

New R-LINE Additions to AERMOD 19191 for Refined Transportation Projects



EPA Webinar Fall 2019

Presented by:

Office of Transportation and Air Quality

Office of Air Quality Planning and Standards

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Purpose of Webinar

- Provide an overview of EPA's [Guidance on New R-LINE Additions to AERMOD 19191 for Refined Transportation Project Analyses](#), released September 2019
 - Focus is the R-LINE features of AERMOD 19191, rather than all changes made to AERMOD
 - A collaboration among several EPA offices: OTAQ and OAQPS with EPA's Office of Air, and the National Exposure Research Laboratory at EPA's Office of Research and Development
- Incorporation of R-LINE features into AERMOD was supported by FHWA funding
- Note that this guidance supplements other information EPA has provided, such as:
 - [EPA's AERMOD User Guide](#)
 - [EPA's PM Hot-spot Guidance](#)

Overview of Webinar

Follows organization of the guidance:

1. Introduction

- Release of AERMOD 19191
- Guidance purpose
- Background on EPA's AERMOD and R-LINE models
- Reminder: End of CALINE3 grace period

2. New R-LINE features in the AERMOD 19191 release

- BETA vs. ALPHA features
- The alternative model process
- Description of BETA features

3. ALPHA Features

1. Introduction: Release of AERMOD 19191

- EPA released AERMOD 19191 on August 21, 2019; replaces AERMOD 18081
 - AERMET and AERMOD executable files, source code, documentation, and test cases have all been updated
- Found at: <https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models#aermod>
- AERMOD 19191 includes
 - Updates, bug fixes, and model enhancements – see relevant Model Change Bulletins (at above link)
 - New source types based on EPA ORD's R-LINE model – covered in this webinar
- EPA will be holding the 12th Conference on Air Quality Modeling October 2nd and 3rd, at the RTP campus
 - <https://www.epa.gov/scram/12th-conference-air-quality-modeling>

1. Introduction: Guidance Purpose

- Guidance focuses on the new R-LINE features now within AERMOD 19191
- Relevant for all users of the new R-LINE features for refined project-level analysis, whether the purpose is regulatory or research
 - E.g., applies when using R-LINE features in AERMOD for transportation conformity, general conformity, and other purposes
 - **BETA** features can be used for regulatory purposes *with EPA approval*
 - **ALPHA** features cannot be used for regulatory purposes, and are provided for research and experimentation
- Guidance includes EPA contacts:
 - Links for EPA Regional Offices: both transportation conformity and dispersion modeling
 - General questions about transportation conformity guidance: Laura Berry
 - Questions and feedback about AERMOD or the Model Clearinghouse: Chris Owen

1. Introduction: AERMOD Background

- EPA's recommended near-field dispersion model for regulatory applications
- A steady-state plume model that incorporates dispersion based on planetary boundary layer turbulence structure and scaling concepts
- Includes options for modeling emissions that come from area, volume, line, and point sources
- Has been used to model air quality near roadways, other transportation sources, and other ground-level sources
- EPA's preferred model since 2005

1. Introduction: End of CALINE3 Grace Period

- EPA removed CALINE3 models (including CAL3QHCR) from the preferred model list on January 17, 2017, and provided a 3-year grace period for the use of that model
 - *New* analyses begun after January 17, 2020 will need to use the current version of AERMOD; will not be able to use CAL3QHCR
 - PM hot-spot analyses begun with CAL3QHCR before that date can be completed
- The end of the CALINE3 grace period is relevant only for refined analyses: CAL3QHCR can continue to be used for CO hot-spot screening analyses for transportation conformity

1. Introduction: EPA's R-LINE Model

- EPA's Office of Research and Development has developed a separate line source model for research and development purposes called the Research LINE source model, or R-LINE
- Based data from wind tunnel and field studies
- Model algorithm is based on a steady-state Gaussian formula and designed to simulate line type source emissions by numerically integrating point source emissions
- Includes algorithms to account for effects of solid barriers and depressed roadway segments
- Note:
 - "R-LINE" refers to the EPA ORD model
 - "RLINE" refers to the RLINE source type, now included in AERMOD 19191

