1. Background

Particulate Matter (PM) is a mixture of substances that include elements such as carbon and metals; compounds such as nitrates, organic and ammonium compounds, and sulfates; and complex mixtures such as diesel exhaust and soil. Some of these particles are emitted directly into the atmosphere. Others, referred to as secondary particles, result from gases that are transformed into particles through physical and chemical processes in the atmosphere.

Transportation project level analyses must consider two PM air quality fractions in association with air quality environmental impacts. These are PM$_{10}$ and PM$_{2.5}$. PM$_{10}$ refers to particles with aerodynamic diameters of 10 microns or less. PM$_{2.5}$ refers to particles with aerodynamic diameters of 2.5 microns or less.

Many scientific studies have linked breathing PM to a series of significant health problems, including: aggravated asthma, increase in respiratory symptoms like coughing and difficult or painful breathing, chronic bronchitis, decreased lung function, and premature death. EPA's scientific evidence reveals that fine particulates (PM$_{2.5}$) are the most dangerous to human health. PM$_{2.5}$ particles settle very slowly in the atmosphere relative to coarser particles, and because weather patterns can keep particles airborne from several hours to several days, these particles can cover distances of hundreds of miles. PM$_{2.5}$ can deposit deep in the lung and, by containing substances that are particularly harmful to human health, pose an increased health risk.

2. NAAQS Standards

The EPA has established primary and secondary national air quality standards (NAAQS) for PM$_{10}$ and PM$_{2.5}$. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set are to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. PM$_{10}$ and PM$_{2.5}$ standards are listed in Table I (units of measure for the standards are micrograms per cubic meter of air).
TABLE 1: NATIONAL AMBIENT AIR QUALITY STANDARDS

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Measurement</th>
<th>Standard Value</th>
<th>Standard Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{10}$</td>
<td>Annual Arithmetic Mean</td>
<td>50 µg/m$^3$</td>
<td>Primary &amp; Secondary</td>
</tr>
<tr>
<td></td>
<td>24-hour Average</td>
<td>150 µg/m$^3$</td>
<td>Primary &amp; Secondary</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>Annual Arithmetic Mean</td>
<td>15 µg/m$^3$</td>
<td>Primary &amp; Secondary</td>
</tr>
<tr>
<td></td>
<td>24-hour Average</td>
<td>65 µg/m$^3$</td>
<td>Primary &amp; Secondary</td>
</tr>
</tbody>
</table>

For both PM$_{10}$ and PM$_{2.5}$ emissions, Department project level analyses shall be conducted for potential significant impacts. Particulate analysis modeling information including model identification, related parameters and emission factor sources is provided in Section 3. Input and assumptions for Level I and Level II microscale analyses are presented in Section 5. Section 6 incorporates particulate considerations into mesoscale analyses.

3. PM Air Quality Modeling

PM pollutant concentrations from motor vehicles at roadway intersections can be calculated using CAL3QHC. CAL3QHC predicts air pollutant concentrations near highways and arterial streets due to emissions from motor vehicles operating under free flow conditions, and the estimation of the contribution of emissions from idling vehicles. CAL3QHC required inputs include: meteorological inputs, roadway geometries and receptor locations, traffic inputs and vehicular emission factors. Although CAL3QHC emission factor inputs could be obtained with any mobile source emission factor model, EAB recommends that particulate matter running and idling emission rates be estimated using the most recent version of the U.S. EPA mobile source emission factor model (MOBILE6 is currently the most recent version of this program).

4. Projects Requiring Analysis

PM impacts shall be estimated for all Department projects that exceed listed thresholds in this interim policy regardless of project location or attainment status.

Initial project level assessment shall include consideration of both Federal and State environmental process review regulations (NEPA & SEQR). For Department projects classified as Categorical Exclusions (CE), as listed in FHWA's regulatory definition provided as 23 CFR 771.117(c) & (d), and determined to be Type II Actions as defined and listed in the NYSDOT SEQR regulations provided as 17 NYCRR § 15.14(d) & (e), no PM impact analysis for either fraction shall be required under this policy. Copies of 23 CFR 771.117(c) & (d) and 17 NYCRR § 15.14(d) & (e) are provided as Attachments D and E, respectively, to this guidance.

Additionally for projects that are determined not to be a Categorical Exclusion and/or a Type II Action but do not result in increased traffic volumes, no PM impact analysis is required. However, screening analysis of these projects shall consider changes in traffic patterns relative to potential increases in PM emissions. Such considerations may include higher percentages of diesel vehicles in the vehicle mix, construction of facilities that increase diesel vehicle idling, etc. Where these or similar types of traffic pattern changes exist that have potential to result in increased PM emissions, consultation with EAB should occur to determine if a PM air quality analysis is appropriate.

For projects satisfying the Categorical Exclusion and Type II Action screening criteria outlined above, the document must state that no PM analysis is required. Appropriate documentation should read as follows:
"The subject project has been classified as a Categorical Exclusion as listed in FHWA's regulatory definition provided as 23 CFR 771.117(c) & (d), and determined to be a Type II Action as defined and listed in the NYSDOT SEQR regulations provided as 17 NYCRR §15.14(d) & (e). The subject project actions do not individually or cumulatively have a significant effect on PM emissions. It can therefore be concluded that the project will have no significant adverse impact on ambient PM levels."

For projects that do not satisfy the Categorical Exclusion and Type II Action screening criteria but are determined to have no increases in traffic volumes, the document must state that no PM analysis is required. Appropriate documentation in this case should read as follows:

“The subject project has not been classified as a Categorical Exclusion as listed in FHWA's regulatory definition provided as 23 CFR 771.117(c) & (d) or a Type II Action as defined and listed in the NYSDOT SEQR regulations provided as 17 NYCRR §15.14(d) & (e), but has been determined to result in no increased traffic volumes. The subject project actions do not individually or cumulatively have a significant effect on PM emissions. It can therefore be concluded that the project will have no significant adverse impact on ambient PM levels."

