United States
Environmental Protection
Agency

Air Pollution Training Institute
MD 20
Environmental Research Center
Research Triangle Park, NC 27711

EPA 450/2-82-002
February, 1982

Air

EPA

APTI Correspondence Course 437 Site Selection for the Monitoring of CO and Photochemical Pollutants in Ambient Air

Guidebook

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Guidebook

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Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Notice

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Availability

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Others may obtain copies, for a fee, from the National Technical Information Service (NTIS), 5825 Port Royal Road, Springfield, VA 22161.

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Course Introduction

Overview of Course

Course Description

This training course is a 35-hour correspondence course dealing with the siting of ambient monitors for CO, nonmethane hydrocarbons, NO, NO_2, and ozone. The course presents general concepts of ambient monitor site selection and specific, detailed considerations and procedures for selecting CO, nonmethane hydrocarbons, NO, NO_2, and ozone ambient monitoring sites. Course topics include the following:

- use of monitoring data and related monitor-siting objectives
- special considerations associated with the monitoring of CO, nonmethane hydrocarbons, NO, NO_2, and ozone
- procedures and criteria for site selection for the monitoring of CO, nonmethane hydrocarbons, NO, NO_2, and ozone
- rationale for siting criteria associated with the monitoring of CO, nonmethane hydrocarbons, NO, NO_2, and ozone
- network design and probe-siting criteria for CO, NO_2, and ozone SLAMS, NAMS, and PSD monitoring stations.

Course Goal

The goal of this course is to familiarize you with general concepts of ambient monitor site selection and with specific, detailed considerations and procedures for selecting ambient monitor sites for the monitoring of CO, nonmethane hydrocarbons, NO, NO_2, and ozone.

Course Objectives

Upon completion of this course, you should be able to:

1. describe general considerations for siting ambient air quality monitors.
2. select the optimum general siting area and probe location for CO, nonmethane hydrocarbons, NO, NO_2, and ozone monitors for a given monitoring objective.
3. describe the logic of the siting criteria for the monitoring of CO, nonmethane hydrocarbons, NO, NO_2, and ozone.

Lesson Titles, Sequence, and Trainee Involvement Time

Lesson number	Lesson title	Trainee involvement time (hours)
1	Introduction to CO Monitoring and to Site Selection for Regional and Neighborhood CO Monitoring Stations	5
2	The Locating of Middle Scale CO Monitoring Stations and the Rationale for CO Monitor-Siting Criteria	5
3	Introduction to the Monitoring of Photochemical Air Pollutants	6
4	Locating Monitoring Stations for Photochemical Air Pollutants	8
5	Rationale for Monitor-Siting Criteria for Photochemical Air Pollutants	6
6	Monitoring Network Design and Probe-Siting Criteria for SLAMS, NAMS, and PSD Monitoring Stations for CO, O_3, and NO_2	5

Requirements for Successful Completion of this Course

In order to receive 3.5 Continuing Education Units (CEUs) and a certificate of course completion you must:

- take two supervised quizzes and a supervised final examination.
- achieve a final course grade of at least 70% (out of 100%) determined as follows:
  - 20% from Quiz 1
  - 20% from Quiz 2
  - 60% from the final examination.

Use of Course Materials

Necessary Materials

- "APTI Correspondence Course 437 Site Selection for the Monitoring of CO and Photochemical Pollutants in Ambient Air: Guidebook"
- EPA 450/3-75-077, "Selecting Sites for Carbon Monoxide Monitoring"
- EPA 450/3-78-013, "Site Selection for the Monitoring of Photochemical Air Pollutants"
- ruler
- pencil or pen

Use of this Guidebook

Relationship Between Guidebook and Assigned Reading Materials

This guidebook directs your progress through the reference texts "Selecting Sites for Carbon Monoxide Monitoring" and "Site Selection for the Monitoring of Photochemical Air Pollutants" and through the excerpts of 40 CFR 58 Appendices D and E and "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)", which are contained in the guidebook.

Description of Guidebook Sections

This guidebook contains six reading assignment sections which correspond to the six lessons of the course.

Each section contains the following:

- reading assignment
- reading assignment topics
- section's learning goal and objectives
- reading guidance
- review exercise

Instructions for Completing the Quizzes and the Final Examination

- You should have received, along with this guidebook, a separate ***sealed*** envelope containing two quizzes and a final examination.
- You must arrange to have someone serve as your test supervisor.
- You must give the ***sealed*** envelope containing the quizzes and final examination to your test supervisor.
- At designated times during the course, under the supervision of your test supervisor, complete the quizzes and the final exam.

- After you have completed each quiz or the exam, your test supervisor must sign a statement on the quiz/exam answer sheet certifying that the quiz/exam was administered in accordance with the specified test instructions.
- After signing the quiz/exam answer sheet, your test supervisor must mail the quiz/exam and its answer sheet to the following address:

  Air Pollution Training Institute
  Environmental Research Center
  MD-20
  Research Triangle Park, NC 27711
- After completing a quiz, continue with the course. Do ***not*** wait for quiz results.
- Quiz/exam and course grade results will be mailed to you.

If you have questions, contact:

Air Pollution Training Institute
Environmental Research Center
MD-20
Research Triangle Park, NC 27711

Telephone numbers:
Commercial: (919) 541-2401
FTS: 629-2401

Section 1

Introduction to CO Monitoring and to Site Selection for Regional and Neighborhood CO Monitoring Stations

Reading Assignment

Pages 1-35 of EPA 450/3-75-077 "Selecting Sites for Carbon Monoxide Monitoring".

Reading Assignment Topics

- Need for objective, uniform siting procedures
- General emission characteristics of CO sources
- Uses of CO monitoring data
- Spatial scales of representativeness
- Correlation of spatial scales of representativeness with uses of monitoring data
- Locating regional CO monitoring stations
- Locating neighborhood CO monitoring stations

Learning Goal and Objectives

Learning Goal

To familiarize you with major sources of CO emissions, general types of monitoring sites used to measure ambient CO concentrations, and siting of regional and neighborhood CO monitoring stations.

Learning Objectives

When you have completed this section, you should be able to:

1. recognize transportation activities, especially the use of motor vehicles, as a major source of CO emissions in the U.S.
2. describe typical concentration patterns of CO emissions from motor vehicles.
3. define spatial scale of representativeness.
4. associate typical spatial scales of representativeness with physical dimensions of siting areas.
5. associate spatial scales of representativeness with uses of CO monitoring data.
6. select the general siting area for regional mean CO monitoring stations.
7. select the general siting area for regional background CO monitoring stations.
8. select the general siting area for neighborhood CO monitoring stations.

Reading Guidance

- Because "Selecting Sites for Carbon Monoxide Monitoring" was published before the promulgation of 40 CFR 58, the monitor probe heights and roadway minimum separation distances for neighborhood stations specified in the document do not agree with the required probe heights and separation distances of 40 CFR 58. Also these differences are due to the less restrictive monitoring objectives and practical siting problems encountered in the 40 CFR 58 regulations. Probe heights and roadway minimum separation distances specified in 40 CFR 58 are addressed in Section 6 of this guidebook.
- Wind roses are discussed in this reading assignment. A wind rose is a graphical representation of wind directional frequency. The farther the bar extends from the circle, the more frequently the wind blows ***from*** that direction.
- The term ***sink*** is mentioned in this reading assignment. For our purposes, ***sink*** is defined as an entity that destroys the pollutant that is being monitored.
- Refer often to the tables and figures of the assigned reading material as you progress through the assignment.
- When you have finished the reading assignment, complete the review exercise for Section 1. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), proceed to Section 2 of this guidebook.

Review Exercise

Now that you've completed the assignment for Section 1, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. In the United States, transportation activities account for about ____(?)____ percent of atmospheric CO, with motor vehicles accounting for about ____(?)____ percent.
   a. 50, 40
   b. 30, 25
   c. 75, 65
   d. 95, 90
2. True or False? CO emissions from motor vehicles may result in large horizontal and vertical concentration gradients.
3. True or False? A spatial scale of representativeness is the volume of air surrounding an air monitoring site which can be described by measurements made at the site.

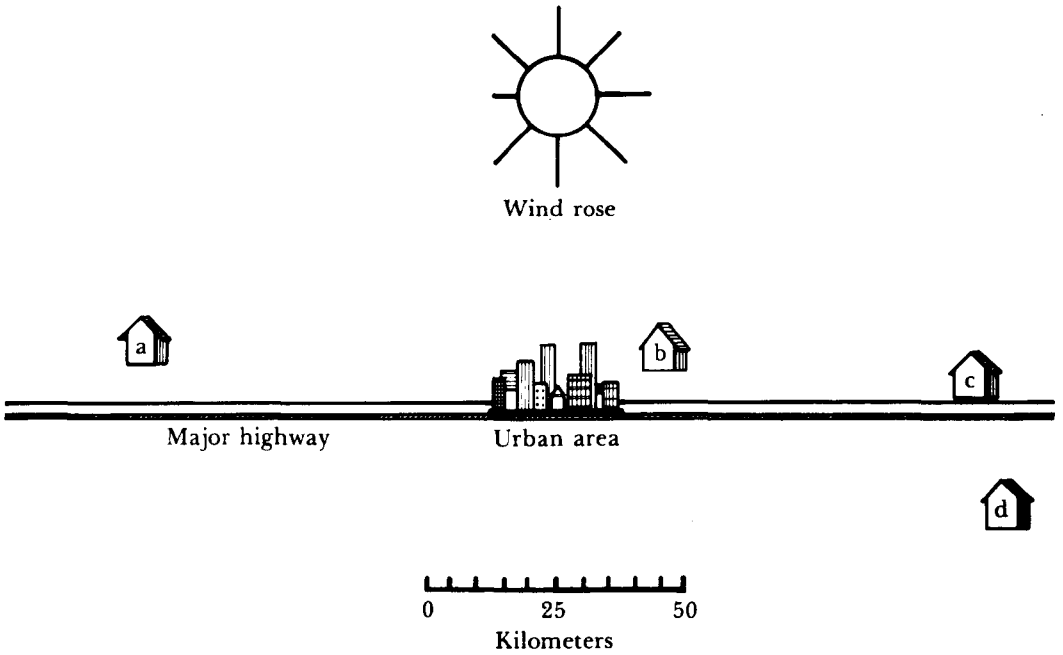
Match each of the following spatial scales of representativeness with its corresponding dimensions. (Questions 4-8)

4. microscale	a. tens to hundreds of meters
5. middle scale	b. hundreds of kilometers
6. neighborhood scale	c. meters to a few tens of meters
7. urban scale	d. entire metropolitan area
8. regional scale	e. a few kilometers

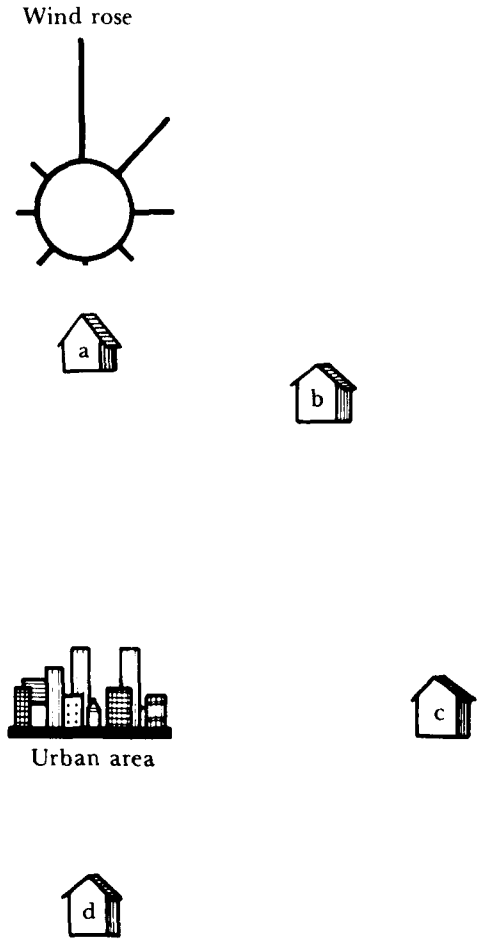
Match each of the following CO monitoring data uses with its appropriate scales of representativeness. (Questions 9-13)

9. determine compliance with ambient air quality standards	a. middle/neighborhood scales
10. alert authorities to existing or impending critical situations	b. neighborhood scale
11. evaluate results of control measures	c. middle/regional scales
12. serve as a data base for city and regional planners	
13. provide measures of the magnitude of sources and sinks	

14. Which of the four general siting areas, labeled a through d, is the best siting area for a CO regional mean concentration monitoring station?

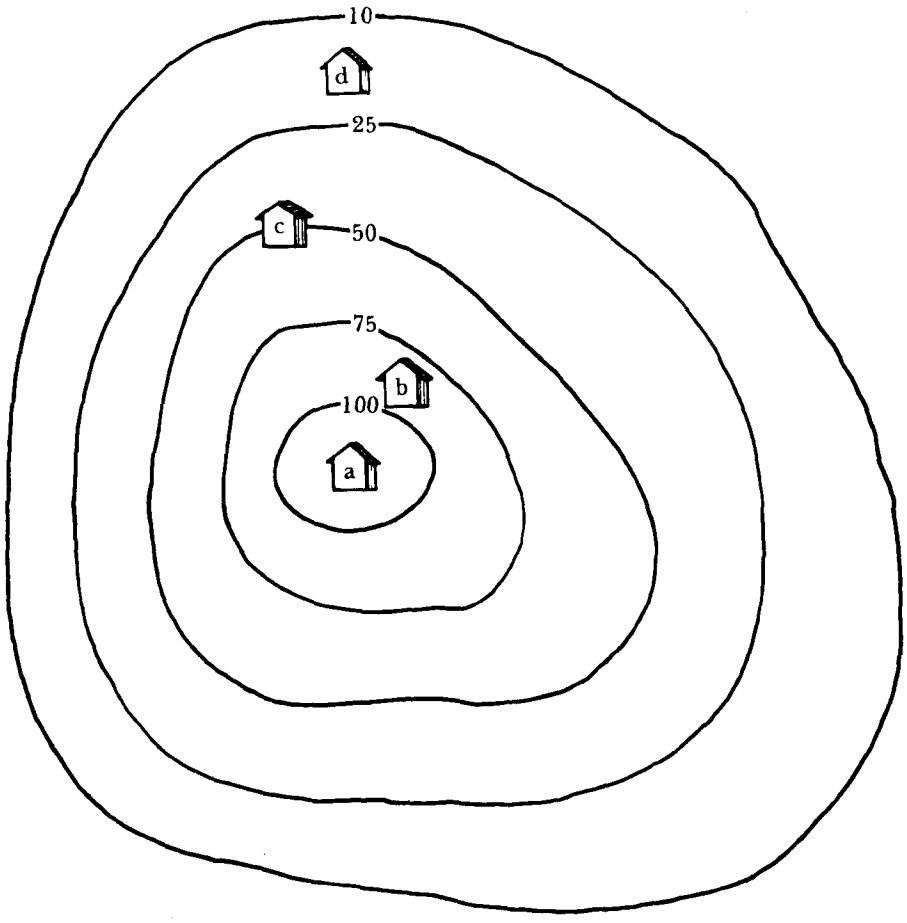


15. Which of the four general siting areas, labeled a through d, is the best siting area for locating a regional monitoring station for assessing the transport of CO into the urban area?



16. Which of the four general siting areas, labeled a through d in question 15, is the best siting area for locating a ***second*** regional monitoring station for assessing the transport of CO into the urban area?

17. The figure below represents an urban area with relative CO concentrations plotted. Which of the four general siting areas, labeled a through d, is the best siting area for assessing CO concentrations in neighborhoods that have average CO concentrations in the urban area?



18. Which of the four general siting areas, labeled a through d in question 17, is the best siting area for assessing CO concentrations in neighborhoods that have the highest CO concentrations in the urban area?

Review Exercise Answers

		Page(s) of CO Siting Manual
1.	c	3
2.	True	4-5
3.	True	9
4.	c	9
5.	a	10
6.	e	10
7.	d	11
8.	b	11
9.	a	16
10.	a	16
11.	a	16
12.	b	17
13.	c	17
14.	d	22, 27-28
15.	a	22, 27
16.	c	22, 27, 29
17.	c	32-33
18.	a	32-33

Section 2

The Locating of Middle Scale CO Monitoring Stations and the Rationale for CO Monitor-Siting Criteria

Reading Assignment

Pages 35-73 of EPA 450/3-75-077 "Selecting Sites for Carbon Monoxide Monitoring".

Reading Assignment Topics

- Types of middle scale CO monitoring stations
- Locating street canyon CO monitoring stations
- Locating roadway CO monitoring stations
- Monitoring CO concentrations in the vicinity of an indirect source
- CO monitoring stations other than regional, neighborhood, and middle scale
- Considerations in locating probe inlets of CO monitors
- Undue influence effects of nearby CO sources

Learning Goal and Objectives

Learning Goal

To familiarize you with the siting of middle scale CO monitoring stations and with the logic of the CO monitor-siting criteria.

Learning Objectives

When you have completed this section, you should be able to:

1. select the general siting area for street canyon CO monitoring stations.
2. select the general siting area for roadway CO monitoring stations.
3. recognize the usefulness of weighted averages of CO measurements for determining urban and national scale CO concentrations.
4. describe considerations and assumptions for determining probe-siting criteria for CO analyzers located in street canyons.
5. describe assumptions for determining regional scale interference distances for major highways and major urban areas.
6. describe the effects of nearby CO sources on CO measurements.

