

**Air Permit Reviewer Reference Guide**

**APDG 5874**

**Modeling and Effects  
Review Applicability:**

**How to Determine the Scope of Modeling and  
Effects Review for Air Permits**

**DRAFT**

**Air Permits Division  
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# How to Determine the Scope of Modeling and Effects Review for Air Permits

## Introduction

The Texas Commission on Environmental Quality (TCEQ) regulates air quality in the state of Texas through the Texas Clean Air Act (TCAA), located in Chapter 382 of the Texas Health and Safety Code and rules, including those in Title 30 Texas Administrative Code (TAC) Chapter 116.

The TCEQ staff conducts a preconstruction technical review during the air permitting process. This review ensures that the operation of a proposed facility will comply with all the rules of the TCEQ and intent of the TCAA, and not cause or contribute to a condition of air pollution. A review of an air permit application involves an assessment of best available control technology (BACT) and human health and welfare effects related to emissions from production and planned maintenance, startup, and shutdown (MSS) activities.

This document provides a process to protect public health and welfare and effectively manage permitting and agency support staff resources. Applications for projects subject to this process are those with new and modified sources of emissions from contaminants for which there are no state or federal ambient air quality standards. In addition, this document establishes a process to determine if refined air dispersion modeling or effects review is required for a permit project, and if required, the scope of the modeling and effects review, and the steps during the process when Toxicology participates.

While this document defines the minimum level of modeling and effects review required for a project it is not regulatory and does not limit the permit reviewer's ability to require a sitewide modeling and effects review. Permit reviewers may deviate from this guidance with the approval of supervisors or the Air Permits Division director.

The initial steps of the document have been designed to be conservative and to provide limited flexibility; however, applicants may not be able to meet guidance thresholds contained in the document. In those situations, the applicant can work with the permit reviewer on a case-by-case basis. In addition, a permit reviewer may advise the applicant that the document cannot be used for a particular project, or request additional information related to the project and other authorized emissions at a site, based on available technical information outside of the permit application. This technical information could come from permit reviewers, toxicologists, regional investigators, agency management or the public.

This document was originally published as interim policy Modeling and Effects Review Applicability Guidance Document for Noncriteria Pollutants dated July 12, 1993, and revised October 16, 1993; January 25, 1994; and August 1998. In addition, this document supersedes the Modeling and Effects Review Applicability technical guidance package dated October 2001.

## Summary of Significant Changes

- General. Clarified that annual impacts analyses are required for all constituents with long term Effects Screening Level (ESLs) that are < 10 percent of their corresponding short-term ESLs. Included new terminology or definitions for the following: Air Permits Division (APD) Review, Chemical Abstract Numbers (CAS Numbers), Planned Maintenance Startup and Shutdown (MSS), Permit By Rule (PBR), Standard Permit

(SP), Single-Property Line Designation (SPLD), permitwide, and unevaluated emissions.

- Step 1. Limited to non-Air Pollutant Watch List (APWL) areas. Expanded to allow for minimal increases in annual emissions and no overall net increase in emissions.
- Step 2. Revised Toxicology Emissions Screening List (Appendix B) to include particulate matter (PM) emissions from controlled painting operations. Added constituents which cannot be used with Step 9C or Step 9D.
- Step 3. Expanded this step to allow small emissions increases when coupled with larger decreases for sites within APWL areas.
- Step 4. Added planned MSS and other unevaluated emissions. Expanded de minimis levels for hourly emission rates to account for constituents with higher ESL concentrations coupled with annual ESLs  $\geq 10$  percent of short-term ESLs.
- Step 5. Expanded look-up tables to include more distances, taller stacks, and day/night differences.
- Step 7. Combined annual emission reduction ratios of 6:1 and 4:1 with distance to a single ratio of 5:1. Limited the amount of short-term emissions increases allowed with annual emissions reductions.
- Step 8. Added a new term (permitwide) and substep to address separate modeling analyses for planned MSS and Production scenarios. Permitwide modeling may be used in addition to project modeling.
- Step 9. Established magnitude and frequency criteria for planned MSS emissions. Added higher thresholds to be used in conjunction with permitwide modeling. Replaced baseline date with most recent sitewide modeling date.
- Step 10. Clarified that the ratio test should be used to test for combined planned MSS and production emissions and impacts.
- Appendices. Deleted previous appendices including Appendix C (Effects Evaluation Procedure), Appendix D (Flowchart Summary (FCS) Form) and Appendix E (Request for Comments (RFC) Form). These internal forms and related processes can be addressed through internal procedures rather than this guidance document.
- Appendices. Modified Appendix A (Glossary of Terms) and Appendix B (Toxicology Emissions Screening List).
- Appendices. Added Appendix C (Step 5 Screening Tables).

## Using the Modeling and Effects Review Flowchart

Figure 1, Modeling and Effects Review Flowchart, is used to determine the scope of modeling and effects review:

- for permit projects that are new construction permits or amendments (renewals will be considered separately from this guidance);
- on a project-by-project basis;
- for allowable emissions;

- on a constituent-by-constituent basis (the term constituent will be used for consistency throughout the document, see the definition in Appendix A); only for the noncriteria or nonregulated constituents where a federal ambient air standard or TCEQ standard does not exist; and
- for constituents with a vapor pressure greater than 0.0002 psia (0.01 mmHg) at maximum operating temperature.

If an ESL is not published, one can be obtained from the Toxicology Section. If no ESL is readily available, a default ESL of 2 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) can be used.