For all other Department projects, an emissions analysis for both PM\(_{10}\) and PM\(_{2.5}\) shall be conducted. Based on build/no-build analysis comparisons for all project alternatives carried into the environmental studies phase, maximum concentration differences or emission differences found to be greater than those thresholds listed below for PM\(_{10}\) and PM\(_{2.5}\) will be determined to represent a potential significant environmental impact.

**PM\(_{10}\) Potential Significant Impact Thresholds:**

For Microscale Analysis:

- Greater than two percent (2%) of NAAQS annual Standard or 1.0 µg/m\(^3\), or
- Greater than 5.0 µg/m\(^3\) on a 24-hour basis

For Mesoscale Analysis:

- Greater than two percent (2%) increase in emission burden

**PM\(_{2.5}\) Potential Significant Impact Thresholds:**

For Microscale Analysis:

- Greater than two percent (2%) of NAAQS annual Standard or 0.3 µg/m\(^3\), or
- Greater than 5.0 µg/m\(^3\) on a 24-hour basis

For Mesoscale Analysis:

- Greater than two percent (2%) increase in emission burden

Thresholds listed above for both PM\(_{10}\) and PM\(_{2.5}\) are based on differences in exhaust emissions and brake and tire wear between the no-build and the build alternatives and do not include incorporation of background PM levels.
If the selected project alternatives exceed either the annual or 24-hour thresholds for PM$_{10}$ or PM$_{2.5}$, it will be necessary to consider and assess mitigation measures that can reduce PM project emissions by the maximum amount practicable with an objective to reduce emissions to levels below the listed thresholds. For mobile source emissions, mitigation at the project level may include one or a combination of the following measures:

- Design configuration changes (e.g. adding or deleting turn lanes, medians, or geometry realignments)
- Operational changes (e.g. signal coordination improvements)
- Re-vegetation of surrounding areas
- Street sweeping programs

At the regional level, mitigation efforts might include: transportation demand reduction measures, off-peak delivery schedules, fuel choice, carpooling incentives, or employer-subsidized public transportation.

If mitigation can be implemented and reduce emission impacts to levels below the listed thresholds for PM, Regions will need to commit to the selected measures in order to continue to progress affected projects under the Environmental Assessment (EA) status.

If mitigation measures are determined not feasible or ineffective for reducing emission impacts to levels below the listed thresholds for PM, affected projects will need to be progressed by means of Environmental Impact Statement (EIS) preparation.

5. PM Microscale Air Quality Analyses

The following steps should be followed in performing a microscale air quality analysis for particulate matter:

a.) Critical Analysis Year(s) Determination

The critical analysis year will be selected based on the worst case emission condition calculated for the project Estimated Time of Completion (ETC) year, ETC+10 and ETC+20. If the project does not cause an air quality impact for these years, then no air quality impact would be expected in any other year.

The critical analysis year is that year of ETC, ETC+10 or ETC+20 that results in the highest emissions. For PM attainment areas the analysis shall be performed for the critical analysis year. For PM nonattainment and maintenance areas, the analysis will be performed for ETC and the critical analysis year of either ETC+10 or ETC+20.

Emission source strengths should be evaluated for a typical project site. Traffic growth rate is the most significant factor affecting the analysis and site selection should be representative of project conditions. As an alternative, highway facility corridor information, rather than typical site information, is acceptable in determining the critical analysis year.

The analysis should be performed using the following input data:

- Peak hour volume, design hour volume or 24-hour average daily volume
- Average speed associated with the above volume
- Vehicle mix representative of the project area
Using the appropriate emission factors generated from MOBILE6 and the above information, the emission factors for each year should be determined. Traffic volume should be multiplied by the emission factors to determine emission source strength and the year with the highest emission source strength is the critical analysis year.

b.) **Level I/Level II Analysis**

There are two levels of air quality microscale analysis for PM. For all Non-Type II and non-Categorical Exclusion projects that result in increased traffic volumes, a Level I microscale analysis will be conducted that calculates emission factors from MOBILE6 and then applies CAL3QHC Version 2.0 to determine the receptor with the highest emission impact. 24-hour and annual threshold criteria will then be compared in association with no-build and the preferred build alternative for both PM fractions. If analyses for either or both fractions exceed the specified thresholds, a Level II Microscale analysis will additionally be performed for the respective exceeding fractions) using MOBILE6, again for the emission factor calculation, and CAL3QHCR for receptor emission impact. Build/no-build emission differences would then be compared to 24-hour and annual average threshold criteria for determination(s) of potential significant impact.

c.) **Ranking & Selection of Sites to be Modeled**

This guidance determines the minimum number of intersections to be analyzed in a project. The analysis should be representative of the project area and should ensure geographic coverage. If a large number of intersections are impacted by the project scope, only those most likely to experience a PM air quality impact need to be analyzed. This is accomplished by identifying and analyzing the intersections with the three highest traffic volumes. If none of these intersections exhibit an exceedance of the PM thresholds, then a sufficient number of intersections have been analyzed. If any one of the first three highest traffic volume intersections experiences an exceedance of the PM thresholds (for either PM$_{10}$ and/or PM$_{2.5}$) following a Level II analysis as described in e. of this section, then the next three intersections with the highest traffic volumes shall be identified and analyzed for the respective exceeding PM fraction(s). This iterative process should continue until results show no PM threshold exceedances for the lowest priority ranked group of intersections analyzed.

d.) **Level I Microscale Analysis Inputs/Assumptions**

The microscale analysis process for PM includes various parameters and inputs. This guidance comes from USEPA guideline modeling requirements. Attached as 1.1-C in the NYSDOT Environmental Procedures Manual (EPM) is the User's Guide for CAL3QHC and the modeling guidelines prepared by EPA.

