TECHNICAL MEMORANDUM

CONSTRUCTION EMISSIONS REVIEW MEMO

UC Davis-Caltrans Air Quality Project
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A request by Caltrans to (1) evaluate existing methodologies used to estimate project-level and regional-scale transportation project construction-related PM_{10} emissions, and (2) identify opportunities to improve existing emissions assessment methods.

INTRODUCTION

As requested by Caltrans, U.C. Davis (UCD) has been working on two short-term exploratory efforts to help define issues related to estimating PM10 emissions from construction. Specifically, we have reviewed and identified options to improve the methodologies used to estimate both regional-scale and microscale construction-related PM_{10} emissions. To address regional-scale analyses, we reviewed existing California Air Resources Board (CARB) state implementation plan (SIP) guidance for estimating total transportation project-level PM_{10} emissions within a metropolitan region, and identified options to improve the existing methodology. We also solicited feedback on these options from both Caltrans and CARB. To address microscale analyses, at Caltrans' request we evaluated two spreadsheets tools used to estimate project-level PM_{10} emissions: one tool developed by Caltrans District 5 and one developed by Jones and Stokes for the Sacramento Metropolitan Air Quality Management District.

The purpose of this technical memorandum is to document the results of our work to-date, and to present our recommendations to improve regional-scale and microscale PM10 construction emissions estimates.

REGIONAL-SCALE ANALYSES

Overview and Summary of Findings

CARB has existing guidance to prepare the road construction portion of the PM_{10} dust SIP emission inventory (see: Section 7.8 of the Area Source Methods Manual, "Road Construction Dust," available via the Internet at: http://arbis.arb.ca.gov/emisinv/areasrc/fullpdf/full7-8.pdf; an index to CARB's entire area source inventory guidance is available at: http://www.arb.ca.gov/emisinv/areasrc/index0.htm). The road construction dust SIP guidance was last updated in 1997. We completed several steps to conduct our review and identify options to improve the existing methodology, including:

- Interviewing Caltrans (Mike Brady) staff to identify concerns with existing procedures.
- Reviewing the existing methodology and identifying opportunities for improvement.
- Soliciting input from CARB staff (Patrick Gaffney) on which methodology improvement options were most important to pursue.

Table 1 presents options for improving the existing CARB SIP inventory methodology for regional-scale road construction PM_{10}. Table 1 presents options organized into four categories:

1. Activity data improvements.
2. Emission factor improvements.
3. Control measure effectiveness assessments.
4. SIP preparation issues.

The table also identifies which of the options was named by either Caltrans or CARB as relatively important to pursue.

Detailed Feedback from CARB as of April 2002

Detailed comments provided by CARB (Patrick Gaffney) include the following (refer to Table 1 categories and item numbers):

> Priority 1 - Activity Data, Items #1, #2, #3. These improvements would be “relatively” straightforward to achieve, and could provide some immediate improvements, without having to examine basic assumptions such as emission factors.
>
> Priority 2 - Control Effectiveness, Items #7, #8. It would be helpful to have someone pull together available information on mitigation measures and to try to standardize the information so people would have easily available references. This is probably a relatively manageable task with a clear endpoint.
>
> Priority 3 - Equipment Specific Emission Factors, Item #4. First, it would probably be better to re-title this as "compile emission specific emission factors." This task would be helpful because it would provide information that could also be used for other tasks (such as controls and activity data). The down-side is that it could be difficult to compile a set of data that is accepted by California industry; it could also be difficult to include a manageable number of input parameters to do the estimates reasonably well. But, without conducting this work, SIPs are stuck with a “one size fits all” emission factor. Potential resources to help with this task: the road construction model, and the AP-42 construction emissions approach, available via the Internet at: http://www.epa.gov/ttn/chief/ap42/ch13/ (see section 13.2.3).
>
> Priority 4 - Preparing SIPs, Item #9. SIPs have been limited to using rough and averaged information for road construction activity (e.g., the difference between year x, and the year x-10 road mileage). This task could be helpful just for compiling basic road construction activity data. The high/low year refinement would be helpful, but having it would also create problems if year-to-year activity differs dramatically.
>
> Priority 5 - PM Settling and Regional Variations, Items #5, #6. These are both good ideas, but could be very difficult to pursue. A smaller project runs the risk of becoming stuck on this issue without producing a concrete work product. A key concern is the lack of adequate existing research findings to support reasonably addressing these questions.