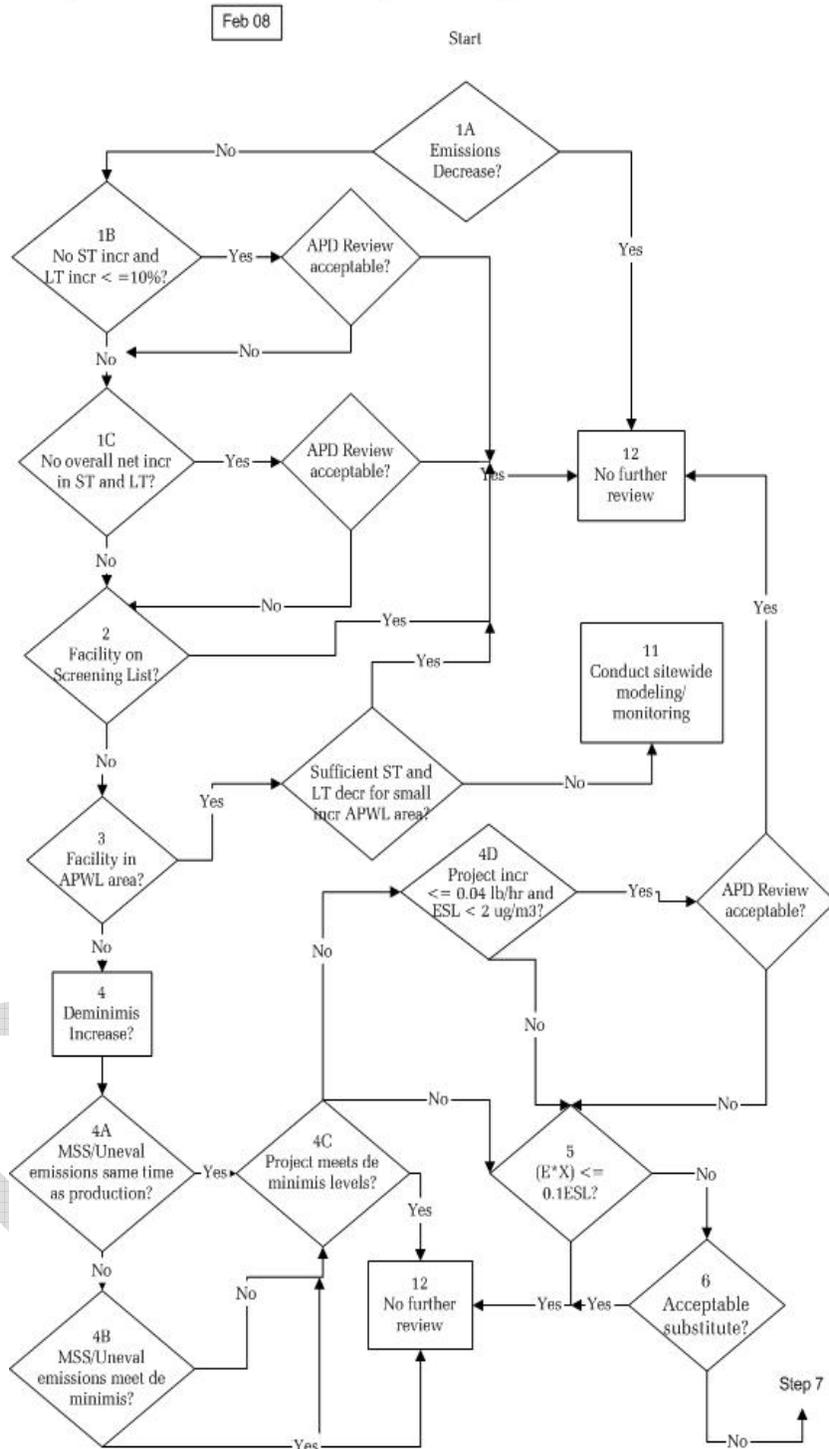
The term modeling used in this document includes 1) screening modeling done in accordance with U.S. Environmental Protection Agency screening procedures and 2) refined dispersion modeling conducted per Air Permits Division Air Dispersion Modeling Team (ADMT) guidance.

The percentages and hours of exceedance in the following steps are guidelines. As an option, permit reviewers may discuss projects with exceedances of the thresholds with APD management before proceeding to the next step in the flowchart.

The remainder of this section provides a step-by-step explanation and supplemental guidance for each block in the flowchart.

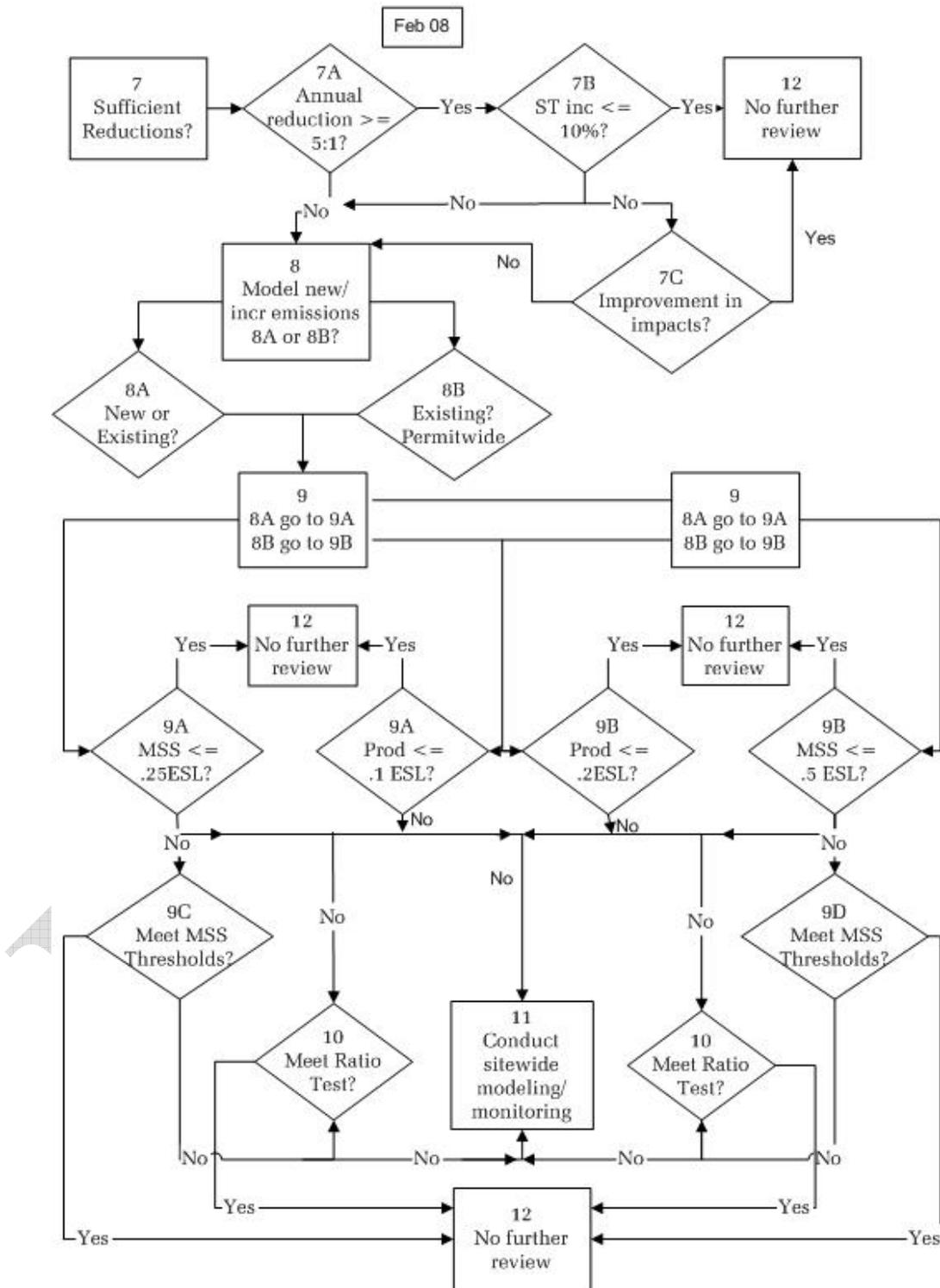
**Note: The MERA flowchart applies on a constituent by constituent basis. The flowchart is a tool to evaluate health and welfare impacts. For any step, consultation with APD may be used in lieu of the flowchart on a case-by-case basis. Not all permitting actions will follow all flowchart steps. Best Available Control Technology (BACT) must be applied prior to using this flowchart.**

Figure 1. How to Determine the Scope of Modeling and Effects Review Flowchart



This flowchart is a summary of the Modeling and Effects Review Applicability technical guidance and is not intended to be a substitute for this guidance.

**Figure 1. How to Determine the Scope of Modeling and Effects Review Flowchart**



**This flowchart is a summary of the Modeling and Effects Review Applicability technical guidance and is not intended to be a substitute for this guidance.**

**Step 1:** This step is used for constituents not identified in an Air Pollutant Watch List (APWL) area, and when there is no increase in short-term emissions but there may be limited increases in annual emissions per constituent.

**Step 1A:** Does the project decrease annual emissions with no increase in short-term emissions from any project emission point (EPN)? This means the project does not affect any short-term emission limits or results only in a reduction in emissions; for example, when the project consists only of adding controls.