The Environmental Analysis Bureau (EAB) has developed ROADMAP to facilitate use of CAL3QHC. The User's Guide to ROADMAP is attached as 1.1-D in the EPM.

Default values are provided for most parameters/inputs, however it is strongly recommended that project specific data be used. Project specific data can be obtained through field collection of data, from existing project information or calculated using traffic engineering principles from the most recent edition of the Highway Capacity Manual and associated software. Defaults are typically conservative for air quality analyses and an over-reliance on defaults may result in impact threshold exceedances that cause unnecessary Level II analyses and/or EIS preparation. All inputs and assumptions used in the
Level I analysis should be carried through the Level II analysis or Environmental Impact Statement (EIS) preparation. Adjustment of inputs can be perceived as a means to obtain satisfactory results.

The accuracy of the microscale analysis is directly dependent on the accuracy of meteorology, traffic, and emission factors. These factors can vary widely by region, so the modeler should be confident on the data inputs and the procedures used to gather or estimate these inputs.

i. Meteorological Inputs

Meteorological conditions are important factors in affecting pollution concentrations. Meteorological effects such as wind speed and wind direction and (not addressed directly in CAL3QHC, but included in MOBILE6 inputs to generate emission factors) interact with topographical features to direct the movement and dispersion of particulate matter.

**Averaging Time [min]**

Averaging time (ATIM) should be within the range of 30 to 60 minutes. The most common value is 60 minutes, since most predictions are performed for a one hour period.

**Surface Roughness Height coefficient [cm]**

Surface roughness coefficient (zo) should be within the range of 3 cm to 400 cm. Table 2, reproduced from the CALINE-3 manual, provides the recommended surface roughness coefficients for various land uses. When the land use is mixed, the use of the smaller roughness height is recommended for a conservative analysis.

**TABLE 2. SURFACE ROUGHNESS LENGTHS (Zo) FOR VARIOUS LAND USES**

<table>
<thead>
<tr>
<th>Type of Surface</th>
<th>Zo (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth desert</td>
<td>0.03</td>
</tr>
<tr>
<td>Grass (5-6 cm)</td>
<td>0.75</td>
</tr>
<tr>
<td>Grass (4 cm)</td>
<td>0.14</td>
</tr>
<tr>
<td>Alfalfa (15.2 cm)</td>
<td>2.72</td>
</tr>
<tr>
<td>Grass (60-70 cm)</td>
<td>11.40</td>
</tr>
<tr>
<td>Wheat (60 cm)</td>
<td>22.00</td>
</tr>
<tr>
<td>Corn (220 cm)</td>
<td>74.00</td>
</tr>
<tr>
<td>Citrus orchard</td>
<td>198.00</td>
</tr>
<tr>
<td>Fir forest</td>
<td>283.00</td>
</tr>
</tbody>
</table>
City land-use

<table>
<thead>
<tr>
<th>Land-Use</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single family residential</td>
<td>108.00</td>
</tr>
<tr>
<td>Apartment residential</td>
<td>370.00</td>
</tr>
<tr>
<td>Office</td>
<td>175.00</td>
</tr>
<tr>
<td>Central business district</td>
<td>321.00</td>
</tr>
<tr>
<td>Park</td>
<td>127.00</td>
</tr>
</tbody>
</table>

PM Settling Velocity [cm/s]

A Settling velocity (Vs) of 0 should generally be used in the CAL3QHC model for all PM analyses.

PM Deposition Velocity [cm/s]

A Deposition velocity (Vd) of 0 should generally be used in the CAL3QHC model for all PM analyses.

Wind Speed [m/s]

A worst-case wind speed of 1.0 m/s should be used in the CAL3QHC model for all PM analyses.

Wind Direction [degrees]

"Worst Case" wind direction angle is determined using five degree increments. The model should be run for all wind angles at 5-degree increments for preliminary analysis to determine the "first pass" highest concentration. If the resulting build/no-build differences are found to be 95% of the thresholds listed in Section 4, the model should be run again at all 1 degree increments from 1 to 360 degrees.

Stability Class [1 to 6 = A to F]

The stability class [1 to 6 = A to F] is a measure of atmospheric stability. Atmospheric stability depends on wind speed, sunlight (i.e. the amount of incoming solar radiation), and other mechanical factors. Strong solar radiation heats the air near the ground causing it to rise and allowing PM pollutants to rise and disperse. Strong winds also tend to dilute PM air pollutants and blow them out. Meteorologists have defined six atmospheric stability classes [1 to 6 = A to F], each representing a different degree of turbulence in the atmosphere.

When there is a moderate to large thermal component (i.e. moderate to strong incoming solar radiation) heating air near the ground, the atmosphere is considered "unstable" or relatively turbulent. Unstable conditions are associated with atmospheric stability classes A and B. When there is a small thermal component, the air near the surface has less of a tendency to rise and
less turbulence develops. In this case, the atmosphere is considered "stable" or less turbulent, the wind is weak, and the stability class would be E or F. Stability classes D and C represent conditions of more "neutral" stability, or moderate turbulence. Neutral conditions are associated with relatively strong wind speeds and moderate solar radiation.

