EPA United States Environmental Protection Agency

2007 National Monitoring Programs (UATMP and NATTS) Volume I: Main Content

December 2008
Final Report

EPA-454/R-08-008a
December 2008

2007 National Monitoring Programs (UATMP and NATTS) Volume I: Main Content

By:
Eastern Research Group, Inc.
Research Triangle Park, North Carolina

Prepared for:
Margaret Dougherty and Mike Jones
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Contract No. 68-D-03-049
Delivery Orders 14 & 15

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emissions, Monitoring and Analysis Division
Research Triangle Park, NC 27711

2007 National Monitoring Programs (UATMP and NATTS)

Final Report
EPA Contract No. 68-D-03-049
Delivery Order 14
Delivery Order 15

Prepared for:

Margaret Dougherty and Mike Jones
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Prepared by:

Eastern Research Group, Inc.
1600 Perimeter Park
Morrisville, NC 27560

December 2008

DISCLAIMER

Through its Office of Air Quality Planning and Standards, the U.S. Environmental Protection Agency funded and managed the research described in this report under EPA Contract No. 68-D-03-049 to Eastern Research Group, Inc. This report has been subjected to the Agency=s peer and administrative review and has been approved for publication as an EPA document. Mention of trade names or commercial products in this report does not constitute endorsement or recommendation for their use.

TABLE OF CONTENTS

Page

List of Figures xxii
List of Tables xxx
List of Acronyms xlv
Abstract xlvii

1.0 Introduction 1-1

1.1 Background 1-1

1.2 The Report 1-2

2.0 The 2007 NATTS/UATMP Network 2-1

2.1 Monitoring Locations 2-1

2.2 Analytical Methods Used and Pollutants Targeted for Monitoring 2-8
    2.2.1 VOC and SNMOC Concurrent Sampling and Analytical Methods 2-14
    2.2.2 Carbonyl Sampling and Analytical Method 2-17
    2.2.3 Semivolatile Sampling and Analytical Method 2-18
    2.2.4 Metals Sampling and Analytical Method 2-19
    2.2.5 Hexavalent Chromium Sampling and Analytical Method 2-20

2.3 Sample Collection Schedules 2-20

2.4 Completeness 2-26

3.0 Summary of the 2007 NATTS/UATMP Data Treatment and Methods 3-1

3.1 Data Treatment 3-1

3.2 Approach to Risk Screening and Pollutants of Interest 3-2

3.3 Risk Screening Evaluation Using Minimum Risk Levels 3-4

3.4 Pearson Correlations 3-5

3.5 Additional Program-Level Analyses of the 2007 NATTS/UATMP Dataset 3-6
    3.5.1 The Impact of Mobile Source Emissions on Spatial Variations 3-6
    3.5.2 Variability Analyses 3-7
    3.5.3 Greenhouse Gas Assessment 3-8

3.6 Additional Site-Specific Analyses 3-9
    3.6.1 Emission Tracer Analysis 3-9

TABLE OF CONTENTS (Continued)

Page

3.6.2 Back Trajectory Analysis 3-9
3.6.3 Wind Rose Analysis 3-10
3.6.4 Site Trends Analysis 3-10
3.6.5 Cancer and Noncancer Surrogate Risk Approximations 3-12
3.6.6 Risk-Based Emissions Assessment 3-14

4.0 Summary of the 2007 NATTS/UATMP Data 4-1

4.1 Statistical Results 4-1
4.1.1 Target Pollutant Detections 4-1
4.1.2 Concentration Range 4-12
4.1.3 Summary Statistics 4-13

4.2 Risk Screening and Pollutants of Interest 4-15
4.2.1 Concentrations of the Pollutants of Interest 4-19
4.2.2 Risk Screening Assessment Using MRLs 4-23
4.2.3 Correlation Between Concentrations and Meteorological Conditions .. 4-25
4.2.3.1 Maximum and Average Temperature 4-25
4.2.3.2 Moisture 4-25
4.2.3.3 Wind and Pressure 4-27

4.3 The Impact of Mobile Sources 4-28
4.3.1 Mobile Source Emissions 4-28
4.3.2 Hydrocarbon Concentrations 4-31
4.3.3 Motor Vehicle Ownership 4-31
4.3.4 Estimated Traffic Volume 4-33
4.3.5 Vehicle Miles Traveled 4-34
4.3.6 Mobile Source Tracer Analysis 4-35
4.3.7 BTEX Concentration Profiles 4-36

4.4 Variability Analysis 4-41
4.4.1 Coefficient of Variation 4-41
4.4.2 Seasonal Variability Analysis 4-53

4.5 Greenhouse Gases 4-76

5.0 Sites in Arizona 5-1

5.1 Site Characterization 5-1

5.2 Meteorological Characterization 5-7
5.2.1 Climate Summary 5-7
5.2.2 Meteorological Conditions in 2007 5-7

TABLE OF CONTENTS (Continued)

Page

5.2.3 Composite Back Trajectories for Sampling Days 5-9
5.2.4 Wind Roses for Sampling Days 5-9

5.3 Pollutants of Interest 5-13

5.4 Concentrations 5-15
5.4.1 2007 Concentration Averages 5-15
5.4.2 Concentration Trends 5-17

5.5 Pearson Correlations 5-17

5.6 Additional Risk Screening Evaluations 5-19
5.6.1 Risk Screening Assessment Using MRLs 5-19
5.6.2 Cancer and Noncancer Surrogate Risk Approximations 5-21
5.6.3 Risk-Based Emissions Assessment 5-24

5.7 Summary of the 2007 Monitoring Data 5-28

6.0 Sites in California 6-1

6.1 Site Characterization 6-1

6.2 Meteorological Characterization 6-8
6.2.1 Climate Summary 6-8
6.2.2 Meteorological Conditions in 2007 6-8
6.2.3 Composite Back Trajectories for Sampling Days 6-9
6.2.4 Wind Roses for Sampling Days 6-13

6.3 Pollutants of Interest 6-14

6.4 Concentrations 6-15
6.4.1 2007 Concentration Averages 6-15
6.4.2 Concentration Trends 6-16

6.5 Pearson Correlations 6-17

6.6 Additional Risk Screening Evaluations 6-17
6.6.1 Risk Screening Assessment Using MRLs 6-17
6.6.2 Cancer and Noncancer Surrogate Risk Approximations 6-19
6.6.3 Risk-Based Emissions Assessment 6-21

6.7 Summary of the 2007 Monitoring Data 6-24

TABLE OF CONTENTS (Continued)

Page

7.0 Site in Colorado 7-1

7.1 Site Characterization 7-1

7.2 Meteorological Characterization 7-5
  7.2.1 Climate Summary 7-6
  7.2.2 Meteorological Conditions in 2007 7-6
  7.2.3 Composite Back Trajectories for Sampling Days 7-6
  7.2.4 Wind Rose for Sampling Days 7-9

7.3 Pollutants of Interest 7-10

7.4 Concentrations 7-11
  7.4.1 2007 Concentration Averages 7-11
  7.4.2 Concentration Trends 7-12

7.5 Pearson Correlations 7-13

7.6 Additional Risk Screening Evaluations 7-13
  7.6.1 Risk Screening Assessment Using MRLs 7-13
  7.6.2 Cancer and Noncancer Surrogate Risk Approximations 7-15
  7.6.3 Risk-Based Emissions Assessment 7-18

7.7 Summary of the 2007 Monitoring Data 7-21

8.0 Site in Washington, D.C. 8-1

8.1 Site Characterization 8-1

8.2 Meteorological Characterization 8-5
  8.2.1 Climate Summary 8-5
  8.2.2 Meteorological Conditions in 2007 8-6
  8.2.3 Composite Back Trajectories for Sampling Days 8-6
  8.2.4 Wind Rose for Sampling Days 8-9

8.3 Pollutants of Interest 8-10

8.4 Concentrations 8-10
  8.4.1 2007 Concentration Averages 8-11
  8.4.2 Concentration Trends 8-12

8.5 Pearson Correlations 8-12

8.6 Additional Risk Screening Evaluations 8-12

TABLE OF CONTENTS (Continued)

Page

8.6.1 Risk Screening Assessment Using MRLs 8-12
8.6.2 Cancer and Noncancer Surrogate Risk Approximations 8-14
8.6.3 Risk-Based Emissions Assessment 8-14

8.7 Summary of the 2007 Monitoring Data 8-18

9.0 Sites in Florida 9-1

9.1 Site Characterization 9-1

9.2 Meteorological Characterization 9-16
9.2.1 Climate Summary 9-16
9.2.2 Meteorological Conditions in 2007 9-16
9.2.3 Composite Back Trajectories for Sampling Days 9-17
9.2.4 Wind Roses for Sampling Days 9-25

9.3 Pollutants of Interest 9-30

9.4 Concentrations 9-31
9.4.1 2007 Concentration Averages 9-31
9.4.2 Concentration Trends 9-34

9.5 Pearson Correlations 9-38

9.6 Additional Risk Screening Evaluations 9-40
9.6.1 Risk Screening Assessment Using MRLs 9-40
9.6.2 Cancer and Noncancer Surrogate Risk Approximations 9-40
9.6.3 Risk-Based Emissions Assessment 9-43

9.7 Summary of the 2007 Monitoring Data 9-50

10.0 Site in Georgia 10-1

10.1 Site Characterization 10-1

10.2 Meteorological Characterization 10-5
10.2.1 Climate Summary 10-6
10.2.2 Meteorological Conditions in 2007 10-6
10.2.3 Composite Back Trajectories for Sampling Days 10-6
10.2.4 Wind Rose for Sampling Days 10-9

10.3 Pollutants of Interest 10-10

10.4 Concentrations 10-11

TABLE OF CONTENTS (Continued)

Page

10.4.1 2007 Concentration Averages 10-11
10.4.2 Concentration Trends 10-12

10.5 Pearson Correlations 10-12

10.6 Additional Risk Screening Evaluations 10-12
10.6.1 Risk Screening Assessment Using MRLs 10-12
10.6.2 Cancer and Noncancer Surrogate Risk Approximations 10-14
10.6.3 Risk-Based Emissions Assessment 10-14

10.7 Summary of the 2007 Monitoring Data 10-19

11.0 Sites in Illinois 11-1

11.1 Site Characterization 11-1

11.2 Meteorological Characterization 11-7
11.2.1 Climate Summary 11-7
11.2.2 Meteorological Conditions in 2007 11-7
11.2.3 Composite Back Trajectories for Sampling Days 11-9
11.2.4 Wind Roses for Sampling Days 11-9

11.3 Pollutants of Interest 11-13

11.4 Concentrations 11-15
11.4.1 2007 Concentration Averages 11-15
11.4.2 Concentration Trends 11-17

11.5 Pearson Correlations 11-23

11.6 Additional Risk Screening Evaluations 11-25
11.6.1 Risk Screening Assessment Using MRLs 11-25
11.6.2 Cancer and Noncancer Surrogate Risk Approximations 11-25
11.6.3 Risk-Based Emissions Assessment 11-30

11.7 Summary of the 2007 Monitoring Data 11-33

12.0 Sites in Indiana 12-1

12.1 Site Characterization 12-1

12.2 Meteorological Characterization 12-11
12.2.1 Climate Summary 12-11
12.2.2 Meteorological Conditions in 2007 12-12

TABLE OF CONTENTS (Continued)

Page

12.2.3 Composite Back Trajectories for Sampling Days ... 12-12
12.2.4 Wind Roses for Sampling Days ... 12-18

12.3 Pollutants of Interest ... 12-21

12.4 Concentrations ... 12-22
12.4.1 2007 Concentration Averages ... 12-23
12.4.2 Concentration Trends ... 12-24

12.5 Pearson Correlations ... 12-25

12.6 Additional Risk Screening Evaluations ... 12-25
12.6.1 Risk Screening Assessment Using MRLs ... 12-25
12.6.2 Cancer and Noncancer Surrogate Risk Approximations ... 12-30
12.6.3 Risk-Based Emissions Assessment ... 12-32

12.7 Summary of the 2007 Monitoring Data ... 12-38

13.0 Site in Kentucky ... 13-1

13.1 Site Characterization ... 13-1

13.2 Meteorological Characterization ... 13-6
13.2.1 Climate Summary ... 13-6
13.2.2 Meteorological Conditions in 2007 ... 13-6
13.2.3 Composite Back Trajectories for Sampling Days ... 13-6
13.2.4 Wind Rose for Sampling Days ... 13-9

13.3 Pollutants of Interest ... 13-10

13.4 Concentrations ... 13-11
13.4.1 2007 Concentration Averages ... 13-11
13.4.2 Concentration Trends ... 13-12

13.5 Pearson Correlations ... 13-12

13.6 Additional Risk Screening Evaluations ... 13-12
13.6.1 Risk Screening Assessment Using MRLs ... 13-12
13.6.2 Cancer and Noncancer Surrogate Risk Approximations ... 13-14
13.6.3 Risk-Based Emissions Assessment ... 13-14

13.7 Summary of the 2007 Monitoring Data ... 13-19

TABLE OF CONTENTS (Continued)

Page

14.0 Site in Massachusetts 14-1

14.1 Site Characterization 14-1

14.2 Meteorological Characterization 14-5
  14.2.1 Climate Summary 14-6
  14.2.2 Meteorological Conditions in 2007 14-6
  14.2.3 Composite Back Trajectories for Sampling Days 14-6
  14.2.4 Wind Rose for Sampling Days 14-9

14.3 Pollutants of Interest 14-10

14.4 Concentrations 14-11
  14.4.1 2007 Concentration Averages 14-11
  14.4.2 Concentration Trends 14-12

14.5 Pearson Correlations 14-14

14.6 Additional Risk Screening Evaluations 14-14
  14.6.1 Risk Screening Assessment Using MRLs 14-14
  14.6.2 Cancer and Noncancer Risk Approximations 14-14
  14.6.3 Risk-Based Emissions Assessment 14-16

14.7 Summary of the 2007 Monitoring Data 14-20

15.0 Sites in Michigan 15-1

15.1 Site Characterization 15-1

15.2 Meteorological Characterization 15-8
  15.2.1 Climate Summary 15-8
  15.2.2 Meteorological Conditions in 2007 15-8
  15.2.3 Composite Back Trajectories for Sampling Days 15-9
  15.2.4 Wind Roses for Sampling Days 15-13

15.3 Pollutants of Interest 15-15

15.4 Concentrations 15-16
  15.4.1 2007 Concentration Averages 15-16
  15.4.2 Concentration Trends 15-18

15.5 Pearson Correlations 15-22

15.6 Additional Risk Screening Evaluations 15-24

TABLE OF CONTENTS (Continued)

Page

15.6.1 Risk Screening Assessment Using MRLs 15-24
15.6.2 Cancer and Noncancer Surrogate Risk Approximations 15-26
15.6.3 Risk-Based Emissions Assessment 15-28

15.7 Summary of the 2007 Monitoring Data 15-32

16.0 Sites in Mississippi 16-1

16.1 Site Characterization 16-1

16.2 Meteorological Characterization 16-8
16.2.1 Climate Summary 16-8
16.2.2 Meteorological Conditions in 2007 16-8
16.2.3 Composite Back Trajectories for Sampling Days 16-10
16.2.4 Wind Roses for Sampling Days 16-10

16.3 Pollutants of Interest 16-14

16.4 Concentrations 16-16
16.4.1 2007 Concentration Averages 16-16
16.4.2 Concentration Trends 16-18

16.5 Pearson Correlations 16-27

16.6 Additional Risk Screening Evaluations 16-29
16.6.1 Risk Screening Assessment Using MRLs 16-29
16.6.2 Cancer and Noncancer Surrogate Risk Approximations 16-29
16.6.3 Risk-Based Emissions Assessment 16-34

16.7 Summary of the 2007 Monitoring Data 16-37

17.0 Site in Missouri 17-1

17.1 Site Characterization 17-1

17.2 Meteorological Characterization 17-5
17.2.1 Climate Summary 17-6
17.2.2 Meteorological Conditions in 2007 17-6
17.2.3 Composite Back Trajectories for Sampling Days 17-6
17.2.4 Wind Rose for Sampling Days 17-9

17.3 Pollutants of Interest 17-10

TABLE OF CONTENTS (Continued)

Page

17.4 Concentrations 17-11
  17.4.1 2007 Concentration Averages 17-11
  17.4.2 Concentration Trends 17-13

17.5 Pearson Correlations 17-19

17.6 Additional Risk Screening Evaluations 17-19
  17.6.1 Risk Screening Assessment Using MRLs 17-19
  17.6.2 Cancer and Noncancer Surrogate Risk Approximations 17-22
  17.6.3 Risk-Based Emissions Assessment 17-24

17.7 Summary of the 2007 Monitoring Data 17-27

18.0 Sites in New Jersey 18-1

18.1 Site Characterization 18-1

18.2 Meteorological Characterization 18-12
  18.2.1 Climate Summary 18-12
  18.2.2 Meteorological Conditions in 2007 18-12
  18.2.3 Composite Back Trajectories for Sampling Days 18-13
  18.2.4 Wind Roses for Sampling Days 18-13

18.3 Pollutants of Interest 18-21

18.4 Concentrations 18-24
  18.4.1 2007 Concentration Averages 18-24
  18.4.2 Concentration Trends 18-28

18.5 Pearson Correlations 18-44

18.6 Additional Risk Screening Evaluations 18-47
  18.6.1 Risk Screening Assessment Using MRLs 18-47
  18.6.2 Cancer and Noncancer Surrogate Risk Approximations 18-48
  18.6.3 Risk-Based Emissions Assessment 18-54

18.7 Summary of the 2007 Monitoring Data 18-60

19.0 Sites in New York 19-1

19.1 Site Characterization 19-1

19.2 Meteorological Characterization 19-8

TABLE OF CONTENTS (Continued)

Page

19.2.1 Climate Summary 19-8
19.2.2 Meteorological Conditions in 2007 19-9
19.2.3 Composite Back Trajectories for Sampling Days 19-9
19.2.4 Wind Roses for Sampling Days 19-13

19.3 Pollutants of Interest 19-15

19.4 Concentrations 19-16
19.4.1 2007 Concentration Averages 19-16
19.4.2 Concentration Trends 19-17

19.5 Pearson Correlations 19-17

19.6 Additional Risk Screening Evaluations 19-17
19.6.1 Risk Screening Assessment Using MRLs 19-19
19.6.2 Cancer and Noncancer Surrogate Risk Approximations 19-19
19.6.3 Risk-Based Emissions Assessment 19-21

19.7 Summary of the 2007 Monitoring Data 19-24

20.0 Sites in Oklahoma 20-1

20.1 Site Characterization 20-1

20.2 Meteorological Characterization 20-11
20.2.1 Climate Summary 20-11
20.2.2 Meteorological Conditions in 2007 20-12
20.2.3 Composite Back Trajectories for Sampling Days 20-12
20.2.4 Wind Roses for Sampling Days 20-18

20.3 Pollutants of Interest 20-18

20.4 Concentrations 20-23
20.4.1 2007 Concentration Averages 20-23
20.4.2 Concentration Trends 20-26

20.5 Pearson Correlations 20-26

20.6 Additional Risk Screening Evaluations 20-29
20.6.1 Risk Screening Assessment Using MRLs 20-29
20.6.2 Cancer and Noncancer Surrogate Risk Approximations 20-31
20.6.3 Risk-Based Emissions Assessment 20-35

20.7 Summary of the 2007 Monitoring Data 20-41

TABLE OF CONTENTS (Continued)

Page

21.0 Sites in Puerto Rico 21-1

21.1 Site Characterization 21-1

21.2 Meteorological Characterization 21-8
  21.2.1 Climate Summary 21-8
  21.2.2 Meteorological Conditions in 2007 21-8
  21.2.3 Composite Back Trajectories for Sampling Days 21-10
  21.2.4 Wind Roses for Sampling Days 21-10

21.3 Pollutants of Interest 21-14

21.4 Concentrations 21-15
  21.4.1 2007 Concentration Averages 21-16
  21.4.2 Concentration Trends 21-18

21.5 Pearson Correlations 21-18

21.6 Additional Risk Screening Evaluations 21-18
  21.6.1 Risk Screening Assessment Using MRLs 21-20
  21.6.2 Cancer and Noncancer Surrogate Risk Approximations 21-20
  21.6.3 Risk-Based Emissions Assessment 21-24

21.7 Summary of the 2007 Monitoring Data 21-28

22.0 Site in Rhode Island 22-1

22.1 Site Characterization 22-1

22.2 Meteorological Characterization 22-5
  22.2.1 Climate Summary 22-5
  22.2.2 Meteorological Conditions in 2007 22-6
  22.2.3 Composite Back Trajectories for Sampling Days 22-6
  22.2.4 Wind Rose for Sampling Days 22-9

22.3 Pollutants of Interest 22-10

22.4 Concentrations 22-10
  22.4.1 2007 Concentration Averages 22-11
  22.4.2 Concentration Trends 22-12

22.5 Pearson Correlations 22-12

22.6 Additional Risk Screening Evaluations 22-12

TABLE OF CONTENTS (Continued)

Page

22.6.1 Risk Screening Assessment Using MRLs 22-12
22.6.2 Cancer and Noncancer Surrogate Risk Approximations 22-14
22.6.3 Risk-Based Emissions Assessment 22-14

22.7 Summary of the 2007 Monitoring Data 22-19

23.0 Site in South Carolina 23-1

23.1 Site Characterization 23-1

23.2 Meteorological Characterization 23-5
23.2.1 Climate Summary 23-5
23.2.2 Meteorological Conditions in 2007 23-6
23.2.3 Composite Back Trajectories for Sampling Days 23-6
23.2.4 Wind Rose for Sampling Days 23-9

23.3 Pollutants of Interest 23-10

23.4 Concentrations 23-10
23.4.1 2007 Concentration Averages 23-11
23.4.2 Concentration Trends 23-11

23.5 Pearson Correlations 23-12

23.6 Additional Risk Screening Evaluations 23-12
23.6.1 Risk Screening Assessment Using MRLs 23-12
23.6.2 Cancer and Noncancer Surrogate Risk Approximations 23-12
23.6.3 Risk-Based Emissions Assessment 23-14

23.7 Summary of the 2007 Monitoring Data 23-18

24.0 Sites in South Dakota 24-1

24.1 Site Characterization 24-1

24.2 Meteorological Characterization 24-8
24.2.1 Climate Summary 24-8
24.2.2 Meteorological Conditions in 2007 24-8
24.2.3 Composite Back Trajectories for Sampling Days 24-9
24.2.4 Wind Roses for Sampling Days 24-13

24.3 Pollutants of Interest 24-14

TABLE OF CONTENTS (Continued)

Page

24.4 Concentrations 24-16
    24.4.1 2007 Concentration Averages 24-16
    24.4.2 Concentration Trends........ 24-18

24.5 Pearson Correlations........ 24-30

24.6 Additional Risk Screening Evaluations........ 24-30
    24.6.1 Risk Screening Assessment Using MRLs 24-30
    24.6.2 Cancer and Noncancer Surrogate Risk Approximations........ 24-35
    24.6.3 Risk-Based Emissions Assessment........ 24-37

24.7 Summary of the 2007 Monitoring Data........ 24-41

25.0 Sites in Tennessee........ 25-1

25.1 Site Characterization 25-1

25.2 Meteorological Characterization 25-7
    25.2.1 Climate Summary 25-7
    25.2.2 Meteorological Conditions in 2007 25-7
    25.2.3 Composite Back Trajectories for Sampling Days 25-9
    25.2.4 Wind Roses for Sampling Days........ 25-9

25.3 Pollutants of Interest 25-13

25.4 Concentrations 25-13
    25.4.1 2007 Concentration Averages 25-14
    25.4.2 Concentration Trends........ 25-16

25.5 Pearson Correlations........ 25-21

25.6 Additional Risk Screening Evaluations........ 25-21
    25.6.1 Risk Screening Assessment Using MRLs 25-21
    25.6.2 Cancer and Noncancer Surrogate Risk Approximations........ 25-23
    25.6.3 Risk-Based Emissions Assessment........ 25-26

25.7 Summary of the 2007 Monitoring Data........ 25-30

26.0 Sites in Texas........ 26-1

26.1 Site Characterization 26-1

26.2 Meteorological Characterization 26-8

TABLE OF CONTENTS (Continued)

Page

26.2.1 Climate Summary 26-8
26.2.2 Meteorological Conditions in 2007 26-9
26.2.3 Composite Back Trajectories for Sampling Days 26-9
26.2.4 Wind Roses for Sampling Days 26-13

26.3 Pollutants of Interest 26-14

26.4 Concentrations 26-16
26.4.1 2007 Concentration Averages 26-16
26.4.2 Concentration Trends 26-18

26.5 Pearson Correlations 26-18

26.6 Additional Risk Screening Evaluations 26-20
26.6.1 Risk Screening Assessment Using MRLs 26-20
26.6.2 Cancer and Noncancer Surrogate Risk Approximations 26-20
26.6.3 Risk-Based Emissions Assessment 26-24

26.7 Summary of the 2007 Monitoring Data 26-27

27.0 Site in Utah 27-1

27.1 Site Characterization 27-1

27.2 Meteorological Characterization 27-5
27.2.1 Climate Summary 27-5
27.2.2 Meteorological Conditions in 2007 27-6
27.2.3 Composite Back Trajectories for Sampling Days 27-6
27.2.4 Wind Rose for Sampling Days 27-9

27.3 Pollutants of Interest 27-10

27.4 Concentrations 27-11
27.4.1 2007 Concentration Averages 27-11
27.4.2 Concentration Trends 27-13

27.5 Pearson Correlations 27-20

27.6 Additional Risk Screening Evaluations 27-20
27.6.1 Risk Screening Assessment Using MRLs 27-22
27.6.2 Cancer and Noncancer Surrogate Risk Approximations 27-22
27.6.3 Risk-Based Emissions Assessment 27-25

TABLE OF CONTENTS (Continued)

Page

27.7 Summary of the 2007 Monitoring Data 27-29

28.0 Site in Vermont 28-1

28.1 Site Characterization 28-1

28.2 Meteorological Characterization 28-5
 28.2.1 Climate Summary 28-6
 28.2.2 Meteorological Conditions in 2007 28-6
 28.2.3 Composite Back Trajectories for Sampling Days 28-6
 28.2.4 Wind Rose for Sampling Days 28-9

28.3 Pollutants of Interest 28-10

28.4 Concentrations 28-11
 28.4.1 2007 Concentration Averages 28-11
 28.4.2 Concentration Trends 28-12

28.5 Pearson Correlations 28-12

28.6 Additional Risk Screening Evaluations 28-12
 28.6.1 Risk Screening Assessment Using MRLs 28-12
 28.6.2 Cancer and Noncancer Surrogate Risk Approximations 28-14
 28.6.3 Risk-Based Emissions Assessment 28-16

28.7 Summary of the 2007 Monitoring Data 28-19

29.0 Site in Washington 29-1

29.1 Site Characterization 29-1

29.2 Meteorological Characterization 29-5
 29.2.1 Climate Summary 29-6
 29.2.2 Meteorological Conditions in 2007 29-6
 29.2.3 Composite Back Trajectories for Sampling Days 29-6
 29.2.4 Wind Rose for Sampling Days 29-9

29.3 Pollutants of Interest 29-10

29.4 Concentrations 29-11
 29.4.1 2007 Concentration Averages 29-11
 29.4.2 Concentration Trends 29-13

TABLE OF CONTENTS (Continued)

Page

29.5 Pearson Correlations 29-13

29.6 Additional Risk Screening Evaluations 29-13
  29.6.1 Risk Screening Assessment Using MRLs 29-13
  29.6.2 Cancer and Noncancer Surrogate Risk Approximations 29-15
  29.6.3 Risk-Based Emissions Assessment 29-18

29.7 Summary of the 2007 Monitoring Data 29-22

30.0 Site in Wisconsin 30-1

30.1 Site Characterization 30-1

30.2 Meteorological Characterization 30-5
  30.2.1 Climate Summary 30-5
  30.2.2 Meteorological Conditions in 2007 30-6
  30.2.3 Composite Back Trajectories for Sampling Days 30-6
  30.2.4 Wind Rose for Sampling Days 30-9

30.3 Pollutants of Interest 30-10

30.4 Concentrations 30-10
  30.4.1 2007 Concentration Averages 30-11
  30.4.2 Concentration Trends 30-12

30.5 Pearson Correlations 30-12

30.6 Additional Risk Screening Evaluations 30-12
  30.6.1 Risk Screening Assessment Using MRLs 30-12
  30.6.2 Cancer and Noncancer Surrogate Risk Approximations 30-14
  30.6.3 Risk-Based Emissions Assessment 30-14

30.7 Summary of the 2007 Monitoring Data 30-19

31.0 Data Quality 31-1

31.1 Method Precision 31-1
  31.1.1 VOC Method Precision 31-5
  31.1.2 SNMOC Method Precision 31-34
  31.1.3 Carbonyl Compounds Method Precision 31-44
  31.1.4 Metals Method Precision 31-54
  31.1.5 Hexavalent Chromium Method Precision 31-57
  31.1.6 SVOC Method Precision 31-58

TABLE OF CONTENTS (Continued)

Page

31.2 Analytical Precision 31-61
  31.2.1 VOC Analytical Precision 31-61
  31.2.2 SNMOC Analytical Precision 31-89
  31.2.3 Carbonyl Compounds Analytical Precision 31-99
  31.2.4 Metals Analytical Precision 31-109
  31.2.5 Hexavalent Chromium Analytical Precision 31-112
  31.2.6 SVOC Analytical Precision 31-113

31.3 Accuracy 31-116

32.0 Summary of Results and Recommendations 32-1

32.1 Summary of Results 32-1
  32.1.1 National-level Summary 32-1
  32.1.2 State-level Summary 32-3
  32.1.3 Composite Site-level Summary 32-31
  32.1.4 Data Quality Summary 32-32

32.2 Recommendations 32-32

33.0 References 33-1

TABLE OF CONTENTS (Continued)

Page

List of Appendices

Appendix A AQS Site Descriptions for the 2007 NATTS and UATMP Monitoring Sites ... A-1

Appendix B 2007 Range of Detection Limits ... B-1

Appendix C 2007 VOC Raw Data ... C-1

Appendix D 2007 SNMOC/TNMOC Raw Data ... D-1

Appendix E 2007 Carbonyl Raw Data ... E-1

Appendix F 2007 SVOC Raw Data ... F-1

Appendix G 2007 Metal Raw Data ... G-1

Appendix H 2007 Hexavalent Chromium Raw Data ... H-1

Appendix I 2007 Summary of Invalidated NATTS/UATMP Samples by Site ... I-1

Appendix J 2007 Summary Statistics for VOC Monitoring ... J-1

Appendix K 2007 Summary Statistics for SNMOC Monitoring ... K-1

Appendix L 2007 Summary Statistics for Carbonyl Monitoring ... L-1

Appendix M 2007 Summary Statistics for SVOC Monitoring ... M-1

Appendix N 2007 Summary Statistics for Metal Monitoring ... N-1

Appendix O 2007 Summary Statistics for Hexavalent Chromium Monitoring ... O-1

Appendix P Risk Factors Used Throughout the 2007 NATTS/UATMP Report ... P-1

LIST OF FIGURES

Page

2-1 Locations of the 2007 NATTS and UATMP Monitoring Sites 2-2

4-1 Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study........ 4-38
4-2 Coefficient of Variation Analysis of 1,3-Butadiene Across 27 Sites 4-42
4-3 Coefficient of Variation Analysis of Acetaldehyde Across 33 Sites............................ 4-43
4-4 Coefficient of Variation Analysis of Acrolein Across 27 Sites.................................... 4-44
4-5 Coefficient of Variation Analysis of Acrylonitrile Across 27 Sites 4-45
4-6 Coefficient of Variation Analysis of Arsenic Across 11 Sites 4-46
4-7 Coefficient of Variation Analysis of Benzene Across 27 Sites.................................... 4-47
4-8 Coefficient of Variation Analysis of Carbon Tetrachloride Across 27 Sites 4-48
4-9 Coefficient of Variation Analysis of Formaldehyde Across 33 Sites........................... 4-49
4-10 Coefficient of Variation Analysis of Manganese Across 11 Sites................................ 4-50
4-11 Coefficient of Variation Analysis of *p*-Dichlorobenzene Across 27 Sites 4-51
4-12 Coefficient of Variation Analysis of Tetrachloroethylene Across 27 Sites.................. 4-52
4-13 Comparison of Average Seasonal 1,3-Butadiene Concentrations by Season............... 4-54
4-14 Comparison of Average Seasonal Acetaldehyde Concentrations by Season 4-56
4-15 Comparison of Average Seasonal Acrolein Concentrations by Season 4-58
4-16 Comparison of Average Seasonal Acrylonitrile Concentrations by Season................. 4-60
4-17 Comparison of Average Seasonal Arsenic PM_{10} Concentrations by Season 4-62
4-18 Comparison of Average Seasonal Arsenic TSP Concentrations by Season................. 4-63
4-19 Comparison of Average Seasonal Benzene Concentrations by Season 4-64
4-20 Comparison of Average Seasonal Carbon Tetrachloride Concentrations by Season ... 4-66
4-21 Comparison of Average Seasonal Formaldehyde Concentrations by Season 4-68
4-22 Comparison of Average Seasonal Manganese PM_{10} Concentrations by Season........... 4-70
4-23 Comparison of Average Seasonal Manganese TSP Concentrations by Season 4-71
4-24 Comparison of Average Seasonal *p*-Dichlorobenzene Concentrations by Season 4-72
4-25 Comparison of Average Seasonal Tetrachloroethylene Concentrations by Season...... 4-74

5-1 Phoenix, Arizona (PXSS) Monitoring Site... 5-2
5-2 South Phoenix, Arizona (SPAZ) Monitoring Site 5-3
5-3 NEI Point Sources Located Within 10 Miles of PXSS and SPAZ 5-4
5-4 Composite Back Trajectory Map for PXSS.. 5-10
5-5 Composite Back Trajectory Map for SPAZ.. 5-11
5-6 Wind Rose for PXSS Sampling Days 5-12
5-7 Wind Rose for SPAZ Sampling Days 5-12

6-1 Los Angeles, California (CELA) Monitoring Site.. 6-2
6-2 Rubidoux, California (RUCA) Monitoring Site 6-3
6-3 NEI Point Sources Located Within 10 Miles of CELA... 6-4
6-4 NEI Point Sources Located Within 10 Miles of RUCA 6-5
6-5 Composite Back Trajectory Map for CELA... 6-11
6-6 Composite Back Trajectory Map for RUCA 6-12
6-7 Wind Rose for CELA Sampling Days 6-13
6-8 Wind Rose for RUCA Sampling Days 6-14

LIST OF FIGURES (Continued)

Page

7-1 Grand Junction, Colorado (GPCO) Monitoring Site 7-2
7-2 NEI Point Sources Located Within 10 Miles of GPCO...... 7-3
7-3 Composite Back Trajectory Map for GPCO...... 7-8
7-4 Wind Rose for GPCO Sampling Days 7-9

8-1 Washington, D.C. (WADC) Monitoring Site 8-2
8-2 NEI Point Sources Located Within 10 Miles of WADC 8-3
8-3 Composite Back Trajectory Map for WADC...... 8-8
8-4 Wind Rose for WADC Sampling Days 8-9

9-1 St. Petersburg, Florida (AZFL) Monitoring Site 9-2
9-2 Tampa, Florida (GAFL) Monitoring Site 9-3
9-3 Pinellas Park, Florida (SKFL) Monitoring Site...... 9-4
9-4 Plant City, Florida (SYFL) Monitoring Site...... 9-5
9-5 Winter Park, Florida (ORFL) Monitoring Site 9-6
9-6 Davie, Florida (FLFL) Monitoring Site...... 9-7
9-7 NEI Point Sources Located Within 10 Miles of the Tampa/St. Petersburg, Florida Monitoring Sites 9-8
9-8 NEI Point Sources Located Within 10 Miles of ORFL 9-9
9-9 NEI Point Sources Located Within 10 Miles of FLFL...... 9-10
9-10 Composite Back Trajectory Map for AZFL 9-19
9-11 Composite Back Trajectory Map for GAFL...... 9-20
9-12 Composite Back Trajectory Map for SKFL...... 9-21
9-13 Composite Back Trajectory Map for SYFL...... 9-22
9-14 Composite Back Trajectory Map for ORFL 9-23
9-15 Composite Back Trajectory Map for FLFL...... 9-24
9-16 Wind Rose for AZFL Sampling Days 9-26
9-17 Wind Rose for FLFL Sampling Days 9-26
9-18 Wind Rose for GAFL Sampling Days 9-27
9-19 Wind Rose for ORFL Sampling Days 9-27
9-20 Wind Rose for SKFL Sampling Days 9-28
9-21 Wind Rose for SYFL Sampling Days 9-28
9-22 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at AZFL...... 9-35
9-23 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at GAFL 9-36
9-24 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at ORFL...... 9-37

10-1 Decatur, Georgia (SDGA) Monitoring Site...... 10-2
10-2 NEI Point Sources Located Within 10 Miles of SDGA 10-3
10-3 Composite Back Trajectory Map for SDGA 10-8
10-4 Wind Rose for SDGA Sampling Days...... 10-9

LIST OF FIGURES (Continued)

Page

11-1 Northbrook, Illinois (NBIL) Monitoring Site 11-2
11-2 Schiller Park, Illinois (SPIL) Monitoring Site 11-3
11-3 NEI Point Sources Located Within 10 Miles of NBIL and SPIL 11-4
11-4 Composite Back Trajectory Map for NBIL 11-10
11-5 Composite Back Trajectory Map for SPIL 11-11
11-6 Wind Rose for NBIL Sampling Days 11-12
11-7 Wind Rose for SPIL Sampling Days 11-12
11-8 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at NBIL 11-18
11-9 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBIL 11-19
11-10 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at SPIL 11-20
11-11 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at SPIL 11-21

12-1 Indianapolis, Indiana (IDIN) Monitoring Site 12-2
12-2 Indianapolis, Indiana (ININ) Monitoring Site 12-3
12-3 Indianapolis, Indiana (WPIN) Monitoring Site 12-4
12-4 Gary, Indiana (INDEM) Monitoring Site 12-5
12-5 NEI Point Sources Located Within 10 Miles of IDIN, ININ, and WPIN 12-6
12-6 NEI Point Sources Located Within 10 Miles of INDEM 12-7
12-7 Composite Back Trajectory Map for IDIN 12-14
12-8 Composite Back Trajectory Map for ININ 12-15
12-9 Composite Back Trajectory Map for WPIN 12-16
12-10 Composite Back Trajectory Map for INDEM 12-17
12-11 Wind Rose for IDIN Sampling Days 12-19
12-12 Wind Rose for ININ Sampling Days 12-19
12-13 Wind Rose for WPIN Sampling Days 12-20
12-14 Wind Rose for INDEM Sampling Days 12-20
12-15 Formaldehyde Pollution Rose for INDEM 12-29

13-1 Hazard, Kentucky (HAKY) Monitoring Site 13-2
13-2 NEI Point Sources Located Within 10 Miles of HAKY 13-3
13-3 Composite Back Trajectory Map for HAKY 13-8
13-4 Wind Rose for HAKY Sampling Days 13-9

14-1 Boston, Massachusetts (BOMA) Monitoring Site 14-2
14-2 NEI Point Sources Located Within 10 Miles of BOMA 14-3
14-3 Composite Back Trajectory Map for BOMA 14-8
14-4 Wind Rose for BOMA Sampling Days 14-9
14-5 Three-Year Rolling Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BOMA 14-13

LIST OF FIGURES (Continued)

Page

15-1 Dearborn, Michigan (DEMI) Monitoring Site 15-2
15-2 Sault Sainte Marie, Michigan (ITCMI) Monitoring Site 15-3
15-3 NEI Point Sources Located Within 10 Miles of DEMI 15-4
15-4 NEI Point Sources Located Within 10 Miles of ITCMI 15-5
15-5 Composite Back Trajectory Map for DEMI 15-11
15-6 Composite Back Trajectory Map for ITCMI 15-12
15-7 Wind Rose for DEMI Sampling Days 15-14
15-8 Wind Rose for ITCMI Sampling Days 15-14
15-9 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at DEMI 15-19
15-10 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at DEMI 15-20
15-11 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at DEMI 15-21

16-1 Gulfport, Mississippi (GPMS) Monitoring Site 16-2
16-2 Tupelo, Mississippi (TUMS) Monitoring Site 16-3
16-3 NEI Point Sources Located Within 10 Miles of GPMS 16-4
16-4 NEI Point Sources Located Within 10 Miles of TUMS 16-5
16-5 Composite Back Trajectory Map for GPMS 16-11
16-6 Composite Back Trajectory Map for TUMS 16-12
16-7 Wind Rose for GPMS Sampling Days 16-13
16-8 Wind Rose for TUMS Sampling Days 16-13
16-9 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at GPMS 16-19
16-10 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at GPMS 16-20
16-11 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at GPMS 16-21
16-12 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at TUMS 16-22
16-13 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at TUMS 16-23
16-14 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at TUMS 16-24

17-1 St. Louis, Missouri (S4MO) Monitoring Site 17-2
17-2 NEI Point Sources Located Within 10 Miles of S4MO 17-3
17-3 Composite Back Trajectory Map for S4MO 17-8
17-4 Wind Rose for S4MO Sampling Days 17-9
17-5 Three-Year Rolling Statistical Metrics for Arsenic Concentrations Measured at S4MO 17-14
17-6 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at S4MO 17-15

LIST OF FIGURES (Continued)

Page

17-7 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at S4MO 17-16
17-8 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at S4MO 17-17

18-1 Camden, New Jersey (CANJ) Monitoring Site 18-2
18-2 Chester, New Jersey (CHNJ) Monitoring Site 18-3
18-3 Elizabeth, New Jersey (ELNJ) Monitoring Site 18-4
18-4 New Brunswick, New Jersey (NBNJ) Monitoring Site 18-5
18-5 NEI Point Sources Located Within 10 Miles of CANJ 18-6
18-6 NEI Point Sources Located Within 10 Miles of CHNJ 18-7
18-7 NEI Point Sources Located Within 10 Miles of ELNJ and NBNJ 18-8
18-8 Composite Back Trajectory Map for CANJ 18-15
18-9 Composite Back Trajectory Map for CHNJ 18-16
18-10 Composite Back Trajectory Map for ELNJ 18-17
18-11 Composite Back Trajectory Map for NBNJ 18-18
18-12 Wind Rose for CANJ Sampling Days 18-19
18-13 Wind Rose for CHNJ Sampling Days 18-19
18-14 Wind Rose for ELNJ Sampling Days 18-20
18-15 Wind Rose for NBNJ Sampling Days 18-20
18-16 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CANJ 18-29
18-17 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at CANJ 18-30
18-18 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at CANJ 18-31
18-19 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CHNJ 18-32
18-20 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at CHNJ 18-33
18-21 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at CHNJ 18-34
18-22 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at ELNJ 18-35
18-23 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at ELNJ 18-36
18-24 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at ELNJ 18-37
18-25 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at NBNJ 18-38
18-26 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBNJ 18-39

LIST OF FIGURES (Continued)

Page

18-27 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at NBNJ 18-40

19-1 Bronx, New York (BXNY) Monitoring Site 19-2
19-2 Rochester, New York (ROCH) Monitoring Site 19-3
19-3 NEI Point Sources Located Within 10 Miles of BXNY 19-4
19-4 NEI Point Sources Located Within 10 Miles of ROCH 19-5
19-5 Composite Back Trajectory Map for BXNY 19-11
19-6 Composite Back Trajectory Map for ROCH 19-12
19-7 Wind Rose for BXNY Sampling Days 19-14
19-8 Wind Rose for ROCH Sampling Days 19-14

20-1 Cherokee Heights, Pryor, Oklahoma (CNEP) Monitoring Site 20-2
20-2 Tulsa, Oklahoma (TOOK) Monitoring Site 20-3
20-3 Tulsa, Oklahoma (TSOK) Monitoring Site 20-4
20-4 Tulsa, Oklahoma (TUOK) Monitoring Site 20-5
20-5 NEI Point Sources Located Within 10 Miles of CNEP 20-6
20-6 NEI Point Sources Located Within 10 Miles of TOOK, TSOK and TUOK 20-7
20-7 Composite Back Trajectory Map for CNEP 20-14
20-8 Composite Back Trajectory Map for TOOK 20-15
20-9 Composite Back Trajectory Map for TSOK 20-16
20-10 Composite Back Trajectory Map for TUOK 20-17
20-11 Wind Rose for CNEP Sampling Days 20-19
20-12 Wind Rose for TOOK Sampling Days 20-19
20-13 Wind Rose for TSOK Sampling Days 20-20
20-14 Wind Rose for TUOK Sampling Days 20-20

21-1 Barceloneta, Puerto Rico (BAPR) Monitoring Site 21-2
21-2 San Juan, Puerto Rico (SJPR) Monitoring Site 21-3
21-3 NEI Point Sources Located Within 10 Miles of BAPR 21-4
21-4 NEI Point Sources Located Within 10 Miles of SJPR 21-5
21-5 Composite Back Trajectory Map for BAPR 21-11
21-6 Composite Back Trajectory Map for SJPR 21-12
21-7 Wind Rose for BAPR Sampling Days 21-13
21-8 Wind Rose for SJPR Sampling Days 21-13

22-1 Providence, Rhode Island (PRRI) Monitoring Site 22-2
22-2 NEI Point Sources Located Within 10 Miles of PRRI 22-3
22-3 Composite Back Trajectory Map for PRRI 22-8
22-4 Wind Rose for PRRI Sampling Days 22-9

23-1 Chesterfield, South Carolina (CHSC) Monitoring Site 23-2
23-2 NEI Point Sources Located Within 10 Miles of CHSC 23-3
23-3 Composite Back Trajectory Map for CHSC 23-8

LIST OF FIGURES (Continued)

Page

23-4 Wind Rose for CHSC Sampling Days 23-9

24-1 Custer, South Dakota (CUSD) Monitoring Site 24-2
24-2 Sioux Falls, South Dakota (SFSD) Monitoring Site 24-3
24-3 NEI Point Sources Located Within 10 Miles of CUSD 24-4
24-4 NEI Point Sources Located Within 10 Miles of SFSD 24-5
24-5 Composite Back Trajectory Map for CUSD 24-11
24-6 Composite Back Trajectory Map for SFSD 24-12
24-7 Wind Rose for CUSD Sampling Days 24-13
24-8 Wind Rose for SFSD Sampling Days 24-14
24-9 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CUSD (SNMOC) 24-19
24-10 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CUSD (TO-15) 24-20
24-11 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at CUSD 24-21
24-12 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at CUSD 24-22
24-13 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at SFSD (SNMOC) 24-23
24-14 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at SFSD (TO-15) 24-24
24-15 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at SFSD 24-25
24-16 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at SFSD 24-26
24-17 Formaldehyde Pollution Rose for SFSD 24-34

25-1 Loudon, Tennessee (LDTN) Monitoring Site 25-2
25-2 Loudon, Tennessee (MSTN) Monitoring Site 25-3
25-3 NEI Point Sources Located Within 10 Miles of LDTN and MSTN 25-4
25-4 Composite Back Trajectory Map for LDTN 25-10
25-5 Composite Back Trajectory Map for MSTN 25-11
25-6 Wind Rose for LDTN Sampling Days 25-12
25-7 Wind Rose for MSTN Sampling Days 25-12
25-8 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at LDTN 25-18
25-9 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at LDTN 25-19
25-10 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at LDTN 25-20

26-1 Deer Park, Texas (CAMS 35) Monitoring Site 26-2
26-2 Karnack, Texas (CAMS 85) Monitoring Site 26-3

LIST OF FIGURES (Continued)

Page

26-3 NEI Point Sources Located Within 10 Miles of CAMS 35 26-4
26-4 NEI Point Sources Located Within 10 Miles of CAMS 85 26-5
26-5 Composite Back Trajectory Map for CAMS 35 26-11
26-6 Composite Back Trajectory Map for CAMS 85 26-12
26-7 Wind Rose for CAMS 35 Sampling Days 26-13
26-8 Wind Rose for CAMS 85 Sampling Days 26-14

27-1 Bountiful, Utah (BTUT) Monitoring Site 27-2
27-2 NEI Point Sources Located Within 10 Miles of BTUT 27-3
27-3 Composite Back Trajectory Map for BTUT 27-8
27-4 Wind Rose for BTUT Sampling Days 27-9
27-5 Three-Year Rolling Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BTUT 27-14
27-6 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at BTUT (SNMOC) 27-15
27-7 Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at BTUT (TO-15) 27-16
27-8 Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at BTUT 27-17
27-9 Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at BTUT 27-18

28-1 Underhill, Vermont (UNVT) Monitoring Site 28-2
28-2 NEI Point Sources Located Within 10 Miles of UNVT 28-3
28-3 Composite Back Trajectory Map for UNVT 28-8
28-4 Wind Rose for UNVT Sampling Days 28-9

29-1 Seattle, Washington (SEWA) Monitoring Site 29-2
29-2 NEI Point Sources Located Within 10 Miles of SEWA 29-3
29-3 Composite Back Trajectory Map for SEWA 29-8
29-4 Wind Rose for SEWA Sampling Days 29-9

30-1 Mayville, Wisconsin (MVWI) Monitoring Site 30-2
30-2 NEI Point Sources Located Within 10 Miles of MVWI 30-3
30-3 Composite Back Trajectory Map for MVWI 30-8
30-4 Wind Rose for MVWI Sampling Days 30-9

LIST OF TABLES

Page

1-1 Organization of the 2007 National Monitoring Programs (NATTS and UATMP) Report 1-4

2-1 Descriptions of the 2007 NATTS and UATMP Monitoring Sites 2-4
2-2 2007 NATTS and UATMP Monitoring Sites and Past Program Participation 2-9
2-3 VOC Method Detection Limits 2-15
2-4 SNMOC Method Detection Limits 2-16
2-5 Carbonyl Method Detection Limits 2-18
2-6 SVOC Method Detection Limits 2-18
2-7 Metals Method Detection Limits 2-20
2-8 Hexavalent Chromium Method Detection Limit 2-20
2-9 Sampling Schedules and Completeness 2-22

3-1 Overview and Layout of Data Presented 3-1

4-1 Statistical Summaries of the VOC Concentrations 4-2
4-2 Statistical Summaries of the Carbonyl Compound Concentrations 4-4
4-3 Statistical Summaries of the SVOC Concentrations 4-5
4-4 Statistical Summaries of the SNMOC Concentrations 4-6
4-5 Statistical Summaries of the Metals Concentrations 4-9
4-6 Statistical Summaries of the Hexavalent Chromium Concentrations 4-10
4-7 Program–Level Risk Screening Summary 4-16
4-8 Site-Specific Risk Screening Comparison 4-17
4-9 Daily Average Comparison of the Carbonyl Pollutants of Interest 4-20
4-10 Daily Average Comparison of the Metal Pollutants of Interest 4-21
4-11 Daily Average Comparison of the VOC Pollutants of Interest 4-22
4-12 Program-Level MRL Risk Assessment Summary 4-24
4-13 Summary of Pearson Correlations between the Pollutants of Interest and Selected Meteorological Parameters 4-26
4-14 Summary of Mobile Source Information by Monitoring Site 4-29
4-15 Average Ethylene-to-Acetylene Ratios for Sites that Measured SNMOC 4-36
4-16 Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study 4-37
4-17 Greenhouse Gases 4-76

5-1 Geographical Information for the Arizona Monitoring Sites 5-5
5-2 Population, Motor Vehicle, and Traffic Information for the Arizona Monitoring Sites 5-6
5-3 Average Meteorological Conditions near the Arizona Monitoring Sites 5-8
5-4 Comparison of Measured Concentrations and EPA Screening Values for the Arizona Monitoring Sites 5-14
5-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Arizona Monitoring Sites 5-16

LIST OF TABLES (Continued)

Page

5-6 Pearson Correlations for Selected Meteorological Parameters and the Pollutants of Interest for the Arizona Monitoring Sites 5-18
5-7 MRL Risk Screening Assessment Summary for the Arizona Monitoring Sites 5-20
5-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in Arizona 5-22
5-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Arizona 5-25
5-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Arizona 5-26

6-1 Geographical Information for the California Monitoring Sites 6-6
6-2 Population, Motor Vehicle, and Traffic Information for the California Monitoring Sites 6-7
6-3 Average Meteorological Conditions near the California Monitoring Sites 6-10
6-4 Comparison of Measured Concentrations and EPA Screening Values for the California Monitoring Sites 6-15
6-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the California Monitoring Sites 6-16
6-6 Pearson Correlations Between Selected Meteorological Parameters and Pollutants of Interest for the California Monitoring Sites 6-18
6-7 Cancer and Noncancer Risk Summary for the Monitoring Sites in California 6-20
6-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in California 6-22
6-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in California 6-23

7-1 Geographical Information for the Colorado Monitoring Site 7-4
7-2 Population, Motor Vehicle, and Traffic Information for the Colorado Monitoring Site 7-5
7-3 Average Meteorological Conditions near the Colorado Monitoring Site 7-7
7-4 Comparison of Measured Concentrations and EPA Screening Values for the Colorado Monitoring Site 7-11
7-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Site 7-12
7-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Colorado Monitoring Site 7-14
7-7 MRL Risk Screening Assessment Summary for the Colorado Monitoring Site 7-16
7-8 Cancer and Noncancer Risk Summary for the Monitoring Site in Colorado 7-17
7-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Colorado 7-19

LIST OF TABLES (Continued)

Page

7-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Colorado 7-20

8-1 Geographical Information for the Washington, D.C. Monitoring Site 8-4
8-2 Population, Motor Vehicle, and Traffic Information for the Washington, D.C. Monitoring Site 8-5
8-3 Average Meteorological Conditions near the Washington, D.C. Monitoring Site 8-7
8-4 Comparison of Measured Concentrations and EPA Screening Values for the Washington, D.C. Monitoring Site 8-10
8-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Washington, D.C. Monitoring Site 8-11
8-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Washington, D.C. Monitoring Site 8-13
8-7 Cancer and Noncancer Risk Summary for the Monitoring Site in Washington, D.C. 8-15
8-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Washington, D.C. 8-16
8-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Washington, D.C. 8-17

9-1 Geographical Information for the Florida Monitoring Sites 9-11
9-2 Population, Motor Vehicle, and Traffic Information for the Florida Monitoring Sites 9-15
9-3 Average Meteorological Conditions near the Florida Monitoring Sites 9-18
9-4 Comparison of Measured Concentrations and EPA Screening Values for the Florida Monitoring Sites 9-30
9-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Florida Monitoring Sites 9-32
9-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Florida Monitoring Sites 9-39
9-7 Cancer and Noncancer Risk Summary for the Monitoring Sites in Florida 9-41
9-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Florida 9-44
9-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Florida 9-47

10-1 Geographical Information for the Georgia Monitoring Site 10-4
10-2 Population, Motor Vehicle, and Traffic Information for the Georgia Monitoring Site 10-5
10-3 Average Meteorological Conditions near the Georgia Monitoring Site 10-7

LIST OF TABLES (Continued)

Page

10-4 Comparison of Measured Concentrations and EPA Screening Values for the Georgia Monitoring Site 10-10
10-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Georgia Monitoring Site 10-11
10-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Georgia Monitoring Site 10-13
10-7 Cancer and Noncancer Risk Summary for the Monitoring Site in Georgia 10-15
10-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Georgia 10-16
10-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Georgia 10-17

11-1 Geographical Information for the Illinois Monitoring Sites 11-5
11-2 Population, Motor Vehicle, and Traffic Information for the Illinois Monitoring Sites 11-6
11-3 Average Meteorological Conditions near the Illinois Monitoring Sites 11-8
11-4 Comparison of Measured Concentrations and EPA Screening Values for the Illinois Monitoring Sites 11-14
11-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Illinois Monitoring Sites 11-16
11-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Illinois Monitoring Sites 11-24
11-7 MRL Risk Screening Assessment Summary for the Illinois Monitoring Sites 11-26
11-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in Illinois 11-28
11-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Illinois 11-31
11-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Illinois 11-32

12-1 Geographical Information for the Indiana Monitoring Sites 12-8
12-2 Population, Motor Vehicle, and Traffic Information for the Indiana Monitoring Sites 12-11
12-3 Average Meteorological Conditions near the Indiana Monitoring Sites 12-13
12-4 Comparison of Measured Concentrations and EPA Screening Values for the Indiana Monitoring Sites 12-22
12-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Indiana Monitoring Sites 12-24
12-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Indiana Monitoring Sites 12-26
12-7 MRL Risk Screening Assessment Summary for the Indiana Monitoring Sites 12-27

LIST OF TABLES (Continued)

Page

12-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in Indiana 12-31
12-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Indiana 12-33
12-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Indiana 12-35

13-1 Geographical Information for the Kentucky Monitoring Site 13-4
13-2 Population, Motor Vehicle, and Traffic Information for the Kentucky Monitoring Site 13-5
13-3 Average Meteorological Conditions near the Kentucky Monitoring Site 13-7
13-4 Comparison of Measured Concentrations and EPA Screening Values for the Kentucky Monitoring Site 13-10
13-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Site 13-11
13-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Kentucky Monitoring Site 13-13
13-7 Cancer and Noncancer Risk Summary for the Monitoring Site in Kentucky 13-15
13-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Kentucky 13-16
13-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Kentucky 13-17

14-1 Geographical Information for the Massachusetts Monitoring Site 14-4
14-2 Population, Motor Vehicle, and Traffic Information for the Massachusetts Monitoring Site 14-5
14-3 Average Meteorological Conditions near the Massachusetts Monitoring Site 14-7
14-4 Comparison of Measured Concentrations and EPA Screening Values for the Massachusetts Monitoring Site 14-10
14-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Massachusetts Monitoring Site 14-12
14-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Massachusetts Monitoring Site 14-15
14-7 Cancer and Noncancer Risk Summary for the Monitoring Site in Massachusetts 14-17
14-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Massachusetts 14-18
14-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Massachusetts 14-19

LIST OF TABLES (Continued)

Page

15-1 Geographical Information for the Michigan Monitoring Sites 15-6
15-2 Population, Motor Vehicle, and Traffic Information for the Michigan Monitoring Sites 15-7
15-3 Average Meteorological Conditions near the Michigan Monitoring Sites 15-10
15-4 Comparison of Measured Concentrations and EPA Screening Values for the Michigan Monitoring Sites 15-15
15-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Michigan Monitoring Sites 15-17
15-6 Pearson Correlations Between Selected Meteorological Parameters and Pollutants of Interest for the Michigan Monitoring Sites 15-23
15-7 MRL Risk Screening Assessment Summary for the Michigan Monitoring Sites 15-25
15-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in Michigan 15-27
15-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Michigan 15-29
15-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Michigan 15-30

16-1 Geographical Information for the Mississippi Monitoring Sites 16-6
16-2 Population, Motor Vehicle, and Traffic Information for the Mississippi Monitoring Sites 16-7
16-3 Average Meteorological Conditions near the Mississippi Monitoring Sites 16-9
16-4 Comparison of Measured Concentrations and EPA Screening Values for the Mississippi Monitoring Sites 16-15
16-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Mississippi Monitoring Sites 16-17
16-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Mississippi Monitoring Sites 16-28
16-7 MRL Risk Screening Assessment Summary for the Mississippi Monitoring Sites 16-30
16-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in Mississippi 16-32
16-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Mississippi 16-35
16-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Mississippi 16-36

17-1 Geographical Information for the Missouri Monitoring Site.. 17-4
17-2 Population, Motor Vehicle, and Traffic Information for the Missouri Monitoring Site 17-5
17-3 Average Meteorological Conditions near the Missouri Monitoring Site 17-7
17-4 Comparison of Measured Concentrations and EPA Screening Values for the Missouri Monitoring Site 17-11

LIST OF TABLES (Continued)

Page

17-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Missouri Monitoring Site 17-12
17-6 Pearson Correlations Between Selected Meteorological Parameters and Pollutants of Interest for the Missouri Monitoring Site 17-20
17-7 MRL Risk Screening Assessment Summary for the Missouri Monitoring Site 17-21
17-8 Cancer and Noncancer Risk Summary for the Monitoring Site in Missouri 17-23
17-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Missouri 17-25
17-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Missouri 17-26

18-1 Geographical Information for the New Jersey Monitoring Sites 18-9
18-2 Population, Motor Vehicle, and Traffic Information for the New Jersey Monitoring Sites 18-11
18-3 Average Meteorological Conditions near the New Jersey Monitoring Sites 18-14
18-4 Comparison of Measured Concentrations and EPA Screening Values for the New Jersey Monitoring Sites 18-22
18-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites 18-25
18-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the New Jersey Monitoring Sites 18-45
18-7 MRL Risk Screening Assessment Summary for the New Jersey Monitoring Sites 18-49
18-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in New Jersey 18-50
18-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in New Jersey 18-55
18-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in New Jersey 18-57

19-1 Geographical Information for the New York Monitoring Sites 19-6
19-2 Population, Motor Vehicle, and Traffic Information for the New York Monitoring Sites 19-7
19-3 Average Meteorological Conditions near the New York Monitoring Sites 19-10
19-4 Comparison of Measured Concentrations and EPA Screening Values for the New York Monitoring Sites 19-15
19-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the New York Monitoring Sites 19-16
19-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the New York Monitoring Sites 19-18
19-7 Cancer and Noncancer Risk Summary for the Monitoring Sites in New York 19-20

LIST OF TABLES (Continued)

Page

19-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in New York 19-22
19-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in New York 19-23

20-1 Geographical Information for the Oklahoma Monitoring Sites 20-8
20-2 Population, Motor Vehicle, and Traffic Information for the Oklahoma Monitoring Sites 20-11
20-3 Average Meteorological Conditions near the Oklahoma Monitoring Sites 20-13
20-4 Comparison of Measured Concentrations and EPA Screening Values for the Oklahoma Monitoring Sites 20-21
20-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites 20-24
20-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Oklahoma Monitoring Sites 20-27
20-7 MRL Risk Screening Assessment Summary for the Oklahoma Monitoring Sites 20-30
20-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in Oklahoma 20-32
20-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Oklahoma 20-36
20-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Oklahoma 20-38

21-1 Geographical Information for the Puerto Rico Monitoring Sites 21-6
21-2 Population, Motor Vehicle, and Traffic Information for the Puerto Rico Monitoring Sites 21-7
21-3 Average Meteorological Conditions near the Puerto Rico Monitoring Sites 21-9
21-4 Comparison of Measured Concentrations and EPA Screening Values for the Puerto Rico Monitoring Sites 21-15
21-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Puerto Rico Monitoring Sites 21-17
21-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Puerto Rico Monitoring Sites 21-19
21-7 MRL Risk Screening Assessment Summary for the Puerto Rico Monitoring Sites 21-21
21-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in Puerto Rico 21-22
21-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Puerto Rico 21-25
21-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Puerto Rico 21-26

LIST OF TABLES (Continued)

Page

22-1 Geographical Information for the Rhode Island Monitoring Site ... 22-4
22-2 Population, Motor Vehicle, and Traffic Information for the Rhode Island Monitoring Site ... 22-5
22-3 Average Meteorological Conditions near the Rhode Island Monitoring Site ... 22-7
22-4 Comparison of Measured Concentrations and EPA Screening Values for the Rhode Island Monitoring Site ... 22-10
22-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Rhode Island Monitoring Site ... 22-11
22-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Rhode Island Monitoring Site ... 22-13
22-7 Cancer and Noncancer Risk Summary for the Monitoring Site in Rhode Island ... 22-15
22-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Rhode Island ... 22-16
22-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Rhode Island ... 22-17

23-1 Geographical Information for the South Carolina Monitoring Site ... 23-4
23-2 Population, Motor Vehicle, and Traffic Information for the South Carolina Monitoring Site ... 23-5
23-3 Average Meteorological Conditions near the South Carolina Monitoring Site ... 23-7
23-4 Comparison of Measured Concentrations and EPA Screening Values for the South Carolina Monitoring Site ... 23-10
23-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the South Carolina Monitoring Site ... 23-11
23-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the South Carolina Monitoring Site ... 23-13
23-7 Cancer and Noncancer Risk Summary for the Monitoring Site in South Carolina ... 23-15
23-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in South Carolina ... 23-16
23-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in South Carolina ... 23-17

24-1 Geographical Information for the South Dakota Monitoring Sites ... 24-6
24-2 Population, Motor Vehicle, and Traffic Information for the South Dakota Monitoring Sites ... 24-7
24-3 Average Meteorological Conditions near the South Dakota Monitoring Sites ... 24-10
24-4 Comparison of Measured Concentrations and EPA Screening Values for the South Dakota Monitoring Sites ... 24-15
24-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the South Dakota Monitoring Sites ... 24-17

Page

24-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the South Dakota Monitoring Sites 24-31
24-7 MRL Risk Screening Assessment Summary for the South Dakota Monitoring Sites 24-33
24-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in South Dakota 24-36
24-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in South Dakota 24-38
24-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in South Dakota 24-39

25-1 Geographical Information for the Tennessee Monitoring Sites 25-5
25-2 Population, Motor Vehicle, and Traffic Information for the Tennessee Monitoring Sites 25-6
25-3 Average Meteorological Conditions near the Tennessee Monitoring Sites 25-8
25-4 Comparison of Measured Concentrations and EPA Screening Values for the Tennessee Monitoring Sites 25-14
25-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Tennessee Monitoring Sites 25-15
25-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Tennessee Monitoring Sites 25-22
25-7 MRL Risk Screening Assessment Summary for the Tennessee Monitoring Sites 25-24
25-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in Tennessee 25-25
25-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Tennessee 25-27
25-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Tennessee 25-28

26-1 Geographical Information for the Texas Monitoring Sites 26-6
26-2 Population, Motor Vehicle, and Traffic Information for the Texas Monitoring Sites 26-7
26-3 Average Meteorological Conditions near the Texas Monitoring Sites 26-10
26-4 Comparison of Measured Concentrations and EPA Screening Values for the Texas Monitoring Sites 26-15
26-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Texas Monitoring Sites 26-17
26-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Texas Monitoring Sites 26-19
26-7 MRL Risk Screening Assessment Summary for the Texas Monitoring Sites 26-21
26-8 Cancer and Noncancer Risk Summary for the Monitoring Sites in Texas 26-23

Page

26-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Texas 26-25
26-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Texas 26-26

27-1 Geographical Information for the Utah Monitoring Site 27-4
27-2 Population, Motor Vehicle, and Traffic Information for the Utah Monitoring Site 27-5
27-3 Average Meteorological Conditions near the Utah Monitoring Site 27-7
27-4 Comparison of Measured Concentrations and EPA Screening Values for the Utah Monitoring Site 27-11
27-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Utah Monitoring Site 27-12
27-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Utah Monitoring Site 27-21
27-7 MRL Risk Screening Assessment Summary for the Utah Monitoring Site 27-23
27-8 Cancer and Noncancer Risk Summary for the Monitoring Site in Utah 27-24
27-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Utah 27-26
27-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Utah 27-27

28-1 Geographical Information for the Vermont Monitoring Site 28-4
28-2 Population, Motor Vehicle, and Traffic Information for the Vermont Monitoring Site 28-5
28-3 Average Meteorological Conditions near the Vermont Monitoring Site 28-7
28-4 Comparison of Measured Concentrations and EPA Screening Values for the Vermont Monitoring Site 28-10
28-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Vermont Monitoring Site 28-11
28-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Vermont Monitoring Site 28-13
28-7 Cancer and Noncancer Risk Summary for the Monitoring Site in Vermont 28-15
28-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Vermont 28-17
28-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Vermont 28-18

29-1 Geographical Information for the Washington Monitoring Site 29-4

LIST OF TABLES (Continued)

Page

29-2 Population, Motor Vehicle, and Traffic Information for the Washington Monitoring Site 29-5
29-3 Average Meteorological Conditions near the Washington Monitoring Site 29-7
29-4 Comparison of Measured Concentrations and EPA Screening Values for the Washington Monitoring Site 29-11
29-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Washington Monitoring Site 29-12
29-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Washington Monitoring Site 29-14
29-7 MRL Risk Screening Assessment Summary for the Washington Monitoring Site 29-16
29-8 Cancer and Noncancer Risk Summary for the Monitoring Site in Washington 29-17
29-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Washington 29-19
29-10 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Washington 29-20

30-1 Geographical Information for the Wisconsin Monitoring Site 30-4
30-2 Population, Motor Vehicle, and Traffic Information for the Wisconsin Monitoring Site 30-5
30-3 Average Meteorological Conditions near the Wisconsin Monitoring Site 30-7
30-4 Comparison of Measured Concentrations and EPA Screening Values for the Wisconsin Monitoring Site 30-10
30-5 Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Wisconsin Monitoring Site 30-11
30-6 Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Wisconsin Monitoring Site 30-13
30-7 Cancer and Noncancer Risk Summary for the Monitoring Site in Wisconsin 30-15
30-8 Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Wisconsin 30-16
30-9 Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Wisconsin 30-17

31-1 Method Precision by Analytical Method 31-4
31-2 VOC Method Precision: 306 Duplicate and Collocated Samples 31-5
31-3 VOC Method Precision: 168 Collocated Samples 31-6
31-4 VOC Method Precision: 138 Duplicate Samples 31-8
31-5 VOC Method Precision: 12 Duplicate Samples for Bountiful, UT (BTUT) 31-10
31-6 VOC Method Precision: 48 Collocated Samples for Deer Park, TX (CAMS 35) 31-11

LIST OF TABLES (Continued)

Page

31-7 VOC Method Precision: 2 Collocated Samples for Karnack, TX (CAMS 85) 31-13
31-8 VOC Method Precision: 10 Collocated Samples for Dearborn, MI (DEMI) 31-14
31-9 VOC Method Precision: 12 Duplicate Samples for Grand Junction, CO (GPCO) 31-16
31-10 VOC Method Precision: 12 Collocated Samples for Northbrook, IL (NBIL)............ 31-18
31-11 VOC Method Precision: 6 Collocated Samples for Phoenix, AZ (PXSS) 31-19
31-12 VOC Method Precision: 12 Duplicate Samples for St. Louis, MO (S4MO).............. 31-21
31-13 VOC Method Precision: 14 Collocated Samples for Seattle, WA (SEWA)............... 31-22
31-14 VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site 31-25
31-15 SNMOC Method Precision: 60 Duplicate and Collocated Samples........................... 31-34
31-16 SNMOC Method Precision: 48 Duplicate Samples 31-36
31-17 SNMOC Method Precision: 12 Duplicate Samples for Bountiful, UT (BTUT) 31-38
31-18 SNMOC Method Precision: 12 Collocated Samples for Northbrook, IL (NBIL)....... 31-40
31-19 SNMOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site 31-42
31-20 Carbonyl Method Precision: 352 Duplicate and Collocated Samples......................... 31-44
31-21 Carbonyl Method Precision: 148 Collocated Samples 31-44
31-22 Carbonyl Method Precision: 204 Duplicate Samples 31-45
31-23 Carbonyl Method Precision: 12 Duplicate Samples for Bountiful, UT (BTUT)......... 31-46
31-24 Carbonyl Method Precision: 4 Collocated Samples for Dearborn, MI (DEMI).......... 31-46
31-25 Carbonyl Method Precision: 12 Duplicate Samples for Grand Junction, CO (GPCO) 31-47
31-26 Carbonyl Method Precision: 12 Collocated Samples for Northbrook, IL (NBIL) 31-47
31-27 Carbonyl Method Precision: 6 Collocated Samples for Phoenix, AZ (PXSS)............ 31-48
31-28 Carbonyl Method Precision: 12 Duplicate Samples for St. Louis, MO (S4MO) 31-49
31-29 Carbonyl Method Precision: 14 Collocated Samples for Seattle, WA (SEWA) 31-49
31-30 Carbonyl Method Precision: 12 Duplicate Samples for Pinellas Park, FL (SKFL) 31-50
31-31 Carbonyl Method Precision: 14 Duplicate Samples for Plant City, FL (SYFL) 31-50
31-32 Carbonyl Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site 31-51
31-33 Metal Method Precision: 198 Collocated Samples.. 31-54
31-34 Metal Method Precision: 60 Collocated Samples at Boston, MA (BOMA) 31-54
31-35 Metal Method Precision: 6 Collocated Samples at Bountiful, UT (BTUT) 31-55
31-36 Metal Method Precision: 22 Collocated Samples at St. Louis, MO (S4MO)............. 31-55
31-37 Metal Method Precision: 2 Collocated Samples at Seattle, WA (SEWA) 31-56
31-38 Metal Method Precision: Coefficient of Variation for all Collocated Samples by Site 31-57
31-39 Hexavalent Chromium Method Precision: Collocated Samples................................. 31-57
31-40 SVOC Method Precision: 50 Collocated Samples 31-58
31-41 SVOC Method Precision: 42 Collocated Samples at Rubidoux, CA (RUCA) 31-59
31-42 SVOC Method Precision: 8 Collocated Samples at Decatur, GA (SDGA)................ 31-60
31-43 VOC Analytical Precision: 596 Replicate Analyses for all Duplicate and Collocated Samples.. 31-62
31-44 VOC Analytical Precision: 316 Replicate Analyses for all Collocated Samples 31-63

LIST OF TABLES (Continued)

Page

31-45 VOC Analytical Precision: 280 Replicate Analyses for all Duplicate Samples 31-65
31-46 VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) 31-67
31-47 VOC Analytical Precision: 80 Replicate Analyses for Collocated Samples for Deer Park, TX (CAMS 35) 31-68
31-48 VOC Analytical Precision: 4 Replicate Analyses for Collocated Samples for Karnack, TX (CAMS 85) 31-70
31-49 VOC Analytical Precision: 24 Replicate Analyses for Collocated Samples for Dearborn, MI (DEMI) 31-71
31-50 VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO) 31-73
31-51 VOC Analytical Precision: 18 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL) 31-74
31-52 VOC Analytical Precision: 12 Replicate Analyses for Collocated Samples for Phoenix, AZ (PXSS) 31-76
31-53 VOC Analytical Precision: 22 Replicate Analyses for Duplicate Samples for St. Louis, MO (S4MO) 31-77
31-54 VOC Analytical Precision: 28 Replicate Analyses for Collocated Samples for Seattle, WA (SEWA) 31-79
31-55 VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site 31-81
31-56 SNMOC Analytical Precision: 112 Replicate Analyses for all Duplicate and Collocated Samples 31-89
31-57 SNMOC Analytical Precision: 96 Replicate Analyses for all Duplicate Samples 31-91
31-58 SNMOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) 31-93
31-59 SNMOC Analytical Precision: 16 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL) 31-95
31-60 SNMOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site 31-97
31-61 Carbonyl Analytical Precision: 818 Replicate Analyses for all Duplicate and Collocated Samples 31-99
31-62 Carbonyl Analytical Precision: 408 Replicate Analyses for all Collocated Samples 31-100
31-63 Carbonyl Analytical Precision: 410 Replicate Analyses for all Duplicate Samples . 31-100
31-64 Carbonyl Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) 31-101
31-65 Carbonyl Analytical Precision: 120 Replicate Analyses for Collocated Samples for Dearborn, MI (DEMI) 31-102
31-66 Carbonyl Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO) 31-102
31-67 Carbonyl Analytical Precision: 24 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL) 31-103

LIST OF TABLES (Continued)

Page

31-68 Carbonyl Analytical Precision: 12 Replicate Analyses for Collocated Samples for Phoenix, AZ (PXSS) 31-103
31-69 Carbonyl Analytical Precision: 24 Replicate Analyses for Duplicate Samples for St. Louis, MO (S4MO) 31-104
31-70 Carbonyl Analytical Precision: 28 Replicate Analyses for Collocated Samples for Seattle, WA (SEWA) 31-104
31-71 Carbonyl Analytical Precision: 28 Replicate Analyses for Duplicate Samples for Pinellas Park, FL (SKFL) 31-105
31-72 Carbonyl Analytical Precision: 28 Replicate Analyses for Duplicate Samples for Plant City, FL (SYFL) 31-105
31-73 Carbonyl Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site 31-106
31-74 Metal Analytical Precision: 384 Collocated Samples........ 31-109
31-75 Metal Analytical Precision: 112 Collocated Samples at Boston, MA (BOMA) 31-109
31-76 Metal Analytical Precision: 12 Collocated Samples at Bountiful, UT (BTUT)........ 31-110
31-77 Metal Analytical Precision: 46 Collocated Samples at St. Louis, MO (S4MO) 31-111
31-78 Metal Analytical Precision: 4 Collocated Samples at Seattle, WA (SEWA) 31-111
31-79 Metals Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site 31-112
31-80 Hexavalent Chromium Analytical Precision: Replicate Analyses for Collocated Samples 31-113
31-81 SVOC Analytical Precision: 98 Collocated Samples 31-114
31-82 SVOC Analytical Precision: 90 Collocated Samples at Rubidoux, CA (RUCA) 31-114
31-83 SVOC Analytical Precision: 8 Collocated Samples at Decatur, GA (SDGA) 31-115
31-84 Carbonyl NATTS PT Audit Samples – Percent Difference from True Value 31-116
31-85 Metals NATTS PT Audit Samples – Percent Difference from True Value 31-117
31-86 VOC NATTS PT Audit Samples – Percent Difference from True Value 31-117

LIST OF ACRONYMS

AADT	Annual average daily traffic
AGL	Above ground level
AIRS	Aerometric Information and Retrieval System
AQS	Air Quality Subsystem (of the Aerometric Information and Retrieval System)
ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethylbenzene, and xylenes (*o*-, *m*-, and *p*-xylene)
CALEPA	California EPA
CBSA	Core-based statistical area(s)
CFR	Code of Federal Regulations
CV	coefficient of variation
DNPH	2,4-dinitrophenylhydrazine
DQO	Data Quality Objective(s)
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group
FHWA	Federal highway administration
GC	gas chromatography
GC/MS-FID	gas chromatography/mass spectrometry and flame ionization detection
GHG	Greenhouse gas
GIS	Geographic Information Systems
GWP	Global warming potential
HAP	hazardous air pollutant
HPLC	high-performance liquid chromatography
HQ	Hazard Quotient
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
IC	Ion Chromatography
L	liter
LOAEL	Lowest observed adverse effect level
m^3	Cubic meter
MDL	method detection limit
MRL	Minimal risk level
MSA	metropolitan statistical area(s)
MTBE	methyl *tert*-butyl ether
NATA	National Air Toxics Assessment
NATTS	National Air Toxics Trends Station
NA	not applicable
NCore	National Core Monitoring Program
ND	Non-detect
NEI	National Emissions Inventory
ng/m^3	Nanograms per cubic meter

LIST OF ACRONYMS (Continued)

NOAA	National Oceanic and Atmospheric Administration
NOx	Oxides of Nitrogen
NWS	National Weather Station
PAMS	Photochemical Assessment Monitoring Strategy
ppbC	parts per billion carbon
ppbv	parts per billion (by volume)
ppm	parts per million
pg/m^3	Picograms per cubic meter
PM	particulate matter
PUF	Polyurethane foam
QAPP	Quality Assurance Project Plan
REL	Reference exposure limit
RfC	Reference Concentration
RFG	Reformulated gasoline
RPD	relative percent difference
SIP	State Implementation Plan(s)
SNMOC	Speciated Nonmethane Organic Compound
SVOC	Semivolatile Organic Compounds
TAD	Technical Assistance Document
TNMOC	Total Nonmethane Organic Compound(s)
tpy	tons per year
TSP	Total Suspended Particulate
UATMP	Urban Air Toxics Monitoring Program
µg/m^3	Micrograms per cubic meter
URE	Unit Risk Estimate
VMT	Vehicle miles traveled
VOC	Volatile Organic Compound(s)
WBAN	Weather Bureau/Army/Navy ID

Abstract

This report presents the results and conclusions from the ambient air monitoring conducted as part of the 2007 Urban Air Toxics Monitoring Program (UATMP), a program designed to characterize the magnitude and composition of potentially toxic air pollution in, or near, urban locations; and the National Air Toxics Trends Stations (NATTS) network, a program designed to generate long-term ambient air toxics concentration data in order to evaluate trends. The 2007 NATTS/UATMP programs consisted of 50 monitoring sites that collected 24-hour air samples including:

- 27 sites that sampled for 60 volatile organic compounds (VOC),
- 33 sites that sampled for 15 carbonyl compounds,
- 5 sites that sampled for 80 speciated nonmethane organic compounds (SNMOC),
- 5 sites that sampled for 19 semivolatile compounds (SVOC),
- 11 sites that sampled for 11 metals, and
- 19 sites that sampled for hexavalent chromium.

Overall, over 190,000 ambient air concentrations were measured during the 2007 NATTS/UATMP. This report uses various graphical, numerical, and statistical analyses to put the vast amount of ambient air monitoring data collected into perspective. Not surprisingly, the ambient air concentrations measured during the program varied significantly from city to city and from season to season.

The ambient air monitoring data collected during the 2007 NATTS/UATMP serve a wide range of purposes. Not only do these data characterize the nature and extent of urban air pollution close to the 50 monitoring sites participating in this study, but they also indicate some trends and patterns that may be common to all urban environments. Therefore, this report presents some results that are specific to particular monitoring locations and presents other results that are apparently common to urban environments. The results should ultimately provide additional insight into the complex nature of urban air pollution. The final data are also included in the appendices to this report.

1.0 Introduction

Air pollution in urban locations incorporates many components that originate from a wide range of stationary, mobile, and natural emissions sources. Because some of these components include toxic compounds known or suspected to have the potential for negative human health impacts, the U.S. Environmental Protection Agency (EPA) encourages state, local, and tribal agencies to understand and appreciate the nature and extent of toxic air pollution in urban locations. To achieve this goal, EPA sponsors the National Monitoring Programs. Components of the National Monitoring Programs include the Photochemical Assessment Monitoring Strategy (PAMS); Urban Air Toxics Monitoring Program (UATMP); National Air Toxics Trends Stations (NATTS) network; and monitoring for specific pollutants such as Hazardous Air Pollutants (HAP) and Non-methane Organic Compounds (NMOC). This report focuses on the UATMP and NATTS programs. The purpose of the UATMP is to characterize the composition and magnitude of urban air pollution through extensive ambient air monitoring. The ultimate goal of the NATTS network is to obtain a statistically significant quantity of high-quality representative air toxics measurements such that long-term trends can be identified.

1.1 Background

EPA began the NMOC program in 1984. Monitoring for selected compounds was performed during the morning hours of the summer ozone season. NMOC data were to be used to develop ozone control strategies. The UATMP was initiated by EPA in 1987 as an extension of the existing NMOC program to meet the increasing need for information on air toxics. The program was intended to allow participating agencies to screen air samples for concentrations of air toxics that could potentially result in adverse human health effects (EPA, 2003). The program has allowed the identification of compounds that are prevalent in ambient air and the identification of emission sources likely contributing to existing concentration levels. Over the years, the program has grown in both participation levels and pollutants targeted (EPA, 2007a).

The NATTS network was created to generate long-term ambient air toxics concentration data at specific fixed sites across the country. The NATTS Pilot program was developed and implemented during 2001 and 2002, leading to the development and initial implementation of the NATTS network during 2003 and 2004. The goal of the program was to estimate the concentrations of air toxics on a national level at fixed sites that remain active over an extended period of time. The generation of large quantities of high-quality data over an extended period may allow concentration trends (i.e., any substantial increase or decrease over a period of time) to be identified. The data generated are also used for validating modeling results and emission inventories, assessing current regulatory benchmarks, and reducing the risk of developing cancerous and noncancerous health effects. The site locations were based on results from preliminary air toxics pilot programs such as the 1996 National Air Toxics Assessment (NATA), which used air toxics emissions data to model ambient monitoring concentrations across the nation. Both urban and rural locations were chosen as NATTS monitoring sites. Urban areas were chosen to measure population exposure, while rural areas were chosen to determine background levels of air pollution (EPA, 2007a). Twenty-five NATTS sites are strategically placed across the country.

Many environmental and health agencies have participated in the programs to assess the sources, the effects, and the changes in air pollution within their jurisdictions. In past reports, measurements from both NATTS and UATMP monitoring sites have been presented together and referred to as “UATMP sites.” Beginning with this report, a distinction is made between the two programs due to the increasing number of NATTS sites covered under the National Monitoring Programs. As such, it is appropriate to describe both programs; to distinguish between the purposes and scopes; and to integrate the data, which will allow the program’s objectives and goals to complement each other.

1.2 The Report

This report summarizes and interprets the 2007 NATTS and UATMP monitoring efforts, which includes up to 12 months of 1-in-6 or 1-in-12 day measurements of ambient air samples at 50 monitoring sites in or near 44 urban/rural locations in 26 states, including 27 metropolitan statistical areas (MSA). Much of the data analysis and interpretation in this report focuses on pollutant-specific risk potential.

The contents of this report provide both a qualitative overview of air toxics pollution at selected urban and rural locations and a quantitative data analysis of the factors that appear to affect urban and rural air quality most significantly. This report also focuses on data characterization at each of the 50 different air sampling locations, a site-specific approach that allows for much more detailed evaluation of the factors (e.g., stationary sources, mobile sources, natural sources, meteorological influences) that affect air quality differently from one location to the next.

The contents of this report offer participating agencies useful insights into important air quality issues. For example, participating agencies can use trends and patterns in the NATTS and UATMP monitoring data to determine whether levels of air pollution present public health concerns, to identify which emission sources contribute most to air pollution, or to forecast whether proposed pollution control initiatives might significantly improve air quality. NATTS and UATMP monitoring data may also be compared to modeling results, such as from EPA's NATA.

Policy-relevant questions that the NATTS and UATMP data may help answer include the following:

- Which anthropogenic sources substantially affect air quality?
- Have pollutant concentrations decreased as a result of regulations?
- Which pollutants contribute the greatest health risk on a short-term, intermediate-term, and long-term basis?

The data analyses contained in this report are applied to every participating NATTS or UATMP monitoring site, depending upon pollutants sampled. Although many types of analyses are presented, state and local environmental agencies are encouraged to perform additional evaluations of the monitoring data so that the many factors that affect their specific ambient air quality can be understood fully.

To facilitate examination of the 2007 NATTS and UATMP monitoring data, the complete set of measured concentrations is presented in the appendices of this report. In addition, these data are publicly available in electronic format from the Air Quality Subsystem

(AQS) of EPA=s Aerometric Information Retrieval System (AIRS) at http://www.epa.gov/ttn/airs/airsaqs/.

The report is organized into 33 sections and 16 appendices. While each state section is designed to be a stand-alone section to allow those interested in a particular site or state to understand the data analyses without having to read the entire report, it is recommended that Sections 1 through 4 (Introduction, Monitoring Network Overview, Methods, and Results) and Sections 31 and 32 (Quality Assurance and Conclusions and Recommendations) be read as complements to the individual state sections. Table 1-1 highlights the contents of each section.

Table 1-1. Organization of the 2007 National Monitoring Programs (NATTS and UATMP) Report

Report Section	Section Title	Overview of Contents
1	Introduction	This section serves as an introduction to the background and scope of the National Monitoring Programs (specifically, the NATTS and UATMP).
2	The 2007 NATTS/UATMP Network	This section provides information on the 2007 NATTS and UATMP programs and network: $ Monitoring locations $ Pollutants selected for monitoring $ Sampling and analytical methods $ Sampling schedules $ Completeness of the air monitoring programs.
3	Summary of the 2007 NATTS/UATMP Data Treatments/Methods	This section presents and discusses the data treatments used on the 2007 NATTS/UATMP data to determine significant trends and relationships in the data, characterize data based on how ambient air concentrations varied with monitoring location and with time, present an interpretation of the significance of the observed spatial and temporal variations, and evaluate risk.
4	Summary of the 2007 NATTS/UATMP Results	This section presents and discusses the results of the data treatments from the 2007 NATTS/UATMP data.
5	Sites in Arizona	Monitoring results for the sites in the Phoenix-Mesa-Scottsdale, AZ MSA (PXSS and SPAZ)
6	Sites in California	Monitoring results for the sites in the Los Angeles-Riverside-Orange County, CA CMSA (CELA and RUCA)

Table 1-1. Organization of the 2007 National Monitoring Programs (NATTS and UATMP) Report (Continued)

Report Section	Section Title	Overview of Contents
7	Site in Colorado	Monitoring results for the site in the Grand Junction, CO MSA (GPCO)
8	Site in Washington, D.C.	Monitoring results for the site in the Washington, DC-VA-MD-WV MSA (WADC)
9	Sites in Florida	Monitoring results for the sites in the Orlando-Kissimmee, FL MSA (ORFL), Miami-Ft. Lauderdale-Pompano Beach, FL MSA (FLFL), and Tampa-St. Petersburg-Clearwater, FL MSA (AZFL, GAFL, SKFL, and SYFL)
10	Site in Georgia	Monitoring results for the site in the Atlanta-Sandy Springs-Marietta, GA MSA (SDGA)
11	Sites in Illinois	Monitoring results for the sites in the Chicago-Naperville-Joliet, IL-IN-WI MSA (NBIL and SPIL)
12	Sites in Indiana	Monitoring results for the sites in the Chicago-Naperville-Joliet, IL-IN-WI MSA (INDEM), and Indianapolis-Carmel, IN MSA (IDIN, ININ, and WPIN)
13	Site in Kentucky	Monitoring results for the site in Hazard, KY (HAKY)
14	Site in Massachusetts	Monitoring results for the site in the Boston-Cambridge-Quincy, MA-NH MSA (BOMA)
15	Sites in Michigan	Monitoring results for the sites in the Detroit-Warren-Livonia, MI MSA (DEMI) and Sault Sainte Marie, MI (ITCMI)
16	Sites in Mississippi	Monitoring results for the sites in Tupelo, MS (TUMS) and the Gulfport-Biloxi, MS MSA (GPMS)
17	Site in Missouri	Monitoring results for the site in the St. Louis, MO-IL MSA (S4MO)
18	Sites in New Jersey	Monitoring results for the sites in the New York-Northern New Jersey-Long Island, NY-NJ-PA MSA (CHNJ, ELNJ, and NBNJ) and Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA (CANJ)
19	Sites in New York	Monitoring results for the sites in the New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA (BXNY) and Rochester, NY MSA (ROCH)
20	Sites in Oklahoma	Monitoring results for the sites in the Tulsa, OK MSA (TOOK, TSOK, and TUOK) and Pryor, OK (CNEP)
21	Sites in Puerto Rico	Monitoring results for the sites in the San Juan-Caguas-Guaynabo, PR MSA (BAPR and SJPR)
22	Site in Rhode Island	Monitoring results for the site in the Providence-New Bedford-Fall River, RI-MA MSA (PRRI)

Table 1-1. Organization of the 2007 National Monitoring Programs (NATTS and UATMP) Report (Continued)

Report Section	Section Title	Overview of Contents
23	Site in South Carolina	Monitoring results for the site in Chesterfield, SC (CHSC)
24	Sites in South Dakota	Monitoring results for the sites in Custer, SD (CUSD) and the Sioux Falls, SD MSA (SFSD)
25	Sites in Tennessee	Monitoring results for the sites in the Knoxville, TN MSA (LDTN and MSTN)
26	Sites in Texas	Monitoring results for the sites in the Houston-Galveston-Brazoria, TX CMSA (CAMS 35) and Longview-Marshall, TX MSA (CAMS 85)
27	Site in Utah	Monitoring results for the site in the Ogden-Clearfield, UT MSA (BTUT)
28	Site in Vermont	Monitoring results for the site in the Burlington-South Burlington, VT MSA (UNVT)
29	Site in Washington	Monitoring results for the site in the Seattle-Tacoma-Bellevue, WA MSA (SEWA)
30	Site in Wisconsin	Monitoring results for the site in Mayville, WI (MVWI)
31	Data Quality	This section defines and discusses the concepts of precision and accuracy. Based on quantitative and qualitative analyses, this section comments on the precision and accuracy of the 2007 NATTS/UATMP ambient air monitoring data.
32	Summary of Results and Recommendations	This section summarizes the most significant findings of the report and makes several recommendations for future projects that involve ambient air monitoring in urban locations.
33	References	This section lists the references cited throughout the report.

2.0 The 2007 NATTS/UATMP Network

Agencies operating NATTS or UATMP sites that choose to participate in the National Monitoring Programs have their samples analyzed by the Eastern Research Group, Inc. (ERG) laboratory in Morrisville, NC. Data from 50 monitoring sites that collected 24-hour integrated ambient air samples for up to 12 months, at 1-in-6 or 1-in-12 day sampling intervals are included in this report. Samples were analyzed for concentrations of selected hydrocarbons, halogenated hydrocarbons, and polar compounds from canister samples (Speciated Nonmethane Organic Compounds (SNMOC) and TO-15), carbonyl compounds from sorbent cartridge samples (TO-11A), semivolatile organic compounds (SVOC) from polyurethane foam (PUF) and XAD-2® resin samples (TO-13), hexavalent chromium from sodium bicarbonate coated filters (EPA-approved method), and trace metals from filters (IO-3.5). Section 2.5 provides further details on each of the sampling methodologies used to collect and analyze samples. Note that agencies operating NATTS sites are not required to have their samples analyzed by ERG or may not have samples for all methods analyzed by ERG, as they may have their own laboratories or use other contractors. In these cases, the data are generated by sources outside ERG and are therefore not included in this report.

The following sections review the monitoring locations, pollutants selected for monitoring, collection schedules, sampling and analytical methods, and completeness of the 2007 NATTS/UATMP dataset.

2.1 Monitoring Locations

For the NATTS Program, monitor siting was based on the need to assess population exposure and background-level concentrations. For the UATMP, representatives from the state, local, and tribal agencies that voluntarily participate in the programs and contribute to the overall monitoring costs select the monitoring locations based on specific siting criteria and study needs. For both programs, some monitors were placed in urban areas near the centers of heavily populated cities (e.g., Chicago, IL and Phoenix, AZ), while others were placed in moderately populated rural areas (e.g., Custer, SD and Chesterfield, SC). Figure 2-1 shows the locations of the 50 monitoring sites participating in the 2007 programs, which encompass 44 different urban and rural areas. Outlined in Figure 2-1 are the associated core-based statistical areas (CBSA), as

Figure 2-1. Locations of the 2007 NATTS and UATMP Monitoring Sites

designated by the U.S. Census Bureau, where each site is located. A CBSA refers to either a micropolitan or metropolitan statistical area (MSA) (U.S. Census Bureau, 2007).

As Figure 2-1 shows, the 2007 UATMP and NATTS monitoring sites are widely distributed across the country. Detailed information on the surroundings near the monitoring sites is contained in Table 2-1 and Appendix A. Monitoring sites that are designated as part the NATTS network are indicated by bold italic type in Table 2-1 and subsequent tables throughout this report in order to distinguish between the two programs' sites. This table shows that the types of locations of the monitoring sites vary significantly, based on elevation, population, land use, climatology, and topography. A more detailed look at each monitoring site's surroundings is provided in the individual state sections. The monitoring data from these 50 sites may indicate certain air quality trends that are common to all urban environments, but may also show distinct geographic trends. The data analyses in this report differentiate the trends that appear to be site-specific from those that appear to be common to most urban environments.

For record keeping and reporting purposes, each site was assigned:

- A unique four- or five-letter site code B used to track samples from the monitoring sites to the ERG laboratory; and

- A unique nine-digit AQS site code B used to index monitoring results in the AQS database.

This report cites the four- or five-letter site code when presenting selected monitoring results. For reference, each site's AQS site code is provided in Table 2-1.

The proximity of the monitoring locations to different emissions sources, especially industrial facilities and heavily traveled roadways, often explains the observed spatial variations in ambient air quality. To provide a first approximation of the contributions of stationary and mobile source emissions on ambient air quality at each site, Table 2-1 lists the stationary source HAP emissions in the monitoring site's residing county, according to the 2002 National Emissions Inventory (NEI). In addition, the number of people living within 10 miles of each monitoring site location is also provided. Lastly, Table 2-1 contains the county-level number of motor vehicles owned in each site's respective county, based on registration.

Table 2-1. Descriptions of the 2007 NATTS and UATMP Monitoring Sites

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic (# vehicles)	Traffic Year Estimate	Population Residing Within 10 Miles of the Monitoring Site[a]	County-level Vehicle Registration	County-level Stationary Source HAP Emissions in the 2002 NEI[c] (tpy)
AZFL	12-103-0018	Azalea Park, St. Petersburg, FL	Residential	Suburban	37,000	2006	917,437	1,548,528	2,825.17
BAPR	72-017-0003	Barceloneta, PR	Residential	Rural	48,400	2004	23,038[b]	13,912	405.85
BOMA	25-025-0042	Boston, MA	Commercial	Urban/City Center	23,800	2005	713,049	467,969	1,636.84
BTUT	49-011-0004	Bountiful, UT	Residential	Suburban	17,310	2006	288,146	230,868	937.91
BXNY	36-005-0110	Bronx, NY	Residential	Urban/City Center	101,475	2002	1,373,659	243,523	4,009.77
CAMS 35	48-201-1039	Deer Park, TX	Residential	Suburban	31,130	2001	3,935,855	3,192,222	18,845.45
CAMS 85	48-203-0002	Karnack, TX	Agricultural	Rural	2,380	2002	63,504	67,719	1,266.61
CANJ	34-007-0003	Camden, NJ	Residential	Suburban	4,633	2005/2007	513,769	352,413	1,396.95
CELA	06-037-1103	Los Angeles, CA	Residential	Urban/City Center	238,000	2005	9,878,554	7,514,916	36,636.15
CHNJ	34-027-3001	Chester, NJ	Agricultural	Rural	18,360	2005	488,475	335,063	1,263.08
CHSC	45-025-0001	Chesterfield, SC	Forest	Rural	650	2006	42,761	42,726	488.26
CNEP	40-097-9014	Pryor, OK	Agricultural	Rural	5	2003	39,627	29,398	343.09
CUSD	46-033-0003	Custer, SD	Residential	Suburban	2,500	2006	7,818	15,345	22.83

BOLD = EPA-designated NATTS site.

[a] Reference: http://zipfind.net

[b] County population used as surrogate.

[c] Reference: EPA, 2006a.

[d] GPCO’s hexavalent chromium monitor is at a separate, but adjacent location; as such, this site has two AQS codes.

Table 2-1. Descriptions of the 2007 NATTS and UATMP Monitoring Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic (# vehicles)	Traffic Year Estimate	Population Residing Within 10 Miles of the Monitoring Site[a]	County-level Vehicle Registration	County-level Stationary Source HAP Emissions in the 2002 NEI[c] (tpy)
DEMI	26-163-0033	Dearborn, MI	Industrial	Suburban	20,900	2006	1,985,101	1,400,461	9,313.21
ELNJ	34-039-0004	Elizabeth, NJ	Industrial	Suburban	200,000	Unknown	524,658	359,882	2,067.39
FLFL	12-011-1002	Davie, FL	Commercial	Suburban	14,000	2006	1,759,591	1,541,754	11,7741.91
GAFL	12-057-1065	Tampa, FL	Commercial	Suburban	41,000	2006	1,174,727	1,203,440	7,251.75
GPCO[d]	08-077-0017/ 08-077-0018	Grand Junction, CO	Commercial	Urban/City Center	12,300	2006	139,082	163,539	553.15
GPMS	28-047-0008	Gulfport, MS	Commercial	Rural	27,000	2006	176,105	170,041	3,272.37
HAKY	21-193-0003	Hazard, KY	Residential	Suburban	21,537	2005	29,213	47,549	115.24
IDIN	18-097-0085	Stout Field, Indianapolis, IN	Military Reservation	Urban/City Center	77,250	2002	876,804	897,388	4,328.71
INDEM	18-089-0022	Gary, IN	Industrial	Urban/City Center	40,710	2002	492,104	453,146	3,300.47
ININ	18-097-0057	South Harding, Indianapolis, IN	Residential	Urban/City Center	97,780	2002	876,804	897,388	4,328.71
ITCMI	26-033-0901	Sault Sainte Marie, MI	Residential	Rural	5,200	2006	38,922	36,768	193.07
LDTN	47-105-0108	Loudon, TN	Residential	Suburban	12,945	2006	45,448	50,519	1,550.05
MSTN	47-105-0109	Loudon, TN	Residential	Suburban	7,287	2006	45,448	50,519	1,550.05

BOLD = EPA-designated NATTS site.

[a] Reference: http://zipfind.net

[b] County population used as surrogate.

[c] Reference: EPA, 2006a.

[d] GPCO’s hexavalent chromium monitor is at a separate, but adjacent location; as such, this site has two AQS codes.

Table 2-1. Descriptions of the 2007 NATTS and UATMP Monitoring Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic (# vehicles)	Traffic Year Estimate	Population Residing Within 10 Miles of the Monitoring Site[a]	County-level Vehicle Registration	County-level Stationary Source HAP Emissions in the 2002 NEI[c] (tpy)
MVWI	55-027-0007	Mayville, WI	Agricultural	Rural	3,500	2004	87,786	92,255	556.02
NBIL	17-031-4201	Northbrook, IL	Residential	Suburban	35,700	2006	5,285,107	2,104,894	23,488.15
NBNJ	34-023-0006	New Brunswick, NJ	Agricultural	Rural	63,326	2005	788,629	540,949	2,627.52
ORFL	12-095-2002	Winter Park, FL	Commercial	Urban/City Center	35,500	2006	1,066,113	1,048,589	4,820.66
PRRI	44-007-0022	Providence, RI	Residential	Urban/City Center	212,100	2006	629,435	142,334	1,271.23
PXSS	04-013-9997	Phoenix, AZ	Residential	Urban/City Center	206,000	2006	3,880,181	3,793,646	9,644.29
ROCH	36-055-1007	Rochester, NY	Residential	Urban/City Center	111,600	2003	729,681	552,452	6,303.94
RUCA	06-065-8001	Rubidoux, CA	Residential	Suburban	17,468	2004	2,073,571	1,344,232	5,367.35
S4MO	29-510-0085	St. Louis, MO	Residential	Urban/City Center	84,821	2006	1,345,877	1,136,095	2,243.81
SDGA	13-089-0002	Decatur, GA	Residential	Suburban	9,100	2006	737,093	471,264	12,101.27
SEWA	53-033-0080	Seattle, WA	Industrial	Suburban	232,000	2006	1,859,284	1,766,228	5,291.45
SFSD	46-099-0007	Sioux Falls, SD	Residential	Urban/City Center	4,265	2005	175,272	212,906	536.15
SJPR	72-021-0006	San Juan, PR	Industrial	Suburban	139,563	2003	220,574[b]	145,642	226.52

BOLD = EPA-designated NATTS site.

[a] Reference: http://zipfind.net

[b] County population used as surrogate.

[c] Reference: EPA, 2006a.

[d] GPCO’s hexavalent chromium monitor is at a separate, but adjacent location; as such, this site has two AQS codes.

Table 2-1. Descriptions of the 2007 NATTS and UATMP Monitoring Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic (# vehicles)	Traffic Year Estimate	Population Residing Within 10 Miles of the Monitoring Site[a]	County-level Vehicle Registration	County-level Stationary Source HAP Emissions in the 2002 NEI[c] (tpy)
SKFL	12-103-0026	Pinellas Park, FL	Residential	Suburban	48,000	2006	917,437	1,548,528	2,825.17
SPAZ	04-013-4003	Phoenix, AZ	Residential	Urban/City Center	113,000	2006	3,880,181	3,793,646	9,644.29
SPIL	17-031-3103	Schiller Park, IL	Mobile	Suburban	202,900	2006	5,285,107	2,104,894	23,488.15
SYFL	12-057-3002	Plant City, FL	Residential	Rural	30,500	2006	1,174,727	1,203,440	7,251.75
TOOK	40-143-0235	Site #1, Tulsa, OK	Industrial	Urban/City Center	67,092	2006	585,068	506,011	1,877.66
TSOK	40-143-0172	Site #2, Tulsa, OK	Residential	Suburban	33,800	2006	585,068	506,011	1,877.66
TUMS	28-081-0005	Tupelo, MS	Commercial	Suburban	12,000	2006	80,349	71,812	1,016.31
TUOK	40-143-0191	Site #3, Tulsa, OK	Residential	Urban/City Center	45,300	2006	585,068	506,011	1,877.66
UNVT	50-007-0007	Underhill, VT	Forest	Rural	1,200	2005	151,826	143,618	589.60
WADC	11-001-0043	Washington, D.C.	Commercial	Urban/City Center	36,800	2002	588,292	219,105	733.24
WPIN	18-097-0078	Washington Park, Indianapolis, IN	Residential	Suburban	155,900	2002	876,804	897,388	4,328.71

BOLD = EPA-designated NATTS site.

[a] Reference: http://zipfind.net

[b] County population used as surrogate.

[c] Reference: EPA, 2006a.

[d] GPCO's hexavalent chromium monitor is at a separate, but adjacent location; as such, this site has two AQS codes.

The 44 monitoring sites whose data have been included in the report previously are listed in Table 2-2. In addition, six new sites that began sampling in 2007 are included in the report for the first time.

At every NATTS or UATMP monitoring site, the sample collection equipment was installed either in a temperature-controlled enclosure (usually a trailer or a shed) with the sampling probe inlet exposed to the ambient air or as a stand-alone sampler. With this common setup, every NATTS and UATMP monitoring site sampled ambient air at heights approximately 5 to 20 feet above local ground level.

2.2 Analytical Methods Used and Pollutants Targeted for Monitoring

Urban air pollution typically contains hundreds of components, including, but not limited to, volatile organic compounds (VOC), carbonyl compounds, metals, and particulate matter. Because the sampling and analysis required to monitor for every component of air pollution has been prohibitively expensive, the UATMP and NATTS programs primarily focus on specific pollutants, as listed below. The target pollutants varied significantly from monitoring site to monitoring site.

- *Compendium Method TO-15* was used concurrently with the SNMOC sampling and analytical method to measure ambient air concentrations of 61 VOC and 80 ozone precursors.

- *Compendium Method TO-11A* was used to measure ambient air concentrations of 15 carbonyl compounds.

- *Compendium Method TO-13A* was used to measure ambient air concentrations of 19 SVOC.

- *Compendium Method IO-3.5* was used to measure ambient air concentrations of 11 metals.

- *EPA-approved hexavalent chromium method* was used to measure ambient air concentrations of hexavalent chromium.

Table 2-2. 2007 NATTS and UATMP Monitoring Sites and Past Program Participation

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004	2005	2006	2007
Azalea Park, St. Petersburg, FL (AZFL)				✓								✓	✓	✓	✓	✓	✓	✓
Barceloneta, PR (BAPR)												✓	✓	✓		✓	✓	✓
Boston, MA (***BOMA***)														✓	✓	✓	✓	✓
Bountiful, UT (***BTUT***)														✓	✓	✓	✓	✓
Bronx, NY (BXNY)																		✓
Camden, NJ (CANJ)	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chester, NJ (CHNJ)												✓	✓	✓	✓	✓	✓	✓
Chesterfield, SC (***CHSC***)																✓	✓	✓
Custer, SD (CUSD)													✓	✓	✓	✓	✓	✓
Davie, FL (FLFL)																✓	✓	✓
Dearborn, MI (***DEMI***)												✓	✓	✓	✓	✓	✓	✓
Deer Park, TX (CAMS 35)																		✓
Decatur, GA (***SDGA***)																✓	✓	✓
Elizabeth, NJ (ELNJ)											✓	✓	✓	✓	✓	✓	✓	✓

[a] The time period for the 1999/2000 UATMP covers October 1999 to December 2000.

BOLD = EPA-designated NATTS site.

Table 2-2. 2007 NATTS and UATMP Monitoring Sites and Past Program Participation (Continued)

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004	2005	2006	2007
Gandy, Tampa, FL (GAFL)												✓	✓	✓	✓	✓	✓	✓
Gary, IN (INDEM)															✓	✓	✓	✓
Grand Junction, CO (***GPCO***)															✓	✓	✓	✓
Gulfport, MS (GPMS)												✓	✓	✓	✓	✓	✓	✓
Hazard, KY (***HAKY***)																✓	✓	✓
Karnack, TX (CAMS 85)																		✓
Los Angeles, CA (CELA)																		✓
Loudon, TN (LDTN)														✓	✓	✓	✓	✓
Loudon, TN (MSTN)																	✓	✓
Mayville, WI (***MVWI***)																✓	✓	✓
New Brunswick, NJ (NBNJ)												✓	✓	✓	✓	✓	✓	✓
Northbrook, IL (***NBIL***)														✓	✓	✓	✓	✓
Phoenix, AZ (***PXSS***)												✓	✓	✓	✓		✓	✓
Phoenix, AZ (SPAZ)												✓	✓	✓	✓			✓

[a] The time period for the 1999/2000 UATMP covers October 1999 to December 2000.

BOLD = EPA-designated NATTS site.

Table 2-2. 2007 NATTS and UATMP Monitoring Sites and Past Program Participation (Continued)

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004	2005	2006	2007
Providence, RI (***PRRI***)																✓	✓	✓
Pryor, OK (CNEP)																	✓	✓
Rochester, NY (ROCH)																		✓
Rubidoux, CA (RUCA)																		✓
San Juan, PR (SJPR)																✓	✓	✓
Sault Ste. Marie, MI (ITCMI)														✓	✓	✓	✓	✓
Schiller Park, IL (SPIL)														✓	✓	✓	✓	✓
Seattle, WA (***SEWA***)																✓	✓	✓
Sioux Falls, SD (SFSD)											✓	✓	✓	✓	✓	✓	✓	✓
Skyview Elementary School, Tampa, FL (***SKFL***)															✓	✓	✓	✓
South Harding, Indianapolis, IN (ININ)																	✓	✓
St. Louis, MO (***S4MO***)													✓	✓	✓	✓	✓	✓
Stout Field, Indianapolis, IL (IDIN)																	✓	✓

[a] The time period for the 1999/2000 UATMP covers October 1999 to December 2000.

BOLD = EPA-designated NATTS site.

Table 2-2. 2007 NATTS and UATMP Monitoring Sites and Past Program Participation (Continued)

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004	2005	2006	2007
Sydney, Plant City, FL (***SYFL***)															✓	✓	✓	✓
Tulsa, OK (TOOK)																	✓	✓
Tulsa, OK (TSOK)																	✓	✓
Tulsa, OK (TUOK)																	✓	✓
Tupelo, MS (TUMS)												✓	✓	✓	✓	✓	✓	✓
Underhill, VT (***UNVT***)													✓			✓	✓	✓
Washington, D.C. (***WADC***)																✓	✓	✓
Washington Park, Indianapolis, IN (WPIN)																	✓	✓
Winter Park, FL (ORFL)			✓											✓	✓	✓	✓	✓

[a] The time period for the 1999/2000 UATMP covers October 1999 to December 2000.

BOLD = EPA-designated NATTS site.

The detection limits of the analytical methods must be considered carefully when interpreting the corresponding ambient air monitoring data. By definition, method detection limits (MDLs) represent the lowest concentrations at which laboratory equipment have been experimentally determined to reliably quantify concentrations of selected pollutants to a specific confidence level. If a chemical concentration in ambient air does not exceed the method sensitivity (as gauged by the detection limit), the analytical method might not differentiate the pollutant from other pollutants in the sample or from the random Anoise@ inherent in laboratory analyses. While quantification below the MDL is possible, the measurement reliability is lower. Therefore, when samples contain concentrations at levels below their respective detection limits, multiple analyses of the same sample may lead to a wide range of measurement results, including highly variable concentrations or Anon-detect@ observations. Data analysts should exercise caution when interpreting monitoring data with many reported concentrations at levels near or below the corresponding detection limits.

MDLs are determined at the ERG laboratory using 40 CFR, Part 136 Appendix B procedures (EPA, 2005a) in accordance with the specifications presented in the NATTS Technical Assistance Document (TAD) (EPA, 2007a). This procedure involves analyzing at least seven replicate standards prepared on/in the appropriate sampling media (per analytical method). Instrument detection limits are not determined (replicates of standards only) because sample contamination and preparation variability would not be considered. Tables 2-3 through 2-8 identify the specific target pollutants for each method and their corresponding MDLs. For the VOC and SNMOC analyses, the experimentally-determined MDLs do not change unless the sample was diluted. For the rest of the analyses, the MDLs may vary due to the actual volume pulled through the sample. For these analyses, the range and average of each MDL is presented for each pollutant in Appendix B.

Because non-detect results significantly limit the range of data interpretations for ambient air monitoring programs, participating agencies should note that the approach for treating non-detects may slightly affect the magnitude of the calculated central tendency concentrations, especially for pollutants with a low detection rate. The non-detects were treated as valid data points. For purposes of risk analysis, non-detects were substituted with one-half of the MDL on a target pollutant basis to calculate seasonal and annual averages.

The following discussion presents an overview of the sampling and analytical methods. For detailed descriptions of the methods, readers should refer to EPA=s original documentation of the Compendium Methods (EPA, 1996; EPA, 1998; EPA, 1999a; EPA, 1999b; EPA, 1999c; EPA, 1999d; EPA, 2006b).

2.2.1 VOC and SNMOC Concurrent Sampling and Analytical Methods

VOC and SNMOC sampling and analysis can be performed concurrently in accordance with a combination of EPA Compendium Method TO-15 and the procedure presented in EPA's "Technical Assistance Document for Sampling and Analysis of Ozone Precursors" (EPA, 1998). Ambient air samples for VOC analysis were collected in passivated stainless steel canisters. The ERG laboratory distributed the prepared canisters (i.e., cleaned and evacuated) to the monitoring sites before each scheduled sample collection event, and site operators connected the canisters to air sampling equipment prior to each sampling day. Prior to field sampling, the passivated canisters had internal pressures much lower than atmospheric pressure. Using this pressure differential, ambient air naturally flowed into the canisters automatically once an associated system solenoid valve was actuated. A mass flow controller on the sampling device inlet ensured that ambient air entered the canister at an integrated constant rate across the collection period. At the end of the 24-hour sampling period, the solenoid valve automatically stopped ambient air from flowing into the canister. Site operators recovered and returned the canisters to the ERG laboratory for analysis.

By analyzing each sample with gas chromatography incorporating mass spectrometry and flame ionization detection (GC/MS-FID), laboratory staff determined ambient air concentrations of 61 VOC, 80 SNMOC, and calculated the total nonmethane organic compounds (TNMOC) concentration. TNMOC is the sum of all hydrocarbon concentrations within the sample. Because isobutene and 1-butene elute from the GC column at the same time, the SNMOC analytical method reports only the sum of the concentrations for these two compounds, and not the separate concentration for each compound. The same approach applies to *m*-xylene and *p*-

xylene for both the VOC and SNMOC methods. These raw data are presented in Appendices C and D.

Laboratory analysts have indicated that acetonitrile values may be artificially high (or nonexistent) due to site conditions and potential cross-contamination with concurrent sampling of carbonyl compounds using Method TO-11A. The inclusion of acetonitrile in data analysis calculations needs to be determined on a site-specific basis by the agency responsible for the site. As such, acetonitrile results are excluded from certain program-wide and site-specific data analyses.

Table 2-3 presents the MDLs for the laboratory analysis of the VOC samples and Table 2-4 presents the MDLs for the analysis of SNMOC samples. The MDL for every VOC is lower than 0.042 parts per billion by volume (ppbv). SNMOC detection limits are expressed in parts per billion carbon (ppbC). All of the SNMOC MDLs are less than 0.76 ppbC.

Table 2-3. VOC Method Detection Limits

Pollutant	MDL (ppbv)	Pollutant	MDL (ppbv)	Pollutant	MDL (ppbv)
Acetonitrile	0.032	1,2-Dibromoethane	0.013	Methyl Isobutyl Ketone	0.016
Acetylene	0.027	*m*-Dichlorobenzene	0.015	Methyl Methacrylate	0.014
Acrolein	0.025	*o*-Dichlorobenzene	0.016	Methyl *tert*-Butyl Ether	0.009
Acrylonitrile	0.024	*p*-Dichlorobenzene	0.015	*n*-Octane	0.007
tert-Amyl Methyl Ether	0.011	Dichlorodifluoromethane	0.018	Propylene	0.039
Benzene	0.024	1,1-Dichloroethane	0.016	Styrene	0.012
Bromochloromethane	0.018	1,2-Dichloroethane	0.021	1,1,2,2-Tetrachloroethane	0.016
Bromodichloromethane	0.018	1,1-Dichloroethene	0.022	Tetrachloroethylene	0.011
Bromoform	0.014	*cis*-1,2-Dichloroethylene	0.017	Toluene	0.017
Bromomethane	0.025	*trans*-1,2-Dichloroethylene	0.016	1,2,4-Trichlorobenzene	0.040
1,3-Butadiene	0.018	Dichloromethane	0.015	1,1,1-Trichloroethane	0.016
Carbon Tetrachloride	0.015	1,2-Dichloropropane	0.019	1,1,2-Trichloroethane	0.017
Carbon Disulfide	0.021	*cis*-1,3-Dichloropropene	0.015	Trichloroethylene	0.018
Chlorobenzene	0.013	*trans*-1,3-Dichloropropene	0.015	Trichlorofluoromethane	0.022
Chloroethane	0.019	Dichlorotetrafluoroethane	0.021	Trichlorotrifluoroethane	0.021
Chloroform	0.017	Ethyl Acrylate	0.015	1,2,4-Trimethylbenzene	0.010
Chloromethane	0.027	Ethyl *tert*-Butyl Ether	0.008	1,3,5-Trimethylbenzene	0.010

Table 2-3. VOC Method Detection Limits (Continued)

Pollutant	MDL (ppbv)	Pollutant	MDL (ppbv)	Pollutant	MDL (ppbv)
Chloromethylbenzene	0.011	Ethylbenzene	0.012	Vinyl Chloride	0.024
Chloroprene	0.013	Hexachloro-1,3-butadiene	0.036	*m*,*p*-Xylene[1]	0.021
Dibromochloromethane	0.014	Methyl Ethyl Ketone	0.041	*o*-Xylene	0.012

[1] Because *m*-xylene and *p*-xylene elute from the GC column at the same time, the VOC analytical method reports the sum of *m*-xylene and *p*-xylene concentrations and not concentrations of the individual compounds.

Table 2-4. SNMOC Method Detection Limits[1]

Pollutant	MDL (ppbC)	Pollutant	MDL (ppbC)	Pollutant	MDL (ppbC)
Acetylene	0.18	*n*-Heptane	0.16	*n*-Octane	0.21
Benzene	0.30	1-Heptene	0.36	1-Octene	0.36
1,3-Butadiene	0.16	*n*-Hexane	0.22	*n*-Pentane	0.12
n-Butane	0.14	1-Hexene	0.49	1-Pentene	0.15
cis-2-Butene	0.16	*cis*-2-Hexene	0.49	*cis*-2-Pentene	0.26
trans-2-Butene	0.15	*trans*-2-Hexene	0.49	*trans*-2-Pentene	0.18
Cyclohexane	0.13	Isobutane	0.13	*α*-Pinene	0.49
Cyclopentane	0.11	Isobutene/1-Butene[2]	0.14	*β*-Pinene	0.49
Cyclopentene	0.26	Isopentane	0.12	Propane	0.17
n-Decane	0.29	Isoprene	0.23	*n*-Propylbenzene	0.34
1-Decene	0.49	Isopropylbenzene	0.33	Propylene	0.15
m-Diethylbenzene	0.49	2-Methyl-1-butene	0.26	Propyne	0.17
p-Diethylbenzene	0.39	3-Methyl-1-butene	0.26	Styrene	0.36
2,2-Dimethylbutane	0.17	2-Methyl-1-pentene	0.49	Toluene	0.34
2,3-Dimethylbutane	0.18	4-Methyl-1-pentene	0.49	*n*-Tridecane	0.75
2,3-Dimethylpentane	0.36	2-Methyl-2-butene	0.26	1-Tridecene	0.75
2,4-Dimethylpentane	0.19	Methylcyclohexane	0.16	1,2,3-Trimethylbenzene	0.35
n-Dodecane	0.75	Methylcyclopentane	0.11	1,2,4-Trimethylbenzene	0.47
1-Dodecene	0.75	2-Methylheptane	0.11	1,3,5-Trimethylbenzene	0.32
Ethane	0.15	3-Methylheptane	0.15	2,2,3-Trimethylpentane	0.36
2-Ethyl-1-butene	0.49	2-Methylhexane	0.17	2,2,4-Trimethylpentane	0.17
Ethylbenzene	0.17	3-Methylhexane	0.12	2,3,4-Trimethylpentane	0.17
Ethylene	0.13	2-Methylpentane	0.12	*n*-Undecane	0.36
m-Ethyltoluene	0.38	3-Methylpentane	0.18	1-Undecene	0.36
o-Ethyltoluene	0.48	*n*-Nonane	0.27	*m*-Xylene/*p*-Xylene[2]	0.27
p-Ethyltoluene	0.39	1-Nonene	0.48	*o*-Xylene	0.20

[1] Concentration in ppbC = concentration in ppbv x number of carbon atoms in compound.

[2] Because isobutene and 1-butene elute from the GC column at the same time, the SNMOC analytical method reports the sum of concentrations for these two compounds and not concentrations of the individual compounds. For the same reason, the *m*-xylene and *p*-xylene concentrations are reported as a sum.

2.2.2 Carbonyl Sampling and Analytical Method

Following the specifications of EPA Compendium Method TO-11A, ambient air samples for carbonyl analysis were collected by passing ambient air through cartridges containing silica gel coated with 2,4-dinitrophenylhydrazine (DNPH), a compound known to react selectively and reversibly with many aldehydes and ketones. Carbonyl compounds in ambient air are retained in the sampling cartridge, while other compounds pass through the cartridge without reacting with the DNPH-coated matrix. As with the VOC sampling, the ERG laboratory distributed the DNPH cartridges to the monitoring sites and site operators connected the cartridges to the air sampling equipment. After each 24-hour sampling period, site operators recovered and returned the cartridges to the ERG laboratory for chemical analysis.

To quantify concentrations of carbonyls in the sampled ambient air, laboratory analysts eluted the exposed DNPH cartridges with acetonitrile. High-performance liquid chromatography (HPLC) analysis and ultraviolet detection of these solutions determined the relative amounts of individual carbonyls present in the original air sample. Because butyraldehyde and isobutyraldehyde elute from the HPLC column at the same time, the carbonyl analytical method reports only the sum of the concentrations for these compounds, and not the separate concentration for each compound. For the same reason, the analytical method reports only the sum of the concentrations for the three tolualdehydes isomers, as opposed to reporting the separate concentration for the three individual compounds. These raw data are presented in Appendix E.

Table 2-5 lists the MDLs reported by the ERG laboratory for measuring concentrations of 15 carbonyl compounds. Although the sensitivity varies from pollutant-to-pollutant and from site-to-site due to the different volumes pulled through the samples, the average detection limit reported by the ERG laboratory for every pollutant is less than 0.013 ppbv.

Table 2-5. Carbonyl Method Detection Limits

Pollutant	Minimum MDL (ppbv)	Maximum MDL (ppbv)	Average MDL (ppbv)[1]
Acetaldehyde	0.0010	0.0400	0.0052
Acetone	0.0020	0.0720	0.0094
Benzaldehyde	0.0003	0.0100	0.0013
Butyraldehyde[1]	0.0007	0.0200	0.0027
Crotonaldehyde	0.0007	0.0220	0.0028
2,5-Dimethylbenzaldehyde	0.0004	0.0170	0.0022
Formaldehyde	0.0020	0.0960	0.0127
Hexaldehyde	0.0004	0.0130	0.0017
Isovaleraldehyde	0.0005	0.0150	0.0019
Propionaldehyde	0.0006	0.0190	0.0026
Tolualdehydes[1]	0.0010	0.0360	0.0047
Valeraldehyde	0.0006	0.0220	0.0028

[1] Because butyraldehyde/isobutyraldehyde elute from the HPLC column at the same time, the carbonyl analytical method can report only the sum of concentrations for these two compounds and not concentrations of the individual compounds. For the same reason, the analytical method also reports only the sum of concentrations for the three tolualdehydes isomers, as opposed to reporting separate concentrations for the three individual compounds.

2.2.3 Semivolatile Sampling and Analytical Method

Semivolatile sampling was performed in accordance with EPA Compendium Method TO-13A. The ERG laboratory supplied prepared sampling media and received the samples from the sites for analysis. Sample collection modules containing PUF and XAD-2® resin, petri dishes containing filters, and Chain of Custody forms and all associated documentation, were shipped to the ERG laboratory. Upon receipt of the collection modules, sample preparation and analysis procedures follow Compendium Method TO-13A. SVOC raw data are presented in Appendix F. Table 2-6 lists the MDLs for the 19 SVOC target pollutants. MDLs for SVOC ranged from 0.028 to 0.295 nanograms per cubic meters (ng/m^3).

Table 2-6. SVOC Method Detection Limits

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)
Acenaphthene	0.043	0.213	0.092
Acenaphthylene	0.032	0.158	0.069
Anthracene	0.050	0.248	0.108
Benzo (a) anthracene	0.048	0.238	0.103
Benzo (a) pyrene	0.043	0.216	0.094
Benzo (b) fluoranthene	0.050	0.251	0.109

Table 2-6. SVOC Method Detection Limits (Continued)

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)
Benzo (e) pyrene	0.049	0.246	0.107
Benzo (g,h,i) perylene	0.044	0.221	0.096
Benzo (k) fluoranthene	0.051	0.254	0.110
Chrysene	0.044	0.221	0.096
Coronene	0.039	0.194	0.084
Dibenz (a,h) anthracene	0.049	0.246	0.107
Fluoranthene	0.028	0.142	0.062
Fluorene	0.044	0.221	0.096
Indeno(1,2,3-cd)pyrene	0.047	0.232	0.101
Naphthalene	0.057	0.287	0.124
Perylene	0.050	0.251	0.109
Phenanthrene	0.059	0.295	0.128
Pyrene	0.035	0.175	0.076

2.2.4 Metals Sampling and Analytical Method

Sampling for the determination of metals in or on particulate matter was performed by the sites in accordance with EPA Compendium Method IO-3.5. Filters with Chain of Custody forms and all associated documentation were shipped to the ERG laboratory from the field. Upon receipt, the filters were analyzed by the ERG laboratory. Metals raw data are presented in Appendix G.

Table 2-7 lists the MDLs for the analysis of the metal samples. Two types of filters were utilized. Sites sampled for either PM_{10} or Total Suspended Particulate (TSP), depending on the site objectives, using either 47 mm Teflon® or 8 x 10” quartz filters. The different filter types correspond to separate and distinct sampling apparatuses: the 47mm Teflon® filter is used for low-volume samplers, where as the 8 x 10” quartz filter is used for high-volume samplers. Due to the difference in sample volume/filter collection media, there are two sets of MDLs listed in Table 2-7. The MDLs ranged from 0.006 to 0.948 ng/m^3 for the quartz filters and from 0.06 to 3.88 ng/m^3 for the Teflon® filters.

Table 2-7. Metals Method Detection Limits

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)	Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)
8 X 10" Quartz Filters				**47mm Teflon® Filters**			
Antimony	0.006	0.067	0.010	Antimony	0.060	0.230	0.193
Arsenic	0.009	0.060	0.009	Arsenic	0.060	0.280	0.237
Beryllium	0.012	0.133	0.020	Beryllium	0.120	0.300	0.262
Cadmium	0.008	0.057	0.008	Cadmium	0.070	0.200	0.170
Chromium	0.142	0.948	0.144	Chromium	0.340	3.880	3.217
Cobalt	0.009	0.067	0.010	Cobalt	0.060	0.260	0.218
Lead	0.018	0.181	0.023	Lead	0.310	0.430	0.392
Manganese	0.016	0.156	0.017	Manganese	0.100	0.260	0.225
Mercury	0.009	0.062	0.009	Mercury	0.190	0.270	0.244
Nickel	0.088	0.587	0.089	Nickel	0.300	0.880	0.759
Selenium	0.018	0.120	0.018	Selenium	0.160	0.350	0.196

2.2.5 Hexavalent Chromium Sampling and Analytical Method

Hexavalent chromium was measured using an EPA-approved approach. For a detailed description of the method, refer to the "Standard Operating Procedure for the Determination of Hexavalent Chromium in Ambient Air Analyzed by Ion Chromatography (IC)" (EPA, 2006b). The MDL is experimentally determined at the ERG laboratory for each site; the average MDL for the program, which is presented in Table 2-8, was 0.0079 ng/m^3. Raw data are presented in Appendix H.

Table 2-8. Hexavalent Chromium Method Detection Limit

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)
Hexavalent Chromium	0.0062	0.0118	0.0079

2.3 Sample Collection Schedules

Table 2-9 presents the first and last date on which sample collection occurred for each monitoring location. The monitoring sites started sampling in January 2007 and stopped sampling in December 2007, with a few exceptions. Seven sites began sampling after January 2007:

- Los Angeles, CA site (CELA) started in April 2007;

- Decatur, GA site (SDGA) started sampling SVOC in April 2007;
- Rubidoux, CA site (RUCA) started sampling in May 2007;
- South Phoenix, AZ site (SPAZ) started in July 2007;
- Phoenix, AZ site (PXSS) started sampling VOC, SVOC, and carbonyls in July 2007;
- Rochester, NY site (ROCH) started in October 2007; and
- Bronx, NY site (BXNY) started in October 2007.

Five sites ended sampling before December 2007:

- Davie, FL site (FLFL) ended in March 2007;
- Decatur, GA site (SDGA) stopped sampling hexavalent chromium in September 2007;
- Indianapolis, IN site (ININ) stopped sampling hexavalent chromium in October 2007;
- Puerto Rico sites (BAPR and SJPR) ended in June 2007.

According to the NATTS/UATMP schedule, 24-hour integrated samples were to be collected at every monitoring site every 1-in-6 or 1-in-12 days (dependent upon location) and each sample collection began and ended at midnight, local standard time. Table 2-9 shows the following:

- VOC and carbonyl samples were collected concurrently at 23 sites.
- Of the 50 sites, 13 did not sample for VOC and/or carbonyls.
- Five sites sampled SVOCs.
- Five sites collected SNMOC samples.
- 11 sites collected metal samples.
- 19 sites collected hexavalent chromium samples.

Table 2-9. Sampling Schedules and Completeness

Site	**Monitoring Period**[a]		**Carbonyl**			**VOC**			**Hexavalent Chromium**			**Metals**			**SNMOC**			**SVOC**		
	Starting Date	**Ending Date**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
AZFL	1/6/07	12/26/07	60	60	100															
BAPR	1/6/07	6/29/07	29	29	100	30	30	100												
BOMA	1/6/07	12/26/07							60	61	98	59	59	100						
BTUT	1/6/07	12/26/07	60	62	97	55	63	87	60	62	97	57	57	100	55	63	87			
BXNY	10/4/07	12/26/07							15	15	100									
CAMS 35	1/18/07	12/26/07				57	57	100												
CAMS 85	1/6/07	12/26/07				52	58	90												
CANJ	1/6/07	12/20/07	57	59	97	57	58	98												
CELA	4/30/07	12/26/07																39	41	95
CHNJ	1/6/07	12/26/07	55	62	89	52	62	84												
CHSC	1/6/07	12/26/07							58	62	94									
CNEP	1/6/07	12/26/07				55	59	93												
CUSD	1/6/07	12/26/07	60	60	100	60	60	100							60	60	100			

[a] Begins with 1st valid sample

A = Valid Samples

B = Total Number of Samples

C = Completeness (%)

BOLD = EPA-designated NATTS site.

Shading indicates a completeness below the DQO of 85%.

Table 2-9. Sampling Schedules and Completeness (Continued)

Site	Monitoring Period[a]		Carbonyl			VOC			Hexavalent Chromium			Metals			SNMOC			SVOC		
	Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
DEMI	1/6/07	12/26/07	58	58	100	59	60	98	61	62	98									
ELNJ	1/6/07	12/26/07	56	60	93	61	62	98												
FLFL	1/12/07	3/13/07	10	11	91															
GAFL	1/6/07	12/26/07	60	62	97															
GPCO	1/6/07	12/26/07	64	64	100	62	64	97	59	61	97									
GPMS	1/6/07	12/25/07	62	62	100	61	62	98							61	62	98			
HAKY	1/6/07	12/26/07							60	61	98									
IDIN	1/6/07	12/26/07	59	62	95							60	60	100						
INDEM	1/6/07	12/26/07	60	60	100															
ININ	1/6/07	12/26/07	61	63	97				50	51	98	60	60	100						
ITCMI	1/6/07	12/26/07																55	57	96
LDTN	1/6/07	12/27/07	62	65	95	60	64	94												
MSTN	1/6/07	12/27/07	59	63	94	60	63	95												

[a] Begins with 1st valid sample
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)
BOLD = EPA-designated NATTS site.
Shading indicates a completeness below the DQO of 85%.

Table 2-9. Sampling Schedules and Completeness (Continued)

Site	Monitoring Period[a]		Carbonyl			VOC			Hexavalent Chromium			Metals			SNMOC			SVOC		
	Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
MVWI	1/6/07	12/26/07							60	62	97									
NBIL	1/6/07	12/26/07	58	60	97	60	60	100	61	61	100	58	59	98	60	60	100			
NBNJ	1/6/07	12/26/07	61	65	94	60	65	92												
ORFL	1/6/07	12/26/07	58	58	100															
PRRI	1/6/07	12/26/07							60	61	98									
PXSS	1/6/07	12/26/07	30	30	100	27	28	96	57	62	92	59	61	97				28	30	93
ROCH	10/3/07	12/26/07							13	15	87									
RUCA	5/6/07	12/26/07																32	32	100
S4MO	1/6/07	12/26/07	60	61	98	61	61	100	58	60	97	60	60	100						
SDGA	1/6/07	12/26/07							41	45	91							41	42	98
SEWA	1/6/07	12/26/07	59	60	98	60	60	100	60	61	98	60	60	100						
SFSD	1/6/07	12/26/07	59	59	100	59	59	100							59	59	100			
SJPR	1/6/07	6/29/07	29	29	100	29	29	100												

[a] Begins with 1st valid sample
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)
BOLD = EPA-designated NATTS site.
Shading indicates a completeness below the DQO of 85%.

Table 2-9. Sampling Schedules and Completeness (Continued)

Site	Monitoring Period[a]		Carbonyl			VOC			Hexavalent Chromium			Metals			SNMOC			SVOC		
	Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
SKFL	1/6/07	12/26/07	60	62	97															
SPAZ	7/5/07	12/26/07				14	15	93												
SPIL	1/6/07	12/26/07	60	60	100	58	60	97												
SYFL	1/6/07	12/26/07	60	60	100				60	62	97									
TOOK	1/6/07	12/26/07	61	63	97	60	63	95				59	59	100						
TSOK	1/6/07	12/26/07	58	59	98	59	60	98				56	58	97						
TUMS	1/6/07	12/26/07	58	60	97	61	61	100												
TUOK	1/6/07	12/26/07	61	63	97	59	62	95				58	59	98						
UNVT	1/6/07	12/26/07							60	62	97									
WADC	1/6/07	12/26/07							60	62	97									
WPIN	1/6/07	12/26/07	56	58	97															
Overall			1,820	1,869	97	1,448	1,505	96	1,013	1,048	97	646	652	99	295	304	97	195	202	97

[a] Begins with 1st valid sample

A = Valid Samples

B = Total Number of Samples

C = Completeness (%)

BOLD = EPA-designated NATTS site.

Shading indicates a completeness below the DQO of 85%.

As part of the sampling schedule, site operators were instructed to collect duplicate samples on roughly 10 percent of the sampling days for select methods when duplicate samplers were available. Sampling calendars were distributed to help site operators schedule the collection of samples, duplicates, and field blanks. Field blanks were collected once a month for carbonyl compounds, hexavalent chromium, metals, and SVOCs. In cases where monitors failed to collect valid samples on a given scheduled sampling day, site operators were instructed to reschedule samples for other days. This practice explains why some monitoring locations periodically strayed from the 1-in-6 or 1-in-12 day sampling schedule.

The 1-in-6 or 1-in-12 day sampling schedule provides cost-effective approaches to data collection for trends characterization of toxic pollutants in ambient air and ensures that sampling days are evenly distributed among the seven days of the week to allow weekday/weekend comparison of air quality. Because the 1-in-6 day schedule yields twice the number of measurements than the 1-in-12 day schedule, data characterization based on this schedule tends to be more representative.

2.4 Completeness

Completeness refers to the number of valid samples collected and analyzed compared to the number of total samples attempted. Monitoring programs that consistently generate valid results have higher completeness than programs that consistently have invalid samples. The completeness of an air monitoring program, therefore, can be a qualitative measure of the reliability of air sampling and laboratory analytical equipment and a measure of the efficiency with which the program was managed. Appendix I identifies samples that were invalidated and lists the specific reasons.

The following observations summarize the completeness of the monitoring data sets collected during the 2007 NATTS/UATMP, as shown in Table 2-9:

- For VOC sampling, the completeness ranged from 84 to 100 percent, with an overall completeness of 96 percent;

- For carbonyl sampling, the completeness ranged from 89 to 100 percent with an overall completeness of 97 percent;

- For SNMOC sampling, the completeness ranged from 87 to 100 percent with an overall completeness of 97 percent;

- For SVOC sampling, the completeness ranged from 93 to 100 percent with an overall completeness of 97 percent;

- For metals sampling, the completeness ranged from 97 to 100 percent with an overall completeness was 99 percent; and

- For hexavalent chromium sampling, the completeness ranged from 87 to 100 percent, with an overall completeness was 97 percent.

The data quality objective (DQO) for completeness based on the EPA-approved Quality Assurance Project Plan (QAPP) specifies that 85-100 percent of samples collected at a given monitoring site must be analyzed successfully to be considered sufficient for data trends analysis (ERG, 2006/2007). The data in Table 2-9 shows that one data set (from a total of 100 data sets) from the 2007 NATTS and UATMP monitoring sites did not meet this data quality objective (shaded in Table 2-9). The CHNJ VOC data set was just below the 85 percent completeness criteria (84 percent). This data set was lower than the 85 percent criteria because the site experienced continual sampler malfunction. However, the sampler was exchanged mid-year, and the sampler performance improved.

3.0 Summary of the 2007 NATTS/UATMP Data Treatment and Methods

This section summarizes the data treatment and methods used to evaluate the data collected during the 2007 NATTS/UATMP sampling year. These data were analyzed on a program-wide basis as well as a site-specific basis. Results from the program-wide data analyses are presented in Section 4.0 and results from the site-specific data analyses are presented in the individual state sections, Sections 5.0 through 31.0.

A total of 190,745 valid urban air toxics concentrations (including non-detect, duplicate analyses, replicate analyses, and analyses for collocated samples) were collected at 50 sites for the 2007 NATTS/UATMP reporting year. A tabular presentation of the raw data and statistical summary is found in Appendices C through O as follows:

Table 3-1. Overview and Layout of Data Presented

Pollutant Group	# Sites	Appendix	
		Raw Data	Statistical Summary
VOC	27	C	J
SNMOC	5	D	K
Carbonyls	33	E	L
SVOC	5	F	M
Metals	11	G	N
Hexavalent Chromium	19	H	O

3.1 Data Treatment

Section 3.0 examines the various statistical tools employed to characterize the data collected during the 2007 sampling year. Certain data analyses were performed at the program-level, other data analyses were performed both at a program-level and site-specific basis, and still other approaches were reserved for site-specific data analyses only. Regardless of the data analysis employed, it is important to understand how the concentration data were treated. The following paragraphs describe techniques used to prepare this large quantity of data for data analysis.

All duplicate (or collocated) and replicate measurements were averaged in order to calculate a single concentration for each pollutant for each sampling day at each site. This is referred to as the *preprocessed daily measurement*.

Concentrations of *m,p*-xylene and *o*-xylene were summed together and are henceforth referred to as “total xylenes,” “xylenes (total),” or simply “xylenes” throughout the remainder of this report, with a few exceptions. Section 4.1 examines the results of basic statistical calculations performed on the dataset. However, in Table 4-1 and Table 4-4, which are the method-specific statistics for VOC and SNMOC, respectively, the xylenes results are retained as *m,p*-xylene and *o*-xylene species. This is also true of the Quality Assurance section (Section 31.0).

In order to compare concentrations across multiple sampling methods, all concentrations have also been converted to a common unit of measure: microgram per cubic meter ($\mu g/m^3$). However, whenever a particular sampling method is isolated from others, such as in Tables 4-1 through 4-6, the statistical parameters are presented in the units of measure associated with the particular sampling method. As such, it is important to pay very close attention to the unit of measure associated with each analysis discussed in this and subsequent sections of the report.

3.2 Approach to Risk Screening and Pollutants of Interest

Each year, a subset of pollutants is selected for further data analyses. A practical approach to making an assessment on a large number of measurements is to focus on a subset of pollutants based on the end-use of the dataset. In UATMP reports prior to 2003, this subset was based on the frequency and magnitude of concentrations (previously called “prevalent compounds”). Since the 2003 UATMP report, risk-based calculations have been used to identify “pollutants of interest.” EPA defines risk as “the probability that damage to life, health, and/or the environment will occur as a result of a given hazard (such as exposure to a toxic chemical)” (EPA, 2006c). For the 2007 NATTS/UATMP report, the pollutants of interest are also based on risk potential.

EPA has published a guidance document outlining a risk screening approach that utilizes a risk-based methodology for performing an initial screen of ambient air toxics monitoring data sets (EPA, 2006d). This screening process provides a risk-based methodology for analysts and interested parties to identify which pollutants may pose a risk in their area. Not all NATTS/UATMP pollutants have screening values; of the 172 pollutants sampled under these programs, 106 pollutants have screening values. Those that have screening values are also referred to as HAPs, since they are known or suspected to cause cancer or other serious health effects such as reproductive effects or birth defects, or adverse environmental and ecological effects. EPA is required to control 188 HAPs (EPA, 2007c). The screening values used in this analysis are presented in Appendix P.

Preprocessed daily measurements of the target pollutants were compared to these risk screening values in order to identify pollutants of interest across the program. The following risk screening process was completed to identify pollutants of interest:

1. If a pollutant was measured by two separate methods at the same site and that yield similar results, such as measuring benzene with VOC and SNMOC methods, then the two concentrations were averaged together. The purpose was to have one concentration per pollutant per day per site. Metals sampled from different sized particulate matter yield different results. Therefore, the results were not averaged together.

2. Each 24-hour speciated measurement was compared against the screening value. Concentrations that were greater than the screening value are described as "failing the screen."

3. The number of failed screens was summed for each applicable pollutant. The number of failures for each metal was summed together to determine the total number of failed screens for each applicable pollutant.

4. The percent contribution of the number of failed screens to the total number of failed screens program-wide was calculated for each applicable pollutant.

5. The pollutants contributing to the top 95 percent of the total failed screens were identified as pollutants of interest.

In regards to step 5, the actual cumulative contribution may exceed 95 percent in order to include all pollutants contributing to the minimum 95 percent criteria (refer to Table 4-7 for an example). In addition, if the 95 percent cumulative criterion is reached, but the next pollutant contributed equally to the number of failed screens, that pollutant was also designated as a pollutant of interest. Results of the risk screening process are provided in Section 4.2.

3.3 Risk Screening Evaluation Using Minimum Risk Levels

In addition to the risk screening described above, a risk screening was also conducted using the Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Level (MRL) factors (ATSDR, 2007a). An MRL is a concentration of a hazardous substance that is “without appreciable risk of adverse noncancer health effects over a specified duration of exposure” (ATSDR, 2007b). MRLs are intended to be used as screening tools, similar to the risk screening approach discussed above. ATSDR defines MRLs for three durations of exposure: acute, intermediate, and chronic exposure. Acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. For this risk screening evaluation, the preprocessed daily measurements were compared to the acute MRLs; seasonal averages were compared to the intermediate MRL; and annual averages were compared to the chronic MRL.

The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDL substitutions for all non-detects. The substitution of 1/2 MDL for non-detects may have a significant impact on pollutants that are rarely measured at or above the associated detection limit and/or have a relatively high MDL. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. The spring season included concentrations from March, April, and May; summer includes June, July, and August; autumn includes September, October, and November; and winter includes December, January, and February. An *annual* average includes all measured detections and 1/2 MDL substituted values for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November, and where method completeness was greater than or equal to 85 percent. Although this analysis was based on site-specific concentrations and averages, the number of exceedances has been summed to the program-level.

ATSDR recently published an updated acute MRL for acrolein. The previous acute MRL was 0.11 ug/m^3; the new acute MRL is 7 ug/m^3, which is an order of magnitude higher than the previous MRL. ATSDR updated the acute MRL for acrolein based on a higher Lowest Observed Adverse Effect Level (LOAEL) of 0.3 ppm and with endpoints of decrease in respiratory rate and nose and throat irritations, as documented in ATSDR's 2007 toxicological profile for acrolein (ATSDR, 2007c). The basis for the former acute MRL is documented in the 1990 toxicological profile for acroelin (ATSDR, 1990). As a result of the new acute MRL, considerably fewer exceedances of the acute MRL are expected. The intermediate MRL (0.09 ug/m^3) for acrolein used in the 2006 UATMP report is still applicable. The MRLs used in this analysis have one significant figure and are presented in Appendix P.

CAL EPA relative exposure limits (RELs) were used for acute risk assessment in addition to the ATSDR MRLs in the 2006 UATMP report. These factors are no longer being used because the duration of exposure is generally 1 hour, which was determined to be too dissimilar to the 24-hour concentrations for a legitimate comparison.

3.4 Pearson Correlations

This report uses Pearson correlation coefficients to measure the degree of correlation between two variables. By definition, Pearson correlation coefficients always lie between -1 and +1. Three qualification statements apply:

- A correlation coefficient of -1 indicates a perfectly Anegative@ relationship, indicating that increases in the magnitude of one variable are associated with proportionate decreases in the magnitude of the other variable, and vice versa.
- A correlation coefficient of +1 indicates a perfectly Apositive@ relationship, indicating that the magnitudes of two variables both increase and both decrease proportionately.
- Data that are completely uncorrelated have Pearson correlation coefficients of 0.

Therefore, the sign (positive or negative) and magnitude of the Pearson correlation coefficient indicate the direction and strength, respectively, of data correlations. In this report, correlation coefficients greater than 0.50 or less than -0.50 are classified as strong, while correlation coefficients less than 0.50 and greater than -0.50 are classified as weak.

When calculating correlations among the NATTS/UATMP data, several measures were taken to identify spurious correlations and to avoid introducing bias to the correlations:

- Data correlations were calculated only for the program-level pollutants of interest, which are identified in Section 4.2, or the site-specific pollutants of interest identified in each state section.

- Correlations were calculated from the processed NATTS/UATMP monitoring data in which each pollutant has just one numerical concentration for each successful sampling date, or the preprocessed daily measurements. Non-detects were not included in this analysis.

The number of observations used in a calculation is an important factor to consider when analyzing the correlations. A correlation using few observations may skew the correlation, making the degree of correlation appear higher than it may actually be. In this report, five data points must be available to present a correlation.

Pearson correlation coefficients are used in several different ways in this report, including determining the degree of correlation between concentration data and meteorological conditions as well as between concentration data and site-characterizing variables such as motor vehicle activity.

3.5 Additional Program-Level Analyses of the 2007 NATTS/UATMP Dataset

This section provides a summary of additional analyses performed on the 2007 NATTS/UATMP dataset at the program level. Additional program-level analyses include an examination of the potential impact of motor vehicles and a review of how concentrations vary among the sites themselves and from season-to-season. The results of these analyses are presented in Sections 4.3 and 4.4.

3.5.1 The Impact of Mobile Source Emissions on Spatial Variations

Mobile source emissions from motor vehicles contribute significantly to air pollution in urban environments. “Mobile sources” refer to emitters of air pollutants that move, or can be moved, from place to place and include both on-road and non-road emissions (EPA, 2008a). Pollutants found in motor vehicle exhaust generally result from incomplete combustion of vehicle fuels. Although modern vehicles and, more recently, vehicle fuels have been engineered to minimize air emissions, all motor vehicles with internal combustion engines emit a wide range of chemical pollutants. The magnitude of these emissions in urban areas primarily depends on the volume of traffic, while the chemical profile of these emissions depends more on vehicle design and fuel formulation. This report uses a variety of parameters to quantify and evaluate the impact of motor vehicle emissions on ambient air quality, which are discussed further in Section 4.3:

- Emissions data from the NEI;
- Total hydrocarbon concentrations;
- Motor vehicle ownership data;
- Estimated daily traffic volume;
- Vehicle miles traveled (VMT);
- BTEX concentration profiles; and
- Ethylene-Acetylene tracer analysis.

3.5.2 Variability Analyses

Variability refers to the degree of difference among values in a data set. Two types of variability are analyzed for this report. The first type examines the coefficient of variation for each of the pollutants of interest across the NATTS/UATMP sites. The coefficient of variation provides a relative measure of variability by expressing standard deviation to the magnitude of the arithmetic mean. It is particularly useful when comparing different sets of data because it is unitless (Taylor, et al.,1999). In this report, variability across data distributions for different sites and different pollutants are compared. The coefficients of variation are shown in the form of a scatter plot, where data points represent the coefficients of variation and a trend line is plotted to show linearity. Pollutants of interest whose data points are clustered together indicate uniformity in how the concentrations are dispersed among the sites. This suggests that concentrations are affected by typical and consistent sources (e.g., mobile sources). Data points that are not clustered suggest the likelihood of a stationary source not typically found in most urban areas (e.g., coke manufacturing facility).

Seasonal variability is the second type of variability assessed in this report. The concentration data for each site were divided into the four seasons, as described in Section 3.3. The measured detection criteria, also described in Section 3.3, is maintained here as well. The site-specific calculated seasonal averages are illustrated by bar graphs for each pollutant of interest. This analysis allows the reader to determine if there is a seasonal correlation with the magnitude of concentrations for a specific pollutant. The seasonal analysis should agree somewhat with the Pearson coefficient correlations calculated on the site-specific level, and are discussed further in the state sections.

3.5.3 Greenhouse Gas Assessment

Currently, there is considerable discussion about climate change amongst atmospheric and environmental scientists. Climate change refers to an extended period of change in meteorological variables used to determine climate, such as temperature and precipitation. Greenhouse gases (GHGs) are those that cause heat to be retained in the atmosphere (EPA, 2008b). Many scientists agree that the atmospheric temperature is increasing. As such, a great deal of research on the relationship between greenhouse gases and climate change has been conducted and continues to be investigated.

Agencies researching the effects of greenhouse gases tend to concentrate primarily on tropospheric levels of these gases. The troposphere is the lowest level of the atmosphere, which extends between 5 and 12 miles high, depending on season and latitude. This is also the layer in which weather phenomenon occur (Weather Questions.com). A handful of VOCs measured with the Method TO-15 are greenhouse gases, although these measurements reflect the concentration at the surface, or in the breathing zone, and do not represent the entire troposphere. Section 4.5 presents the 10 GHGs currently measured with the Method TO-15, their Global Warming Potential (GWP), and the average concentration across the program. GWP is a way to determine a pollutant's ability to retain heat relative to carbon dioxide, which is one of the predominant anthropogenic GHGs in the atmosphere (EPA, 2008c and NOAA, 2008). In the future, additional GHG pollutants may be added to the Method TO-15 target pollutant list in order to assess their surface level ambient concentrations.

3.6 Additional Site-Specific Analyses

In addition to many of the analyses described in the preceding sections, the state-specific sections (5.0 through 31.0) contain additional analyses that are applicable only at a local level. This section provides an overview of these analyses but does not discuss their results. Results of these site-specific analyses are presented in the state-specific sections.

3.6.1 Emission Tracer Analysis

Pollution roses were created for each of the site-specific pollutants of interest that exceeded the acute risk factors to help identify the geographical area where the emission sources of these pollutants may have originated. A pollution rose is a plot of the ambient concentration versus the unit vector of the wind direction; high concentrations can be shown in relation to the direction of potential emissions sources.

3.6.2 Back Trajectory Analysis

A back trajectory traces the origin of an air parcel in relation to the location where it is currently being measured. The method of constructing a back trajectory uses the Lagrangian frame of reference. In simplest terms, an air parcel can be traced back one hour to a new point of reference based on the current measured wind speed and direction. At this new point of reference (that is now one hour prior to the current observation), the wind speed and direction are used again to determine where the air was one hour before. Back trajectory calculations are also governed by other meteorological parameters, such as pressure and temperature. Each time segment is referred to as a “time step.” Although back trajectories may be modeled for extended periods of time (weeks), trajectories for this report were constructed for durations of 24 hours to match the 24-hour sampling duration.

Gridded meteorological data and the model used for back trajectory analyses were prepared and developed by the National Oceanic and Atmospheric Administration (NOAA) using data from the National Weather Service (NWS) and other cooperative agencies. The model used is the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) (Draxler, R.R. and Rolph, G.D., 2003). Back trajectories were computed for each sampling day, and a composite back trajectory map was constructed for each monitoring site using Geographical

Information System (GIS) software. Trajectories are modeled with an initial height of 250 meters above ground level (AGL), and each sampling day's trajectory is plotted to create a composite back trajectory map. One value of the composite back trajectory map is the estimation of a 24-hour air shed domain for each site. An air shed domain is the geographical area surrounding a site from which an air parcel may typically travel within the 24-hour time frame. Agencies can use the air shed domain to evaluate regions where long-range transport may affect their monitoring site.

3.6.3 Wind Rose Analysis

Wind roses were constructed for each site to help identify the predominant direction from which the wind blows. A wind rose shows the frequency of wind directions on a 16-point compass, and uses color or shading to represent wind speeds. Wind roses are constructed by uploading hourly surface wind data from the nearest weather station into a wind rose software program, WRPLOT (Lakes, 2006). A wind rose is often used in determining where to install an ambient monitoring site when trying to capture emissions from an upwind source. A wind rose may also be useful in determining whether high concentrations correlate with a specific wind direction. While the composite back trajectory maps show where a parcel of air originated on a number of days, the wind rose shows the frequency at which wind speed and direction are measured near the monitoring site. Thus, the back trajectory analysis focuses on long range transport, while the wind rose captures day-to-day fluctuations at the surface. Both are used to identify potential meteorological influences on the monitoring sites.

3.6.4 Site Trends Analysis

Table 2-2 presented current monitoring sites that have participated in the NATTS/UATMP in previous years. Site-specific trends analyses were conducted for sites with at least five years of data analyzed under the National Monitoring Programs contract. The approach to this trends analysis is described below and the results are presented in the individual state sections (Sections 5.0 through 31.0).

In previous years, trends graphs were created for sites with three years of concentration data for formaldehyde, benzene, and 1,3-butadiene. Beginning with the 2007 report, site-specific trends graphs for each of the NATTS core compounds are presented (EPA, 2007a), based on the availability of data. NATTS core compounds are those that the program has chosen to focus on due to their ability to adversely affect human health. The six NATTS core compounds are as follows:

- acrolein (measured by Method TO-15);
- arsenic (as measured by Method IO-3.5);
- benzene (as measured by both Method TO-15 and SNMOC method);
- 1,3-butadiene (measured by Method TO-15 method);
- formaldehyde (measured by Method TO-11A method); and
- hexavalent chromium (as measured by the EPA-approved method developed by ERG).

Trends graphs from previous UATMP reports presented all three pollutants' concentrations on one graph. Due to the large variation in magnitude of the concentrations among the pollutants and the sites, each figure for this year's trends analysis presents data for one pollutant only, thus enabling the reader to better interpret the figures.

The trends figures and subsequent analysis for the 2007 report are presented as three-year rolling statistical metrics. In previous reports, daily averages, as defined in Section 3.3, were presented in bar graphs for each year for sites with at least three years of data analyzed under the National Monitoring Programs contract. For 2007, the following criteria were used to calculate valid rolling statistical metrics:

- Sampling for one or more of the NATTS core compounds;
- analysis performed under the National Monitoring Programs contract; and
- at least five years of concurrent data.

For the 2007 program year, 18 sites met the criteria for three-year rolling statistical metrics to be calculated.

The three-year rolling statistical metrics graphs are presented as box and whisker plots or simply boxplots, an example of which can be seen in Figure 9-22. Boxplots show the minimum and maximum concentration measured during the three-year period (as shown by the upper and lower value of the lines extending from the box); the first, second, and third quartiles, or 25th, 50th (or median), and 75th percentiles, (as shown by the y-values corresponding with the bottom, gray line, or top of the box, respectively); and the three-year rolling average concentration (as denoted by the white diamond). Each rolling metric represents all measurements from that three year period. The inclusion of the rolling average, which is traditionally not represented in a box and whisker plot, allows for a smoothing of raw data in order to identify long-term trends (Stockcharts.com).

Data used in this analysis were downloaded from EPA's AQS database (EPA, 2008d). Non-detects are uploaded into AQS as zeros (EPA, 2007a), thus, the approach for calculating rolling averages presented in this section is slightly different than approaches used in other data analyses in the 2007 report. As such, zeros representing non-detects were used in these calculations. However, samples with precision data (duplicates, collocates, and/or replicates) were still averaged together to allow for the determination of a single concentration value per pollutant per site per date, reflecting the data treatment described in Section 3.1.

3.6.5 Cancer and Noncancer Surrogate Risk Approximations

In February 2006, EPA released the results of its national-scale air toxics assessment, NATA, for base year 1999 (EPA, 2006c). NATA uses the NEI for HAP as its starting point, but also incorporates ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. Cancer and noncancer risk factors are then applied to the modeled concentrations to yield census tract-level cancer and noncancer risk values.

Cancer risk is defined as the likelihood of developing cancer as a result of exposure over a 70-year period, and is presented as the number of people at risk for cancer per million people (EPA, 2006c). The cancer risks presented in this report estimate the cancer risk due to exposure at the modeled concentration over a 70-year period, not the risk resulting from exposure over the time period covered in this report. A cancer risk greater than 1.0 in-a-million is considered significant. Noncancer risk is presented as the Noncancer Hazard Quotient (HQ). Noncancer health effects include conditions such as asthma. "If the HQ is calculated to be less than 1.0, then no adverse health effects are expected as a result of exposure, if the HQ is greater than 1.0 the adverse health effects are possible" (EPA, 2006c). NATA is a useful resource that helps federal and state/local/tribal agencies identify potential areas of air quality concern.

NATA risk factors applied to calculate cancer and noncancer risks are typically cancer unit risk estimates (UREs) and noncancer reference concentrations (RfCs), which are developed by EPA. However, UREs and RfCs are not available for all pollutants. In the absence of EPA values, risk factors developed by agencies with credible methods and that are similar in scope and definition were used (EPA, 2005b).

National pollutant drivers are those that affect more than 25 million people, whereas regional driver pollutants affect more than 10 million people, as defined by NATA. Several of the program-level and site-specific pollutants of interest are HAP that were identified as NATA driver pollutants (EPA, 2006c):

- acrolein (national noncancer);
- benzene (national cancer);
- 1,3-butadiene (regional cancer and noncancer);
- carbon tetrachloride (regional cancer);
- tetrachloroethylene (regional cancer).