Recommended Next Steps

Caltrans and UCD should discuss the options included in Table 1, and identify which tasks Calrans would like UCD to pursue further.

Table 1. Options to improve existing SIP methods used to estimate regional-scale road construction PM_{10}.

Research Option	Priority For:	
	ARB	Caltrans
<u>Improve Activity Data</u>		
1. *Research Need*: Expand and improve assumptions about typical project duration. *Current Approach*: Currently, the guidance suggests assuming that the typical construction project lasts 18 months. *Potential Research Tasks*: Categorize road construction projects; research and assign project durations by category (e.g., road widening vs. new facility construction).	✓	
2. *Research Need*: Improve how the methodology allocates the amount of construction activity over time. *Current Approach*: Currently, the guidance assumes a “typical” construction duration of 18 months, and assumes that all the miles of a particular project are actively being constructed during that entire 18 month period. For example, if 10 miles of new freeway are being constructed, the methodology assumes that the freeway is 5 lanes and that 12.1 acres per mile are disturbed during construction, and that all 10 miles of freeway are under construction over the entire 18 month construction period. This is equivalent to 2,178 acre-months of activity (10 miles * 12.1 acres per mile * 18 months). *Potential Research Tasks*: Review literature and/or survey Caltrans to determine what fraction of construction occurs during a typical month. For example, if a 10 mile freeway is under construction, what fraction of that 10 miles is under construction on a “typical” day.	✓	
3. *Research Need*: Develop a broader menu of project descriptions to better characterize road construction activity. *Current Approach*: The methodology assumes various characteristics such as road width, number of lanes, and other factors, that apply uniformly to all projects. For example, the methodology assumes all freeway and highway construction involves five lanes, and all city and county road construction involves two lanes. *Potential Research Tasks*: Develop look-up tables that provide greater specificity for the potential range of project types typically under development across California. For example, identify activity factors for freeway construction that involves one or more lanes up to a maximum ten lanes; identify range of lane widths used in typical projects.	✓	

Research Option	Priority For:	
	ARB	Caltrans
Improve Emission Factors		
4. Research Need: Develop equipment-specific emission factors. *Current Approach*: Currently, the guidance offers one aggregate emission factor (0.11 tons of PM_{10} per acre-month of activity, or 0.17 tons of TSP per acre-month). Patrick Gaffney believes the research used to create that emission factor is based on general construction activity and is not necessarily specific to building roads. *Potential Research Tasks*: Prepare emission factors based on either individual equipment used, or road construction project category (e.g., road widening vs. new facility construction). Survey literature and Caltrans staff and identify specific equipment types used for various projects. Review updated AP-42 emission factors to determine whether they contain relevant equipment-specific emission factors. Create look-up tables with emissions factors for specific equipment, and/or for various project types (by aggregating a “typical” equipment mix and equipment-specific activity rates for project categories; e.g., road widening or new facility construction).	✓	
5. Research Need: Understand rate at which suspended PM_{10} settles prior to contributing to ambient concentrations. *Current Approach*: No explicit consideration is given to the possibility that some quantity of emitted PM_{10} quickly settles out prior to contributing to ambient particulate matter concentrations at downwind receptors. *Potential Research Tasks*: Review literature to determine if there is an appropriate factor to apply to emissions rates to reflect settling. For example, recent work by the Desert Research Institute, EPA, and others suggests that up to 75% of suspended road dust may settle out within a relatively short distance from the road. Research should determine whether analogous information is available that would apply to road construction activities.		
6. Research Need: Determine whether emission rates should vary by area of the state, to better account for local meteorological and soil moisture conditions, local soil types, and resulting emissions. *Current Approach*: The ARB methodology assumes one emission factor applicable throughout California. *Potential Research Tasks*: Review literature to determine what soil factors contribute to dust emissions (e.g., moisture, geological characteristics). Identify whether literature includes quantitative relationships between soil characteristics and dust emissions. Depending upon information available, characterize emission rates by soil type, and characterize locations in state where soil types occur.		