The atmospheric stability class that should be used for project level PM air quality analyses varies by the urban/rural nature of the area surrounding the analysis location. In general, the following stability classes should be used for the area of interest:

<table>
<thead>
<tr>
<th>Area</th>
<th>Stability Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>D (4)</td>
</tr>
<tr>
<td>Rural - Suburban</td>
<td>E (5)</td>
</tr>
</tbody>
</table>

In the case of mixed urban-rural-suburban land use, if at least half of the area is rural or suburban (i.e., at least half of the area is covered with vegetation), the use of E stability is recommended. Conversely, if more than half of the area is urban (i.e., less than half the area is covered with vegetation), the use of D stability is recommended. This is based on studies by Auer (Correlation of Land Use and Cover with Meteorological Anomalies, Journal of Applied Meteorology, 1978, Vol. 17, pp 636-643) who observed that areas with significant urban heat island impact, and therefore more frequent unstable atmospheric conditions, are generally industrial, commercial and concentrated residential areas with vegetation coverage being less than 50%.

**Mixing Height [m]**

Mixing height should be generally set at 1000 m. CALINE-3 sensitivity to mixing height is significant only for extremely low values (much less than 100 m).

**Geometry of the Roadway Inputs**

Geometry of the roadway will be needed to input the link location, length, and width data as well as the receptor locations. All roadway geometry should be established to accurately reflect orientation to true north.

**Link Coordinates [x,y,z] [m or ft]**

A link is defined as a straight section of roadway with constant lane width, height, speed, and emission source strength (traffic volume x emission factor). A new link must be coded when any of those parameters changes. CAL3QHC defines two types of links: free flow links, and queue links. The location of a link is specified by its start and end point coordinates (X1, Y1, and X2, Y2).

**Free Flow Link Coordinates**

Free-flow links will be designated as those roadway links where vehicles are assumed to be traveling without stopping. Link lengths must exceed the link width. All roadway links within 1000 feet of the receptor (including those from nearby intersections even though they may not be included in the project) should be included in the analysis. In circumstances where receptors are clustered around the center of an intersection, the 1000 foot requirement may be taken from the center of the intersection.
In establishing the links to be modeled for the 1000 foot requirement, cross streets beyond the intersection of prime interest will occasionally be encountered. For these modeled cross streets, the links should extend to mid-block or 100 feet, whichever is less.

Those cross streets whose line-of-sight to the intersection of prime interest is blocked by buildings need not be modeled. Those cross streets that are "visible" (i.e. whose line-of-sight is not blocked) should be modeled. Judgment should be applied for those cross streets whose line-of-sight is not entirely blocked by buildings. If the majority of the cross street is "visible" to the intersection of prime interest, then it should be modeled. If more than half is blocked, then it need not be modeled.

In a few cases, it may not be reasonable or practicable to include all links within 1000 feet of the receptor. Consultation with EAB for concurrence in those circumstances is encouraged.

Queue Link Coordinates

Queue links represent the line of vehicles idling at the stop line of an intersection. Speed is considered to be 0 mph on queue links. Queue links must be entered with the first set of coordinates at the beginning of the queue (i.e., X1, Y1 coordinates), where vehicles are starting to line up (the stop line) and an arbitrary end point (i.e., X2, Y2 coordinates of any point along the line where the queue is forming). The purpose of specifying a queue link end point is to specify the direction of the queue. The queue links should be accurately defined to the exact physical limits where vehicles can queue. This will prevent any additional work to re-establish queue links in case a level II air quality analysis is necessary, since CAL3QHC includes a queue truncation algorithm to prevent queue lengths from exceeding the specified physical limits.

The actual length of the queue is estimated by the program based on the traffic volume and the capacity of the approach. This will result in a different endpoint of the queue from what was entered into the input file. The emission factors for queue links on the output will be 100 grams/mile regardless of what was included in the input. These are not errors but merely part of the algorithm that CAL3QHC uses to calculate the queue link emissions.

Source Height [m]

For at grade roadways, the source height should be specified as 0.0 m. For fill, bridge, and depressed roadways the actual elevation of the roadway should be used as the source height relative to the surrounding terrain. If the source height is greater than 10 m (elevated section), the source height should be specified as 10 m. A source height of -10 m should be specified if the source height is less than -10 m (depressed section).

Roadway Width [m or ft]

Roadway width refers to the width of the "mixing zone" where the plume has been generated and dispersed. The mixing zone is considered to be the area of uniform emissions and turbulence.

Free Flow Roadway Width - Free flow roadway width is the width of the free flow link (lanes of moving traffic only) plus 3 meters (10 feet) on each of the outside travel lanes to account for the dispersion of the plume generated by the wake of moving vehicles.
Queue Link Roadway Width - Queue link roadway width is determined by the width of only the traveled roadway (width of the lanes on which vehicles are idling). Three meters are not added on each side since it is assumed that vehicles are not moving and no wake is generated.

Receptor Coordinates \([x, y, z] \text{ [m or ft]}\)

Sufficient receptors should be located and included to ensure that project air quality impacts can be detected. Receptor locations are specified in terms of \(X, Y,\) and \(Z\) coordinates. Receptors should be located outside the roadway width plus 3 meters (10 feet) on each of the outside travel lanes. The mixing zone height (or receptor height \(z\)) does not have any restrictions, but for most applications receptors are entered at an assumed breathing height of 1.8 meters (6.0 feet).

Based on EPA guidance, a reasonable receptor location should consider:

- Significant Decreases in Source-Receptor Distance (distance from edge of nearest travel lane to the receptor)
- Significant Increases in Traffic Volume
- Proximity to the Roadway
- Proximity to Areas of High Emissions (i.e., congested intersections, etc.)

Based on EPA guidelines, the following sites are reasonable for receptor placement:

- All sidewalks where the general public has continuous access. Receptor placement should be the midpoint of the sidewalk. Sidewalk receptors that fall within 3 meters of the traveled roadway should be placed at 3.01 meters from that roadway. If physical structure constraints exists (i.e., building lines, etc.), a truncated mixing zone will be used to allow for placement of receptors outside the mixing zone. At a minimum, receptors should be located near the corner and at mid-block for each approach and departure at the intersection. For long approaches, receptor locations are recommended at 25 meter intervals from the intersection corner up to the mid block receptor.