New R-LINE Features in AERMOD 19191

2. BETA vs. ALPHA Features

BETA features

- Not part of the approved AERMOD model
- Have been vetted through the scientific community and are waiting to be promulgated as regulatory options
- Until in the preferred model via regulation, these features require alternative model approval for use in regulatory applications

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- RLINE source type
 - RLEMCONV

ALPHA features

- Not part of the approved AERMOD model
- Are research and experimental options provided for the user community's review and evaluation
- Need additional research and evaluation
- Do not have the reliability or validity that the regulatory model AERMOD has, or that BETA options have
- Not intended for regulatory purpose at this time

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- **RLINEXT** source type
 - **RBARRIER**, to describe a barrier
 - **RDEPRESS**, to describe a depressed roadway
 - **URBAN** applied to either RLINE or RLINEXT

2. Process for Obtaining Approval of RLINE as an Alternative Model

- EPA's Appendix W regulation of January 17, 2017 (82 FR 5182) describes the use of alternative models
- Use of the RLINE source type could be used as an alternative model in a regulatory application if:
 - Approved by the EPA Regional Office in consultation with EPA's Model Clearinghouse
 - Documented with memos between the EPA Regional Office and Model Clearinghouse
- Approval needed for use of RLINE on a project-by-project basis
 - Approval may be simplified if substantively similar to a previous project where RLINE was approved
- **Process begins by making a request to the appropriate Regional Office dispersion modeling contact**
- Consultation with the Regional Office transportation conformity contact would also be necessary
 - based on the conformity regulation's requirement for consultation processes for "evaluating and choosing a model (or models) and associated methods and assumptions to be used in hot-spot analyses" (40 CFR 93.105(c)(1)(i)).

2. New R-LINE Features in AERMOD

- **RLINE** source type can be used to model a line source such as a road segment using the R-LINE algorithm
- **RLINEXT** source type, which stands for “RLINE-extended,” uses the same dispersion calculations as the RLINE source type
 - Used to model a source that either includes a barrier or is depressed
 - **RBARRIER** used with RLINEXT to describe a barrier
 - **RDEPRESS** used with RLINEXT to describe a depressed roadway
- Both **RLINE** and **RLINEXT** account for plume meander during low-wind conditions
- **URBAN** is an option that includes the effect of urban heat islands, and its use with RLINE or RLINEXT is **ALPHA**
- **RLEMCONV** can be used with either RLINE or RLINEXT source types, and allows the emissions for these sources to be in units of grams per link per hour

Including RLINE Sources in an AERMOD Input File

Control Pathway

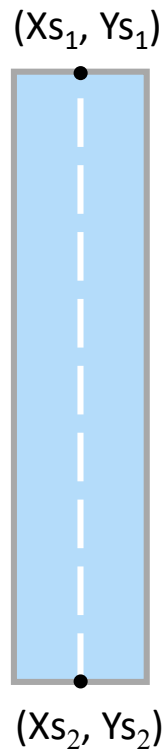
- **BETA** flag must be included in MODELOPT keyword; model will not run without this flag
 - Labels each page of AERMOD output file with “BETA” for reviewers
- FLAT MODELOPT flag also required
 - R-LINE formulated as a flat terrain model, so the RLINE source type can only represent flat terrain
 - Using RLINE for other types of terrain would lead to erroneous results
- Cannot use with the regulatory default mode, i.e., the DFAULT option in MODELOPT
- If using **URBAN** option, then **ALPHA** flag is also required in MODELOPT
 - In this case, the ALPHA and BETA flags are used together
 - This combination is not eligible for approval under alternative model process

Source Pathway

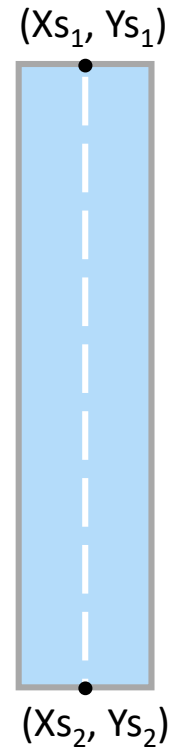
- Location statement: source name, endpoints of the source (X,Y)
 - Specifying elevation in a (Zs) term is optional – not operational at this point
 - If used, (Zs) should be entered as “0.0” or “FLAT”
 - Any other input would result in an error and model will not run
- Source Parameter statement: source name, emissions rate, release height, width, and initial Sigma z
- **Syntax for RLINE source type is the same as the LINE source type**
 - User can run an existing AERMOD input file with LINE sources type just by using BETA and FLAT flags in the Control Pathway and changing LINE to RLINE in the source pathway