Research Option	Priority For:	
	ARB	Caltrans
<u>Research Control Measure Effectiveness</u>		
7. Research Need: Identify required mitigation, by major air district, and assumed effectiveness rates for each required mitigation technique. *Current Approach*: The guidance states that the emission factor includes an assumption that construction site watering occurs, and that emissions are reduced by 50% from uncontrolled levels. Patrick Gaffney (ARB) clarified that the emission factor in the current guidance does not actually account for mitigation. The emission factor is based on site observations developed by the Midwest Research Institute (MRI). MRI instructed the site operators to not use any mitigation on the days they were being observed. Resulting observed emissions were substantially less than previous estimates, and ARB was not comfortable discounting those emissions by an additional 50%. *Potential Research Tasks*: Research required mitigation, including statewide control requirements, and air basin-specific control requirements. Identify assumed effectiveness rates for each required mitigation (for example, the South Coast Air District's Rule 403 is assumed to result in a 10% reduction in PM_{10} emissions). Identify through literature reviews, AP-42 review, interviews with air district enforcement staff, EPA, and/or construction contractors, compliance rates for implementation of mitigation efforts such as on-site watering. Develop recommended effectiveness rates for various mitigation techniques (for example, EPA typically assumes that various stationary source control measures are fully operative only 80% of the time). Apply effectiveness rates to emission factors identified in earlier tasks, and develop look-up tables, by air basin, documenting emission factors that reflect required mitigation measures and their expected effectiveness.	✓	✓
8. Research Need: Identify mitigation options for areas that need to further reduce road construction-related PM_{10} emissions. *Current Approach*: The methodology does not offer additional control options or information on various control measures. *Potential Research Tasks*: Review literature, including recent PM10 SIPs such as the Maricopa County (Phoenix) PM10 SIP approved by EPA, and identify mitigation measures not currently included in California or Air District rules. Identify potential effectiveness of these mitigation techniques, and information resources where follow-up material could be obtained by those considering implementing the measure. Develop look-up tables that document effectiveness rates for specific measures (e.g., shoulder widening, paving of unpaved roads).	✓	✓

Research Option	Priority For:	
	ARB	Caltrans
<u>Improve SIP Preparation</u>		
9. *Research Need*: Develop recommended approach for preparing SIP. *Current Approach*: SIPs typically include an average construction emissions estimate, grown for future forecast years by some inflation factor. *Potential Research Tasks*: Identify examples of how long range regional transportation plans (RTPs) and transportation improvement programs (TIPs) allocate new projects over time. Identify if RTPs and TIPs schedule construction activity uniformly over time, or in discrete efforts that may involve a number of projects under construction in a given year, followed by years of relatively little construction activity. If activity occurs in discrete efforts that vary over time, identify, using RTP examples, example "high construction activity" years that occur over a typical 20- or 25-year RTP horizon. Evaluate the benefits and drawbacks of encouraging SIP development that is based on "high activity" years for road construction. Example benefit: the SIP will not underestimate road construction activity and therefore create conformity problems for specific RTP and TIP analysis years. Example drawback: by including a "high activity" year as the SIP baseline, construction activity may be required to implement more controls than would be needed during most years.		✓
10. *Research Need* (note, this was added subsequent to getting feedback from ARB and thus has not yet been shared with Patrick Gaffney): Develop recommended approach for addressing construction activities spanning multiple future years. *Current Approach*: The presumed current approach is that most areas linearly apportion an approximation of expected construction activities and related emissions across future years. The linear method evenly allocates activity and emissions across a range of years. At least one metropolitan planning organization, the Southern California Association of Governments (SCAG), recently allocated specific construction activities to specific future years, rather than use a linear method. The result allowed SCAG to allocate some construction-related activity and emissions to future years separate from the required conformity milestone analysis years. SCAG's approach wound up limiting construction emissions that occurred during the milestone years and thus facilitated making a conformity determination. *Potential Research Tasks*: Evaluate the merits of various allocation methods by using the SCAG case study as an example. Identify, if appropriate, recommended approaches that differ from linear extrapolations.		

