Department of Resources Recycling and Recovery

SCOPE OF WORK
Recycled Crumb Rubber Infill in Hot Mix Asphalt Design

I. Introduction/Objectives

The Department of Resources Recycling and Recovery (CalRecycle) currently promotes the use of waste tires in various asphalt pavement applications as part of ongoing efforts to divert waste tires from landfills in California. To improve these strategies, CalRecycle proposes to investigate the feasibility and benefits of using crumb rubber infill (CRI) from synthetic turf athletic fields (Figure 1) in hot mix asphalt.

A critical component of synthetic turf fields is an infill layer that adds traction and shock absorption. Crumb rubber is a popular choice for turf infill mixes due to its durability, availability, and performance characteristics. The Synthetic Turf Council (STC) estimates that in 2019 about 100 new fields were installed in California and between 30-50 existing fields were replaced. These numbers are somewhat higher than 2018, indicating a possible increase in synthetic turf usage.

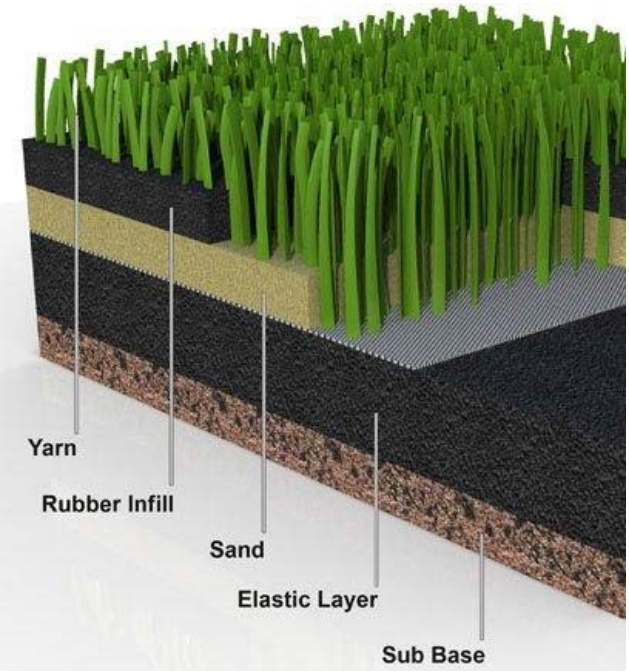

Figure 1. Components of Synthetic Turf including Crumb Rubber Infill

Each athletic field uses approximately 230,000 pounds of crumb rubber or 19,200 passenger tire equivalents. At the end of a synthetic turf fields working life, CRI is typically landfilled because the multi-material mix (crumb rubber, sand, and contaminants acquired during use) makes it unsuitable for other recycling uses. Although there are some very limited markets for CRI, these markets only consume a small percentage of the used CRI material generated annually.

Currently, there is a lack of research regarding the viability of using CRI in hot mix asphalt. This study proposes to investigate the feasibility of incorporating CRI material into standardized rubberized hot mix asphalt manufacturing processes. The contractor will investigate adding CRI

via both the dry method (added to the aggregate) and wet method (added to the binder) to produce hot mix asphalt materials for laboratory testing and evaluation.

II. Work to be Performed

The work to be performed on this project is as follows:

- Create laboratory samples of CRI modified asphalt using both dry and wet methods. Various mix formulas will be created for laboratory evaluation.
- Perform testing on laboratory samples using industry standard methods to compare the physical properties of various CRI modified asphalts to standard RAC and conventional asphalt.
- Perform an evaluation of test results to determine feasibility of CRI use and identify the most favorable methods to utilize CRI and meet Caltrans asphalt testing standards
- Produce a Final Report that documents all work conducted, conclusions and recommendations for possible future CalRecycle research efforts. If applicable, develop a peer-reviewed scientific article on using CRI in asphalt pavement..

III. Tasks Identified

This contract will consist of the following tasks and subtasks:

Task 1. Conduct a literature search on CRI modified asphalt to inform the study design.