LINE and RLINE Sources

LINE Source:
Specified with endpoints
 (X_{s_1}, Y_{s_1}) and (X_{s_2}, Y_{s_2})



RLINE Source:
Also specified with endpoints
 (X_{s_1}, Y_{s_1}) and (X_{s_2}, Y_{s_2})



Key



Source



Endpoint of Source

ALPHA Options: RLINEXT,
RBARRIER, and RDEPRESS

Use of ALPHA Options

- ALPHA features are not as mature in model development
 - There may be less scientific certainty about the appropriateness of the formulation
- EPA has provided these features so that the user community can review and evaluate them
- We recommend consulting with the EPA Regional Office dispersion modeling contact before using
- Please send feedback to Chris Owen at OAQPS, owen.chris@epa.gov

RLINE vs. RLINEXT Source Types

RLINE Source Type

- Based on R-LINE algorithm
- **BETA**: Could be used with EPA Alternative Model approval
- Units are g/s/m^2
- Syntax: same as LINE source
- Use: line-type sources

RLINEXT Source Type

- Based on R-LINE algorithm (same as RLINE source type)
- **ALPHA**: Research/experimentation only
- Units are g/s/m
- Syntax : additional parameters needed to describe RLINEXT sources
- Use: line-type sources that either have solid barriers, or that are depressed

Including RLINEXT Sources in an AERMOD Input File: Control Pathway

- **ALPHA** flag must be included in MODELOPT keyword; model will not run without this flag
 - Labels each page of AERMOD output file with “ALPHA” for reviewers
- **FLAT** MODELOPT flag also required
 - R-LINE formulated as a flat terrain model, so the RLINEXT source type can only represent flat terrain
 - Using RLINEXT for other types of terrain would lead to erroneous results
- Cannot use with the regulatory default mode (DFAULT option in MODELOPT)
- **URBAN** option can also be used with RLINEXT, which is also an ALPHA option

Including RLINEXT Sources in an AERMOD Input File: Source Pathway

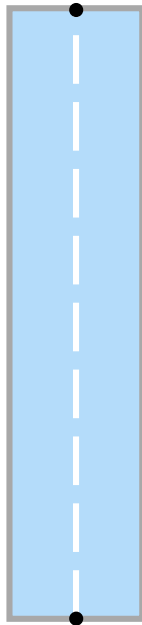
- Location statement: source name, endpoints of the source in (X, Y, and Z), and optional (Zs) term
 - Endpoint (Z) terms represent release height and could potentially be different
 - Optional (Zs) term applies to the entire source, but not operational now
 - If used, (Zs) should be entered as “0.0” or “FLAT”
 - Any other input would result in an error and model will not run
- Source Parameter statement: source name, emissions rate, distance from the center line (DCL), width, and initial Sigma z
 - All of these are required, but user can enter “0” for any parameter not needed

RLINE and RLINEXT Sources

RLINE Source:

Specified with endpoints
 (X_{s1}, Y_{s1}) and (X_{s2}, Y_{s2})
(Optional Z term not
shown)

(X_{s1}, Y_{s1})

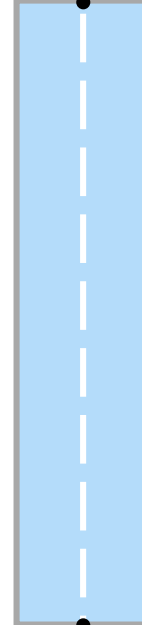


(X_{s2}, Y_{s2})

RLINEXT Source:

Specified with endpoints
 (X_{s1}, Y_{s1}, Z_{s1}) and (X_{s2}, Y_{s2}, Z_{s2})

(X_{s1}, Y_{s1}, Z_{s1})



(X_{s2}, Y_{s2}, Z_{s2})