Chronic cancer and noncancer risk estimates were retrieved from the 1999 NATA for each site's respective census tract (e.g., the CNEP monitoring site is located in census tract 40097040400). Using the cancer URE and noncancer RfC factors, modeled census tract-level concentrations were back-calculated for any pollutants that failed at least one screen for each monitoring site. NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Census tract-level data from EPA's 1999 NATA are presented in each state section.

Cancer URE and noncancer RfC factors can be applied to the annual averages to approximate surrogate chronic risk estimates based on ambient monitoring data. While these risk approximations do not incorporate human activity patterns and therefore do not reflect true human inhalation exposure, they may allow analysts to further refine their focus by 1) identifying concentrations of specific pollutants that may present health risks and 2) determining if the approximations are similar or dissimilar to the results from NATA. Cancer UREs and/or noncancer RfCs, site-specific annual averages, and corresponding annual average-based surrogate chronic risk approximations are presented in each state section.

It is important to note that although the most recent results from NATA were published in 2006, they are based on emissions data for the base year 1999. EPA cautions users of NATA from making direct comparisons across different base years. Although it may be useful to see if the concentration profiles are similar, readers must exercise caution when interpreting the results presented in these tables and drawing conclusions, given the age of the data from NATA. According to EPA, the results from NATA may be used to prioritize pollutants and emission sources, identify locations of interest for further investigation, provide a starting point for local-scale assessments, focus community efforts, and inform monitoring programs, but should not be used as a sole means for identifying localized hotspots, as a definitive means to pinpoint specific risk values within a census tract, to characterize or compare risks at local levels such as between neighborhoods, as the sole basis for developing risk reduction plans or regulations, to control specific sources or pollutants, or quantify benefits of reduced air toxic emissions (EPA, 2008f).

3.6.6 Risk-Based Emissions Assessment

A pollutant emitted in high quantities does not necessarily present a higher risk to human health than a pollutant emitted in very low quantities. The more toxic the pollutant, the more risk associated with its emissions in ambient air. The development of various health-based risk factors has allowed analysts to apply weight to the emissions of pollutants based on toxicity rather than mass emissions. This approach incorporates both a pollutant’s toxicity potential and the quantity emitted.

This assessment compares county-level emissions to toxicity-weighted emissions based on the EPA-approved approach described below (EPA, 2007b). The 10 pollutants with the highest total mass emissions and the associated toxicity-weighted emissions for pollutants with cancer and noncancer toxicity factors are presented in each state section. While the absolute magnitude of the pollutant-specific toxicity-weighted emissions is not meaningful, the relevant magnitude of toxicity-weighted emissions is useful in identifying the order of potential priority for air quality managers. Higher values suggest greater priority; however, even the highest values may not reflect potential cancer effects greater than a level of concern (1 in-a-million) or potential noncancer effects above levels of concern (e.g., HQ = 1). The pollutants exhibiting the 10 highest annual average-based surrogate chronic cancer and noncancer risk approximations are also presented in each state section. The results of this data analysis may help state, local, and tribal agencies better understand which pollutants emitted, from a toxicity basis, are of the greatest concern.

The toxicity-weighted emissions approach consists of the following steps:

1. Obtain HAP emissions data for all anthropogenic sectors from the NEI. For point sources, sum the process-level emissions to the county-level.

2. Apply the mass extraction speciation profiles to extract metal and cyanide mass. The only exception is for two chromium species: chromium and chromium compounds.

3. For chromium and chromium compounds, trivalent chromium (non-toxic) must be separated from hexavalent chromium (toxic). To do this, apply the chromium speciation profile to extract the hexavalent chromium mass by industry group.

4. Apply weight to the emissions derived from the steps above based on their toxicity.

    a. To apply weight based on cancer toxicity, multiply the emissions of each pollutant by its cancer URE.

    b. To apply weight based on noncancer toxicity, divide the emissions of each pollutant by its noncancer RfC.

4.0 Summary of the 2007 NATTS/UATMP Data

This section summarizes the results of the data analyses performed on the dataset as described in Section 3.0.

4.1 Statistical Results

This section examines different statistical parameters for each analytical method: 1) number of measured detections, 2) concentration ranges and data distribution, and 3) central tendency statistics. Sections 4.1.1 through 4.1.3 review the basic findings of these statistical calculations.

4.1.1 Target Pollutant Detections

Every pollutant has an MDL as described in Section 2.2. Quantification below the MDL is possible, although the measurement's reliability is lower. If a concentration does not exceed the MDL, it does not mean that the pollutant is not present in the air. If the method does not produce a concentration, the measurement is marked as ND, or "non-detect." As explained in Section 2.2, data analysts must exercise caution when interpreting monitoring data with many reported concentrations at levels near or below the corresponding MDLs. Therefore, a thorough review of the number of measured detections, the number of non-detects, and the total number of samples is beneficial to understanding the representativeness of the interpretations made.

Tables 4-1 through 4-6 summarize the number of times the target pollutants were detected out of the number of valid samples collected and analyzed. Approximately 52 percent of the pollutants sampled were measured above the MDLs (including non-detect, duplicate analyses, replicate analyses, and analyses for collocated samples). The percentages listed below represent the percent of measurements that were above the MDLs:

- 39.5 percent of VOC;
- 84.9 percent of carbonyl compounds;
- 45.4 percent of SNMOC;
- 87.3 percent of metals;

Table 4-1. Statistical Summaries of the VOC Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
Acetonitrile	1332	0.010	311.928	2.455	0.170	0.368	0.466	0.172	1.033	13.724	5.590
Acetylene	1445	0.015	10.800	0.763	1.010	0.519	0.550	0.323	0.913	0.807	1.058
Acrolein	1433	0.030	2.950	0.322	0.160	0.249	0.252	0.159	0.400	0.268	0.830
Acrylonitrile	157	0.006	0.911	0.121	0.008	0.083	0.070	0.040	0.123	0.153	1.263
tert-Amyl Methyl Ether	30	0.001	0.007	0.003	0.002	0.002	0.003	0.002	0.004	0.002	0.529
Benzene	1448	0.005	2.430	0.309	0.140	0.242	0.247	0.156	0.382	0.238	0.772
Bromochloromethane	1	0.004		NA							
Bromodichloromethane	56	0.005	1.020	0.073	0.020	0.020	0.026	0.016	0.034	0.185	2.517
Bromoform	20	0.001	0.031	0.009	0.004	0.007	0.007	0.005	0.010	0.007	0.789
Bromomethane	1415	0.004	0.895	0.018	0.010	0.012	0.013	0.010	0.014	0.053	2.870
1,3-Butadiene	1353	0.004	4.580	0.047	0.030	0.030	0.031	0.017	0.054	0.131	2.774
Carbon Tetrachloride	1446	0.007	0.175	0.096	0.080	0.095	0.092	0.082	0.110	0.023	0.246
Carbon Disulfide	1252	0.005	64.100	1.982	0.020	0.442	0.312	0.032	2.114	4.826	2.434
Chlorobenzene	94	0.001	0.115	0.042	0.010	0.045	0.031	0.020	0.060	0.025	0.587
Chloroethane	1176	0.005	0.808	0.021	0.010	0.014	0.016	0.010	0.020	0.037	1.744
Chloroform	1241	0.004	2.290	0.048	0.020	0.024	0.029	0.018	0.037	0.114	2.355
Chloromethane	1446	0.014	1.390	0.602	0.420	0.589	0.584	0.516	0.658	0.146	0.243
Chloromethylbenzene	8	0.002	0.008	0.005	0.006	0.005	0.004	0.003	0.006	0.002	0.404
Chloroprene	27	0.003	0.079	0.024	0.026	0.020	0.017	0.011	0.030	0.019	0.797
Dibromochloromethane	102	0.001	0.335	0.016	0.002	0.006	0.006	0.003	0.010	0.047	2.878
1,2-Dibromoethane	1	0.003		NA							
m-Dichlorobenzene	33	0.002	0.099	0.010	0.004	0.005	0.006	0.004	0.008	0.017	1.754
o-Dichlorobenzene	30	0.002	0.017	0.008	0.004	0.007	0.007	0.004	0.010	0.004	0.519
p-Dichlorobenzene	1150	0.002	0.586	0.025	0.010	0.013	0.015	0.008	0.026	0.044	1.762
Dichlorodifluoromethane	1447	0.008	6.710	0.536	0.494	0.520	0.523	0.487	0.564	0.187	0.349
1,1-Dichloroethane	18	0.003	0.024	0.008	0.004	0.005	0.007	0.004	0.010	0.006	0.716
1,2-Dichloroethane	48	0.004	1.290	0.108	0.010	0.012	0.028	0.010	0.063	0.245	2.267
1,1-Dichloroethene	9	0.004	0.060	0.025	0.006	0.023	0.018	0.006	0.040	0.019	0.728
cis-1,2-Dichloroethylene	6	0.040	0.200	0.096	NA	0.075	0.082	0.054	0.123	0.056	0.581
trans-1,2-Dichloroethylene	34	0.003	0.092	0.028	0.008	0.018	0.020	0.010	0.036	0.025	0.887

[a] Number of measured detections out of 1,448 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-1. Statistical Summaries of the VOC Concentrations (Continued)

Pollutant	# of Measured Detections[a]	Minimum (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
Dichloromethane	1445	0.010	72.400	0.222	0.070	0.086	0.101	0.062	0.135	2.010	9.044
1,2-Dichloropropane	4	0.007	0.009	0.008	0.007	0.008	0.008	0.007	0.008	0.001	0.107
cis-1,3-Dichloropropene	3	0.012	0.051	0.037	NA	0.049	0.031	0.031	0.050	0.018	0.480
trans-1,3-Dichloropropene	4	0.007	0.038	0.023	NA	0.023	0.018	0.009	0.037	0.014	0.629
Dichlorotetrafluoroethane	1445	0.002	0.306	0.018	0.016	0.016	0.016	0.015	0.018	0.017	0.939
Ethyl Acrylate	1	0.004		NA							
Ethyl *tert*-Butyl Ether	1	0.044		NA							
Ethylbenzene	1447	0.005	1.408	0.081	0.020	0.053	0.053	0.028	0.097	0.097	1.197
Hexachloro-1,3-butadiene	11	0.002	0.059	0.016	0.010	0.010	0.010	0.005	0.017	0.017	1.053
Methyl Ethyl Ketone	1425	0.012	11.900	0.526	0.150	0.349	0.351	0.189	0.611	0.649	1.234
Methyl Isobutyl Ketone	1253	0.001	2.470	0.061	0.020	0.036	0.038	0.021	0.063	0.128	2.112
Methyl Methacrylate	114	0.001	2.480	0.211	0.027	0.059	0.074	0.028	0.217	0.345	1.636
Methyl *tert*-Butyl Ether	273	0.001	2.130	0.065	0.010	0.026	0.027	0.012	0.046	0.189	2.935
n-Octane	1321	0.004	0.634	0.038	0.010	0.025	0.027	0.016	0.045	0.045	1.192
Propylene	1448	0.034	41.500	0.618	0.350	0.313	0.338	0.183	0.527	1.617	2.618
Styrene	1301	0.002	1.540	0.048	0.010	0.026	0.028	0.015	0.048	0.088	1.836
1,1,2,2-Tetrachloroethane	10	0.002	0.008	0.005	0.002	0.005	0.004	0.003	0.007	0.002	0.442
Tetrachloroethylene	1306	0.003	2.200	0.038	0.010	0.021	0.023	0.012	0.040	0.091	2.416
Toluene	1448	0.007	36.900	0.780	0.270	0.404	0.438	0.212	0.880	1.408	1.806
1,2,4-Trichlorobenzene	47	0.003	0.122	0.012	0.007	0.009	0.009	0.007	0.013	0.017	1.373
1,1,1-Trichloroethane	1447	0.003	0.470	0.020	0.016	0.017	0.018	0.015	0.020	0.021	1.053
1,1,2-Trichloroethane	29	0.003	0.028	0.007	0.004	0.006	0.006	0.004	0.008	0.005	0.774
Trichloroethylene	571	0.002	1.060	0.034	0.010	0.020	0.022	0.012	0.034	0.062	1.828
Trichlorofluoromethane	1440	0.003	3.430	0.276	0.230	0.255	0.259	0.235	0.287	0.170	0.614
Trichlorotrifluoroethane	1447	0.008	3.350	0.104	0.100	0.100	0.099	0.090	0.109	0.094	0.899
1,2,4-Trimethylbenzene	1433	0.003	0.878	0.066	0.010	0.042	0.042	0.022	0.086	0.071	1.078
1,3,5-Trimethylbenzene	1374	0.001	0.230	0.022	0.010	0.016	0.016	0.009	0.029	0.022	0.972
Vinyl chloride	283	0.002	0.156	0.011	0.005	0.006	0.007	0.004	0.010	0.018	1.581
m,p-Xylene	1446	0.005	4.720	0.228	0.040	0.129	0.130	0.065	0.260	0.326	1.429
o-Xylene	1446	0.004	1.710	0.083	0.020	0.052	0.053	0.028	0.102	0.103	1.232

[a] Number of measured detections out of 1,448 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-2. Statistical Summaries of the Carbonyl Compound Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
Acetaldehyde	1820	0.02	17.70	1.31	1.02	1.00	1.02	0.66	1.59	1.13	0.86
Acetone	1820	0.02	17.10	1.25	1.32	0.93	0.89	0.52	1.64	1.12	0.89
Benzaldehyde	1801	0.01	0.51	0.04	0.02	0.03	0.03	0.02	0.05	0.05	1.16
Butyraldehyde	1814	0.01	2.43	0.12	0.06	0.08	0.09	0.06	0.14	0.14	1.20
Crotonaldehyde	1803	0.01	1.80	0.14	0.03	0.06	0.08	0.04	0.16	0.18	1.34
2,5-Dimethylbenzaldehyde	13	0.01	0.06	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.74
Formaldehyde	1820	0.01	135.00	3.39	2.12	2.03	2.10	1.27	3.34	6.48	1.91
Hexaldehyde	1773	0.01	1.52	0.07	0.01	0.03	0.03	0.02	0.05	0.14	2.15
Isovaleraldehyde	540	0.01	0.65	0.04	0.01	0.02	0.03	0.01	0.05	0.05	1.29
Propionaldehyde	1801	0.01	5.54	0.16	0.09	0.11	0.11	0.07	0.17	0.24	1.55
Tolualdehydes	1771	0.01	0.78	0.04	0.02	0.03	0.03	0.02	0.05	0.05	1.11
Valeraldehyde	1777	0.01	2.52	0.06	0.03	0.03	0.04	0.02	0.05	0.10	1.82

[a] Number of measured detections out of 1,820 valid samples.

Table 4-3. Statistical Summaries of the SVOC Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Mode (ng/m^3)	Median (ng/m^3)	Geometric Mean (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)	Coefficient of Variation
Acenaphthene	188	0.03	9.48	1.99	1.82	1.78	1.46	0.93	2.67	1.44	0.72
Acenaphthylene	125	0.04	7.98	1.30	0.14	0.54	0.63	0.26	1.60	1.63	1.25
Anthracene	121	0.02	7.13	0.48	0.43	0.26	0.25	0.12	0.45	0.90	1.85
Benzo (a) anthracene	168	0.01	0.98	0.10	0.10	0.04	0.06	0.03	0.10	0.13	1.38
Benzo (a) pyrene	170	0.02	0.85	0.27	0.27	0.25	0.23	0.17	0.34	0.14	0.52
Benzo (b) fluoranthene	161	0.02	1.32	0.17	0.13	0.09	0.10	0.05	0.20	0.21	1.22
Benzo (e) pyrene	133	0.02	0.92	0.15	0.06	0.09	0.10	0.05	0.18	0.15	1.00
Benzo (g,h,i) perylene	169	0.02	0.91	0.14	0.10	0.08	0.10	0.05	0.16	0.16	1.10
Benzo (k) fluoranthene	150	0.01	1.03	0.13	0.03	0.06	0.07	0.03	0.15	0.16	1.29
Chrysene	188	0.01	1.80	0.21	0.13	0.13	0.14	0.08	0.24	0.23	1.11
Coronene	116	0.02	0.36	0.09	0.11	0.06	0.07	0.04	0.11	0.07	0.79
Dibenz (a,h) anthracene	28	0.01	0.19	0.05	NA	0.04	0.04	0.03	0.06	0.04	0.70
Fluoranthene	193	0.02	6.77	1.66	1.02	1.24	1.27	0.89	2.05	1.24	0.75
Fluorene	194	0.04	8.30	2.87	3.66	2.81	2.29	1.65	3.66	1.62	0.56
Indeno(1,2,3-cd)pyrene	117	0.02	0.93	0.15	0.13	0.09	0.10	0.05	0.16	0.16	1.07
Naphthalene	195	0.27	220.00	61.98	75.80	53.00	37.86	28.55	92.40	45.53	0.73
Perylene	34	0.02	0.23	0.06	NA	0.06	0.05	0.03	0.07	0.04	0.71
Phenanthrene	195	0.06	29.50	6.72	11.00	5.43	5.02	3.57	9.01	4.49	0.67
Pyrene	193	0.02	3.76	0.98	1.32	0.81	0.78	0.54	1.32	0.66	0.68

[a] Number of measured detections out of 195 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-4. Statistical Summaries of the SNMOC Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Mode (ppbC)	Median (ppbC)	Geometric Mean (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)	Coefficient of Variation
Acetylene	295	0.40	19.90	1.90	1.34	1.48	1.52	0.97	2.20	1.80	0.95
Benzene	293	0.19	39.70	1.70	1.41	1.14	1.24	0.79	1.74	2.67	1.57
1,3-Butadiene	183	0.03	0.94	0.15	0.08	0.11	0.11	0.07	0.17	0.13	0.89
n-Butane	279	0.51	97.20	5.62	4.56	3.12	3.58	2.00	6.62	8.19	1.46
cis-2-Butene	260	0.02	2.08	0.22	0.12	0.18	0.16	0.09	0.29	0.21	0.96
trans-2-Butene	285	0.05	4.93	0.30	0.14	0.25	0.23	0.14	0.34	0.36	1.21
Cyclohexane	294	0.05	6.89	0.53	0.10	0.29	0.32	0.17	0.52	0.72	1.35
Cyclopentane	284	0.03	8.86	0.55	0.35	0.25	0.29	0.15	0.46	1.01	1.84
Cyclopentene	86	0.10	1.51	0.33	0.12	0.25	0.27	0.16	0.39	0.26	0.80
n-Decane	287	0.03	25.40	0.72	0.42	0.32	0.34	0.17	0.58	2.16	3.00
1-Decene	2	0.10	0.35	0.23	NA	0.23	0.18	0.16	0.29	0.13	0.57
m-Diethylbenzene	197	0.05	1.66	0.31	0.14	0.22	0.23	0.14	0.38	0.30	0.95
p-Diethylbenzene	98	0.02	2.38	0.23	0.05	0.11	0.12	0.07	0.20	0.39	1.70
2,2-Dimethylbutane	283	0.03	2.37	0.33	0.33	0.26	0.25	0.15	0.43	0.29	0.87
2,3-Dimethylbutane	284	0.03	5.28	0.45	0.24	0.31	0.30	0.16	0.52	0.54	1.20
2,3-Dimethylpentane	287	0.05	6.25	0.60	0.44	0.37	0.37	0.20	0.62	0.73	1.22
2,4-Dimethylpentane	284	0.03	3.40	0.32	0.17	0.23	0.22	0.12	0.37	0.36	1.11
n-Dodecane	275	0.02	48.10	0.80	0.10	0.19	0.23	0.10	0.40	3.60	4.51
1-Dodecene	151	0.03	1.41	0.27	0.06	0.16	0.17	0.08	0.31	0.28	1.06
Ethane	295	0.87	107.00	8.33	11.00	6.15	6.58	4.38	9.27	8.98	1.08
2-Ethyl-1-butene	0	NA									
Ethylbenzene	294	0.03	5.31	0.62	1.49	0.45	0.43	0.23	0.77	0.61	0.98
Ethylene	294	0.41	15.20	2.43	1.70	1.94	1.99	1.29	2.93	1.80	0.74
m-Ethyltoluene	265	0.04	2.10	0.40	0.29	0.32	0.31	0.18	0.51	0.30	0.76
o-Ethyltoluene	243	0.04	57.90	0.52	0.07	0.20	0.21	0.12	0.36	3.70	7.17
p-Ethyltoluene	268	0.03	4.57	0.27	0.24	0.20	0.20	0.13	0.32	0.34	1.25
n-Heptane	294	0.07	7.65	0.68	0.14	0.36	0.40	0.22	0.63	1.05	1.53
1-Heptene	233	0.04	1.31	0.19	0.13	0.14	0.15	0.10	0.22	0.17	0.86

[a] Number of measured detections out of 295 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-4. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Measured Detections[a]	Minimum (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Mode (ppbC)	Median (ppbC)	Geometric Mean (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)	Coefficient of Variation
n-Hexane	295	0.09	53.80	1.67	1.14	0.76	0.84	0.40	1.37	3.88	2.33
1-Hexene	266	0.04	0.69	0.21	0.09	0.17	0.17	0.10	0.31	0.14	0.66
cis-2-Hexene	28	0.04	0.60	0.21	0.05	0.13	0.14	0.06	0.30	0.18	0.87
trans-2-Hexene	26	0.05	0.83	0.16	0.05	0.12	0.12	0.08	0.19	0.15	0.96
Isobutane	295	0.26	126.00	4.87	1.19	1.80	2.22	1.09	4.04	11.07	2.27
Isobutene/1-Butene	192	0.10	23.50	2.45	1.49	1.87	1.66	1.08	2.66	2.72	1.11
Isopentane	238	0.35	132.00	13.43	10.90	10.80	9.97	6.55	16.15	13.29	0.99
Isoprene	265	0.03	9.71	1.06	0.35	0.39	0.46	0.17	1.46	1.40	1.32
Isopropylbenzene	149	0.03	5.97	0.16	0.13	0.12	0.11	0.08	0.15	0.48	2.98
2-Methyl-1-butene	261	0.03	11.80	0.58	0.20	0.30	0.31	0.15	0.73	1.09	1.87
3-Methyl-1-butene	20	0.18	3.92	1.18	NA	1.00	0.84	0.39	1.67	0.97	0.82
2-Methyl-1-pentene	47	0.03	0.43	0.11	0.06	0.09	0.09	0.06	0.14	0.07	0.66
4-Methyl-1-pentene	9	0.04	0.36	0.09	NA	0.06	0.07	0.05	0.08	0.09	1.05
2-Methyl-2-butene	230	0.06	2.08	0.30	0.26	0.25	0.25	0.16	0.35	0.23	0.76
Methylcyclohexane	288	0.03	9.63	0.57	0.23	0.25	0.30	0.16	0.53	0.91	1.60
Methylcyclopentane	294	0.07	8.65	0.68	1.24	0.47	0.48	0.28	0.78	0.77	1.12
2-Methylheptane	224	0.02	2.07	0.21	0.11	0.13	0.14	0.09	0.27	0.22	1.07
3-Methylheptane	248	0.03	1.62	0.21	0.15	0.15	0.16	0.10	0.26	0.19	0.90
2-Methylhexane	259	0.05	8.24	0.78	0.56	0.52	0.50	0.28	0.83	1.01	1.30
3-Methylhexane	287	0.11	11.90	0.84	1.50	0.48	0.53	0.30	0.81	1.37	1.63
2-Methylpentane	294	0.27	17.70	1.68	1.06	1.25	1.27	0.79	2.07	1.60	0.95
3-Methylpentane	294	0.08	10.10	0.89	0.74	0.64	0.63	0.34	1.06	0.95	1.06
n-Nonane	292	0.04	5.13	0.33	0.19	0.20	0.22	0.12	0.35	0.45	1.36
1-Nonene	119	0.02	2.15	0.21	0.12	0.14	0.15	0.09	0.24	0.26	1.24
n-Octane	293	0.04	4.24	0.39	0.34	0.26	0.27	0.16	0.41	0.48	1.22
1-Octene	136	0.04	3.48	0.19	0.09	0.13	0.14	0.09	0.22	0.31	1.60
n-Pentane	295	0.21	339.00	6.82	2.25	2.46	2.77	1.36	4.88	25.60	3.75
1-Pentene	293	0.05	175.00	1.74	0.28	0.37	0.44	0.21	0.63	10.64	6.12
cis-2-Pentene	196	0.03	0.86	0.17	0.12	0.15	0.14	0.10	0.22	0.11	0.64

[a] Number of measured detections out of 295 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-4. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Measured Detections[a]	Minimum (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Mode (ppbC)	Median (ppbC)	Geometric Mean (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)	Coefficient of Variation
trans-2-Pentene	269	0.03	1.43	0.25	0.28	0.22	0.19	0.13	0.32	0.19	0.77
a-Pinene	230	0.06	5.64	0.77	1.03	0.58	0.53	0.28	1.02	0.72	0.93
b-Pinene	62	0.01	4.75	0.94	1.30	0.62	0.59	0.34	1.30	0.89	0.95
Propane	295	0.77	358.50	13.28	10.60	7.35	8.21	4.49	14.45	24.66	1.86
n-Propylbenzene	255	0.03	0.76	0.18	0.13	0.15	0.15	0.10	0.23	0.12	0.66
Propylene	295	0.29	8.99	1.24	1.05	0.95	1.03	0.70	1.43	0.99	0.80
Propyne	0	NA									
Styrene	115	0.05	3.89	0.63	0.20	0.43	0.43	0.25	0.76	0.66	1.04
Toluene	295	0.39	109.00	4.84	1.61	2.90	2.85	1.39	4.96	8.10	1.67
n-Tridecane	57	0.04	5.95	0.36	0.09	0.15	0.17	0.09	0.26	0.86	2.38
1-Tridecene	3	0.09	0.35	0.19	NA	0.14	0.16	0.11	0.24	0.11	0.60
1,2,3-Trimethylbenzene	229	0.03	0.86	0.16	0.12	0.14	0.13	0.08	0.21	0.12	0.73
1,2,4-Trimethylbenzene	292	0.04	3.68	0.59	1.13	0.47	0.45	0.27	0.72	0.51	0.86
1,3,5-Trimethylbenzene	225	0.03	1.42	0.24	0.19	0.19	0.19	0.12	0.31	0.20	0.83
2,2,3-Trimethylpentane	209	0.04	2.13	0.25	0.11	0.17	0.18	0.10	0.28	0.25	1.02
2,2,4-Trimethylpentane	294	0.08	9.58	0.85	0.47	0.51	0.56	0.31	0.97	1.08	1.28
2,3,4-Trimethylpentane	289	0.05	3.21	0.38	0.07	0.28	0.27	0.14	0.48	0.37	0.96
n-Undecane	288	0.03	101.00	1.30	0.37	0.30	0.36	0.17	0.61	7.25	5.59
1-Undecene	91	0.02	1.19	0.14	0.05	0.08	0.10	0.05	0.16	0.16	1.16
m-Xylene/*p*-Xylene	295	0.10	18.90	1.67	1.51	1.07	1.06	0.54	1.95	1.94	1.17
o-Xylene	295	0.04	5.25	0.61	1.28	0.43	0.43	0.24	0.73	0.62	1.02
SNMOC (Sum of Knowns)	295	15.60	943.00	90.59	111.00	64.38	69.21	45.45	99.56	101.65	1.12
Sum of Unknowns	295	4.22	591.00	68.01	57.90	46.80	47.24	25.23	80.00	71.45	1.05
TNMOC	295	29.70	1140.00	158.29	126.00	116.00	124.18	78.45	179.00	142.33	0.90

[a] Number of measured detections out of 295 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-5. Statistical Summaries of the Metals Concentrations

Pollutant	# of Measured Detections[a,b]	Minimum (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Mode (ng/m^3)	Median (ng/m^3)	Geometric Mean (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)	Coefficient of Variation
Antimony (PM$_{10}$)	473	0.01	9.68	1.36	1.40	0.93	0.97	0.59	1.46	1.41	1.04
Arsenic (PM$_{10}$)	473	0.02	44.10	0.97	1.09	0.69	0.69	0.44	1.04	2.17	2.23
Beryllium (PM$_{10}$)	461	0.000	0.07	0.01	0.004	0.01	0.01	0.003	0.01	0.01	1.12
Cadmium (PM$_{10}$)	473	0.03	1.93	0.27	0.10	0.17	0.18	0.10	0.32	0.30	1.09
Chromium (PM$_{10}$)	472	0.97	12.20	2.64	1.88	2.32	2.43	1.82	3.23	1.19	0.45
Cobalt (PM$_{10}$)	472	0.004	6.53	0.22	0.22	0.14	0.14	0.08	0.24	0.38	1.73
Lead (PM$_{10}$)	473	0.09	57.30	6.04	3.15	4.30	4.55	2.95	6.70	6.11	1.01
Manganese (PM$_{10}$)	473	0.17	91.70	9.64	10.60	6.86	6.71	3.57	12.80	9.55	0.99
Mercury (PM$_{10}$)	458	0.00	25.50	0.59	0.01	0.03	0.04	0.01	0.08	3.46	5.84
Nickel (PM$_{10}$)	473	0.15	29.00	1.61	1.05	1.21	1.28	0.88	1.68	1.98	1.23
Selenium (PM$_{10}$)	471	0.01	11.90	0.88	0.32	0.57	0.54	0.27	1.19	0.99	1.13
Antimony (TSP)	173	0.18	4.48	0.97	1.03	0.81	0.80	0.51	1.19	0.66	0.68
Arsenic (TSP)	173	0.19	49.10	1.32	1.13	0.78	0.80	0.52	1.09	3.88	2.94
Beryllium (TSP)	171	<0.001	0.09	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.84
Cadmium (TSP)	173	0.05	4.84	0.25	0.16	0.17	0.18	0.12	0.26	0.39	1.57
Chromium (TSP)	173	1.01	7.93	2.23	1.71	1.95	2.07	1.61	2.61	1.01	0.45
Cobalt (TSP)	173	0.13	6.29	0.88	0.22	0.48	0.56	0.29	0.96	1.11	1.26
Lead (TSP)	173	1.57	43.30	6.33	10.50	5.33	5.26	3.62	7.36	4.92	0.78
Manganese (TSP)	173	1.48	131.00	22.53	16.80	18.30	17.52	10.90	28.45	17.59	0.78
Mercury (TSP)	173	0.01	1.43	0.10	0.02	0.04	0.04	0.02	0.07	0.21	2.03
Nickel (TSP)	173	0.36	26.90	1.82	1.47	1.37	1.43	0.98	1.94	2.27	1.25
Selenium (TSP)	173	0.08	12.43	1.12	1.24	0.86	0.80	0.49	1.38	1.26	1.13

[a] For PM$_{10}$ number of measured detections out of 473 valid samples.

[b] For TSP number of measured detections out of 173 valid samples.

Table 4-6. Statistical Summaries of the Hexavalent Chromium Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Mode (ng/m^3)	Median (ng/m^3)	Geometric Mean (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)	Coefficient of Variation
Hexavalent Chromium	709	0.001	0.42	0.03	0.01	0.02	0.02	0.01	0.04	0.04	1.20

[a] Number of measured detections out of 1,013 valid samples.

- 74.4 percent of SVOC; and
- 59.7 percent of hexavalent chromium samples.

Some pollutants are always detected while others are infrequently detected. Similar to previous years, acetaldehyde and acetone had the greatest number of measured detections (1,820), using the preprocessed daily measurements. These pollutants were reported in every valid sample collected (1,820). Formaldehyde was also detected in every carbonyl sample collected in 2007. Toluene, propylene, and benzene were detected in every VOC sample collected (1,448), although fewer VOC samples were collected compared to carbonyls. Antimony, nickel, manganese, arsenic, lead, and cadmium were detected in every metal sample collected (646). Nine pollutants (isobutene, ethane, xylenes, propane, propylene, toluene, *n*-pentane, *n*-hexane, and acetylene) were detected in every SNMOC sample collected. Benzene is also a pollutant measured by the SNMOC method. While it was detected in every VOC sample collected in 2007, two non-detects were reported by the concurrent SNMOC method. Further review showed that benzene was present in these samples, but co-eluted with another compound during analysis and could not be separated to a degree to allow for individual quantitation. According to ERG's approved procedures, the measurements were reported as non-detects.

Naphthalene and phenanthrene were detected in every SVOC sample collected. Hexavalent chromium was detected in approximately 70 percent of samples collected. Only two pollutants, 2-ethyl-1-butene and propyne had zero measured detections. Both pollutants are SNMOC.

NBIL had the greatest number of measured detections (6,403 out of a possible 9,675 valid data points). In previous years, BTUT had the greatest number of measured detections (6,392 out of 8,997 for 2007). However, BTUT's detection rate (71 percent) is higher than NBIL's (66 percent). Detection rates for sites that sampled pollutants that are frequently detected tended to be higher (refer to the list of method-specific percentages of measurements above the MDL listed above). For example, metals rarely reported as non-detects. As a result, sites (such as BOMA) that sampled only metals would likely have higher detection rates.

BOMA's detection rate is 97 percent. Conversely, VOCs had the lowest detection rate (39.5 percent). A site measuring only VOC would likely have lower detection rates, such as CNEP (46.8 percent).

4.1.2 Concentration Range

The concentrations measured during the 2007 NATTS/UATMP show a wide range of variability. The following observations were made in regards to the measured detections at the program level:

- Nearly 81 percent of the measured detections had concentration values less than 1 μg/m^3, while less than 3 percent had concentrations greater than 5 μg/m^3.

- VOC had the highest number of samples with concentrations greater than 5 μg/m^3 (900); SNMOC had the least (585); and carbonyl compounds were in the middle (748). SVOC, metals, and hexavalent chromium had no concentrations greater than 5 μg/m^3.

- A pollutant had a measurement greater than 5 μg/m^3 on 85 of 124 total sampling days.

- Concentrations of 72 pollutants never exceeded 1 μg/m^3.

- Six sites had maximum concentration values over 100 μg/m^3.

- BTUT had the greatest number of samples with concentrations greater than 5 μg/m^3 (317, out of a possible 8,997 valid data points), which is similar to previous years. CUSD had the next highest number of samples with concentrations greater than 5 μg/m^3 (161).

The minimum and maximum concentration measured for each target pollutant is also presented in Tables 4-1 through 4-6 (in respective pollutant group units). Some pollutants, such as acetonitrile, had a large range of concentrations measured, while other pollutants, such as carbon tetrachloride, did not, even though they were detected frequently. The pollutant for each method-specific pollutant group with the largest range in measured concentrations is as follows:

- For VOC, acetonitrile (0.01 to 311.93 ppbv)

- For SNMOC, propane (0.77 to 358.50 ppbC)

- For carbonyl compounds, formaldehyde (0.01 to 135.0 ppbv)

- For SVOC, naphthalene (0.27 to 220.0 ng/m^3)

- For metals, both sizes, manganese (0.17 to 91.7 ng/m^3 for PM_{10} and 1.48 to 131.0 ng/m^3 for TSP).

On July 4, 2006, a large number of monitoring sites that sampled for hexavalent chromium measured elevated concentrations. Hexavalent chromium is a component in fireworks (NLM, 2008) and it is possible that Independence Day fireworks celebrations may have caused this increased concentration level. Based on the 1-in-6 sampling schedule for 2007, samples were collected on July 5, 2007. Although a few sites experienced elevated concentrations on July 5, 2007, most concentrations did not vary much on this date from other samples collected throughout the year. Additional studies of this phenomena were recommended in the 2006 UATMP Report.

4.1.3 Summary Statistics

In addition to the number of measured detections and the concentration ranges, Tables 4-1 through 4-6 also present a number of central tendency and data distribution statistics (arithmetic mean, geometric mean, median, mode, first and third quartiles, standard deviation, and coefficient of variation) for each of the pollutants sampled during the 2007 NATTS/UATMP program year by respective pollutant group units. A multitude of observations can be made from these tables. As such, the three highest average concentrations, by mass, for each pollutant group is provided below:

The top three VOCs by average mass concentration, as presented in Table 4-1, are:

- acetonitrile (2.45 ppbv);
- carbon disulfide (1.98 ppbv); and
- toluene (0.78 ppbv).

The top three carbonyl compounds by average mass concentration, as presented in Table 4-2, are:

- formaldehyde (3.39 ppbv);

- acetaldehyde (1.31 ppbv); and
- acetone (1.25 ppbv).

The top three SVOC by average mass concentration, as presented in Tables 4-3, are:

- naphthalene (61.98 ng/m^3);
- phenanthrene (6.72 ng/m^3); and
- fluorene (2.87 ng/m^3).

The top three SNMOC by average mass concentration, as presented in Table 4-4, are:

- isopentane (13.43 ppbC);
- propane (13.28 ppbC); and
- ethane (8.33 ppbC).

The top three metals by average mass concentration for both PM$_{10}$ and TSP fractions, as presented in Table 4-5, are;

- manganese (TSP = 22.53 ng/m3, PM10 = 9.64 ng/m3);
- lead (TSP= 6.33 ng/m3, PM10 = 6.04 ng/m3); and
- total chromium (TSP = 2.23 ng/m3, PM10 = 2.64 ng/m3).

The average mass concentration of hexavalent chromium, as presented in Table 4-6, is 0.033 ng/m^3.

Appendices J through O present similar statistical calculations, but are based on each individual sample, including duplicate, collocated, and replicate analyses, rather than the preprocessed daily measurements (as presented here).

4.2 Risk Screening and Pollutants of Interest

Section 3.2 described the process for identifying the program-wide pollutants of interest. Table 4-7 identifies the pollutants that failed at least one screen; summarizes each pollutant's total number of measured detections, percentage failed, and cumulative percentage of failed screens; and highlights those pollutants designated as the program-wide "pollutants of interest."

Concentrations of 31 HAPs, of the 106 HAPs with screening values, failed at least one screen (29 percent). Of these, a total of 11,731 of 25,207 concentrations (46.54 percent) failed screens, as shown in Table 4-7. By comparison, for the 2006 programs, 45.55 percent of applicable HAP measurements failed screens. If all of the pollutants with screening values are considered (including those that did not fail any screens), the percentage of concentrations failing screens is less (11,731 of 42,871, or 27.36 percent).

Table 4-7 shows that acetaldehyde failed the largest number of screens (1,777), and also had the highest number of measured detections (1,820). This is equivalent to a 97.64 percent failure rate. Although formaldehyde had the same number of measured detections as acetaldehyde, it failed screens fewer times (1,644 failures, or a 90.33 percent failure rate). Acrolein exhibited a 100 percent failure rate when detected (1,433 failures out of 1,433 measured detections). Pollutants bolded in Table 4-7 indicate the designation of an EPA NATTS core compound as discussed in Section 3.6.4.

Using the approach described in Section 3.2, the program-level pollutants of interest, as indicated by the shading in Table 4-7, were identified as follows:

- Acetaldehyde
- Acrylonitrile
- Acrolein
- Arsenic
- Benzene
- 1,3-Butadiene

Table 4-7. Program–Level Risk Screening Summary

Pollutant	# of Failed Screens	# of Measured Detections	% of Failed Screens	% of Total Failures	Cumulative % Contribution
Acetaldehyde	1777	1820	97.64	15.15	15.15
Formaldehyde	1644	1820	90.33	14.01	29.16
Benzene	1444	1448	99.72	12.31	41.47
Carbon Tetrachloride	1443	1446	99.79	12.30	53.77
Acrolein	1433	1433	100.00	12.22	65.99
1,3-Butadiene	1139	1362	83.63	9.71	75.70
Arsenic	624	646	96.59	5.32	81.02
Tetrachloroethylene	552	1306	42.27	4.71	85.72
p-Dichlorobenzene	487	1150	42.35	4.15	89.87
Manganese	463	646	71.67	3.95	93.82
Acrylonitrile	155	157	98.73	1.32	95.14
Naphthalene	145	195	74.36	1.24	96.38
Nickel	112	646	17.34	0.95	97.33
Hexavalent Chromium	64	709	9.03	0.55	97.88
Cadmium	57	646	8.82	0.49	98.36
Dichloromethane	46	1445	3.18	0.39	98.76
1,2-Dichloroethane	41	48	85.42	0.35	99.10
Trichloroethylene	28	571	4.90	0.24	99.34
Bromomethane	16	1415	1.13	0.14	99.48
Carbon Disulfide	11	1252	0.88	0.09	99.57
Vinyl chloride	11	283	3.89	0.09	99.67
1,1,2,2-Tetrachloroethane	8	10	80.00	0.07	99.74
Hexachloro-1,3-butadiene	8	11	72.73	0.07	99.80
Xylenes	7	1447	0.48	0.06	99.86
Chloromethylbenzene	5	8	62.50	0.04	99.91
1,1,2-Trichloroethane	3	29	10.34	0.03	99.93
Methyl *tert*-Butyl Ether	2	273	0.73	0.02	99.95
Toluene	2	1448	0.14	0.02	99.97
Chloroform	2	1241	0.16	0.02	99.98
n-Hexane	1	295	0.34	0.01	99.99
1,2-Dibromoethane	1	1	100.00	0.01	100.00
Total	11,731	25,207	46.54		

BOLD = EPA NATTS core compound.

- Carbon Tetrachloride
- *p*-Dichlorobenzene
- Formaldehyde
- Manganese
- Tetrachloroethylene

The 2007 list of pollutants of interest is very similar to the 2006 list of pollutants of interest. The 2006 and 2007 lists have 10 pollutants in common. Acrylonitrile is new for 2007, while hexachloro-1,3-butadiene, naphthalene, and hexavalent chromium did not make the list. As discussed in Section 3.2, there is currently some question about the reliability of the acetonitrile data. Therefore, acetonitrile results were excluded from the risk screening process and designation as a pollutant of interest.

Table 4-8 presents the total number of failed screens per site, in descending order, as a means of comparing the results of the risk screening process across the sites. As shown, S4MO had the largest number of failed screens (579), followed by TUOK (558) and TOOK (555). In addition to the number of failed screens, Table 4-8 also shows the total number of screens conducted (one screen per valid measured detection for each site for all pollutants with screening values). The failure rate, as a percentage, was determined from the number of failed screens and the total number of screens conducted (applicable measured detections) and is also provided in Table 4-8.

Table 4-8. Site-Specific Risk Screening Comparison

Site	# of Failed Screens	Total # of Measured Detections[1]	% of Failed Screens	# of Pollutant Groups Analyzed
S4MO	579	1996	29.01	4
TUOK	558	1898	29.40	3
TOOK	555	1931	28.74	3
TSOK	535	1895	28.23	3

[1] Total number of measured detections for all pollutants with screening values, not just those failing screens.

BOLD = EPA-designated NATTS Site

Table 4-8. Site-Specific Risk Screening Comparison (Continued)

Site	# of Failed Screens	Total # of Measured Detections[1]	% of Failed Screens	# of Pollutant Groups Analyzed
BTUT	499	1912	26.10	5
CANJ	453	1366	33.16	2
SEWA	446	1902	23.45	4
ELNJ	437	1421	30.75	2
GPCO	434	1444	30.06	3
GPMS	433	1470	29.46	3
SPIL	432	1288	33.54	2
DEMI	425	1418	29.97	3
NBIL	421	1983	21.23	5
NBNJ	397	1364	29.11	2
LDTN	387	1316	29.41	2
PXSS	386	1666	23.17	5
TUMS	370	1336	27.69	2
CUSD	361	1295	27.88	3
MSTN	350	1289	27.15	2
CAMS 35	318	1251	25.42	1
SFSD	314	1273	24.67	3
CHNJ	302	1092	27.66	2
SJPR	225	678	33.19	2
ININ	218	767	28.42	3
BAPR	217	672	32.29	2
IDIN	210	715	29.37	2
CNEP	184	1011	18.20	1
CAMS 85	170	862	19.72	1
AZFL	120	120	100.00	1
INDEM	120	120	100.00	1
ORFL	116	116	100.00	1
SYFL	116	155	74.84	2
GAFL	115	120	95.83	1
WPIN	110	112	98.21	1
SKFL	102	120	85.00	1
SPAZ	88	302	29.14	1
BOMA	86	634	13.56	2
SDGA	39	559	6.98	2
CELA	34	522	6.51	1
RUCA	26	432	6.02	1
ITCMI	23	847	2.72	1
FLFL	16	20	80.00	1
PRRI	2	37	5.41	1
ROCH	1	9	11.11	1

[1] Total number of measured detections for all pollutants with screening values, not just those failing screens.

BOLD = EPA-designated NATTS Site

Table 4-8. Site-Specific Risk Screening Comparison (Continued)

Site	# of Failed Screens	Total # of Measured Detections[1]	% of Failed Screens	# of Pollutant Groups Analyzed
HAKY	1	33	3.03	1
CHSC	0	17	0.00	1
MVWI	0	29	0.00	1
BXNY	0	12	0.00	1
WADC	0	33	0.00	1
UNVT	0	11	0.00	1

[1] Total number of measured detections for all pollutants with screening values, not just those failing screens.

BOLD = EPA-designated NATTS Site

The number of total screens and the number of pollutants measured by each site must also be considered when interpreting the results in Table 4-8. For example, sites sampling three, four, or five pollutant groups tended to have a higher number of failed screens. Yet, AZFL, INDEM, and ORFL had the highest failure rates (100 percent); however, each of these sites sampled only one pollutant group (carbonyl compounds). Two pollutants measured with Method TO-11A have screening values (acetaldehyde and formaldehyde) and these two pollutants tend to fail all or most of the screens conducted (refer to Table 4-7). Thus, sites sampling only carbonyls have high failure rates. Conversely, sites that sampled several pollutant groups tended to have lower failure rates due to the larger number of HAPs screened, as is the case with NBIL, S4MO, and SEWA. For this reason, the number of pollutant groups for which sampling was conducted is also presented in Table 4-8. Five sites, UNVT, MVWI, BXNY, CHSC, and WADC, did not fail any screens. These five sites sampled only hexavalent chromium within the NATTS program, which limits the number of failed screens possible.

The following sections focus only on those pollutants designated as program-level pollutants of interest.

4.2.1 Concentrations of the Pollutants of Interest

Concentrations of the program-level pollutants of interest vary significantly, among the pollutants and among the sites. Tables 4-9 through 4-11 present the top 10 daily average concentrations and 95 percent confidence intervals by site for each of the pollutants of interest (for carbonyls, metals, and VOC, respectively). As discussed in Section 3.3, a daily average is the average concentration of all measured detections. Please note that not all sites sampled each pollutant. Certain pollutants, such as the metals, do not have 10 sites listed because less than 10 sites sampled that pollutant group. It is also important to note that the arsenic and manganese average concentrations in Table 4-10 are reported in ng/m^3 for ease of viewing, while Tables 4-9 and 4-11 are reported in µg/m^3.

Table 4-9. Daily Average Comparison of the Carbonyl Pollutants of Interest

Rank	**Acetaldehyde (µg/m^3)**	**Formaldehyde (µg/m^3)**
1	SJPR 6.35 ± 1.99	INDEM 36.07 ± 6.34
2	ELNJ 5.84 ± 0.88	***DEMI*** 5.76 ± 0.71
3	***DEMI*** 5.44 ± 0.89	***PXSS*** 4.98 ± 0.45
4	INDEM 4.56 ± 0.52	ELNJ 4.69 ± 0.65
5	***S4MO*** 4.06 ± 0.52	***S4MO*** 4.57 ± 0.68
6	***PXSS*** 3.32 ± 0.42	ININ 4.15 ± 0.71
7	***GPCO*** 2.79 ± 0.26	WPIN 4.06 ± 0.58
8	***SYFL*** 2.73 ± 0.52	***GPCO*** 4.02 ± 0.33
9	LDTN 2.62 ± 0.42	CANJ 3.78 ± 0.52
10	GAFL 2.54 ± 0.23	LDTN 3.74 ± 0.64

BOLD = EPA-designated NATTS Site

Table 4-10. Daily Average Comparison of the Metal Pollutants of Interest

Rank	**Arsenic (PM$_{10}$) (ng/m^3)**	**Arsenic (TSP) (ng/m^3)**	**Manganese (PM$_{10}$) (ng/m^3)**	**Manganese (TSP) (ng/m^3)**
1	***S4MO*** 1.83 ± 1.40	TUOK 2.01 ± 1.67	***PXSS*** 18.82 ± 2.71	TOOK 30.11 ± 5.70
2	IDIN 1.08 ± 0.23	TOOK 1.02 ± 0.21	***SEWA*** 12.61 ± 4.18	TUOK 19.76 ± 3.61
3	***BTUT*** 1.06 ± 0.44	TSOK 0.91 ± 0.31	***S4MO*** 12.48 ± 1.73	TSOK 17.43 ± 3.02
4	ININ 0.98 ± 0.16		***BTUT*** 10.08 ± 1.82	
5	***NBIL*** 0.86 ± 0.15		***NBIL*** 7.82 ± 1.71	
6	***SEWA*** 0.76 ± 0.12		ININ 6.18 ± 1.05	
7	***PXSS*** 0.73 ± 0.22		IDIN 5.87 ± 0.83	
8	***BOMA*** 0.46 ± 0.05		***BOMA*** 3.29 ± 0.34	

BOLD = EPA-designated NATTS Site

Table 4-11. Daily Average Comparison of the VOC Pollutants of Interest

Rank	Acrolein (µg/m^3)	Acrylonitrile (µg/m^3)	Benzene (µg/m^3)	1,3-Butadiene (µg/m^3)	Carbon Tetrachloride (µg/m^3)	*p*-Dichlorobenzene (µg/m^3)	Tetrachloroethylene (µg/m^3)
1	***PXSS*** 2.27 ± 0.46	***SPAZ*** 1.07 ± 0.27	***PXSS*** 2.06 ± 0.47	***CAMS 35*** 0.43 ± 0.34	***SEWA*** 0.69 ± 0.04	SJPR 0.40 ± 0.08	***PXSS*** 0.77 ± 0.25
2	CNEP 1.52 ± 0.17	***PXSS*** 0.86 ± 0.92	TOOK 2.05 ± 0.31	***PXSS*** 0.30 ± 0.08	SPIL 0.69 ± 0.04	***PXSS*** 0.39 ± 0.08	GPMS 0.62 ± 0.63
3	SPAZ 1.23 ± 0.31	***CAMS 35*** 0.55 ± 0.29	SPAZ 2.01 ± 0.68	SPAZ 0.24 ± 0.10	***CAMS 35*** 0.68 ± 0.04	***NBIL*** 0.33 ± 0.19	SPIL 0.39 ± 0.07
4	TUOK 1.05 ± 0.19	TOOK 0.33 ± 0.14	***CAMS 35*** 1.59 ± 0.32	SJPR 0.17 ± 0.03	SJPR 0.68 ± 0.05	BAPR 0.31 ± 0.12	SPAZ 0.39 ± 0.19
5	GPMS 0.91 ± 0.10	***CAMS 85*** 0.31 ± <0.01	SJPR 1.48 ± 0.22	***GPCO*** 0.16 ± 0.03	***CAMS 85*** 0.68 ± 0.04	SPAZ 0.31 ± 0.10	TUOK 0.37 ± 0.10
6	TOOK 0.89 ± 0.14	CUSD 0.28 ± 0.05	***GPCO*** 1.46 ± 0.20	ELNJ 0.14 ± 0.02	***NBIL*** 0.66 ± 0.03	***S4MO*** 0.26 ± 0.10	***BTUT*** 0.34 ± 0.15
7	TSOK 0.88 ± 0.16	SFSD 0.23 ± 0.03	**BTUT** 1.29 ± 0.23	SPIL 0.12 ± 0.02	CNEP 0.65 ± 0.03	***BTUT*** 0.25 ± 0.16	***GPCO*** 0.32 ± 0.06
8	BAPR 0.87 ± 0.23	GPMS 0.21 ± 0.04	TUOK 1.29 ± 0.14	BAPR 0.12 ± 0.02	***DEMI*** 0.63 ± 0.03	GPMS 0.22 ± 0.13	ELNJ 0.32 ± 0.05
9	CANJ 0.87 ± 0.18	TUMS 0.21 ± 0.03	***CAMS 85*** 1.15 ± 0.15	***BTUT*** 0.11 ± 0.03	GPMS 0.62 ± 0.03	CANJ 0.19 ± 0.03	***DEMI*** 0.30 ± 0.07
10	***S4MO*** 0.79 ± 0.12	TSOK 0.19 ± 0.06	ELNJ 1.09 ± 0.18	***DEMI*** 0.10 ± 0.02	BAPR 0.62 ± 0.04	SPIL 0.15 ± 0.06	LDTN 0.29 ± 0.37

BOLD = EPA-designated NATTS Site.

Some observations from Table 4-9 through 4-11 include the following:

- The highest daily average concentration was calculated for formaldehyde for INDEM (36.07 ± 6.34 µg/m^3). INDEM's average formaldehyde concentration is significantly higher than the other nine daily average formaldehyde concentrations.
- PXSS was on the top 10 list for every pollutant it sampled (TSP metals were not sampled at PXSS) except carbon tetrachloride. In addition, SPAZ, which only sampled for VOC, appears on seven of the eight VOC top 10 lists.
- All four Oklahoma sites appear on the acrolein top 10 list.

4.2.2 Risk Screening Assessment Using MRLs

A summary of the program-level MRL risk assessment is presented in Table 4-12. Acrolein and formaldehyde were the only pollutants with at least one exceedance of an ATSDR risk factor. Out of 1,820 measured detections of formaldehyde, 16 exceeded the ATSDR acute MRL (50 μg/m^3). Fifteen of these exceedances were measured at INDEM; the other exceedance was measured at SFSD. No measured detections of acrolein exceeded the new ATSDR acute MRL (7 μg/m^3). This is significantly different from 2006, when nearly all acrolein concentrations exceeded the short-term risk factor. Exceedances of the acute risk factors are discussed on a site-specific basis in further detail in Sections 5.0 through 31.0.

Out of 123 seasonal averages of formaldehyde, only one seasonal average exceeded the ATSDR intermediate MRL (40 μg/m^3). This seasonal average, calculated for the summer season, was calculated for INDEM. Conversely, all 99 seasonal averages for acrolein across the program exceeded the ATSDR intermediate MRL (0.09 μg/m^3). Exceedances of the intermediate risk factors are discussed on a site-specific basis in further detail in Sections 5.0 through 31.0. Graphical displays of the site-specific seasonal averages for the program-level pollutants of interest are presented and discussed in Section 4.4.2.

Acrolein does not have a chronic risk factor, therefore, chronic risk cannot be evaluated in this manner. Out of 29 valid annual averages, only one annual average exceeded the ATSDR chronic MRL for formaldehyde (10 μg/m^3). Again, this annual average was calculated for INDEM. Exceedances of the chronic risk factors are also discussed in further detail on a site-specific basis in Sections 5.0 through 31.0.

Table 4-12. Program-Level MRL Risk Assessment Summary

Sampling Method	Pollutant	Acute Risk		Intermediate Risk					Chronic Risk	
		ATSDR MRL[1] (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR MRL[1] (µg/m^3)	# of Winter Exceedances/ # of Seasonal Averages	# of Spring Exceedances/ # of Seasonal Averages	# of Summer Exceedances/ # of Seasonal Averages	# of Autumn Exceedances/ # of Seasonal Averages	ATSDR Chronic MRL[1] (µg/m^3)	# of Exceedances/ # of Annual Averages
TO-11A	Formaldehyde	50	16/1820	40	0/32	0/31	1/30	0/30	10	1/29
TO-15	Acrolein	7	0/1433	0.09	25/25	25/25	24/24	25/25	--	--

[1] Reflects the use of one significant digit for MRLs

-- = an MRL risk factor is not available

4.2.3 Correlation Between Concentrations and Meteorological Conditions

Concentrations in ambient air can be significantly influenced by meteorological conditions. The following three sections describe select meteorological parameters and how each may affect air quality. Pearson correlation coefficients, which were described in Section 3.4, were calculated between concentration data for the program-level pollutants of interest and the following meteorological parameters: average maximum daily temperature; average daily temperature; average daily dew point temperature; average daily wet bulb temperature; average daily relative humidity; average daily sea level pressure; and average wind speed. Data from the closest NWS station to each site are used for the correlations. Table 4-13 presents the resulting correlations.

4.2.3.1 Maximum and Average Temperature

Temperature is often a factor associated with high ambient air concentrations for some pollutants, such as ozone. Higher temperatures help speed up the kinetic process as pollutants react with each other. Pearson correlations were calculated between the program-level pollutants of interest and average maximum daily temperature and average daily temperature.

Table 4-13 shows that the program-level pollutants of interest had fairly weak correlations with maximum temperature and average temperature. Although the correlations shown in Table 4-13 are generally low, they are primarily positive, which indicates that an increase in temperature is generally associated with a proportionate increase in concentration. The poor correlations exhibited at the program-level are not surprising due to the complex and diverse local meteorology associated with the monitoring sites. For this report, 50 sites are spread across 48 states, the District of Columbia, and Puerto Rico. The temperature parameters correlate better at select individual sites, as discussed in Sections 5.0 through 31.0.

4.2.3.2 Moisture

Three moisture parameters were used in this study for correlation with the pollutants of interest. The *dew point temperature* is the temperature to which moist air must be cooled to reach saturation with respect to water. The *wet bulb temperature* is the temperature to which moist air must be cooled by evaporating water into it at constant pressure until saturation is

Table 4-13. Summary of Pearson Correlations between the Pollutants of Interest and Selected Meteorological Parameters

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Acetaldehyde	1,820	0.16	0.15	0.10	0.10	-0.18	-0.21	-0.16
Acrolein	1,433	0.30	0.30	0.22	0.24	-0.15	-0.26	-0.06
Acrylonitrile	157	0.26	0.27	-0.02	0.10	-0.39	0.03	-0.09
Arsenic (PM_{10})	473	-0.03	-0.05	-0.01	-0.04	0.07	0.06	-0.17
Arsenic (TSP)	173	0.10	0.06	0.06	0.06	0.04	0.08	-0.21
Benzene	1,448	0.10	0.08	0.04	0.07	-0.03	0.13	-0.23
1,3-Butadiene	1,362	0.00	-0.01	-0.02	-0.01	-0.02	0.05	-0.06
Carbon Tetrachloride	1,446	0.19	0.22	0.28	0.25	0.14	-0.06	-0.04
Formaldehyde	1,820	-0.05	-0.04	-0.03	-0.08	-0.23	-0.73	-0.09
Manganese (PM_{10})	473	0.27	0.25	0.01	0.15	-0.35	-0.12	-0.26
Manganese (TSP)	173	0.01	-0.05	-0.19	-0.12	-0.44	0.17	-0.21
Naphthalene	1,150	0.16	0.17	0.12	0.15	-0.06	0.05	-0.05
p-Dichlorobenzene	1,306	0.08	0.07	0.06	0.07	-0.01	0.06	-0.11
Tetrachloroethylene	1,820	0.16	0.15	0.10	0.10	-0.18	-0.21	-0.16

reached. The *relative humidity* is the ratio of the mixing ratio to its saturation value at the same temperature and pressure (Rogers and Yau, 1989). All three of these parameters provide an indication of how much moisture is presently in the air. Higher dew point and wet bulb temperatures indicate increasing amounts of moisture in the air, while relative humidity is expressed as a percentage with 100 percent indicating saturation. It should be noted that a high dew point and wet bulb temperature do not necessarily equate to a relative humidity near 100 percent, nor does a relative humidity near 100 percent equate to a relatively high dew point or wet bulb temperature.

As shown in Table 4-13, the three moisture parameters had weak correlations with the pollutants of interest. The sites participating in the 2007 programs were located in different climatic zones ranging from a desert climate (Phoenix, Arizona) to a very moist climate (Florida and Puerto Rico). The moisture parameters correlate better at select individual sites, as discussed in Sections 5.0 through 31.0.

4.2.3.3 Wind and Pressure

Wind is an important component affecting air quality. Surface wind observations include two primary components: wind speed and wind direction. *Wind speed*, by itself, is a scalar value and is usually measured in nautical miles or knots (1 knot = 0.5 meters per second = 1.15 miles per hour). *Wind direction* describes where the wind is coming from, and is measured in degrees where 0/360E is from the north, 90E is from the east, 180E is from the south, and 270E is from the west. Wind speed and direction together represent a vector quantity, but in some cases wind speed can be quantified separately (the scalar value).

As shown in Table 4-13, the scalar wind speed had weak correlations with the pollutants of interest at the program level, which is consistent with the temperature and moisture parameter observations. Geographical features such as mountains or valleys influence both wind speed and wind direction. The sites used for sampling in the 2007 programs are located in different geographic zones ranging from a mountainous region (Colorado) to a plains region (South Dakota). Additionally, sites located downwind of emission sources may correlate better with the measured concentrations than sites upwind. All of the correlations with wind speed are negative, however, indicating that as wind speed decreases, concentrations of the pollutants of interest tend to increase. The scalar wind speed correlates better at select individual sites, as discussed in Sections 5.0 through 31.0.

Wind is created through changes in pressure. The magnitude of the pressure difference (or pressure gradient) over an area is directly proportional to the magnitude of the wind speed. The direction of the wind flow is governed by the direction of the pressure gradient. Sea level pressure is the local station pressure corrected for elevation, in effect bringing all geographic locations down to sea-level, thus making different topographical areas comparable. Overall, sea level pressure correlated weakly with ambient concentrations. However, a strong correlation was calculated for formaldehyde (-0.73).

4.3 The Impact of Mobile Sources

Ambient air is significantly impacted by mobile sources, as discussed in Section 3.5.1. Table 4-14 contains several parameters that are used to assess mobile source impact on air quality near the monitoring sites, including emission data, concentration data, and site-characterizing data, such as vehicle ownership.

4.3.1 Mobile Source Emissions

On-road emissions come from mobile sources that use roadways such as automobiles, buses, and construction vehicles; non-road emissions come from the remaining mobile sources such airplanes, lawn mowers, and boats (EPA, 2008a). Table 4-14 contains county-level on-road and non-road HAP emissions from the 2002 NEI. Mobile source emissions tended to be highest in large urban areas and lowest in rural areas. Estimated on-road county emissions were highest in Los Angeles County, CA, where CELA is located, followed by King County, WA, where SEWA is located, and Wayne County, MI, where DEMI is located. Estimated non-road county emissions were also highest in Los Angeles County, CA, followed by Harris County, TX, where CAMS 35 is located, and Maricopa County, AZ, where SPAZ and PXSS are located. Estimated on-road and non-road county emissions were lowest in the Barceloneta Municipio, PR, Custer County, SD, and Hazard County, KY, where BAPR, CUSD, and HAKY are located, respectively.

Table 4-14. Summary of Mobile Source Information by Monitoring Site

Site	County Motor Vehicle Registration	Estimated 10-Mile Ownership	Annual Average Daily Traffic	VMT by Urban Area (thousands)	County-Level On-road Emissions (tpy)	County-Level Non-road Emissions (tpy)	Hydrocarbon Arithmetic Mean[1] (ppbv)	Acetylene Arithmetic Mean[1] (ppbv)
AZFL	1,548,528	957,297	37,000	63,178	4,825.87	1,767.40	--	--
BAPR	13,912	*NA*	48,400	*NA*	7.92	39.41	3.36	0.78
BOMA	467,969	1,040,856	23,800	94,248	1,132.35	972.11	--	--
BTUT	230,868	201,584	17,310	10,373	1,063.51	490.79	4.22	1.03
BXNY	243,523	1,141,304	101,475	299,706	1,397.33	858.38	--	--
CAMS 35	3,192,222	541,414	31,130	97,774	8,667.14	7,151.94	5.15	0.66
CAMS 85	67,719	3,233	2,380	1,688	387.96	125.44	1.50	0.33
CANJ	352,413	1,374,075	4,633	106,558	1,100.36	787.25	3.13	1.01
CELA	7,514,916	2,825,650	238,000	279,041	21,963.19	8,653.97	--	--
CHNJ	335,063	166,661	18,360	*NA*	1,730.09	1,498.21	1.65	0.42
CHSC	42,726	36,525	650	*NA*	227.87	95.54	--	--
CNEP	29,398	21,627	5	*NA*	267.98	134.46	1.37	0.53
CUSD	15,345	10,891	2,500	*NA*	41.94	51.68	1.83	0.48
DEMI	1,400,461	803,365	20,900	104,126	9,889.36	2,220.42	2.90	1.00
ELNJ	359,882	1,497,998	200,000	299,706	1,394.87	883.12	6.16	1.20
FLFL	1,541,754	1,162,795	14,000	132,934	7,621.94	2,765.30	--	--
GAFL	1,203,440	487,353	41,000	63,178	5,571.31	2,198.46	--	--
GPCO	163,539	134,661	12,300	2,024	538.18	247.77	4.64	1.37
GPMS	170,041	149,717	27,000	6,936	856.42	892.01	2.32	0.52
HAKY	47,549	51,859	21,537	*NA*	142.23	22.53	--	--
IDIN	897,388	608,497	77,250	30,572	4,091.14	1,210.89	--	--
INDEM	453,146	370,693	40,710	170,934	1,513.09	984.22	--	--
ININ	897,388	684,270	97,780	30,572	4,091.14	1,210.89	--	--
ITCMI	36,768	20,596	5,200	*NA*	177.28	585.30	--	--
LDTN	50,519	56,136	12,945	*NA*	361.82	239.12	2.00	0.56
MSTN	50,519	56,136	7,287	*NA*	361.82	239.12	1.70	0.50
MVWI	92,255	26,067	3,500	*NA*	349.53	325.29	--	--

[1] This parameter is only available for monitoring sites sampling VOC.

BOLD = EPA-designated NATTS Site

NA = Data not available.

Table 4-14. Summary of Mobile Source Information by Monitoring Site (Continued)

Site	County Motor Vehicle Registration	Estimated 10 Mile Ownership	Annual Average Daily Traffic	VMT by Urban Area (thousands)	County-Level On-road Emissions (tpy)	County-Level Non-road Emissions (tpy)	Hydrocarbon Arithmetic Mean[1] (ppbv)	Acetylene Arithmetic Mean[1] (ppbv)
NBIL	2,104,894	346,717	35,700	170,934	8,728.23	5,897.21	1.77	0.64
NBNJ	540,949	541,057	63,326	299,706	2,335.59	1,543.58	1.81	0.66
ORFL	1,048,589	991,709	35,500	42,448	5,580.22	2,585.71	--	--
PRRI	142,334	151,607	212,100	26,744	1,990.93	789.91	--	--
PXSS	3,793,646	1,478,227	206,000	77,267	9,566.18	6,054.97	7.21	1.74
ROCH	552,452	482,248	111,600	16,038	2,739.09	1,095.15	--	--
RUCA	1,344,232	632,436	17,468	42,861	4,225.82	1,799.36	--	--
S4MO	1,136,095	688,893	84,821	63,584	1,373.22	496.29	2.57	0.88
SDGA	471,264	496,466	9,100	128,353	2,954.13	1,216.56	--	--
SEWA	1,766,228	848,783	232,000	69,967	11,744.97	4,575.81	2.29	0.82
SFSD	212,906	203,000	4,265	2,344	542.49	209.80	1.90	0.45
SJPR	145,642	*NA*	139,563	32,364	490.18	259.97	7.53	1.07
SKFL	1,548,528	1,166,308	48,000	63,178	4,825.87	1,767.40	--	--
SPAZ	3,793,646	905,994	113,000	77,267	9,566.18	6,054.97	7.25	1.55
SPIL	2,104,894	816,437	202,900	170,934	8,728.23	5,897.21	2.50	0.91
SYFL	1,203,440	288,549	30,500	63,178	5,571.31	2,198.46	--	--
TOOK	506,011	399,376	67,092	20,904	3,474.89	1,480.26	4.92	0.72
TSOK	506,011	291,749	33,800	20,904	3,474.89	1,480.26	3.24	0.65
TUMS	71,812	64,079	12,000	*NA*	433.93	207.08	1.80	0.52
TUOK	506,011	401,033	45,300	20,904	3,474.89	1,480.26	3.63	0.79
UNVT	143,618	32,105	1,200	3,013	891.46	371.70	--	--
WADC	219,105	693,106	36,800	97,009	1,273.69	601.45	--	--
WPIN	897,388	809,471	155,900	30,572	4,091.14	1,210.89	--	--

[1] This parameter is only available for monitoring sites sampling VOC.

BOLD = EPA-designated NATTS Site

NA = Data not available

4.3.2 Hydrocarbon Concentrations

Hydrocarbons are organic compounds that contain only carbon and hydrogen. Hydrocarbons are derived mostly from crude petroleum sources and are classified according to the arrangement of atoms, as alicyclic, aliphatic, and aromatic. Hydrocarbons are of prime economic importance because they encompass the constituents of the major fossil fuels, petroleum and natural gas, as well as plastics, waxes, and oils. Hydrocarbons in the atmosphere originate from natural sources and from various anthropogenic sources, such as the combustion of fuel and biomass, petroleum refining, petrochemical manufacturing, solvent use, and gas and oil production and use. In urban air pollution, these components, along with oxides of nitrogen (NOx) and sunlight, contribute to the formation of tropospheric ozone. According to the EPA, 47 percent of hydrocarbon emissions are from mobile sources (both on-road and non-road) (EPA, 2008e). As such, the concentration of hydrocarbons in ambient air may act as an indicator of mobile source activity levels. Several hydrocarbons are sampled with Method TO-15, including benzene, ethylbenzene, and toluene.

Table 4-14 presents the average of the sum of hydrocarbons for each site sampling VOC. Note that only sites sampling VOC have data in this column. Table 4-14 shows that SJPR, SPAZ, PXSS, and ELNJ had the highest hydrocarbon averages among the monitoring sites. Each of these sites is located in a highly populated urban area and in close proximity to heavily traveled roadways. For example, ELNJ is located near Exit 13 on I-95. The sites with the lowest hydrocarbon averages (CNEP, CHNJ, and CAMS 85) are located in fairly rural areas. The average hydrocarbon concentration can be compared to other indicators of mobile source activity, such as the ones discussed below, to determine if correlations exist.

4.3.3 Motor Vehicle Ownership

Another indicator of motor vehicle activity near the monitoring sites is the number of vehicles owned by residents in the county where the monitoring site is located. Actual county-level vehicle registration data were obtained from the state or local agency, where possible. If data were not available, vehicle registration data are available at the state-level (EIA, 2007). The county proportion of the state population was then applied to the state registration count.

The county-level motor vehicle ownership data and the average of hydrocarbon concentration are presented in Table 4-14. As previously discussed, SJPR, SPAZ, and PXSS had the highest average hydrocarbon concentrations, respectively, while CNEP, CAMS 85, and CHNJ had the least. Table 4-14 also shows that SPAZ, PXSS, CAMS 35, and SPIL had the highest county-level vehicle ownership of the sites sampling VOC, while BAPR, CUSD, and CNEP have the least. CELA, which had the highest county-level vehicle ownership of all the sites, did not sample VOC. A Pearson correlation coefficient can be calculated between these two data sets. The correlation is 0.47. While this correlation falls below the “strong” classification, it does indicate a positive correlation between hydrocarbon concentrations and vehicle registration.

The vehicle ownership at the county-level may not be completely indicative of the ownership in a particular area. As an illustration, for a county with a large city in the middle of its boundaries and less populated areas surrounding it, the total county-level ownership may be more representative of areas inside the city limits than in the rural outskirts. Therefore, a vehicle registration to population ratio was developed for each county with a monitoring site. Each ratio was then applied to the 10-mile population surrounding the monitors (from Table 2-1) and is presented in Table 4-14. Table 4-14 shows that ELNJ, PXSS, and CANJ have the highest 10-mile estimated vehicle ownership of the sites sampling VOC, while CAMS 85, CUSD, and CNEP have the least. Again, CELA, which had the highest 10-mile vehicle ownership of all the sites, did not sample VOC. Due to insufficient data availability, a 10-mile vehicle registration estimate could not be computed for the Puerto Rico sites. The Pearson correlation coefficient calculated between the average hydrocarbon calculations and the 10-mile vehicle registration estimate is 0.62. This represents a strong positive correlation, indicating that as vehicle registration inside the 10-mile radius increases, concentrations of hydrocarbons proportionally increase.

Other factors may impact the reliability of motor vehicle ownership data as an indicator of ambient air monitoring data results:

- Estimates of higher car ownership surrounding a monitoring site do not necessarily imply increased motor vehicle use in the immediate vicinity of a monitoring site. Conversely, sparsely populated regions often contain heavily traveled roadways.
- Emission sources in the area other than motor vehicles may significantly affect levels of hydrocarbons in the ambient air.

4.3.4 Estimated Traffic Volume

In previous UATMP reports, traffic data, which represents the average number of vehicles passing the monitoring site on a daily basis, was obtained from AQS. However, much of the populated traffic data reflected traffic conditions during site initiation, and were often five or more years old. Therefore, updated traffic data was obtained from state and local agencies, primarily Departments of Transportation. Most of the numbers in this report reflect annual average daily traffic (AADT), which is “the total volume of traffic on a highway segment for one year, divided by the number of days in the year,” and incorporates both directions of traffic (FLDOT, 2007). AADT counts obtained were based on data from 2001 to 2007. The updated traffic values are presented in Table 4-14.

Several limitations exist to obtaining the AADT near each monitoring site. AADT statistics are developed for roadways managed by different municipalities or government agencies, such as interstates, state highways, or local roadways. AADT is not always available in rural areas or for secondary roadways. For monitoring sites located near interstates, the AADT for the interstate segment closest to the site was obtained. For other monitoring sites, the highway or secondary road closest to the monitoring site was used. Only one AADT value was obtained for each monitoring site, which is different from the approach for previous UATMP reports. The intersection or roadway chosen for each monitoring site is discussed in each state section.

Table 4-14 shows that SEWA, PXSS, and SPIL have the highest daily traffic volume of the sites sampling VOC, while CAMS 85, CUSD, and CNEP have the lowest. Of all the monitoring sites, the highest daily traffic volume occurs near CELA, SEWA, and PRRI. CELA is located in downtown Los Angeles; SEWA is located in Seattle near the intersection of I-5 and I-9; and PRRI is located near I-95 just south of Providence. The average hydrocarbon concentration at SEWA was 2.29 ppbv, which ranked 17th among sites that measured VOC. CELA and PRRI did not measure VOC. A Pearson correlation coefficient calculated between the average hydrocarbon calculations and the traffic counts is 0.51. This represents a strong positive correlation, indicating that as traffic volume increases, concentrations of hydrocarbons proportionally increase. Previous reports showed very little correlation between these two parameters, supporting the recommendation to update the traffic values, both in the report and in AQS.

4.3.5 Vehicle Miles Traveled

Another approach to determining how mobile sources affect urban air quality is to review OK vehicle miles traveled (VMT). This approach was not included in previous UATMP reports. VMT is the sum of distances traveled by all motor vehicles in a specified system of highways for a given period of time (ODOT, 2007). As such, VMT values tend to be rather large (in the millions). County-level data is not available for all states. However, daily VMT data are available from the Federal Highway Administration (FHWA) by urban area (FHWA, 2006). The MSA designations are used to designate in which urban area each monitoring site resides. For example, CAMS 35 is located in Deer Park, Texas. This city is located near Houston and is part of the Houston-Galveston-Brazoria, TX MSA. Therefore, VMT for CAMS 35 is for the value reported for Houston. VMT are presented in Table 4-14, where available.

The urban areas with UATMP or NATTS sites with the highest VMT are New York, Los Angeles, and Chicago. A Pearson correlation coefficient calculated between the average hydrocarbon calculations and VMT is almost zero (-0.02), indicating virtually no relationship between the two. However, many of the sites with the largest VMT did not measure VOC (such as CELA, RUCA, BXNY, and INDEM). In addition, VMT was not available for sites not in “urban areas,” as defined by the FHWA. Seven sites that measured VOC (almost one-third) are not in urban areas.

4.3.6 Mobile Source Tracer Analysis

Research has shown that acetylene can be used as a signature compound (or tracer) for automotive emissions (Warneck, 1988; NRC, 1991) because this VOC is not typically emitted from biogenic or stationary sources. Table 4-14 presents average acetylene concentrations for each monitoring site that sampled VOC. As shown, PXSS, SPAZ, and GPCO have the highest average acetylene concentrations, respectively.

Pearson correlation coefficients were calculated between the average acetylene concentrations and each of the parameters discussed above (vehicle ownership, traffic data, and VMT). The Pearson correlations were generally stronger for the average acetylene concentrations than for the average hydrocarbon concentrations:

- Between county-level vehicle ownership and acetylene: 0.56
- Between 10-mile vehicle ownership and acetylene: 0.72
- Between traffic volume and acetylene: 0.57
- Between VMT and acetylene: 0.12.

Nearly all emissions of ethylene are due to automotive sources, with the exception of activities related to natural gas production and transmission. Ethylene is not detected as a VOC by the TO-15 sampling method, but is detected using the SNMOC method. According to tunnel studies, an ethylene to acetylene ratio of 1.7 to 1 is indicative of mobile sources (TCEQ, 2002). For the five sites that chose the SNMOC option, ethylene to acetylene concentration ratios were computed and compared to the 1.7 to 1 ratio in Table 4-15.

All of the calculated ratios are less than the expected ratio of 1.7. This indicates that there is likely an ethylene sink or an acetylene source affecting the concentrations of these pollutants. Of the sites that sampled SNMOC, NBIL=s ethylene to acetylene ratio was the closest to the expected 1.7 ratio (1.52), while SFSD’s ratio was least like the expected ratio (1.24). These results are very similar to those in the 2006 UATMP report.

Table 4-15. Average Ethylene-to-Acetylene Ratios for Sites that Measured SNMOC

Site	Average Ethylene to Acetylene Ratio	% Difference from 1.70 Ratio
BTUT	1.29	-24.14
CUSD	1.33	-22.01
GPMS	1.42	-16.73
NBIL	1.52	-10.65
SFSD	1.24	-27.15

BOLD = EPA-designated NATTS Site.

4.3.7 BTEX Concentration Profiles

The *magnitude* of emissions from motor vehicles generally depends on the volume of traffic in urban areas, but the *composition* of these emissions depends more on vehicle design. Because the distribution of vehicle designs (i.e., the relative number of motor vehicles of different styles) is probably quite similar from one urban area to the next, the composition of air pollution resulting from motor vehicle emissions is not expected to exhibit significant spatial variations. In support of this hypothesis, previous air monitoring studies have observed relatively constant composition of ambient air samples collected along heavily traveled urban roadways (Conner et al., 1995). Roadside studies have found particularly consistent proportions of four hydrocarbons (benzene, toluene, ethylbenzene, and the xylene isomers - the ABTEX@ compounds) both in motor vehicle exhaust and in ambient air near roadways.

To examine the impact of motor vehicle emissions on air quality at the 2007 UATMP and NATTS monitoring sites, Table 4-16 and Figure 4-1 compare average concentration ratios for the BTEX compounds measured during the 2007 program year to the ratios reported in the roadside study. Table 4-16 contains the 95 percent confidence interval for each average BTEX ratio. This comparison provides a qualitative depiction of how greatly motor vehicle emissions affect air quality at the UATMP and NATTS monitoring sites: the more similar the concentration ratios at a particular monitoring site are to those of the roadside study, the more likely that motor vehicle emissions impact ambient levels of hydrocarbons at that location.

Table 4-16. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study

Site	Benzene-Ethylbenzene Ratio	Toluene-Ethylbenzene Ratio	Xylenes-Ethylbenzene Ratio
Roadside Study	2.85	5.85	4.55
BAPR	3.17 ± 0.40	9.35 ± 3.18	3.88 ± 0.13
BTUT	4.59 ± 0.36	15.44 ± 10.21	4.22 ± 0.17
CAMS 35	7.26 ± 0.82	8.97 ± 1.46	3.10 ± 0.14
CAMS 85	18.13 ± 2.06	10.56 ± 0.89	3.48 ± 0.17
CANJ	4.88 ± 0.42	7.65 ± 0.77	3.59 ± 0.09
CHNJ	6.57 ± 1.19	44.53 ± 52.46	3.02 ± 0.19
CNEP	8.05 ± 0.93	7.65 ± 0.99	2.89 ± 0.14
CUSD	7.87 ± 1.00	8.00 ± 0.94	3.32 ± 0.16
DEMI	5.16 ± 0.56	6.91 ± 0.48	3.59 ± 0.10
ELNJ	3.94 ± 0.32	7.67 ± 1.40	3.54 ± 0.08
GPCO	3.37 ± 0.24	8.27 ± 1.98	4.46 ± 0.07
GPMS	3.24 ± 0.34	6.94 ± 0.97	3.33 ± 0.15
LDTN	6.69 ± 0.67	8.14 ± 1.06	3.42 ± 0.20
MSTN	7.87 ± 1.09	9.75 ± 1.22	3.26 ± 0.09
NBIL	5.26 ± 0.67	7.76 ± 0.83	3.26 ± 0.13
NBNJ	4.62 ± 0.55	6.80 ± 0.34	3.31 ± 0.08
PXSS	3.35 ± 0.41	11.79 ± 1.87	3.62 ± 0.11
S4MO	3.91 ± 0.37	6.82 ± 0.68	3.12 ± 0.08
SEWA	4.51 ± 0.32	6.75 ± 0.22	3.80 ± 0.09
SFSD	5.85 ± 0.86	21.37 ± 5.00	2.89 ± 0.19
SJPR	1.45 ± 0.22	8.06 ± 0.80	4.20 ± 0.08
SPAZ	2.12 ± 0.67	5.45 ± 0.82	3.97 ± 0.21
SPIL	5.13 ± 0.46	6.71 ± 0.41	3.33 ± 0.11
TOOK	5.14 ± 0.58	12.69 ± 2.28	4.15 ± 0.10
TSOK	3.65 ± 0.38	14.33 ± 3.20	3.51 ± 0.23
TUMS	5.75 ± 0.67	10.45 ± 1.69	3.52 ± 0.11
TUOK	4.78 ± 0.35	12.44 ± 1.72	3.99 ± 0.11

BOLD = EPA-designated NATTS Site.

Figure 4-1. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study

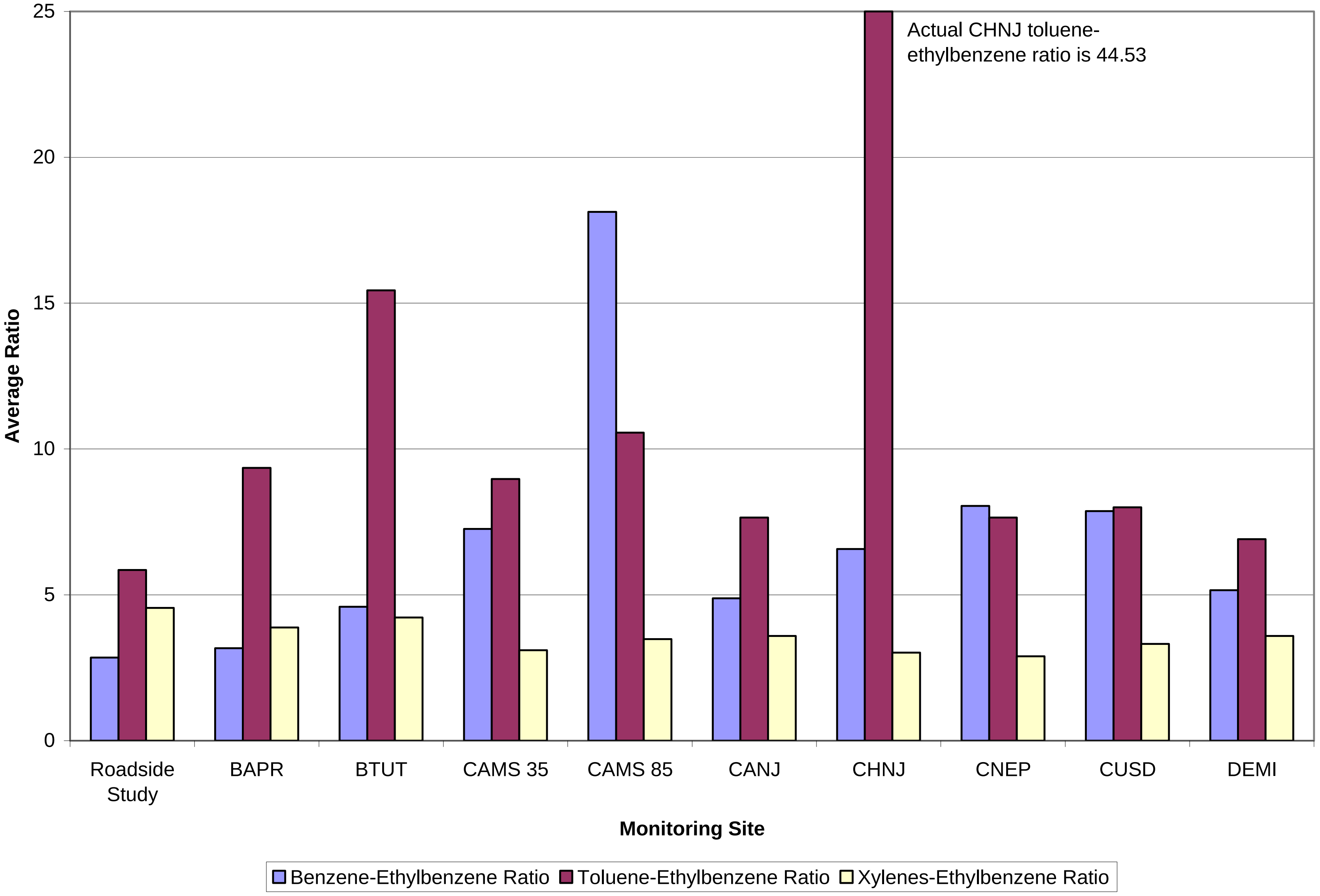

Actual CHNJ toluene-ethylbenzene ratio is 44.53

Figure 4-1. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study (Continued)

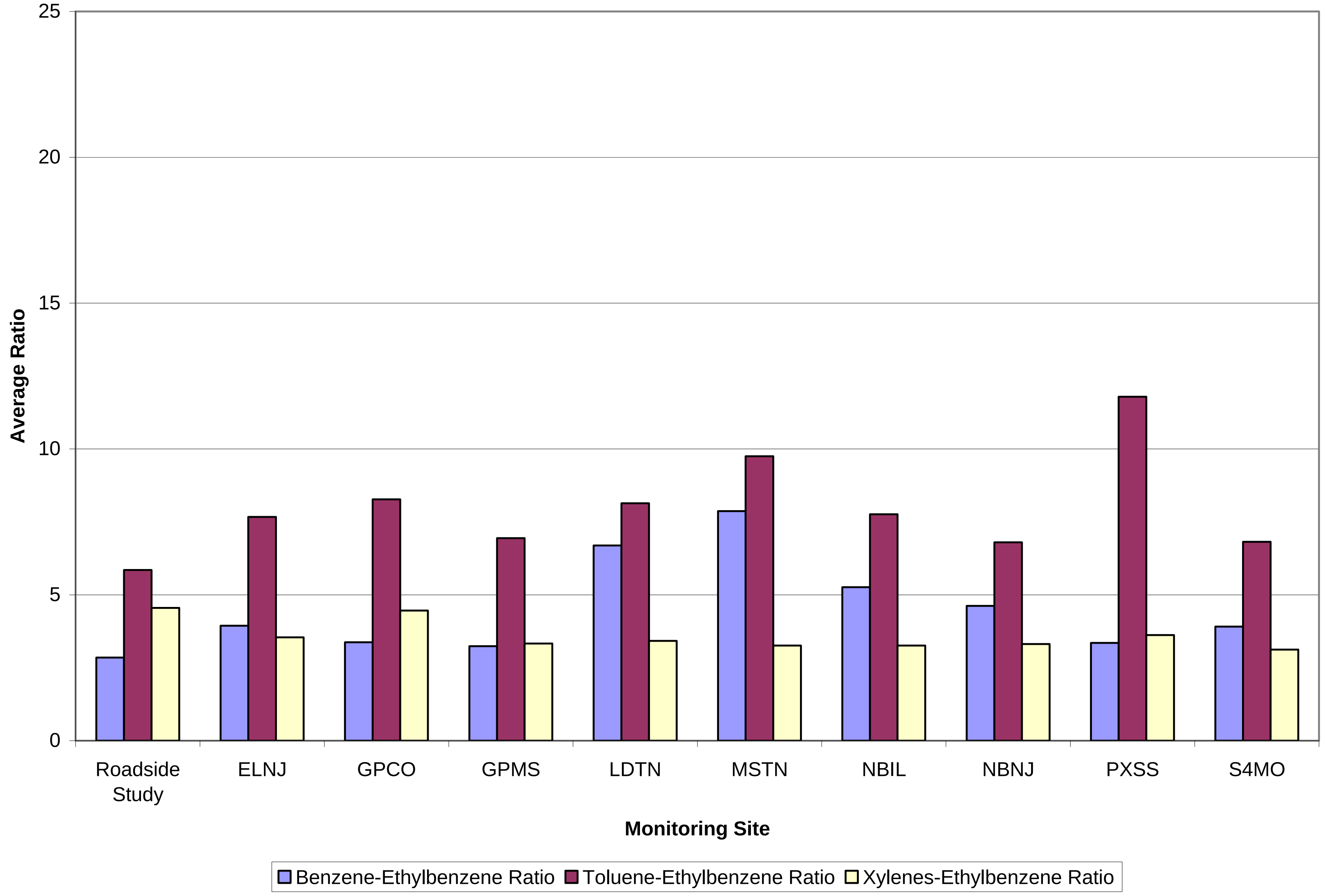
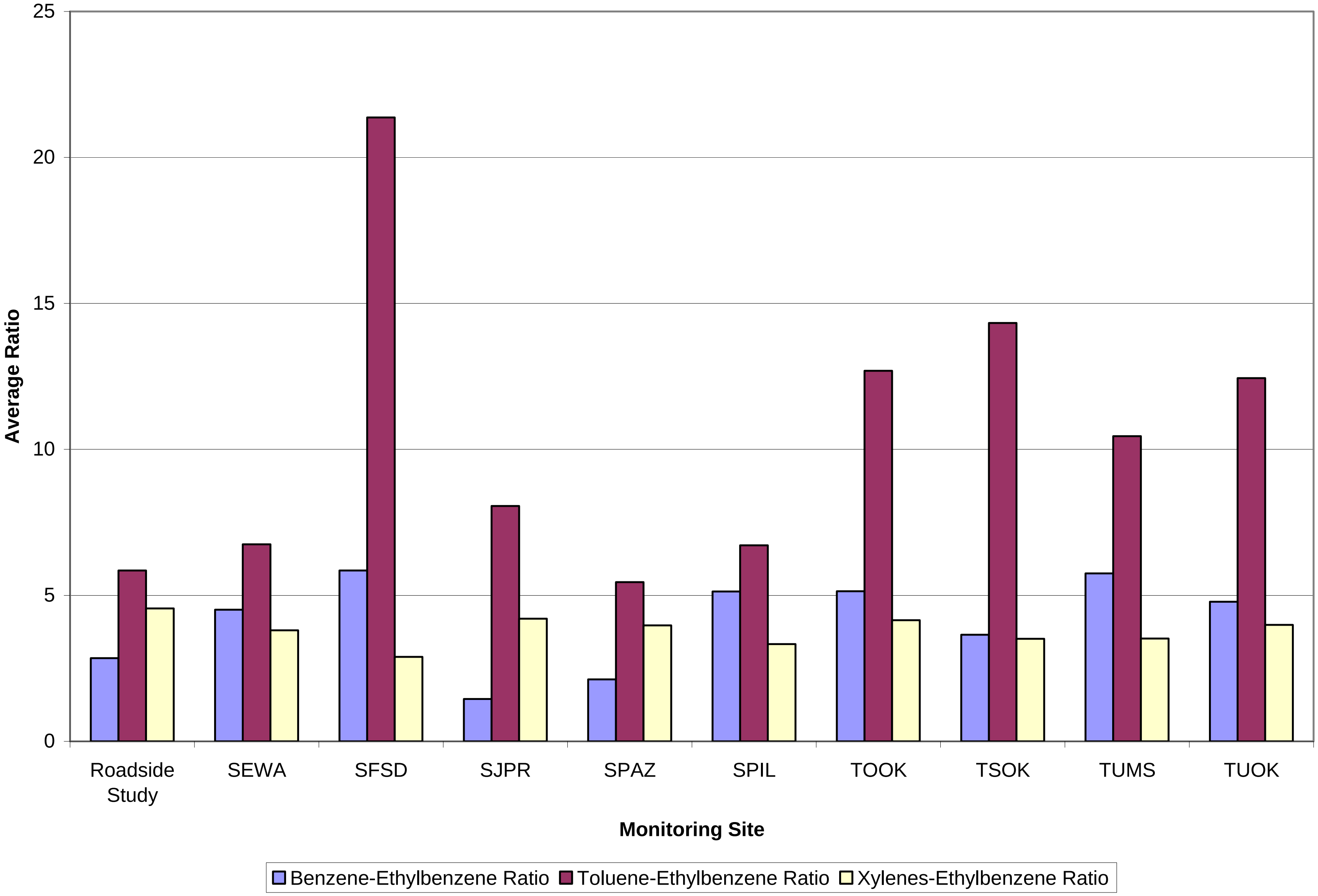


Figure 4-1. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study (Continued)



As presented in Figure 4-1, the concentration ratios for BTEX compounds measured at most of the monitoring sites bear some resemblance to the ratios reported in the roadside study. The BTEX ratios at the BAPR and GPCO monitoring sites appear to be the most similar to the roadside study profile. For all monitoring sites, the toluene-ethylbenzene ratio is the largest of the three ratios, with the exceptions of CAMS 85 and CNEP. The benzene-ethylbenzene ratio is the smallest of the three ratios at six sites, while the xylenes-ethylbenzene ratio is the smallest at 21 sites. These observations suggest that emissions from motor vehicles have an impact on the levels of hydrocarbons in urban ambient air, although they are not the only contributing factor.

4.4 Variability Analysis

This section presents the results of the two variability analyses described in Section 3.5.2.

4.4.1 Coefficient of Variation

Figures 4-2 through 4-12 are graphical displays of site-specific coefficient of variations (standard deviation versus average concentration). The figures show that several of the compounds appear to exhibit the “clustering” discussed in Section 3.5.2. Formaldehyde appears to exhibit clustering in Figure 4-9; however, the data point representing INDEM’s average and standard deviation is significantly higher than the others. INDEM resides in a heavily industrialized area, and this may be the result of emissions from nearby petroleum refinery and steel manufacturing facilities. If this data point was removed and the scales adjusted, the formaldehyde concentrations would show more variability. This example demonstrates that the range of concentrations must be considered when interpreting the graphs.

Carbon tetrachloride and 1,3-butadiene exhibit clustering, or uniformity in concentrations. Carbon tetrachloride is a pollutant that was used world wide as a refrigerant. However, it was identified as an ozone-depleting substance in the stratosphere and its use was banned at the Kyoto Accords. This pollutant has a long lifetime in the atmosphere, but slowly degrades over time. Since being banned, its concentration in ambient air is fairly ubiquitous regardless of where it is measured. The compressed range of associated coefficients of variations shown in Figure 4-8 not only supports this expected uniformity (i.e., lack of

Figure 4-2. Coefficient of Variation Analysis of 1,3-Butadiene Across 27 Sites

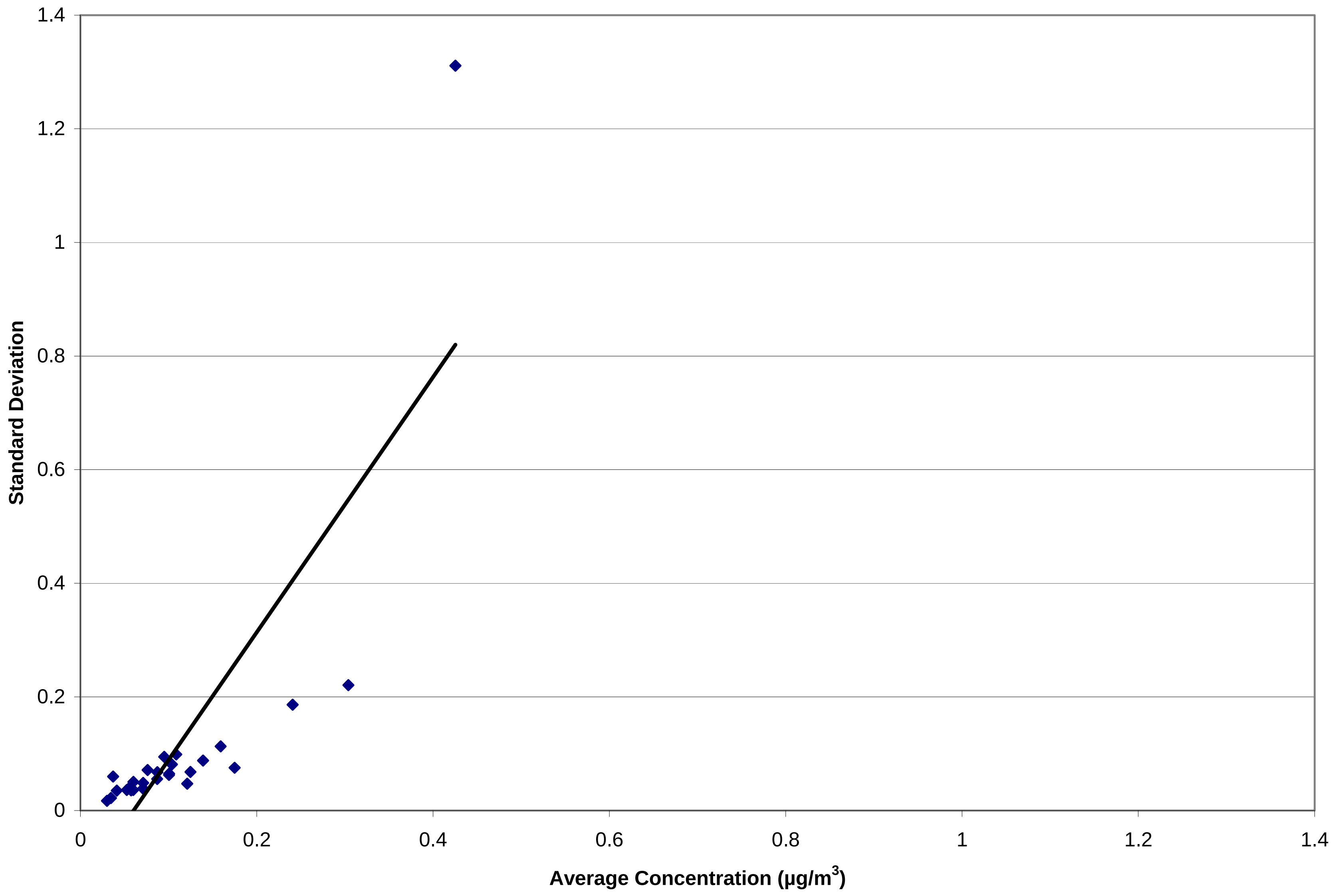


Figure 4-3. Coefficient of Variation Analysis of Acetaldehyde Across 33 Sites

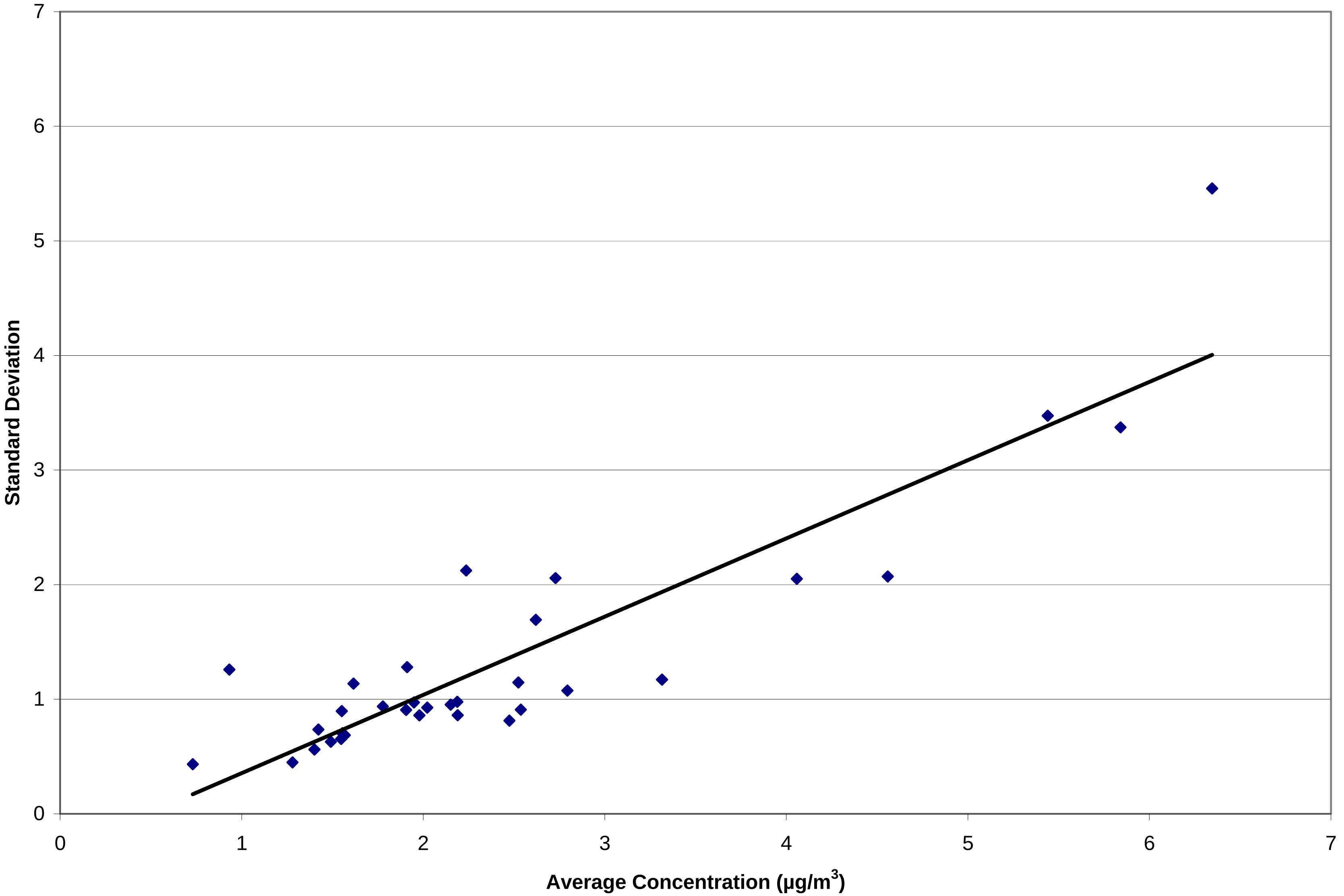


Figure 4-4. Coefficient of Variation Analysis of Acrolein Across 27 Sites

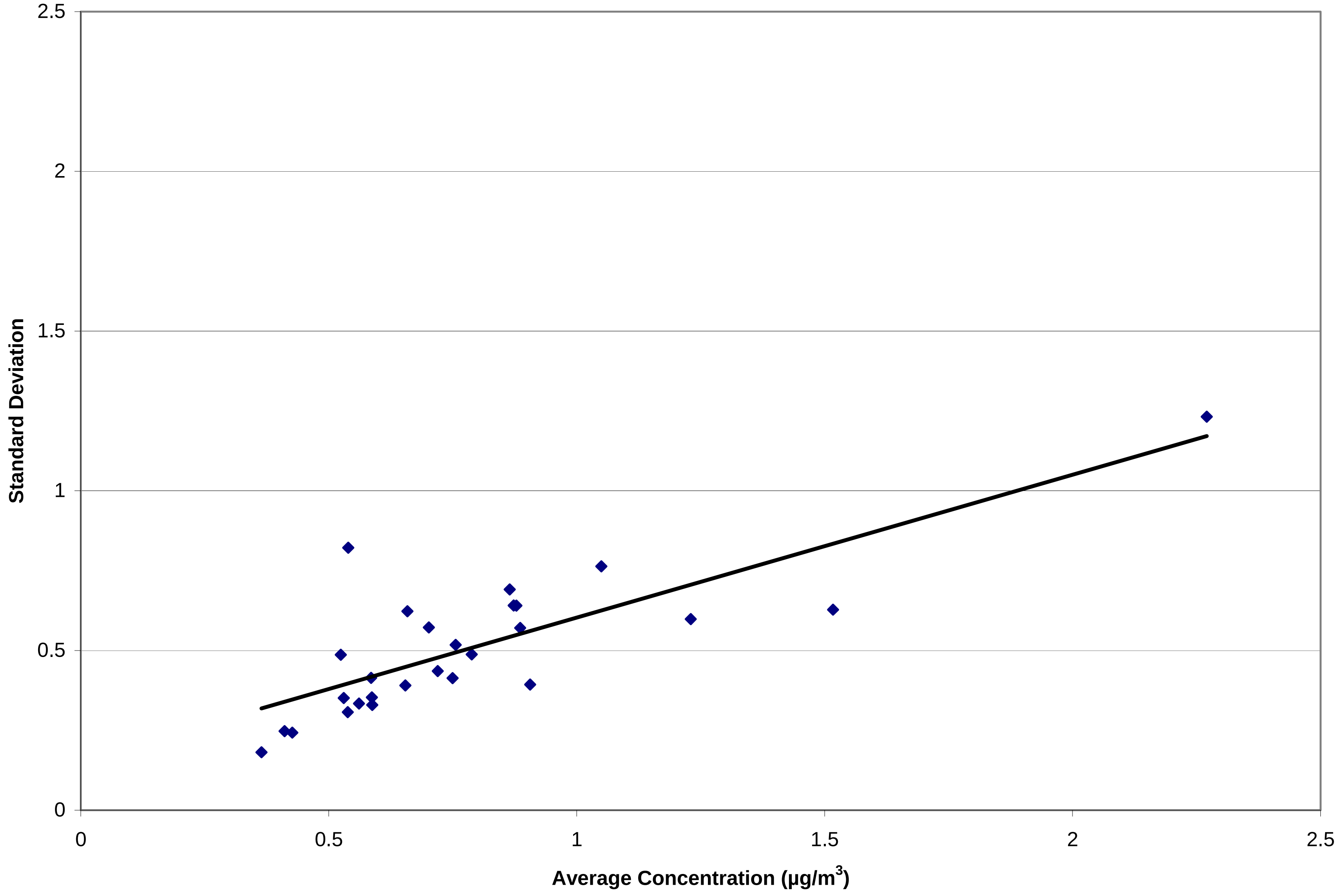


Figure 4-5. Coefficient of Variation Analysis of Acrylonitrile Across 27 Sites

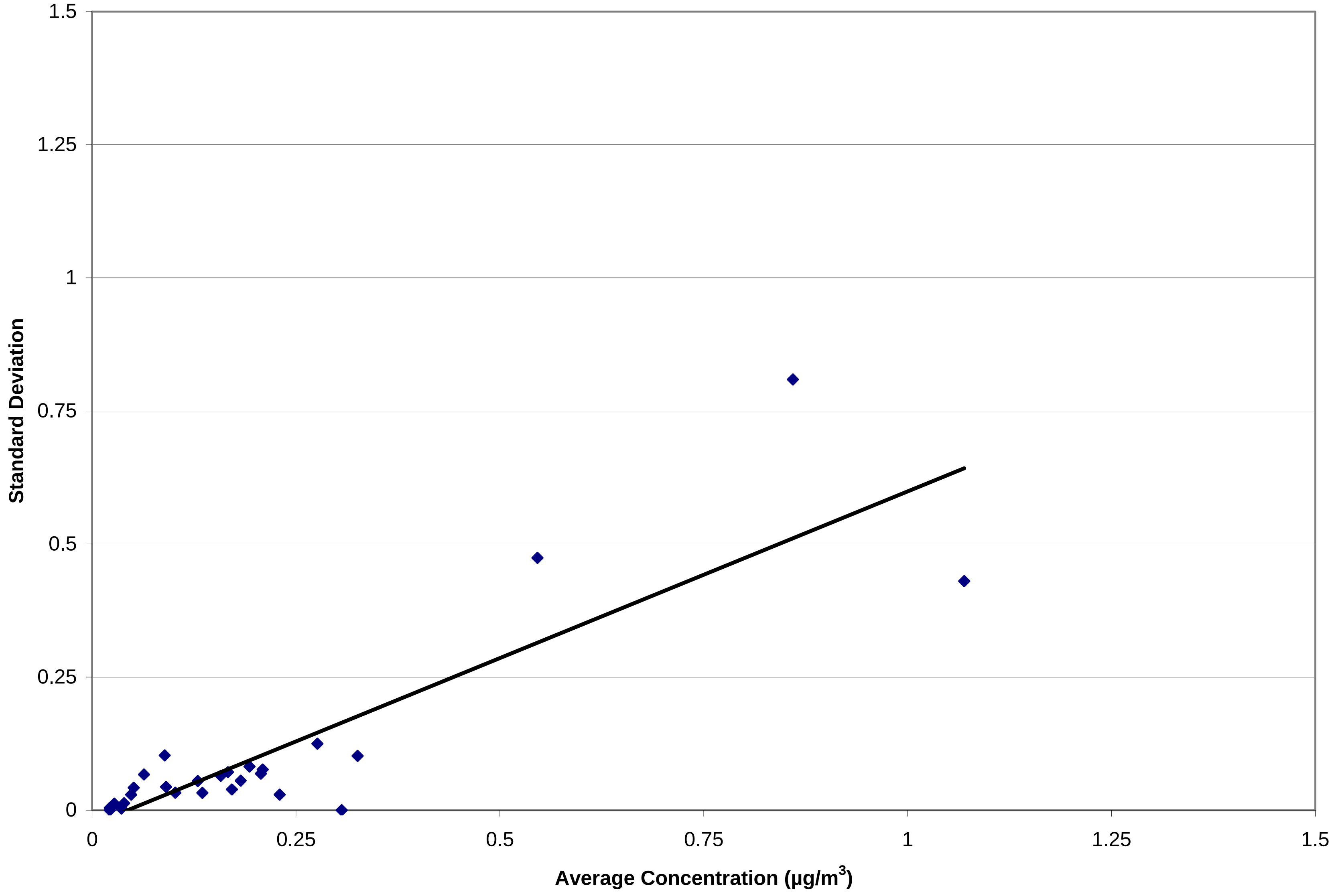


Figure 4-6. Coefficient of Variation Analysis of Arsenic Across 11 Sites

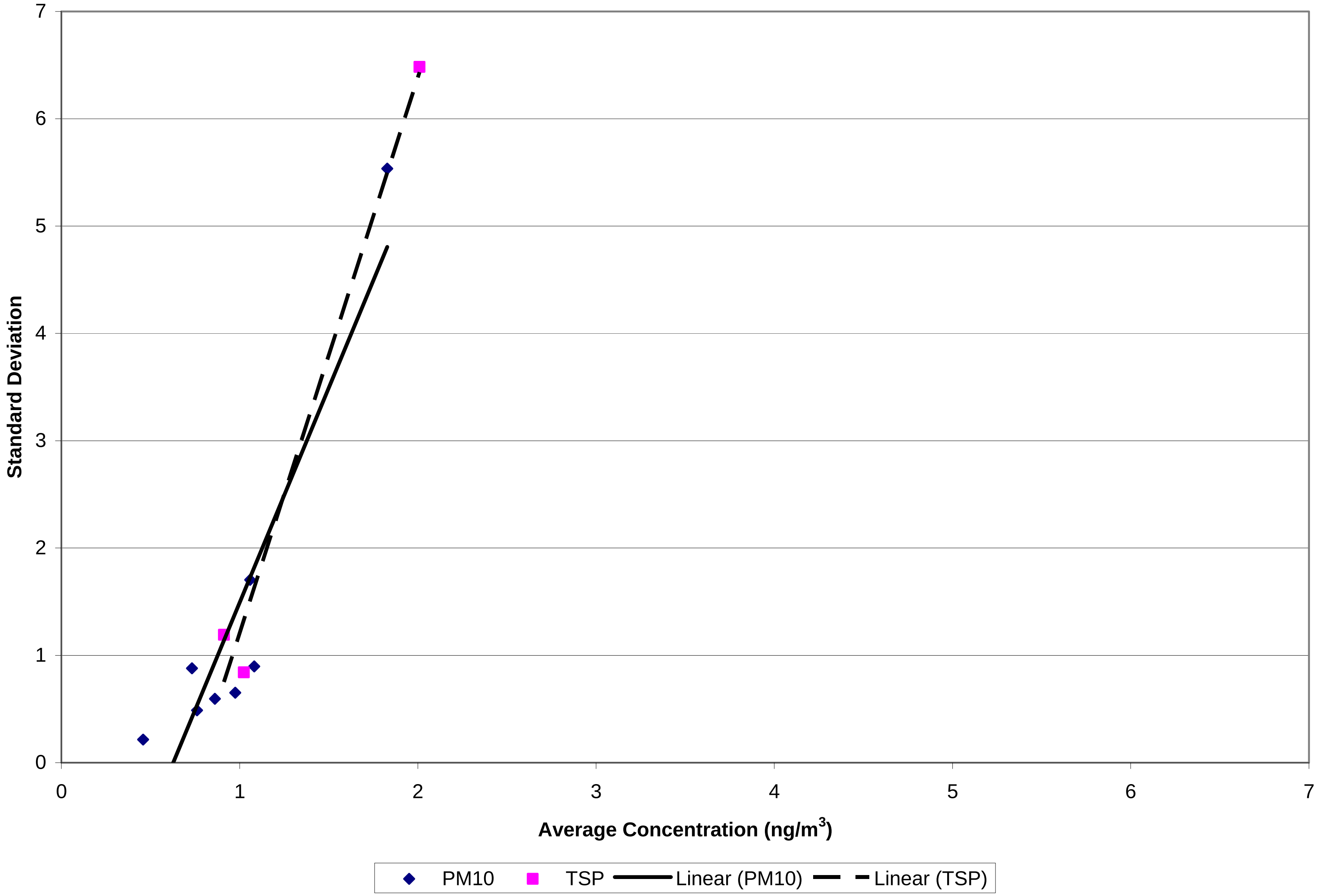


Figure 4-7. Coefficient of Variation Analysis of Benzene Across 27 Sites

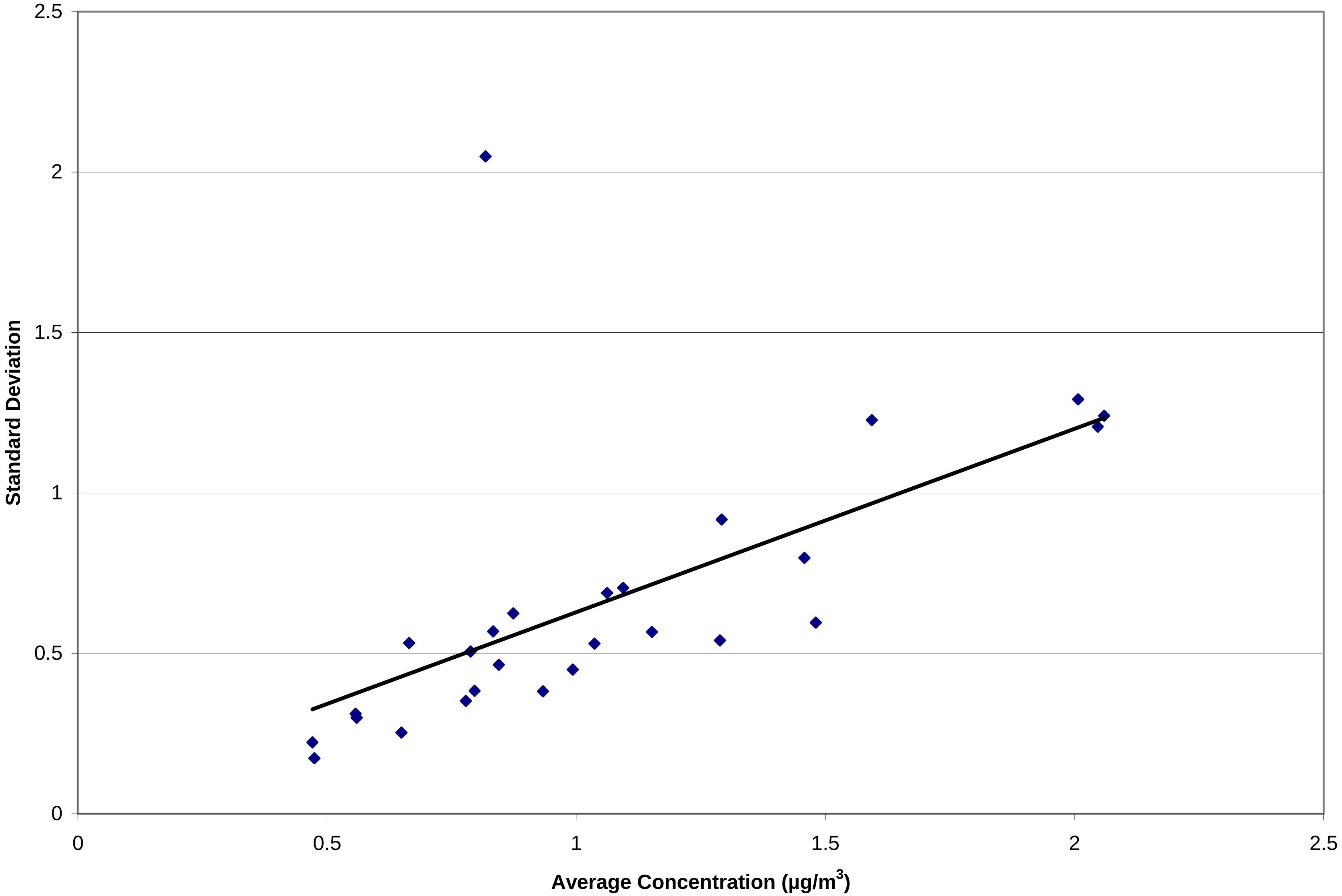


Figure 4-8. Coefficient of Variation Analysis of Carbon Tetrachloride Across 27 Sites

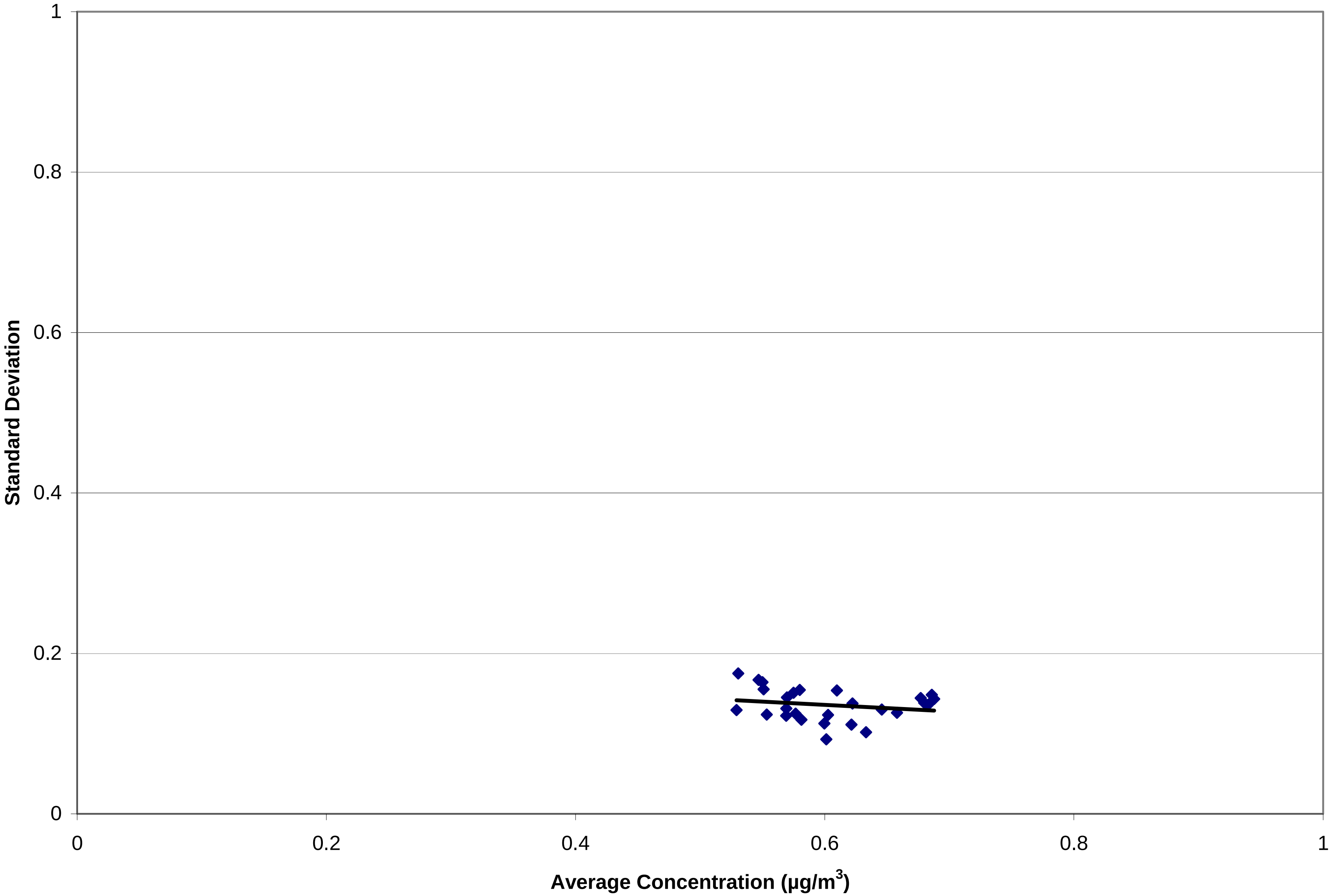


Figure 4-9. Coefficient of Variation Analysis of Formaldehyde Across 33 Sites

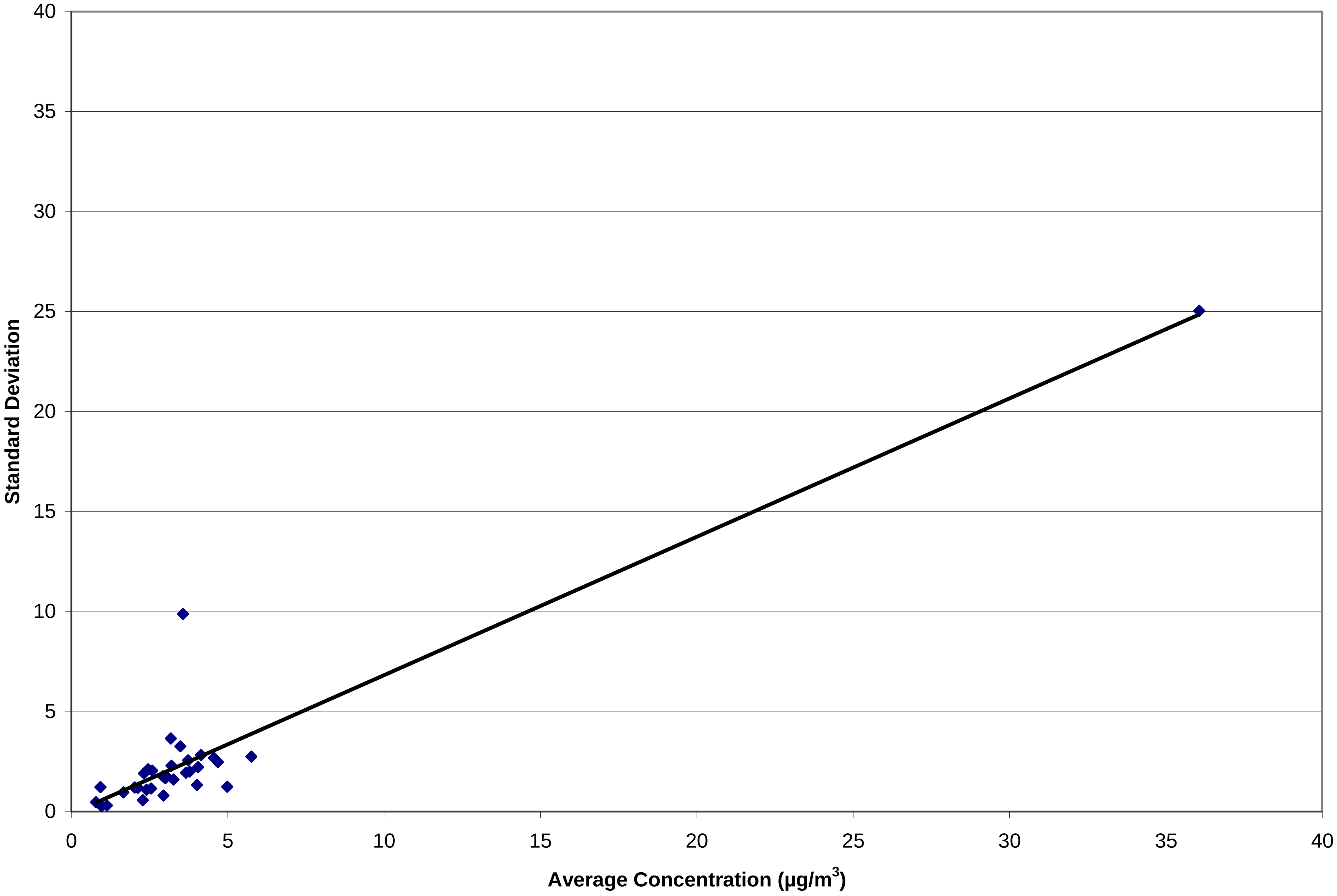


Figure 4-10. Coefficient of Variation Analysis of Manganese Across 11 Sites

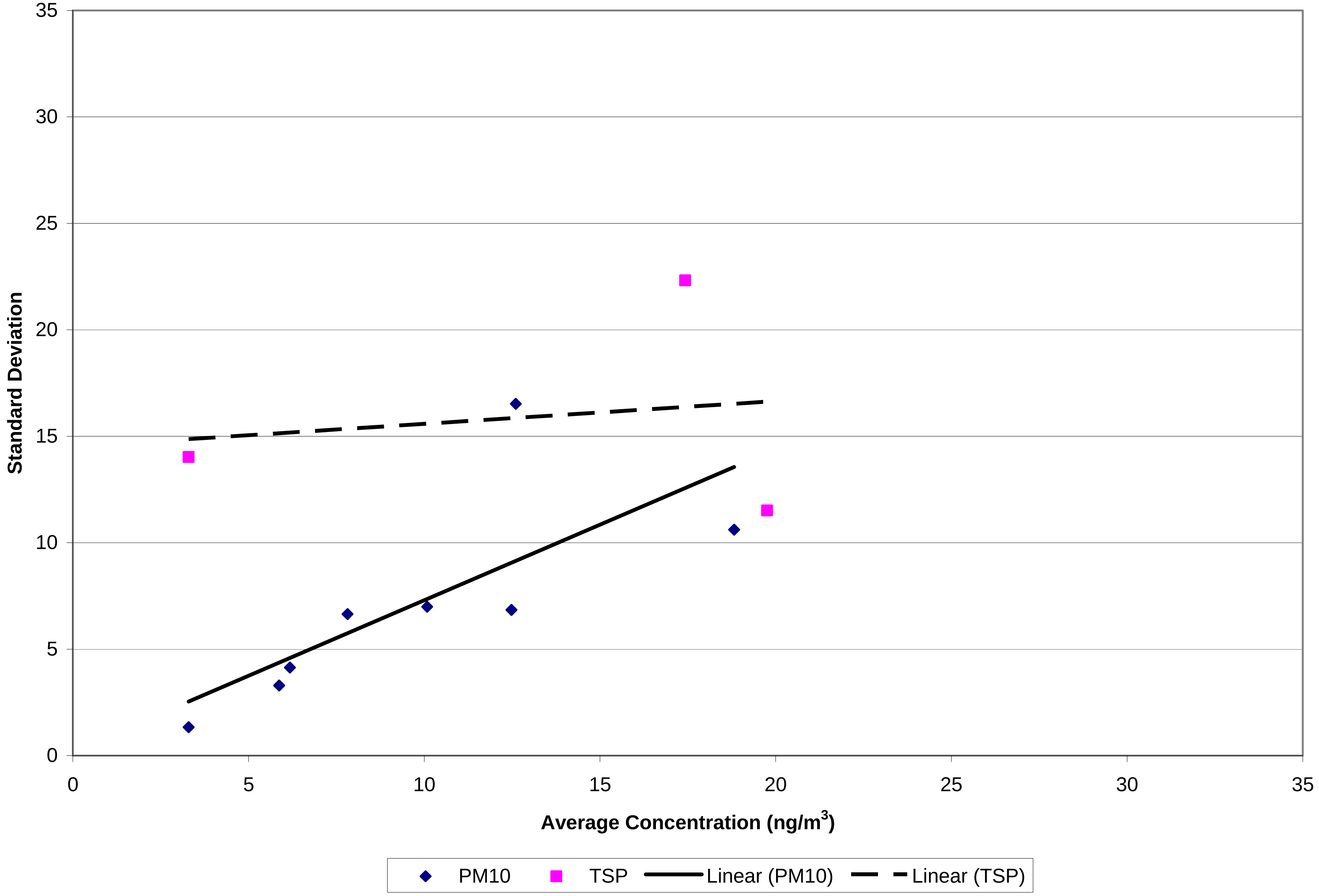


Figure 4-11. Coefficient of Variation Analysis of *p*-Dichlorobenzene Across 27 Sites

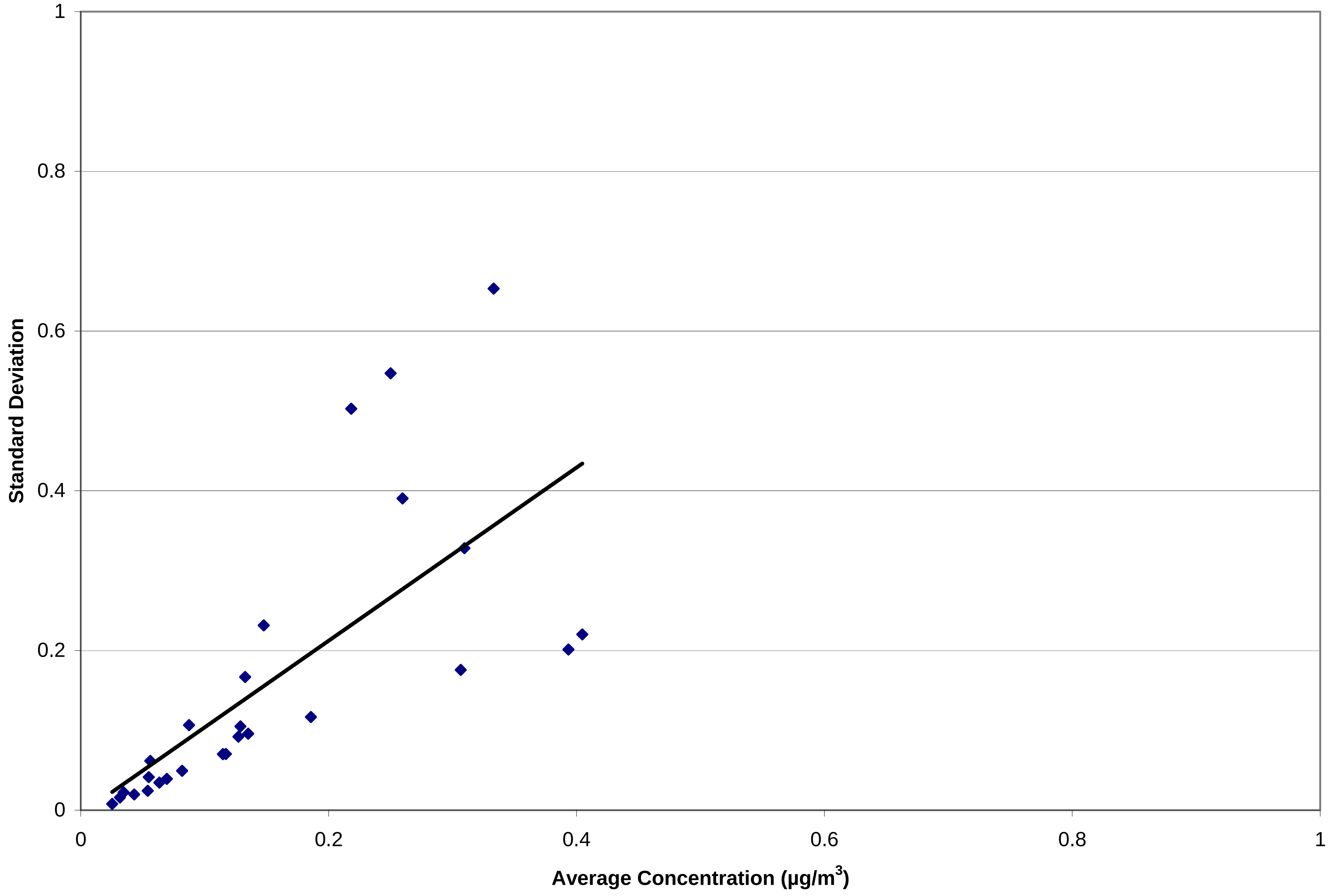
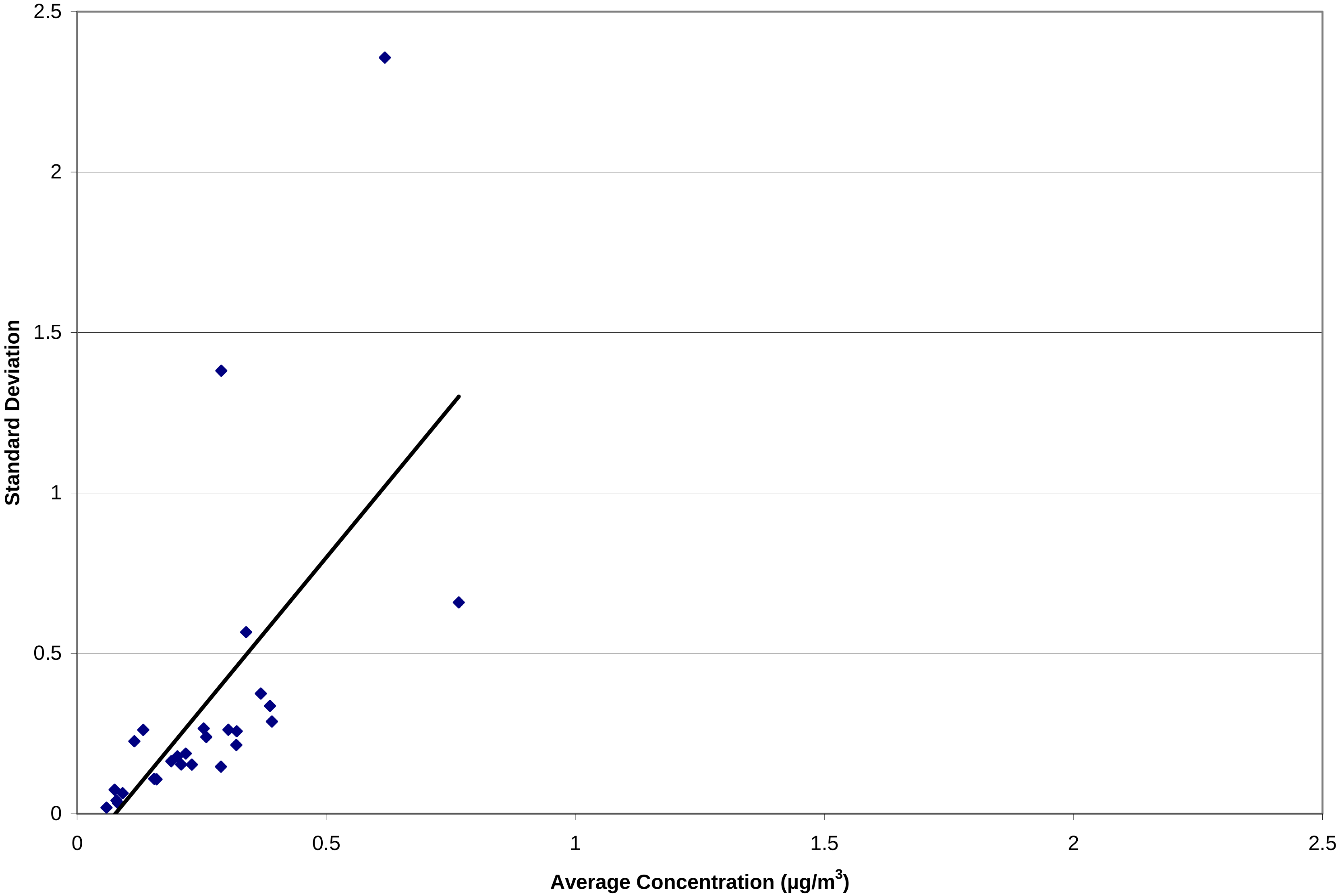


Figure 4-12. Coefficient of Variation Analysis of Tetrachloroethylene Across 27 Sites



variability) in “background” concentrations of carbon tetrachloride, but is also a testament to the representativeness of the data produced under the EPA National Monitoring Programs.

Although many of the other pollutants do not exhibit easily classifiable clustering, or even appear to follow a linear pattern, many of them are thrown off by one or two data points that do not fall in line with the others. For example, the larger standard deviations exhibited for tetrachloroethylene indicate that these averages were influenced by outliers. Excluding this data point would allow the rest to follow a linear trend line.

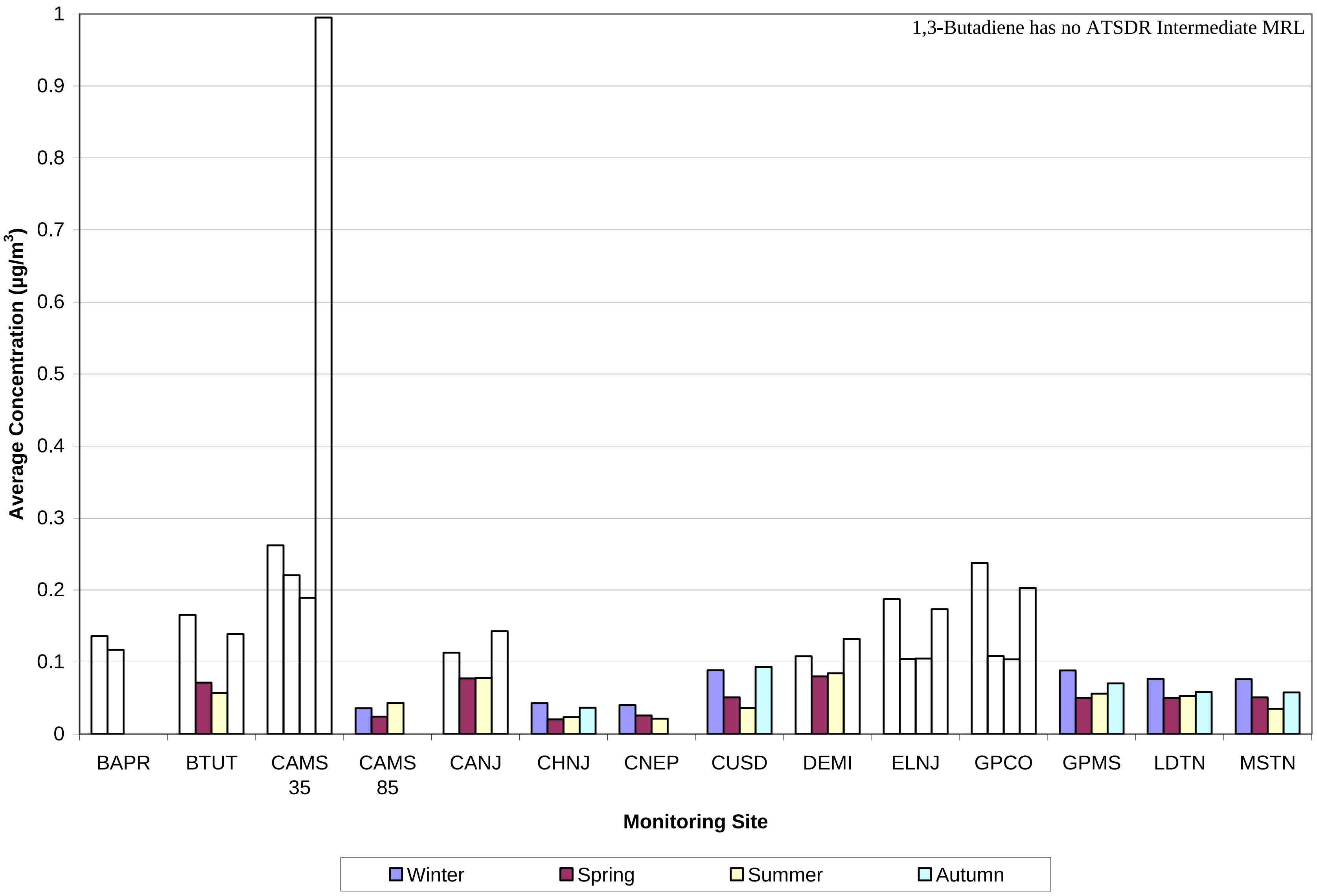
4.4.2 Seasonal Variability Analysis

Figures 4-13 through 4-25 provide a graphical display of the average concentrations by season for the program-level pollutants of interest. Seasonal averages are calculated based on criteria specified in Section 3.3. If the pollutant of interest has a corresponding ATSDR Intermediate MRL, then this value is indicated on the graph and is plotted where applicable.

Some of the program-wide pollutants of interest, such as *p*-dichlorobenzene, were measured frequently in some seasons but not in others. As a result of the seasonal average criteria, there are gaps in the figures for these pollutants for certain seasons. For example, Figure 4-24 shows that *p*-dichlorobenzene had fewer winter averages, even though many of the sites sampled year-round. Figure 4-16 for acrylonitrile has only spring and summer averages for only three sites. This indicates that this pollutant is infrequently detected. But given its pollutant of interest classification, most detects failed the screening process. The start and stop dates of each site must be considered when interpreting the seasonal graphs.