If “Yes” → **Step 12.**

If “No” → **Step 1B.**

**Step 1B:** Are the total requested annual emission increases  $\leq 10$  percent of the current authorized annual emissions for the EPNs with the annual emission rate increases? *This substep only considers annual emission rate increases, and there can be no increases for short-term emission rates per EPN.* Annual emission decreases should not be considered at this point in the process; however, annual emission rate increases can vary among EPNs with annual increases as long as the total annual emissions do not increase  $> 10$  percent.

For example:

Constituent A, Emission Point Number	Current Short-term (lb/hr) Emissions	Proposed Short-term (lb/hr) Emissions	Current Annual (tpy) Emissions	Proposed Annual (tpy) Emissions	Annual% Change
EPN 1	5.0	5.0	10.0	10.5	5%
EPN 2	3.0	3.0	5.0	6.0	20%
<b>EPN 3</b>	<b>1.0</b>	<b>1.0</b>	<b>3.0</b>	<b>2.0</b>	<b>-33%</b>
Project Total	8.0	8.0	15.0	16.5	10%

In this example, the proposed annual emissions decrease from EPN 3 does not apply and therefore is not included in the project total. The maximum annual emissions increase for the project is limited to a total of 1.5 tpy based on the current annual emissions from EPNs 1 and 2.

If “Yes” → **APD Review.** APD Review is a technical evaluation of each authorized air constituent to ensure that human health and welfare are protected. This review may include but not be limited to the following: previous modeling results, representative ambient air monitoring data, pollution controls, best management practice (BMP), location of previous and proposed sources, compliance history, comments from the public, governmental agencies, headquarters and regional staff, etc.

If “No” → **Step 1C.**

**Step 1C:** Is there no overall net increase in both short-term and annual emissions? The short-term and annual emission rates can vary by emission point as long as the overall emission rates do not increase for the project.

For example:

Emission Point Number	Current Short-term (lb/hr) Emissions	Proposed Short-term (lb/hr) Emissions	Current Annual (tpy) Emissions	Proposed Annual (tpy) Emissions
EPN 1	5.0	4.5	10.0	9.0
EPN 2	3.0	3.5	5.0	6.0
<b>Project Total</b>	<b>8.0</b>	<b>8.0</b>	<b>15.0</b>	<b>15.0</b>

In this example, the short-term and annual emission rates vary by emission point, but the overall emission rates remain the same.

**If “Yes” → APD Review.**

**If “No” → Step 2.**

**Step 2:** Is the proposed facility on the Toxicology Emissions Screening List?

The Toxicology Emissions Screening List (see Appendix B) identifies certain types of projects and emissions for which the Toxicology Section has determined, based on many past case-by-case reviews, that no further effects review is necessary. Submit requests to add or remove a type of project or emissions from the Emissions Screening List to the Toxicology Section along with supporting documentation.

Please note that if no further modeling is required for effects evaluation, modeling may be needed to demonstrate compliance with other rules, for example, Title 30 TAC § 116.112 or the National Ambient Air Quality Standards (NAAQS).

**If “Yes” → Step 12.**

**If “No” → Step 3.**

**Step 3:** This step applies to sites that have project increases of APWL constituents and applies only to the review of proposed increases of those APWL constituents. If the project is not within an APWL area proceed to Step 4.

Have there been sitewide decreases  $\geq 30$  percent within the last 5 years from the date the application of this project was received by APD? If so, the project can have an increase in emissions  $\leq 1$  percent of the reduction. The increases/decreases must be met for both short-term and annual time periods. This provision gives credit to applicants who have reduced emissions of APWL constituents but it cannot be used if the emission reductions were the result of enforcement actions.

For example:

Current authorized emissions for constituent A

Short-term (lb/hr) Emissions	Annual (tpy) Emissions
50.0	20.0

There must be a decrease in both short-term and annual authorized emissions of  $\geq 30$  percent within the last 5 years.

Highest Authorized Emissions within Previous 5 Years		Current Authorized Emissions		% Reduction	
Short-term	Annual	Short-term	Annual	Short-term	Annual
100.0 lb/hr	50.0 tpy	50.0 lb/hr	20.0 tpy	<b>50%</b>	<b>60%</b>

In this example, because the percent reduction ( $\geq 30$ ) is met, this step can be used only if the proposed authorized emissions for constituent A are no greater than 50.5 lb/hr and 20.3 tpy, based on reductions of 50 lb/hr and 30 tpy, respectively.

Short-term Reductions (lb/hr)	Annual Reductions (tpy)	$\leq 1\%$ Short-term (lb/hr) Emissions Increase	$\leq 1\%$ Annual (tpy) Emissions Increase
50	30	50.5	20.3

If this step is met, the increase in emissions may be added as a sitewide cap. Special conditions may be added to the permit to enforce this cap. Once a reduction has been used, it cannot be used for subsequent projects.

If “Yes” → **Step 12.** Review complete for APWL constituent. Continue through the flowchart for other constituents.

If “No” → **Step 11.**

**Step 4:** This step applies for projects with a de minimis increase in emissions. Determine the emission rate increase for each facility (emission point) involved in the project. Sum the individual lb/hr increases to obtain the project total. If the project includes more than one emission point, do not exclude any emission increases. Do not consider emission rate decreases; that is, do not use the net increase.

**Step 4A:** Will planned Maintenance, Startup and Shutdown (MSS) activities and other unevaluated emissions occur at the same time as production emissions for this project?

If “Yes” → Step 4C.

If “No” → Step 4B.

**Step 4B:** Are planned MSS and other unevaluated emissions  $\leq 0.1$  lb/hr and ESL  $\geq 2 \mu\text{g}/\text{m}^3$  for each constituent?

If “Yes” and no production increase → Step 12.

If “Yes” and project has production increase → Step 4C.

If “No” → Step 4C.

**Step 4C:** Are short-term emissions increases (total for a constituent from all EPNs) within one of the three following de minimis levels, and the annual ESL is  $\geq 10$  percent of the short-term ESL?

Short-term ESL ( $\mu\text{g}/\text{m}^3$ )	Short-term Emissions Increase (lb/hr)
$\geq 2 < 500$	$\leq 0.04$
$\geq 500 < 3500$	$\leq 0.1$
$\geq 3500$	$\leq 0.4$

If “Yes” → Step 12.

If “No” → APD Review, then proceed to Step 4D, Step 5, or Step 12.

**Step 4D:** Is the project increase  $\leq 0.04$  lb/hr and the constituent’s ESL  $< 2 \mu\text{g}/\text{m}^3$ ?

If “Yes” → APD Review.

If “No” → Step 5.

**Step 5:** Is the total concentration due to the emission increases  $\leq 0.1$  ESL? Only increases in emissions are considered for this step.

The purpose of this step is to allow small emission increases without requiring full modeling and effects review. This step uses an equation that restricts an emission increase impact to  $\leq 10$  percent of an ESL. Only increases in emissions are considered for this step. Comparisons are made to the short-term ESL except for constituents with long-term ESLs that are  $< 10$  percent of their corresponding short-term ESLs. For these constituents, compare concentrations obtained from this step to both the short- and long-term ESL.

The concentration is usually obtained from quick look tables which were developed by using conservative screening modeling techniques based on emissions from a source with no plume rise (see Appendix C). As an option, the permit reviewer or applicant may conduct modeling using an approved EPA model with actual building and stack parameters in lieu of using the quick look tables. If this option is selected, include enough receptors in the model to locate the maximum off-property concentration, which then should be used in this step.

Note that this step may not be appropriate for all facility types; for example, bulk terminals which have extensive constituent lists. If this step is skipped, go to the next applicable step in the flowchart.