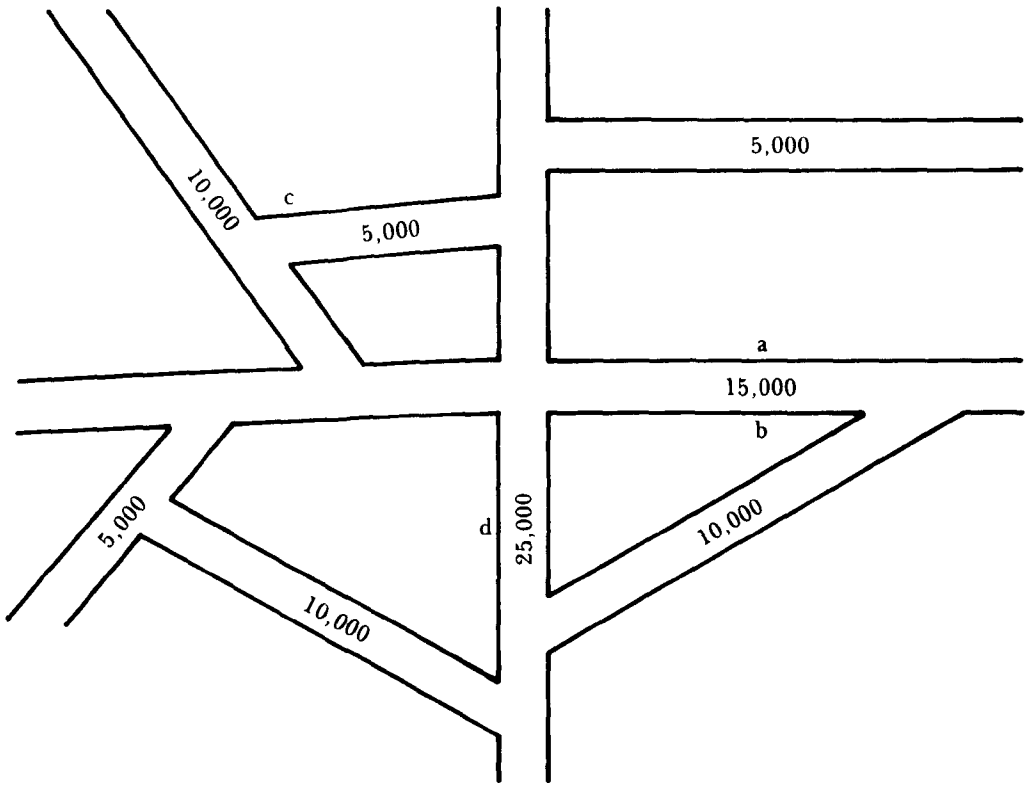
Reading Guidance

- Because "Selecting Sites for Carbon Monoxide Monitoring" was published before the promulgation of 40 CFR 58, the monitor probe heights and roadway minimum separation distances for middle scale stations specified in the document do not agree with the required probe heights and separation distances of 40 CFR 58. Probe heights and roadway minimum separation distances specified in 40 CFR 58 are addressed in Section 6 of this guidebook.
- Middle scale sites described in "Selecting Sites for Carbon Monoxide Monitoring" are approximately equivalent to microscale sites defined in 40 CFR 58.
- Try to visualize how the siting criteria would be affected if the assumptions described in this reading assignment were altered.
- Refer often to the figures of the assigned reading material as you progress through the assignment.
- When you have finished the reading assignment, complete the review exercise for Section 2. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), take Quiz 1. Follow the directions listed in the Course Introduction section of this guidebook.
- After completing Quiz 1, proceed to Section 3 of this guidebook.

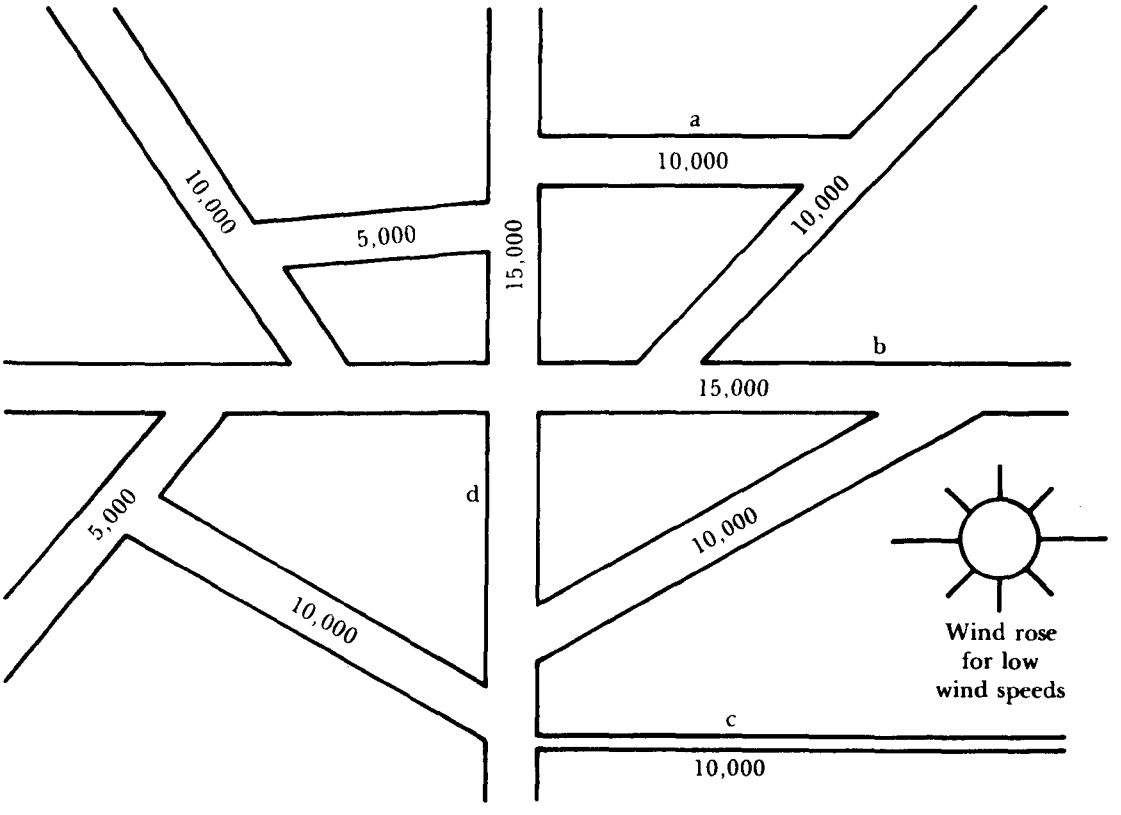
Review Exercise

Now that you've completed the assignment for Section 2, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. The figure below represents a downtown street canyon area with average daily traffic volumes for major two-way streets indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a CO monitor to measure the highest concentrations in the downtown area?

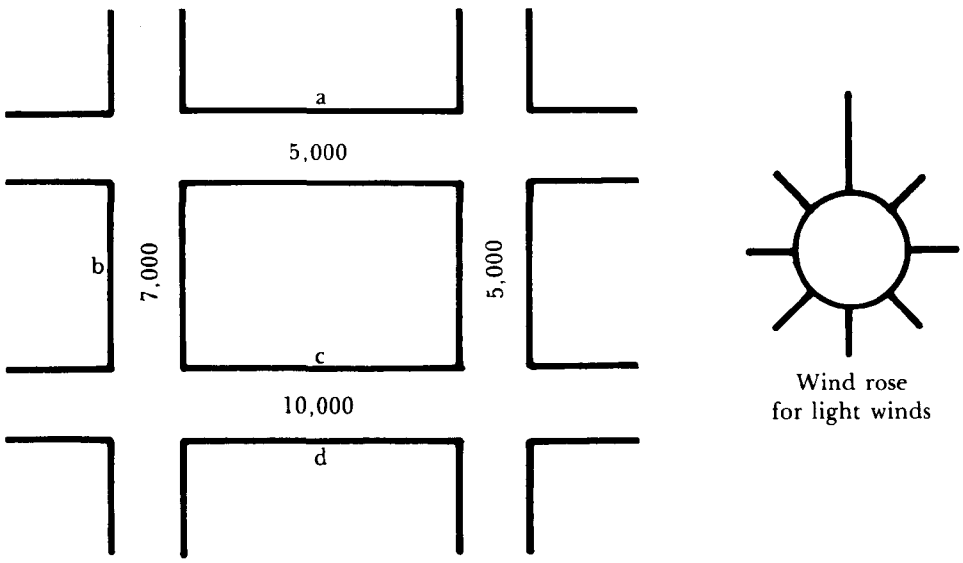


2. The figure below represents a downtown street canyon area with average daily traffic volumes indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a CO monitor to measure typical concentrations in the downtown area?

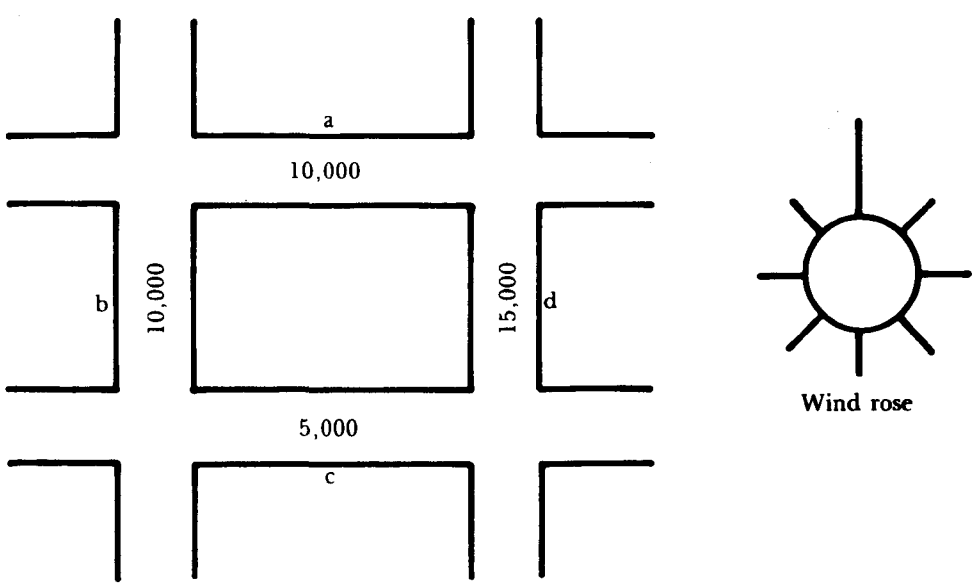


3. True or False? One sampling inlet is adequate for a street canyon CO monitor that is located in an area of asymmetrical wind directional frequencies.

4. The figure below represents a roadway area with average daily traffic volumes indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a CO monitor to measure the highest concentrations in the roadway area?



5. The figure below represents a roadway area with average daily traffic volumes indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a CO monitor to measure typical concentrations in the roadway area?



6. True or False? When monitoring CO concentrations resulting from a roadway in an area having wind directional frequencies that are asymmetrical, it is desirable to locate sampling inlets on both sides of the roadway.

7. Which of the following is necessary for determining the general locations of maximum CO concentrations resulting from an elevated roadway?
   a. atmospheric stability class
   b. wind direction
   c. wind speed
   d. CO emission rate of the roadway
   e. all of the above

8. True or False? Short-term bag sampling is an efficient means of refining general locations of maximum CO concentrations resulting from an elevated roadway.

9. True or False? Simple averaging of CO concentrations from neighborhood monitoring sites in an urban area is the best approach for determining urban CO concentrations when no urban scale monitoring site exists.

10. True or False? Weighted averaging of CO concentrations from regional and urban monitoring sites is a useful approach for determining national scale CO concentrations.

11. Which of the following factors was(were) considered in selecting the optimum probe height of 3 meters for CO monitors which are located in street canyons?
    a. average breathing height
    b. prevention of vandalism
    c. a and b, above
    d. none of the above

12. The recommended 1-meter probe height range for CO monitor probes which are located in street canyons is based on the assumption that CO hourly average concentrations in street canyons vary about ____(?)____ ppm per meter.
    a. 0.1
    b. 1
    c. 3
    d. 5

13. Which of the following factors was(were) considered in recommending that street canyon CO monitor probes be located greater than 10 meters from an intersection?
    a. Intersections represent a much smaller portion of downtown space than do the streets between them.
    b. Pedestrian exposure times are probably greater in street canyons than at intersections.
    c. Practical difficulties of positioning probe inlets are less at midblock locations than at intersections.
    d. Empirical data suggest that there is a reasonable uniformity of CO concentration throughout the part of a block that is more than 10 meters from an intersection.
    e. all of the above

For questions 14 and 15, select the values that were assumed for each of the following parameters in determining the CO regional scale interference distance for major highways.

14. Undue influence CO concentration level (mg/m^3):
    a. 0.01
    b. 0.2
    c. 1
    d. 2
15. Peak CO emission rate of highway (g/m/s):
    a. 0.001
    b. 0.008
    c. 0.08
    d. 0.26

16. An extended straight section of a major highway has ___(?)___ influence on CO concentrations measured at regional monitoring sites which are aligned within 5 degrees of it than(as) at regional monitoring sites which are outside 5-degree alignment.
    a. more
    b. less
    c. the same

For questions 17-21, select the values that were assumed for each of the following parameters in determining the CO regional scale interference distance for major urban areas.

17. Effective CO emission height (m):
    a. 1
    b. 5
    c. 10
    d. 20
18. Urban area maximum CO emission rate ($g/m^2/s$):
    a. 0.75×10^{-6}
    b. 0.86×10^{-5}
    c. 1.3×10^{-4}
    d. 2.4×10^{-3}
19. Wind speed (m/s):
    a. 0.1
    b. 1
    c. 10
    d. 15
20. Atmospheric stability
    a. unstable
    b. slightly stable
    c. stable
21. Undue influence CO concentration level (mg/m^3):
    a. 0.01
    b. 0.2
    c. 1
    d. 2

22. In general, CO emissions from streets located in the center of a city have ____(?)____ influence on CO concentrations measured at street canyon monitoring sites than(as) streets located at the edge of the city.
    a. more
    b. less
    c. the same

23. Usually, emissions from sources located within 2 kilometers of a CO neighborhood monitoring site account for ____(?)____ percent of the CO concentrations measured at the site.
    a. 5 to 10
    b. 15 to 40
    c. 50 to 75
    d. 80 to 90

Review Exercise Answers

		Page(s) of CO Siting Manual
1.	d	38-39
2.	a	38-40
3.	False	39-40
4.	d	42, 44
5.	b	42, 44
6.	True	42, 44-45
7.	e	46, 48
8.	True	45, 46
9.	False	51
10.	True	53
11.	c	55
12.	b	56
13.	e	60
14.	b	63
15.	b	63
16.	a	63
17.	c	65
18.	c	64
19.	b	64
20.	b	65
21.	b	64
22.	b	66
23.	b	69

Section 3

Introduction to the Monitoring of Photochemical Air Pollutants

Reading Assignment

Pages 7-23 of EPA 450/3-78-013 "Site Selection for the Monitoring of Photochemical Air Pollutants".

Reading Assignment Topics

- Pollutants related to the formation of photochemical oxidants
- Emission sources and photochemical reactions of nonmethane hydrocarbons
- Emission sources and photochemical reactions of nitric oxide and nitrogen dioxide
- Photochemical formation of ozone
- National Ambient Air Quality Standards (NAAQS) for the photochemical pollutants
- Purposes of monitoring
- General types of monitoring sites

Learning Goal and Objectives

Learning Goal

To familiarize you with major sources of nonmethane hydrocarbons and nitrogen oxide emissions, the photochemical formation of ozone, and general types of monitoring sites used to measure nonmethane hydrocarbons, nitric oxide, nitrogen dioxide, and ozone.

Learning Objectives

When you have completed this section, you should be able to:

1. recognize the major ambient air pollutants related to the formation of photochemical oxidants.
2. explain why methane concentrations are not of concern when monitoring the formation of photochemical oxidants.
3. recognize the use of motor vehicles and the use of organic solvents as major sources of nonmethane hydrocarbon emissions in the U.S.
4. recognize stationary source combustion and transportation activities as major sources of oxides of nitrogen emissions in the U.S.

5. recognize nitric oxide and nitrogen dioxide as the major constituents of the oxides of nitrogen.
6. recognize that nitric oxide is frequently oxidized to nitrogen dioxide.
7. describe the major chemical reactions of the atmospheric nitrogen dioxide photolytic cycle.
8. recognize ozone as the major constituent of photochemical oxidants.
9. describe diurnal concentration patterns for ozone, nitric oxide, and nitrogen dioxide.
10. recognize photochemical reactions of nonmethane hydrocarbons and oxides of nitrogen as the major source of ozone.
11. recognize electrical discharges and stratospheric injection as minor sources of ozone.
12. recognize the importance of the ratio of nonmethane hydrocarbon concentration to oxides of nitrogen concentration for the formation of ozone.
13. recognize major purposes for monitoring nonmethane hydrocarbons, nitric oxide, nitrogen dioxide, and ozone.
14. recognize neighborhood and urban/regional as important spatial scales of representativeness for the monitoring of photochemical air pollutants.
15. differentiate between source-oriented and general monitoring sites.
16. differentiate between reactant-oriented and product-oriented monitoring sites.
17. associate nonmethane hydrocarbons, nitric oxide, nitrogen dioxide, and ozone with their appropriate general types of monitoring sites.

Reading Guidance

- Refer often to the tables and figures of the assigned reading material as you progress through the assignment.
- The CO concentration curve depicted in Figure 6 on page 15 of the reading assignment is a surrogate for nonmethane hydrocarbons concentration. Because both CO and nonmethane hydrocarbons are emitted from motor vehicles, nonmethane hydrocarbon concentration should increase during the morning rush hours in the same manner as CO concentration.
- The NAAQS of 0.08 ppm for photochemical oxidants described in Table 4 on page 17 of the reading assignment has been changed to 0.12 ppm for ozone.
- The averaging time for hydrocarbons indicated as 9 to 6 a.m. in Table 4 on page 17 of the reading assignment should be 6 to 9 a.m.
- When you have finished the reading assignment, complete the review exercise for Section 3. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), proceed to Section 4 of this guidebook.