Some pollutants of interest, such as formaldehyde, benzene, and acetaldehyde, were detected year-round. Comparing the seasonal averages for the sites with four valid seasonal averages often reveals a trend for these pollutants. For example, formaldehyde averages tended to be higher in the summer, as shown in Figure 4-21, while 1,3-butadiene and benzene averages tended to be higher in the autumn and winter, as shown in Figure 4-13 and Figure 4-19. The seasonal behavior of benzene and formaldehyde suggests the influence of reformulated gasoline (RFG), as the benzene content is typically lowered during the warmer periods (i.e., summer and

Figure 4-13. Comparison of Average Seasonal 1,3-Butadiene Concentrations by Season



1,3-Butadiene has no ATSDR Intermediate MRL

Figure 4-13. Comparison of Average Seasonal 1,3-Butadiene Concentrations by Season (Continued)

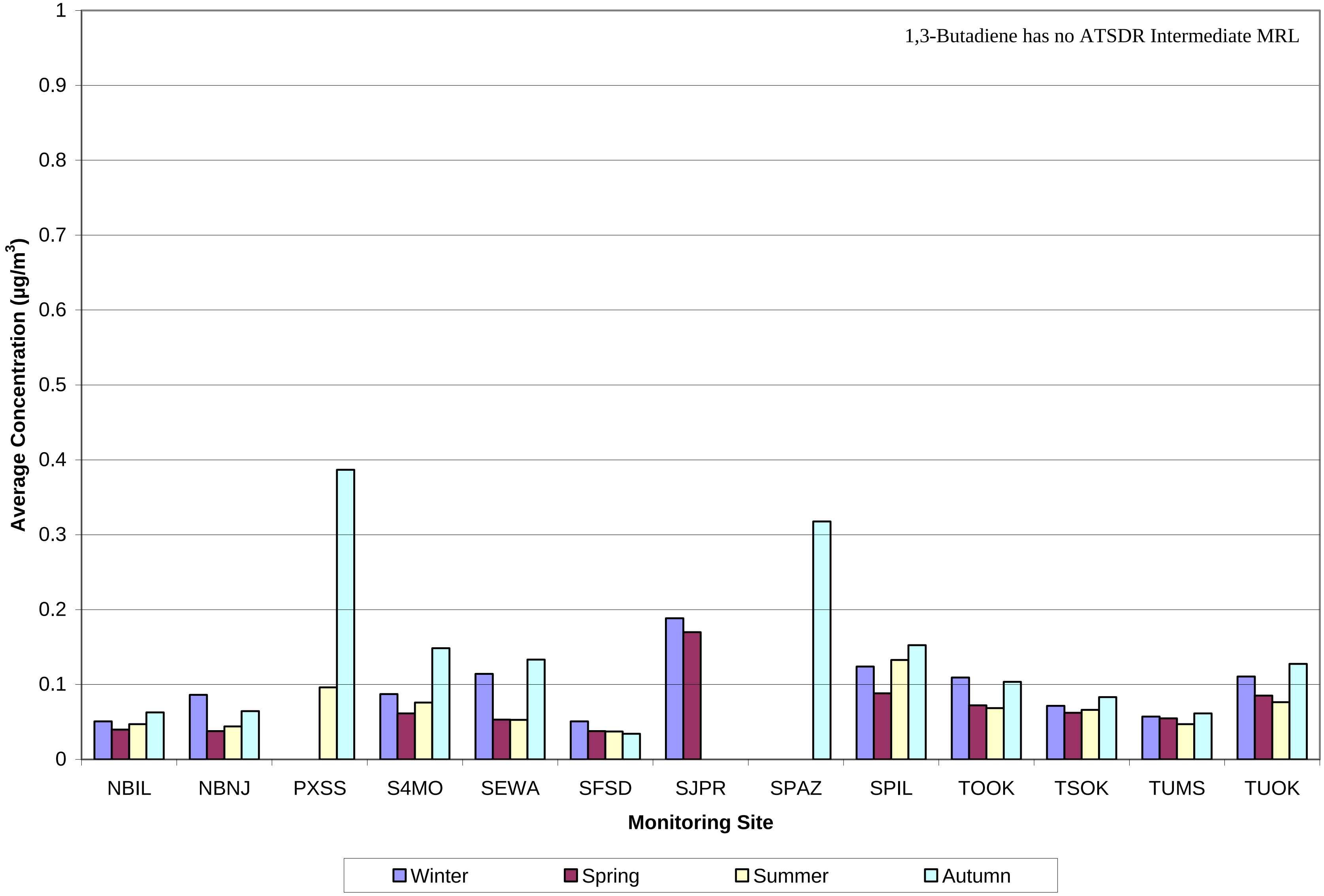


Figure 4-14. Comparison of Average Seasonal Acetaldehyde Concentrations by Season

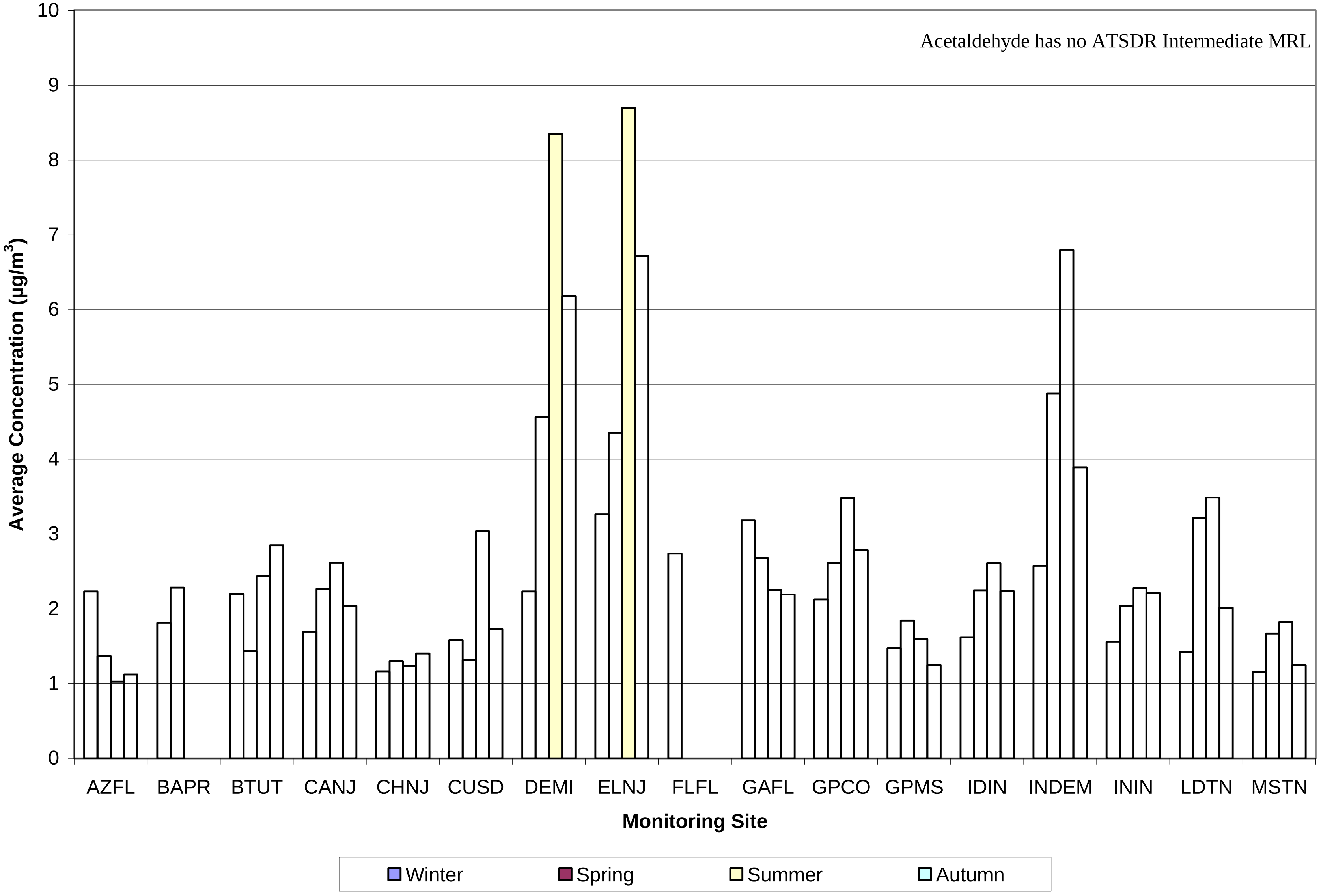

Acetaldehyde has no ATSDR Intermediate MRL

Figure 4-14. Comparison of Average Seasonal Acetaldehyde Concentrations by Season (Continued)

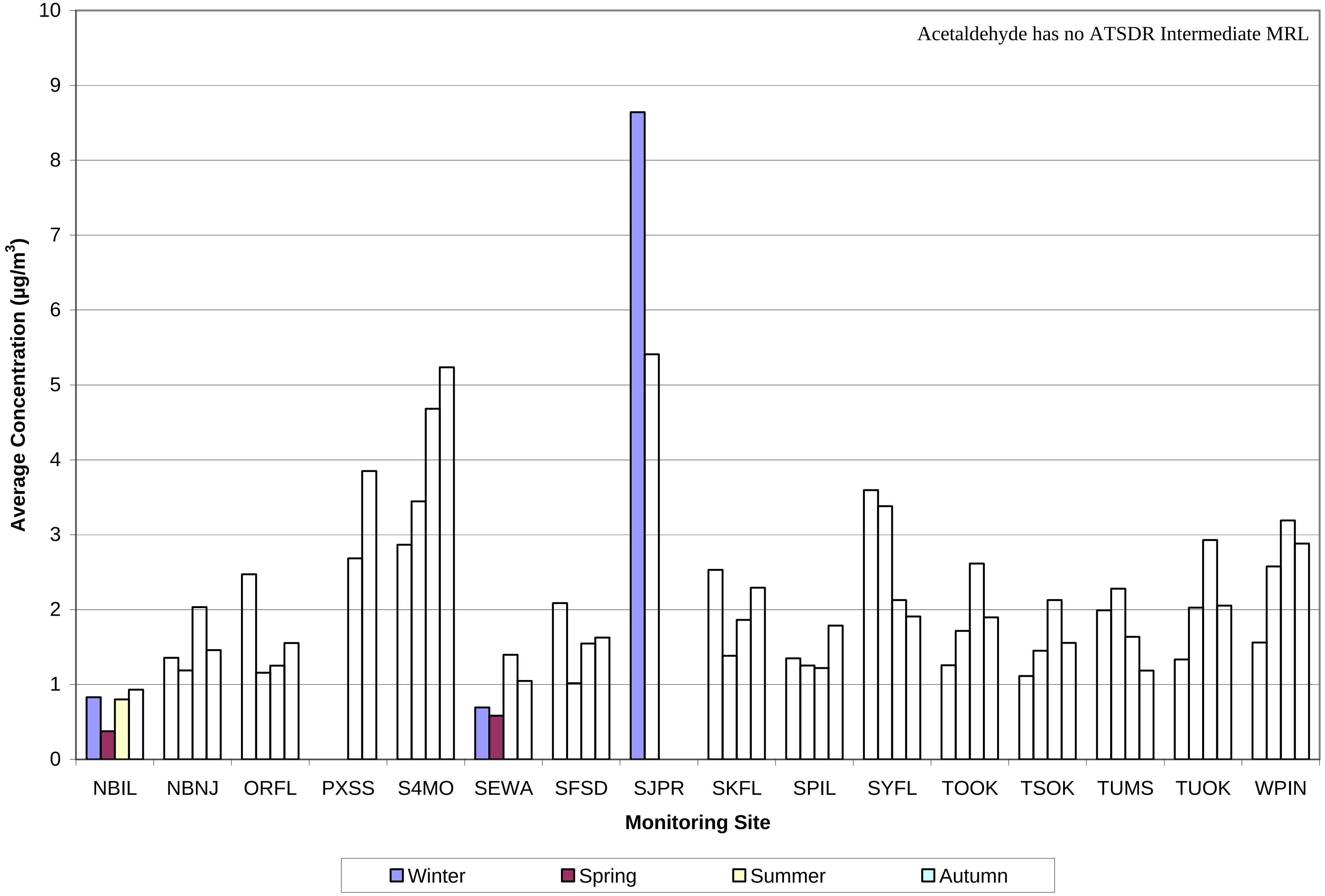


Figure 4-15. Comparison of Average Seasonal Acrolein Concentrations by Season

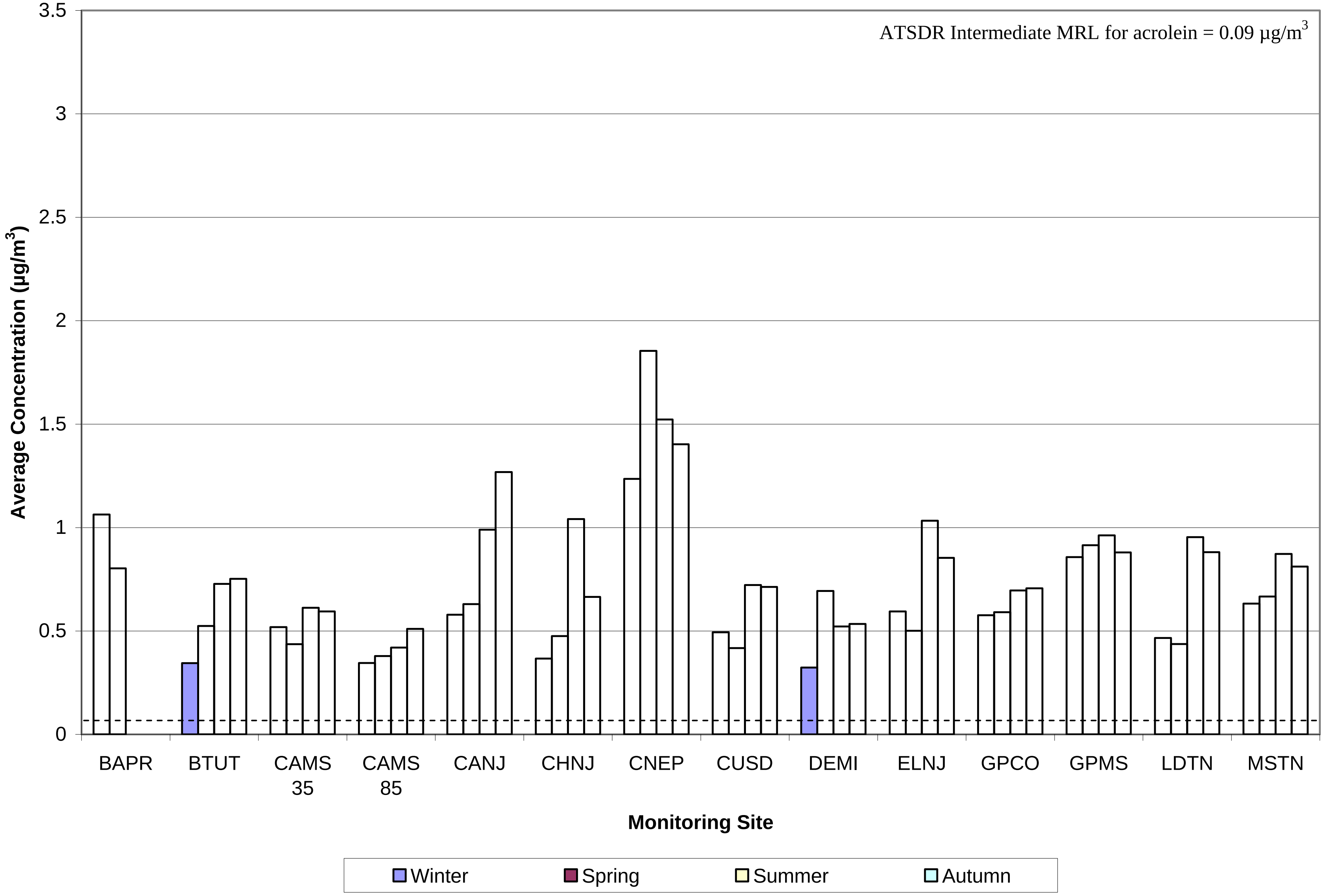


Figure 4-15. Comparison of Average Seasonal Acrolein Concentrations by Season (Continued)

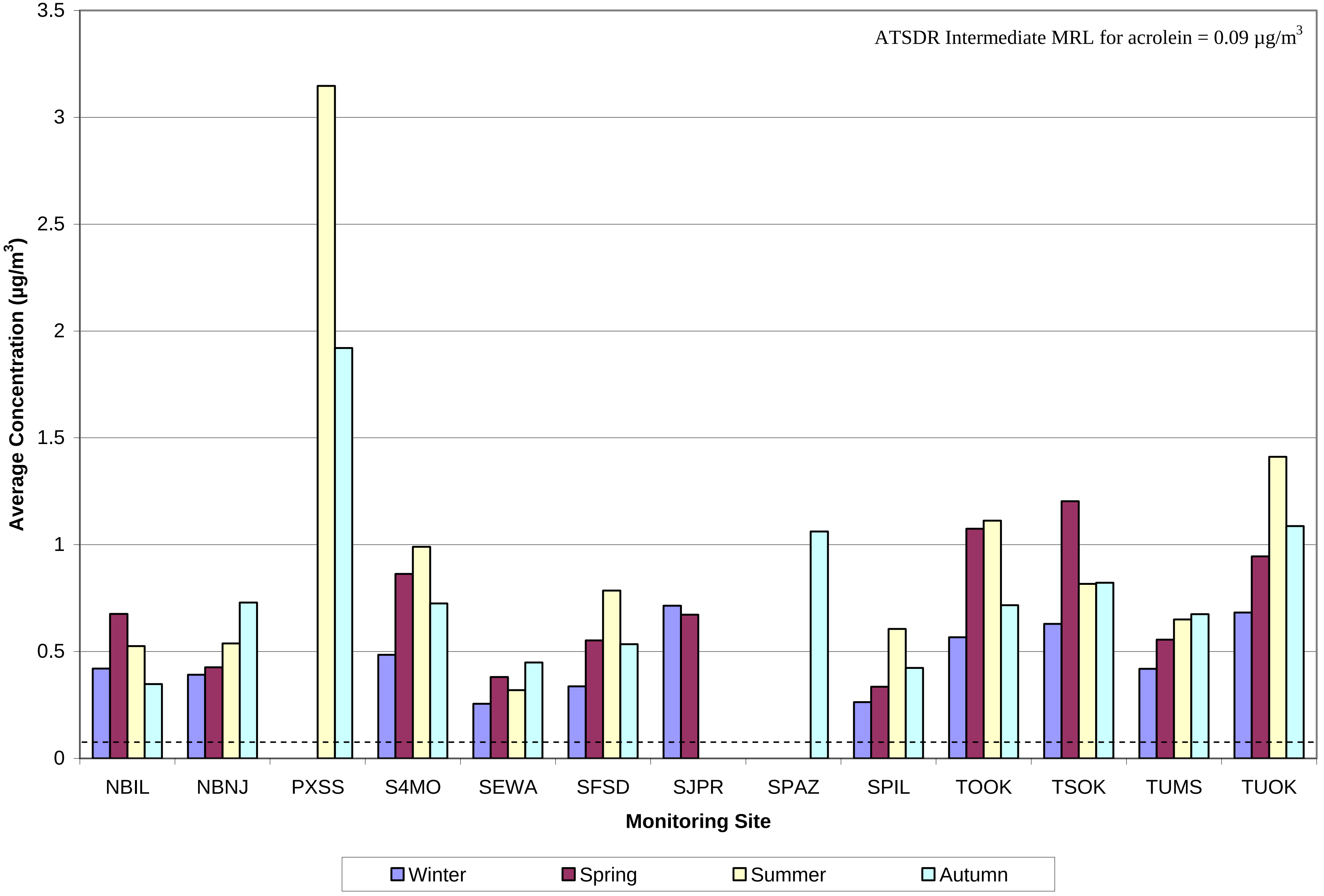
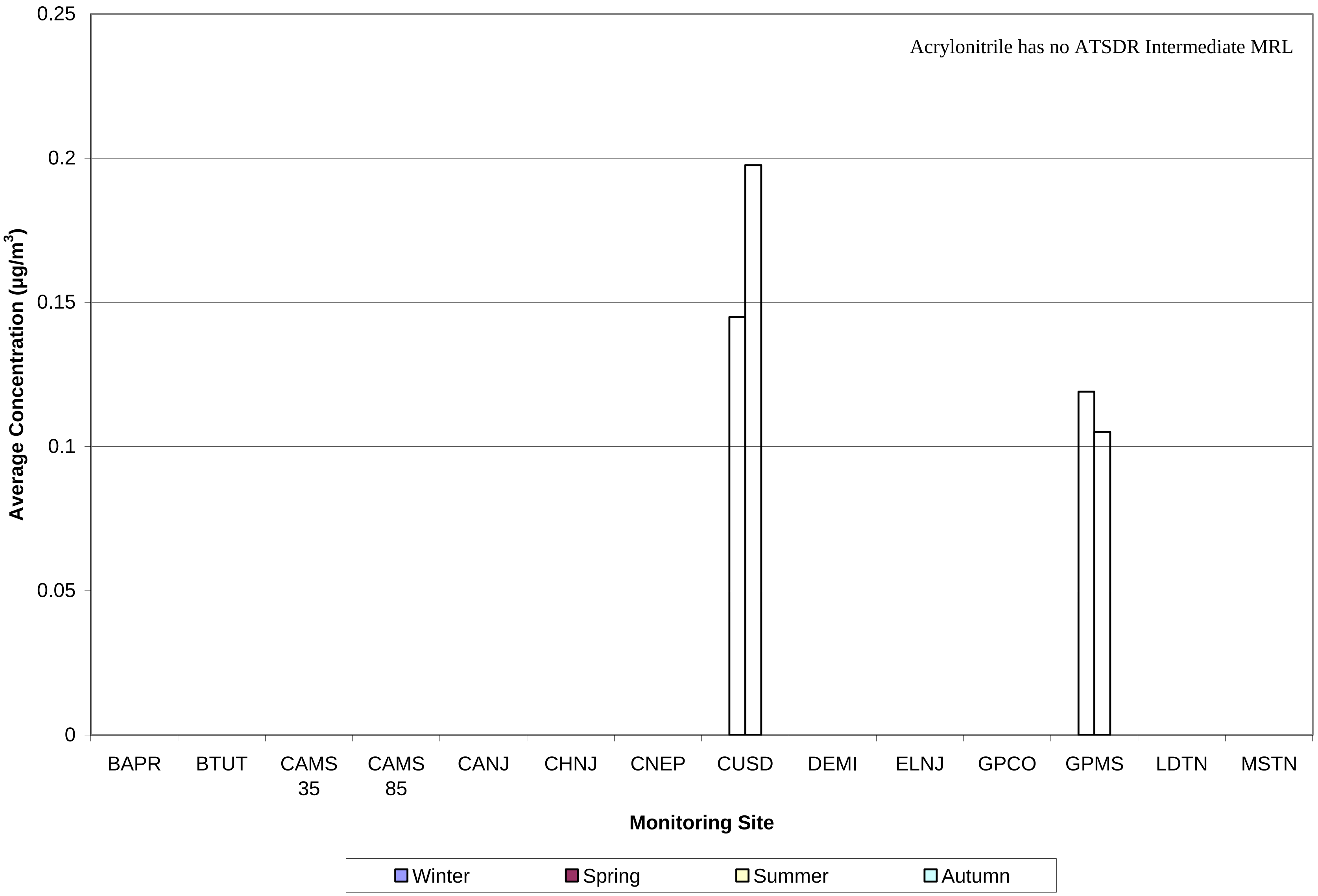


Figure 4-16. Comparison of Average Seasonal Acrylonitrile Concentrations by Season



Acrylonitrile has no ATSDR Intermediate MRL

Figure 4-16. Comparison of Average Seasonal Acrylonitrile Concentrations by Season (Continued)

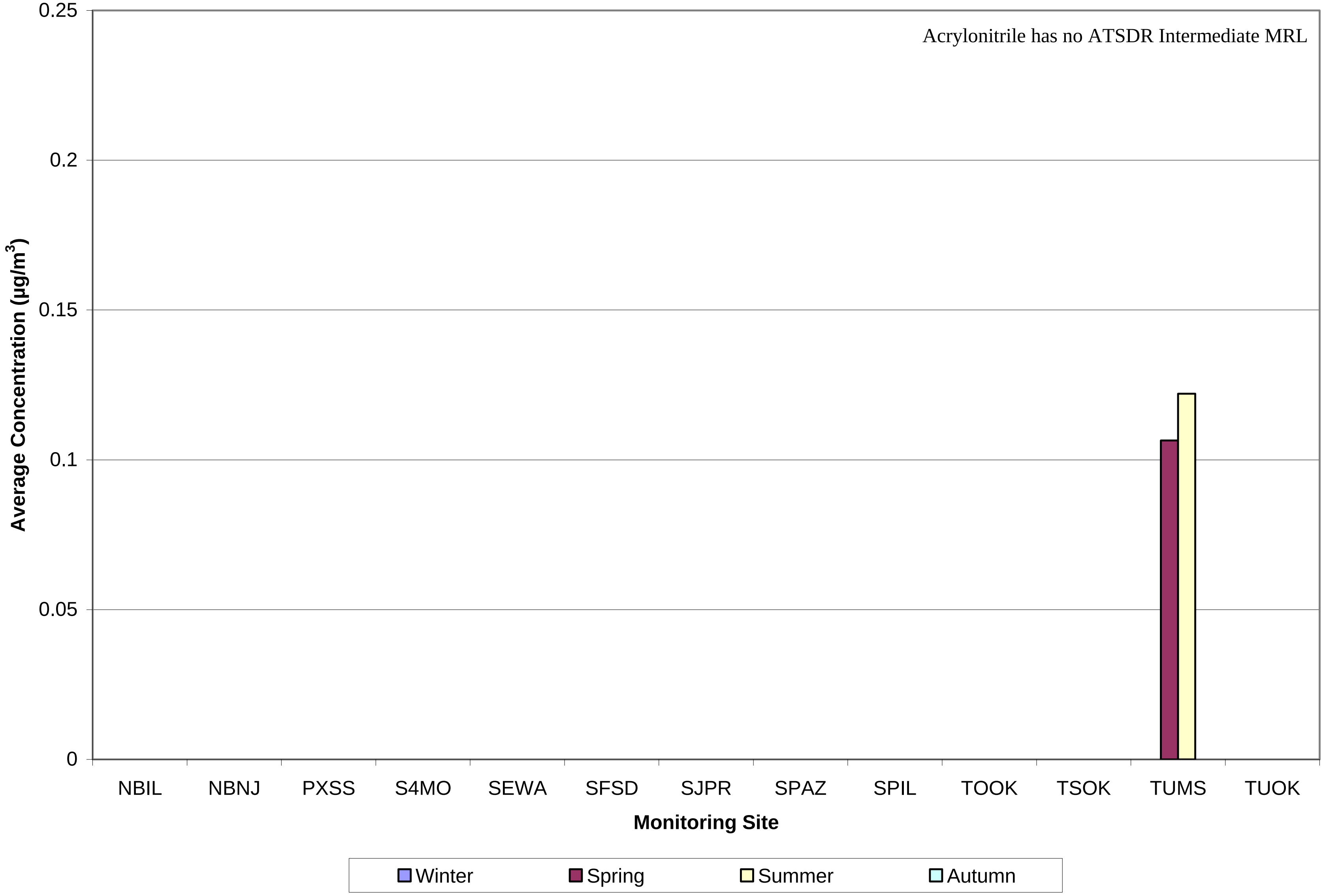


Figure 4-17. Comparison of Average Seasonal Arsenic PM_{10} Concentrations by Season

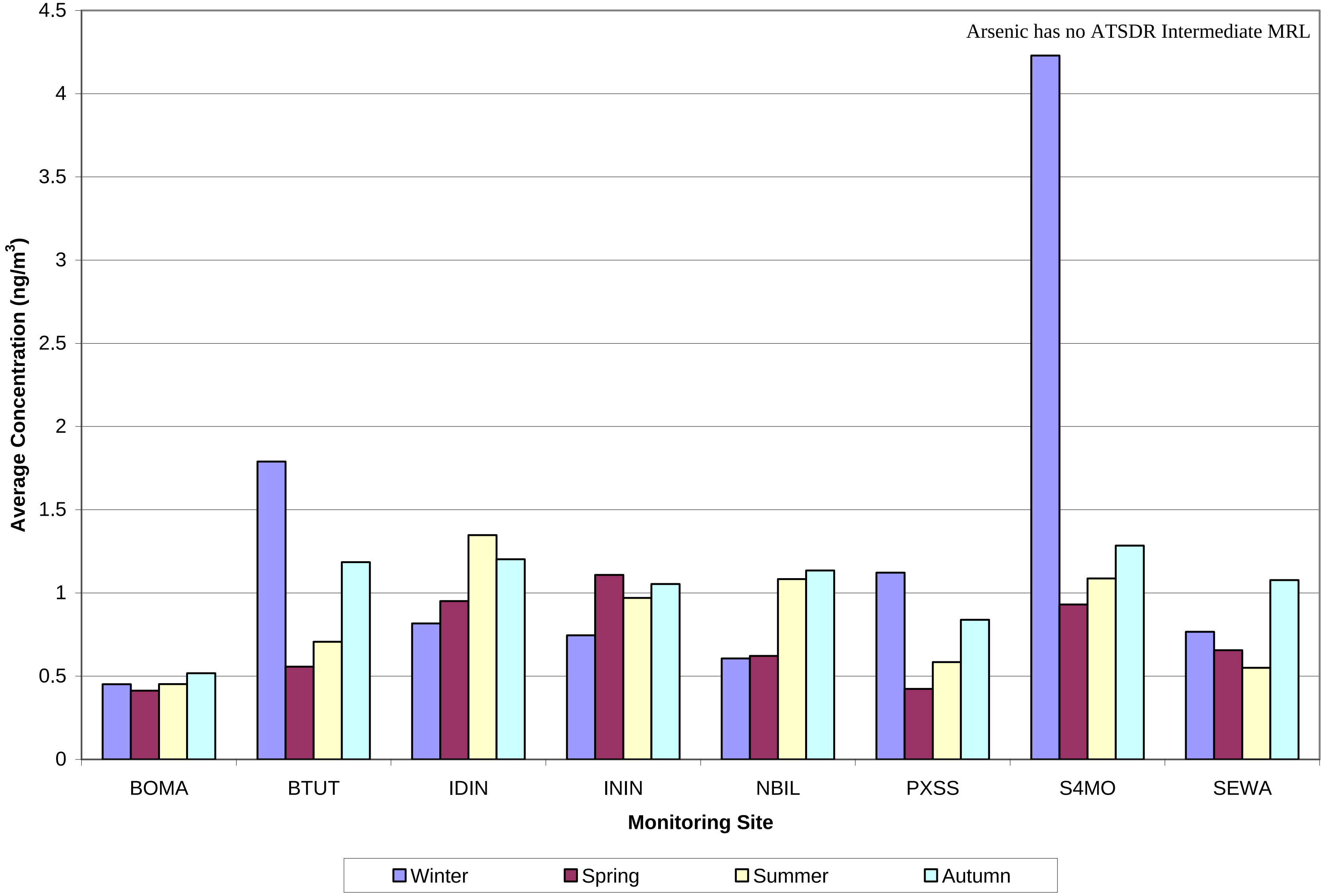


Figure 4-18. Comparison of Average Seasonal Arsenic TSP Concentrations by Season

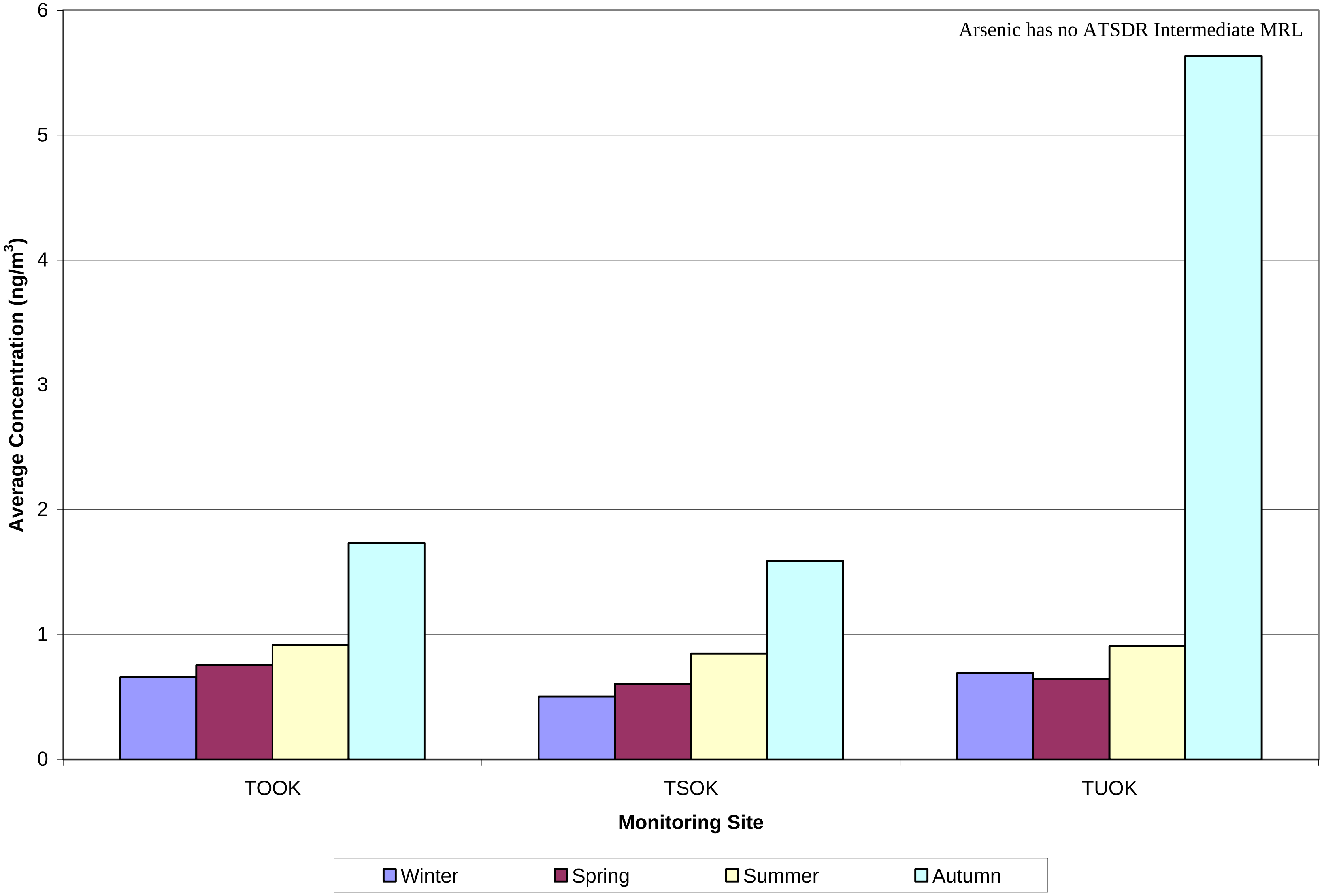


Figure 4-19. Comparison of Average Seasonal Benzene Concentrations by Season

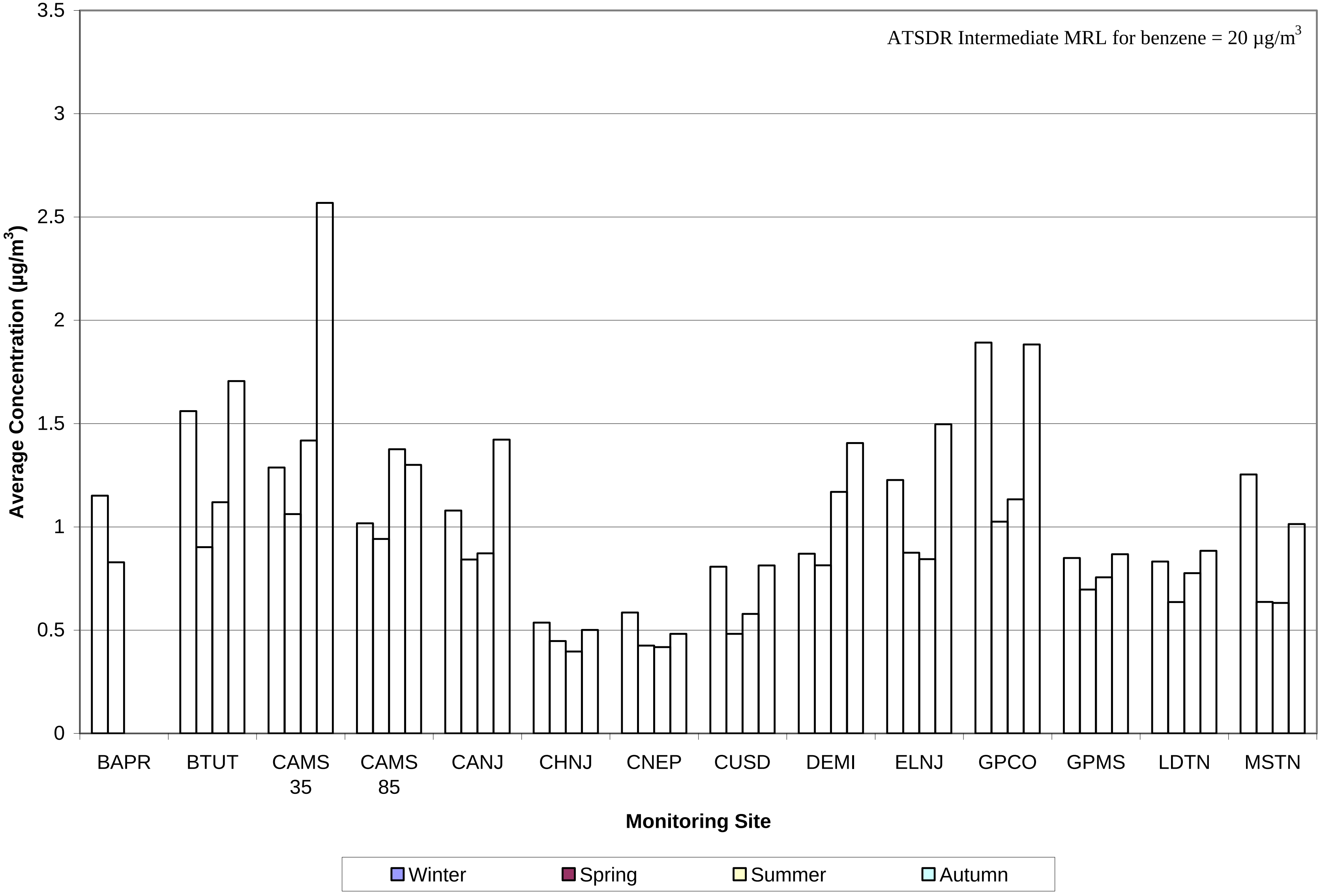
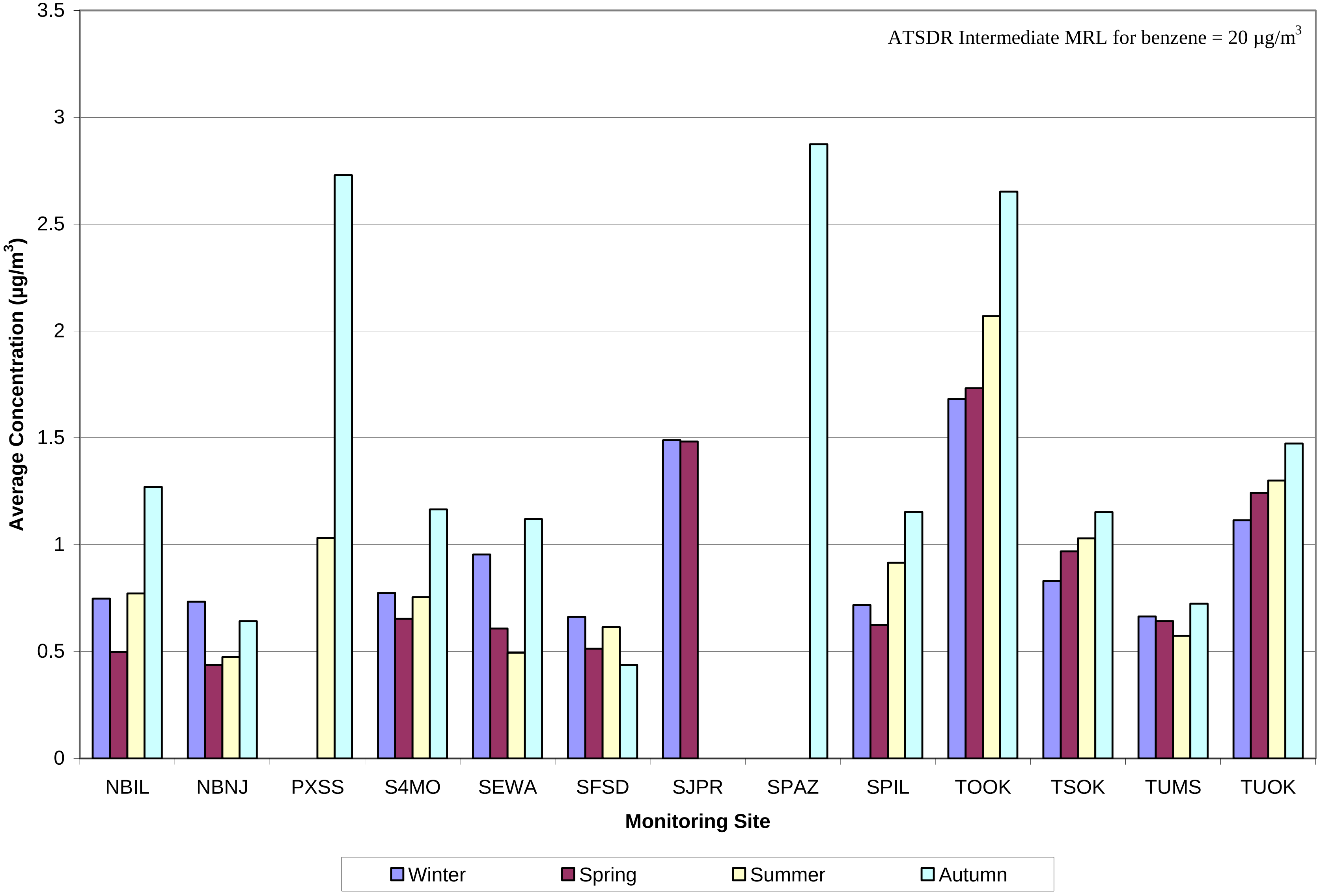


Figure 4-19. Comparison of Average Seasonal Benzene Concentrations by Season (Continued)



ATSDR Intermediate MRL for benzene = 20 µg/m^3

Figure 4-20. Comparison of Average Seasonal Carbon Tetrachloride Concentrations by Season

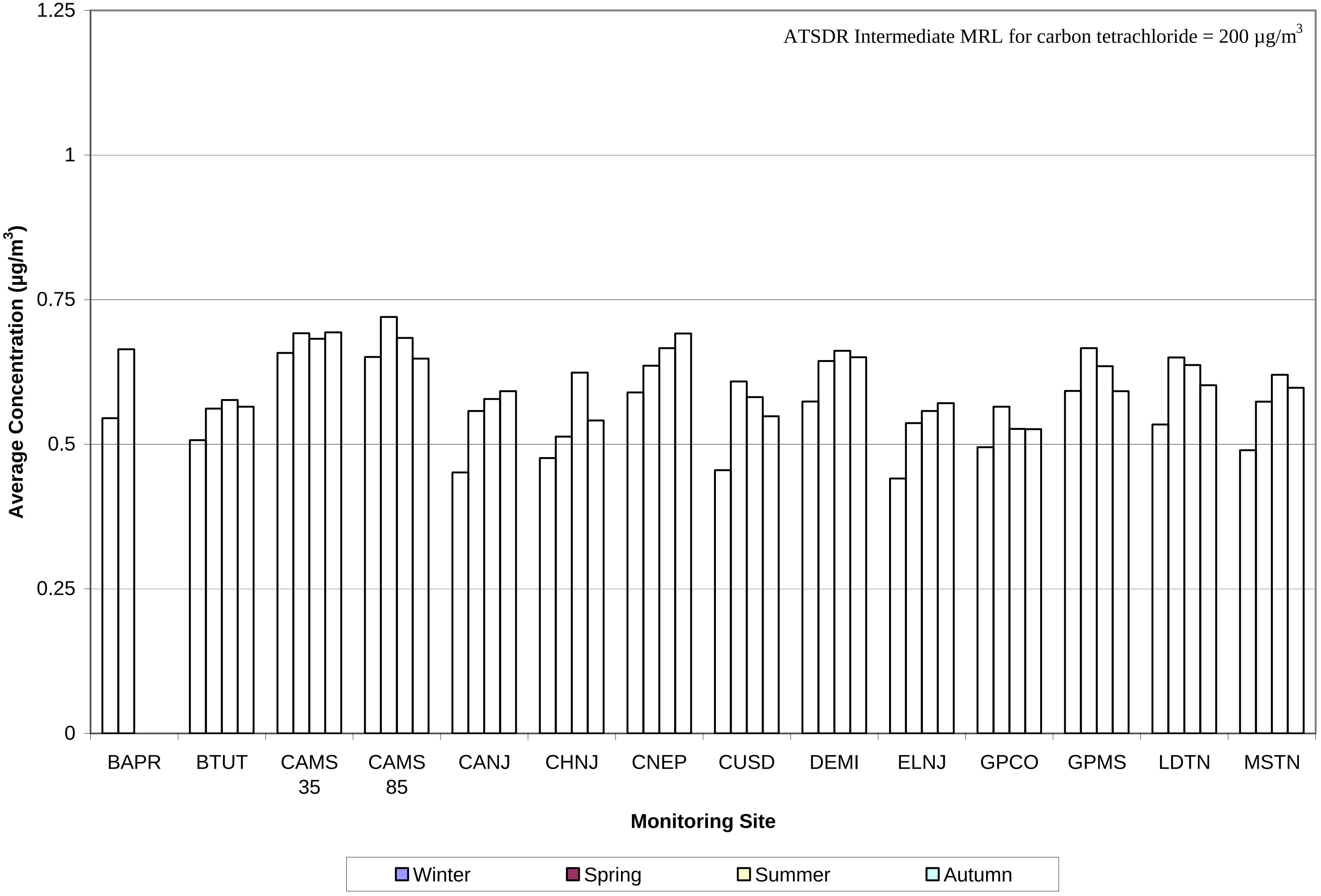

ATSDR Intermediate MRL for carbon tetrachloride = 200 µg/m^3

Figure 4-20. Comparison of Average Seasonal Carbon Tetrachloride Concentrations by Season (Continued)

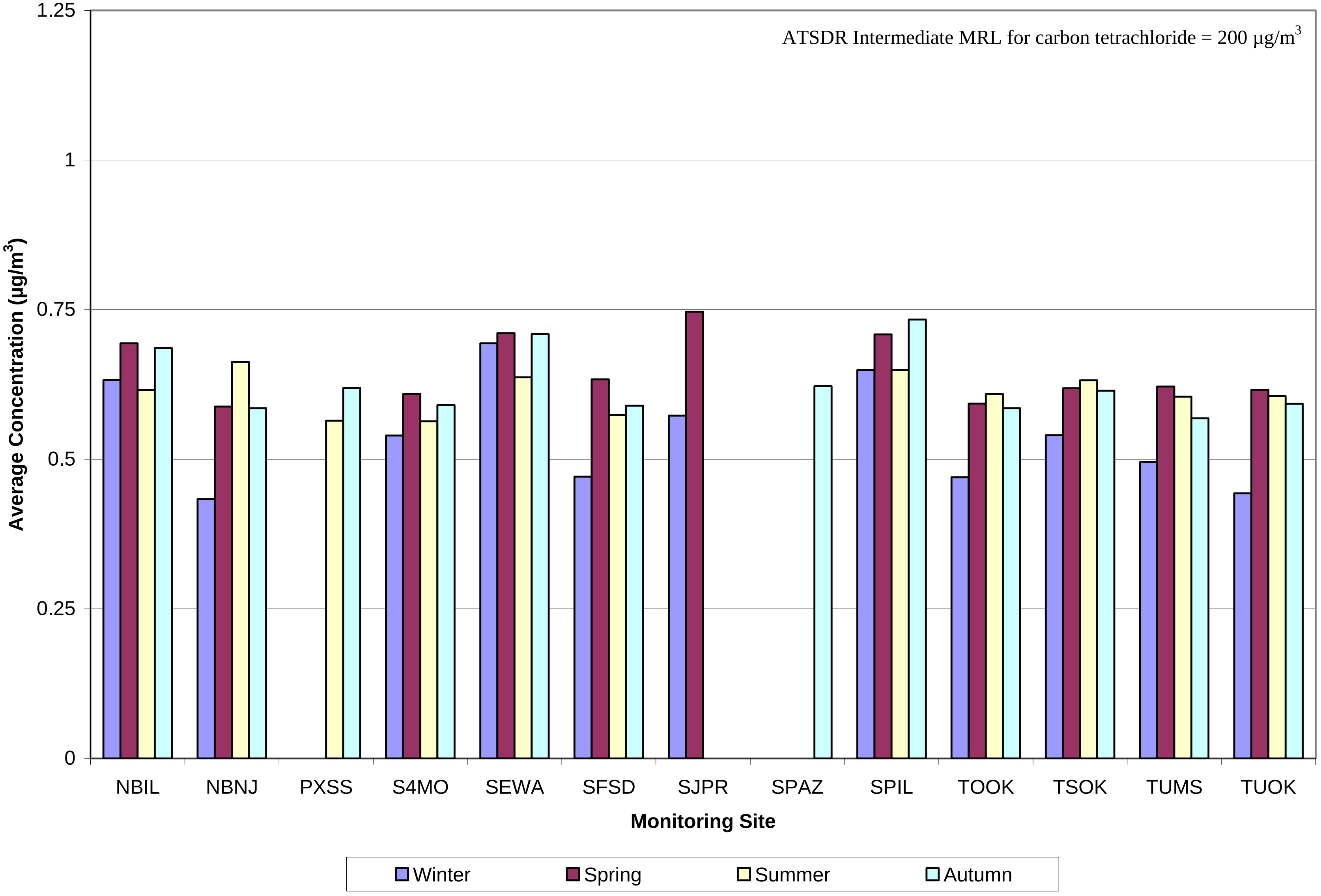


Figure 4-21. Comparison of Average Seasonal Formaldehyde Concentrations by Season

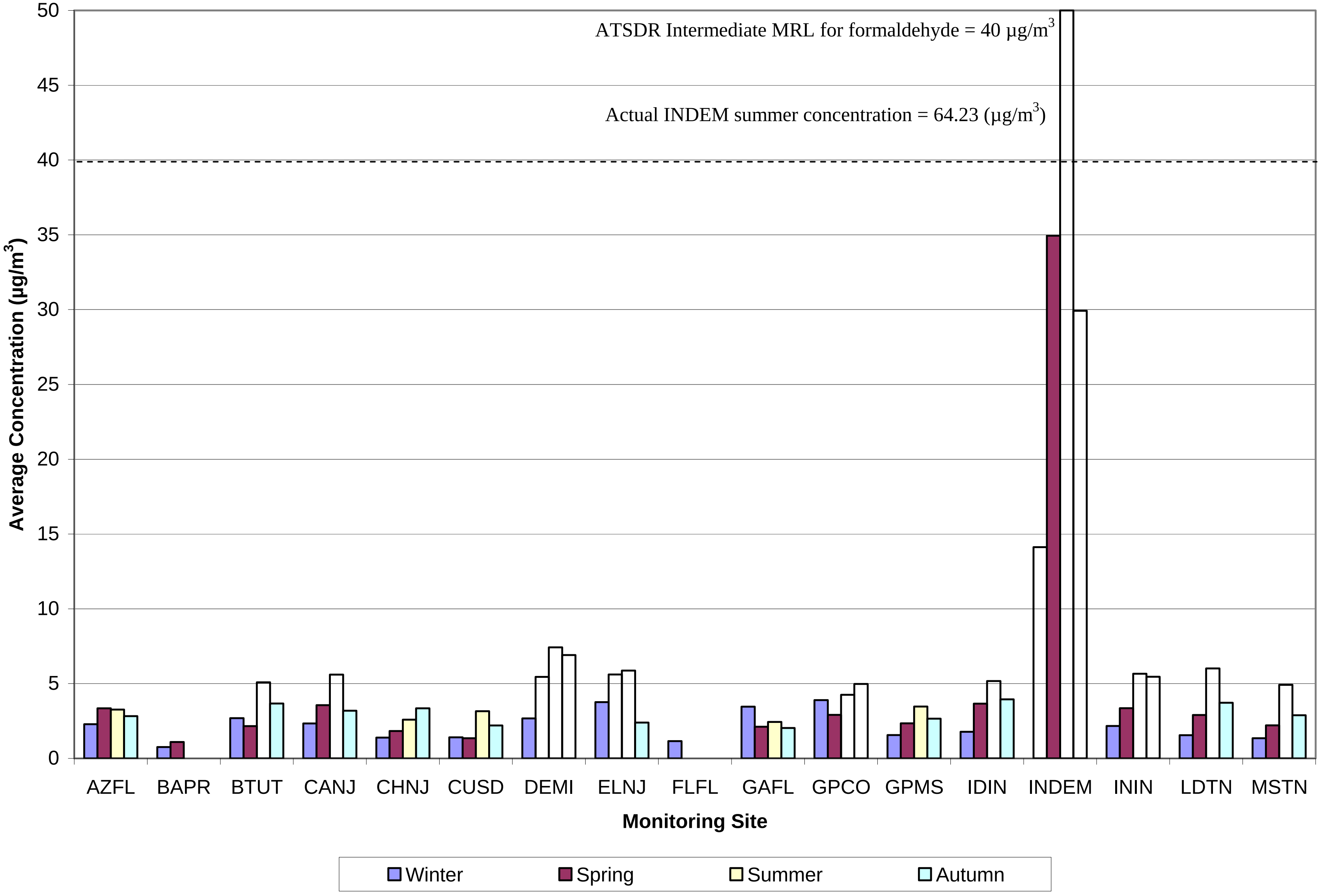


Figure 4-21. Comparison of Average Seasonal Formaldehyde Concentrations by Season (Continued)

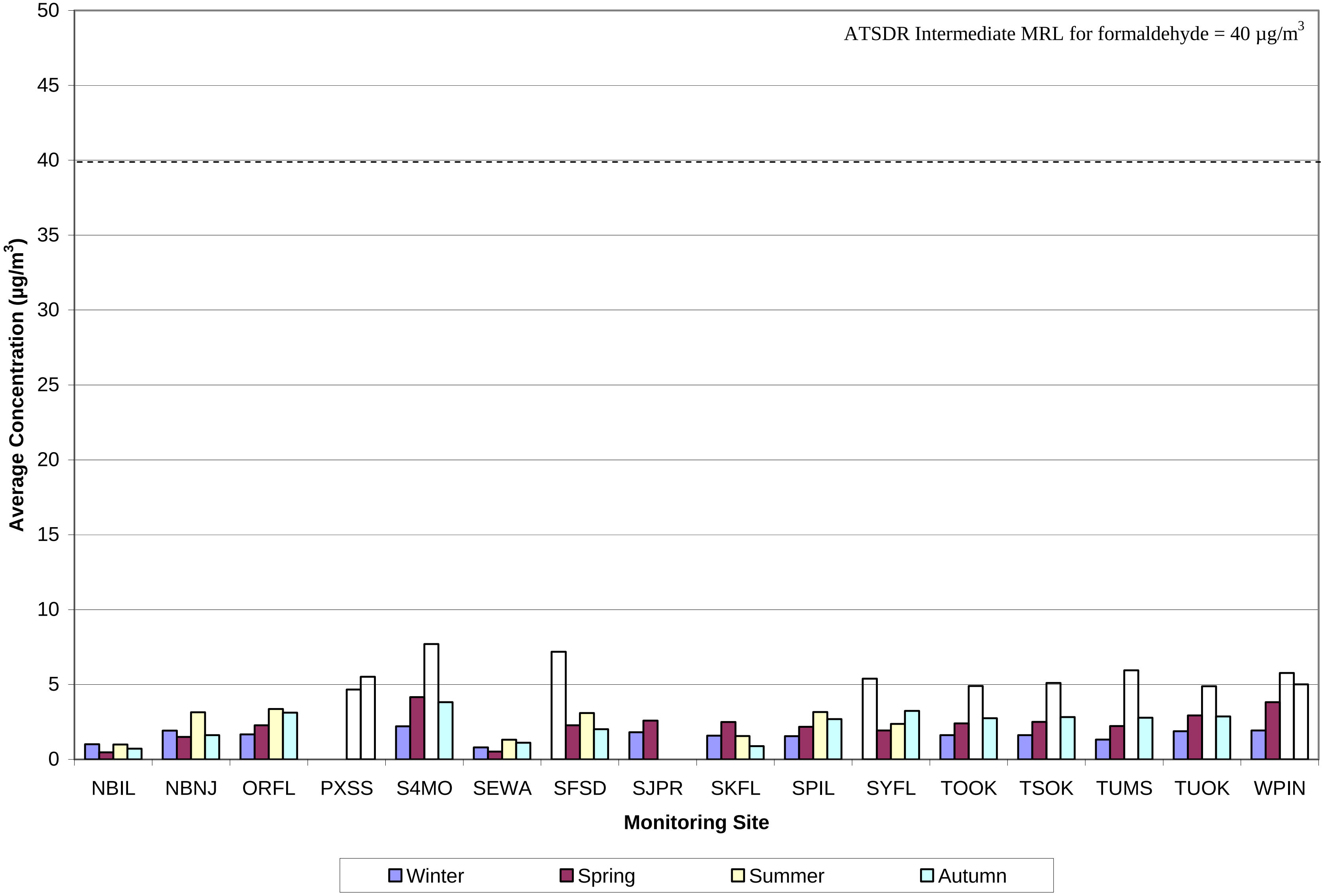


Figure 4-22. Comparison of Average Seasonal Manganese PM_{10} Concentrations by Season

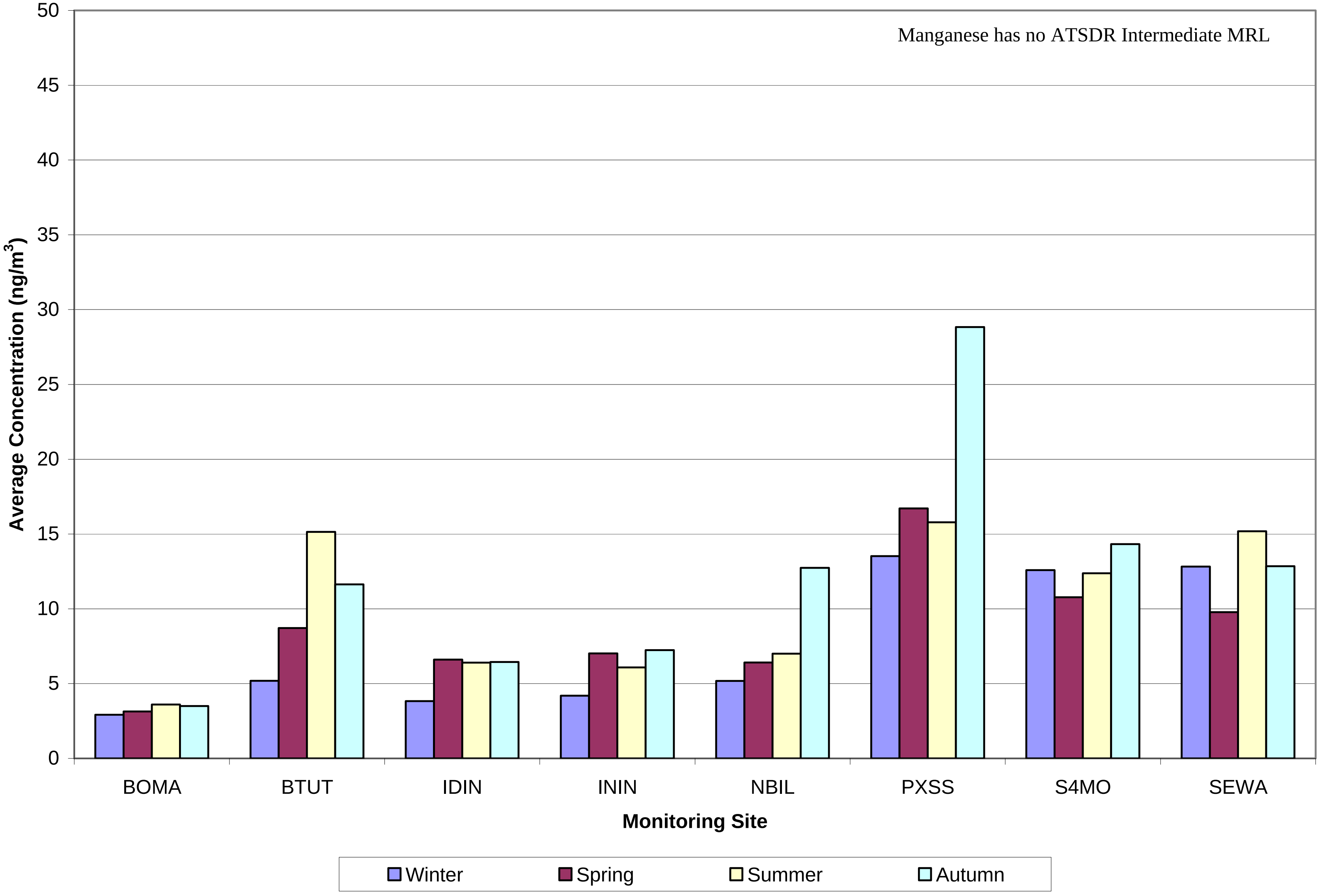


Figure 4-23. Comparison of Average Seasonal Manganese TSP Concentrations by Season

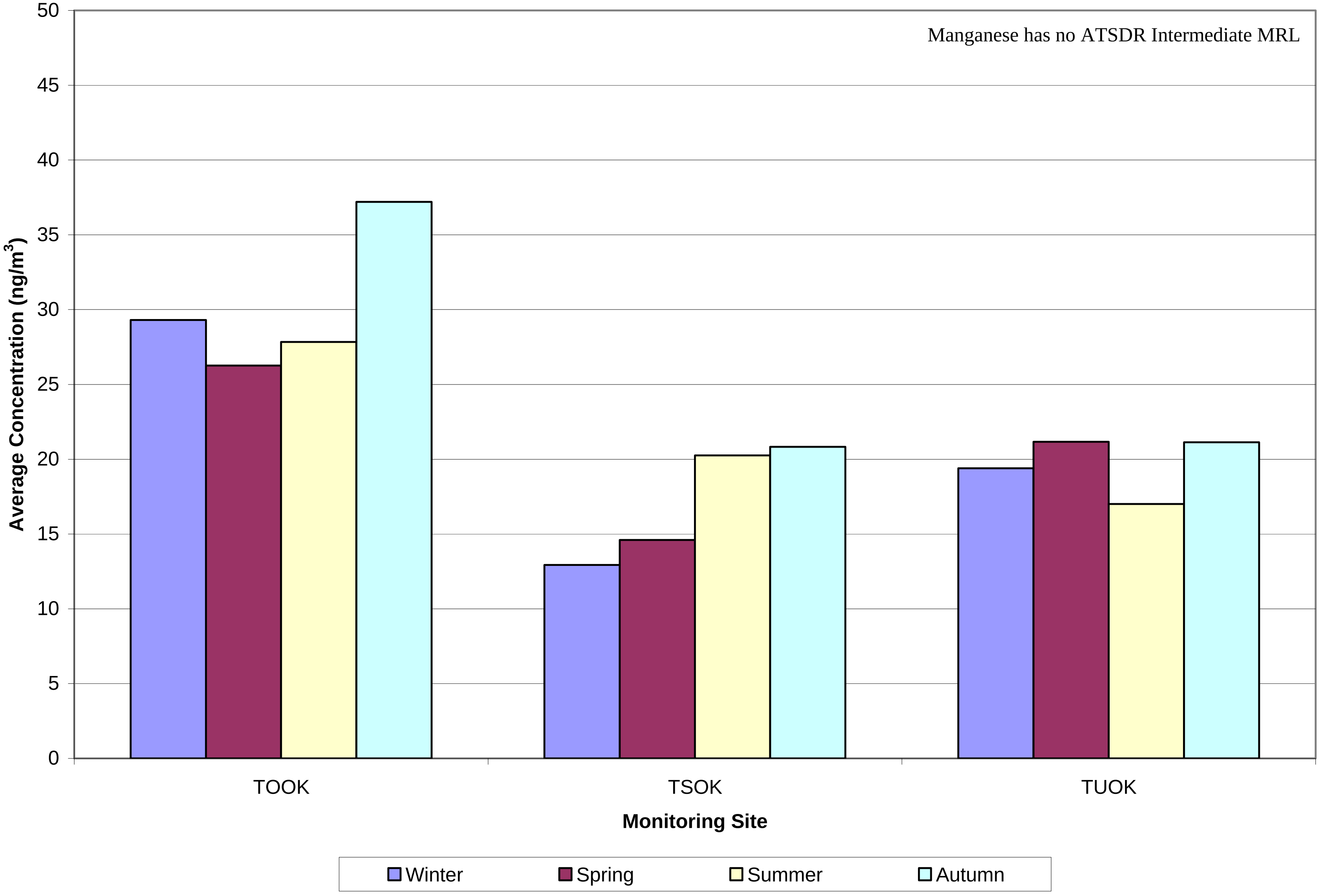

Manganese has no ATSDR Intermediate MRL

Figure 4-24. Comparison of Average Seasonal *p*-Dichlorobenzene Concentrations by Season

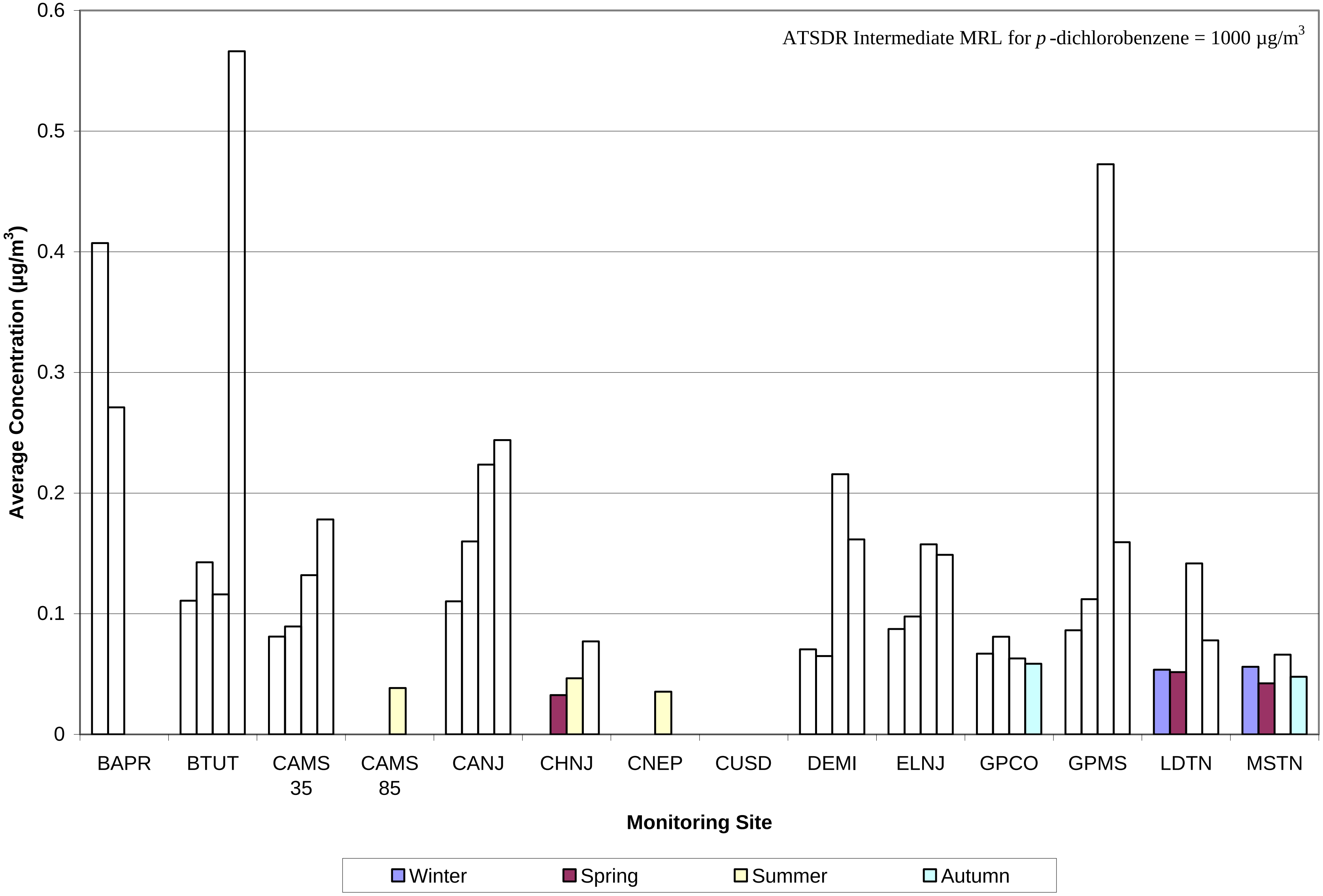
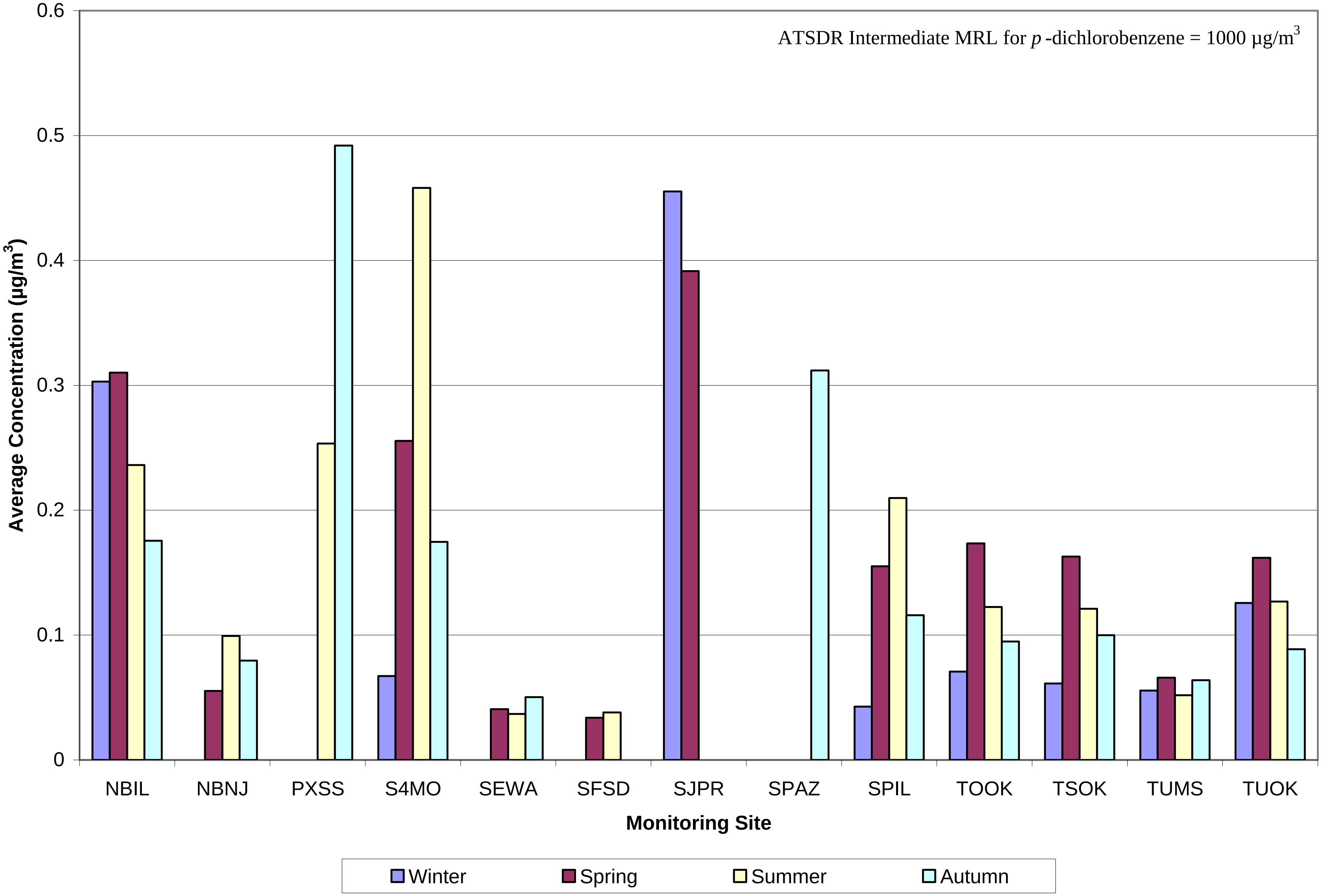


Figure 4-24. Comparison of Average Seasonal *p*-Dichlorobenzene Concentrations by Season (Continued)



ATSDR Intermediate MRL for *p* -dichlorobenzene = 1000 µg/m^3

Figure 4-25. Comparison of Average Seasonal Tetrachloroethylene Concentrations by Season

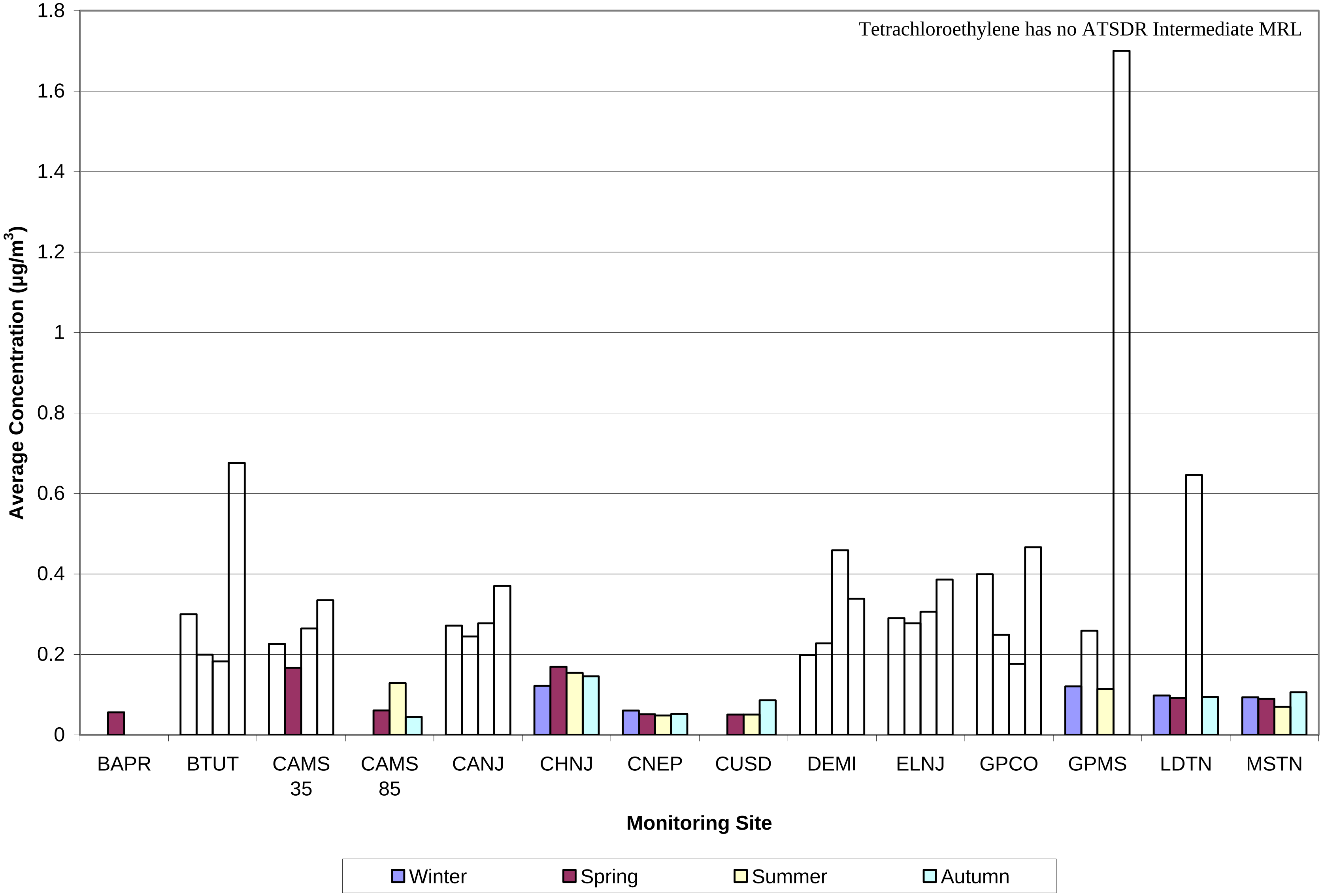
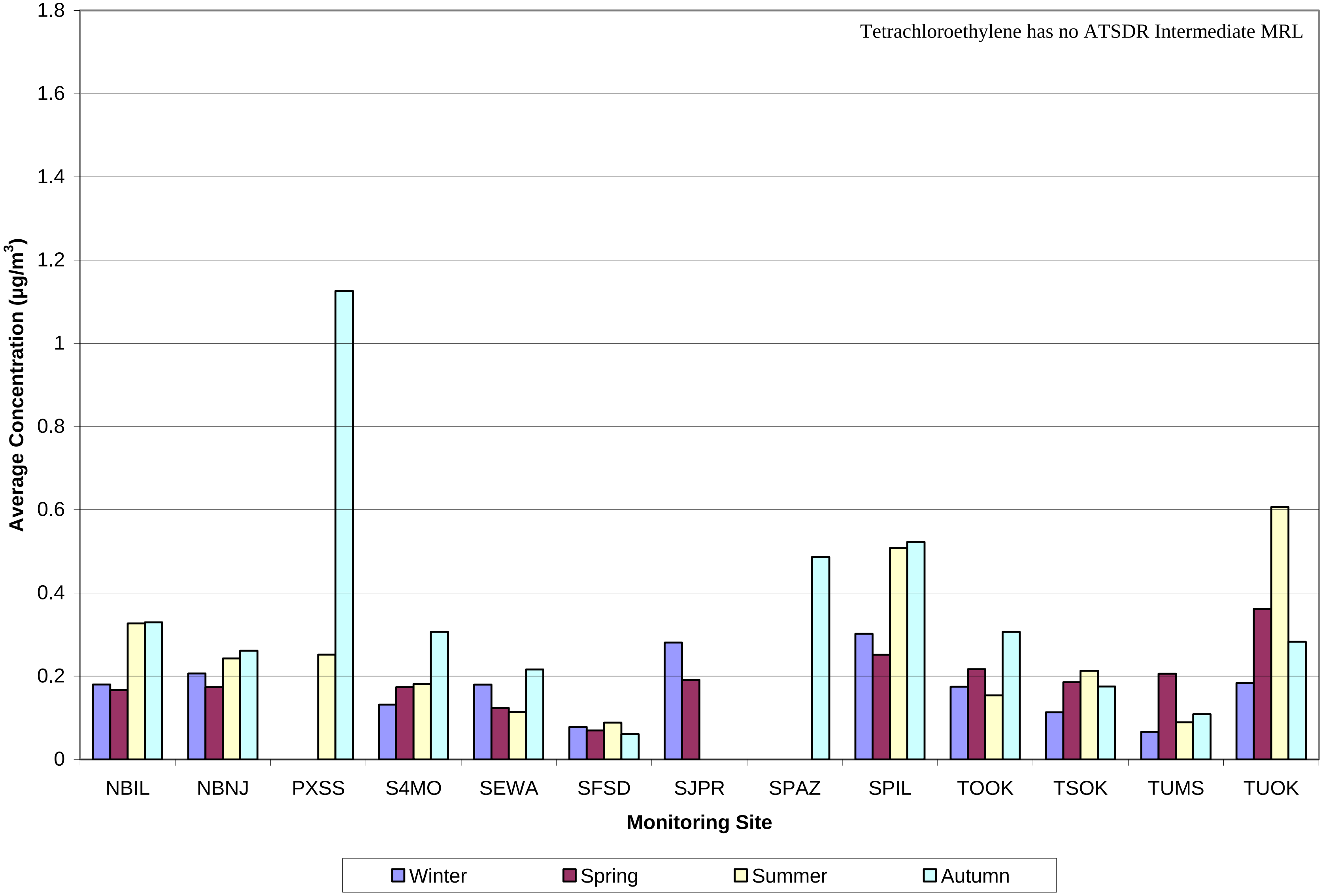


Figure 4-25. Comparison of Average Seasonal Tetrachloroethylene Concentrations by Season (Continued)



spring). Refineries typically begin production of RFG during the spring and end in the autumn. Additionally, methyl-*tert*-butyl ether (MTBE) is often used as an RFG additive in fuels to replace the lowered benzene content. Research has shown that the combustion of fuels containing MTBE leads to the secondary production of formaldehyde. Thus, while benzene concentrations decrease during the summer months, formaldehyde concentrations may increase if MTBE is used in the gasoline blend. Other pollutants may not exhibit such a trend.

The seasonal average comparison also allows for the identification of sites with unusually high concentrations of the pollutants of interest compared to other sites and when those high concentrations were measured. For example, Figure 4-23 shows that INDEM's formaldehyde concentrations are significantly higher than other sites, and that they are elevated year-round.

4.5 Greenhouse Gases

Table 4-17 presents the program-level daily average concentration of the ten GHGs measured by Method TO-15, in descending order by GWP. As shown, each of the GHGs is detected in nearly every sample collected (there were a total 1448 VOC samples collected). The one exception is chloroform, although it was detected in over 85 percent of samples. Dichlorodifluoromethane has the highest GWP, as well as the highest program-level daily average. Dichlorodifluoromethane's GWP (10,600) is almost twice the next highest GWP, and its program-level daily average (2.65 ± 0.05 µg/m^3) is an order of magnitude higher than most of the other GHGs. Bromomethane has both the lowest GWP (5) and the lowest program-level daily average (0.07 ± 0.01 µg/m^3).

Table 4-17. Greenhouse Gases

Pollutant	Global Warming Potential (100 yrs)	# of Measured Detections	Program Daily Average (µg/m^3)
Dichlorodifluoromethane	10,600	1,447	2.65 ± 0.05
Trichlorotrifluoroethane	6,000	1,447	0.80 ± 0.04
Trichlorofluoromethane	4,600	1,440	1.55 ± 0.05

Table 4-17. Greenhouse Gases (Continued)

Pollutant	Global Warming Potential (100 yrs)	# of Measured Detections	Program Daily Average (µg/m^3)
Carbon Tetrachloride	1,800	1,446	0.60 ± 0.01
Dichlorotetrafluoroethane	1,800	1,445	0.13 ± 0.01
1,1,1-Trichloroethane	1,400	1,447	0.11 ± 0.01
Chloroform	30	1,241	0.24 ± 0.03
Chloromethane	16	1,446	1.24 ± 0.02
Dichloromethane	10	1,445	0.77 ± 0.36
Bromomethane	5	1,415	0.07 ± 0.01

5.0 Sites in Arizona

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP sites in Arizona, and integrates these concentrations with emissions, meteorological, and risk information.

5.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. The Arizona sites are located in the Phoenix-Mesa-Scottsdale, AZ MSA. PXSS is located in central Phoenix and SPAZ is located further south. Figures 5-1 and 5-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban locations. Figure 5-3 identifies point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 5-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 5-1 shows that PXSS is located in a highly residential area on North 17th Avenue in central Phoenix. The site is approximately three quarters of a mile east of I-17 and two miles north of I-10. SPAZ is located in South Phoenix. Figure 5-2 shows that SPAZ is located to the southeast of Hayden Park and is surrounded on the west side by residential properties, and commercial properties to the east. SPAZ is located approximately one mile south of I-17.

As Figure 5-3 shows, SPAZ and PXSS are located within 10 miles of each other. The majority of emission sources are located to the south of PXSS and north of SPAZ. Fewer point sources are located within a mile or two of PXSS than SPAZ. Facilities engaged in fuel combustion processes are the most numerous sources near these monitoring sites. The emission sources nearest PXSS primarily reflect the manufacture of industrial machinery; the manufacture of stone, clay, and concrete products; and processes involving fuel combustion. Facilities engaged in surface coating processes are the point sources closest to SPAZ.

Figure 5-1. Phoenix, Arizona (PXSS) Monitoring Site

©2008 Google/©NAVTECH

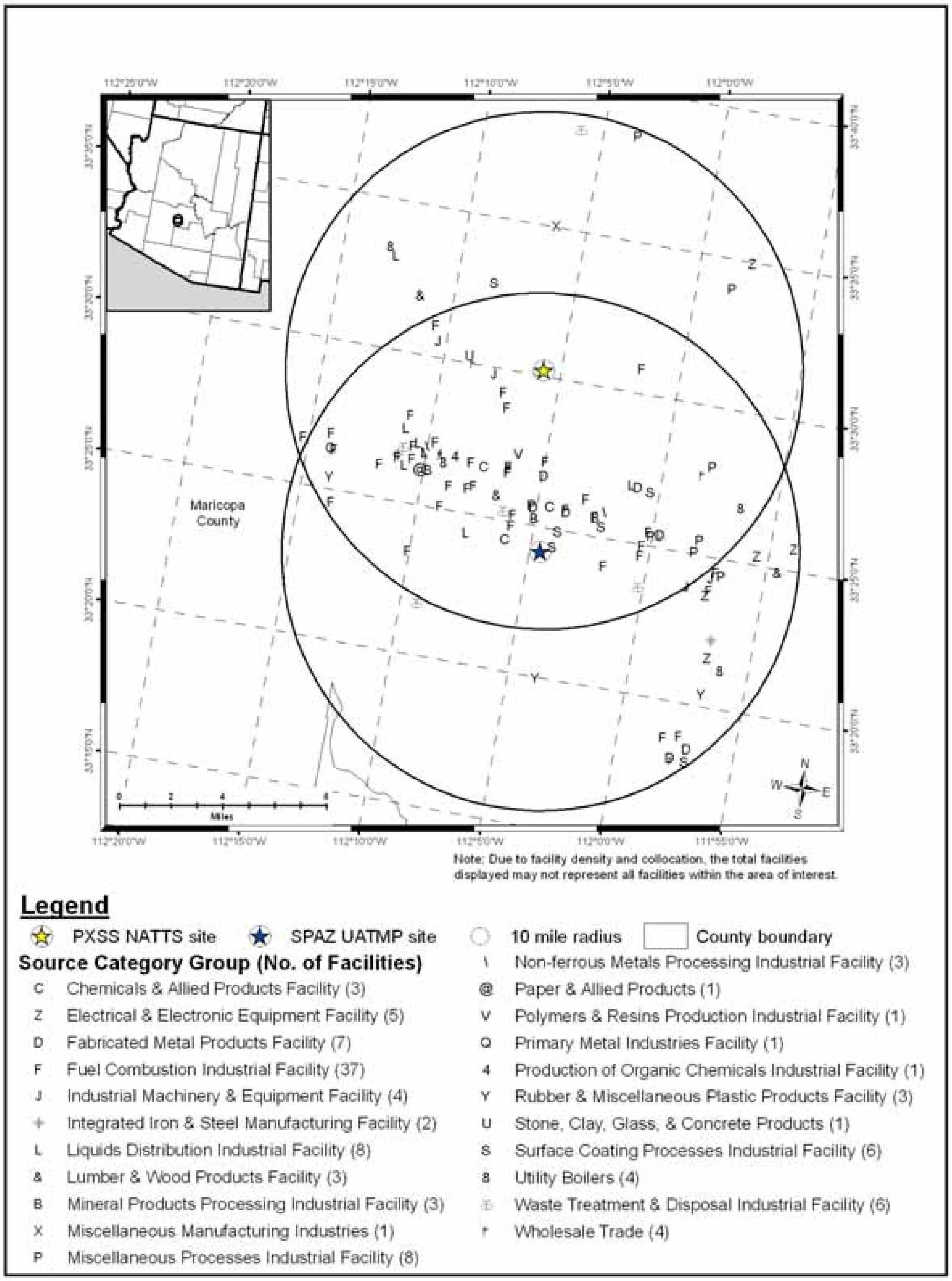
Scale 3cm = 100m

Figure 5-2. South Phoenix, Arizona (SPAZ) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 5-3. NEI Point Sources Located Within 10 Miles of PXSS and SPAZ



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 5-1. Geographical Information for the Arizona Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
PXSS	04-013-9997	Phoenix	Maricopa	Phoenix-Mesa-Scottsdale, AZ Metropolitan Statistical Area	33.503667, -112.095139	Residential	Urban/City Center	The JLG Supersite (Phoenix) was established by the Arizona Department of Environmental Quality (ADEQ) to represent air quality in the central core of the Phoenix metropolitan area. The site was designated a PAMS site in 1999. In 2007, ADEQ operated an automated GC/MS monitoring system for PAMS data collection. Monitors operated during the ozone season (April through October) included trace level oxides of nitrogen (NO_{TL}), total reactive oxides of nitrogen (NO_y), multi-canister samplers for VOCs, and multiport carbonyl samplers. Monitors operated year round include toxics and carbonyls samplers, CO, O_3, SO_2, NO_X, wind speed and direction, temperature, relative humidity, visibility equipment, PM_{10}, $PM_{2.5}$, CSN sampler, and aethalometer (black carbon). The area surrounding the site is primarily residential neighborhoods. An interstate highway is located approximately one mile west of the site. Commercial and industrial areas are within five miles of the site.
SPAZ	04-013-4003	Phoenix	Maricopa	Phoenix-Mesa-Scottsdale, AZ Metropolitan Statistical Area	33.40316, -112.07533	Residential	Urban/City Center	Maricopa County Air Quality Department established the South Phoenix site at its current location in 1999 and operates the CO, O_3, PM_{10}, and $PM_{2.5}$ monitors located there. Arizona Department of Environmental Quality operates the air toxics monitors located there. The site is at the edge of a residential area, but also borders on a mixture of commercial properties (retail stores, restaurants, and offices). Industrial areas are located approximately one mile north of the site. Two high population areas (greater than 5000 people per square mile) are located to the north and west of the site. In 2007, TO-15 toxics sampling occurred every 12th day. PAMS VOC and carbonyl sampling were discontinued.

BOLD = EPA-designated NATTS Site

Table 5-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Arizona monitoring sites. County-level vehicle registration and population data for Maricopa County, Arizona were obtained from the Arizona Department of Transportation and the U.S. Census Bureau. Table 5-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 5-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. For both sites, traffic data for locations along I-17 were gathered. Finally, Table 5-2 presents the daily VMT for each urban area.

Table 5-2. Population, Motor Vehicle, and Traffic Information for the Arizona Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
PXSS	3,880,181	3,793,646	0.98	1,511,946	1,478,227	206,000	77,267
SPAZ	3,880,181	3,793,646	0.98	926,660	905,994	113,000	77,267

[1] Daily Average Traffic Data reflects 2006 data from the Arizona DOT

BOLD = EPA-designated NATTS Site

Observations from Table 5-2 include the following:

- Maricopa County had the fourth highest county population and second highest county-level vehicle registration compared to all counties with NATTS or UATMP sites.
- The vehicle per person ratio was nearly one vehicle per person.
- The 10-mile radius population and estimated vehicle ownership was higher near PXSS than SPAZ.
- PXSS experienced a higher annual average traffic volume than SPAZ, based on locations along I-17. The PXSS traffic volume was the fourth highest of all UATMP and NATTS sites, behind CELA, SEWA, and PRRI.

- The Phoenix area VMT ranked eleventh among urban areas with UATMP or NATTS sites.

5.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Arizona on sampling days, as well as over the course of the year.

5.2.1 Climate Summary

The Phoenix area is located in the Salt River Valley, which is part of the Sonora Desert. The area experiences mild winters and extremely hot and dry summers. Differences between the daytime maximum temperature and overnight minimum temperature can be as high as 50°F. A summer "monsoon" period brings precipitation to the area for part of the summer, while storms originating off the Pacific Coast bring rain in the winter and early spring. Winds are generally light. (Ruffner and Bair, 1987, and WRCC, 2006).

5.2.2 Meteorological Conditions in 2007

Hourly meteorological data from weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The two closest NWS weather stations are located at Phoenix Sky Harbor International Airport (near PXSS) and Phoenix Deer Valley Airport (near SPAZ) WBAN 23183 and 03184, respectively.

Table 5-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 5-3 is the 95 percent confidence interval for each parameter. As shown in Table 5-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year. Table 5-3 also shows that these sites experience some of the lowest relative humidity levels among all of the NATTS and UATMP monitoring sites.

Table 5-3. Average Meteorological Conditions near the Arizona Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
PXSS	Phoenix Sky Harbor Intl Airport 23183	Sampling Day	88.41 ± 3.96	77.48 ± 3.84	36.77 ± 3.10	56.18 ± 2.36	28.09 ± 3.26	1011.35 ± 1.21	5.60 ± 0.52
		All 2007	86.95 ± 1.73	76.30 ± 1.69	37.19 ± 1.44	55.93 ± 1.07	29.92 ± 1.62	1011.59 ± 0.54	5.40 ± 0.21
SPAZ	Phoenix Deer Valley Airport 03184	Sampling Day	88.60 ± 9.14	78.94 ± 8.85	38.51 ± 8.58	57.40 ± 6.11	27.53 ± 7.36	1010.60 ± 2.08	4.67 ± 1.35
		All 2007	84.63 ± 1.69	74.17 ± 1.65	35.44 ± 1.48	54.37 ± 1.07	29.70 ± 1.70	1011.48 ± 0.52	4.67 ± 0.21

BOLD = EPA-designated NATTS Site

5.2.3 Composite Back Trajectories for Sampling Days

Figures 5-4 and 5-5 are composite back trajectory maps for the Arizona monitoring sites for days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 5-4 and 5-5 represents 100 miles.

Observations from Figures 5-4 and 5-5 include the following:

- Back trajectories originated from a variety of directions at PXSS. However, a cluster of the trajectories originated from the southwest and west.

- The 24-hour air shed domain was smaller for PXSS than for most other monitoring sites. The furthest away a trajectory originated was off the California coast, or approximately 400 miles away. However, most trajectories originated within 300 miles of PXSS.

- Sampling was conducted at SPAZ for the second half of the calendar year. In addition, samples were collected every 12 days at SPAZ, which is half the frequency of sample collection at PXSS. As a result, fewer trajectories are shown in Figure 5-5.

- Trajectories from SPAZ seem to follow a similar pattern as those from PXSS.

- Most trajectories originated within 300 miles of SPAZ.

5.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations at Phoenix Sky Harbor International Airport (for PXSS) and Phoenix Deer Valley Airport (for SPAZ) were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 5-6 and 5-7 are the wind roses for the Arizona monitoring sites on days that samples were collected.

Observations from Figure 5-6 for PXSS include the following:

- Easterly winds were most prevalent (19 percent of wind observations), followed by westerly winds (11 percent).

Figure 5-4. Composite Back Trajectory Map for PXSS

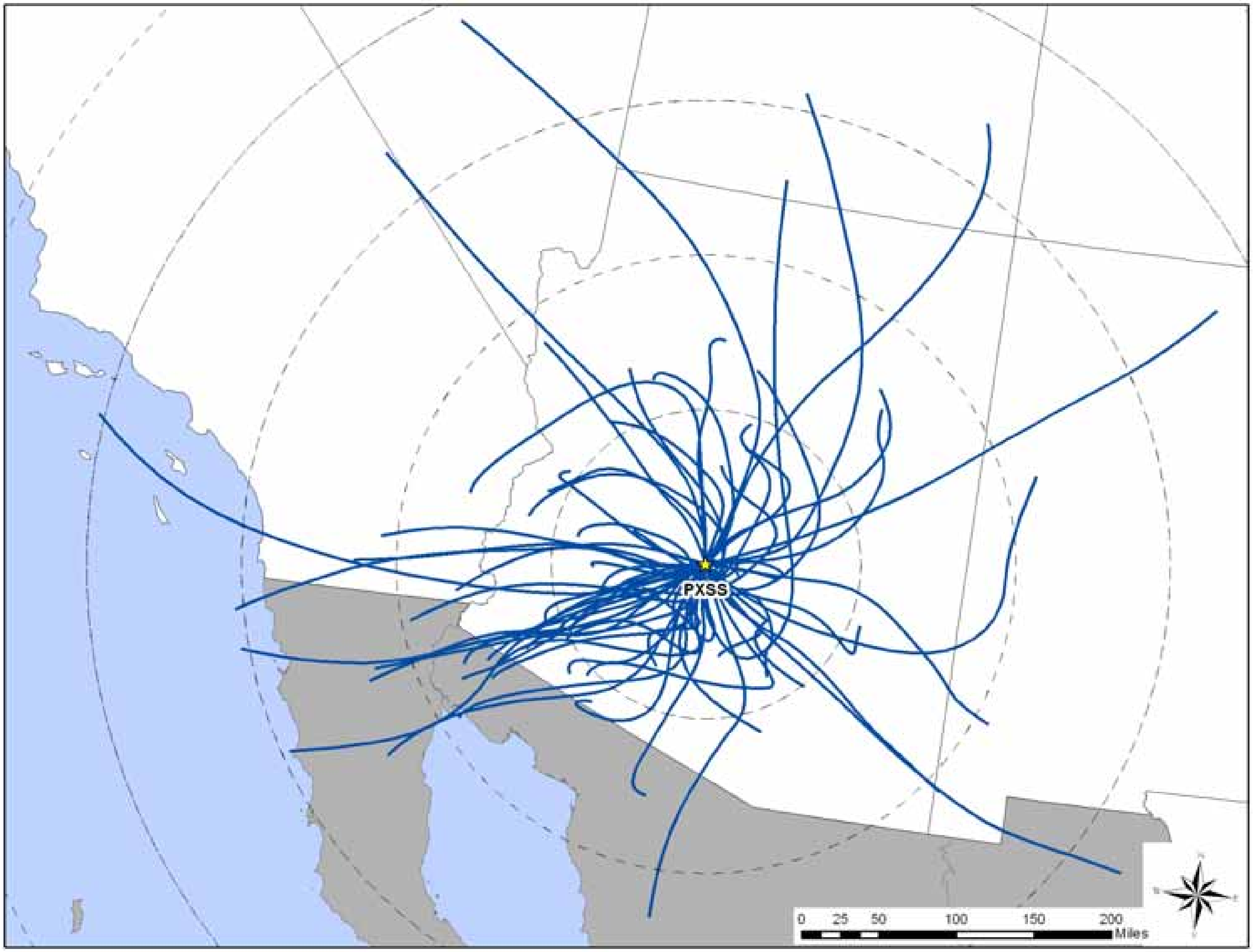


Figure 5-5. Composite Back Trajectory Map for SPAZ

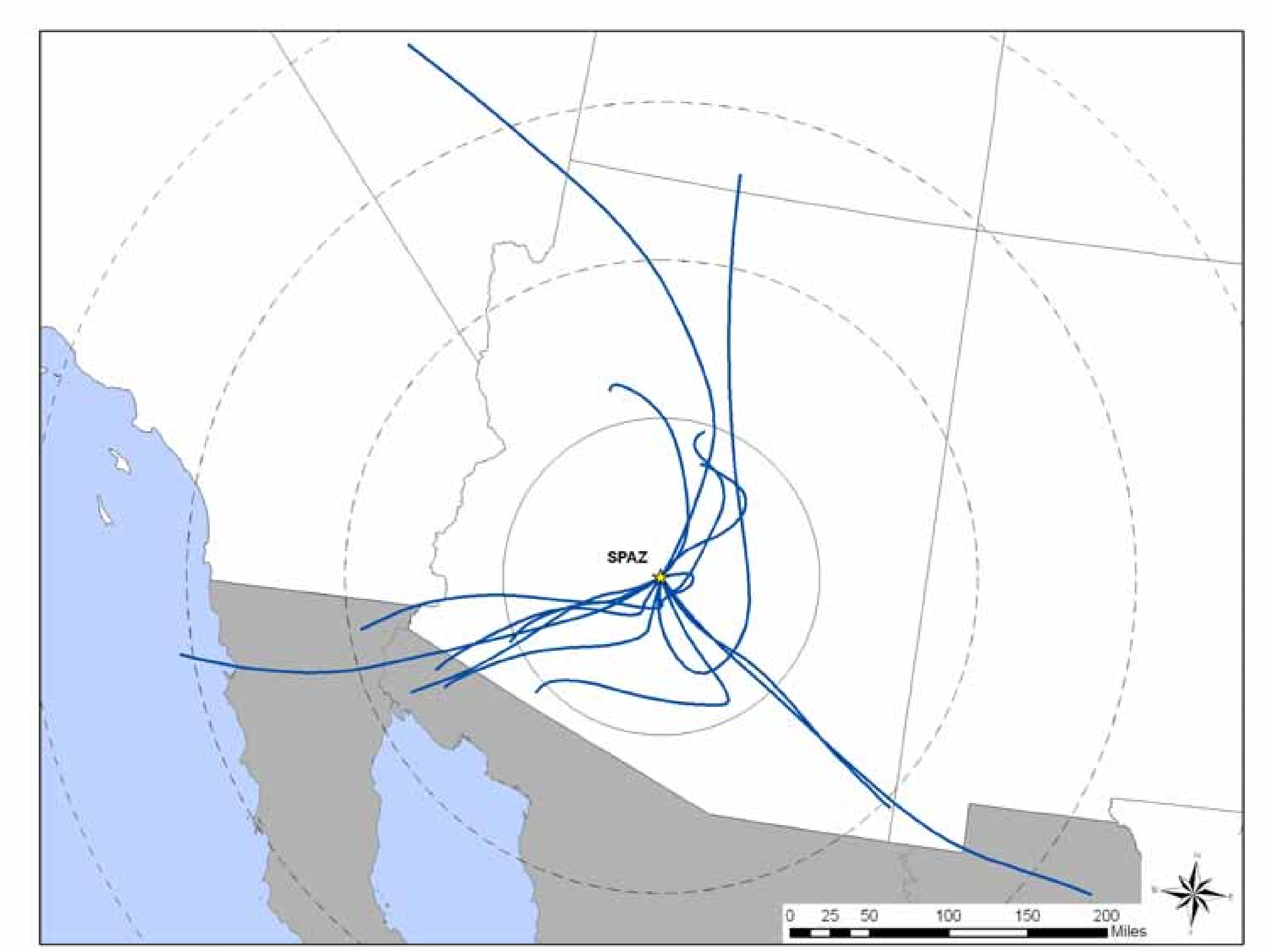


Figure 5-6. Wind Rose for PXSS Sampling Days

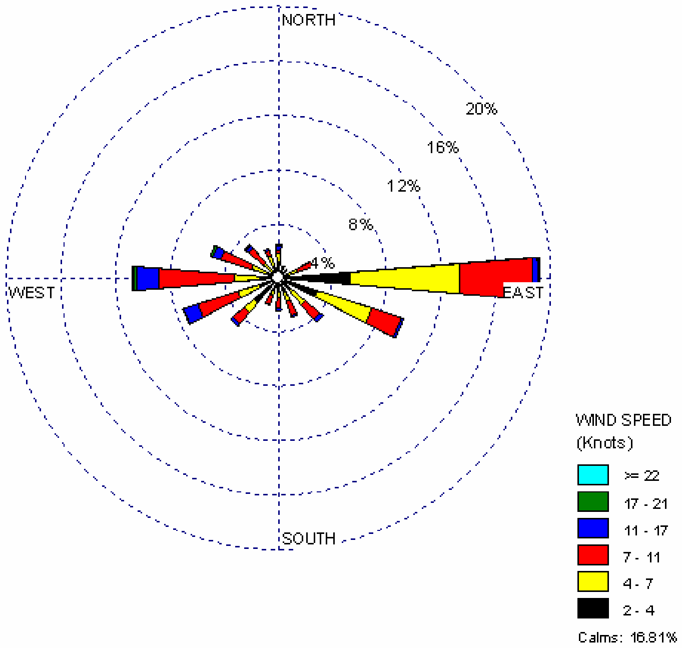
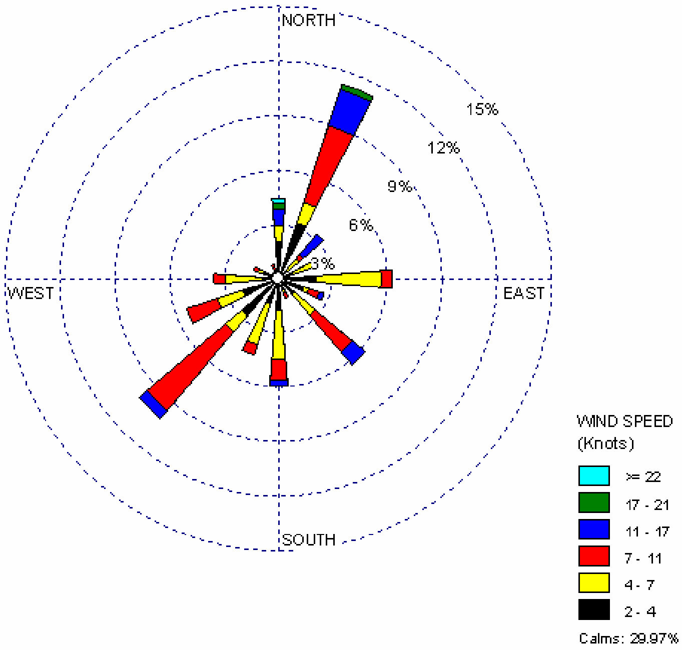


Figure 5-7. Wind Rose for SPAZ Sampling Days



- Calm winds were observed for nearly 17 percent of the hourly measurements. Winds exceeding 11 knots made up less than 9 percent of observations.

Observations from Figure 5-7 for SPAZ include the following:

- Wind direction fluctuated more near SPAZ than PXSS.
- Calm winds were observed more frequently near SPAZ than PXSS (nearly 30 percent). Winds exceeding 11 knots made up less than 8 percent of observations.
- For wind speeds greater than two knots, north-northeasterly winds were most often observed (11 percent of wind observations), followed by southwesterly winds (10 percent).

5.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Arizona monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 5-4 presents the pollutants that failed at least one screen for each Arizona monitoring site and highlights each site's pollutants of interest (shaded). PXSS sampled for VOC, carbonyls, SVOC, metals (PM_{10}), and hexavalent chromium; SPAZ sampled for VOC only.

Observations from Table 5-4 include the following:

- The number of pollutants failing screens varied significantly between the two monitoring sites.
- Sixteen pollutants with a total of 386 measured concentrations failed at least one screen for PXSS.
- Ten pollutants with a total of 88 measured concentrations failed screens for SPAZ.
- Six pollutants of interest were common to both sites: acrolein, benzene, 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene, and tetrachloroethylene.

Table 5-4. Comparison of Measured Concentrations and EPA Screening Values for the Arizona Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Phoenix, Arizona - PXSS					
Manganese (PM_{10})	58	59	98.31	15.03	15.03
Arsenic (PM_{10})	54	59	91.53	13.99	29.02
Acetaldehyde	30	30	100.00	7.77	36.79
Formaldehyde	30	30	100.00	7.77	44.56
Acrolein	27	27	100.00	6.99	51.55
Benzene	27	27	100.00	6.99	58.55
Carbon Tetrachloride	27	27	100.00	6.99	65.54
1,3-Butadiene	25	26	96.15	6.48	72.02
p-Dichlorobenzene	25	26	96.15	6.48	78.50
Naphthalene	23	28	82.14	5.96	84.46
Tetrachloroethylene	22	26	84.62	5.70	90.16
Hexavalent Chromium	20	57	35.09	5.18	95.34
Nickel (PM_{10})	13	59	22.03	3.37	98.70
Acrylonitrile	3	3	100.00	0.78	99.48
Cadmium (PM_{10})	1	59	1.69	0.26	99.74
Hexachloro-1,3-butadiene	1	1	100.00	0.26	100.00
Total	386	544	70.96		
South Phoenix, Arizona - SPAZ					
Carbon Tetrachloride	14	14	100.00	15.91	15.91
Acrolein	14	14	100.00	15.91	31.82
1,3-Butadiene	13	13	100.00	14.77	46.59
Benzene	13	14	92.86	14.77	61.36
p-Dichlorobenzene	12	13	92.31	13.64	75.00
Acrylonitrile	10	10	100.00	11.36	86.36
Tetrachloroethylene	8	12	66.67	9.09	95.45
Xylenes	2	14	14.29	2.27	97.73
Carbon Disulfide	1	14	7.14	1.14	98.86
1,1,2,2-Tetrachloroethane	1	1	100.00	1.14	100.00
Total	88	119	73.95		

- Of the six common pollutants of interest, 100 percent of the measured detections of acrolein and carbon tetrachloride failed screens for PXSS and SPAZ.

- Of the pollutants with at least one failed screen, 71 percent of measurements failed screens for PXSS, while 74 percent failed screens for SPAZ.

5.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Arizona monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

5.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 5-5, where applicable.

Observations for PXSS from Table 5-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (4.98 ± 0.45 µg/m^3), acetaldehyde (3.32 ± 0.42 µg/m^3), and acrolein (2.27 ± 0.46 µg/m^3).

- As shown in Tables 4-9 through 4-11, of the program-level pollutants of interest, PXSS had the highest daily average concentration of acrolein, benzene, manganese (PM$_{10}$), and tetrachloroethylene. In addition, daily average concentration of the following pollutants for PXSS were among the 10 highest average concentration for all NATTS and UATMP sites: acetaldehyde, acrylonitrile, arsenic (PM$_{10}$), 1,3-butadiene, formaldehyde, and *p*-dichlorobenzene.

- Winter and spring averages could only be calculated for metals and hexavalent chromium because sampling for SVOC, VOC, and carbonyls began in July.

- Based on the available seasonal averages, concentrations of the pollutants of interest tended to be higher in autumn than the summer, with a few exceptions.

Table 5-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Arizona Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Phoenix, Arizona - PXSS								
1,3-Butadiene	26	27	0.30 ± 0.08	NA	NA	0.10 ± 0.02	0.39 ± 0.13	NA
Acetaldehyde	30	30	3.32 ± 0.42	NA	NA	2.68 ± 0.33	3.85 ± 0.65	NA
Acrolein	27	27	2.27 ± 0.46	NA	NA	3.15 ± 1.00	1.92 ± 0.43	NA
Arsenic (PM$_{10}$)	59	59	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzene	27	27	2.06 ± 0.47	NA	NA	1.03 ± 0.25	2.73 ± 0.71	NA
Carbon Tetrachloride	27	27	0.60 ± 0.04	NA	NA	0.56 ± 0.11	0.62 ± 0.04	NA
Formaldehyde	30	30	4.98 ± 0.45	NA	NA	4.67 ± 0.47	5.51 ± 0.69	NA
Hexavalent Chromium	57	57	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese (PM$_{10}$)	59	59	0.02 ± 0.01	0.01 ± <0.01	0.02 ± 0.01	0.02 ± <0.01	0.03 ± 0.01	NA
Naphthalene	28	28	0.09 ± 0.02	NA	NA	0.04 ± 0.01	0.11 ± 0.02	NA
p-Dichlorobenzene	26	27	0.39 ± 0.08	NA	NA	0.25 ± 0.06	0.49 ± 0.13	NA
Tetrachloroethylene	26	27	0.77 ± 0.25	NA	NA	0.25 ± 0.09	1.13 ± 0.39	NA
South Phoenix, Arizona - SPAZ								
1,3-Butadiene	13	14	0.24 ± 0.10	NA	NA	NR	0.32 ± 0.14	NA
Acrolein	14	14	1.23 ± 0.31	NA	NA	NR	1.06 ± 0.29	NA
Acrylonitrile	10	14	1.07 ± 0.27	NA	NA	NR	NR	NA
Benzene	14	14	2.01 ± 0.68	NA	NA	NR	2.87 ± 0.70	NA
Carbon Tetrachloride	14	14	0.60 ± 0.05	NA	NA	NR	0.62 ± 0.06	NA
p-Dichlorobenzene	13	14	0.31 ± 0.10	NA	NA	NR	0.31 ± 0.10	NA
Tetrachloroethylene	12	14	0.39 ± 0.19	NA	NA	NR	0.49 ± 0.26	NA

NR = Not reportable due to the detection criteria for calculating a seasonal average.

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average.

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for SPAZ from Table 5-5 include the following:

- The pollutants with the highest daily average concentrations by mass were benzene (2.01 ± 0.68 μg/m^3), acrolein (1.23 ± 0.31 μg/m^3), and acrylonitrile (1.07 ± 0.27 μg/m^3).

- As shown in Table 4-11, of the program-level pollutants of interest, SPAZ had the highest daily average concentration of acrylonitrile. In addition, the daily average concentrations of the following pollutants for SPAZ were among the 10 highest average concentration for all NATTS and UATMP sites: acrolein, benzene, 1,3-butadiene, *p*-dichlorobenzene, and tetrachloroethylene.

- Seasonal averages could only be calculated for autumn. Summer averages could not be calculated because sampling began in July and the 1-in-12 sampling schedule did not yield enough samples in July and August for a valid seasonal average calculation.

- Annual averages were not calculated for this site due to the short sampling duration.

5.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. Neither PXSS nor SPAZ have sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

5.5 Pearson Correlations

Table 5-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for PXSS from Table 5-6 include the following:

- Strong negative correlations were calculated between 1,3-butadiene and the temperature variables, indicating that as temperature increase, concentrations of 1,3-butadiene decrease. Although the remaining correlations were generally weak, they were mostly negative, supporting this inverse tendency.

Table 5-6. Pearson Correlations for Selected Meteorological Parameters and the Pollutants of Interest for the Arizona Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Phoenix, Arizona - PXSS								
1,3-Butadiene	26	-0.56	-0.65	-0.57	-0.68	0.06	0.61	-0.70
Acetaldehyde	30	-0.10	-0.20	-0.33	-0.30	-0.27	0.25	-0.66
Acrolein	27	0.41	0.39	0.21	0.33	-0.21	-0.29	0.15
Arsenic (PM_{10})	59	-0.26	-0.29	-0.15	-0.28	0.11	0.21	-0.24
Benzene	27	-0.39	-0.48	-0.50	-0.54	-0.08	0.49	-0.69
Carbon Tetrachloride	27	-0.14	-0.18	0.05	-0.08	0.21	0.12	-0.21
Formaldehyde	30	0.20	0.12	-0.05	0.02	-0.35	-0.06	-0.55
Hexavalent Chromium	57	-0.13	-0.18	-0.18	-0.21	-0.02	0.24	-0.30
Manganese (PM_{10})	59	0.02	0.00	-0.13	-0.05	-0.19	0.01	0.12
Naphthalene	28	-0.38	-0.46	-0.53	-0.56	-0.08	0.51	-0.57
p-Dichlorobenzene	26	-0.14	-0.23	-0.30	-0.29	-0.18	0.27	-0.52
Tetrachloroethylene	26	-0.27	-0.37	-0.41	-0.43	-0.14	0.31	-0.57
South Phoenix, Arizona – SPAZ								
1,3-Butadiene	13	-0.54	-0.60	-0.54	-0.67	-0.16	0.77	-0.41
Acrolein	14	0.39	0.35	0.12	0.26	-0.18	-0.29	-0.17
Acrylonitrile	10	0.24	0.21	-0.09	0.08	-0.23	-0.35	0.23
Benzene	14	-0.37	-0.43	-0.49	-0.53	-0.29	0.62	-0.35
Carbon Tetrachloride	14	-0.02	0.04	-0.10	-0.04	-0.13	0.09	0.53
p-Dichlorobenzene	13	0.03	-0.02	-0.17	-0.14	-0.34	0.07	-0.30
Tetrachloroethylene	12	-0.18	-0.26	-0.40	-0.40	-0.33	0.45	-0.46

- Strong negative correlations were calculated between 1,3-butadiene, benzene, and naphthalene and the dew point and wet bulb temperatures. This indicates that as moisture content increases, concentrations of these pollutants decrease. Although the remaining correlations were generally weak, they were mostly negative, supporting this inverse tendency. This trend was not reflected in the relative humidity correlations.

- These same three pollutants also had strong positive correlations with sea level pressure.

- Most of the pollutants of interest exhibited strong negative correlations with wind speed, indicating that concentrations of the pollutants of interest increase as wind speeds decrease.

Observations for SPAZ from Table 5-6 include the following:

- Benzene and 1,3-butadiene exhibited strong negative correlations with certain temperature and moisture variables, similar to PXSS.

- Although fewer pollutants of interest exhibited strong negative correlations with wind speed, most of the correlations were still negative.

5.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Sections 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

5.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Arizona monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 5-7. Where a seasonal or annual average exceeds the

Table 5-7. MRL Risk Screening Assessment Summary for the Arizona Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average (µg/m^3)
PXSS	TO-15	Acrolein	7.00	0/27	0.09	NA	NA	**3.15 ± 1.00**	**1.92 ± 0.43**	--	NA
SPAZ	TO-15	Acrolein	7.00	0/14	0.09	NA	NA	NR	**1.06 ± 0.29**	--	NA

-- = an MRL risk factor is not available
BOLD = EPA-designated NATTS Site
NA = Not available due to the duration criteria for calculating a seasonal and/or annual average
NR = Not reportable due to the detection criteria for calculating a seasonal average
BOLD = exceedance of the intermediate or chronic MRL

applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein from Table 5-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL for either site.
- For PXSS, the summer and autumn seasonal averages of acrolein exceeded the intermediate MRL. Winter and spring averages could not be calculated because sampling for VOC did not begin until July.
- For SPAZ, the autumn seasonal average of acrolein exceeded the intermediate MRL. Winter and spring averages could not be calculated because sampling did not begin until July. A summer average could not be calculated because there were less than seven detects of this pollutant.
- Acrolein has no chronic MRL. In addition, annual averages could not be calculated for these two sites because they did not begin sampling VOC until July. Therefore, a chronic risk comparison could not be conducted.

5.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Arizona monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 5-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the Arizona monitoring sites is as follows:

- The census tract for PXSS is 04013108902, which had a population of 5,222, and represented less than one percent of the Maricopa County population in 2000.
- The census tract for SPAZ is 04013115802, which had a population of 2,938, and represented less than one percent of the Maricopa County population in 2000.

Table 5-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Arizona

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average[1] (µg/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Phoenix, Arizona (PXSS) - Census Tract ID 04013108902								
Acetaldehyde	0.000002	0.009	2.07	4.58	0.23	NA	NA	NA
Acrolein	--	0.00002	0.19	--	9.67	NA	NA	NA
Acrylonitrile	0.000068	0.002	<0.01	0.33	<0.01	NA	NA	NA
Arsenic (PM_{10})	0.0043	0.00003	<0.01	0.05	<0.01	<0.01 ± <0.01	3.15	0.02
Benzene	0.000007	0.03	1.69	13.22	0.05	NA	NA	NA
1,3-Butadiene	0.00003	0.002	0.16	4.87	0.08	NA	NA	NA
Cadmium (PM_{10})	0.0018	0.00002	<0.01	0.02	<0.01	<0.01 ± <0.01	0.28	0.01
Carbon Tetrachloride	0.000015	0.04	0.21	3.15	0.01	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	2.07	0.01	0.21	NA	NA	NA
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	NA	NA	NA
Hexavalent Chromium	0.012	0.0001	<0.01	0.36	<0.01	<0.01 ± <0.01	1.03	<0.01
Manganese (PM_{10})	--	0.00005	<0.01	--	<0.01	0.02 ± <0.01	--	0.38
Naphthalene	0.000034	0.003	0.08	2.85	0.02	NA	NA	NA
Nickel (PM_{10})	0.00016	0.000065	<0.01	0.02	<0.01	<0.01 ± <0.01	0.26	0.03
***p*-Dichlorobenzene**	0.000011	0.8	0.08	0.90	<0.01	NA	NA	NA
Tetrachloroethylene	0.000005	0.27	0.36	2.15	<0.01	NA	NA	NA

-- = a URE or RfC is not available

Bold = pollutant of interest

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 5-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Arizona (Continued)

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE ($\mu g/m^3$)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration ($\mu g/m^3$)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] ($\mu g/m^3$)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
South Phoenix, Arizona (SPAZ) - Census Tract ID 04013115802								
Acrolein	--	0.00002	0.19	--	9.63	NA	NA	NA
Acrylonitrile	0.000068	0.002	0.01	0.62	<0.01	NA	NA	NA
Benzene	0.000007	0.03	1.67	13.05	0.05	NA	NA	NA
1,3-Butadiene	0.00003	0.002	0.15	4.62	0.07	NA	NA	NA
Carbon Disulfide	--	0.7	0.05	--	<0.01	NA	NA	NA
Carbon Tetrachloride	0.000015	0.04	0.21	3.16	0.01	NA	NA	NA
***p*-Dichlorobenzene**	0.000011	0.8	0.07	0.79	<0.01	NA	NA	NA
1,1,2,2-Tetrachloroethane	0.000058	--	0.07	3.92	--	NA	NA	NA
Tetrachloroethylene	0.000005	0.27	0.23	1.36	<0.01	NA	NA	NA
Xylenes	--	0.1	2.29	--	0.02	NA	NA	NA

-- = a URE or RfC is not available

Bold = pollutant of interest

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for PXSS from Table 5-8 include the following:

- The pollutants with the highest concentrations according to NATA were formaldehyde, acetaldehyde, and benzene.
- The pollutants with the highest cancer risks according to NATA were benzene, 1,3-butadidne, and acetaldehyde.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (9.67).
- Annual averages (and therefore cancer and noncancer surrogate risk approximations) could only be calculated for metals and hexavalent chromium due to the sampling duration criteria. Of those, only manganese had an annual average greater than 0.01 $\mu g/m^3$.
- Arsenic had the highest cancer risk approximation at 3.15 in-a-million. None of the noncancer risk approximations were greater than 1.0.

Observations for SPAZ from Table 5-8 include the following:

- The pollutants with the highest concentrations according to NATA were xylenes, benzene, and tetrachloroethylene.
- The pollutants with the highest cancer risks according to NATA were benzene, 1,3-butadidne, and 1,1,2,2-tetrachloroethane.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (9.63).
- Annual averages (and therefore cancer and noncancer surrogate risks approximations) could not be calculated due to the sampling duration criteria.

5.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 5-9 and 5-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 5-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest surrogate cancer risk approximations (in-a-million), as calculated from the annual averages. Table 5-10 presents similar information, but identifies the 10 pollutants with the highest surrogate noncancer risk approximations (HQ), as calculated from the annual averages. The

Table 5-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Arizona

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Phoenix, Arizona (PXSS) – Maricopa County					
Benzene	1,928.24	Benzene	1.50E-02	Arsenic (PM_{10})	3.15
Formaldehyde	1,054.10	1,3-Butadiene	6.90E-03	Hexavalent Chromium	1.03
Acetaldehyde	392.41	Naphthalene	4.07E-03	Cadmium (PM_{10})	0.28
Tetrachloroethylene	280.26	Hexavalent Chromium	2.54E-03	Nickel (PM_{10})	0.26
1,3-Dichloropropene	238.48	Arsenic, PM	2.06E-03		
1,3-Butadiene	229.90	Tetrachloroethylene	1.65E-03		
Dichloromethane	162.00	*p*-Dichlorobenzene	1.36E-03		
p-Dichlorobenzene	123.55	1,3-Dichloropropene	9.54E-04		
Naphthalene	119.63	Acetaldehyde	8.63E-04		
POM, Group 2	11.58	Cadmium, PM	7.52E-04		
South Phoenix, Arizona (SPAZ) – Maricopa County					
Benzene	1,928.24	Benzene	1.50E-02		
Formaldehyde	1,054.10	1,3-Butadiene	6.90E-03		
Acetaldehyde	392.41	Naphthalene	4.07E-03		
Tetrachloroethylene	280.26	Hexavalent Chromium	2.54E-03		
1,3-Dichloropropene	238.48	Arsenic, PM	2.06E-03		
1,3-Butadiene	229.90	Tetrachloroethylene	1.65E-03		
Dichloromethane	162.00	*p*-Dichlorobenzene	1.36E-03		
p-Dichlorobenzene	123.55	1,3-Dichloropropene	9.54E-04		
Naphthalene	119.63	Acetaldehyde	8.63E-04		
POM, Group 2	11.58	Cadmium, PM	7.52E-04		

Table 5-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Arizona

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Phoenix, Arizona (PXSS) – Maricopa County					
Toluene	5,912.44	Acrolein	2,746,685.59	Manganese (PM_{10})	0.38
Xylenes	4,253.08	1,3-Butadiene	114,950.11	Nickel (PM_{10})	0.03
Benzene	1,928.24	Formaldehyde	107,561.49	Arsenic (PM_{10})	0.02
Methyl *tert*-butyl ether	1,629.16	Bromomethane	66,526.00	Cadmium (PM_{10})	0.01
Methanol	1,263.81	Benzene	64,274.54	Hexavalent Chromium	<0.01
Hexane	1,117.09	Acetaldehyde	43,601.40		
Formaldehyde	1,054.10	Xylenes	42,530.81		
Ethylbenzene	941.78	Naphthalene	39,876.97		
1,1,1-Trichloroethane	634.01	Cyanide Compounds, gas	38,834.32		
Ethylene glycol	507.41	Cadmium, PM	20,885.36		
South Phoenix, Arizona (SPAZ) – Maricopa County					
Toluene	5,912.44	Acrolein	2,746,685.59		
Xylenes	4,253.08	1,3-Butadiene	114,950.11		
Benzene	1,928.24	Formaldehyde	107,561.49		
Methyl *tert*-butyl ether	1,629.16	Bromomethane	66,526.00		
Methanol	1,263.81	Benzene	64,274.54		
Hexane	1,117.09	Acetaldehyde	43,601.40		
Formaldehyde	1,054.10	Xylenes	42,530.81		
Ethylbenzene	941.78	Naphthalene	39,876.97		
1,1,1-Trichloroethane	634.01	Cyanide Compounds, gas	38,834.32		
Ethylene glycol	507.41	Cadmium, PM	20,885.36		

pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 5.3, PXSS sampled for VOC, carbonyls, SVOC, metals (PM_{10}), and hexavalent chromium; SPAZ sampled for VOC only. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated. Only metals and hexavalent chromium were sampled long enough at PXSS for annual averages to be calculated.

Observations from Table 5-9 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Maricopa County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, 1,3-butadiene, and naphthalene.
- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- For PXSS, arsenic, cadmium, and hexavalent chromium, for which cancer risk approximations could be calculated, had high toxicity-weighted emissions; yet none of the pollutants were among the 10 highest emitted pollutants.

Observations from Table 5-10 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Maricopa County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and formaldehyde.
- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- With the exception of cadmium, none of the pollutants for which noncancer risk approximations could be calculated for PXSS appeared on the list of highest emitted pollutants or the list of highest toxicity weighted emissions.

5.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *The pollutants of interest common to each Arizona monitoring site were acrolein, benzene, 1,3-butadiene, carbon tetrachloride, p-dichlorobenzene, and tetrachloroethylene.*

- *Formaldehyde had the highest daily average concentration for PXSS, while benzene had the highest daily average concentration for SPAZ.*

- *The summer and autumn seasonal average concentrations of acrolein exceeded the intermediate MRL health benchmark for PXSS. The autumn seasonal average concentration of acrolein exceeded the intermediate health benchmark MRL for SPAZ.*

6.0 Sites in California

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at NATTS sites in California, and integrates these concentrations with emissions, meteorological, and risk information.

6.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the locations of the sites and the surrounding areas. The California sites are located in the Los Angeles-Riverside-Orange County, CA MSA. CELA is located near downtown Los Angeles and RUCA is located in Rubidoux, near Riverside. Figures 6-1 and 6-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban locations. Figures 6-3 and 6-4 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 6-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land, location setting, and locational coordinates.

CELA is located on the rooftop of a two-story building just northeast of downtown Los Angeles, near Dodgers' Stadium. Figure 6-1 shows that CELA is surrounded by major freeways, including I-5, Rt. 110, and Hwy 101. Although the area is classified as residential, a freight yard is located to the south of the site. The Los Angeles River runs north-south just east of the site. This monitoring site was originally set up as an emergency response monitor. RUCA is located just outside of Riverside, in a residential area of the suburban town of Rubidoux. Highway 60 runs east-west to the north of the site. Flabob Airport is located about ¾ of a mile to the southeast of the site. Figure 6-2 shows that RUCA is adjacent to a power substation near the intersection of Mission Boulevard and Riverview Drive.

As Figure 6-3 shows, CELA is situated among numerous point sources. Point sources located in very close proximity to CELA are involved in food product industries, iron and steel manufacturing, and processes involving fuel combustion. A large number of emission sources are near CELA are involved in surface coating or utilize fuel combustion processes. Figure 6-4 shows that fewer emission sources surround RUCA. Most of these emission sources are located

Figure 6-1. Los Angeles, California (CELA) Monitoring Site

©2008 Google/©NAVTECH

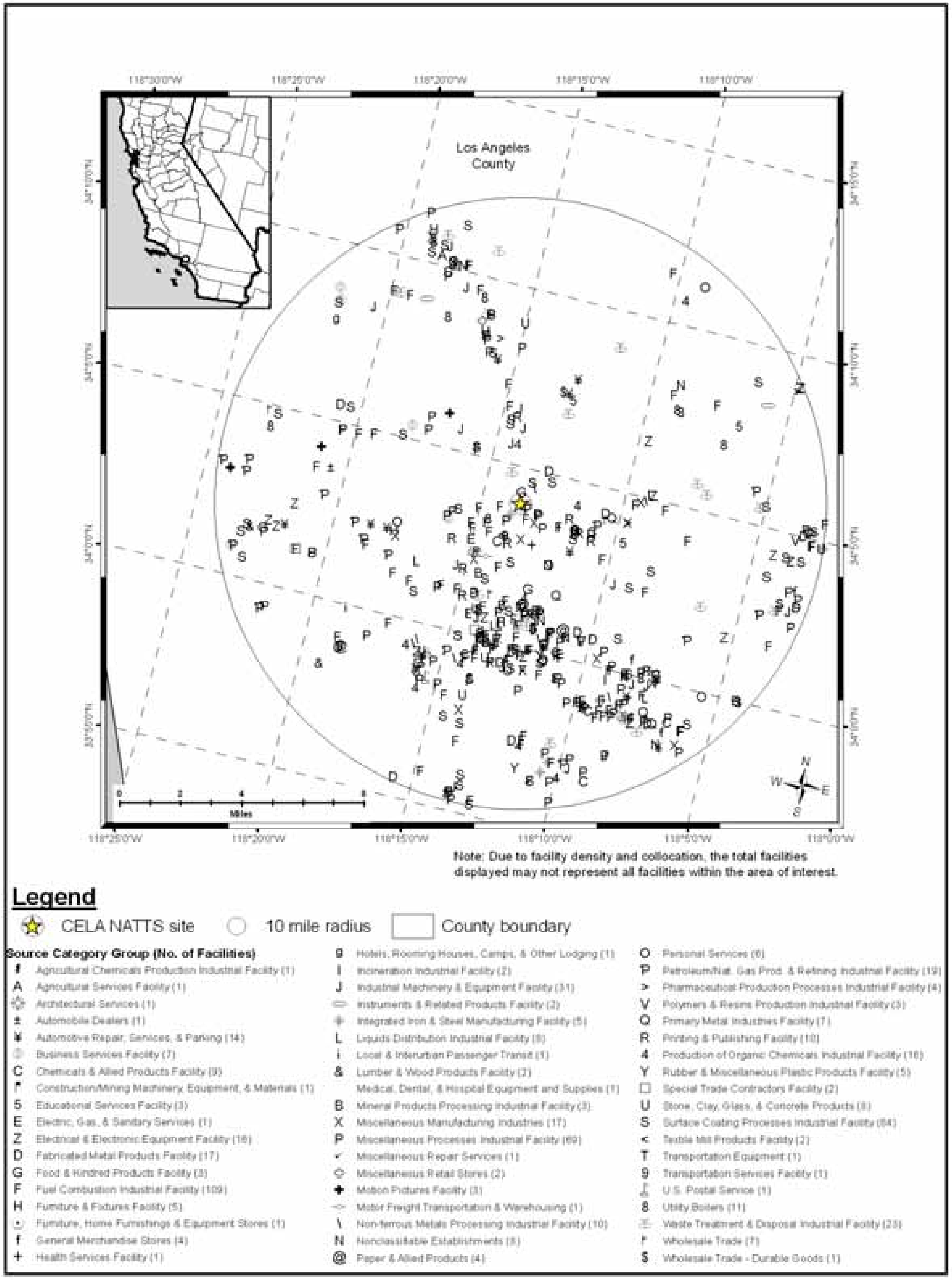
Scale: 3cm = 200m

Figure 6-2. Rubidoux, California (RUCA) Monitoring Site

©2008 Google/©NAVTECH

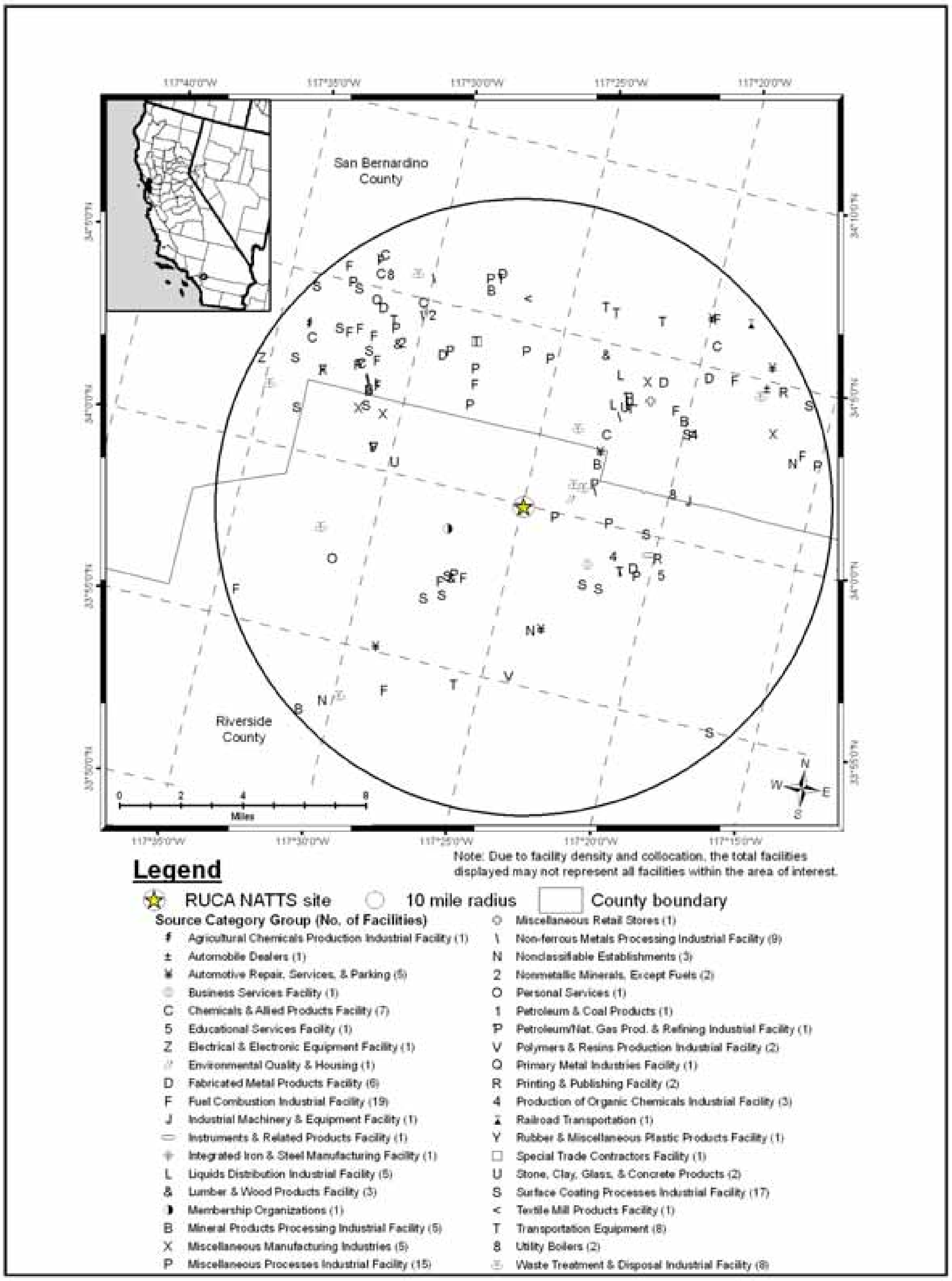
Scale: 3cm = 100m

Figure 6-3. NEI Point Sources Located Within 10 Miles of CELA



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 6-4. NEI Point Sources Located Within 10 Miles of RUCA



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 6-1. Geographical Information for the California Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
CELA	06-037-1103	Los Angeles	Los Angeles	Los Angeles-Riverside-Orange County, CA CMSA	34.06659, -118.22688	Residential	Urban/City Center	CELA is located on the rooftop of a two-story building just northeast of downtown Los Angeles, near Dodgers' Stadium. The location is surrounded by major freeways, including I-5, Rt. 110, and Hwy 101. A freight yard is located to the south of the site and the Los Angeles River runs north-south near the site. Pollutants monitored for include CO, SO_2, NO_2, O_3, PM_{10}, $PM_{2.5}$, and hexavalent chromium. Meteorological observations are also recorded. West winds are predominant at the site.
RUCA	06-065-8001	Rubidoux	Riverside	Los Angeles-Riverside-Orange County, CA CMSA	33.999167, -117.415833	Residential	Urban/City Center	RUCA is located just outside of Riverside, in a residential area of the suburban town of Rubidoux. The shelter is located in an enclosed, secure area that is adjacent to a power substation with unimproved lots directly to the east of the site. Highway 60 runs east-west to the north of the site. Flabob Airport is located about ¾ of a mile to the southeast of the site. Pollutants monitored for include CO, SO_2, NO_2, O_3, PM_{10}, $PM_{2.5}$, and hexavalent chromium. Meteorological observations are also recorded. West winds are predominant at the site.

BOLD = EPA-designated NATTS Site

to the north of the site. Point sources located in very close proximity to RUCA are involved in environmental quality and wastewater treatment and disposal. Similar to CELA, the most common emission source categories for point sources near RUCA are surface coating and fuel combustion.

Table 6-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the California monitoring sites. County-level vehicle registration and population data for Riverside and Los Angeles Counties were obtained from the LA Almanac and UC Libraries and the U.S. Census Bureau. Table 6-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 6-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 6-2 presents the daily VMT for each urban area.

Table 6-2. Population, Motor Vehicle, and Traffic Information for the California Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
CELA	9,878,554	7,514,916	0.76	3,714,391	2,825,650	238,000	279,041
RUCA	2,073,571	1,344,232	0.65	975,577	632,436	17,468	42,861

[1] Daily Average Traffic Data reflects 2005 data from the LA Almanac (CELA) and 2002 data from the Counting California, UC Libraries (RUCA)

BOLD = EPA-designated NATTS Site

Observations from Table 6-2 include the following:

- Los Angeles County had the highest county population, county-level vehicle registration, and 10-mile estimated vehicle ownership compared to all counties with NATTS or UATMP sites. However, the 10-mile population near this site ranked second behind BXNY, which is located in the Bronx Borough of New York City.

- Riverside County had the fifth highest county population and ninth highest county-level vehicle registration.

- The vehicle per person ratio was somewhat higher for Los Angeles County than Riverside County.

- CELA experiences the highest average daily traffic volume of any UATMP or NATTS site and has a substantially higher traffic volume than RUCA. The traffic data for CELA was based on data from exit 136 off I-5 at Main Street. The traffic data for RUCA was based on data from Mission Boulevard, west of Riverview Drive.

- The Los Angeles area's VMT ranked second among urban areas with UATMP or NATTS sites, while the Riverside area ranked fifteenth.

6.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in California on sampling days, as well as over the course of the year.

6.2.1 Climate Summary

While the proximity to the Pacific Ocean acts as a moderating influence on the city, the elevation changes between the mountains and valleys allow the distance from the ocean to create substantial differences in temperature, rainfall, and wind over a relatively short distance. Overall, the climate of Los Angeles is mild. Precipitation falls primarily in winter months, while summers tend to be dry. Stagnant wind conditions in the summer can result in air pollution episodes, while breezy Santa Ana winds can create hot, dusty conditions. Fog and cloudy conditions are more prevalent near the coast than further inland (Ruffner and Bair, 1987 and WRCC).

6.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The two closest

NWS weather stations are located at Downtown Los Angeles/USC Campus (near CELA) and Riverside Municipal Airport (near RUCA) WBAN 93134 and 03171.

Table 6-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 6-3 is the 95 percent confidence interval for each parameter. As shown in Table 6-3, average meteorological conditions on sampling days near CELA were fairly representative of average weather conditions throughout the year. Average meteorological conditions near RUCA were warmer on sampling days. Both sites began sampling in the spring, thus missing the coldest months of the year. This seemed to have a larger impact on RUCA's sample day averages than CELA's averages.

6.2.3 Composite Back Trajectories for Sampling Days

Figures 6-5 and 6-6 are composite back trajectory maps for the California monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 6-5 and 6-6 represents 100 miles.

Observations from Figures 6-5 and 6-6 include the following:

- Back trajectories originated primarily from the northwest at CELA and RUCA. A secondary group of trajectories originated from the northeast.

- The 24-hour air shed domains were smaller for these sites than for other monitoring sites. The furthest away a trajectory originated was northern California or Utah, both over 500 miles away. However, over 90 percent of trajectories originated within 300 miles of the sites.

- Sampling began in late April or early May at these sites. The composite back trajectory maps for these sites with a full year's worth of sample days may look much different.

Table 6-3. Average Meteorological Conditions near the California Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CELA	Downtown L.A./USC Campus 93134	Sampling Day	76.02 ± 2.65	66.17 ± 2.16	51.07 ± 2.97	57.98 ± 1.95	62.25 ± 4.24	1013.70 ± 1.02	1.32 ± 0.17
		All 2007	74.16 ± 0.91	64.11 ± 0.71	47.84 ± 1.13	55.67 ±0.70	60.01 ± 1.51	1015.09 ± 0.39	1.40 ± 0.08
RUCA	Riverside Municipal Airport 03171	Sampling Day	84.80 ± 5.90	69.12 ± 4.23	45.07 ± 12.34	53.79 ± 4.11	51.77 ± 18.55	1011.43 ± 0.50	6.75 ± 1.01
		All 2007	75.01 ± 1.65	60.85 ± 1.21	39.45 ± 1.93	50.65 ± 1.06	53.40 ± 2.55	1014.85 ± 0.54	6.18 ± 0.29

BOLD = EPA-designated NATTS Site

Figure 6-5. Composite Back Trajectory Map for CELA

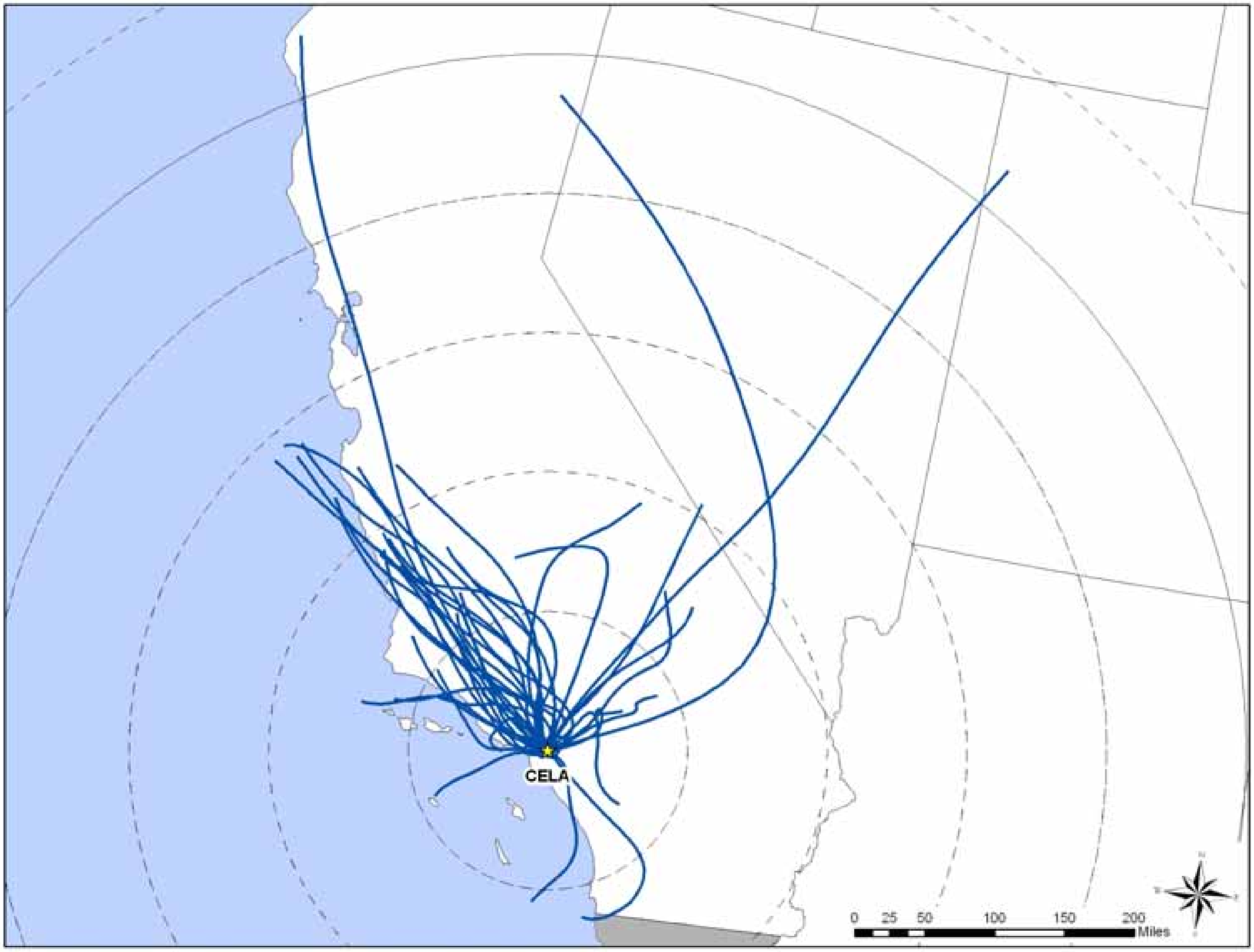
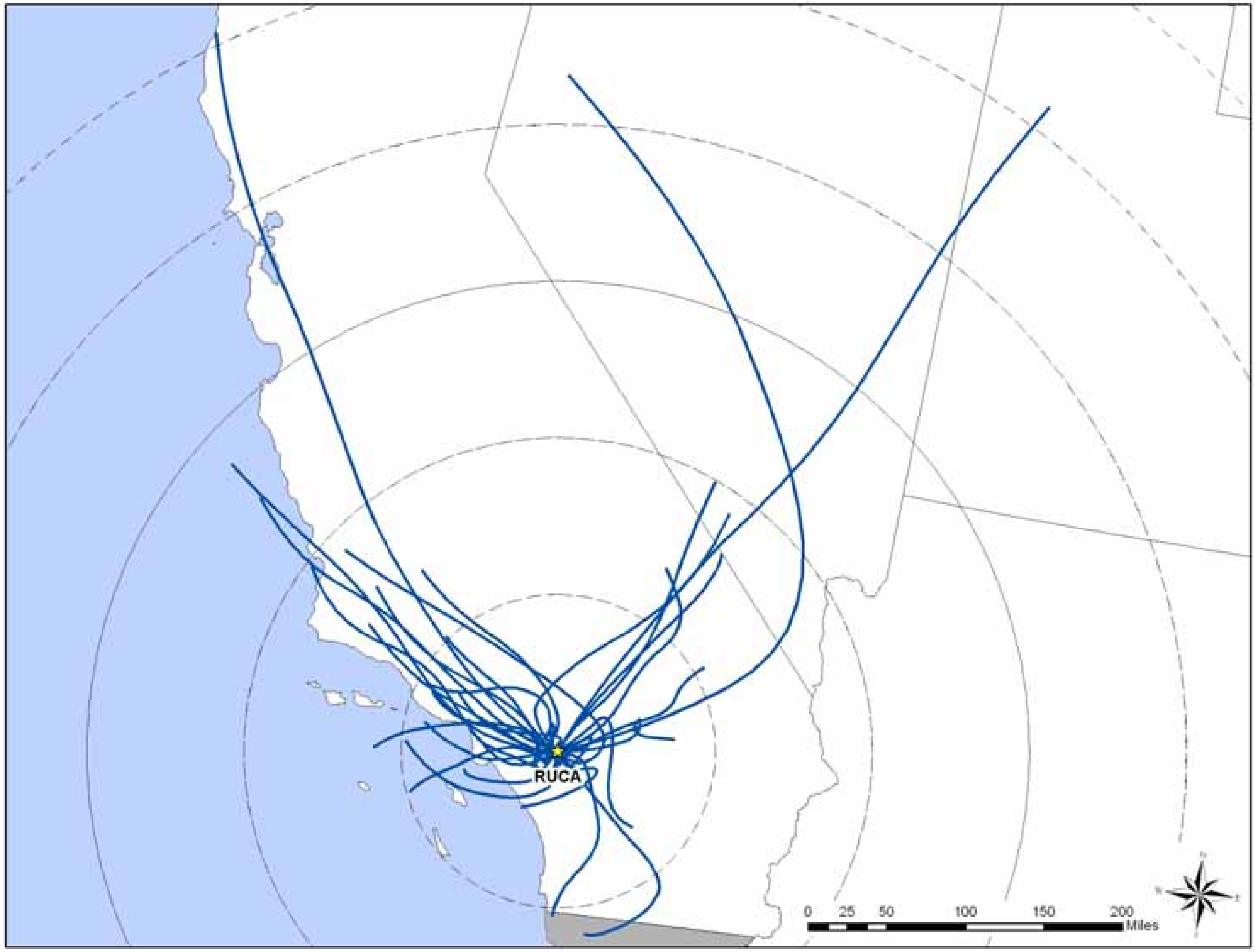


Figure 6-6. Composite Back Trajectory Map for RUCA



6.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations at the Downtown Los Angeles/USC Campus (for CELA) and Riverside Municipal Airport near (for RUCA) were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 6-7 and 6-8 are the wind roses for the California monitoring sites on days that samples were collected.

Observations from Figure 6-7 for CELA include the following:

- Winds were generally light near the site, with calm winds observed for 84 percent of the observations. Wind speeds greater than 11 knots were not measured at this weather station.
- For winds greater than two knots, westerly winds were predominant.

Figure 6-7. Wind Rose for CELA Sampling Days

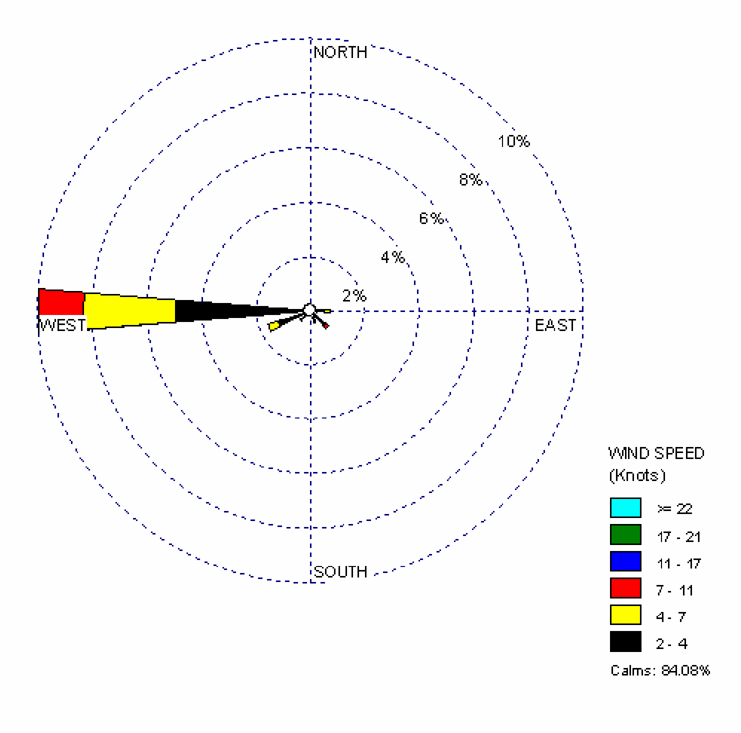
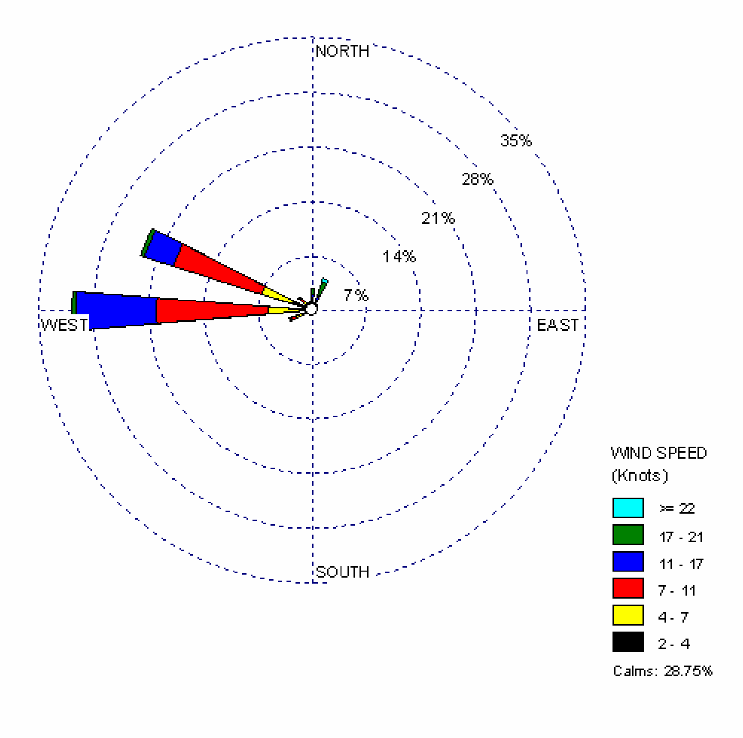


Figure 6-8. Wind Rose for RUCA Sampling Days



Observations from Figure 6-8 for RUCA include the following:

- Both wind speed and direction fluctuated more near RUCA than CELA, although westerly winds were still the predominant wind direction (31 percent of observations). West-northwesterly winds were observed for 23 percent of observations.
- Calm winds were observed for one-third of the observations near RUCA. However, winds exceeding 11 knots made up nearly 23 percent of observations.

6.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the California monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens.

Table 6-4 presents the pollutants that failed at least one screen for each California monitoring site and highlights each site's pollutants of interest (shaded). CELA and RUCA sampled for SVOC only.

Observations from Table 6-4 include the following:

- Naphthalene was the only pollutant to fail screens for both sites, making it the only pollutant of interest for both sites.
- Naphthalene failed 87 percent of screens for CELA and 81 percent of screens for RUCA.

Table 6-4. Comparison of Measured Concentrations and EPA Screening Values for the California Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Los Angeles, California - CELA					
Naphthalene	34	39	87.18	100.00	100.00
Total	34	39	87.18		
Rubidoux, California - RUCA					
Naphthalene	26	32	81.25	100.00	100.00
Total	26	32	81.25		

6.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the California monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

6.4.1 2007 Concentration Averages

Daily, seasonal, and annual averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 6-5, where applicable.

Table 6-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the California Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average (µg/m^3)
Los Angeles, California - CELA								
Naphthalene	39	39	0.07 ± 0.01	NA	NR	0.05 ± 0.01	0.08 ± 0.02	NA
Rubidoux, California – RUCA								
Naphthalene	32	32	0.06 ± 0.01	NA	NR	0.05 ± 0.01	0.07 ± 0.02	NA

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average
NR = Not reportable due to the detection criteria for calculating a seasonal average

Observations for the California monitoring sites from Table 6-5 include the following:

- The daily averages of naphthalene were similar for both sites.
- Because sampling did not begin until late spring at CELA and RUCA, winter and spring averages could not be calculated. The summer and autumn averages varied little.
- Annual averages were not calculated due to the short sampling duration.

6.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. Neither CELA nor RUCA have sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

6.5 Pearson Correlations

Table 6-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for the California sites from Table 6-6 include the following:

- The correlations with naphthalene were generally weak at the California sites.
- However, the strongest correlation for CELA was calculated for relative humidity (-0.44) and the strongest correlation for RUCA was calculated for wind speed (-0.49).

6.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Sections 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

6.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the California monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the pollutants measured at the California sites exceeded any of the MRL risk values.

Table 6-6. Pearson Correlations Between Selected Meteorological Parameters and Pollutants of Interest for the California Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Los Angeles, California - CELA								
Naphthalene	39	0.12	-0.09	-0.41	-0.33	-0.44	0.22	-0.43
Rubidoux, California - RUCA								
Naphthalene	32	-0.17	-0.18	-0.15	-0.18	-0.17	-0.19	-0.49

6.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the California monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 6-7. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the California sites is as follows:

- The census tract for CELA is 06037463500, which had a population of 5,396, and represented less than one percent of the Los Angeles County population in 2000.

- The census tract for RUCA is 06065040301, which had a population of 6,634, and represented less than one percent of the Riverside County population in 2000.

Observations for California sites from Table 6-7 include the following:

- Naphthalene was the only pollutant to fail screens for the California sites.

- The NATA modeled concentration of naphthalene is slightly higher for CELA than RUCA, which translated into slightly higher cancer and noncancer risks.

- Annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for naphthalene due to the sampling duration criteria.

Table 6-7. Cancer and Noncancer Risk Summary for the Monitoring Sites in California

			1999 NATA			2007 NATTS/UATMP		
Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Los Angeles, California (CELA) - Census Tract ID 06037463500								
Naphthalene	0.000034	0.003	0.13	4.51	0.04	NA	NA	NA
Rubidoux, California (RUCA) - Census Tract ID 06065040301								
Naphthalene	0.000034	0.003	0.09	3.03	0.02	NA	NA	NA

Bold = pollutant of interest

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

6.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 6-8 and 6-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 6-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest surrogate cancer risk approximations (in-a-million), as calculated from the annual averages. Table 6-9 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual average are limited to those pollutants for which each respective site sampled. As discussed in Section 6.3, the California monitoring sites sampled only for SVOC. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated. Because sampling did not begin until late spring, cancer and noncancer risk approximations were not calculated for the California monitoring sites.

Observations from Table 6-8 include the following:

- Formaldehyde, benzene, and dichloromethane were the highest emitted pollutants with cancer UREs in both Los Angeles and Riverside County, although the quantity emitted was much higher for Los Angeles County.
- The two pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene and 1,3-butadiene for both counties.
- Six of the highest emitted pollutants also have the highest toxicity-weighted emissions for both counties.
- Naphthalene, which was the only pollutant to fail screens for either site, appears on both top 10 lists for both counties. Naphthalene had the third highest toxicity-weighted emissions for Los Angeles County and fourth highest toxicity-weighted emissions for Riverside County.

Table 6-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in California

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Los Angeles, California (CELA) – Los Angeles County					
Formaldehyde	3,761.00	Benzene	2.62E-02		
Benzene	3,358.23	1,3-Butadiene	1.66E-02		
Dichloromethane	2,821.10	Naphthalene	1.17E-02		
Tetrachloroethylene	1,973.72	Tetrachloroethylene	1.16E-02		
Acetaldehyde	1,156.58	Hexavalent Chromium	8.60E-03		
1,3-Butadiene	553.78	*p*-Dichlorobenzene	5.62E-03		
p-Dichlorobenzene	511.02	Arsenic, PM	3.29E-03		
Naphthalene	344.62	Acrylonitrile	3.23E-03		
Trichloroethylene	205.49	Hydrazine	3.06E-03		
1,3-Dichloropropene	73.69	Acetaldehyde	2.54E-03		
Rubidoux, California (RUCA) – Riverside County					
Formaldehyde	775.04	Benzene	5.80E-03		
Benzene	744.15	1,3-Butadiene	3.17E-03		
Dichloromethane	357.00	Hexavalent Chromium	2.59E-03		
Acetaldehyde	261.24	Naphthalene	2.04E-03		
Tetrachloroethylene	236.94	Tetrachloroethylene	1.40E-03		
1,3-Butadiene	105.53	Arsenic, PM	9.87E-04		
p-Dichlorobenzene	84.46	*p*-Dichlorobenzene	9.29E-04		
1,3-Dichloropropene	65.85	Acrylonitrile	6.97E-04		
Naphthalene	60.11	Acetaldehyde	5.75E-04		
Trichloroethylene	27.54	Cadmium, PM	5.53E-04		

Table 6-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in California

Top 10 Total Emissions for Pollutants with Nonancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Los Angeles, California (CELA) – Los Angeles County					
1,1,1-Trichloroethane	11,143.75	Acrolein	9,822,537.40		
Toluene	10,867.59	Chlorine	757,779.08		
Methyl *tert*- butyl ether	7,231.31	Formaldehyde	383,775.50		
Xylenes	6,551.48	1,3-Butadiene	276,889.19		
Formaldehyde	3,761.00	Acetaldehyde	128,508.79		
Methanol	3,728.19	Naphthalene	114,873.21		
Benzene	3,358.23	Nickel, PM	113,809.87		
Dichloromethane	2,821.10	Benzene	111,941.11		
Hexane	2,732.53	Manganese, PM	110,563.54		
Tetrachloroethylene	1,973.72	Xylenes	65,514.80		
Rubidoux, California (RUCA) – Riverside County					
Toluene	1,964.44	Acrolein	2,142,512.31		
Xylenes	1,355.80	Chlorine	154,853.27		
Methyl *tert*-butyl ether	1,296.42	Formaldehyde	79,085.43		
1,1,1-Trichloroethane	1,122.24	1,3-Butadiene	52,763.78		
Formaldehyde	775.04	Manganese, PM	41,359.46		
Benzene	744.15	2,4-Toluene diisocyanate	37,029.00		
Methanol	573.39	Bromomethane	29,494.00		
Hexane	454.07	Acetaldehyde	29,026.13		
Dichloromethane	357.00	Benzene	24,805.07		
Ethylbenzene	264.61	Naphthalene	20,035.08		

Observations from Table 6-9 include the following:

- 1,1,1-Trichloroethylene, toluene, methyl *tert* butyl ether, and xylenes were the highest emitted pollutants with noncancer RfCs in both counties, although not necessarily in that order.

- Similar to pollutants with cancer UREs, emissions were higher in Los Angeles County than Riverside County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, chlorine, and formaldehyde for both counties.

- Three of the highest emitted pollutants in Los Angeles County also have the highest toxicity-weighted emissions and only two of the highest emitted pollutants in Riverside County also have the highest toxicity-weighted emissions

- Naphthalene had the sixth and tenth highest toxicity-weighted emissions for Los Angeles and Riverside Counties, respectively, but is not one of the highest emitted pollutants with a noncancer toxicity factor in either county.

6.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *Naphthalene was the only pollutant to fail screens for both California monitoring sites.*

- ❖ *The daily and seasonal average concentrations of naphthalene, where they could be calculated, were similar for both sites.*

- ❖ *Naphthalene did not exceed any of the MRL health benchmarks.*

7.0 Site in Colorado

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Colorado, and integrates these concentrations with emissions, meteorological, and risk information.

7.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The Colorado site is located in the Grand Junction, CO MSA. Figure 7-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its urban location. Figure 7-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 7-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

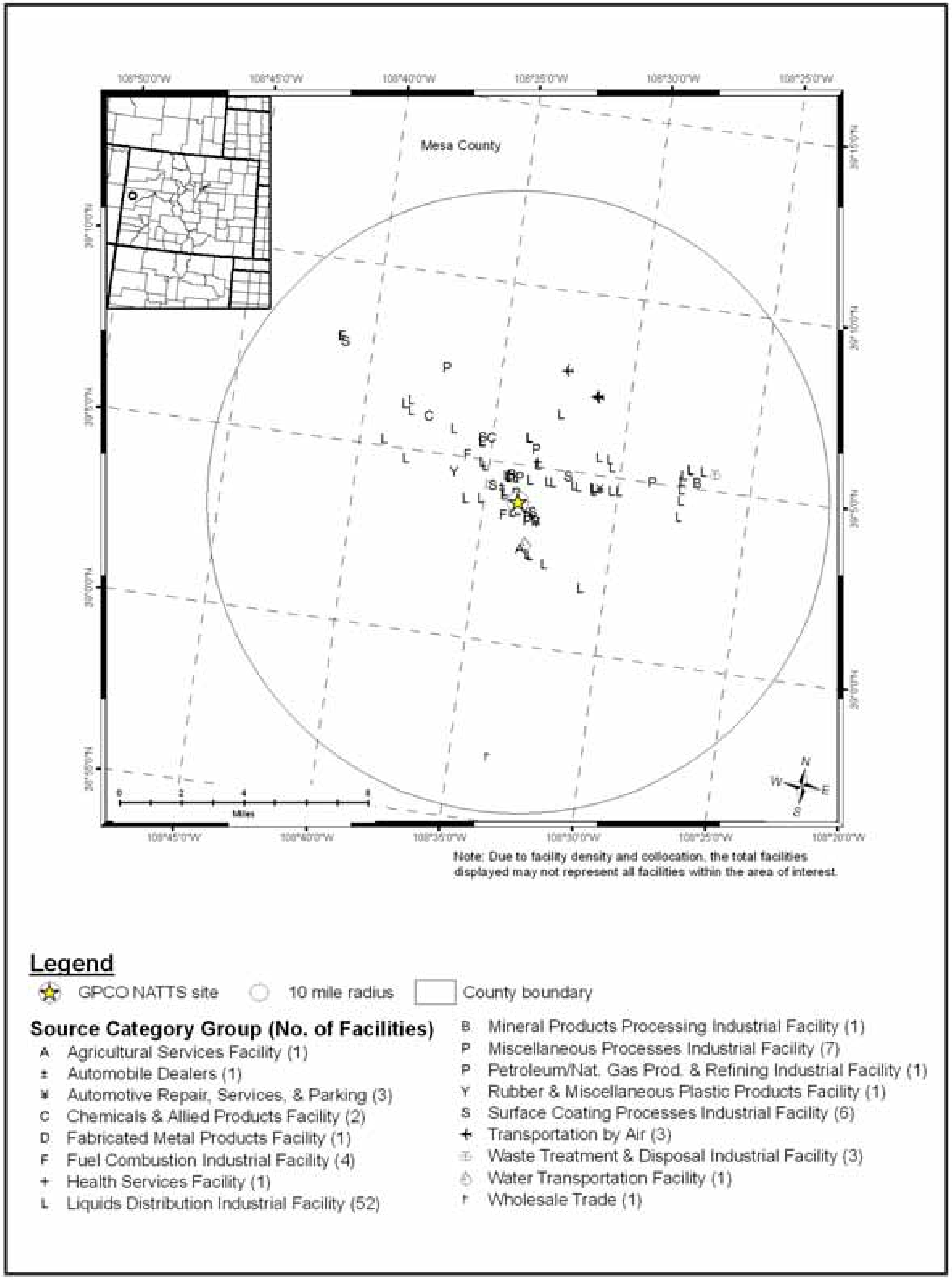
The GPCO monitoring site is comprised of two locations. The first is a small 1-story shelter that houses the VOC/carbonyl sampler. The second location is on an adjacent 2-story building that has the filter-based PM_{10} and hexavalent chromium samplers on the roof. As a result, two AQS codes are provided in Table 7-1. Figure 7-1 shows that the area surrounding GPCO is very mixed usage, with commercial businesses to the west, northwest and north, residential areas to the northeast and east, and industrial areas to the southeast, south and southwest. The site's location is next to one of the major east-west roads in Grand Junction. A railroad runs east-west to the south of the GPCO monitoring site, and merges with another railroad to the southwest of the site. As Figure 7-2 shows, GPCO is located within 10 miles of numerous emission sources, many of which are located in close proximity of the site. A large number of point sources near GPCO fall into the liquids distribution source category.

Table 7-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Colorado monitoring site. County-level vehicle registration and population data for Mesa County, Colorado were obtained from the Colorado Department of Revenue and the U.S. Census

Figure 7-1. Grand Junction, Colorado (GPCO) Monitoring Site

Scale: 3cm = 200

Figure 7-2. NEI Point Sources Located Within 10 Miles of GPCO



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 7-1. Geographical Information for the Colorado Monitoring Site

Site Code	**AQS Code**	**Location**	**County**	**Micro- or Metropolitan Statistical Area**	**Latitude and Longitude**	**Land Use**	**Location Setting**	**Description of the Immediate Surroundings**
GPCO	08-077-0017 & 08-077-0018	Grand Junction	Mesa	Grand Junction, CO	39.064295, -108.561545	Commercial	Urban/City Center	The GPCO site is comprised of two locations. The first is a small 1-story shelter that houses the VOC/carbonyl sampler (08-077-0018, 645 ¼ Pitkin Avenue). The inlet for this sampler is 13' above the ground and 35' south of Pitkin Avenue. This location also has meteorological sensors (WS, WD, T, RH) on a 10 meter tower, a carbon monoxide sampler and a continuous PM_{10} sampler. The second location is on an adjacent 2-story building that has the filter-based PM_{10} and hexavalent chromium samplers on the roof (08-077-0017, 650 South Avenue). This location also has a filter-based $PM_{2.5}$ sampler, a $PM_{2.5}$ speciation sampler and a continuous $PM_{2.5}$ sampler. Monitoring is being conducted on the southeast side of the downtown area. The area is very mixed usage, with commercial businesses to the west, northwest and north, residential to the northeast and east, and industrial to the southeast, south and southwest. The location is next to one of the major east-west roads in Grand Junction.

BOLD = EPA-designated NATTS Site

Table 7-2. Population, Motor Vehicle, and Traffic Information for the Colorado Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
GPCO	139,082	163,539	1.18	114,523	134,661	12,300	2,024

[1] Daily Average Traffic Data reflects 2006 data from the Colorado DOT
BOLD = EPA-designated NATTS Site

Bureau. Table 7-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of the site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 7-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 7-2 presents the daily VMT for the urban area.

Observations from Table 7-2 include the following:

- GPCO's county and 10-mile populations were in the low to mid-range compared to all counties with NATTS or UATMP sites. This is also true for its county-level and 10-mile vehicle ownership.
- The vehicle per person ratio was the fifth highest compared to other NATTS or UATMP sites.
- The traffic volume experienced near GPCO also ranked in the low to mid-range compared to other monitoring sites. The traffic estimate used came from Business-70 between 5th and 7th Streets.
- The Grand Junction area VMT was the second lowest among urban areas with UATMP or NATTS sites.

7.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Colorado on sampling days, as well as over the course of the year.

7.2.1 Climate Summary

Grand Junction is located in a mountain valley on the west side of the Rockies. This location can help protect the area from dramatic weather changes. The area tends to be rather dry and winds tend to flow out of the east-southeast on average, due to the valley breeze effect. Valley breezes occur as the sun heats up the side of a mountain. The warm air rises, creating a current that will move up the valley walls (Ruffner and Bair, 1987).

7.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at Walker Field Airport (WBAN 23066).

Table 7-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 7-3 is the 95 percent confidence interval for each parameter. As shown in Table 7-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

7.2.3 Composite Back Trajectories for Sampling Days

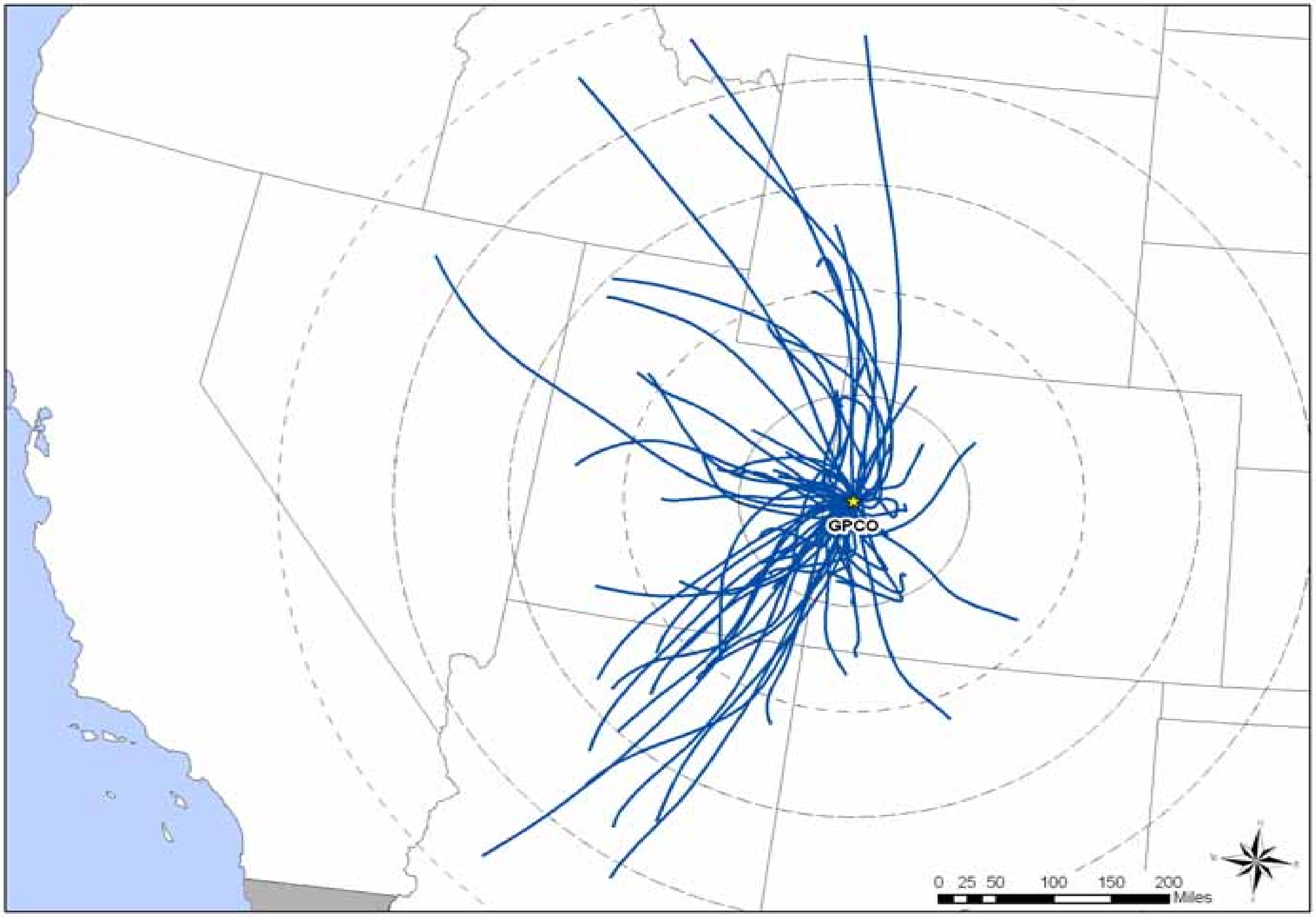
Figure 7-3 is a composite back trajectory map for the Colorado monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figures 7-3 represents 100 miles.