Key



Source



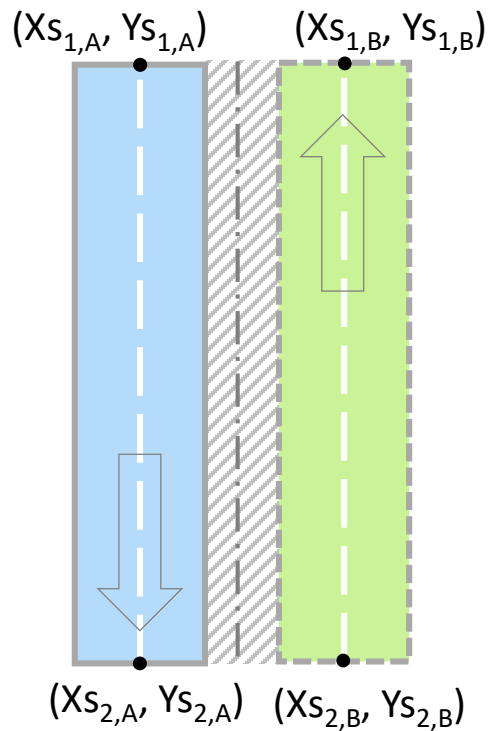
Endpoint of Source

RLINEXT Source Type: Distance from Center Line (DCL) Parameter

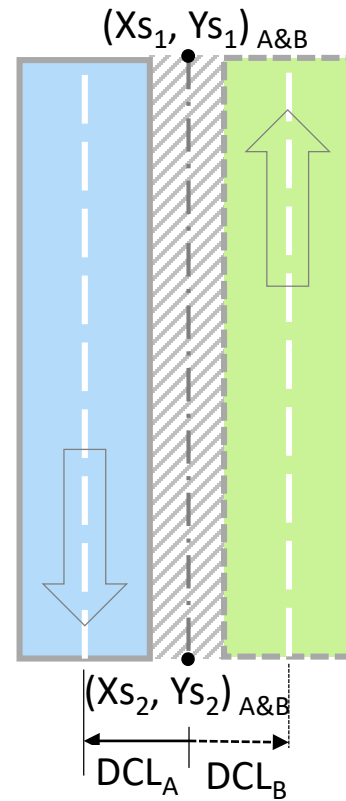
- DCL is optional – enter “0” if not used to describe source
- However, DCL is needed when using RLINEXT to model a depressed road with the RDEPRESS keyword
- DCL is also useful for describing multiple sources that are parallel and of same length
 - Next figure illustrates this

Two Ways to Specify RLINEXT Sources






RLINEXT sources A and B specified with individual endpoints (DCL specified as "0" for each)



RLINEXT sources A and B specified with common endpoints and a unique DCL for each source



Key

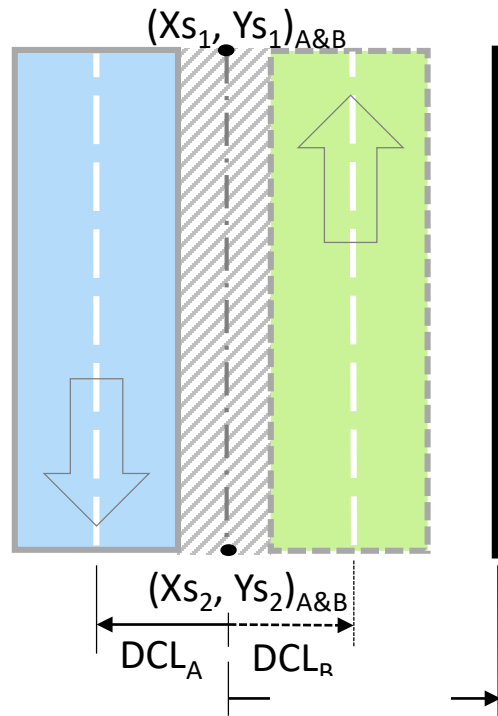
-  Source A
-  Source B
-  Endpoint of Source
-  Median
-  Center of Median