If the maximum predicted concentration occurs at the property line, the permit reviewer may consider the surrounding land use to decide if a concentration at a distance other than the property line may be used for this step. The applicant must demonstrate to the permit reviewer that the area from the property line to the closest receptor or 500 feet—whichever is closer—will not be used for any public purpose and is not productive for agricultural or wildlife use.

Use the following equations to predict impacts from single or multiple emission points, respectively:

For a single emission point:

$$(X) (E) \leq 0.1(ESL) \text{ or, } E \leq 0.1 \frac{ESL}{X}$$

For multiple emission points (weighted average):

$$E_{i-n} = 0.1 \left[ \frac{E_1}{E_{total}} \left( \frac{ESL}{X_1} \right) + \frac{E_2}{E_{total}} \left( \frac{ESL}{X_2} \right) + \frac{E_n}{E_{total}} \left( \frac{ESL}{X_n} \right) \right]$$

where

$E_i$  = emission rate in lb/hr for the constituent emitted from emission point  $i$

$n$  = total number of emission points

$E_{i-n}$  = emission rate in lb/hr for the constituent emitted from multiple emission points emitting simultaneously

ESL = the effects screening level in  $\mu\text{g}/\text{m}^3$  for the constituent being evaluated (published in the most recent edition of the list of ESLs by the Toxicology Section)

$X_i$  = the appropriate X-value in  $\mu\text{g}/\text{m}^3$  per lb/hr for the emission point  $i$  at the applicable distance  $D$ , taken from either Table 1, 2, 3 or Table 4, as applicable (see Appendix C)

$D$  = the downwind distance to the nearest property line from the emission point that relates to the facility

**Example, Constituent A:**

EPN	ESL ( $\mu\text{g}/\text{m}^3$ )	Distance (feet)	Height (feet)	X Value ( $\mu\text{g}/\text{m}^3$ / lb/hr)	$E_i/E_{total}$
1	100	1000	10	200	0.3
2	100	4000	20	50	0.7

$$E_{i-n} = 0.1 [ ((E_1/E_{total})(ESL/X_1)) + ((E_2/E_{total})(ESL/X_2)) ]$$

$$E_{i-n} = 0.1 [ ((0.3)(100 \mu\text{g}/\text{m}^3 / 200 \mu\text{g}/\text{m}^3 / \text{lb/hr})) + ((0.7)(100 \mu\text{g}/\text{m}^3 / 50 \mu\text{g}/\text{m}^3 / \text{lb/hr})) ]$$

$$E_{i-n} = 0.1 [ 0.15 \text{ lb/hr (EPN}_1) + 1.4 \text{ lb/hr (EPN}_2) ]$$

$$E_{i-n} = 0.1 [ 1.55 \text{ lb/hr (EPN}_1 + \text{EPN}_2) ] = 0.155 \text{ lb/hr}$$

The maximum allowable emission rate for constituent A is 0.155 lb/hr.

**If “Yes” → Step 12.** This means the emission rate increase multiplied by the value in Tables 1 through 4 or modeling results in an impact that is  $\leq 10$  percent of the ESL (both the short-term and long-term ESL for constituents with long-term ESLs that are  $< 10$  percent of their corresponding short-term ESLs) and no further modeling or effects review is required.

**If “No” → Step 6.**

**Step 6:** Acceptable constituent substitution?

This step allows for limited constituent substitutions. A substitution is defined as a proposal to eliminate one constituent—for example, xylene—and then emit a different constituent—for example, toluene—from an emission point that has previously been through permit and effects review.

Note this step applies only:

- to constituents previously approved by the Toxicology Section or that were reviewed using the flowchart, and
- to replace constituents at the currently authorized individual EPN for each constituent.

To be acceptable, the applicant must show that the substitution—which must be made at the same EPN currently authorized—will not result in adverse impacts. This demonstration is accomplished by satisfying either Test A (where there is a direct substitution of one constituent for another) or Test B (where the replacement has different constituents), as applicable. Note that the use of Test B might not be appropriate for some facilities, such as specialty chemical facilities.

Both short and long-term impacts must be evaluated for constituents with long-term ESLs that are  $< 10$  percent of their corresponding short-term ESLs, or for any other constituent requested by APD or Toxicology Section staff. The request could be made based on such factors as the impacts from previous evaluations, comments by regional staff, ambient monitoring concentrations, or compliance history. Currently authorized emission limits could change based on the value of the replacement ESL.

- Replacement constituent has lower ESL. If the replacement constituent has a lower ESL, the emission rate must be decreased to meet Test A. If not, additional Toxicology Section review, which may include modeling, would be required to keep the same emission limits as currently authorized.
- Replacement constituent has higher ESL. If an applicant wants to replace the currently authorized constituent with one that has a higher ESL, with no increase in throughput, the applicant would be bound by the currently authorized rate. On the other hand, if an applicant wants to replace one constituent for another with a higher ESL, and requests an increase in throughput, the applicant could exceed the previously authorized emission rate up to the amount derived by using Test A. The proposed increase in throughput would require an amendment to the permit.

$$\text{Test A: } \frac{ER_2}{ESL_2} \leq \frac{ER_1}{ESL_1}$$

where:

$ER_2$  = emission rate of the replacement constituent;

ESL<sub>2</sub> = effects screening level of the replacement constituent;  
 ER<sub>1</sub> = emission rate of the currently authorized constituent; and  
 ESL<sub>1</sub> = effects screening level of the currently authorized constituent.

$$\text{Test B: } \frac{ER_{2a}}{ESL_{2a}} + \frac{ER_{2b}}{ESL_{2b}} + \dots + \frac{ER_{2n}}{ESL_{2n}} \leq \frac{ER_{1a}}{ESL_{1a}} + \frac{ER_{1b}}{ESL_{1b}} + \dots + \frac{ER_{1n}}{ESL_{1n}}$$

where:

ER<sub>2a...n</sub> = emission rate of the replacement constituent, from a through n constituents;

ESL<sub>2a...n</sub> = ESL of the replacement constituent, from a through n constituents;

ER<sub>1a...n</sub> = emission rate of the currently authorized constituent, from a through n constituents; and

ESL<sub>1a...n</sub> = ESL of the currently authorized constituent, from a through n constituents.

**If “Yes” → Step 12.** One of the tests is satisfied; no further modeling or effects review is required.

**If “No” → Step 7.** Neither test is satisfied.

**Step 7:** Does this project involve annual emission reductions with minimal short-term emission increases of the same constituent, and are reductions sufficient?

**Step 7A:** Are the total annual project reductions to increases ≥ 5:1?

For example:

Emission Point Number (EPN)	Current Short-term Emissions (lb/hr)	Proposed Short-term Emissions (lb/hr)	Current Annual Emissions (tpy)	Proposed Annual Emissions (tpy)
EPN 1	100	100	50	50
EPN 2	100	0	100	0
EPN 3	500	500	200	200
EPN 4	0	70	0	20

In this example, EPN 2 is being removed and EPN 4 is being added. The ratio of total annual reductions to project increases meets the 5:1 ratio (100 tpy reduction/ 20 tpy increase).

**If “Yes” → Step 7B.**

**If “No” → Step 8.**

**Step 7B:** Are the total short-term increases ≤ 10 percent of the current permitted short-term emissions?

In the example above, the ratio of total annual reductions to project increases meets the 5:1 ratio, and the maximum hourly emission rate for EPN 4 is 70 lb/hr (10 % of 700 lb/hr).