MICROSCALE (PROJECT-LEVEL) ESTIMATION USING SACRAMENTO APCD AND CALTRANS DISTRICT 5 SPREADSHEETS

In the following text, we summarize our findings for each of the two project-level PM_{10} construction emissions spreadsheet tools that we evaluated. The District 5 spreadsheet will be referred to as D5 and the air district's spreadsheet model, Road Build v2.1developed by Jones and Stokes, will be denoted as SACTO. We have organized our comments into the general areas of inquiry identified during a review of these spreadsheets.

General Comments on Both Spreadsheets

The D5 and SACTO spreadsheets differ appreciably in the level of complexity used to estimate project specific emissions, with the SACTO model offering more nuances to the estimation process. While there are certain advantages to using a simpler model (e.g., better transparency between modeling inputs, calculations, and results), a more sophisticated model, such as SACTO, offers much greater flexibility in terms of the types of machinery/scenarios that can be handled within the spreadsheet model.

In reviewing the general approaches incorporated in the models, both seem to be reasonable approaches. For example, in comparing a few emission factors and activity defaults contained in the spreadsheets to CARB's OFFROAD emissions model [www.arb.ca.gov/msei/msei.htm], we found very few differences.

One important note is that the PM10 numbers calculated in both models comprise emissions from fuel combustion and from fugitive dust. Normal air district mitigation measures, e.g., the San Joaquin Valley (SJV) Regulation VIII, address only fugitive dust.

D5

D5 computes the pollutants emitted from heavy-duty trucks and off-road vehicles. This spreadsheet is very simplistic and does not include many pieces of equipment, or allow for any nuances associated with construction phasing.

SACTO

SACTO covers four phases of construction and four emissions-generating activities (off-road, worker commute, disturbed area fugitive dust, and hauling). The model does not include ROG emissions due to asphalt paving and architecture coating. **Table 2** provides a summary of the construction periods covered by SACTO, and the emissions-generating activities the model associates with each construction period.

Table 2. Construction periods and emissions-generating activities included in SACTO.

Construction Period	**Emission Sources**			
	Off-road	**Work Commute**	**Disturbed Area**	**Hauling**
Grubbing/Land Clearing	Yes	Yes	Yes	Yes
Grading/Excavation	Yes	Yes	Yes	Yes
Drainage/Utilities/Sub-grade	Yes	Yes	No	No
Paving	Yes	Yes	No	No

The basic equations used in the SACTO model are:

(1) Daily emissions from off-road = $N * f * l * t * h$

where N is the number of pieces of equipment of type i used in a given period, f is the off-road equipment emission factor in grams per brake-horsepower hour, l is the load factor, t is the equipment activity, and h is the average horse-power (all for equipment type i). All emissions of equipment type i are summed for a given period to produce total off-road emissions.

(2) Work commute emissions = $((f_{VMT} + \varepsilon) * VMT + f_S * N) * T$

where f_{VMT} is the light duty truck emission factor (g/mi), f_s is the start emission factor, N is the predicted number of trips to be generated at the construction site during a given time period, T is the total number of working days in the given construction period. Note here that f_s is 0 if EMFAC7f is used. The variable ε is a "PM10 correction factor" for light duty trucks; it equals 0.02 when EMFAC7g is used, zero otherwise.

(3) Disturbed area emissions = $\theta * S_d * f_d$

where S_d is the maximum amount of disturbed area, f_d is the PM10 fugitive dust emission rate per month (per CARB, 220 lbs/mo), and θ denotes the percentage of dust control through watering and associated dust control measures (assumed to be 50% in SACTO).