RBARRIER

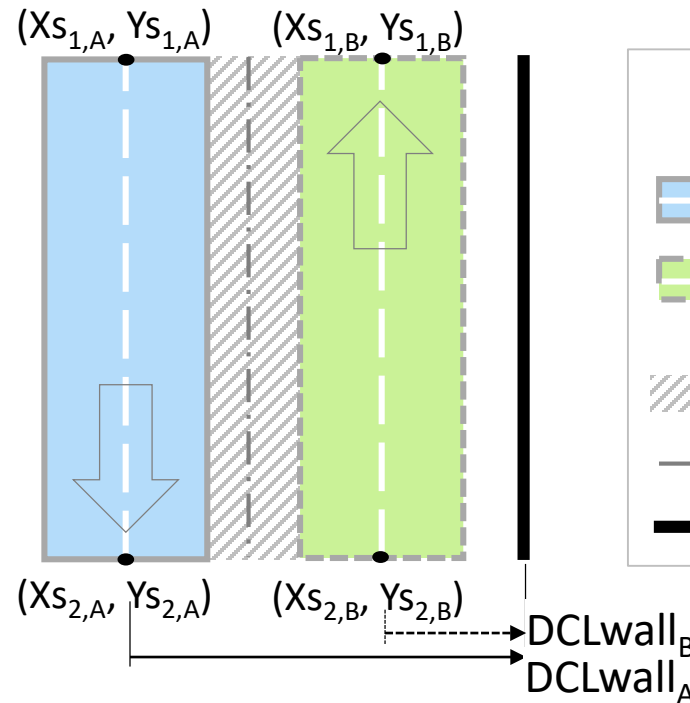
- An RLINEXT source can optionally include a solid barrier that extends to the ground (such as a noise barrier) with the keyword RBARRIER
- **RBARRIER is associated with only one source**
 - If road with barrier is made up of several sources, each of these RLINEXT sources would have an RBARRIER statement
 - RBARRIER length = RLINEXT source length
 - RBARRIER affects the modeled dispersion of emissions *only from the RLINEXT source it is associated with*; does not affect modeled dispersion of any other sources in the vicinity
- RBARRIER statement: source name, height of barrier (Ht_{wall}), and distance from centerline of the source to the barrier (DCL_{wall})

Example: Barrier on One Side Only







RLINEXT sources specified with the same endpoints. DCLwall, which represents distance from endpoints to barrier, is the same for both sources



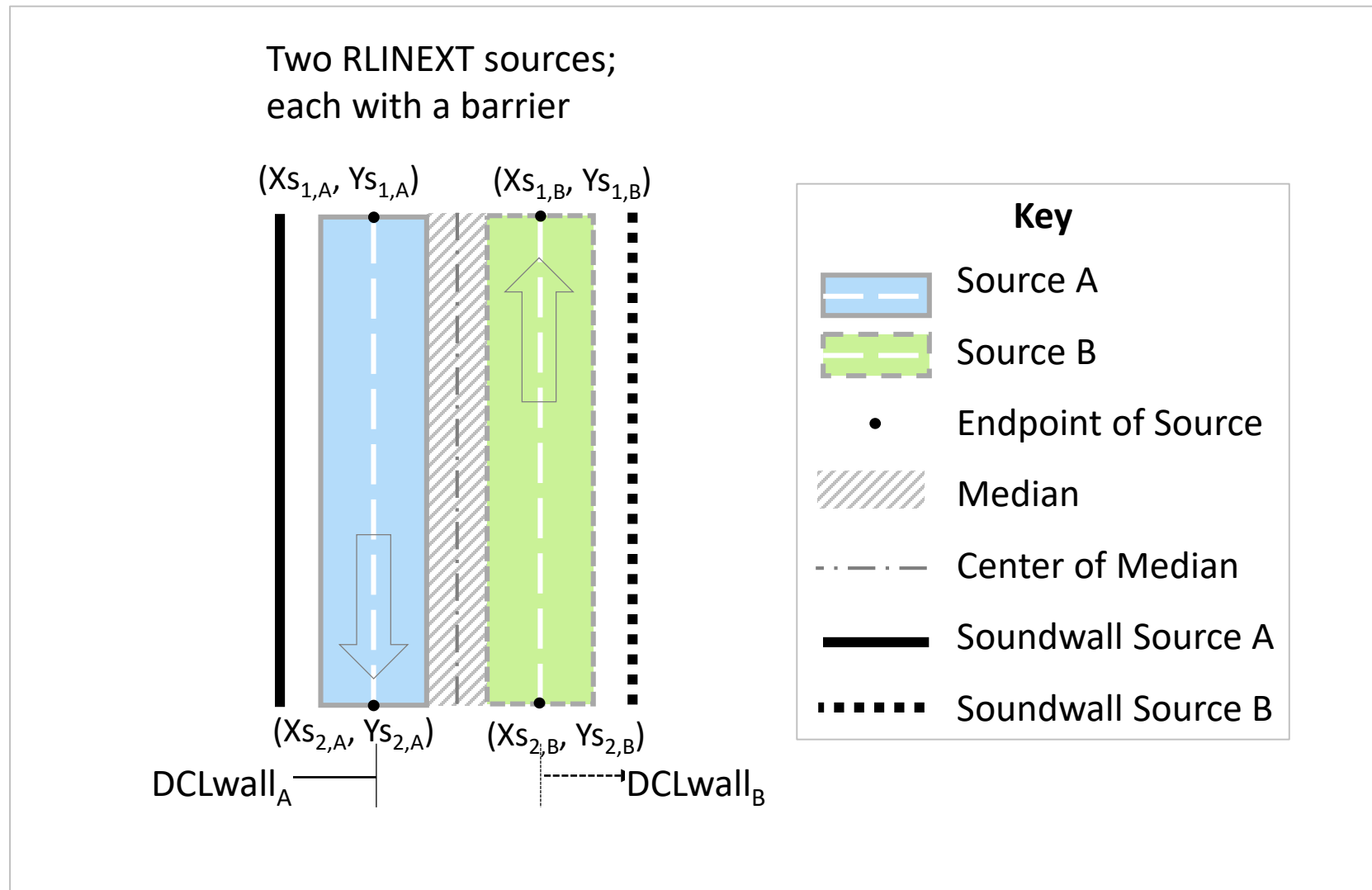
RLINEXT sources A and B specified with unique endpoints (DCL is "0" for each source). Each source defines the barrier in the same location with a unique DCLwall term