**If “Yes” → Step 12.** The total short-term increase is minimal and no further modeling or effects review is required.

**If “No” → Step 7C or Step 8.**

**Step 7C:** Is there an improvement in impact as determined by APD Review? This means that on a qualitative or quantitative basis, it is expected that short- and long-term impacts will be improved by the reduction, the reduction is considered sufficient, and no further modeling or effects review is required.

If “Yes” → **Step 12.**

If “No” → **Step 8.**

**Step 8:** Model all new emissions, including those previously unevaluated, and increased emissions; or proposed permit allowable emissions.

New constituent → **Step 8A.** Applies to the project only. Use the modeling results in Step 9A.

Existing constituent → **Step 8A or 8B.** Applies to the project or permitwide.

If the constituent is new, the applicant must use Step 8A. Step 8A applies to a project and Step 8B applies to the entire permit. The applicant can choose 8A or 8B, for existing constituents that have undergone effects review and have been specified in a permit condition or appear on the Maximum Allowable Emission Rate Table (MAERT) for this permit. Remember, BACT must be applied prior to conducting modeling.

Unless otherwise specified, all modeling shall be performed to obtain applicable maximum, off-property short-term concentrations (usually one hour for the majority of constituents), and be based on the emission rates for the sources related to the permit application. This guidance does not apply to constituents with long-term ESLs that are < 10 percent of their corresponding short-term ESLs, or for any other constituent requested by APD or Toxicology Section staff. For these constituents both short-term and annual concentrations are required.

At this step, applicants that claim a single property-line designation (SPLD) with another company model only emissions from the applicant’s site (see 30 TAC § 101.2). For subsequent steps that involve the use of sitewide emissions or require an evaluation of sitewide impacts, the applicant may need to include all emissions from all sites that comprise the single property. This determination will be made on a case-by-case basis by APD and Toxicology Section staff.

**Step 8A:** This step must be used if the constituent is new or may be used for an existing constituent that has undergone effects review and has been specified in a permit condition or appears on the MAERT for this permit. Model the new and increased emissions for planned MSS and Production scenarios separately. Perform modeling in accordance with guidance from the ADMT. Use the modeling results in Step 9A.

**Step 8B:** This step may be used for an existing constituent that has undergone effects review and has been specified in a permit condition or appears on the MAERT for this permit. The applicant must model the permitwide proposed emissions (existing emissions plus project emissions) for planned MSS and Production scenarios separately. Perform modeling in accordance with guidance from the ADMT. Use the modeling results in Step 9B.

Example:

Short-term emissions for Constituent A are proposed to be increased for EPN 2 and EPN 3 in Permit xyz. There are no proposed changes to annual emissions for this constituent.

Emission Point Number (EPN)	Current Short-term Emissions (lb/hr)	Proposed Short-term Emissions (lb/hr)
EPN 1	5.0	5.0
EPN 2	7.0	<b>7.5</b>
EPN 3	10.0	<b>12.0</b>
EPN 4	5.0	5.0
EPN 5	8.0	8.0

In this example, if modeling is performed only for EPN 2 and EPN 3 (project increases only), use thresholds in Step 9A. If modeling is performed for EPN 1 through EPN 5 (permitwide emissions), use thresholds in Step 9B.

**Step 9:** Results from Step 8A are used in Step 9A and results from Step 8B are used in Step 9B to determine if further evaluation is needed.

To make this determination, the criteria in Steps 9A or 9B must be met. In addition, both short-term and long-term thresholds in the following tables must be met for constituents with long-term ESLs that are < 10 percent of their corresponding short-term ESLs, or for any other constituent requested by APD or Toxicology Section staff.

**Step 9A:** This step must be used if the constituent is new or may be used for an existing constituent that has undergone effects review and has been specified in a permit condition or appears on the MAERT for this permit. The applicant must have modeled the new and increased emissions for planned MSS and Production scenarios separately. If the project includes both planned MSS and Production, the modeling results should be evaluated individually against the following table.

Will the following thresholds be met at the location of the  $GLC_{max}$ ?

Planned MSS Only	Production Only
$\leq 25\%$ ESL <b>AND</b> $\leq 50\%$ ESL from all new and increased planned MSS emissions since the most recent sitewide modeling	$\leq 10\%$ ESL per project <b>AND</b> $\leq 25\%$ ESL from all new and increased production emissions since the most recent sitewide modeling

If “Yes” → **Step 12.**

If “No” for planned MSS → **Step 9C, Step 10, or Step 11.**

If “No” for Production → **Step 10 or Step 11.**

**Step 9B:** The step may be used for an existing constituent that has undergone effects review and has been specified in a permit condition or appears on the MAERT for this permit. The applicant must have modeled the permitwide proposed emissions (existing emissions plus project emissions) for planned MSS and Production scenarios separately. If the project

includes both planned MSS and Production, the modeling results should be evaluated individually against the following table.

Will the following thresholds be met at the location of the  $GLC_{max}$ ?

Planned MSS Only	Production Only
$\leq 50\%$ ESL <b>AND</b> $\leq$ ESL from all new and increased planned MSS emissions since the most recent sitewide modeling	$\leq 20\%$ ESL for the permit <b>AND</b> $\leq 50\%$ ESL from all new and increased production emissions since the most recent sitewide modeling

If “Yes” → Step 12.

If “No” for planned MSS → Step 9D, Step 10, or Step 11.

If “No” for Production → Step 10 or Step 11.

**Note: Projects with the constituents included in Appendix B cannot use Step 9C. The applicant should continue to Step 10 or Step 11.**

**Step 9C:** Will the planned MSS emissions from the project meet the following thresholds?

Planned MSS Only
$\leq 24$ hours $> 1$ X ESL <b>AND</b>
$\leq 12$ hours $\geq 2$ X ESL <b>AND</b>
$\leq 6$ hours $\geq 4$ X ESL <b>AND</b>
1 hour $\geq 10$ X ESL

If “Yes” → Step 12.

If “No” → Step 10 or Step 11.

**Note: Projects with the constituents included in Appendix B cannot use Step 9D. The applicant should continue to Step 10 or Step 11.**

**Step 9D:** Will the planned MSS emissions from the permit meet the following thresholds?

Planned MSS Only
≤ 48 hours > 1 X ESL <b>AND</b>
≤ 24 hours ≥ 2 X ESL <b>AND</b>
≤ 12 hours ≥ 4 X ESL <b>AND</b>
≤ 2 hours ≥ 10 X ESL

If “Yes” → **Step 12.**

If “No” → **Step 10 or Step 11.**

**Step 10:** Will increased emissions pass the ratio test for combined planned MSS and Production?

*This purpose of this step is to determine if the total impacts could potentially be acceptable by assuming that the existing emissions disperse in a similar manner as the new emissions.*

The applicant can demonstrate that sitewide modeling would not be required for each constituent based on the following ratio test:

$$\frac{GLC_{\max}}{ESL} \leq \frac{E_n}{E_t} \text{ where:}$$

- $GLC_{\max}$  is the predicted maximum ground-level concentration of the new and increased emissions from planned MSS and Production combined (from Step 8A or Step 8B; see note below);
- ESL is the effects screening level of the particular constituent in question;
- $E_n$  represents the new and increased emissions in lb/hr of the constituent in question; and
- $E_t$  represents the the total sitewide emissions in lb/hr of the constituent in question at the property; for example, existing emissions plus new and increased emissions.