Review Exercise

Now that you've completed the assignment for Section 3, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. Which one of the following ambient air pollutants is ***not*** involved in the formation of photochemical oxidants?
   a. NMHC
   b. NO_2
   c. NO
   d. CO

2. True or False? Methane does not participate in the formation of photochemical oxidants.

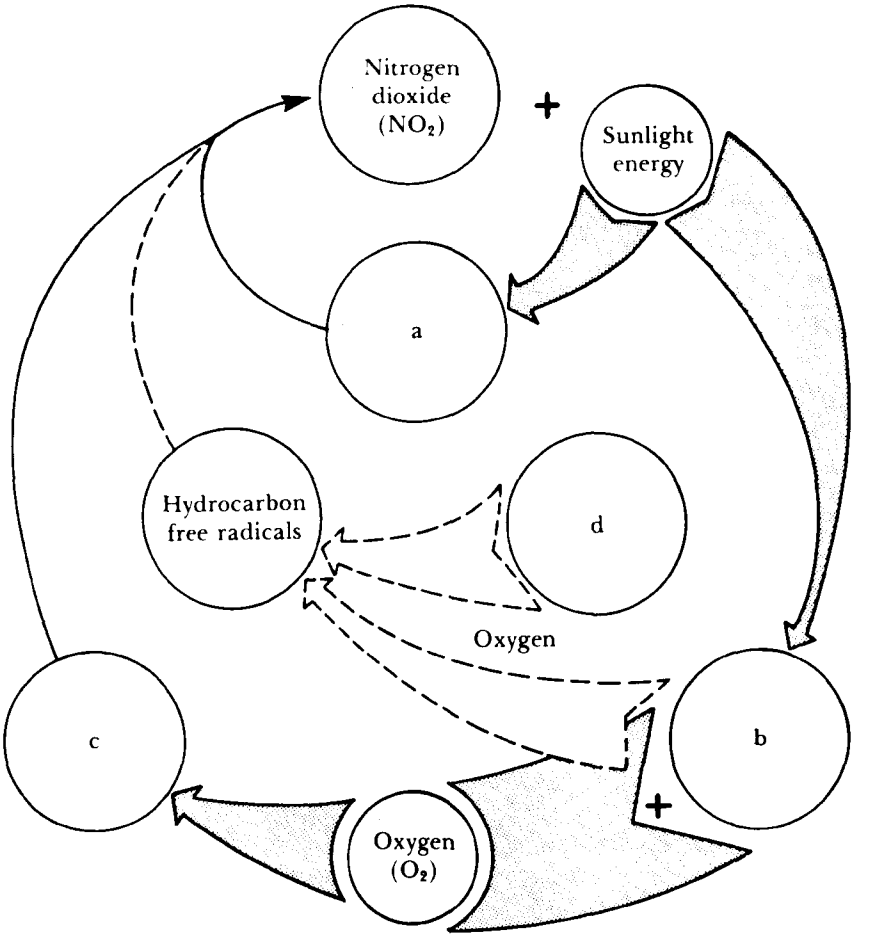
3. In the United States, transportation activities account for about ____(?)____ percent of hydrocarbon emissions and the use of organic solvents accounts for about ____(?)____ percent.
   a. 40, 25
   b. 60, 20
   c. 40, 10
   d. 60, 30

4. In the United States, stationary fuel combustion accounts for about ____(?)____ percent of NO_x emissions and transportation activities account for about ____(?)____ percent.
   a. 75, 20
   b. 50, 45
   c. 50, 20
   d. 30, 10

5. Which of the following is(are) the major constituent(s) of NO_x?
   a. NO
   b. NO_2
   c. a and b, above
   d. none of the above

6. True or False? NO is frequently oxidized to form NO_2.

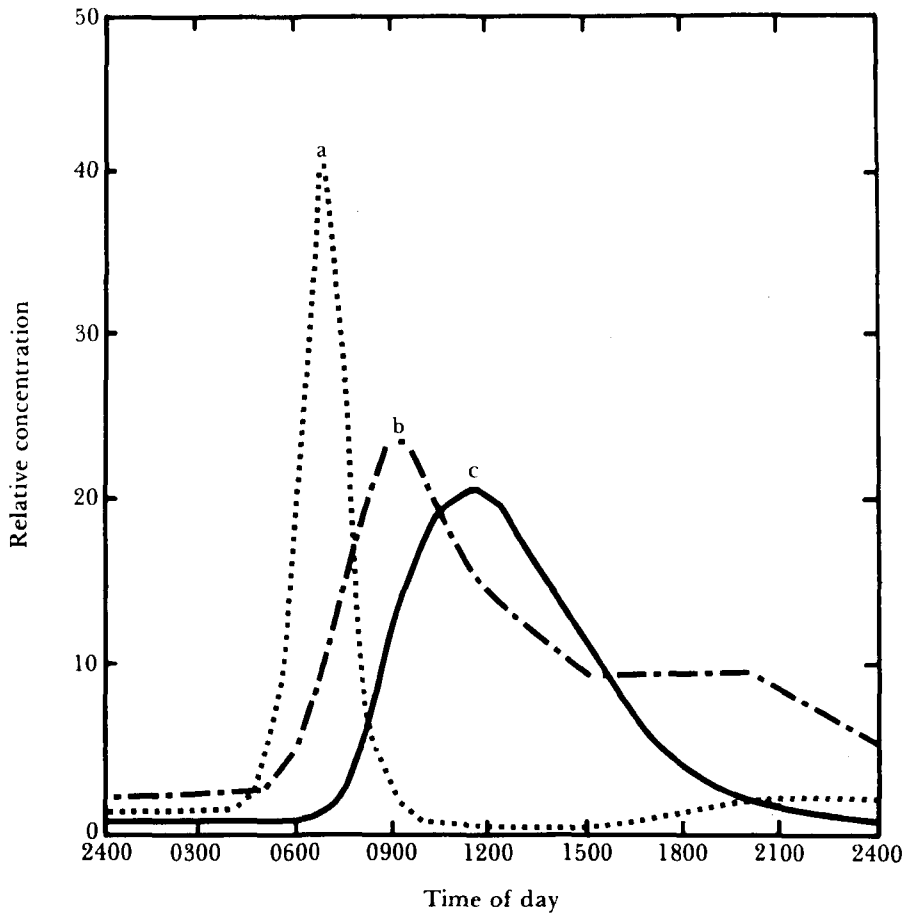
7. In the figure below, a, b, c, and d are ____(?)____, respectively.
   a. NO, O_3, atomic oxygen, and hydrocarbons
   b. O_3, NO, atomic oxygen, and hydrocarbons
   c. NO, atomic oxygen, O_3, and hydrocarbons
   d. O_3, atomic oxygen, NO, and NO_2



8. True or False? Photochemical oxidant concentrations are decreased when the steady state of the NO_2 photolytic cycle is disrupted by NMHC reacting with NO to unbalance the cycle.

9. ____(?)____ is the major constituent of photochemical oxidants.
   a. NO
   b. NO_2
   c. O_3
   d. none of the above

10. In the figure below, curves labeled a, b, and c represent diurnal concentration patterns for ____(?)____, respectively.
    a. NO, NO_2, and O_3
    b. NO_2, NO, and O_3
    c. O_3, NO, and NO_2
    d. NO, O_3, and NO_2



11. Ozone's reaction with ____(?)____ causes the amount of ozone near a highway to be much lower than that found a short distance from the highway.
    a. NO
    b. NO_2
    c. oxygen
    d. NMHC

12. ____(?)____ is a major source of ozone while ____(?)____ and ____(?)____ are relatively minor sources.
    a. Stratospheric injection, photochemical reactions of NMHC and NO_x, electrical discharges
    b. Photochemical reactions of NMHC and NO_x, electrical discharges, stratospheric injection
    c. Electrical discharge, photochemical reactions of NMHC and NO_x, stratospheric injection

13. True or False? The ratio of NMHC concentration to NO_x concentration affects the amount of ozone photochemically produced.

For each of questions 14-17, match the stated monitoring purpose with its appropriate group of pollutants.

14. determine compliance with air quality standards	a. NMHC, NO_2, and O_x
15. evaluate results of control measures	b. NMHC, NO, NO_2, and O_x
16. provide a basis for invoking short-term or emergency control measures	c. NO_2 and O_x
17. evaluate effects of exposure on humans	

18. Which of the following spatial scales of representativeness is(are) important for the monitoring of photochemical air pollutants?
    a. middle
    b. neighborhood
    c. urban/regional
    d. b and c, above

19. True or False? Source-oriented sites are those associated with siting objectives that require information regarding impacts from a specific source or a group of specific sources.

20. True or False? General sites are those located in areas where information concerning the total air pollutant concentration is important but where information concerning contributions from individual sources to the total concentration is relatively unimportant.

21. ____(?)____-oriented sites are those associated with the measuring of air pollutants which are in the same chemical state as when they were emitted into the atmosphere, while ____(?)____-oriented sites are associated with measuring air pollutants which have been created by chemical reactions in the atmosphere.
    a. Reactant, product
    b. Product, reactant
    c. neither a nor b, above

For each of questions 22-25, match the given pollutant with its appropriate general types of monitoring sites.

22. NMHC	a. source-oriented and general neighborhood; reactant-oriented and general urban/regional
23. NO	b. source-oriented and general neighborhood; reactant-oriented, product-oriented, and general urban/regional
24. NO_2	c. general neighborhood; product-oriented and general urban/regional
25. O_3	

Review Exercise Answers

		Page(s) of Photochemical Air Pollutants Siting Manual
1.	d	7
2.	True	9
3.	a	10
4.	b	14
5.	c	9, 13
6.	True	9
7.	c	12
8.	False	9
9.	c	13
10.	a	15
11.	a	13
12.	b	13
13.	True	16, 18
14.	a	20
15.	b	20
16.	b	20
17.	c	20
18.	d	21
19.	True	19
20.	True	19
21.	a	19
22.	a	23
23.	a	23
24.	b	23
25.	c	23

Section 4

Locating Monitoring Stations for Photochemical Air Pollutants

Reading Assignment

Pages 25-50 of EPA 450/3-78-013 "Site Selection for the Monitoring of Photochemical Air Pollutants".

Reading Assignment Topics

- General principles of site selection
- Site selection procedures for nonmethane hydrocarbons
- Site selection procedures for nitric oxide and nitrogen dioxide
- Site selection procedures for oxidants (ozone)

Learning Goal and Objectives

Learning Goal

To familiarize you with the siting of nonmethane hydrocarbons, nitric oxide, nitrogen dioxide, and ozone monitoring stations.

Learning Objectives

When you have completed this section, you should be able to:

1. list in order the major steps involved in selecting a specific monitoring site.
2. recognize the importance of minimizing effects from individual sources on monitoring sites other than source-oriented sites.
3. recognize that regions associated with strong concentration gradients or sinks should be avoided when selecting monitoring sites.
4. associate monitoring purposes with types of sites used for monitoring nonmethane hydrocarbons, nitric oxide, nitrogen dioxide, and ozone.
5. select the general siting area for a source-oriented nonmethane hydrocarbon monitoring station.
6. select the general siting area for a nonmethane hydrocarbon background monitoring station for an elevated point source.
7. select the general siting area for a reactant-oriented nonmethane hydrocarbon monitoring station.
8. select probe locations for nonmethane hydrocarbon monitoring stations.

9. select general siting areas for monitoring maximum short-term and long-term average nitrogen dioxide concentrations resulting from an elevated point source.
10. select general siting areas for locating reactant-oriented and product-oriented neighborhood NO/NO_2 monitoring stations.
11. select the general siting area for a product-oriented regional NO_2 monitoring site.
12. select the general siting areas for regional and neighborhood ozone monitoring sites.

Reading Guidance

- Refer often to the tables, flow charts, and figures of the assigned reading material as you progress through the assignment.
- The table on page 40 of the reading assignment should be labeled Table 9.
- Because "Site Selection for the Monitoring of Photochemical Air Pollutants" was published before the promulgation of 40 CFR 58, the roadway minimum separation distances for neighborhood NO_2 and O_3 monitoring stations specified in the document do not agree with the required minimum separation distances of 40 CFR 58. Roadway minimum separation distances specified in 40 CFR 58 are addressed in Section 6 of this guidebook.
- When you have finished the reading assignment, complete the review exercise for Section 4. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), take Quiz 2. Follow the directions listed in the Course Introduction section of this guidebook.
- After completing Quiz 2, proceed to Section 5 of this guidebook.

Review Exercise

Now that you've completed the assignment for Section 4, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. Which of the following is the proper sequence of major steps involved in selecting a monitoring site?
   a. identify general site location, identify purpose of monitoring, identify type of site that will best serve the monitoring purpose, identify specific monitoring site
   b. identify general site location, identify specific monitoring site, identify purpose of monitoring, identify type of site that will best serve the monitoring purpose
   c. identify purpose of monitoring, identify type of site that will best serve the monitoring purpose, identify general site location, identify specific monitoring site
2. True or False? The most important principle in the selection of specific monitoring sites is that the effects from individual sources, other than those of interest in source-oriented monitoring, should be minimal.
3. True or False? In general, monitoring sites should be located in areas associated with strong concentration gradients or sinks.

For each of questions 4-6, match the stated NMHC monitoring purpose with its appropriate types of monitoring sites.

4. determine compliance with air quality standards	a. reactant-oriented and general urban/regional; general neighborhood
5. evaluate results of control measures	b. general urban/regional; source-oriented neighborhood
6. provide a basis for invoking short-term or emergency control measures	c. reactant-oriented urban/regional

For each of questions 7-10, match the stated NO_2 monitoring purpose with its appropriate types of monitoring sites.

7. determine compliance with air quality standards
8. evaluate results of control measures
9. provide a basis for invoking short-term or emergency control measures
10. evaluate effects of human exposure

a. reactant-oriented and general urban/regional; source-oriented and general neighborhood
b. general urban/regional; source-oriented neighborhood
c. reactant-oriented, product-oriented, and general urban/regional; source-oriented and general neighborhood
d. general urban/regional; source-oriented and general neighborhood

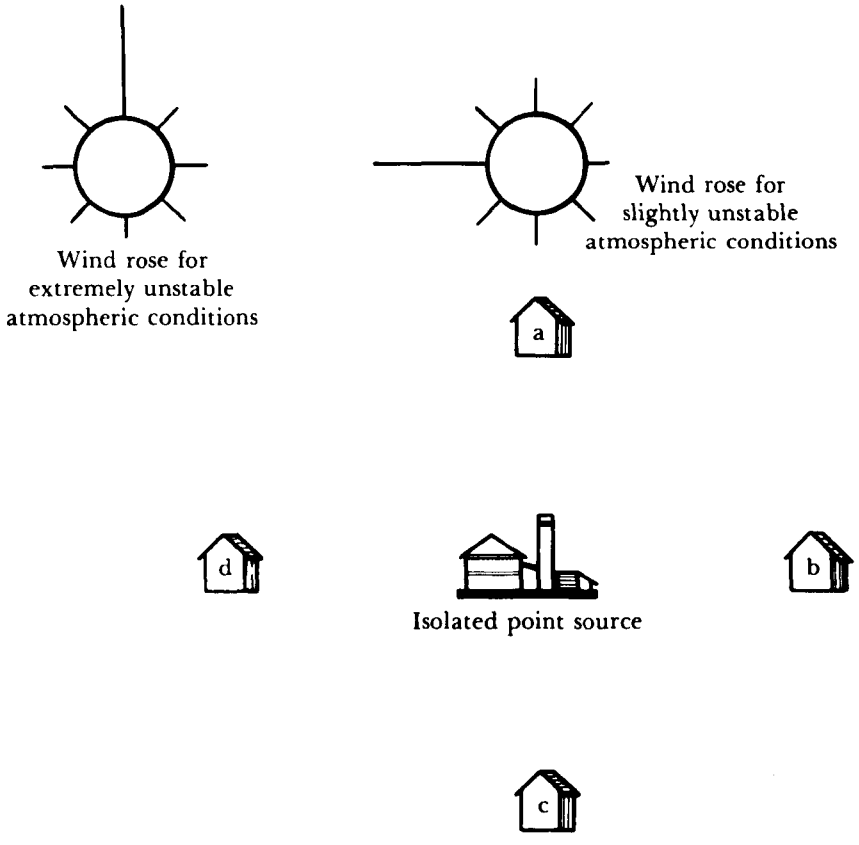
For each of questions 11-13, match the stated O_3 monitoring purpose with its appropriate types of monitoring sites.

11. determine compliance with air quality standards
12. provide a basis for invoking short-term or emergency control measures
13. evaluate effects of human exposure

a. product-oriented and general urban/regional; general neighborhood
b. general urban/regional; general neighborhood

14. For NO, a ___(?)___ site is the appropriate type of monitoring site for providing a basis for invoking short-term or emergency control measures.
    a. general urban/regional
    b. reactant-oriented urban/regional
    c. source-oriented neighborhood
    d. general neighborhood

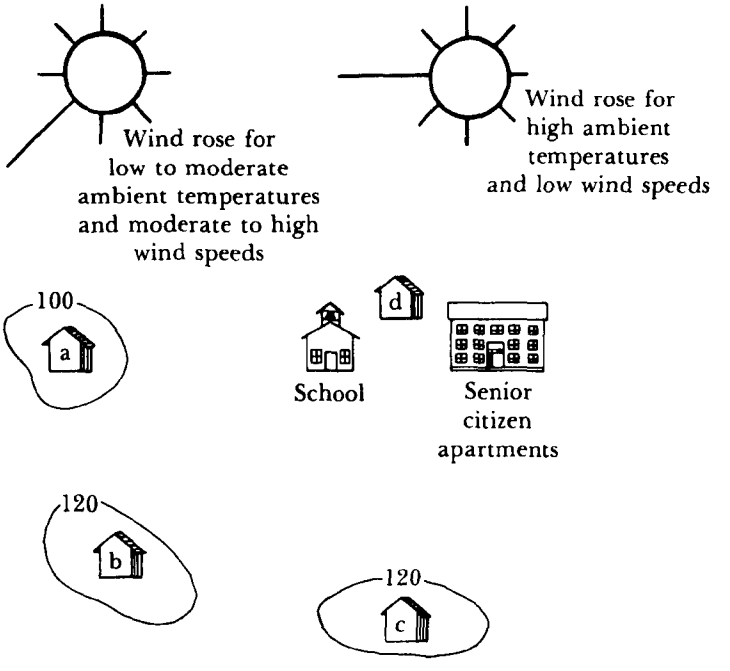
15. Which of the four general siting areas, labeled a through d, is the best siting area for a monitoring station for determining 6 to 9 a.m. peak NMHC concentrations resulting from the isolated point source?



