded tire and chain wear. The mixture included a small amount of crumb rubber as an aggregate and was named Rubit™. In the late 1970's this product was introduced and patented in the United State as PlusRide™. It evolved in a series of field projects in Alaska and other states from 1979 through 1985. PlusRide ™ has been managed by a number of firms and is presently marketed by Envirotire, Inc.

In recent years there has been a great surge to make use of the used tires that are being stockpiled all around the world. This is primarily due to the advancement in technology and realization of benefits associated with application and reduction of used tires. Because of the increase in the number of tires accumulating around the world, and environmental hazards associated with them, more nations are looking for ways to make use of this tremendous resource.

It should be noted that the effectiveness of rubberized asphalt in reducing traffic noise levels would be highest on roadways with relatively low percentages of heavy duty trucks, as truck engine and exhaust stack noise is not believed to be substantially affected by rubberized paving.

Appendix A
Acoustical Terminology

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.
L_{dn}	Day/Night Average Sound Level. Similar to CNEL but with no evening weighting.
L_{eq}	Equivalent or energy-averaged sound level.
L_{max}	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 AMaximum@ level, which is the highest RMS level.
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
Noise Standards Commonly Applied in Sacramento County

Appendix B - Noise Standards Commonly Applied to Projects in Sacramento County

Sacramento County Noise Element Policies

The Sacramento County Noise Element establishes land-use compatibility criteria for both interior and exterior areas of various land uses. The County Noise Element policies which pertain to transportation noise follow.

NO-1: Noise created by new transportation noise sources should be mitigated so as not to exceed 60-dB Ldn/CNEL at outdoor activity areas of any affected residential lands or land use situated in the unincorporated areas. When a practical application of the beast available noise-reduction technology cannot achieve the 60-dB Ldn/CNEL standards, then an exterior noise level of 65-dB Ldn/CNEL may be allowed in outdoor activity areas.

NO-4: Where residential land uses are proposed in areas exposed or projected exterior noise levels exceeding 60 dB Ldn / CNEL or the performance standards described above, an acoustical analysis shall be required as part of the environmental review process.

NO-6: The compatibility of proposed nonresidential projects with existing and future noise levels due to transportation noise sources shall be evaluated through a comparison to the standards described in Table 5 (below) and Table II-3 found in the Sacramento County Noise Element of the General Plan.

NO-7: Proposed Development of Residential land uses should not be permitted in areas exposed to existing or project levels of noise from transportation which exceed 60 dB to 65 dB Ldn / CNEL unless the project design includes effective mitigation measures to reduce noise.

Table 5
Sacramento County Noise Element Noise Standards

	Exterior Noise Level Standard, Ldn	
Land Use Category	**Acceptable**	**Conditionally Acceptable**
Residential	60	75
Agriculture Residential	65	75
Churches	60	70
Golf Courses	75	80
Office/Commercial/Professional	65	75
Industrial/Utilities/Agriculture	70	80

Source: Sacramento County Noise Element

In addition to the Noise Element Noise Standards above, the General Plan Noise Element includes standards for acceptable noise levels for the interior spaces of noise-sensitive land uses affected by Transportation Noise. Those interior noise level standards are shown in Table 6.

Table 6
Acceptable Noise Levels In Unoccupied Rooms Affected By Transportation Noise

Location	Average Sound Level1 dBA
Radio studies, recording studios	25-30
Music Rooms	30-35
Concert halls, auditoriums	30-35
Theaters (speech)	30-35
Motion picture theaters	40-45
Churches	35-40
Conference rooms, small offices	40-45
Classrooms	35-45
Public offices, banks, stores	45-50
Hospitals	40-45
Restaurants, cafeterias	45-50
Court rooms	40-45
Libraries	40-45

1. Leq in worst-case hour during periods of use.

California Environmental Quality Act Guidelines (CEQA)

The California Environmental Quality Act guidelines state that transportation noise will have a significant impact if it "Increased substantially the ambient noise levels for adjoining areas". There are several criteria CEQA uses to access the transportation noise impact on a project.

1. If the exposure of persons to or generation of noise levels result in an excess of standards established the local general plan or other applicable standards

2. If the project results in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.

3. If the project results in substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

Federal Policies

The criteria for evaluating noise impacts that are used by the Federal Highway Administration and Caltrans are contained in the Caltrans Traffic Noise Analysis Protocol (the Protocol). The Protocol establishes Noise Abatement Criteria (NAC) for various land uses. Table 7 presents a summary of the Federal Noise Abatement Criteria.

Table 7
Federal Noise Abatement Criteria
[Hourly A-Weighted Sound Level-decibels (dBA)1]

Activity Category	Leq (h), dBA	L10(h), dBA	Activity Category Description
A	57 (Exterior)	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	67 (Exterior)	70 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	75 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	C	C	Undeveloped Lands.
E	52 (Interior)	55 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

1 Either L10(h) or Leq(h) (but not both) may be used on a project.

Appendix C
References Consulted

References Consulted

1. *Environmental Noise Analysis, Alta Arden Expressway Resurfacing Project*, Brown-Buntin Associates, December 20, 1993.

2. *Environmental Noise Analysis, Rubberized Vs. Conventional Asphalt Overlays, Alta Arden Expressway and Bond Road*, Brown-Buntin Associates, November 20, 1995.

3. *Environmental Noise Analysis, Antelope Road Widening Project*, Brown-Buntin Associates, February 2, 1996.

4. *Mixed Roadway Surface Noise Measurement Results* prepared for The County of Orange (Report No. 91-191), by Mestre Greve Associates February 12, 1992.

5. *Noise Reduction with Asphalt-Rubber*, by Asphalt Rubber Producer Group, Washington D.C.

6. *Open Graded Rubberized Asphalt for Traffic Noise Reduction in Urban Areas*, by IR. J. C. P. Heerkens & DR. IR A. Von Meier, The Netherlands.

7. *Recycling Crumb Rubber Modified Pavements* (Research project 1333), by Texas Department of Transportation, November 1995.

8. *Rubberized asphalt reduced I-90 noise, official says*, Robert Will, Green Valley News & Sun, December 31, 199?.

9. *Sound Level Survey*. Tucson, Arizona. WT Job No. 7130K022. By Western Technologies INC. April 6, 1990.

10. *The Full scale Evaluation of Rubberized asphalt Concrete in British Columbia*, by Roger Johnson, James Sproule and Alan Juristovski, Canadian Technical Asphalt Association, Charlottetown B PEI, 1995.

11. *Asphalt Rubber Overlay Noise Study,* Acoustical Analysis Associates Inc., prepared for the City of Thousand Oaks, September 1992.

12. *The European Commission Green Paper*, Noise News International, June 1997.