  If a receptor location has been selected outside the mixing zone, or if the mixing zone has been truncated, additional care should be exercised in ensuring the accuracy of the results. Modeled receptor results that are within 0.5ppm of threshold criteria in these cases should be re-evaluated in terms of inputs, measurements and assumptions. Consultation with EAB is also encouraged.

- The nearest edge of a parking lot or vacant lot to which the general public has continuous access. If this cannot be determined, the property line of the lot nearest to the traffic lanes should be used.
- The nearest point of the property lines of all residences, hospitals, rest homes, schools, playgrounds, or entrances and air intakes to all other buildings.
- The receptors selected should represent the worst case. Care should be exercised in receptor placement. Receptors must be located in places of reasonable public access. Receptors should not be located in areas obscure of public access (i.e., middle of a building, beyond the edge of a bridge, etc.) in trying to meet siting requirements.
iii Traffic Inputs

The following traffic parameters should be the peak hour traffic volumes and the associated speeds. The design hour volumes can be used if peak hour data is not available.

Traffic Volume

Traffic volume is the number of vehicles that pass a given point. For each link, enter the peak hour traffic volume in veh/hr. The design hour volumes can be used if peak hour data is not available.

Traffic Speed

Enter the peak hour running speed (the distance a vehicle travels divided by running time) for each link in veh/hr. Running speed is defined to include the effects of acceleration and deceleration associated with a traffic signal but does not include the effect of idling associated with the signal (CAL3QHC has a separate queue emissions component). Running speed can be obtained from field measurements. If this information is not available the average speed (standard definition) or the "typical free flow" speed from Tables 3 and 4 can be used, whichever is slower.

Average Signal Cycle Length

Enter the average cycle length for each intersection in seconds.

Average Red Time Length

Enter for Each approach the period in the signal cycle during which the signal is red, expressed in seconds.

Clearance Lost Time [s]

Enter the time, in seconds, between signal phases during which an intersection is not used by any traffic. The clearance lost time equals the lost time (from the Highway Capacity Manual) minus two seconds. As a default, a value of two seconds can be used for the clearance lost time.

Other Optional Inputs

1. Saturation Flow rate - The equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced, in veh/hour.

2. Signal Type [pre-timed, actuated, or semi-actuated]
   - Pre-timed: A signal control in which the cycle length, phase plan and phase times are preset to repeat continuously.
   - Actuated: A signal control that places detectors on all legs of the intersection and changes the timing of the lights to maximize traffic flow.
• Semi-actuated signal: utilizes detectors only on the minor cross street. When the detector is activated, the green light on the major street is interrupted to allow the minor street traffic to safely enter the intersection.

3. Arrival Rate [worst, below average, average, above average, best progression] - Enter 1 for worst progression (dense platoon at beginning of red), 2 for below average progression (dense platoon during middle of red), 3 (default value) for average progression (random arrivals), 4 for above average progression (dense platoon during middle of green), 5 for best progression (dense platoon at beginning of green).

### TABLE 3: ARTERIAL CLASS ACCORDING TO FUNCTION AND DESIGN  
(CATEGORY SOURCE: TRB, 1985)

<table>
<thead>
<tr>
<th>Design Category</th>
<th>Principal Arterial</th>
<th>Minor Arterial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburban</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Intermediate (Suburban/Urban)</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>Urban</td>
<td>III</td>
<td>III</td>
</tr>
</tbody>
</table>

### TABLE 4: FREE FLOW SPEEDS FOR ARTERIALS (SOURCE: TRB, 1985)

<table>
<thead>
<tr>
<th>Arterial Class</th>
<th>Range of Free Flow Speeds (mph)</th>
<th>Typical Free Flow Speeds (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Range of Free Flow Speeds (mph)</td>
<td>35 to 45</td>
<td>30 to 35</td>
</tr>
<tr>
<td>Typical Free Flow Speeds (mph)</td>
<td>40</td>
<td>33</td>
</tr>
</tbody>
</table>

iv. Other Traffic Considerations

As discussed in criterion 4 of subsection I-2 in Section 9 of the EPM, on some occasions an intersection controlled by a stop sign will need to be analyzed. Since the PM microscale dispersion model, CAL3QHC, does not have explicit treatment of stop signs and provides no specific guidance on their treatment, the following guidance should be used for the analysis of un-signalized intersections.

When vehicles approach a stop sign they are generally in the condition of stop and go. Vehicle speeds near the stop sign are relatively low. A free flow link should be established which is the distance from the stop sign back along the link to the point where the average number of vehicles waiting at the stop sign ends. Emission factors for this free flow link should be based on an average vehicle speed of 5.0 mph. A second approach link should be established from this point back along the roadway to fulfill the remaining distance requirement of 1000 feet. For this second free flow approach link, the vehicle average speed is established the same way as for any other free flow link.