16. Which of the four general siting areas, labeled a through d in question 15, is the best siting area for an NMHC background monitoring station?

17. True or False? A monitoring site for measuring maximum NMHC concentrations resulting from an NMHC point source probably should be located somewhat farther from the point source than the distance predicted for maximum concentrations.

18. The figure below represents a region with relative NMHC concentrations plotted. Which of the four general siting areas, labeled a through d, is the best siting area for a reactant-oriented NMHC monitor?



19. An NMHC monitor's probe inlet should be located about ____(?)____ meters above ground level.
    a. 2 to 10
    b. 3 to 10
    c. 2 to 20
    d. 3 to 15

20. The probe inlet for an NMHC monitor should be located at least about ____(?)____ meter(s) above its supporting structure.
    a. 0.5
    b. 1
    c. 3
    d. 5

21. The probe inlet for an NMHC monitor should be located at least ____(?)____ meters from a roadway having an average daily traffic (ADT) volume less than 1,000.
    a. 5
    b. 15
    c. 25
    d. 50

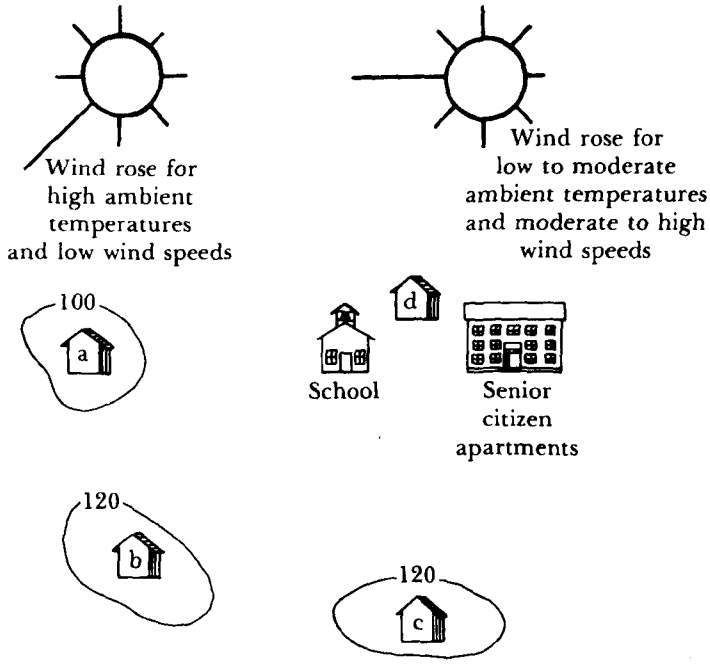
22. The minimum separation between the inlet probe of an NMHC monitor and a roadway having an average daily traffic (ADT) volume greater than 10,000 should be ____(?)____ meters.
    a. 50
    b. 100
    c. 200
    d. 400

23. An NMHC monitor's probe inlet should be located away from surrounding obstacles so that the distance between an obstacle and the inlet is at least about ____(?)____ times the height that the obstacle protrudes above the inlet.
    a. 2
    b. 4
    c. 5
    d. 10

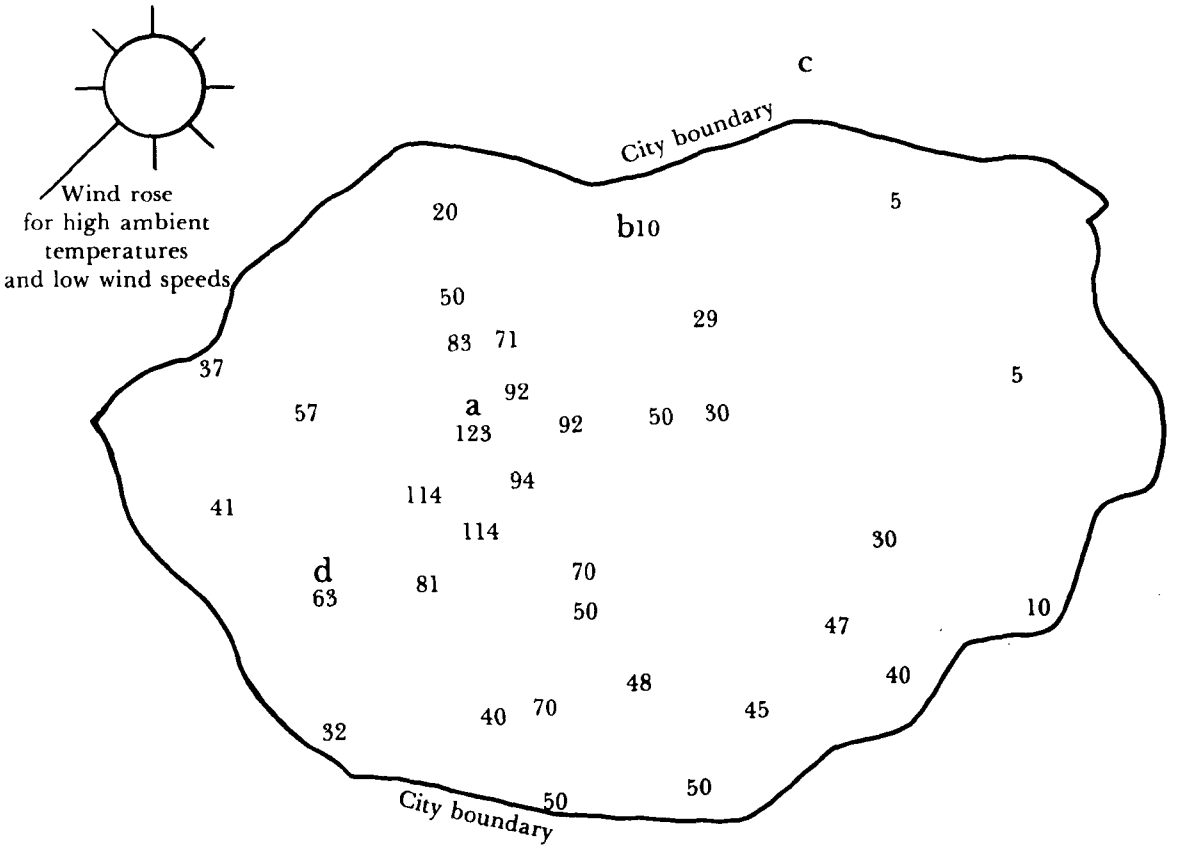
24. In general, areas of highest ____(?)____ average NO/NO_2 concentrations resulting from an elevated point source are more likely to occur nearer the point source than are areas of highest ____(?)____ average NO/NO_2 concentrations resulting from the point source.
    a. long-term, short-term
    b. short-term, long-term
    c. neither a nor b, above

25. True or False? A monitoring site for measuring maximum NO_2 concentrations resulting from an NO_x point source should be located somewhat farther from the point source than the distance predicted for maximum NO_x concentrations.

26. The figure below represents a region with relative NO_x concentrations plotted. Which of the four general siting areas, labeled a through d, is the best siting area for a reactant-oriented neighborhood NO_x monitor?

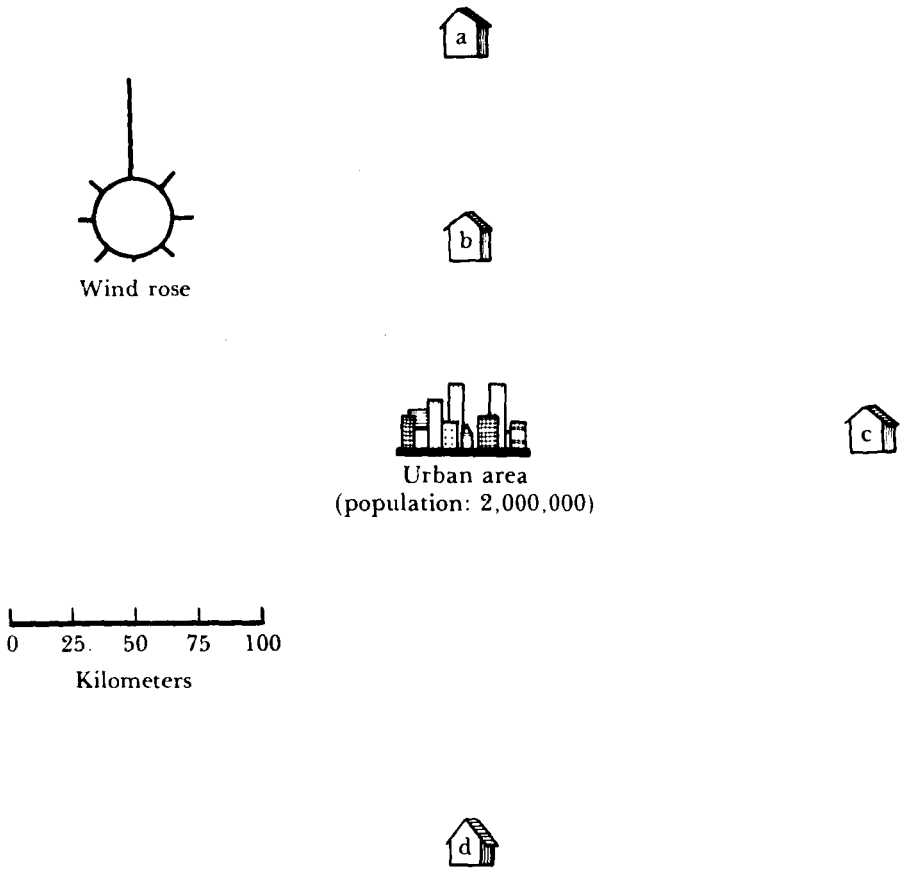


27. The figure below represents a city area with relative NO_x emissions plotted. Which of the four general siting areas, labeled a through d, is the best siting area for locating a product-oriented neighborhood NO_2 monitoring site to measure maximum short-term average NO_2 concentrations?



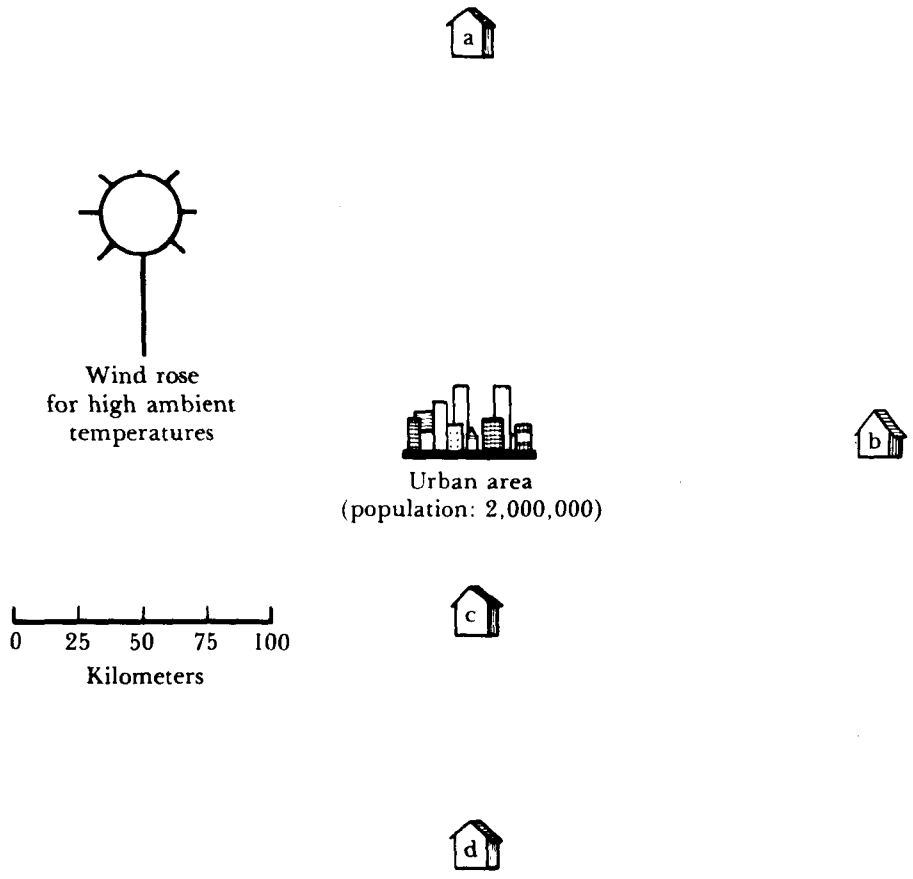
28. Which of the four general siting areas, labeled a through d in question 27, is the best siting area for locating a product-oriented neighborhood NO_2 monitoring site to measure maximum long-term average NO_2 concentrations?

29. Which of the four general siting areas, labeled a through d, is the best siting area for locating a product-oriented regional NO_2 monitoring site?

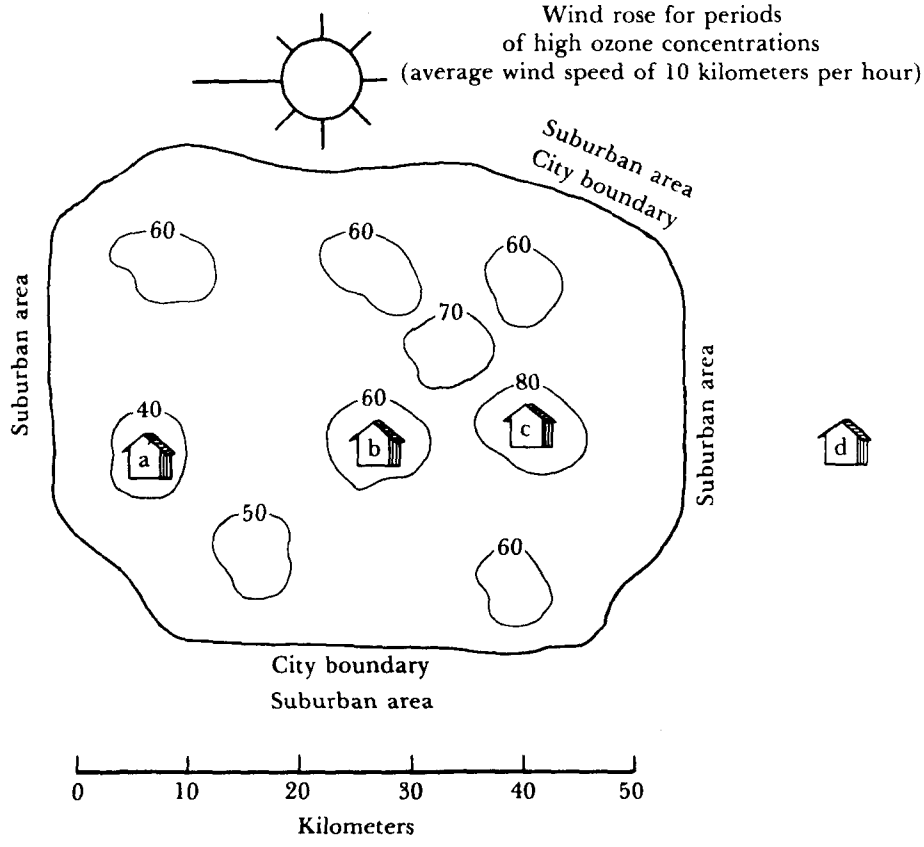


30. Select the value that was assumed for the undue influence NO_x concentration level (ppb) in determining the NO_2 regional scale interference distances for urban areas.
    a. 1
    b. 7
    c. 23
    d. 50

31. Which of the four general siting areas, labeled a through d, is the best siting area for locating a regional O_3 monitoring site?



32. The figure below represents a city area with relative ozone concentrations plotted. Which of the four general siting areas, labeled a through d, is the best siting area for assessing ozone concentrations in the city neighborhoods that have average neighborhood scale ozone concentrations?



33. Which of the four general siting areas, labeled a through d in question 32, is the best siting area for measuring maximum ozone concentrations?

34. True or False? Monthly wind roses are more useful than high-temperature wind roses for determining wind directions during periods which are conducive to the photochemical formation of ozone.

Review Exercise Answers

		Page(s) of Photochemical Air Pollutants Siting Manual
1.	c	25
2.	True	25
3.	False	25
4.	c	26
5.	b	26
6.	a	26
7.	a	26
8.	b	26
9.	c	26
10.	d	26
11.	a	26
12.	a	26
13.	b	26
14.	c	26
15.	b	27, 33
16.	d	33
17.	True	33
18.	a	27, 38
19.	d	27, 38
20.	b	38
21.	b	27
22.	d	27
23.	a	38
24.	b	41
25.	True	41
26.	b	43-44
27.	a	43-44
28.	b	43-44
29.	a	44-46
30.	b	45
31.	d	45-46, 48-49
32.	b	48-49
33.	d	48-50
34.	False	49

Section 5

Rationale for Monitor-Siting Criteria for Photochemical Air Pollutants

Reading Assignment

Pages 51-100 of EPA 450/3-78-013 "Site Selection for the Monitoring of Photochemical Air Pollutants".