Table 7-3. Average Meteorological Conditions near the Colorado Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
GPCO	Walker Field Airport 23066	Sampling Day	68.49 ± 5.01	55.75 ± 4.65	29.25 ± 2.71	42.74 ± 3.07	43.88 ± 4.36	1014.24 ± 1.84	6.92 ± 0.71
		All 2007	66.15 ± 2.30	53.79 ± 2.11	28.27 ± 1.28	41.41 ± 1.42	45.38 ± 1.97	1015.01 ± 0.85	6.45 ± 0.29

BOLD = EPA-designated NATTS Site

Figure 7-3. Composite Back Trajectory Map for GPCO



Observations from Figure 7-3 include the following:

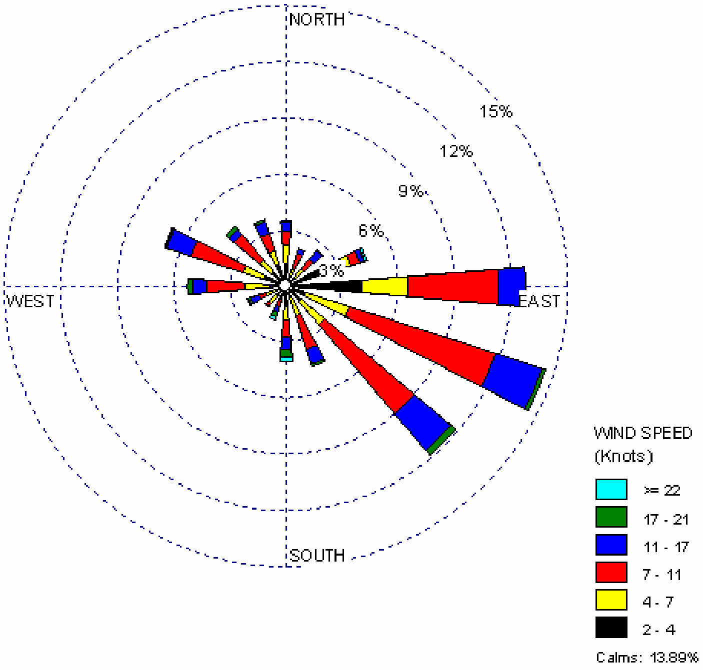
- Back trajectories originated from a variety of directions at GPCO. However, trajectories originated from a direction with an easterly component less frequently than other directions.

- The 24-hour air shed domain for GPCO was somewhat smaller in size than other monitoring sites. The furthest away a trajectory originated was central Idaho, or nearly 500 miles away. However, most trajectories originated within 300 miles of the site.

7.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at Walker Field near GPCO were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 7-4 is the wind rose for the Colorado monitoring site on days that samples were collected.

Figure 7-4. Wind Rose for GPCO Sampling Days



Observations from Figure 7-4 for GPCO include the following:

- Easterly, east-southeasterly, and southeasterly winds were prevalent near GPCO.
- Calm winds were observed for approximately 14 percent of the hourly wind measurements.
- Winds exceeding 11 knots made up approximately 17 percent of observations.

7.3 Pollutants of Interest

"Pollutants of interest" were determined for the monitoring site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Colorado monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 7-4 presents the pollutants that failed at least one screen at the Colorado monitoring site and highlights the site's pollutants of interest (shaded). GPCO sampled for VOC, carbonyls, and hexavalent chromium.

Observations from Table 7-4 include the following:

- Thirteen pollutants with a total of 434 measured concentrations failed at least one screen for GPCO.
- The following pollutants were identified as pollutants of interest for GPCO: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and tetrachloroethylene.
- Of the seven pollutants of interest, acetaldehyde, acrolein, benzene, 1,3-butadiene, and carbon tetrachloride failed 100 percent of screens for GPCO.
- Seventy nine percent of measured detections failed screens (of the pollutants that failed at least one screen) for GPCO.

Table 7-4. Comparison of Measured Concentrations and EPA Screening Values for the Colorado Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Grand Junction, Colorado - GPCO					
Acetaldehyde	64	64	100.00	14.75	14.75
Benzene	62	62	100.00	14.29	29.03
Carbon Tetrachloride	62	62	100.00	14.29	43.32
Formaldehyde	62	64	96.88	14.29	57.60
1,3-Butadiene	62	62	100.00	14.29	71.89
Acrolein	61	61	100.00	14.06	85.94
Tetrachloroethylene	40	61	65.57	9.22	95.16
p-Dichlorobenzene	10	57	17.54	2.30	97.47
Acrylonitrile	6	6	100.00	1.38	98.85
1,2-Dichloroethane	2	2	100.00	0.46	99.31
1,2-Dibromoethane	1	1	100.00	0.23	99.54
Hexachloro-1,3-butadiene	1	1	100.00	0.23	99.77
Hexavalent Chromium	1	43	2.33	0.23	100.00
Total	434	546	79.49		

7.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Colorado monitoring site. The averages presented are provided for the pollutants of interest for the monitoring site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

7.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 7-5, where applicable.

Observations for GPCO from Table 7-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (4.02 ± 0.33 µg/m^3), acetaldehyde (2.79 ± 0.26 µg/m^3), and benzene (1.46 ± 0.20 µg/m^3). The annual averages for these pollutants were the same as their respective daily averages.

- As shown in Tables 4-9 and 4-11, of the program-level pollutants of interest, the daily average concentration of the following pollutants for GPCO were among the 10 highest average concentrations for all NATTS and UATMP sites: acetaldehyde, benzene, 1,3-butadiene, formaldehyde, and tetrachloroethylene.

- Benzene and 1,3-butadiene concentrations were higher in the autumn and winter at GPCO.

Table 7-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Grand Junction, Colorado - GPCO								
Acetaldehyde	64	64	2.79 ± 0.26	2.13 ± 0.41	2.62 ± 0.57	3.48 ± 0.44	2.78 ± 0.43	2.79 ± 0.26
Acrolein	61	62	0.65 ± 0.10	0.58 ± 0.24	0.59 ± 0.26	0.70 ± 0.11	0.71 ± 0.14	0.64 ± 0.10
Benzene	62	62	1.46 ± 0.20	1.89 ± 0.53	1.03 ± 0.19	1.13 ± 0.20	1.88 ± 0.40	1.46 ± 0.20
1,3-Butadiene	62	62	0.16 ± 0.03	0.24 ± 0.07	0.11 ± 0.02	0.10 ± 0.02	0.20 ± 0.06	0.16 ± 0.03
Carbon Tetrachloride	62	62	0.53 ± 0.03	0.49 ± 0.05	0.56 ± 0.07	0.53 ± 0.06	0.53 ± 0.07	0.53 ± 0.03
Formaldehyde	64	64	4.02 ± 0.33	3.90 ± 0.44	2.91 ± 0.67	4.25 ± 0.53	4.98 ± 0.47	4.02 ± 0.33
Tetrachloroethylene	61	62	0.32 ± 0.06	0.40 ± 0.11	0.25 ± 0.09	0.18 ± 0.05	0.47 ± 0.18	0.32 ± 0.06

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

7.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. GPCO has not sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

7.5 Pearson Correlations

Table 7-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for GPCO from Table 7-6 include the following:

- A strong negative correlation was calculated between 1,3-butadiene and the average temperature and wet bulb temperature, indicating that as temperature and moisture content increase, concentrations of 1,3-butadiene decrease. This supports the seasonal average trends discussed in Section 7.4.1.

- Strong positive correlations were calculated between 1,3-butadiene and benzene and sea level pressure. This indicates that as pressure increases, concentrations of these pollutants increase.

- Most of the pollutants of interest exhibited weak negative correlations with wind speed, suggesting that concentrations of the pollutants of interest may increase as wind speeds decrease.

7.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

7.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Colorado monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate

Table 7-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Colorado Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Grand Junction, Colorado - GPCO								
Acetaldehyde	64	0.47	0.45	0.11	0.35	-0.55	0.00	-0.25
Acrolein	61	0.17	0.13	0.14	0.14	-0.11	0.18	-0.01
Benzene	62	-0.37	-0.42	-0.34	-0.43	0.30	0.55	-0.43
1,3-Butadiene	62	-0.48	-0.52	-0.48	-0.55	0.33	0.60	-0.44
Carbon Tetrachloride	62	0.09	0.11	0.16	0.15	-0.03	-0.06	-0.05
Formaldehyde	64	0.12	0.07	0.19	0.10	0.03	0.23	-0.25
Tetrachloroethylene	61	-0.24	-0.26	-0.28	-0.27	0.08	0.35	-0.32

MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 7-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein from Table 7-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- All of the seasonal averages of acrolein exceeded the intermediate MRL.
- Acrolein has no chronic MRL. Therefore, a chronic risk comparison could not be conducted.

7.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Colorado monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk from NATA and calculating cancer and noncancer surrogate risk estimates approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 7-8. Data from NATA are presented for the census tract where the monitoring site is located. GPCO is located in census tract ID 08077000800, for which the population was 5,845, and represented about five percent of the 2000 county population. The pollutants of interest for GPCO are bolded.

Observations for GPCO from Table 7-8 include the following:

- The pollutants with the highest concentrations according to NATA were formaldehyde, acetaldehyde, and benzene
- The pollutants with the highest cancer risks according to NATA were benzene, carbon tetrachloride, and 1,2-dibromoethane.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (1.04).

Table 7-7. MRL Risk Screening Assessment Summary for the Colorado Monitoring Site

Site	Method	Pollutant	ATSDR Acute MRL (µg/m³)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m³)	Winter Average (µg/m³)	Spring Average (µg/m³)	Summer Average (µg/m³)	Autumn Average (µg/m³)	ATSDR Chronic MRL (µg/m³)	Annual Average[1] (µg/m³)
GPCO	TO-15	Acrolein	7.00	0/61	0.09	**0.58 ± 0.24**	**0.59 ± 0.26**	**0.70 ± 0.11**	**0.71 ± 0.14**	--	0.64 ± 0.10

-- = an MRL risk factor is not available

BOLD = EPA-designated NATTS Site

BOLD = exceedance of the intermediate or chronic MRL

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 7-8. Cancer and Noncancer Risk Summary for the Monitoring Site in Colorado

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration (µg/m^3)	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Grand Junction, Colorado (GPCO) - Census Tract ID 08077000800								
Acetaldehyde	0.000002	0.009	0.57	1.27	0.06	2.79 ± 0.26	5.59	0.31
Acrolein	--	0.00002	0.02	--	1.04	0.64 ± 0.10	--	32.22
Acrylonitrile	0.000068	0.002	<0.01	0.15	<0.01	0.04 ± 0.01	2.43	0.02
Benzene	0.000007	0.03	0.56	4.38	0.01	1.46 ± 0.20	10.21	0.05
1,3-Butadiene	0.00003	0.002	0.04	1.25	0.02	0.16 ± 0.03	4.77	0.08
Carbon Tetrachloride	0.000015	0.04	0.21	3.18	0.01	0.53 ± 0.03	7.94	0.01
1,2-Dibromoethane	0.00022	0.0008	0.01	2.92	0.01	0.05 ± <0.01	11.30	0.06
p-Dichlorobenzene	0.000011	0.8	0.01	0.13	<0.01	0.07 ± 0.01	0.74	<0.01
1,2-Dichloroethane	0.000026	2.4	0.02	0.63	<0.01	0.04 ± <0.01	1.11	<0.01
Formaldehyde	5.5E-09	0.0098	0.73	<0.01	0.07	4.02 ± 0.33	0.02	0.41
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.19 ± <0.01	4.26	<0.01
Hexavalent Chromium	0.012	0.0001	<0.01	0.03	<0.01	<0.01 ± <0.01	0.19	<0.01
Tetrachloroethylene	0.000005	0.27	0.07	0.42	<0.01	0.32 ± 0.06	1.58	<0.01

-- = a URE or RfC is not available

Bold = pollutant of interest

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

- The pollutants with the highest annual averages were formaldehyde, acetaldehyde, and benzene, which were all an order of magnitude higher than the NATA-modeled concentrations.

- The pollutants with the highest cancer risk approximations were 1,2-dibromoethane, benzene, and carbon tetrachloride. 1,2-Dibromoethane was detected once at GPCO.

- Similar to the NATA results, acrolein was the only pollutant with a noncancer risk approximation greater than 1.0. However, the noncancer risk approximation (32.22) was an order of magnitude higher than NATA.

7.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 7-9 and 7-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 7-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 7-10 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on the site’s annual averages are limited to those pollutants for which the monitoring site sampled. As discussed in Section 7.3, GPCO sampled for VOC, carbonyl compounds, and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 7-9 include the following:

- Benzene, formaldehyde, and dichloromethane were the highest emitted pollutants with cancer UREs in Mesa County.

Table 7-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Colorado

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Grand Junction, Colorado (GPCO) – Mesa County					
Benzene	155.92	Benzene	1.22E-03	1,2-Dibromoethane	11.30
Formaldehyde	59.09	1,3-Butadiene	4.58E-04	Benzene	10.21
Dichloromethane	20.67	Arsenic, PM	2.01E-04	Carbon Tetrachloride	7.94
Acetaldehyde	19.25	Hexavalent Chromium	1.62E-04	Acetaldehyde	5.59
1,3-Butadiene	15.26	POM, Group 2	1.62E-04	1,3-Butadiene	4.77
Naphthalene	3.80	Naphthalene	1.29E-04	Hexachloro-1,3-butadiene	4.26
POM, Group 2	2.95	Acrylonitrile	5.94E-05	Acrylonitrile	2.43
Tetrachloroethylene	2.91	Acetaldehyde	4.23E-05	Tetrachloroethylene	1.58
Trichloroethylene	1.49	1,1,2,2-Tetrachloroethane	2.81E-05	1,2-Dichloroethane	1.11
Vinyl chloride	1.19	POM, Group 5	2.44E-05	*p*-Dichlorobenzene	0.74

Table 7-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Colorado

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Grand Junction, Colorado (GPCO) – Mesa County					
Toluene	390.17	Acrolein	14,2376.52	Acrolein	32.22
Xylenes	233.73	1,3-Butadiene	7,630.08	Formaldehyde	0.41
Benzene	155.92	Manganese, PM	6,088.13	Acetaldehyde	0.31
Hexane	60.09	Formaldehyde	6,029.49	1,3-Butadiene	0.08
Formaldehyde	59.09	Benzene	5,197.47	1,2-Dibromoethane	0.06
Methanol	55.34	Xylenes	2,337.29	Benzene	0.05
Ethylbenzene	53.93	Acetaldehyde	2,138.62	Acrylonitrile	0.02
Hydrogen fluoride	36.34	Arsenic, PM	1,560.78	Carbon Tetrachloride	0.01
Dichloromethane	20.67	Cyanide Compounds, gas	1,466.67	Hexachloro-1,3-butadiene	<0.01
Acetaldehyde	19.25	Naphthalene	1,265.16	Tetrachloroethylene	<0.01

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, 1,3-butadiene, and arsenic.

- Five of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- 1,2-Dibromoethane was the pollutant with the highest cancer surrogate risk approximation, yet appeared on neither emissions-based list. However, the low detection rate indicates that this pollutant is rarely detected in ambient air near GPCO.

- Benzene, which ranked highest on both emissions-based lists, had the second highest cancer surrogate risk approximation.

Observations from Table 7-10 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Mesa County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and manganese.

- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Acrolein, which had the highest noncancer risk approximation, also had the highest toxicity-weighted emissions.

7.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *The pollutants of interest for GPCO were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and tetrachloroethylene.*

- ❖ *Formaldehyde had the highest daily average concentration for GPCO.*

- ❖ *All four seasonal averages of acrolein exceeded the intermediate MRL health benchmark.*

8.0 Site in Washington, D.C.

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Washington, D.C., and integrates these concentrations with emissions, meteorological, and risk information.

8.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The WADC site is located in the Washington-Arlington-Alexandria, DC-VA-MD-WV MSA. Figure 8-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its urban location. Figure 8-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 8-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use**,** location setting, and locational coordinates.

Figure 8-1 shows that the WADC monitoring site is located in an open field at the southeast of end of the McMillian Water Reservoir in Washington, D.C. It is also located near several heavily traveled roadways. The site is located in a commercial area, and is surrounded by a hospital, a cemetery, and a university. As Figure 8-2 shows, WADC is surrounded by a handful of point sources, with very few actually residing in the District itself. Several of these emission sources have processes utilizing fuel combustion or utility boilers, although an electric, gas, and sanitary service facility resides fairly close to the WADC monitoring site.

Table 8-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Washington, D.C. monitoring site. District-level vehicle registration and population data were obtained from the Federal Highway Administration and the U.S. Census Bureau. Table 8-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of the site is presented. An estimate of 10-mile vehicle registration

Figure 8-1. Washington, D.C. (WADC) Monitoring Site

Scale: 3cm = 200m

Figure 8-2. NEI Point Sources Located Within 10 Miles of WADC

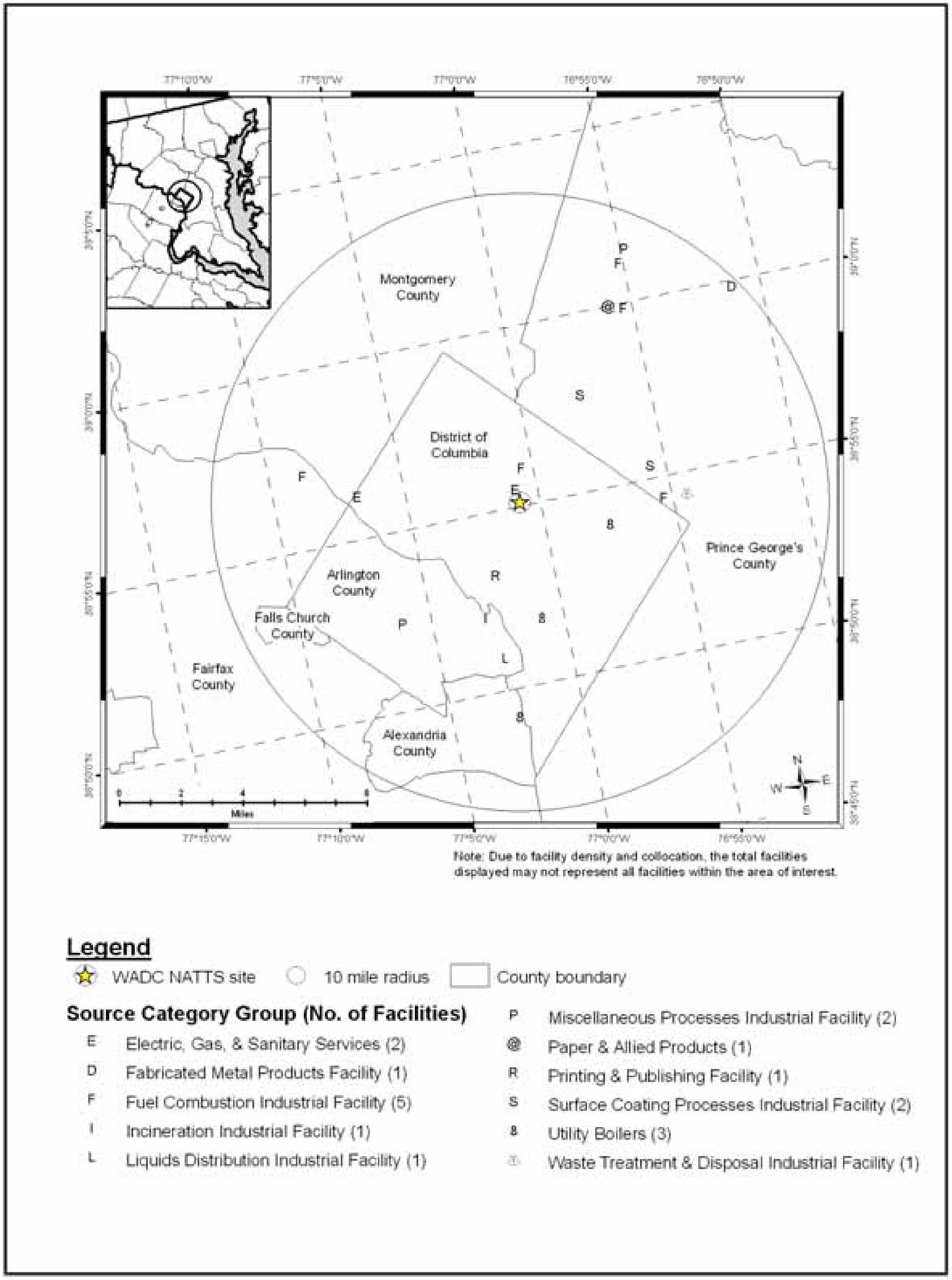


Table 8-1. Geographical Information for the Washington, D.C. Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
WADC	11-001-0043	Washington D.C.	District Of Columbia	Washington-Arlington-Alexandria, DC-VA-MD-WV	38.921847, 77.013178	Commercial	Urban/City Center	WADC is located in an open field at the southeast of end of the McMillian Water Reservoir in Washington, D.C. It is also located near several heavily traveled roadways. The site is surrounded by a hospital, a cemetery, and a university. WADC is a PAMS site.

BOLD = EPA-designated NATTS Site

Table 8-2. Population, Motor Vehicle, and Traffic Information for the Washington, D.C. Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
WADC	588,292	230,000	0.37	1,860,974	693,106	36,800	97,009

[1] Daily Average Traffic Data reflects 2002 data from District DOT

BOLD = EPA-designated NATTS Site

was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 8-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 8-2 presents the daily VMT for the urban area.

Observations from Table 8-2 include the following:

- Washington, D.C.'s population ranked 20th compared to all counties with NATTS or UATMP sites. However, its 10-mile population ranked sixth.
- The District-level vehicle registration ranked 25th compared to all counties with NATTS or UATMP sites, while its 10-mile ownership estimated ranked 16th.
- The vehicle per person ratio was the third lowest compared to other NATTS or UATMP sites.
- The traffic volume experienced near WADC ranked mid-range compared to other monitoring sites. The traffic estimate used came from the intersection of Michigan Avenue and North Capital Street.
- The District area VMT ranked ninth among urban areas with UATMP or NATTS sites.

8.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Washington, D.C. on sampling days, as well as over the course of the year.

8.2.1 Climate Summary

Located on the Potomac River that divides Virginia and Maryland, the capital enjoys all four seasons, although its weather is somewhat variable. Summers are warm and often humid, as southerly winds prevail, which can be accentuated by the urban heat island effect. Winters are typical of the Mid-Atlantic region, where cool, blustery air masses are common followed by a fairly quick return to mild temperatures. Precipitation is evenly distributed across the seasons (Ruffner and Bair, 1987).

8.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at Ronald Reagan Washington National Airport (WBAN 13743).

Table 8-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 8-3 is the 95 percent confidence interval for each parameter. As shown in Table 8-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

8.2.3 Composite Back Trajectories for Sampling Days

Figure 8-3 is a composite back trajectory map for the Washington, D.C. monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 8-3 represents 100 miles.

Observations from Figure 8-3 include the following:

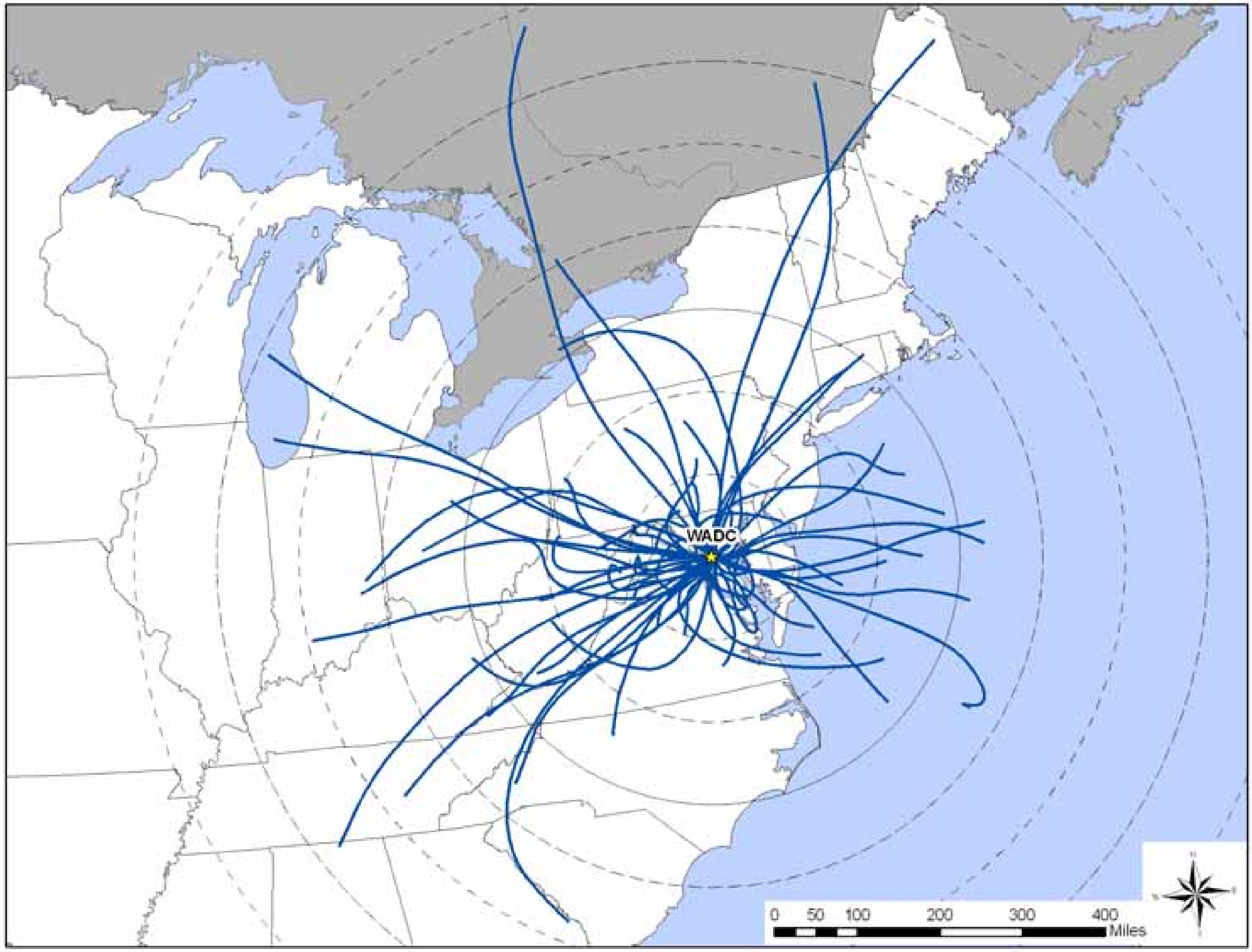
- Back trajectories originated from a variety of directions at WADC. However, there was a lack of trajectories originating from the south.

Table 8-3. Average Meteorological Conditions near the Washington, D.C. Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
WADC	Ronald Reagan Washington National Airport 13743	Sampling Day	66.56 ± 4.71	58.62 ± 4.37	44.72 ± 4.63	51.68 ± 3.99	62.89 ± 3.15	1018.44 ± 1.60	6.89 ± 0.72
		All 2007	66.99 ± 1.96	58.87 ± 1.80	44.11 ± 1.91	51.55 ± 1.63	61.25 ± 1.43	1018.10 ± 0.69	7.26 ± 0.29

BOLD = EPA-designated NATTS Site

Figure 8-3. Composite Back Trajectory Map for WADC

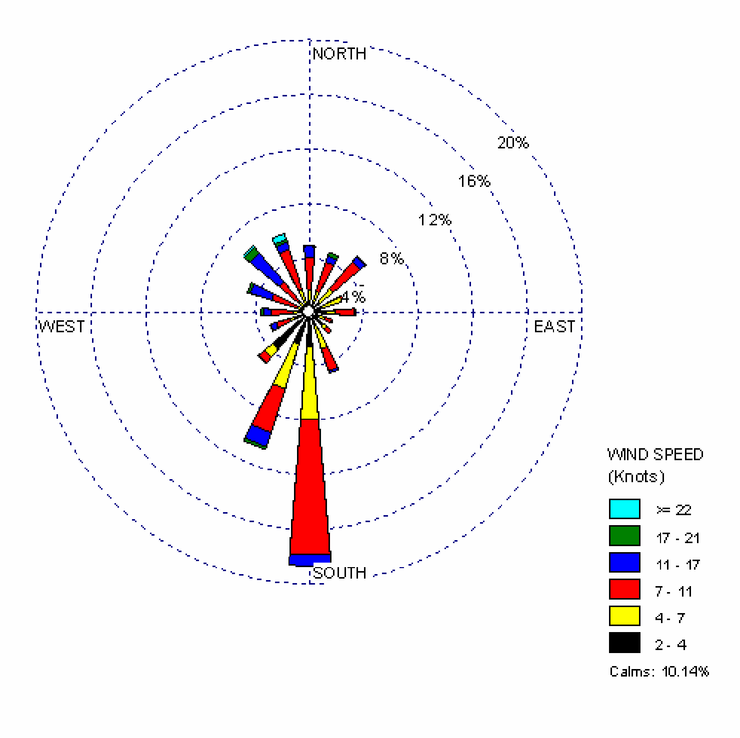


- The 24-hour air shed domain for WADC was similar in size to other monitoring sites. The furthest away a trajectory originated was northern Maine, or nearly 700 miles away. However, most trajectories originated within 400 miles of the site.

8.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at Ronald Reagan Washington National Airport near WADC were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 8-4 is the wind rose for the Washington, D.C. monitoring site on days that samples were collected.

Figure 8-4. Wind Rose for WADC Sampling Days



Observations from Figure 8-4 for WADC include the following:

- Southerly winds were prevalent (19 percent of wind observations), followed by southwesterly winds (11 percent).

- Calm winds were observed for approximately 10 percent of the hourly measurements.

- Winds exceeding 11 knots made up 13 percent of observations. The strongest winds originated from the northwest.

8.3 Pollutants of Interest

"Pollutants of interest" were determined for the monitoring site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Washington, D.C. monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 8-4 presents the results of the risk screening process and highlights the site's pollutants of interest (shaded).

Table 8-4. Comparison of Measured Concentrations and EPA Screening Values for the Washington, D.C. Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Washington, D.C. - WADC					
Hexavalent Chromium	0	33	0.00	0.00	0.00
Total	0	33	0.00		

Observations from Table 8-4 include the following:

- WADC sampled for hexavalent chromium only.
- Hexavalent chromium was detected in 33 samples and did not fail any screens.
- In order to facilitate analysis, hexavalent chromium is considered WADC's pollutant of interest.

8.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Washington, D.C. monitoring site. The averages presented are provided for the pollutants of interest for the monitoring site. Complete site-specific statistical summaries are provided in

Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

8.4.1 2007 Concentration Averages

Daily, seasonal, and annual averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November, and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 8-5, where applicable. The averages presented in Table 8-5 are shown in ng/m^3 for ease of viewing.

Table 8-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Washington, D.C. Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (ng/m^3)	Winter Average (ng/m^3)	Spring Average (ng/m^3)	Summer Average (ng/m^3)	Autumn Average (ng/m^3)	Annual Average[1] (ng/m^3)
Washington, D.C. - WADC								
Hexavalent Chromium	33	60	0.012 ± 0.003	NR	0.008 ± 0.003	0.010 ± 0.004	0.010 ± 0.004	0.008 ± 0.002

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for WADC from Table 8-5 include the following:

- The daily average concentration of hexavalent chromium was slightly higher than the annual average concentration(0.012 ± 0.003 ng/m^3 vs. 0.008 ± 0.002 ng/m^3), which illustrates the effect of the substitution of ½ MDL.
- Seasonal averages of hexavalent chromium were fairly similar to each other. A winter average could not be calculated due to the low number of detections.

8.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. WADC has not sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

8.5 Pearson Correlations

Table 8-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for WADC from Table 8-6 include the following:

- All of the correlations for WADC were weak.

8.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

8.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Washington, D.C monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or average concentrations of hexavalent chromium at the WADC monitoring site exceeded any of the MRL risk values.

Table 8-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Washington, D.C. Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Washington, D.C. - WADC								
Hexavalent Chromium	33	0.07	0.11	0.16	0.14	0.14	-0.19	-0.18

8.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 8-7. The data from NATA are presented for the census tract where the monitoring site is located. The census tract ID for WADC is 11001003400, for which the population was 2,707, and represented less than one percent of the District population in 2000. The pollutants of interest are bolded.

Observations for WADC from Table 8-7 include the following:

- The modeled concentration for hexavalent chromium from NATA was less than 0.01 µg/m^3, as was the annual average.
- Cancer and noncancer risks for hexavalent chromium according to NATA were low. This was also true of the cancer and noncancer surrogate risk approximations.

8.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 8-8 and 8-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 8-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million,) as calculated from the annual averages. Table 8-9 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Table 8-7. Cancer and Noncancer Risk Summary for the Monitoring Site in Washington, D.C.

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE ($\mu g/m^3$)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration ($\mu g/m^3$)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] ($\mu g/m^3$)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Washington, D.C. (WADC) - Census Tract ID 11001003400								
Hexavalent Chromium	0.012	0.0001	<0.01	0.34	<0.01	<0.01 ± <0.01	0.10	<0.01

Bold = pollutant of interest

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 8-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Washington, D.C.

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Washington, D.C. (WADC)					
Benzene	219.82	Benzene	1.71E-03	Hexavalent Chromium	0.10
Formaldehyde	124.36	1,3-Butadiene	7.96E-04		
Acetaldehyde	43.67	Tetrachloroethylene	2.07E-04		
Tetrachloroethylene	35.16	Naphthalene	1.94E-04		
1,3-Butadiene	26.54	Hexavalent Chromium	1.58E-04		
Trichloroethylene	16.03	*p*-Dichlorobenzene	1.34E-04		
p-Dichlorobenzene	12.17	Arsenic, PM	1.12E-04		
Dichloromethane	8.85	Acetaldehyde	9.61E-05		
Naphthalene	5.70	POM, Group 2	7.87E-05		
POM, Group 2	1.43	Ethylene oxide	4.87E-05		

Table 8-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Washington, D.C.

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Washington, D.C. (WADC)					
Toluene	494.98	Acrolein	335,237.81	Hexavalent Chromium	<0.01
Methyl *tert*- butyl ether	437.77	1,3-Butadiene	13,271.78		
Xylenes	344.77	Formaldehyde	12,690.12		
Benzene	219.82	Chlorine	8,575.00		
Methanol	198.96	Benzene	7,327.25		
Formaldehyde	124.36	Cyanide Compounds, gas	7,313.33		
Ethylbenzene	75.64	Acetaldehyde	4,851.97		
Hexane	63.93	Xylenes	3,447.74		
1,1,1-Trichloroethane	60.44	Naphthalene	1,900.71		
Ethylene glycol	48.22	Toluene	1,237.45		

for which each respective site sampled. As discussed in Section 8.3, WADC sampled for hexavalent chromium only. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 8-8 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in the District of Columbia.
- Benzene was also the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by 1,3-butadiene and tetrachloroethylene.
- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- Hexavalent chromium, which was the only pollutant sampled for at WADC, had the fifth highest toxicity-weighted emissions for the District of Columbia. This pollutant did not appear on the list of highest emitted pollutants.

Observations from Table 8-9 include the following:

- Toluene, methyl *tert*-butyl ether, and xylenes were the highest emitted pollutants with noncancer RfCs in the District of Columbia.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and formaldehyde.
- Four of the highest emitted pollutants in the District of Columbia also had the highest toxicity-weighted emissions.
- Hexavalent chromium did not appear on the list of highest emitted pollutants or the list of highest toxicity-weighted emissions for pollutants with a noncancer toxicity factor.

8.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *Hexavalent chromium did not fail any screens for WADC. However, it was considered a pollutant of interest in order to allow data analyses to be conducted.*
- ❖ *Hexavalent chromium did not exceed any of the MRL health benchmarks.*

9.0 Sites in Florida

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP sites in Florida, and integrates these concentrations with emissions, meteorological, and risk information.

9.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. The Florida sites are located in several different urban areas. Sites located in the Tampa-St. Petersburg-Clearwater, FL MSA include AZFL, GAFL, SKFL, and SYFL. FLFL is located in the Miami-Fort Lauderdale-Pompano Beach, FL MSA. ORFL is located in the Orlando-Kissimmee, FL MSA. Figures 9-1 through 9-6 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban and rural locations. Figures 9-7 through 9-9 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 9-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

AZFL is located in Azalea Park, in St. Petersburg. Figure 9-1 shows that the area surrounding AZFL consists of mixed land use, including residential, commercial, and industrial properties. Heavily traveled roadways are located less than a mile from the monitoring site. AZFL is just over a mile east of Boca Ciega Bay.

GAFL is located near the east side of the Gandy Bridge on Highway 92 in Tampa. Figure 9-2 shows that GAFL is located on a small peninsula on old Tampa Bay. The setting is suburban and the surrounding area has mixed land use.

SKFL is located in Pinellas Park, north of St. Petersburg. This site is on the property of Skyview Elementary School near 86th Avenue North. Figure 9-3 shows that SKFL is located in a residential area. Population exposure is the purpose behind monitoring in this location.

Figure 9-1. St. Petersburg, Florida (AZFL) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 9-2. Tampa, Florida (GAFL) Monitoring Site

©2008 Google/©NAVTECH Scale: 3cm = 200m

Figure 9-3. Pinellas Park, Florida (SKFL) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 9-4. Plant City, Florida (SYFL) Monitoring Site

©2008 Google/©NAVTECH

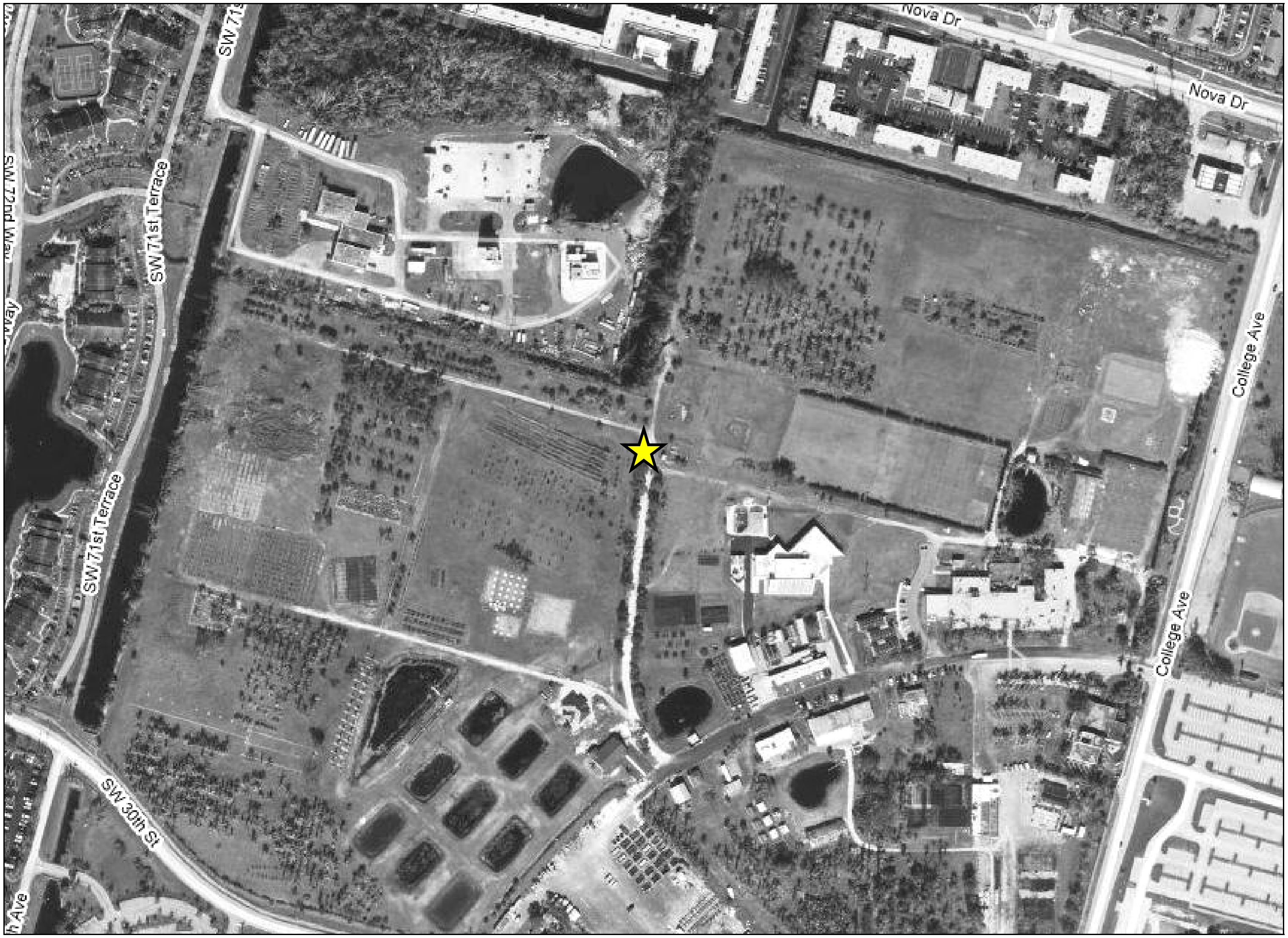
Scale: 3cm = 100m

Figure 9-5. Winter Park, Florida (ORFL) Monitoring Site

©2008 Google/©NAVTECH

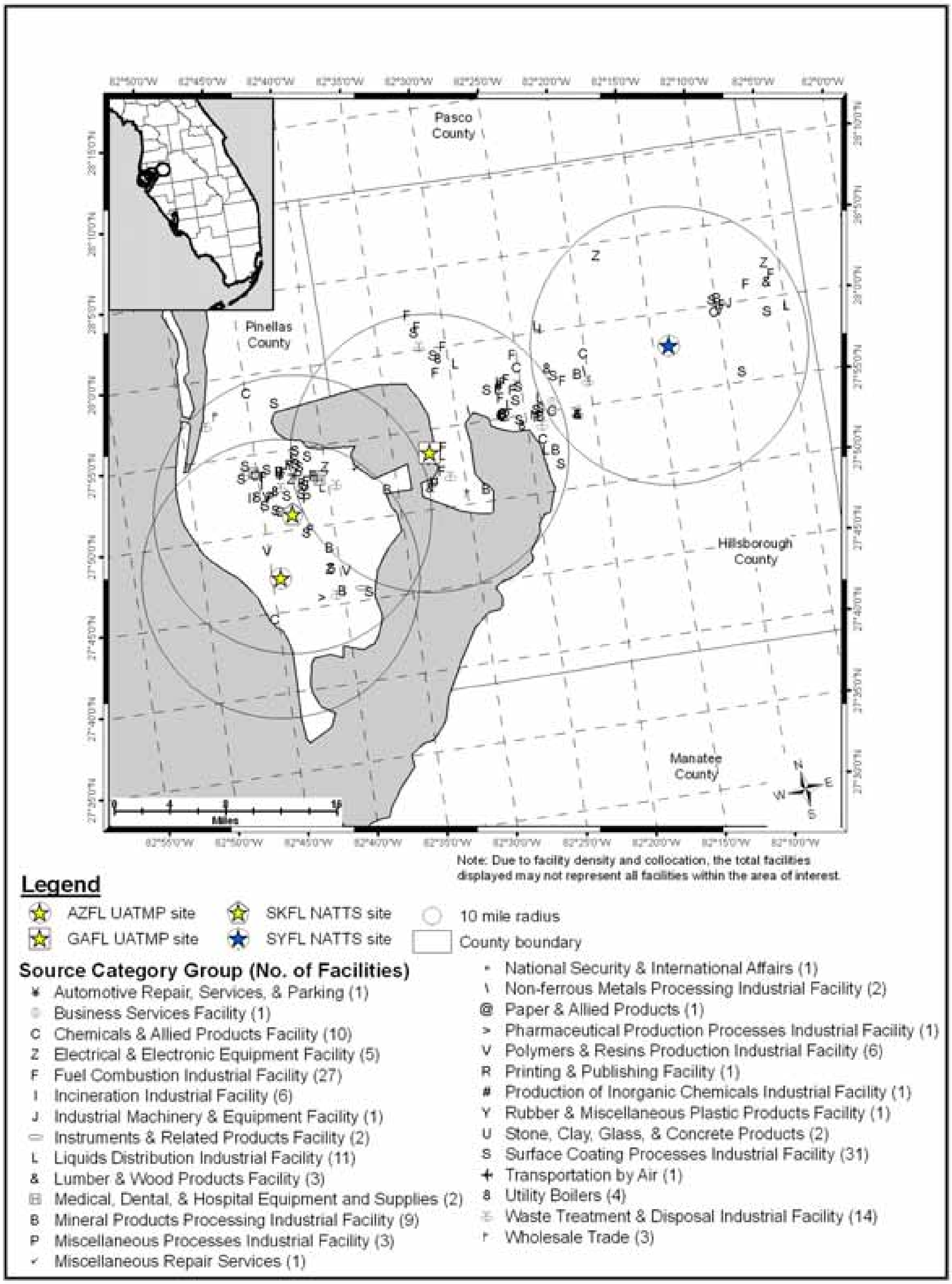
Scale: 3cm = 100m

Figure 9-6. Davie, Florida (FLFL) Monitoring Site



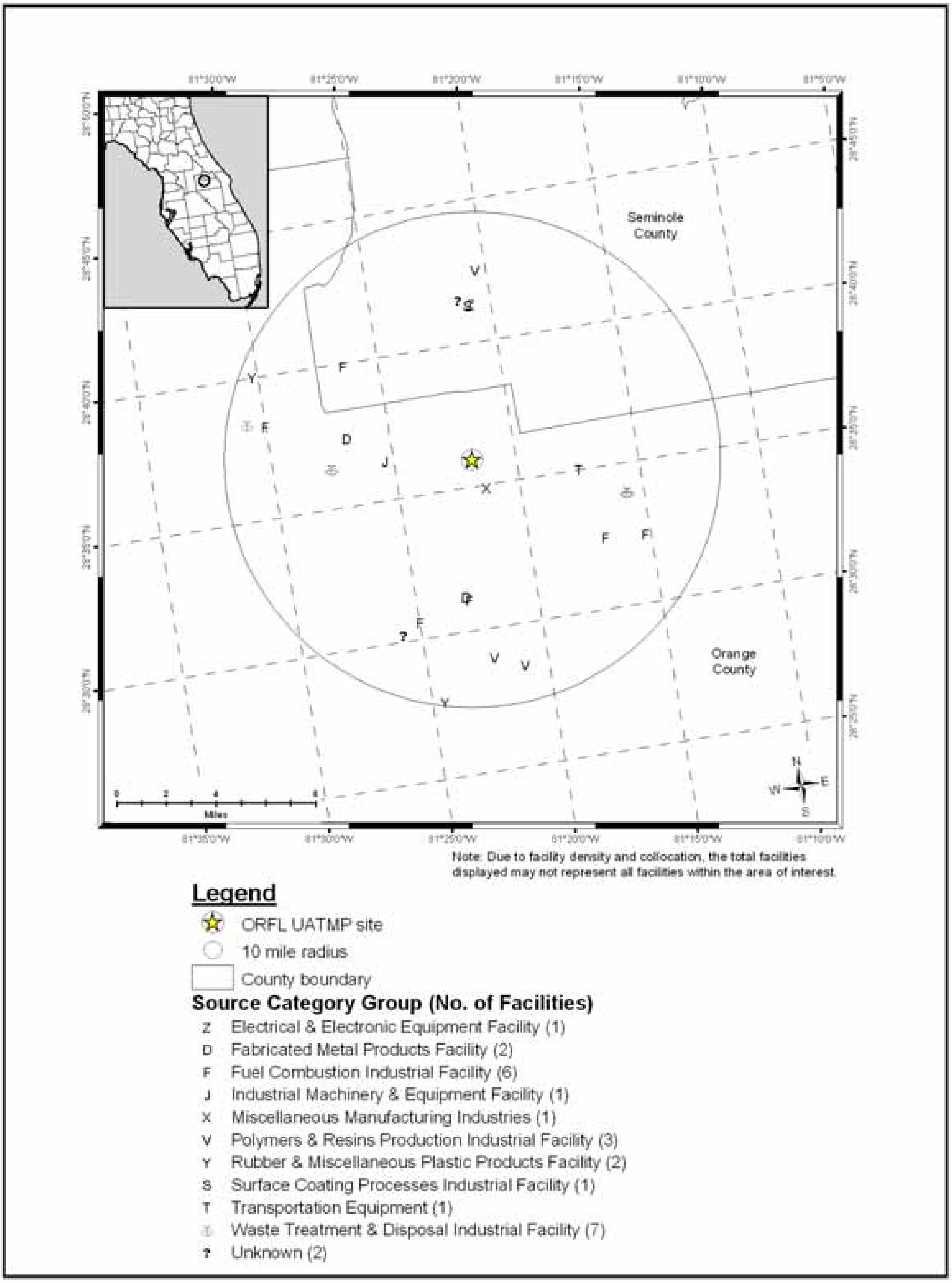
©2008 Google/©NAVTECH Scale: 3cm = 100m

Figure 9-7. NEI Point Sources Located Within 10 Miles of the Tampa/ St. Petersburg, Florida Monitoring Sites



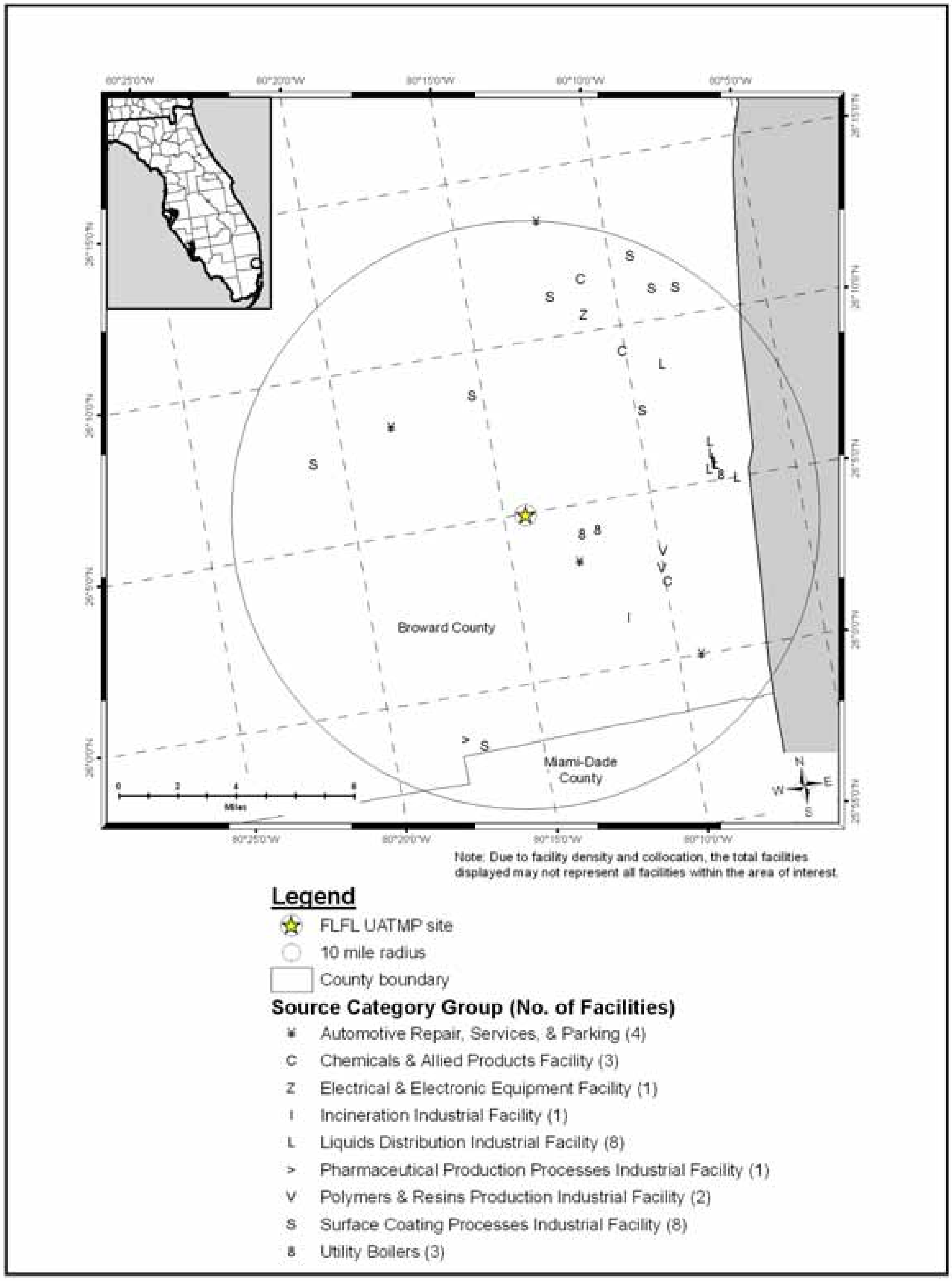
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 9-8. NEI Point Sources Located Within 10 Miles of ORFL



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 9-9. NEI Point Sources Located Within 10 Miles of FLFL



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 9-1. Geographical Information for the Florida Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
AZFL	12-103-0018	St. Petersburg	Pinellas	Tampa-St. Petersburg-Clearwater, FL	27.785556, -82.74	Residential	Suburban	A neighborhood spatial scale of representativeness characterizes this monitoring site selected for the Tampa Bay pilot project. This monitor is sited in an area of high population density with uniform mixed land use, consisting of residential, commercial, and industrial properties. Major point sources are located approximately 2 to 10 miles from the monitoring site. In addition, this site is at least 150 meters from major roadways. However, given the proximity of motor vehicle traffic it is expected that mobile sources will contribute appreciably to the measured samples.
FLFL	12-011-1002	Davie	Broward	Miami-Fort Lauderdale-Pompano Beach, FL	26.08534, -80.24104	Commercial	Suburban	The site is located on the campus of the University of Florida, Agricultural Research Center in Davie, Florida. It is located in a generally residential area that is surrounded by 4 major thoroughfares in the county (~1 mile from I-595, ~2 miles from the Florida Turnpike, ~6 miles from I-95, and ~6 miles from I-75). It is located ~ 6 miles from the Ft. Lauderdale-Hollywood International Airport and ~9 miles from Port Everglades. It is in an area generally representative of the ambient air conditions experienced throughout the county. It is expected that this site will become an NCore type II site in the near future.

BOLD = EPA-designated NATTS Site

Table 9-1. Geographical Information for the Florida Monitoring Sites (Continued)

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
GAFL	12-057-1065	Tampa	Hillsborough	Tampa-St. Petersburg-Clearwater, FL	27.892222, -82.538611	Commercial	Suburban	A neighborhood spatial scale of representativeness characterizes this monitoring site selected for the Tampa Bay Region Air Toxics Study Monitoring Stations (TBRATS) pilot project. This monitor is sited in an area of high population density with uniform mixed land use, consisting of residential, commercial, and industrial properties. Major point sources are located greater than one mile from the monitoring site. Since the emission points from these sources are elevated and not proximate to the monitor, concentrations measured during this study should not be dominated by a single source. In addition, this site is at least 150 meters from major roadways. However, given the proximity of motor vehicle traffic, mobile sources are expected to contribute appreciably to the measured samples.
ORFL	12-095-2002	Winter Park	Orange	Orlando-Kissimmee, FL	28.596444, -81.362444	Commercial	Urban/City Center	The site is an Urban/Neighborhood spatial scale site to determine the concentrations of the EPA Criteria pollutants (and now Air Toxics) to which the area population may be exposed. The primary emission source is motor vehicles, with many commercial businesses also in the area.
SKFL	12-103-0026	Pinellas Park	Pinellas	Tampa-St. Petersburg-Clearwater, FL	27.850041, -82.714590	Residential	Suburban	This air monitoring site is located in south central Pinellas County at Skyview Elementary School, 8601 60th St. N., Pinellas Park, Florida. This site is a NATTS and samples for all pollutants/parameters required by NATTS, including VOCs, carbonyls, metals, $PM_{2.5}$ speciation, and black carbon. In addition, measurements are made for wind speed, wind direction, ambient pressure, and ambient temperature. Site spatial scale is neighborhood. This is a population-oriented site.

BOLD = EPA-designated NATTS Site

Table 9-1. Geographical Information for the Florida Monitoring Sites (Continued)

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
SYFL	12-057-3002	Plant City	Hills-borough	Tampa-St. Petersburg-Clearwater, FL	27.96565, -82.2304	Residential	Rural	The site in Sydney is a NATTS neighborhood/rural site. Monitoring has been occurring at Sydney for 5 years as a background site. Current development in the area warranted it becoming a NATTS site. The Sydney site is also being used for an intercomparison of the port of Tampa as compared to a neighbor/rural site.

BOLD = EPA-designated NATTS Site

SYFL is located in Plant City, which is also part of the Tampa-St. Petersburg-Clearwater, FL MSA, although it is on the eastern outskirts of the area. Unlike the other program, the SYFL monitoring site is in a rural area although, as Figure 9-4 shows, a residential community lies to the west of the site. This site serves as a background site, although the impact of increased development in the area is likely being captured by the monitor.

Figure 9-7 shows the location of Tampa/St. Petersburg sites in relation to each other. SYFL is located the furthest east and AZFL is the furthest west. The majority of the point sources are located just north of SKFL. Another cluster of emission sources is located about halfway between SYFL and GAFL. There are also several emission sources just east of GAFL. Surface coating and processes involving fuel combustion are the most numerous source categories in the Tampa/St. Petersburg area (based on the areas covered by the 10-mile radii).

ORFL is located in Winter Park, north of Orlando. Figure 9-5 shows that ORFL is located near Lake Mendsen, east of Lake Killarney and south of Winter Park Village. This site lies in a commercial area and serves as a population exposure monitor. Several emission sources surround ORFL, as shown in Figure 9-8, most of which are involved in waste treatment and disposal or processes utilizing fuel combustion.

FLFL is located on Florida’s east coast in Davie, near Ft. Lauderdale. The site is located at the Agricultural Research Center on the University of Florida campus. Figure 9-6 shows that the surrounding area is suburban and commercial. The site is less than a mile south of I-595 and other major highways are also within a few miles. Nearby point sources are located mostly to the northeast and east of the monitoring site, as shown in Figure 9-9. A majority of the point sources are involved in liquids distribution or surface coating.

Table 9-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Florida monitoring sites. County-level vehicle registration and population data for Pinellas, Broward, Hillsborough, and Orange Counties were obtained from the Florida Department of Highway

Table 9-2. Population, Motor Vehicle, and Traffic Information for the Florida Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
AZFL	917,437	1,548,528	1.69	567,158	957,297	37,000	63,178
FLFL	1,759,591	1,541,754	0.88	1,327,088	1,162,795	14,000	132,934
GAFL	1,174,727	1,203,440	1.02	475,725	487,353	41,000	63,178
ORFL	1,066,113	1,048,589	0.98	1,008,282	991,709	35,500	42,448
SKFL	917,437	1,548,528	1.69	690,988	1,166,308	48,000	63,178
SYFL	1,174,727	1,203,440	1.02	281,664	288,549	30,500	63,178

[1] Daily Average Traffic Data reflects 2006 data from the Florida DOT

BOLD = EPA-designated NATTS Site

Safety and Motor Vehicles and the U.S. Census Bureau. Table 9-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 9-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 9-2 presents the daily VMT for each urban area.

Observations from Table 9-2 include the following:

- Broward County, where FLFL is located, is the most populous of the Florida counties with monitoring sites, although Hillsborough and Orange Counties both have over a million people. Broward County is the eighth most populous county of all the NATTS and UATMP counties covered in this report.

- The FLFL and ORFL monitoring sites have the highest population within 10 miles of all the Florida sites.

- Vehicle registration counts for the Florida sites are all over one million, with Pinellas County having the most. The 10-mile ownership estimates are more variable.

- The vehicles per person ratios ranged from 0.88 (FLFL) to 1.69 (AZFL and SKFL).

- VMT was highest for the Miami/Ft. Lauderdale urban area and lowest for the Orlando urban area. The Miami/Ft. Lauderdale VMT ranked fourth highest among urban areas with NATTS and UATMP monitoring sites.

- Traffic volumes near the Florida monitoring sites were mid-range among NATTS and UATMP monitoring sites. The following list provides the roadways or intersections from which the traffic data was obtained:
  - AZFL – Tyrone Boulevard, west of 66th Street North
  - FLFL – College Avenue, south of Nova Drive
  - GAFL – Gandy Boulevard, east of Westshore Boulevard
  - ORFL – intersection of Lee Road and Orlando Avenue
  - SKFL – Park Boulevard, east of 66th Street North
  - SYFL - East of Dover Road

9.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Florida on sampling days, as well as over the course of the year.

9.2.1 Climate Summary

Florida=s climate is subtropical, with very mild winters and warm, humid summers. The annual average maximum temperature is around 80EF for all locations and average relative humidity is near 70 percent. Although land and sea breezes affect each of the locations, wind generally blows from an easterly direction due to high pressure offshore (Ruffner and Bair, 1987).

9.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The weather station closest to the AZFL monitoring site is located at St. Petersburg/Whitted Airport (WBAN 92806); closest to GAFL is at Tampa International Airport (WBAN 12842); closest to SKFL is at St. Petersburg/Clearwater International Airport (WBAN 12873); closest to SYFL is at Winter Haven=s Gilbert Airport (WBAN 12876); closest to ORFL is at Orlando Executive Airport (WBAN 12841); and closest to FLFL is at Ft. Lauderdale/Hollywood International Airport (WBAN 12849).

Table 9-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 9-3 is the 95 percent confidence interval for each parameter. As shown in Table 9-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year, with the exception of FLFL. Temperatures and humidity appear much lower during sample days for this site. FLFL stopped sampling in March 2007, thereby capturing only the coolest months of the year.

9.2.3 Composite Back Trajectories for Sampling Days

Figures 9-10 through 9-15 are composite back trajectory maps for the Florida monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 9-10 through 9-15 represents 100 miles.

Observations from Figures 9-10 through 9-13 for the Tampa/St. Petersburg sites include the following:

- The composite back trajectory maps for the Tampa/St. Petersburg sites are very similar to each other.
- Back trajectories originated from a variety of directions at the Tampa/St. Petersburg sites. However, the bulk of the trajectories originated from the east.
- The 24-hour air shed domain was comparable in size to other monitoring sites. The furthest away a trajectory originated was over the Atlantic Ocean, or just over 600 miles away.
- Most trajectories originated within 400 miles of the Tampa/St. Petersburg monitoring sites.

Observations from Figure 9-14 for ORFL include the following:

- The composite back trajectory map for ORFL is fairly similar to the Tampa/St. Petersburg sites.

Table 9-3. Average Meteorological Conditions near the Florida Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
AZFL	St. Petersburg/ Whitted Airport 92806	Sampling Day	81.07 ± 2.30	71.43 ± 2.23	63.84 ± 2.57	67.81 ± 2.19	70.92 ± 2.16	1017.28 ± 1.10	7.48 ± 0.72
		All 2007	80.75 ± 0.88	74.12 ± 0.88	63.61 ± 1.00	67.59 ± 0.86	71.15 ± 0.93	1017.01 ± 0.41	7.86 ± 0.31
FLFL	Ft Lauderdale/ Hollywood Intl Airport 12849	Sampling Day	75.82 ± 2.90	69.56 ± 4.05	54.61 ± 5.56	61.08 ± 4.26	60.81 ± 6.16	1020.52 ± 2.20	9.11 ± 1.93
		All 2007	83.70 ± 0.58	77.98 ± 0.63	64.63 ± 0.83	69.51 ± 0.66	64.82 ± 0.81	1016.52 ± 0.37	8.53 ± 0.33
GAFL	Tampa/ International 12842	Sampling Day	83.02 ± 2.19	74.38 ± 2.24	62.17 ± 2.83	66.93 ± 2.30	67.91 ± 2.41	1017.92 ± 1.03	5.55 ± 0.39
		All 2007	82.29 ± 0.88	73.78 ± 0.92	61.85 ± 1.13	66.52 ± 0.92	68.50 ± 1.03	1017.52 ± 0.41	5.74 ± 0.20
ORFL	Orlando Executive Airport 12841	Sampling Day	82.62 ± 2.46	73.44 ± 2.36	60.90 ± 2.80	65.83 ± 2.31	67.24 ± 2.27	1018.56 ± 1.15	5.76 ± 0.50
		All 2007	82.47 ± 0.92	73.18 ± 0.89	60.59 ± 1.12	65.62 ± 0.90	67.18 ± 1.01	1018.30 ± 0.43	6.17 ± 0.25
SKFL	St Petersburg-Clearwater Intl Airport 12873	Sampling Day	82.79 ± 2.21	74.78 ± 2.19	63.87 ± 2.80	68.06 ± 2.28	70.67 ± 2.49	1017.61 ± 1.10	6.84 ± 0.64
		All 2007	82.36 ± 0.87	74.29 ± 0.88	63.54 ± 1.11	67.69 ± 0.91	71.03 ± 1.05	1017.48 ± 0.41	6.92 ± 0.27
SYFL	Winter Haven's Gilbert Airport 12876	Sampling Day	83.95 ± 2.39	73.38 ± 2.26	62.17 ± 2.58	66.49 ± 2.19	70.93 ± 2.04	1018.08 ± 1.06	6.23 ± 0.52
		All 2007	82.88 ± 0.95	72.58 ± 0.91	61.72 ± 1.09	65.98 ± 0.91	71.63 ± 0.94	1017.85 ± 0.41	6.43 ± 0.25

BOLD = EPA-designated NATTS Site

Figure 9-10. Composite Back Trajectory Map for AZFL

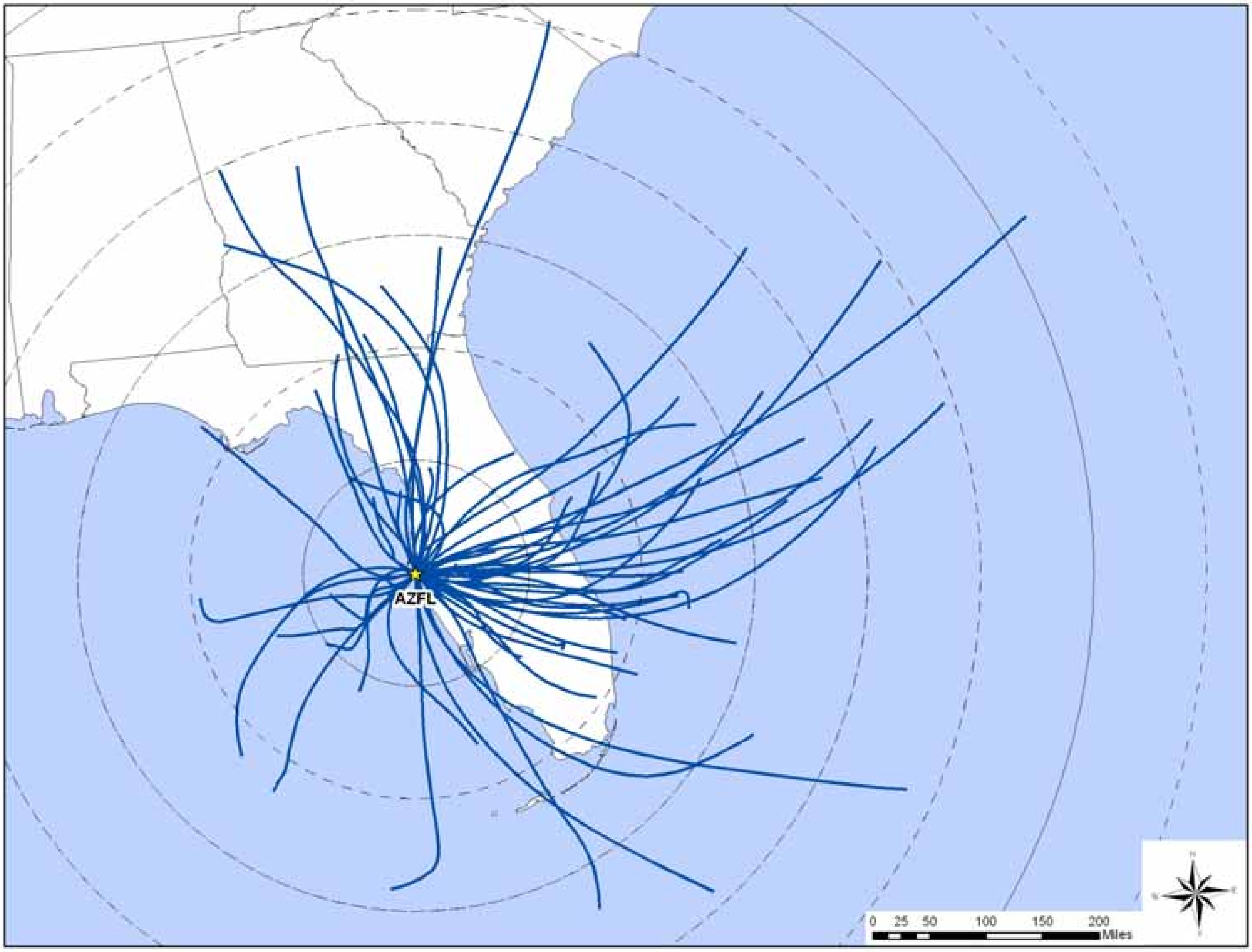


Figure 9-11. Composite Back Trajectory Map for GAFL

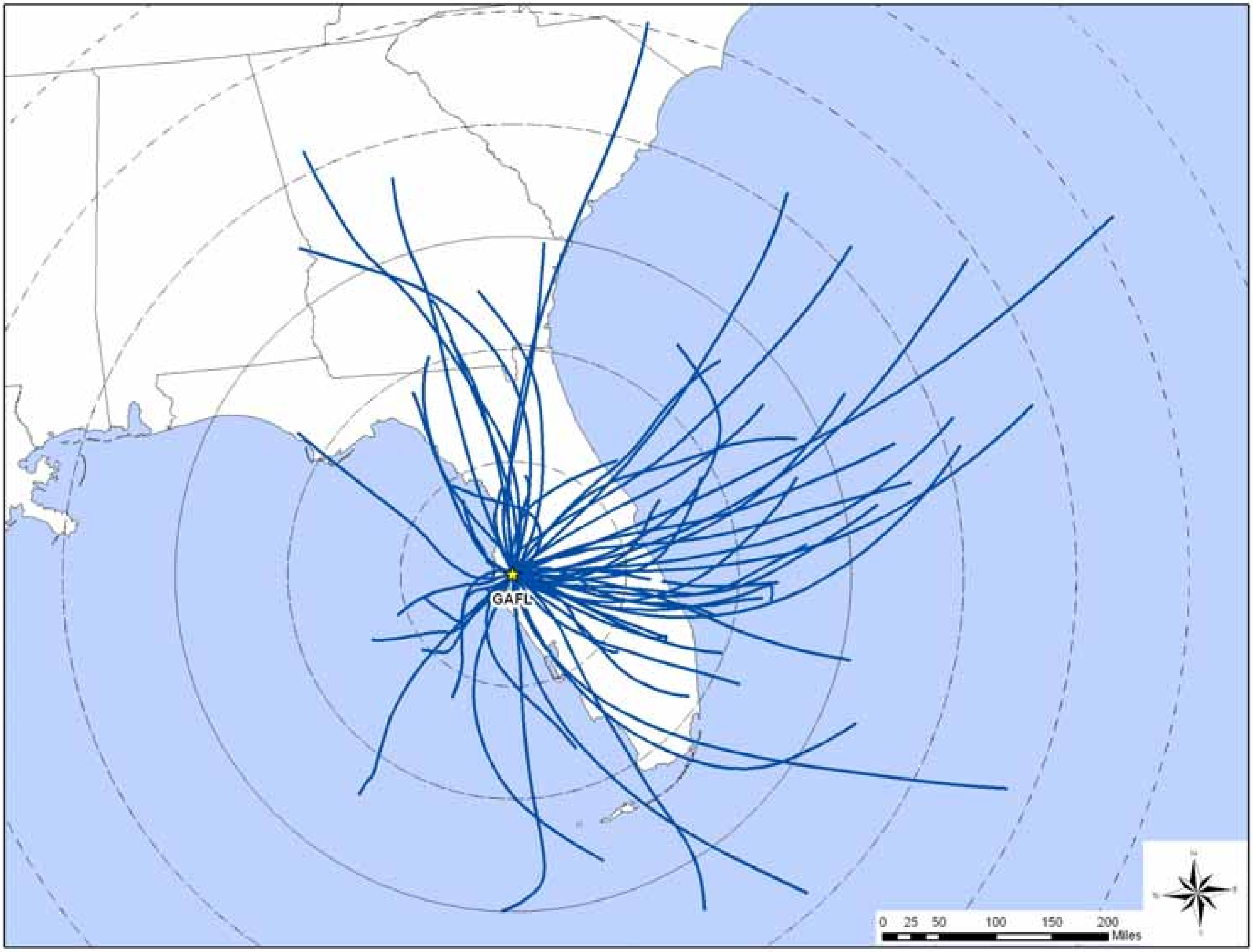


Figure 9-12. Composite Back Trajectory Map for SKFL

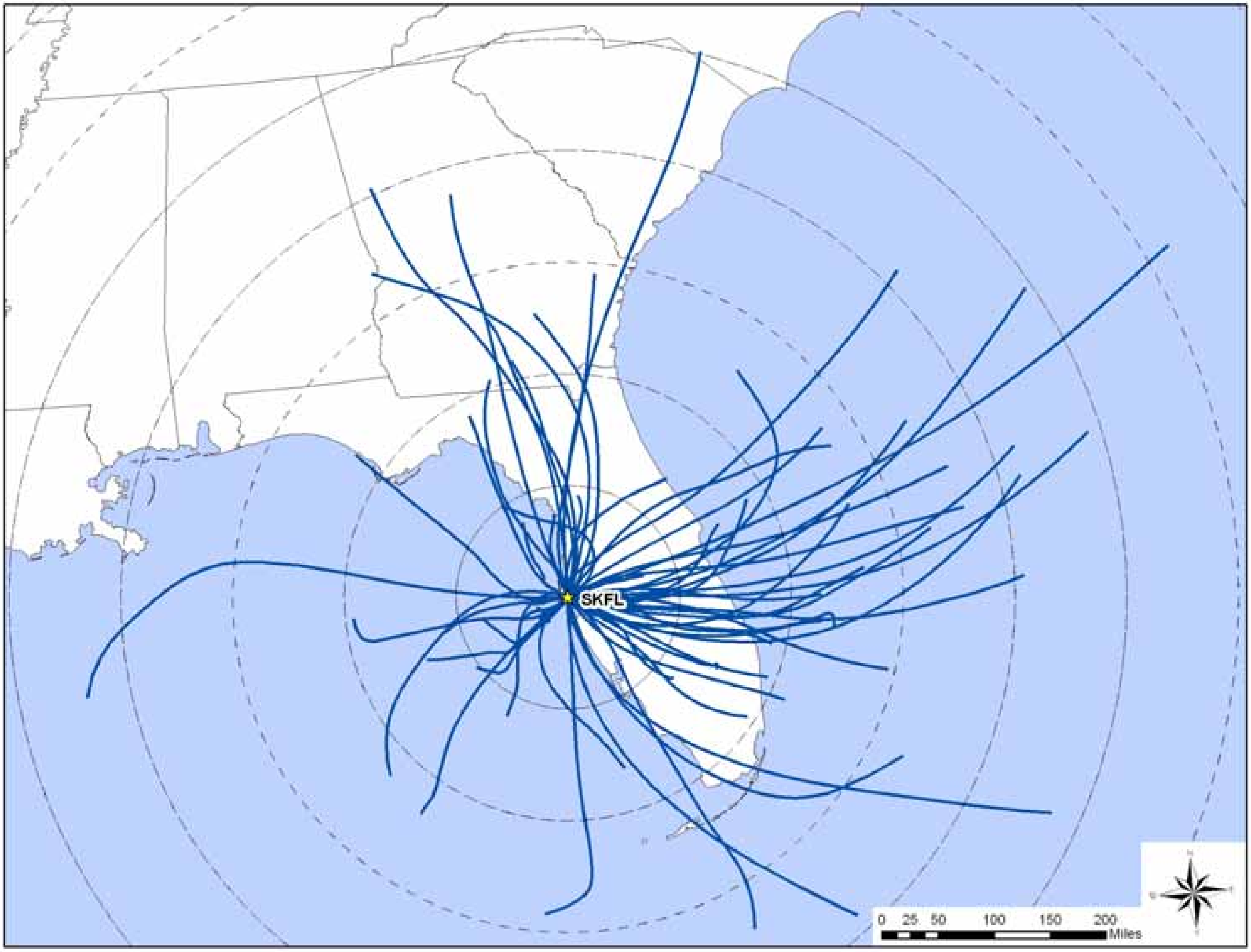


Figure 9-13. Composite Back Trajectory Map for SYFL

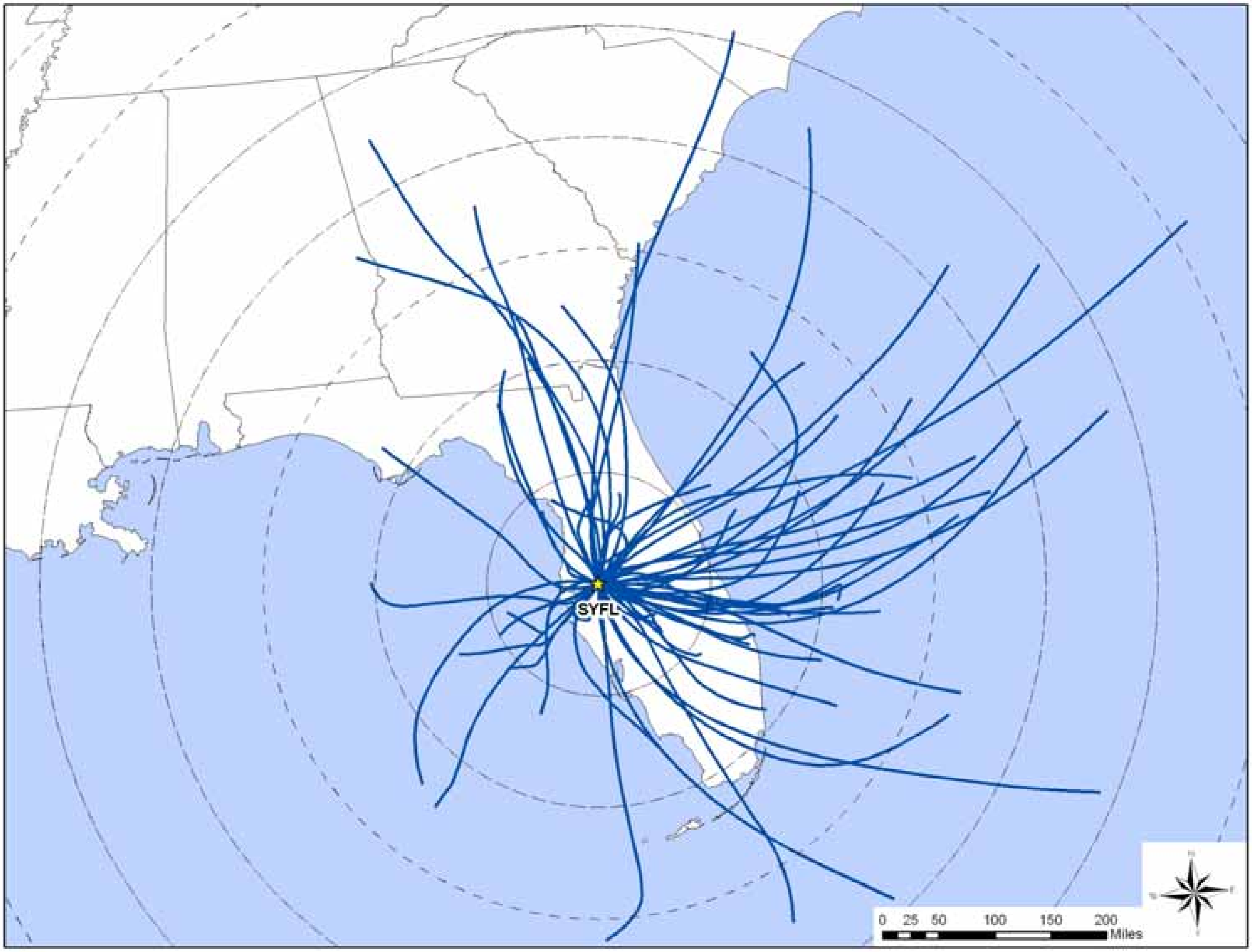


Figure 9-14. Composite Back Trajectory Map for ORFL

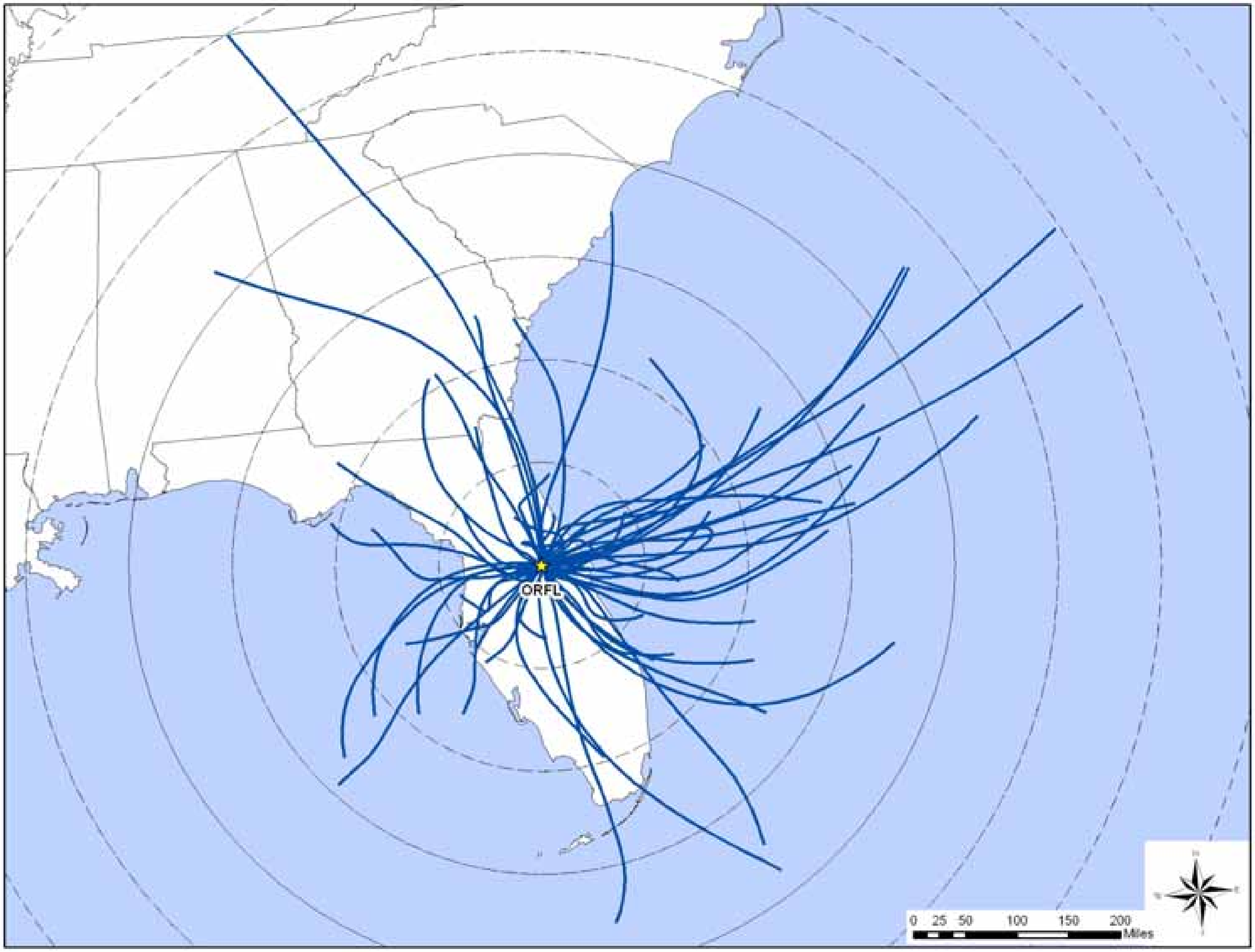
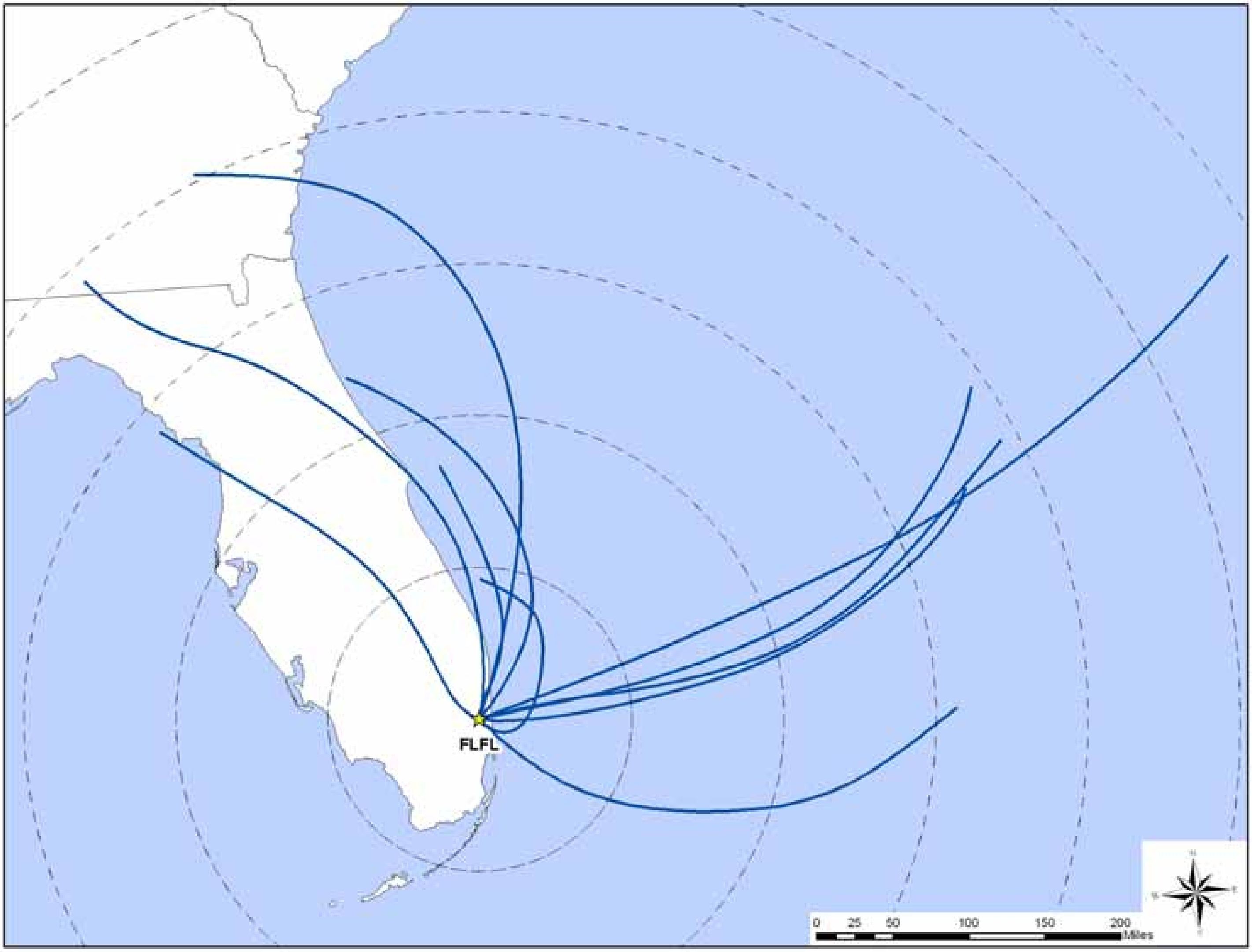


Figure 9-15. Composite Back Trajectory Map for FLFL



- Back trajectories originated from a variety of directions at ORFL. However, the bulk of the trajectories originate from the east.

- The 24-hour air shed domain was comparable in size to the other Florida monitoring sites. The furthest away a trajectory originated was north-central Tennessee, or nearly 600 miles away.

- Similar to the Tampa/St. Petersburg sites, most trajectories originated with 400 miles of ORFL.

Observations from Figure 9-15 for FLFL include the following:

- Sampling was conducted at FLFL for the first quarter of the calendar year only. As a result, fewer trajectories are shown in Figure 9-15.

- Back trajectories primarily originated from the east and north-northeast.

- The 24-hour air shed domain appears slightly smaller for FLFL than for the other Florida monitoring sites. The furthest away a trajectory originated was over the Atlantic, or less than 600 miles away.

9.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations near the Florida sites, as presented in Section 9.2.2, were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 9-16 through 9-21 are the wind roses for the Florida monitoring sites on days that samples were collected.

Observations from Figure 9-16 for AZFL include the following:

- Easterly, northeasterly, and northerly winds were prevalent near AZFL.

- Calm winds were observed infrequently near AZFL (less than eight percent).

- Winds exceeding 11 knots made up less than 17 percent of observations. Stronger wind speeds were observed with easterly and northeasterly winds.

Observations from Figure 9-17 for FLFL include the following:

- Easterly winds prevailed near FLFL (nearly 27 percent of observations).

Figure 9-16. Wind Rose for AZFL Sampling Days

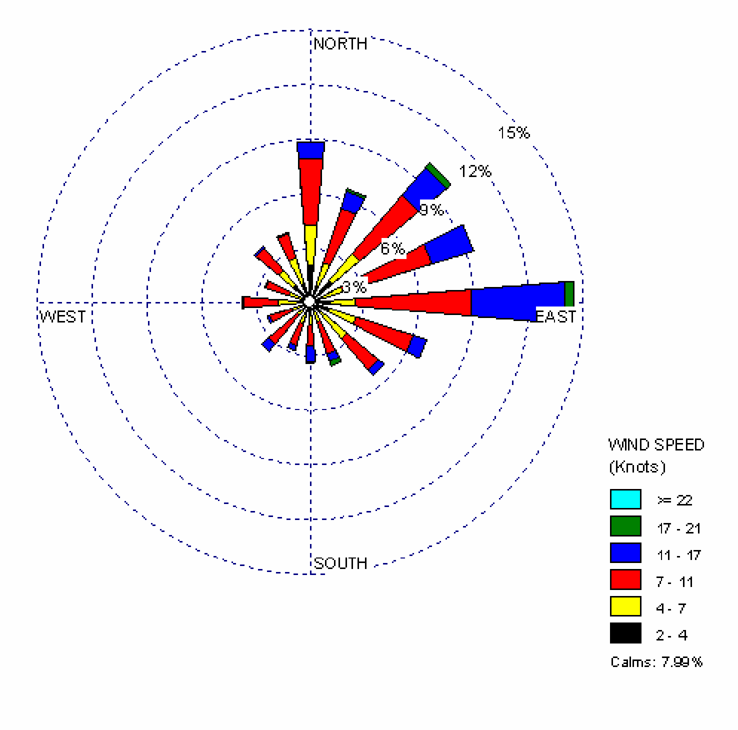


Figure 9-17. Wind Rose for FLFL Sampling Days

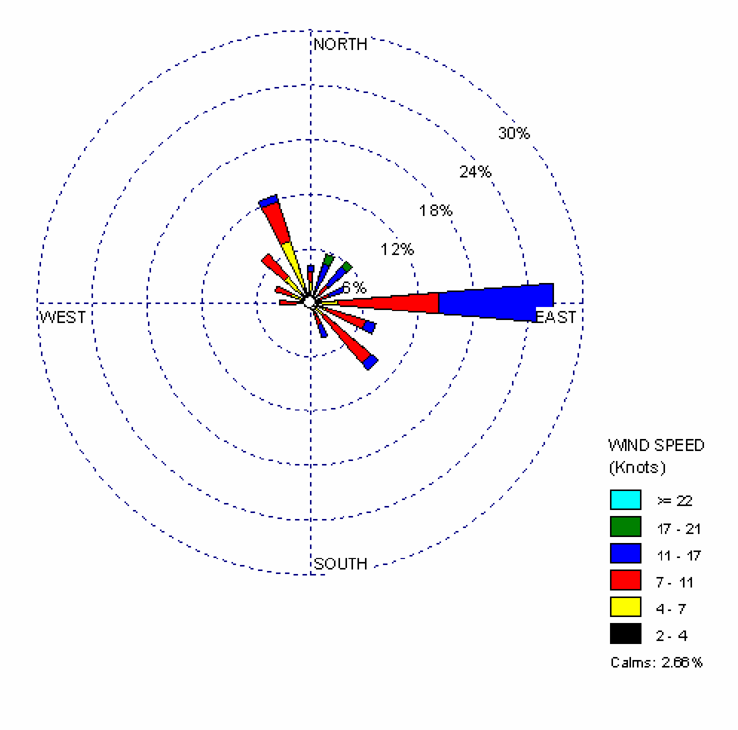


Figure 9-18. Wind Rose for GAFL Sampling Days

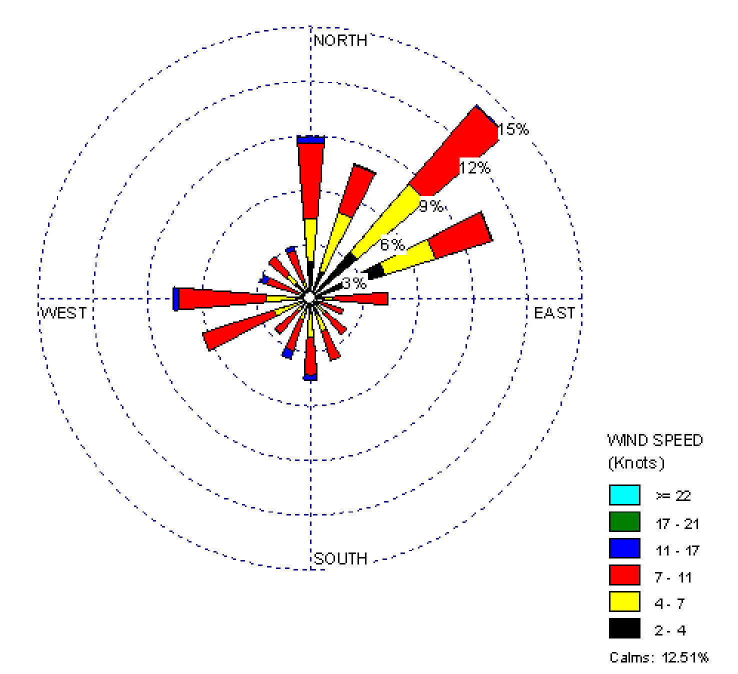


Figure 9-19. Wind Rose for ORFL Sampling Days

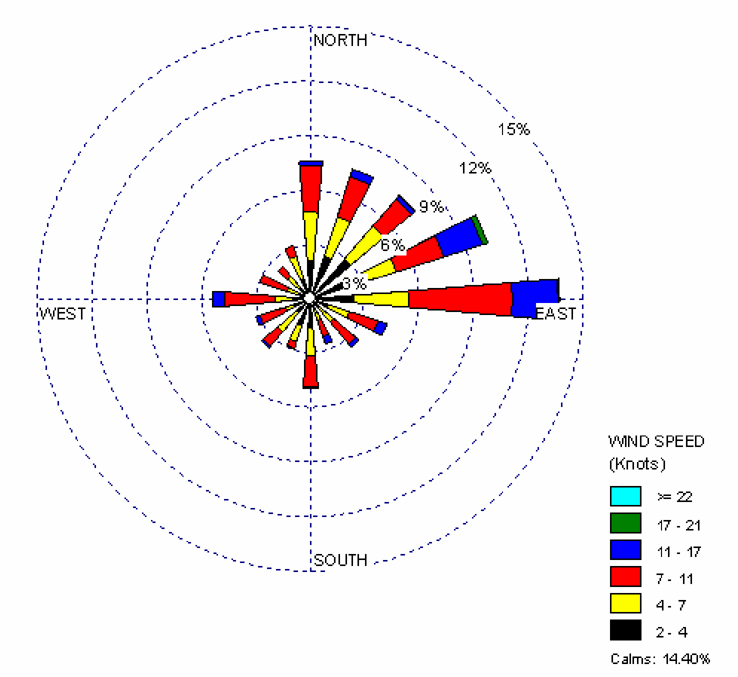


Figure 9-20. Wind Rose for SKFL Sampling Days

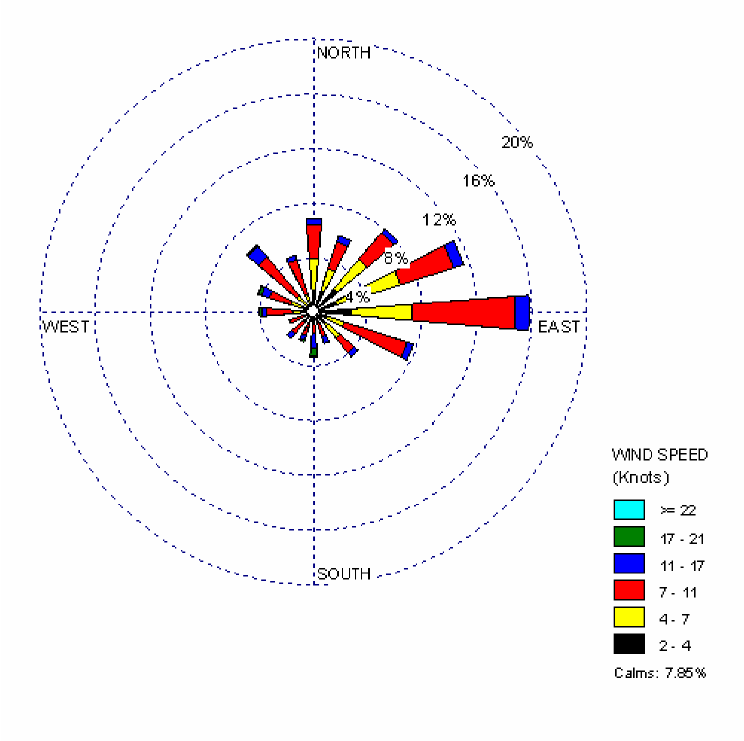
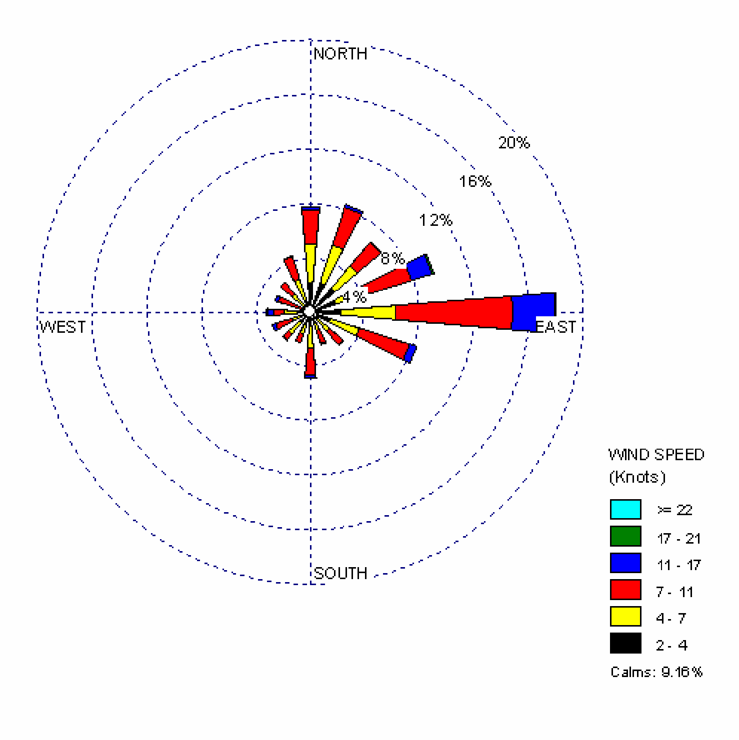


Figure 9-21. Wind Rose for SYFL Sampling Days



- Calm winds were observed very infrequently near FLFL (less than three percent).

- Winds exceeding 11 knots madeup nearly 28 percent of observations. Stronger wind speeds were observed with easterly and northeasterly winds.

- The observations contained in the wind rose for FLFL include the first quarter of the year only. A wind rose with a full year's worth of observations may look differently.

Observations from Figure 9-18 for GAFL include the following:

- Northeasterly and east-northeasterly winds prevailed near GAFL.

- Calm winds were observed for less than 13 percent of the measurements.

- Winds exceeding 11 knots were less frequently observed, with less than three percent of observations.

Observations from Figure 9-19 for ORFL include the following:

- Easterly, northeasterly, and northerly winds were prevalent near ORFL.

- Calm winds were observed for less than 15 percent of the measurements.

- Winds exceeding 11 knots were observed for just over eight percent of observations. Stronger wind speeds were observed most frequently with easterly and northeasterly winds.

Observations from Figure 9-20 for SKFL include the following:

- Easterly and northeasterly winds were prevalent near SKFL.

- Calm winds were observed for less than eight percent of the measurements.

- Winds exceeding 11 knots were observed for less than eight percent of observations. The strongest wind speeds were observed with southerly and southwesterly winds.

Observations from Figure 9-21 for SYFL include the following:

- Easterly winds were prevalent near SYFL.

- Calm winds were observed for nine percent of the measurements.

- Winds exceeding 11 knots were observed for less than eight percent of observations.

9.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Florida monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 9-4 presents the pollutants that failed at least one screen for the Florida monitoring sites and highlights each site's pollutants of interest (shaded). All of the Florida sites sampled for carbonyl compounds. Additionally, SYFL sampled hexavalent chromium.

Observations from Table 9-4 include the following:

- Acetaldehyde and formaldehyde are the only two carbonyls with screening values.
- Acetaldehyde and formaldehyde failed at least one screen for all six Florida monitoring sites. Most, if not all, of the measured detections of these pollutants failed screens.
- Acetaldehyde and formaldehyde contributed equally to the number of failed screens for AZFL and ORFL, while acetaldehyde contributed more to the number of failed screens for the remaining sites.
- Hexavalent chromium did not fail any screens for SYFL.

Table 9-4. Comparison of Measured Concentrations and EPA Screening Values for the Florida Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Petersburg, Florida - AZFL					
Acetaldehyde	60	60	100.00	50.00	50.00
Formaldehyde	60	60	100.00	50.00	100.00
Total	120	120	100.00		

Table 9-4. Comparison of Measured Concentrations and EPA Screening Values for the Florida Monitoring Sites (Continued)

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Davie, Florida - FLFL					
Acetaldehyde	10	10	100.00	62.50	62.50
Formaldehyde	6	10	60.00	37.50	100.00
Total	16	20	80.00		
Tampa, Florida - GAFL					
Acetaldehyde	59	60	98.33	51.30	51.30
Formaldehyde	56	60	93.33	48.70	100.00
Total	115	120	95.83		
Winter Park, Florida - ORFL					
Formaldehyde	58	58	100.00	50.00	50.00
Acetaldehyde	58	58	100.00	50.00	100.00
Total	116	116	100.00		
Pinellas Park, Florida - SKFL					
Acetaldehyde	60	60	100.00	58.82	58.82
Formaldehyde	42	60	70.00	41.18	100.00
Total	102	120	85.00		
Plant City, Florida - SYFL					
Acetaldehyde	60	60	100.00	51.72	51.72
Formaldehyde	56	60	93.33	48.28	100.00
Total	116	120	96.67		

9.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Florida monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

9.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 9-5, where applicable.

Table 9-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Florida Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
St. Petersburg, Florida - AZFL								
Acetaldehyde	60	60	1.42 ± 0.19	2.23 ± 0.53	1.36 ± 0.20	1.03 ± 0.15	1.12 ± 0.15	1.42 ± 0.19
Formaldehyde	60	60	2.95 ± 0.20	2.28 ± 0.34	3.35 ± 0.36	3.26 ± 0.42	2.82 ± 0.23	2.95 ± 0.20
Davie, Florida - FLFL								
Acetaldehyde	10	10	2.47 ± 0.50	2.74 ± 0.56	NA	NA	NA	NA
Formaldehyde	10	10	1.14 ± 0.19	1.15 ± 0.27	NA	NA	NA	NA
Tampa, Florida - GAFL								
Acetaldehyde	60	60	2.54 ± 0.23	3.18 ± 0.29	2.68 ± 0.57	2.26 ± 0.28	2.19 ± 0.42	2.54 ± 0.23
Formaldehyde	60	60	2.45 ± 0.54	3.45 ± 2.45	2.12 ± 0.42	2.44 ± 0.26	2.03 ± 0.40	2.45 ± 0.54
Winter Park, Florida - ORFL								
Acetaldehyde	58	58	1.62 ± 0.29	2.47 ± 0.59	1.16 ± 0.28	1.25 ± 0.19	1.55 ± 0.80	1.62 ± 0.29
Formaldehyde	58	58	2.59 ± 0.53	1.67 ± 0.26	2.28 ± 0.53	3.37 ± 0.49	3.12 ± 1.90	2.59 ± 0.53
Pinellas Park, Florida - SKFL								
Acetaldehyde	60	60	1.98 ± 0.22	2.53 ± 0.42	1.38 ± 0.22	1.86 ± 0.55	2.29 ± 0.26	1.98 ± 0.22
Formaldehyde	60	60	1.66 ± 0.24	1.59 ± 0.20	2.50 ± 0.40	1.56 ± 0.58	0.88 ± 0.11	1.66 ± 0.24

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 9-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Florida Monitoring Sites (Continued)

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Plant City, Florida - SYFL								
Acetaldehyde	60	60	2.73 ± 0.52	3.60 ± 1.98	3.38 ± 0.49	2.13 ± 0.19	1.91 ± 0.27	2.73 ± 0.52
Formaldehyde	60	60	3.18 ± 0.93	5.39 ± 2.80	1.93 ± 0.37	2.38 ± 0.58	3.24 ± 2.16	3.18 ± 0.93

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations about acetaldehyde from Table 9-5 include the following:

- The sites with the highest daily average concentration of acetaldehyde were SYFL (2.73 ± 0.52 µg/m^3), GAFL (2.54 ± 0.23 µg/m^3), and FLFL (2.47 ± 0.50 µg/m^3).
- The winter average concentrations of acetaldehyde tended to be higher than other seasons. However, the confidence intervals suggest that only the winter average for AZFL is significantly higher than other seasons.
- The large confidence interval for SYFL indicates that the winter average was influenced by outliers.
- As shown in Table 4-9, SYFL and GAFL had the eighth and tenth highest daily average concentrations of acetaldehyde among all NATTS and UATMP sites.

Observations about formaldehyde from Table 9-5 include the following:

- The sites with the highest daily average concentration of formaldehyde were SYFL (3.18 ± 0.93 µg/m^3), AZFL (2.95 ± 0.20 µg/m^3), and ORFL (2.59 ± 0.53 µg/m^3).
- The large confidence intervals for the winter averages for GAFL and SYFL indicate that these averages were influenced by outliers. The same can be said for the autumn averages for SYFL and ORFL.
- The Florida sites did not have any of the 10 highest daily averages of formaldehyde, according to Table 4-9.

9.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. AZFL, GAFL, and ORFL have sampled as part of the UATMP or NATTS for at least five years. Figures 9-22 through 9-24 present the three-year rolling statistical metrics graphically for formaldehyde for each of these sites. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Observations from Figure 9-22 for formaldehyde measurements at AZFL include the following:

- Sampling for carbonyl compounds under the UATMP at AZFL began in 2001.
- The maximum formaldehyde concentration shown was measured during the 2001-2003 time frame. The maximum concentrations measured in subsequent time periods were less than half the maximum concentration from the 2001-2003 time frame.
- The rolling average concentrations have a decreasing trend from 2001-2003 through the 2003-2005 time periods. Although an increase is observed for the 2004-2006 through 2005-2007 periods, the range of values measured from the 2002-2004 time period forward changed little over time.
- The central tendency of the rolling averages and the median values were observed to be similar for each time period. The “closeness” in these metrics indicates little variability in the central tendency.
- All formaldehyde concentrations reported to AQS over the seven years of sampling were measured detections.

Observations from Figure 9-23 for formaldehyde measurements at GAFL include the following:

- Sampling for carbonyl compounds under the UATMP at GAFL began in 2001.
- The maximum formaldehyde concentration shown was measured during 2005. The average concentration is greater than the third quartile for the last three time frames, indicating the presence of outliers.

Figure 9-22. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at AZFL

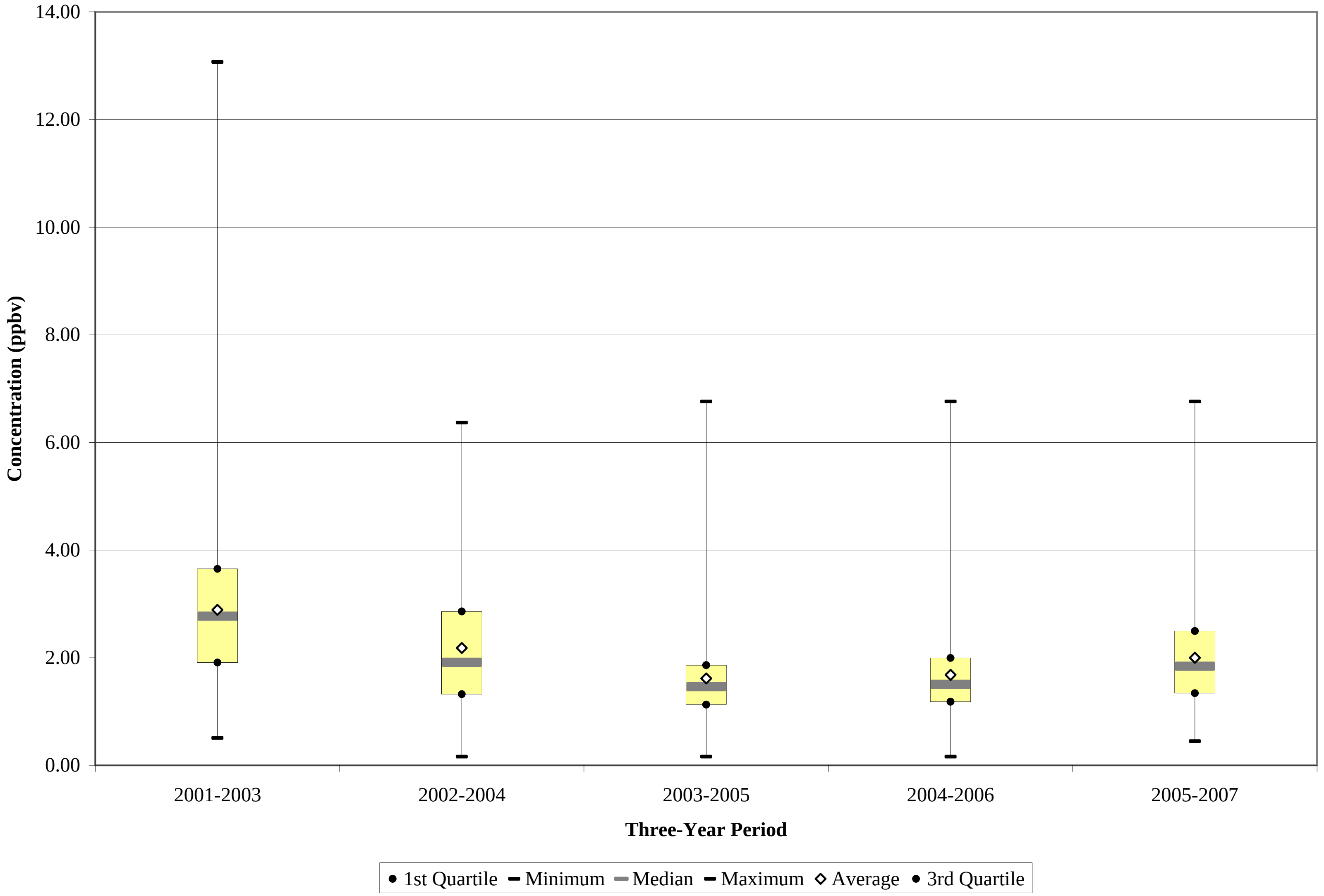


Figure 9-23. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at GAFL

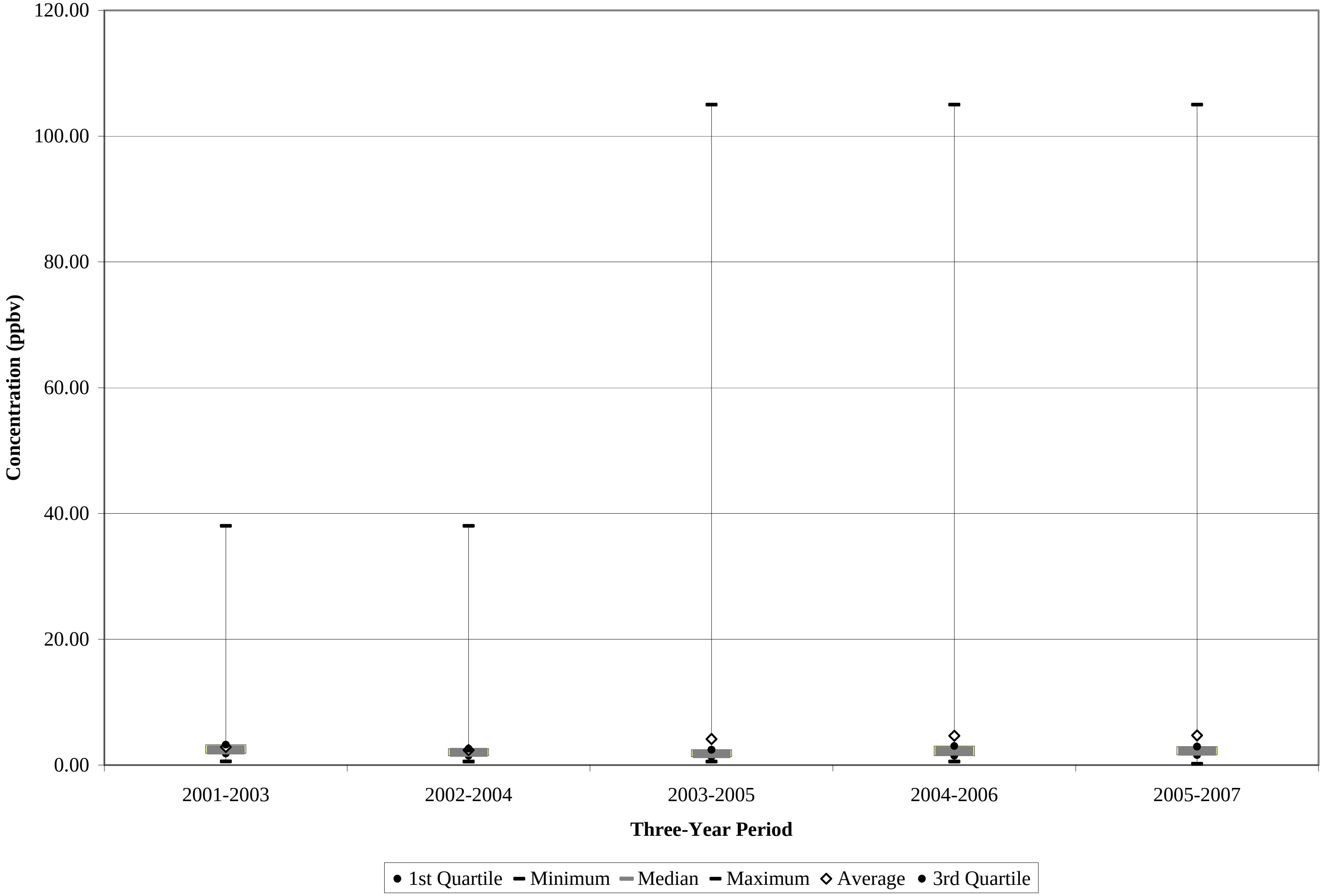
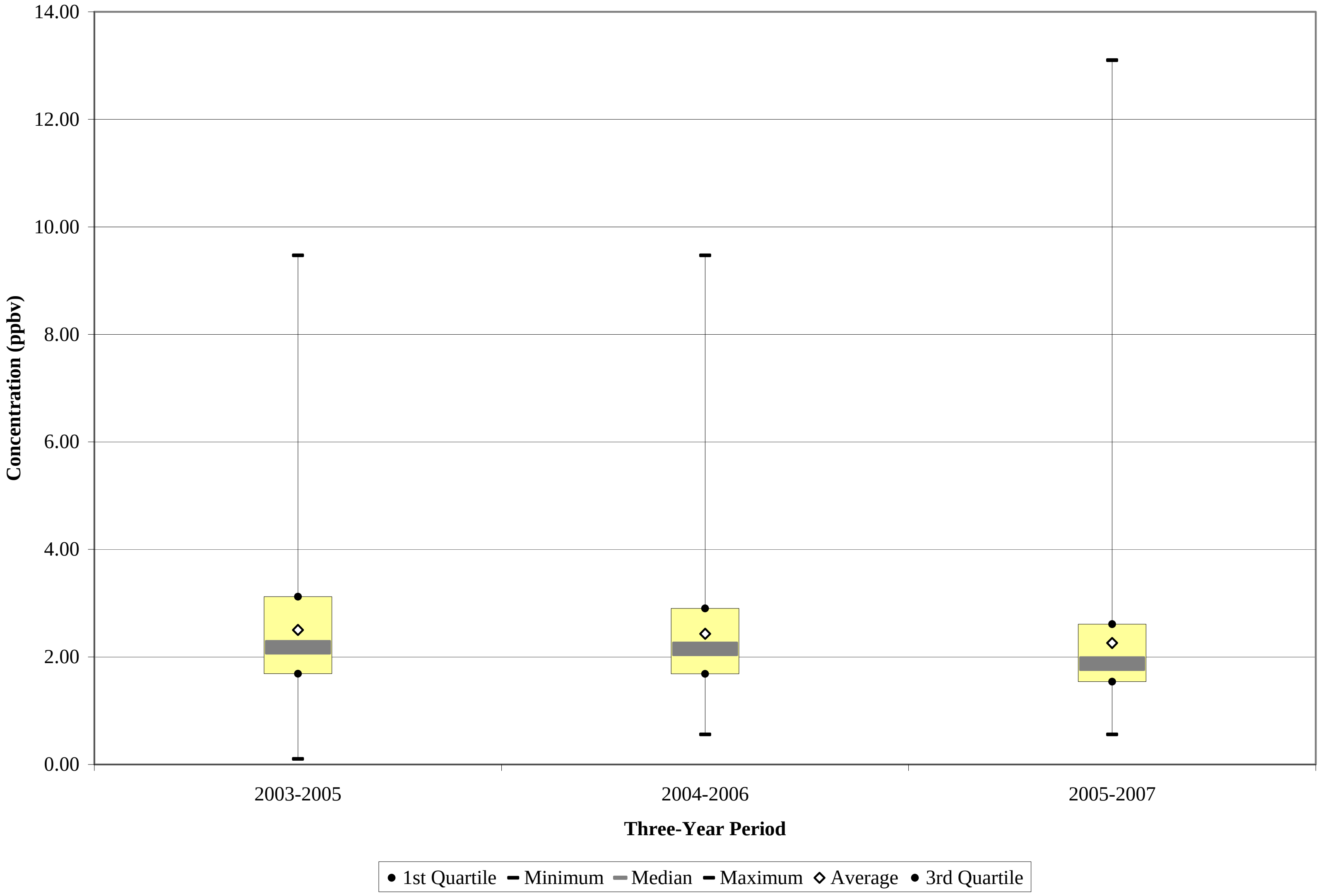


Figure 9-24. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at ORFL



- The first and third quartiles are very similar for each time period, as are the median and rolling average concentrations. The "closeness" in these metrics indicates little variability in the central tendency.

- All formaldehyde concentrations reported to AQS over the seven years of sampling were measured detections.

Observations from Figure 9-24 for formaldehyde measurements at ORFL include the following:

- Sampling for carbonyl compounds under the UATMP at ORFL began in 2003.

- The rolling average concentrations appeared to have decreased slightly over the period shown, although the maximum formaldehyde concentration shown was measured during the 2005-2007 time frame. However, the calculation of confidence intervals indicates the decrease is not statistically significant.

- The central tendency of the rolling averages and the median values were observed to be similar for each time period. This indicates little variability in the central tendency.

- Similar to AZFL and GAFL, all formaldehyde concentrations reported to AQS over the five years of sampling were measured detections.

9.5 Pearson Correlations

Table 9-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for acetaldehyde from Table 9-6 include the following:

- AZFL exhibited strong negative correlations with the temperature and moisture variables. With the exception of FLFL and SKFL, all of the correlations with these variables were negative. This indicates that as temperature and moisture content decrease, concentrations of acetaldehyde increase.

- All of the sites exhibited negative correlations with wind speed, indicating that concentrations of acetaldehyde increase as wind speeds decrease.

- The FLFL monitoring site exhibited the strongest negative correlation with wind speed. However, the low number of measurements may skew this correlation.

Table 9-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Florida Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
St. Petersburg, Florida - AZFL								
Acetaldehyde	60	-0.61	-0.65	-0.70	-0.69	-0.40	0.47	-0.15
Formaldehyde	60	0.58	0.49	0.35	0.39	-0.17	-0.11	0.05
Davie, Florida - FLFL								
Acetaldehyde	10	0.03	-0.20	-0.20	-0.21	-0.12	0.03	-0.69
Formaldehyde	10	0.13	-0.07	-0.01	-0.04	0.08	-0.49	-0.53
Tampa, Florida - GAFL								
Acetaldehyde	60	-0.28	-0.32	-0.29	-0.31	-0.16	0.33	-0.38
Formaldehyde	60	0.02	0.07	0.10	0.09	0.15	0.15	-0.16
Winter Park, Florida - ORFL								
Acetaldehyde	58	-0.45	-0.46	-0.52	-0.50	-0.39	0.13	-0.04
Formaldehyde	58	0.36	0.35	0.27	0.30	-0.02	-0.35	-0.04
Pinellas Park, Florida - SKFL								
Acetaldehyde	60	-0.12	-0.13	-0.06	-0.09	0.11	0.11	-0.46
Formaldehyde	60	-0.01	-0.09	-0.22	-0.18	-0.35	0.10	0.01
Plant City, Florida - SYFL								
Acetaldehyde	60	-0.41	-0.39	-0.35	-0.37	-0.02	0.31	-0.03
Formaldehyde	60	-0.38	-0.34	-0.24	-0.29	0.14	0.21	-0.31

Observations for formaldehyde from Table 9-6 include the following:

- AZFL exhibited strong positive correlations with the temperature variables. This tendency was not observed for the other Florida sites.
- The FLFL site exhibited the strongest negative correlation with wind speed. However, the low number of measurements may skew this correlation.
- The remaining correlations were weak.

9.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

9.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Florida monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the pollutants measured at the Florida sites exceeded any of the MRL risk values.

9.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Florida sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 of this report regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 9-7. The data from NATA

Table 9-7. Cancer and Noncancer Risk Summary for the Monitoring Sites in Florida

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (HQ)	2007 NATTS/UATMP Annual Average[1] (µg/m^3)	2007 NATTS/UATMP Cancer Risk Approximation (in-a-million)	2007 NATTS/UATMP Noncancer Risk Approximation (HQ)
St. Petersburg, Florida (AZFL) - Census Tract ID 12103022402								
Acetaldehyde	0.000002	0.009	1.20	2.66	0.13	1.42 ± 0.19	2.85	0.16
Formaldehyde	5.5E-09	0.0098	1.31	0.01	0.13	2.95 ± 0.20	0.02	0.30
Davie, Florida (FLFL) - Census Tract ID 12011070204								
Acetaldehyde	0.000002	0.009	1.66	3.70	0.18	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	2.30	0.01	0.23	NA	NA	NA
Tampa, Florida (GAFL) - Census Tract ID 12057006500								
Acetaldehyde	0.000002	0.009	1.71	3.80	0.19	2.54 ± 0.23	5.07	0.28
Formaldehyde	5.5E-09	0.0098	1.72	0.01	0.17	2.45 ± 0.54	0.01	0.25
Winter Park, Florida (ORFL) - Census Tract ID 12095015901								
Acetaldehyde	0.000002	0.009	1.98	4.37	0.22	1.62 ± 0.29	3.23	0.18
Formaldehyde	5.5E-09	0.0098	1.99	0.01	0.2	2.59 ± 0.53	0.01	0.26
Pinellas Park, Florida (SKFL) - Census Tract ID 12103024905								
Acetaldehyde	0.000002	0.009	1.64	3.62	0.18	1.98 ± 0.22	3.96	0.22
Formaldehyde	5.5E-09	0.0098	1.73	0.01	0.17	1.66 ± 0.24	0.01	0.17
Plant City, Florida (SYFL) - Census Tract ID 12057012204								
Acetaldehyde	0.000002	0.009	1.24	2.74	0.13	2.73 ± 0.52	5.46	0.30
Formaldehyde	5.5E-09	0.0098	1.42	0.01	0.14	3.18 ± 0.93	0.02	0.32

Bold = pollutant of interest

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the Florida sites is as follows, grouped by county:

- 12103022402 for AZFL and12103024905 for SKFL; the 5,456 people residing in the AZFL census tract represented 0.6 percent of the 2000 Pinellas County population, while the 6,522 residents of the SKFL census tract represented 0.7 percent of the 2000 Pinellas County population.

- 12011070204 for FLFL; the 4,301 residents of the FLFL census tract represented 0.3 percent of the 2000 Broward County population.

- 12057006500 for GAFL, 12057012204 for SYFL; the 5,913 people residing in the GAFL census tract represented 0.6 percent of the 2000 Hillsborough County population; the 4,362 residents of the SYFL census tract represented 0.4 percent of the 2000 Hillsborough County population.

- 12095015901 for ORFL; the 2,083 people residing in the ORFL census tract represented 0.2 percent of the 2000 Orange County population.

Observations for the Florida sites from Table 9-7 include the following:

- The NATA modeled concentrations of acetaldehyde and formaldehyde were fairly similar to the annual averages.

- The cancer risk for acetaldehyde from NATA ranged from 2.66 in-a-million (AZFL) to 4.37 in-a-million (ORFL). Cancer risk from formaldehyde was 0.01 in-a-million for all six Florida sites, according to NATA.

- The cancer surrogate risk approximations from acetaldehyde ranged from 2.85 in-a-million (AZFL) to 5.46 in-a-million (SYFL). The surrogate cancer risk approximations for formaldehyde were 0.02 in-a-million or less for all six Florida sites, according to NATA.

- Both the noncancer risk from NATA and the noncancer surrogate risk approximations were less than 1.0 (HQ) for all of the Florida sites for formaldehyde and acetaldehyde.

- Annual averages were not calculated for FLFL; therefore, this site has no surrogate risk approximations in Table 9-7.

9.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 9-8 and 9-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 9-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest surrogate cancer risk approximations (in-a-million), as calculated from the annual averages. Table 9-9 presents similar information, but identifies the 10 pollutants with the highest surrogate noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 9.3, each Florida site sampled for carbonyl compounds. SYFL also sampled hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated; therefore, cancer and noncancer risk approximations are not presented for FLFL.

Observations from Table 9-8 include the following:

- Benzene was the highest emitted pollutant with a cancer URE in all four Florida counties (Pinellas, Hillsborough, Orange, and Broward).

- With the exception of Broward County, benzene was also had the highest toxicity-weighted emissions. Benzene ranked 2nd behind naphthalene for Broward County.

- For Pinellas County, six of the highest emitted pollutants also had the highest toxicity-weighted emissions; seven for Hillsborough County; six for Orange County; and seven for Broward County. Four pollutants, acetaldehyde, benzene, naphthalene, and 1,3-butadiene appeared on both lists for each county.

- Acetaldehyde, which appeared on both lists for each county, topped the cancer risk approximations for each site. Formaldehyde, which was one of the highest emitted pollutants in each county, had very low cancer risk approximations

Table 9-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Florida

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
St. Petersburg, FL (AZFL) – Pinellas County					
Benzene	867.42	Benzene	6.77E-03	Acetaldehyde	2.85
Formaldehyde	294.04	1,3-Butadiene	2.91E-03	Formaldehyde	0.02
Acetaldehyde	105.52	Nickel, PM	2.32E-03		
1,3-Butadiene	97.04	Hexavalent Chromium	1.20E-03		
Dichloromethane	64.63	Arsenic, PM	8.50E-04		
Naphthalene	22.10	Naphthalene	7.51E-04		
Trichloroethylene	20.61	Acetaldehyde	2.32E-04		
Nickel,PM	14.49	POM, Group 2	1.41E-04		
Tetrachloroethylene	10.28	Cadmium, PM	9.21E-05		
POM, Group 2	2.56	Ethylene oxide	6.22E-05		
Pinellas Park, FL (SKFL) – Pinellas County					
Benzene	867.42	Benzene	6.77E-03	Acetaldehyde	3.96
Formaldehyde	294.04	1,3-Butadiene	2.91E-03	Formaldehyde	0.01
Acetaldehyde	105.52	Nickel, PM	2.32E-03		
1,3-Butadiene	97.04	Hexavalent Chromium	1.20E-03		
Dichloromethane	64.63	Arsenic, PM	8.50E-04		
Naphthalene	22.10	Naphthalene	7.51E-04		
Trichloroethylene	20.61	Acetaldehyde	2.32E-04		
Nickel, PM	14.49	POM, Group 2	1.41E-04		
Tetrachloroethylene	10.28	Cadmium, PM	9.21E-05		
POM, Group 2	2.56	Ethylene oxide	6.22E-05		

Table 9-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Florida (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Tampa, FL (GAFL) – Hillsborough County					
Benzene	2,067.73	Benzene	1.61E-02	Acetaldehyde	5.07
Formaldehyde	913.70	1,3-Butadiene	7.01E-03	Formaldehyde	0.01
Acetaldehyde	350.13	Hexavalent Chromium	4.58E-03		
1,3-Butadiene	233.70	Naphthalene	1.79E-03		
Tetrachloroethylene	58.96	Acetaldehyde	7.70E-04		
Naphthalene	52.68	Cadmium, PM	7.28E-04		
Dichloromethane	32.73	Arsenic, PM	6.45E-04		
Trichloroethylene	21.10	Nickel, PM	4.76E-04		
POM, Group 2	7.76	POM, Group 2	4.27E-04		
Nickel, PM	2.98	Tetrachloroethylene	3.48E-04		
Plant City, FL (SYFL) – Hillsborough County					
Benzene	2,067.73	Benzene	1.61E-02	Acetaldehyde	5.46
Formaldehyde	913.70	1,3-Butadiene	7.01E-03	Formaldehyde	0.02
Acetaldehyde	350.13	Hexavalent Chromium	4.58E-03		
1,3-Butadiene	233.70	Naphthalene	1.79E-03		
Tetrachloroethylene	58.96	Acetaldehyde	7.70E-04		
Naphthalene	52.68	Cadmium, PM	7.28E-04		
Dichloromethane	32.73	Arsenic, PM	6.45E-04		
Trichloroethylene	21.10	Nickel, PM	4.76E-04		
POM, Group 2	7.76	POM, Group 2	4.27E-04		
Nickel, PM	2.98	Tetrachloroethylene	3.48E-04		

Table 9-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Florida (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Winter Park, FL (ORFL) – Orange County					
Benzene	1,098.33	Benzene	8.57E-03	Acetaldehyde	3.23
Formaldehyde	387.81	1,3-Butadiene	3.67E-03	Formaldehyde	0.01
Dichloromethane	157.30	Arsenic, PM	2.27E-03		
Acetaldehyde	138.94	Hexavalent Chromium	1.10E-03		
1,3-Butadiene	122.49	Naphthalene	9.20E-04		
Tetrachloroethylene	61.86	Tetrachloroethylene	3.65E-04		
Naphthalene	27.07	Acetaldehyde	3.06E-04		
Trichloroethylene	24.14	POM, Group 2	2.35E-04		
POM, Group 2	4.27	Nickel, PM	1.04E-04		
POM, Group 1	0.86	Ethylene oxide	7.48E-05		
Davie, FL (FLFL) – Broward County					
Benzene	1,394.39	Naphthalene	2.79E-02		
Naphthalene	820.97	Benzene	1.09E-02		
Dichloromethane	530.06	1,3-Butadiene	4.89E-03		
Formaldehyde	528.26	Nickel, PM	1.83E-03		
Acetaldehyde	193.44	Hexavalent Chromium	1.01E-03		
1,3-Butadiene	162.88	Arsenic, PM	1.01E-03		
1,3-Dichloropropene	116.00	*p*-Dichlorobenzene	6.54E-04		
Tetrachloroethylene	92.69	Tetrachloroethylene	5.47E-04		
p-Dichlorobenzene	59.41	1,3-Dichloropropene	4.64E-04		
Trichloroethylene	34.748	Acetaldehyde	4.26E-04		

Table 9-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Florida

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
St. Petersburg, FL (AZFL) – Pinellas County					
Toluene	2,360.70	Acrolein	691,264.22	Formaldehyde	0.30
Xylenes	1,502.26	Nickel, PM	222,915.40	Acetaldehyde	0.16
Methanol	1,169.63	1,3-Butadiene	48,519.24		
Benzene	867.42	Formaldehyde	30,004.46		
Hexane	444.08	Benzene	28,914.03		
Hydrochloric acid	435.32	Manganese, PM	22,103.35		
Ethylbenzene	384.26	Hydrochloric acid	21,765.98		
Formaldehyde	294.04	Xylenes	15,022.64		
Styrene	293.54	Acetaldehyde	11,724.95		
Methyl *tert*-butyl ether	185.54	Naphthalene	7,367.29		
Pinellas Park, FL (SKFL) – Pinellas County					
Toluene	2,360.70	Acrolein	691,264.22	Acetaldehyde	0.22
Xylenes	1,502.26	Nickel, PM	222,915.40	Formaldehyde	0.17
Methanol	1,169.63	1,3-Butadiene	48,519.24		
Benzene	867.42	Formaldehyde	30,004.46		
Hexane	444.08	Benzene	28,914.03		
Hydrochloric acid	435.32	Manganese, PM	22,103.35		
Ethylbenzene	384.26	Hydrochloric acid	21,765.98		
Formaldehyde	294.04	Xylenes	15,022.64		
Styrene	293.54	Acetaldehyde	11,724.95		
Methyl *tert*-butyl ether	185.54	Naphthalene	7,367.29		

Table 9-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Florida (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Tampa, FL (GAFL) – Hillsborough County					
Toluene	5,324.13	Acrolein	2,220,358.79	Acetaldehyde	0.28
Xylenes	3,622.30	Hydrochloric acid	155,323.16	Formaldehyde	0.25
Hydrochloric acid	3,106.46	1,3-Butadiene	116,850.75		
Benzene	2,067.73	Formaldehyde	93,235.15		
Methanol	1,171.85	Benzene	68,924.48		
Hexane	981.04	Nickel, PM	45,774.78		
Formaldehyde	913.70	Manganese, PM	44,427.07		
Ethylbenzene	895.02	Acetaldehyde	38,903.12		
Hydrofluoric acid	403.65	Xylenes	36,223.00		
Methyl *tert*-butyl ether	371.15	Cadmium, PM	20,209.11		
Plant City, FL (SYFL) – Hillsborough County					
Toluene	5,324.13	Acrolein	2,220,358.79	Formaldehyde	0.32
Xylenes	3,622.30	Hydrochloric acid	155,323.16	Acetaldehyde	0.30
Hydrochloric acid	3,106.46	1,3-Butadiene	116,850.75		
Benzene	2,067.73	Formaldehyde	93,235.15		
Methanol	1,171.85	Benzene	68,924.48		
Hexane	981.04	Nickel, PM	45,774.78		
Formaldehyde	913.70	Manganese, PM	44,427.07		
Ethylbenzene	895.02	Acetaldehyde	38,903.12		
Hydrofluoric acid	403.65	Xylenes	36,223.00		
Methyl *tert*-butyl ether	371.15	Cadmium, PM	20,209.11		

Table 9-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Florida (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Winter Park, FL (ORFL) – Orange County					
Toluene	2,962.97	Acrolein	1,127,315.05	Formaldehyde	0.26
Xylenes	2,022.98	Hydrochloric acid	71,713.15	Acetaldehyde	0.18
Hydrochloric acid	1,434.26	1,3-Butadiene	61,246.00		
Benzene	1,098.33	Formaldehyde	39,572.83		
Methanol	979.18	Benzene	36,610.86		
Hexane	533.36	Xylenes	20,229.81		
Ethylbenzene	485.48	Arsenic, PM	17,596.94		
Formaldehyde	387.81	Acetaldehyde	15,437.99		
Methyl isobutyl ketone	340.49	Cyanide Compounds, gas	11,327.06		
Styrene	245.46	Nickel, PM	10,021.61		
Davie, FL (FLFL) – Broward County					
Xylenes	56,145.14	Acrolein	1,581,166.23		
Toluene	31,910.88	Xylenes	561,451.39		
Ethylbenzene	13,721.63	Naphthalene	273,658.20		
Chloroform	9,751.73	Nickel, PM	176,064.68		
Methanol	7,845.07	Chloroform	99,507.48		
Benzene	1,394.39	1,3-Butadiene	81,441.74		
Naphthalene	820.97	Toluene	79,777.19		
Hexane	666.85	Formaldehyde	53,903.66		
Dichloromethane	530.06	Benzene	46,479.65		
Formaldehyde	528.26	Bromomethane	32,400.00		

Observations from Table 9-9 include the following:

- Toluene and xylenes were the highest emitted pollutants with noncancer RfCs in all four Florida counties.
- Acrolein had the highest toxicity-weighted emissions of the pollutants with noncancer RfCs.
- For Pinellas County, four of the highest emitted pollutants also had the highest toxicity-weighted emissions; four for Hillsborough County; four for Orange County; and five for Broward County. Three pollutants, benzene, xylenes, and formaldehyde appeared on both lists for each county.
- Formaldehyde, which appeared on both lists for each county, had low noncancer risk approximations for each site.
- Acetaldehyde, which was one of the highest emitted pollutants with a cancer URE in each county, did not appear on the list of highest emitted pollutants with a noncancer RfC. However, this pollutant did have one of the 10 highest toxicity-weighted emissions for pollutants with noncancer RfCs. Acetaldehyde also had low noncancer risk approximations for each site.

9.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *The pollutants of interest common to each Florida monitoring site were acetaldehyde and formaldehyde.*
- ❖ *SYFL had the highest daily average concentrations of both acetaldehyde and formaldehyde among the monitoring sites, even though this site was intended to serve as a background site.*
- ❖ *None of the pollutants of interest for the Florida sites exceeded any of the MRL health benchmarks.*

10.0 Site in Georgia

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Georgia, and integrates these concentrations with emissions, meteorological, and risk information.

10.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The Georgia site is located in the Atlanta-Sandy Springs-Marietta, GA MSA. Figure 10-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its urban location. Figure 10-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 10-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

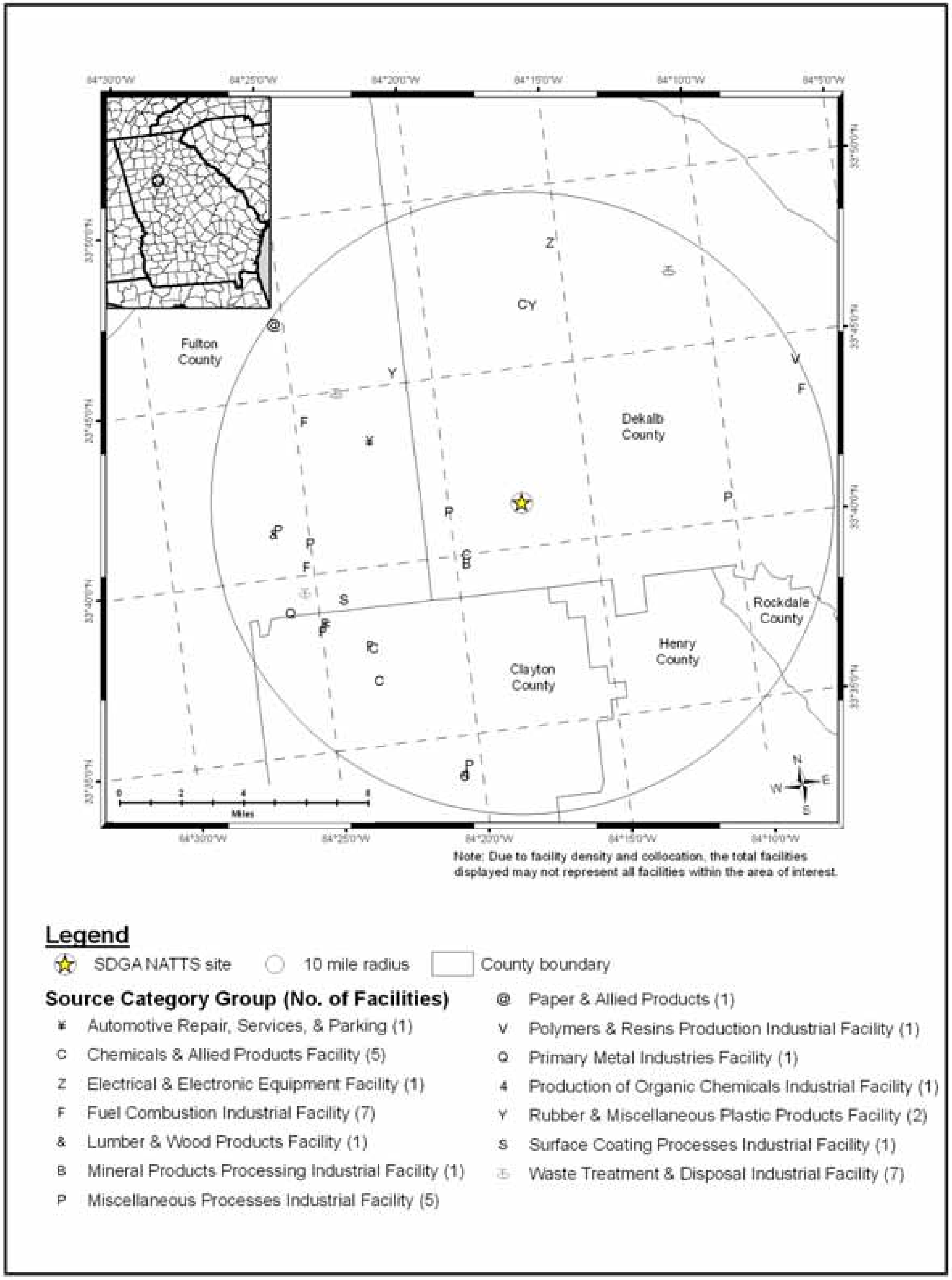
The SDGA monitoring is located in Decatur, Georgia, southeast of Atlanta. The site is located on the DeKalb County Schools Environmental Education property off Wildcat Road. Figure 10-1 shows that residential subdivisions, a greenhouse and horse barn, an athletic field, and a high school surround the monitoring site. A golf course backs up against the school property. I-285 is located less than a mile north of the site. As Figure 10-2 shows, SDGA is located near several point sources, most of which are located to the west of the site. These emission sourcess are involved in a wide variety of industries, including waste treatment and disposal, the manufacture of chemicals and allied products, and processes involving fuel combustion.

Table 10-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Georgia monitoring site. County-level vehicle registration and population data for DeKalb County were obtained from the Georgia Department of Revenue and the U.S. Census Bureau. Table 10-2 also

Figure 10-1. Decatur, Georgia (SDGA) Monitoring Site

©2008 Google/©NAVTECH   Scale: 3cm = 100m

Figure 10-2. NEI Point Sources Located Within 10 Miles of SDGA



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 10-1. Geographical Information for the Georgia Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
SDGA	13-089-0002	Decatur	DeKalb	Atlanta-Sandy Springs-Marietta, GA	33.6875, -84.290278	Residential	Suburban	Northwesterly winds predominate making this site a short-range downwind location from Atlanta's urban core. Undeveloped land surrounds the site but within 1/8 of a mile there is a residential subdivision, a greenhouse/horse barn, an athletic field, and a high school. Traffic on Wildcat Road (a dead end, 2-lane blacktop) has considerable vehicular and diesel traffic during school hours. Three shelters comprise the dry structures at the site. One houses the PAMS GC, carbonyls and VOC equipment, another the continuous monitors, and the third one belongs to Georgia Tech. Particulate matter, IMPROVE and PM_{10} metals reside on exposed structures.

BOLD = EPA-designated NATTS Site

Table 10-2. Population, Motor Vehicle, and Traffic Information for the Georgia Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
SDGA	737,093	471,264	0.64	776,511	496,466	9,100	128,353

[1] Daily Average Traffic Data reflects 2006 data from the Georgia DOT

BOLD = EPA-designated NATTS Site

includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of the site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 10-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 10-2 presents the daily VMT for each urban area.

Observations from Table 10-2 include the following:

- SDGA's county and 10-mile populations were in the middle of the range compared to all counties with NATTS or UATMP sites. This is also true for its county-level and 10-mile vehicle ownership.

- The vehicle per person ratio was the sixth lowest compared to other NATTS or UATMP sites.

- The traffic volume experienced near SDGA also ranked in the low to mid-range compared to other monitoring sites. The traffic estimate used came from Clifton Spring Road between Wildcat Road and Clifton Church Road.

- The Atlanta area VMT was the fifth highest among urban areas with UATMP or NATTS sites.

10.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Georgia on sampling days, as well as over the course of the year.

10.2.1 Climate Summary

Atlanta is the largest city in Georgia, and is located at the base of the Blue Ridge Mountains. The Gulf of Mexico to the south is the major moisture source for weather systems that move across the region. Both topographical features, in addition to the Atlantic Ocean to the east, exert moderating influences on the area's climate (Ruffner and Bair, 1987).

10.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at W. B. Hartsfield/Atlanta International Airport (WBAN 13874).

Table 10-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 10-3 is the 95 percent confidence interval for each parameter. As shown in Table 10-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

10.2.3 Composite Back Trajectories for Sampling Days

Figure 10-3 is the composite back trajectory map for the Georgia monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 10-3 represents 100 miles.

Observations from Figure 10-3 include the following:

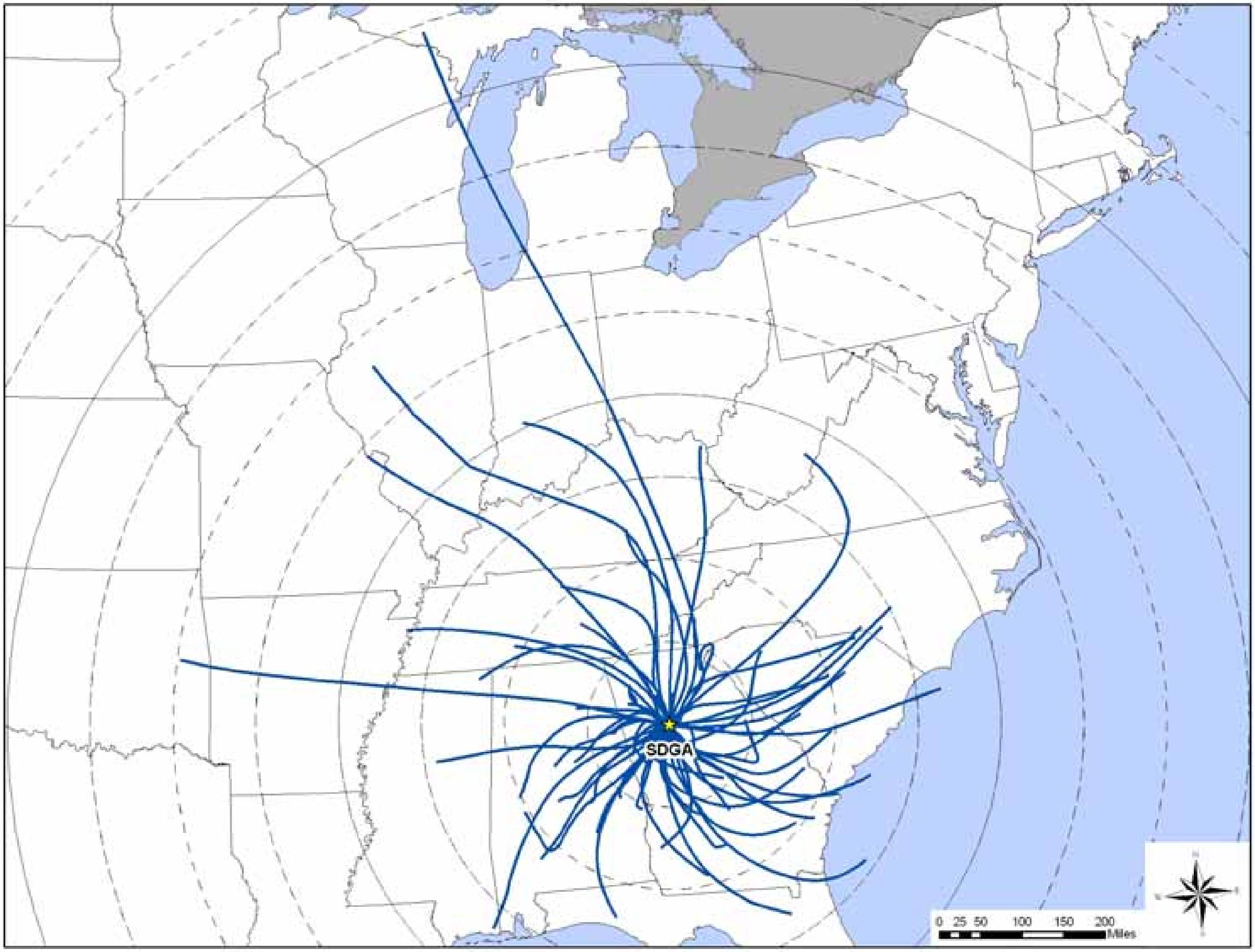
- Back trajectories originated from a variety of directions at SDGA.

Table 10-3. Average Meteorological Conditions near the Georgia Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
SDGA	W.B. Hartsfield/Atlanta Intl Airport 13874	Sampling Day	75.48 ± 3.62	65.61 ± 3.61	49.30 ± 3.98	56.77 ± 3.25	59.30 ± 3.73	1018.65 ± 1.28	6.18 ± 0.60
		All 2007	73.60 ± 1.54	64.04 ± 1.52	48.19 ± 1.70	55.63 ± 1.39	59.99 ± 1.52	1018.58 ± 0.51	6.82 ± 0.28

BOLD = EPA-designated NATTS Site

Figure 10-3. Composite Back Trajectory Map for SDGA



- The 24-hour air shed domain for SDGA was fairly large in size compared to other monitoring sites. The furthest away a trajectory originated was the Upper Peninsula of Michigan, or nearly 900 miles away.

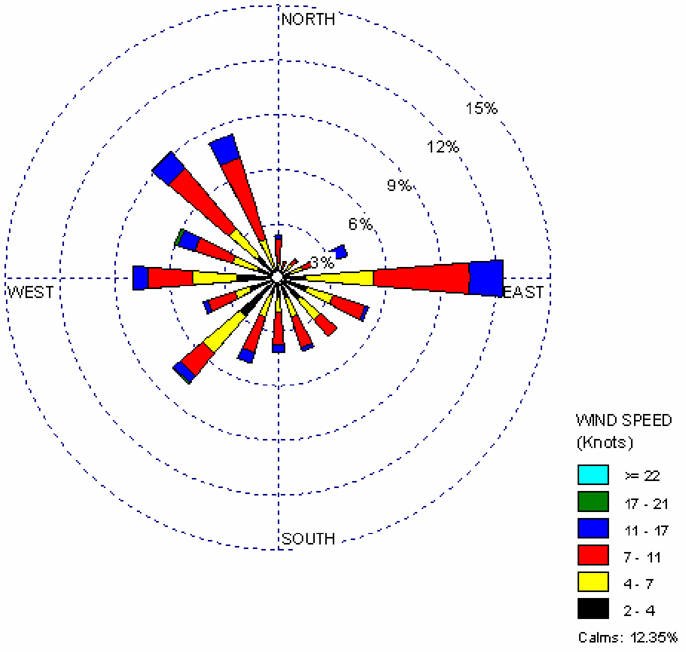
- The longest trajectories originated from westerly, northwesterly, and northerly directions.

- However, most trajectories originated within 300 miles of the site.

10.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at Hartsfield International Airport near SDGA were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 10-4 is the wind rose for the Georgia monitoring site on days that samples were collected.

Figure 10-4. Wind Rose for SDGA Sampling Days



Observations from Figure 10-4 for SDGA include the following:

- Easterly winds were the most frequently observed wind direction near SDGA (12 percent of observations), although southwesterly, westerly, and northwesterly winds were also common.

- Calm winds were observed for over 12 percent of the hourly wind measurements.

- Winds exceeding 11 knots made up approximately 10 percent of observations.

10.3 Pollutants of Interest

"Pollutants of interest" were determined for the monitoring site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Georgia monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 10-4 presents the pollutants that failed at least one screen at the SDGA monitoring site and highlights the pollutants of interest (shaded). SDGA sampled for SVOC and hexavalent chromium.

Table 10-4. Comparison of Measured Concentrations and EPA Screening Values for the Georgia Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Decatur, Georgia - SDGA					
Naphthalene	39	41	95.12	100.00	100.00
Total	39	41	95.12		

Observations from Table 10-4 include the following:

- Naphthalene was the only pollutant to fail at least one screen for SDGA, making it SDGA's only pollutant of interest.

- Of the 41 measured detections of naphthalene, 39 failed screens, which translates into a 95 percent failure rate.

10.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Georgia monitoring site. The averages presented are provided for the pollutants of interest for the monitoring site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the sites, where applicable.

10.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 10-5, where applicable.

Table 10-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Georgia Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average (µg/m^3)
Decatur, Georgia - SDGA								
Naphthalene	41	41	0.08 ± 0.01	NA	NR	0.09 ± 0.02	0.09 ± 0.02	NA

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average
NR = Not reportable due to the detection criteria for calculating a seasonal average

Observations for SDGA from Table 10-5 include the following:

- Because sampling of SVOC did not begin until the end of April, SDGA does not have a winter, spring, or annual average for naphthalene.
- The summer and autumn averages of naphthalene were similar to the daily average.

10.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. SDGA has not sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

10.5 Pearson Correlations

Table 10-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for SDGA from Table 10-6 include the following:

- Naphthalene exhibited a strong negative correlation with scalar wind speed (-0.69). This indicates that concentrations of naphthalene increase with decreasing wind speed.

- The remaining correlations were relatively weak.

10.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

10.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Georgia monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the pollutants measured at the Georgia monitoring site exceeded any of the MRL risk values.

Table 10-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Georgia Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Decatur, Georgia - SDGA								
Naphthalene	41	0.29	0.26	0.06	0.15	-0.32	-0.13	-0.69

10.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Georgia monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncaner risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 10-7. The data from NATA are presented for the census tract where the monitoring site is located. The pollutants of interest for the monitoring site are bolded.

Observations for SDGA from Table 10-7 include the following:

- The census tract for SDGA is 13089023404. The census tract had a population of 9,033, which represented less than two percent of DeKalb County's population in 2000.
- Naphthalene was the only pollutant to fail screens for the Georgia site.
- Annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for naphthalene due to the sampling duration criteria.
- The NATA modeled concentration of naphthalene is similar to the daily average of naphthalene (which was presented in Table 10-5).

10.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 10-8 and 10-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 10-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 10-9 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors,

Table 10-7. Cancer and Noncancer Risk Summary for the Monitoring Site in Georgia

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (μg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (μg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average (μg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Decatur, Georgia (SDGA) - Census Tract ID 13089023404								
Naphthalene	0.000034	0.003	0.09	3.06	0.03	NA	NA	NA

Bold = pollutant of interest

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

Table 10-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Georgia

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Decatur, Georgia (SDGA) – DeKalb County					
Benzene	716.38	Benzene	5.59E-03		
Formaldehyde	227.52	Arsenic, PM	2.66E-03		
Dichloromethane	118.49	1,3-Butadiene	2.09E-03		
Acetaldehyde	81.97	Hexavalent Chromium	1.39E-03		
1,3-Butadiene	69.56	Naphthalene	5.74E-04		
Tetrachloroethylene	52.60	Tetrachloroethylene	3.10E-04		
Naphthalene	16.89	POM, Group 2	2.02E-04		
Trichloroethylene	11.94	Acetaldehyde	1.80E-04		
POM, Group 2	3.68	Cadmium, PM	1.18E-04		
Bis(2-ethylhexyl)phthalate	1.57	Nickel, PM	7.68E-05		

Table 10-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Georgia

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Decatur, Georgia (SDGA) – DeKalb County					
Methyl isobutyl ketone	3,454.02	Acrolein	711,105.67		
Toluene	2,787.11	Hydrochloric acid	81,487.50		
Xylenes	2,301.23	1,3-Butadiene	34,782.15		
Hydrochloric acid	1,629.75	Glycol ethers, gas	34,325.85		
Benzene	716.38	Benzene	23,879.28		
Glycol ethers, gas	686.52	Formaldehyde	23,216.21		
Ethylene glycol	360.80	Xylenes	23,012.26		
1,1,1-Trichloroethane	357.79	Arsenic, PM	20,589.96		
Ethylbenzene	305.95	Acetaldehyde	9,107.72		
Methanol	273.76	Cyanide Compounds, gas	8,416.67		

respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual average are limited to those pollutants for which each respective site sampled. As discussed in Section 10.3, SDGA sampled for SVOC and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated. Because SVOC sampling did not begin until late spring, cancer and noncancer surrogate risk approximations were not calculated.

Observations from Table 10-8 include the following:

- Benzene, formaldehyde, and dichloromethane were the highest emitted pollutants with cancer UREs in DeKalb County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, arsenic, and 1,3-butadiene.
- Six of the highest emitted pollutants also have the highest toxicity-weighted emissions for DeKalb County.
- Naphthalene, which was the only pollutant to fail screens at SDGA, has the fifth highest toxicity-weighted emissions for DeKalb County.
- Hexavalent chromium, the only other pollutant sampled by SDGA to be included in either list, has the fourth highest toxicity-weighted emissions for DeKalb County.