Task 1 includes the following subtasks:

- Task 1-A. Research publications by transportation and pavement groups such as the Transportation Research Board, State Transportation Commission, American Society of Civil Engineers, National Cooperative Highway Research Program, and California State Department of Transportation.
- Task 1-B. Search journals, articles, books and national and international conferences on the applications of recycled crumb rubber.
- Task 1-C. Prepare and submit a CRI modified asphalt testing plan for CalRecycle contract manager's review.

Task 2. Develop dry methods of incorporating CRI in hot mix asphalt.

Task 2 includes the following subtasks:

- Task 2-A. Obtain sufficient end-of-life infill material from two different turf fields in California to conduct all required testing. Analyze the gradation and proportion of crumb rubber and sand in turf infill. Use the gravity separation method to separate the recycled crumb rubber and sand. After separation, use sieve analysis, or another method if approved by CalRecycle's contract manager, to obtain the typical gradations of recycled crumb rubber and sand, respectively.
- Task 2-B. Obtain hot mix asphalt materials and a Caltrans approved mix design from a qualified construction company. Fabricate a laboratory specimen as the control mix.

Conduct Superpave mix design tests on the control specimen including volumetric tests, Hamburg tests, and moisture damage tests.

- Task 2-C. Replace the sand portion of the Caltrans approved mix design with recycled crumb rubber and sand infill. Different replacement rates will be evaluated based on results from the literature search.

- Task 2-D. Conduct mix design tests to find the optimal binder contents for samples created in Task 2-C.

- Task 2-E. Conduct performance based evaluation, such as balanced mix design tests, on high potential CRI modified asphalt.

Task 3. Develop wet methods of incorporating CRI in hot mix asphalt.

Task 3 includes the following subtasks:

- Task 3-A. Fabricate laboratory specimen as the control mix for this task. Conduct Superpave mix design tests on the control specimen including volumetric tests, Hamburg tests, and moisture damage tests. Conduct Superpave binder tests to obtain characteristics of the binder, such as Dynamic Shear Rheometer (DSR), Bending Beam Rheometer (BBR), Rolling Thin Film Oven (RTFO) short term aging, Pressure Aging Vessel (PAV) long term aging.

- Task 3-B. Create asphalt rubber binders by blending neat asphalt binder with CRI at various replacement percentages. Conduct Superpave binder tests to obtain the binder properties that are performance related.

- Task 3-C. Conduct mix design tests to find the optimal binder contents for samples created in Task 3-B.

- Task 3-D. Conduct performance-based evaluation, such as a balanced mix design approach, on high beneficial CRI modified asphalt.

Task 4. Final Report.

Task 4 includes the following subtasks:

- Task 4-A. Prepare a final report that summarizes the work completed and make conclusions and recommendations on further development of CRI modified asphalt. Quantify the benefits and limitations of using CRI modified asphalt. Focus will be on issues related to commercial scale production.

- Task 4-B. If applicable, disseminate the knowledge of this study by writing a scientific article, news article, and /or technical report. This may include outreach to potential users of CRI modified asphalt, attendance or presentations at meetings (subject to CalRecycle Contract Manager approval) where asphalt rubber and rubberized hot mixes are discussed.

IV. Contract/Task Time Frame

The proposed contract period will be from May 1, 2021 to May 15, 2024 for a total time of approximately 36½ months. Table 1 shows the project schedule. Note that some of the time frames of the tasks overlap.

Table 1: Project Work Schedule

Task Number	**Task Description**	**Start Date**	**End Date**
Task 1	Literature search on recycled CRI applications	May 1, 2021	September 30, 2021
Task 2	Develop dry methods of incorporating CRI in hot mix asphalt	August 1, 2021	July 31, 2022
Task 3	Develop wet methods of incorporating CRI in hot mix asphalt	September 1, 2021	August 31, 2022
Task 4	Develop a scientific articleon the benefits and limitations of CRI modified asphalt	May 1, 2023	Jan 30, 2024
Task 5	Final report	August 1, 2021	March 15, 2024