For the free flow link with a vehicle speed of 5.0 mph, the length of the link should be established through field observation. The number of vehicles waiting at the stop sign should be counted at 5-minute intervals during the peak hour for three representative occasions (for example Tuesday, Wednesday and Thursday of a typical workweek). The average of these values during the hour should be used to establish the length of the link. Like other free flow links, this slow moving free flow link should also have a 10-foot mixing zone added to each side of the traveled roadway. For future year analysis, the length of these free flow links should be increased or reduced according to the area's traffic growth rate.

v. Emission Factor Inputs

CAL3QHC requires the input of particulate matter composite emission factors for free flow links [g/veh-mile], and idle emission factors for each queue link [g/veh-hour]. These particulate matter emission factors will be determined from EPA's MOBILE6, which is the currently approved emission
factor model. MOBILE6 generates emission factors based on the makeup characteristics of the vehicle fleet and the project inputs that are entered into the calculation. All emission factors for PM analyses have been generated from MOBILE6 and are available as Attachment A in this policy. Emission factor tables are presented for three geographic areas of the State as follows:

- Regions 1, 2, 3, 4, 5, 6, 7, 9 & Columbia and Ulster Counties in Region 8
- Dutchess, Orange & Putnam Counties in Region 8
- Regions 10, 11 & Rockland and Westchester Counties in Region 8

Provided with the emission factor tables in Attachment A is a user's guidance document entitled MOBILE 6.2 PM\(_{10}/\text{PM}_{2.5}\) EMISSION FACTORS FOR REGIONAL, MESOSCALE, CMAQ, AND MICROSCALE AIR QUALITY ANALYSIS. Reference should be made to this guidance for appropriate project emission factor use when conducting analyses.

vii. CAL3QHC Operation

CAL3QHC requires an input file, with specific data placement and format of the data, be created before the model is run. Any text editor or word processor can be used to edit an input file provided that it results in an ASCII file. The format is as described in the User's Guide to CAL3QHC. The DOS Text Editor is excellent to view/edit the files since it maintains line and space indications for the document. The editor indicates that a character is at a certain line and column which is beneficial in ensuring proper placement of all data in an input file. If a WordPerfect program is used, the files should be saved in the ASCII format. Otherwise the model will not run.

The above analysis will estimate the maximum one hour exhaust concentrations for both PM\(_{10}\) and PM\(_{2.5}\) without a background component. To arrive at the 24-hour concentrations, simply multiply the one hour concentrations by the applicable persistence factor.

There will be occasional project analyses, when interpreting the initial results, where it is obvious that actual conditions are not represented by the model. An example is the calculation of a queue link length for a left turn lane that significantly exceeds the lane physical limit. Provisions are included in the User's Guide to CAL3QHC for truncating links to the physical geometry of the road and for substitution of an equivalent free flow link using the emission factor of 100 grams/mile, the coordinates of the lane physical limits, and the resulting traffic volume computed for the queue link from the initial model run. Further assistance in these situations can be provided by EAB.

viii. PM Background Concentrations

Threshold criteria for both PM\(_{10}\) and PM\(_{2.5}\) are based on differences in exhaust emissions between no-build and the preferred build alternative and do not consider background emission concentrations.

ix PM Persistence Factors

Persistence factors, recommended by USEPA's Office of Air Quality Planning & Standards and referenced in the October 1992 USEPA guidance document SCREENING PROCEDURES FOR ESTIMATING THE AIR QUALITY IMPACT OF STATIONARY SOURCES – REvised (EPA-454/R-92-019), need to be used for conversion of 1-hour PM average concentrations generated from the Level I Microscale analyses. For both PM fractions, the following 24-hour and annual persistence factors shall be used:
If analyses for either or both PM fractions exceed the specified 24-hour or annual threshold criteria, a Level II Microscale analysis will additionally be performed for the respective exceeding fraction(s).

e.) Level II Microscale Air Quality Analysis

If the results from the Level I analysis indicate an exceedance of the 24-hour threshold criteria (listed in Section 4) for either PM fraction, it will be necessary to do a Level II analysis with CAL3QHCR. Due to the complexity of CAL3QHCR, its inputs, and the rather lengthy computer processing time, in those cases where CAL3QHCR must be run in-house, EAB will work with the Regional staff, as necessary. This will include coordination with EPA to ensure consistent application of CAL3QHCR.

CAL3QHCR is an enhanced version of CAL3QHC. However, it is more complex in terms of data processing, input/output, and model result analysis. The model processes up to a year of hourly meteorological data (MET) and vehicular emissions, traffic volume and signalization (ETS) data in one run. One model run contains a total of six input/output files. The model requires a MET data file and an ETS data file for input, creates two intermediate files containing vehicular emissions, traffic volume and signalization data in a form suitable for efficient use of the model, and produces two summary files containing pollutant concentration and link formation.

Meteorological data from the National Weather Service cannot be used directly as input for CAL3QHCR. The data must be processed through the PCRAMMET program. PCRAMMET is an EPA’s standard program for meteorological data processing.

To establish project impacts, several options are available for running CAL3QHCR, including using five years of hourly meteorological data from the closest airport, or hourly project specific meteorological data for one 6-month period. Each of these options can be run using a worst case hour of traffic data to represent every hour of the run, a 24 hour distribution of daily traffic or a 24 hour distribution of weekly traffic (including weekends).

Department projects that exceed either the annual or 24-hour thresholds for PM$_{10}$ or PM$_{2.5}$ will need to consider and assess mitigation measures, as discussed in Section 4, that can reduce PM project emissions by the maximum amount practicable with an objective to reduce PM emissions below the criteria thresholds.

6. PM Mesoscale Air Quality Analyses

If a project would significantly affect traffic conditions over a large area, it is appropriate to consider regional air quality effects of the project by way of a mesoscale analysis.

A mesoscale analysis is conceptually similar to critical year analysis as described previously. However, it covers a larger geographic area that is typically larger than the immediate project area and smaller than the entire network system. The size of the analysis area will be dependent upon the scale and scope of the project and should include, at a minimum, all the roadways that are affected by the project.
In addition to regional CO, VOCs and NOx emission concerns, PM emissions (PM\(_{10}\) and PM\(_{2.5}\)) are now considered a regional issue with a regional or "mesoscale" analysis being the appropriate method of determining their impact. Thus, a mesoscale analysis considers the regional effects for all five air pollutants (PM\(_{2.5}\), PM\(_{10}\), CO, VOC, and NOx).