Observations from Table 10-9 include the following:

- Methyl isobutyl ketone, toluene, xylenes were the highest emitted pollutants with noncancer RfCs in DeKalb County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, hydrochloric acid, and 1,3-butadiene.
- Four of the highest emitted pollutants in DeKalb County also have the highest toxicity-weighted emissions.

- Naphthalene is not one of the highest emitted pollutants with a noncancer toxicity factor, nor does it have one of the highest toxicity-weighted emissions.

10.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *Naphthalene was the only pollutant to fail screens for SDGA.*
- *Naphthalene did not exceed any of the MRL health benchmarks.*

11.0 Sites in Illinois

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP sites in Illinois, and integrates these concentrations with emissions, meteorological, and risk information.

11.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. The Illinois sites are located in the Chicago-Naperville-Joliet, IL-IN-WI MSA. Both sites are located in northwestern suburbs of Greater Chicago. More specifically, NBIL is located in Northbrook and SPIL is located in Schiller Park. Figures 11-1 and 11-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban locations. Figure 11-3 identifies point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 11-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

NBIL is located on the property of the Northbrook Water Filtration Station. Figure 11-1 shows that NBIL is located on State Highway 68, Dundee Road, near exit 29 on I-94. A railway intersects Dundee Road close to the site. The surrounding area is classified as suburban and residential. Commercial, residential, and forested areas are nearby.

SPIL is located on the eastern edge of the Chicago-O’Hare International Airport on Mannheim Road. The nearest runway is less than a half mile away from the site. Figure 11-2 shows that SPIL is located near the Irving Park Road exit on I-294. The surrounding area is classified as suburban and mobile. Commercial and residential areas are nearby.

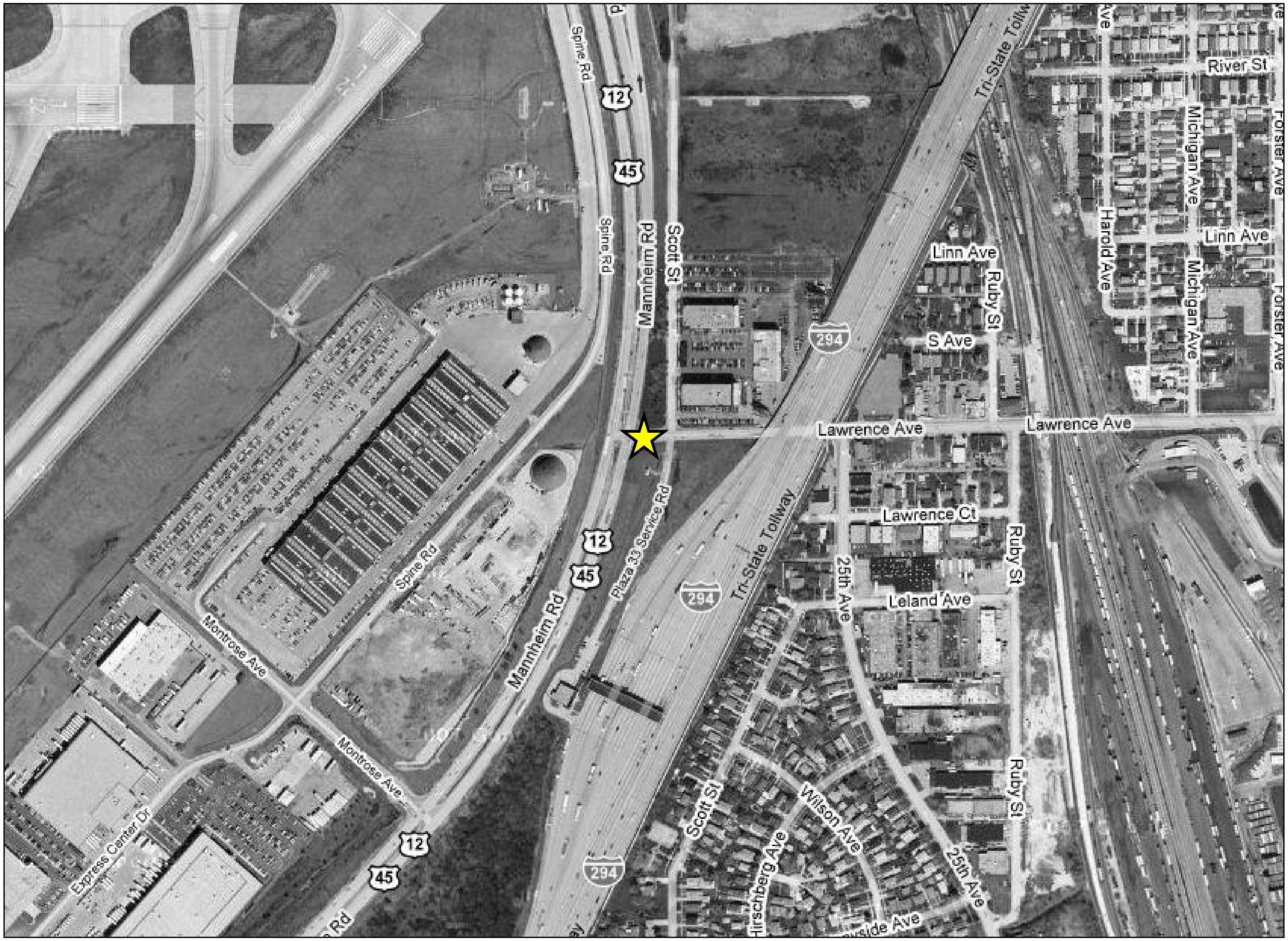
Figure 11-3 shows that NBIL and SPIL are located within 10 miles of each other. The sites are also located within 10 miles of numerous point sources. The most numerous emission sources are involved in surface coating and fuel combustion processes. Few point sources are

Figure 11-1. Northbrook, Illinois (NBIL) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 11-2. Schiller Park, Illinois (SPIL) Monitoring Site



©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 11-3. NEI Point Sources Located Within 10 Miles of NBIL and SPIL

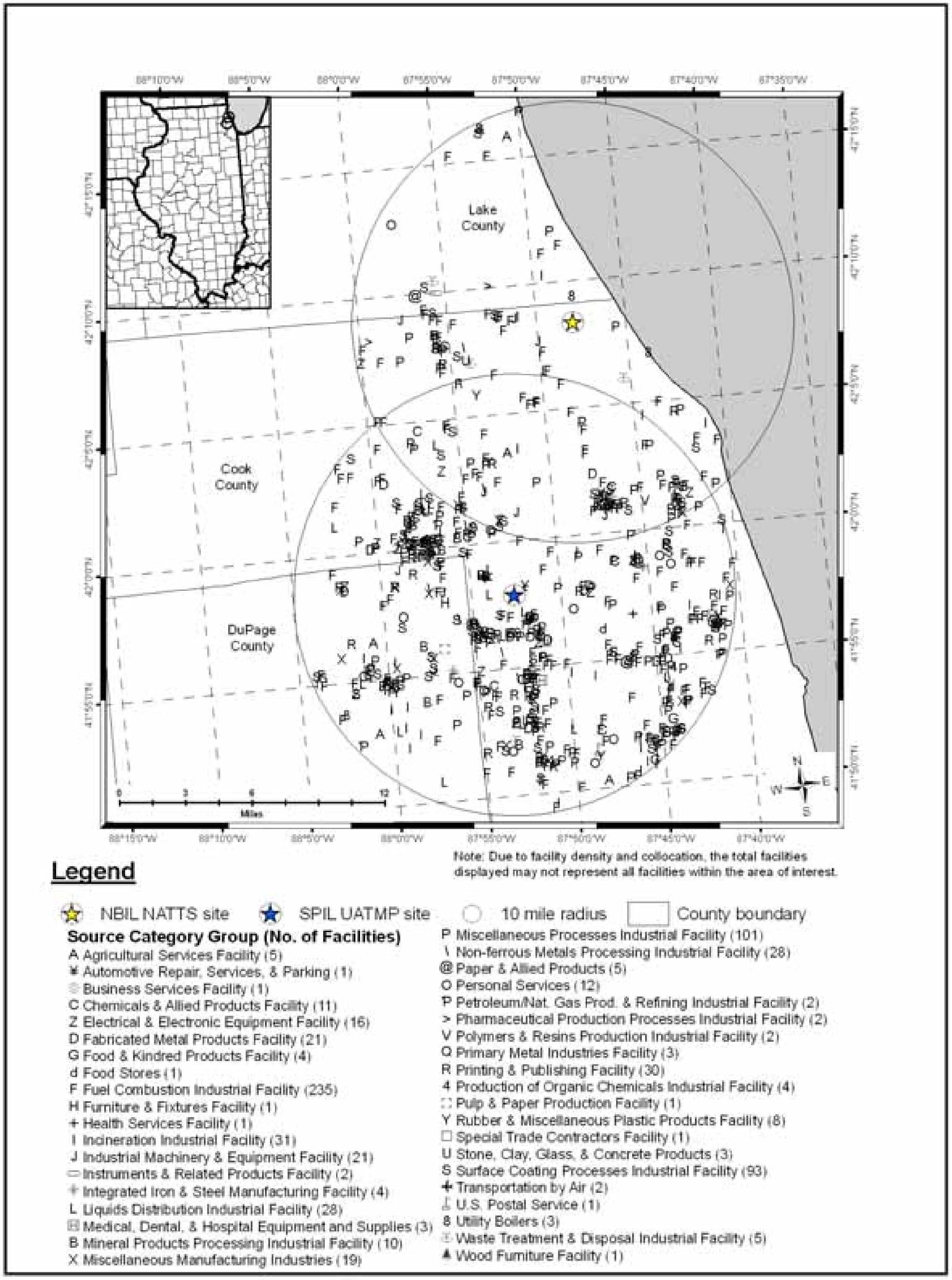


Table 11-1. Geographical Information for the Illinois Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
NBIL	17-031-4201	Northbrook	Cook County	Chicago-Naperville-Joliet, IL-IN-WI MSA	42.14, -87.799167	Residential	Suburban	The village of Northbrook is located in northeast Cook County. This monitoring site is located at the Northbrook Water Filtration Station at 750 Dundee Road. A forest preserve is located immediately south with residential areas farther south (southeast to southwest). Residential areas are also immediately to the west. Commercial areas are located along Dundee Road and to the east. A major expressway (I-94) is located 1 km to the east and north. O'Hare Airport is located 18 km to the southwest and the Chicago Loop is located 32 km to the southeast.
SPIL	17-031-3103	Schiller Park	Cook County	Chicago-Naperville-Joliet, IL-IN-WI MSA	41.965278, -87.876389	Mobile	Suburban	This monitoring site is located on a trailer at 4743 Mannheim Road just south of Lawrence Ave. and between Mannheim Road and I-294. The closest runway at O'Hare Airport is 0.5 km to the northwest. The immediate vicinity is mostly commercial. Residential areas are located east across I-294.

BOLD = EPA-designated NATTS Site

located within two miles of NBIL, with most of the sources located further west or south. The closest sources to NBIL are involved in processes using utility boilers or fuel combustion, or the manufacture of industrial machinery and equipment. Numerous sources are located in close proximity of SPIL. The closest sources to SPIL are involved in fuel combustion processes, surface coating processes, automotive repair and services, and liquids distribution.

Table 11-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Illinois monitoring sites. County-level vehicle registration and population data for Cook County, Illinois were obtained from the Illinois Secretary of State and the U.S. Census Bureau. Table 11-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 11-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Traffic data for NBIL is for Dundee Road near the railroad crossing; traffic data for SPIL is from I-294 and the intersection of Mannheim and Lawrence. Finally, Table 11-2 presents the daily VMT for the urban area.

Table 11-2. Population, Motor Vehicle, and Traffic Information for the Illinois Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
NBIL	5,285,107	2,104,894	0.40	870,561	346,717	35,700	170,934
SPIL	5,285,107	2,104,894	0.40	2,049,963	816,437	202,900	170,934

[1] Daily Average Traffic Data reflects 2006 data from the Illinois DOT
BOLD = EPA-designated NATTS Site

Observations from Table 11-2 include the following:

- Cook County had the second highest county population and fourth highest county-level vehicle registration compared to all counties with NATTS or UATMP sites.

- The 10-mile radius population and estimated vehicle ownership were higher near SPIL than NBIL.

- The vehicle per person ratio for these sites was the fourth lowest compared to other NATTS or UATMP sites.

- SPIL experienced a higher annual average traffic volume than NBIL. SPIL's traffic volume was the fifth highest of all UATMP and NATTS sites, behind CELA, SEWA, PRRI, and PXSS.

- The Chicago area VMT ranked third among urban areas with UATMP or NATTS sites.

11.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Illinois on sampling days, as well as over the course of the year.

11.2.1 Climate Summary

Daily weather fluctuations are common for the Chicago area. The proximity of Chicago to Lake Michigan offers moderating effects from the continental climate of the region. In the summertime, afternoon lake breezes can cool the city when winds from the south and southwest push temperatures upward. The origin of an air mass determines the amount and type of winter precipitation. The largest snowfalls tend to occur when cold air masses flow southward over Lake Michigan. Wind speeds average around 10 mph, but can be greater due to the winds channeling between tall buildings downtown (Ruffner and Bair, 1987).

11.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The two closest NWS weather stations are located at Palwaukee Municipal Airport (near NBIL) and O'Hare International Airport (near SPIL), WBAN 04838 and 94846, respectively.

Table 11-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity),

Table 11-3. Average Meteorological Conditions near the Illinois Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
NBIL	Palwaukee Municipal Airport 04838	Sampling Day	59.89 ± 5.42	52.00 ± 4.98	40.50 ± 4.66	46.31 ± 4.42	68.03 ± 3.07	1017.08 ± 1.60	6.89 ± 0.72
		All 2007	59.13 ± 2.30	51.09 ± 2.13	39.64 ± 2.00	45.48 ± 1.09	67.77 ± 1.23	1017.42 ± 0.67	7.01 ± 0.33
SPIL	O'Hare International Airport 94846	Sampling Day	60.47 ± 5.62	52.46 ± 5.18	40.01 ± 4.78	46.30 ± 4.54	65.79 ± 3.30	1016.87 ± 1.61	8.54 ± 0.73
		All 2007	59.52 ± 2.32	51.58 ± 2.15	39.39 ± 1.98	45.58 ± 1.89	66.16 ± 1.31	1016.97 ± 0.66	8.63 ± 0.33

BOLD = EPA-designated NATTS Site

pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 11-3 is the 95 percent confidence interval for each parameter. As shown in Table 11-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

11.2.3 Composite Back Trajectories for Sampling Days

Figures 11-4 and 11-5 are composite back trajectory maps for the Illinois monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 11-4 and 11-5 represents 100 miles.

Observations from Figures 11-4 and 11-5 include the following:

- Back trajectories originated from a variety of directions at the sites, although less frequently from the east and southeast. The predominant direction of trajectory origin is from the southwest and northwest.

- The 24-hour air shed domains were larger for these sites than for most other monitoring sites. The furthest away a trajectory originated was north-central Montana, approximately 1,000 miles away. However, nearly 80 percent of trajectories originated within 500 miles of the sites.

11.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations at Palwaukee Municipal Airport (for NBIL) and O’Hare International Airport (for SPIL) were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 11-6 and 11-7 are the wind roses for the Illinois monitoring sites on days that samples were collected.

Observations from Figure 11-6 for NBIL include the following:

- Winds from a variety of directions were observed near NBIL, although southeasterly winds were observed the least.

Figure 11-4. Composite Back Trajectory Map for NBIL

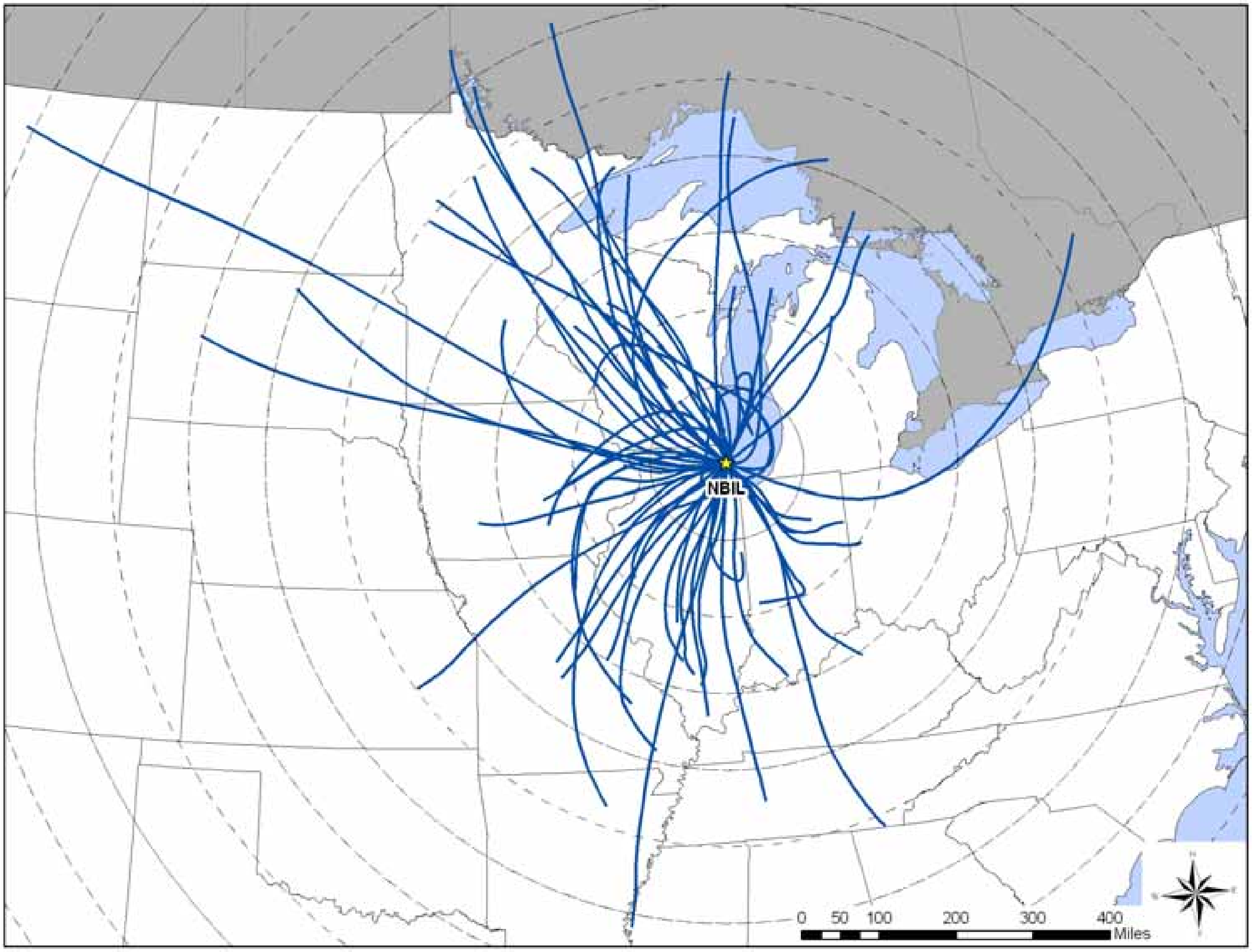


Figure 11-5. Composite Back Trajectory Map for SPIL

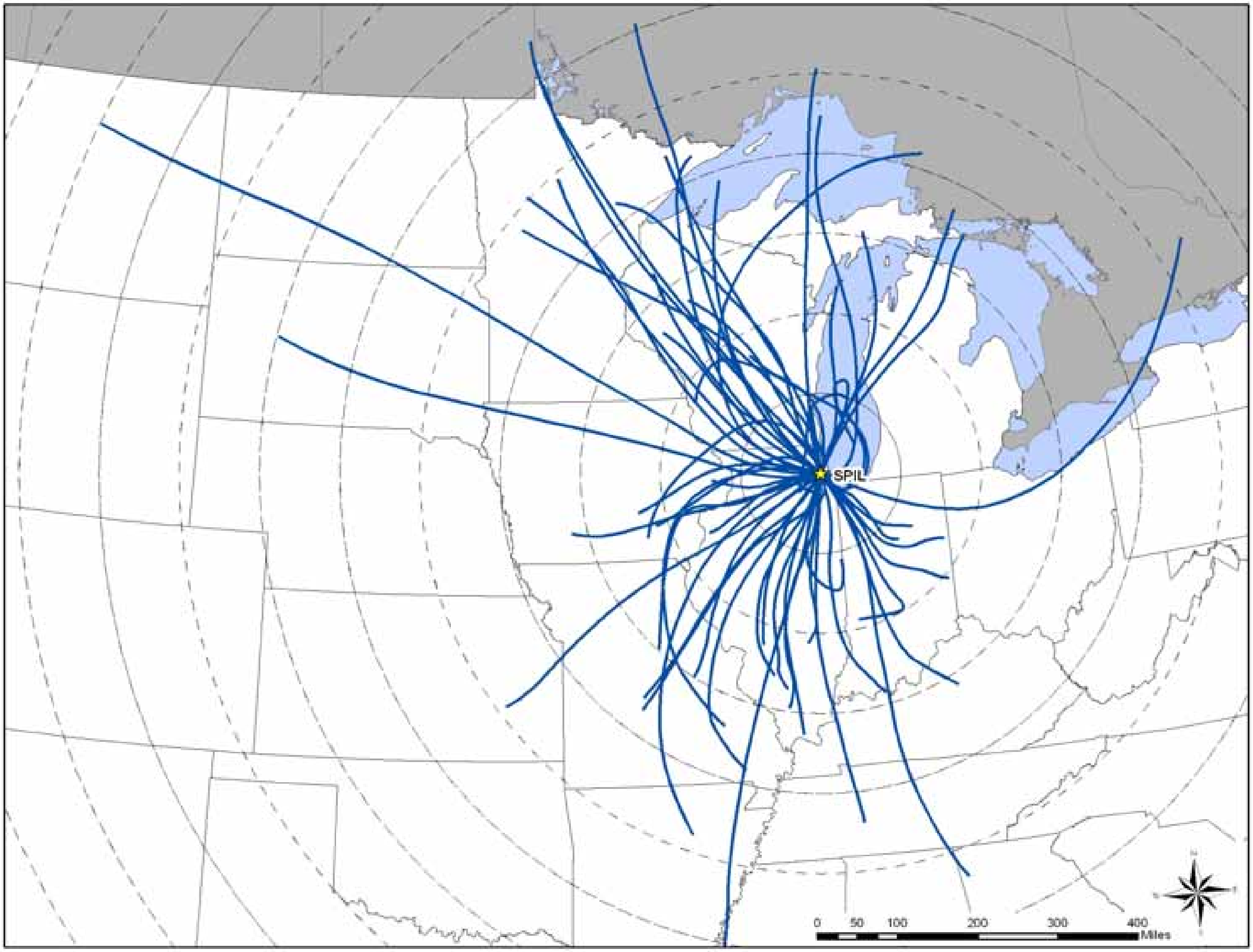


Figure 11-6. Wind Rose for NBIL Sampling Days

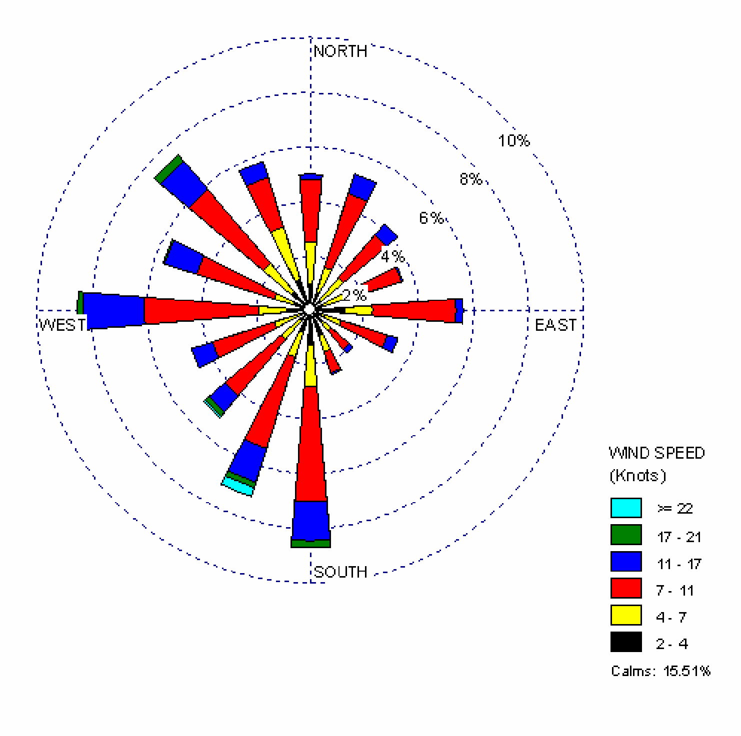
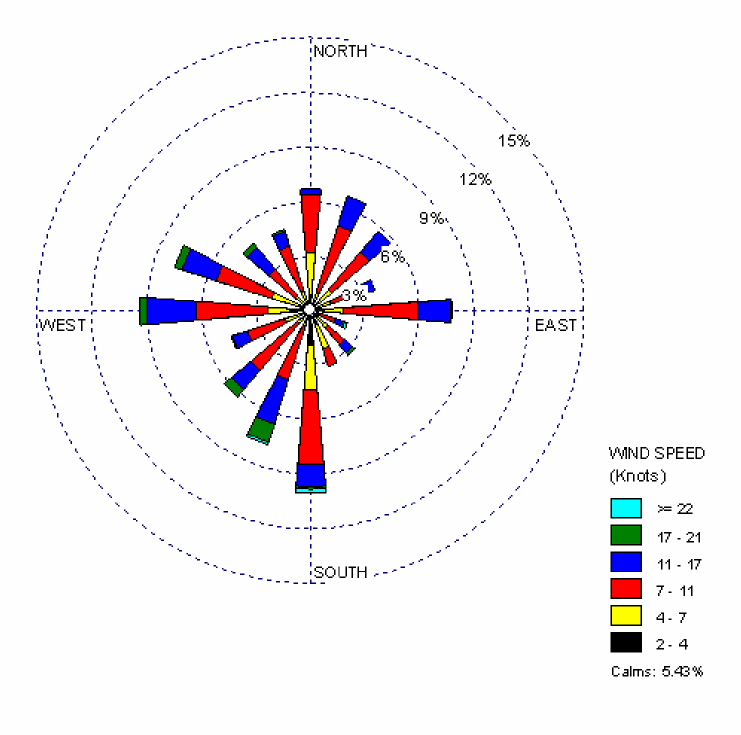


Figure 11-7. Wind Rose for SPIL Sampling Days



- Calm winds were observed for nearly 16 percent of the hourly measurements. Winds exceeding 11 knots made up approximately 14 percent of observations and were most often out of the south or southwest.

Observations from Figure 11-7 for SPIL include the following:

- The wind rose for SPIL is similar to the wind rose for NBIL, in regards to the wind direction observations.

- Calm winds were observed for five percent of the hourly measurements. Winds exceeding 11 knots made up approximately 24 percent of observations and were most often out of the south or southwest.

11.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Illinois monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 11-4 presents the pollutants that failed at least one screen for each Illinois monitoring site and highlights each site's pollutants of interest (shaded). NBIL sampled for VOC, carbonyls, SNMOC, metals (PM_{10}), and hexavalent chromium; SPIL sampled for VOC and carbonyls only.

Observations from Table 11-4 include the following:

- Although NBIL sampled more pollutants groups than SPIL, the total number of failed screens and pollutants failing screens was higher for SPIL.

- Eighteen pollutants with a total of 421 measured concentrations failed screen for NBIL.

- Twelve pollutants with a total of 432 measured concentrations failed screens for SPIL.

- Eight pollutants of interest were common to both sites: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, *p*-dichlorobenzene, and tetrachloroethylene.

Table 11-4. Comparison of Measured Concentrations and EPA Screening Values for the Illinois Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Northbrook, Illinois – NBIL					
Carbon Tetrachloride	60	60	100.00	14.25	14.25
Benzene	60	60	100.00	14.25	28.50
Arsenic (PM_{10})	56	58	96.55	13.30	41.81
Acrolein	55	55	100.00	13.06	54.87
Acetaldehyde	42	58	72.41	9.98	64.85
1,3-Butadiene	38	56	67.86	9.03	73.87
Manganese (PM_{10})	33	58	56.90	7.84	81.71
Tetrachloroethylene	29	59	49.15	6.89	88.60
p-Dichlorobenzene	17	44	38.64	4.04	92.64
Formaldehyde	15	58	25.86	3.56	96.20
Dichloromethane	4	60	6.67	0.95	97.15
Nickel (PM_{10})	3	58	5.17	0.71	97.86
Chloroform	2	60	3.33	0.48	98.34
Acrylonitrile	2	2	100.00	0.48	98.81
1,2-Dichloroethane	2	3	66.67	0.48	99.29
Hexachloro-1,3-butadiene	1	1	100.00	0.24	99.52
Trichloroethylene	1	39	2.56	0.24	99.76
Hexavalent Chromium	1	45	2.22	0.24	100.00
Total	421	834	50.48		
Schiller Park, Illinois – SPIL					
Acetaldehyde	59	60	98.33	13.66	13.66
Benzene	58	58	100.00	13.43	27.08
Formaldehyde	57	60	95.00	13.19	40.28
Acrolein	57	57	100.00	13.19	53.47
Carbon Tetrachloride	57	58	98.28	13.19	66.67
1,3-Butadiene	54	57	94.74	12.50	79.17
Tetrachloroethylene	46	58	79.31	10.65	89.81
p-Dichlorobenzene	20	49	40.82	4.63	94.44
Trichloroethylene	17	50	34.00	3.94	98.38
Acrylonitrile	4	4	100.00	0.93	99.31
Dichloromethane	2	57	3.51	0.46	99.77
Chloromethylbenzene	1	1	100.00	0.23	100.00
Total	432	569	75.92		

- Of the eight common pollutants of interest, 100 percent of the measured detections of acrolein and benzene failed screens for NBIL and SPIL.

- Of the pollutants with at least one failed screen, 50 percent of measurements failed screens for NBIL, while 76 percent failed screens for SPIL.

11.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Illinois monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

11.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 11-5, where applicable.

Observations for NBIL from Table 11-5 include the following:

- The pollutants with the highest daily average concentrations by mass were benzene (0.82 ± 0.38 $\mu g/m^3$), formaldehyde (0.79 ± 0.12 $\mu g/m^3$), and acetaldehyde (0.73 ± 0.11 $\mu g/m^3$).

- As shown in Tables 4-9 through 4-11, of the program-level pollutants of interest, NBIL had the fifth highest daily average concentration of arsenic (PM_{10}) and third highest daily average concentration of *p*-dichlorobenzene. In addition, the NBIL daily average concentration of carbon tetrachloride was among the 10 highest average concentrations for all NATTS and UATMP sites. However, concentrations of carbon tetrachloride were fairly uniform across the sites.

Table 11-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Illinois Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Northbrook, Illinois - NBIL								
Acetaldehyde	58	58	0.73 ± 0.11	0.83 ± 0.23	0.37 ± 0.17	0.80 ± 0.11	0.93 ± 0.24	0.73 ± 0.11
Acrolein	55	60	0.54 ± 0.22	0.42 ± 0.31	0.68 ± 0.62	0.53 ± 0.34	0.35 ± 0.07	0.50 ± 0.20
Arsenic (PM$_{10}$)	58	58	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Benzene	60	60	0.82 ± 0.38	0.75 ± 0.42	0.50 ± 0.15	0.77 ± 0.46	1.27 ± 1.34	0.82 ± 0.38
1,3-Butadiene	56	60	0.05 ± 0.01	0.05 ± 0.01	0.04 ± 0.01	0.05 ± 0.01	0.06 ± 0.02	0.05 ± 0.01
Carbon Tetrachloride	60	60	0.66 ± 0.03	0.63 ± 0.07	0.69 ± 0.07	0.62 ± 0.06	0.69 ± 0.04	0.66 ± 0.03
p-Dichlorobenzene	44	60	0.33 ± 0.19	0.30 ± 0.31	0.31 ± 0.36	0.24 ± 0.29	0.18 ± 0.13	0.26 ± 0.15
Formaldehyde	58	58	0.79 ± 0.12	1.01 ± 0.24	0.47 ± 0.14	1.00 ± 0.29	0.72 ± 0.15	0.79 ± 0.12
Manganese (PM$_{10}$)	58	58	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01
Tetrachloroethylene	59	60	0.25 ± 0.07	0.18 ± 0.05	0.17 ± 0.06	0.33 ± 0.20	0.33 ± 0.14	0.25 ± 0.07
Schiller Park, Illinois - SPIL								
Acetaldehyde	60	60	1.40 ± 0.14	1.35 ± 0.35	1.25 ± 0.17	1.22 ± 0.23	1.79 ± 0.28	1.40 ± 0.14
Acrolein	57	58	0.41 ± 0.06	0.26 ± 0.07	0.33 ± 0.07	0.61 ± 0.19	0.42 ± 0.06	0.40 ± 0.06
Benzene	58	58	0.84 ± 0.12	0.72 ± 0.17	0.62 ± 0.13	0.92 ± 0.25	1.15 ± 0.29	0.84 ± 0.12
1,3-Butadiene	57	58	0.12 ± 0.02	0.12 ± 0.03	0.09 ± 0.03	0.13 ± 0.03	0.15 ± 0.04	0.12 ± 0.02
Carbon Tetrachloride	58	58	0.69 ± 0.04	0.65 ± 0.07	0.71 ± 0.06	0.65 ± 0.11	0.73 ± 0.06	0.69 ± 0.04
p-Dichlorobenzene	49	58	0.15 ± 0.06	0.04 ± 0.01	0.16 ± 0.15	0.21 ± 0.13	0.12 ± 0.05	0.13 ± 0.06
Formaldehyde	60	60	2.40 ± 0.28	1.55 ± 0.43	2.17 ± 0.49	3.16 ± 0.50	2.69 ± 0.44	2.40 ± 0.28
Tetrachloroethylene	58	58	0.39 ± 0.07	0.30 ± 0.10	0.25 ± 0.05	0.51 ± 0.19	0.52 ± 0.17	0.39 ± 0.07
Trichloroethylene	50	58	0.60 ± 0.25	0.29 ± 0.22	0.27 ± 0.10	0.59 ± 0.26	1.00 ± 0.79	0.53 ± 0.22

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

- Concentrations of most of the pollutants of interest for NBIL did not vary significantly from season to season, although concentrations of formaldehyde and acetaldehyde were lowest during the spring.

Observations for SPIL from Table 11-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (2.40 ± 0.28 $\mu g/m^3$), acetaldehyde (1.40 ± 0.14 $\mu g/m^3$), and benzene (0.84 ± 0.12 $\mu g/m^3$). The acetaldehyde and formaldehyde concentrations were significantly higher for SPIL than for NBIL.

- As shown in Table 4-11, of the program-level pollutants of interest, SPIL had the third highest daily average concentration of tetrachloroethylene, the seventh highest daily average concentration of 1,3-butadiene, and tenth highest daily average concentration of *p*-dichlorobenzene. In addition, the daily average concentration of carbon tetrachloride was among the 10 highest average concentrations for all NATTS and UATMP sites. However, concentrations of carbon tetrachloride were fairly uniform across the sites.

- Concentrations of most of the pollutants of interest for SPIL did not vary significantly from season to season, although concentrations of formaldehyde were higher during the warmer seasons.

- Trichloroethylene appeared to be considerably higher during autumn. However, the large confidence interval indicates that outlier(s) were affecting the average.

11.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. NBIL and SPIL have sampled VOC under the UATMP and/or NATTS since 2003. Figures 11-8 through 11-11 present the three-year rolling statistical metrics graphically for benzene and 1,3-butadiene for both sites. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Observations from Figure 11-8 for benzene measurements at NBIL include the following:

- The maximum benzene concentration shown was measured in 2004.

- The rolling median and average concentrations have a decreasing trend over the time periods shown.

Figure 11-8. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at NBIL

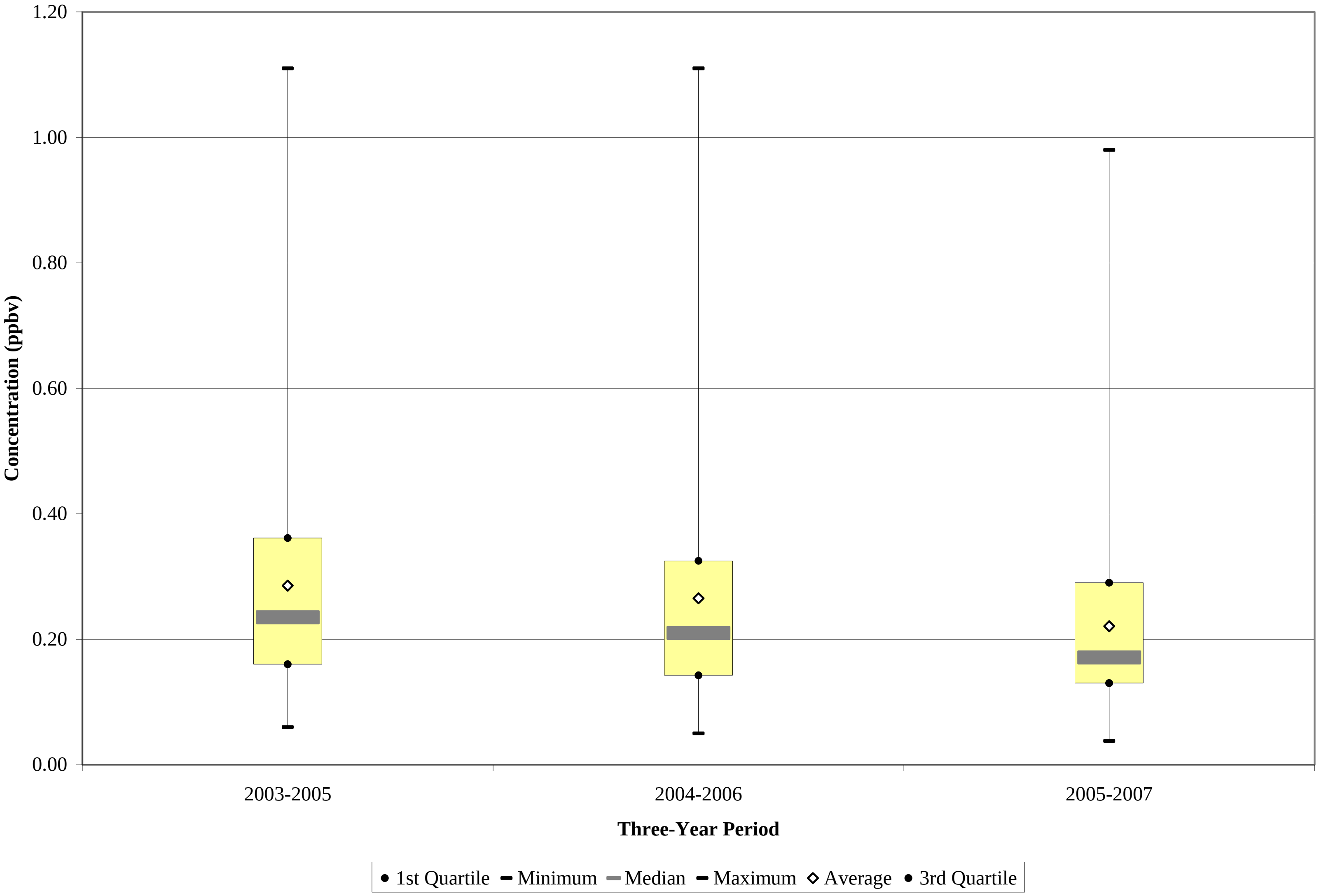


Figure 11-9. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBIL

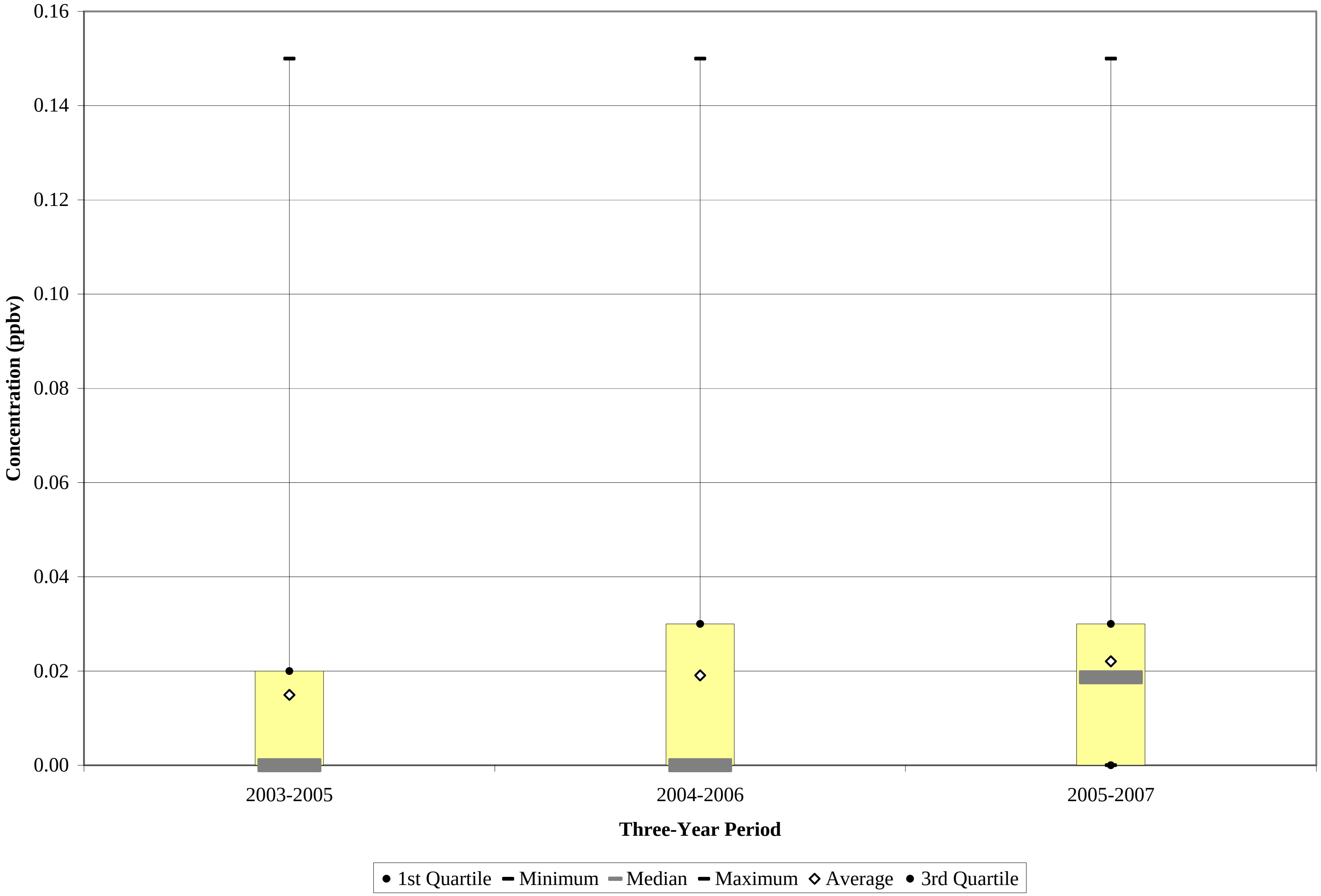


Figure 11-10. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at SPIL

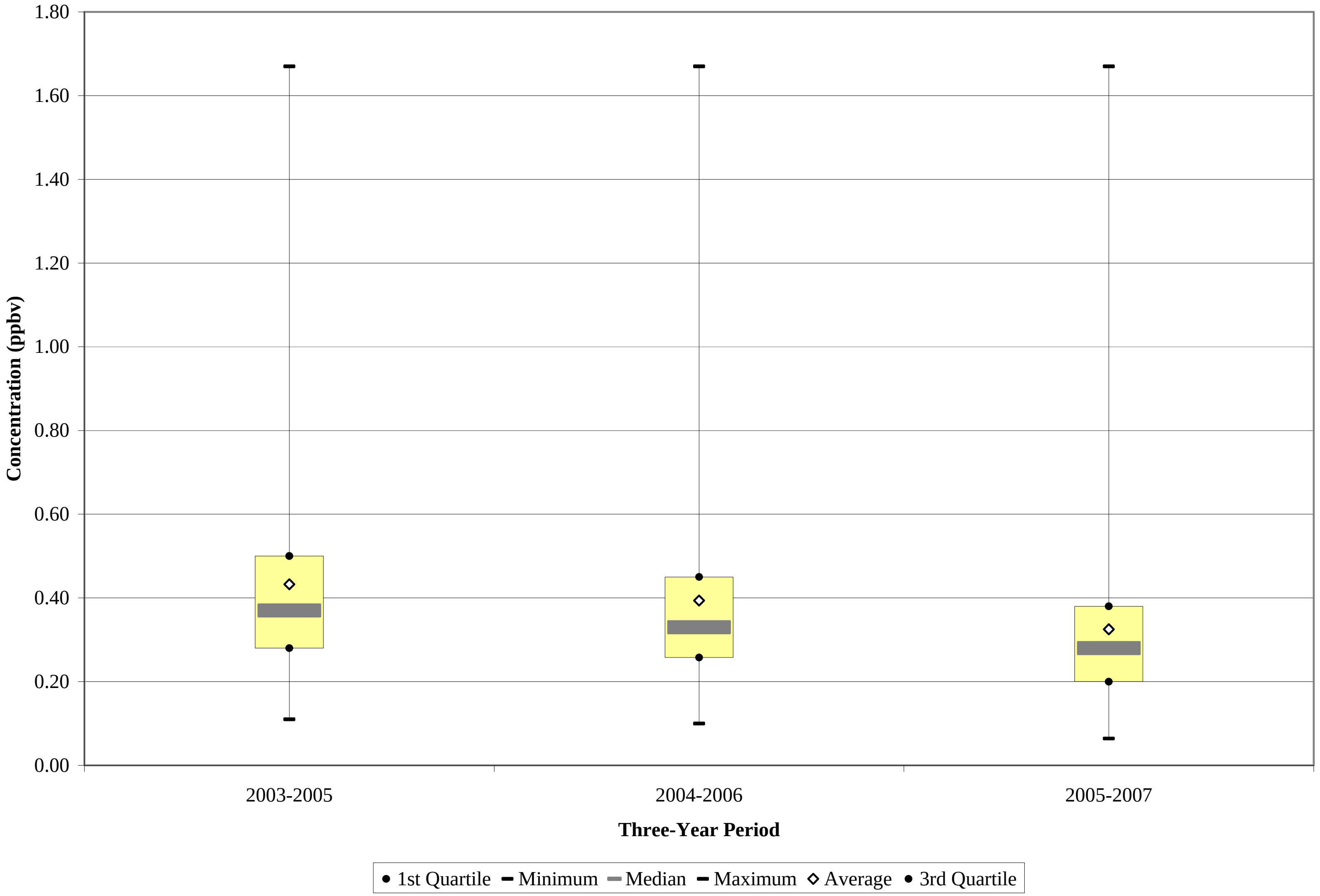
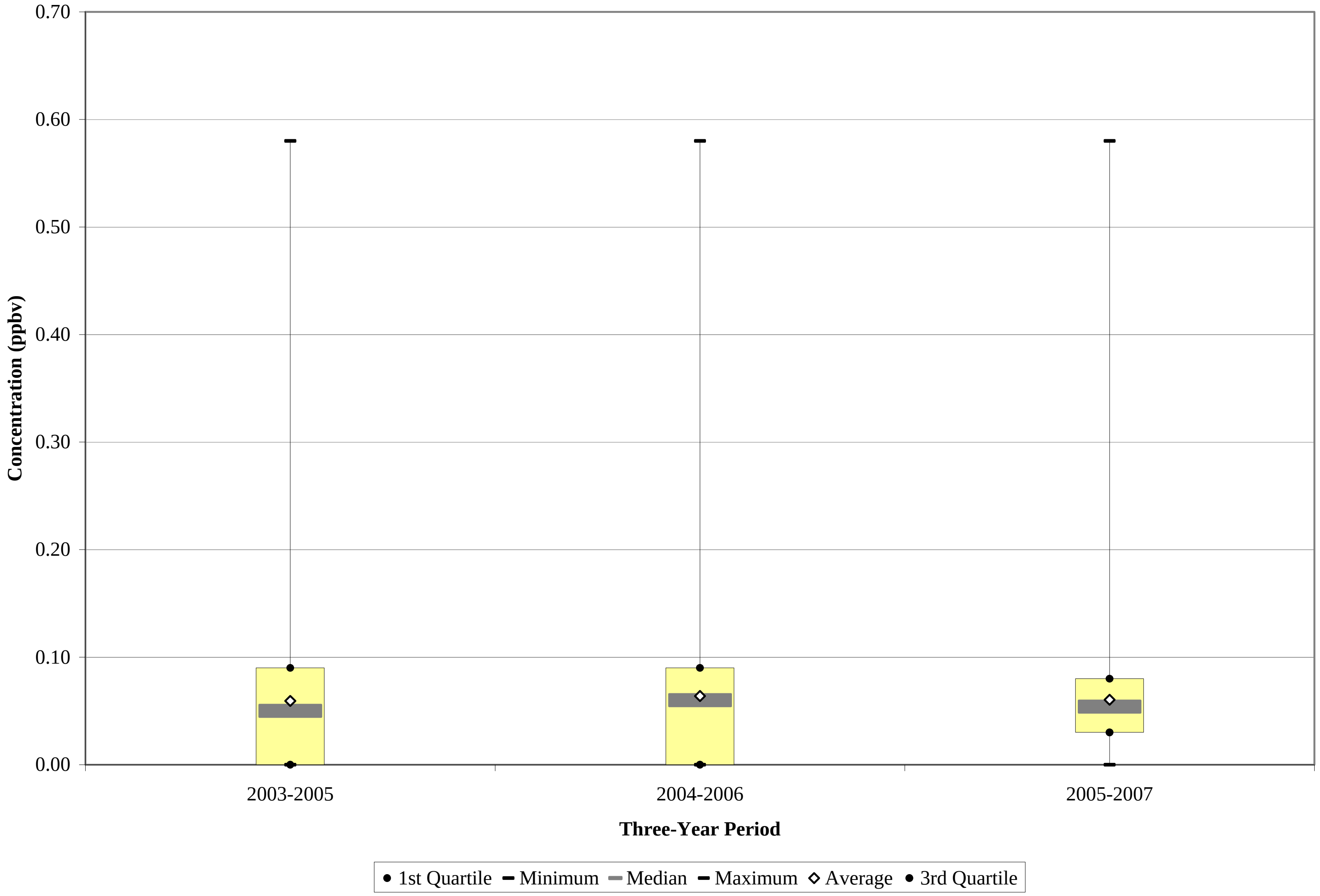


Figure 11-11. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at SPIL



- All benzene concentrations reported to AQS over the five years of sampling were measured detections.

Observations from Figure 11-9 for 1,3-butadiene measurements at NBIL include the following:

- The rolling metrics for 1,3-butadiene look very different than the rolling metrics for benzene due to the impact of the frequency of detection. The minimum, first quartile, and median concentrations for 1,3-butadiene during the 2003-2005 and 2004-2006 time frames were zero.

- As the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant increased. This pollutant was detected in 31 percent of samples during the 2003-2005 time frame; 49 percent of samples during 2004-2006; and 75 percent of samples during 2005-2007.

- As the detection rate increased, the median value increased as well. The rolling median and average concentrations shown for the 2005-2007 time frames are the most similar of the periods, which indicates less variability in the central tendency during 2005-2007.

Observations from Figure 11-10 for benzene measurements at SPIL include the following:

- The maximum benzene concentration shown was measured in 2005, which explains why the maximum concentration for each time period was the same.

- Similar to NBIL, the median and average rolling concentrations have a decreasing trend over the time periods shown.

- All benzene concentrations reported to AQS over the five years of sampling were measured detections.

Observations from Figure 11-11 for 1,3-butadiene measurements at SPIL include the following:

- The minimum and first quartile for 1,3-butadiene during the 2003-2005 and 2004-2006 time frames were zero, similar to NBIL. However, the rolling average and median concentrations were close together for each time frame for SPIL, which indicates less variability in the central tendency for this site.

- The detection rate for 1,3-butadiene also increased over the period. But the detection rate for SPIL was higher than NBIL during each time frame. This pollutant was detected in 59 percent of samples during the 2003-2005 time frame; 73 percent of samples during 2004-2006; and 87 percent of samples during 2005-2007.

- The rolling average and median concentrations changed little across the time frames shown.

11.5 Pearson Correlations

Table 11-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for NBIL from Table 11-6 include the following:

- Most of the correlations between the pollutants of interest and the meteorological parameters were less than 0.50 or greater than -0.50, which indicates that these meteorological parameters have little influence on the concentrations of these pollutants.

- However, the majority of the correlations with the temperature and moisture parameters were positive, indicating that as the temperature and moisture content increase, concentrations of the pollutants of interest may proportionally increase at NBIL.

- In addition, most of the correlations with scalar wind speed were negative, indicating that as wind speed decreases, concentrations of the pollutants of interest may increase at NBIL.

Observations for SPIL from Table 11-6 include the following:

- Formaldehyde and acrolein exhibited strong positive correlations with the temperature and moisture parameters, indicating that as the temperature and moisture content increase, concentrations of these pollutants proportionally increase at SPIL.

- Although most of the correlations between the pollutants of interest and the temperature and moisture parameters were less than 0.50 or greater than -0.50, they were mostly positive, indicating that as the temperature and moisture content increase, concentrations of the pollutants of interest may proportionally increase at SPIL.

- All of the correlations with scalar wind speed were negative, indicating that as wind speed decreases, concentrations of the pollutants of interest may increase at SPIL.

Table 11-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Illinois Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Northbrook, Illinois – NBIL								
Acetaldehyde	58	0.01	-0.03	0.03	0.00	0.21	-0.01	-0.46
Acrolein	55	0.19	0.21	0.16	0.17	-0.15	0.06	0.19
Arsenic (PM_{10})	58	0.34	0.36	0.40	0.38	0.13	-0.10	-0.43
Benzene	60	0.21	0.21	0.20	0.20	-0.04	-0.11	-0.04
1,3-Butadiene	56	0.10	0.07	0.06	0.06	0.01	0.09	-0.34
Carbon Tetrachloride	60	-0.07	-0.05	-0.06	-0.07	0.02	0.11	<0.01
p-Dichlorobenzene	44	0.09	0.11	0.04	0.07	-0.24	0.06	0.32
Formaldehyde	58	-0.02	-0.04	-0.02	-0.03	0.04	0.12	-0.24
Manganese (PM_{10})	58	0.32	0.30	0.21	0.25	-0.30	-0.02	-0.16
Tetrachloroethylene	59	0.35	0.34	0.33	0.34	-0.06	-0.07	-0.33
Schiller Park, Illinois – SPIL								
Acetaldehyde	60	0.00	-0.03	-0.03	-0.03	-0.05	0.13	-0.30
Acrolein	57	0.49	0.50	0.48	0.50	-0.11	-0.04	-0.27
Benzene	58	0.25	0.24	0.26	0.24	0.04	0.02	-0.47
1,3-Butadiene	57	-0.05	-0.05	-0.02	-0.04	0.11	0.05	-0.45
Carbon Tetrachloride	58	0.08	0.08	0.02	0.06	-0.19	-0.05	-0.09
p-Dichlorobenzene	49	0.31	0.32	0.29	0.31	-0.13	-0.03	-0.22
Formaldehyde	60	0.62	0.61	0.56	0.59	-0.24	0.00	-0.35
Tetrachloroethylene	58	0.21	0.20	0.20	0.20	-0.05	-0.02	-0.41
Trichloroethylene	50	0.27	0.23	0.25	0.24	0.01	0.00	-0.42

11.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

11.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Illinois monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 11-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein from Table 11-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- For both sites, all of the seasonal averages of acrolein exceeded the intermediate MRL.
- Acrolein has no chronic MRL. Therefore, chronic risk could not be evaluated.

11.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Illinois monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and

Table 11-7. MRL Risk Screening Assessment Summary for the Illinois Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average[1] (µg/m^3)
NBIL	TO-15	Acrolein	7.00	0/55	0.09	**0.42 ± 0.31**	**0.68 ± 0.62**	**0.53 ± 0.34**	**0.35 ± 0.07**	--	0.50 ± 0.20
SPIL	TO-15	Acrolein	7.00	0/57	0.09	**0.26 ± 0.07**	**0.33 ± 0.07**	**0.61 ± 0.19**	**0.42 ± 0.06**	--	0.40 ± 0.06

BOLD = EPA-designated NATTS Site
-- = an MRL risk factor is not available
BOLD = exceedance of the intermediate or chronic MRL

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

noncancer surrogate risk approximations are presented in Table 11-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the Illinois monitoring sites is as follows:

- The census tract for NBIL is 17031801500, which had a population of 6,227, and represented approximately 0.1 percent of the Cook County population in 2000.

- The census tract for SPIL is 17031811600, which had a population of 6,372, and also represented approximately 0.1 percent of the county population in 2000.

Observations for NBIL from Table 11-8 include the following:

- The pollutants with the highest concentrations according to NATA were formaldehyde, acetaldehyde, and benzene.

- The pollutants with the highest cancer risks according to NATA were benzene, 1,3-butadiene, and acetaldehyde.

- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (8.98).

- The pollutants with the highest 2007 annual averages were chloroform, benzene, and formaldehyde, which were all lower than the modeled concentrations from NATA.

- The pollutants with the highest surrogate cancer risk approximations were carbon tetrachloride, benzene, and hexachloro-1,3-butadidne.

- Acrolein was the only pollutant with a surrogate noncancer risk approximation greater than 1.0 (24.84), although this approximation was three times the NATA-modeled noncancer risk.

Observations for SPIL from Table 11-8 include the following:

- The pollutants with the highest concentrations according to NATA were acetaldehyde, formaldehyde, and benzene, similar to NBIL.

- The pollutants with the highest cancer risks according to NATA were benzene, 1,3-butadiene, and acetaldehyde, similar to NBIL.

- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (11.07).

Table 11-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Illinois

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE ($\mu g/m^3$)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration ($\mu g/m^3$)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] ($\mu g/m^3$)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Northbrook, Illinois (NBIL) - Census Tract ID 17031801500								
Acetaldehyde	0.000002	0.009	2.71	5.98	0.30	0.73 ± 0.11	1.46	0.08
Acrolein	--	0.00002	0.18	--	8.98	0.50 ± 0.20	--	24.84
Acrylonitrile	0.000068	0.002	<0.01	0.06	<0.01	0.03 ± <0.01	1.74	0.01
Arsenic (PM_{10})	0.0043	0.00003	<0.01	0.06	<0.01	<0.01 ± <0.01	3.71	0.03
Benzene	0.000007	0.03	2.63	20.55	0.08	0.82 ± 0.38	5.73	0.03
1,3-Butadiene	0.00003	0.002	0.32	9.59	0.15	0.05 ± 0.01	1.50	0.02
Carbon Tetrachloride	0.000015	0.04	0.21	3.22	0.01	0.66 ± 0.03	9.87	0.02
Chloroform	--	0.098	0.11	--	<0.01	0.83 ± 0.51	--	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.04	0.43	<0.01	0.26 ± 0.15	2.82	<0.01
1,2-Dichloroethane	0.000026	2.4	0.05	1.24	<0.01	0.04 ± <0.01	1.11	<0.01
Dichloromethane	0.00000047	1	0.62	0.29	<0.01	0.62 ± 0.17	0.29	<0.01
Formaldehyde	5.5E-09	0.0098	2.73	0.01	0.27	0.79 ± 0.12	<0.01	0.08
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.19 ± <0.01	4.23	<0.01
Hexavalent Chromium	0.012	0.0001	<0.01	0.73	<0.01	<0.01 ± <0.01	0.26	<0.01
Manganese (PM_{10})	--	0.00005	<0.01	--	0.01	0.01 ± <0.01	--	0.16
Nickel (PM_{10})	0.00016	0.000065	<0.01	0.05	0.01	<0.01 ± <0.01	0.18	0.02
Tetrachloroethylene	0.000005	0.27	0.24	1.43	<0.01	0.25 ± 0.07	1.25	<0.01
Trichloroethylene	0.000002	0.6	0.25	0.51	<0.01	0.14 ± 0.04	0.28	<0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 11-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Illinois (Continued)

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (µg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Schiller Park, Illinois (SPIL) - Census Tract ID 17031811600								
Acetaldehyde	0.000002	0.009	3.31	7.32	0.36	1.40 ± 0.14	2.80	0.16
Acrolein	--	0.00002	0.22	--	11.07	0.40 ± 0.06	--	20.22
Acrylonitrile	0.000068	0.002	<0.01	0.05	<0.01	0.03 ± <0.01	1.76	0.01
Benzene	0.000007	0.03	2.79	21.78	0.09	0.84 ± 0.12	5.91	0.03
1,3-Butadiene	0.00003	0.002	0.31	9.21	0.15	0.12 ± 0.02	3.69	0.06
Carbon Tetrachloride	0.000015	0.04	0.21	3.16	0.01	0.69 ± 0.04	10.29	0.02
Chloromethylbenzene	0.000049	--	<0.01	<0.01	--	0.03 ± <0.01	1.36	--
***p*-Dichlorobenzene**	0.000011	0.8	0.06	0.64	<0.01	0.13 ± 0.06	1.45	<0.01
Dichloromethane	0.00000047	1	1.11	0.54	<0.01	0.59 ± 0.14	0.28	<0.01
Formaldehyde	5.5E-09	0.0098	2.99	0.01	0.30	2.40 ± 0.28	0.01	0.25
Tetrachloroethylene	0.000005	0.27	0.41	2.41	<0.01	0.39 ± 0.07	1.96	<0.01
Trichloroethylene	0.000002	0.6	1.72	3.45	<0.01	0.53 ± 0.22	1.05	<0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

- The pollutants with the highest 2007 annual averages were formaldehyde, acetaldehyde, and benzene.

- The pollutants with the highest surrogate cancer risk approximations were carbon tetrachloride, 1,3-butadiene, and acetaldehyde.

- Acrolein was the only pollutant with a noncancer risk approximation greater than 1.0 (20.22), which was twice the modeled risk from NATA.

11.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 11-9 and 11-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 11-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest surrogate cancer risk approximations (in-a-million), as calculated from the annual averages. Table 11-10 presents similar information, but identifies the 10 pollutants with the highest surrogate noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 11.3, SPIL sampled for VOC and carbonyl compounds. NBIL sampled for these pollutants as well, but also sampled for SNMOC, metals, and hexavalent chromium. In addition, the cancer and noncancer risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated. NBIL and SPIL sampled year-round for each pollutant group mentioned above.

Observations from Table 11-9 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Cook County.

Table 11-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Illinois

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Northbrook, Illinois (NBIL) – Cook County					
Benzene	3,598.91	Benzene	2.81E-02	Carbon Tetrachloride	9.87
Formaldehyde	2,321.18	1,3-Butadiene	1.41E-02	Benzene	5.73
Acetaldehyde	1,270.31	Arsenic, PM	1.32E-02	Hexachloro-1,3-butadiene	4.23
Tetrachloroethylene	1,167.17	Hexavalent Chromium	1.05E-02	Arsenic	3.71
p-Dichlorobenzene	523.43	Coke Oven Emissions	1.04E-02	*p*-Dichlorobenzene	2.82
1,3-Butadiene	470.95	Naphthalene	8.73E-03	Acrylonitrile	1.74
Trichloroethylene	420.80	Tetrachloroethylene	6.89E-03	1,3-Butadiene	1.50
Dichloromethane	316.75	*p*-Dichlorobenzene	5.76E-03	Acetaldehyde	1.46
Naphthalene	256.74	Acetaldehyde	2.79E-03	Tetrachloroethylene	1.25
1,3-Dichloropropene	89.83	Cadmium, PM	2.52E-03	1,2-Dichloroethane	1.11
Schiller Park, Illinois (SPIL) – Cook County					
Benzene	3,598.91	Benzene	2.81E-02	Carbon Tetrachloride	10.29
Formaldehyde	2,321.18	1,3-Butadiene	1.41E-02	Benzene	5.91
Acetaldehyde	1,270.31	Arsenic, PM	1.32E-02	1,3-Butadiene	3.69
Tetrachloroethylene	1,167.17	Hexavalent Chromium	1.05E-02	Acetaldehyde	2.80
p-Dichlorobenzene	523.43	Coke Oven Emissions	1.04E-02	Tetrachloroethylene	1.96
1,3-Butadiene	470.95	Naphthalene	8.73E-03	Acrylonitrile	1.76
Trichloroethylene	420.80	Tetrachloroethylene	6.89E-03	*p*-Dichlorobenzene	1.45
Dichloromethane	316.75	*p*-Dichlorobenzene	5.76E-03	Chloromethylbenzene	1.36
Naphthalene	256.74	Acetaldehyde	2.79E-03	Trichloroethylene	1.05
1,3-Dichloropropene	89.83	Cadmium, PM	2.52E-03	Dichloromethane	0.28

Table 11-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Illinois

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Northbrook, Illinois (NBIL) – Cook County					
Toluene	12,266.89	Acrolein	5,378,964.91	Acrolein	24.84
Xylenes	8,434.64	Formaldehyde	236,855.60	Manganese	0.16
Benzene	3,598.91	1,3-Butadiene	235,474.70	Acetaldehyde	0.08
Methanol	3,403.96	Manganese, PM	155,030.41	Formaldehyde	0.08
Formaldehyde	2,321.18	Acetaldehyde	141,145.03	Arsenic	0.03
Hexane	1,950.17	Benzene	119,963.72	Benzene	0.03
Ethylbenzene	1,559.68	Bromomethane	113,355.88	1,3-Butadiene	0.02
Methyl isobutyl ketone	1,483.65	Nickel, PM	105,702.86	Nickel	0.02
Acetaldehyde	1,270.31	Arsenic, PM	101,996.12	Carbon Tetrachloride	0.02
Tetrachloroethylene	1,167.17	Naphthalene	85,581.25	Acrylonitrile	0.01
Schiller Park, Illinois (SPIL) – Cook County					
Toluene	12,266.89	Acrolein	5,378,964.91	Acrolein	20.22
Xylenes	8,434.64	Formaldehyde	236,855.60	Formaldehyde	0.25
Benzene	3,598.91	1,3-Butadiene	235,474.70	Acetaldehyde	0.16
Methanol	3,403.96	Manganese, PM	155,030.41	1,3-Butadiene	0.06
Formaldehyde	2,321.18	Acetaldehyde	141,145.03	Benzene	0.03
Hexane	1,950.17	Benzene	119,963.72	Carbon Tetrachloride	0.02
Ethylbenzene	1,559.68	Bromomethane	113,355.88	Acrylonitrile	0.01
Methyl isobutyl ketone	1,483.65	Nickel, PM	105,702.86	Tetrachloroethylene	<0.01
Acetaldehyde	1,270.31	Arsenic, PM	101,996.12	Trichloroethylene	<0.01
Tetrachloroethylene	1,167.17	Naphthalene	85,581.25	Dichloromethane	<0.01

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Cook County were benzene, 1,3-butadiene, and arsenic.

- Six of the highest emitted pollutants in Cook County also had the highest toxicity-weighted emissions.

- For both monitoring sites, carbon tetrachloride and benzene had the highest surrogate cancer risk approximations. Carbon tetrachloride did not appear on either emissions-based list, while benzene ranked highest on both.

Observations from Table 11-10 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Cook County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Cook County were acrolein, formaldehyde, and 1,3-butadiene.

- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- The pollutant with the highest noncancer risk approximation was acrolein. Acrolein was also the pollutant with the highest toxicity-weighted emissions, yet this pollutant's emissions ranked 26th for Cook County.

11.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *The pollutants of interest common to each Illinois monitoring site were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, p-dichlorobenzene, and tetrachloroethylene.*

- *Formaldehyde, benzene, and acetaldehyde had the highest daily average concentration for both of the monitoring sites.*

- *Seasonal averages of acrolein exceeded the ATSDR intermediate MRL health benchmark for both sites.*

12.0 Sites in Indiana

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP sites in Indiana, and integrates these concentrations with emissions, meteorological, and risk information.

12.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. Three Indiana sites (ININ, IDIN, and WPIN) are located in the Indianapolis-Carmel, IN MSA. INDEM is located in the Chicago-Naperville-Joliet, IL-IN-WI MSA. Figures 12-1 through 12-4 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban locations. Figures 12-5 through 12-7 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 12-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

IDIN is located in southwest Indianapolis at Stout Field, a National Guard Armory and former airfield. Figure 12-1 shows that the area surrounding IDIN is fairly industrialized, with Olin Brass and Reilly Tar and Chemical just to the east of the monitoring site. The placement of this site is based on results from NATA. Heavily traveled roadways, including I-70, are located less than a mile from the monitoring site.

ININ is located in central Indianapolis, about a half-mile south of I-70. Residential areas are located to the west of the site, while industrial areas are located to the east, as shown in Figure 12-2. The placement of this site is also based on results from NATA.

WPIN is located in northeast Indianapolis, at Washington Park near East 30th Street. Figure 12-3 shows that the area surrounding WPIN is suburban and residential, with little industry in close proximity.

Figure 12-1. Indianapolis, Indiana (IDIN) Monitoring Site

©2008 Google/©NAVTECH Scale: 3cm = 200m

Figure 12-2. Indianapolis, Indiana (ININ) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 12-3. Indianapolis, Indiana (WPIN) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 12-4. Gary, Indiana (INDEM) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 12-5. NEI Point Sources Located Within 10 Miles of IDIN, ININ, and WPIN

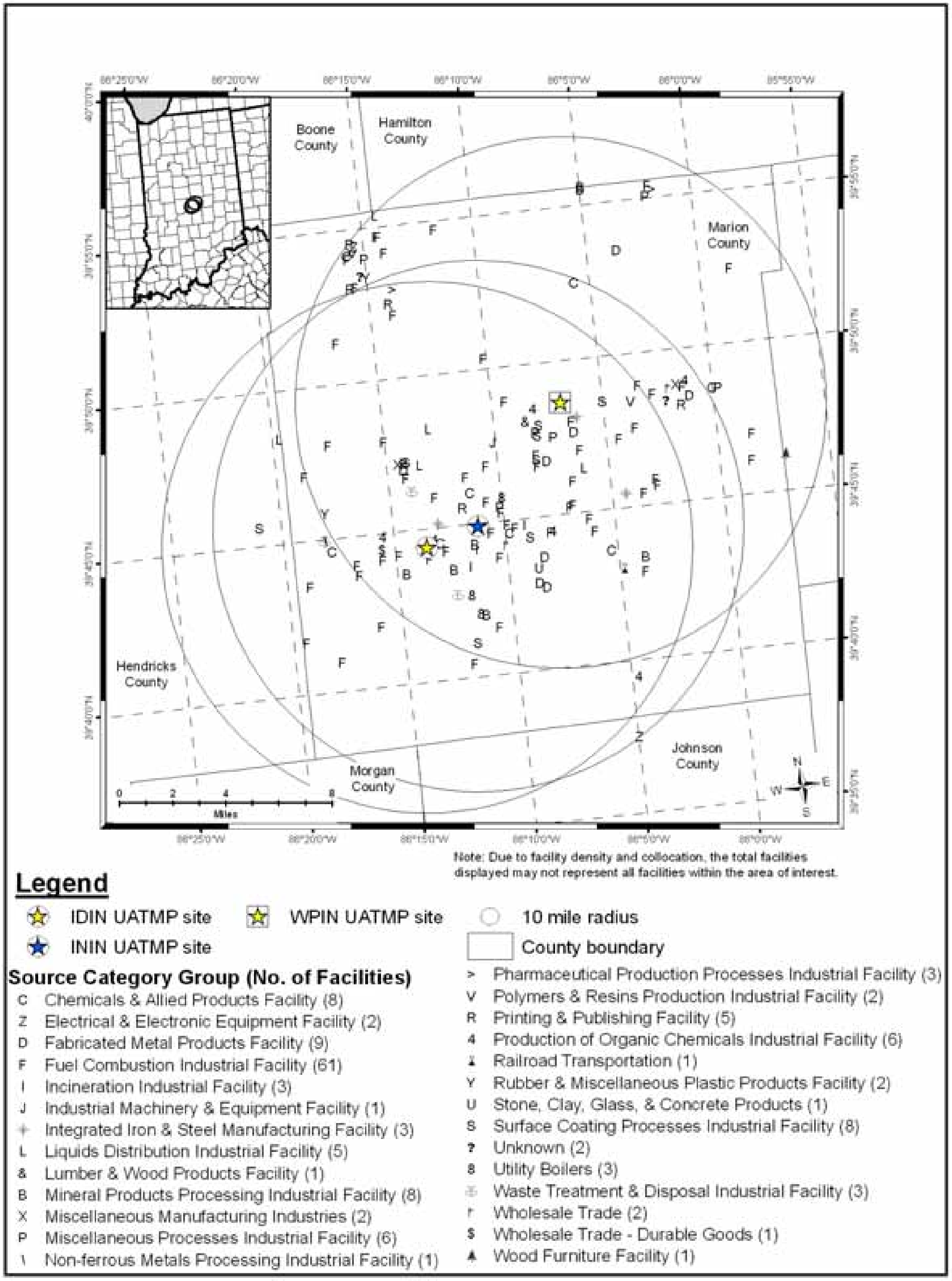


Figure 12-6. NEI Point Sources Located Within 10 Miles of INDEM

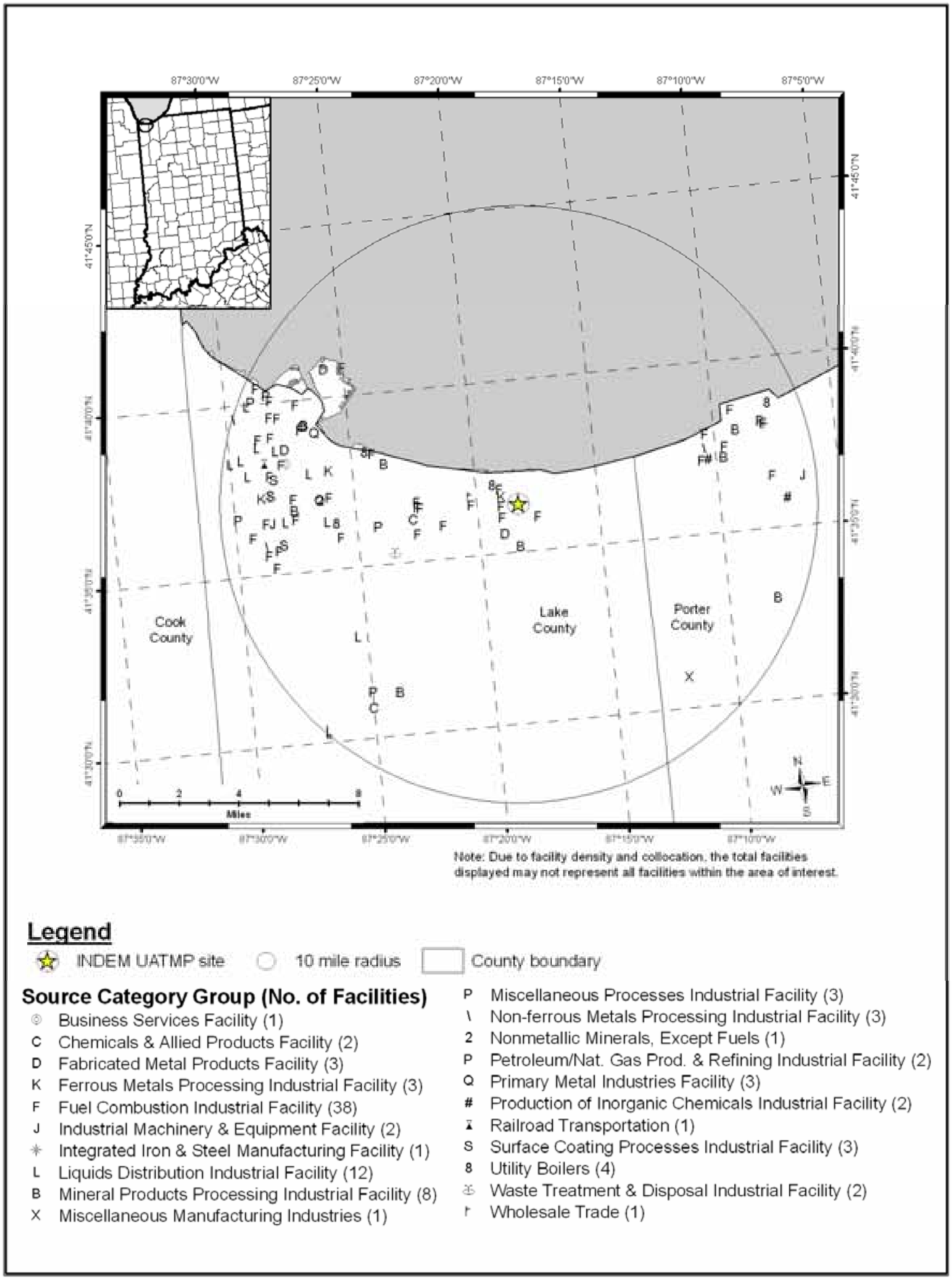


Table 12-1. Geographical Information for the Indiana Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
IDIN	18-097-0085	Indianapolis	Marion	Indianapolis-Carmel, IN	39.740383, -86.225950	Military Reservation	Urban/City Center	This site is located at Stout Field National Guard Armory. This monitor is strategically located based on an evaluation of U.S. EPA's 1996 and 1999 NATA; its proximity to major sources for HAP emissions; its proximity to areas where the public lives and congregates; and its history of housing operating monitors. This site monitors for metals, carbonyls, and VOC.
INDEM	18-089-0022	Gary	Lake	Chicago-Naperville-Joliet, IL-IN-WI	41.606667, -87.304722	Industrial	Urban/City Center	This site is located on property now owned by the Dunes National Lakeshore. It is approximately one-half to three-quarters of a mile south west of the USX coking battery for their mill. The site is part of the Chicago PAMS network. It is considered a Type 2 or source site. Monitoring for ozone, NO/NO_x, ozone precursors, and carbonyls began in 1995 as the network was deployed in Wisconsin, Illinois, Indiana, and Michigan. Other parameters monitored at this location are SO_2, PM_{10}, $PM_{2.5}$, speciated $PM_{2.5}$, and several meteorological parameters.
ININ	18-097-0057	Indianapolis	Marion	Indianapolis-Carmel, IN	39.748889, -86.186243	Residential	Urban/City Center	This site is located on South Harding Street. This monitor is strategically located based on an evaluation of U.S. EPA's 1996 and 1999 NATA; its proximity to major sources for HAP emissions; its proximity to areas where the public lives and congregates; and its history of housing operating monitors. This site monitors for metals, carbonyls, VOC, and hexavalent chromium.

Table 12-1. Geographical Information for the Indiana Monitoring Sites (Continued)

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
WPIN	18-097-0078	Indianapolis	Marion	Indianapolis-Carmel, IN	39.811097, -86.114469	Residential	Suburban	The Washington Park Monitoring Site is located approximately 3.75 miles from the center of the city in the northeast part of Indianapolis. The nearest main roads are 30th St. (40 meters to the south) and Keystone Ave. (600 meters to the west). The site is located on the south end of Washington Park in a mostly residential neighborhood. No significant industry is located near the site. Washington Park was established in 1999 as a $PM_{2.5}$ and toxics monitoring location. It collects $PM_{2.5}$ mass for compliance purposes, along with $PM_{2.5}$ speciation and continuous $PM_{2.5}$. Air toxics monitoring began as one of the sites in the four-city Children's Health Initiative. Currently, samples collected at the site are analyzed for sixty-two VOC/HAPS. Carbonyl compounds and metals are also monitored. It is considered a long term trends site for Indianapolis. Future plans include possible designation as an NCore Site.

Figure 12-5 shows that IDIN, ININ, and WPIN are located within 10 miles of many point sources, most of which are located towards the center of Marion County. Facilities involved in processes utilizing fuel combustion are the most numerous emission sources in the area.

INDEM is located in Gary, Indiana, a few miles east of the Indiana-Illinois border and southeast of Chicago. Gary is located on the southernmost bank of Lake Michigan. The site is just north of I-90 and I-65. Although INDEM resides on the Indiana Dunes National Lakeshore, the surrounding area is highly industrialized, as shown in Figure 12-4. Figure 12-6 shows that the majority of point sources are located to the west of INDEM. The sources closest to INDEM are involved in ferrous metals processing or processes utilizing fuel combustion. Similar to Indianapolis, facilities involved in processes utilizing fuel combustion are the most numerous sources within the 10-mile radius.

Table 12-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Indiana monitoring sites. County-level vehicle registration and population data for Marion and Lake Counties were obtained from the Indiana Bureau of Motor Vehicles and the U.S. Census Bureau. Table 12-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 12-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. For the Indianapolis sites, data from I-70 was obtained; for INDEM, data for I-90 was obtained. Finally, Table 12-2 presents the daily VMT for each urban area.

Observations from Table 12-2 include the following:

- Marion County had almost twice the county population and vehicle registration than Lake County. The difference between the two counties decreases somewhat when focusing on the 10-mile population and ownership estimates.

Table 12-2. Population, Motor Vehicle, and Traffic Information for the Indiana Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
IDIN	876,804	897,388	1.02	594,540	608,497	77,250	30,572
INDEM	492,104	453,146	0.92	402,562	370,693	40,710	170,934
ININ	876,804	897,388	1.02	668,574	684,270	97,780	30,572
WPIN	876,804	897,388	1.02	790,904	809,471	155,900	30,572

[1] Daily Average Traffic Data reflects 2002 data from the Indiana DOT

- The vehicle per person ratio for the Indianapolis sites was greater than one vehicle per person and ranked tenth highest compared to other NATTS or UATMP sites.

- WPIN experienced a significantly higher traffic volume than the other Indianapolis sites, although traffic estimates for all three sites was based on data from I-70. The traffic volume near WPIN is the seventh highest among NATTS and UATMP sites.

- Traffic volume for INDEM is nearly half of the lowest traffic volume for Indianapolis sites with the least traffic.

- The VMT shown for INDEM is based on the urban area of Chicago. The Chicago area VMT ranked third among urban areas with UATMP or NATTS sites, while the VMT for the Indianapolis area ranked eighteenth.

12.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Indiana on sampling days, as well as over the course of the year.

12.2.1 Climate Summary

The city of Indianapolis is located in the center of Indiana, and experiences a temperate continental climate. Summers are warm and often humid, winters are chilly with occasional Arctic outbreaks, and precipitation is spread rather evenly throughout the year. The prevailing wind direction is southwesterly. Gary is located to the southeast of Chicago, and at the southern-most tip of Lake Michigan. Gary’s proximity to Lake Michigan is an important factor controlling the weather of the area. In the summer, warm temperatures can be suppressed, while cold winter temperatures are often moderated. Winds that blow across Lake Michigan and over

Gary in the winter can provide abundant amounts of lake-effect snow (Ruffner and Bair, 1987 and Gary, 2007).

12.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The two closest NWS weather stations are located at Indianapolis International Airport (near the Indianapolis monitoring sites) and Lansing Municipal Airport (near INDEM), WBAN 93819 and 04879, respectively.

Table 12-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 12-3 is the 95 percent confidence interval for each parameter. As shown in Table 12-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

12.2.3 Composite Back Trajectories for Sampling Days

Figures 12-7 through 12-10 are composite back trajectory maps for the Indiana monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 12-7 through 12-10 represents 100 miles.

Observations from Figures 12-7 through 12-9 for the Indianapolis sites include the following:

- Back trajectories originated from a variety of directions at the Indianapolis sites, although less frequently from the southeast. The predominant direction of trajectory origin is from the southwest and northwest.

Table 12-3. Average Meteorological Conditions near the Indiana Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
IDIN	Indianapolis Intl Airport 93819	Sampling Day	65.35 ± 5.20	56.96 ± 4.87	43.61 ± 4.27	49.95 ± 4.15	64.73 ± 3.36	1017.18 ± 1.46	8.28 ± 0.76
		All 2007	64.00 ± 2.25	55.16 ± 2.10	42.40 ± 1.86	48.52 ± 1.81	65.68 ± 1.36	1017.45 ± 0.60	8.13 ± 0.36
INDEM	Lansing Municipal Airport 04879	Sampling Day	58.71 ± 5.88	50.56 ± 5.29	39.45 ± 5.03	45.51 ± 5.09	68.69 ± 3.95	NA	6.58 ± 0.89
		All 2007	57.59 ± 2.45	49.28 ± 2.23	38.69 ± 2.12	44.73 ± 2.17	69.96 ± 1.56	NA	6.98 ± 0.39
ININ	Indianapolis Intl Airport 93819	Sampling Day	64.95 ± 5.20	56.47 ± 4.87	42.88 ± 4.20	49.36 ± 4.12	64.28 ± 3.41	1017.18 ± 1.41	8.25 ± 0.76
		All 2007	64.00 ± 2.25	55.16 ± 2.10	42.40 ± 1.86	48.52 ± 1.81	65.68 ± 1.36	1017.45 ± 0.60	8.13 ± 0.36
WPIN	Indianapolis Intl Airport 93819	Sampling Day	64.90 ± 5.47	56.35 ± 5.14	42.69 ± 4.45	49.22 ± 4.36	64.01 ± 3.45	1017.43 ± 1.53	8.14 ± 0.74
		All 2007	64.00 ± 2.25	55.16 ± 2.10	42.40 ± 1.86	48.52 ± 1.81	65.68 ± 1.36	1017.45 ± 0.60	8.13 ± 0.36

NA= Sea level pressure was not recorded at the Lansing Municipal Airport

Figure 12-7. Composite Back Trajectory Map for IDIN

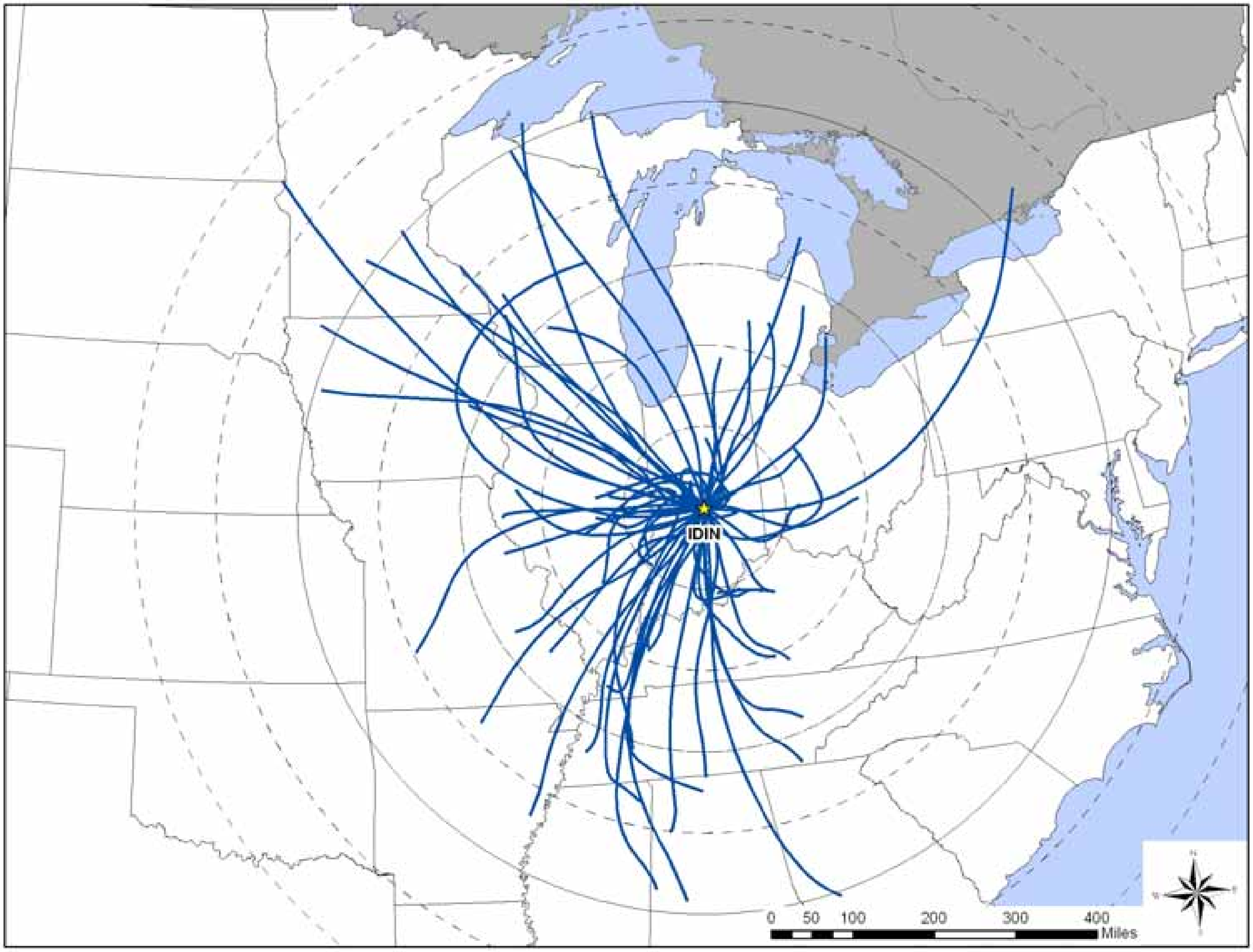


Figure 12-8. Composite Back Trajectory Map for ININ

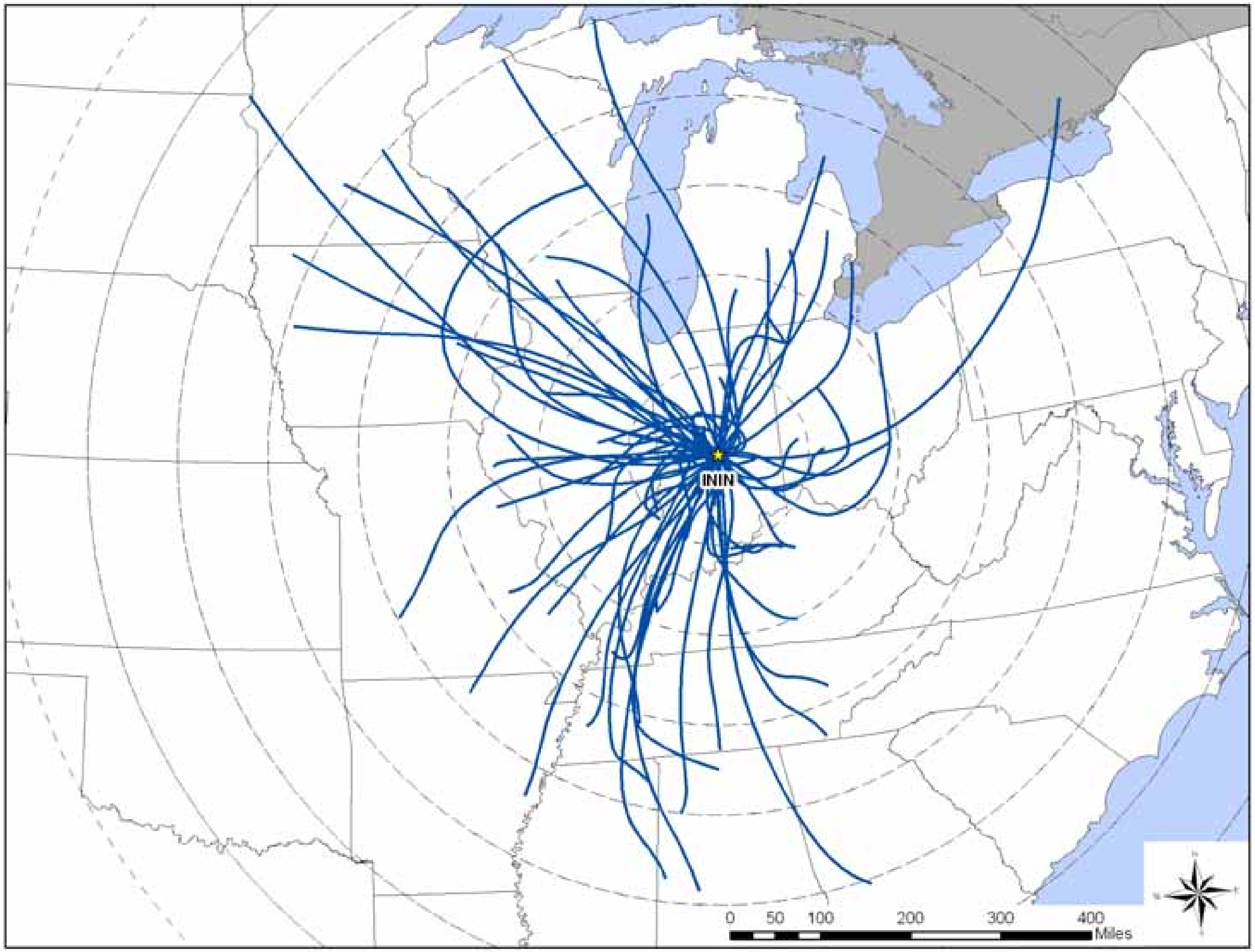


Figure 12-9 Composite Back Trajectory Map for WPIN

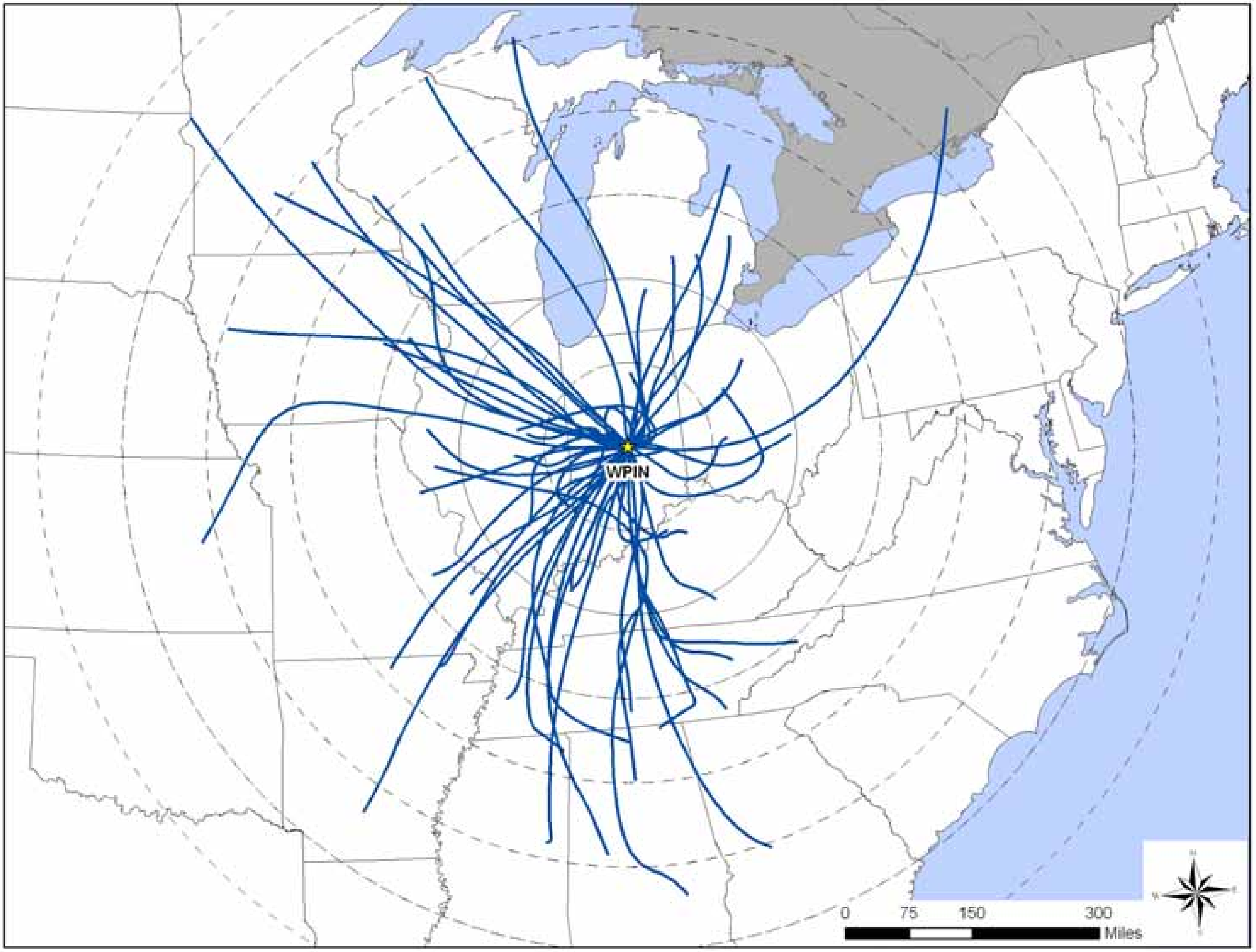
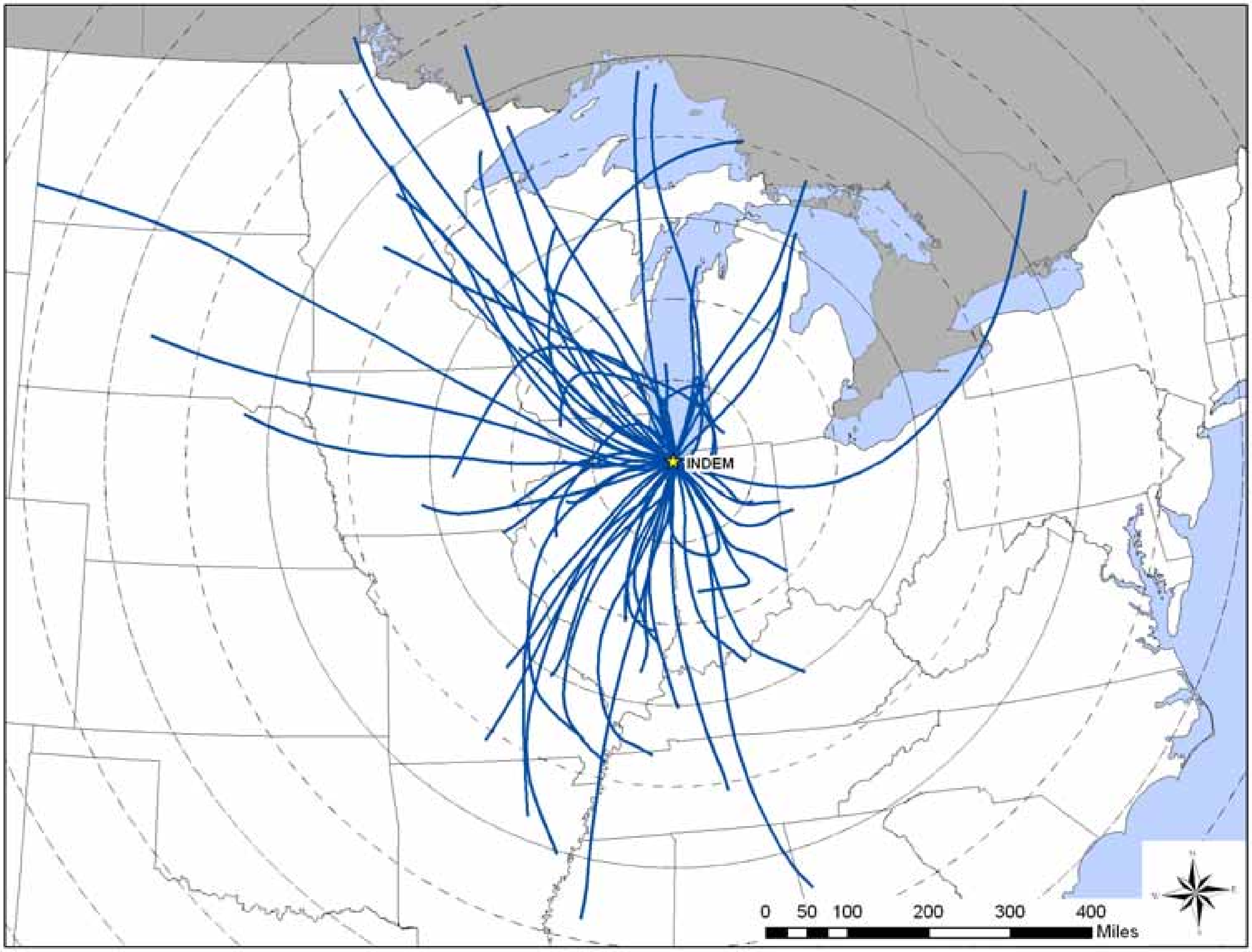


Figure 12-10. Composite Back Trajectory Map for INDEM



- The 24-hour air shed domains were comparable to other monitoring sites. The furthest away a trajectory originated was west-central Minnesota, or greater than 600 miles away. However, most trajectories originated within 400 miles.

Observations from Figure 12-10 for INDEM include the following:

- Back trajectories originated from a variety of directions at the INDEM site, although less frequently from the east. Similar to the Indianapolis sites, the predominant direction of trajectory origin is from the southwest and northwest.

- The 24-hour air shed domain was somewhat larger than the other Indiana monitoring sites. The furthest away a trajectory originated was western North Dakota, or greater than 800 miles away. However, most trajectories originated within 500 miles.

12.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations near the Indiana sites, as presented in Section 12.2.2, were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 12-11 through 12-14 are the wind roses for the Indiana monitoring sites on days that samples were collected.

Observations from Figures 12-11 through 12-13 for IDIN, ININ, and WPIN, respectively, include the following:

- The wind roses for the Indianapolis sites are very similar to each other.

- Winds from a variety of directions were observed near the Indianapolis sites, although winds with a westerly component were observed more frequently.

- Calm winds were observed for approximately six percent of the hourly measurements.

- Winds exceeding 11 knots made up approximately 22 percent of observations and most often had a westerly component.

Observations from Figure 12-14 for INDEM include the following:

- The wind rose for INDEM looks different from the wind roses for the Indianapolis sites.

Figure 12-11. Wind Rose for IDIN Sampling Days

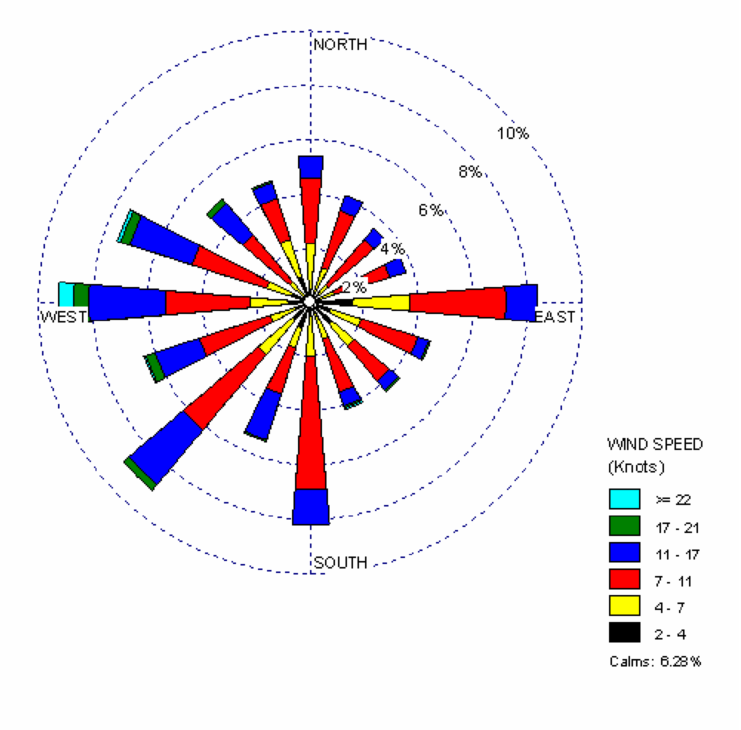


Figure 12-12. Wind Rose for ININ Sampling Days

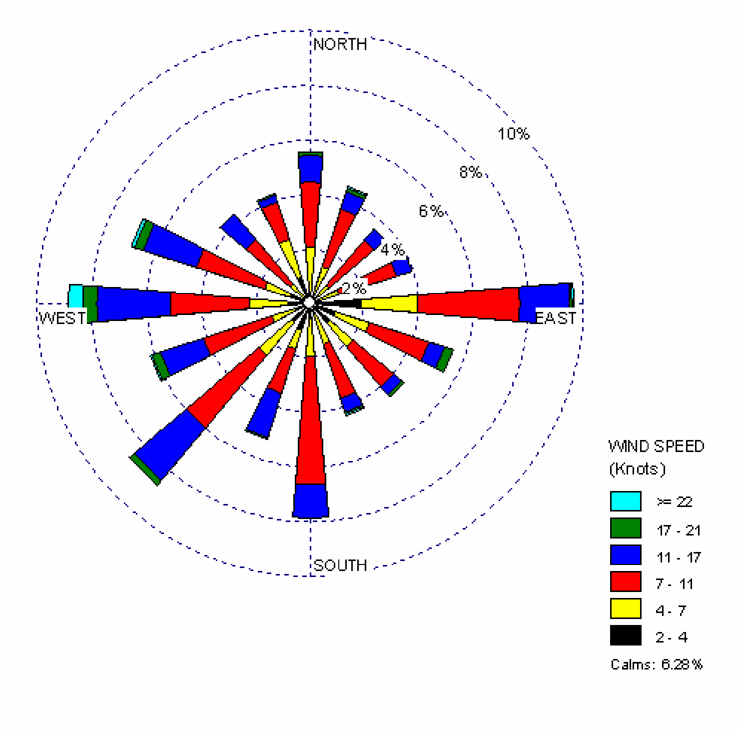


Figure 12-13. Wind Rose for WPIN Sampling Days

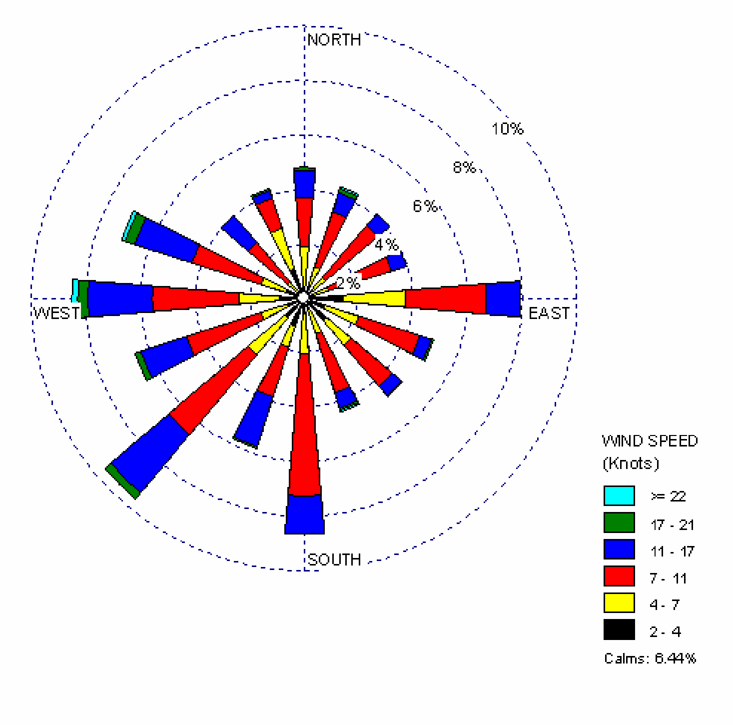
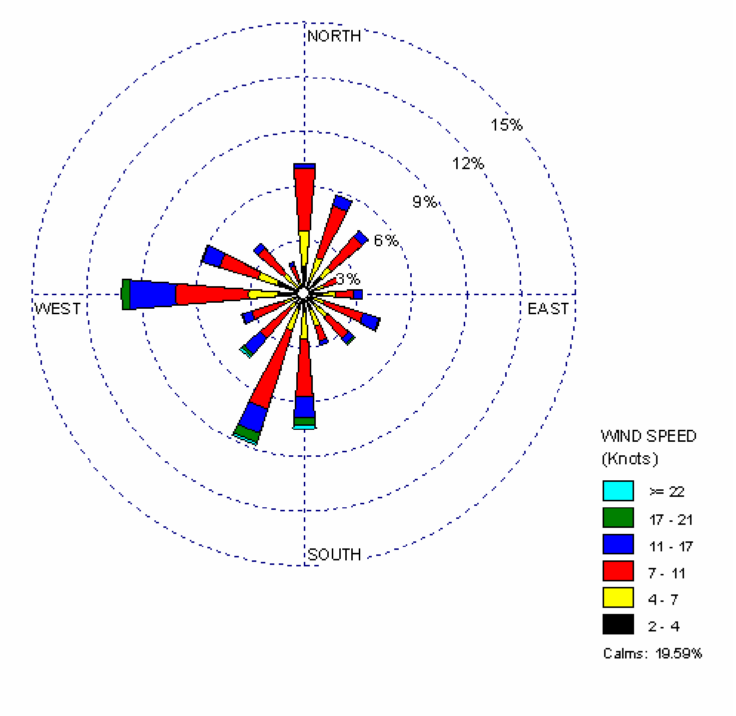


Figure 12-14. Wind Rose for INDEM Sampling Days



- Although winds from a variety of directions were observed near INDEM, westerly, south-southwesterly, and southerly winds were observed most frequently.

- Calm winds were observed for nearly 20 percent of the hourly measurements, more than twice the frequency of the Indianapolis sites.

- Winds exceeding 11 knots made up approximately 14 percent of observations and were mostly frequently out of the south or southwest.

12.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Indiana monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 12-4 presents the pollutants that failed at least one screen for each Indiana monitoring site and highlights each site's pollutants of interest (shaded). ININ sampled for carbonyls, metals (PM_{10}), and hexavalent chromium; IDIN sampled for carbonyls and metals (PM_{10}); WPIN and INDEM sampled for carbonyls only.

Observations from Table 12-4 include the following:

- Six pollutants failed screens for IDIN and seven failed screens for ININ. More than half of the measured concentrations of these pollutants failed screens at these sites.

- Formaldehyde and acetaldehyde are the only carbonyls with risk screening values. Both pollutants failed screens for INDEM and WPIN. All of the measured concentrations of these two pollutants failed screens for INDEM and nearly 99 percent failed screens for WPIN.

- Formaldehyde and acetaldehyde were also pollutants of interest for ININ and IDIN. Manganese and arsenic were the other two pollutants of interest for these sites.

Table 12-4. Comparison of Measured Concentrations and EPA Screening Values for the Indiana Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
South Holt, Indianapolis, Indiana - IDIN					
Arsenic (PM_{10})	60	60	100.00	28.57	28.57
Acetaldehyde	58	59	98.31	27.62	56.19
Formaldehyde	58	59	98.31	27.62	83.81
Manganese (PM_{10})	31	60	51.67	14.76	98.57
Nickel (PM_{10})	2	60	3.33	0.95	99.52
Cadmium (PM_{10})	1	60	1.67	0.48	100.00
Total	210	358	58.66		
Gary, Indiana - INDEM					
Acetaldehyde	60	60	100.00	50.00	50.00
Formaldehyde	60	60	100.00	50.00	100.00
Total	120	120	100.00		
South Harding, Indianapolis, Indiana - ININ					
Acetaldehyde	60	61	98.36	27.52	27.52
Formaldehyde	60	61	98.36	27.52	55.05
Arsenic (PM_{10})	58	60	96.67	26.61	81.65
Manganese (PM_{10})	32	60	53.33	14.68	96.33
Cadmium (PM_{10})	5	60	8.33	2.29	98.62
Hexavalent Chromium	2	47	4.26	0.92	99.54
Nickel (PM_{10})	1	60	1.67	0.46	100.00
Total	218	409	53.30		
Washington Park, Indianapolis, Indiana - WPIN					
Acetaldehyde	55	56	98.21	50.00	50.00
Formaldehyde	55	56	98.21	50.00	100.00
Total	110	112	98.21		

12.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Indiana monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical parameters are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

12.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages for the Indiana sites are presented in Table 12-5, where applicable.

Observations for the Indiana sites from Table 12-5 include the following:

- Formaldehyde exhibited the highest daily average concentration by mass for all four sites. The daily average concentration of formaldehyde for INDEM was an order of magnitude higher than the daily averages for the other three sites.

- Formaldehyde concentrations were lowest in the winter at all four sites. Acetaldehyde concentrations were also lowest in the winter at INDEM and WPIN.

- As shown in Table 4-9, INDEM had the highest daily average concentration of formaldehyde among all NATTS and UATMP sites, which was an order of magnitude higher than the next highest daily average of formaldehyde. ININ and WPIN also had the sixth and seventh highest daily averages of formaldehyde, respectively.

- INDEM also had the fourth highest daily average concentration of acetaldehyde, as shown in Table 4-9. IDIN had the second highest daily average concentration of arsenic, behind only S4MO, among sites sampling arsenic (PM_{10}), as shown in Table 4-10.

- The average concentrations of the arsenic and manganese for ININ and IDIN were generally 0.01 $\mu g/m^3$ or less.

Table 12-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Indiana Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (μg/m^3)	Winter Average (μg/m^3)	Spring Average (μg/m^3)	Summer Average (μg/m^3)	Autumn Average (μg/m^3)	Annual Average[1] (μg/m^3)
South Holt, Indianapolis, Indiana - IDIN								
Acetaldehyde	59	59	2.19 ± 0.25	1.62 ± 0.43	2.25 ± 0.35	2.61 ± 0.60	2.24 ± 0.45	2.19 ± 0.25
Arsenic (PM_{10})	60	60	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Formaldehyde	59	59	3.67 ± 0.50	1.78 ± 0.40	3.66 ± 0.82	5.17 ± 0.83	3.95 ± 0.95	3.67 ± 0.50
Manganese (PM_{10})	60	60	0.01 ± <0.01	<0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01
Gary, Indiana - INDEM								
Acetaldehyde	60	60	4.56 ± 0.52	2.58 ± 0.24	4.88 ± 1.16	6.80 ± 0.64	3.89 ± 0.43	4.56 ± 0.52
Formaldehyde	60	60	36.07 ± 6.34	14.12 ± 3.15	34.94 ± 9.19	64.23 ± 14.44	29.92 ± 3.23	36.07 ± 6.34
South Harding, Indianapolis, Indiana – ININ								
Acetaldehyde	61	61	2.02 ± 0.23	1.56 ± 0.23	2.04 ± 0.38	2.28 ± 0.4	2.21 ± 0.66	2.02 ± 0.23
Arsenic (PM_{10})	60	60	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Formaldehyde	61	61	4.15 ± 0.71	2.17 ± 0.39	3.36 ± 0.95	5.66 ± 1.69	5.46 ± 1.44	4.15 ± 0.71
Manganese (PM_{10})	60	60	0.01 ± <0.01	<0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01
Washington Park, Indianapolis, Indiana – WPIN								
Acetaldehyde	56	56	2.52 ± 0.3	1.56 ± 0.19	2.58 ± 0.5	3.19 ± 0.62	2.88 ± 0.64	2.52 ± 0.3
Formaldehyde	56	56	4.06 ± 0.58	1.93 ± 0.31	3.81 ± 0.95	5.77 ± 1.06	5.01 ± 1.03	4.06 ± 0.58

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

12.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. None of the Indiana sites have sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

12.5 Pearson Correlations

Table 12-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for the Indiana sites from Table 12-6 include the following:

- The correlations for INDEM were weak.
- All of the correlations between the pollutants of interest for the Indianapolis sites and the maximum, average, dew point, and wet bulb temperatures were positive. The correlations with formaldehyde and these parameters were strong. In addition, acetaldehyde exhibited strong positive correlations with these parameters for WPIN. This indicates that concentrations of the pollutants of interest, especially the carbonyls, tend to increase with increasing dry bulb, dew point, and wet bulb temperatures.
- Conversely, the correlations between the pollutants of interest for all four sites and the relative humidity and scalar wind speed were negative, many of which were strong. This indicates that concentrations of the pollutants of interest, especially the carbonyls, tend to increase with decreasing relative humidity and wind speed.

12.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

12.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Indiana monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 12-7. Where a seasonal or annual average exceeds the

Table 12-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Indiana Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
South Holt, Indianapolis, Indiana - IDIN								
Acetaldehyde	59	0.48	0.45	0.30	0.37	-0.53	0.09	-0.56
Arsenic (PM_{10})	60	0.25	0.25	0.22	0.24	-0.10	-0.06	-0.31
Formaldehyde	59	0.83	0.81	0.70	0.76	-0.54	-0.16	-0.45
Manganese (PM_{10})	60	0.42	0.37	0.19	0.28	-0.60	0.02	-0.40
Gary, Indiana - INDEM								
Acetaldehyde	60	0.12	0.14	0.21	0.00	-0.47	--	-0.40
Formaldehyde	60	0.01	0.04	0.11	-0.01	-0.42	--	-0.39
South Harding, Indianapolis, Indiana - ININ								
Acetaldehyde	61	0.48	0.44	0.37	0.41	-0.30	0.03	-0.57
Arsenic (PM_{10})	60	0.34	0.30	0.19	0.25	-0.32	0.18	-0.47
Formaldehyde	61	0.63	0.63	0.63	0.63	-0.16	-0.13	-0.43
Manganese (PM_{10})	60	0.38	0.33	0.19	0.26	-0.49	0.02	-0.25
Washington Park, Indianapolis, Indiana - WPIN								
Acetaldehyde	56	0.68	0.65	0.53	0.59	-0.50	-0.23	-0.43
Formaldehyde	56	0.81	0.80	0.69	0.75	-0.51	-0.16	-0.43

-- = Sea level pressure was not recorded at the Lansing Municipal Airport

Table 12-7. MRL Risk Screening Assessment Summary for the Indiana Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average[1] (µg/m^3)
INDEM	TO-11A	Formaldehyde	50	15/60	40	14.12 ± 3.15	34.94 ± 9.19	**64.23 ± 14.44**	29.92 ± 3.23	10	**36.07 ± 6.34**

BOLD = exceedance of the intermediate or chronic MRL

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

applicable MRL, the concentration is bolded. Formaldehyde measurements from INDEM exceeded one or more of the MRL risk values.

Observations about formaldehyde in Table 12-7 include the following:

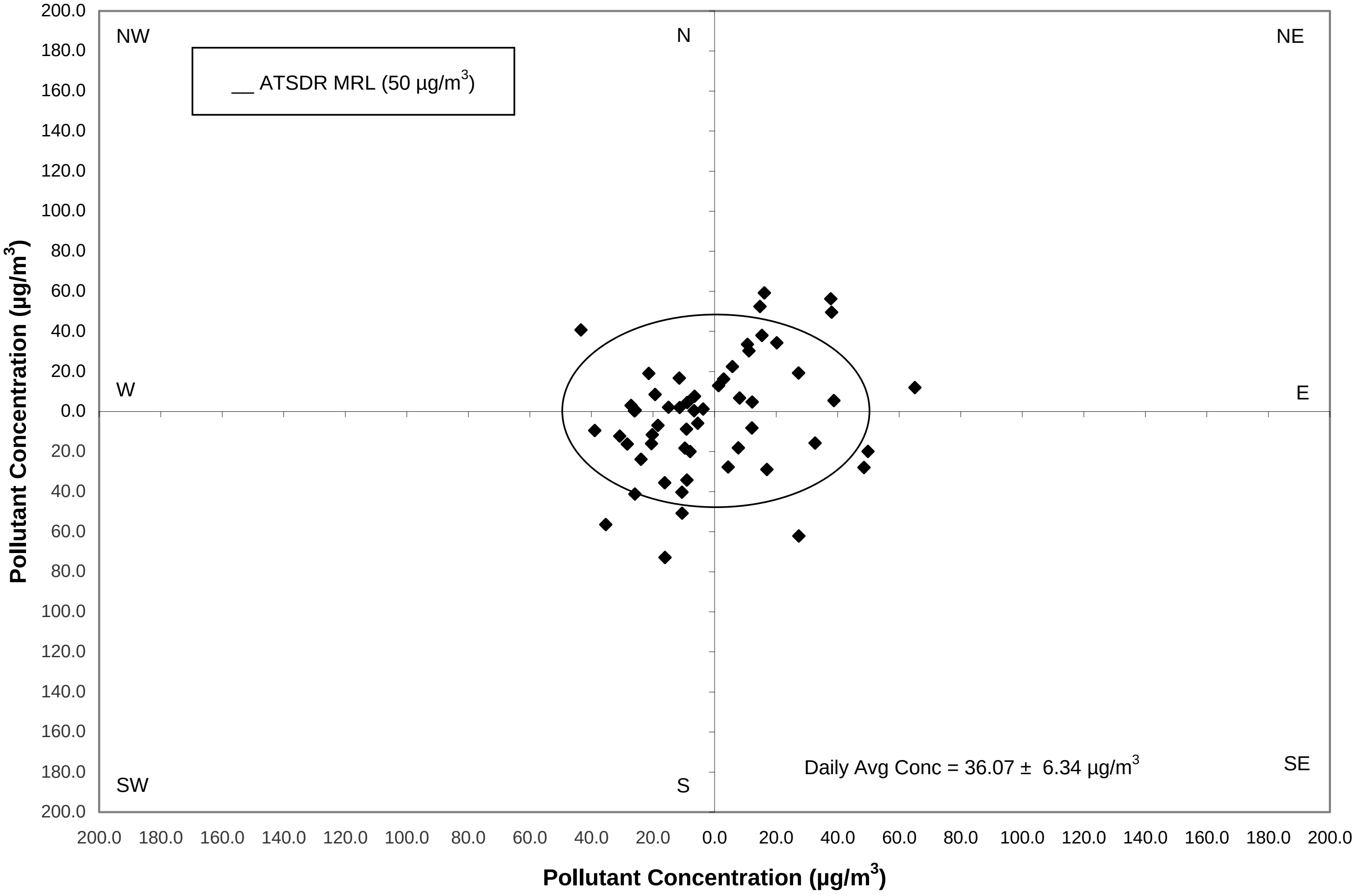
- Fifteen out of 60 (or one-fourth) measured detections exceeded the ATSDR acute MRL for formaldehyde (50 $\mu g/m^3$).
- Only one other site (SFSD) exceeded the ATSDR acute MRL for formaldehyde; however, 15 out of the 16 exceedances occurred at INDEM.
- Although INDEM has the highest seasonal averages of formaldehyde for each season among NATTS and UATMP sites, only the summer average exceeded the ATSDR intermediate MRL (40 $\mu g/m^3$).
- The annual average of formaldehyde for INDEM also exceeded the ATSDR chronic MRL for formaldehyde (10 $\mu g/m^3$). This is the only annual average to exceed a chronic risk value. The annual average of formaldehyde for INDEM was more than three times the ATSDR chronic MRL (36.07 ± 6.34 $\mu g/m^3$).

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction, as described in Section 3.6.1. Figure 12-15 is the formaldehyde pollution rose for INDEM, where the acute risk factor for formaldehyde was exceeded.

Observations from the pollution rose include the following:

- Exceedances of the ATSDR acute MRL for formaldehyde occurred with winds blowing from a variety of directions, although fewer exceedances occurred with northwesterly winds.
- The highest concentration occurred on a day where wind observations were designated as “missing” by the NWS.
- On days with available wind observations, the two highest concentrations were measured on days with a mean wind direction of south and east.

Figure 12-15. Formaldehyde Pollution Rose for INDEM



12.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Indiana monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 of this report regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 12-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the Indiana monitoring sites is as follows:

- The census tract for IDIN is 18097342300, which had a population of 6,536 and represented approximately 0.8 percent of the Marion County population in 2000.
- The census tract for ININ is 18097358100, which had a population of 3,374 and represented approximately 0.4 percent of the Marion County population in 2000.
- The census tract for WPIN is 18097350700, which had a population of 2,058 and represented approximately 0.2 percent of the Marion County population in 2000.
- The census tract for INDEM is 18089010202, which had a population of 1,689 and represented approximately 0.3 percent of the Lake County population in 2000.

Observations for the Indiana sites from Table 12-8 include the following:

- The pollutants with the highest concentrations according to NATA were formaldehyde and acetaldehyde for all four Indiana sites.
- The pollutant with the highest cancer risk according to NATA for WPIN and INDEM was acetaldehyde.
- The pollutant with the highest cancer risk according to NATA for ININ and IDIN was arsenic. The cancer risk estimate for arsenic for ININ was 208 in-a-million, which was the highest cancer risk estimate among all counties with UATMP or NATTS sites from NATA for any given air toxic pollutant.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was arsenic for ININ (1.61).

Table 12-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Indiana

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average[1] (µg/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
South Holt Road, Indianapolis, Indiana (IDIN) - Census Tract ID 18097342300								
Acetaldehyde	0.000002	0.009	1.40	3.10	0.15	2.19 ± 0.25	4.38	0.24
Arsenic (PM$_{10}$)	0.0043	0.00003	<0.01	4.73	0.03	<0.01 ± <0.01	4.65	0.04
Cadmium (PM$_{10}$)	0.0018	0.00002	<0.01	0.05	<0.01	<0.01 ± <0.01	0.42	0.01
Formaldehyde	5.5E-09	0.0098	1.74	0.01	0.17	3.67 ± 0.50	0.02	0.37
Manganese (PM$_{10}$)	--	0.00005	<0.01	--	0.08	0.01 ± <0.01	--	0.12
Nickel (PM$_{10}$)	0.00016	0.000065	<0.01	0.05	0.01	<0.01 ± <0.01	0.21	0.02
Gary, Indiana (INDEM) - Census Tract ID 18089010202								
Acetaldehyde	0.000002	0.009	1.95	4.32	0.21	4.56 ± 0.52	9.12	0.51
Formaldehyde	5.5E-09	0.0098	1.86	0.01	0.19	36.07 ± 6.34	0.20	3.68
South Harding Road, Indianapolis, Indiana (ININ) - Census Tract ID 18097358100								
Acetaldehyde	0.000002	0.009	1.63	3.60	0.18	2.02 ± 0.23	4.04	0.22
Arsenic (PM$_{10}$)	0.0043	0.00003	0.05	208.16	1.61	<0.01 ± <0.01	4.19	0.03
Cadmium (PM$_{10}$)	0.0018	0.00002	<0.01	0.08	<0.01	<0.01 ± <0.01	0.50	0.01
Formaldehyde	5.5E-09	0.0098	1.92	0.01	0.19	4.15 ± 0.71	0.02	0.42
Hexavalent Chromium	0.012	0.0001	<0.01	3.18	<0.01	NA	NA	NA
Manganese (PM$_{10}$)	--	0.00005	0.01	--	0.13	0.01 ± <0.01	--	0.12
Nickel (PM$_{10}$)	0.00016	0.000065	<0.01	0.04	<0.01	<0.01 ± <0.01	0.16	0.02
Washington Park, Indianapolis, Indiana (WPIN) - Census Tract ID 18097350700								
Acetaldehyde	0.000002	0.009	1.46	3.24	0.16	2.52 ± 0.30	5.05	0.28
Formaldehyde	5.5E-09	0.0098	1.47	0.01	0.14	4.06 ± 0.58	0.02	0.41

-- = a URE or RfC is not available

Bold = pollutant of interest

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

- The pollutant with the highest 2007 annual average was formaldehyde for every Indiana site, which were all higher than the modeled concentrations from NATA, especially for INDEM.

- The pollutants with the highest surrogate cancer risk approximations were acetaldehyde and arsenic (for ININ and IDIN only).

- Formaldehyde was the only pollutant with a noncancer risk approximation greater than 1.0 (3.68 for INDEM).

- An annual average and risk approximations were not provided for hexavalent chromium for ININ because the site did not sample this pollutant for a long enough duration.

12.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 12-9 and 12-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 12-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 12-10 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 12.3, ININ sampled for carbonyls, metals (PM_{10}), and hexavalent chromium; IDIN sampled for carbonyls and metals (PM_{10}); WPIN and INDEM sampled for carbonyls only. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Table 12-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Indiana

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
South Holt Road, Indianapolis, Indiana (IDIN) – Marion County					
Benzene	769.55	Coke Oven Emissions	1.89E-02	Arsenic	4.65
Formaldehyde	315.72	Benzene	6.00E-03	Acetaldehyde	4.38
Acetaldehyde	130.46	Hexavalent Chromium	3.66E-03	Cadmium	0.42
Dichloromethane	123.11	1,3-Butadiene	3.06E-03	Nickel	0.21
1,3-Butadiene	101.98	Arsenic, PM	2.75E-03	Formaldehyde	0.02
1,3-Dichloropropene	62.41	Naphthalene	1.55E-03		
Naphthalene	45.44	Cadmium, PM	6.48E-04		
Coke Oven Emissions	30.48	Acetaldehyde	2.87E-04		
Trichloroethylene	21.22	POM, Group 2	2.85E-04		
p-Dichlorobenzene	13.79	1,3-Dichloropropene	2.50E-04		
South Harding Road, Indianapolis, Indiana (ININ) – Marion County					
Benzene	769.55	Coke Oven Emissions	1.89E-02	Arsenic	4.19
Formaldehyde	315.72	Benzene	6.00E-03	Acetaldehyde	4.04
Acetaldehyde	130.46	Hexavalent Chromium	3.66E-03	Cadmium	0.50
Dichloromethane	123.11	1,3-Butadiene	3.06E-03	Nickel	0.16
1,3-Butadiene	101.98	Arsenic, PM	2.75E-03	Formaldehyde	0.02
1,3-Dichloropropene	62.41	Naphthalene	1.55E-03		
Naphthalene	45.44	Cadmium, PM	6.48E-04		
Coke Oven Emissions	30.48	Acetaldehyde	2.87E-04		
Trichloroethylene	21.22	POM, Group 2	2.85E-04		
p-Dichlorobenzene	13.79	1,3-Dichloropropene	2.50E-04		

Table 12-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Indiana (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Washington Park, Indianapolis, Indiana (WPIN) – Marion County					
Benzene	769.55	Coke Oven Emissions	1.89E-02	Acetaldehyde	5.05
Formaldehyde	315.72	Benzene	6.00E-03	Formaldehyde	0.02
Acetaldehyde	130.46	Hexavalent Chromium	3.66E-03		
Dichloromethane	123.11	1,3-Butadiene	3.06E-03		
1,3-Butadiene	101.98	Arsenic, PM	2.75E-03		
1,3-Dichloropropene	62.41	Naphthalene	1.55E-03		
Naphthalene	45.44	Cadmium, PM	6.48E-04		
Coke Oven Emissions	30.48	Acetaldehyde	2.87E-04		
Trichloroethylene	21.22	POM, Group 2	2.85E-04		
p-Dichlorobenzene	13.79	1,3-Dichloropropene	2.50E-04		
Gary, Indiana (INDEM) – Lake County					
Benzene	409.17	Coke Oven Emissions	6.45E-02	Acetaldehyde	9.12
Formaldehyde	185.18	Arsenic, PM	4.00E-03	Formaldehyde	0.20
Acetaldehyde	144.55	Benzene	3.19E-03		
Coke Oven Emissions	104.05	Hexavalent Chromium	1.77E-03		
Naphthalene	50.39	Naphthalene	1.71E-03		
Dichloromethane	47.35	1,3-Butadiene	1.22E-03		
1,3-Butadiene	40.56	POM, Group 2	3.52E-04		
1,3-Dichloropropene	35.15	Acetaldehyde	3.18E-04		
p-Dichlorobenzene	7.77	Cadmium, PM	2.67E-04		
POM, Group 2	6.40	Nickel, PM	2.67E-04		

Table 12-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Indiana

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
South Holt Road, Indianapolis, Indiana (IDIN) – Marion County					
Toluene	2,163.40	Acrolein	1,036,753.79	Formaldehyde	0.37
Xylenes	1,366.15	Manganese, PM	112,061.79	Acetaldehyde	0.24
Hydrochloric acid	1,062.54	Hydrochloric acid	53,126.94	Manganese	0.12
Benzene	769.55	1,3-Butadiene	50,989.24	Arsenic	0.04
Methanol	403.44	Formaldehyde	32,216.23	Nickel	0.02
Hexane	337.93	Benzene	25,651.62	Cadmium	0.01
Formaldehyde	315.72	Arsenic, PM	21,302.11		
Ethylbenzene	300.19	Bromomethane	18,964.01		
Methyl isobutyl ketone	253.94	Cadmium, PM	17,988.33		
Methyl *tert*-butyl ether	157.32	Nickel, PM	16,907.60		
South Harding Road, Indianapolis, Indiana (ININ) – Marion County					
Toluene	2,163.40	Acrolein	1,036,753.79	Formaldehyde	0.42
Xylenes	1,366.15	Manganese, PM	112,061.79	Acetaldehyde	0.22
Hydrochloric acid	1,062.54	Hydrochloric acid	53,126.94	Manganese	0.12
Benzene	769.55	1,3-Butadiene	50,989.24	Arsenic	0.03
Methanol	403.44	Formaldehyde	32,216.23	Nickel	0.02
Hexane	337.93	Benzene	25,651.62	Cadmium	0.01
Formaldehyde	315.72	Arsenic, PM	21,302.11		
Ethylbenzene	300.19	Bromomethane	18,964.01		
Methyl isobutyl ketone	253.94	Cadmium, PM	17,988.33		
Methyl *tert*-butyl ether	157.32	Nickel, PM	16,907.60		

Table 12-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Indiana (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Washington Park, Indianapolis, Indiana (WPIN) – Marion County					
Toluene	2,163.40	Acrolein	1,036,753.79	Formaldehyde	0.41
Xylenes	1,366.15	Manganese, PM	112,061.79	Acetaldehyde	0.28
Hydrochloric acid	1,062.54	Hydrochloric acid	53,126.94		
Benzene	769.55	1,3-Butadiene	50,989.24		
Methanol	403.44	Formaldehyde	32,216.23		
Hexane	337.93	Benzene	25,651.62		
Formaldehyde	315.72	Arsenic, PM	21,302.11		
Ethylbenzene	300.19	Bromomethane	18,964.01		
Methyl isobutyl ketone	253.94	Cadmium, PM	17,988.33		
Methyl *tert*-butyl ether	157.32	Nickel, PM	16,907.60		
Gary, Indiana (INDEM) – Lake County					
Hydrochloric acid	1,133.23	Manganese, PM	813,671.59	Formaldehyde	3.68
Toluene	1,007.99	Acrolein	461,981.86	Acetaldehyde	0.51
Xylenes	714.90	Hydrochloric acid	56,661.27		
Benzene	409.17	Arsenic, PM	31,017.17		
Methanol	243.54	Nickel, PM	25,633.60		
Hexane	233.90	1,3-Butadiene	20,279.67		
Formaldehyde	185.18	Chlorine	19,571.26		
Acetaldehyde	144.55	Formaldehyde	18,895.60		
Ethylbenzene	117.17	Naphthalene	16,797.39		
Hydrofluoric acid	104.37	Acetaldehyde	16,061.30		

Observations from Table 12-9 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in both Marion and Lake County.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for both counties was coke oven emissions. Benzene and hexavalent chromium had the second and third highest toxicity-weighted emissions in Marion County, while arsenic and benzene ranked second and third in Lake County.

- Six of the highest emitted pollutants in Marion and Lake County also had the highest toxicity-weighted emissions (although the actual pollutants varied in each county).

- Arsenic, which had the fifth highest toxicity-weighted emissions in Marion County, had the highest surrogate cancer risk approximations for ININ and IDIN.

- Acetaldehyde, which was the third highest emitted pollutant and had the eighth highest toxicity-weighted emissions in both Lake and Marion Counties, had the highest surrogate cancer risk approximation for WPIN and INDEM, and the second highest for ININ and IDIN.

- Although formaldehyde was the second highest emitted pollutant in both Lake and Marion Counties, it did not appear on the list of highest toxicity-weighted emissions and its cancer risk approximations for all sites were low.

Observations from Table 12-10 include the following:

- Toluene, xylenes, and hydrochloric acid were the highest emitted pollutants with noncancer RfCs in both Marion and Lake County, although not necessarily in that order.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties were acrolein, manganese, and hydrochloric acid, although not necessarily in that order.

- Three of the highest emitted pollutants in both counties also had the highest toxicity-weighted emissions (although the actual pollutants varied in each county).

- The pollutant with the highest noncancer risk approximation was formaldehyde for all four sites. Formaldehyde also ranked among the pollutants with the highest emissions and toxicity-weighted emissions.

12.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *Acetaldehyde and formaldehyde were the pollutants of interest common to each Indiana monitoring site. For the two monitoring sites sampling metals, arsenic and manganese were also pollutants of interest.*

- *Concentrations and averages of formaldehyde had the highest daily average concentration for each of the monitoring sites. The daily average concentration for INDEM was the highest among all participating monitoring sites.*

- *Concentrations and averages of formaldehyde exceeded the acute, intermediate, and chronic MRL health benchmarks for INDEM.*

13.0 Site in Kentucky

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Kentucky, and integrates these concentrations with emissions, meteorological, and risk information.

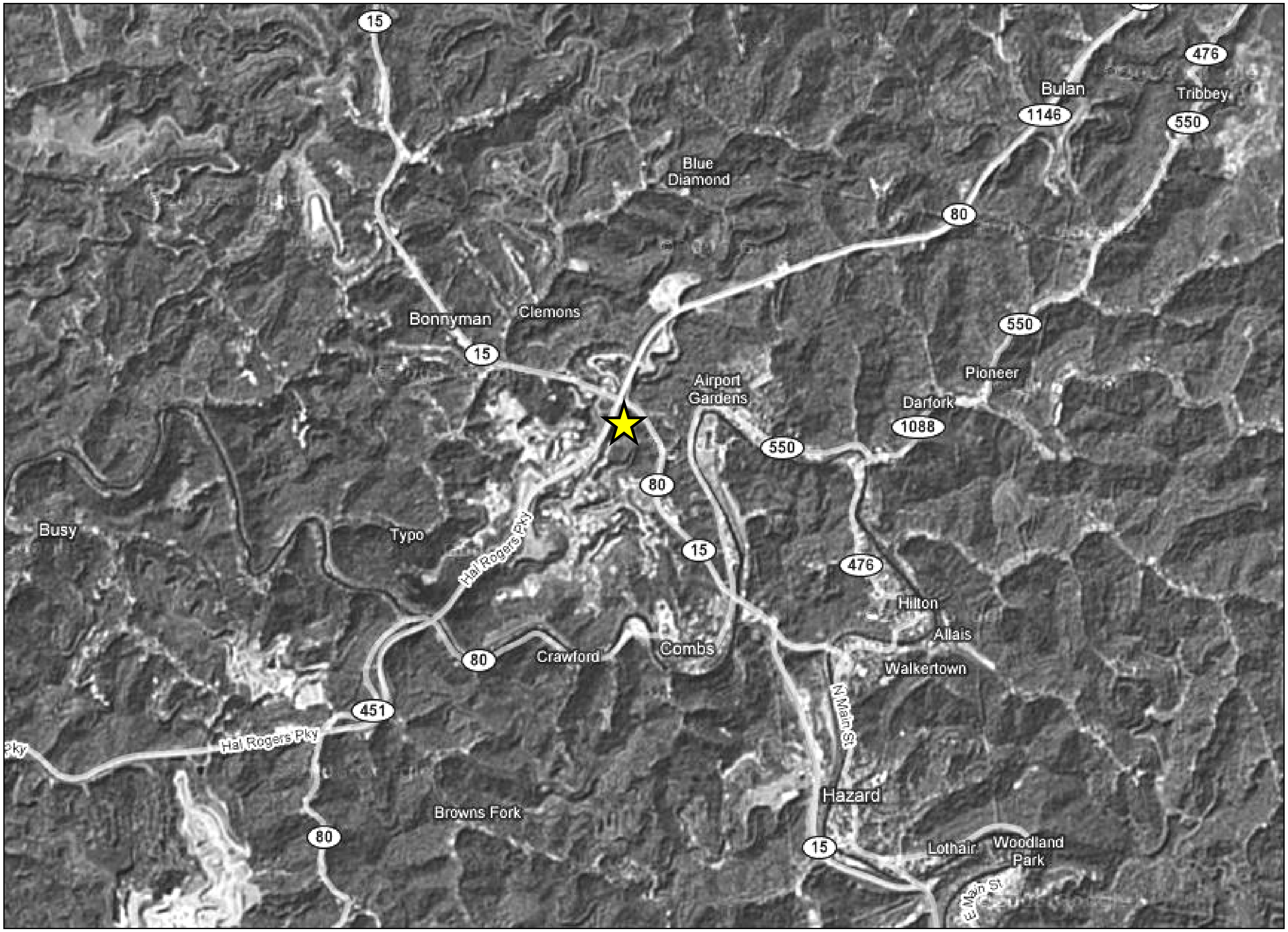
13.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. Figure 13-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its rural location. Figure 13-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 13-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

The HAKY monitoring site is located in southeastern Kentucky, between the towns of Hazard and Bonnyman, just on the outskirts of the Daniel Boone National Forest. The site is located on the property of the Perry County Horse Park. Due to the rural nature of the area, a close-in satellite map is not available. However, Figure 13-1 does show the rolling topography of the region as well as the major highways near the site. The Hal Rogers Parkway and State Highways 15 and 80 merge just to the north of the monitoring site. As Figure 13-2 shows, HAKY is located near a small number of point sources, which are located mainly to the north and southeast of the monitoring site. A wood furniture manufacturer, a lumber and food products manufacturer, a waste treatment disposal facility, and a facility utilizing fuel combustion processes are within a 10-mile radius of HAKY.

Table 13-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Kentucky monitoring site. County-level vehicle registration and population data for Perry County were obtained from the Kentucky Transportation Cabinet and the U.S. Census Bureau. Table 13-2 also includes a vehicle registration to county population ratio (vehicles per person).

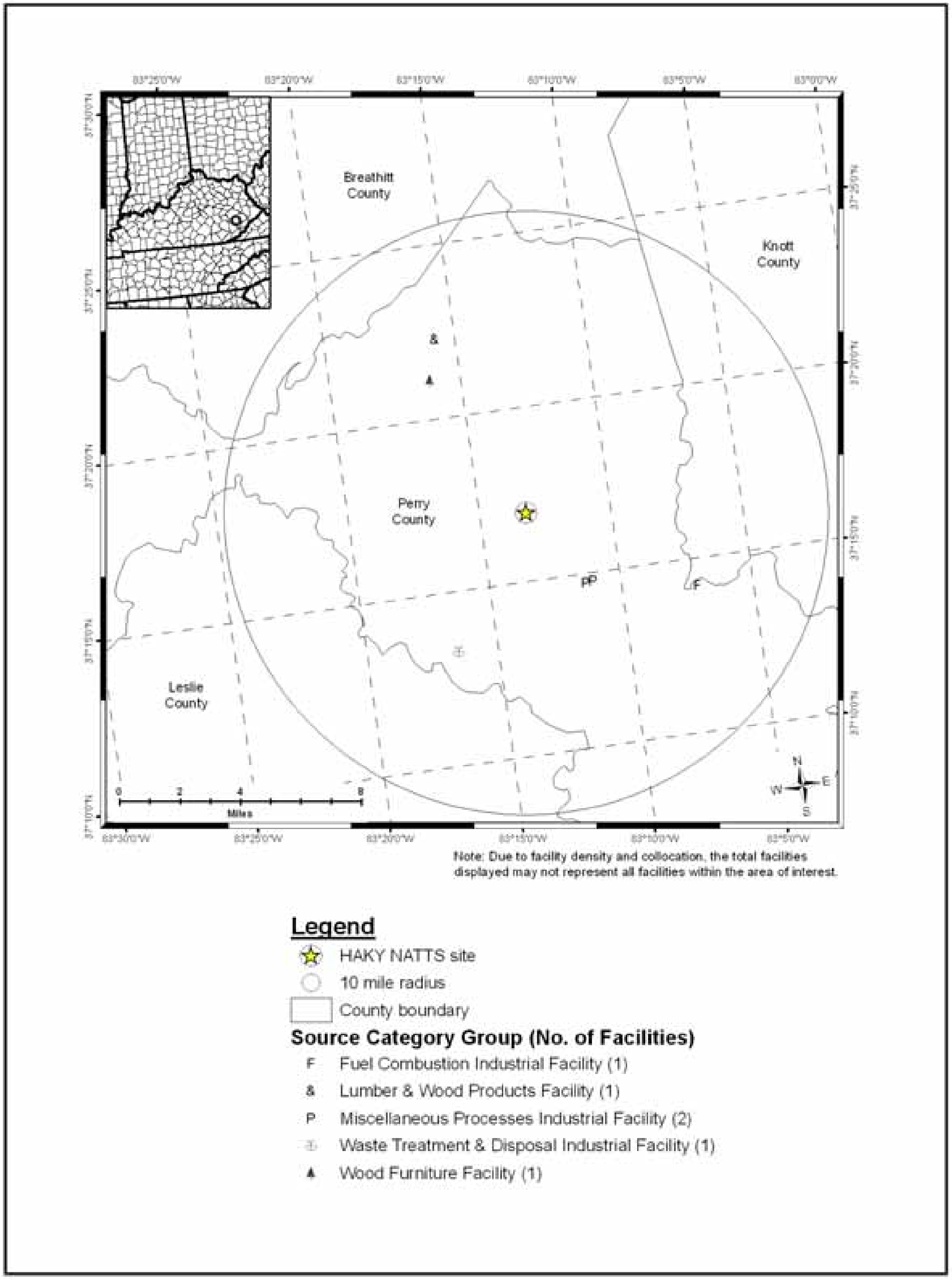
Figure 13-1. Hazard, Kentucky (HAKY) Monitoring Site



©2008 Google/©NAVTECH

Scale: 3cm = 1 mile

Figure 13-2. NEI Point Sources Located Within 10 Miles of HAKY



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 13-1. Geographical Information for the Kentucky Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
HAKY	21-193-0003	Hazard	Perry	Not in an MSA	42.32944, -71.082778	Residential	Suburban	The Perry County Horse Park monitoring station was established in April 2000 and is designated as a SLAMS site for PM_{10} and a Special Purpose Monitoring site for ozone and $PM_{2.5}$. In October 2001, $PM_{2.5}$ Speciation sampling was added as part of the national speciation program. The site is located on the grounds of the Perry County Horse Park and is approximately 2.5 miles north/northeast of Hazard. The monitoring station is an 8' x 10' aluminum clad shelter with a wooden deck covering the roof. The closest structure to the site is Perry Central High School, which is about 600 feet northwest of the site. The elevation is at 912 feet.

BOLD = EPA-designated NATTS Site

Table 13-2. Population, Motor Vehicle, and Traffic Information for the Kentucky Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
HAKY	29,213	47,549	1.63	31,861	51,859	21,537	NA

[1] Daily Average Traffic Data reflects 2005 data from the Kentucky Transportation Cabinet

BOLD = EPA-designated NATTS Site

In addition, the population within 10 miles of the site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 13-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 13-2 presents the daily VMT for each urban area.

Observations from Table 13-2 include the following:

- The Perry County population was the third lowest compared to all counties with NATTS or UATMP sites, while HAKY's 10-mile population ranked sixth lowest.

- The Perry County vehicle registration was the sixth lowest compared to all counties with NATTS or UATMP sites, while its 10-mile estimated ownership was eighth lowest.

- The rather low population and vehicle ownership compared to other NATTS or UATMP sites is not surprising given the rural nature of the surrounding area.

- The vehicle per person ratio was the third highest compared to other NATTS or UATMP sites.

- The traffic volume experienced near HAKY ranked in the middle of the range compared to other monitoring sites. The traffic estimate used came from the Daniel Boone Parkway, a major thoroughfare across southeast Kentucky.

- VMT was unavailable for this area.

13.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Kentucky on sampling days, as well as over the course of the year.

13.2.1 Climate Summary

The town of Hazard is located in southeast Kentucky, just on the outskirts of Daniel Boone National Forest. The area experiences all four seasons, and precipitation is fairly evenly distributed throughout the year (Wildernet, 2007).

13.2.2 Meteorological Conditions in 2007

Hourly meteorological data at the weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at Julian Carroll Airport, Jackson, Kentucky (WBAN 03889).

Table 13-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 13-3 is the 95 percent confidence interval for each parameter. As shown in Table 13-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

13.2.3 Composite Back Trajectories for Sampling Days

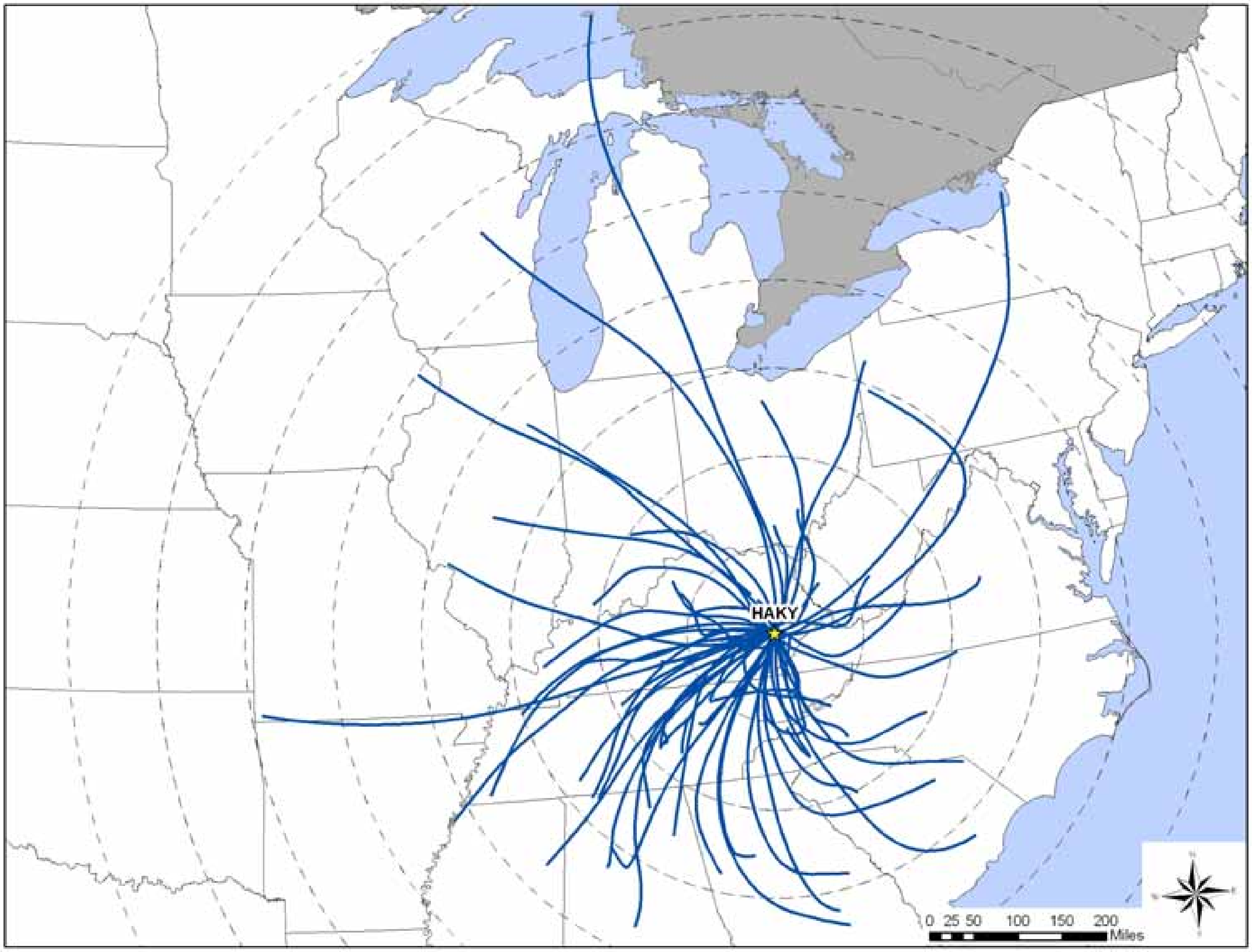
Figure 13-3 is a composite back trajectory map for the Kentucky monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 13-3 represents 100 miles.

Table 13-3. Average Meteorological Conditions near the Kentucky Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
HAKY	Julian Carroll Airport, Jackson, KY 03889	Sampling Day	68.23 ± 4.74	59.35 ± 4.29	44.90 ± 4.39	51.93 ± 3.85	62.44 ± 3.73	1018.03 ± 1.34	2.76 ± 0.47
		All 2007	67.35 ± 1.91	57.93 ± 1.81	43.36 ± 1.81	50.51 ± 1.61	61.96 ± 1.47	1018.28 ± 0.54	2.78 ± 0.20

BOLD = EPA-designated NATTS Site

Figure 13-3. Composite Back Trajectory Map for HAKY



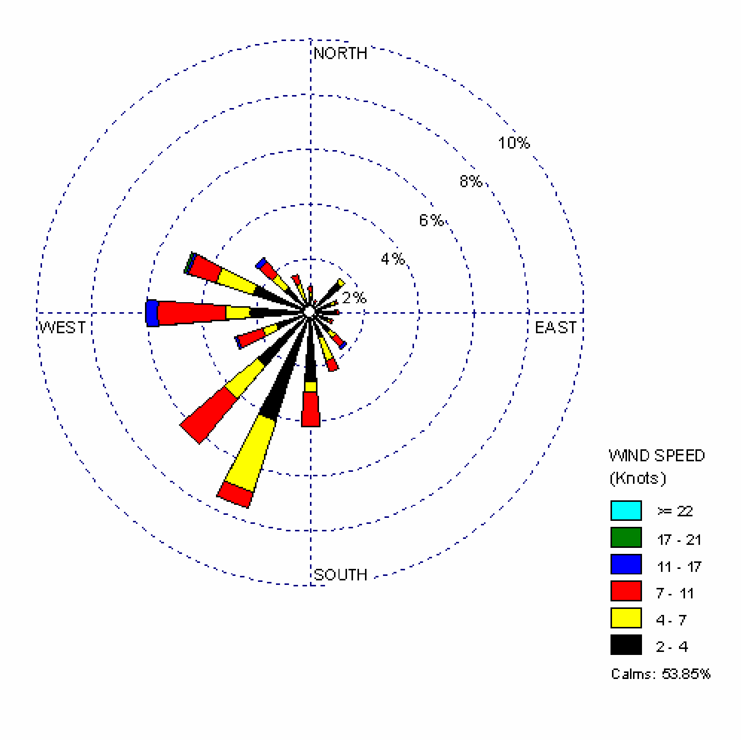
Observations from Figure 13-3 include the following:

- Back trajectories originated from a variety of directions at HAKY. However, trajectories originated primarily from the south and southwest.
- The 24-hour air shed domain for HAKY was similar in size to other monitoring sites. The furthest away a trajectory originated was Lake Superior, or greater than 700 miles away. However, 90 percent of trajectories originated within 400 miles of the monitoring site.

13.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at Julian Carroll Airport near HAKY were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 13-4 is the wind rose for the Kentucky monitoring site on days that samples were collected.

Figure 13-4. Wind Rose for HAKY Sampling Days



Observations from Figure 13-4 for HAKY include the following:

- Calm winds were prevalent near HAKY, as calm winds were observed for more than half of the hourly measurements.
- For winds greater than two knots, southwesterly and westerly winds were observed most frequently.
- Winds exceeding 11 knots made up only one percent of observations.

13.3 Pollutants of Interest

"Pollutants of interest" were determined for the monitoring site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Kentucky monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 13-4 presents the pollutants that failed at least one screen for the Kentucky monitoring site and highlights the site's pollutants of interest (shaded).

Observations from Table 13-4 include the following:

- HAKY sampled for hexavalent chromium only.
- One measured detection of hexavalent chromium failed a screen for HAKY. This represents a three percent failure rate.

Table 13-4. Comparison of Measured Concentrations and EPA Screening Values for the Kentucky Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Hazard, Kentucky - HAKY					
Hexavalent Chromium	1	33	3.03	100.00	100.00
Total	1	33	3.03		

13.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Kentucky monitoring site. The averages presented are provided for the pollutants of interest for the site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

13.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 13-5, where applicable. The averages presented in Table 13-5 are shown in ng/m^3 for ease of viewing.

Table 13-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (ng/m^3)	Winter Average (ng/m^3)	Spring Average (ng/m^3)	Summer Average (ng/m^3)	Autumn Average (ng/m^3)	Annual Average[1] (ng/m^3)
Hazard, Kentucky - HAKY								
Hexavalent Chromium	33	60	0.018 ± 0.006	NR	0.014 ± 0.008	0.017 ± 0.010	0.011 ± 0.004	0.012 ± 0.004

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for HAKY from Table 13-5 include the following:

- The daily average concentration of hexavalent chromium was somewhat higher than the annual average (0.018 ± 0.006 ng/m^3 vs. 0.012 ± 0.004 ng/m^3), which illustrates the effect of the substitution of 1/2 MDL.

- Seasonal averages of hexavalent chromium were fairly similar to each other when the confidence interval is considered. A winter average could not be calculated due to the low number of detections.

13.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. HAKY has not sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

13.5 Pearson Correlations

Table 13-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations from Table 13-6 include the following:

- All of the correlations for HAKY were weak.

13.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

13.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Kentucky monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the concentrations

Table 13-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Kentucky Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Hazard, Kentucky - HAKY								
Hexavalent Chromium	33	-0.09	-0.02	0.06	0.04	0.17	-0.24	0.19

of hexavalent chromium measured at the HAKY monitoring site exceeded any of the MRL risk values.

13.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Kentucky monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 13-7. The data from NATA are presented for the census tract where the monitoring site is located. The census tract ID for HAKY is 21193970400, for which the population was 4,359, and represented 15 percent of the 2000 county population. The pollutants of interest for the site are bolded.

Observations for HAKY from Table 13-7 include the following:

- The modeled concentration for hexavalent chromium from NATA was less than 0.01 µg/m^3, as was the annual average.
- Cancer and noncancer risks from hexavalent chromium according to NATA were relatively low. This was also true of the cancer and noncancer surrogate risk approximations.