Key

-  Source A
-  Source B
-  Endpoint of Source
-  Median
-  Center of Median
-  Soundwall

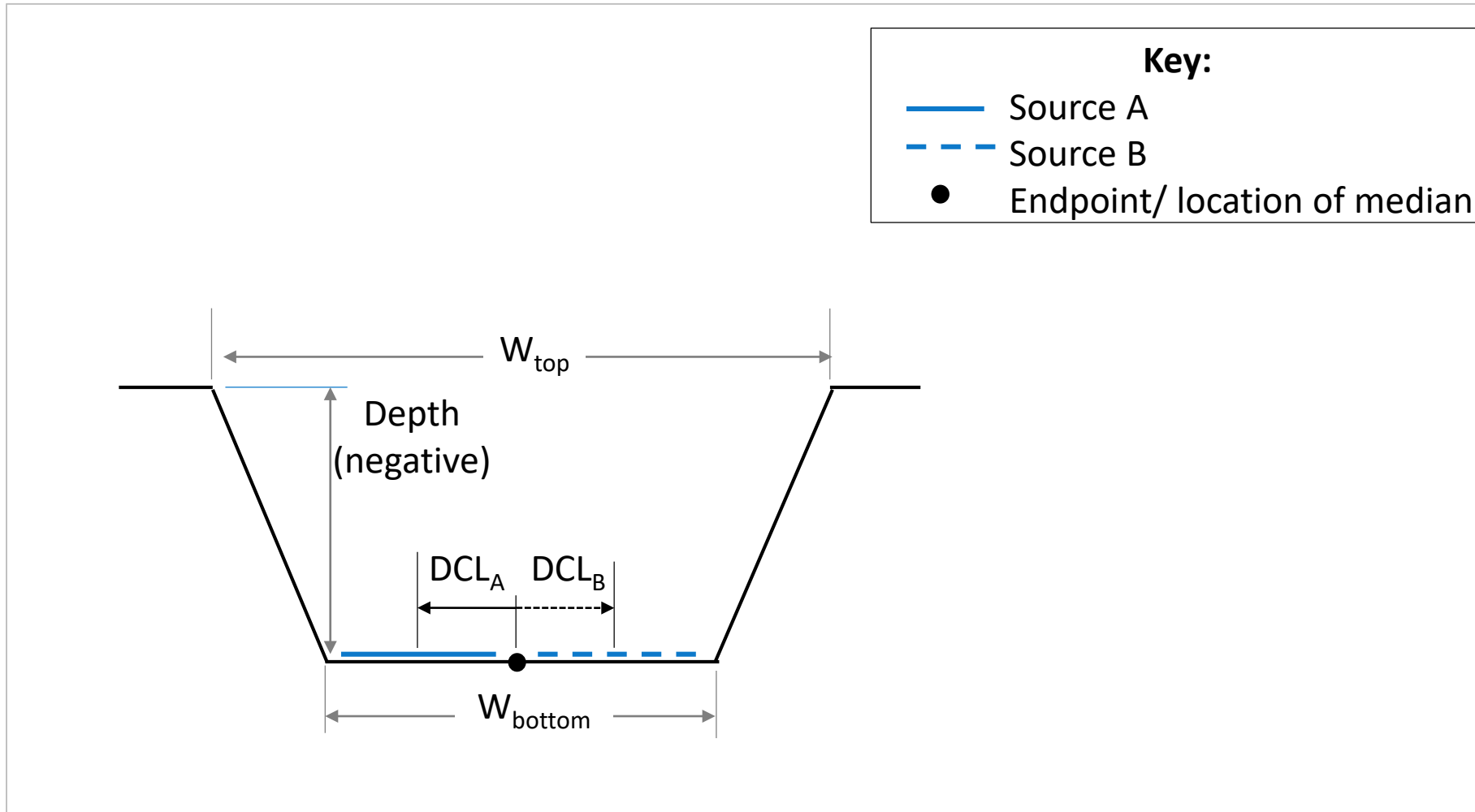
Example: Divided Arterial with Barriers on Both Sides