Reading Assignment Topics

- Identification of conditions conducive to high pollutant concentrations
- Identification of general areas suitable for monitoring
- Local effects and the selection of specific sites

Learning Goal and Objectives

Learning Goal

To familiarize you with the logic of the monitor-siting criteria for photochemical air pollutants.

Learning Objectives

When you have completed this section, you should be able to:

1. identify essential ingredients for the photochemical formation of high ozone concentrations.
2. recognize meteorological conditions that favor the formation of high ozone concentrations.
3. recognize meteorological conditions that favor maximum long-term ground level pollutant concentrations resulting from emissions from elevated point sources.
4. describe the relationship between distributions of nonmethane hydrocarbons and nitric oxide ambient air concentrations and distributions of nonmethane hydrocarbons and nitric oxide emissions.
5. describe spatial and temporal separations between precursor emissions and NO_2 and O_3 ambient air concentrations.
6. describe conditions conducive to the formation of high NO_2 concentrations in the vicinity of strong NO emissions.
7. describe relative locations of NO_2 and O_3 maximum ambient air concentrations.

8. describe assumptions for determining the areas of maximum ozone concentrations resulting from urban areas.
9. recognize potential scavenging of NO_2 and O_3 by obstructions.
10. describe air cavity effects of buildings.
11. recognize the scavenging of O_3 near roadways by nitric oxide emissions from motor vehicles.
12. describe assumptions for determining minimum separation distance between roadways and NMHC monitor probes.
13. recognize the scavenging of O_3 by valleys.

Reading Guidance

- Refer often to the tables and figures of the assigned reading material as you progress through the assignment.
- Although it is stated on page 52 of the reading assignment that Figure 22 shows 13 cases when the average temperature exceeded 75°F and ozone remained below 80 ppb, the figure actually indicates only 12 such cases.
- Try to visualize how the siting criteria would be affected if the assumptions described in this reading assignment were altered.
- When you have finished the reading assignment, complete the review exercise for Section 5. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), proceed to Section 6 of this guidebook.

Review Exercise

Now that you've completed the assignment for Section 5, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. Which of the following ingredients is(are) essential for the photochemical formation of high concentrations of ozone?
   a. an accumulation of precursor emissions
   b. sunshine
   c. relatively little ozone removal
   d. all of the above
2. ____(?)____ ambient temperatures and ____(?)____ wind speeds favor the formation of high ozone concentrations.
   a. Low, low
   b. High, high
   c. Low, high
   d. High, low
3. High ozone concentrations occur most frequently during ____(?)____.
   a. January and February
   b. November and December
   c. January, February, and March
   d. June, July, and August
4. The most commonly occurring combination of wind speed and wind direction during ____(?)____ atmospheric conditions will often determine where the maximum long-term average ground-level pollutant concentrations resulting from emissions from an elevated point source will occur.
   a. neutral
   b. slightly stable
   c. stable
   d. unstable
5. True or False? Most of the ambient concentrations of inert pollutants whose emission sources are near ground level result from nearby sources.
6. True or False? Spatial and temporal separations of precursor emissions and ozone concentrations may be quite large.
7. True or False? Spatial and temporal separations of NO emissions and NO_2 concentrations resulting from the NO emissions can be quite large if local ozone concentrations are high, or smaller if ozone concentrations are low.

8. Which of the following conditions favor the formation of high NO_2 concentrations in the vicinity of strong NO emissions?
   a. high O_3 concentrations and nearly stagnant winds
   b. high O_3 concentrations and appreciable winds
   c. low O_3 concentrations and stagnant winds
   d. all of the above

9. Maximum NO_2 concentrations are found ____(?)____ maximum ozone concentrations.
   a. upwind of
   b. downwind of
   c. at the same location as

10. Which of the following assumptions was(were) made in locating the area of maximum ozone concentrations resulting from emissions of a relatively large urban area?
    a. Maximum ozone concentrations are most likely to accompany large accumulations of precursor emissions.
    b. Large accumulations of precursor emissions are most likely in air that travels across the entire emitting region, especially during the morning rush hour.
    c. Maximum ozone concentrations are reached in the early to middle afternoon, after the morning rush hour emissions have been traveling 5 to 7 hours.
    d. Emissions of NO within the metropolitan area will destroy ozone near ground level and keep the concentrations below their maxima.
    e. all of the above

11. True or False? In locating areas of maximum ozone concentrations resulting from emissions of a small urban area, it was assumed that lateral mixing of clean air into the urban plume increases the separation distance between the urban area and the area of maximum ozone concentrations.

12. True or False? In locating areas of maximum ozone concentrations resulting from emissions of large sprawling metropolitan areas, it was assumed that the metropolitan areas may contain "islands" of low NO emissions which may be locations of maximum ozone concentrations.

13. True or False? Ozone and perhaps NO_x can be destroyed by coming into contact with obstructions.

14. An air cavity extends downwind of a building about ____(?)____ heights of the building.
    a. 1.5
    b. 4.5
    c. 9
    d. 15

15. True or False? Ozone near roadways will be destroyed by nitric oxide emitted by motor vehicles.

For each of questions 16-21, select the value that was assumed for the specified parameter when determining the separation distances between roadways and NMHC monitor probes.

16. Undue influence NMHC concentration level (pphm):
    a. 1
    b. 8
    c. 20
    d. 50
17. Wind speed (m/s):
    a. 0.1
    b. 1
    c. 5
    d. 10
18. NMHC emission rate for pre-1970 model vehicles (g/mile):
    a. 0.5
    b. 1
    c. 4
    d. 10
19. Peak hour traffic volume (percent of average daily traffic):
    a. 10
    b. 20
    c. 35
    d. 50
20. Atmospheric stability
    a. neutral
    b. slightly stable
    c. stable
    d. unstable
21. Initial vertical dispersion height (m):
    a. 0.25
    b. 0.5
    c. 1.5
    d. 2.5

22. True or False? In general, ozone concentrations found in valleys are lower than typical ambient ozone concentrations.

Review Exercise Answers

		Page(s) of Photochemical Air Pollutants Siting Manual
1.	d	51
2.	d	51-53
3.	d	52, 55
4.	a	52
5.	True	52, 57
6.	True	57
7.	False	57
8.	d	57
9.	a	60
10.	e	69
11.	False	69
12.	True	69
13.	True	87
14.	a	87
15.	True	92
16.	b	92
17.	b	92
18.	c	92
19.	a	92
20.	b	94
21.	c	94
22.	True	97, 99

Section 6

Monitoring Network Design and Probe-Siting Criteria for SLAMS, NAMS, and PSD Monitoring Stations for CO, O_3, and NO_2

Reading Assignment

Pages 6-4 through 6-16 of this guidebook.

Reading Assignment Topics

- Excerpts of 40 CFR 58 Appendix D
  - SLAMS network design for CO, O_3, and NO_2 monitoring stations
  - NAMS network design for CO, O_3, and NO_2 monitoring stations
- Excerpts of 40 CFR 58 Appendix E
  - Probe-siting criteria for CO SLAMS and NAMS
  - Probe-siting criteria for O_3 SLAMS and NAMS
  - Probe-siting criteria for NO_2 SLAMS and NAMS
  - Materials of construction and maximum sample residence times for NO_2 and O_3 probes
  - Waiver provisions for SLAMS and NAMS probe-siting criteria
- Excerpts of "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)" (EPA 450/4-80-012)
  - Network design for PSD monitoring stations
  - Probe-siting criteria for ground-level sources

Learning Goal and Objectives

Learning Goal

To familiarize you with regulations and guidelines concerning monitoring network design and probe-siting criteria for CO, O_3, and NO_2 SLAMS, NAMS, and PSD monitoring stations.

Learning Objectives

When you have completed this section, you should be able to:

1. recognize the four basic monitoring objectives of SLAMS.
2. associate SLAMS monitoring objectives with spatial scales of representativeness.
3. recognize applicable spatial scales of representativeness for CO, O_3, and NO_2 SLAMS.
4. recognize the primary monitoring objective of NAMS.
5. describe the two basic categories of NAMS.
6. recognize the two primary uses of NAMS data.
7. determine the number of CO, O_3, and NO_2 NAMS required for a given monitoring area.
8. recognize the spatial scales of representativeness required for CO, O_3, and NO_2 NAMS.
9. select probe locations for CO, O_3, and NO_2 SLAMS, NAMS, and PSD monitoring stations.
10. select the appropriate materials of construction and the maximum sample residence times for O_3 and NO_2 probes.
11. describe waiver provisions for SLAMS and NAMS probe-siting criteria.
12. select general siting areas for PSD monitoring stations.
13. estimate the number of CO, O_3, and NO_2 monitoring stations needed for preconstruction and postconstruction PSD monitoring networks.
14. define ***ambient air***.
15. recognize that PSD monitors should be located in ambient air areas.
16. select appropriate probe heights for O_3, and NO_2 PSD monitors used to measure impacts of ground-level sources.

Reading Guidance

- SLAMS and NAMS are required for State Implementation Plan ambient air quality monitoring networks.
- The information concerning SLAMS and NAMS contained in the assigned reading material is stated as a regulation.
- PSD monitoring stations are used to determine the air quality impacts of existing or proposed sources that are located in areas meeting the National Ambient Air Quality Standards (NAAQS).
- The information concerning PSD monitoring stations contained in the assigned reading material is stated as a guideline.
- The probe-siting criteria for CO PSD monitoring stations are identical to the probe-siting criteria for CO SLAMS and NAMS.
- The probe-siting criteria for O_3 and NO_2 PSD monitoring stations are identical to the probe-siting criteria for O_3 and NO_2 SLAMS and NAMS except for the PSD monitoring of ground-level sources. Therefore, only ground-level source monitoring information is included in the PSD monitor-siting portion of the reading assignment.

- NMHC monitoring is not required for PSD purposes because O_3 monitoring is required in lieu of NMHC monitoring.
- Table 4 of the excerpts of 40 CFR 58 Appendix D is incorrectly titled as "Figure 5-2. Particulate field data". The correct title is "Summary of Spatial Scales for SLAMS and Required Scales for NAMS".
- $\leq 110{,}000$ which appears in Tables 2 and 3 of the excerpts of 40 CFR 58 Appendix E should be $\geq 110{,}000$.
- The last reference found in the footnotes of the excerpts of 40 CFR 58 Appendix E should read 21-22, not 21-21.
- When you have finished the reading assignment, complete the review exercise for Section 6. It begins on page 6-17.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), take the final examination for the course. Follow the directions listed in the Course Introduction section of this guidebook.
- Your course grade results will be mailed to you.

Excerpts of 40 CFR 58 Appendices D and E

APPENDIX D—NETWORK DESIGN FOR STATE AND LOCAL AIR MONITORING STATIONS (SLAMS) AND NATIONAL AIR MONITORING STATIONS (NAMS)

1. SLAMS Monitoring Objectives and Spatial Scales
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2.5 Ozone (O_3) Design Criteria for SLAMS
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3. Network Design for National Air Monitoring Stations (NAMS)
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1. SLAMS MONITORING OBJECTIVES AND SPATIAL SCALES

The purpose of this appendix is to describe monitoring objectives and general criteria to be applied in establishing the State and Local Air Monitoring Stations (SLAMS) networks and for choosing general locations for new monitoring stations. It also describes criteria for determining the number and location of National Air Monitoring Stations (NAMS). These criteria will also be used by EPA in evaluating the adequacy of SLAMS/NAMS networks.

The network of stations which comprise SLAMS should be designed to meet a minimum of four basic monitoring objectives. These basic monitoring objectives are: (1) To determine highest concentrations expected to occur in the area covered by the network; (2) to determine representative concentrations in areas of high population density; (3) to determine the impact on ambient pollution levels of significant sources or source categories; and (4) to determine general background concentration levels.

To a large extent, the existing State Implementation Plan (SIP) monitoring networks have been designed with these four objectives in mind. Thus, they can serve as the logical starting point for establishing the SLAMS network. This will, however, require a careful review of each existing SIP ambient network to determine the principal objectives of each station and the extent to which the location criteria presented herein are being met. It should be noted that this appendix contains no criteria for determining the total number of stations in SLAMS networks. The optimum size of a particular SLAMS network involves trade offs among data needs and available resources which EPA believes can best be resolved during the network design process.

This appendix focuses on the relationship between monitoring objectives and the geographical location of monitoring stations. Included are a rationale and set of general criteria for identifying candidate station locations in terms of physical characteristics which most closely match a specific monitoring objective. The criteria for more specifically siting the monitoring station including spacing from roadways and vertical and horizontal probe placement, are described in Appendix E of this part.

To clarify the nature of the link between general monitoring objectives and the physical location of a particular monitoring station, the concept of spatial scale of representativeness of a monitoring station is defined. The goal in siting stations is to correctly match the spatial scale represented by the sample of monitored air with the spatial scale most appropriate for the monitoring objective of the station.

Thus, spatial scale of representativeness is described in terms of the physical dimensions of the air parcel nearest to a monitoring station throughout which actual pollutant concentrations are reasonably similar. The scale of representativeness of most interest for the monitoring objectives defined above are as follows:

- *Microscale*—defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters.
- *Middle Scale*—defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer.
- *Neighborhood Scale*—defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range.
- *Urban Scale*—defines the overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale would usually require more than one site for definition.
- *Regional Scale*—defines usually a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers.
- *National and Global Scales*—these measurement scales represent concentrations characterizing the nation and the globe as a whole.

Proper siting of a monitoring station requires precise specification of the monitoring objective which usually includes a desired spatial scale of representativeness. For example, consider the case where the objective is to determine maximum CO concentrations in areas where pedestrians may reasonably be exposed. Such areas would most likely be located within major street canyons of large urban areas and near traffic corridors. Stations located in these areas are most likely to have a microscale of representativeness since CO concentrations typically peak nearest roadways and decrease rapidly as the monitor is moved from the roadway. In this example, physical location was determined by consideration of CO emission patterns, pedestrian activity, and physical characteristics affecting pollutant dispersion. Thus, spatial scale of representativeness was not used in the selection process but was a *result* of station location.

In some cases, the physical location of a station is determined from joint consideration of both the basic monitoring objective, and a desired spatial scale of representativeness. For example, to determine CO concentrations which are typical over a reasonably broad geographic area having relatively high CO concentrations, a neighborhood scale station is more appropriate. Such a station would likely be located in a residential or commercial area having a high overall CO emission density but not in the immediate vicinity of any single roadway. Note that in this example, the desired scale of representativeness was an important factor in determining the physical location of the monitoring station.

In either case, classification of the station by its intended objective and spatial scale of representativeness is necessary and will aid in interpretation of the monitoring data.

Table 1 illustrates the relationship between the four basic monitoring objectives and the scales of representativeness that are generally most appropriate for that objective.

TABLE 1.—*Relationship among monitoring objectives and scale of representativeness*

Monitoring objective	Appropriate siting scales
Highest concentration	Micro, middle, neighborhood (sometimes urban)
Population	Neighborhood, urban
Source impact	Micro, middle, neighborhood
General/background	Neighborhood, regional

Subsequent sections of this appendix describe in greater detail the most appropriate scales of representativeness and general monitoring locations for each pollutant.

2. SLAMS NETWORK DESIGN PROCEDURES

The preceding section of this appendix has stressed the importance of defining the objectives for monitoring a particular pollutant. Since monitoring data are collected to "represent" the conditions in a section or subregion of a geographical area, the previous section included a discussion of the scale of representativeness of a monitoring station. The use of this physical basis for locating stations allows for an objective approach to network design.

The discussion of scales in Sections 2.2-2.6 does not include all of the possible scales for each pollutant. The scales which are discussed are those which are felt to be most pertinent for SLAMS network design.

In order to evaluate a monitoring network and to determine the adequacy of particular monitoring stations, it is necessary to examine each pollutant monitoring station individually by stating its monitoring objective and determining its spatial scale of representativeness. This will do more than insure compatibility among stations of the same type. It will also provide a physical basis for the interpretation and application of the data. This will help to prevent mismatches between what the data actually represent and what the data are interpreted to repre-

sent. It is important to note that SLAMS are not necessarily sufficient for completely describing air quality. In many situations, diffusion models must be applied to complement ambient monitoring, e.g., determining the impact of point sources or defining boundaries of nonattainment areas.

2.1 *Background Information for Establishing SLAMS*

Background information that must be considered in the process of selecting SLAMS from the existing network and in establishing new SLAMS includes emission inventories, climatological summaries, and local geographical characteristics. Such information is to be used as a basis for the judgmental decisions that are required during the station selection process. For new stations, the background information should be used to decide on the actual location considering the monitoring objective and spatial scale while following the detailed procedures in References 1 through 4.

Emission inventories are generally the most important type of background information needed to design the SLAMS network. The emission data provide valuable information concerning the size and distribution of large point sources. Area source emissions are usually available for counties but should be subdivided into smaller areas or grids where possible, especially if diffusion modeling is to be used as a basis for determining where stations should be located. Sometimes this must be done rather crudely, for example, on the basis of population or housing units. In general, the grids should be smaller in areas of dense population than in less densely populated regions.

Emission inventory information for point sources should be generally available for any area of the country for annual and seasonal averaging times. Specific information characterizing the emissions from large point sources for the shorter averaging times (diurnal variations, load curves, etc.) can often be obtained from the source. Area source emission data by season, although not available from the EPA, can be generated by apportioning annual totals according to degree days.

Detailed area source data are also valuable in evaluating the adequacy of an existing station in terms of whether the station has been located in the desired spatial scale of representativeness. For example, it may be the desire of an agency to have an existing CO station measuring in the neighborhood scale.

By examining the traffic data for the area and examining the physical location of the station with respect to the roadways, a determination can be made as to whether or not the station is indeed measuring the air quality on the desired scale.

The climatological summaries of greatest use are the frequency distributions of wind speed and direction. The wind rose is an easily interpreted graphical presentation of the directional frequencies. Other types of useful climatological data are also available, but generally are not as directly applicable to the site selection process as are the wind statistics.