Projects with build alternatives that could have a significant impact on emissions on a regional basis should have a mesoscale analysis performed. Some examples of regionally significant projects include:

- HOV lanes vs general use lanes,
- new or significant modifications to interchanges on access-controlled facilities,
- large-scale signal coordination projects,
- in attainment area, projects having alternatives (including the no-build) with significantly different (10%) VMT,
- widening to provide additional travel lanes more than a mile in length

If a project meets any of the above criteria, then a quantitative mesoscale analysis for both PM fractions (in addition to CO, VOCs and NOx) is required.

A PM\(_{10}\) quantitative mesoscale analysis is also required for all projects located in New York county, that exceed the initial screening criteria as described previously in Section 4. (Department projects that are not classified as a Categorical Exclusion as listed by FHWA and not listed in the NYSDOT SEQR regulations as a Type 11 project and result in any traffic volume increases).

Required transportation data for the PM mesoscale analysis includes VMT, speed and vehicle mix. The data should be by link and the analysis provides a total estimate of the PM pollutant burden associated with the project.

The analysis is done in the following manner:

- Using the speeds and the default thermal input (50°F) for the project year, determine the emission factor for each vehicle type from the tables provided in Attachment A.
- The emissions burden is then found by multiplying the emission factor determined above by the VMT. If link level speeds were used, then link level VMTs should be used. The emission factor for each vehicle type is then multiplied by the vehicle mix percentage (in decimal units) and summed to determine a total emission factor for the link. The total emissions burden for the project is found by summing the emissions burdens for the links. If one area wide average speed was used to determine the emission factor, then the total area VMT should be multiplied by that emission factor (after having been weighted by the vehicle mix) to determine the project emissions burden.

This analysis is repeated for all alternatives that could have a significant impact on regional emissions (as discussed previously).

7. Construction PM Analyses

Mobile source particulate matter emissions are classified as on-road (e.g. cars, trucks, buses, and motorcycles), and non-road emissions. Non-road emissions result from a diverse collection of vehicles and equipment including the ones used in transportation construction projects (i.e., excavators, asphalt pavers, backhoes, bulldozers, etc.). The EPA estimates that non-road diesel engines currently account for about 44 percent of total diesel particulate matter emissions (with up to 18 percent of total PM2.5 emissions in urban areas) and about 12 percent of total nitrogen oxides (NO\(_X\)) emissions from mobile
sources nationwide. Due to non-road engines accounting for substantial portions of PM emissions, emissions from non-road construction equipment shall be assessed on a project level basis for significant environmental impact.

Based on assessment of non-road construction emissions and the estimated emissions calculated from the following analyses, mitigation measures (i.e., Ultra-low Sulfur Fuel, Retrofit Exhaust Technologies, Alternative Fuels, Operational Limitations, etc.) may be required during the construction phase in order to reduce non-road emission levels by the maximum amount practicable with an objective to reduce emissions below the provided threshold criteria for PM$_{10}$ and/or PM$_{2.5}$.

a.) Projects Requiring Analysis

For all Department projects that do not meet the initial screening criteria described in section 4. and have estimated construction periods of more than 3 years, a project level non-road construction equipment exhaust PM analysis shall be conducted for both PM$_{10}$ and PM$_{2.5}$.

In order to determine the severity of the impacts, project level PM$_{10}$ and PM$_{2.5}$ non-road construction equipment emissions should be compared to an annual threshold of 15 tons per year. Project analysis for determining potential significant impacts shall be based on non-road construction emissions analysis year (the year of project construction activity that results in the highest PM emissions) calculations.

b.) Non-Road Construction Emissions Analysis Year Determination

According to EPA guidance, the dollar value of construction provides a good reflection of construction equipment activity because there is a proportional relationship between the dollar spent on construction and the amount of construction activity in a given area. For this reason, the non-road construction emissions analysis year will be selected based on the expected highest annual dollar value over the life of the construction phase of the project.

c.) Non-road Construction PM Emissions Calculations

As of this issuance EPA has issued NONROAD2002a, a draft mobile source emissions inventory model for non-road equipment, which models construction equipment exhaust emissions. The draft NONROAD model predicts emissions of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), sulfur oxides (SOx), exhaust particulate matter (PM), carbon dioxide (CO2), as well as volume of fuel consumed. Particulate matter can be reported as PM$_{10}$ or PM$_{2.5}$. Modeled emissions are based on all construction equipment sectors (private and public construction work). The model also allocates emissions geographically to the state level, county level and sub-county level.

i. Allocating emissions to the transportation sector

As mentioned before, the dollar value of construction provides a good reflection of construction equipment emissions because of the proportional relationship between the dollar value of construction, and the amount of construction activity in a given area. Based on Table 7. in the the U.S. 1997 Economic Census for Construction Activities in New York State, the estimated value of construction associated with highways, streets, bridges, tunnels, elevated highways and mass transit in 1997 was $3,940,311,000. The total New York State construction value in 1997 was $43,890,804,000. Therefore, the percentage of construction dollars spent on transportation construction as compared to the total New York State construction dollars in 1997 is approximately 9%.
For the present analysis, it will therefore be assumed that approximately 9% of the NONROAD model output PM construction emissions will be produced by the construction of transportation projects. Future updates to the U.S. Economic Census data for construction in New York State will be incorporated into this guidance as they occur in factoring non-road construction emissions for each Region. Estimates of non-road construction PM emissions associated with only Road & Bridge construction for each NYSDOT Region, for years 2004 through 2014 are provided in Attachment B.

ii Allocating emissions geographically

During scoping and design phases of Department projects, project specific construction equipment information (e.g. equipment fuel and engine type, construction activity, etc.) is typically not available. The NONROAD model uses the dollar value of construction to allocate state default construction equipment type and activity to individual counties. For this reason, Department project level analysis will be estimated based on comparisons of construction dollar value of the project and annual non-road construction emissions generated for the emissions analysis year using the NONROAD model.