(4) Emissions from hauling soil = $L_t * V_s/C_t * (f_{VMT} + \varepsilon_{HD}) * T$

where L_t and C_t are the delivery distance and delivery capacity per truck trip, respectively, V_s is the total volume of soil being transported each day, f_{VMT} is the heavy-duty emission factor (gm/mi), and ε_{HD} is a heavy duty correction factor that is set to 0.05 when EMFAC7g is used and 0 otherwise. [Here, also note that there appears to be a coding bug that results in 0 when EMFAC7f is specified].

In reviewing the two spreadsheets, we also addressed questions that were raised in earlier discussions with Caltrans:

1. Is there a practical way to estimate the effects of various PM10 mitigation measures that are commonly available?

The SACTO model assumes 50% control of fugitive dust from watering and associated dust control measures (default). That is, the PM10 mitigation measures do not vary by project. Note that discussion item #7 in Table 1 includes information that suggests the 50% control factor may be in error.

The model could be easily modified to introduce updated control efficiency factors into the spreadsheet. A summary of efficiency factors included in the El Dorado County APCD-CEQA Guide, Proposed Final and Rule 403 is shown below in **Table 3**. These, or others could be introduced into the spreadsheet.

Table 3. Example mitigation measure effectiveness, as documented by the El Dorado County APCD-CEQA Guide.

Source	**Mitigation Measure**	**Control Efficiency**
Soil Piles	Enclose, cover and water twice daily Install automatic sprinkler system	16% 39%
Exposed Surface/Grading	Water all exposed soil twice daily Water soil with adequate frequency to keep surface moist during the day	37% 75%
Truck Hauling Road	Water all haul roads twice daily Pave all haul roads	3% 7%
Truck Hauling Load	Maintain at least two feet of freeboard Cover load of all haul/dump trucks securely	1% 2%

Another way that might be useful for introducing control measures is to base modifications on the SJV Regulation VIII (Rules 8020 and 8021), which specifies control measures for construction, excavation, extraction, and other earthmoving activity:

<u>Pre-activity control</u>

- Pre-water site to limit visible dust emissions (VDE) to 20% opacity. Intuitively, this should reduce the emission factor in (3) by the adopted control efficiency (e.g., in SJV soil pile watering efficiency is 19%).
- Reduce the amount of disturbed soil. This reduces S_d in (3) and since it is a direct input can easily be modified.

<u>Active operations control</u>

- Application of water or chemical/organic stabilizers sufficient to limit VDE to 20% (similar to above).
- Construct/maintain wind barriers, in conjunction with the above, sufficient to limit VDE to 20%.
- Application of water or chemical/organic stabilizers sufficient to limit VDE to 20% (similar to above) for all unpaved roads and traffic areas (sufficient to meet conditions of stabilized unpaved road criteria).

<u>Temporary stabilization during periods of inactivity</u>

- Restrict vehicle access (this will reduce the vehicle activity inputs in (2) and (4)).

2. The SACTO model assumes that a project that runs 4 years in duration will have twice the emissions of a similar project that runs only 2 years. The analogy holds for other scenarios as well (a 10-year long project has five times the emissions of a 2-year long project). Given that fleet turnover should introduce cleaner fleet equipment over time, is the SACTO model over-predicting emissions for longer-duration projects?

The on-road vehicle emissions provided in EMFAC7f/g decrease between 2000 and 2010 and the off-road equipment/machine emissions included in SACTO worksheet Appendix D also tend to decline between 2000 and 2010. One problem is the spreadsheet does not treat the emission factors as a function of time. That is, the start year emission factors are used throughout the project length. Assuming that there is no change over time to the average age of the construction equipment used for specific projects, there should be some reduction in non-road emissions over time (as the construction approaches completion) to reflect the fleet turnover effects as newer equipment replaces older equipment. If, however, it is more appropriate to assume that the same equipment will be used continuously at one construction site over time, then the emission factors should probably increase over time as that equipment ages (this scenario may not be as likely as the fleet turnover scenario with large projects involving numerous pieces of equipment and large contracting firms). There are two possibilities for introducing time into the calculations. One is to have a project timeline and use different emission rates for different phases of the project. The second possibility is to develop a weighted average emissions rate. Note that in general, construction-related dust emissions will be a larger fraction of the overall PM_{10} problem than exhaust emissions, so the relative importance of this problem may be limited.