In many cases, the meteorological data originating from the most appropriate (not necessarily the nearest) national weather service (NWS) airport station in the vicinity of the prospective siting area will adequately reflect conditions over the area of interest, at least for annual and seasonal averaging times. In developing data in complex meteorological and terrain situations, diffusion meteorologists should be consulted. NWS stations can usually provide most of the relevant weather information in support of network design activities anywhere in the country. Such information includes joint frequency distributions of winds and atmospheric stability (stability-wind roses).

The geographical material is used to determine the distribution of natural features, such as forests, rivers, lakes, and manmade features. Useful sources of such information may include road and topographical maps, aerial photographs, and even satellite photographs. This information may include the terrain and land-use setting of the prospective monitor siting area, the proximity of larger water bodies, the distribution of pollutant sources in the area, the location of NWS airport stations from which weather data may be obtained, etc. Land use and topographical characteristics of specific areas of interest can be determined from U.S. Geological Survey (USGS) maps and land use maps. Detailed information on urban physiography (building/street dimensions, etc.) can be obtained by visual observations, aerial photography, and also surveys to supplement the information available from those sources. Such information could be used in determining the location of local pollutant sources in and around the prospective station locations.

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2.4 *Carbon Monoxide (CO) Design Criteria for SLAMS*

Micro, middle, and neighborhood scale measurements are necessary station classifications for SLAMS since most people are exposed to CO concentrations in these scales. Carbon monoxide maxima occur primarily in areas near major roadways and intersections with high traffic density and poor atmospheric ventilation. As these maxima can be predicted by ambient air quality modeling, a large fixed network of CO monitors is not required. Long-term CO monitoring should be confined to a limited number of micro and neighborhood scale stations in large metropolitan areas to measure maximum pollution levels and to determine the effectiveness of control strategies.

• *Microscale.*—Measurements on this scale would represent distributions within street canyons, over sidewalks, and near major roadways. The measurements at a particular location in a street canyon would be typical of one high concentration area which can be shown to be a representation of many more areas throughout the street canyon or other similar locations in a city. This is a scale of measurement that would provide valuable information for devising and evaluating "hot spot" control measures.

• *Middle Scale.*—This category covers dimensions from 100 meters to 0.5 kilometer. In certain cases discussed below, it may apply to regions that have a total length of several kilometers. In many cases of interest, sources and land use may be reasonably homogeneous for long distances along a street, but very inhomogeneous normal to the street. This is the case with strip development and freeway corridors. Included in this category are measurements to characterize the CO concentrations along the urban features just enumerated. When a location is chosen to represent conditions in a block of street development, then the characteristic dimensions of this scale are tens of meters by hundreds of meters. If an attempt is made to characterize street-side conditions throughout the downtown area or along an extended stretch of freeway, the dimensions may be tens of meters by kilometer.

The middle scale would also include the parking lots and feeder streets associated with indirect sources which attract significant numbers of pollutant emitters, particularly autos. Shopping centers, stadia, and office buildings are examples of indirect sources.

• *Neighborhood Scale.*—Measurements in this category would represent conditions throughout some reasonably homogeneous urban subregions, with dimensions of a few kilometers and generally more regularly shaped than the middle scale. Homogeneity refers to CO concentration, but it probably also applies to land use. In some cases, a location carefully chosen to provide neighborhood scale data, might represent not only the immediate neighborhood, but also neighborhoods of the same type in other parts of the city. These kinds of stations would provide information relating to health effects because they would represent conditions in areas where people live and work. Neighborhood scale data would provide valuable information for developing, testing, and revising concepts and models that describe the larger scale concentration patterns, especially those models relying on spatially smoothed emission fields for inputs. These types of measurements could also be used for interneighborhood comparisons within or between cities.

After the spatial scale has been determined to meet the monitoring objectives for each location, the location selection procedures, as shown in reference 3 should be used to evaluate the adequacy of each existing CO station and must be used to relocate an existing station or to locate any new SLAMS stations. The background material necessary for these procedures may include the average daily traffic on all streets in the area, wind roses for different hours of the day, and maps showing one-way streets, street widths, and building heights. If the station is to typify the area with the highest concentrations, the streets with the greatest daily traffic should be identified. If some streets are one-way, those streets that have the greatest traffic during the afternoon and evening hours should be selected as tentative locations, because the periods of high traffic volume are usually of greatest duration through the evening hours. However, the strength of the morning inversion has to be considered along with the traffic volume and pattern when seeking areas with the highest concentrations. Traffic counters near the stations will provide valuable data for interpreting the observed CO Concentrations.

Monitors should not be placed in the vicinity of possible anomalous source areas. Examples of such areas include toll gates on turnpikes, metered freeway ramps, and drawbridge approaches. Additional information on network design may be found in reference 3.

2.5 *Ozone (O_3) Design Criteria for SLAMS*

Ozone is not directly emitted into the atmosphere but results from complex photochemical reactions involving organic compounds, oxides of nitrogen, and solar radiation.

The relationships between primary emissions (precursors) and secondary pollutants (O_3) tend to produce large separations spatially and temporally between the major sources and the areas of high oxidant pollution. This suggests that the meteorological transport process and the relationships between sources and sinks need to be considered in the development of the network design criteria and placement of monitoring stations, especially in measuring peak concentration levels.

The principal spatial scales for SLAMS purposes based on the monitoring objectives are neighborhood, urban, regional, and to a lesser extent, middle scale. Since ozone requires appreciable formation time, the mixing of reactants and products occurs over large volumes of air, and this reduces the importance of monitoring small scale spatial variability.

• *Middle Scale.*—Measurement in this scale would represent conditions close to sources of NO_x such as roads where it would be expected that suppression of O_3 concentrations would occur. Measurements at these stations would represent conditions over relatively small portions of the urban area.

• *Neighborhood Scale.*—Measurements in this category represent conditions throughout some reasonably homogeneous urban subregion, with dimensions of a few kilometers. Homogeneity refers to pollutant concentrations. Neighborhood scale data will provide valuable information for developing, testing, and revising concepts and models that describe urban/regional concentration patterns. They will be useful to the understanding and definition of processes that take periods of hours to occur and hence involve considerable mixing and transport. Under stagnation conditions, a station located in the neighborhood scale may also experience peak concentration levels within the urban areas.

• *Urban Scale.*—Measurement in this scale will be used to estimate concentrations over large portions of an urban area with dimensions of several kilometers to 50 or more kilometers. Such measurements will be used for determining trends, and designing areawide control strategies. The urban scale stations would also be used to measure high concentrations downwind of the area having the highest precursor emissions.

• *Regional Scale.*—This scale of measurement will be used to typify concentrations over large portions of a metropolitan area and even larger areas with dimensions of as much as hundreds of kilometers. Such measurements will be useful for assessing the ozone that is transported into an urban area. Data from such stations may be useful in accounting for the ozone that cannot be reduced by control strategies in that urban area.

The location selection procedure continues after the spatial scale is selected based on the monitoring objectives. The appropriate network design procedures as found in reference 4, should be used to evaluate the adequacy of each existing O_3 monitor and must be used to relocate an existing station or to locate any new O_3 SLAMS stations. The first step in the siting procedure would be to collect the necessary background material, which may consist of maps, emission inventories for nonmethane hydrocarbons and oxides of nitrogen (NO_x), climatological data, and existing air quality data for ozone, nonmethane hydrocarbons, and NO_2/NO.

For locating a neighborhood scale station to measure typical city concentrations, a reasonably homogeneous geographical area near the center of the region should be selected which is also removed from the influence of major NO_x sources. For an urban scale station to measure the high concentration areas, the emission inventories should be used to define the extent of the area of important nonmethane hydrocarbons and NO_x emissions. The most frequent wind speed and direction for periods of important photochemical activity should be determined. Then the prospective monitoring area should be selected in a direction from the city that is most frequently downwind during periods of photochemical activity. The distance from the station to the upwind edge of the city should be about equal to the distance traveled by air moving for 5 to 7 hours at wind speeds prevailing during periods of photochemical activity. Prospective areas for locating O_3 monitors should always be outside the area of major NO_x.

In locating a neighborhood scale station which is to measure high concentrations, the same procedures used for the urban scale are followed except that the station should be located closer to the areas bordering on the center city or slightly further downwind in an area of high density population.

For regional scale background monitoring stations, the most frequent wind associated with important photochemical activity should be determined. The prospective monitoring area should be upwind for the most frequent direction and outside the area of city influence.

Where ozone levels have significant fluctuations throughout the year, consideration should be given to monitoring ozone only during the seasons when levels above the NAAQS occur as documented by previous data. Additional discussion on the procedures for siting ozone stations may be found in reference 4.

2.6 *Nitrogen Dioxide (NO_2) Design Criteria for SLAMS*

The typical spatial scales of representativeness associated with nitrogen dioxide monitoring based on monitoring objectives are middle, neighborhood, and urban. Since nitrogen dioxide is primarily formed in the atmosphere from the oxidation of NO, large volumes of air and mixing times usually reduce the importance of monitoring on small scale spatial variability especially for long averaging times. However, there may be some situations where NO_2 measurements would be made on the middle scale for both long- and short-term averages.

• *Middle Scale.*—Measurements on this scale would cover dimensions from about 100 meters to 0.5 kilometer. These measurements would characterize the public exposure to NO_2 in populated areas. Also monitors that are located closer to roadways than the minimum distances specified in Table 3 of Appendix E of this part, would be represented by measurements on this scale.

• *Neighborhood and Urban Scales.*—The same considerations as discussed in Section 2.5 for O_3 would also apply to NO_2.

After the spatial scale is selected based on the monitoring objectives, then the siting procedures as found in reference 4 should be used to evaluate the adequacy of each existing NO_2 station and must be used to relocate an existing station or to locate any new NO_2 SLAMS stations. The siting procedures begin with collecting the background material. This background information may include the characteristics of the area and its sources under study, climatological data to determine where concentration maxima are most likely to be found, and any existing monitoring data for NO_2.

For neighborhood or urban scales, the emphasis in site selection will be in finding those areas where long-term averages are expected to be the highest. Nevertheless, it should be expected that the maximum NO_2 concentrations will occur in approximately the same locations as the maximum total oxides of nitrogen concentrations. The best course would be to locate the station somewhat further downwind beyond the expected point of maximum total oxides of nitrogen to allow more time for the formation of NO_2. The dilution of the emissions further downwind from the source should be considered along with the need for reaction time for NO_2 formation in locating stations to measure peak concentration. If dispersion is favorable, maximum concentrations may occur closer to the emission sources than the locations predicted from oxidation of NO to NO_2 alone. This will occur downwind of sources based on winter wind direction or in areas where there are high ozone concentrations and high density NO_2 emissions such as on the fringe of the central business district or further downwind. The distance and direction downwind would be based on ozone season wind patterns.

Once the major emissions areas and wind patterns are known, areas of potential maximum NO_2 levels can be determined. Nitrogen dioxide concentrations are likely to decline rather rapidly outside the urban area. Therefore, the best location for measuring NO_2 concentrations will be in neighborhoods near the edge of the city.

3. Network Design for National Air Monitoring Stations (NAMS)

The NAMS must be stations selected from the SLAMS network with emphasis given to urban and multisource areas. Areas to be monitored must be selected based on urbanized population and pollutant concentration levels. Generally, a larger number of NAMS are needed in more polluted urban and multisource areas. The network design criteria discussed below reflect these concepts. However, it should be emphasized that deviations from the NAMS network design criteria may be necessary in a few cases. Thus, these design criteria are not a set of rigid rules but rather a guide for achieving a proper distribution of monitoring sites on a national scale.

The primary objective for NAMS is to monitor in the areas where the pollutant concentration and the population exposure are expected to be the highest consistent with the averaging time of the NAAQS. Accordingly, the NAMS fall into two categories:

Category (a): Stations located in the area(s) of expected maximum concentrations (generally neighborhood scale, except micro scale for CO and urban scale for O_3);

Category (b): Stations which combine poor air quality with a high population density but not necessarily located in an area of expected maximum concentrations (neighborhood scale, except urban scale for NO_2). Category (b) monitors would generally be representative of larger spatial scales than category (a) monitors.

For each urban area where NAMS are required, both categories of monitoring stations must be established. In the case of TSP and SO_2 if only one NAMS is needed, then category (a) must be used. The analysis and interpretation of data from NAMS should consider the distinction between these types of stations as appropriate.

The concept of NAMS is designed to provide data for national policy analyses/ trends and for reporting to the public on major metropolitan areas. It is not the intent to monitor in every area where the NAAQS are violated. On the other hand, the data from SLAMS should be used primarily for nonattainment decisions/ analyses in specific geographical areas. Since the NAMS are stations from the SLAMS network, station locating procedures for NAMS are part of the SLAMS network design process.

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3.3 *Carbon Monoxide (CO) Design Criteria for NAMS*

Information is needed on ambient CO levels in major urbanized areas where CO levels have been shown or inferred to be a significant concern. At the national level, EPA will not routinely require data from as many stations as are required for TSP, and perhaps, SO_2, since CO trend stations are principally needed to assess the overall air quality progress resulting from the emission controls required by the Federal motor vehicle control program (FMVCP).

Although State and local air programs may require extensive monitoring to document and measure the local impacts of CO emissions and emission controls, an adequate national perspective is possible with as few as two stations per major urban area. The two categories for which CO NAMS would be required are: (a) Peak concentration areas such as are found around major traffic arteries and near heavily traveled streets in downtown areas (micro scale); and (b) neighborhoods where concentration exposures are significant (neighborhood scale).

The peak concentration station (micro scale) is usually found near heavily traveled downtown streets (street canyons), but could be found along major arterials (corridors), either near intersections or at low elevations which are influenced by downslope drainage patterns under low inversion conditions. The peak concentration station should be located so that it is representative of several similar source configurations in the urban area, where the general population has access. Thus, it should reflect one of many potential peak situations which occur throughout the urban area. It is recognized that this does not measure air quality which represents large geographical areas. Thus, a second type of station on the neighborhood scale is necessary to provide data representative of the high concentration levels which exist over large geographical areas.

The neighborhood station (neighborhood scale) should be located in areas with a stable, high population density, projected continuity of neighborhood character, and high traffic density. The stations should be located where no major zoning changes, new highways, or new shopping centers are being considered. The station should be where a significant CO pollution problem exists, but not be under the influence of any one line source. Rather, it should be more representative of the overall effect of the sources in a significant portion of the urban area.

Because CO is generally associated with heavy traffic and population clusters, an urbanized area with a population greater than 500,000 is the principal critertion for identifying the urban areas for which pairs of NAMS for this pollutant will be required. The criterion is based on judgment that stations in urban areas with greater than 500,000 population would provide sufficient data for national analysis and national reporting to Congress and the public. Also, it has generally been shown that major CO problems are found in areas greater than 500,000 population.

3.4 *Ozone (O_3) Design Criteria for NAMS*

The criterion for selecting locations for ozone NAMS is any urbanized area having a population of more than 200,000. This population cut off is used since the sources of hydrocarbons are both mobile and stationary and are more diverse. Also, because of local and national control strategies and the complex chemical process of ozone formation and transport, more sampling stations than for CO are needed on a national scale to better understand the ozone problem. This selection criterion is based entirely on population and will include those relatively highly populated areas where most of the oxidant precursors originate.

Each urban area will generally require only two ozone NAMS. One station would be representative of maximum ozone concentrations (category (a), urban scale) under the wind transport conditions as discussed in section 2.5. The exact location should balance local factors affecting transport and buildup of peak O_3 levels with the need to represent population exposure. The second station (category (b), neighborhood scale), should be representative of high density population areas on the fringes of the central business district along the predominant summer/fall daytime wind direction. This latter station should measure peak O_3 levels under light and variable or stagnant wind conditions. Two ozone NAMS stations will be sufficient in most urban areas since spatial gradients for ozone generally are not as sharp as for other criteria pollutants.

3.5 *Nitrogen Dioxide (NO_2) Criteria for NAMS*

Nitrogen dioxide NAMS will be required in those areas of the country which have a population greater than 1,000,000. These areas will have two NO_2 NAMS. It is felt that stations in these major metropolitan areas would provide sufficient data for a national analysis of the data, and also because NO_2 problems occur in areas of greater than 1,000,000 population.

Within urban areas requiring NAMS, two permanent monitors are sufficient. The first station (category (a) neighborhood scale) would be to measure the photochemical production of NO_2 and would best be located in that part of the urban area where the emission density of NO_x is the highest. The second station (category (b) urban scale), would be to measure the NO_2 produced from the reaction of NO with O_3 and should be downwind of the area of peak NO_x emission areas.

4. Summary

Table 4 shows by pollutant, all of the spatial scales that are applicable for SLAMS and the required spatial scales for NAMS. There may also be some situations, as discussed later in Appendix E, where additional scales may be allowed for NAMS purposes.

Table 4—Summary of Spatial Scales for SLAMS and Required Scales for NAMS

Spatial scale	Scales applicable for SLAMS					Scales required for NAMS				
	TSP	SO_2	CO	O_3	NO_2	TSP	SO_2	CO	O_3	NO_2
Micro			✓					✓		
Middle	✓	✓	✓	✓	✓					
Neighborhood	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Urban	✓	✓		✓	✓				✓	✓
Regional	✓	✓		✓						

Figure 5-2. Particulate field data.

5. References

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[44 FR 27571, May 10, 1979; 44 FR 72592, Dec. 14, 1979]

APPENDIX E—PROBE SITING CRITERIA FOR AMBIENT AIR QUALITY MONITORING

1. Introduction
2. Total Suspended Particulates (TSP)
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1. INTRODUCTION

This appendix contains probe siting criteria to be applied to ambient air quality monitors or monitor probes after the general station location has been selected based on the monitoring objectives and spatial scale of representativeness as discussed in Appendix D of this part. Adherence to these siting criteria is necessary to ensure the uniform collection of compatible and comparable air quality data.