Construction dollar value projections for each NYSDOT Region were obtained from the NYSDOT 12 year Capital Program and are provided for years 2004 through 2014 as Attachment C. Department capital program projections are considered conservative values in association with the non-road emission calculations for road and bridge work because some federal funding is provided directly to metropolitan transit agencies and is not passed through the Department's Capital program.

Annual project level non-road construction emissions can be calculated for the emission analysis year using a simple ratio that relates annual NYSDOT Region transportation construction emissions and annual NYSDOT region transportation construction expenditure, with project level construction emissions and project level construction cost (where the project level non-road PM emissions are the unknowns):

\[
\frac{RCPM}{RCV\$} = \frac{PLCPM}{PLCV\$}
\]

Variables Represented:

\[
RCPM - NYSDOT Region Non-road Construction PM_{2.5} or PM_{10} in \text{ tons/year}
\]

\[
PLCPM - Project Level Non-road Construction PM_{2.5} or PM_{10} in \text{ tons/year}
\]

\[
RCV\$ - NYSDOT Region Construction Value in \text{ dollars/year}
\]

\[
PLCV\$ - Project Level Construction Value in \text{ dollars/year}
\]

Project level Project Level Non-road Construction PM is obtained by solving equation 1 as follows:

\[
PLCPM = \frac{RCPM}{RCV\$} \cdot PLCV\$
\]

Eq. 2
To simplify the project level analysis of non-road construction equipment, table 6. (for PM₁₀) and 7. (for PM₂.₅) provide the $RCPM/RCV$ coefficients that should be used to calculate project level non-road construction emissions. Project specific construction cost should be used in equation 2 together with the appropriate coefficient value (using emissions year and the NYSDOT Region where the project is located) from the respective PM table(s).

### Table 6: NYSDOT Regional Non-road Construction PM₁₀ ($RCPM/RCV$) Coefficients

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### Table 7: NYSDOT Regional Non-road Construction PM₂.₅ ($RCPM/RCV$) Coefficients

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An example is provided for PM 10 analysis of a hypothetical Region 8 project with a non-road construction emissions analysis year of 2008 as follows:

\[ \frac{RCPM}{RCV\$} = 2.6339 \times 10^{-7} \text{ (from table 6.)} \]

\[ PLCV\$ = 50,000,000 \text{ dollars/year (non-road construction emissions analysis year dollars)} \]

PLCPM is Unknown

Substituting table 6. value into equation 2:

\[ PLCPM = \frac{RCPM}{RCV\$} \times PLCV\$ \]

\[ PLCPM = 2.6339 \times 10^{-7} \times 50,000,000 \]

\[ PLCPM = 13.1696 \text{ tons/year for PM}_{10} \quad (\text{< 15 tons per year criteria for significant impact}) \]

d.) Potential Significant Impact Analysis

The threshold criteria for determining potential significant impacts shall be based on project level non-road construction emission analysis year calculations that exceed 15 tons/year for either PM\textsubscript{10} or PM\textsubscript{2.5}. If PM\textsubscript{10} or PM\textsubscript{2.5} emissions do not exceed 15 tons per year, then the construction PM impacts from the project shall be deemed insignificant (as in the above example) and no further assessment shall be required under this guidance.

Because of the potential significant impact to air quality levels and public health, and lack of identified mitigation, projects where initial project level analysis results in emission analysis year PM\textsubscript{10} or PM\textsubscript{2.5} non-road construction emissions of greater than 15 tons/year will require an advanced PM construction emissions analysis using the NONROAD model. This advanced analysis will be performed with assistance from Main Office EAB Air Quality staff and will require project-specific non-road equipment information from the contractor awarded the contract (i.e., operational types, engine makes, models, fuels, horse-power, anticipated hours of operation, etc.).

If advanced analyses result in non-road construction emission analysis year PM\textsubscript{10} or PM\textsubscript{2.5} results of greater than 15 tons/year, contracts will need to incorporate non-road construction equipment PM mitigation measures commitments (e.g., lower sulfur fuel, exhaust retrofit technology, alternative fuels and/or operational limitations) prior to significant construction work commencing on the contract. Selected measures shall reduce emissions by the maximum amount practicable with an objective of being effectual in reducing non-road construction PM emissions for the emissions analysis year to levels below the 15 tons/year criteria.

Selected mitigation measures and affected project specific non-road equipment, identified as part of an advanced analysis, will be enforced by Regional Construction Inspection staff for the project in association with administering necessary contract changes (orders on contract) that incorporate these measures and non-road equipment commitments. The Environmental is Bureau will coordinate with project Construction engineering and inspection staff on affected projects to assist in enforcement of mitigation measures, as necessary and requested by Regional personnel.

e.) Changes in Project Scope

For all projects where the initial non-road construction PM analysis resulted in annual emission analysis year PM results between 12 and 15 tons/year for either fraction, project scope changes during Construction that increase the project level construction value (PLCVS) for the emission analysis year by 25% will necessitate the need for a subsequent initial analysis that includes the increased dollar
value for the emission analysis year. If the revised initial analysis results in PM levels greater than 15 tons/year, an advanced non-road PM analysis will be required (as described previously).

For all projects that required an advanced non-road construction PM analysis, project scope changes during Construction that increase the project level construction value (PLCV$) for the emission analysis year by 10% will necessitate the need for a subsequent advanced analysis that includes the increased dollar value for the emission analysis year. If the revised advanced analysis results in PM levels greater than 15 tons/year, mitigation measures (as described previously) will need to be selected and implemented on the project.