RDEPRESS

- An RLINEXT source can represent a depressed roadway with the addition of keyword RDEPRESS
 - To model depressed roads, define RLINEXT sources with DCL, rather than individual coordinates:
 - User would specify centerline endpoints and use a non-zero DCL for all RLINEXT sources
 - DCL is necessary as it tells the model the location of the source within the depression, influencing recirculation and dispersion within the depression
- RDEPRESS statement: source name, depth of depression, width of both the top and bottom of the depression

Depressed Roadway Parameters



RLEMCONV Keyword

- Allows user to define RLINE or RLINEXT source emission rates in grams/link/hour instead of g/s/m^2 or g/s/m
 - E.g., MOVES Project Scale output when “Inventory” is used is grams/link/hour
- However:
 - Some MOVES links may need to be input as than one AERMOD source (e.g., if curved) - emissions would have to be apportioned to each source
 - Also, if MOVES has been run for different hours in different seasons, more than one MOVES emissions rate would be associated with each source
- MOVES2AERMOD may be more convenient to use – found on EPA’s web site at <https://www.epa.gov/moves/tools-develop-or-convert-moves-inputs#emisfact>
 - If you use MOVES2AERMOD, do not use RLEMCONV

Conclusion

Conclusion: Modeling Transportation Sources

- Accurately characterizing the quantity and location of emissions in AERMOD is important, regardless of source type used
- Each direction of travel should be modeled as a unique source
 - Emission rates for each direction of travel are likely to be different from each other over the course of a day
- Analysis could be further refined with additional sources:
 - A separate source could be used for each lane, if travel data is available by lane
 - Separate sources could be used for light-duty and heavy-duty emissions (located in the same place, i.e., superimposed on each other) – See EPA’s PM Hot-spot Guidance, Appendix J for more information <https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses#pmguidance>

Conclusion: Things to Remember

- EPA's *Guidance on New R-LINE Additions to AERMOD 19191 for Refined Transportation Project Analyses* supplements information found in:
 - [EPA's AERMOD User Guide](#)
 - [EPA's PM Hot-spot Guidance](#)
- Contact EPA early if you are:
 - seeking Alternative Model approval for a **BETA** option
 - planning to use an **ALPHA** option – EPA can help you use these options correctly, saving time
- Send EPA feedback on **ALPHA** and **BETA** options as you have experience with them - owen.chris@epa.gov
- Questions from webinar audience?