Use the lb/hr rate based on annual emissions for comparison with the long-term ESL for constituents with long-term ESLs that are < 10 percent of their corresponding short-term ESLs. Applicants must provide sitewide emissions including all previously unevaluated emissions of the constituent in question, and should certify that the represented emissions are complete and accurate to the best of their knowledge.

Note: There may be cases where the entire site consists of only a few sources. The results from screening modeling could then be used in this step. For example, if there is only one source (the one undergoing effects review), and the ratio of the  $GLC_{\max}$  to the ESL is one or less, the demonstration is complete. Additionally, if there are only two sources (the one undergoing effects review and a previously permitted source), and the  $GLC_{\max}$  for both sources combined is equal to or less than the ESL, the demonstration is complete.

If “Yes” → **Step 12.** This means that the ratio  $GLC_{\max}/ESL$  is less than the ratio  $E_n/E_t$ .

If “No” → **Step 11** and either provide sitewide modeling or representative ambient monitoring data. This means that the ratio  $GLC_{max}/ESL$  is greater than the ratio  $E_n/E_t$ .

**Step 11:** Conduct sitewide modeling.

Reaching this step means that either the permit reviewer or the Toxicology Section requires sitewide modeling. The applicant must either:

- conduct sitewide modeling;
- submit sitewide modeling from a recently approved project; or
- submit monitoring data and demonstrate that monitoring data are representative of near worst-case impacts and should be used instead of sitewide modeling.

Modeling must be done in accordance with the ADMT’s guidance. Applicants that claim a SPLD should model emissions from all sources on the combined areas covered in the SPLD (see 30 TAC § 101.2). The permit reviewer should submit modeling results (including previous modeling results, if applicable) in a Request for Comments (RFC) to Toxicology.

If monitoring data is to be used, the applicant must contact the permit reviewer to arrange a meeting with Toxicology Section, ADMT, and Monitoring Operations staff to discuss monitoring data already available or to receive guidance for (and approval of) a strategy to collect monitoring data. Technical feasibility of monitoring for the constituent of concern will be a key criterion for whether ambient monitoring data will be an acceptable substitute for sitewide modeling. Several months of data may be sufficient for evaluating the impact of short-term emissions of an acute toxicant, but up to a year of data may be necessary for evaluating long-term exposure levels of a chronic toxicant.

Generally, at a minimum, the following issues should be addressed in developing a monitoring strategy:

- Siting of monitors;
- Monitoring method;
- Amount and type of monitoring. This would have to be decided on a case-by-case basis and would depend on such factors as:
  - the air constituent,
  - types and locations of sources,
  - source parameters and operating hours,
  - meteorology,
  - location of nonindustrial receptors, and
  - location of other sources of the constituent
- Quality assurance procedures.

**Step 12:** Documentation

The flowchart process is complete. For every project, the permit reviewer must complete and profile a MERA flowchart summary form or discuss the impacts review in a technical review. This requirement applies when any step leads to this step. For example, if a project “falls off the flowchart” at Step 1, the user is directed to Step 12.

# Appendix A

## Glossary of Terms

**air contaminant**—Particulate matter, radioactive materials, dust fumes, gas, mist, smoke, vapor, or odor, including any combination of those items, produced by processes other than natural (Texas Health and Safety Code (THSC) § 382.003). May also be referred to as constituent, chemical, pollutant, or toxicant.

**ADMT**—Air Dispersion Modeling Team

**air pollution**—The presence in the atmosphere of one or more air contaminants in such concentration and of such duration that are or tend to be injurious to or to adversely affect human health or welfare, animal life, vegetation, or property; or interfere with the normal use and enjoyment of animal life, vegetation, or property (THSC § 382.003).

**ambient air**—That portion of the atmosphere, external to buildings, to which the general public has access (30 Texas Administrative Code (TAC) § 101.1). For purposes of the MERA, ambient air starts at the property line.

**APD**—Air Permits Division

**APD Review**—A technical evaluation of proposed increases in authorized emission rates of each non-criteria air constituent to ensure that human health and welfare are protected. This review may include but not be limited to the following: previous modeling results, representative ambient air monitoring data, pollution controls, best management practice (BMP), location of previous and proposed sources, compliance history, comments from the public, governmental agencies, headquarters and regional staff, etc.

**authorization**—A mechanism to allow the release of emissions of constituents into ambient air. Typical authorizations are PBRs, SPs, and case-by-case NSR Permits.

**BACT**—Best available control technology with consideration given to the technical practicability and the economic reasonableness of reducing or eliminating emissions from the facility (30 TAC § 116.10).

**BMP**—Best management practices are operating techniques and good housekeeping principles for reducing and preventing pollution before it occurs.

**CAS Number**—These are assigned by the Chemical Abstracts Service (CAS) of the American Chemical Society. CAS registry numbers are unique numerical identifiers for chemical constituents, polymers, biological sequences, mixtures and alloys.

**constituent**—A general term that refers to an individual contaminant, chemical, chemical constituent, pollutant, or particulate matter.

**emission point**—Point of constituent emissions release into the air.

**EPN**—Emission point number. A unique identifier for an emission point at a site.

**ESL**—Effects screening level as derived by the Toxicology Section. Guideline concentrations used to evaluate ambient air concentrations of constituents. Based on a constituent's potential to cause adverse health effects, odor nuisances, vegetation effects, or materials damage. Health-based screening levels are set at levels lower than levels reported to produce adverse health effects, and are set to protect the general public, including sensitive subgroups such as children, the elderly, or people with existing respiratory conditions. If an air

concentration of a constituent is below the screening level, adverse effects are not expected. If an air concentration of a constituent is above the screening level, it is not indicative that an adverse effect will occur, but rather that further evaluation is warranted (see Appendix C).

**exceedance**—In excess of a pre-established comparison level.

**facility**—A discrete or identifiable structure, device, item, equipment, or enclosure that constitutes or contains a stationary source, including appurtenances other than emission control equipment. A mine, quarry, well test, or road is not considered to be a facility (THSC § 382.003 and 30 TAC § 116.10).

**GLC**—Ground-level concentration in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) as predicted by modeling. May also be observed by long-term monitoring.

**GLC<sub>max</sub>** —Maximum off-property ground-level concentration at any receptor.

**GLC<sub>ni</sub>** —Ground-level concentration at the maximally affected, off-property nonindustrial receptor, ni.

**industrial receptor**—A receptor relating to the manufacturing of products or handling of raw materials or finished products without any associated retail product sales on property.

**MAERT**—Maximum Allowable Emission Rate Table.

**mmHg**—Millimeters of mercury (a measure of gas pressure).

**MSS**—Maintenance, Startup, and Shutdown. For the purposes of authorizations, only emissions from planned maintenance, startup, and shutdown activities may be included.

**NAAQS**—National Ambient Air Quality Standards (40 Code of Federal Regulations (CFR) § 50.2)

**nonindustrial receptor**—A receptor type such as residential, recreational, commercial, business, agricultural, or a school, hospital, day-care center, or church. Other types include rights-of-way, waterways, or the like. In addition, receptors in unzoned or undeveloped areas are treated as nonindustrial. Nonindustrial receptors may also be referred to as sensitive.

**NSR**—New Source Review

**PBR**—Permit by Rule (formerly Standard Exemption)

**permitwide**—All allowable emissions associated with an individual permit.

**project**—An operational and/or physical change that may affect air emission rates at a site including unevaluated emissions from activities and/or facilities.

**property**—All land under common control or ownership coupled with all improvements on such land, and all fixed or movable objects on such land, or any vessel on the waters of this state (30 TAC § 101.1).