13.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 13-8 and 13-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 13-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 13-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although

Table 13-7. Cancer and Noncancer Risk Summary for the Monitoring Site in Kentucky

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (µg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Hazard, Kentucky (HAKY) - Census Tract ID 21193970400								
Hexavalent Chromium	0.012	0.0001	<0.01	0.02	<0.01	<0.01 ± <0.01	0.15	<0.01

Bold = pollutant of interest

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 13-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Kentucky

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Hazard, Kentucky (HAKY) – Perry County					
Benzene	38.80	Benzene	3.03E-04	Hexavalent Chromium	0.15
Formaldehyde	12.01	1,3-Butadiene	7.17E-05		
Acetaldehyde	4.06	POM, Group 2	4.34E-05		
Tetrachloroethylene	3.86	Naphthalene	3.83E-05		
Dichloromethane	2.40	POM, Group 3	2.52E-05		
1,3-Butadiene	2.39	Tetrachloroethylene	2.28E-05		
Naphthalene	1.13	POM, Group 5	1.74E-05		
POM, Group 2	0.79	Hexavalent Chromium	1.02E-05		
p-Dichlorobenzene	0.62	Acetaldehyde	8.93E-06		
Trichloroethylene	0.09	Arsenic, PM	7.89E-06		

Table 13-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Kentucky

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Hazard, Kentucky (HAKY) – Perry County					
Toluene	68.56	Acrolein	41,819.77	Hexavalent Chromium	<0.01
Xylenes	46.03	Benzene	1,293.21		
Benzene	38.80	4,4'-Methylenediphenyl diisocyanate, gas	1,255.09		
Methanol	14.77	Formaldehyde	1,225.33		
Formaldehyde	12.01	1,3-Butadiene	1,194.22		
Methyl *tert*-butyl ether	11.32	Cyanide Compounds, gas	983.33		
Ethylbenzene	10.42	Xylenes	460.25		
Hexane	10.34	Acetaldehyde	450.84		
Methyl isobutyl ketone	5.03	Naphthalene	375.62		
Styrene	4.49	Toluene	171.40		

the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 13.3, HAKY sampled forhexavalent chromium only. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 13-8 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Perry County. The overall emissions for this county were low compared to other counties with NATTS or UATMP sites.

- Benzene was also the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by 1,3-butadiene and POM group 2.

- Six of the highest emitted pollutants also had the highest toxicity-weighted emissions for Perry County.

- Hexavalent chromium, which was the only pollutant sampled for at HAKY, had the eighth highest toxicity-weighted emissions for Perry County. This pollutant did not appear on the list of highest emitted pollutants.

Observations from Table 13-9 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Perry County. The overall emissions for this county were low compared to other counties with NATTS or UATMP sites.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, benzene, and gaseous 4,4'-methylenediphenyl diisocyanate.

- Four of the highest emitted pollutants in Perry County also had the highest toxicity-weighted emissions.

- Hexavalent chromium did not appear on the list of highest emitted pollutants or the list of highest toxicity-weighted emissions for pollutants with a noncancer toxicity factor.

13.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *Hexavalent chromium failed one screen for HAKY.*
- *Hexavalent chromium did not exceed any of the MRL health benchmarks.*

14.0 Site in Massachusetts

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Massachusetts, and integrates these concentrations with emissions, meteorological, and risk information.

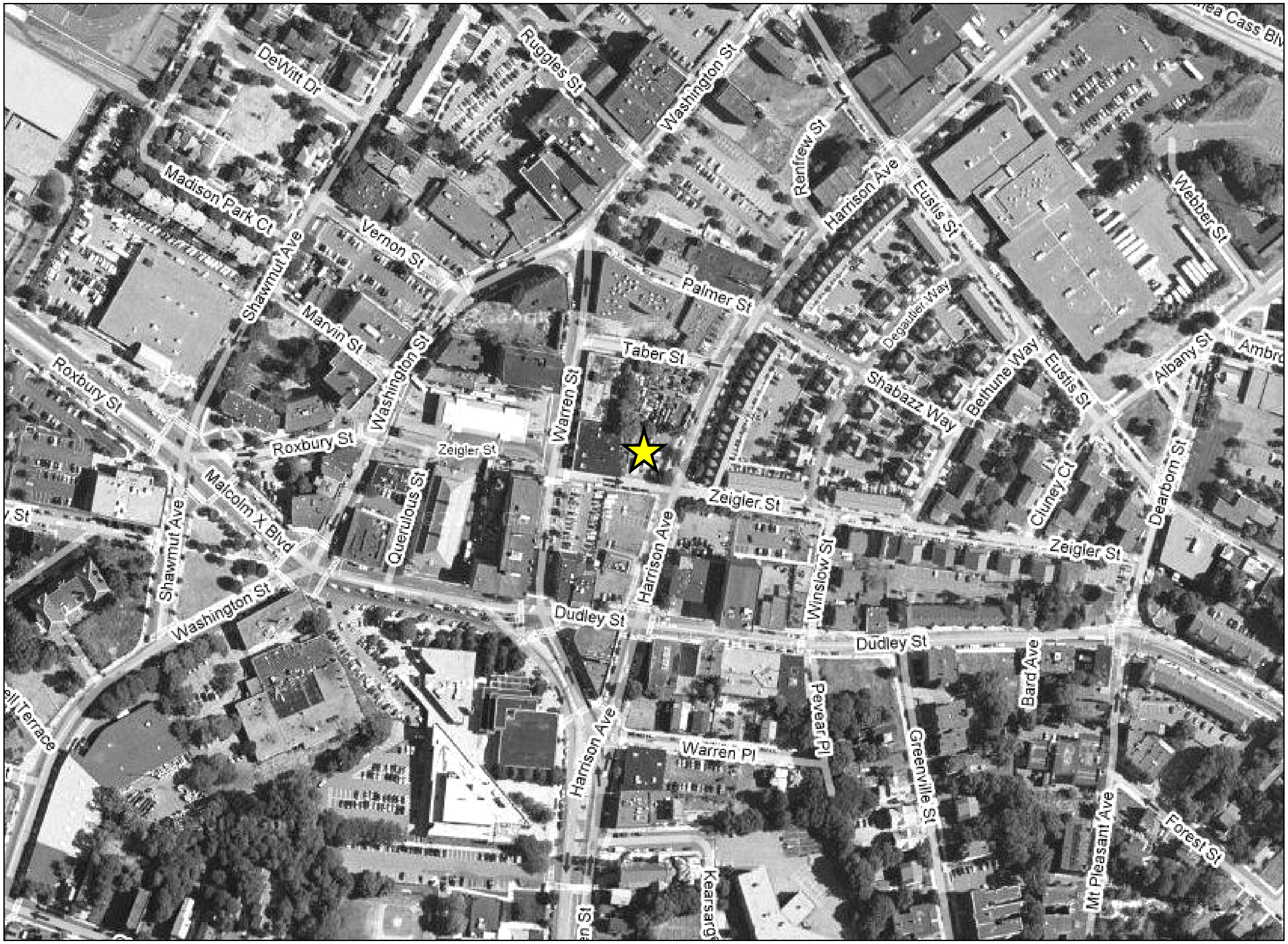
14.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The Massachusetts site is located in the Boston-Cambridge-Quincy, MA-NH MSA. Figure 14-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its urban location. Figure 14-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 14-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

The BOMA monitoring is located at Dudley Square in Roxbury, southwest of Boston. The surrounding area is commercial as well as residential, as shown in Figure 14-1. The monitoring site is approximately one mile south of I-90 and one mile west of I-93. The original purpose for the location of this site was to measure population exposure to a city bus terminal located across the street from the monitoring site. In recent years, the buses servicing the area were converted to compressed natural gas (CNG). As Figure 14-2 shows, BOMA is located near a number of emission sources, which are primarily located to the north and west of the site. The majority of the emission sources surrounding BOMA employ fuel combustion processes.

Table 14-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Massachusetts monitoring site. County-level vehicle registration and population data for Suffolk County were obtained from the Massachusetts Registry of Motor Vehicles and the U.S. Census Bureau. Table 14-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of

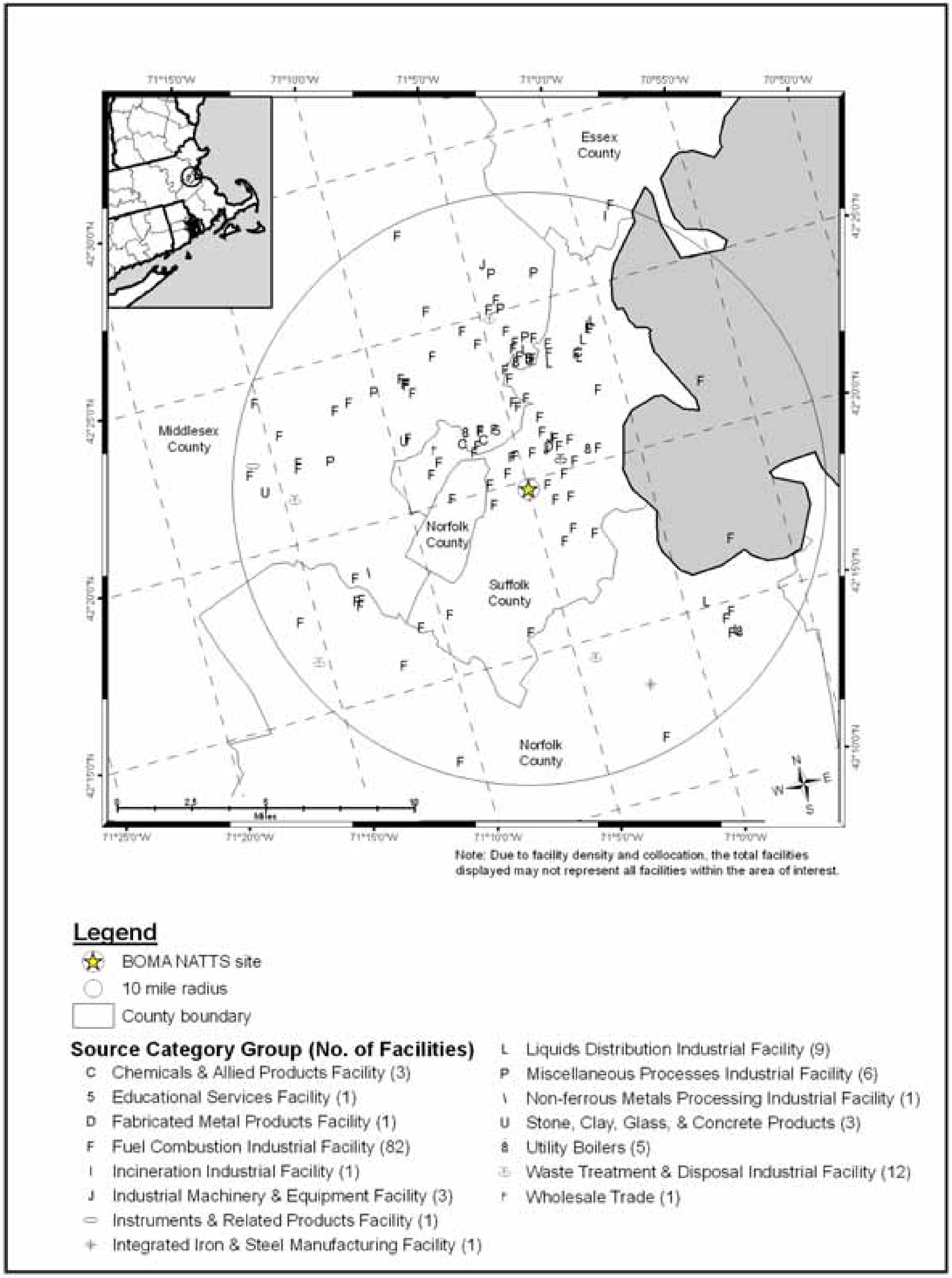
Figure 14-1. Boston, Massachusetts (BOMA) Monitoring Site



©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 14-2. NEI Point Sources Located Within 10 Miles of BOMA



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 14-1. Geographical Information for the Massachusetts Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
BOMA	25-025-0042	Boston	Suffolk	Boston-Cambridge-Quincy, MA-NH	42.32944, -71.082778	Commercial	Urban/City Center	The Boston site is located in a mixed commercial/residential neighborhood on Harrison Avenue in Dudley Square. The site is a core urban background/environmental justice site. A city bus terminal is located across the street from the monitor. The buses have been converted to compressed natural gas (CNG).

BOLD = EPA-designated NATTS Site

Table 14-2. Population, Motor Vehicle, and Traffic Information for the Massachusetts Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
BOMA	713,049	467,969	0.66	1,585,962	1,040,856	23,800	94,248

[1] Daily Average Traffic Data reflects 2005 data from the Mass Highway Department

BOLD = EPA-designated NATTS Site

10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 14-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 14-2 presents the daily VMT for each urban area.

Observations from Table 14-2 include the following:

- The Suffolk County population was in the middle of the range compared to all counties with NATTS or UATMP sites, while BOMA's 10-mile population ranked seventh highest.
- The Suffolk County vehicle registration was in the middle of the range compared to all counties with NATTS or UATMP sites, while its 10-mile estimated ownership was eighth highest.
- The vehicle per person ratio was the eighth lowest compared to other NATTS or UATMP sites.
- The traffic volume experienced near BOMA ranked in the middle of the range compared to other monitoring sites. The traffic estimate used came from Melnea Cass Boulevard between Washington Street and Harrison Avenue.
- VMT for the Boston area ranked tenth among urban areas with available data.

14.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Massachusetts on sampling days, as well as over the course of the year.

14.2.1 Climate Summary

Boston's location on the East Coast ensures that the city experiences a fairly active weather pattern. Most storm systems track across the Northeast, bringing ample precipitation to the area. The proximity to the Atlantic Ocean helps moderate temperature, both in the summer and the winter, while at the same time allowing winds to gust higher than they would farther inland. Winds generally flow from the northwest in the winter and southwest in the summer (Ruffner and Bair, 1987).

14.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at Logan International Airport (WBAN14739).

Table 14-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 14-3 is the 95 percent confidence interval for each parameter. As shown in Table 14-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

14.2.3 Composite Back Trajectories for Sampling Days

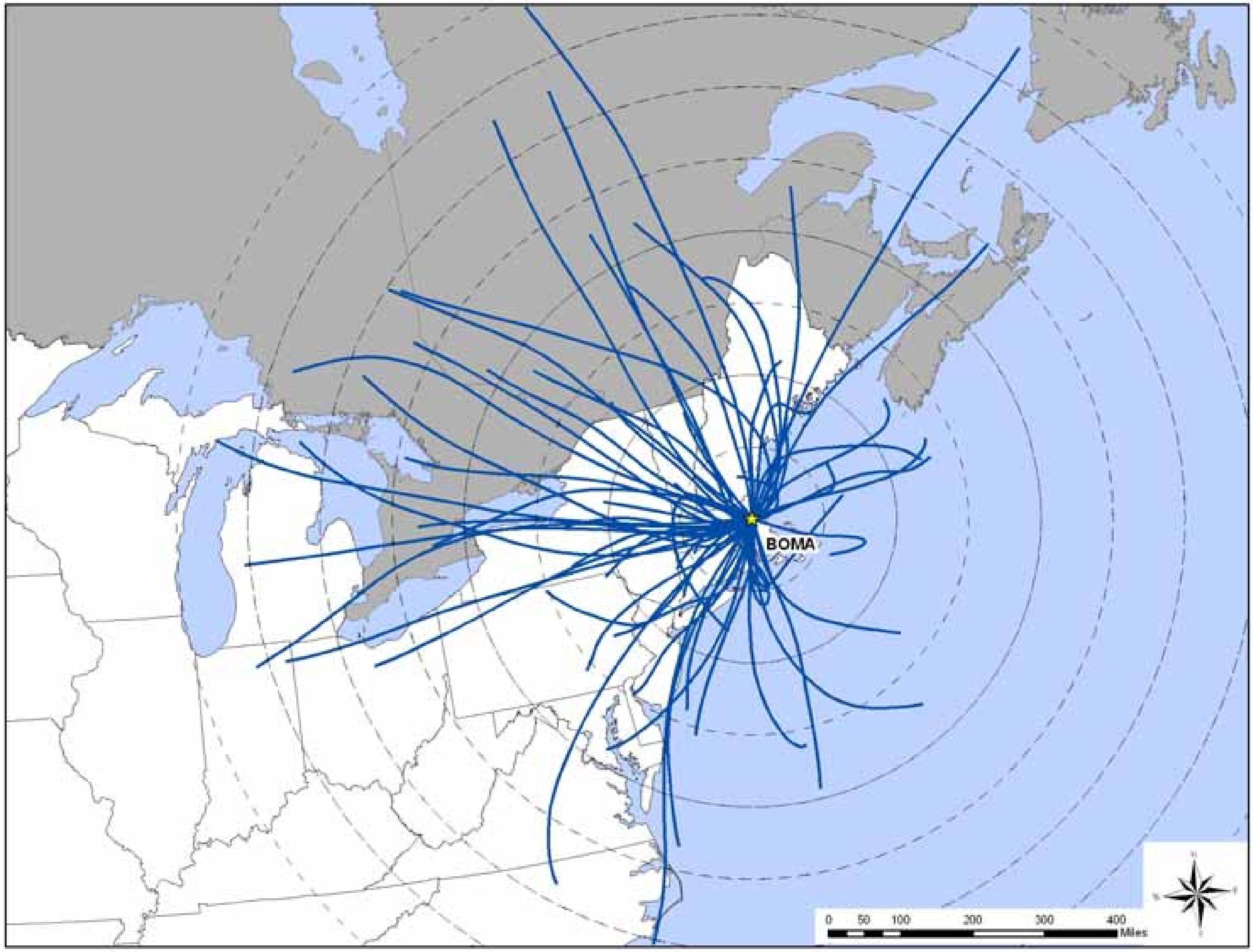
Figure 14-3 is a composite back trajectory map for the Massachusetts monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 14-3 represents 100 miles.

Table 14-3. Average Meteorological Conditions near the Massachusetts Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
BOMA	Logan International Airport 14739	Sampling Day	58.16 ± 4.71	51.15 ± 4.40	38.56 ± 4.95	45.64 ± 4.11	64.89 ± 3.87	1017.17 ± 1.73	9.30 ± 074
		All 2007	58.80 ± 1.99	51.57 ± 1.85	38.02 ± 2.00	45.55 ± 1.68	63.11 ± 1.69	1015.88 ± 0.80	9.39 ± 0.35

BOLD = EPA-designated NATTS Site

Figure 14-3. Composite Back Trajectory Map for BOMA



Observations from Figure 14-3 include the following:

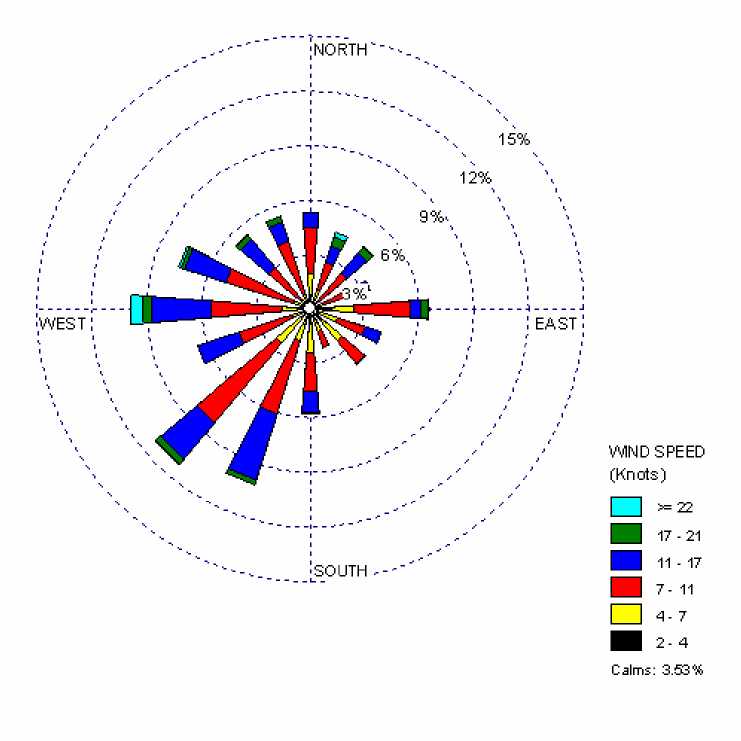
- Back trajectories originated from a variety of directions at BOMA. However, trajectories originated less frequently from the southeast and east than other directions.

- The 24-hour air shed domain for BOMA was comparable in size to other monitoring sites. The furthest away a trajectory originated was central Quebec, Canada, or nearly 800 miles away. However, most trajectories originated within 600 miles of the monitoring site.

14.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at Logan International Airport near BOMA were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 14-4 is the wind rose for the Massachusetts monitoring site on days that samples were collected.

Figure 14-4. Wind Rose for BOMA Sampling Days



Observations from Figure 14-4 for BOMA include the following:

- Southwesterly and westerly winds were prevalent near BOMA.
- Calm winds were observed for less than four percent of the hourly wind measurements.
- Winds exceeding 11 knots made up nearly 30 percent of observations, making this one of the windier locations.

14.3 Pollutants of Interest

"Pollutants of interest" were determined for the site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Massachusetts monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 14-4 presents the pollutants that failed at least one screen for the Massachusetts monitoring site and highlights the site's pollutants of interest (shaded). BOMA sampled for metals (PM_{10}) and hexavalent chromium.

Table 14-4. Comparison of Measured Concentrations and EPA Screening Values for the Massachusetts Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Boston, Massachusetts - BOMA					
Arsenic (PM_{10})	53	59	89.83	61.63	61.63
Nickel (PM_{10})	23	59	38.98	26.74	88.37
Manganese (PM_{10})	7	59	11.86	8.14	96.51
Hexavalent Chromium	3	44	6.82	3.49	100.00
Total	86	221	38.91		

Observations from Table 14-4 include the following:

- Four pollutants with a total of 221 measured concentrations failed at least one screen for BOMA.

- Arsenic, nickel, and manganese were identified as the pollutants of interest for BOMA.

- Less than 40 percent of measured detections failed screens (of the pollutants that failed at least one screen) for BOMA.

14.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Massachusetts monitoring site. The averages presented are provided for the pollutants of interest for the site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

14.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 14-5, where applicable. The concentration averages in Table 14-5 are presented in ng/m^3 for ease of viewing.

Observations for BOMA from Table 14-5 include the following:

- The pollutants with the highest daily average concentration by mass were manganese (3.29 ± 0.34 ng/m^3), nickel (2.28 ± 0.35 ng/m^3), and arsenic (0.46 ± 0.05 ng/m^3). The annual averages for these pollutants were the same as their respective daily averages.

- As shown in Table 4-10, the daily average concentration of arsenic and manganese for BOMA was the lowest among sites sampling PM_{10} metals.

- The average concentrations of the pollutants of interest for BOMA did not differ significantly from season to season.

Table 14-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Massachusetts Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (ng/m^3)	Winter Average (ng/m^3)	Spring Average (ng/m^3)	Summer Average (ng/m^3)	Autumn Average (ng/m^3)	Annual Average[1] (ng/m^3)
Boston, Massachusetts - BOMA								
Arsenic (PM_{10})	59	59	0.46 ± 0.05	0.45 ± 0.07	0.41 ± 0.10	0.45 ± 0.12	0.52 ± 0.13	0.46 ± 0.05
Manganese (PM_{10})	59	59	3.29 ± 0.34	2.92 ± 0.49	3.14 ± 0.74	3.60 ± 0.69	3.50 ± 0.71	3.29 ± 0.34
Nickel (PM_{10})	59	59	2.28 ± 0.35	3.25 ± 0.62	2.04 ± 0.38	1.73 ± 0.63	2.18 ± 0.82	2.28 ± 0.35

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

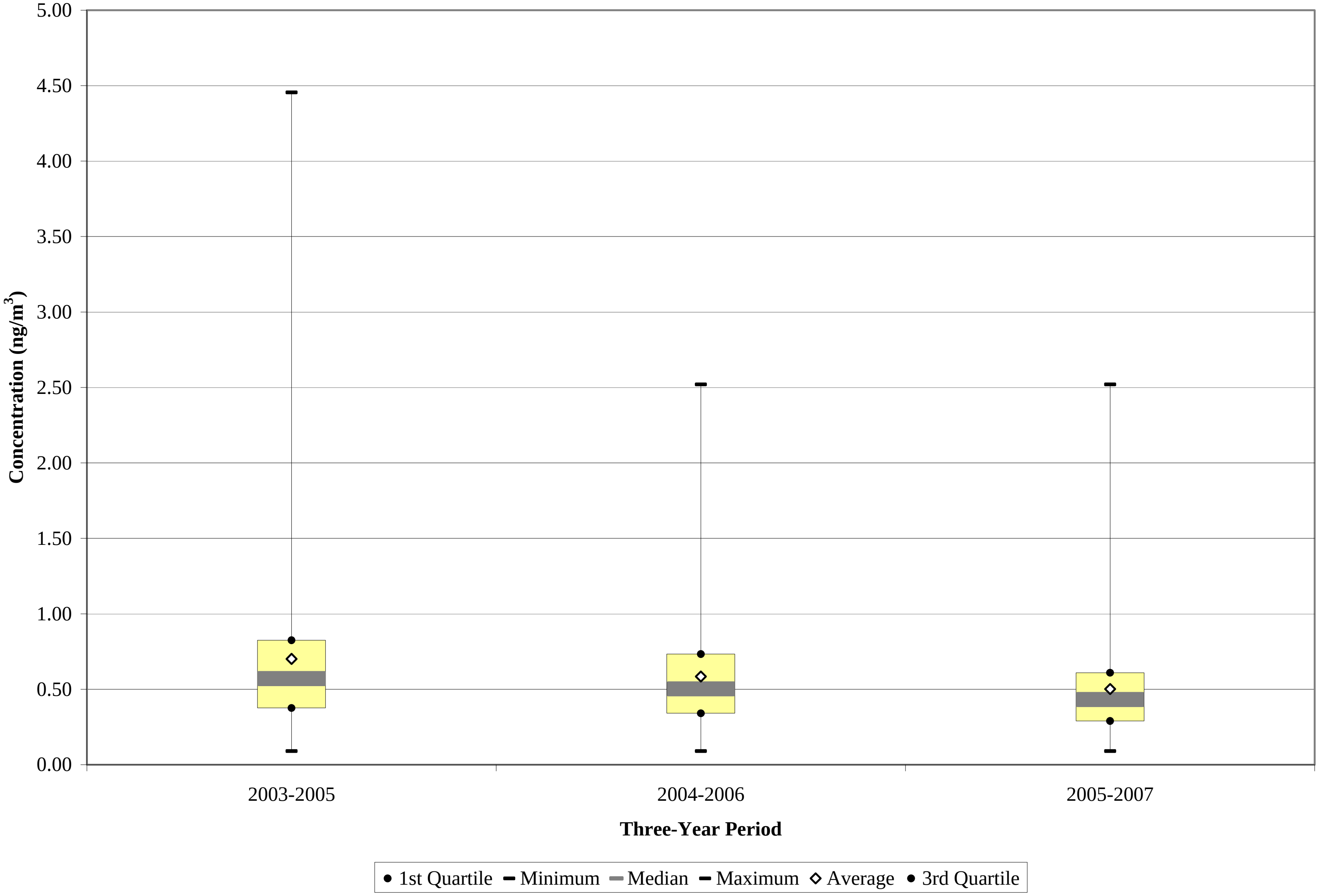
14.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. BOMA has participated in the UATMP and/or NATTS for at least five years. Figure 14-5 presents the three-year rolling statistical metrics graphically for arsenic. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Observations from Figure 14-5 for arsenic measurements at BOMA include the following:

- Sampling for metals under the UATMP and/or NATTS at BOMA began in 2003.
- The maximum arsenic concentration shown was measured during the 2003-2005 time frame. The maximum concentrations measured in subsequent time periods were nearly half the maximum concentration from the 2003-2005 time frame.
- The rolling average concentrations have a decreasing trend over the time periods shown.
- The rolling averages and the median values became more similar over the periods. The increasing “closeness” of these metrics indicates decreasing variability in the central tendency.
- All arsenic concentrations reported to AQS over the five years of sampling were measured detections.

Figure 14-5. Three-Year Rolling Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BOMA



14.5 Pearson Correlations

Table 14-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for BOMA from Table 14-6 include the following:

- The pollutants of interest exhibited weak correlations with the meteorological parameters.

14.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

14.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Massachusetts monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the concentrations measured at the BOMA site exceeded any of the MRL risk values.

14.6.2 Cancer and Noncancer Risk Approximations

For the pollutants that failed at least one screen at the Massachusetts monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated).

Table 14-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Massachusetts Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Boston, Massachusetts - BOMA								
Arsenic (PM_{10})	59	0.19	0.12	0.11	0.11	0.04	0.07	-0.27
Manganese (PM_{10})	59	0.25	0.22	0.11	0.17	-0.24	0.10	-0.38
Nickel (PM_{10})	59	-0.41	-0.41	-0.33	-0.38	0.07	0.30	-0.20

Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 14-7. The data from NATA are presented for the census tract where the monitoring site is located. BOMA is located in census tract ID 25025080400, for which the population was 723, and represented 0.1 percent of the county population in 2000. The pollutants of interest are bolded.

Observations for BOMA from Table 14-7 include the following:

- According to NATA, the concentrations of the pollutants that failed at least one screen for BOMA were less than 0.01 $\mu g/m^3$.
- Cancer and noncancer risk attributable to the pollutants that failed at least one screen for BOMA were low, according to NATA.
- The annual averages of the pollutants that failed at least one screen for BOMA were also less than 0.01 $\mu g/m^3$.
- Cancer risk approximations based on the annual averages for arsenic and nickel were an order of magnitude higher than the NATA cancer risk estimates.
- Similar to the NATA results, noncancer risk approximations based on the annual averages were low.

14.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 14-8 and 14-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 14-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 14-9 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Table 14-7. Cancer and Noncancer Risk Summary for the Monitoring Site in Massachusetts

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (µg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Boston, Massachusetts (BOMA) - Census Tract ID 25025080400								
Arsenic (PM_{10})	0.0043	0.00003	<0.01	0.28	<0.01	<0.01 ± <0.01	1.97	0.02
Hexavalent Chromium	0.012	0.0001	<0.01	0.53	<0.01	<0.01 ± <0.01	0.29	<0.01
Manganese (PM_{10})	--	0.00005	<0.01	--	<0.01	<0.01 ± <0.01	--	0.07
Nickel (PM_{10})	0.00016	0.000065	<0.01	0.09	0.01	<0.01 ± <0.01	0.37	0.04

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 14-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Massachusetts

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Boston, Massachusetts (BOMA) – Suffolk County					
Benzene	232.26	Benzene	1.81E-03	Arsenic	1.97
Formaldehyde	176.23	1,3-Butadiene	9.42E-04	Nickel	0.37
Acetaldehyde	68.00	POM, Group 1	4.34E-04	Hexavalent Chromium	0.29
Dichloromethane	57.42	Naphthalene	3.82E-04		
1,3-Butadiene	31.39	Hexavalent Chromium	2.81E-04		
Tetrachloroethylene	24.90	POM, Group 2	2.72E-04		
Naphthalene	11.23	POM, Group 5	1.82E-04		
POM, Group 1	7.90	Arsenic, PM	1.59E-04		
Trichloroethylene	6.93	Acetaldehyde	1.50E-04		
POM, Group 2	4.94	Tetrachloroethylene	1.47E-04		

Table 14-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Massachusetts

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Boston, Massachusetts (BOMA) – Suffolk County					
Toluene	636.32	Acrolein	507,083.33	Manganese	0.07
Methyl *tert*-butyl ether	504.90	Formaldehyde	17,982.94	Nickel	0.04
Xylenes	483.17	1,3-Butadiene	15,692.84	Arsenic	0.02
Methanol	401.01	Nickel, PM	13,832.64	Hexavalent Chromium	0.00
Benzene	232.26	Cyanide Compounds, gas	8,716.67		
Formaldehyde	176.23	Benzene	7,741.84		
Methyl isobutyl ketone	146.05	Acetaldehyde	7,555.62		
Ethylene glycol	123.01	Xylenes	4,831.74		
Ethylbenzene	85.88	Naphthalene	3,744.26		
Hexane	81.15	Glycol ethers, gas	2,620.25		

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 14.3, BOMA sampled for metals and hexavalent chromium. In addition, the cancer and noncancer risk approximations are limited to those sites sampling for a long enough period for an annual average to be calculated.

Observations from Table 14-8 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Suffolk County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, 1,3-butadiene, and POM Group 1.
- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- Arsenic was the pollutant with the highest cancer surrogate risk approximation for BOMA. This pollutant also appeared on the list of highest toxicity-weighted emissions. Hexavalent chromium, which had the third highest cancer surrogate risk approximation, also appeared on the list of highest toxicity-weighted emissions.

Observations from Table 14-9 include the following:

- Toluene, methyl *tert*-butyl ether, and xylenes were the highest emitted pollutants with noncancer RfCs in Suffolk County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, formaldehyde, and 1,3-butadiene.
- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- Nickel, which had the second highest noncancer risk approximation, also had the fourth highest toxicity-weighted emissions. The remaining pollutants of interest did not appear on the list of highest toxicity-weighted emissions.

14.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

❖ *The pollutants of interest for BOMA were arsenic, manganese, and nickel.*

- *Manganese had the highest daily average concentration among the pollutants of interest for BOMA.*

- *There were no exceedances of the MRL health benchmarks at BOMA.*

15.0 Sites in Michigan

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP sites in Michigan, and integrates these concentrations with emissions, meteorological, and risk information.

15.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. The DEMI monitoring site is located in the Detroit-Warren-Livonia, MI MSA. ITCMI is located in Sault Sainte Marie on the Upper Peninsula. Figures 15-1 and 15-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban locations. Figures 15-3 and 15-4 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 15-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

DEMI is located at Paul Costea Park in Dearborn, just southwest of Detroit. The surrounding area is both suburban and industrial in nature. Figure 15-1 shows that a freight yard is located to the west of the site and a residential neighborhood is located to the east. Industrial sources such as an auto and steel manufacturing facility are also located in the vicinity. Heavily traveled roadways surround the monitoring site, as the site lies between I-75 and I-94. As Figure 15-3 shows, a number of point sources surround DEMI, several of which are located just south of the site. Many of the point sources within 10 miles of DEMI are engaged in processes involving fuel combustion or waste treatment and disposal processes. Five point sources are shown in very close proximity of DEMI, including emission sources involved in iron and steel manufacturing, ferrous metal processing, and the use of utility boilers.

ITCMI is located on the property of Lake Superior State University in Sault Sainte Marie and is operated by the Intertribal Council of Michigan. Monitoring was initiated at this location because tribal members were concerned about industrial emission sources across the St. Mary's

Figure 15-1. Dearborn, Michigan (DEMI) Monitoring Site

©2008 Google/©NAVTECH

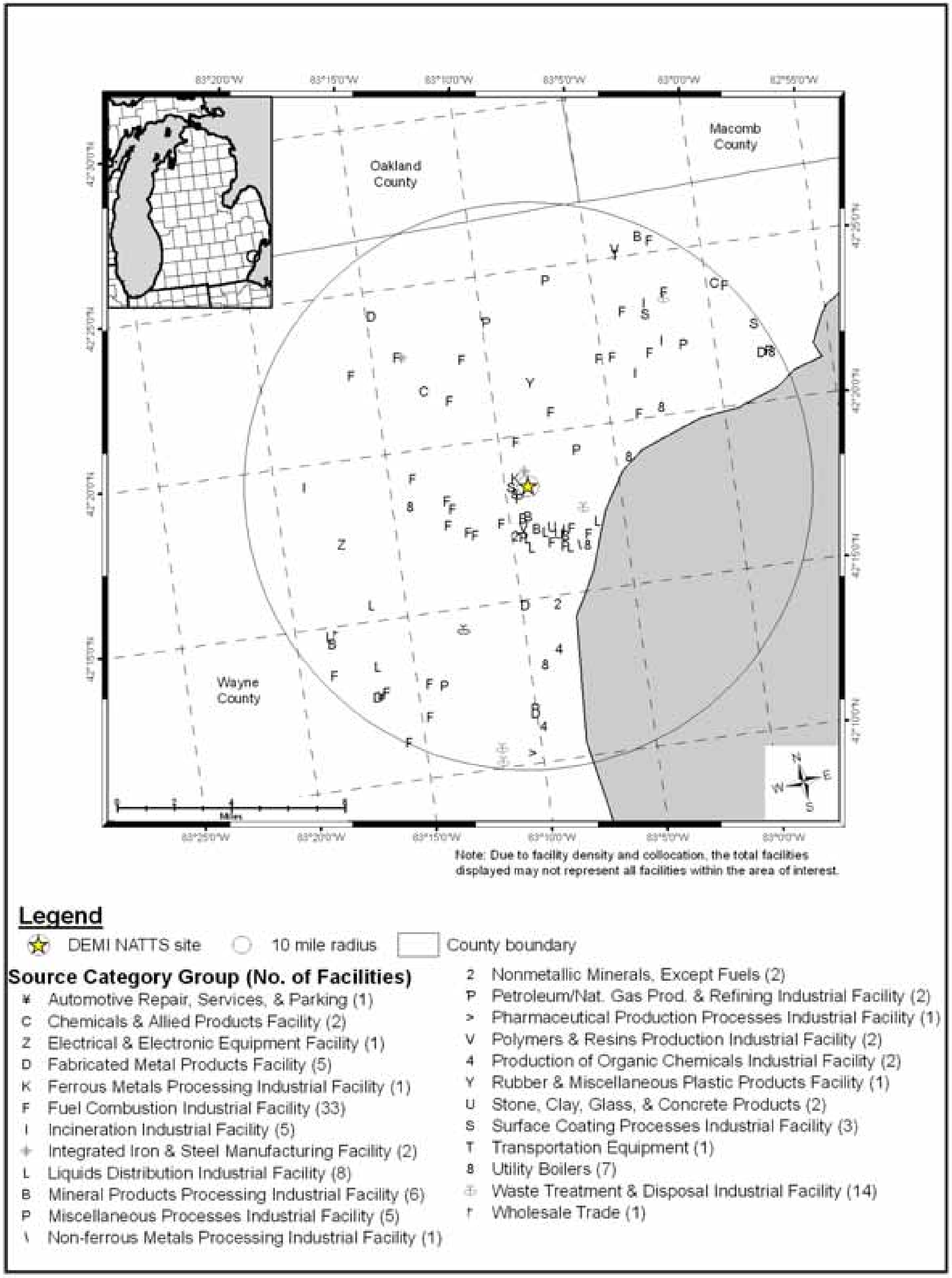
Scale: 3cm = 100m

Figure 15-2. Sault Sainte Marie, Michigan (ITCMI) Monitoring Site

©2008 Google/©NAVTECH

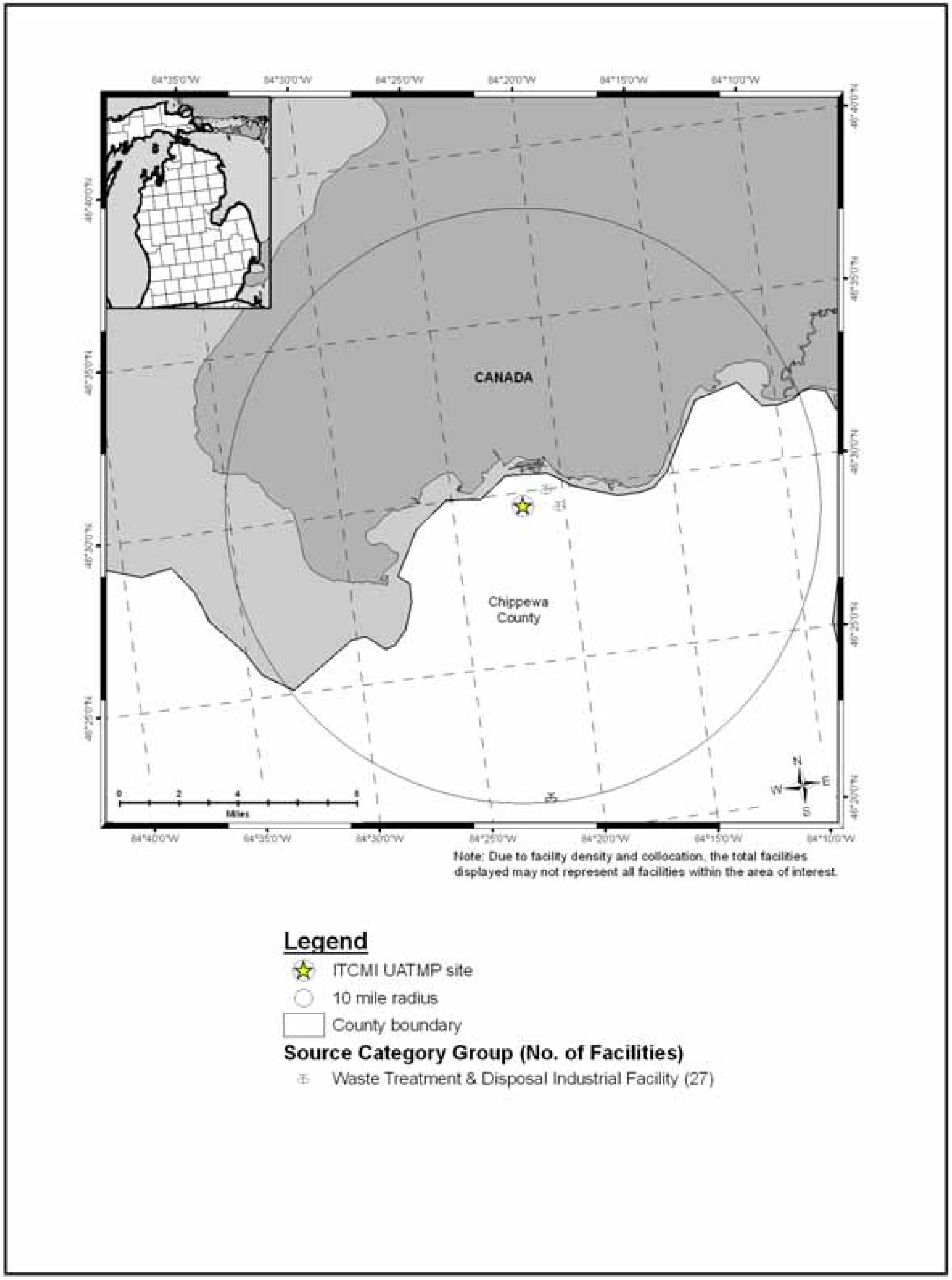
Scale: 3cm = 200m

Figure 15-3. NEI Point Sources Located Within 10 Miles of DEMI



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 15-4. NEI Point Sources Located Within 10 Miles of ITCMI



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 15-1. Geographical Information for the Michigan Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
DEMI	26-163-0033	Dearborn	Wayne	Detroit-Warren-Livonia, MI	42.30754, -83.14961	Industrial	Suburban	The Dearborn, MI site is located in a residential neighborhood with industrial impacts. Auto and steel manufacturing plants, in addition to other sources, are located in close proximity to the monitoring site. Previous violations of the PM$_{10}$ standard have also occurred at this site. The site lies between I-75 and I-94. This site is expected to show some of the highest levels of air toxics in the Detroit Pilot program area. Continuous EC/OC, aethalometry and the suite of NATTS analytes are monitored for at this location, as are TSP trace metals, co-located PM$_{10}$ trace metals, and a 1-in-6 day PM$_{2.5}$ speciation site. This site is often used for special studies.
ITCMI	26-033-0901	Sault Ste. Marie	Chippewa	Sault Ste. Marie, MI	46.493611, -84.364167	Residential	Rural	Tribal members had issued complaints arising from the smell and clouds being produced from a steel plant and paper mill located on the other side of the Saint Mary's River. The monitoring site is located on Lake Superior State University campus, which is a residential area. This site includes a sequential PM$_{2.5}$ filter based FRM monitors, a PM$_{2.5}$ TEOM monitor, an AVOCS monitor, a PAH monitor, and a meteorological station.

BOLD = EPA-designated NATTS Site

River in Ontario, Canada. Figure 15-2 shows that ITCMI is east of I-75 and north of Business-75. The area surrounding ITCMI is primarily residential. As Figure 15-4 shows, all of the point sources in the U.S. within 10 miles of ITCMI are involved in waste treatment and disposal. Any possible emissions sources located in Canada are not provided in Figure 15-4.

Table 15-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Michigan monitoring sites. County-level vehicle registration and population data for Wayne and Chippewa Counties were obtained from the Michigan Department of State and the U.S. Census Bureau. Table 15-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 15-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 15-2 presents the daily VMT for each urban area (where applicable).

Table 15-2. Population, Motor Vehicle, and Traffic Information for the Michigan Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
DEMI	1,985,101	1,400,461	0.71	1,138,740	803,365	20,900	104,126
ITCMI	38,922	36,768	0.94	21,803	20,596	5,200	NA

[1] Daily Average Traffic Data reflects 2006 data from the Michigan DOT

BOLD = EPA-designated NATTS Site

Observations from Table 15-2 include the following:

- Wayne County had the sixth highest county population and eighth highest county-level vehicle registration compared to all counties with NATTS or UATMP sites. Conversely, Chippewa County had the fourth lowest county population and county-level vehicle registration compared to all counties with NATTS or UATMP sites. This difference among the two Michigan sites is also reflected in the population and ownership estimates within 10 miles.

- The vehicle per person ratio for ITCMI was nearly one vehicle per person, which is higher than the vehicle per person ratio for DEMI.

- DEMI experienced a higher average daily traffic volume than ITCMI, although both were relatively low compared to other program sites. Traffic for ITCMI was obtained from I-75 near the intersection of West Spruce Street and Portage Avenue; traffic for DEMI was obtained from I-94, near Michigan Avenue and Loyno Street.

- The Detroit area VMT ranked seventh among urban areas with UATMP or NATTS sites. VMT for the Sault Sainte Marie area was not available.

15.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Michigan on sampling days, as well as over the course of the year.

15.2.1 Climate Summary

The Detroit area is located in the Great Lakes region, where storm systems frequently track across the region. Winters tend to be cold and wet, while summers are generally mild. The urbanization of the area along with Lake St. Clair to the east are two major influences on the city's weather. The lake tends to keep the Detroit area warmer in the winter and cooler in the summer than more inland areas. The urban heat island keeps the city warmer than outlying areas. Winds are often breezy and generally flow from the southwest on average (Ruffner and Bair, 1987).

Sault Sainte Marie is located on the northeast edge of Michigan's Upper Peninsula. While this area also experiences an active weather pattern, its climate is somewhat tempered by the surrounding waters of Lakes Superior and Huron, as the city resides on the channel between the two lakes. This location experiences ample precipitation, especially during lake-effect snow events (Ruffner and Bair, 1987).

15.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The two closest NWS weather stations are located at Detroit-Metropolitan Airport (near DEMI) and Sault Ste. Marie Municipal Airport (near ITCMI), WBAN 94847 and 14847, respectively.

Table 15-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 15-3 is the 95 percent confidence interval for each parameter. As shown in Table 15-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

15.2.3 Composite Back Trajectories for Sampling Days

Figures 15-5 and 15-6 are composite back trajectory maps for the Michigan monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 15-5 and 15-6 represents 100 miles.

Observations from Figure 15-5 for DEMI include the following:

- Back trajectories originated from a variety of directions at the DEMI site, although there were fewer trajectories from the southeast. The predominant direction of trajectory origin was from the south and northwest.

- The 24-hour air shed domain for DEMI was comparable to other monitoring sites. The furthest away a trajectory originated was northern Alabama, or less than 700 miles away. However, most trajectories originated within 500 miles of the site.

Observations from Figure 15-6 for ITCMI include the following:

- Back trajectories originated from a variety of directions at the ITCMI site, although there were fewer trajectories from the northeast and southeast. The predominant direction of trajectory origin was from the northwest. A secondary cluster of trajectories originated from the southwest.

Table 15-3. Average Meteorological Conditions near the Michigan Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
DEMI	Detroit/ Metropolitan Airport 94847	Sampling Day	60.47 ± 5.35	52.35 ± 4.93	40.11 ± 4.47	46.27 ± 4.32	66.11 ± 3.03	1017.08 ± 1.60	7.10 ± 0.78
		All 2007	59.20 ± 2.22	51.19 ± 2.04	39.20 ± 1.88	45.34 ± 1.80	66.42 ± 1.23	1017.35 ± 0.67	7.43 ± 0.36
ITCMI	Sault Ste. Marie Municipal Airport 14847	Sampling Day	52.30 ± 6.11	44.01 ± 5.48	34.74 ± 5.04	39.72 ± 4.92	73.08 ± 3.30	1015.55 ± 1.71	6.62 ± 0.74
		All 2007	50.97 ± 2.27	42.78 ± 2.07	33.93 ± 1.97	38.83 ± 1.89	73.78 ± 1.25	1015.35 ± 0.77	6.32 ± 0.26

BOLD = EPA-designated NATTS Site

Figure 15-5. Composite Back Trajectory Map for DEMI

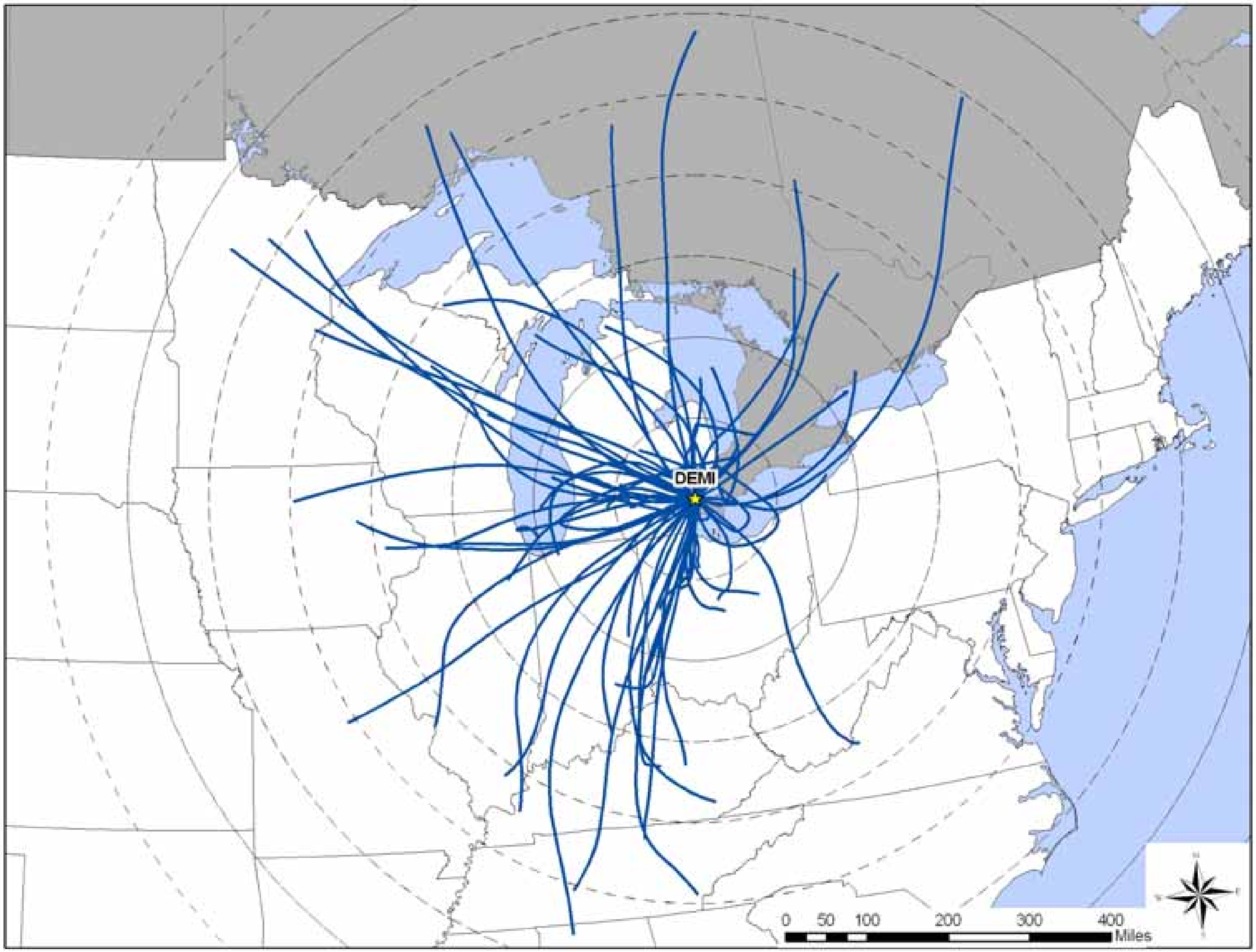
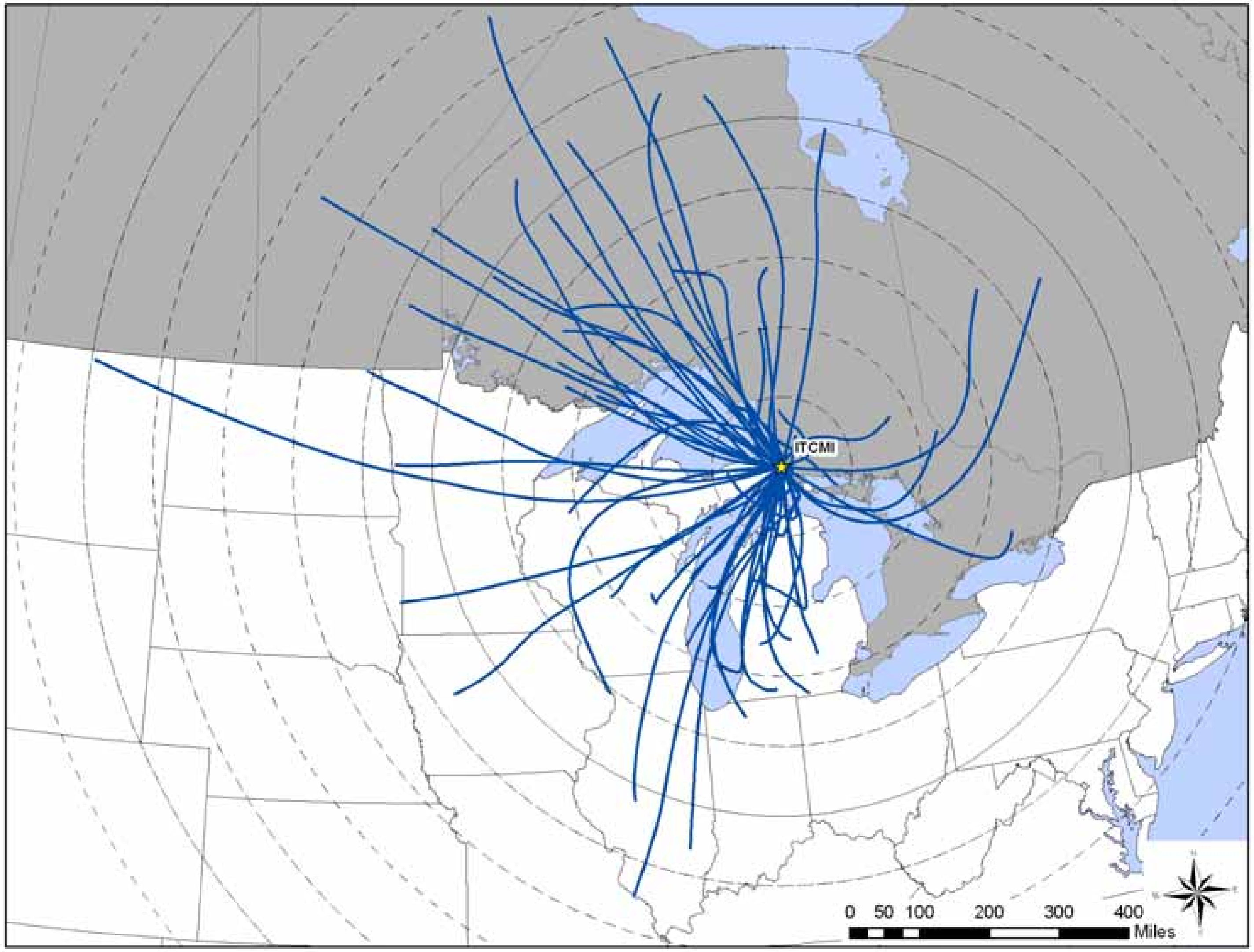


Figure 15-6. Composite Back Trajectory Map for ITCMI



- The 24-hour air shed domain for ITCMI was larger than DEMI and many other monitoring sites. The furthest away a trajectory originated was north-central Montana, or nearly 1,000 miles away. However, nearly 90 percent of trajectories originated within 600 miles of the site.

15.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations at the Detroit-Metropolitan (for DEMI) and Sault Ste. Marie International (for ITCMI) Airports were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 15-7 and 15-8 are the wind roses for the Michigan monitoring sites on days that samples were collected.

Observations from Figure 15-7 for DEMI include the following:

- Winds from a variety of directions were observed near DEMI, although southeasterly winds were observed less frequently than winds from other directions.
- Calm winds were observed for approximately 12 percent of the hourly measurements.
- Winds exceeding 11 knots made up approximately 17.5 percent of observations. The strongest winds often originated from the south, southwest, and west.

Observations from Figure 15-8 for ITCMI include the following:

- Winds from a variety of directions were observed near ITCMI, although easterly and northwesterly winds were observed more frequently than winds from other directions.
- Calm winds were observed for approximately 14 percent of the hourly measurements.
- Winds exceeding 11 knots made up approximately 16 percent of observations. The strongest winds often originated from the southwest and northwest.

Figure 15-7. Wind Rose for DEMI Sampling Days

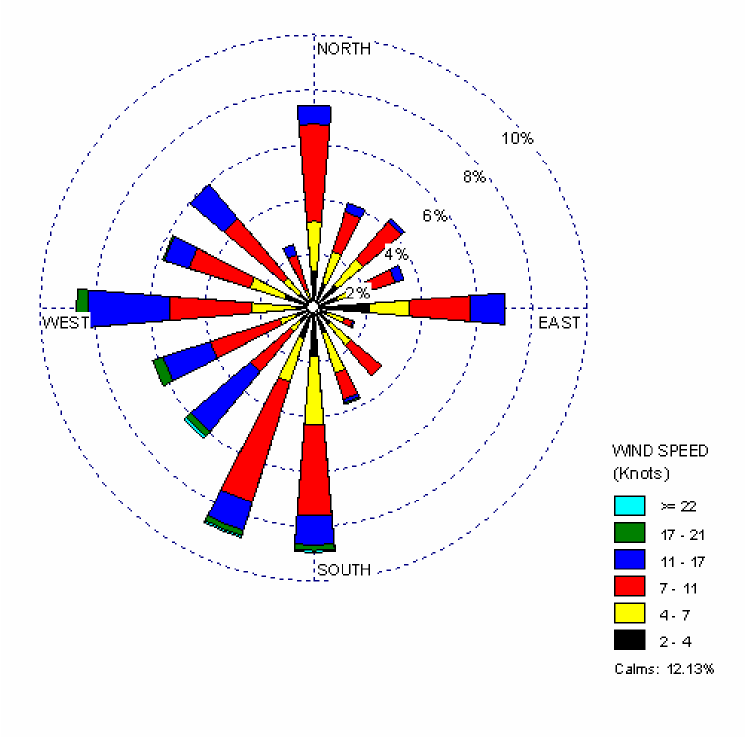
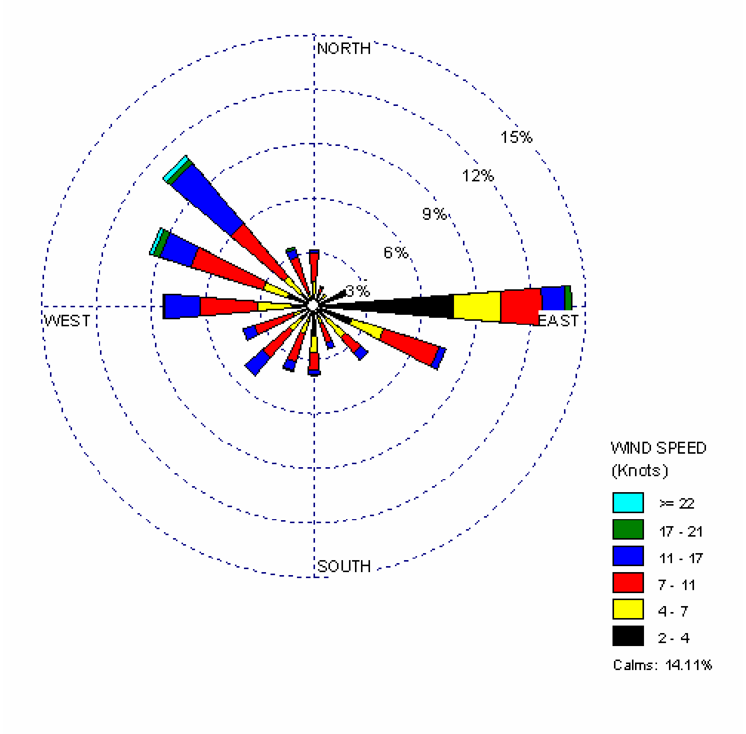


Figure 15-8. Wind Rose for ITCMI Sampling Days



15.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Michigan monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 15-4 presents the pollutants that failed at least one screen for each Michigan monitoring site and highlights each site's pollutants of interest (shaded). DEMI sampled for VOC, carbonyls, and hexavalent chromium; ITCMI sampled for SVOC only.

Table 15-4. Comparison of Measured Concentrations and EPA Screening Values for the Michigan Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Dearborn, Michigan - DEMI					
Benzene	59	59	100.00	13.88	13.88
Carbon Tetrachloride	59	59	100.00	13.88	27.76
Acrolein	59	59	100.00	13.88	41.65
Acetaldehyde	58	58	100.00	13.65	55.29
Formaldehyde	58	58	100.00	13.65	68.94
1,3-Butadiene	55	57	96.49	12.94	81.88
Tetrachloroethylene	41	59	69.49	9.65	91.53
p-Dichlorobenzene	21	55	38.18	4.94	96.47
Hexavalent Chromium	10	60	16.67	2.35	98.82
Chloromethylbenzene	3	4	75.00	0.71	99.53
Acrylonitrile	2	3	66.67	0.47	100.00
Total	425	531	80.04		
Sault Ste. Marie, Michigan - ITCMI					
Naphthalene	23	55	41.82	100.00	100.00
Total	23	55	41.82		

Observations from Table 15-4 include the following:

- Eleven pollutants with a total of 425 measured concentrations failed at least one screen for DEMI.
- Eight pollutants contributed to 95 percent of all failed screens for DEMI: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, *p*-dichlorobenzene, and tetrachloroethylene.
- Five of the eight pollutants of interest failed 100 percent of the screens for DEMI.
- Of the pollutants with at least one failed screen, 80 percent of measurements failed screens for DEMI.
- Of the SVOC measured at ITCMI, only naphthalene failed screens. Less than half of the measured detections of naphthalene exceeded the screening value.

15.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Michigan monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical parameters are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

15.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 15-5, where applicable.

Table 15-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Michigan Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Dearborn, Michigan - DEMI								
Acetaldehyde	58	58	5.44 ± 0.89	2.23 ± 0.59	4.56 ± 1.36	8.35 ± 1.73	6.18 ± 1.49	5.44 ± 0.89
Acrolein	59	59	0.52 ± 0.12	0.32 ± 0.08	0.69 ± 0.42	0.52 ± 0.09	0.53 ± 0.09	0.52 ± 0.12
Benzene	59	59	1.06 ± 0.18	0.87 ± 0.25	0.81 ± 0.19	1.17 ± 0.24	1.41 ± 0.52	1.06 ± 0.18
1,3-Butadiene	57	59	0.10 ± 0.02	0.11 ± 0.04	0.08 ± 0.02	0.08 ± 0.02	0.13 ± 0.06	0.10 ± 0.02
Carbon Tetrachloride	59	59	0.63 ± 0.03	0.57 ± 0.06	0.64 ± 0.04	0.66 ± 0.06	0.65 ± 0.04	0.63 ± 0.03
p-Dichlorobenzene	55	59	0.13 ± 0.04	0.07 ± 0.02	0.07 ± 0.02	0.22 ± 0.13	0.16 ± 0.09	0.13 ± 0.04
Formaldehyde	58	58	5.76 ± 0.71	2.67 ± 0.67	5.45 ± 1.30	7.43 ± 1.14	6.91 ± 1.01	5.76 ± 0.71
Tetrachloroethylene	59	59	0.30 ± 0.07	0.20 ± 0.04	0.23 ± 0.07	0.46 ± 0.21	0.34 ± 0.11	0.30 ± 0.07
Sault Ste. Marie, Michigan - ITCMI								
Naphthalene	55	55	0.03 ± 0.01	0.02 ± 0.02	0.01 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	0.03 ± 0.01

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for DEMI from Table 15-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (5.76 ± 0.71 µg/m^3), acetaldehyde (5.44 ± 0.89 µg/m^3), and benzene (1.06 ± 0.18 µg/m^3).
- As shown in Table 4-9, of the program-level pollutants of interest, DEMI had the second highest daily average concentration of formaldehyde and third highest daily average concentration of acetaldehyde.
- Concentrations of both formaldehyde and acetaldehyde were higher during the warmer months and lower during the cooler months.
- The annual average concentrations for DEMI's pollutants of interest were the same as the daily averages.

Observations for ITCMI from Table 15-5 include the following:

- The averages of naphthalene were relatively similar to each other.

15.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. DEMI has sampled VOC and carbonyls under the UATMP and/or NATTS since 2003. Figures 15-9 through 15-11 present the three-year rolling statistical metrics graphically for benzene, 1,3-butadiene, and formaldehyde for DEMI. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Observations from Figure 15-9 for benzene measurements at DEMI include the following:

- The maximum benzene concentration shown was measured in 2004, and appears in Figure 15-9 for both the 2003-2005 and 2004-2006 time frames.
- The median and rolling average concentrations have a decreasing trend over the time periods shown.
- All benzene concentrations reported to AQS over the five years of sampling were measured detections.

Observations from Figure 15-10 for 1,3-butadiene measurements at DEMI include the following:

- The minimum and first quartile for 1,3-butadiene were both zero for the 2003-2005 and 2004-2006 time frames. This is due to the low detection rate of this pollutant at the onset of sampling. As the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant increased. This pollutant was detected in 52 percent of samples during the 2003-2005 time frame; 66 percent of samples during 2004-2006; and 85 percent of samples during 2006-2007.
- The median and average rolling concentrations shown for all time frames changed little across each period, indicating little variability in the central tendency.

Figure 15-9. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at DEMI

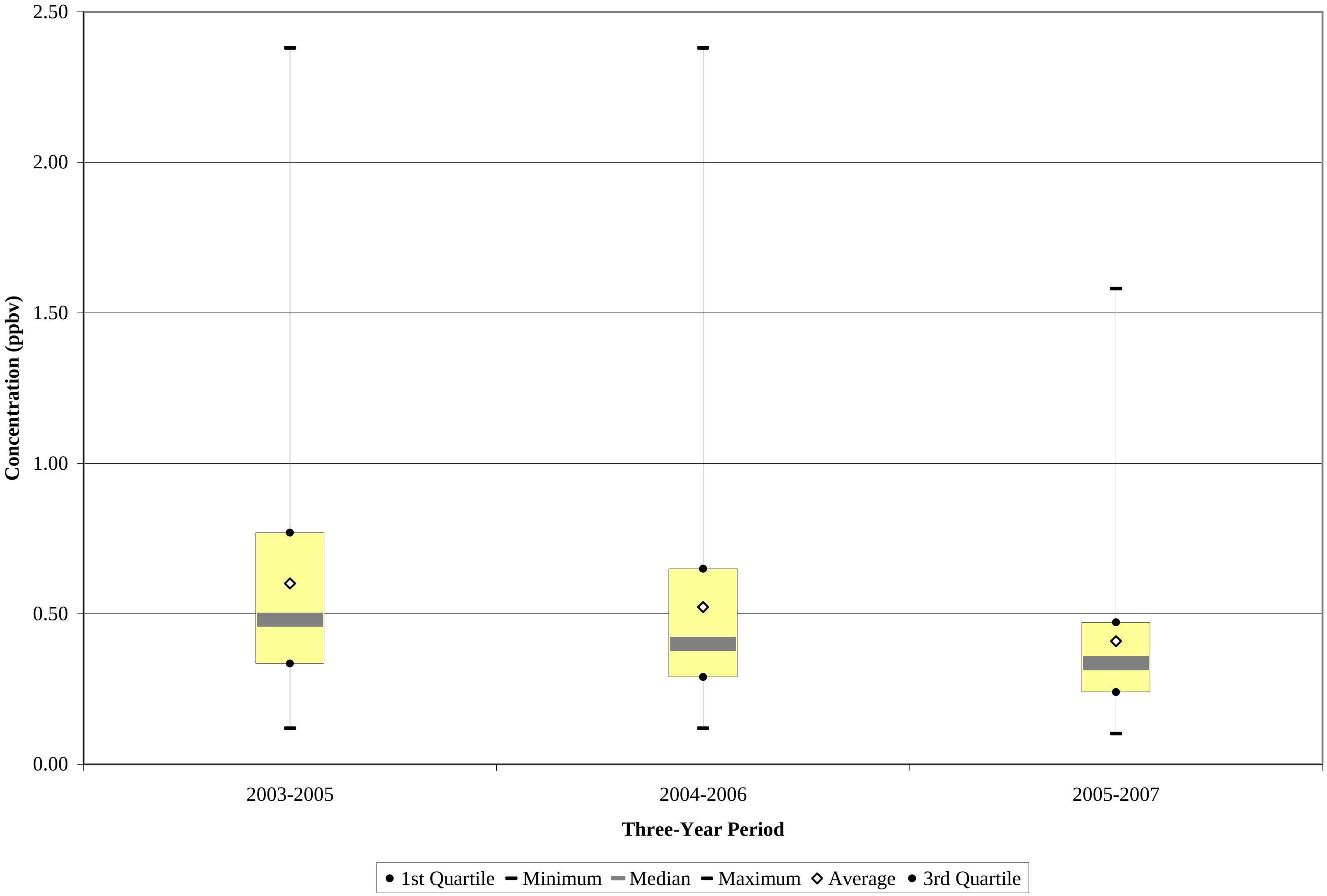


Figure 15-10. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at DEMI

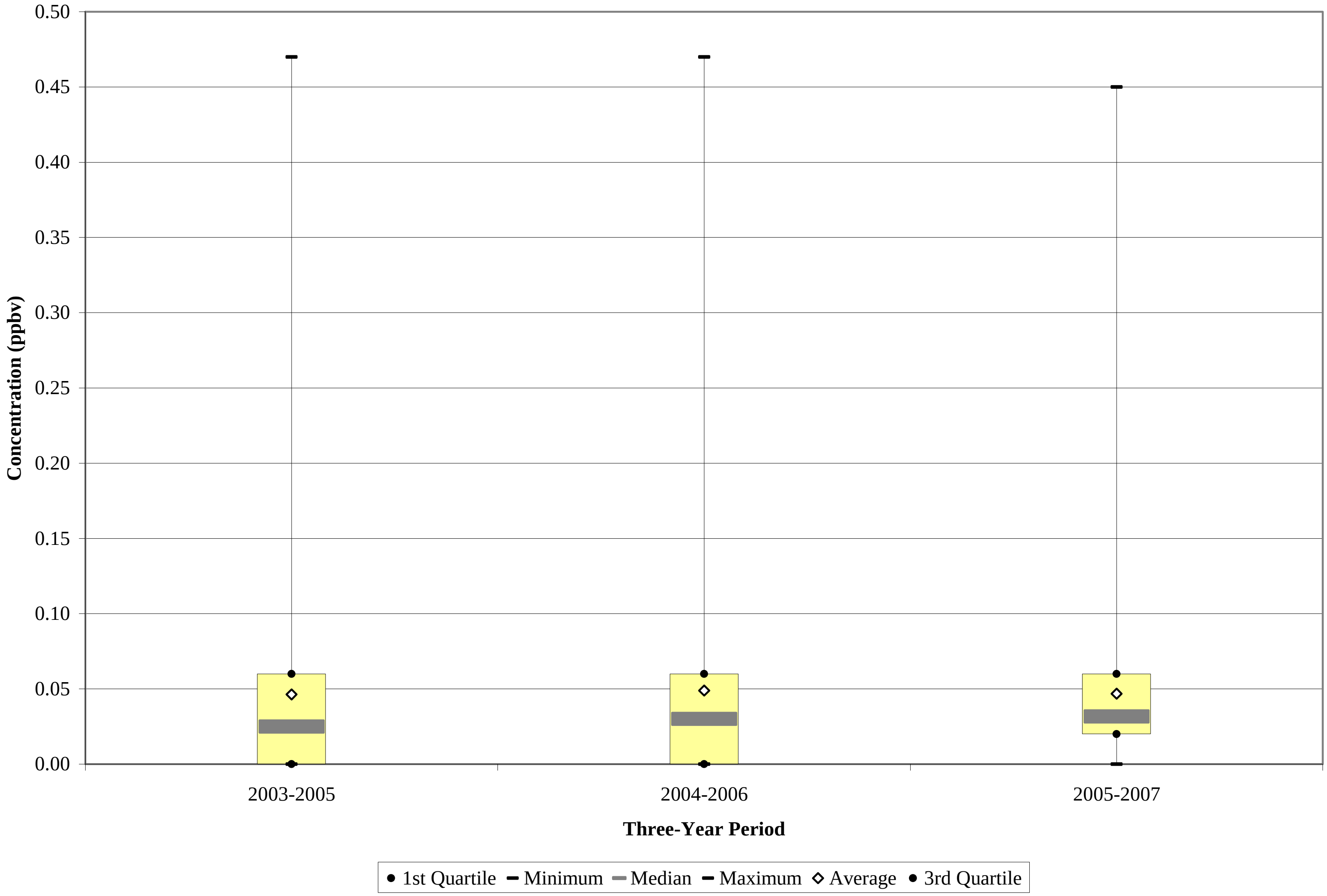
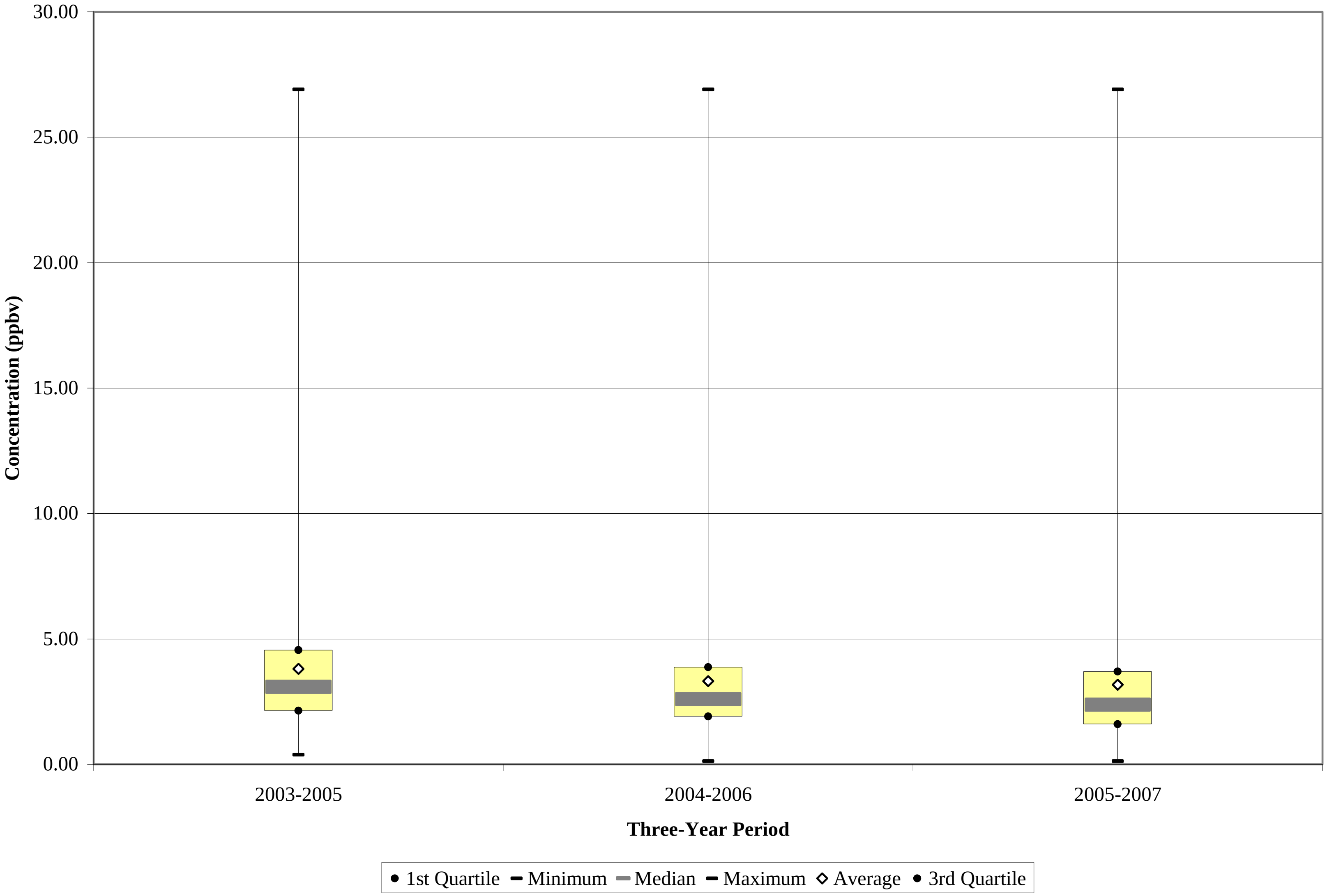


Figure 15-11. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at DEMI



Observations from Figure 15-11 for formaldehyde measurements at DEMI include the following:

- The maximum formaldehyde concentration shown was measured in 2005, and appears for all the time frames shown. The five highest measurements of formaldehyde were all measured in 2005.

- A decrease in the rolling average and median concentration is shown in Figure 15-11. However, the calculation of confidence intervals indicates that the decrease is not significant.

- The rolling median and average concentrations were fairly similar for each period, indicating rather low variabilities in central tendency since sampling began in 2003.

- All formaldehyde concentrations reported to AQS over the five years of sampling were measured detections.

15.5 Pearson Correlations

Table 15-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for DEMI from Table 15-6 include the following:

- Formaldehyde and acetaldehyde exhibited strong positive correlations with the temperature and moisture parameters (except relative humidity). This indicates that concentrations of these pollutants tend to increase as temperature and moisture content increase.
- While the majority of the correlations with the temperature and moisture parameters were low, most of them were positive, indicating that as the temperature and moisture content increase, concentrations of the pollutants of interest may proportionally increase at DEMI.

- The correlations with scalar wind speed were all negative, most of which were moderate to strong, indicating that as wind speed decreases, concentrations of the pollutants of interest may increase at DEMI.

Table 15-6. Pearson Correlations Between Selected Meteorological Parameters and Pollutants of Interest for the Michigan Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Dearborn, Michigan - DEMI								
Acetaldehyde	58	0.77	0.76	0.75	0.76	-0.15	-0.02	-0.61
Acrolein	59	0.27	0.26	0.22	0.25	-0.17	-0.11	-0.05
Benzene	59	0.21	0.19	0.23	0.21	0.11	0.15	-0.58
1,3-Butadiene	57	-0.07	-0.09	-0.02	-0.06	0.26	0.19	-0.54
Carbon Tetrachloride	59	0.29	0.31	0.26	0.29	-0.18	0.04	-0.29
p-Dichlorobenzene	55	0.32	0.31	0.32	0.31	-0.02	0.06	-0.34
Formaldehyde	58	0.78	0.77	0.75	0.77	-0.17	-0.08	-0.49
Tetrachloroethylene	59	0.38	0.38	0.42	0.40	0.06	-0.02	-0.43
Sault Ste. Marie, Michigan - ITCMI								
Naphthalene	55	0.40	0.37	0.36	0.36	-0.07	0.15	-0.47

Observations for ITCMI from Table 15-6 include the following:

- Similar to DEMI, correlations with the temperature and moisture parameters were positive (except relative humidity), indicating that as the temperature and moisture content increase, concentrations of naphthalene may proportionally increase.
- The correlation between naphthalene and scalar wind speed was negative. This is similar to the trends exhibited by the pollutants of interest for DEMI.

15.6 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each monitoring site. Refer to Sections 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

15.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Michigan monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 15-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein from Table 15-7 include the following:

- None of the preprocessed daily measurements of acrolein at DEMI exceeded the acute MRL.
- All four seasonal averages of acrolein exceeded the intermediate MRL.
- Acrolein has no chronic MRL. Therefore, chronic risk could not be evaluated.

Table 15-7. MRL Risk Screening Assessment Summary for the Michigan Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL (µg/m³)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m³)	Winter Average (µg/m³)	Spring Average (µg/m³)	Summer Average (µg/m³)	Autumn Average (µg/m³)	ATSDR Chronic MRL (µg/m³)	Annual Average[1] (µg/m³)
DEMI	TO-15	Acrolein	7.00	0/59	0.09	**0.32 ± 0.08**	**0.69 ± 0.42**	**0.52 ± 0.09**	**0.53 ± 0.09**	--	0.52 ± 0.12

-- = an MRL risk factor is not available

BOLD = EPA-designated NATTS Site

BOLD = exceedance of the intermediate or chronic MRL

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

15.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Michigan monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 15-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the Michigan sites is as follows:

- The census tract for DEMI is 26163573500, which had a population of 5,214 and represented approximately 0.3 percent of the Wayne County population in 2000.
- The census tract for ITCMI is 26033970300, which had a population of 3,744, and represented approximately 10 percent of the county population in 2000.

Observations for DEMI from Table 15-8 include the following:

- The pollutants with the highest concentrations according to NATA were benzene, acetaldehyde, and formaldehyde.
- The pollutants with the highest cancer risks according to NATA were benzene, 1,3-butadidne, and acetaldehyde.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (9.51).
- The pollutants with the highest 2007 annual average concentrations were formaldehyde, acetaldehyde, and benzene, which were all within an order of magnitude of the modeled concentrations from NATA.
- The pollutants with the highest surrogate cancer risk approximations were acetaldehyde, carbon tetrachloride, and benzene.
- Acrolein was the only pollutant with a noncancer risk approximation greater than 1.0 (26.21).

Table 15-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Michigan

Pollutant	Cancer URE $(\mu g/m^3)$	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration $(\mu g/m^3)$	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average[1] $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Dearborn, Michigan (DEMI) - Census Tract ID 26163573500								
Acetaldehyde	0.000002	0.009	2.59	5.71	0.28	5.44 ± 0.89	10.88	0.60
Acrolein	--	0.00002	0.19	--	9.51	0.52 ± 0.12	--	26.21
Acrylonitrile	0.000068	0.002	<0.01	0.25	<0.01	0.03 ± <0.01	1.90	0.01
Benzene	0.000007	0.03	3.79	29.55	0.12	1.06 ± 0.18	7.44	0.04
1,3-Butadiene	0.00003	0.002	0.33	10.05	0.16	0.10 ± 0.02	3.03	0.05
Carbon Tetrachloride	0.000015	0.04	0.21	3.14	0.01	0.63 ± 0.03	9.50	0.02
Chloromethylbenzene	0.000049	--	<0.01	<0.01	--	0.03 ± <0.01	1.37	--
***p*-Dichlorobenzene**	0.000011	0.8	0.08	0.92	<0.01	0.13 ± 0.04	1.39	<0.01
Formaldehyde	5.5E-09	0.0098	2.58	0.01	0.26	5.76 ± 0.71	0.03	0.59
Hexavalent Chromium	0.012	0.0001	<0.01	1.65	<0.01	<0.01 ± <0.01	0.50	<0.01
Tetrachloroethylene	0.000005	0.27	0.36	2.16	<0.01	0.30 ± 0.07	1.52	<0.01
Sault Sainte Marie, Michigan (ITCMI) - Census Tract ID 26033970300								
Naphthalene	0.000034	0.003	0.02	0.64	0.01	0.03 ± 0.01	1.01	0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for ITCMI from Table 15-8 include the following:

- Naphthalene was the only pollutant to fail screens for ITCMI. The modeled concentration from NATA and the annual average were similar.
- The surrogate cancer risk approximation for naphthalene was greater than 1-in-a-million, the threshold value of concern, while the cancer risk estimate from NATA was just slightly less (0.64).
- The noncancer risk estimate from NATA and the surrogate noncancer risk approximation for naphthalene were both 0.01.

15.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 15-9 and 15-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 15-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest surrogate cancer risk approximations (in-a-million), as calculated from the annual averages. Table 15-10 presents similar information, but identifies the 10 pollutants with the highest surrogate noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk approximations based on each site’s annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 15.3, DEMI sampled for VOC, carbonyls, and hexavalent chromium, while ITCMI sampled for SVOC only. In addition, the cancer and noncancer risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Table 15-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Michigan

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Dearborn, Michigan (DEMI) – Wayne County					
Benzene	1,955.25	Coke Oven Emissions	2.50E-02	Acetaldehyde	10.88
Formaldehyde	736.84	Benzene	1.53E-02	Carbon Tetrachloride	9.50
Tetrachloroethylene	388.01	1,3-Butadiene	5.90E-03	Benzene	7.44
Dichloromethane	290.34	Quinoline	4.83E-03	1,3-Butadiene	3.03
Acetaldehyde	270.56	Naphthalene	3.81E-03	Acrylonitrile	1.88
1,3-Butadiene	196.76	POM, Group 5	3.66E-03	Tetrachloroethylene	1.52
1,3-Dichloropropene	147.65	Cadmium, PM	3.16E-03	*p*-Dichlorobenzene	1.39
Naphthalene	112.11	Tetrachloroethylene	2.29E-03	Chloromethylbenzene	1.33
p-Dichlorobenzene	76.62	Hexavalent Chromium	2.20E-03	Hexavalent Chromium	0.50
Trichloroethylene	47.76	POM, Group 2	9.96E-04	Formaldehyde	0.03
Sault Sainte Marie, Michigan (ITCMI) – Chippewa County					
Benzene	83.87	Benzene	6.54E-04	Naphthalene	1.01
Formaldehyde	23.23	1,3-Butadiene	2.33E-04		
Tetrachloroethylene	18.21	Tetrachloroethylene	1.07E-04		
Acetaldehyde	9.74	Naphthalene	9.54E-05		
1,3-Butadiene	7.76	POM, Group 2	7.26E-05		
Dichloromethane	6.10	Arsenic, PM	6.23E-05		
Naphthalene	2.81	Acrylonitrile	4.51E-05		
1,3-Dichloropropene	2.80	POM, Group 3	4.25E-05		
p-Dichlorobenzene	1.49	POM, Group 5	2.20E-05		
Trichloroethylene	1.42	Acetaldehyde	2.14E-05		

Table 15-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Michigan

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Dearborn, Michigan (DEMI) – Wayne County					
Toluene	5,059.56	Acrolein	2,034,637.64	Acrolein	26.21
Xylenes	3,410.03	Manganese, PM	330,597.75	Acetaldehyde	0.60
Benzene	1,955.25	1,3-Butadiene	98,379.67	Formaldehyde	0.59
Hydrochloric acid	1,627.76	Cadmium, PM	87,737.35	1,3-Butadiene	0.05
Methanol	907.48	Hydrochloric acid	81,388.20	Benzene	0.04
Ethylbenzene	768.20	Formaldehyde	75,188.18	Carbon Tetrachloride	0.02
Hexane	749.98	Benzene	65,175.08	Acrylonitrile	0.01
Formaldehyde	736.84	Bromomethane	41,215.39	Tetrachloroethylene	<0.01
Glycol ethers, gas	476.41	Nickel, PM	40,479.09	Hexavalent Chromium	<0.01
Methyl isobutyl ketone	469.79	Naphthalene	37,369.07	*p*-Dichlorobenzene	<0.01
Sault Sainte Marie, Michigan (ITCMI) – Chippewa County					
Toluene	317.92	Acrolein	65,430.36	Naphthalene	0.01
Xylenes	192.77	1,3-Butadiene	3,877.68		
Benzene	83.87	Benzene	2,795.66		
Ethylbenzene	43.41	Formaldehyde	2,370.13		
Hexane	34.64	Xylenes	1,927.73		
Formaldehyde	23.23	Acetaldehyde	1,082.21		
Tetrachloroethylene	18.21	Cyanide Compounds, gas	950.00		
Methanol	15.62	Naphthalene	935.41		
Acetaldehyde	9.74	Toluene	794.80		
Hydrochloric acid	9.45	Bromomethane	782.00		

Observations from Table 15-9 include the following:

- Benzene, formaldehyde, and tetrachloroethylene were the highest emitted pollutants with cancer UREs in both Wayne and Chippewa Counties, although the magnitude of the emissions were very different.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Wayne County were coke oven emissions, benzene, and 1,3-butadiene. The pollutants with the highest toxicity-weighted emissions for Chippewa County were benzene, 1,3-butadiene, and tetrachloroethylene.
- Four of the highest emitted pollutants in Wayne County also had the highest toxicity-weighted emissions. Five of the highest emitted pollutants in Chippewa County also had the highest toxicity-weighted emissions.
- For DEMI, acetaldehyde, carbon tetrachloride, and benzene had the highest surrogate cancer risk approximations. Carbon tetrachloride did not appear on either emissions-based list. Acetaldehyde was one of the highest emitted pollutants, but did not appear on the list of highest toxicity-weighted emissions.
- Benzene, 1,3-butadiene, and tetrachloroethylene appeared on all three lists for DEMI.
- For ITCMI, naphthalene appeared on all three lists.

Observations from Table 15-10 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in both Wayne and Chippewa Counties, although the magnitude of the emissions were different.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Wayne County were acrolein, manganese, and 1,3-butadiene. The pollutants with the highest toxicity-weighted emissions for Chippewa County were acrolein, 1,3-butadiene, and benzene.
- Three of the highest emitted pollutants in Wayne County also had the highest toxicity-weighted emissions. Five of the highest emitted pollutants in Chippewa County also had the highest toxicity-weighted emissions.
- The pollutant with the highest noncancer risk approximation for DEMI was acrolein. Acrolein was also the pollutant with the highest toxicity-weighted emissions, yet this pollutant's emissions ranked 26th.
- For ITCMI, naphthalene was not one of the highest emitted pollutants, but appeared on the list of highest toxicity-weighted emissions.

15.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *The pollutants of interest for DEMI were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, p-dichlorobenzene, formaldehyde, and tetrachloroethylene. Naphthalene was the only pollutant to failed screens for ITCMI.*
- *Formaldehyde had the highest daily average concentration for DEMI.*
- *Seasonal averages of acrolein exceeded the intermediate MRL health benchmark for DEMI.*

16.0 Sites in Mississippi

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at UATMP sites in Mississippi, and integrates these concentrations with emissions, meteorological, and risk information.

16.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the locations of the sites and the surrounding areas. The GPMS monitoring site is located in the Gulfport-Biloxi, MS MSA. TUMS is located in Tupelo, Mississippi. Figures 16-1 and 16-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban and rural locations. Figures 16-3 and 16-4 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 16-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

GPMS is located in the coastal city of Gulfport, less than one mile from the shore and approximately one half-mile from the Gulfport-Biloxi International Airport. The surrounding area is lightly commercial as well as residential. The monitoring site is located behind the Harrison County Youth Court building, as shown in Figure 16-1. The site is positioned between several major thoroughfares through Gulfport, including Business 90, Pass Road, and I-10. Keesler Air Force Base and a U.S. Naval Reserve Station are within a few miles of the monitoring site. As Figure 16-3 shows, few point sources are located near GPMS. Most of the emission sources are located to the north of the site and are predominantly involved in surface coating processes.

TUMS is located on the west side of Tupelo, a town in the northeast corner of the state. Figure 16-2 shows that TUMS is located on the property of the Tupelo Regional Airport. Residential and light commercial areas surround the airport. Busy roadways such as Natchez Trace Parkway are located within a mile of the monitoring site. As Figure 16-4 shows, point

Figure 16-1. Gulfport, Mississippi (GPMS) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 16-2. Tupelo, Mississippi (TUMS) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 16-3. NEI Point Sources Located Within 10 Miles of GPMS

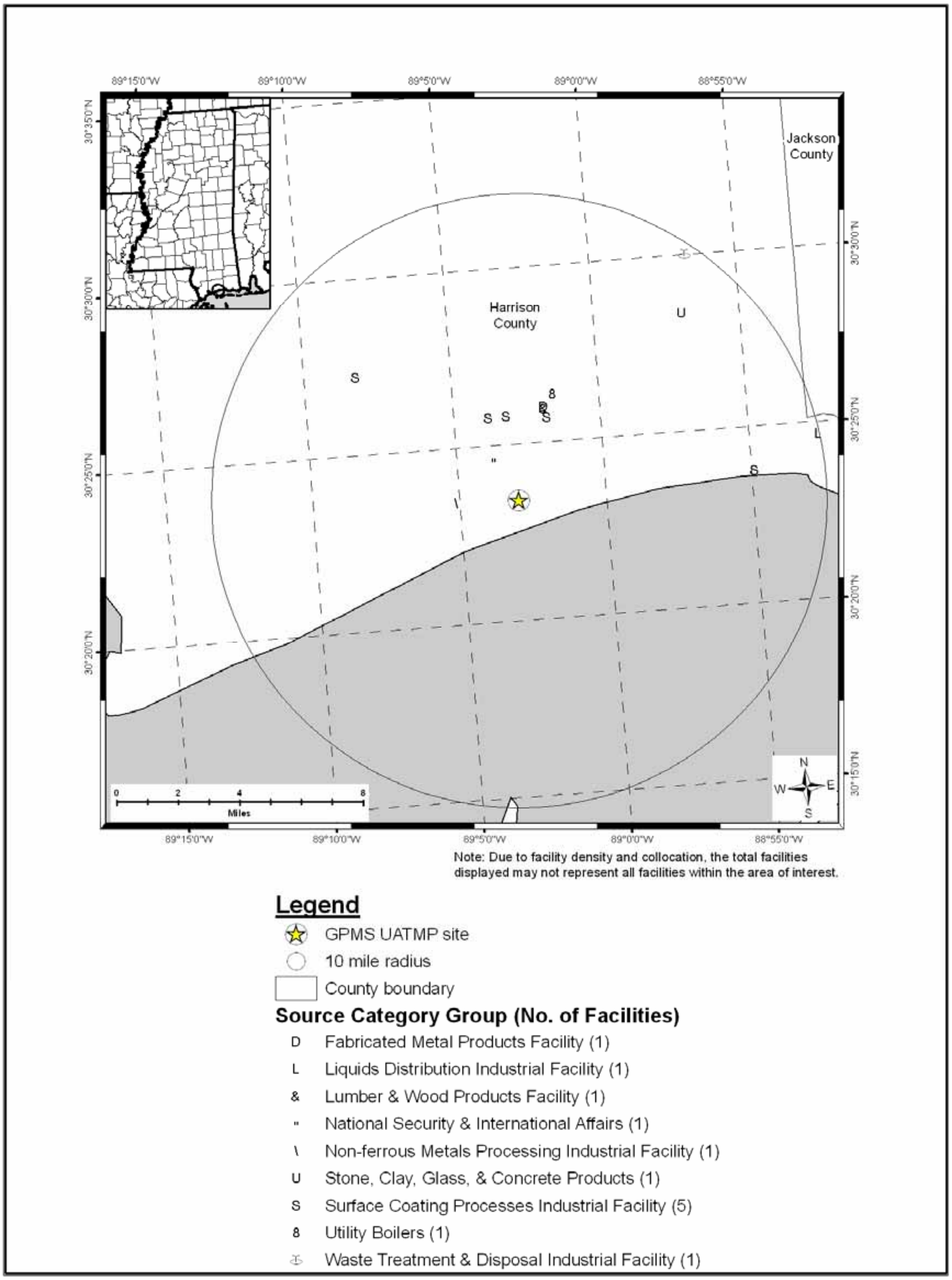
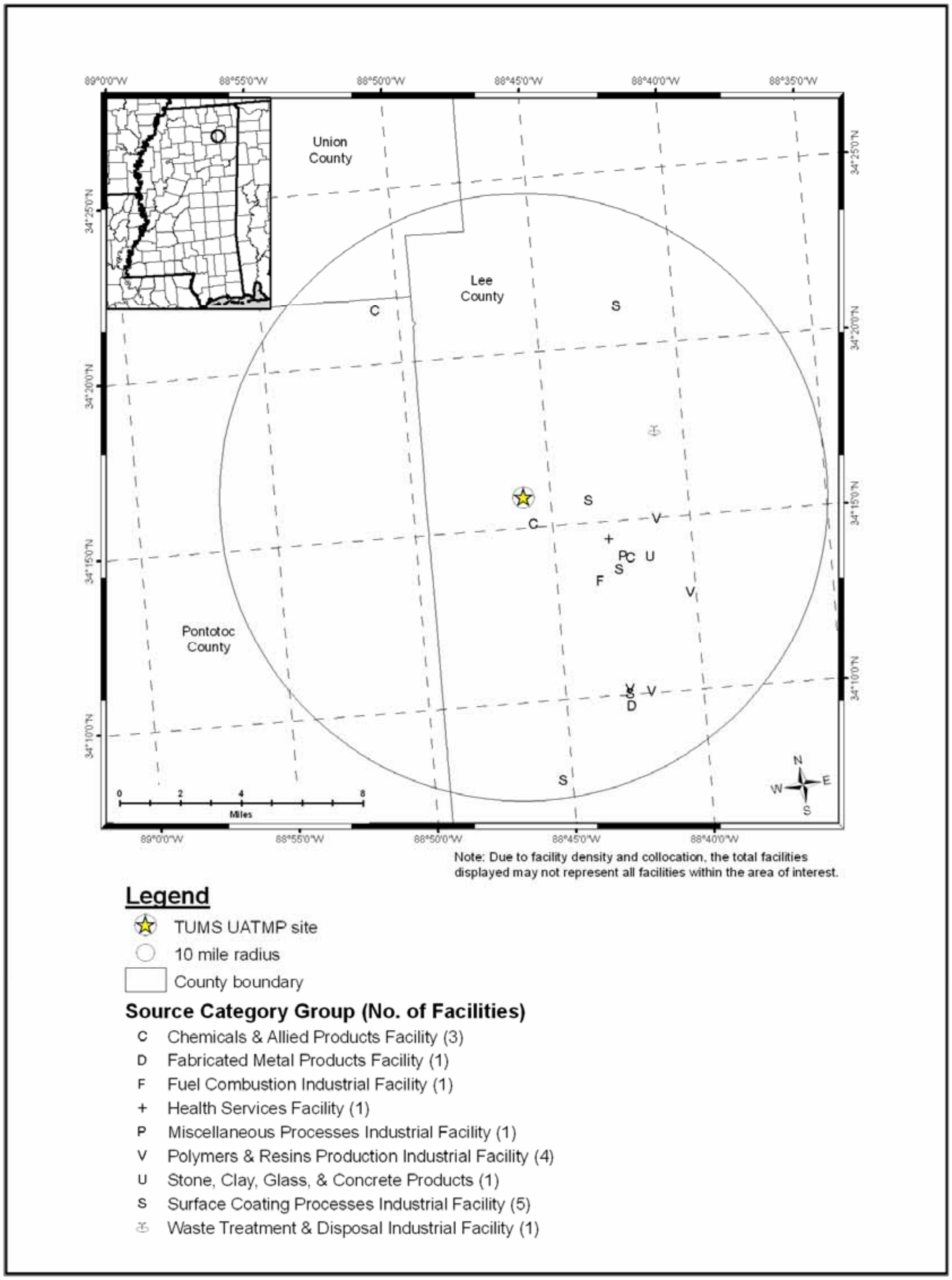


Figure 16-4. NEI Point Sources Located Within 10 Miles of TUMS



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 16-1. Geographical Information for the Mississippi Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
GPMS	28-047-0008	Gulfport	Harrison	Gulfport-Biloxi, MS	30.390139, -89.049722	Commercial	Rural	The Gulfport site is in a light commercial and residential area. This site was selected because this area is believed to have high ambient air toxic concentrations based upon information from the NATA study and Mississippi's major source emission inventories.
TUMS	28-081-0005	Tupelo	Lee	Tupelo, MS	34.264917, -88.766222	Commercial	Suburban	The Tupelo site is in a light commercial and residential area. This site was selected because this area is believed to have high ambient air toxic concentrations based upon information from the NATA study and Mississippi's major source emission inventories.

sources within a 10 mile radius of TUMS are primarily located to the east and southeast of the site. A number of the emission sources near TUMS are involved in surface coating processes, polymer and resin production, and chemical and allied products production.

Table 16-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Mississippi monitoring sites. County-level vehicle registration and population data for Harrison and Lee Counties were obtained from the Mississippi State Tax Commission and the U.S. Census Bureau. Table 16-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding each monitoring site. Table 16-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 16-2 presents the daily VMT for each urban area (where applicable).

Table 16-2. Population, Motor Vehicle, and Traffic Information for the Mississippi Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
GPMS	176,105	170,041	0.97	155,056	149,717	27,000	6,936
TUMS	80,349	71,812	0.89	71,697	64,079	12,000	NA

[1] Daily Average Traffic Data reflects 2006 data from the Mississippi DOT

Observations from Table 16-2 include the following:

- The Harrison County population is more than twice the Lee County population, although both relatively low compared to other counties with monitoring sites. The same is true of the 10-mile populations.
- The county-level and 10-mile vehicle ownership estimates for GPMS and TUMS reflect the same trends as the populations.
- The vehicle per person ratio for GPMS was nearly one vehicle per person, which falls in the middle of the range compared to other program sites. The ratio for TUMS was slightly lower than GPMS.

- GPMS experienced a higher annual average daily traffic volume than TUMS. Compared to other program sites, the traffic near TUMS was rather low while the traffic volume was in the middle of the range for GPMS. Traffic for GPMS was obtained from Pass Road; traffic for TUMS was obtained from Coley Road, north of State Road 6.

- The Gulfport area VMT ranked fifth lowest among urban areas with UATMP or NATTS sites. VMT was not available for the Tupelo area.

16.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Mississippi on sampling days, as well as over the course of the year.

16.2.1 Climate Summary

Climatologically, both of the Mississippi cities are warm and humid, especially Gulfport, the site nearest the coast. High temperatures and humidity, due to proximity to the Gulf of Mexico, can make this region feel uncomfortable. Precipitation is distributed fairly evenly throughout the year, and thunderstorms are fairly common, especially in the summer and nearer to the coast (Ruffner and Bair, 1987).

16.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The two closest NWS weather stations are located at Gulfport-Biloxi Regional Airport (near GPMS) and Tupelo Municipal Airport (near TUMS), WBAN 93874 and 93862, respectively.

Table 16-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 16-3 is the 95 percent confidence interval for each parameter. As shown in Table 16-3, average meteorological

Table 16-3. Average Meteorological Conditions near the Mississippi Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
GPMS	Gulfport, MS/Biloxi Regional Airport 93874	Sampling Day	78.06 ± 2.91	69.86 ± 2.97	60.50 ± 3.34	64.31 ± 2.91	74.52 ± 2.53	1017.66 ± 1.19	5.20 ± 0.67
		All 2007	76.79 ± 1.24	68.13 ± 1.29	58.60 ± 1.49	62.65 ± 1.28	73.99 ± 1.11	1017.89 ± 0.48	5.37 ± 0.27
TUMS	Tupelo Municipal Airport 93862	Sampling Day	77.56 ± 3.94	66.62 ± 3.80	52.20 ± 3.94	58.53 ± 3.39	63.34 ± 3.04	1017.90 ± 1.31	5.29 ± 0.59
		All 2007	75.77 ± 1.72	64.70 ± 1.64	50.63 ± 1.70	56.96 ± 1.49	63.88 ± 1.16	1018.27 ± 0.53	5.22 ± 0.23

conditions on sampling days were fairly representative of average weather conditions throughout the year.

16.2.3 Composite Back Trajectories for Sampling Days

Figures 16-5 and 16-6 are composite back trajectory maps for the Mississippi monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 16-5 and 16-6 represents 100 miles.

Observations from Figure 16-5 for GPMS include the following:

- Back trajectories originated from a variety of directions at the GPMS site. The predominant direction of trajectory origin was from offshore, particularly from the southeast.
- The 24-hour air shed domain for GPMS was somewhat smaller in size than TUMS and other monitoring sites. The furthest away a trajectory originated was the central Gulf of Mexico, or just over 500 miles away. However, most trajectories originated within 300 miles.

Observations from Figure 16-6 for TUMS include the following:

- Back trajectories originated from a variety of directions at the TUMS site. The predominant direction of trajectory origin was from the southeast, south, and southwest.
- The 24-hour air shed domain for TUMS was comparable in size to other monitoring sites. The furthest away a trajectory originated was Wisconsin, or greater than 600 miles away. However, most trajectories originated within 300 miles.

16.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations near the Mississippi sites, as presented in Section 16.2.2, were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 16-7 and 16-8 are the wind roses for the Mississippi monitoring sites on days that samples were collected.

Figure 16-5. Composite Back Trajectory Map for GPMS

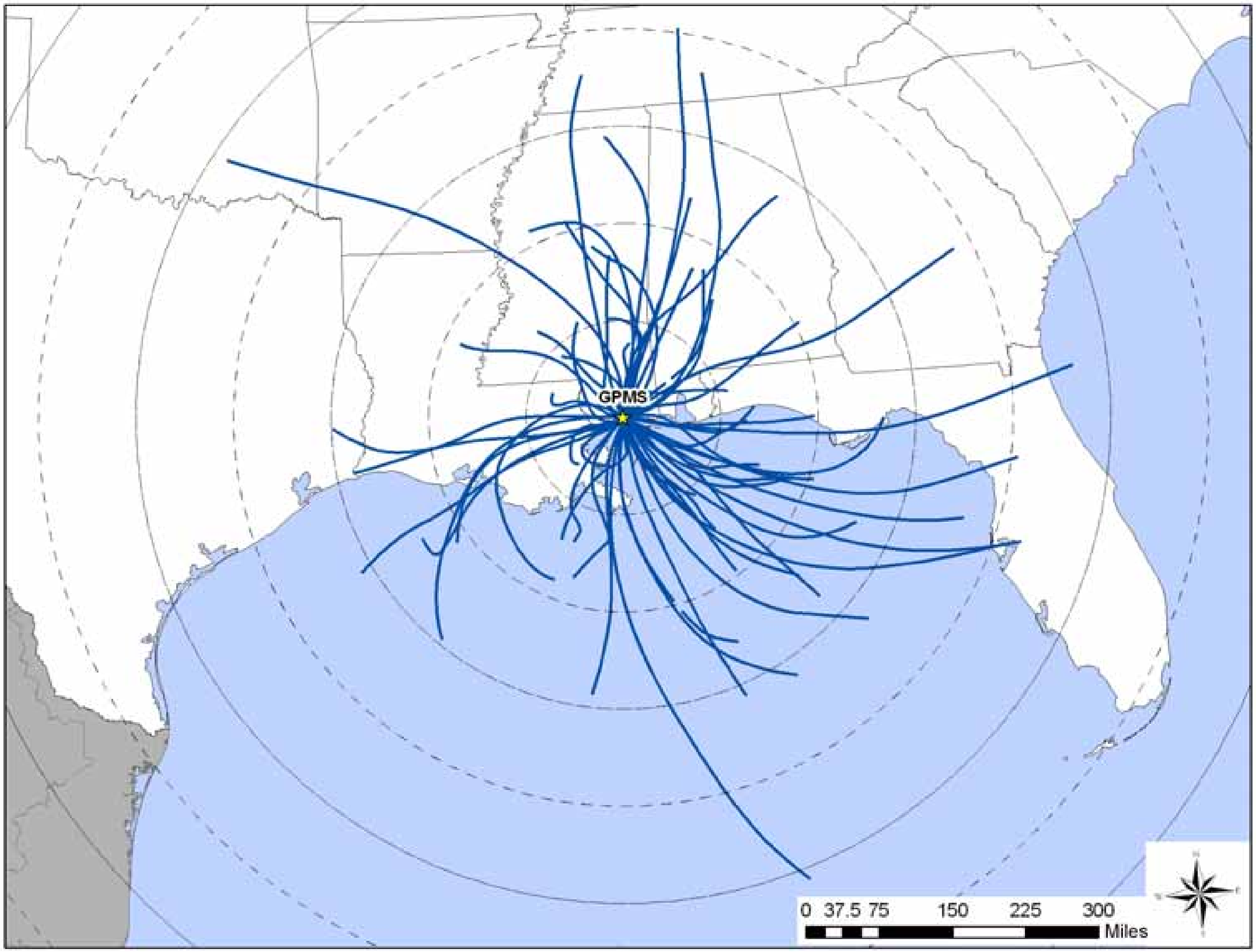


Figure 16-6. Composite Back Trajectory Map for TUMS

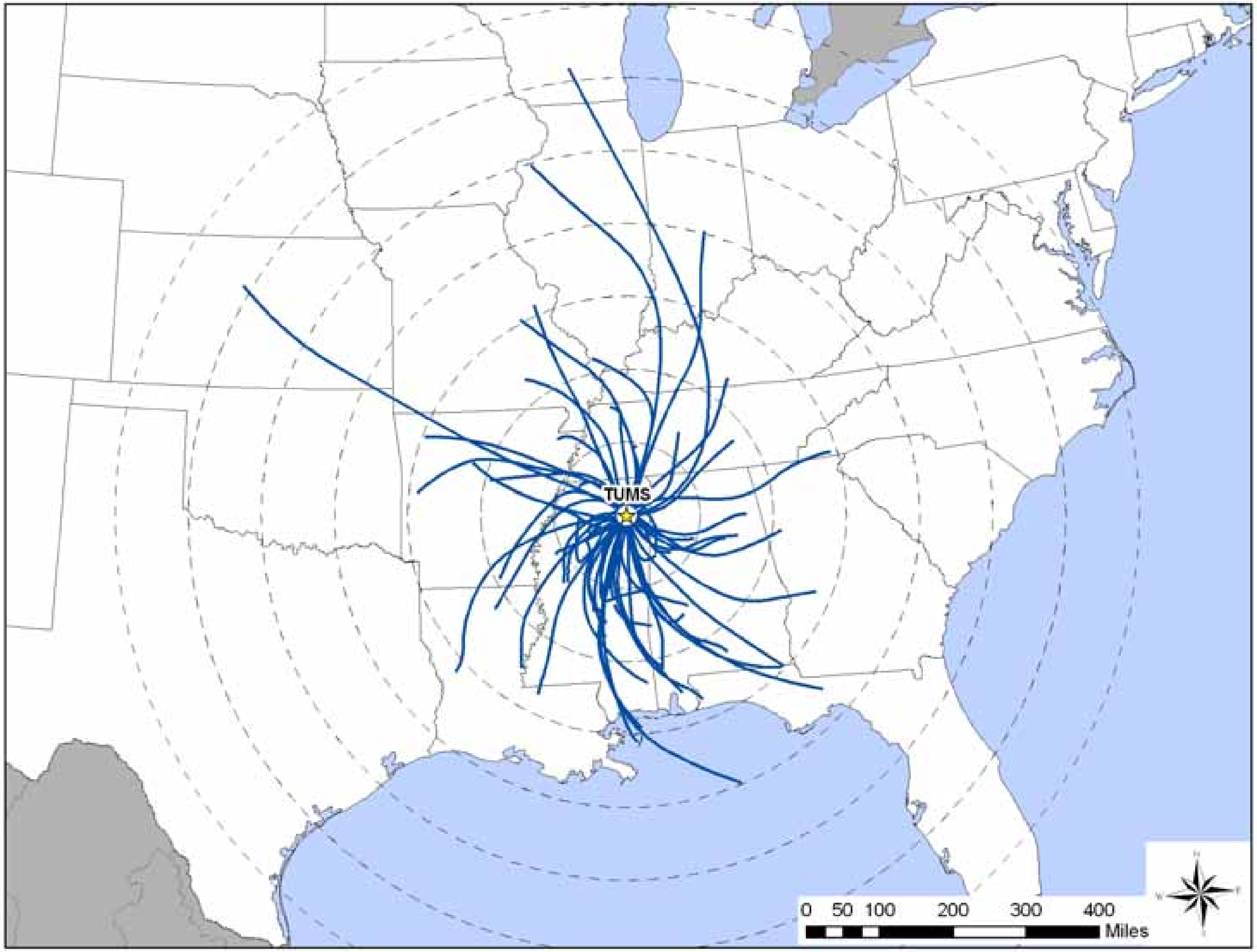


Figure 16-7. Wind Rose for GPMS Sampling Days

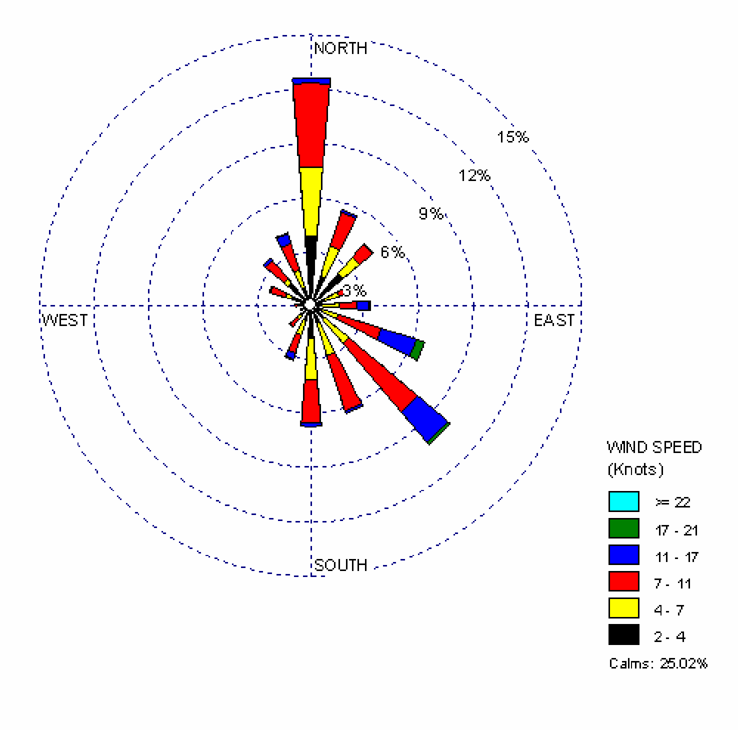
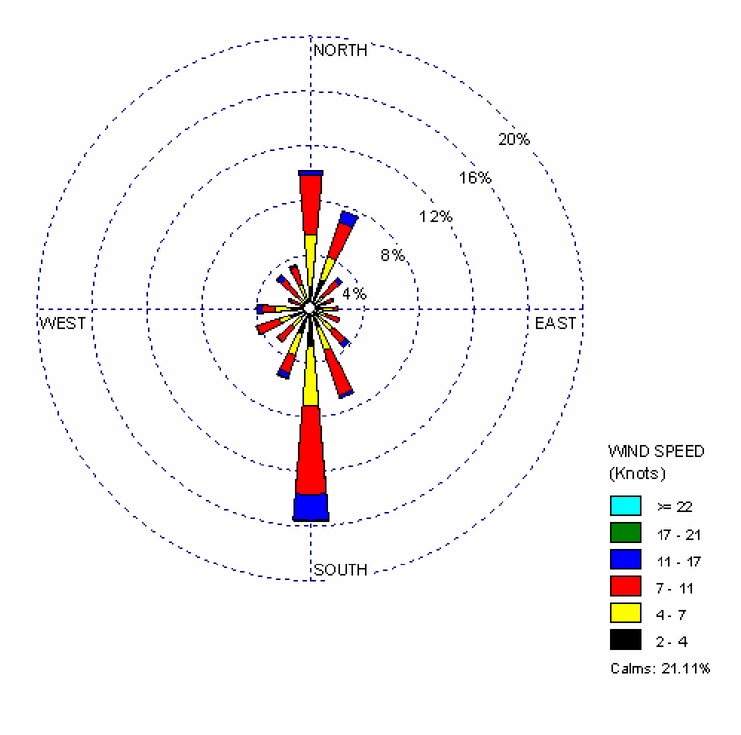


Figure 16-8. Wind Rose for TUMS Sampling Days



Observations from Figure 16-7 for GPMS include the following:

- Calm winds were prevailed near GPMS. They were observed for approximately 25 percent of the hourly measurements.
- Northerly and southeasterly winds were also observed frequently.
- Winds exceeding 11 knots made up approximately eight percent of observations. The strongest winds often originated from the southeast.

Observations from Figure 16-8 for TUMS include the following:

- Similar to GPMS, calm winds were prevalent near TUMS. They were observed for approximately 21 percent of the hourly measurements.
- For wind speeds greater than two knots, southerly winds were observed most frequently, followed by northerly winds.
- Winds exceeding 11 knots made up six percent of observations. The strongest winds often originated from the south.

16.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Mississippi monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 16-4 presents the pollutants that failed at least one screen for each Mississippi monitoring sites and highlights each site's pollutants of interest (shaded). GPMS and TUMS both sampled for VOC and carbonyls. In addition, SNMOC were also sampled at GPMS.

Observations from Table 16-4 include the following:

- Thirteen pollutants with a total of 433 measured concentrations failed at least one screen for GPMS. Thirteen pollutants with a total of 370 measured concentrations failed at least one screen for TUMS.

Table 16-4. Comparison of Measured Concentrations and EPA Screening Values for the Mississippi Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Gulfport, Mississippi - GPMS					
Acetaldehyde	62	62	100.00	14.32	14.32
Acrolein	61	61	100.00	14.09	28.41
Carbon Tetrachloride	61	61	100.00	14.09	42.49
Benzene	61	61	100.00	14.09	56.58
Formaldehyde	60	62	96.77	13.86	70.44
1,3-Butadiene	53	60	88.33	12.24	82.68
p-Dichlorobenzene	39	61	63.93	9.01	91.69
Acrylonitrile	17	17	100.00	3.93	95.61
Tetrachloroethylene	14	53	26.42	3.23	98.85
1,1,2,2-Tetrachloroethane	2	2	100.00	0.46	99.31
1,2-Dichloroethane	1	1	100.00	0.23	99.54
Dichloromethane	1	61	1.64	0.23	99.77
Xylenes	1	61	1.64	0.23	100.00
Total	433	623	69.50		
Tupelo, Mississippi - TUMS					
Carbon Tetrachloride	61	61	100.00	16.49	16.49
Acrolein	60	60	100.00	16.22	32.7
Benzene	60	61	98.36	16.22	48.92
Acetaldehyde	58	58	100.00	15.68	64.59
Formaldehyde	51	58	87.93	13.78	78.38
1,3-Butadiene	48	59	81.36	12.97	91.35
Acrylonitrile	17	17	100.00	4.59	95.95
p-Dichlorobenzene	6	45	13.33	1.62	97.57
Tetrachloroethylene	5	52	9.62	1.35	98.92
Vinyl chloride	1	28	3.57	0.27	99.19
1,1,2-Trichloroethane	1	3	33.33	0.27	99.46
1,1,2,2-Tetrachloroethane	1	1	100.00	0.27	99.73
Hexachloro-1,3-butadiene	1	1	100.00	0.27	100.00
Total	370	504	73.41		

- The following seven pollutants of interest were common to both sites: acetaldehyde, acrolein, acrylonitrile, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.

- Of the seven common pollutants of interest, 100 percent of the measured detections of acrolein, acrylonitrile, acetaldehyde, and carbon tetrachloride failed screens for both sites.

- Of the pollutants with at least one failed screen, nearly 70 percent of measurements failed screens for both sites.

16.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Mississippi monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

16.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 16-5, where applicable.

Observations for GPMS from Table 16-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (2.55 ± 0.29 µg/m^3), acetaldehyde (1.55 ± 0.16 µg/m^3), and acrolein (0.91 ± 0.10 µg/m^3).

Table 16-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Mississippi Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Gulfport, Mississippi - GPMS								
Acetaldehyde	62	62	1.55 ± 0.16	1.47 ± 0.39	1.84 ± 0.39	1.59 ± 0.25	1.25 ± 0.11	1.55 ± 0.16
Acrolein	61	61	0.91 ± 0.10	0.86 ± 0.27	0.91 ± 0.17	0.96 ± 0.18	0.88 ± 0.16	0.91 ± 0.10
Acrylonitrile	17	61	0.21 ± 0.04	NR	0.12 ± 0.05	0.11 ± 0.05	NR	0.08 ± 0.02
Benzene	61	61	0.80 ± 0.08	0.85 ± 0.13	0.70 ± 0.13	0.76 ± 0.18	0.87 ± 0.19	0.79 ± 0.08
1,3-Butadiene	60	61	0.07 ± 0.01	0.09 ± 0.03	0.05 ± 0.01	0.06 ± 0.01	0.07 ± 0.03	0.07 ± 0.01
Carbon Tetrachloride	61	61	0.62 ± 0.03	0.59 ± 0.07	0.67 ± 0.07	0.63 ± 0.08	0.59 ± 0.04	0.62 ± 0.03
p-Dichlorobenzene	61	61	0.22 ± 0.13	0.09 ± 0.02	0.11 ± 0.04	0.47 ± 0.43	0.16 ± 0.04	0.22 ± 0.13
Formaldehyde	62	62	2.55 ± 0.29	1.55 ± 0.26	2.34 ± 0.54	3.47 ± 0.57	2.65 ± 0.34	2.55 ± 0.29
Tupelo, Mississippi - TUMS								
Acetaldehyde	58	58	1.78 ± 0.24	1.99 ± 0.67	2.28 ± 0.51	1.64 ± 0.29	1.19 ± 0.17	1.78 ± 0.24
Acrolein	60	61	0.59 ± 0.08	0.42 ± 0.17	0.56 ± 0.15	0.65 ± 0.16	0.68 ± 0.16	0.58 ± 0.08
Acrylonitrile	17	61	0.21 ± 0.03	NR	0.11 ± 0.05	0.12 ± 0.05	NR	0.08 ± 0.02
Benzene	61	61	0.65 ± 0.06	0.66 ± 0.12	0.64 ± 0.13	0.57 ± 0.10	0.72 ± 0.14	0.65 ± 0.06
1,3-Butadiene	59	61	0.06 ± 0.01	0.06 ± 0.02	0.05 ± 0.01	0.05 ± 0.01	0.06 ± 0.03	0.05 ± 0.01
Carbon Tetrachloride	61	61	0.58 ± 0.04	0.50 ± 0.09	0.62 ± 0.06	0.60 ± 0.08	0.57 ± 0.05	0.58 ± 0.04
Formaldehyde	58	58	3.20 ± 0.59	1.33 ± 0.29	2.23 ± 0.64	5.95 ± 1.12	2.79 ± 0.49	3.20 ± 0.59

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

- As shown in Table 4-11, of the program-level pollutants of interest, GPMS had the fifth highest daily average concentration of acrolein and second highest daily average concentration of tetrachloroethylene. Tetrachloroethylene was not a pollutant of interest for GPMS and is therefore not shown in Table 16-5.

- Concentrations of most of the pollutants of interest for GPMS did not vary significantly from season to season. However, concentrations of formaldehyde were highest during the summer.

- The summer average concentration of *p*-dichlorobenzene is significantly higher than its other averages. However, the confidence interval is very high, indicating that this average is influenced by outliers.

Observations for TUMS in Table 16-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (3.20 ± 0.59 $\mu g/m^3$), acetaldehyde (1.78 ± 0.24 $\mu g/m^3$), and benzene (0.65 ± 0.06 $\mu g/m^3$).
- As shown in Table 4-11, of the program-level pollutants of interest, TUMS and GPMS both had the eighth highest daily average concentration of acrylonitrile.
- Concentrations of most of the pollutants of interest for TUMS did not vary significantly from season to season. However, concentrations of formaldehyde were highest during the summer, similar to GPMS.

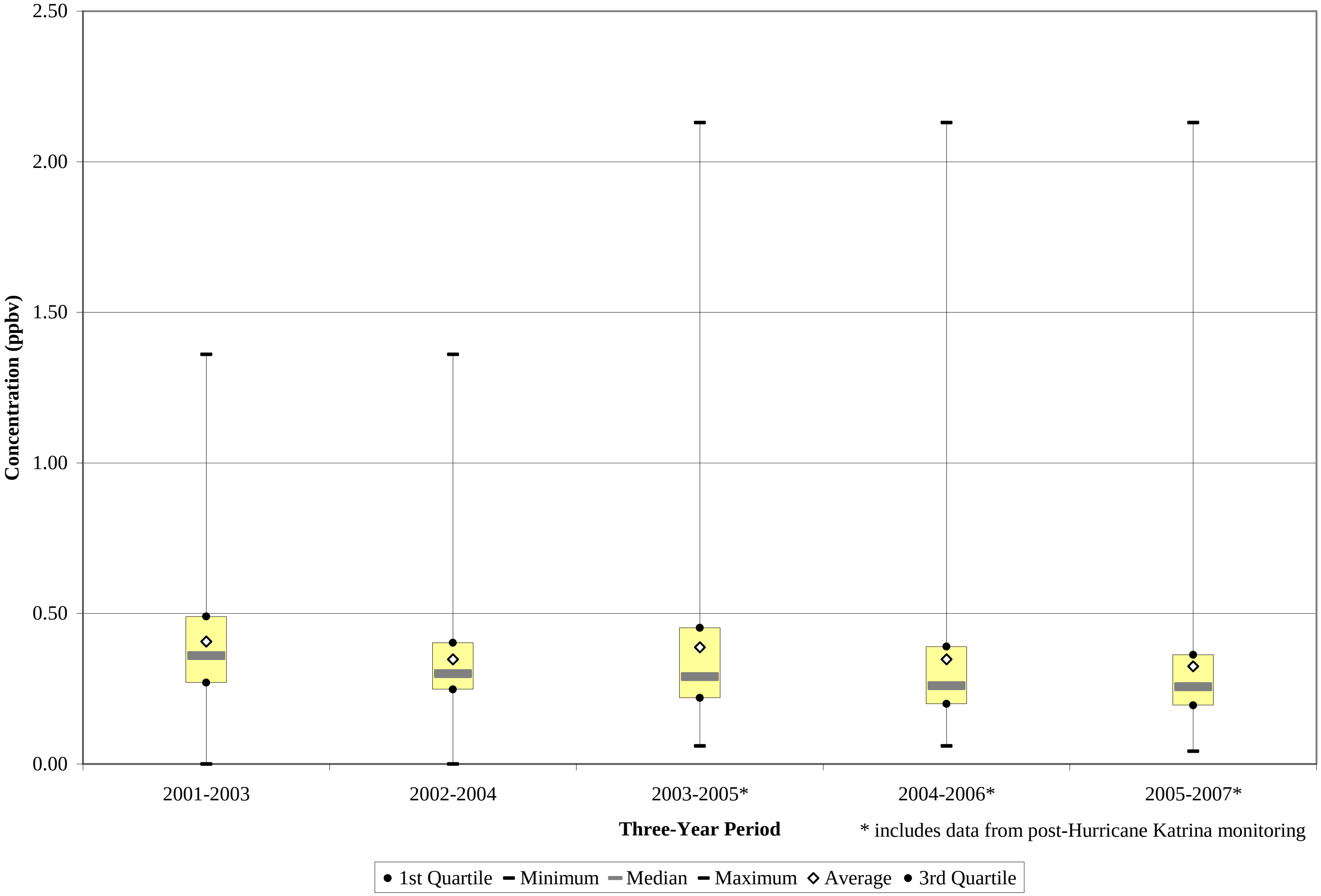
16.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. GPMS and TUMS have sampled VOC and carbonyls under the UATMP since 2003. Figures 16-9 through 16-14 present the three-year rolling statistical metrics graphically for benzene, 1,3-butadiene, and formaldehyde for each site. Both sites have sampled since 2001. GPMS, however, stopped sampling briefly in 2005 until the post-Hurricane Katrina monitoring effort began. Metrics incorporating data collected as part of that effort are denoted in the Figures by an asterisk (*). The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Observations from Figure 16-9 for benzene measurements at GPMS include the following:

- The maximum benzene concentration shown was measured in 2005.
- The rolling average concentrations vary between 0.3 and 0.4 ppbv, but were highest during the 2001-2003 time frame and lowest during the 2005-2007 time frame.
- Two non-detects were recorded during the first two years of sampling. After 2002, all benzene concentrations reported to AQS were measured detections.

Figure 16-9. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at GPMS



* includes data from post-Hurricane Katrina monitoring

Figure 16-10. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at GPMS

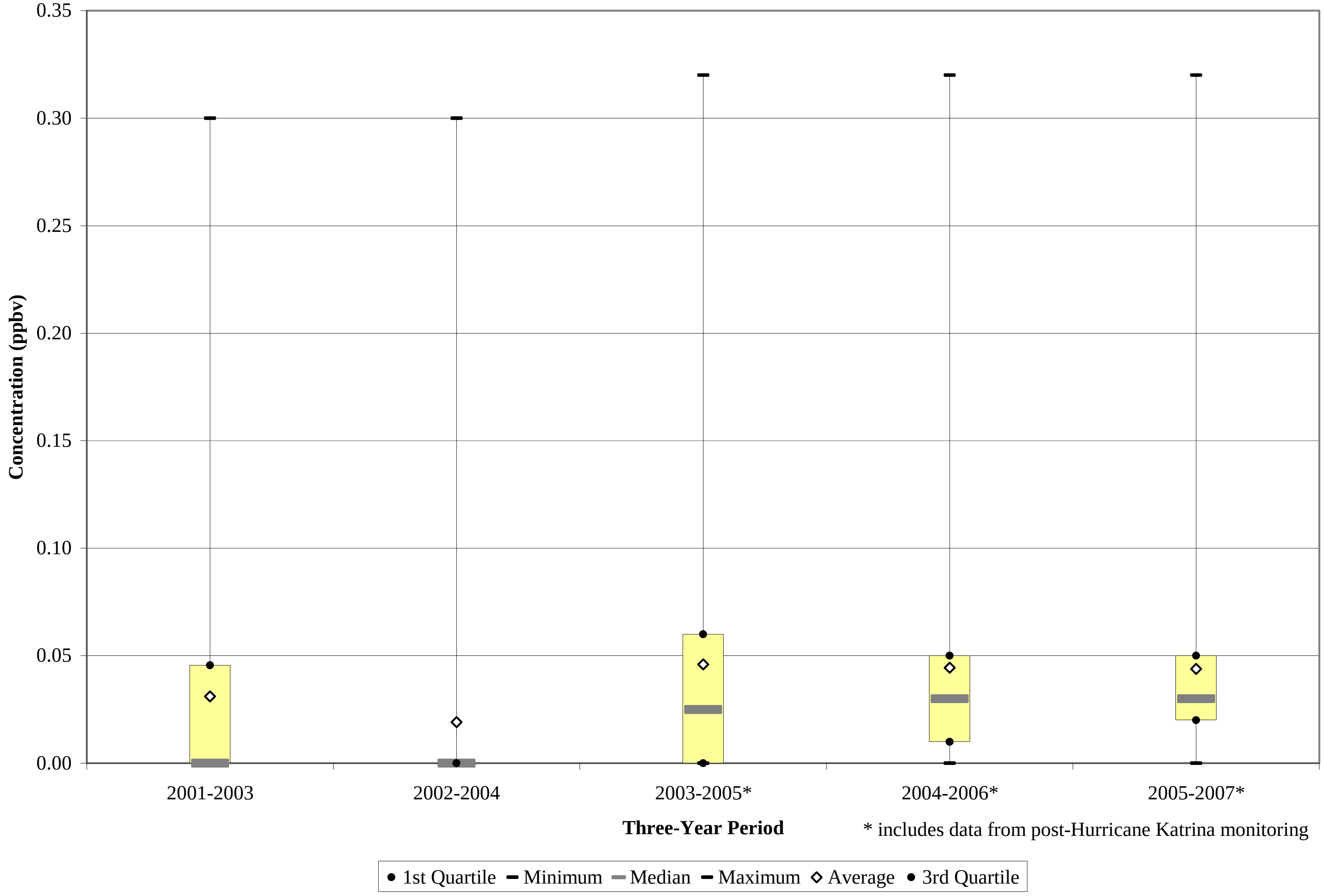
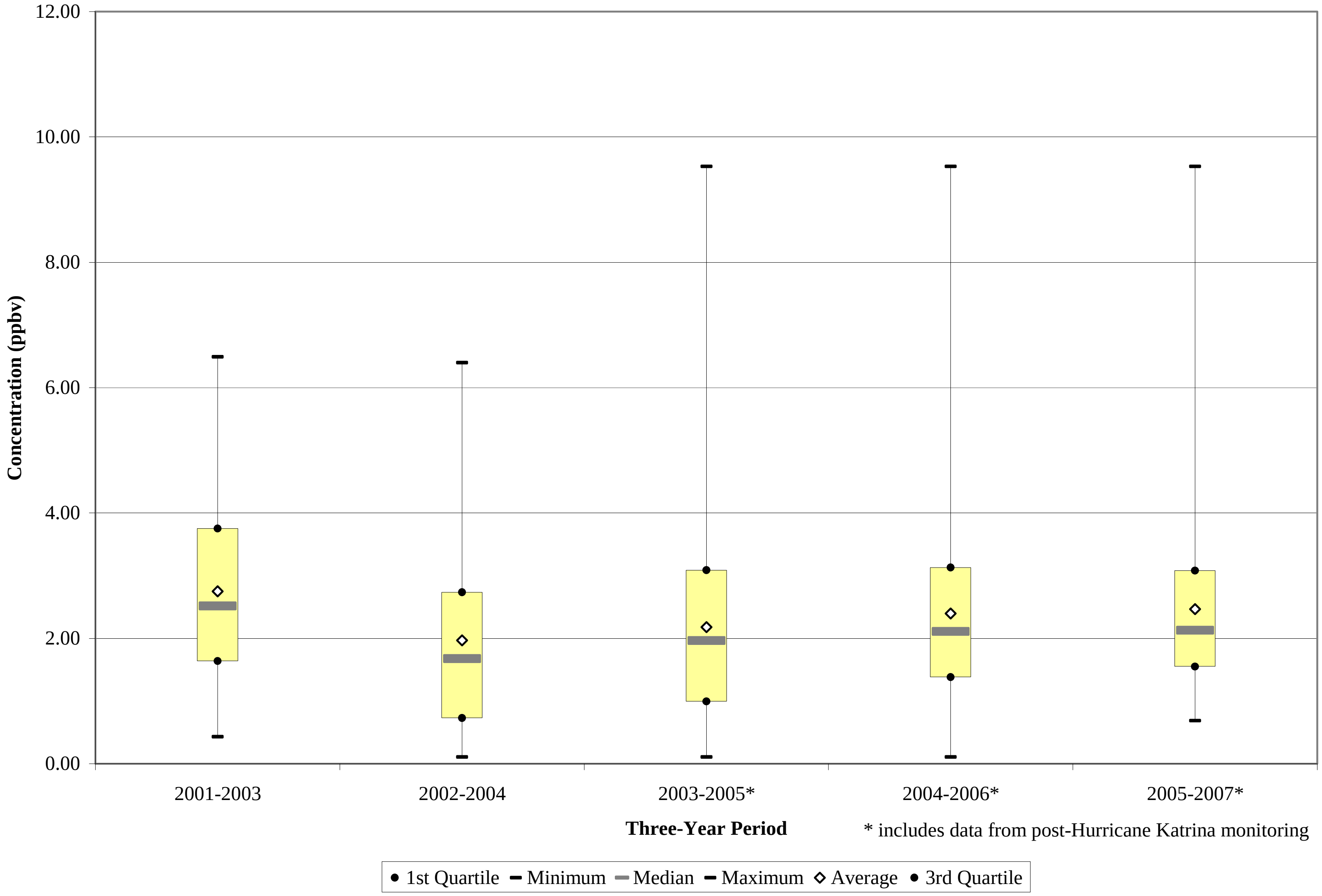


Figure 16-11. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at GPMS



* includes data from post-Hurricane Katrina monitoring

Figure 16-12. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at TUMS

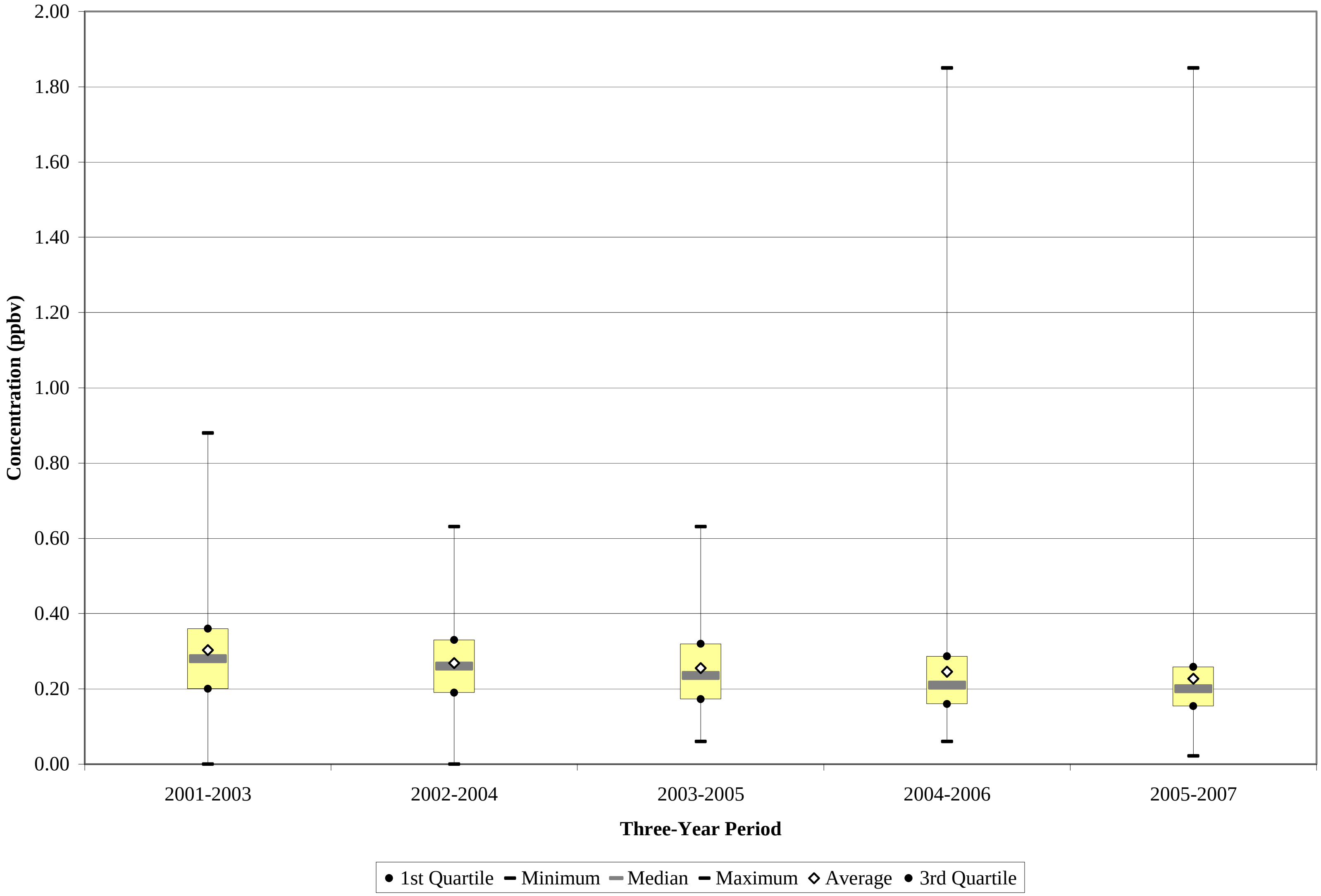


Figure 16-13. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at TUMS

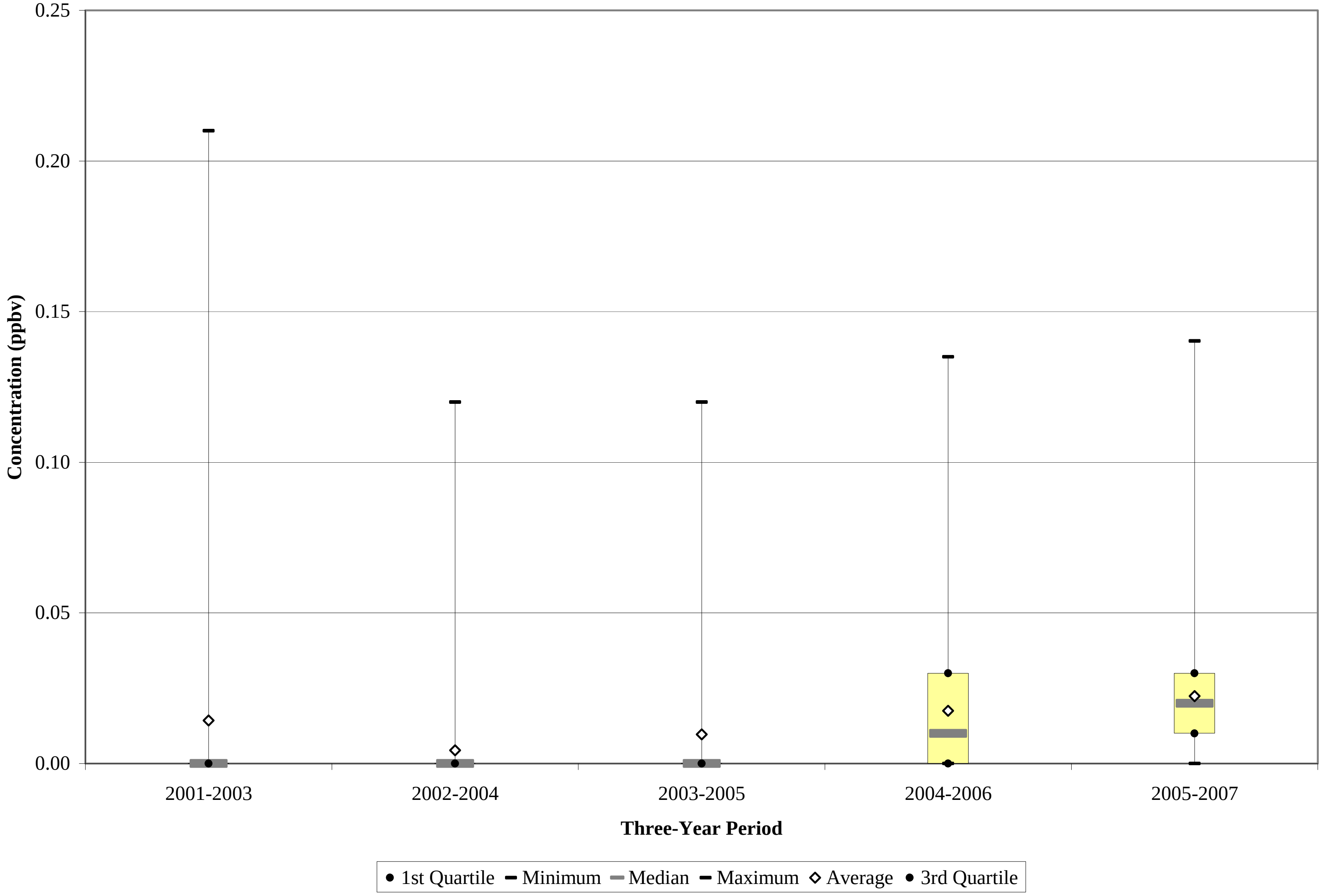
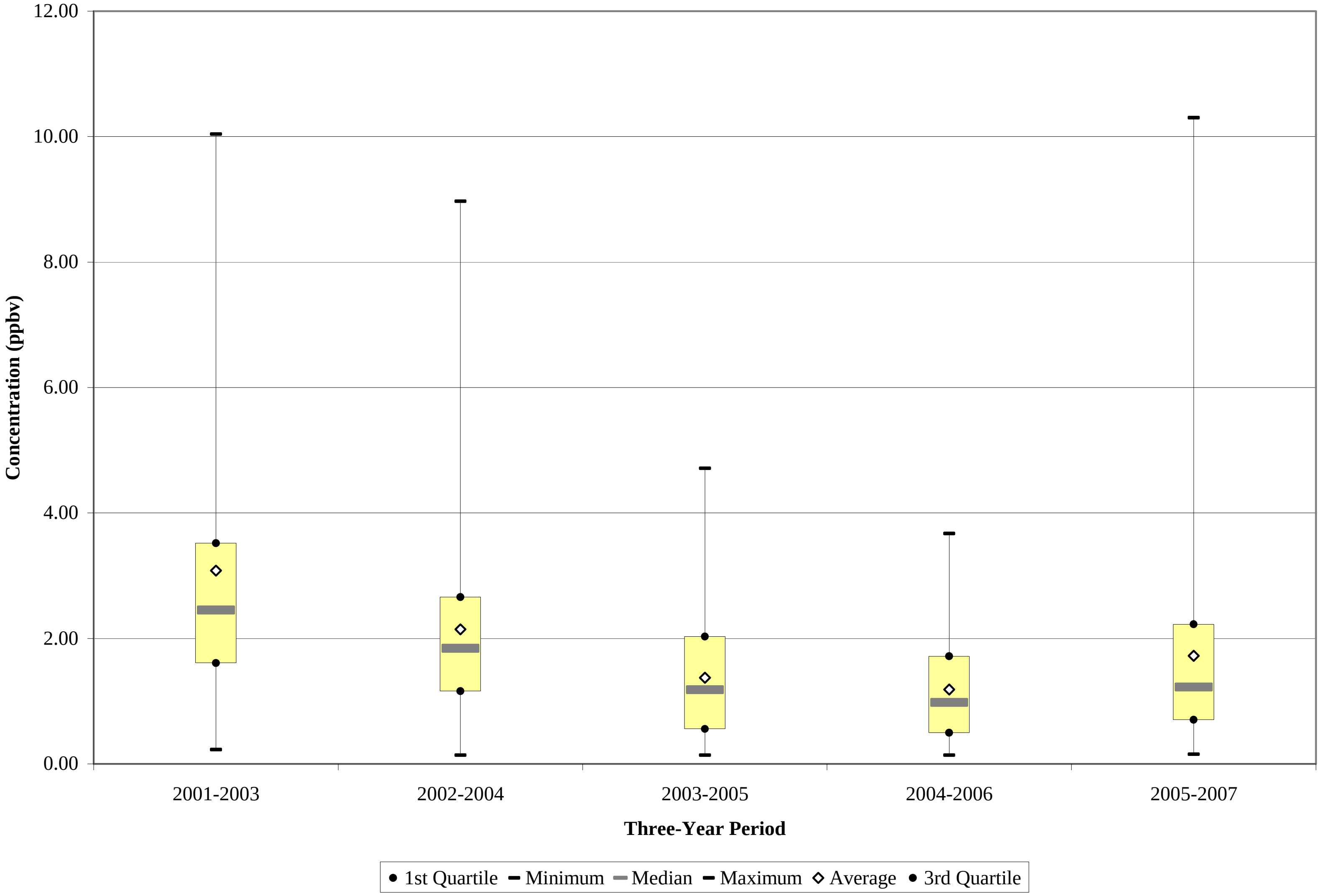


Figure 16-14. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at TUMS



Observations from Figure 16-10 for 1,3-butadiene measurements at GPMS include the following:

- The rolling metrics for 1,3-butadiene look very different than the rolling metrics for benzene, primarily due to the impact of the frequency of detection rather than the magnitude of the measurements.

- The minimum and first quartile were both zero for the 2001-2003 time frame, and minimum, first quartile, and median concentrations for the 2002-2004 time frame were zero. The detection rate actually decreased between the time frames, from 33 percent to 20 percent.

- As the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant increased. This pollutant was detected in 67 percent of samples during the 2003-2005 time frame; 80 percent of samples during 2004-2006; and 94 percent of samples during 2005-2007.

- As the detection rate increased, the median value increased as well. The median and rolling average concentrations shown became more similar over the last three periods, which indicates decreasing variability in the central tendency.

- The highest concentration of 1,3-butadiene was measured in 2005, on the same day that the highest concentration of benzene was measured.

Observations from Figure 16-11 for formaldehyde measurements at GPMS include the following:

- The maximum formaldehyde concentration shown was measured in 2005, but not the same day as benzene and 1,3-butadiene.

- There is a slight decrease in the average concentration from 2001-2003 to 2002-2004, then a slight increase for each additional period shown.

- The central tendency of the rolling averages and the median values were similar to each other for each time period. The “closeness” in these metrics indicates relatively little variability in the central tendency.

- All formaldehyde concentrations reported to AQS over the seven years of sampling were measured detections.

Observations from Figure 16-12 for benzene measurements at TUMS include the following:

- The maximum benzene concentration shown was measured in 2006.
- Although the range of concentrations measured has increased, the rolling average and median concentrations have decreased slightly since the onset of sampling.
- A single non-detect was recorded during the second year of sampling. After 2002, all benzene concentrations reported to AQS were measured detections.

Observations from Figure 16-13 for 1,3-butadiene measurements at TUMS include the following:

- The rolling metrics for the first five years of 1,3-butadiene sampling look very similar to the rolling metrics from GPMS for the 2002-2004 time frame. The minimum, first quartile, and median concentrations for the first three time frames were all zero.
- The minimum, first quartile, and median concentrations for both the 2001-2003 and the 2002-2004 time frames were zero. The detection rate decreased between the first two time frames, then increased during the third (21, 8, and 22 percent, respectively)
- As the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant increased. The detection rate for the final time frame (2005-2007) was nearly 80 percent.
- As the detection rate increased, the median value increased as well. The median and rolling average concentrations shown became more similar over the last three periods, which indicates decreasing variability in the central tendency.
- The highest concentration of 1,3-butadiene was measured in 2001.

Observations from Figure 16-14 for formaldehyde measurements at TUMS include the following:

- The average concentrations show a decreasing trend from the 2001-2003 time frame until the 2004-2006 time frame. An increase is shown for 2005-2007.
- The rolling averages and the median values became more similar for each time period through 2004-2006. The increasing “closeness” in these metrics indicates decreasing variability in the central tendency. The difference widens between the two metrics in the final time frame.

- The maximum formaldehyde concentration shown was measured in 2007. However, the maximum concentration measured in 2001 was just slightly lower.

- All formaldehyde concentrations reported to AQS over the seven years of sampling were measured detections.

16.5 Pearson Correlations

Table 16-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for GPMS from Table 16-6 include the following:

- Formaldehyde exhibited strong positive correlations with the temperature parameters, indicating that an increase in temperature results in a proportionate increase in concentration. This supports the observations from Table 16-5.

- 1,3-Butadiene exhibited strong negative correlations with the maximum, dew point, and wet bulb temperatures, indicating that an increase in temperature and moisture content results in a proportionate decrease in concentration.

- Acetaldehyde exhibited a strong negative correlation with relative humidity, indicating that an increase in moisture content results in a proportionate decrease in concentration. The correlations with wet bulb and dew point temperatures were also negative, but did not show the same strength in correlation.

- All but one of the correlations with scalar wind speed were negative, indicating that as wind speed decreases, concentrations of the pollutants of interest may increase at GPMS.

Observations for TUMS from Table 16-6 include the following:

- Similar to TUMS, formaldehyde exhibited strong positive correlations with the temperature parameters. In addition, this pollutant also exhibited strong positive correlations with the dew point and wet bulb temperatures. This supports the observations from Table 16-5.

- Acrylonitrile also exhibited strong positive correlations with the temperature and moisture parameters.

- All of the correlations with scalar wind speed were negative, indicating that as wind speed decreases, concentrations of the pollutants of interest may increase at TUMS.

Table 16-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Mississippi Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Gulf port, Mississippi - GPMS								
Acetaldehyde	62	-0.02	-0.15	-0.32	-0.26	-0.54	0.02	-0.36
Acrolein	61	0.18	0.20	0.19	0.19	0.06	-0.25	-0.08
Acrylonitrile	17	0.03	0.10	0.13	0.13	0.05	-0.12	-0.16
Benzene	61	-0.12	-0.15	-0.13	-0.13	-0.01	0.12	-0.42
1,3-Butadiene	60	-0.47	-0.52	-0.50	-0.51	-0.15	0.29	-0.44
Carbon Tetrachloride	61	0.18	0.25	0.29	0.29	0.23	-0.09	0.08
p-Dichlorobenzene	61	0.16	0.14	0.18	0.17	0.18	-0.16	-0.14
Formaldehyde	62	0.63	0.54	0.38	0.45	-0.29	-0.39	-0.36
Tupelo, Mississippi - TUMS								
1,3-Butadiene	59	-0.14	-0.22	-0.21	-0.23	0.01	0.17	-0.42
Acetaldehyde	58	-0.10	-0.16	-0.29	-0.25	-0.39	0.34	-0.31
Acrolein	60	0.26	0.24	0.19	0.20	-0.06	-0.15	-0.10
Acrylonitrile	17	0.45	0.51	0.54	0.55	0.16	0.53	-0.31
Benzene	61	-0.02	-0.04	0.01	-0.03	0.15	0.06	-0.39
Carbon Tetrachloride	61	0.27	0.29	0.39	0.34	0.34	-0.16	-0.14
Formaldehyde	58	0.77	0.73	0.58	0.65	-0.21	-0.28	-0.39

16.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

16.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Mississippi monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 16-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Acrolein exceeded one or more of the MRL risk factors for both sites.

Observations about acrolein from Table 16-7 include the following:

- None of the preprocessed daily measurements of acrolein from the Mississippi sites exceeded the acute MRL.
- All four seasonal averages of acrolein exceeded the intermediate MRL for both sites.
- Acrolein has no chronic MRL. Therefore, chronic risk could not be evaluated.

16.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Mississippi monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer

Table 16-7. MRL Risk Screening Assessment Summary for the Mississippi Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL ($\mu g/m^3$)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL ($\mu g/m^3$)	Winter Average ($\mu g/m^3$)	Spring Average ($\mu g/m^3$)	Summer Average ($\mu g/m^3$)	Autumn Average ($\mu g/m^3$)	ATSDR Chronic MRL ($\mu g/m^3$)	Annual Average[1] ($\mu g/m^3$)
GPMS	TO-15	Acrolein	7.00	0/61	0.09	**0.86 ± 0.27**	**0.91 ± 0.17**	**0.96 ± 0.18**	**0.88 ± 0.16**	--	0.91 ± 0.10
TUMS	TO-15	Acrolein	7.00	0/60	0.09	**0.42 ± 0.17**	**0.56 ± 0.15**	**0.65 ± 0.16**	**0.68 ± 0.16**	--	0.58 ± 0.08

BOLD = exceedance of the intermediate or chronic MRL

-- = an MRL risk factor is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 16-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the Mississippi monitoring sites is as follows:

- The census tract for GPMS is 28047001700, which had a population of 6,200 and represented approximately 3.3 percent of the Harrison County population in 2000.
- The census tract for TUMS is 280081950600, which had a population of 7,862, and represented approximately 10 percent of the Lee County population in 2000.

Observations for GPMS from Table 16-8 include the following:

- The pollutants with the highest concentrations according to NATA were xylenes, acetaldehyde, and formaldehyde.
- The pollutants with the highest cancer risks according to NATA were benzene, carbon tetrachloride, and 1,1,2,2-tetrachloroethane.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (2.96).
- The pollutants with the highest 2007 annual averages were xylenes, formaldehyde, and acetaldehyde.
- The pollutants with the highest surrogate cancer risk approximations were carbon tetrachloride, benzene, and acrylonitrile.
- Acrolein was the only pollutant with a noncancer risk approximation greater than 1.0. (45.31).

Observations for TUMS from Table 16-8 include the following:

- The pollutants with the highest concentrations according to NATA were benzene, acetaldehyde, and formaldehyde.
- The pollutants with the highest cancer risks according to NATA were benzene, carbon tetrachloride, and 1,1,2-trichloroethane.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (2.05).

Table 16-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Mississippi

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average[1] (µg/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Gulfport, Mississippi (GPMS) - Census Tract ID 28047001700								
Acetaldehyde	0.000002	0.009	0.97	2.16	0.10	1.55 ± 0.16	3.10	0.17
Acrolein	--	0.00002	0.06	--	2.96	0.91 ± 0.10	--	45.31
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	0.08 ± 0.02	5.24	0.04
Benzene	0.000007	0.03	0.90	7.02	0.03	0.79 ± 0.08	5.53	0.03
1,3-Butadiene	0.00003	0.002	0.07	1.99	0.03	0.07 ± 0.01	1.97	0.03
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	0.62 ± 0.03	9.33	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.02	0.22	<0.01	0.22 ± 0.13	2.40	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.67	<0.01	0.04 ± <0.01	1.10	<0.01
Dichloromethane	0.00000047	1	0.28	0.13	<0.01	0.39 ± 0.08	0.18	<0.01
Formaldehyde	5.5E-09	0.0098	0.97	0.01	0.09	2.55 ± 0.29	0.01	0.26
1,1,2,2-Tetrachloroethane	0.000058	--	0.04	2.23	--	0.05 ± <0.01	3.18	--
Tetrachloroethylene	0.000005	0.27	0.12	0.70	<0.01	0.54 ± 0.55	2.71	<0.01
Xylenes	--	0.1	1.72	--	0.01	1.68 ± 0.45	--	0.02

-- = a URE or RfC is not available

Bold = pollutant of interest

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 16-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Mississippi (Continued)

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE ($\mu g/m^3$)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration ($\mu g/m^3$)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] ($\mu g/m^3$)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Tupelo, Mississippi (TUMS) - Census Tract ID 28081950600								
Acetaldehyde	0.000002	0.009	0.81	1.80	0.09	1.78 ± 0.24	3.56	0.20
Acrolein	--	0.00002	0.04	--	2.05	0.58 ± 0.08	--	28.92
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	0.08 ± 0.02	5.23	0.04
Benzene	0.000007	0.03	0.90	7.05	0.03	0.65 ± 0.06	4.55	0.02
1,3-Butadiene	0.00003	0.002	0.05	1.55	0.02	0.05 ± 0.01	1.65	0.03
Carbon Tetrachloride	0.000015	0.04	0.21	3.13	0.01	0.58 ± 0.04	8.63	0.01
p-Dichlorobenzene	0.000011	0.8	0.02	0.22	<0.01	0.06 ± 0.01	0.65	<0.01
Formaldehyde	5.5E-09	0.0098	0.76	<0.01	0.07	3.20 ± 0.59	0.02	0.33
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.20 ± 0.02	4.45	<0.01
1,1,2,2-Tetrachloroethane	0.000058	--	0.02	1.26	--	0.06 ± <0.01	3.22	--
Tetrachloroethylene	0.000005	0.27	0.06	0.38	<0.01	0.12 ± 0.06	0.60	<0.01
1,1,2-Trichloroethane	0.000016	0.4	0.12	1.93	<0.01	0.05 ± <0.01	0.76	<0.01
Vinyl chloride	0.000008	0.1	0.01	0.11	<0.01	0.03 ± 0.01	0.26	<0.01

-- = a URE or RfC is not available

Bold = pollutant of interest

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

- The pollutants with the highest 2007 annual averages were formaldehyde, acetaldehyde, benzene, and acrolein.