There is another confounding coding convention that also complicates interpreting how the time element for estimating the emissions is handled in the spreadsheet. If columns K, L, and M are unhidden, it appears that the programmer has fixed the percentage of each type of work. For example, grubbing and land clearing has 10% of the total project construction time (regardless of the acreage cleared), grading and excavation has 40%, drainage and sub-grade has 35%, and paving has 15% of the total project time. Thus, regardless of the project stage, the time spent on various tasks is constant.

3. Are evaporative emissions handled correctly in the SACTO model?

Yes, there are no evaporative emissions if the model specified for use is EMFAC7f. There are, however, some coding errors in this section. For example, it looks like cells D69-F69, C71-F71, C73-F73, C75-F75 are miscoded where for C69…**(C68*$C59*$C$60*2))**…should be coded as …**(C68*D59*D60*2))**...but this needs to be checked carefully if Caltrans elects to use the model.

4. Can UCD conduct spot-checks on the SACTO model coding?

We also conducted a number of spot checks on the model coding. This examination was just to generally confirm coding protocol/accuracy and to examine the logic flow or appropriateness of the model factors and variables.

Comparing the activity and emission factor to the off-road inventory prepared using OFFROAD (http://www.arb.ca.gov/msei/msei.htm)

If we check signal boards and scrapers, there are some differences that might be important depending on the size of the construction project being reviewed. For signal boards, the average horse-power is slightly higher in SACTO and the activity time is considerably longer than that specified in the emission inventory (EI) prepared using OFFROAD. For most of the equipment, the activity rates are substantially different.

One element that is worth noting is that the EI prepared by CARB uses the California Diesel Standard for NOx in 2000. The SACTO model computes the NOx emissions based on the weighted average of emissions by construction-related equipment before 1996 (11.7 g/bhp-hr) and 1996-2000 (6.9). There may be other computations that would need to be clearly documented if Caltrans decides to use the model. **Table 4** compares assumptions included in the SACTO model with those included in the CARB OFFROAD model.

Table 4. Comparison of example assumptions included in SACTO and CARB's OFFROAD model.

	SACTO		OFFROAD (CARB)	
	Avg-hp	**Activity (hrs/yr)**	**Avg-hp**	**Activity (hrs/yr)**
Excavators	180.1	5810	168.6	6972
Graders	174.0	4825	173.7	5790
Scrapers	313.2	5450	313.2	5450
Signal Boards	118.8	1605	116.2	2140

UCD also conducted some small scale comparisons between the emission factors contained in SACTO worksheet Appendix D, and emission rates identified by the U.S. EPA. To make the comparison we assumed that the data listed in SACTO Appendix D are for diesel-powered (as opposed to spark ignition) engines. If the data are diesel, then we can compare the rates to those in EPA's Report NR-009A, "Exhaust Emission Factors for Nonroad Engine Modeling—Compression Ignition" (see: http://www.epa.gov/OMS/models/nonrdmdl/nr-009a.pdf). In general, the rates in the SACTO model seem to be less, much less in some cases, than those in the EPA document. **Table 5** provides a comparison between the emission factors included in SACTO and the emission factors provided by EPA. It would be helpful to further identify the reasons behind the difference between the SACTO and the EPA rates. As an example of a possible problem, note the different emission factors for 120 hp equipment. The Clean Air Act preempts California from establishing emission standards for new construction equipment less than 175 hp, so there is at least a starting presumption that equipment below 175 hp would have similar emission characteristics regardless of state. If the SACTO emission factors were *less than* the EPA factors, a possible explanation might be California's more stringent fuel standards; however, as can be seen in Table 5, in some cases the SACTO model assumes higher emission factors compared to EPA. It would be helpful to further quality check the emission factor assumptions imbedded in SACTO.