**psia**—Pounds per square inch absolute (a measure of gas pressure).

**receptor**—A location where the public could be exposed to an air constituent in the ambient air. For the effects evaluation process, receptors are classified as industrial or nonindustrial.

**single-property line designation (SPLD)**—As defined by 30 TAC § 101.2 and approved by the Executive Director of the TCEQ or his designee.

**site**—The total of all stationary sources located on one or more contiguous or adjacent properties, which are under common control of the same person (or persons under common control) (30 TAC § 122.10).

**sitewide modeling**—Modeling (refined or screening) of emissions from all emission points and areas on a contiguous property or at a site. Synonymous with plantwide modeling. Includes all sources authorized under 30 TAC Chapters 106 and 116. Note that de minimis emissions under 30 TAC § 116.119 are not included for sitewide modeling demonstrations. May apply to emissions from all emission points on land identified in single property-line designations between multiple owners.

**source**—A point of origin of air contaminants, whether privately or publicly owned or operated (THSC § 382.003 and 30 TAC § 116.10). Upon request of a source owner, the executive director shall determine whether multiple processes emitting air contaminants from a single point of emission will be treated as a single source or as multiple sources (30 TAC § 101.1).

**SP**—Standard Permit

**TCEQ**—Texas Commission on Environmental Quality

**unevaluated emissions**—Any existing emissions that have not been reviewed per the MERA process such as emissions from PBRs, SPs or any other authorization.

# Appendix B

## Toxicology Emissions Screening List

Projects with the following constituents cannot be used in Step 9C or Step 9D.

- Acrolein
- Acrylonitrile
- Benzene
- Bromine
- 1,3-butadiene
- Carbon disulfide
- Chlorine
- Chloroform
- Chloroprene
- Epichlorohydrin
- Fluorine
- Formaldehyde
- HCl
- HF
- Hydrazine
- Mercaptans
- Methyl bromide
- MDI
- Phosgene
- Phosphine
- Styrene
- TDI

Projects with the following types of emissions do not require effects review:

- Emissions of constituents that must meet either NAAQS or state rules and regulations. *This paragraph does not apply to speciated particulate emissions. For example, the portion of total particulate matter that is silica would be evaluated.*
- Odor and particulate emissions from agricultural, food processing, or animal feeding or handling facilities.
- Emissions of particulates from abrasive blast cleaning provided they do not contain:
  - asbestos;

- metals with an ESL of less than 50  $\mu\text{g}/\text{m}^3$ ; or
- crystalline silica greater than or equal to 1 percent (weight) of the total particulate weight.
- Emissions of particulate matter, except for metals and silica, from controlled surface coating operations. Controlled surface coating operations mean particulate matter shall be captured and abated with a water wash or dry filter system (at least 95% removal efficiency) and exhausted through elevated stack with no obstruction to vertical flow.
- Emissions of particulate matter from rock crushers, concrete batch plants and soil stabilization plants.
- Emissions from boilers, engines, or other combustion units fueled only by pipeline-quality natural gas.
- Emissions from flares, heaters, thermal oxidizers, and other combustion devices burning gases only from onshore crude oil and natural gas processing plants. *However, glycol dehydrators or amine units do require effects review.*
- Emissions of freons that have ESLs greater than 15,000  $\mu\text{g}/\text{m}^3$ .
- Emissions of the following 10 gases, which have been classified as simple asphyxiants:
  - argon
  - carbon dioxide
  - ethane
  - helium
  - hydrogen
  - methane
  - neon
  - nitrogen
  - propane
  - propylene

# Appendix C

## Step 5 Screening Tables

The following notes apply to the selection and use of Tables 1 through 4:

- How do I determine if an emission point is downwashed? Is there a building or structure such as a storage tank within 5L (L is lesser of the building height or projected width) and is the building or structure  $\geq 40\%$  of stack height? If yes, use Table 1 or 3. If no, use Table 2 or 4.
- How do I determine which distance to use? Distance is determined to the nearest property line from the emission point that relates to the facility. If there is more than one emission point, determine the distance to the nearest property line for each emission point.
- Can I interpolate between heights and distances in the tables? Yes. Linear interpolation is allowed between height and distance points.
- How do I determine annual values? To obtain an annual value, multiply the hourly value in Table 1 through Table 4 by 0.08. The lb/hr rate based on annual emissions can be used in lieu of the maximum hourly emissions. Annual values must be determined for constituents with long-term ESLs that are  $<10$  percent of their corresponding short-term ESLs.
- Can I adjust the results in the tables to account for low-level fugitive emissions? No. The tables are designed to be conservative and it is not appropriate at this stage to refine predicted concentrations.
- What are daytime hours? For the purpose of these tables, day time hours are 6 a.m. to 6 p.m.

**Table 1. Downwash for All Hours ( $\mu\text{g}/\text{m}^3$  per 1 lb/hr)**

Distance (feet)	Stack Height (feet)																				
	3	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
50	2965	2363	2260	1005	596	362	251	185	141	112	90	75	63	54	46	40	35	31	28	25	23
100	2024	1719	1003	708	596	362	251	185	141	112	90	75	63	54	46	40	35	31	28	25	23
150	1338	1195	822	708	596	342	251	185	141	112	90	75	63	54	46	40	35	31	28	25	23
200	950	873	708	708	559	342	218	185	141	112	90	75	63	54	46	40	35	31	28	25	23
250	800	743	617	617	512	321	213	149	112	112	90	75	63	54	46	40	35	31	28	25	23
300	720	670	550	550	454	300	205	145	107	80	75	75	63	54	46	40	35	31	28	25	23
400	593	557	460	460	354	246	184	133	100	77	61	48	46	46	46	40	35	31	28	25	23
500	502	473	397	397	292	203	151	118	92	72	58	47	38	32	31	31	31	31	28	25	23
600	430	408	350	350	248	173	129	101	81	67	54	44	37	31	26	22	19	17	14	13	11
700	373	357	313	313	216	151	112	88	71	59	50	41	35	29	25	22	19	16	14	13	11
800	330	315	282	282	192	134	100	78	63	52	44	38	33	28	24	21	18	16	14	12	11
900	293	280	255	255	173	121	90	70	57	47	40	34	30	26	23	20	17	15	14	12	11
1000	262	252	233	233	157	110	82	64	52	43	36	31	27	24	21	19	17	15	13	12	11
1500	172	167	157	157	107	77	58	45	36	30	25	22	19	17	15	12	12	11	9.9	9.3	8.7
2000	122	120	117	117	80	58	44	35	28	23	20	17	15	13	11	10	9.2	8.4	7.8	7.3	6.8
2500	93	92	90	90	64	47	36	28	23	19	16	14	12	11	9.4	8.4	7.6	6.9	6.4	6	5.6
3000	75	73	72	72	52	39	30	24	20	16	14	12	10	9	8	7.1	6.4	5.8	5.5	5.1	4.8
4000	50	50	50	50	37	29	23	18	15	13	11	9.1	7.9	7	6.2	5.5	5	4.5	4.2	4	3.7
5000	37	37	37	37	29	23	18	15	12	10	8.7	7.5	6.5	5.7	5.1	4.5	4.1	3.7	3.4	3.2	3