- The pollutants with the highest surrogate cancer risk approximations were carbon tetrachloride, acrylonitrile, and benzene, which was similar to GPMS.

- Acrolein was the only pollutant with a noncancer risk approximation greater than 1.0. (28.92).

16.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 16-9 and 16-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 16-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest surrogate cancer risk approximations (in-a-million), as calculated from the annual averages. Table 16-10 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk approximations based on each site’s annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 16.3, GPMS and TUMS both sampled for VOC and carbonyl compounds; GPMS also sampled for SNMOC. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 16-9 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Harrison County. Dichloromethane was the highest emitted pollutant in Lee County, followed by benzene, formaldehyde, and acetaldehyde.

Table 16-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Mississippi

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Gulfport, Mississippi (GPMS) – Harrison County					
Benzene	221.28	Benzene	1.73E-03	Carbon Tetrachloride	9.33
Formaldehyde	70.95	1,3-Butadiene	6.29E-04	Benzene	5.53
Acetaldehyde	27.85	Hexavalent Chromium	1.89E-04	Acrylonitrile	5.23
1,3-Butadiene	20.97	Naphthalene	1.64E-04	1,1,2,2-Tetrachloroethane	3.19
Dichloromethane	16.45	Arsenic, PM	1.22E-04	Acetaldehyde	3.10
Tetrachloroethylene	16.04	Tetrachloroethylene	9.46E-05	Tetrachloroethylene	2.71
Naphthalene	4.84	POM, Group 2	6.40E-05	*p*-Dichlorobenzene	2.40
p-Dichlorobenzene	4.09	Acetaldehyde	6.13E-05	1,3-Butadiene	1.97
Trichloroethylene	1.21	Nickel, PM	4.53E-05	1,2-Dichloroethane	1.11
POM, Group 2	1.16	*p*-Dichlorobenzene	4.50E-05	Dichloromethane	0.18
Tupelo, Mississippi (TUMS) – Lee County					
Dichloromethane	213.35	Hexavalent Chromium	2.45E-03	Carbon Tetrachloride	8.63
Benzene	128.71	Benzene	1.00E-03	Acrylonitrile	5.21
Formaldehyde	31.20	Naphthalene	3.36E-04	Benzene	4.55
Acetaldehyde	11.19	1,3-Butadiene	2.83E-04	Hexachloro-1,3-butadiene	4.48
Naphthalene	9.89	Nickel, PM	1.40E-04	Acetaldehyde	3.56
1,3-Butadiene	9.44	Arsenic, PM	1.23E-04	1,1,2,2-Tetrachloroethane	3.22
Tetrachloroethylene	6.29	Dichloromethane	1.00E-04	1,3-Butadiene	1.65
Trichloroethylene	2.39	Cadmium, PM	9.86E-05	1,1,2-Trichloroethane	0.77
p-Dichlorobenzene	1.65	POM, Group 2	4.00E-05	*p*-Dichlorobenzene	0.65
Nickel, PM	0.88	Tetrachloroethylene	3.71E-05	Tetrachloroethylene	0.60

Table 16-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Mississippi

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Gulfport, Mississippi (GPMS) – Harrison County					
Hydrochloric acid	1,034.41	Acrolein	228,271.03	Acrolein	45.31
Xylenes	913.82	Hydrochloric acid	5,1720.73	Formaldehyde	0.26
Toluene	681.78	Chlorine	16,950.00	Acetaldehyde	0.17
Benzene	221.28	1,3-Butadiene	10,485.95	Acrylonitrile	0.04
Ethylbenzene	195.13	Manganese, PM	9950.47	1,3-Butadiene	0.03
Hexane	173.04	Xylenes	9138.24	Benzene	0.03
Methanol	123.31	Benzene	7376.01	Carbon Tetrachloride	0.02
Hydrofluoric acid	78.09	Formaldehyde	7239.59	Xylenes	0.01
Formaldehyde	70.95	Nickel, PM	4355.41	Tetrachloroethylene	<0.01
Methyl isobutyl ketone	70.81	Cyanide Compounds, gas	3493.33	Dichloromethane	<0.01
Tupelo, Mississippi (TUMS) – Lee County					
Toluene	315.99	Acrolein	90,138.26	Acrolein	28.92
Xylenes	223.51	Nickel, PM	13,509.21	Formaldehyde	0.33
Dichloromethane	213.35	1,3-Butadiene	4,718.07	Acetaldehyde	0.20
Methyl isobutyl ketone	199.37	Benzene	4,290.41	Acrylonitrile	0.04
Benzene	128.71	2,4-Toluene diisocyanate	4,091.84	1,3-Butadiene	0.03
Glycol ethers, gas	63.75	Naphthalene	3,296.01	Benzene	0.02
Methanol	55.58	Manganese, PM	3,193.94	Carbon Tetrachloride	0.01
Hexane	50.67	Glycol ethers, gas	3,187.32	Hexachloro-1,3-butadiene	<0.01
Ethylbenzene	40.92	Formaldehyde	3,183.87	Tetrachloroethylene	<0.01
Formaldehyde	31.20	Cadmium, PM	2,739.45	Vinyl chloride	<0.01

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Harrison County were benzene, 1,3-butadiene, and hexavalent chromium. Hexavalent chromium was the pollutant with the highest toxicity-weighted emissions for Lee County, followed by benzene and naphthalene.

- Seven of the highest emitted pollutants in Harrison County also had the highest toxicity-weighted emissions. Six of the highest emitted pollutants in Lee County also had the highest toxicity-weighted emissions.

- For GPMS, carbon tetrachloride, benzene, and acrylonitrile had the highest surrogate cancer risk approximations. These pollutants also topped the list for TUMS, although in a different order. Neither carbon tetrachloride nor acrylonitrile appeared on either emissions-based list, while benzene appeared on all three lists.

Observations from Table 16-10 include the following:

- Hydrochloric acid, toluene, and xylenes were the highest emitted pollutants with noncancer RfCs in Harrison County. Toluene, xylenes, and dichloromethane were the highest emitted pollutants in Lee County.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties was acrolein.

- Four of the highest emitted pollutants in Harrison County also had the highest toxicity-weighted emissions. Three of the highest emitted pollutants in Lee County also had the highest toxicity-weighted emissions.

- The pollutant with the highest noncancer risk approximation for both sites was acrolein. Acrolein was also the pollutant with the highest toxicity-weighted emissions, yet this pollutant's county-level emissions ranked 22nd for GPMS and 23rd for TUMS.

16.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *The pollutants of interest common to each Mississippi monitoring site were acetaldehyde, acrolein, acrylonitrile, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.*

- ❖ *Formaldehyde had the highest daily average concentration for each of the monitoring sites.*

- ❖ *Seasonal averages of acrolein exceeded the intermediate MRL health benchmark for both monitoring sites.*

17.0 Site in Missouri

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Missouri, and integrates these concentrations with emissions, meteorological, and risk information.

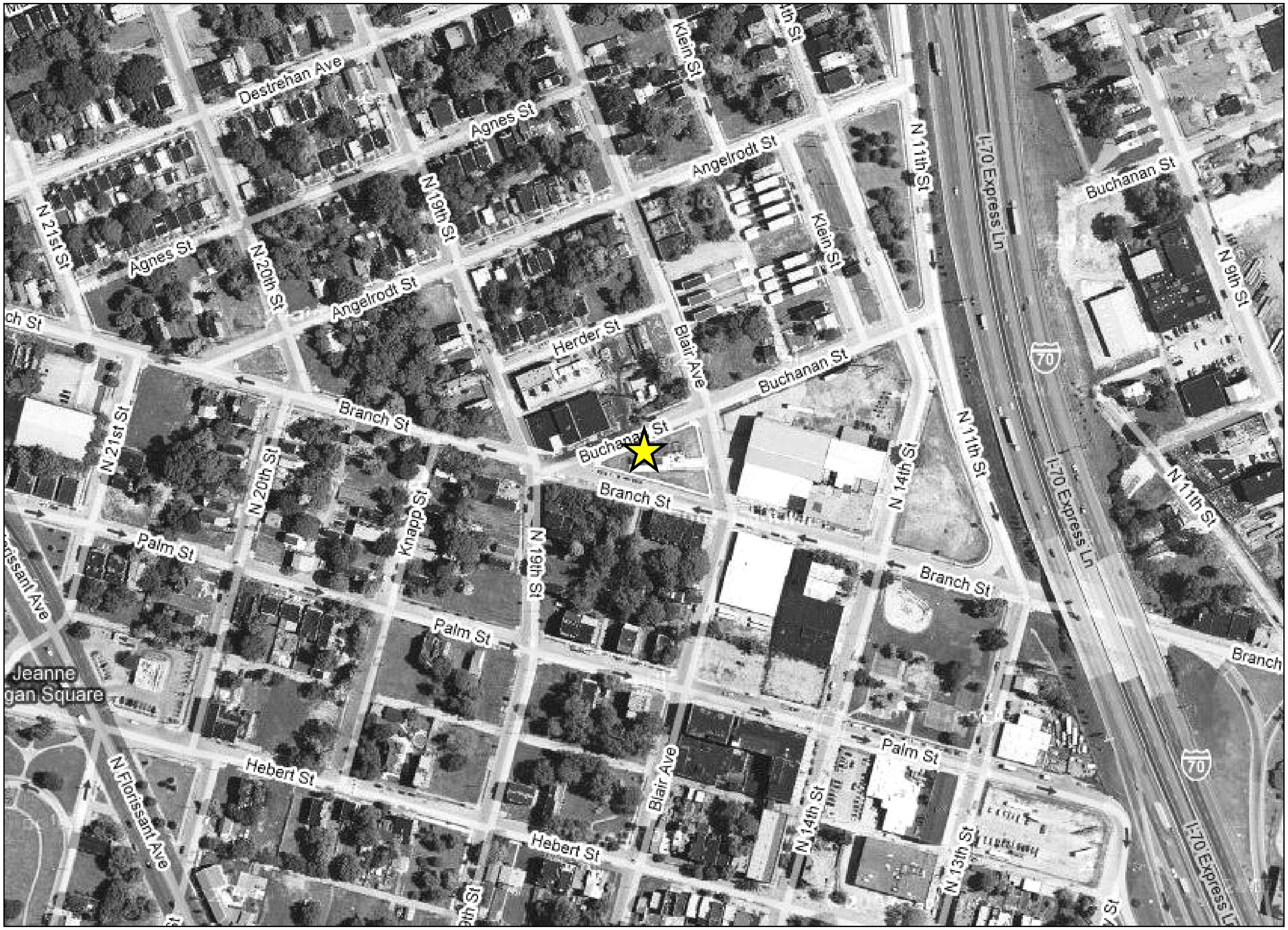
17.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The S4MO site is located in the St. Louis, MO-IL MSA. Figure 17-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its urban location. Figure 17-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 17-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use**,** location setting, and locational coordinates.

S4MO is located in central St. Louis. Figure 17-1 shows that the S4MO monitoring site is located less than a quarter-mile from I-70. The Mississippi River, which separates Missouri from Illinois, is less than a mile east of the site. Although the area directly around the monitoring site is residential, industrial facilities are located just on the other side of I-70. Figure 17-2 shows a large number of point sources are located within 10 miles of S4MO. Some of the most numerous emission sources are involved in fuel combustion processes, chemical and allied product production, liquids distribution, and surface coating processes. In the immediate vicinity of S4MO are an organic chemical production facility to the east and a wood furniture production facility to the west.

Table 17-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Missouri monitoring site. County-level vehicle registration and population data for St Louis City and County were obtained from the Missouri Department of Revenue and the U.S. Census Bureau. Table 17-2 also includes a vehicle registration to county population ratio (vehicles per

Figure 17-1. St. Louis, Missouri (S4MO) Monitoring Site



©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 17-2. NEI Point Sources Located Within 10 Miles of S4MO

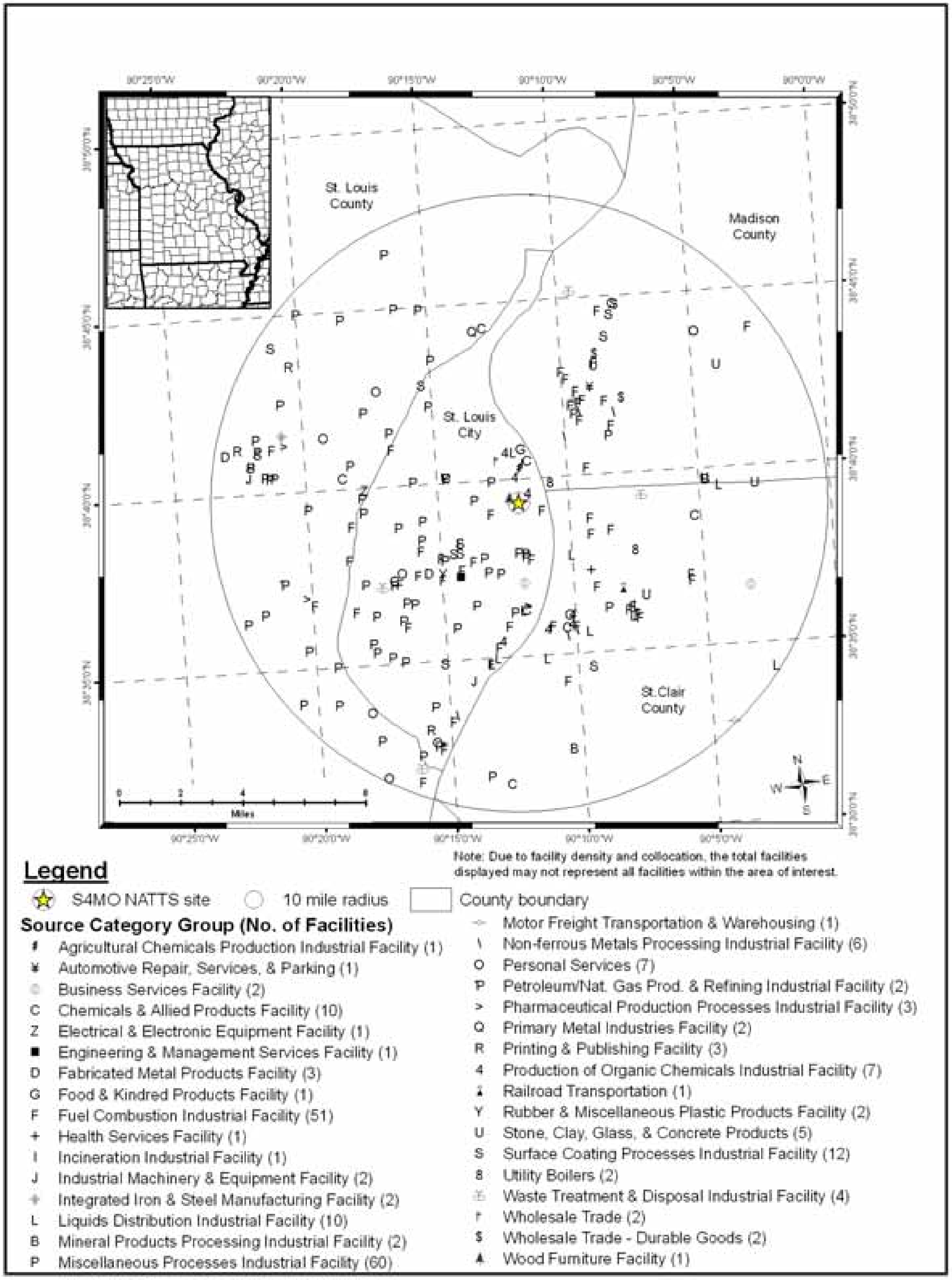


Table 17-1. Geographical Information for the Missouri Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
S4MO	29-510-0085	St. Louis	St. Louis	St. Louis, MO-IL	38.656436, -90.198661	Residential	Urban/City Center	Blair Street has some industry around it and a fair amount of industry to the east. The site is also only about 220 meters from I-70 (at its closest point).

BOLD = EPA-designated NATTS Site

Table 17-2. Population, Motor Vehicle, and Traffic Information for the Missouri Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
S4MO	1,345,877	1,136,095	0.84	816,098	688,893	84,821	63,584

[1] Daily Average Traffic Data reflects 2006 data from the Missouri DOT
BOLD = EPA-designated NATTS Site

person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 17-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 17-2 presents the daily VMT for the urban area.

Observations from Table 17-2 include the following:

- S4MO's county and 10-mile populations were in the upper to mid-range compared to all counties with NATTS or UATMP sites. This is also true for its county-level and 10-mile vehicle ownership.
- The vehicle per person ratio was in the middle of the range compared to other NATTS or UATMP sites.
- The traffic volume experienced near S4MO ranked thirteenth highest compared to other monitoring sites. The traffic estimate used came from I-70 near exit 250.
- The St. Louis area VMT was the thirteenth highest among urban areas with UATMP or NATTS sites. The St. Louis VMT was very similar to the Tampa area VMT.

17.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Missouri on sampling days, as well as over the course of the year.

17.2.1 Climate Summary

St. Louis has a climate that is continental in nature, with cold, dry winters; warm, somewhat wetter summers; and significant seasonal variability. Warm, moist air flowing northward from the Gulf of Mexico alternating with cold, dry air marching southward from Canada and the northern U.S. results in weather patterns that do not persist for very long (Ruffner and Bair, 1987).

17.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at St. Louis Downtown Airport (WBAN 03960).

Table 17-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 17-3 is the 95 percent confidence interval for each parameter. As shown in Table 17-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

17.2.3 Composite Back Trajectories for Sampling Days

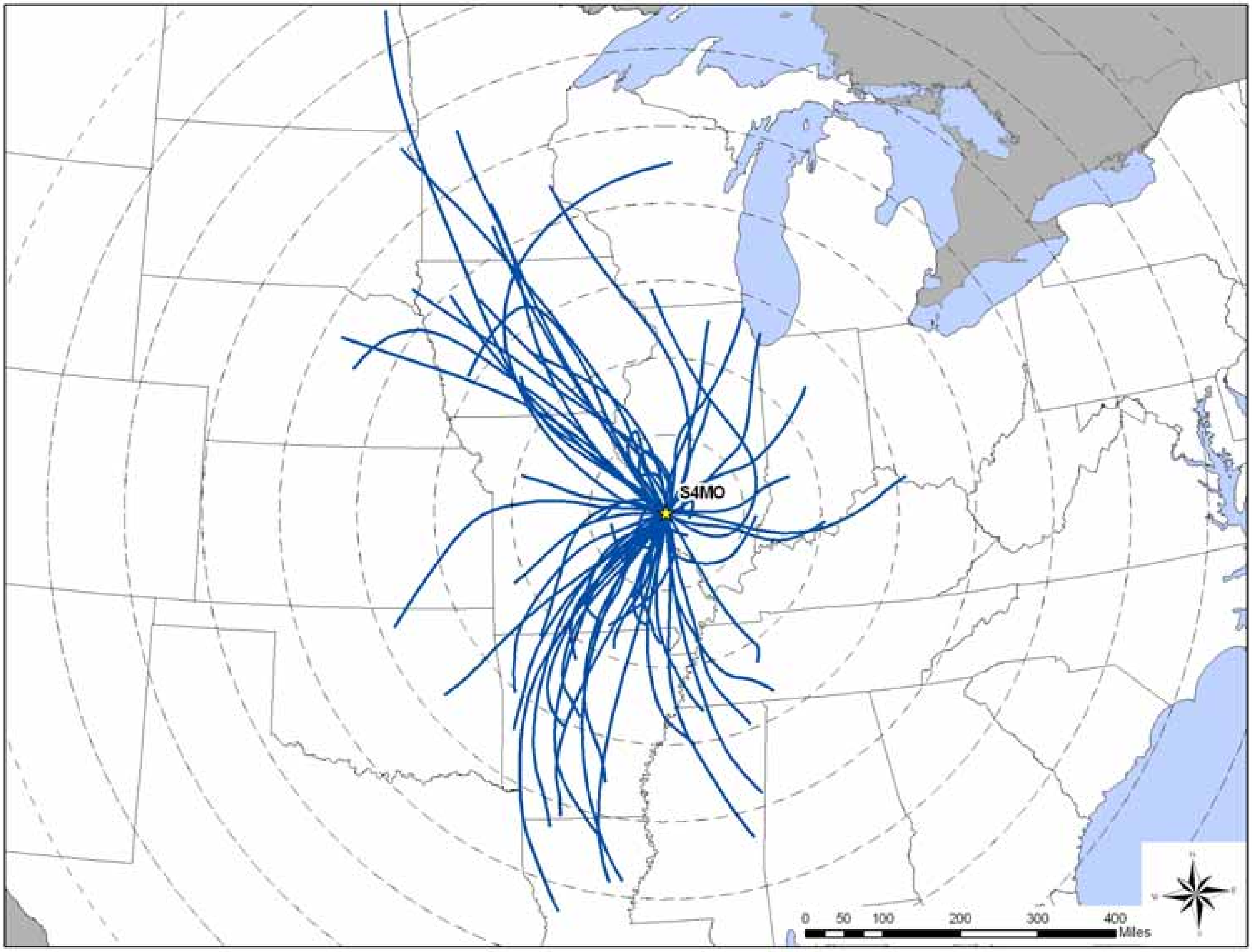
Figure 17-3 is a composite back trajectory map for the Missouri monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 17-3 represents 100 miles.

Table 17-3. Average Meteorological Conditions near the Missouri Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
S4MO	St. Louis Downtown Airport 03960	Sampling Day	70.05 ± 4.91	59.85 ± 4.44	47.20 ± 4.23	53.08 ± 3.93	66.35 ± 2.65	1017.70 ± 1.46	6.21 ± 0.83
		All 2007	67.68 ± 2.15	57.50 ± 1.97	45.23 ± 1.92	51.11 ± 1.76	66.96 ± 1.20	1018.04 ± 0.62	5.98 ± 0.32

BOLD = EPA-designated NATTS Site

Figure 17-3. Composite Back Trajectory Map for S4MO



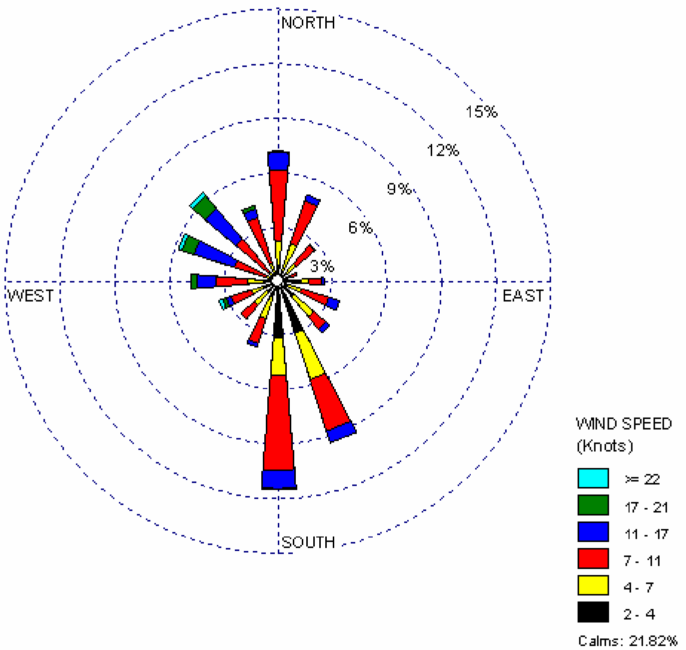
Observations from Figure 17-3 include the following:

- Back trajectories originated from a variety of directions at S4MO. The bulk of the trajectories originated from the southwest and northwest.
- The 24-hour air shed domain for S4MO was comparable in size to other monitoring sites. The furthest away a trajectory originated was North Dakota, or more than 700 miles away. However, 90 percent of trajectories originated within 500 miles of the site.

17.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at the St. Louis Downtown Airport near S4MO were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 17-4 is the wind rose for the Missouri monitoring site on days that samples were collected.

Figure 17-4. Wind Rose for S4MO Sampling Days



Observations from Figure 17-4 for S4MO include the following:

- Calm winds were prevalent near S4MO and were observed for approximately 22 percent of the hourly wind measurements.
- Southerly and south-southeasterly winds were frequently observed near S4MO.
- Winds exceeding 11 knots made up approximately 14 percent of observations and were most frequently measured for winds with a westerly component.

17.3 Pollutants of Interest

"Pollutants of interest" were determined for the site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Missouri monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 17-4 presents the pollutants that failed at least one screen for the Missouri monitoring site and highlights the site's pollutants of interest (shaded). S4MO sampled for VOC, carbonyls, metals (PM_{10}), and hexavalent chromium.

Observations from Table 17-4 include the following:

- Seventeen pollutants with a total of 579 measured concentrations failed at least one screen for S4MO.
- The following eleven pollutants were identified as pollutants of interest for S4MO: acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, cadmium, carbon tetrachloride, formaldehyde, manganese, *p*-dichlorobenzene, and tetrachloroethylene.
- Of the eleven pollutants of interest, six failed 100 percent of screens for S4MO.
- Nearly 67 percent of measured detections failed screens (of the pollutants that failed at least one screen) for S4MO.

Table 17-4. Comparison of Measured Concentrations and EPA Screening Values for the Missouri Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Louis, Missouri - S4MO					
Carbon Tetrachloride	61	61	100.00	10.54	10.54
Benzene	61	61	100.00	10.54	21.07
Arsenic (PM_{10})	60	60	100.00	10.36	31.43
Acetaldehyde	60	60	100.00	10.36	41.80
Acrolein	60	60	100.00	10.36	52.16
Formaldehyde	60	60	100.00	10.36	62.52
Manganese (PM_{10})	57	60	95.00	9.84	72.37
1,3-Butadiene	56	59	94.92	9.67	82.04
Cadmium (PM_{10})	33	60	55.00	5.70	87.74
p-Dichlorobenzene	30	57	52.63	5.18	92.92
Tetrachloroethylene	24	60	40.00	4.15	97.06
Hexavalent Chromium	7	49	14.29	1.21	98.27
Acrylonitrile	4	4	100.00	0.69	98.96
Nickel (PM_{10})	3	60	5.00	0.52	99.48
Dichloromethane	1	61	1.64	0.17	99.65
Trichloroethylene	1	32	3.13	0.17	99.83
1,1,2,2-Tetrachloroethane	1	1	100.00	0.17	100.00
Total	579	865	66.94		

17.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Missouri monitoring site. The averages presented are provided for the pollutants of interest for the site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

17.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 17-5, where applicable.

Table 17-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Missouri Monitoring Site

Pollutant	**# of Measured Detections**	**# of Samples**	**Daily Average ($\mu g/m^3$)**	**Winter Average ($\mu g/m^3$)**	**Spring Average ($\mu g/m^3$)**	**Summer Average ($\mu g/m^3$)**	**Autumn Average ($\mu g/m^3$)**	**Annual Average[1] ($\mu g/m^3$)**
St. Louis, Missouri - S4MO								
Acetaldehyde	60	60	4.06 ± 0.52	2.86 ± 0.41	3.44 ± 0.43	4.68 ± 0.64	5.24 ± 1.73	4.06 ± 0.52
Acrolein	60	61	0.79 ± 0.12	0.49 ± 0.13	0.86 ± 0.27	0.99 ± 0.26	0.73 ± 0.20	0.78 ± 0.12
Arsenic (PM_{10})	60	60	<0.01 ± <0.01	<0.01 ± 0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Benzene	61	61	0.83 ± 0.14	0.77 ± 0.19	0.65 ± 0.11	0.75 ± 0.22	1.17 ± 0.44	0.83 ± 0.14
1,3-Butadiene	59	61	0.09 ± 0.02	0.09 ± 0.03	0.06 ± 0.01	0.08 ± 0.01	0.15 ± 0.08	0.09 ± 0.02
Cadmium (PM_{10})	60	60	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Carbon Tetrachloride	61	61	0.58 ± 0.03	0.54 ± 0.08	0.61 ± 0.05	0.56 ± 0.06	0.59 ± 0.06	0.58 ± 0.03
p-Dichlorobenzene	57	61	0.26 ± 0.10	0.07 ± 0.02	0.26 ± 0.21	0.46 ± 0.25	0.17 ± 0.09	0.25 ± 0.10
Formaldehyde	60	60	4.57 ± 0.68	2.20 ± 0.37	4.16 ± 0.92	7.70 ± 1.21	3.81 ± 0.70	4.57 ± 0.68
Manganese (PM_{10})	60	60	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01
Tetrachloroethylene	60	61	0.20 ± 0.05	0.13 ± 0.04	0.17 ± 0.04	0.18 ± 0.04	0.31 ± 0.15	0.20 ± 0.04

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for S4MO from Table 17-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (4.57 ± 0.68 $\mu g/m^3$), acetaldehyde (4.06 ± 0.52 $\mu g/m^3$), and benzene (0.83 ± 0.14 $\mu g/m^3$). The annual averages for these pollutants were the same as their respective daily averages.

- As shown in Table 4-10, of the program-level pollutants of interest, S4MO had the highest daily average concentration of arsenic (PM_{10}) and the third highest concentration of manganese (PM_{10}). In addition, the following pollutants for S4MO were among the 10 highest average concentrations for all NATTS and UATMP sites, as shown in Tables 4-9 and 4-11: acetaldehyde, acrolein, formaldehyde, and *p*-dichlorobenzene.

- Most of the concentrations of the pollutants of interest for S4MO did not vary significantly by season. However, formaldehyde concentrations were highest in the summer and lowest in the winter. Also, acetaldehyde concentrations were lowest in the winter and highest in the summer and fall.

17.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one ore more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. S4MO has sampled carbonyls under the UATMP and/or NATTS since 2002 and VOC and metals since 2003. Figures 17-5 through 17-8 present the three-year rolling statistical metrics graphically for arsenic, benzene, 1,3-butadiene, and formaldehyde for S4MO, respectively. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Observations from Figure 17-5 for arsenic include the following:

- The maximum arsenic concentration was measured in 2007, as shown for the 2005-2007 time frame.

- The central tendency shows little variability, as indicated by the closeness of the first and third quartiles, the median, and the average concentrations.

- The average concentration is very similar to the third quartile for each time period shown. Given that the third quartile represents the value below which 75 percent of concentrations fall below, the average concentration shown for each period was influenced by the outliers, such as the maximum concentrations shown for each period.

- The rolling average concentrations of arsenic have changed little over the time periods shown.

- All arsenic concentrations reported to AQS over the five years of sampling were measured detections.

Figure 17-5. Three-Year Rolling Statistical Metrics for Arsenic Concentrations Measured at S4MO

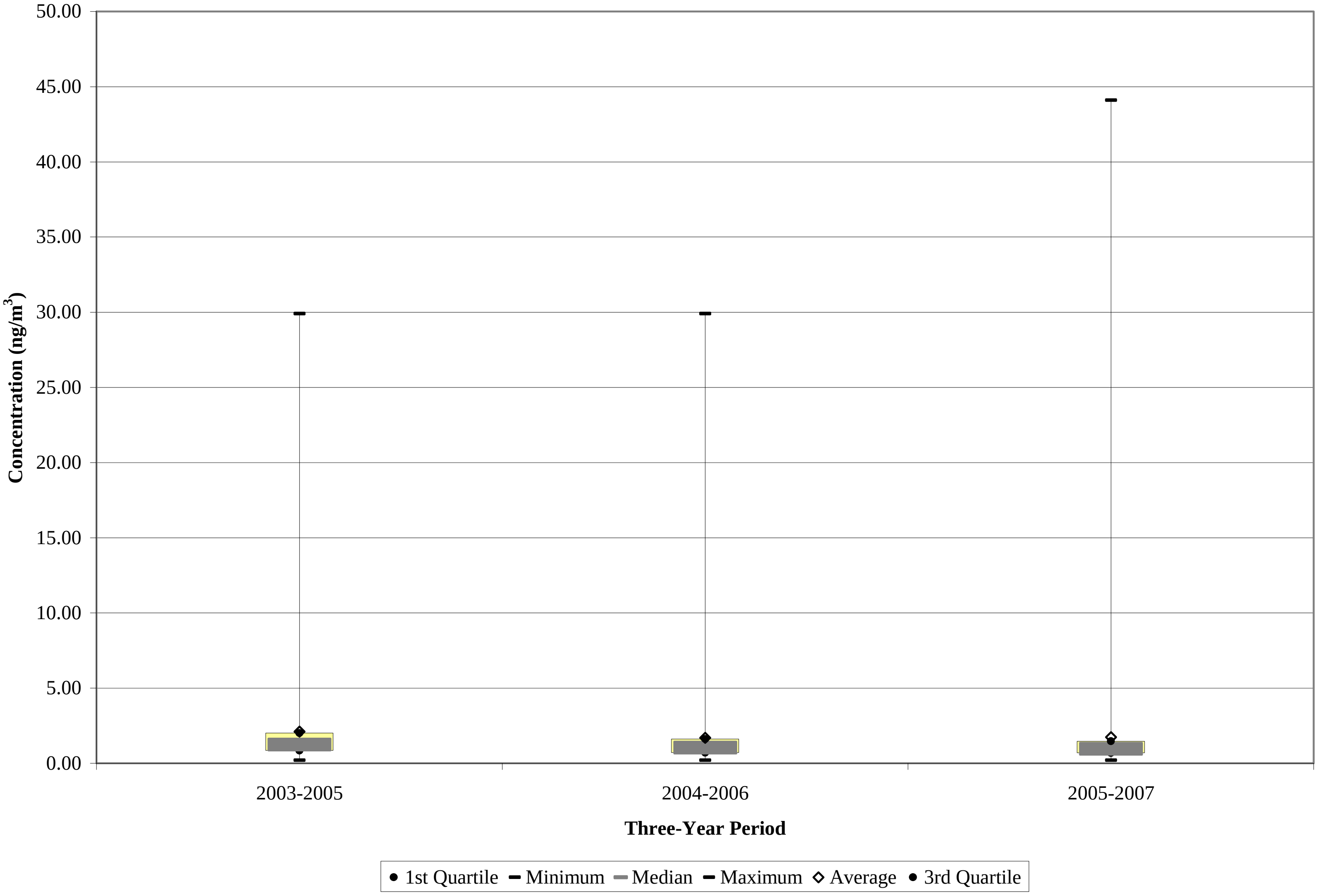


Figure 17-6. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at S4MO

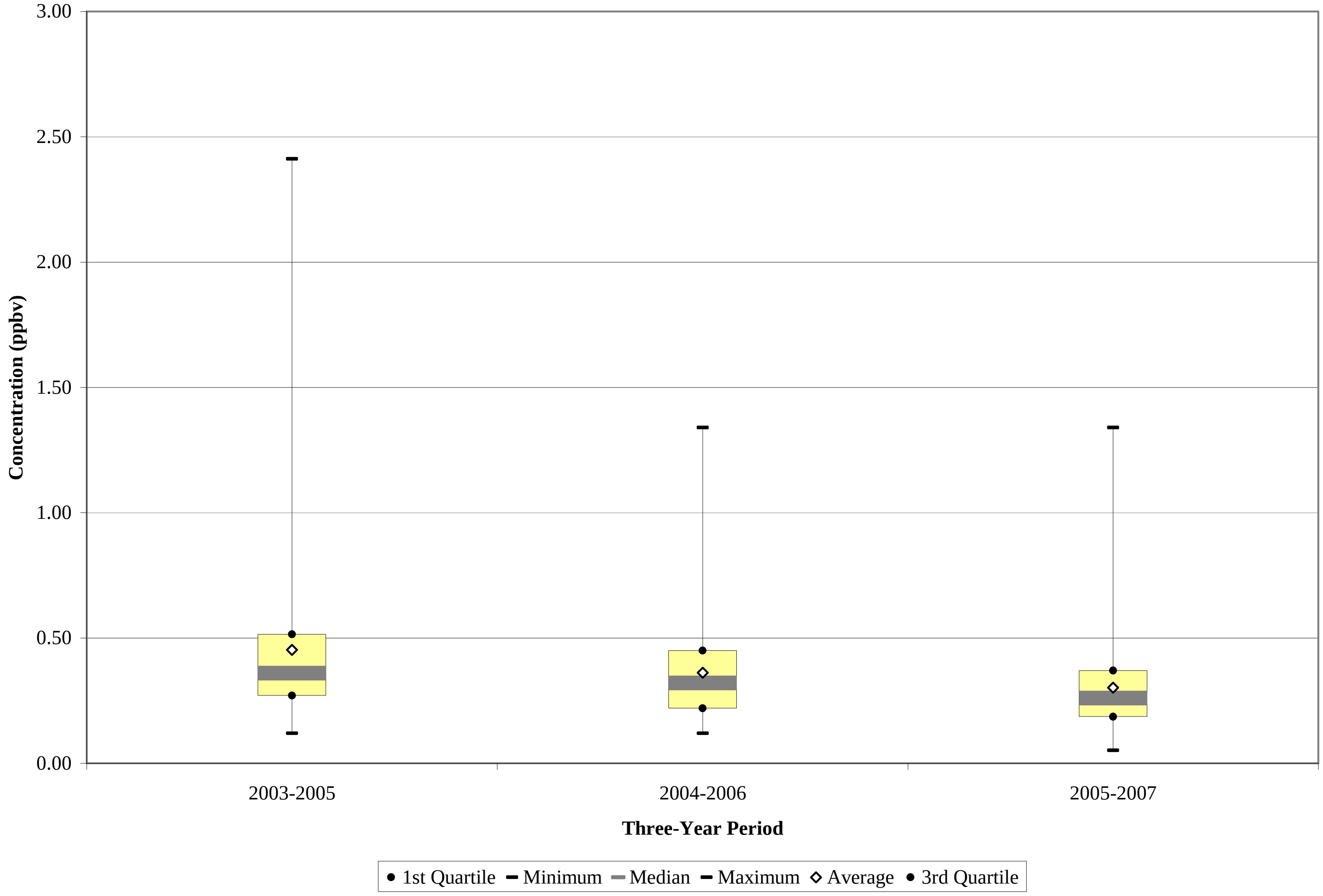


Figure 17-7. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at S4MO

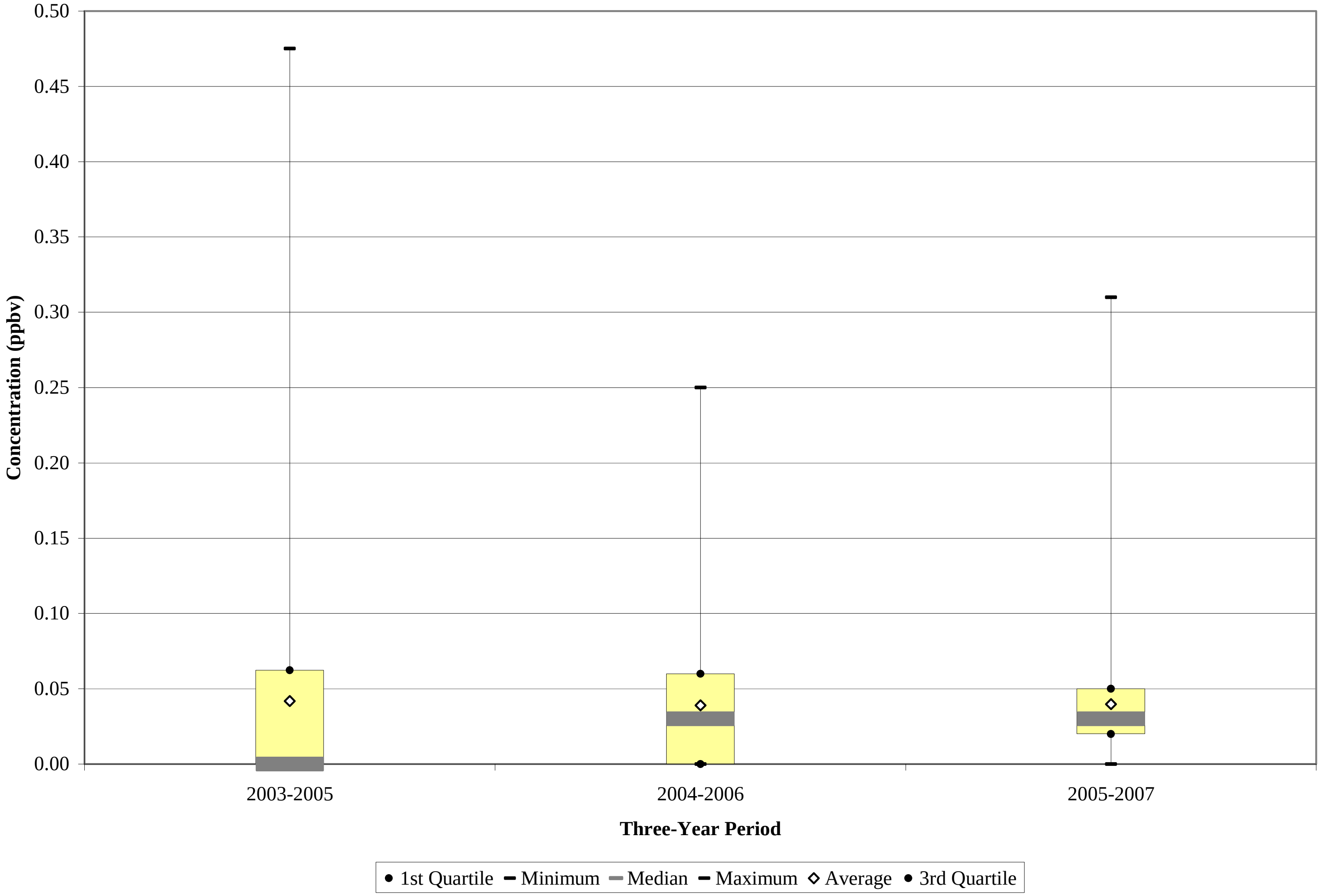
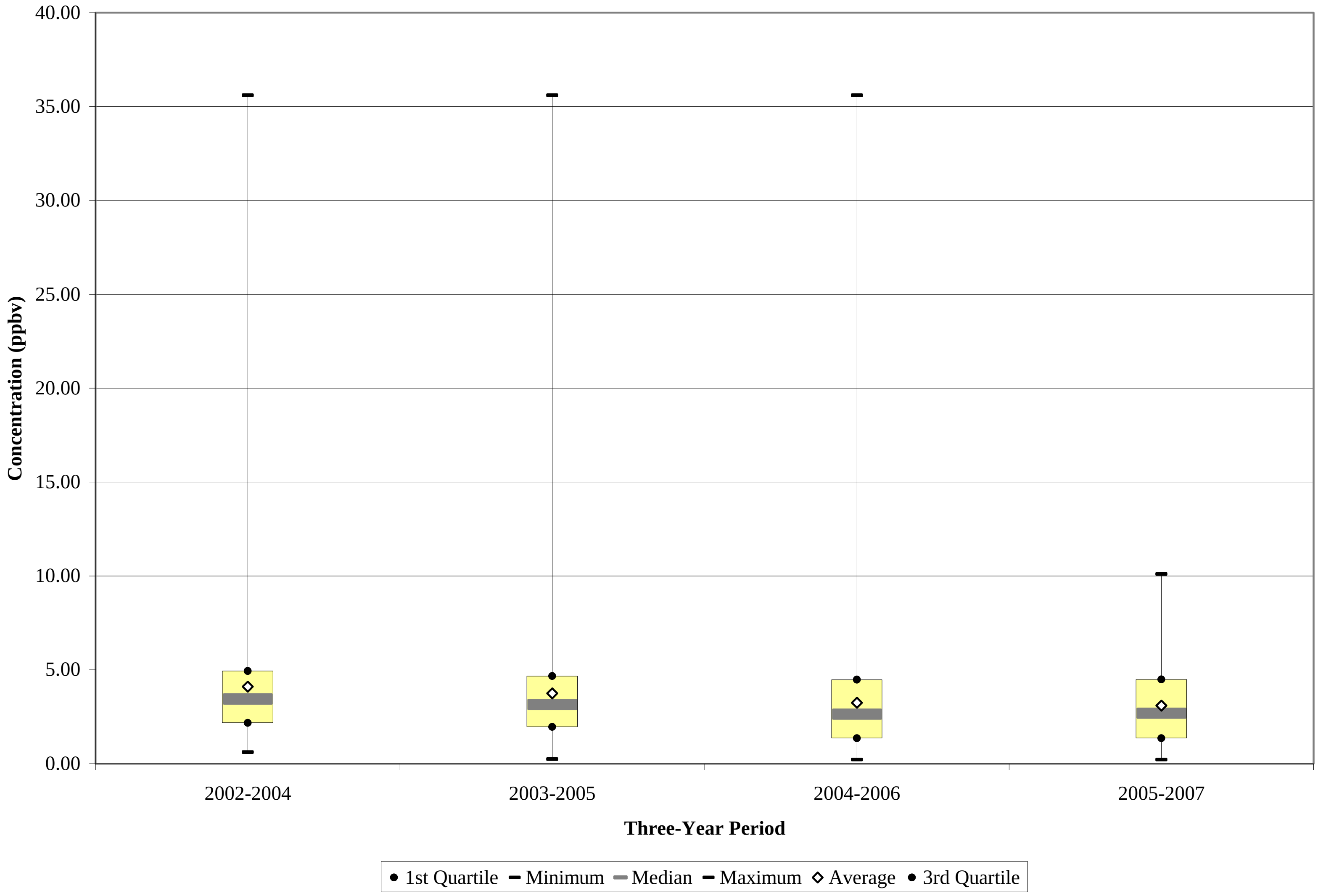


Figure 17-8. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at S4MO



Observations from Figure 17-6 for benzene include the following:

- The maximum benzene concentration shown was measured in 2003, as shown by the 2003-2005 time frame. The maximum concentrations for the remaining time frames were nearly half of the maximum concentration from 2003-2005.

- The median and rolling average concentrations have a decreasing trend over the time periods shown.

- All benzene concentrations reported to AQS over the five years of sampling were measured detections. The decreasing MDL is shown by the decreasing minimum concentration over the periods.

Observations from Figure 17-7 for 1,3-butadiene include the following:

- Figure 17-7 for 1,3-butadiene is similar to plots of 1,3-butadiene for other program sites.

- The minimum, first quartile, and median concentrations for 1,3-butadiene were all zero for the 2003-2005 time frame. As the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant increased, and a larger spread between these metrics is observed. This pollutant was detected in 44 percent of samples during the 2003-2005 time frame; 61 percent of samples during 2004-2006; and 82 percent of samples during 2005-2007.

- The rolling average concentrations shown for all time frames changed little across each period.

Observations from Figure 17-8 for formaldehyde include the following:

- The maximum formaldehyde concentration shown was measured in 2004, and appears in Figure 17-8 for the all time frames shown, except the most recent (2005-2007).

- The median and rolling average concentrations were fairly similar to each other for each period, indicating rather low variability in central tendency since sampling began in 2002.

- Both the median and average concentrations exhibited a slight decreasing trend.

- All formaldehyde concentrations reported to AQS over the six years of sampling were measured detections.

17.5 Pearson Correlations

Table 17-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for S4MO from Table 17-6 include the following:

- Most of the correlations between the pollutants of interest for S4MO were weak.
- The exceptions include the strong positive correlations calculated between formaldehyde and the temperature and moisture parameters (except relative humidity). This indicates that as temperature and moisture content increase, concentrations of formaldehyde also increase.
- Formaldehyde and acetaldehyde both exhibited strong negative correlations with wind speed. In addition, all but one of the pollutants of interest exhibited negative correlations with wind speed, suggesting that concentrations of the pollutants of interest may increase as wind speeds decrease.

17.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

17.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Missouri monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 17-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk factors.

Table 17-6. Pearson Correlations Between Selected Meteorological Parameters and Pollutants of Interest for the Missouri Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
St. Louis, Missouri - S4MO								
Acetaldehyde	60	0.37	0.29	0.24	0.27	-0.13	-0.02	-0.56
Acrolein	60	0.29	0.28	0.25	0.28	-0.17	-0.34	-0.09
Arsenic (PM_{10})	60	-0.14	-0.17	-0.14	-0.16	0.12	-0.02	-0.16
Benzene	61	0.11	0.04	0.01	0.02	-0.03	0.01	-0.41
1,3-Butadiene	59	0.02	-0.06	-0.09	-0.08	-0.03	0.08	-0.45
Cadmium (PM_{10})	60	0.14	0.09	0.05	0.07	-0.10	-0.14	-0.16
Carbon Tetrachloride	61	0.20	0.24	0.28	0.26	0.22	-0.21	0.01
p-Dichlorobenzene	57	0.40	0.38	0.29	0.33	-0.24	-0.20	-0.31
Formaldehyde	60	0.79	0.78	0.73	0.76	-0.14	-0.27	-0.58
Manganese (PM_{10})	60	-0.08	-0.17	-0.25	-0.21	-0.29	0.29	-0.24
Tetrachloroethylene	60	0.21	0.14	0.10	0.12	-0.08	-0.06	-0.42

Table 17-7. MRL Risk Screening Assessment Summary for the Missouri Monitoring Site

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average[1] (µg/m^3)
S4MO	TO-15	Acrolein	7.00	0/60	0.09	**0.49 ± 0.13**	**0.86 ± 0.27**	**0.99 ± 0.26**	**0.73 ± 0.20**	--	0.78 ± 0.12

BOLD = EPA-designated NATTS Site

BOLD = exceedance of the intermediate or chronic MRL

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations about acrolein in Table 17-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- Each of the seasonal averages of acrolein exceeded the intermediate MRL.
- Acrolein has no chronic MRL. Therefore, a chronic risk comparison could not be conducted.

17.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen for the Missouri monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 17-8. The data from NATA are presented for the census tract where the monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for S4MO is as follows:

- The census tract for S4MO is 29510126700.
- The population for this census tract was 1,997, which represented less than 0.1 percent of the St. Louis City/County population in 2000.

Observations for S4MO from Table 17-8 include the following:

- The pollutants with the highest concentrations according to NATA were dichloromethane, benzene, and acetaldehyde.
- The pollutants with the highest cancer risks according to NATA were benzene, 1,3-butadiene, and acetaldehyde.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (12.81).

Table 17-8. Cancer and Noncancer Risk Summary for the Monitoring Site in Missouri

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration (µg/m^3)	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
St. Louis, Missouri (S4MO) - Census Tract ID 29510126700								
Acetaldehyde	0.000002	0.009	2.42	5.35	0.27	4.06 ± 0.52	8.11	0.45
Acrolein	--	0.00002	0.26	--	12.81	0.78 ± 0.12	--	38.80
Acrylonitrile	0.000068	0.002	<0.01	0.31	<0.01	0.03 ± 0.01	2.29	0.02
Arsenic (PM_{10})	0.0043	0.00003	<0.01	0.48	<0.01	<0.01 ± <0.01	7.86	0.06
Benzene	0.000007	0.03	2.61	20.38	0.08	0.83 ± 0.14	5.83	0.03
1,3-Butadiene	0.00003	0.002	0.25	7.55	0.12	0.09 ± 0.02	2.78	0.05
Cadmium (PM_{10})	0.0018	0.00002	<0.01	3.61	0.10	<0.01 ± <0.01	1.31	0.04
Carbon Tetrachloride	0.000015	0.04	0.21	3.16	0.01	0.58 ± 0.03	8.65	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.29	3.24	<0.01	0.25 ± 0.10	2.70	<0.01
Dichloromethane	0.00000047	1	4.53	2.14	<0.01	0.50 ± 0.12	0.24	<0.01
Formaldehyde	5.5E-09	0.0098	2.29	0.01	0.23	4.57 ± 0.68	0.03	0.47
Hexavalent Chromium	0.012	0.0001	<0.01	3.16	<0.01	<0.01 ± <0.01	0.41	<0.01
Manganese (PM_{10})	--	0.00005	0.03	--	0.51	0.01 ± <0.01	--	0.25
Nickel (PM_{10})	0.00016	0.000065	<0.01	0.25	0.02	<0.01 ± <0.01	0.23	0.02
1,1,2,2-Tetrachloroethane	0.000058	--	0.05	3.14	--	0.06 ± <0.01	3.21	--
Tetrachloroethylene	0.000005	0.27	0.26	1.54	<0.01	0.20 ± 0.04	0.99	<0.01
Trichloroethylene	0.000002	0.6	0.31	0.62	<0.01	0.10 ± 0.02	0.21	<0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

- The pollutants with the highest annual averages were formaldehyde, acetaldehyde, and benzene.

- The pollutants with the highest cancer risk approximations were carbon tetrachloride, acetaldehyde, and arsenic.

- Similar to the NATA results, acrolein was the only pollutant with a noncancer risk approximation greater than 1.0 (38.80).

17.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 17-9 and 17-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 17-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 17-10 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on the site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 17.3, S4MO sampled for VOC, carbonyls, metals (PM_{10}), and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 17-9 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in St. Louis.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, 1,3-butadiene, and hexavalent chromium..

Table 17-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Missouri

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
St. Louis, Missouri (S4MO) – St. Louis City					
Benzene	253.77	Benzene	1.98E-03	Carbon Tetrachloride	8.65
Formaldehyde	158.58	1,3-Butadiene	8.96E-04	Acetaldehyde	8.11
Acetaldehyde	62.08	Hexavalent Chromium	3.70E-04	Arsenic	7.86
1,3-Butadiene	29.85	Arsenic, PM	3.69E-04	Benzene	5.83
Trichloroethylene	27.59	Hydrazine	3.19E-04	1,1,2,2-Tetrachloroethane	3.22
Tetrachloroethylene	18.27	Naphthalene	2.55E-04	1,3-Butadiene	2.78
Dichloromethane	13.23	Acetaldehyde	1.37E-04	*p*-Dichlorobenzene	2.70
Naphthalene	7.49	Nickel, PM	1.12E-04	Acrylonitrile	2.27
POM, Group 2	1.02	Tetrachloroethylene	1.08E-04	Cadmium	1.31
Nickel, PM	0.70	POM, Group 2	5.62E-05	Tetrachloroethylene	0.99

Table 17-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Missouri

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximation Based on Annual Average Concentrations (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
St. Louis, Missouri (S4MO) – St. Louis City					
Toluene	688.47	Acrolein	375,570.89	Acrolein	38.80
Xylenes	452.54	Chlorine	23,771.26	Formaldehyde	0.47
Methanol	445.38	Hydrochloric acid	17,432.98	Acetaldehyde	0.45
Hydrochloric acid	348.66	Formaldehyde	16,181.60	Manganese	0.25
Methyl *tert*-butyl ether	320.40	1,3-Butadiene	14,925.25	Arsenic	0.06
Ethylene glycol	254.80	Nickel, PM	10,794.77	1,3-Butadiene	0.05
Benzene	253.77	Maleic anhydride	9,645.64	Cadmium	0.04
Formaldehyde	158.58	Benzene	8,459.05	Benzene	0.03
Methyl isobutyl ketone	142.85	Acetaldehyde	6,898.31	Nickel	0.02
Ethylbenzene	92.04	Manganese, PM	5,314.87	Acrylonitrile	0.02

- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Carbon tetrachloride was the pollutant with the highest cancer surrogate risk approximation, yet appeared on neither emissions-based list.

- Four of the 10 pollutants with the highest cancer risk approximations, also appear on both emissions-based lists (acetaldehyde, benzene, 1,3-butadiene, and tetrachloroethylene).

Observations from Table 17-10 include the following:

- Toluene, xylenes, and methanol were the highest emitted pollutants with noncancer RfCs in St. Louis.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, chlorine, and hydrochloric acid.

- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Acrolein, which had the highest noncancer risk approximation, also had the highest toxicity-weighted emissions.
- Formaldehyde and benzene appeared on all three lists.

17.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *The pollutants of interest for S4MO were acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, cadmium, carbon tetrachloride, formaldehyde, manganese, p-dichlorobenzene, and tetrachloroethylene.*

- ❖ *Formaldehyde had the highest daily average concentration for S4MO.*

- ❖ *Seasonal averages of acrolein exceeded the intermediate MRL health benchmark.*

18.0 Sites in New Jersey

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at UATMP sites in New Jersey, and integrates these concentrations with emissions, meteorological, and risk information.

18.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. The New Jersey sites are located in several different urban areas. CHNJ, ELNJ, and NBNJ are located in the New York-Northern New Jersey-Long Island, NY-NJ-PA MSA. CANJ is located in the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA. Figures 18-1 through 18-4 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban and rural locations. Figures 18-5 through 18-7 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 18-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

CANJ is located in Camden, which lies just across the Pennsylvania/New Jersey border and Delaware River, east of Philadelphia. Figure 18-1 shows that the monitoring site is located at Whitman Park Field, near the intersection of Davis Street and Copewood Street. The areas west and south of CANJ are residential, while commercial areas are located to the north and east. Heavily traveled roadways, including I-676, are located less than a mile from the monitoring site and a railroad lies less than a half mile from the site. As Figure 18-5 shows, CANJ is located within 10 miles of a number of point sources. Most of the emission sources are located across the border in Pennsylvania. The source category with the largest number of emission sources surrounding CANJ is fuel combustion processes, although there are a number of liquids distribution and surface coating facilities nearby as well.

CHNJ is located in northern New Jersey, west of the New York City metropolitan area. Figure 18-2 shows that CHNJ is located in an open area near Building 1 on the property of Bell

Figure 18-1. Camden, New Jersey (CANJ) Monitoring Site

Scale: 3cm = 100m

Figure 18-2. Chester, New Jersey (CHNJ) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 18-3. Elizabeth, New Jersey (ELNJ) Monitoring Site

©2008 Google/©NAVTECH

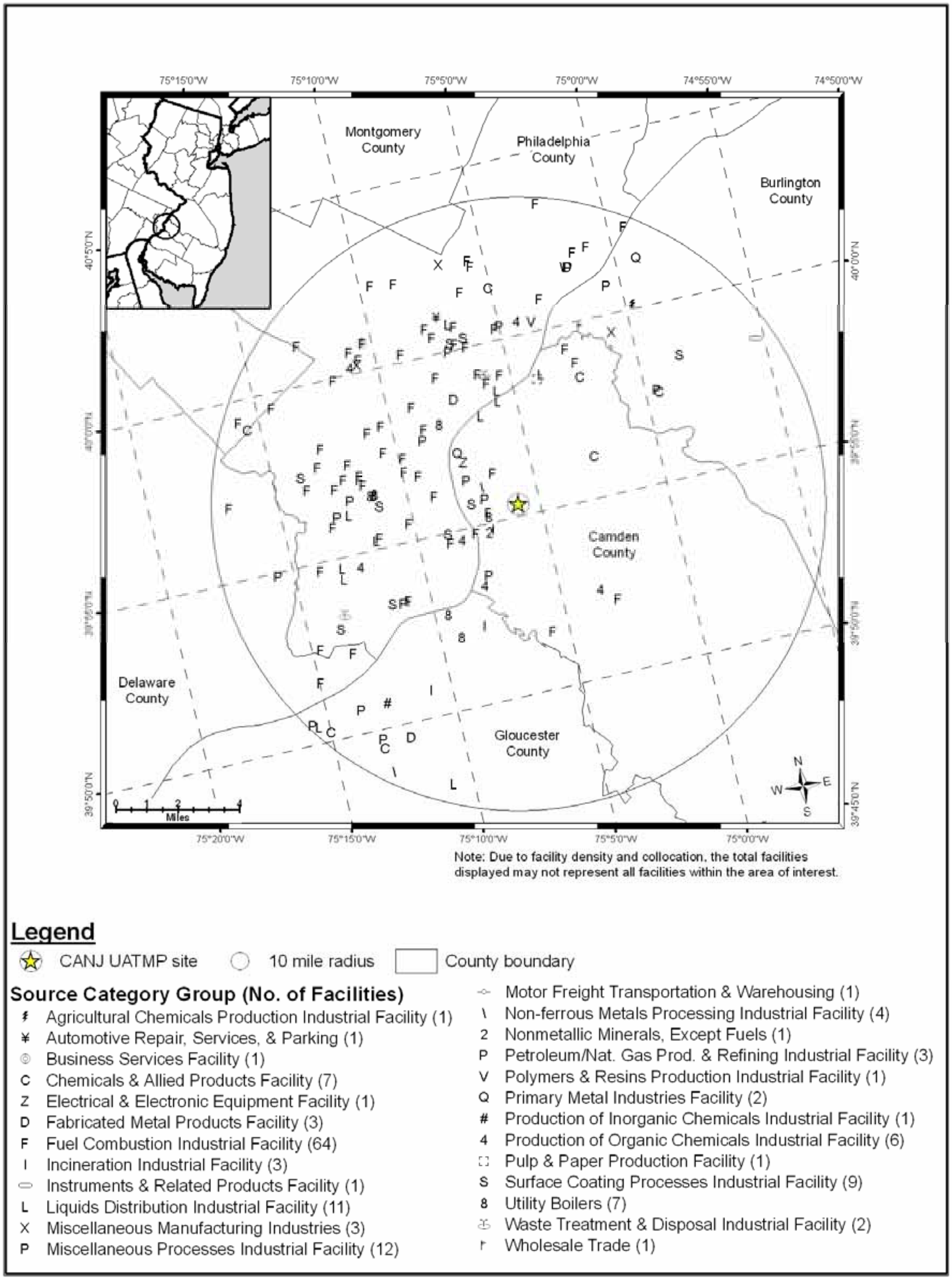
Scale: 3cm = 200m

Figure 18-4. New Brunswick, New Jersey (NBNJ) Monitoring Site

©2008 Google/©NAVTECH

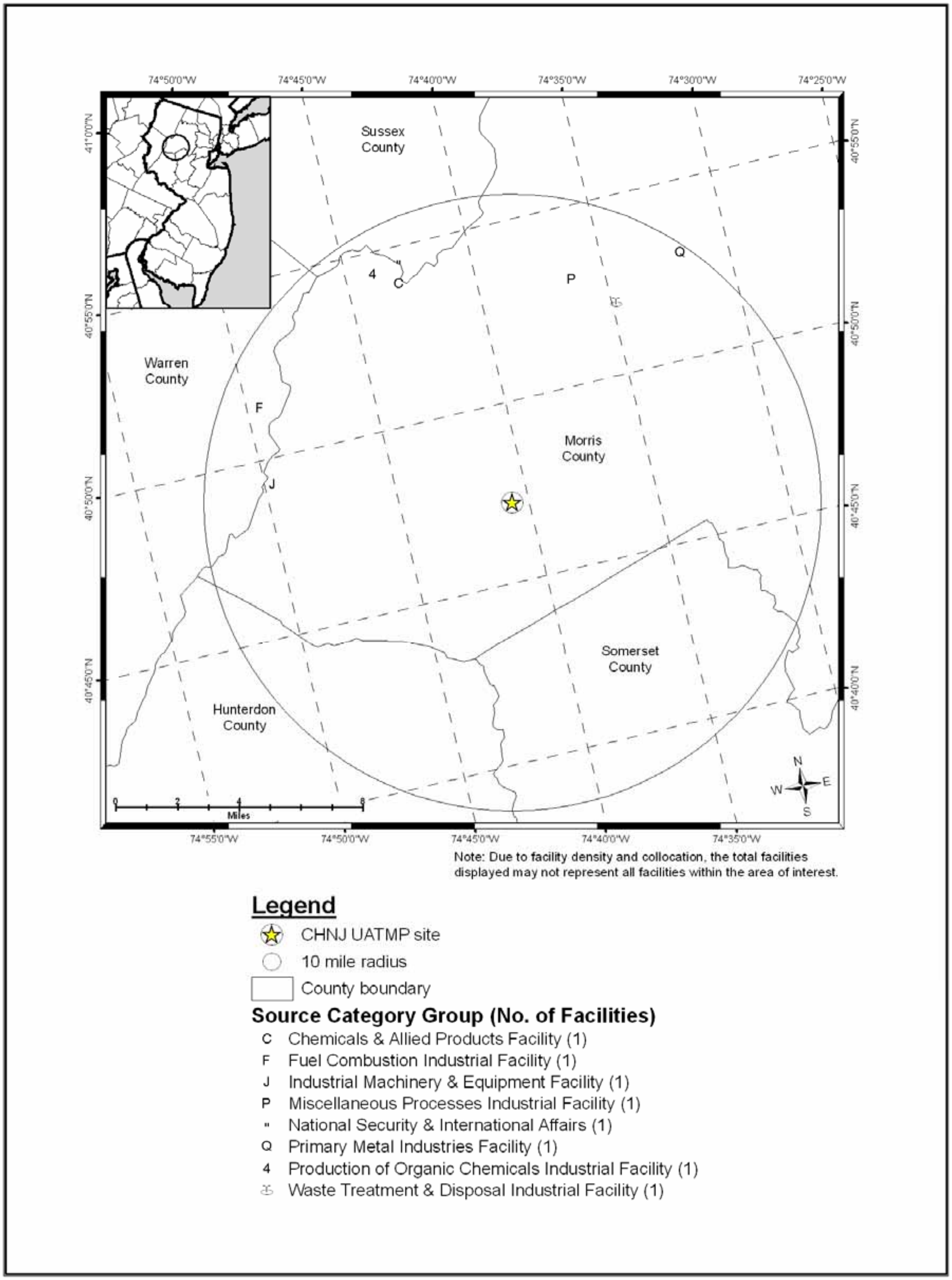
Scale: 3cm = 200m

Figure 18-5. NEI Point Sources Located Within 10 Miles of CANJ



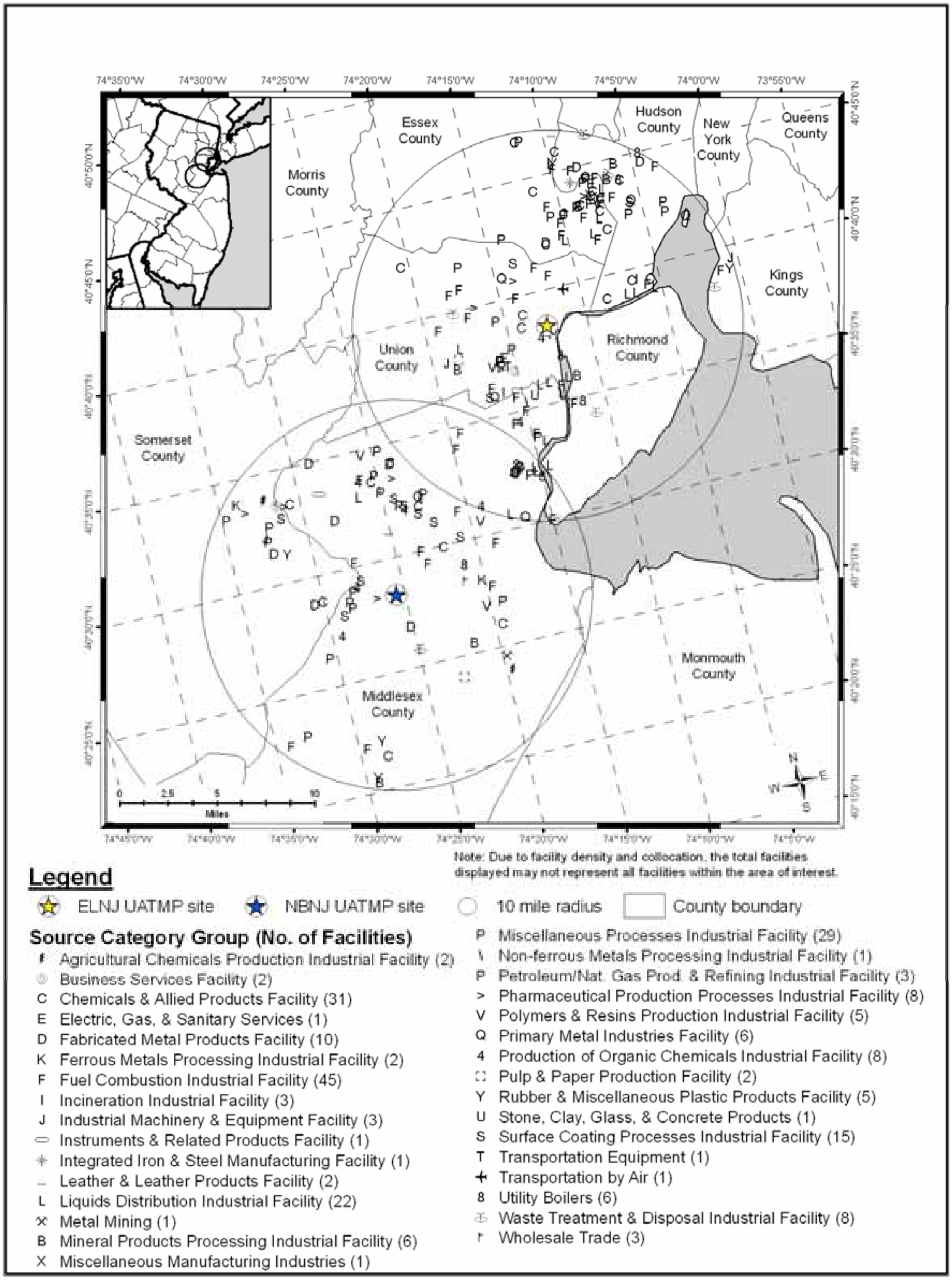
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 18-6. NEI Point Sources Located Within 10 Miles of CHNJ



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 18-7. NEI Point Sources Located Within 10 Miles of ELNJ and NBNJ



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 18-1. Geographical Information for the New Jersey Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
CANJ	34-007-0003	Camden	Camden	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	39.92304, -75.09762	Residential	Suburban	Although this monitoring site in Camden, NJ, is in a residential area, numerous industrial facilities and busy roadways are located within a 10 mile radius. The monitors are situated in a parking lot of a business complex.
CHNJ	34-027-3001	Chester	Morris	New York-Northern New Jersey-Long Island, NY-NJ-PA	40.78763, -74.6763	Agricultural	Rural	The Chester, NJ, site is located in a rural-agricultural, residential section and is topographically rolling. The site is located near Lucent Laboratory Building #1. There is potential population exposure to ozone, NO_2, and SO_2.
ELNJ	34-039-0004	Elizabeth	Union	New York-Northern New Jersey-Long Island, NY-NJ-PA	40.64144, -74.20836	Industrial	Suburban	The Elizabeth site is located in Union County, NJ, at an urban-industrial site where the topography is relatively smooth. The monitoring site is located 75 yards away from the Toll Plaza and about one mile from Bayway Refinery. The neighborhood scale is at maximum concentration. The location has a PM_{10} filter analyzer for sulfates and nitrates as well as the UATMP site.
NBNJ	34-023-0006	New Brunswick	Middlesex	New York-Northern New Jersey-Long Island, NY-NJ-PA	40.47279, -74.42251	Agricultural	Rural	The New Brunswick site is located in a suburban-agricultural, residential area and is topographically smooth. The actual site location is in Rutgers University's Horticultural Farm.

Labs, which is owned by Alcatel-Lucent. The surrounding area is rural and agricultural with a rolling topography, but surrounded by small neighborhoods. Although the location is considered part of the New York City MSA, the site's location is clearly outside most of the urbanized areas. As Figure 18-6 shows, only eight emission sources are located nearby, most of which lie just within the 10 mile radius from the site.

ELNJ is located in the city of Elizabeth, New Jersey, which lies just south of Newark and west of Newark Bay and Staten Island, New York. As Figure 18-3 shows, the monitoring site is located just off Exit 13 of the New Jersey Turnpike (I-95), near the toll plaza. Interstate 278 intersects the Turnpike here as well. The surrounding area is highly industrialized, with the Bayway oil refinery located just southwest of the site. However, residential neighborhoods are located to the northwest of the site. As Figure 18-7 shows, the majority of emission sources in the vicinity are involved in fuel combustion processes, chemical and allied products production, and liquid distribution. The emission sources closest to the site, which are partially covered by the star marker for ELNJ, are involved in organic chemical production, petroleum and natural gas production and refining, and liquids distribution.

NBNJ is located in New Brunswick, about 20 miles southwest of Elizabeth. The monitoring site is located on the property of Rutgers University's Cook-Douglass campus, on a horticultural farm. The surrounding area is agricultural and rural, although residential neighborhoods are located to the east, across a branch of the Raritan River, as shown in Figure 18-4. US-1 and State Highway 617 intersect just west of the site. Figure 18-7 shows that the outer portions of NBNJ and ELNJ's 10 mile radii intersect. The emission source in closest proximity to the NBNJ monitoring site is involved in pharmaceutical production processes.

Table 18-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the New Jersey monitoring sites. County-level vehicle registration data for Union, Morris, Camden, and Middlesex Counties were not available from the State of New Jersey. Thus, state-level vehicle registration, which was obtained from the Energy Information Administration (EIA), was

Table 18-2. Population, Motor Vehicle, and Traffic Information for the New Jersey Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
CANJ	513,769	371,045	0.69	2,003,209	1,374,075	4,633	106,558
CHNJ	488,475	353,934	0.69	242,969	166,661	18,360	299,706
ELNJ	524,658	381,155	0.69	2,183,873	1,497,998	200,000	299,706
NBNJ	788,629	564,799	0.69	788,786	541,057	63,326	299,706

[1] Daily Average Traffic Data reflects 2005/2007 data from the New Jersey DOT (CANJ), 2005 data from the New Jersey DOT (CHNJ), data from the New Jersey Turnpike webpage (ELNJ), and 2005 data from the New Jersey DOT (NBNJ)

allocated to the county level using the county-level proportion of the state population. County-level population information in these counties was obtained from the U.S. Census Bureau. Table 18-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 18-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 18-2 presents the daily VMT for each urban area.

Observations from Table 18-2 include the following:

- Middlesex County, where NBNJ is located, had the highest county population of the New Jersey sites. But ELNJ had the highest 10-mile population among the New Jersey sites.

- Compared to monitoring sites in other locations, the county-level populations were in the middle of the range. However, ELNJ had the third highest 10-mile population, behind only BXNY and CELA. CANJ had the fifth highest 10-mile population. The other program sites' 10-mile populations were in the middle of the range.

- The estimated county-level vehicle ownership values were fairly similar across the New Jersey sites. The registration estimates were in the middle of the range compared to other program sites.

- Compared to other program sites, ELNJ had the second highest 10-mile vehicle ownership estimate, behind only CELA, while CANJ had the fourth highest 10-mile population.

- Of the New Jersey sites, ELNJ experienced a significantly higher average traffic volume than the other program sites, while CANJ experienced the least. Traffic data for ELNJ were obtained from I-95, between Exit 11 and 14; traffic data for CANJ were obtained from Sheridan Street between Norris Street and Pershing Street; traffic data for CHNJ were obtained from Main Street between Collis Lane and Oakdale Road; and traffic data for NBNJ were obtained from US-1 near State Road 617 (Ryders Lane).

- VMT for the New York City metropolis ranked first among all urban areas with UATMP or NATTS sites (and among all U.S. urban areas). The VMT for the Philadelphia area ranked sixth.

18.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in New Jersey on sampling days, as well as over the course of the year.

18.2.1 Climate Summary

Frontal systems push across New Jersey fairly regularly, producing variable weather. However, the state’s proximity to the Atlantic Ocean has a moderating effect on temperature. Summers along the coast tend to be cooler than areas farther inland, while winters tend to be warmer. New Jersey’s mid-Atlantic location also allows for ample annual precipitation and high humidity. A southwesterly wind is most common in the summer and a northwesterly wind is typical in the winter (Ruffner and Bair, 1987).

18.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The three closest NWS weather stations are located at Philadelphia International (near CANJ), Somerville-Somerset Airport (near CHNJ and NBNJ), and Newark International Airport (near ELNJ), WBAN 13739, 54785, and 14734, respectively.

Table 18-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 18-3 is the 95 percent confidence interval for each parameter. As shown in Table 18-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

18.2.3 Composite Back Trajectories for Sampling Days

Figures 18-8 through 18-11 are composite back trajectory maps for the New Jersey monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 18-8 through 18-11 represents 100 miles.

Observations from Figures 18-8 through 18-11 include the following:

- Due to their fairly close proximity to each other and standardization of sampling days, the composite trajectories for the New Jersey sites are fairly similar to each other.
- Back trajectories originated from a variety of directions at the sites, although less frequently from the east and southeast. The predominant direction of trajectory origin was from the southwest and northwest.
- The 24-hour air shed domains were somewhat larger for these sites than for other monitoring sites. The furthest away a trajectory originated was the Gulf of St. Lawrence, north of New Brunswick, Canada, or nearly 800 miles away. However, most trajectories originated within 500 miles of the sites.

18.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations at the Philadelphia International (for CANJ), Somerville-Somerset (for CHNJ and NBNJ), and Newark International Airports (for ELNJ) were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 18-12 through 18-15 are the wind roses for the New Jersey monitoring sites on days that samples were collected.

Table 18-3. Average Meteorological Conditions near the New Jersey Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CANJ	Philadelphia Intl Airport 13739	Sampling Day	64.75 ± 4.93	57.11 ± 4.63	43.56 ± 5.06	50.61 ± 4.30	63.74 ± 3.62	1017.93 ± 1.70	7.77 ± 0.82
		All 2007	64.25 ± 2.02	56.31 ± 1.85	42.00 ± 2.00	49.51 ± 1.69	62.15 ± 1.52	1017.60 ± 0.74	8.15 ± 0.33
CHNJ	Somerville, New Jersey/ Somerset Airport 54785	Sampling Day	63.15 ± 4.93	53.24 ± 4.56	42.07 ± 4.88	47.95 ± 4.28	69.55 ± 3.45	1017.59 ± 1.61	3.00 ± 0.56
		All 2007	62.95 ± 2.02	52.73 ± 1.81	41.01 ± 2.00	47.30 ± 1.71	68.26 ± 1.41	1016.73 ± 0.75	3.38 ± 0.24
ELNJ	Newark International Airport 14734	Sampling Day	63.34 ± 4.92	55.85 ± 4.66	41.66 ± 4.89	49.09 ± 4.22	61.82 ± 3.47	1017.47 ± 1.64	8.13 ± 0.82
		All 2007	62.98 ± 1.99	55.30 ± 1.86	39.99 ± 1.97	48.12 ± 1.67	59.55 ± 1.46	1016.90 ± 0.76	8.51 ± 0.33
NBNJ	Somerville, New Jersey/ Somerset Airport 54785	Sampling Day	64.46 ± 4.67	54.49 ± 4.33	43.46 ± 4.68	49.18 ± 4.09	70.00 ± 3.35	1017.15 ± 1.55	3.00 ± 0.54
		All 2007	62.95 ± 2.02	52.73 ± 1.81	41.01 ± 2.00	47.30 ± 1.71	68.26 ± 1.41	1016.73 ± 0.75	3.38 ± 0.24

Figure 18-8. Composite Back Trajectory Map for CANJ

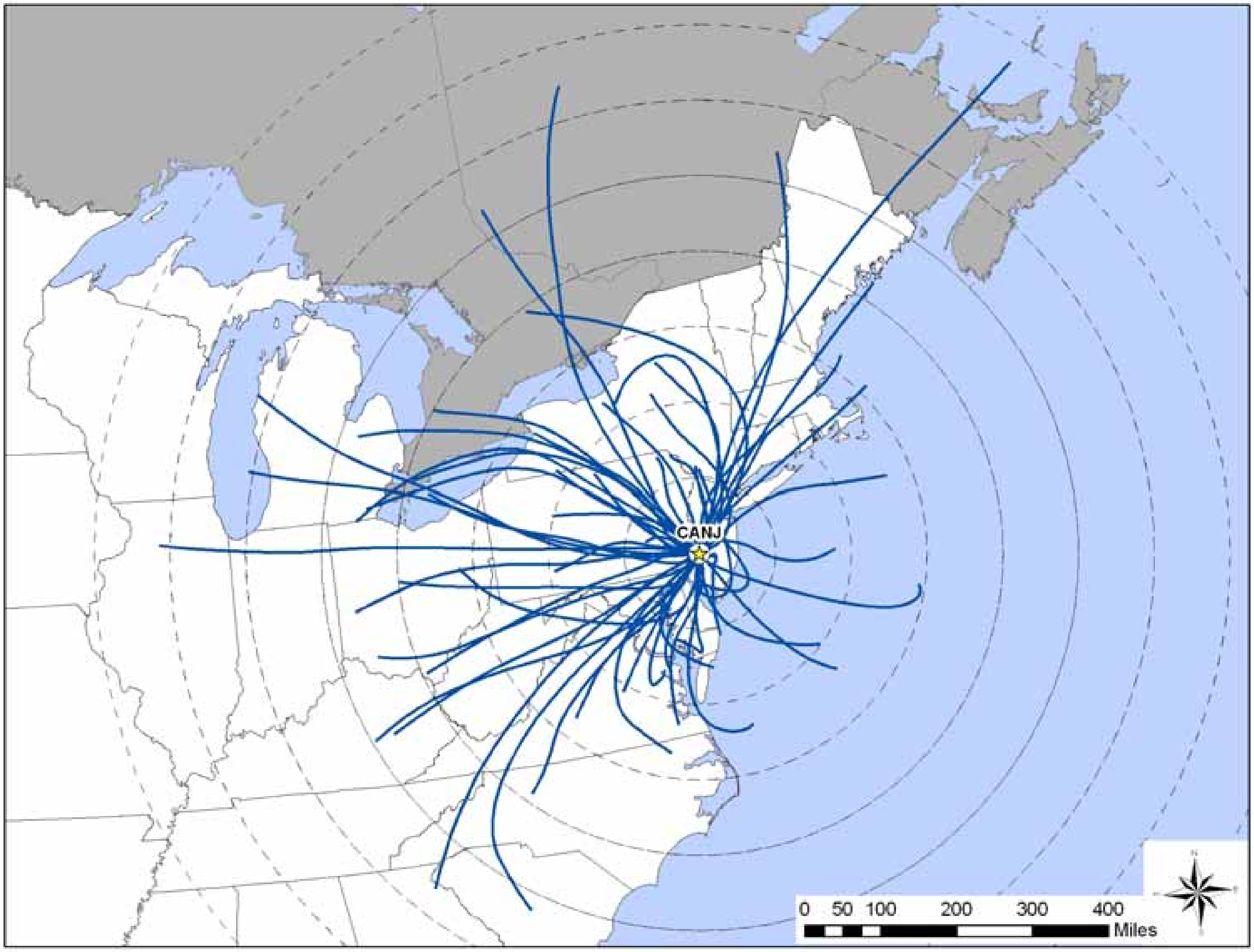


Figure 18-9. Composite Back Trajectory Map for CHNJ

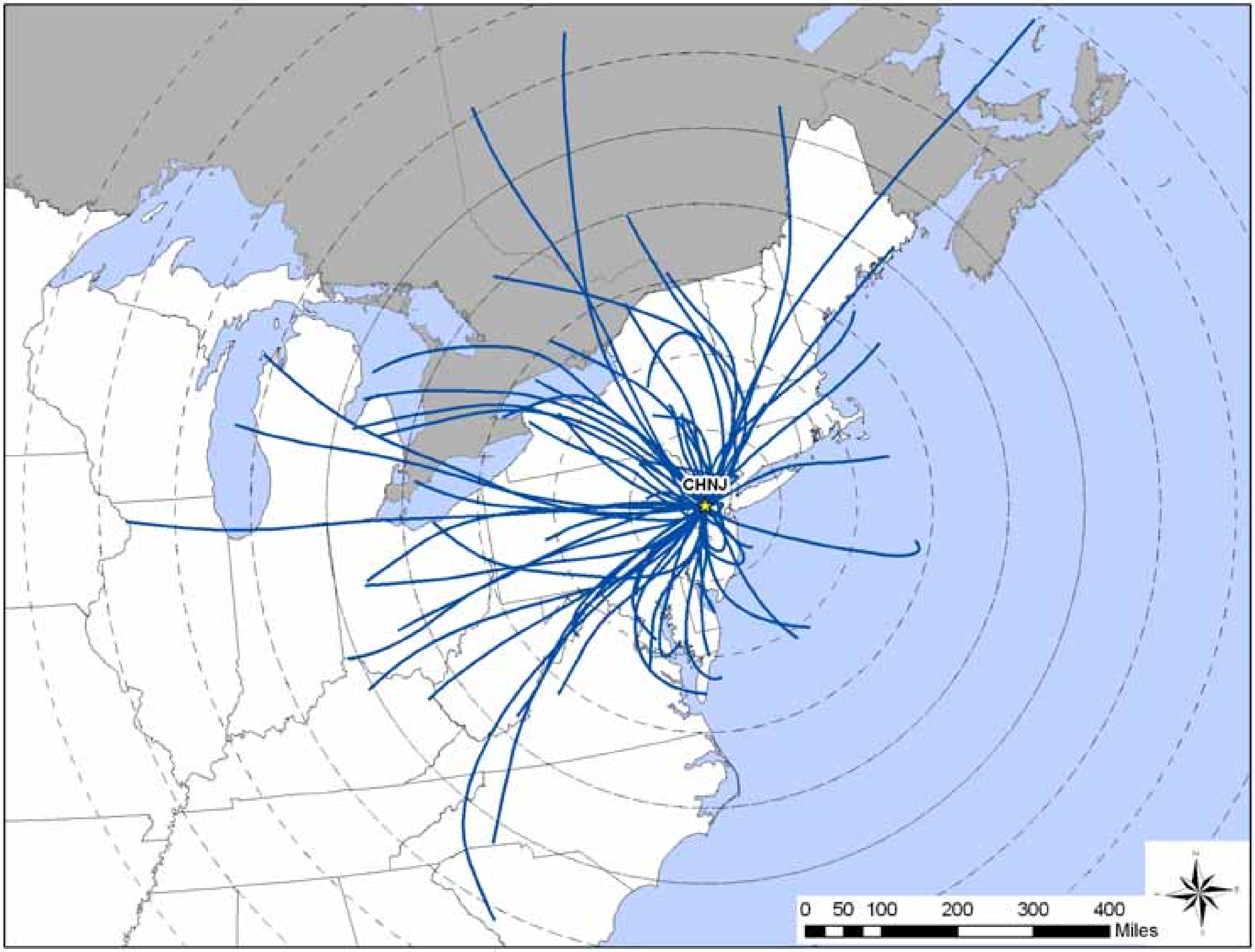


Figure 18-10. Composite Back Trajectory Map for ELNJ

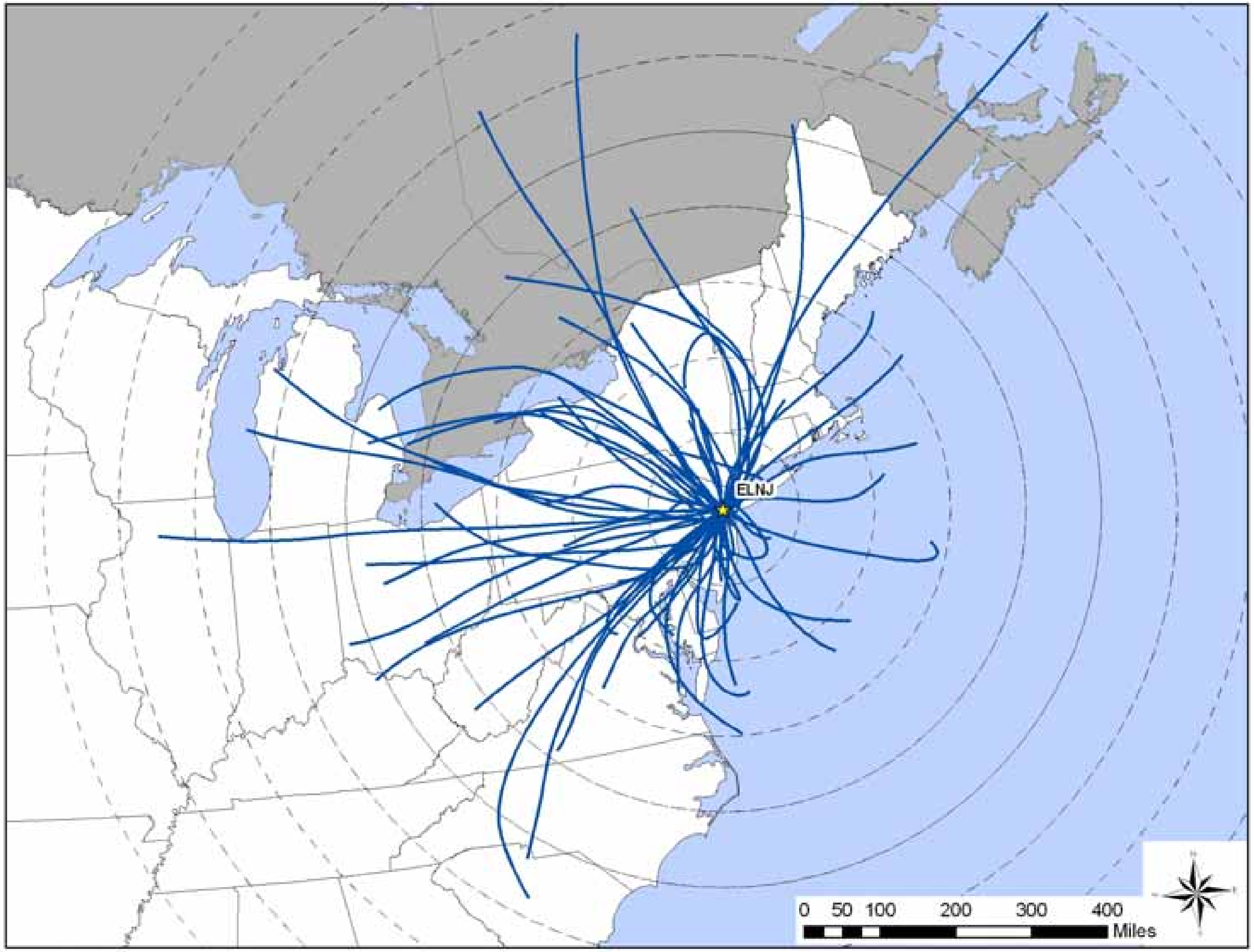


Figure 18-11. Composite Back Trajectory Map for NBNJ

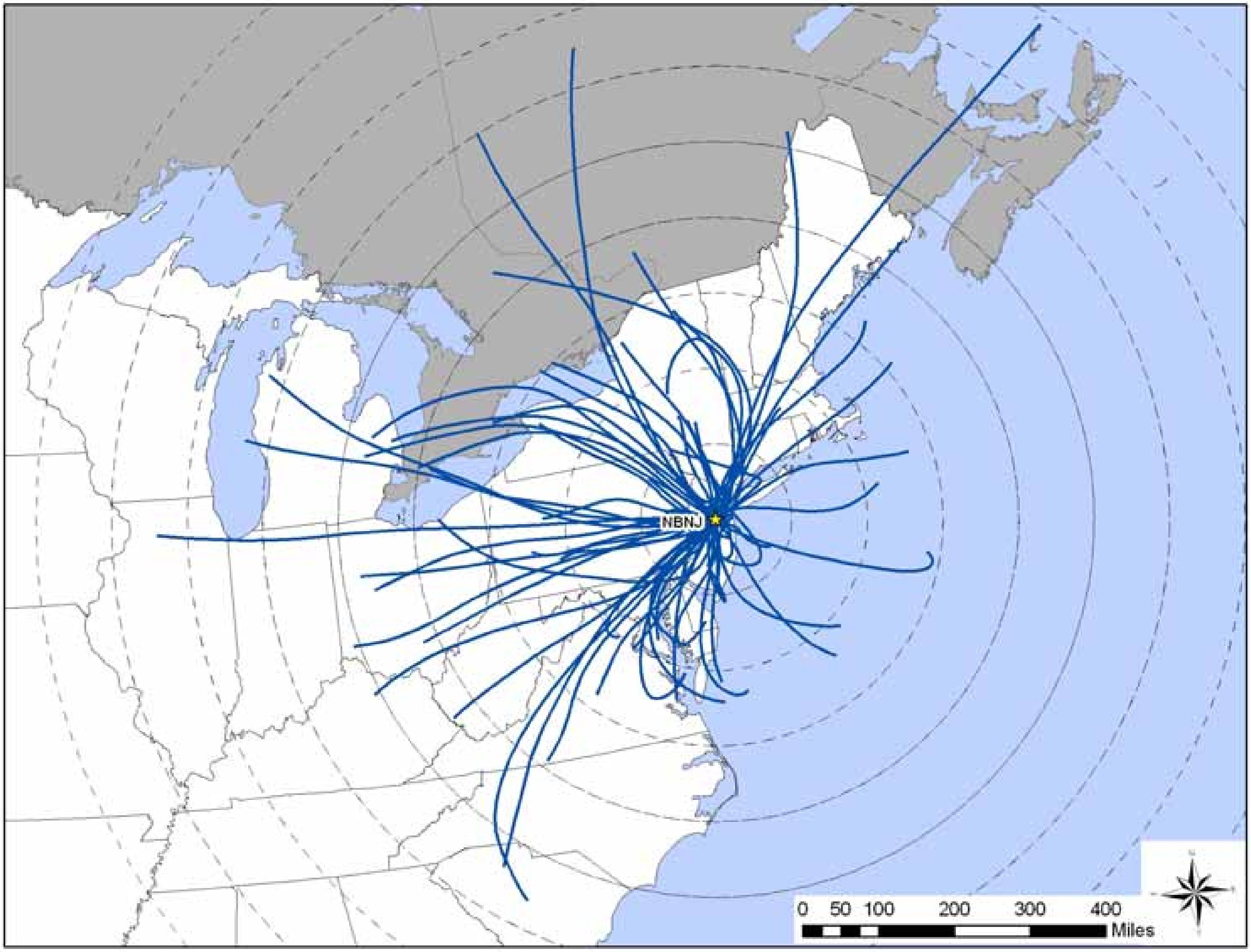


Figure 18-12. Wind Rose for CANJ Sampling Days

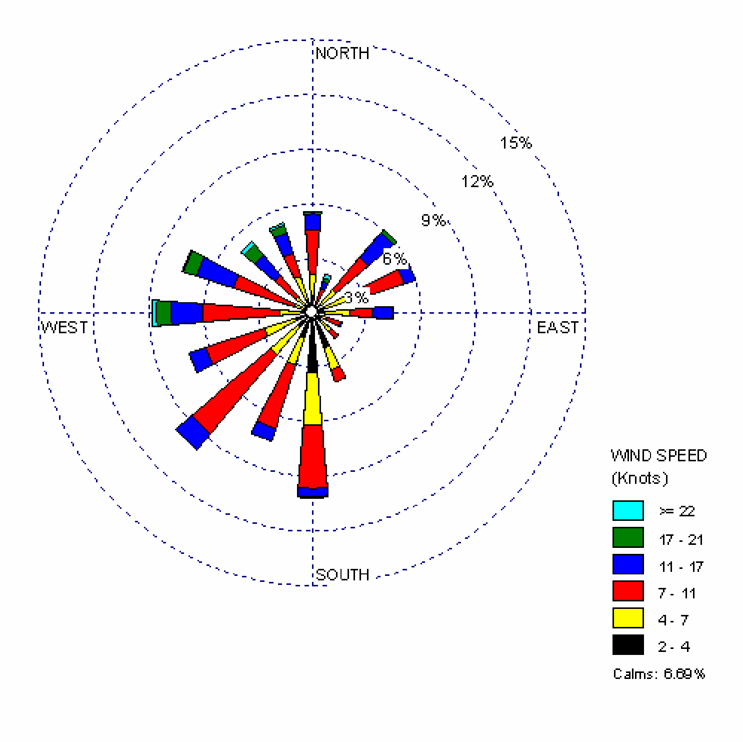


Figure 18-13. Wind Rose for CHNJ Sampling Days

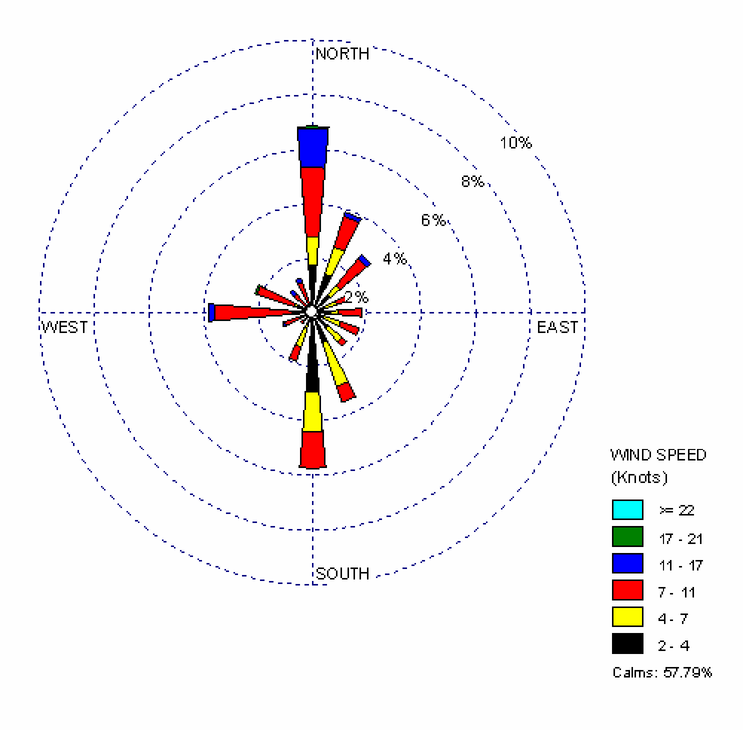


Figure 18-14. Wind Rose for ELNJ Sampling Days

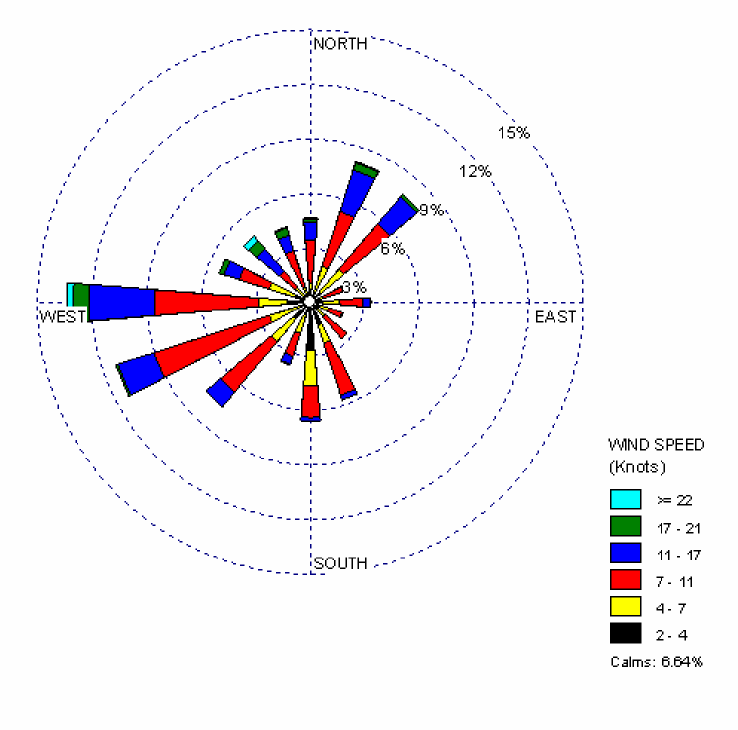
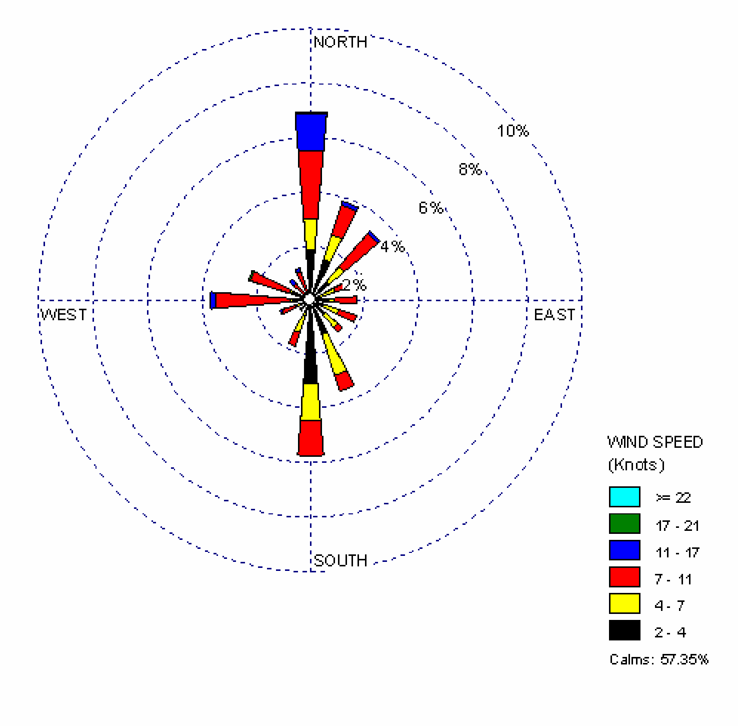


Figure 18-15. Wind Rose for NBNJ Sampling Days



Observations from Figure 18-12 for CANJ include the following:

- Winds from a variety of directions were observed near CANJ, although infrequently from the southeast. Southerly, southwesterly, and westerly winds were frequently recorded.
- The wind rose shows that calm winds were observed for less than seven percent of observations.
- Wind speeds greater than 11 knots were observed for nearly 20 percent of observations, and were most frequently observed with westerly and northwesterly winds.

Observations from Figures 18-13 and 18-15 for CHNJ and NBNJ include the following:

- The wind roses for CHNJ and NBNJ are fairly similar. This is expected given that the wind data is from the same weather station and the similarity in sampling days between the sites.
- The wind roses for these sites show that calm winds were observed for nearly 60 percent of observations.
- Northerly and southerly winds were observed more frequently than winds from other directions.
- Wind speeds greater than 11 knots were observed for less than three percent of observations.

Observations from Figure 18-14 for ELNJ include the following:

- The wind rose for ELNJ is somewhat similar to the wind rose for CANJ.
- Winds from a variety of directions were observed near ELNJ, although infrequently from the southeast. Westerly and southwesterly winds were frequently observed near ELNJ, as were northeasterly winds.
- Calm winds were observed for less than seven percent of observations.
- Wind speeds greater than 11 knots were observed for 21 percent of observations, and were most frequently observed with westerly and northwesterly winds.

18.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the New

Jersey monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 18-4 presents the pollutants that failed at least one screen for each New Jersey monitoring site and highlights each site's pollutants of interest (shaded). All four New Jersey monitoring sites sampled for VOC and carbonyl compounds.

Table 18-4. Comparison of Measured Concentrations and EPA Screening Values for the New Jersey Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Camden, New Jersey - CANJ					
Acetaldehyde	57	57	100.00	12.58	12.58
Carbon Tetrachloride	57	57	100.00	12.58	25.17
Benzene	57	57	100.00	12.58	37.75
Formaldehyde	57	57	100.00	12.58	50.33
Acrolein	57	57	100.00	12.58	62.91
1,3-Butadiene	55	57	96.49	12.14	75.06
Tetrachloroethylene	45	57	78.95	9.93	84.99
p-Dichlorobenzene	42	57	73.68	9.27	94.26
Bromomethane	14	57	24.56	3.09	97.35
Trichloroethylene	4	47	8.51	0.88	98.23
Dichloromethane	3	57	5.26	0.66	98.90
Acrylonitrile	2	2	100.00	0.44	99.34
1,2-Dichloroethane	1	1	100.00	0.22	99.56
1,1,2,2-Tetrachloroethane	1	1	100.00	0.22	99.78
Hexachloro-1,3-butadiene	1	1	100.00	0.22	100.00
Total	453	622	72.83		
Chester, New Jersey - CHNJ					
Acetaldehyde	54	55	98.18	17.88	17.88
Formaldehyde	52	55	94.55	17.22	35.10
Benzene	51	52	98.08	16.89	51.99
Acrolein	51	51	100.00	16.89	68.87
Carbon Tetrachloride	50	51	98.04	16.56	85.43
1,3-Butadiene	17	38	44.74	5.63	91.06
Tetrachloroethylene	14	49	28.57	4.64	95.70
Acrylonitrile	7	8	87.50	2.32	98.01
p-Dichlorobenzene	3	30	10.00	0.99	99.01
Hexachloro-1,3-butadiene	2	2	100.00	0.66	99.67
Dichloromethane	1	51	1.96	0.33	100.00
Total	302	442	68.33		

Table 18-4. Comparison of Measured Concentrations and EPA Screening Values for the New Jersey Monitoring Sites (Continued)

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Elizabeth, New Jersey - ELNJ					
Acrolein	61	61	100.00	13.96	13.96
Carbon Tetrachloride	61	61	100.00	13.96	27.92
Benzene	61	61	100.00	13.96	41.88
1,3-Butadiene	59	61	96.72	13.50	55.38
Formaldehyde	56	56	100.00	12.81	68.19
Acetaldehyde	56	56	100.00	12.81	81.01
Tetrachloroethylene	45	60	75.00	10.30	91.30
p-Dichlorobenzene	32	54	59.26	7.32	98.63
Dichloromethane	3	61	4.92	0.69	99.31
Acrylonitrile	1	1	100.00	0.23	99.54
1,2-Dichloroethane	1	1	100.00	0.23	99.77
Trichloroethylene	1	38	2.63	0.23	100.00
Total	437	571	76.53		
New Brunswick, New Jersey - NBNJ					
Acetaldehyde	61	61	100.00	15.37	15.37
Carbon Tetrachloride	60	60	100.00	15.11	30.48
Benzene	60	60	100.00	15.11	45.59
Acrolein	60	60	100.00	15.11	60.71
Formaldehyde	57	61	93.44	14.36	75.06
1,3-Butadiene	40	54	74.07	10.08	85.14
Tetrachloroethylene	32	58	55.17	8.06	93.20
p-Dichlorobenzene	18	51	35.29	4.53	97.73
Acrylonitrile	4	4	100.00	1.01	98.74
Dichloromethane	2	60	3.33	0.50	99.24
1,2-Dichloroethane	2	4	50.00	0.50	99.75
Bromomethane	1	60	1.67	0.25	100.00
Total	397	593	66.95		

Observations from Table 18-4 include the following:

- Fifteen pollutants failed at least one screen for CANJ; 11 failed screens for CHNJ; and 12 failed screens for ELNJ and NBNJ.
- The following seven pollutants of interest were common to all sites: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and tetrachloroethylene.
- Of the seven common pollutants of interest, 100 percent of the measured detections of acrolein failed screens for all four sites. If CHNJ is excluded, benzene, carbon tetrachloride, and acetaldehyde also failed 100 percent of the screens for the remaining three sites.

- The total failure rate ranged from 66.95 percent for NBNJ to 76.53 percent for ELNJ (of the pollutants with at least one failed screen).

18.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the New Jersey monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the sites, where applicable.

18.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 18-5, where applicable.

Observations for CANJ from Table 18-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (3.78 ± 0.52 $\mu g/m^3$), acetaldehyde (2.19 ± 0.22 $\mu g/m^3$), and benzene (1.04 ± 0.14 $\mu g/m^3$).

- As shown in Tables 4-9 and 4-11, of the program-level pollutants of interest, CANJ had the ninth highest daily average concentration of formaldehyde, acrolein, and *p*-dichlorobenzene.

- Concentrations of most of the pollutants of interest for CANJ did not vary significantly from season to season. However, concentrations of formaldehyde were highest during the summer.

Table 18-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Camden, New Jersey - CANJ								
Acetaldehyde	57	57	2.19 ± 0.22	1.70 ± 0.29	2.27 ± 0.40	2.62 ± 0.42	2.04 ± 0.48	2.19 ± 0.22
Acrolein	57	57	0.87 ± 0.18	0.58 ± 0.25	0.63 ± 0.17	0.99 ± 0.20	1.27 ± 0.60	0.87 ± 0.18
Benzene	57	57	1.04 ± 0.14	1.08 ± 0.31	0.84 ± 0.16	0.87 ± 0.15	1.42 ± 0.36	1.04 ± 0.14
Bromomethane	57	57	0.52 ± 0.22	0.75 ± 0.62	0.83 ± 0.53	0.14 ± 0.06	0.40 ± 0.26	0.52 ± 0.22
1,3-Butadiene	57	57	0.10 ± 0.02	0.11 ± 0.02	0.08 ± 0.01	0.08 ± 0.02	0.14 ± 0.06	0.10 ± 0.02
Carbon Tetrachloride	57	57	0.55 ± 0.04	0.45 ± 0.10	0.56 ± 0.09	0.58 ± 0.08	0.59 ± 0.05	0.55 ± 0.04
p-Dichlorobenzene	57	57	0.19 ± 0.03	0.11 ± 0.03	0.16 ± 0.05	0.22 ± 0.05	0.24 ± 0.07	0.19 ± 0.03
Formaldehyde	57	57	3.78 ± 0.52	2.33 ± 0.28	3.56 ± 0.66	5.60 ± 1.18	3.19 ± 0.70	3.78 ± 0.52
Tetrachloroethylene	57	57	0.29 ± 0.04	0.27 ± 0.08	0.24 ± 0.05	0.28 ± 0.06	0.37 ± 0.10	0.29 ± 0.04
Chester, New Jersey - CHNJ								
Acetaldehyde	55	55	1.28 ± 0.12	1.16 ± 0.15	1.30 ± 0.24	1.24 ± 0.23	1.40 ± 0.28	1.28 ± 0.12
Acrolein	51	52	0.66 ± 0.17	0.37 ± 0.14	0.48 ± 0.12	1.04 ± 0.35	0.66 ± 0.42	*NA*
Benzene	52	52	0.47 ± 0.06	0.54 ± 0.14	0.45 ± 0.12	0.40 ± 0.11	0.50 ± 0.10	*NA*
1,3-Butadiene	38	52	0.03 ± 0.01	0.04 ± 0.02	0.02 ± <0.01	0.02 ± 0.01	0.04 ± 0.01	*NA*
Carbon Tetrachloride	51	52	0.55 ± 0.05	0.48 ± 0.08	0.51 ± 0.11	0.62 ± 0.07	0.54 ± 0.10	NA
Formaldehyde	55	55	2.32 ± 0.51	1.39 ± 0.20	1.83 ± 0.51	2.59 ± 0.44	3.35 ± 1.58	2.32 ± 0.51
Tetrachloroethylene	49	52	0.15 ± 0.03	0.12 ± 0.02	0.17 ± 0.09	0.15 ± 0.06	0.15 ± 0.04	*NA*

NA = completeness was less than 85 percent for VOC for CHNJ

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 18-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites (Continued)

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Elizabeth, New Jersey - ELNJ								
Acetaldehyde	56	56	5.84 ± 0.88	3.26 ± 1.04	4.35 ± 1.03	8.70 ± 1.41	6.72 ± 1.97	5.84 ± 0.88
Acrolein	61	61	0.76 ± 0.13	0.59 ± 0.19	0.50 ± 0.13	1.03 ± 0.35	0.85 ± 0.17	0.76 ± 0.13
Benzene	61	61	1.09 ± 0.18	1.23 ± 0.23	0.87 ± 0.20	0.84 ± 0.17	1.50 ± 0.56	1.09 ± 0.18
1,3-Butadiene	61	61	0.14 ± 0.02	0.19 ± 0.06	0.10 ± 0.02	0.10 ± 0.02	0.17 ± 0.06	0.14 ± 0.02
Carbon Tetrachloride	61	61	0.53 ± 0.04	0.44 ± 0.10	0.54 ± 0.10	0.56 ± 0.08	0.57 ± 0.05	0.53 ± 0.04
p-Dichlorobenzene	54	61	0.14 ± 0.03	0.09 ± 0.03	0.10 ± 0.04	0.16 ± 0.06	0.15 ± 0.04	0.12 ± 0.02
Formaldehyde	56	56	4.69 ± 0.65	3.76 ± 0.76	5.61 ± 1.17	5.87 ± 1.17	2.39 ± 0.94	4.69 ± 0.65
Tetrachloroethylene	60	61	0.32 ± 0.05	0.29 ± 0.09	0.28 ± 0.08	0.31 ± 0.09	0.39 ± 0.16	0.31 ± 0.05
New Brunswick, New Jersey - NBNJ								
Acetaldehyde	61	61	1.55 ± 0.18	1.36 ± 0.22	1.19 ± 0.28	2.03 ± 0.37	1.46 ± 0.28	1.55 ± 0.18
Acrolein	60	60	0.53 ± 0.09	0.39 ± 0.09	0.43 ± 0.16	0.54 ± 0.09	0.73 ± 0.26	0.53 ± 0.09
Benzene	60	60	0.56 ± 0.08	0.73 ± 0.26	0.44 ± 0.07	0.47 ± 0.07	0.64 ± 0.16	0.56 ± 0.08
1,3-Butadiene	54	60	0.06 ± 0.01	0.09 ± 0.05	0.04 ± 0.01	0.04 ± 0.01	0.06 ± 0.02	0.06 ± 0.01
Carbon Tetrachloride	60	60	0.58 ± 0.04	0.43 ± 0.09	0.59 ± 0.05	0.66 ± 0.06	0.59 ± 0.07	0.58 ± 0.04
p-Dichlorobenzene	51	60	0.08 ± 0.01	NR	0.06 ± 0.02	0.10 ± 0.02	0.08 ± 0.02	0.08 ± 0.01
Formaldehyde	61	61	2.13 ± 0.30	1.92 ± 0.34	1.50 ± 0.29	3.14 ± 0.69	1.62 ± 0.29	2.13 ± 0.30
Tetrachloroethylene	58	60	0.23 ± 0.04	0.21 ± 0.09	0.17 ± 0.04	0.24 ± 0.06	0.26 ± 0.11	0.22 ± 0.04

NA = completeness was less than 85 percent for VOC for CHNJ

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for CHNJ from Table 18-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (2.32 ± 0.51 µg/m^3), acetaldehyde (1.28 ± 0.12 µg/m^3), and acrolein (0.66 ± 0.17 µg/m^3).

- None of the pollutants of interest for CHNJ appeared in Table 4-9 or Table 4-11, indicating that the daily averages of these pollutants were not among the 10 highest concentrations.

- Annual averages were not calculated for VOC at CHNJ. This is because this site did not meet the 85 percent completeness criteria discussed in Section 2.4.

- Concentrations of most of the pollutants of interest for CHNJ did not vary significantly from season to season. Concentrations of formaldehyde appear higher during the summer and fall, but the confidence intervals indicate that the difference was not significant.

Observations for ELNJ from Table 18-5 include the following:

- The pollutants with the highest daily average concentrations by mass were acetaldehyde (5.84 ± 0.88 $\mu g/m^3$), formaldehyde (4.69 ± 0.65 $\mu g/m^3$), and benzene (1.09 ± 0.18 $\mu g/m^3$). These averages were the highest among the New Jersey sites.

- As shown in Tables 4-9 and 4-11, of the program-level pollutants of interest, ELNJ had the second highest daily average concentration of acetaldehyde; the fourth highest daily average concentration of formaldehyde; and the tenth highest daily average concentration of benzene.

- Concentrations of most of the pollutants of interest for ELNJ did not vary significantly from season to season. However, concentrations of acetaldehyde were highest during the summer and autumn and concentrations of 1,3-butadiene were highest in autumn and winter.

Observations for NBNJ from Table 18-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (2.13 ± 0.30 $\mu g/m^3$), acetaldehyde (1.55 ± 0.18 $\mu g/m^3$), and carbon tetrachloride (0.58 ± 0.04 $\mu g/m^3$).

- Similar to CHNJ, none of the pollutants of interest for NBNJ appeared in Table 4-9 or Table 4-11, indicating that the daily averages of these pollutants were not among the 10 highest concentrations.

- Concentrations of most of the pollutants of interest for NBNJ did not vary significantly from season to season. However, concentrations of formaldehyde were highest during the summer.

18.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. The New Jersey sites have sampled VOC and carbonyls under the UATMP for many years. CHNJ and NBNJ have sampled since 2001; ELNJ since 2000; and CANJ since 1994. Figures 18-16 through 18-30 present the three-year rolling statistical metrics graphically for benzene, 1,3-butadiene, and formaldehyde for each monitoring site. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Observations from Figure 18-16 for benzene measurements at CANJ include the following:

- The maximum benzene concentration shown was measured in 1996 and was more than twice the next highest maximum concentration (measured in 2001).
- Although the range of concentrations measured varies, the rolling average concentrations vary between 0.35 and 0.70 ppbv. A slight decreasing trend in the average and median concentrations is evident beginning around the 1997-1999 time frame through the last time period.
- One non-detect was recorded in 2002, which explains why the minimum concentration decreased to zero for three of the time frames shown.

Observations from Figure 18-17 for 1,3-butadiene measurements at CANJ include the following:

- The highest concentration of 1,3-butadiene was measured in 1994.
- The minimum and first quartile were both zero for all time frames except 2005-2007, which explains why the “box” rests on the x-axis for most of the plot. The median decreased to zero for the 2002-2004 and 2003-2005 time frames.
- Even as the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant hovered around 60 percent until 2000-2002, when it decreased for a few time periods. The detection rate began to increase again in 2004-2006 and was up to 87 percent for the final time frame (2005-2007).
- The median and rolling average concentrations shown became more similar over the final two periods, which indicates decreasing variability in the central tendency.

Figure 18-16. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CANJ

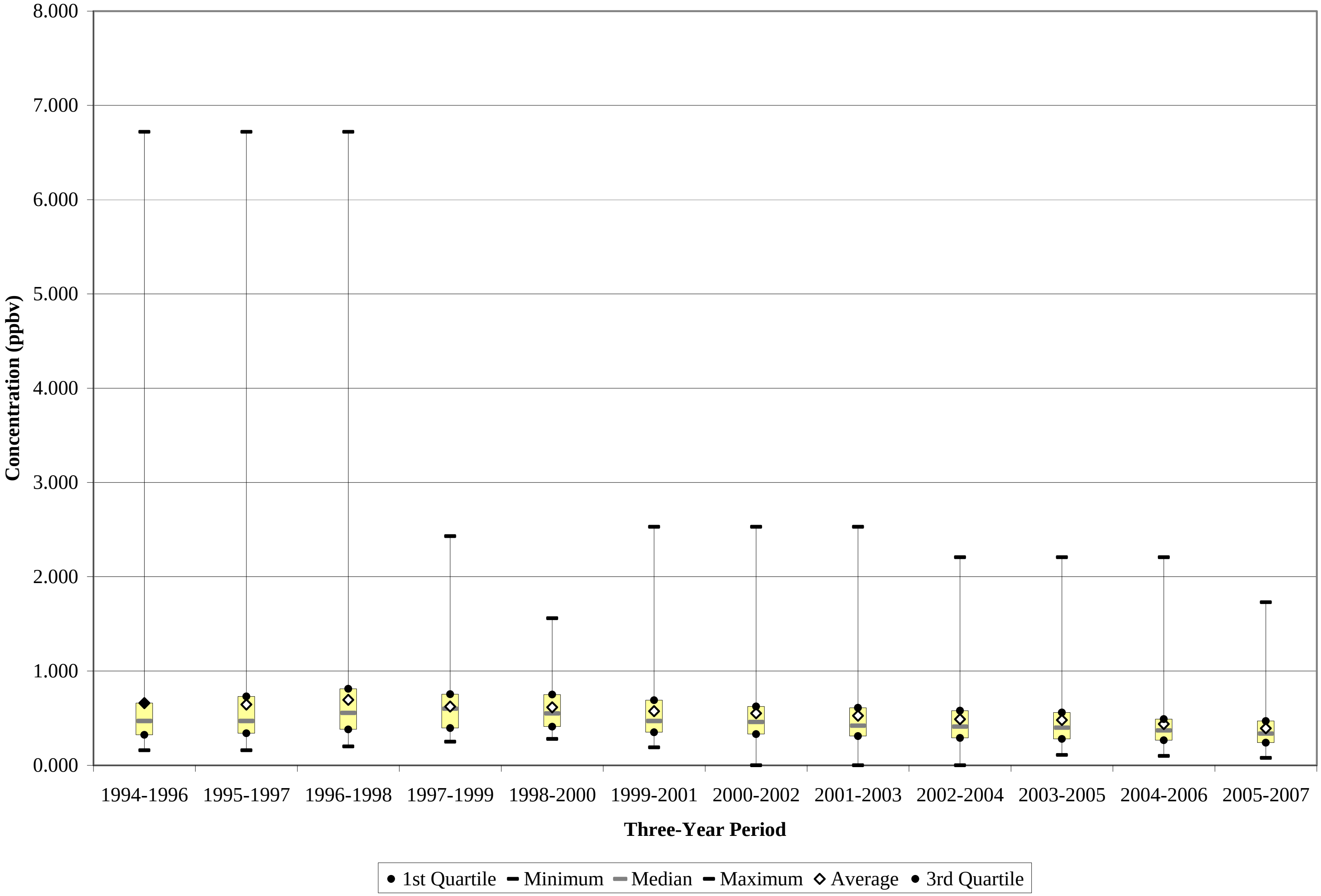


Figure 18-17. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at CANJ

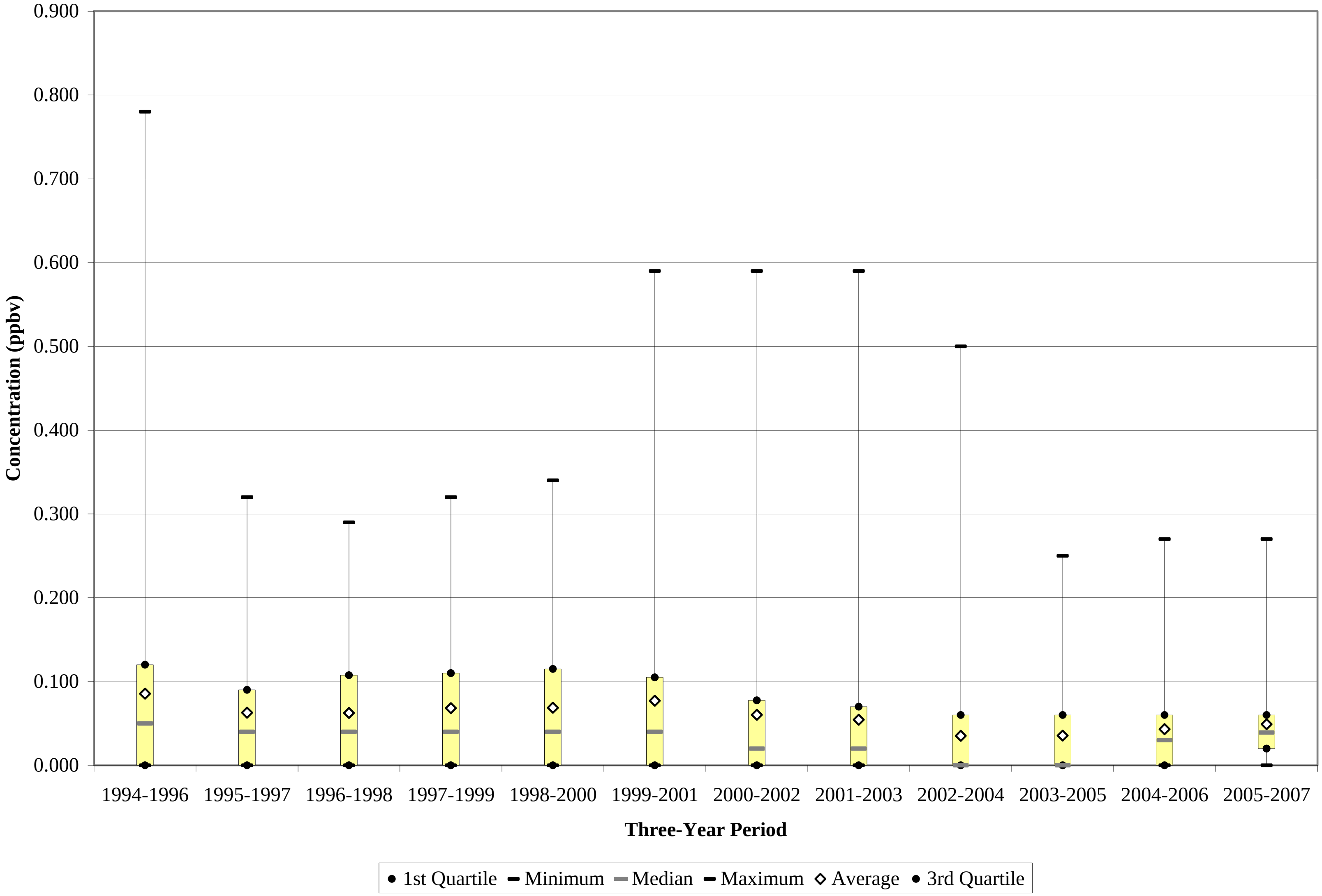


Figure 18-18. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at CANJ

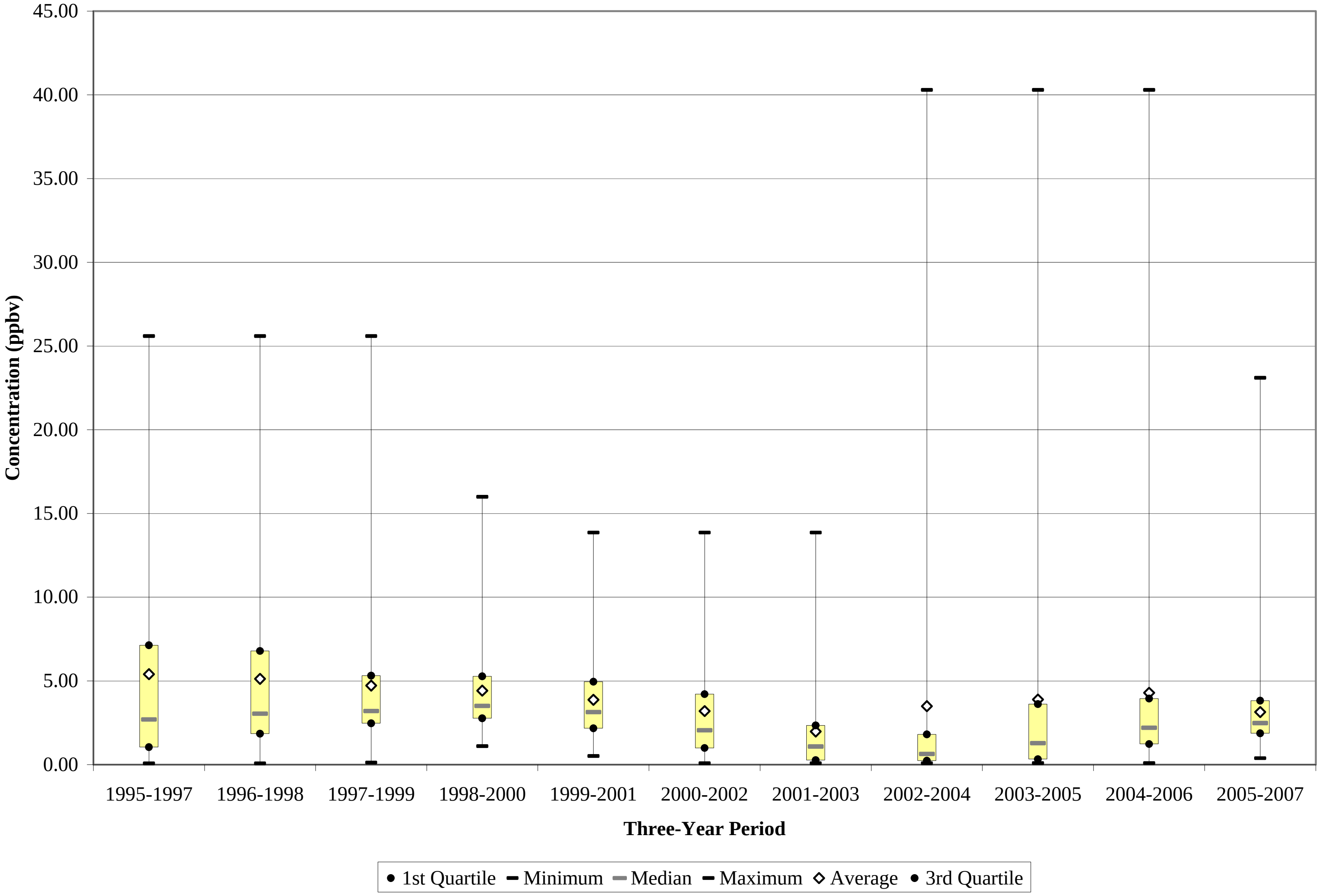


Figure 18-19. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CHNJ

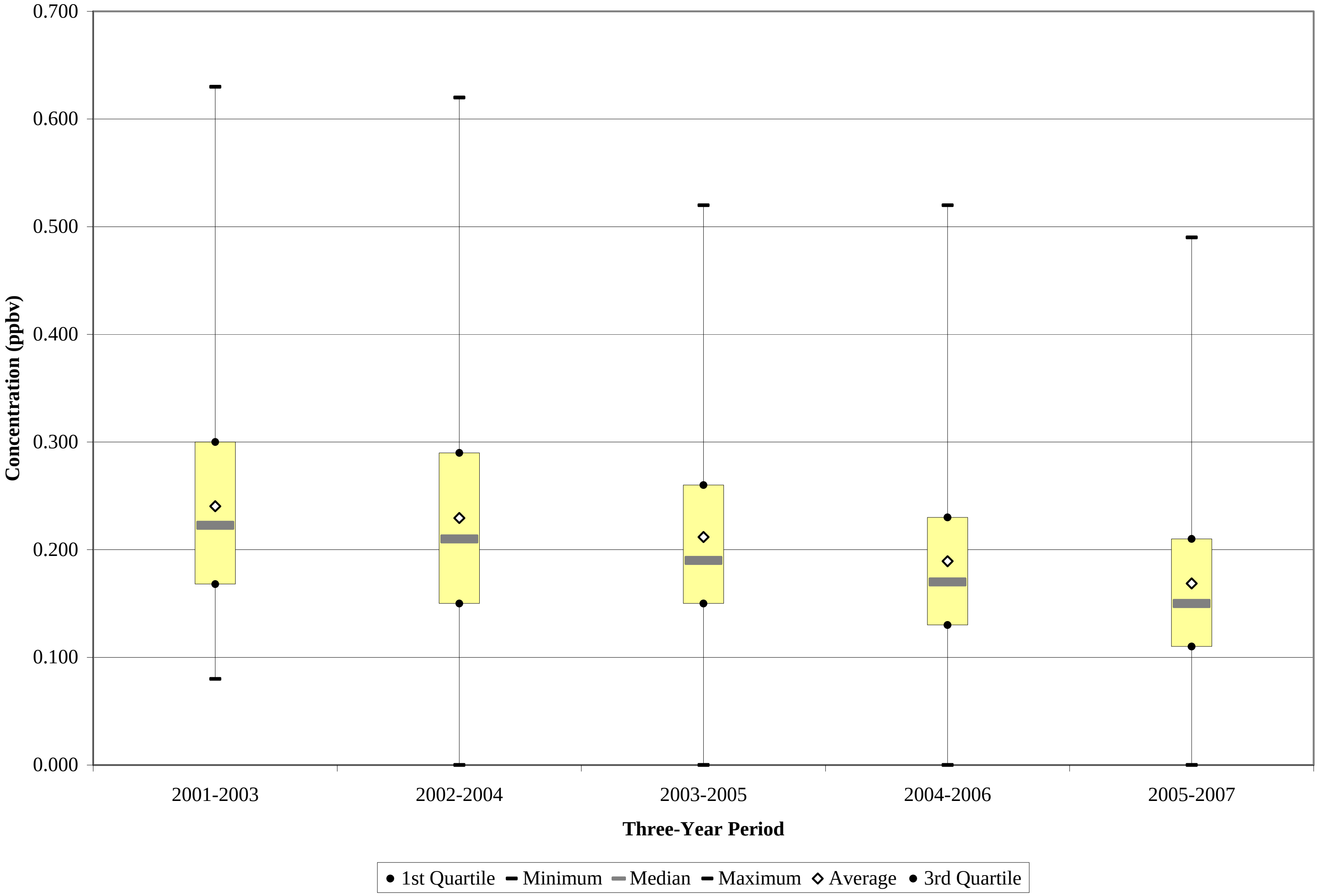


Figure 18-20. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at CHNJ

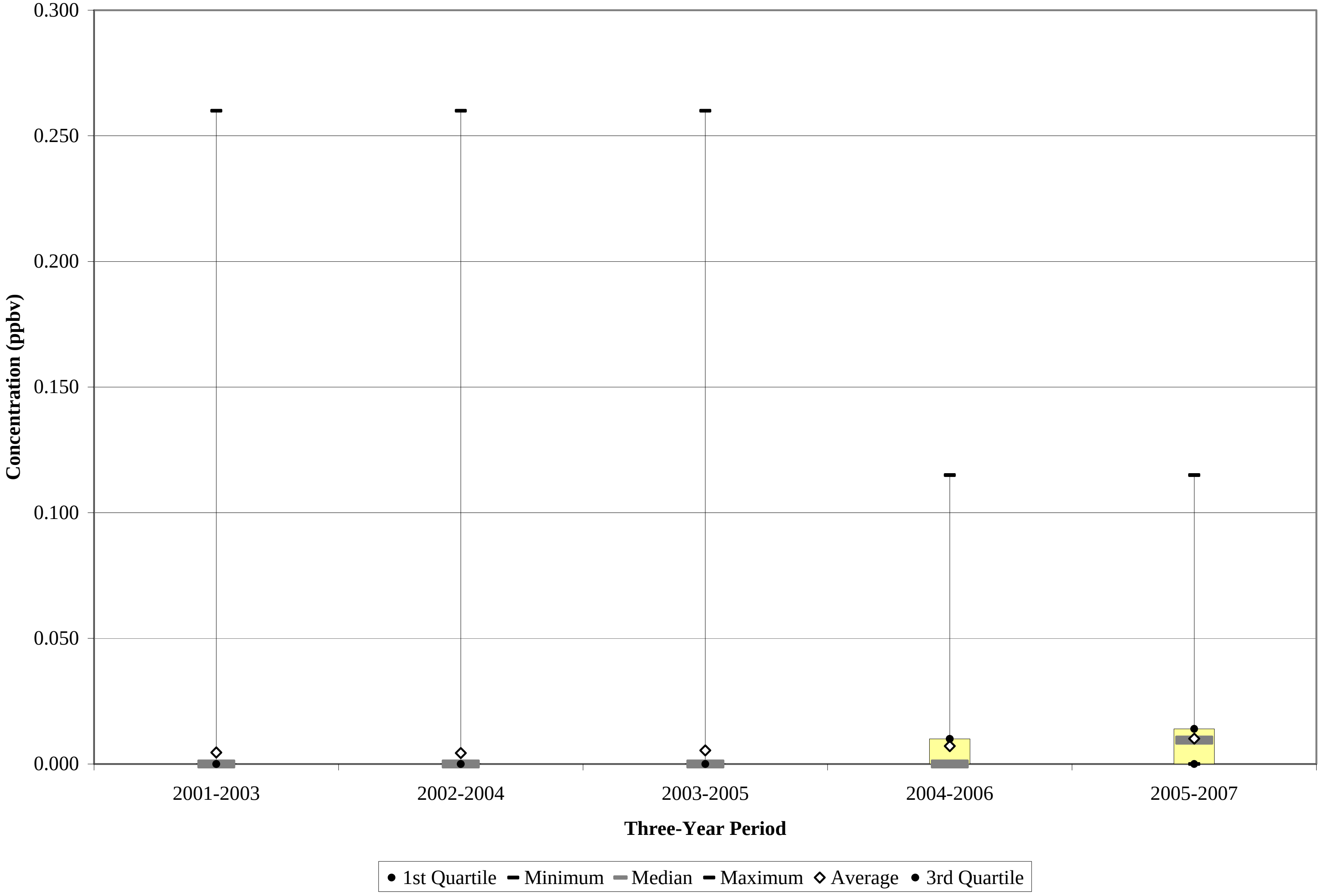


Figure 18-21. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at CHNJ

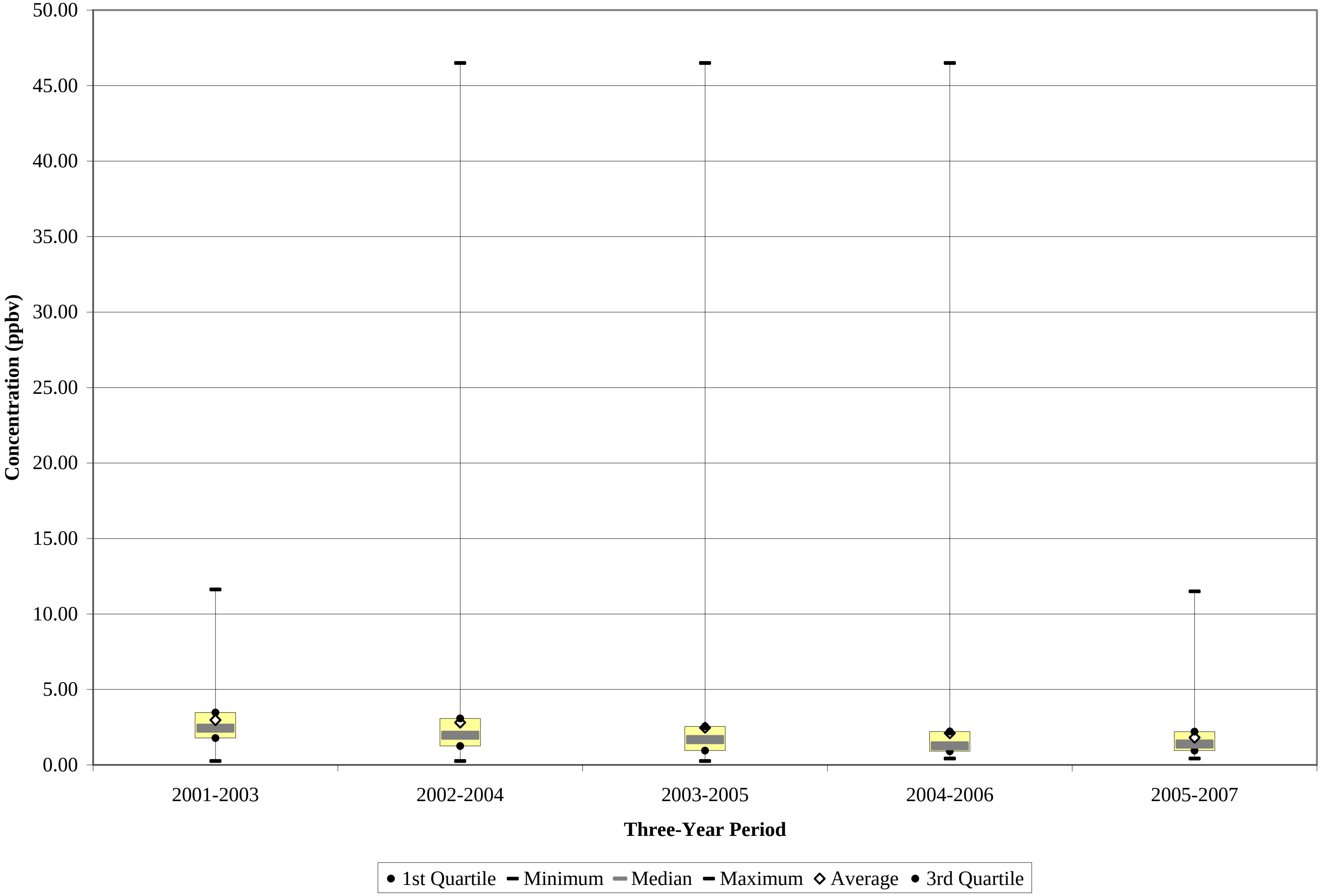


Figure 18-22. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at ELNJ

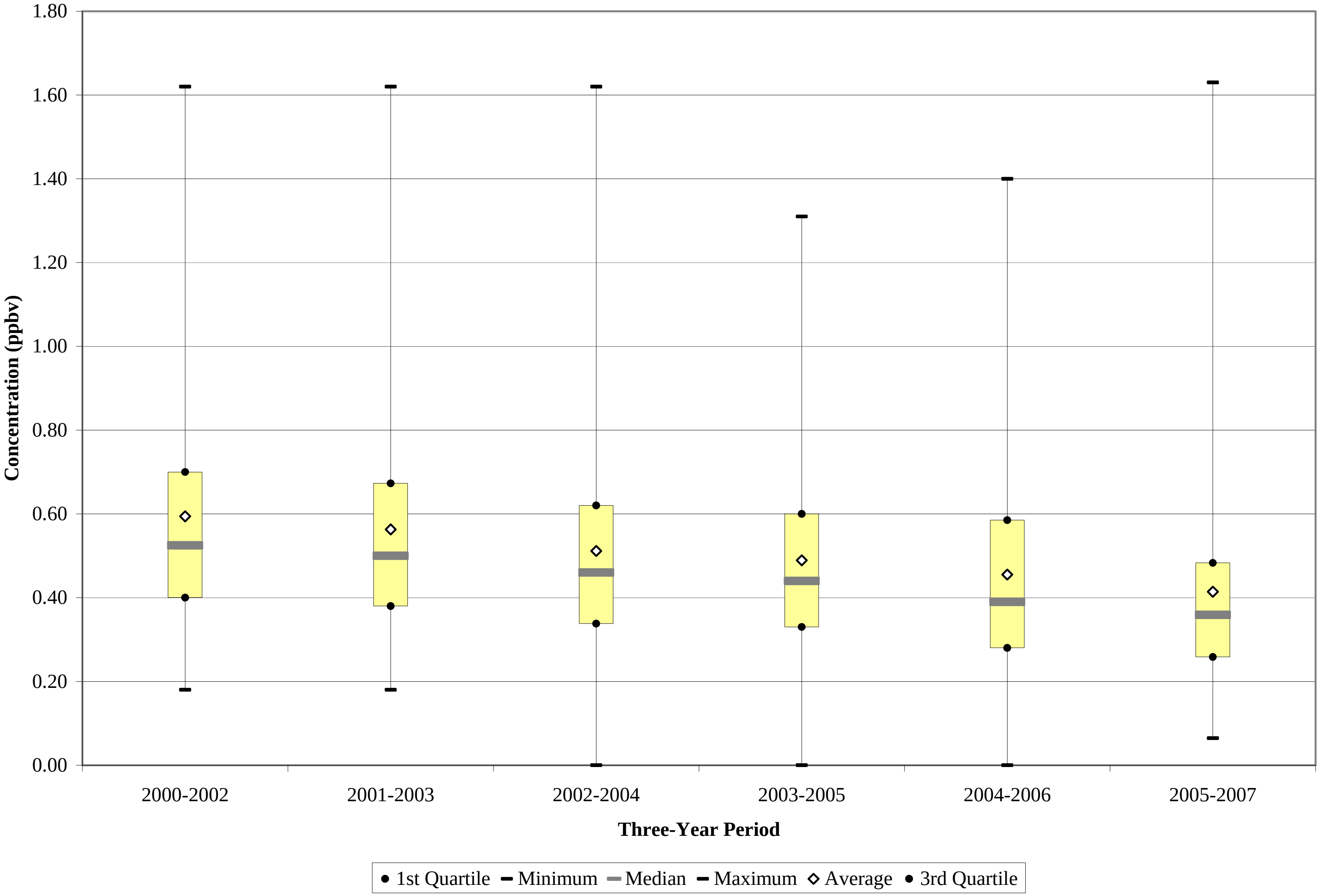


Figure 18-23. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at ELNJ

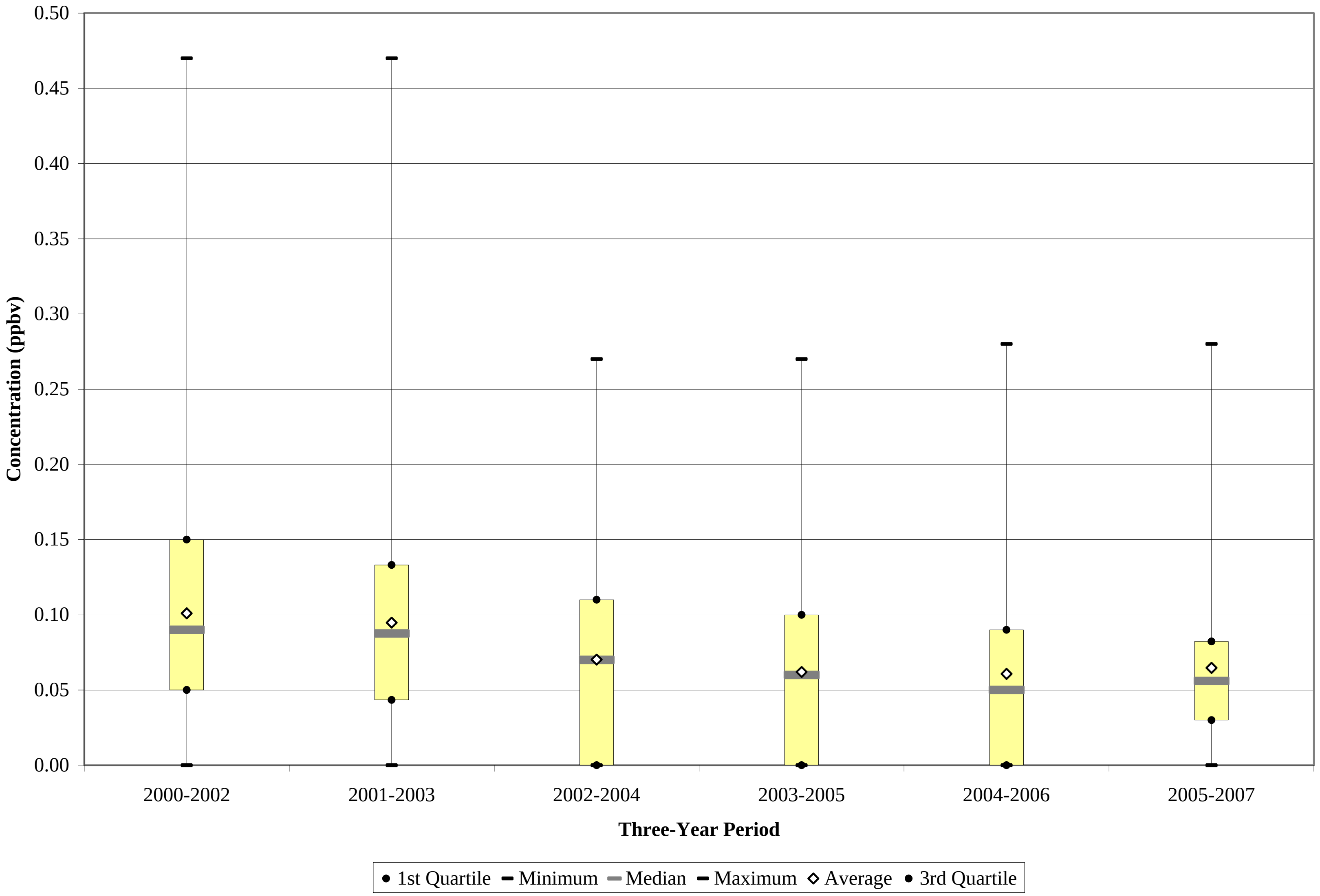


Figure 18-24. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at ELNJ

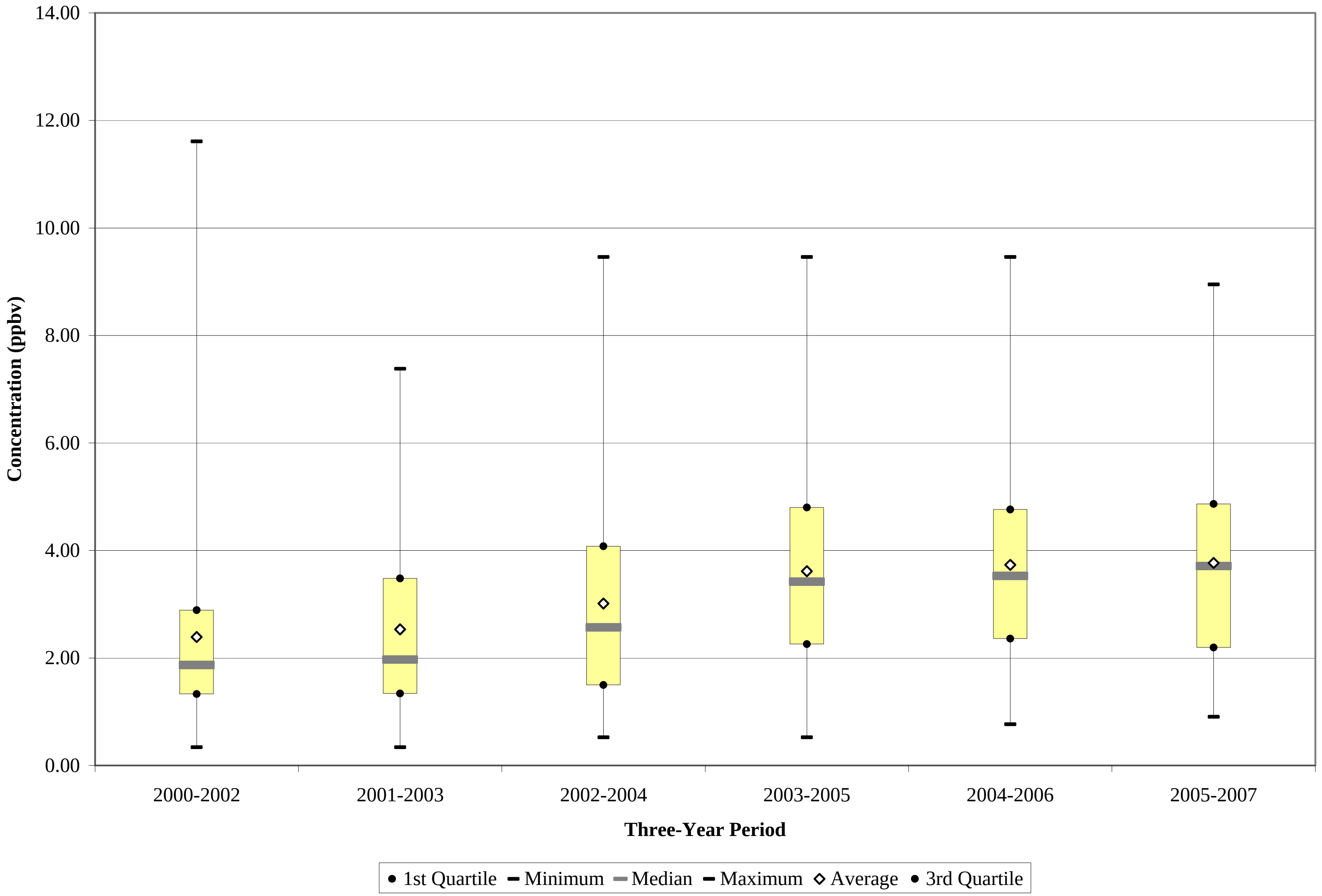


Figure 18-25. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at NBNJ

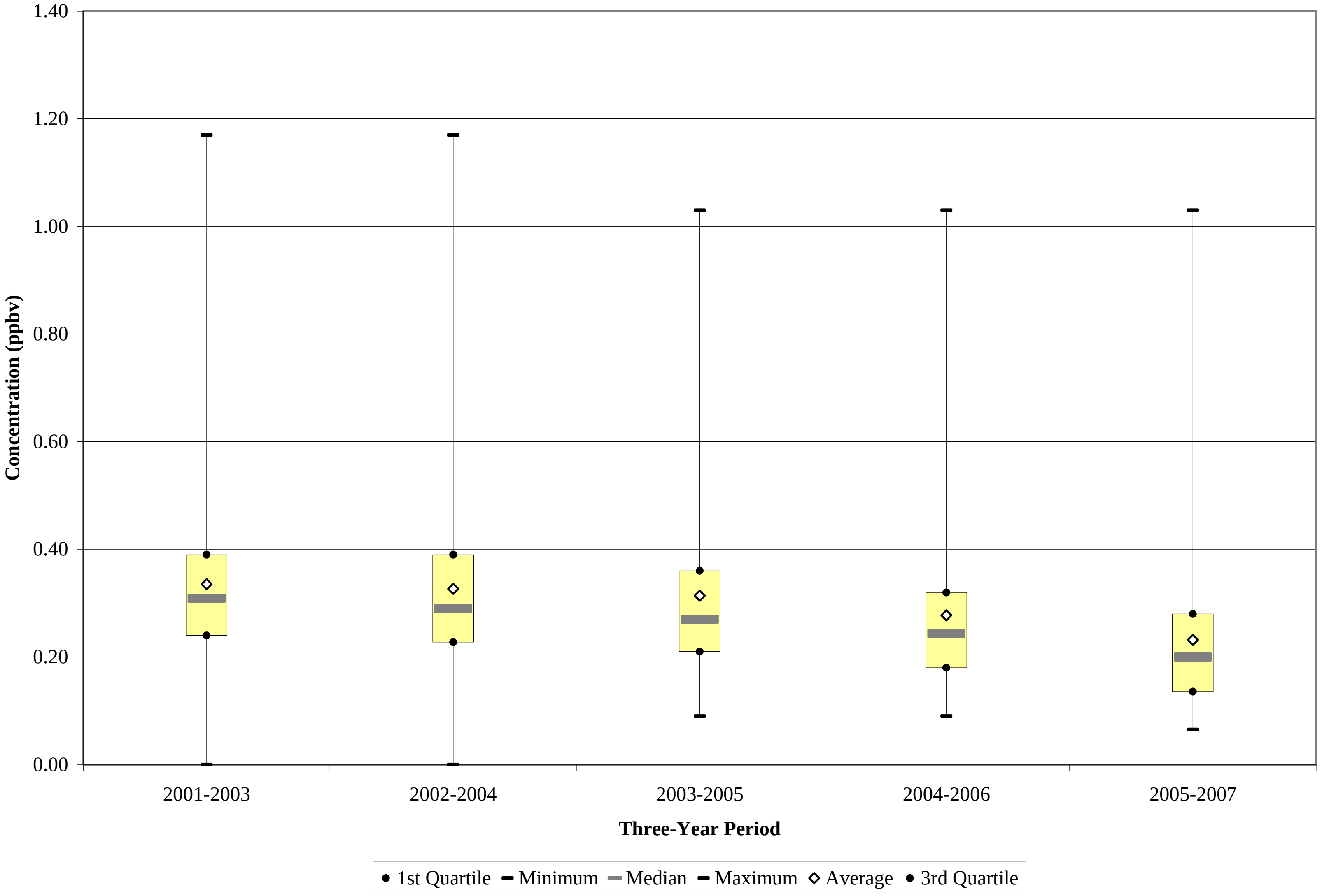


Figure 18-26. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBNJ

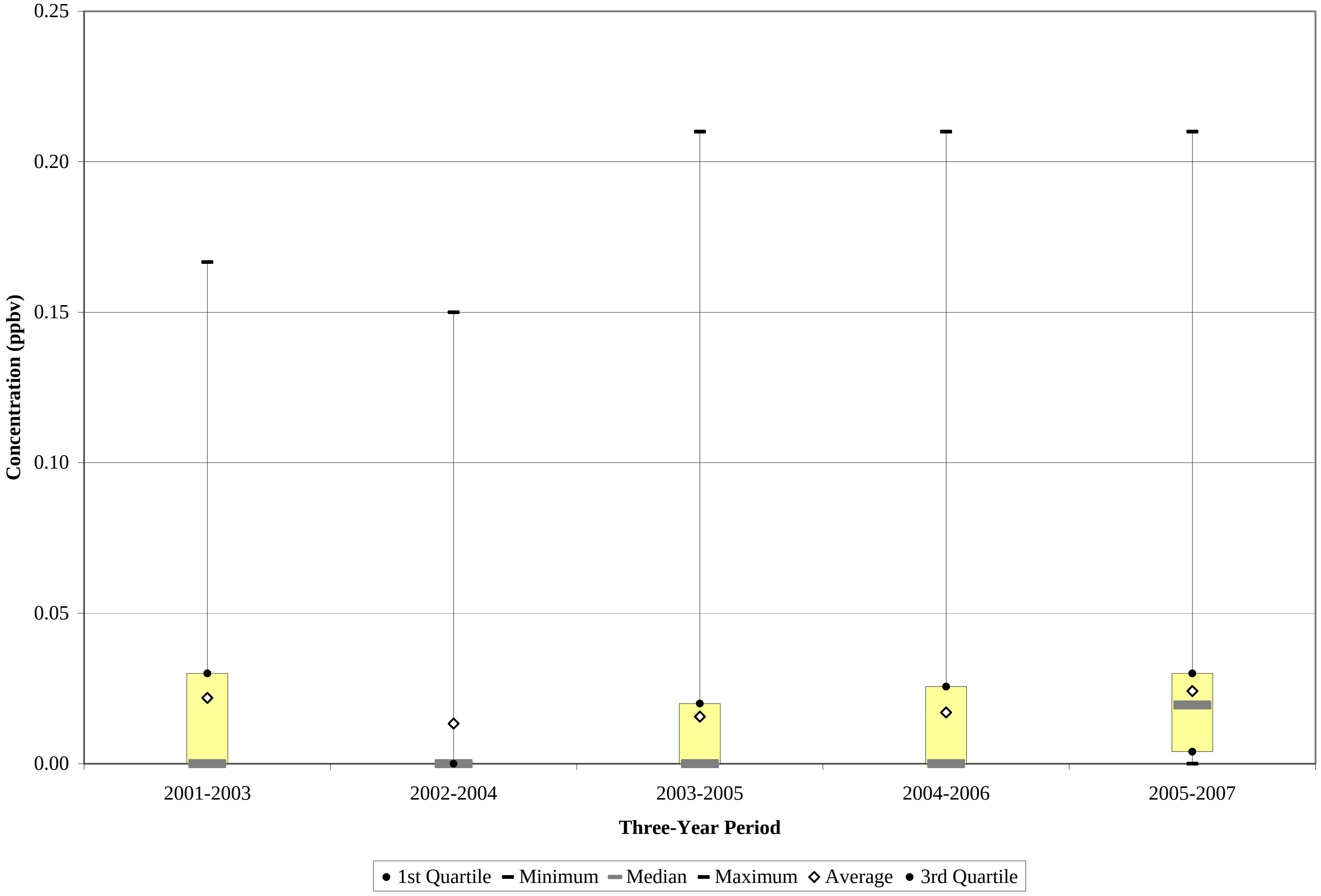
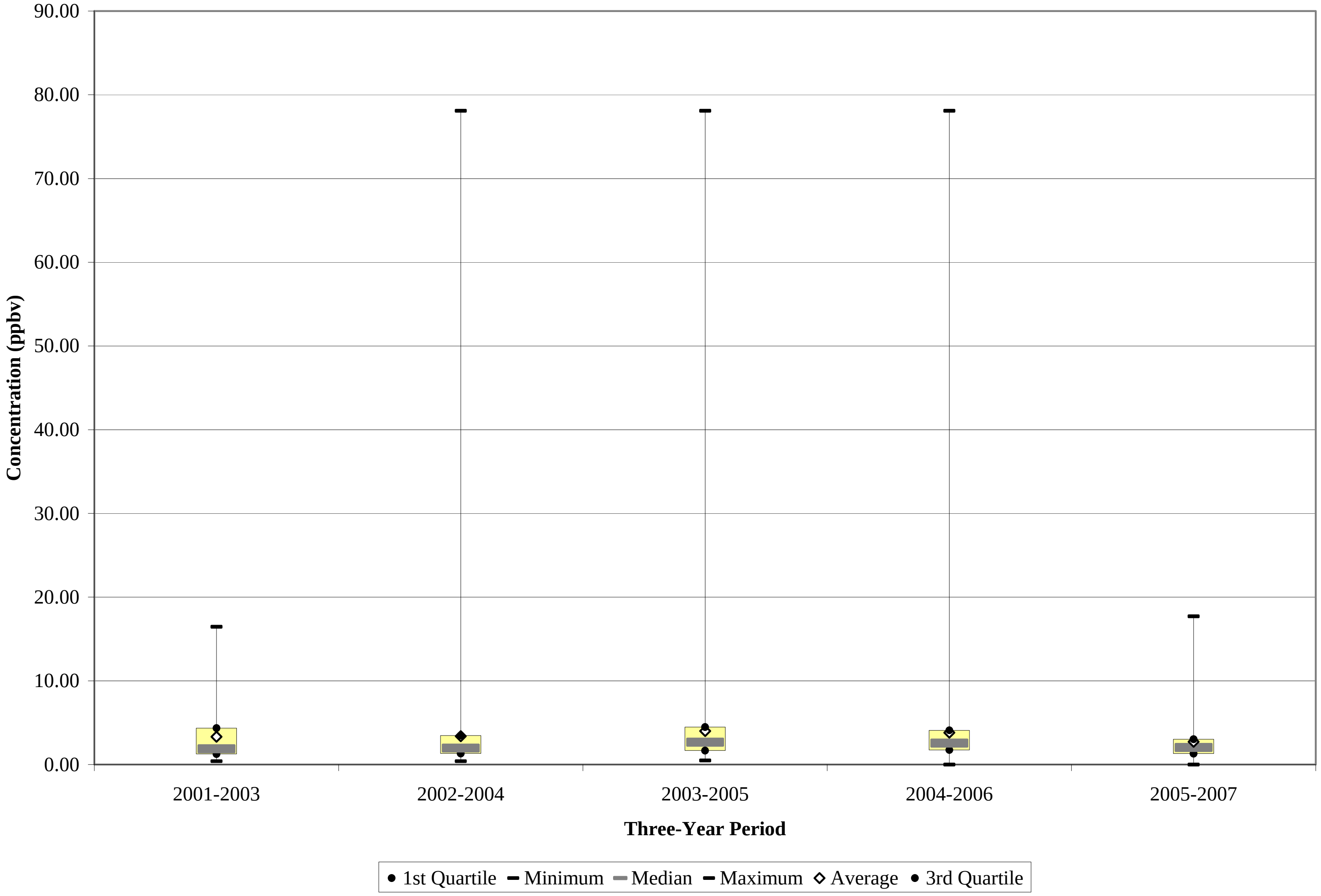


Figure 18-27. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at NBNJ



Observations from Figure 18-18 for formaldehyde measurements at CANJ include the following:

- The maximum formaldehyde concentration shown was measured in 2004. The seven highest concentrations of formaldehyde since the onset of sampling were measured in 2004, which explains the increasing difference in the central tendency statistics (median and average concentrations) during the time periods incorporating measurements for 2004. The average and median concentration were fairly similar again for the 2005-2007 time frame.