The probe siting criteria as discussed below must be followed to the maximum extent possible. It is recognized that there may be situations when the probe siting criteria cannot be followed. If the siting criteria cannot be met, this must be thoroughly documented with a written request for a waiver which describes how and why the siting criteria differs. This documentation should help to avoid later questions about the data. Conditions under which EPA would consider an application for waiver from these siting criteria are discussed in Section 8 of this appendix.

The spatial scales of representativeness used in this appendix, i.e., micro, middle, neighborhood, urban, and regional are defined and discussed in Appendix D of this part. The pollutant specific probe siting criteria generally apply to all spatial scales except where noted otherwise. Specific siting criteria that are prefaced with a "must" are defined as a requirement and exceptions must be approved through the waiver provisions. However, siting criteria that are prefaced with a "should" are defined as a goal to meet for consistency but are not a requirement.

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4. CARBON MONOXIDE (CO)

4.1 *Horizontal and Vertical Probe Placement*

Because of the importance of measuring population exposure to CO concentrations, air should be sampled at average breathing heights. However, practical factors require that the inlet probe be higher. The required height of the inlet probe for CO monitoring is therefore $3 \pm \frac{1}{2}$ meter for a microscale site, which is a compromise between representative breathing height and prevention of vandalism. The recommended 1 meter range of heights is also a compromise to some extent. For consistency and comparability, it would be desirable to have all inlets at exactly the same height, but practical considerations often prevent this. Some reasonable range must be specified and 1 meter provides adequate leeway to meet most requirements.

For the middle and neighborhood scale stations the vertical concentration gradients are not as great as for the microscale station. This is because the diffusion from roads is greater and the concentrations would represent larger areas than for the microscale. Therefore, the required height of the inlet probe is 3 to 15 meters for middle and neighborhood scale stations. The inlet probe must be located more than 1 meter in the vertical or horizontal direction from any supporting structure.

4.2 *Spacing from Obstructions*

Airflow must also be unrestricted in an arc of at least 270° around the inlet probe, and the predominant wind direction for the season of greatest pollutant concentration potential must be included in the 270° arc. If the probe is located on the side of a building, 180° clearance is required.

4.3 *Spacing from Roads*

Street canyon and traffic corridor stations (microscale) are intended to provide a measurement of the influence of the immediate source on the pollution exposure of the population. In order to provide some reasonable consistency and comparability in the air quality data from such stations, a minimum distance of 2 meters and a maximum distance of 10 meters from the edge of the nearest traffic lane must be maintained for these CO monitor inlet probes. This should give consistency to the data, yet still allow flexibility of finding suitable locations.

Street canyon/corridor (microscale) inlet probes must be located at least 10 meters from an intersection and preferably at a midblock location. Midblock locations are preferable to intersection locations because intersections represent a much smaller portion of downtown space than do the streets between them. Pedestrian exposure is probably also greater in street canyon/corridors than at intersections. Finally, the practical difficulty of positioning sampling inlets is less at midblock locations than at the intersection.

In determining the minimum separation between a neighborhood scale monitoring station and a specific line source, the presumption is made that measurements should not be unduly influenced by any one roadway. Computations were made to determine the separation distances, and table 1 provides the required minimum separation distance between roadways and neighborhood scale stations. Sampling stations that are located closer to roads than this criterion allows should not be classified as a neighborhood scale, since the measurements from such a station would closely represent the middle scale. Therefore, stations not meeting this criterion should be classified as middle scale. In some cases, such a monitoring station would be acceptable for SLAMS purposes, but not NAMS since no middle scale NAMS stations are required. Additional information on CO probe siting may be found in reference 12.

TABLE 1—*Minimum separation distance between neighborhood scale CO stations and roadways (edge of nearest traffic lane)*

Roadway average daily traffic, vehicles per day	Minimum separation distance between stations and roadways, meters
10,000	10*
15,000	25
20,000	45
30,000	80
40,000	115
50,000	135
60,000	150

* Distances should be interpolated based on traffic flow.

5. OZONE (O_3)

5.1 *Vertical and Horizontal Probe Placement*

The inlet probe for ozone monitors should be as close as possible to the breathing zone. The complicating factors discussed previously, however, require that the probe be elevated. The height of the inlet probe must be located 3 to 15 meters above ground level. The probe must also be located more than 1 meter vertically or horizontally away from any supporting structure.

5.2 *Spacing from Obstructions*

The probe must be located away from obstacles and buildings such that the distance between the obstacles and the inlet probe is at least twice the height that the obstacle protrudes above the sampler. The probe should also be located at least 20 meters from trees. Since the scavenging effect of trees is greater for ozone than for TSP, SO_2, CO, and NO_2, strong consideration should be used in locating the inlet probe to avoid this effect. Airflow must be unrestricted in an arc of at least 270° around the inlet probe, and the predominant wind direction for the season of greatest pollutant concentration potential must be included in the 270° arc. If the probe is located on the side of a building, 180° clearance is required.

5.3 *Spacing from Roads*

It is important in the probe siting process to minimize destructive interferences from sources of nitric oxide (NO) since NO readily reacts with ozone. Table 2 provides the required minimum separation distances between roadways and ozone monitoring stations. These distances were based on recal-

culations using the methodology in reference 13 and validated using more recent ambient data collected near a major roadway. Sampling stations that are located closer to roads than this criterion allows should not be classified as neighborhood or urban scale, since the measurements from such stations would more closely represent the middle scale. Accordingly, such stations should be classified as middle scale. In some cases, a middle scale station would be acceptable for SLAMS purposes, but not for NAMS since no middle scale NAMS are required. The minimum separation distance must also be maintained between an ozone station and other similar volumes of automotive traffic, such as parking lots. Additional information on ozone probe siting criteria may be found in reference 13.

TABLE 2—*Minimum separation distance between neighborhood and urban scale ozone stations and roadways (edge of nearest traffic lane)*

Roadway average daily traffic, vehicles per day	Minimum separation distance between roadways and stations, meters
<10,000	>10*
15,000	20
20,000	30
40,000	50
70,000	100
<110,000	>250

* Distances should be interpolated based on traffic flow

6. NITROGEN DIOXIDE (NO_2)

6.1 *Vertical and Horizontal Probe Placement*

The height of the NO_2 inlet probe must be 3 to 15 meters above the ground. This is a compromise between measuring in the breathing zone and avoidance of vandalism, finding suitable sites, etc. For NO_2, the height does not appear to be a critical factor since the NO_2 should be fairly well mixed and somewhat uniform in the vertical direction. The distance of the inlet probe from any supporting structure must be greater than 1 meter vertically or horizontally.

6.2 *Spacing from Obstructions*

Buildings, trees, and other obstacles may possibly scavenge NO_2. In order to avoid this kind of interference, the station must be located well away from such obstacles so that the distance between obstacles and the inlet probe is at least twice the height that the obstacle protrudes above the probe. Sampling stations that are located closer to obstacles than this criterion allows should not be classified in the neighborhood or urban scales, since the measurements from such stations would more closely represent the middle scale. Such stations should be classified as middle scale. For similar reasons, a probe inlet along a vertical wall is undesirable because air moving along that wall may be subject to possible removal mechanisms. The inlet probe should also be at least 20 meters from trees. There must be unrestricted airflow in an arc of at least 270° around the inlet probe, and the predominant wind direction for the season of greatest pollutant concentration potential must be included in the 270° arc. If the probe is located on the side of the building, 180° clearance is required.

6.3 *Spacing from Roads*

It is important that the monitoring probe be removed from oxides of nitrogen sources to avoid measurements being dominated by any one source and to allow time for conversion (reactions) of NO emissions to NO_2. Further, the effects of roadway sources must be minimized by using separation distances for neighborhood and urban scale stations found in Table 3. These distances were based on recalculations using the methodology in reference 13 and validated using more recent ambient data collected near a major roadway. The minimum separation distance must also be maintained between an NO_2 probe and any other similar volume of automotive traffic such as parking lots. Sampling stations that are located closer to roads than this criterion allows should not generally be classified as neighborhood or urban scales, since the measurements from such stations would more closely represent middle scale stations. Such stations should generally be classified as middle scale. In some cases, such a monitoring station would be acceptable for SLAMS purposes, but not for NAMS since no middle scale NAMS are acceptable. Additional information on NO_2 probe siting criteria may be found in reference 13.

TABLE 3—*Minimum separation distance between neighborhood and urban scale NO_2 stations and roadways (edge of nearest traffic lane)*

Roadway average daily traffic, vehicles per day	Minimum separation distance between roadways and station, meters
<10,000	>10*
15,000	20
20,000	30
40,000	50
70,000	100
<110,000	>250

* Distances should be interpolated based on traffic flow

7. PROBE MATERIAL AND POLLUTANT SAMPLE RESIDENCE TIME

For the reactive gases, SO_2, NO_2, and O_3, special probe material must be used. Studies [14-18] have been conducted to determine the suitability of materials such as polypropylene, polyethylene, polyvinylchloride, tygon, aluminum, brass, stainless steel, copper, pyrex glass and teflon for use as intake sampling lines. Of the above materials, only pyrex glass and teflon have been found to be acceptable for use as intake sampling lines for all the reactive gaseous pollutants. Furthermore, EPA[19] has specified borosilicate glass or FEP teflon as the only acceptable probe materials for delivering test atmospheres in the determination of reference or equivalent methods. Therefore, borosilicate glass, FEP teflon, or their equivalent must be used for existing and new NAMS or SLAMS.

No matter how nonreactive the sampling probe material is initially, after a period of use reactive particulate matter is deposited on the probe walls. Therefore, the time it takes the gas to transfer from the probe inlet to the sampling device is also critical. Ozone in the presence of NO will show significant losses even in the most inert probe material when the residence time exceeds 20 seconds.[20] Other studies[21-22] indicate that a 10-second or less residence time is easily achievable. Therefore, sampling probes for reactive gas monitors at SLAMS or NAMS must have a sample residence time less than 20 seconds.

8. WAIVER PROVISIONS

It is believed that most sampling probes or monitors can be located so that they meet the requirements of this appendix. New stations with rare exceptions, can be located within the limits of this appendix. However, some existing stations may not meet these requirements and yet still produce useful data for some purposes. EPA will consider a written request from the State Agency to waive one or more siting criteria for some monitoring stations providing that the State can adequately demonstrate the need (purpose) for monitoring or establishing a monitoring station at that location. For establishing a new station, a waiver may be granted only if both of the following criteria are met:

- The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.
- The monitor or probe cannot reasonably be located so as to meet the siting criteria because of physical constraints (e.g., inability to locate the required type of station the necessary distance from roadways or obstructions).

However, for an existing station, a waiver may be granted if either of the above criteria are met.

Cost benefits, historical trends, and other factors may be used to add support to the above, however, they in themselves, will not be acceptable reasons for granting a waiver. Written requests for waivers must be submitted to the Regional Administrator. For those SLAMS also designated as NAMS, the request will be forwarded to the Administrator.

9. DISCUSSION AND SUMMARY

Table 4 presents a summary of the requirements for probe siting criteria with respect to distances and heights. It is apparent from Table 4 that different elevation distances above the ground are shown for the various pollutants. The discussion in the text for each of the pollutants described reasons for elevating the monitor or probe. The differences in the specified range of heights are based on the vertical concentration gradients. For CO, the gradients in the vertical direction are very large for the microscale, so a small range of heights has been specified. For SO_2, NO_2, TSP, and O_3 (except near roadways), the vertical gradients are smaller and thus a larger range of heights can be used. The upper limit of 15 meters was specified for consistency between pollutants and to allow the use of a single manifold for monitoring more than one pollutant.

[14-18] See References at end of this Appendix.

[19] See References at end of this Appendix.

[20] See References at end of this Appendix.

[21-22] See References at end of this Appendix.

Table 4. Summary of probe siting criteria

Pollutant	Scale	Height above ground, meters	Distance from supporting structure, meters		Other spacing criteria
			Vertical	Horizontal[a]	
TSP	All	2 - 15	--	> 2	1. Should be >20 meters from trees. 2. Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler.[b] 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby.[c] 5. Must have minimum spacing from roads. This varies with height of monitor and spatial scale (see Figure 1).
SO_2	All	3 - 15	> 1	> 1	1. Should be >20 meters from trees. 2. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet probe.[b] 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. No furnace or incineration flues should be nearby.[c]
CO	Micro	3 ± 1/2	> 1	> 1	1. Must be >10 meters from intersection and should be at a midblock location. 2. Must be 2-10 meters from edge of nearest traffic lane. 3. Must have unrestricted airflow 180° around the inlet probe.
	Middle Neighborhood	3 - 15	> 1	> 1	1. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 2. Spacing from roads varies with traffic (see Table 1).
O_3	All	3 - 15	> 1	> 1	1. Should be >20 meters from trees. 2. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. Spacing from roads varies with traffic (see Table 2).
NO_2	All	3 - 15	> 1	> 1	1. Should be >20 meters from trees. 2. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet probe.[b] 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. Spacing from roads varies with traffic (see Table 3).

[a] When probe is located on rooftop, this separation distance is in reference to walls, parapets, or penthouses located on the roof.

[b] Sites not meeting this criterion would be classified as middle scale (see text).

[c] Distance is dependent on height of furnace or incineration flue, type of fuel or waste burned, and quality of fuel (sulfur and ash content). This is to avoid undue influences from minor pollutant sources.

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[44 FR 27571, May 10, 1979; 44 FR 72592, Dec. 14, 1979]

Excerpts of Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD) EPA 450/4-80-012

3. *NETWORK DESIGN AND PROBE SITING CRITERIA*

A source subject to PSD should only proceed with designing a PSD monitoring network only after going through the procedure in Appendix A to determine if monitoring data will be required. To fulfill that requirement, a source may use representative air quality data which was discussed in *section 2.4* or monitor This section presents guidance to be used if an applicant decides to monitor in lieu of using representative air quality data.

3.1 Network Design

The design of a network for criteria and noncriteria pollutants will be affected by many factors, such as topography, climatology, population, and existing emission sources. Therefore, the ultimate design of a network for PSD purposes must be decided on a case-by-case basis by the permit granting authority. *Section 3.2* discusses the number and location of monitors for a PSD network. Additional guidance on the general siting of the monitors may be found in references 6-9 which discuss highest concentration stations, isolated point sources, effects of topography, etc. Probe siting criteria for the monitors are discussed in *section 3.3*. The guidelines presented here should be followed to the maximum extent practical in developing the final PSD monitoring network.

3.2 Number and Location of Monitors

The number and location of monitoring sites will be determined on a case-by-case basis by the source owner or operator and reviewed by the permit granting authority. Consideration should be given to the effects of existing sources, terrain, meteorological conditions, existence of fugitive or reentrained dusts, averaging time for the pollutant, etc. Generally, the number of monitors will be higher where the expected spatial variability of the pollutant in the area(s) of study is higher.

3.2.1 Preconstruction Phase

Information obtained in the ambient air quality analysis in Appendix A will be used to assist in determining the number and location of monitors for the preconstruction phase. The air quality levels before construction were determined by modeling or in conjunction with monitoring data. The screening procedure (or more refined model) estimates were determined in Appendix A.

The source should first use the screening procedure or refined model estimates to determine the general location(s) for the maximum air quality concentrations from the proposed source or modification. Secondly, the source should determine by modeling techniques the general location(s) for the maximum air quality levels from existing sources. Thirdly, the modeled pollutant contribution of the proposed source or modification should be analyzed in conjunction with the modeled results for existing sources to determine the maximum impact area. Application of these models must be consistent with EPA's *"Guideline on Air Quality Models"* [34]. This would provide sufficient information for the applicant to place a monitor at (a) the location(s) of the maximum concentration increase expected from the proposed source or modification, (b) the location(s) of the maximum air pollutant concentration from existing sources of emissions, and (c) the location(s) of the maximum impact area, i.e., where the maximum pollutant concentration would hypothetically occur based on the combination effect of existing sources and the proposed new source or modification. In some cases, two or more of these locations may coincide and thereby reduce the number of monitoring stations.

Monitoring should then be conducted in or as close to these areas as possible (also see discussion in *section 3.2.3*). Generally, one to four sites would cover most situations in multisource settings. For remote areas in which the permit granting authority has determined that there are no significant existing sources, a minimum number of monitors would be needed, i.e., one or probably two at the most. For new sources, in these remote areas, as opposed to modifications, some concessions will be made on the locations of these monitors. Since the maximum impact from these new sources would be in remote areas, the monitors may be located, based on convenience or accessibility, near the proposed new source rather than near the maximum impact area since the existing air quality would be essentially the same in both areas. However, the maximum impact area is still the preferred location.

★ ★ ★ ★ ★ ★ ★ For fugitive hydrocarbon emissions, the applicant should locate a monitor downwind of the source at the point of expected maximum ozone concentration contribution. This location will be found downwind during conditions that are most conducive to ozone formation, such as temperature above 20°C (68°F) and high solar radiation intensity. For hydrocarbon emissions from a stack, the applicant should also locate the monitor in the area of expected maximum ozone concentration. For both fugitive and stack emissions, the selection of areas of highest ozone concentrations will require wind speed and direction data for periods of photochemical activity. Monitoring for ozone will only be necessary during the seasons when high concentrations occur.

Since ozone is the result of a complex photochemical process, the rate of movement across an area of the air mass containing precursors should be considered. The distance from the proposed source to the monitor for an urban situation should be about equal to the distance traveled by the air moving for 5 to 7 hours at wind speeds occurring during periods of photochemical activity. In an urban situation, ozone formation over the initial few hours may be supressed by nitric oxide (NO) emissions. For a point source, the NO interactions may be minimal, and the travel time to the expected maximum ozone concentration may be 3

to 4 hours downwind. In general, the downwind distance for the maximum ozone site should generally not be more than 15 to 20 miles from the source because a lower wind speed (2-3 miles per hour) with less dilution would be a more critical case. Additionally, the frequency that the wind would blow from the source over the site diminishes with increasing distances.