Table 5. Comparison of emission factors (in g/hp-hr) data included in SACTO to data available from U.S. EPA (assumes SACTO data are for diesel engines).

		SACTO				**EPA NR-009A**			
HP	**Model Year**	**ROG**	**CO**	**NOx**	**PM**	**ROG**	**CO**	**NOx**	**PM**
50	1998	1.80	5.00	6.90	0.76	1.80	5.00	6.90	0.80
120	1997	0.99	3.49	8.75	0.69	0.40	1.00	6.90	0.40
175	2002	0.68	2.70	6.90	0.38	0.40	1.00	6.90	0.40
250	2003	0.19	0.92	5.00	0.12	0.40	1.00	4.50	0.40
500	2005	0.10	0.92	4.00	0.11	0.30	1.00	4.50	0.40
750	2020	0.10	0.92	2.45	0.11	0.20	1.00	2.80	0.40

We also found a number of coding errors in the SACTO model. For example, in Appendix D, the calculations in columns B-E, rows 130-140 may be wrong; there might be a missing '$'.

Recommendations

- Given that Caltrans has CEQA requirements that will likely need fugitive dust assessments, we recommend working with the SACTO model rather than developing an entirely new model. While there are some coding errors and problems, it would be more straightforward to develop the spreadsheet further than develop a complete new one. Most of the inputs/outputs look reasonable; however there are coding elements that need additional scrutiny. In late spring, we (informally) received another version of the spreadsheet. It is possible that many of the problems discussed earlier have been resolved.

- If Caltrans decides to go forward with this spreadsheet, we recommend evaluating the updated version and formally suggesting changes, if any, that are needed. For example, if the spreadsheet were not proprietary, UCD could incorporate elements such as mitigation measures into the model structure. At the moment, it is not clear if the model is open for revision without infringing on copyright.

POTENTIAL NEXT STEPS TO IMPROVE CONSTRUCTION EMISSIONS

UCD has identified a number of potential follow-up tasks related to regional-scale and microscale (project-level) emissions analyses. It would be helpful for Caltrans to review with UCD the findings, and to provide feedback on priorities. The recommended work items identified in the microscale discussion could be addressed separately or as part of any follow-up work conducted under the regional-scale effort, since the two efforts are interrelated. **Table 6** provides a summary list of the potential follow-up actions identified in this memo.

Table 6. Summary of potential follow-up work to improve construction-related PM_{10} emissions.

Regional Scale
Improve Activity Data 1. Project duration 2. Amount of construction activity over time (per project) 3. Broaden road construction activity descriptions
Improve Emission Factors 4. Develop equipment-specific emission factors 5. Research PM_{10} settling characteristics 6. Research emission rates by area of state
Research Control Measure Effectiveness 7. Identify required mitigation by air district, plus assumed effectiveness rates 8. Identify mitigation options
Improve SIP Preparation 9. Develop recommended SIP approach 10. Develop approach to allocate construction activities across future years (per region)
Project-Level Options focus only on reviewing and improving upon the SACTO model, since that is the more advanced of the two tools reviewed. In addition, prior to moving forward with any of the tasks listed, we recommend conducting a review of the newest model version to see whether any of these problems have already been addressed.
Substantive Improvements / Quality Review 1. Expand upon the mitigation measure control efficiencies included 2. Base mitigation measure modifications on SJV Regulation VIII 3. Change emission factors over time (to account for fleet turnover and deterioration) 4. Determine reason behind activity differences between OFFROAD and SACTO 5. Update the emission factors to reflect California's latest (2000) diesel NO_x standards 6. Identify reasons behind different equipment-specific emission factors included in SACTO as opposed to EPA literature
Fix Coding Bugs / Improve Coding 7. Fix bug related to estimating emissions from hauling soil 8. Improve coding of how much time is spent on various (currently uses fixed percents) 9. Fix coding errors related to evaporative emissions 10. Fix coding errors in the SACTO Appendix D worksheet