**Table 2. No Downwash for All Hours ( $\mu\text{g}/\text{m}^3$  per 1 lb/hr)**

Distance (feet)	Stack Height (feet)																				
	3	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
50	23773	2787	725	323	175	107	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
100	19785	2233	697	323	175	107	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
150	12608	1942	550	310	175	107	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
200	8458	1942	482	275	166	107	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
250	6040	1837	482	243	155	100	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
300	4531	1837	453	243	132	96	67	48	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
400	2838	1613	448	203	128	76	60	46	35	30	24	19	16	13	11	9.8	8.8	7.5	6.6	5.9	5.2
500	1958	1322	422	195	114	76	49	40	33	27	21	17	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
600	1440	1075	417	188	105	70	49	36	28	24	20	17	14	12	11	9.8	8.5	7.5	6.6	5.9	5.2
700	1110	885	417	188	105	64	48	36	27	21	18	16	14	12	9.9	8.7	7.9	7.5	6.6	5.9	5.2
800	888	738	402	180	100	64	44	36	27	21	17	14	13	11	9.8	8.5	7.4	6.6	6.1	5.6	5.2
900	728	625	377	170	95	64	43	33	27	21	17	14	12	10	9.3	8.3	7.3	6.5	5.7	5.2	4.8
1000	610	535	348	170	95	62	43	30	25	21	17	14	11	9.7	8.6	7.8	7	6.3	5.7	5	4.6
1500	308	287	228	157	83	52	36	29	22	17	17	14	11	9.6	8.3	7.1	6.1	5.5	5	4.6	4.2
2000	188	182	157	123	79	45	32	23	20	16	13	11	8.9	8.2	7.4	6.8	6.1	5.5	4.9	4.4	3.9
2500	130	127	113	97	68	44	27	21	16	14	12	10	8.8	7.3	6.2	5.7	5.3	4.9	4.6	4.2	3.9
3000	98	95	88	77	57	40	27	19	15	12	11	10	8.3	7.2	6.2	5.3	4.4	4.2	3.9	3.7	3.5
4000	62	62	58	53	42	31	23	17	12	10	8.4	7.4	6.7	6.1	5.5	4.9	4.4	3.8	3.4	2.9	2.6
5000	45	43	42	38	32	25	19	15	11	8.3	7.2	6.2	5.4	5	4.6	4.2	3.8	3.5	3.2	2.8	2.6

**Table 3. Downwash for Daytime ( $\mu\text{g}/\text{m}^3$  per 1 lb/hr)**

<b>Distance (feet)</b>	<b>3</b>	<b>10</b>	<b>20</b>	<b>30</b>	<b>40</b>	<b>50</b>	<b>60</b>	<b>70</b>	<b>80</b>	<b>90</b>	<b>100</b>	<b>110</b>	<b>120</b>	<b>130</b>	<b>140</b>	<b>150</b>	<b>160</b>	<b>170</b>	<b>180</b>	<b>190</b>	<b>200</b>
50	2965	2363	2260	1005	565	362	251	185	141	112	90	75	63	54	46	40	35	31	28	25	23
100	2024	1719	1003	565	565	362	251	185	141	112	90	75	63	54	46	40	35	31	28	25	23
150	1338	1195	822	353	320	251	251	185	141	112	90	75	63	54	46	40	35	31	28	25	23
200	950	873	665	352	300	201	185	185	141	112	90	75	63	54	46	40	35	31	28	25	23
250	700	655	532	335	275	189	135	112	112	112	90	75	63	54	46	40	35	31	28	25	23
300	563	532	437	312	247	176	129	97	76	75	75	75	63	54	46	40	35	31	28	25	23
400	392	373	322	263	195	147	116	90	71	57	48	46	46	46	46	40	35	31	28	25	23
500	290	280	247	220	160	122	97	80	65	54	45	38	32	31	31	31	31	31	28	25	23
600	225	218	197	183	134	104	84	69	58	50	42	36	31	27	23	20	18	16	14	13	11
700	185	180	165	155	115	91	73	61	52	44	39	33	29	25	22	20	17	16	14	13	11
800	152	148	138	133	100	80	65	54	46	40	35	31	28	24	21	19	17	15	14	12	11
900	128	125	117	117	88	71	58	49	42	36	32	28	25	23	20	18	16	15	13	12	11
1000	110	108	102	102	77	63	53	44	38	33	29	26	23	21	19	17	16	14	13	12	11
1500	58	58	57	57	47	40	34	30	26	23	20	18	16	15	14	12	11	11	9.9	9.3	8.7
2000	37	37	37	37	31	27	24	21	19	17	15	14	13	12	11	9.7	9	8.3	7.8	7.3	6.8
2500	27	27	27	27	23	20	19	17	15	14	12	11	10	9.4	8.6	8	7.4	6.9	6.4	6	5.6
3000	20	20	20	20	18	16	15	14	12	11	10	9.3	8.6	7.9	7.3	6.7	6.3	5.8	5.5	5.1	4.8
4000	13	13	13	13	12	11	10	9.4	8.7	8	7.4	6.8	6.3	5.9	5.5	5.1	4.8	4.5	4.2	4	3.7
5000	9.3	9.3	9.3	9.3	8.6	8	7.5	7	6.5	6.1	5.7	5.3	4.9	4.6	4.3	4.1	3.8	3.6	3.4	3.2	3

**Table 4. No Downwash for Daytime ( $\mu\text{g}/\text{m}^3$  per 1 lb/hr)**

Distance (feet)	Stack Height (feet)																				
	3	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
50	18738	2787	725	323	175	107	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
100	7657	1902	697	323	175	107	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
150	3983	1542	550	310	175	107	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
200	2445	1542	478	275	166	107	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
250	1662	1215	453	217	155	100	72	51	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
300	1207	962	453	212	132	96	67	48	38	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
400	727	633	402	195	116	75	60	46	35	30	24	19	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
500	488	445	327	195	105	73	49	40	33	27	21	17	16	13	11	9.8	8.5	7.5	6.6	5.9	5.2
600	353	330	263	182	105	68	49	36	28	24	20	17	14	12	11	9.8	8.5	7.5	6.6	5.9	5.2
700	268	255	215	162	105	64	48	36	27	21	18	16	14	12	9.9	8.7	7.9	7.5	6.6	5.9	5.2
800	212	203	177	142	100	64	44	36	27	21	17	14	13	11	9.8	8.5	7.4	6.6	6.1	5.6	5.2
900	172	167	148	123	92	64	43	33	27	21	17	14	12	10	9.3	8.3	7.3	6.5	5.7	5.2	4.8
1000	142	138	127	108	84	62	43	30	25	21	17	14	11	9.7	8.6	7.8	7.0	6.3	5.7	5.0	4.6
1500	70	70	67	62	53	45	36	29	22	17	17	14	11	9.6	8.3	7.1	6.1	5.5	5.0	4.6	4.2
2000	43	43	42	40	36	31	27	23	20	16	13	11	8.9	8.2	7.4	6.8	6.1	5.5	4.9	4.4	3.9
2500	30	28	28	28	25	23	21	19	16	14	12	10	8.8	7.3	6.2	5.7	5.3	4.9	4.6	4.2	3.9
3000	22	22	22	20	19	18	16	15	13	12	11	10	8.3	7.2	6.2	5.3	4.4	4.2	3.9	3.7	3.5
4000	14	14	13	13	12	12	11	10	9.4	8.7	8.0	7.4	6.7	6.1	5.5	4.9	4.4	3.8	3.4	2.9	2.6
5000	9.5	9.5	9.3	9.3	8.9	8.4	7.9	7.5	7.1	6.6	6.2	5.8	5.4	5.0	4.6	4.2	3.8	3.5	3.2	2.8	2.6