3.2.2 Postconstruction Phase

As discussed above for preconstruction monitoring, appropriate dispersion modeling techniques are used to estimate the location of the air quality impact of the new source or modification. Monitors should then be placed at (a) the expected area of the maximum concentration from the new source or modification, and (b) the maximum impact area(s), i.e., where the maximum pollutant concentration will occur based on the combined effect of existing sources and the new source or modification. It should be noted that locations for these monitors may be different from those sites for the preconstruction phase due to other new sources or modifications in the area since the preconstruction monitoring.

Generally, two to three sites would be sufficient for most situations in multisource areas. In remote areas where there are no significant existing sources, one or two sites would be sufficient. These sites would be placed at the locations indicated from the model results. The same concerns discussed in *section 3.2.1* regarding industrial process fugitive particulate emissions, fugitive hydrocarbon emissions, and ozone monitoring would also be applicable for the postconstruction phase.

3.2.3 Special Concerns for Location of Monitors

For the preconstruction and postconstruction phases, modeling is used to determine the general area where monitors would be located. Some of the modeled locations may be within the confines of the source's boundary. However, monitors should be placed in those locations satisfying the definition of ambient air. Ambient air is defined in 40 CFR 50.1(e) as "that portion of the atmosphere, external to buildings, to which the general public has access." Therefore, if the modeled locations are within an area excluded from ambient air, the monitors should be located downwind at the boundary of that area.

In some cases, it is simply not practical to place monitors at the indicated modeled locations. Some examples may include over open bodies of water, on rivers, swamps, cliffs, etc. The source and the permit granting authority should determine on a case-by-case basis alternative locations.

3.3 Probe Siting Criteria

The desire for comparability in monitoring data requires adherence to some consistent set of guidelines. Therefore, the probe siting criteria discussed below must be followed to the maximum extent possible to ensure uniform collection of air quality data that are comparable and compatible.

Before proceeding with the discussion of pollutant specific probe siting criteria, it is important to expand on the discussion in *section 3.2* of the location of monitors. In particular, reference is made to two monitoring objectives.

- Case 1: Locating monitors to determine the maximum concentration from the proposed source and/or existing sources.

- Case 2: Locating monitors to determine where the combined impact of the proposed source and existing sources would be expected to exhibit the highest concentrations.

For Case 1, the driving force for locating the siting area of the monitor as well as the specific location of the probe or instrument shelter is the objective of measuring the maximum impact from the proposed source. Two Case 1 examples are given. Consider the first situation in which a proposed source would be emitting pollutants from an elevated stack. Under these circumstances, sufficient mixing generally occurs during the transport of the emissions from the stack to the ground resulting in small vertical gradients near ground level, thus, a wide range of probe heights, 3-15 meters for gases and 2-15 meters for particulates is acceptable. For the same objective (maximum concentration from proposed source), consider the second example in which pollutants would be emitted from a ground level source. In this case, the concentration gradient near the ground can be large, thereby requiring a much tighter range of acceptable probe heights. For ground level sources emitting pollutants with steep vertical concentration gradients, efforts should be made to locate the inlet probe for gaseous pollutant monitors as close to 3 meters (a reasonable practical representation of the breathing zone) as possible and for particulate monitors using the hi-volume sampler 2 to 7 meters above ground level. The rationale for the 3 meters is that for gaseous pollutant measurements, the inlet probe can be adjusted for various heights even though the monitor is located in a building or trailer. Conversely, the 2-3 meter height for the hi-volume sampler placement is not practical in certain areas. The 7 meter height allows for placement on a one story building and is reasonably close to representing the breathing zone.

Turn now to the second monitoring objective, Case 2, which is locating monitors to determine the maximum impact area taking into consideration the proposed source as well as existing sources. The critical element to keep in mind in locating a monitor to satisfy this objective is that the intent is to maximize the combined effect. Thus, in one circumstance, the existing source might contribute the largest impact. The importance of the above discussion to the topic of probe siting criteria is that in attempting to locate a monitor to achieve this objective, the placement of the probe or instrument shelter can vary depending upon which source is the predominant influence on the maximum impact area. As an extreme example, consider the situation where a proposed elevated source would emit CO into an urban area and have maximum combined CO impact coincident to an area adjacent to a heavily traveled traffic corridor. It is known that traffic along corridors emit CO in fairly steep concentration gradients so the placement of the probe to measure the areas of highest CO concentration can vary significantly with probe height as well as distance from the corridor.

In this example, the traffic corridor has the major influence on the combined impact and therefore controls the probe placement. As noted in the CO probe siting criteria in *section 3.3.3* as well as Appendix E of the May 10, 1979 Federal Register promulgation of the Ambient Air Monitoring Regulations [10], the required probe height in such microscale cases is given as 3 ± 1/2 meters while the distance of the probe from the roadway would be between 2 and 10 meters.

As another example, consider the case where the same proposed CO source would emit CO at elevated heights and have a combined maximum CO impact in an urban area that is only slightly affected by CO emissions from a roadway. The combined impact area in this case is far enough away from the two sources to provide adequate mixing and only small vertical concentration gradients at the impact area. In this case, the acceptable probe height would be in the range of 3-15 meters.

It is recognized that there may be other situations occurring which prevent the probe siting criteria from being followed. If so, the differences must be thoroughly documented. This documentation should minimize future questions about the data.

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Review Exercise

Now that you've completed the assignment for Section 6, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. Which of the following is(are) a basic monitoring objective(s) of a SLAMS network?
   a. determination of the highest air pollutant concentrations that are expected to occur in the area covered by the network
   b. determination of representative air pollutant concentrations in areas of high population density
   c. determination of the impact on air pollution levels of significant sources or source categories
   d. determination of general background air pollutant concentration levels
   e. all of the above

2. True or False? The number of monitoring stations required for a SLAMS network is specified in Appendix D of 40 CFR 58.

Match each of the following SLAMS monitoring objectives with its appropriate type of monitoring site. (Questions 3-6)

3. determination of the highest air pollutant concentrations that are expected to occur in the area covered by the network	a. neighborhood and regional
4. determination of representative air pollutant concentrations in areas of high population density	b. neighborhood and urban
5. determination of the impact on air pollution levels of significant sources or source categories	c. micro-, middle, and neighborhood
6. determination of general background air pollutant concentration levels	d. micro-, middle, neighborhood, and urban

7. True or False? The primary monitoring objective of NAMS is to monitor in areas where pollutant concentrations and population exposure are expected to be the highest consistent with the averaging times of the National Ambient Air Quality Standards.

8. Which of the following is(are) a NAMS category(ies)?
   a. monitoring stations located in areas of expected maximum pollutant concentrations
   b. monitoring stations located in areas of combined poor air quality and high population density
   c. both a and b, above
   d. none of the above

9. Which of the following is(are) a primary use(s) of NAMS data?
   a. analyzing national policy and trends
   b. reporting air quality information concerning major metropolitan areas to the public
   c. both a and b, above
   d. none of the above

For each of questions 10-12, match the specified pollutant with its appropriate SLAMS spatial scales of representativeness.

10. CO	a. micro-, middle, neighborhood
11. O_3	b. middle, neighborhood, urban, regional
12. NO_2	c. middle, neighborhood, urban

13. In general, urbanized areas having populations greater than ____(?)____ are required to have at least ____(?)____ CO NAMS.
   a. 200,000; 1
   b. 500,000; 2
   c. 500,000; 3
   d. 1,000,000; 2

14. In general, urbanized areas having populations greater than ____(?)____ are required to have at least ____(?)____ O_3 NAMS.
   a. 200,000; 2
   b. 500,000; 2
   c. 500,000; 3
   d. 1,000,000; 2

15. Urbanized areas having populations greater than ____(?)____ are required to have ____(?)____ NO_2 NAMS.
   a. 200,000; 2
   b. 500,000; 2
   c. 500,000; 3
   d. 1,000,000; 2

For each of questions 16-18, match the specified pollutant with its required NAMS spatial scales of representativeness.

16. CO	a. micro-, neighborhood
17. O_3	b. neighborhood, urban
18. NO_2	

For each of questions 19-26, select the CO SLAMS/NAMS siting criterion specified in Appendix E of 40 CFR 58 for the specified parameter.

19. For microscale sites, height range of CO monitor's inlet probe above ground level (meters):
    a. 1 to 3
    b. 2.5 to 3.5
    c. 2 to 10
    4. 3 to 15
20. Minimum horizontal separation distance of CO monitor's inlet probe from its supporting structure (meters):
    a. 0.5
    b. 1
    c. 2
    d. 5
21. Minimum vertical separation distance of CO monitor's inlet probe from its supporting structure (meters):
    a. 0.5
    b. 1
    c. 2
    d. 5
22. Arc of unrestricted air flow for CO monitor inlet probes which are ***not*** located on sides of buildings (degrees):
    a. 90
    b. 180
    c. 270
    d. 360
23. Arc of unrestricted air flow for CO monitor inlet probes which ***are*** located on sides of buildings (degrees):
    a. 45
    b. 90
    c. 135
    d. 180
24. For middle scale and neighborhood scale sites, height range of CO monitor's inlet probe above ground level (meters):
    a. 2 to 10
    b. 3 to 10
    c. 2 to 15
    d. 3 to 15
25. Separation distance range of a microscale CO monitor's inlet probe from the edge of the nearest traffic lane (meters):
    a. 1 to 5
    b. 1 to 10
    c. 2 to 5
    d. 2 to 10

26. Minimum separation distance of a microscale CO monitor's inlet probe from the nearest traffic intersection (meters):
    a. 1
    b. 5
    c. 10
    d. 20

27. The probe inlet for a neighborhood scale CO SLAMS/NAMS monitor must be located at least ____(?)____ meters from a roadway having an average daily traffic volume less than 10,000.
    a. 5
    b. 10
    c. 15
    d. 20

28. The minimum separation distance between the inlet probe of a neighborhood scale CO SLAMS/NAMS monitor and a roadway having an average daily traffic volume greater than 60,000 must be ____(?)____ meters.
    a. 20
    b. 50
    c. 150
    d. 250

For each of questions 29-34, select the O_3/NO_2 SLAMS/NAMS siting criterion specified in Appendix E of 40 CFR 58 for the specified parameter.

29. Height range of O_3/NO_2 monitor's inlet probe above ground level (meters):
    a. 2 to 10
    b. 3 to 10
    c. 2 to 15
    d. 3 to 15
30. Minimum horizontal separation distance of O_3/NO_2 monitor's inlet probe from its supporting structure (meters):
    a. 0.5
    b. 1
    c. 2
    d. 5
31. Minimum vertical separation distance of O_3/NO_2 monitor's inlet probe from its supporting structure (meters):
    a. 0.5
    b. 1
    c. 2
    d. 5
32. O_3/NO_2 monitor inlet probe's minimum separation distance from trees (meters):
    a. 2
    b. 5
    c. 10
    d. 20

33. Arc of unrestricted air flow for O_3/NO_2 monitor inlet probes which are ***not*** located on sides of buildings (degrees):
    a. 90
    b. 180
    c. 270
    d. 360
34. Arc of unrestricted air flow for O_3/NO_2 monitor inlet probes which ***are*** located on sides of buildings (degrees):
    a. 45
    b. 90
    c. 135
    d. 180

35. The probe inlet for a neighborhood/urban scale O_3 or NO_2 SLAMS/NAMS monitor must be located at least ____(?)____ meters from a roadway having an average daily traffic volume less than 10,000.
    a. 5
    b. 10
    c. 15
    d. 20

36. The minimum separation distance between the inlet probe of a neighborhood/urban scale O_3 or NO_2 SLAMS/NAMS monitor and a roadway having an average daily traffic volume greater than 110,000 must be ____(?)____ meters.
    a. 20
    b. 50
    c. 150
    d. 250

37. True or False? Minimum roadway separation distances for neighborhood/urban O_3 and NO_2 SLAMS/NAMS must also be maintained between neighborhood/urban O_3 and NO_2 SLAMS/NAMS and other similar volumes of automotive traffic, such as parking lots.

38. True or False? Neighborhood/urban CO, O_3, and NO_2 SLAMS/NAMS that do not meet the minimum roadway separation requirements should be classified as middle scale.

39. Appendix E of 40 CFR 58 requires that the inlet probe of an O_3 or NO_2 monitor be located away from obstacles such as buildings, so that the distance between an obstacle and the probe is at least ____(?)____ times the height that the obstacle protrudes above the probe.
    a. 2
    b. 4
    c. 5
    d. 10

40. True or False? Appendix E of 40 CFR 58 requires that intake sampling lines for existing and new O_3 and NO_2 SLAMS/NAMS monitors be constructed of borosilicate glass, FEP teflon, or their equivalent.

41. Appendix E of 40 CFR 58 requires that sampling probes at O_3 and NO_2 SLAMS/NAMS have a sample residence time of less than ____(?)____ seconds.
    a. 5
    b. 10
    c. 15
    d. 20

42. True or False? If the probe siting criteria specified in Appendix E of 40 CFR 58 cannot be met, a written request for a waiver must be submitted to EPA.

43. In establishing a ***new*** SLAMS/NAMS, which of the following conditions must be met in order to obtain a waiver from the monitor siting criteria specified in Appendix E of 40 CFR 58?
    a. The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.
    b. The monitor or probe cannot reasonably be located so as to meet the siting criteria.
    c. both a and b, above
    d. either a or b, above

44. For an ***existing*** monitoring station, which of the following conditions must be met in order to obtain a waiver from the monitor siting criteria specified in Appendix E of 40 CFR 58?
    a. The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.
    b. The monitor or probe cannot reasonably be located so as to meet the siting criteria.
    c. both a and b, above
    d. either a or b, above

45. For preconstruction PSD ambient air quality monitoring, monitors should be sited at which of the following locations?
    a. area(s) of the maximum air pollutant concentration increase expected from the proposed source or modification
    b. area(s) of the maximum air pollutant concentration resulting from existing sources of emissions
    c. area(s) where the maximum air pollutant concentration would hypothetically occur based on the combined effect of existing sources and the proposed new source or modification
    d. all of the above

46. For postconstruction PSD ambient air quality monitoring, monitors should be sited at which of the following locations?
    a. expected area of the maximum air pollutant concentration resulting from the new source or modification
    b. area(s) where the maximum pollutant concentration will occur based on the combined effect of existing sources and the new source or modification
    c. area(s) of the maximum air pollutant concentration resulting from existing sources of emissions
    d. all of the above
    e. a and b, above

47. For preconstruction PSD ambient air quality monitoring in a multisource setting, ____(?)____ to ____(?)____ monitoring sites will be sufficient for most situations.
    a. 1, 3
    b. 1, 4
    c. 2, 5
    d. 2, 6

48. For postconstruction PSD ambient air quality monitoring in a multisource setting, ____(?)____ or ____(?)____ monitoring sites will be sufficient for most situations.
    a. 1, 2
    b. 2, 3
    c. 3, 4
    d. 4, 5

49. For preconstruction or postconstruction PSD ambient air quality monitoring in a remote area, ____(?)____ or ____(?)____ monitoring sites will be sufficient for most situations.
    a. 1, 2
    b. 2, 3
    c. 3, 4
    d. 4, 5

50. True or False? ***Ambient air*** is defined in 40 CFR 50 as "that portion of the atmosphere, external to buildings, to which the general public has access".

51. True or False? PSD ambient air quality monitors should be placed in locations which satisfy the definition of ambient air.

52. For PSD purposes, when monitoring gaseous concentrations resulting from a ground-level source, the monitor's inlet probe should be located as close as possible to ____(?)____ meter(s) above ground level.

a. 1
b. 3
c. 10
d. 15

Review Exercise Answers

		Page(s) of Section 6 of Guidebook
1.	e	4
2.	False	4
3.	d	4
4.	b	4
5.	c	4
6.	a	4
7.	True	6
8.	c	6-7
9.	c	7
10.	a	5, 7
11.	b	6-7
12.	c	6-7
13.	b	7
14.	a	7
15.	d	7
16.	a	7
17.	b	7
18.	b	7
19.	b	8
20.	b	8
21.	b	8
22.	c	8
23.	d	8
24.	d	8
25.	d	8
26.	c	8
27.	b	8
28.	c	8
29.	d	8-9
30.	b	8-9
31.	b	8-9
32.	d	8-9
33.	c	8-9
34.	d	8-9
35.	b	9
36.	d	9
37.	True	9
38.	True	8-9
39.	a	8-9
40.	True	9

	Page(s) of Section 6 of Guidebook
41. d	9
42. True	8
43. c	9
44. d	9
45. d	13
46. e	14
47. b	13
48. b	14
49. a	13-14
50. True	14
51. True	14
52. b	15

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16. ABSTRACT

This Guidebook was developed for use in the Air Pollution Training Institute's Correspondence Course 437, "Site Selection for the Monitoring of CO and Photochemical Pollutants in Ambient Air." It contains reading assignments and review exercises covering the following topics:

- Use of Monitoring Data and Related Monitor-Siting Objectives
- Special Considerations Associated with the Monitoring of CO, NMHC, NO, NO_2, and O_3
- Procedures and Criteria for Site Selection for CO, NMHC, NO, NO_2 and O_3 Monitors
- Rationale for CO, NMHC, NO, NO_2, and O_3 Monitor-Siting Criteria
- Network Design and Probe-Siting Criteria for CO, NO_2, and O_3 SLAMS, NAMS, and PSD Monitoring Stations

The Guidebook is designed for use in conjunction with "Selecting Sites for Carbon Monoxide Monitoring" (EPA 450/3-75-077) and "Site Selection for the Monitoring of Photochemical Air Pollutants" (EPA 450/3-78-013).

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