- Beginning with the 1998-2000 period, a decreasing trend in the average concentrations was apparent, until the 2002-2004 time frame.

- All formaldehyde concentrations reported to AQS over the thirteen years of sampling were measured detections.

Observations from Figure 18-19 for benzene measurements at CHNJ include the following:

- The maximum benzene concentration shown was measured in 2001.

- The central tendency of the rolling averages and the median values were similar to each other for each time period. The "closeness" in these metrics indicates relatively little variability in the central tendency.

- A slight decreasing trend in the average and median concentrations is evident across the sampling periods.

- With the exception of the 2001-2003 time frame, a few non-detects were recorded in each time frame, which may be attributable to co-elution with another pollutant.

Observations from Figure 18-20 for 1,3-butadiene measurements at CHNJ include the following:

- The maximum 1,3-butadiene concentration shown was measured in 2003.

- However, the minimum, first quartile, third quartile, and median concentrations for the first three periods were all zero. The averages for these periods were also very low. This is due to the large number of non-detects.

- As the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant increased. The detection rate increased from eight percent during the first time frame to 57 percent for the final time frame. This detection rate is still rather low compared to other monitoring sites.

- As the detection rate increased, the values for the rolling metrics increased as well.

Observations from Figure 18-21 for formaldehyde measurements at CHNJ include the following:

- Similar to CANJ, the maximum formaldehyde concentration shown was measured in 2004. This concentration of formaldehyde was nearly four times the maximum concentrations shown for other periods not including 2004. The second highest concentration was also measured in 2004, but was nearly half the magnitude.

- However, a slight decrease is shown across the periods for both the rolling average and median concentrations.

- All formaldehyde concentrations reported to AQS over the seven years of sampling were measured detections.

Observations from Figure 18-22 for benzene measurements at ELNJ include the following:

- The maximum benzene concentration shown was measured in 2007. However, this value is very similar to the highest concentration measured in 2002. As such, the maximum concentration shown in Figure 18-22 appears the same for the first three and final time periods.

- The rolling averages and the median values were similar to each other for each time period. The "closeness" in these metrics indicates relatively little variability in the central tendency.

- A decreasing trend in the rolling average and median concentrations is evident across the sampling periods, even though the maximum concentration increased over the 2004-2006 and 2005-2007 time frames.

- With the exception of the first two periods, one non-detect was recorded in each period.

Observations from Figure 18-23 for 1,3-butadiene measurements at ELNJ include the following:

- The first quartile decreased to zero over the first three periods, then remained at zero for the next two periods.

- Even as the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant decreased for a few periods. The detection rate began to increase in 2004-2006 and was up to 88 percent for the final time frame (2005-2007).

- The rolling average and the median concentrations were similar to each other for each time period. The “closeness” in these metrics indicates relatively little variability in the central tendency. In addition, these metrics show a decreasing trend across most of the periods.

- The highest concentration of 1,3-butadiene was measured in 2001.

Observations from Figure 18-24 for formaldehyde measurements at ELNJ include the following:

- Although the maximum formaldehyde concentration shown was measured in 2000, the other metrics, including the rolling average and median concentrations, increased for each three-year period shown.

- The rolling average and the median values became more similar to each other for each time period. The improving “closeness” in these metrics indicates decreasing variability in the central tendency.

- All formaldehyde concentrations reported to AQS over the seven years of sampling were measured detections.

Observations from Figure 18-25 for benzene measurements at NBNJ include the following:

- The maximum benzene concentration shown was measured in 2002.

- The rolling averages and the median values were similar to each other for each time period. The “closeness” in these metrics indicates relatively little variability in the central tendency.

- A decreasing trend in the average and median concentrations is shown across the sampling periods.

- A single non-detect was recorded in 2002.

Observations from Figure 18-26 for 1,3-butadiene measurements at NBNJ include the following:

- The minimum, first quartile, and median concentrations were zero for 2001-2003, 2003-2005, and 2004-2006 time frames. These metrics as well as the third quartile were zero for the 2002-2004 time frame. This demonstrates the impact of the zero substitution for non-detects.

- The detection rate decreased over the 2002-2004 time frame, from 35 percent to 21 percent, then increased during each period following as the MDL for 1,3-butadiene improved (i.e, decreased).

- The median and rolling average concentrations became more similar to each other during the final time period, which indicates decreasing variability in the central tendency.

- The highest concentration of 1,3-butadiene was measured in 2005.

Observations from Figure 18-27 for formaldehyde measurements at NBNJ include the following:

- Similar to CANJ and CHNJ, the maximum formaldehyde concentration shown was measured in 2004. This concentration of formaldehyde was nearly four times the maximum concentrations shown for other periods not including 2004.

- For each period shown, the average concentration is more similar to the third quartile than the median concentration, even for periods not affected by the 2004 maximum concentration.

- A single non-detect was recorded in 2006.

18.5 Pearson Correlations

Table 18-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Table 18-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the New Jersey Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Camden, New Jersey - CANJ								
Acetaldehyde	57	0.57	0.52	0.40	0.46	-0.16	-0.19	-0.36
Acrolein	57	0.29	0.29	0.29	0.29	0.11	-0.03	0.03
Benzene	57	0.15	0.14	0.17	0.15	0.17	-0.16	-0.19
Bromomethane	57	-0.09	-0.11	-0.18	-0.15	-0.26	0.24	0.29
1,3-Butadiene	57	-0.12	-0.12	-0.04	-0.09	0.22	-0.06	-0.26
Carbon Tetrachloride	57	0.33	0.36	0.38	0.37	0.25	-0.14	-0.01
p-Dichlorobenzene	57	0.54	0.52	0.46	0.49	0.08	-0.25	-0.36
Formaldehyde	57	0.69	0.67	0.54	0.60	-0.11	-0.29	-0.30
Tetrachloroethylene	57	0.09	0.12	0.19	0.15	0.30	-0.02	-0.44
Chester, New Jersey - CHNJ								
Acetaldehyde	55	0.17	0.11	0.17	0.14	0.25	0.18	-0.45
Acrolein	51	0.39	0.43	0.41	0.43	0.06	-0.29	0.04
Benzene	52	-0.33	-0.33	-0.23	-0.30	0.23	0.15	-0.37
1,3-Butadiene	38	-0.49	-0.49	-0.32	-0.42	0.46	0.27	-0.43
Carbon Tetrachloride	51	0.21	0.24	0.29	0.27	0.27	-0.09	-0.11
Formaldehyde	55	0.29	0.29	0.36	0.33	0.35	-0.07	-0.29
Tetrachloroethylene	49	-0.17	-0.18	-0.10	-0.14	0.19	0.04	-0.35
Elizabeth, New Jersey - ELNJ								
Acetaldehyde	56	0.71	0.72	0.67	0.70	0.04	-0.15	-0.39
Acrolein	61	0.34	0.36	0.40	0.39	0.22	0.00	-0.26
Benzene	61	-0.05	-0.07	0.03	-0.02	0.29	0.01	-0.43
1,3-Butadiene	61	-0.26	-0.27	-0.12	-0.21	0.40	0.28	-0.46
Carbon Tetrachloride	61	0.22	0.25	0.29	0.27	0.19	0.06	-0.24
p-Dichlorobenzene	54	0.22	0.25	0.35	0.30	0.32	0.09	-0.55
Formaldehyde	56	0.36	0.35	0.20	0.27	-0.36	-0.16	-0.11
Tetrachloroethylene	60	0.03	0.04	0.16	0.09	0.37	0.15	-0.54

Table 18-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the New Jersey Monitoring Sites (Continued)

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
New Brunswick, New Jersey - NBNJ								
Acetaldehyde	61	0.48	0.42	0.42	0.41	0.17	0.12	-0.51
Acrolein	60	0.19	0.16	0.22	0.19	0.23	-0.09	-0.21
Benzene	60	-0.32	-0.33	-0.17	-0.27	0.41	0.18	-0.45
1,3-Butadiene	54	-0.47	-0.46	-0.29	-0.40	0.40	0.31	-0.42
Carbon Tetrachloride	60	0.54	0.58	0.62	0.61	0.39	-0.18	-0.18
p-Dichlorobenzene	51	0.19	0.21	0.31	0.26	0.35	0.09	-0.44
Formaldehyde	61	0.41	0.40	0.41	0.41	0.18	0.00	-0.37
Tetrachloroethylene	58	-0.07	-0.06	0.10	0.01	0.48	0.21	-0.55

Observations from Table 18-6 include the following:

- The majority of the correlations for the pollutants of interest for the New Jersey sites and the selected meteorological parameters were weak. There were, however, a few notable exceptions. Acetaldehyde exhibited strong positive correlations with the temperature and moisture variables (except relative humidity) for ELNJ, indicating that concentrations of this pollutant tend to increase as temperature and moisture content increase. This supports the seasonal average observations from 18.4.1. This is also true for acetaldehyde and the temperature parameters for CANJ, although the correlations were not as strong.

- Formaldehyde exhibited strong positive correlations with the temperature and moisture variables (except relative humidity) for CANJ, indicating that concentrations of this pollutant tend to increase as temperature and moisture content increase. This supports the seasonal average observations from 18.4.1. This is also true for *p*-dichlorobenzene and the temperature parameters for CANJ, although the correlations were not as strong.

- Carbon tetrachloride exhibited strong positive correlations with the temperature and moisture variables for NBNJ, indicating that concentrations of this pollutant tend to increase as temperature and moisture content increase.

- Weak, moderate, and strong correlations were calculated for the pollutants of interest and wind speed. However, all but two were negative, indicating a tendency for increased concentrations with lower wind speeds.

18.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

18.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the New Jersey monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 18-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein from Table 18-7 include the following:

- None of the preprocessed daily measurements of acrolein from the New Jersey sites exceeded the acute MRL.
- All four seasonal averages of acrolein exceeded the intermediate MRL for all four New Jersey sites.
- Acrolein has no chronic MRL. Therefore, chronic risk could not be evaluated.

18.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the New Jersey monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 18-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the New Jersey sites is as follows:

- The CANJ monitoring site is located in census tract 34007601500, which had a population of 6,424, and represented 1.3 percent of the Camden County population in 2000.
- The CHNJ monitoring site is located in census tract 34027045901, which had a population of 1,635, and represented 0.3 percent of Morris County's 2000 population.
- ELNJ is located in census tract 34039030100. The population in that census tract in 2000 was 334, or less than 0.1 percent of Union County's population.

Table 18-7. MRL Risk Screening Assessment Summary for the New Jersey Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average[1] (µg/m^3)
CANJ	TO-15	Acrolein	7.00	0/57	0.09	**0.58 ± 0.25**	**0.63 ± 0.17**	**0.99 ± 0.2**	**1.27 ± 0.60**	--	0.87 ± 0.18
CHNJ	TO-15	Acrolein	7.00	0/51	0.09	**0.37 ± 0.14**	**0.48 ± 0.12**	**1.04 ± 0.35**	**0.66 ± 0.42**	--	*NA*
ELNJ	TO-15	Acrolein	7.00	0/61	0.09	**0.59 ± 0.19**	**0.50 ± 0.13**	**1.03 ± 0.35**	**0.85 ± 0.17**	--	0.76 ± 0.13
NBNJ	TO-15	Acrolein	7.00	0/60	0.09	**0.39 ± 0.09**	**0.43 ± 0.16**	**0.54 ± 0.09**	**0.73 ± 0.26**	--	0.53 ± 0.09

BOLD = exceedance of the intermediate or chronic MRL
-- = an MRL risk factor is not available
NA = completeness was less than 85 percent for VOC for CHNJ
[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 18-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in New Jersey

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (µg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Camden, New Jersey (CANJ) - Census Tract ID 34007601500								
Acetaldehyde	0.000002	0.009	2.49	5.50	0.27	2.19 ± 0.22	4.38	0.24
Acrolein	--	0.00002	0.19	--	9.63	0.87 ± 0.18	--	43.25
Acrylonitrile	0.000068	0.002	<0.01	0.06	<0.01	0.03 ± <0.01	1.80	0.01
Benzene	0.000007	0.03	1.90	14.86	0.06	1.04 ± 0.14	7.26	0.03
Bromomethane	--	0.005	0.28	--	0.05	0.52 ± 0.22	--	0.10
1,3-Butadiene	0.00003	0.002	0.18	5.36	0.08	0.10 ± 0.02	3.02	0.05
Carbon Tetrachloride	0.000015	0.04	0.22	3.29	0.01	0.55 ± 0.04	8.20	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.09	1.00	<0.01	0.19 ± 0.03	2.04	<0.01
1,2-Dichloroethane	0.000026	2.4	0.04	1.05	<0.01	0.05 ± <0.01	1.17	<0.01
Dichloromethane	0.00000047	1	0.77	0.37	<0.01	0.61 ± 0.23	0.29	<0.01
Formaldehyde	5.5E-09	0.0098	2.45	0.01	0.24	3.78 ± 0.52	0.02	0.39
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.20 ± 0.01	4.32	<0.01
1,1,2,2-Tetrachloroethane	0.000058	--	0.05	3.11	--	0.05 ± <0.01	3.17	--
Tetrachloroethylene	0.000005	0.27	0.23	1.38	<0.01	0.29 ± 0.04	1.44	<0.01
Trichloroethylene	0.000002	0.6	0.15	0.30	<0.01	0.22 ± 0.06	0.44	<0.01

Bold = pollutant of interest
NA = completeness was less than 85 percent for VOC for CHNJ
-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 18-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in New Jersey (Continued)

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (HQ)	2007 NATTS/UATMP Annual Average[1] (µg/m^3)	2007 NATTS/UATMP Cancer Risk Approximation (in-a-million)	2007 NATTS/UATMP Noncancer Risk Approximation (HQ)
Chester, New Jersey (CHNJ) - Census Tract ID 34027045901								
Acetaldehyde	0.000002	0.009	1.09	2.42	0.12	1.28 ± 0.12	2.56	0.14
Acrolein	--	0.00002	0.07	--	3.33	*NA*	*NA*	*NA*
Acrylonitrile	0.000068	0.002	<0.01	0.02	<0.01	*NA*	*NA*	*NA*
Benzene	0.000007	0.03	1.03	8.08	0.03	*NA*	*NA*	*NA*
1,3-Butadiene	0.00003	0.002	0.11	3.42	0.05	*NA*	*NA*	*NA*
Carbon Tetrachloride	0.000015	0.04	0.21	3.11	0.01	*NA*	*NA*	*NA*
p-Dichlorobenzene	0.000011	0.8	0.02	0.24	<0.01	*NA*	*NA*	*NA*
Dichloromethane	0.00000047	1	0.36	0.18	<0.01	*NA*	*NA*	*NA*
Formaldehyde	5.5E-09	0.0098	1.29	0.01	0.13	2.32 ± 0.51	0.01	0.24
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	*NA*	*NA*	*NA*
Tetrachloroethylene	0.000005	0.27	0.12	0.71	<0.01	*NA*	*NA*	*NA*

Bold = pollutant of interest

NA = completeness was less than 85 percent for VOC for CHNJ

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 18-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in New Jersey (Continued)

Pollutant	Cancer URE (µg/m³)	Noncancer RfC (mg/m³)	1999 NATA Modeled Concentration (µg/m³)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (HQ)	2007 NATTS/UATMP Annual Average[1] (µg/m³)	2007 NATTS/UATMP Cancer Risk Approximation (in-a-million)	2007 NATTS/UATMP Noncancer Risk Approximation (HQ)
Elizabeth, New Jersey (ELNJ) - Census Tract ID 34039030100								
Acetaldehyde	0.000002	0.009	4.35	9.59	0.48	5.84 ± 0.88	11.68	0.65
Acrolein	--	0.00002	0.71	--	35.46	0.76 ± 0.13	--	37.80
Acrylonitrile	0.000068	0.002	<0.01	0.07	<0.01	0.03 ± <0.01	1.77	0.01
Benzene	0.000007	0.03	3.37	26.33	0.11	1.09 ± 0.18	7.66	0.04
1,3-Butadiene	0.00003	0.002	0.54	16.09	0.26	0.14 ± 0.02	4.18	0.07
Carbon Tetrachloride	0.000015	0.04	0.21	3.16	0.01	0.53 ± 0.04	7.96	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.07	0.72	<0.01	0.12 ± 0.02	1.37	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.91	<0.01	0.04 ± <0.01	1.10	<0.01
Dichloromethane	0.00000047	1	0.68	0.33	<0.01	1.04 ± 0.45	0.49	<0.01
Formaldehyde	5.5E-09	0.0098	4.49	0.03	0.57	4.69 ± 0.65	0.03	0.48
Tetrachloroethylene	0.000005	0.27	0.31	1.81	<0.01	0.31 ± 0.05	1.57	<0.01
Trichloroethylene	0.000002	0.6	0.12	0.23	<0.01	0.10 ± 0.02	0.20	<0.01

Bold = pollutant of interest

NA = completeness was less than 85 percent for VOC for CHNJ

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 18-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in New Jersey (Continued)

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE ($\mu g/m^3$)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration ($\mu g/m^3$)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] ($\mu g/m^3$)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
New Brunswick, New Jersey (NBNJ) - Census Tract ID 34023006206								
Acetaldehyde	0.000002	0.009	1.97	4.36	0.22	1.55 ± 0.18	3.11	0.17
Acrolein	--	0.00002	0.15	--	7.61	0.53 ± 0.09	--	26.51
Acrylonitrile	0.000068	0.002	<0.01	0.07	<0.01	0.04 ± 0.01	2.40	0.02
Benzene	0.000007	0.03	2.25	17.62	0.07	0.56 ± 0.08	3.92	0.02
Bromomethane	--	0.005	0.13	--	0.02	0.08 ± 0.05	--	0.02
1,3-Butadiene	0.00003	0.002	0.28	8.32	0.13	0.06 ± 0.01	1.68	0.03
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	0.58 ± 0.04	8.70	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.04	0.44	<0.01	0.08 ± 0.01	0.84	<0.01
1,2-Dichloroethane	0.000026	2.4	0.04	0.92	<0.01	0.04 ± <0.01	1.10	<0.01
Dichloromethane	0.00000047	1	0.49	0.23	<0.01	0.59 ± 0.19	0.28	<0.01
Formaldehyde	5.5E-09	0.0098	2.29	0.01	0.23	2.13 ± 0.30	0.01	0.22
Tetrachloroethylene	0.000005	0.27	0.20	1.20	<0.01	0.22 ± 0.04	1.12	<0.01

Bold = pollutant of interest

NA = completeness was less than 85 percent for VOC for CHNJ

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

- Finally, NBNJ is located in census tract 34023006206. In 2000, the population in this census tract was 1,794, or 0.2 percent of the Middlesex County population.

Observations from Table 18-8 include the following:

- The pollutants with the highest concentrations for each site according to NATA were acetaldehyde, formaldehyde, and benzene (although not necessarily in that order).

- The pollutants with the highest cancer risks for each site according to NATA were benzene, 1,3-butadiene, and acetaldehyde (although not necessarily in that order), except CHNJ. Benzene, 1,3-butadiene, and carbon tetrachloride were the pollutants with the highest cancer risk for CHNJ.

- Benzene had the highest cancer risks for each site according to NATA, and ranged from 8.08 in-a-million (for CHNJ) to 26.33 in-a-million (for ELNJ).

- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (ranging from 3.33 for CHNJ to 35.46 for ELNJ).

- The pollutants with the highest 2007 annual averages for CANJ and ELNJ were benzene, formaldehyde, and acetaldehyde (although not necessarily in that order). The pollutants with the highest 2007 annual averages for NBNJ were formaldehyde, acetaldehyde, and carbon tetrachloride.

- Annual averages were not calculated for VOC for CHNJ. This is because this site did not meet the 85 percent completeness criteria discussed in Section 2.4. Therefore, cancer and noncancer risk estimates could only be calculated for acetaldehyde and formaldehyde. The annual average for formaldehyde was nearly twice the annual average for acetaldehyde.

- The pollutants with the highest surrogate cancer risk approximations were carbon tetrachloride, benzene, and acetaldehyde for CANJ, ELNJ, and NBNJ (although not necessarily in that order).

- The only pollutant with a surrogate noncancer risk approximation greater than 1.0 was acrolein (ranging from 26.51 for NBNJ to 43.25 for CANJ).

18.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 18-9 and 18-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 18-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest

Table 18-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in New Jersey

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Camden, New Jersey (CANJ) – Camden County					
Benzene	202.20	Benzene	1.58E-03	Carbon Tetrachloride	8.20
Formaldehyde	129.48	1,3-Butadiene	7.61E-04	Benzene	7.26
Dichloromethane	54.82	Naphthalene	6.35E-04	Acetaldehyde	4.38
Tetrachloroethylene	38.54	Hexavalent Chromium	3.32E-04	Hexachloro-1,3-butadiene	4.34
1,3-Dichloropropene	36.95	Tetrachloroethylene	2.27E-04	1,1,2,2-Tetrachloroethane	3.18
Acetaldehyde	33.68	*p*-Dichlorobenzene	2.10E-04	1,3-Butadiene	3.02
1,3-Butadiene	25.38	POM, Group 2	1.57E-04	*p*-Dichlorobenzene	2.04
p-Dichlorobenzene	19.07	1,3-Dichloropropene	1.48E-04	Acrylonitrile	1.78
Naphthalene	18.69	POM, Group 3	8.27E-05	Tetrachloroethylene	1.44
POM, Group 2	2.86	Cadmium, PM	8.20E-05	1,2-Dichloroethane	1.18
Chester, New Jersey (CHNJ) – Morris County					
Benzene	320.42	Benzene	2.50E-03	Acetaldehyde	2.56
Formaldehyde	145.06	1,3-Butadiene	1.35E-03	Formaldehyde	0.01
Dichloromethane	55.35	Naphthalene	6.63E-04		
Acetaldehyde	45.85	Hexavalent Chromium	4.47E-04		
1,3-Butadiene	45.10	Nickel, PM	2.53E-04		
1,3-Dichloropropene	34.55	*p*-Dichlorobenzene	1.96E-04		
Tetrachloroethylene	30.12	Tetrachloroethylene	1.78E-04		
Naphthalene	19.50	1,3-Dichloropropene	1.38E-04		
p-Dichlorobenzene	17.84	POM, Group 2	1.33E-04		
Trichloroethylene	17.27	Arsenic, PM	1.10E-04		

Table 18-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in New Jersey (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Elizabeth, New Jersey (ELNJ) – Union County					
Benzene	255.56	Benzene	1.99E-03	Acetaldehyde	11.68
Formaldehyde	120.42	1,3-Butadiene	9.94E-04	Carbon Tetrachloride	7.96
Dichloromethane	76.41	Naphthalene	7.11E-04	Benzene	7.66
Tetrachloroethylene	42.40	Nickel, PM	3.56E-04	1,3-Butadiene	4.18
Acetaldehyde	40.12	Hexavalent Chromium	2.78E-04	Acrylonitrile	1.75
1,3-Dichloropropene	38.31	Tetrachloroethylene	2.50E-04	Tetrachloroethylene	1.57
1,3-Butadiene	33.14	*p*-Dichlorobenzene	2.18E-04	*p*-Dichlorobenzene	1.37
Naphthalene	20.92	Arsenic, PM	2.01E-04	1,2-Dichloroethane	1.11
p-Dichlorobenzene	19.80	Hexavalent Chromium	1.53E-04	Dichloromethane	0.49
Trichloroethylene	4.55	POM, Group 2	1.49E-04	Trichloroethylene	0.19
New Brunswick, New Jersey (NBNJ) – Middlesex County					
Benzene	414.77	Benzene	3.24E-03	Carbon Tetrachloride	8.70
Formaldehyde	221.09	1,3-Butadiene	1.70E-03	Benzene	3.92
Dichloromethane	108.90	Naphthalene	1.10E-03	Acetaldehyde	3.11
Acetaldehyde	75.01	Hexavalent Chromium	4.57E-04	Acrylonitrile	2.38
Tetrachloroethylene	59.93	Tetrachloroethylene	3.54E-04	1,3-Butadiene	1.68
1,3-Butadiene	56.56	*p*-Dichlorobenzene	3.18E-04	Tetrachloroethylene	1.12
1,3-Dichloropropene	55.98	POM, Group 2	2.29E-04	1,2-Dichloroethane	1.11
Naphthalene	32.23	1,3-Dichloropropene	2.24E-04	*p*-Dichlorobenzene	0.84
p-Dichlorobenzene	28.93	Acetaldehyde	1.65E-04	Dichloromethane	0.28
Trichloroethylene	7.53	Arsenic, PM	1.40E-04	Formaldehyde	0.01

Table 18-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in New Jersey

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Camden, New Jersey (CANJ) – Camden County					
Toluene	655.16	Acrolein	301,014.59	Acrolein	43.25
Methyl *tert*-butyl ether	529.03	Formaldehyde	13,212.64	Formaldehyde	0.39
Xylenes	453.12	1,3-Butadiene	12,687.52	Acetaldehyde	0.24
Benzene	202.20	Bromomethane	10,308.00	Bromomethane	0.10
Methyl isobutyl ketone	135.59	Manganese, PM	9,357.78	1,3-Butadiene	0.05
Formaldehyde	129.48	Benzene	6,740.12	Benzene	0.03
1,1,1-Trichloroethane	120.65	Cyanide Compounds, gas	6,430.71	Carbon Tetrachloride	0.01
Hexane	89.32	Naphthalene	6,229.86	Acrylonitrile	0.01
Ethylbenzene	81.35	Xylenes	4,531.17	Hexachloro-1,3-butadiene	<0.01
Methanol	59.09	Nickel, PM	3,981.65	Tetrachloroethylene	<0.01
Chester, New Jersey (CHNJ) – Morris County					
Toluene	945.16	Acrolein	381,629.55	Formaldehyde	0.24
Methyl *tert*-butyl ether	837.21	Nickel, PM	24,324.58	Acetaldehyde	0.14
Xylenes	690.78	1,3-Butadiene	22,551.13		
Benzene	320.42	Formaldehyde	14,801.90		
Formaldehyde	145.06	Benzene	10,680.64		
Ethylbenzene	136.16	Bromomethane	9,638.01		
Hexane	134.66	Xylenes	6,907.84		
Methyl isobutyl ketone	115.78	Naphthalene	6,499.09		
1,1,1-Trichloroethane	109.08	Cyanide Compounds, gas	5,943.73		
Methanol	59.57	Acetaldehyde	5,094.05		

Table 18-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in New Jersey (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Elizabeth, New Jersey (ELNJ) – Union County					
Toluene	836.78	Acrolein	339,633.20	Acrolein	37.80
Methyl *tert*-butyl ether	626.69	Nickel, PM	34,213.95	Acetaldehyde	0.65
Xylenes	607.19	1,3-Butadiene	16,571.17	Formaldehyde	0.48
Hexane	332.31	Formaldehyde	12,287.61	1,3-Butadiene	0.07
Benzene	255.56	Bromomethane	10,686.00	Benzene	0.04
Methyl isobutyl ketone	182.87	Benzene	8,518.80	Carbon Tetrachloride	0.01
1,1,1-Trichloroethane	122.48	Naphthalene	6,973.06	Acrylonitrile	0.01
Formaldehyde	120.42	Cyanide Compounds, gas	6,604.11	Tetrachloroethylene	<0.01
Ethylbenzene	119.06	Xylenes	6,071.91	Dichloromethane	<0.01
Methanol	81.55	Chlorine	5,812.50	Trichloroethylene	<0.01
New Brunswick, New Jersey (NBNJ) – Middlesex County					
Toluene	1,326.75	Acrolein	577,997.45	Acrolein	26.51
Xylenes	1,092.74	1,3-Butadiene	28,277.57	Formaldehyde	0.22
Methyl *tert*-butyl ether	1,041.45	Formaldehyde	22,560.33	Acetaldehyde	0.17
Benzene	414.77	Manganese, PM	18,349.98	1,3-Butadiene	0.03
Methyl isobutyl ketone	255.79	Bromomethane	15,616.01	Benzene	0.02
Hexane	228.73	Benzene	13,825.76	Acrylonitrile	0.02
Formaldehyde	221.09	Xylenes	10,927.38	Bromomethane	0.02
Ethylbenzene	199.28	Naphthalene	10,741.99	Carbon Tetrachloride	0.01
1,1,1-Trichloroethane	177.07	Cyanide Compounds, gas	9,482.11	Tetrachloroethylene	<0.01
Glycol ethers, gas	126.68	Acetaldehyde	8,333.90	Dichloromethane	<0.01

cancer risk approximations (in-a-million), as calculated from the annual averages. Table 18-10 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ,) as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 18.3, all four New Jersey monitoring sites sampled for VOC and carbonyl compounds. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated. Although CHNJ sampled for the entire calendar year, the completeness criteria was not met, so annual averages, and thus, cancer and noncancer risk approximations, were not calculated for VOC.

Observations from Table 18-9 include the following:

- Benzene was the highest emitted pollutant with cancer UREs in Union, Middlesex, Morris, and Camden Counties.
- In addition, benzene was the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for all four counties.
- Seven of the 10 highest emitted pollutants in Camden County also had the highest toxicity-weighted emissions; six of the highest emitted pollutants in Morris County also had the highest toxicity-weighted emissions; five of the highest emitted pollutants in Union County also had the highest toxicity-weighted emissions; and seven of the highest emitted pollutants in Middlesex County also had the highest toxicity-weighted emissions.
- As mentioned in the previous section, carbon tetrachloride, benzene, and acetaldehyde had the highest cancer risk approximations for CANJ, ELNJ, and NBNJ. Benzene appeared on all three lists for all four New Jersey sites. Acetaldehyde appeared on the list of 10 highest emitted pollutants for all four sites (and the list of highest toxicity-weighted emissions for NBNJ). Carbon tetrachloride did not appear on either emissions-based list for any site.

Observations from Table 18-10 include the following:

- Toluene was the highest emitted pollutant with cancer UREs in Union, Middlesex, Morris, and Camden Counties. However, this pollutant did not appear on any list for highest toxicity-weighted emissions.
- Acrolein was the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer RfCs) for all four counties. In addition, this pollutant had the highest noncancer risk approximation for the three sites where valid annual averages could be calculated.
- Three of the 10 highest emitted pollutants for all four counties (xylenes, benzene, and formaldehyde) also had the highest toxicity-weighted emissions.

18.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *The pollutants of interest common to each New Jersey site were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and tetrachloroethylene.*
- ❖ *Formaldehyde had the highest daily average concentration for three of the four sites, while acetaldehyde had the highest daily average concentration for the fourth (ELNJ).*
- ❖ *Seasonal averages of acrolein exceeded the intermediate MRL health benchmarks for all four sites.*

19.0 Sites in New York

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations collected at the NATTS sites in New York, and integrates these concentrations with emissions, meteorological, and risk information.

19.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the locations of the sites and the surrounding areas. The BXNY monitoring site is located in the New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA. ROCH is located in the Rochester, NY MSA. Figures 19-1 and 19-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban locations. Figures 19-3 and 19-4 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 19-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

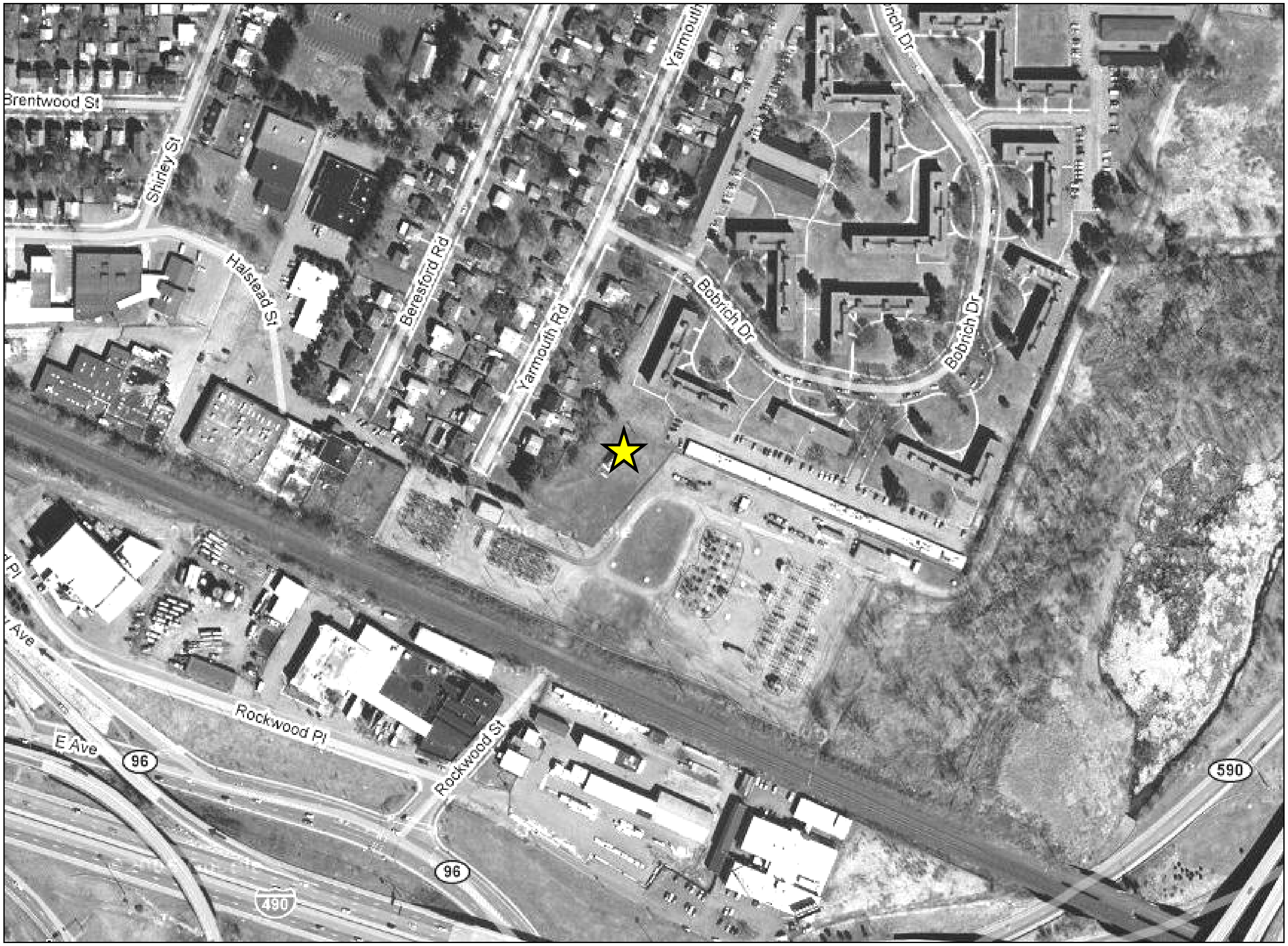
BXNY is located on the property of Public School 52 (PS 52) in the Bronx Borough of New York City, northeast of Manhattan. The site was established in 1999 and is considered one of the premier particulate sampling sites in New York City. The surrounding area is urban and residential, as shown in Figure 19-1. The Bruckner Expressway (I-278) is located a few blocks east of the monitoring site and other heavily traveled roadways are located within a few miles of the site. BXNY is less than a half mile from the East River. As Figure 19-3 shows, numerous point sources are located within 10 miles of the BXNY site. The bulk of the emission sources are located to the southwest of the site, with another cluster to the west. Many of the emission sources surrounding BXNY employ fuel combustion processes, use utility boilers, or are involved in liquids distribution. The point source closest to BXNY uses fuel combustion processes.

ROCH is located on the east side of Rochester, in western New York, at a power substation. Rochester is approximately half way between Syracuse and Buffalo, and Lake

Figure 19-1. Bronx, New York (BXNY) Monitoring Site

©2008 Google/©NAVTECH Scale: 3cm = 100m

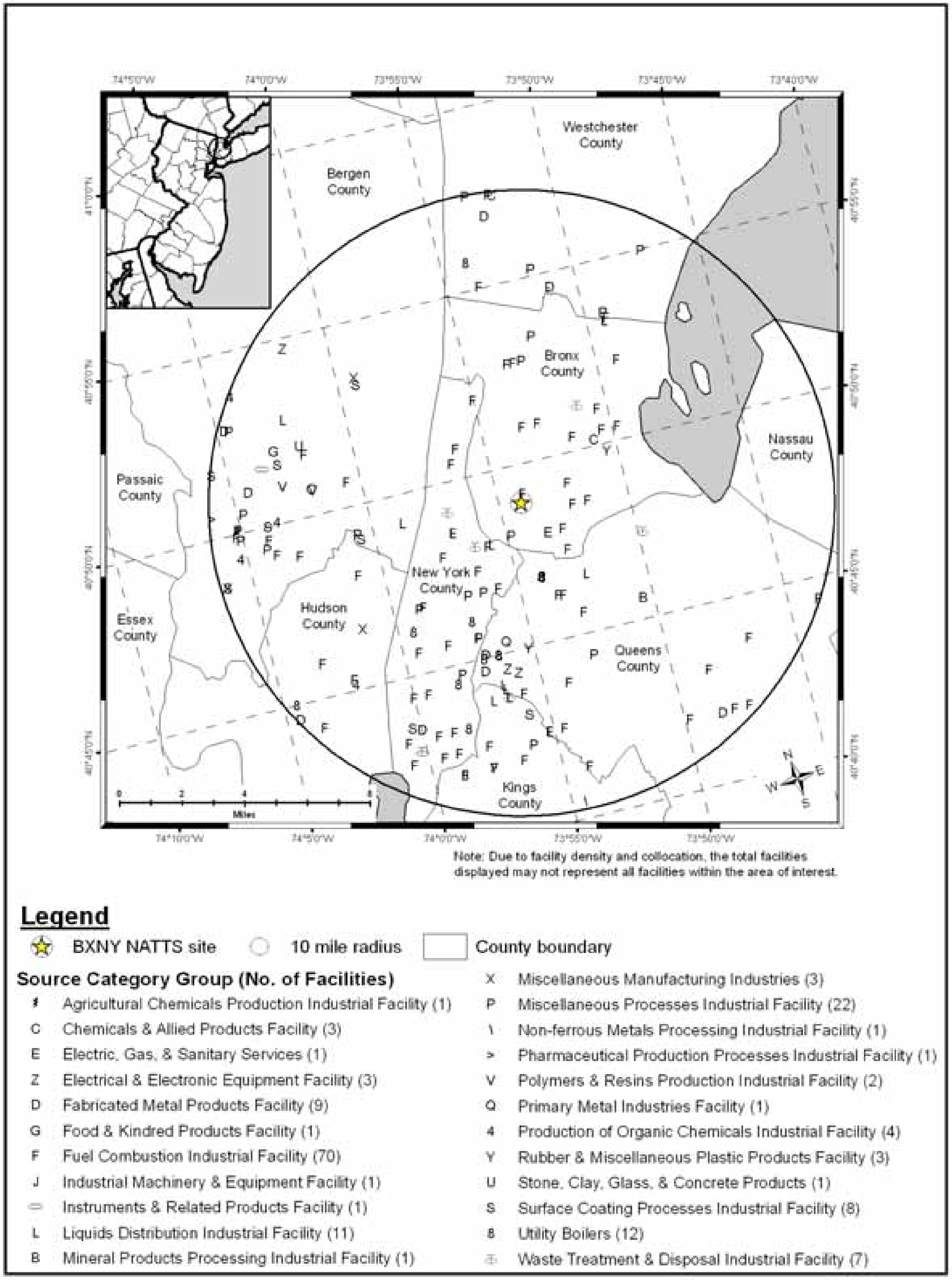
Figure 19-2. Rochester, New York (ROCH) Monitoring Site



©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 19-3. NEI Point Sources Located Within 10 Miles of BXNY



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 19-4. NEI Point Sources Located Within 10 Miles of ROCH

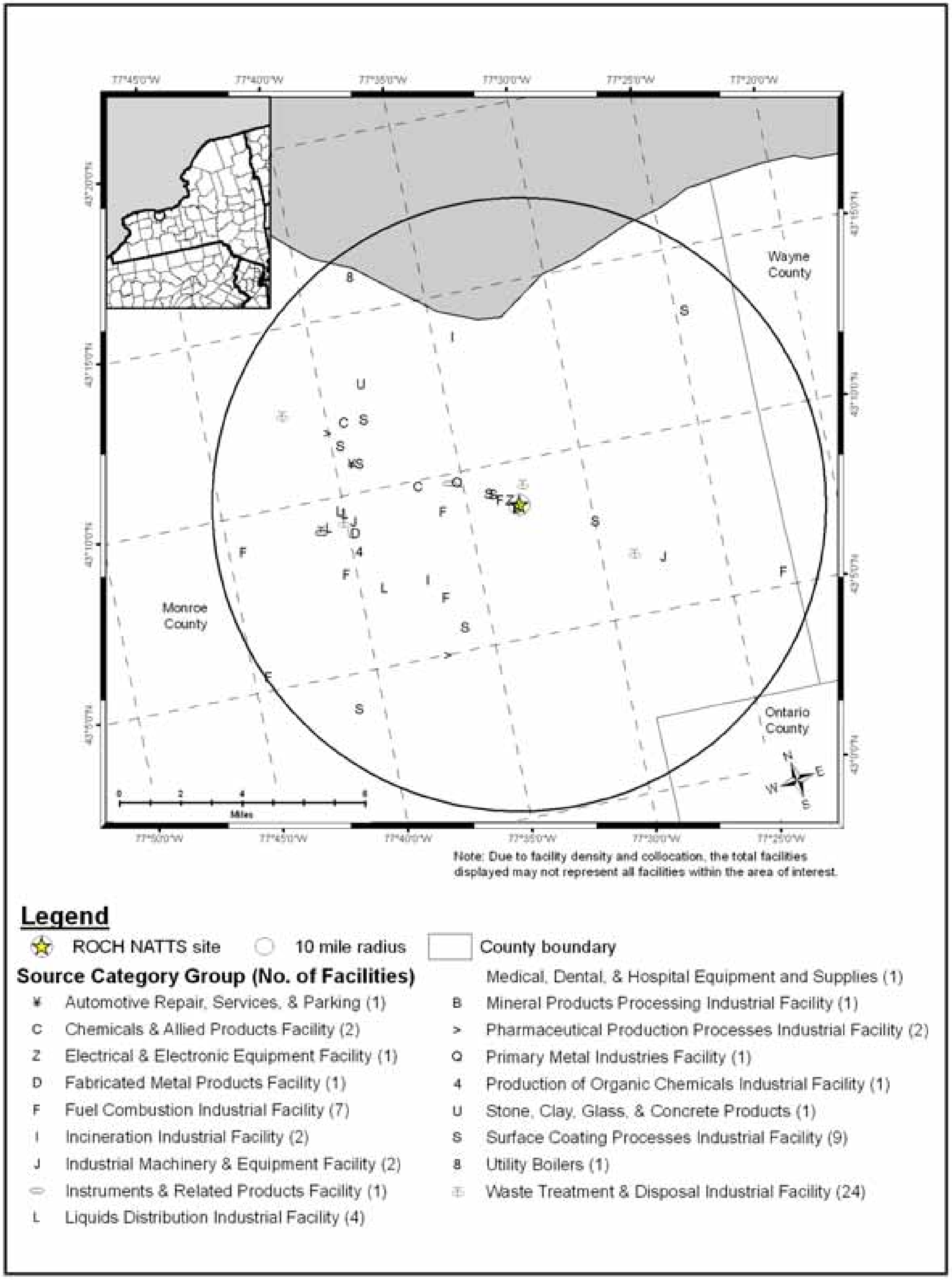


Table 19-1. Geographical Information for the New York Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
BXNY	36-005-0110	New York	Bronx	New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA	40.81616, -73.90207	Residential	Urban/City Center	This site was established in 1999 as a replacement site for Public School 155. Initially the site contained ozone, oxides of nitrogen, sulfur dioxide, continuous $PM_{2.5}$ and continuous PM_{10}. Following an upgrade of the electricity, additional monitoring parameters were added, creating one of the premier particulate sampling sites in New York City. The site contains criteria parameters and methods along with many experimental methods. This site is routinely utilized by outside entities for research and data comparison. Currently the Bureau is assisting Columbia University with the Multi-Ethnic Study of Atherosclerosis (MESA). The continuous fine particulate ($PM_{2.5}$) monitoring data from this site are reported to AirNow.
ROCH	36-055-1007	Rochester	Monroe	Rochester, NY MSA	43.146198, -77.54813	Residential	Urban/City Center	This site was established in 2004 to consolidate monitoring operations in the Rochester area. This is the major site in upstate New York and has been selected as a $PM_{2.5}$ Speciation Trends site, a NATTS site and an NCORE site. The Ozone and continuous $PM_{2.5}$ readings from this site are reported to AirNow. The site is also used by researchers from several universities for short term monitoring studies. Current research monitoring includes Mercury speciation and ultra-fine particle counting. Data from this site is often integrated in the work from the PM Health Center which is located at the University of Rochester Medical Center. The Rochester PM Center is one of five in the country.

BOLD = EPA-designated NATTS Site

Ontario lies further north. Although the area north and west of the site is primarily residential, as Figure 19-2 shows, a rail road transverses the area just south of the site, and I-590 and I-490 intersect further south. The site is used by researchers from several universities for short-term monitoring studies. As Figure 19-4 shows, point sources within a 10 mile radius of ROCH are located primarily to the west and northwest of the site. A number of the emission sources near the ROCH site are involved in waste treatment and disposal. The emission sources in closest proximity to ROCH are involved in mineral product processing and utilize electrical equipment.

Table 19-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the New York monitoring sites. County-level vehicle registration and population data for the Bronx and Monroe County were obtained from the New York State Department of Motor Vehicles and the U.S. Census Bureau. Table 19-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 19-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 19-2 presents the daily VMT for each urban area.

Table 19-2. Population, Motor Vehicle, and Traffic Information for the New York Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
BXNY	1,373,659	243,523	0.18	6,437,842	1,141,304	101,475	299,706
ROCH	729,681	552,452	0.76	636,955	482,248	111,600	16,038

[1] Daily Average Traffic Data reflects 2002 data from the New York State DOT (BXNY) and 2003 data from the New York State DOT (ROCH)

BOLD = EPA-designated NATTS Site

Observations from Table 19-2 include the following:

- The Bronx had the ninth highest county population but the highest 10-mile radius population of all NATTS and UATMP sites.

- The Bronx had the 31st highest county-level vehicle ownership. Although the 10-mile ownership estimate ranked seventh, given the large population within 10 miles, the vehicle per person ratio is very low (0.18), which was the lowest vehicle per person ratio. This might seem surprising given its high population, but may be explained by the use of mass transportation systems.

- The population surrounding ROCH is significantly lower than BXNY. However, the county-level vehicle ownership is higher near ROCH. The same is not true of the 10-mile ownership estimate.

- The population and vehicle ownership data were in the middle of the range of sites for ROCH.

- The traffic flow near both New York sites is fairly similar and ranked 10th and 11th among the NATTS and UATMP monitoring sites. The traffic data for BXNY was obtained from I-278 between I-87 & I-895; the traffic data for ROCH was obtained from I-490 between I-590 & Route 590.

- The New York City area VMT was the highest among urban areas with UATMP or NATTS sites. By comparison, VMT for the Rochester area ranked 21st.

19.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in New York on sampling days, as well as over the course of the year.

19.2.1 Climate Summary

Weather is somewhat variable in New York City as most frontal systems track across the area. Precipitation is spread fairly evenly throughout the year, with thunderstorms in the summer and fall and more significant rain or snow events in the winter and spring. The proximity to the Atlantic Ocean offers a moderating influence from cold outbreaks; the summer heat and the urban heat island effect also tend to keep the city warmer than outlying areas. In addition, air sinking down from the mountains from the west can help drive temperatures higher during warm spells (Ruffner and Bair, 1987).

Rochester is located in western New York and borders Lake Ontario’s south side. Elevation increases significantly from the shore to the southern most parts of the city, rising over 800 feet. While the lake acts as a moderating influence on the city’s temperatures, it also plays a major factor in the city's precipitation patterns. Lake effect snow enhances the area's snowfall totals, although snowfall rates tend to be higher near Lake Ontario than further inland (Ruffner and Bair, 1987).

19.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The two closest NWS weather stations are located at La Guardia International Airport (near BXNY) and Greater Rochester International Airport (near ROCH), WBAN 14732 and 14768, respectively.

Table 19-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 19-3 is the 95 percent confidence interval for each parameter. As shown in Table 19-3, average meteorological conditions on sampling days appear cooler than for the entire year. Both New York sites began sampling October. Therefore, the sample day averages represent only the final three months of the year, which likely explains the differences seen in Table 19-3.

19.2.3 Composite Back Trajectories for Sampling Days

Figures 19-5 and 19-6 are composite back trajectory maps for the New York monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 19-5 and 19-6 represents 100 miles.

Observations from Figures 19-5 and 19-6 include the following:

- The back trajectory maps for BXNY and ROCH include approximately a quarter of the back trajectories that would be shown for a site sampling for the entire year. As such, the maps might look much different if an entire year's worth of trajectories were shown.

Table 19-3. Average Meteorological Conditions near the New York Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
BXNY	La Guardia Airport 14732	Sampling Day	57.80 ± 4.86	51.26 ± 7.12	40.06 ± 7.40	46.10 ± 6.62	67.21 ± 5.19	1019.57 ± 2.57	7.85 ± 1.18
		All 2007	63.28 ± 1.95	56.71 ± 1.84	40.26 ± 1.93	48.91 ± 1.64	56.85 ± 1.41	1016.75 ± 0.77	9.27 ± 0.36
ROCH	Greater Rochester Intl Airport 14768	Sampling Day	52.07 ± 7.58	44.70 ± 6.58	36.27 ± 6.36	40.93 ± 6.06	73.73 ± 4.45	1018.11 ± 2.96	7.60 ± 1.57
		All 2007	57.88 ± 2.22	49.61 ± 1.97	37.92 ± 1.83	44.02 ± 1.74	67.07 ± 1.13	1016.82 ± 0.73	7.99 ± 0.35

BOLD = EPA-designated NATTS Site

Figure 19-5. Composite Back Trajectory Map for BXNY

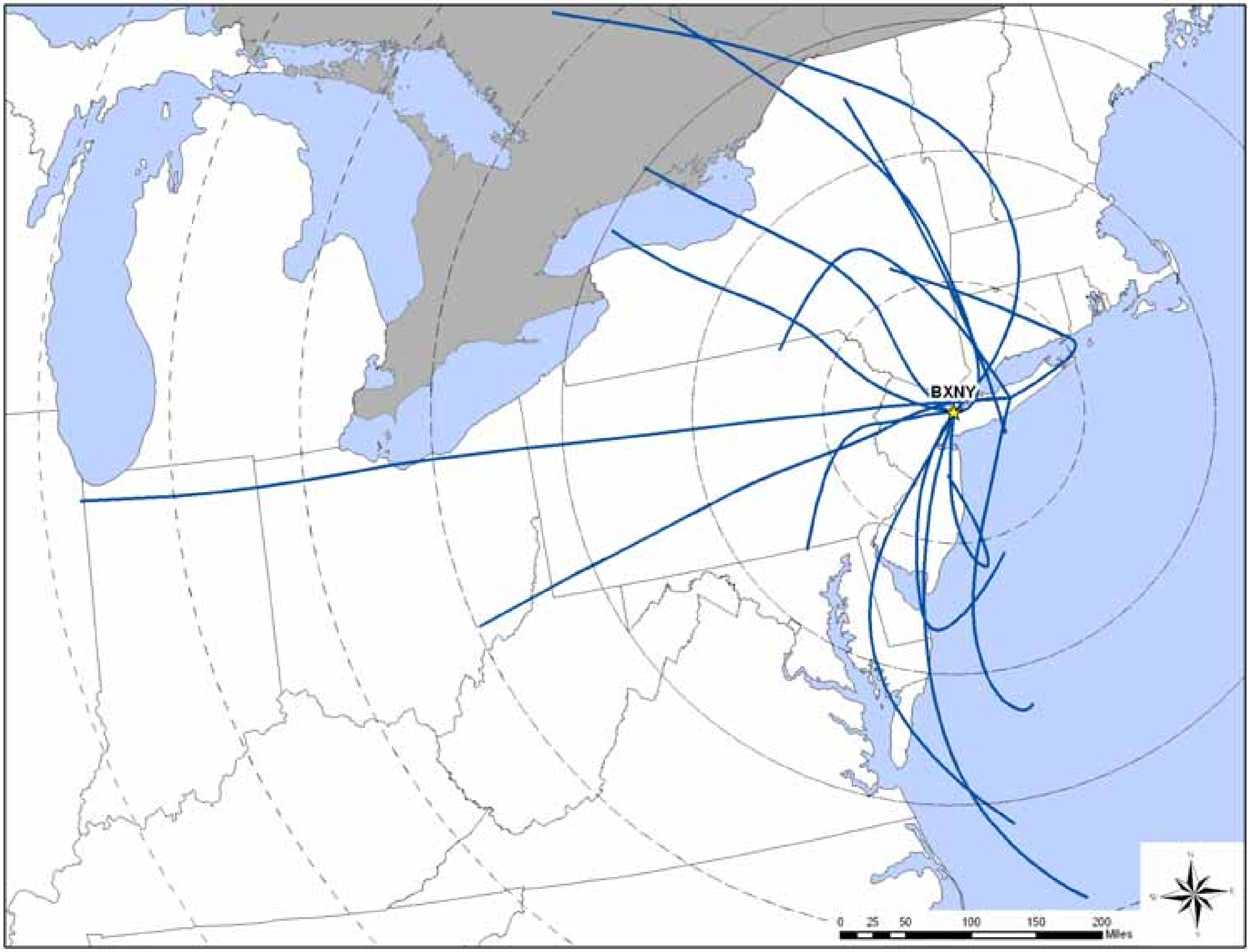
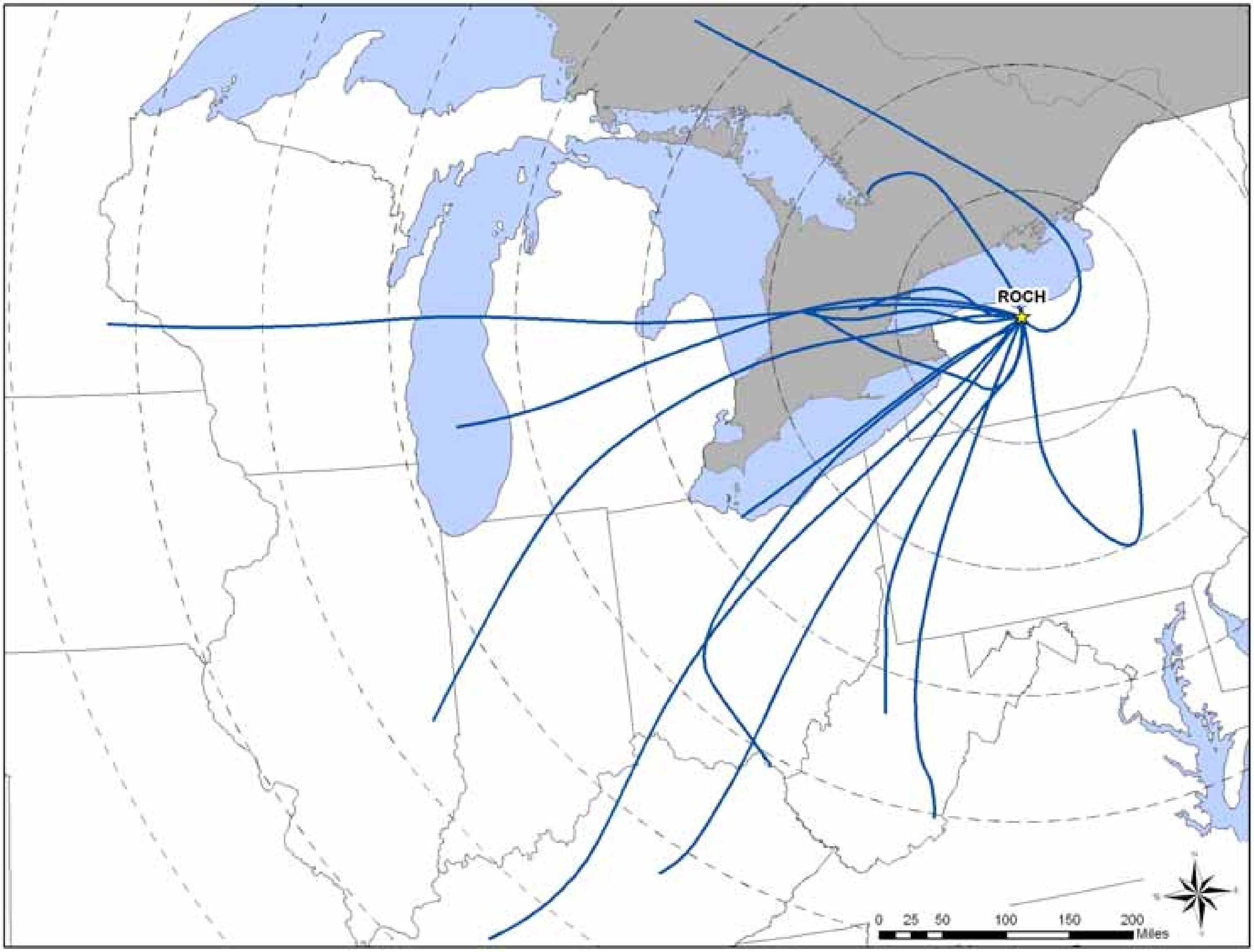


Figure 19-6. Composite Back Trajectory Map for ROCH



- Back trajectories originated from a variety of directions at BXNY, although rarely from the east and southeast. Trajectories primarily originated from the southwest and west at ROCH.

- The 24-hour air shed domains for BXNY and ROCH were comparable in size to each other, as well as other NATTS and UATMP sites. The longest trajectory for both sites was for the same day, December 14, 2007, where the trajectory originated due west of the sites (near Lake Michigan for BXNY and southeast Minnesota for ROCH). However, most trajectories originated within 500 miles of the sites.

19.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations near BXNY and ROCH were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 19-7 and 19-8 are the wind roses for the New York monitoring sites on days that samples were collected. Similar to the back trajectory maps, the wind roses might look much different if an entire year's worth of observations were shown.

Observations from Figure 19-7 for BXNY include the following:

- Winds from a variety of directions were observed near BXNY, although southerly and northwesterly winds were observed the most.

- Calm winds were observed for approximately eight percent of the hourly measurements. Winds exceeding 11 knots made up approximately 18 percent of observations.

Observations from Figure 19-8 for ROCH include the following:

- The wind rose for ROCH is very different than the wind rose for BXNY.

- Winds from the south, southwest, and west were observed more frequently than winds from other directions.

- Calm winds were observed for nearly 11 percent of the hourly measurements. Winds exceeding 11 knots made up approximately 21 percent of observations. These stronger winds also tended to be from the south, southwest, and west.

Figure 19-7. Wind Rose for BXNY Sampling Days

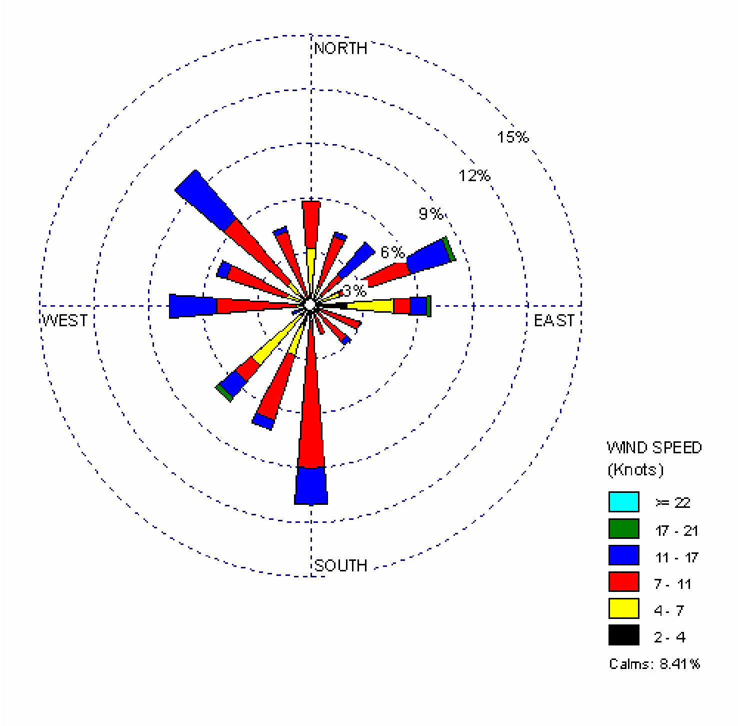
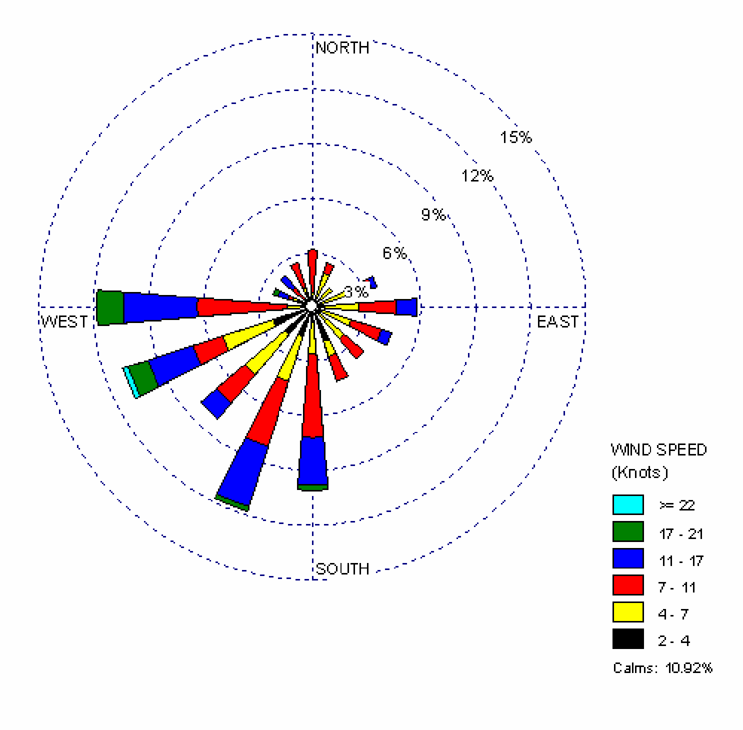


Figure 19-8. Wind Rose for ROCH Sampling Days



19.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the New York monitoring sites were identified using the EPA risk screening process described in Section 3.2. Each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 19-4 presents the pollutants that failed at least one screen for each New York monitoring site and highlights each site's pollutants of interest (shaded). Both New York sites sampled hexavalent chromium.

Observations from Table 19-4 include the following:

- There were no exceedances of the screening value for hexavalent chromium concentrations measured at BXNY. This pollutant is considered a pollutant of interest in order to facilitate analysis for BXNY.

- One measured detection of hexavalent chromium failed a screen for ROCH. This represents an 11 percent failure rate.

Table 19-4. Comparison of Measured Concentrations and EPA Screening Values for the New York Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Bronx, New York - BXNY					
Hexavalent Chromium	0	12	0.00	0.00	0.00
Total	0	12	0.00		
Rochester, New York - ROCH					
Hexavalent Chromium	1	9	11.11	100.00	100.00
Total	1	9	11.11		

19.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the New York monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

19.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and whee the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 19-5, where applicable. Please note that concentration averages have been converted to ng/m^3 in Table 19-5 for ease of viewing.

Table 19-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the New York Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (ng/m^3)	Winter Average (ng/m^3)	Spring Average (ng/m^3)	Summer Average (ng/m^3)	Autumn Average (ng/m^3)	Annual Average (ng/m^3)
Bronx, New York - BXNY								
Hexavalent Chromium	12	15	0.029 ± 0.009	NR	NA	NA	0.028 ± 0.011	NA
Rochester, New York - ROCH								
Hexavalent Chromium	9	13	0.032 ± 0.015	NR	NA	NA	0.029 ± 0.016	NA

NR = Not reportable due to the detection criteria for calculating a seasonal average
NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

Observations for BXNY and ROCH from Table 19-5 include the following:

- The daily average concentration of hexavalent chromium was somewhat higher at ROCH than BXNY. However, the confidence intervals indicate that the difference is not significant.

- Seasonal averages of hexavalent chromium could only be calculated for autumn, due to the start date of sampling.

19.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one ore more the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. The New York sites have not sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

19.5 Pearson Correlations

Table 19-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations from Table 19-6 include the following:

- All of the correlations for BXNY were weak.

- The correlations between hexavalent chromium concentrations from ROCH and the temperature and moisture variables were strong and positive. This suggests that as temperature and moisture content increase, concentration of hexavalent chromium tend to increase at ROCH. However, the number of measured detections was low (9). Basing correlations on a low number of samples may skew the correlations.

19.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Sections 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

Table 19-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the New York Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Bronx, New York - BXNY								
Hexavalent Chromium	12	0.10	0.11	0.03	0.08	-0.21	-0.35	0.23
Rochester, New York - ROCH								
Hexavalent Chromium	9	0.51	0.56	0.68	0.62	0.31	-0.27	-0.20

19.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the New York monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the concentrations of hexavalent chromium measured at the BXNY and ROCH sites exceeded any of the MRL risk values.

19.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the New York monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 19-7. The data from NATA are presented for the census tract where the monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the New York sites is as follows:

- The census tract for BXNY is 36005008500, which had a population of 5,428, and represented less than one percent of the Bronx population in 2000.
- The census tract for ROCH is 36055007700, which had a population of 2,952, and represented less than one percent of the Monroe County population in 2000.

Table 19-7. Cancer and Noncancer Risk Summary for the Monitoring Sites in New York

Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**1999 NATA**			**2007 NATTS/UATMP**		
			Modeled Concentration (µg/m^3)	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Bronx, New York (BXNY) - Census Tract ID 36005008500								
Hexavalent Chromium	0.012	0.0001	<0.01	0.81	<0.01	NA	NA	NA
Rochester, New York (ROCH) - Census Tract ID 36055007700								
Hexavalent Chromium	0.012	0.0001	<0.01	0.85	<0.01	NA	NA	NA

Bold = pollutant of interest

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

Observations for New York sites from Table 19-7 include the following:

- Hexavalent chromium was the only pollutant for which samples were collected at the New York sites.

- The NATA modeled concentration and risk estimates for hexavalent chromium were similar for the New York sites. Both estimates were below the level of concern.

- Annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for hexavalent chromium due to the sampling duration criteria.

19.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 19-8 and 19-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 19-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 19-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for hexavalent chromium. Therefore, the cancer and noncaner surrogate risk approximations based on each site’s annual averages are limited to that pollutant. The cancer and noncancer risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated. Because sampling did not begin at the New York sites until October, cancer and noncancer risk approximations were not calculated.

Observations from Table 19-8 include the following:

- Tetrachloroethylene, benzene, and formaldehyde were the highest emitted pollutants with cancer UREs in the Bronx; benzene, dichloromethane, and formaldehyde were the highest emitted pollutants with cancer UREs in Monroe County.

Table 19-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in New York

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Bronx, New York (BXNY) – Bronx County					
Tetrachloroethylene	304.00	Naphthalene	2.25E-03		
Benzene	271.05	Benzene	2.11E-03		
Formaldehyde	139.54	Tetrachloroethylene	1.79E-03		
Dichloromethane	134.42	1,3-Butadiene	9.72E-04		
1,3-Dichloropropene	108.32	Hexavalent Chromium	8.60E-04		
Naphthalene	66.14	1,3-Dichloropropene	4.33E-04		
Acetaldehyde	46.15	Arsenic, PM	2.95E-04		
1,3-Butadiene	32.41	*p*-Dichlorobenzene	2.63E-04		
p-Dichlorobenzene	23.90	Nickel, PM	1.80E-04		
Vinyl chloride	7.72	Acetaldehyde	1.02E-04		
Rochester, New York (ROCH) – Monroe County					
Benzene	683.49	Benzene	5.33E-03		
Dichloromethane	569.66	Naphthalene	2.35E-03		
Formaldehyde	190.12	1,3-Butadiene	1.85E-03		
Tetrachloroethylene	149.57	Hexavalent Chromium	1.14E-03		
Acetaldehyde	70.79	Tetrachloroethylene	8.82E-04		
Naphthalene	69.26	POM, Group 2	8.21E-04		
1,3-Butadiene	61.73	Arsenic, PM	7.15E-04		
1,3-Dichloropropene	59.07	POM, Group 5	2.96E-04		
Trichloroethylene	37.57	Dichloromethane	2.68E-04		
POM, Group 2	14.94	1,3-Dichloropropene	2.36E-04		

Table 19-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in New York

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Bronx, New York (BXNY) – Bronx County					
Methanol	824.37	Acrolein	978,214.02		
Toluene	820.92	Bromomethane	30,060.01		
Xylenes	729.47	Naphthalene	22,046.79		
Methyl *tert*-butyl ether	587.40	Nickel, PM	17,335.76		
Hexane	478.12	Cyanide Compounds, gas	16,843.33		
1,1,1-Trichloroethane	322.20	1,3-Butadiene	16,204.46		
Tetrachloroethylene	304.00	Formaldehyde	14,238.47		
Benzene	271.05	Manganese, PM	10,131.93		
Ethylene glycol	164.83	Benzene	9,034.93		
Bromomethane	150.30	Xylenes	7,294.71		
Rochester, New York (ROCH) – Monroe County					
Toluene	1,828.38	Acrolein	592,660.55		
Xylenes	1,272.49	1,3-Butadiene	30,864.96		
Methanol	877.96	Hydrochloric acid	27,370.91		
Benzene	683.49	Naphthalene	23,086.30		
Dichloromethane	569.66	Benzene	22,782.84		
Hexane	553.87	Formaldehyde	19,399.94		
Hydrochloric acid	547.42	Nickel, PM	19,031.82		
Methyl isobutyl ketone	522.58	Bromomethane	16,401.62		
Ethylene glycol	418.54	Xylenes	12,724.95		
1,1,1-Trichloroethane	307.27	Cyanide Compounds, gas	9,295.79		

- The two pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene and naphthalene for both counties, although not necessarily in that order.

- Six of the highest emitted pollutants also had the highest toxicity-weighted emissions for the Bronx; seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for Monroe County.

- Hexavalent chromium, which was the only pollutant sampled at either site, appeared on the list of highest toxicity-weighted emissions for both counties.

Observations from Table 19-9 include the following:

- Methanol, xylenes, and toluene were the highest emitted pollutants with noncancer RfCs in both counties, although not necessarily in that order.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) was acrolein for both counties.

- Three of the highest emitted pollutants in both counties also had the highest toxicity-weighted emissions.

- Hexavalent chromium did not appear on either emissions-based noncancer list.

19.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *Hexavalent chromium failed one screen for ROCH and did not fail any screens for BXNY.*

- ❖ *Hexavalent chromium did not exceed any of the MRL health benchmarks for either site.*

20.0 Sites in Oklahoma

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP sites in Oklahoma, and integrates these concentrations with emissions, meteorological, and risk information.

20.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. Three Oklahoma sites (TOOK, TSOK, and TUOK) are located in the Tulsa, OK MSA. The fourth site, CNEP, is located south of Pryor, Oklahoma. Figures 20-1 through 20-4 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban and rural locations. Additionally, Figures 20-5 and 20-6 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 20-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

The CNEP monitoring site was established by the Cherokee Nation Environmental Program in the tribal community of Cherokee Heights, about halfway between the towns of Pryor and Locust Grove, in northeastern Oklahoma. Due to the rural nature of the area, a close-in satellite map is not available. However, Figure 20-1 does show major topographic features of the area, including a branch of the Grand River from Lake Hudson. The immediate area is rural and agricultural. An industrial park is located to the west of the community. Figure 20-5 shows that eleven point sources are located within 10 miles of CNEP. The emission sources are involved in varying processes, including source categories such as pulp and paper production, fuel combustion, and chemical product production.

TOOK is located in West Tulsa, on the southwest side of the Arkansas River. The site is located in the parking lot of the Public Works building. The surrounding area is primarily industrial. As shown in Figure 20-2, an oil refinery is located just south of the site. Another refinery is located to the northwest of the site. The monitoring site is positioned between the

Figure 20-1. Cherokee Heights, Pryor, Oklahoma (CNEP) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 1 mile

Figure 20-2. Tulsa, Oklahoma (TOOK) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 20-3. Tulsa, Oklahoma (TSOK) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 20-4. Tulsa, Oklahoma (TUOK) Monitoring Site

©2008 Google/©NAVTECH Scale: 3cm = 100m

Figure 20-5. NEI Point Sources Located Within 10 Miles of CNEP

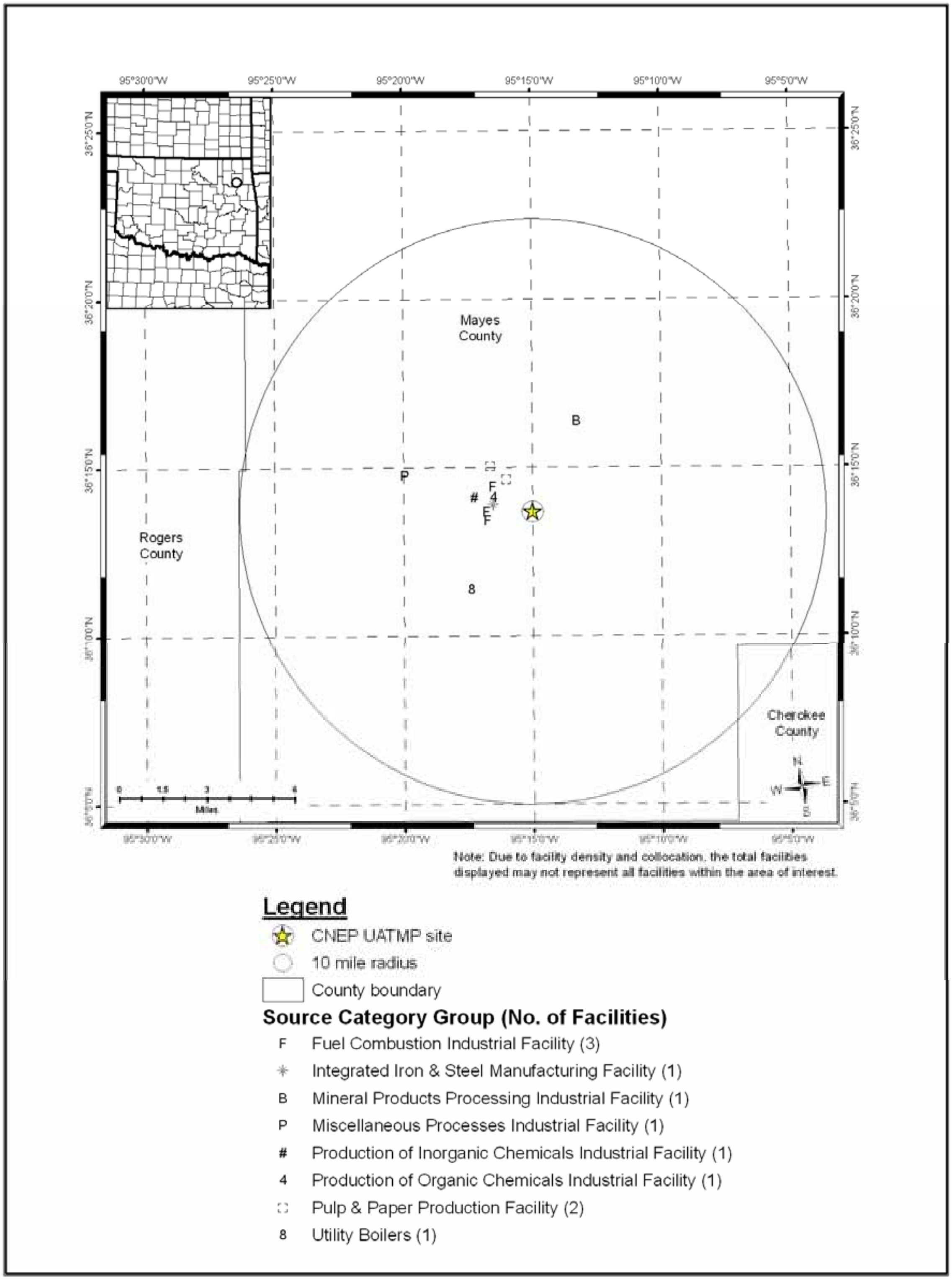


Figure 20-6. NEI Point Sources Located Within 10 Miles of TOOK, TSOK and TUOK

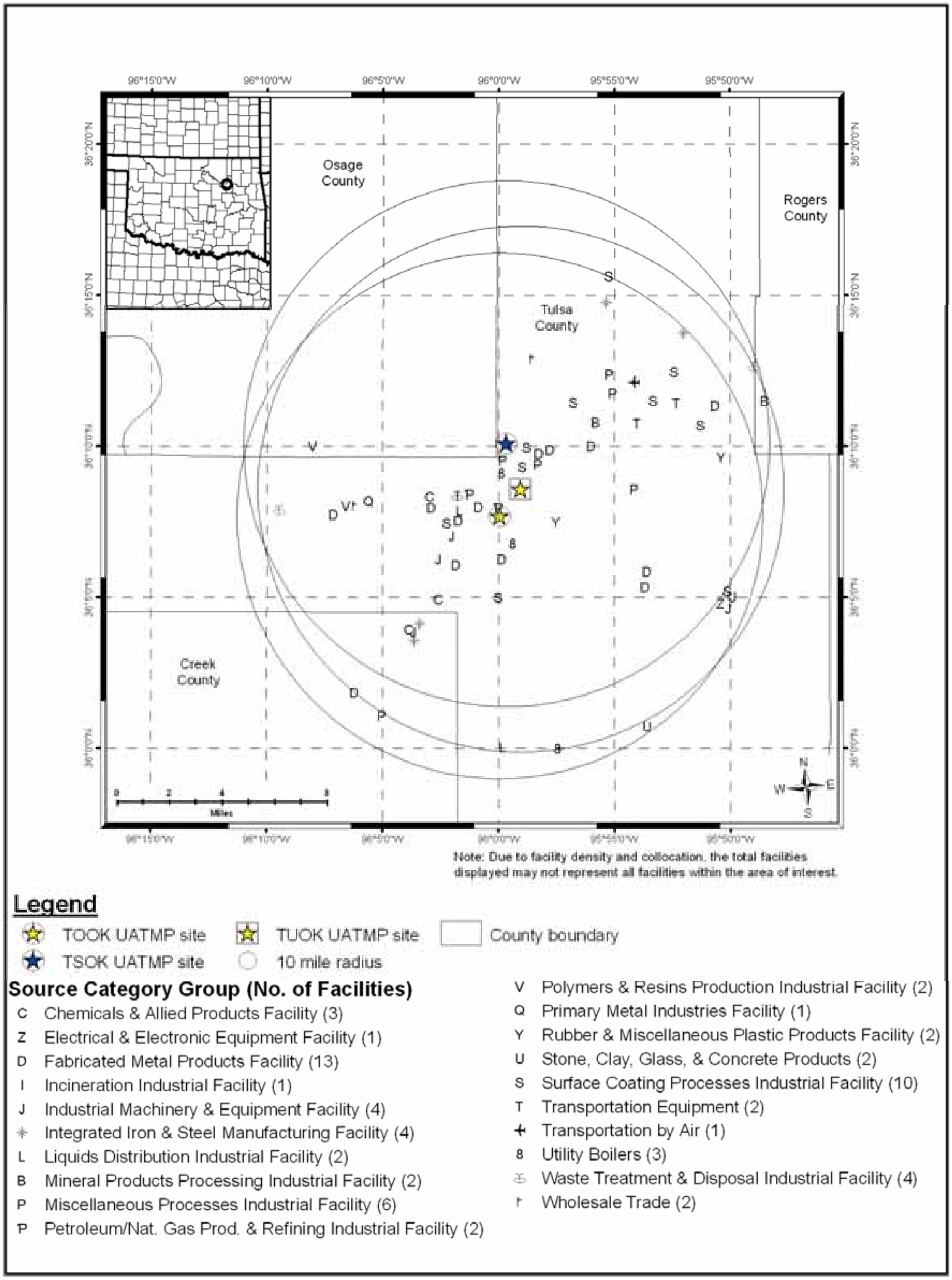


Table 20-1. Geographical Information for the Oklahoma Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
CNEP	40-097-9014	Pryor	Mayes	Not in an MSA	36.2284, -95.25	Agricultural	Rural	The CNEP established this ambient air monitoring site on tribal trust land at the Cherokee Heights community in 2004. The purpose of this sampling project is to obtain additional data about the concentrations of VOCs in ambient air at the Pryor site and in the adjacent Cherokee Heights tribal community. This site is approximately 3.8 miles from the coal-fired power plant, 1.5 miles from the gas-fired power plant, and 0.75 mile from the sewage lagoon of the industrial park. Current instrumentation at the site includes the following: R & P TEOM for continuous PM10 measurement (Federal Equivalent Method), R & P TEOM with FDMS for continuous $PM_{2.5}$ measurement (the FDMS includes reference flow to account for volatile loss), R & P 2025 sequential sampler for $PM_{2.5}$ (Federal Reference Method), API gaseous monitors for NO_x, NOy, ozone, and SO_2, and MetOne meteorological instruments for wind speed, wind direction, ambient temperature, and relative humidity.
TOOK	40-143-0235	Tulsa	Tulsa	Tulsa, OK	36.126945, -95.998941	Industrial	Urban/City Center	This site is located approximately ¾ mile east of I-244. It is primarily located in an industrial area with Sun Refinery approximately 2 miles NW and Sinclair Refinery approximately ¼ mile South of site. It contains SO_2, H_2S, TSP Metals, and Toxics (VOC and Carbonyl).

Table 20-1. Geographical Information for the Oklahoma Monitoring Sites (Continued)

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
TSOK	40-143-0172	Tulsa	Tulsa	Tulsa, OK	36.164435, -95.985204	Residential	Suburban	The Greenwood site is located approximately 200 yards N-NE of I-244 on the Oklahoma State University at Tulsa Campus. It is primarily neighborhood scale with no major industry nearby. A railroad track switching site is located approximately 50 ft. SE of the site. It contains TSP Metals and Toxics (VOC and Carbonyl).
TUOK	40-143-0191	Tulsa	Tulsa	Tulsa, OK	36.141697, -95.983793	Residential	Urban/City Center	This site is located approximately 50 ft. south of Highway 51, a major crosstown expressway. It is primarily neighborhood scale with no major industry nearby and influenced primarily by downtown traffic. It contains CO, PM_{10}, TSP Metals, and Toxics (VOC and Carbonyl).

Arkansas River and I-244, which runs parallel to Southwest Boulevard (which is pictured in Figure 20-2). A rail yard is located on the opposite side of I-244.

TSOK is located in central Tulsa, north of Exit 6 on I-244 and west of US-75. The site is located on the property of Oklahoma State University's Tulsa campus, as shown in Figure 20-3. Roberts Park is located to the north of the site and a railroad switching station is located very close the monitoring site. Much of the surrounding area is residential.

TUOK is located just on the other side of the Arkansas River from TOOK, in downtown Tulsa. The site is located just south of the US-64/US-75/Highway 51 interchange, as shown in Figure 20-4. Although commercial areas are located immediately to the west, the surrounding areas are primarily residential.

Figure 20-6 shows that the three Tulsa sites are within 5 miles of each other, and are surrounded by more point sources than CNEP. Most of the emission sources are located along a line running northeast-southwest across Tulsa County. Fabricated metal production and surface coating processes are the most numerous emission sources surrounding the Tulsa sites.

Table 20-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Oklahoma monitoring sites. County-level vehicle registration and population data for Tulsa and Mayes County were obtained from the Oklahoma Tax Commission and the U.S. Census Bureau. Table 20-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 20-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 20-2 presents the daily VMT for each urban area (where applicable).

Table 20-2. Population, Motor Vehicle, and Traffic Information for the Oklahoma Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
CNEP	39,627	29,398	0.74	29,152	21,627	5	NA
TOOK	585,068	506,011	0.86	461,773	399,376	67,092	20,904
TSOK	585,068	506,011	0.86	337,331	291,749	33,800	20,904
TUOK	585,068	506,011	0.86	463,689	401,033	45,300	20,904

[1] Daily Average Traffic Data reflects data from the AIRS/AQS (CNEP) and 2006 data from the Oklahoma DOT (TOOK, TSOK, TUOK)

Observations from Table 20-2 include the following:

- The Mayes County (CNEP) population is significantly lower than the Tulsa County population. This is also true of the 10-mile population. Compared to other monitoring sites, the Tulsa populations were in the middle of the range, while CNEP's populations were on the low end.

- The Mayes County vehicle registration and 10-mile estimated vehicle registration data are also significantly lower than similar information in Tulsa County. These observations are expected given the rural nature of the area surrounding CNEP compared to the urban location of the Tulsa sites. Compared to other monitoring sites, the ownership estimates followed a similar pattern as the populations.

- The average daily traffic volume passing the CNEP site is considerably lower than each of the Tulsa sites, and is the lowest compared to all other monitoring sites. Of the three Tulsa sites, TOOK experiences the highest daily traffic, while TSOK experiences the least.

- VMT for the Tulsa MSA is approximately 21 million miles, which is relatively low compared to other urban areas. For comparison purposes, VMT for the New York City area is 300 million miles. VMT was not available for CNEP.

20.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Oklahoma on sampling days, as well as over the course of the year.

20.2.1 Climate Summary

Tulsa is located in northeast Oklahoma, just southeast of the Osage Indian Reservation, and along the Arkansas River. The area is characterized by a continental climate, with warm and humid summers and cool winters. The region experiences ample rainfall, with spring as the wettest season. A southerly wind prevails, bringing warm, moist air northward from the Gulf of Mexico. Pryor is also in northeast Oklahoma, approximately 30 miles east of Tulsa, so the climate is much like that of Tulsa. Oklahoma is part of "Tornado Alley", where severe thunderstorms are capable of producing strong winds, hail, and tornadoes. Tornadoes are more prevalent here than any other region in the U.S. (Ruffner and Bair, 1987).

20.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The three closest NWS weather stations are located at Claremore Regional Airport (near CNEP), Richard Lloyd Jones Jr. Airport (near TOOK and TUOK), and Tulsa International Airport (near TSOK), WBAN 53940, 53908, and 13968, respectively.

Table 20-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 20-3 is the 95 percent confidence interval for each parameter. As shown in Table 20-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

20.2.3 Composite Back Trajectories for Sampling Days

Figures 20-7 through 20-10 are composite back trajectory maps for the Oklahoma monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 20-7 through 20-10 represents 100 miles.

Table 20-3. Average Meteorological Conditions near the Oklahoma Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CNEP	Claremore Regional Airport 53940	Sampling Day	70.68 ± 4.40	60.81 ± 4.17	48.93 ± 4.26	54.73 ± 4.17	68.71 ± 2.96	NA	6.22 ± 0.85
		All 2007	70.03 ± 1.85	59.79 ± 1.78	47.74 ± 1.88	53.73 ± 1.78	68.20 ± 1.17	NA	6.29 ± 0.33
TOOK	Richard Lloyd Jones Jr. Airport 53908	Sampling Day	73.52 ± 4.11	63.12 ± 3.99	51.93 ± 4.08	56.92 ± 3.70	69.84 ± 2.52	1017.64 ± 1.38	5.37 ± 0.68
		All 2007	71.45 ± 1.88	60.91 ± 1.82	49.23 ± 1.91	54.68 ± 1.71	68.61 ± 1.15	1017.81 ± 0.64	5.41 ± 0.28
TSOK	Tulsa International Airport 13968	Sampling Day	73.08 ± 4.30	63.32 ± 4.23	50.66 ± 4.17	56.32 ± 3.79	66.39 ± 2.89	1016.35 ± 1.49	7.57 ± 0.82
		All 2007	71.23 ± 1.88	61.65 ± 1.84	48.86 ± 1.90	54.80 ± 1.69	65.96 ± 1.29	1016.59 ± 0.66	7.71 ± 0.34
TUOK	Richard Lloyd Jones Jr. Airport 53908	Sampling Day	73.43 ± 4.17	62.94 ± 4.04	51.64 ± 4.11	56.69 ± 3.73	69.61 ± 2.52	1017.62 ± 1.40	5.34 ± 0.68
		All 2007	71.45 ± 1.88	60.91 ± 1.82	49.23 ± 1.91	54.68 ± 1.71	68.61 ± 1.15	1017.81 ± 0.64	5.41 ± 0.28

NA = Sea level pressure was not recorded at the Claremore Regional Airport

Figure 20-7. Composite Back Trajectory Map for CNEP

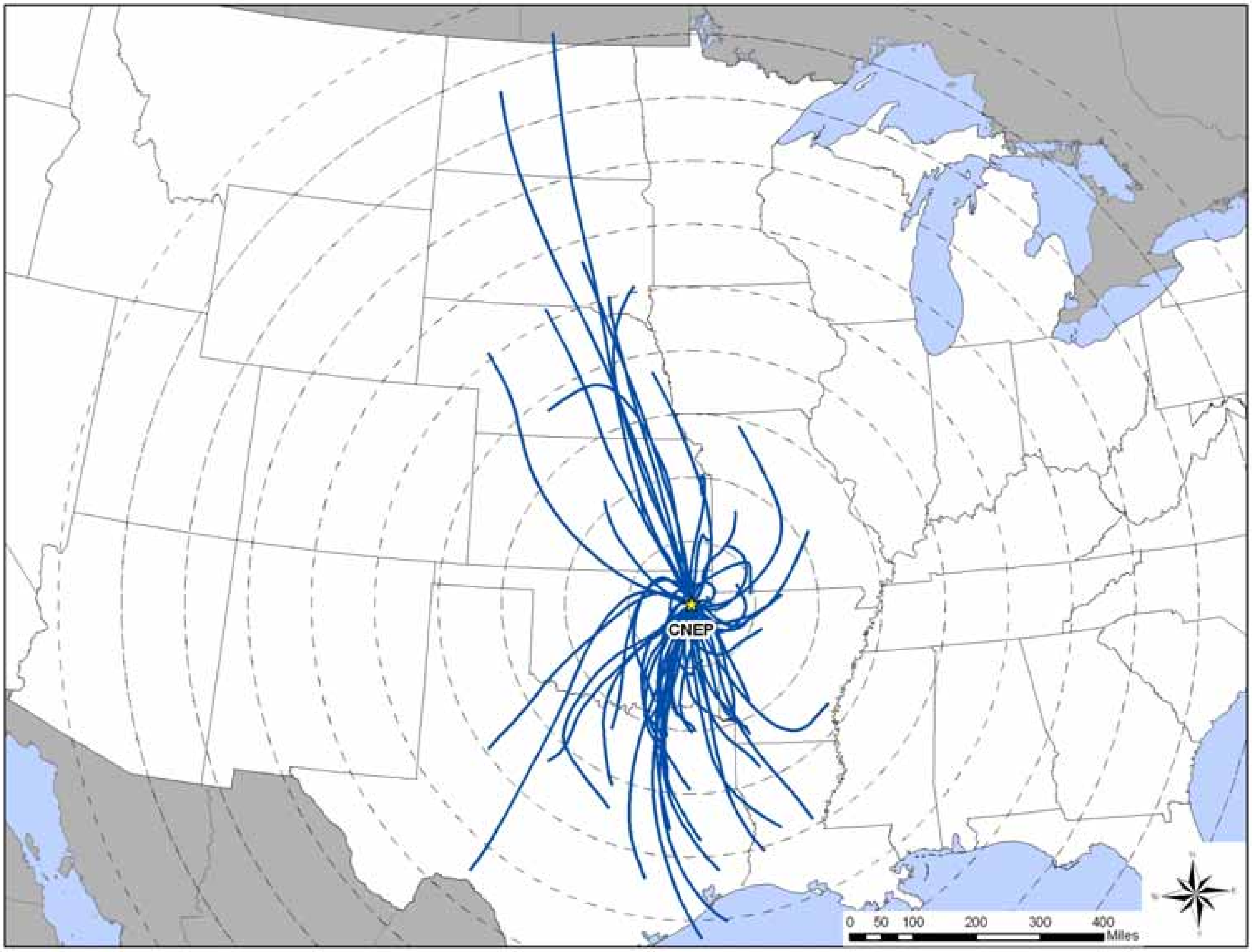


Figure 20-8. Composite Back Trajectory Map for TOOK

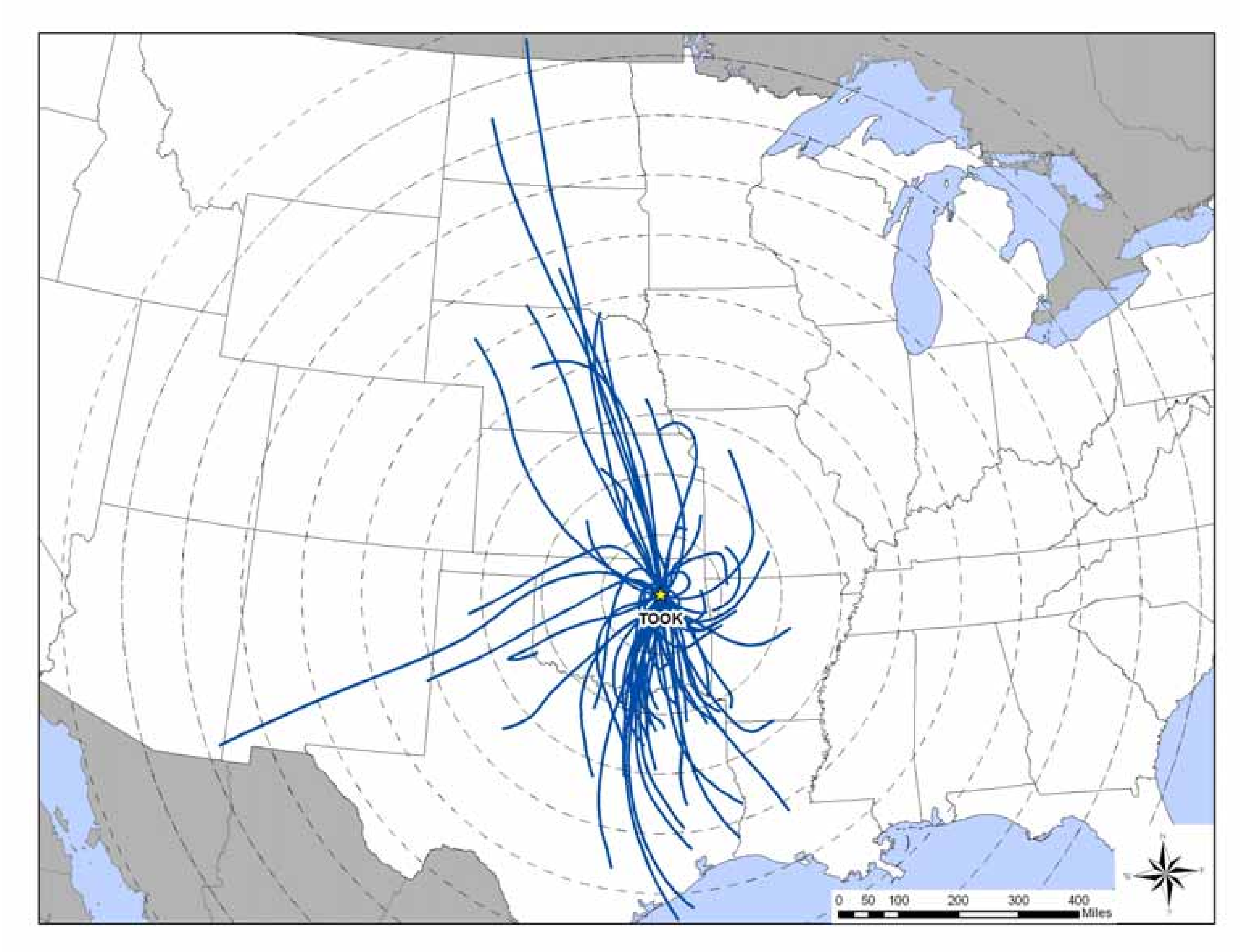


Figure 20-9. Composite Back Trajectory Map for TSOK

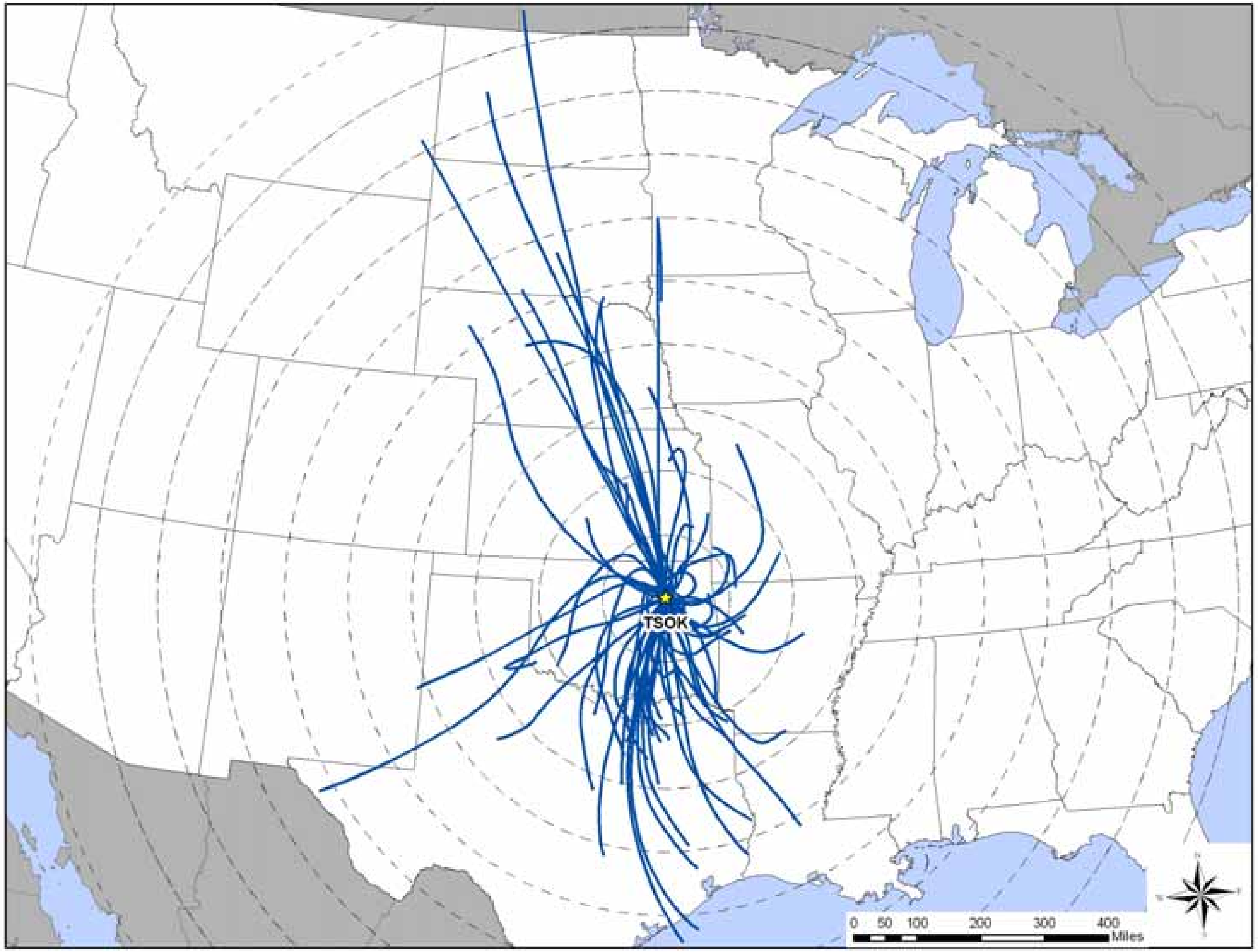
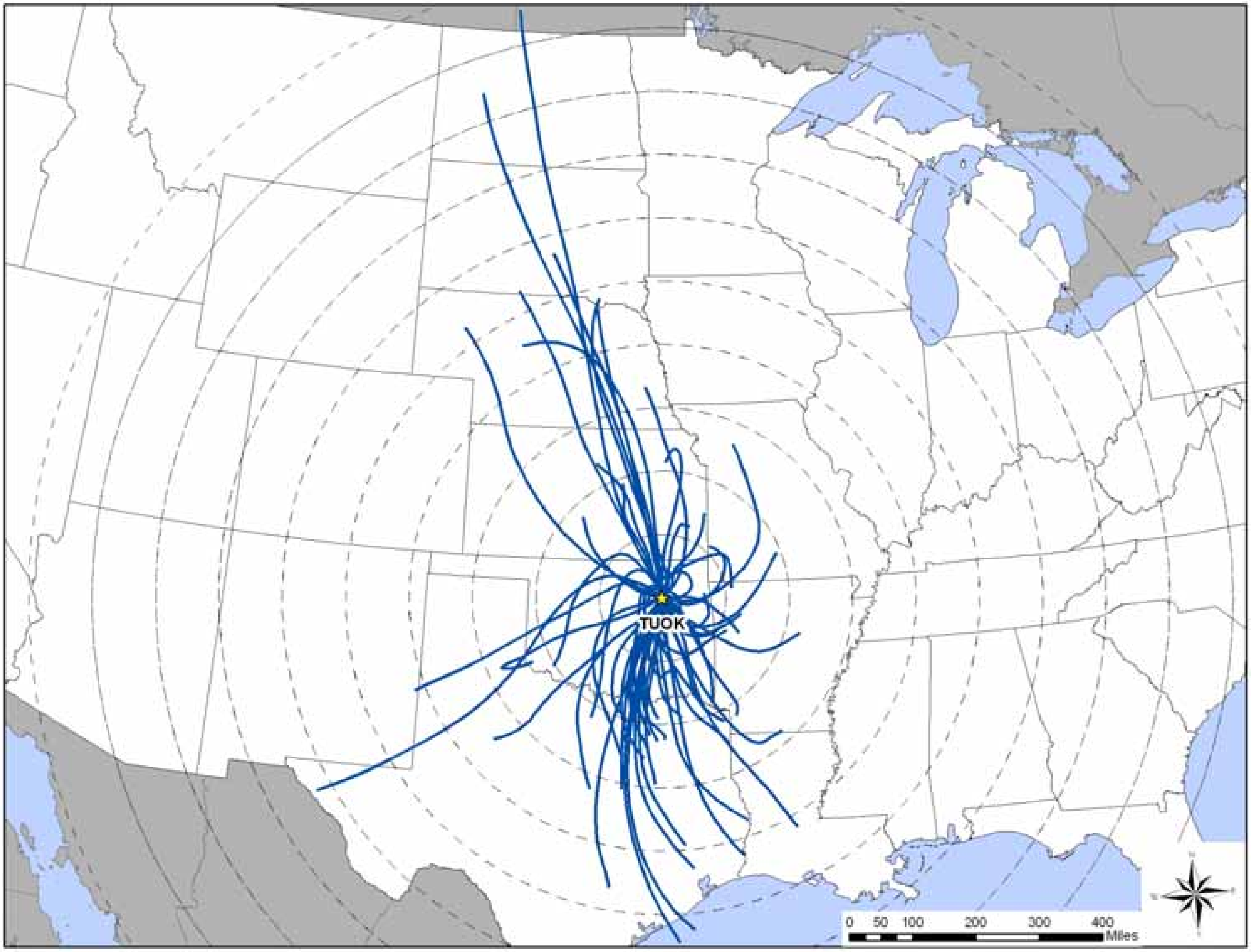


Figure 20-10. Composite Back Trajectory Map for TUOK



Observations from Figures 20-7 through 20-10 include the following:

- The back trajectory maps are very similar to each other. This is expected, given their close proximity to each other and the similarity in sampling days.
- Back trajectories originated from a variety of directions at the Oklahoma sites. The bulk of the trajectories originated from the south. There is a second cluster of trajectories originating from the northwest.
- The 24-hour air shed domains for these four sites were somewhat larger in size than other monitoring sites. The furthest away a trajectory originated was southern Manitoba, Canada, or greater than 900 miles away. However, most trajectories originated within 500 miles of the sites.

20.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations near the Oklahoma sites, as presented in Section 20.2.2, were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 20-11 through 20-14 are the wind roses for the Oklahoma monitoring sites on days that samples were collected.

Observations from Figures 20-11 through 20-14 include the following:

- The wind roses for the Oklahoma sites are fairly similar to each other.
- Southerly winds prevailed near each monitoring site.
- The percentage of calm winds varied among the sites, ranging from nine percent near TSOK to 28 percent near TUOK.
- The percentage of winds exceeding 11 knots also varied among the sites, ranging from eight percent near TOOK and TUOK to 19 percent near TSOK. The strongest winds were most frequently from the south and south-southwest.

20.3 Pollutants of Interest

“Pollutants of interest” were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Oklahoma monitoring sites were identified using the EPA risk screening process described in Section 3.2.

Figure 20-11. Wind Rose for CNEP Sampling Days

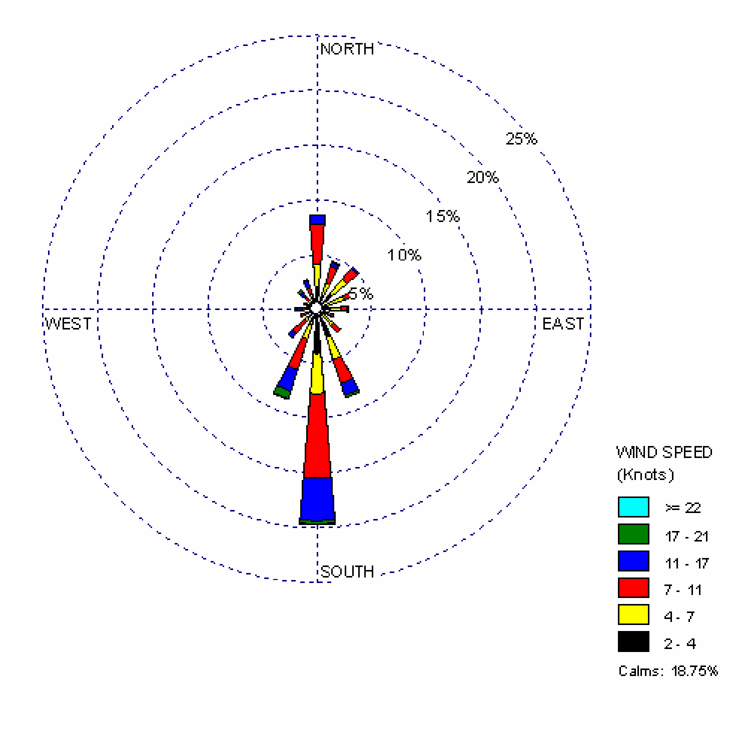


Figure 20-12. Wind Rose for TOOK Sampling Days

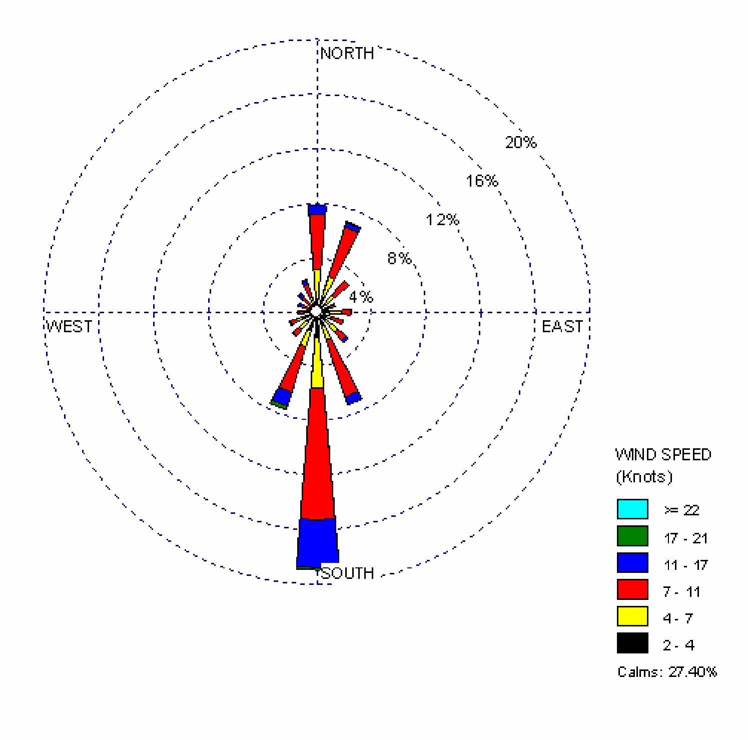


Figure 20-13. Wind Rose for TSOK Sampling Days

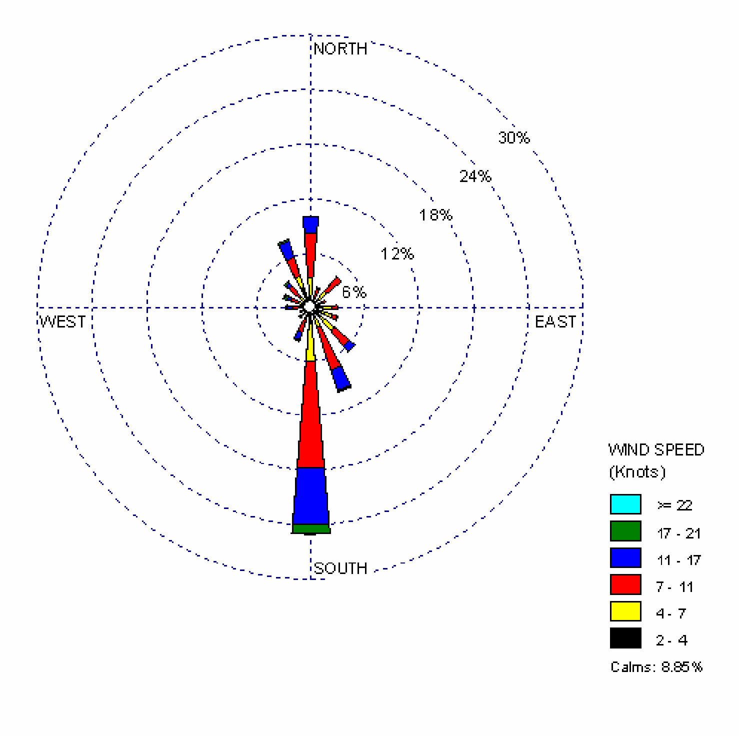
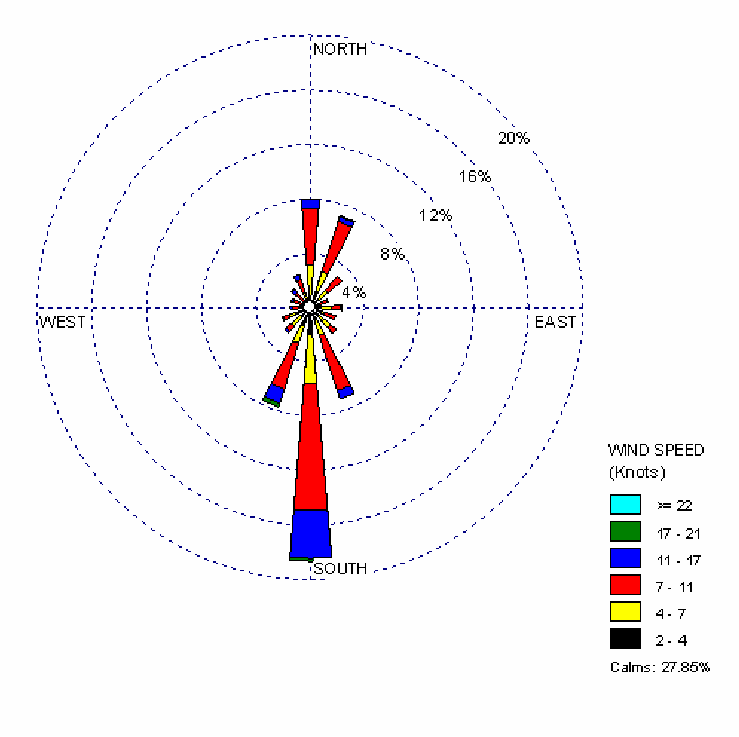


Figure 20-14. Wind Rose for TUOK Sampling Days



In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of each site's total failed screens. Table 20-4 presents the pollutants that failed at least one screen for each Oklahoma monitoring site and highlights each site's pollutants of interest (shaded). The three Tulsa sites sampled for VOC, carbonyls, and metals (TSP); CNEP sampled for VOC only.

Table 20-4. Comparison of Measured Concentrations and EPA Screening Values for the Oklahoma Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Pryor, Oklahoma - CNEP					
Benzene	55	55	100.00	29.89	29.89
Acrolein	55	55	100.00	29.89	59.78
Carbon Tetrachloride	55	55	100.00	29.89	89.67
1,3-Butadiene	16	41	39.02	8.70	98.37
Acrylonitrile	2	2	100.00	1.09	99.46
1,2-Dichloroethane	1	1	100.00	0.54	100.00
Total	184	209	88.04		
Tulsa, Oklahoma, Site #1 - TOOK					
Acetaldehyde	61	61	100.00	10.99	10.99
Acrolein	60	60	100.00	10.81	21.80
Benzene	60	60	100.00	10.81	32.61
Carbon Tetrachloride	60	60	100.00	10.81	43.42
Arsenic (TSP)	59	59	100.00	10.63	54.05
1,3-Butadiene	59	60	98.33	10.63	64.68
Manganese (TSP)	58	59	98.31	10.45	75.14
Formaldehyde	58	61	95.08	10.45	85.59
p-Dichlorobenzene	30	60	50.00	5.41	90.99
Tetrachloroethylene	25	58	43.10	4.50	95.50
Nickel (TSP)	16	59	27.12	2.88	98.38
Cadmium (TSP)	7	59	11.86	1.26	99.64
Acrylonitrile	2	2	100.00	0.36	100.00
Total	555	718	77.30		

Table 20-4. Comparison of Measured Concentrations and EPA Screening Values for the Oklahoma Monitoring Sites (Continued)

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Tulsa, Oklahoma, Site #2 - TSOK					
Benzene	59	59	100.00	11.03	11.03
Carbon Tetrachloride	59	59	100.00	11.03	22.06
Acrolein	59	59	100.00	11.03	33.08
Acetaldehyde	58	58	100.00	10.84	43.93
1,3-Butadiene	56	58	96.55	10.47	54.39
Formaldehyde	55	58	94.83	10.28	64.67
Arsenic (TSP)	54	56	96.43	10.09	74.77
Manganese (TSP)	52	56	92.86	9.72	84.49
p-Dichlorobenzene	34	58	58.62	6.36	90.84
Tetrachloroethylene	23	53	43.40	4.30	95.14
Nickel (TSP)	12	56	21.43	2.24	97.38
Acrylonitrile	8	8	100.00	1.50	98.88
1,2-Dichloroethane	2	2	100.00	0.37	99.25
Cadmium (TSP)	2	56	3.57	0.37	99.63
1,1,2-Trichloroethane	1	2	50.00	0.19	99.81
Trichloroethylene	1	41	2.44	0.19	100.00
Total	535	739	72.40		
Tulsa, Oklahoma, Site #3 - TUOK					
Acetaldehyde	61	61	100.00	10.93	10.93
Formaldehyde	60	61	98.36	10.75	21.68
Acrolein	59	59	100.00	10.57	32.26
Benzene	59	59	100.00	10.57	42.83
Carbon Tetrachloride	59	59	100.00	10.57	53.41
Arsenic (TSP)	58	58	100.00	10.39	63.80
1,3-Butadiene	56	58	96.55	10.04	73.84
Manganese (TSP)	56	58	96.55	10.04	83.87
Tetrachloroethylene	42	59	71.19	7.53	91.40
p-Dichlorobenzene	29	58	50.00	5.20	96.59
Nickel (TSP)	11	58	18.97	1.97	98.57
Acrylonitrile	7	7	100.00	1.25	99.82
Trichloroethylene	1	35	2.86	0.18	100.00
Total	558	690	80.87		

Observations from Table 20-4 include the following:

- Six pollutants with a total of 184 measured concentrations failed at least one screen for CNEP; 13 pollutants with a total of 555 measured concentrations failed screens for TOOK; 16 pollutants with a total of 535 measured concentrations failed screens for TSOK; and 13 pollutants with a total of 558 measured concentrations failed screens for TUOK.

- The following four pollutants were identified as pollutants of interest for all four sites: acrolein, benzene, 1,3-butadiene, and carbon tetrachloride. If only the Tulsa sites are considered, the list of common pollutants also includes acetaldehyde, formaldehyde, *p*-dichlorobenzene, tetrachloroethylene, arsenic, and manganese.

- All of the four common pollutants of interest failed 100 percent of screens for each site.

- The percentage of measured detections failing screens (of the pollutants that failed at least one screen) ranged from 72 percent (TSOK) to 88 percent (CNEP).

20.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Oklahoma monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

20.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 20-5, where applicable.

Table 20-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Pryor, Oklahoma - CNEP								
Acrolein	55	55	1.52 ± 0.17	1.24 ± 0.14	1.85 ± 0.35	1.52 ± 0.35	1.40 ± 0.32	1.52 ± 0.17
Benzene	55	55	0.47 ± 0.05	0.59 ± 0.13	0.42 ± 0.07	0.42 ± 0.05	0.48 ± 0.06	0.47 ± 0.05
1,3-Butadiene	41	55	0.03 ± 0.01	0.04 ± 0.01	0.03 ± <0.01	0.02 ± <0.01	NR	0.03 ± <0.01
Carbon Tetrachloride	55	55	0.65 ± 0.03	0.59 ± 0.06	0.64 ± 0.04	0.67 ± 0.09	0.69 ± 0.07	0.65 ± 0.03
Tulsa, Oklahoma, Site #1 - TOOK								
Acetaldehyde	61	61	1.91 ± 0.23	1.26 ± 0.30	1.72 ± 0.43	2.61 ± 0.39	1.90 ± 0.37	1.91 ± 0.23
Acrolein	60	60	0.89 ± 0.14	0.57 ± 0.15	1.08 ± 0.41	1.11 ± 0.24	0.72 ± 0.15	0.89 ± 0.14
Arsenic (TSP)	59	59	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Benzene	60	60	2.05 ± 0.31	1.68 ± 0.50	1.73 ± 0.41	2.07 ± 0.33	2.65 ± 0.92	2.05 ± 0.31
1,3-Butadiene	60	60	0.09 ± 0.01	0.11 ± 0.04	0.07 ± 0.02	0.07 ± 0.01	0.10 ± 0.03	0.09 ± 0.01
Carbon Tetrachloride	60	60	0.57 ± 0.03	0.47 ± 0.07	0.59 ± 0.06	0.61 ± 0.04	0.59 ± 0.05	0.57 ± 0.03
p-Dichlorobenzene	60	60	0.12 ± 0.02	0.07 ± 0.01	0.17 ± 0.05	0.12 ± 0.02	0.09 ± 0.03	0.12 ± 0.02
Formaldehyde	61	61	3.00 ± 0.42	1.62 ± 0.33	2.41 ± 0.42	4.90 ± 0.76	2.75 ± 0.55	3.00 ± 0.42
Manganese (TSP)	59	59	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.04 ± 0.01	0.03 ± 0.01
Tetrachloroethylene	58	60	0.22 ± 0.05	0.17 ± 0.07	0.22 ± 0.06	0.15 ± 0.03	0.31 ± 0.15	0.21 ± 0.05

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 20-5. Daily, Seasonal, and Annual Average Concentrations for the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	# of Measured Detections	# of Samples	Daily Average ($\mu g/m^3$)	Winter Average ($\mu g/m^3$)	Spring Average ($\mu g/m^3$)	Summer Average ($\mu g/m^3$)	Autumn Average ($\mu g/m^3$)	Annual Average[1] ($\mu g/m^3$)
Tulsa, Oklahoma, Site #2 - TSOK								
Acetaldehyde	58	58	1.57 ± 0.18	1.11 ± 0.23	1.45 ± 0.28	2.13 ± 0.34	1.56 ± 0.33	1.57 ± 0.18
Acrolein	59	59	0.88 ± 0.16	0.63 ± 0.15	1.20 ± 0.42	0.82 ± 0.13	0.82 ± 0.41	0.88 ± 0.16
Arsenic (TSP)	56	56	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Benzene	59	59	0.99 ± 0.11	0.83 ± 0.25	0.97 ± 0.19	1.03 ± 0.16	1.15 ± 0.29	0.99 ± 0.11
1,3-Butadiene	58	59	0.07 ± 0.01	0.07 ± 0.03	0.06 ± 0.01	0.07 ± 0.01	0.08 ± 0.03	0.07 ± 0.01
Carbon Tetrachloride	59	59	0.60 ± 0.03	0.54 ± 0.07	0.62 ± 0.06	0.63 ± 0.05	0.61 ± 0.06	0.60 ± 0.03
p-Dichlorobenzene	58	59	0.11 ± 0.02	0.06 ± 0.01	0.16 ± 0.05	0.12 ± 0.01	0.10 ± 0.03	0.11 ± 0.02
Formaldehyde	58	58	3.03 ± 0.46	1.62 ± 0.33	2.50 ± 0.39	5.10 ± 0.92	2.83 ± 0.68	3.03 ± 0.46
Manganese (TSP)	56	56	0.02 ± <0.01	0.01 ± 0.01	0.01 ± <0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± <0.01
Tetrachloroethylene	53	59	0.19 ± 0.04	0.11 ± 0.05	0.19 ± 0.10	0.21 ± 0.09	0.18 ± 0.05	0.17 ± 0.04
Tulsa, Oklahoma, Site #3 - TUOK								
Acetaldehyde	61	61	2.15 ± 0.24	1.33 ± 0.29	2.03 ± 0.44	2.93 ± 0.37	2.05 ± 0.39	2.15 ± 0.24
Acrolein	59	59	1.05 ± 0.19	0.68 ± 0.14	0.95 ± 0.20	1.41 ± 0.49	1.09 ± 0.43	1.05 ± 0.19
Arsenic (TSP)	58	58	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	0.01 ± 0.01	<0.01 ± <0.01
Benzene	59	59	1.29 ± 0.14	1.11 ± 0.24	1.24 ± 0.30	1.30 ± 0.18	1.47 ± 0.32	1.29 ± 0.14
1,3-Butadiene	58	59	0.10 ± 0.02	0.11 ± 0.03	0.09 ± 0.03	0.08 ± 0.02	0.13 ± 0.04	0.10 ± 0.02
Carbon Tetrachloride	59	59	0.57 ± 0.03	0.44 ± 0.09	0.62 ± 0.05	0.61 ± 0.05	0.59 ± 0.03	0.57 ± 0.03
p-Dichlorobenzene	58	59	0.13 ± 0.02	0.13 ± 0.07	0.16 ± 0.05	0.13 ± 0.02	0.09 ± 0.02	0.13 ± 0.02
Formaldehyde	61	61	3.27 ± 0.40	1.88 ± 0.35	2.93 ± 0.45	4.88 ± 0.70	2.87 ± 0.63	3.27 ± 0.40
Manganese (TSP)	58	58	0.02 ± <0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± <0.01	0.02 ± <0.01
Tetrachloroethylene	59	59	0.37 ± 0.10	0.18 ± 0.10	0.36 ± 0.12	0.61 ± 0.28	0.28 ± 0.07	0.37 ± 0.10

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for CNEP from Table 20-5 include the following:

- Acrolein exhibited the highest daily average concentration by mass. This concentration (1.52 ± 0.17 µg/m^3) was more than twice the next highest daily average concentration (carbon tetrachloride, 0.65 ± 0.03 µg/m^3).
- As shown in Table 4-11, CNEP had the second highest daily average concentration of acrolein among all NATTS and UATMP sites.
- The seasonal concentrations of the pollutants of interest for CNEP did not vary much across the seasons. Although benzene appears to be higher during the winter, the confidence interval shows that the difference is not significant. A seasonal average could not be calculated for 1,3-butadiene for autumn due to the low number of measured detections.

Observations for the Tulsa sites from Table 20-5 include the following:

- Formaldehyde, benzene, and acetaldehyde exhibited the highest daily average concentrations by mass for each site (although not necessarily in that order).
- As shown in Table 4-11, the Tulsa sites had the fourth, sixth, and seventh highest daily average concentrations of acrolein among all NATTS and UATMP sites. TOOK and TUOK also had the second and eighth highest daily average of concentrations of benzene.
- The Tulsa sites were the only sites to monitor for TSP metals, so they are the only sites that appear in Table 4-10.
- The average summer concentrations of acetaldehyde and formaldehyde were higher than other seasons for the Tulsa sites.

20.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one ore more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. None of the Oklahoma site have sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

20.5 Pearson Correlations

Table 20-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Table 20-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Oklahoma Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Pryor, Oklahoma - CNEP								
Acrolein	55	0.03	0.07	0.02	-0.10	-0.23	NA	0.27
Benzene	55	-0.32	-0.39	-0.31	-0.10	0.25	NA	-0.20
1,3-Butadiene	41	-0.55	-0.54	-0.50	-0.27	0.12	NA	-0.16
Carbon Tetrachloride	55	0.15	0.19	0.20	0.22	0.14	NA	0.07
Tulsa, Oklahoma, Site #1 - TOOK								
Acetaldehyde	61	0.59	0.50	0.47	0.48	0.00	-0.17	-0.58
Acrolein	60	0.28	0.31	0.30	0.30	0.02	-0.05	-0.09
Arsenic (TSP)	59	0.28	0.24	0.22	0.23	-0.01	0.10	-0.36
Benzene	60	0.22	0.11	0.09	0.10	0.00	0.06	-0.58
1,3-Butadiene	60	-0.25	-0.35	-0.31	-0.34	0.08	0.25	-0.56
Carbon Tetrachloride	60	0.42	0.46	0.48	0.47	0.18	-0.30	0.13
p-Dichlorobenzene	60	0.16	0.15	0.13	0.14	-0.05	0.07	-0.14
Formaldehyde	61	0.77	0.73	0.67	0.70	-0.06	-0.28	-0.37
Manganese (TSP)	59	-0.01	-0.07	-0.22	-0.15	-0.55	0.18	-0.06
Tetrachloroethylene	58	-0.11	-0.18	-0.16	-0.17	0.06	0.15	-0.32
Tulsa, Oklahoma, Site #2 - TSOK								
Acetaldehyde	58	0.57	0.54	0.45	0.49	-0.27	-0.16	-0.40
Acrolein	59	0.21	0.23	0.21	0.22	-0.08	-0.07	-0.01
Arsenic (TSP)	56	0.21	0.15	0.13	0.14	-0.01	0.10	-0.41
Benzene	59	0.21	0.18	0.15	0.15	-0.07	0.07	-0.54
1,3-Butadiene	58	-0.03	-0.06	-0.08	-0.08	-0.06	0.19	-0.60
Carbon Tetrachloride	59	0.27	0.32	0.35	0.33	0.12	-0.24	0.03
p-Dichlorobenzene	58	0.25	0.24	0.24	0.24	0.00	-0.04	-0.12
Formaldehyde	58	0.74	0.75	0.63	0.68	-0.30	-0.30	-0.20
Manganese (TSP)	56	0.22	0.18	-0.01	0.08	-0.53	0.03	-0.31
Tetrachloroethylene	53	0.11	0.10	0.13	0.12	0.13	-0.11	-0.39

NA = Sea level pressure was not recorded at the Claremore Regional Airport

Table 20-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Tulsa, Oklahoma, Site #3 - TUOK								
Acetaldehyde	61	0.68	0.61	0.59	0.60	0.12	-0.18	-0.59
Acrolein	59	0.35	0.37	0.35	0.36	0.01	-0.10	-0.13
Arsenic (TSP)	58	0.10	0.05	0.06	0.05	0.06	0.11	-0.24
Benzene	59	0.07	0.01	0.05	0.02	0.19	0.13	-0.68
1,3-Butadiene	58	-0.24	-0.30	-0.26	-0.29	0.11	0.38	-0.57
Carbon Tetrachloride	59	0.42	0.44	0.48	0.46	0.30	-0.23	-0.06
p-Dichlorobenzene	58	-0.09	-0.03	0.03	-0.01	0.21	-0.08	-0.08
Formaldehyde	61	0.74	0.70	0.64	0.67	-0.02	-0.24	-0.42
Manganese (TSP)	58	-0.12	-0.20	-0.33	-0.26	-0.48	0.25	-0.21
Tetrachloroethylene	59	0.39	0.34	0.32	0.33	0.04	-0.03	-0.33

NA = Sea level pressure was not recorded at the Claremore Regional Airport

Observations for CNEP from Table 20-6 include the following:

- 1,3-Butadiene exhibited strong negative correlations with the maximum, average, and dew point temperatures. This indicates than an increase in these parameters correlates with a decrease in concentration.
- The remaining correlations were weak.

Observations for the Tulsa sites from Table 20-6 include the following:

- Formaldehyde and acetaldehyde exhibited strong positive correlations with the maximum, average, dew point, and wet bulb temperatures. This indicates than an increase in these parameters correlates with an increase in the concentrations of these pollutants. These correlations support the observations in seasonal averages discussed in Section 20.4.1.
- Manganese exhibited strong negative correlations with the relative humidity for all three sites. This indicates that decreases in relative humidity lead to increases in manganese concentrations.
- All but two (carbon tetrachloride for TOOK and TSOK) of the correlations with wind speed were negative, although of varying magnitude. This indicates that decreasing wind speed correlates with increasing concentrations of the pollutants of interest.

20.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

20.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Oklahoma monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 20-7. Where a seasonal or annual average exceeds the

Table 20-7. MRL Risk Screening Assessment Summary for the Oklahoma Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average[1] (µg/m^3)
CNEP	TO-15	Acrolein	7.00	0/55	0.09	**1.24 ± 0.14**	**1.85 ± 0.35**	**1.52 ± 0.35**	**1.40 ± 0.32**	--	1.52 ± 0.17
TOOK	TO-15	Acrolein	7.00	0/60	0.09	**0.57 ± 0.15**	**1.08 ± 0.41**	**1.11 ± 0.24**	**0.72 ± 0.15**	--	0.89 ± 0.14
TSOK	TO-15	Acrolein	7.00	0/59	0.09	**0.63 ± 0.15**	**1.20 ± 0.42**	**0.82 ± 0.13**	**0.82 ± 0.41**	--	0.88 ± 0.16
TUOK	TO-15	Acrolein	7.00	0/59	0.09	**0.68 ± 0.14**	**0.95 ± 0.20**	**1.41 ± 0.49**	**1.09 ± 0.43**	--	1.05 ± 0.19

BOLD = exceedance of the intermediate or chronic MRL

-- = an MRL risk factor is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein from Table 20-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- All four seasonal averages of acrolein exceeded the intermediate MRL for all four sites.
- Acrolein has no chronic MRL. Therefore, chronic risk could not be evaluated.

20.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Oklahoma monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 20-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the Oklahoma monitoring sites is as follows:

- The census tract for CNEP is 40097040400, which had a population of 5,307 and represented approximately 14 percent of the Mayes County population in 2000.
- The census tract for TOOK is 40143004600, which had a population of 3,147 and represented approximately 0.6 percent of the Tulsa County population in 2000.
- The census tract for TSOK is 40143001000, which had a population of 1,494 and represented less than 0.3 percent of the Tulsa County population in 2000.
- The census tract for TUOK is 40143003200, which had a population of 1,677, and represented approximately 0.3 percent of the Tulsa County population in 2000.

Table 20-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Oklahoma

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration (µg/m^3)	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Pryor, Oklahoma (CNEP) - Census Tract ID 40097040400								
Acrolein	--	0.00002	0.02	--	0.94	1.52 ± 0.17	--	75.85
Acrylonitrile	0.000068	0.002	<0.01	<0.01	<0.01	0.03 ± <0.01	1.79	0.01
Benzene	0.000007	0.03	0.43	3.36	0.01	0.47 ± 0.05	3.32	0.02
1,3-Butadiene	0.00003	0.002	0.01	0.30	0.01	0.03 ± <0.01	0.83	0.01
Carbon Tetrachloride	0.000015	0.04	0.21	3.19	0.01	0.65 ± 0.03	9.69	0.02
1,2-Dichloroethane	0.000026	2.4	0.01	0.32	<0.01	0.04 ± <0.01	1.11	<0.01
Tulsa, Oklahoma (TOOK) Site #1 - Census Tract ID 40143004600								
Acetaldehyde	0.000002	0.009	1.90	4.20	0.21	1.91 ± 0.23	3.81	0.21
Acrolein	--	0.00002	0.13	--	6.59	0.89 ± 0.14	--	44.30
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	0.04 ± 0.01	2.51	0.02
Arsenic (TSP)	0.0043	0.00003	<0.01	0.12	<0.01	<0.01 ± <0.01	4.40	0.03
Benzene	0.000007	0.03	3.89	30.34	0.12	2.05 ± 0.31	14.33	0.07
1,3-Butadiene	0.00003	0.002	0.24	7.34	0.12	0.09 ± 0.01	2.61	0.04
Cadmium (TSP)	0.0018	0.00002	<0.01	0.14	<0.01	<0.01 ± <0.01	0.53	0.01
Carbon Tetrachloride	0.000015	0.04	0.21	3.20	0.01	0.57 ± 0.03	8.54	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.35	<0.01	0.12 ± 0.02	1.29	<0.01
Formaldehyde	5.5E-09	0.0098	1.74	0.01	0.17	3.00 ± 0.42	0.02	0.31
Manganese (TSP)	--	0.00005	<0.01	--	0.03	0.03 ± 0.01	--	0.60
Nickel (TSP)	0.00016	0.000065	<0.01	0.44	0.04	<0.01 ± <0.01	0.30	0.03
Tetrachloroethylene	0.000005	0.27	0.17	0.99	<0.01	0.21 ± 0.05	1.06	<0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 20-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Oklahoma (Continued)

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE ($\mu g/m^3$)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration ($\mu g/m^3$)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] ($\mu g/m^3$)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Tulsa, Oklahoma (TSOK) Site #2 - Census Tract ID 40143001000								
Acetaldehyde	0.000002	0.009	1.69	3.74	0.18	1.57 ± 0.18	3.14	0.17
Acrolein	--	0.00002	0.11	--	5.51	0.88 ± 0.16	--	43.92
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	0.05 ± 0.02	3.37	0.02
Arsenic (TSP)	0.0043	0.00003	<0.01	0.07	<0.01	<0.01 ± <0.01	3.92	0.03
Benzene	0.000007	0.03	1.66	12.94	0.05	0.99 ± 0.11	6.95	0.03
1,3-Butadiene	0.00003	0.002	0.15	4.48	0.07	0.07 ± 0.01	2.10	0.04
Cadmium (TSP)	0.0018	0.00002	<0.01	0.08	<0.01	<0.01 ± <0.01	0.46	0.01
Carbon Tetrachloride	0.000015	0.04	0.21	3.16	0.01	0.60 ± 0.03	9.04	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.30	<0.01	0.11 ± 0.02	1.25	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.85	<0.01	0.04 ± <0.01	1.13	<0.01
Formaldehyde	5.5E-09	0.0098	1.44	0.01	0.14	3.03 ± 0.46	0.02	0.31
Manganese (TSP)	--	0.00005	<0.01	--	0.02	0.02 ± <0.01	--	0.35
Nickel (TSP)	0.00016	0.000065	<0.01	0.17	0.01	<0.01 ± <0.01	0.34	0.03
Tetrachloroethylene	0.000005	0.27	0.18	1.05	<0.01	0.17 ± 0.04	0.87	<0.01
1,1,2-Trichloroethane	0.000016	0.4	<0.01	<0.01	<0.01	0.05 ± <0.01	0.78	<0.01
Trichloroethylene	0.000002	0.6	0.08	0.17	<0.01	0.16 ± 0.03	0.32	<0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 20-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Oklahoma (Continued)

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (µg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Tulsa, Oklahoma (TUOK) Site #3 - Census Tract ID 40143003200								
Acetaldehyde	0.000002	0.009	1.58	3.50	0.17	2.15 ± 0.24	4.30	0.24
Acrolein	--	0.00002	0.11	--	5.43	1.05 ± 0.19	--	52.49
Acrylonitrile	0.000068	0.002	<0.01	0.02	<0.01	0.05 ± 0.01	3.12	0.02
Arsenic (TSP)	0.0043	0.00003	<0.01	0.08	<0.01	<0.01 ± <0.01	8.64	0.07
Benzene	0.000007	0.03	1.79	13.94	0.05	1.29 ± 0.14	9.02	0.04
1,3-Butadiene	0.00003	0.002	0.18	5.27	0.08	0.10 ± 0.02	2.97	0.05
Carbon Tetrachloride	0.000015	0.04	0.21	3.13	0.01	0.57 ± 0.03	8.54	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.32	<0.01	0.13 ± 0.02	1.38	<0.01
Formaldehyde	5.5E-09	0.0098	1.47	0.01	0.15	3.27 ± 0.40	0.02	0.33
Manganese (TSP)	--	0.00005	<0.01	--	0.02	0.02 ± <0.01	--	0.40
Nickel (TSP)	0.00016	0.000065	<0.01	0.18	0.01	<0.01 ± <0.01	0.24	0.02
Tetrachloroethylene	0.000005	0.27	0.21	1.26	<0.01	0.37 ± 0.10	1.84	<0.01
Trichloroethylene	0.000002	0.6	0.10	0.19	<0.01	0.10 ± 0.03	0.21	<0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for CNEP from Table 20-8 include the following:

- With the exception of acrolein and acrylonitrile, the modeled concentrations of the pollutants of interest were fairly similar to the annual averages. The annual average of acrolein was higher by two orders of magnitude. The annual average of acrylonitrile was higher by three orders of magnitude.

- The cancer risk estimates from NATA for some pollutants, such as benzene, were very similar to the cancer risk approximations, but very different for others, such as acrylonitrile.

- None of the pollutants had noncancer HQs greater than 1.0 according to NATA, although acrolein was close (0.94). By contrast, acrolein's noncancer risk approximation was 75.85. This is the second highest noncancer risk approximation among program sites sampling acrolein (PXSS had the highest noncancer risk approximation for acrolein).

Observations for the Tulsa sites from Table 20-8 include the following:

- Benzene, formaldehyde, and acetaldehyde had the highest modeled concentrations and annual averages of all the pollutants failing at least one screen at the Tulsa sites.

- The pollutants with the highest cancer risks according to NATA were benzene, 1,3-butadiene and acetaldehyde, while benzene, carbon tetrachloride, and arsenic had the highest cancer risk approximations.

- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein. The same is true for the noncancer risk approximations, although the cancer risk approximations were higher by an order of magnitude.

20.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 20-9 and 20-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 20-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million,) as calculated from the annual averages. Table 20-10 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Table 20-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Oklahoma

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Pryor, Oklahoma (CNEP) – Mayes County					
Benzene	72.35	Arsenic, PM	3.88E-03	Carbon Tetrachloride	9.69
Formaldehyde	57.48	Hexavalent Chromium	2.81E-03	Benzene	3.32
Acetaldehyde	9.36	Benzene	5.64E-04	Acrylonitrile	1.78
1,3-Butadiene	5.71	Cadmium, PM	1.94E-04	1,2-Dichloroethane	1.12
Naphthalene	5.19	Naphthalene	1.76E-04	1,3-Butadiene	0.83
Dichloromethane	3.46	1,3-Butadiene	1.71E-04		
Hexavalent Chromium	2.05	POM, Group 1	1.10E-04		
POM, Group 1	1.99	Nickel, PM	9.64E-05		
Trichloroethylene	1.85	Chloromethylbenzene	6.86E-05		
Chloromethylbenzene	1.40	POM, Group 2	5.81E-05		
Tulsa, Oklahoma, Site #1 (TOOK) – Tulsa County					
Benzene	725.16	Benzene	5.66E-03	Benzene	14.33
Formaldehyde	244.82	1,3-Butadiene	2.53E-03	Carbon Tetrachloride	8.54
Tetrachloroethylene	95.56	Hexavalent Chromium	2.19E-03	Arsenic	4.40
Acetaldehyde	85.75	Naphthalene	6.30E-04	Acetaldehyde	3.81
1,3-Butadiene	84.18	Tetrachloroethylene	5.64E-04	1,3-Butadiene	2.61
Dichloromethane	24.18	Acetaldehyde	1.89E-04	Acrylonitrile	2.49
Trichloroethylene	22.29	Arsenic, PM	1.79E-04	*p*-Dichlorobenzene	1.29
Naphthalene	18.52	POM, Group 2	1.67E-04	Tetrachloroethylene	1.06
p-Dichlorobenzene	12.21	*p*-Dichlorobenzene	1.34E-04	Cadmium	0.53
POM, Group 2	3.04	Ethylene oxide	1.22E-04	Nickel	0.30

Table 20-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Oklahoma (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Tulsa, Oklahoma, Site #2 (TSOK) – Tulsa County					
Benzene	725.16	Benzene	5.66E-03	Carbon Tetrachloride	9.04
Formaldehyde	244.82	1,3-Butadiene	2.53E-03	Benzene	6.95
Tetrachloroethylene	95.56	Hexavalent Chromium	2.19E-03	Arsenic	3.92
Acetaldehyde	85.75	Naphthalene	6.30E-04	Acrylonitrile	3.35
1,3-Butadiene	84.18	Tetrachloroethylene	5.64E-04	Acetaldehyde	3.14
Dichloromethane	24.18	Acetaldehyde	1.89E-04	1,3-Butadiene	2.10
Trichloroethylene	22.29	Arsenic, PM	1.79E-04	*p*-Dichlorobenzene	1.25
Naphthalene	18.52	POM, Group 2	1.67E-04	1,2-Dichloroethane	1.14
p-Dichlorobenzene	12.21	*p*-Dichlorobenzene	1.34E-04	Tetrachloroethylene	0.87
POM, Group 2	3.04	Ethylene oxide	1.22E-04	1,1,2-Trichloroethane	0.78
Tulsa, Oklahoma, Site #3 (TUOK) – Tulsa County					
Benzene	725.16	Benzene	5.66E-03	Benzene	9.02
Formaldehyde	244.82	1,3-Butadiene	2.53E-03	Arsenic	8.64
Tetrachloroethylene	95.56	Hexavalent Chromium	2.19E-03	Carbon Tetrachloride	8.54
Acetaldehyde	85.75	Naphthalene	6.30E-04	Acetaldehyde	4.30
1,3-Butadiene	84.18	Tetrachloroethylene	5.64E-04	Acrylonitrile	3.10
Dichloromethane	24.18	Acetaldehyde	1.89E-04	1,3-Butadiene	2.97
Trichloroethylene	22.29	Arsenic, PM	1.79E-04	Tetrachloroethylene	1.84
Naphthalene	18.52	POM, Group 2	1.67E-04	*p*-Dichlorobenzene	1.38
p-Dichlorobenzene	12.21	*p*-Dichlorobenzene	1.34E-04	Nickel	0.24
POM, Group 2	3.04	Ethylene oxide	1.22E-04	Trichloroethylene	0.21

Table 20-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Oklahoma

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Pryor, Oklahoma (CNEP) – Mayes County					
Toluene	148.70	Acrolein	82,589.42	Acrolein	75.85
Xylenes	99.56	Arsenic, PM	30,049.69	Carbon Tetrachloride	0.02
Benzene	72.35	Manganese, PM	20,652.70	Benzene	0.02
Hydrochloric acid	61.44	Nickel, PM	9,274.01	1,3-Butadiene	0.01
Methanol	58.81	Formaldehyde	5,865.21	Acrylonitrile	0.01
Formaldehyde	57.48	Cadmium, PM	5,391.68	1,2-Dichloroethane	<0.01
Ethylene glycol	25.75	Hydrochloric acid	3,072.04		
Hexane	23.69	1,3-Butadiene	2,856.93		
Ethylbenzene	23.49	Mercury, PM	2,650.63		
Styrene	12.98	Benzene	2,411.52		
Tulsa, Oklahoma, Site #1 (TOOK) – Tulsa County					
Toluene	1,860.89	Acrolein	697,881.56	Acrolein	44.30
Xylenes	1,246.17	Manganese, PM	44,623.75	Manganese	0.60
Benzene	725.16	1,3-Butadiene	42,091.36	Formaldehyde	0.31
Hexane	319.06	Formaldehyde	24,981.83	Acetaldehyde	0.21
Methanol	315.40	Benzene	24,172.15	Benzene	0.07
Ethylbenzene	304.55	Xylenes	12,461.74	1,3-Butadiene	0.04
Formaldehyde	244.82	Nickel, PM	10,466.38	Arsenic	0.03
Methyl isobutyl ketone	132.35	Acetaldehyde	9,528.27	Nickel	0.03
Tetrachloroethylene	95.56	Cyanide Compounds, gas	7,120.10	Acrylonitrile	0.02
Ethylene glycol	91.93	Naphthalene	6,172.03	Cadmium	0.01

Table 20-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Oklahoma (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Tulsa, Oklahoma, Site #2 (TSOK) – Tulsa County					
Toluene	1,860.89	Acrolein	697,881.56	Acrolein	43.92
Xylenes	1,246.17	Manganese, PM	44,623.75	Manganese	0.35
Benzene	725.16	1,3-Butadiene	42,091.36	Formaldehyde	0.31
Hexane	319.06	Formaldehyde	24,981.83	Acetaldehyde	0.17
Methanol	315.40	Benzene	24,172.15	1,3-Butadiene	0.04
Ethylbenzene	304.55	Xylenes	12,461.74	Benzene	0.03
Formaldehyde	244.82	Nickel, PM	10,466.38	Nickel	0.03
Methyl isobutyl ketone	132.35	Acetaldehyde	9,528.27	Arsenic	0.03
Tetrachloroethylene	95.56	Cyanide Compounds, gas	7,120.10	Acrylonitrile	0.02
Ethylene glycol	91.93	Naphthalene	6,172.03	Carbon Tetrachloride	0.02
Tulsa, Oklahoma, Site #3 (TUOK) – Tulsa County					
Toluene	1,860.89	Acrolein	697,881.56	Acrolein	52.49
Xylenes	1,246.17	Manganese, PM	44,623.75	Manganese	0.40
Benzene	725.16	1,3-Butadiene	42,091.36	Formaldehyde	0.33
Hexane	319.06	Formaldehyde	24,981.83	Acetaldehyde	0.24
Methanol	315.40	Benzene	24,172.15	Arsenic	0.07
Ethylbenzene	304.55	Xylenes	12,461.74	1,3-Butadiene	0.05
Formaldehyde	244.82	Nickel, PM	10,466.38	Benzene	0.04
Methyl isobutyl ketone	132.35	Acetaldehyde	9,528.27	Acrylonitrile	0.02
Tetrachloroethylene	95.56	Cyanide Compounds, gas	7,120.10	Nickel	0.02
Ethylene glycol	91.93	Naphthalene	6,172.03	Carbon Tetrachloride	0.01

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 20.3, TOOK, TSOK, and TUOK sampled for VOC, carbonyls, and metals (TSP), while CNEP sampled for VOC only. In addition, the cancer and noncancer risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated. The Oklahoma sites sampled year-round for each pollutant group mentioned above.

Observations from Table 20-9 include the following:

- Benzene and formaldehyde were the highest emitted pollutants with cancer UREs in both Mayes and Tulsa County. The benzene emissions for Tulsa County were almost exactly 10 times higher than the benzene emissions for Mayes County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Mayes County were arsenic and hexavalent chromium, while the pollutants with the highest toxicity-weighted emissions for Tulsa County were benzene and 1,3-butadiene.
- Six of the highest emitted pollutants in Mayes County also had the highest toxicity-weighted emissions. Hexavalent chromium was the pollutant with the seventh highest emissions in Mayes County. For no other county with a monitoring site did hexavalent chromium appear on the list of highest emissions. This suggests that the overall emissions may be rather low in Mayes County. Conversely, of the 41 counties with monitoring sites with hexavalent chromium emissions reported to the NEI, the Mayes County emissions ranked seventh highest.
- Seven of the highest emitted pollutants in Tulsa County also had the highest toxicity-weighted emissions.
- Carbon tetrachloride had the highest surrogate cancer risk approximation for CNEP. This pollutant did not appear on either emissions-based list. However, benzene and 1,3-butadiene appear on all three lists.
- Benzene, arsenic, and carbon tetrachloride had the highest surrogate cancer risk approximations for the Tulsa sites. Similar to CNEP, carbon tetrachloride did not appear on either emissions-based list.
- Six pollutants (benzene, 1,3-butadiene, acetaldehyde, arsenic, *p*-dichlorobenzene, and tetrachloroethylene) were among the highest cancer risk approximations for all three Tulsa sites and appear on the list of highest toxicity-weighted emissions. Five pollutants (benzene, 1,3-butadiene, acetaldehyde, *p*-dichlorobenzene, and

tetrachloroethylene) were among the highest cancer risk approximations for all three Tulsa sites and appear on the list of highest emitted pollutants.

Observations from Table 20-10 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Mayes and Tulsa County, although the magnitude of the emissions is much higher in Tulsa County.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties was acrolein.

- Three of the highest emitted pollutants in both counties also have the highest toxicity-weighted emissions (although the actual pollutants varied in each county).

- The pollutant with the highest noncancer risk approximation was acrolein for all four sites. Acrolein was also the pollutant with the highest toxicity-weighted emissions, but ranked 14th for total emissions for Tulsa County and 35th for Mayes County.

20.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *The pollutants of interest common to each Oklahoma monitoring site were acrolein, benzene, 1,3-butadiene, and carbon tetrachloride.*

- *Acrolein had the highest daily average concentration for CNEP, while formaldehyde had the highest daily average concentration for the Tulsa sites.*

- *The seasonal average concentrations of acrolein exceeded the intermediate MRL health benchmark for all four sites.*

21.0 Sites in Puerto Rico

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP sites in Puerto Rico, and integrates these concentrations with emissions, meteorological, and risk information.

21.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. The BAPR and SJPR monitoring sites are located in the San Juan-Caguas-Guaynabo, PR MSA. Figures 21-1 and 21-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their rural and urban locations. Figures 21-3 and 21-4 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 21-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

BAPR is located on the west side of the Barceloneta Municipio, west of San Juan. This location is only two miles from the north coast of Puerto Rico. The site is located in a residential neighborhood, although the surrounding area is primarily rural, as shown in Figure 21-1. Major roadways through the area lie on either side of the monitoring site, with Highway 22 (Autopisto Jose de Diego) to the north and State Road 2 to the south. The point sources within 10 miles of BAPR are located roughly within two miles of the coast, with most of them located along a line running east-west along State Road 2 and Highway 22. Several pharmaceutical plants are located just east of the monitoring site, as indicated in Figure 21-3.

SJPR is located in the southeast corner of the Regional Jail of Bayamon property. This location is southwest of the city of San Juan and the Bay of San Juan (Bahia de San Juan). According to officials for Puerto Rico, the San Juan metro area is one of the most polluted areas on the island, and there is a concern about the respiratory disease incidence in the area. As Figure 21-2 shows, the surrounding area is industrial and suburban, with residential areas nearby. Highway 22 to the north and Highway 5 to the east intersect about a half mile northeast of the

Figure 21-1. Barceloneta, Puerto Rico (BAPR) Monitoring Site

©2008 Google/©NAVTECH

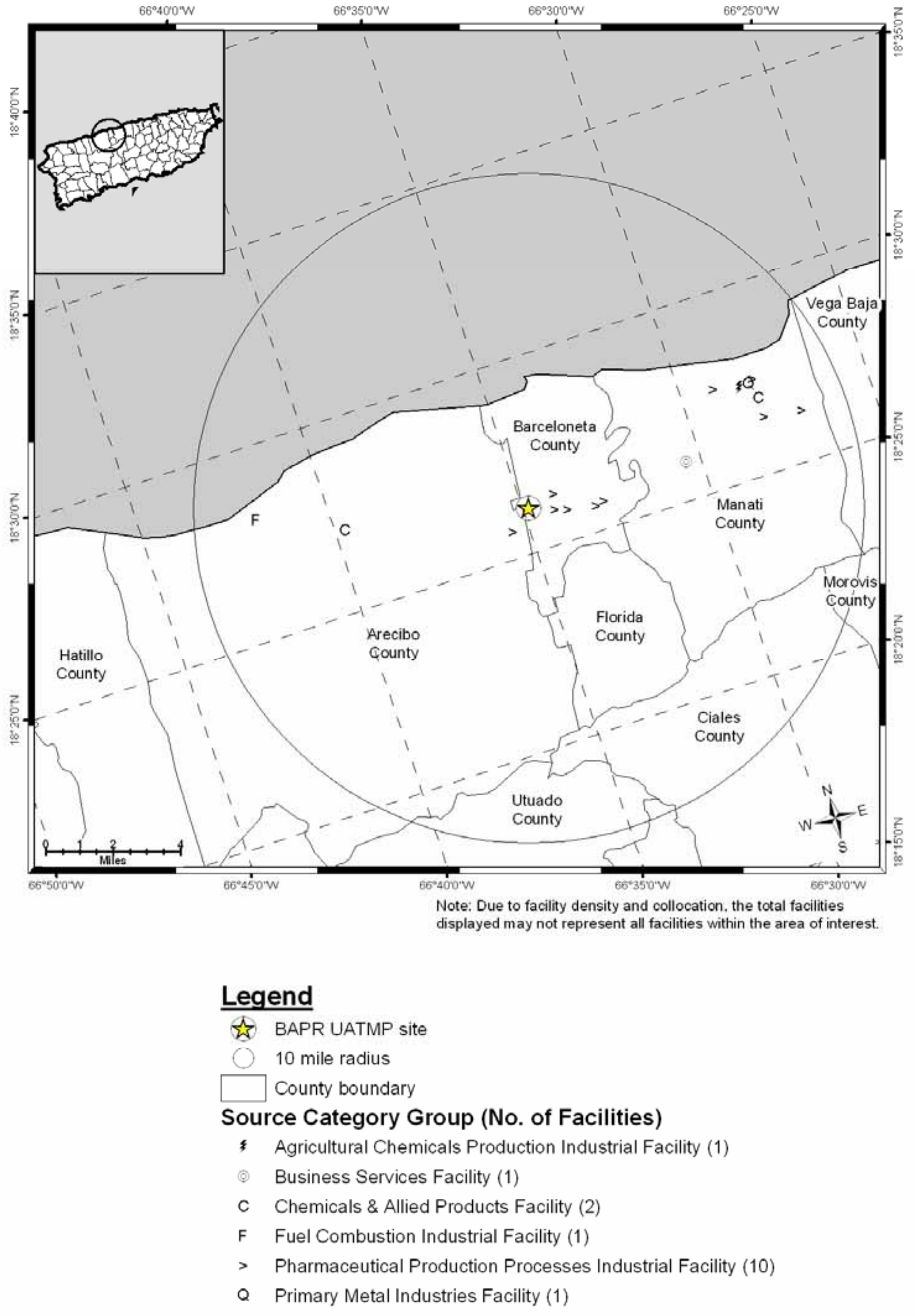
Scale: 3cm = 100m

Figure 21-2. San Juan, Puerto Rico (SJPR) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 21-3. NEI Point Sources Located Within 10 Miles of BAPR



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 21-4. NEI Point Sources Located Within 10 Miles of SJPR

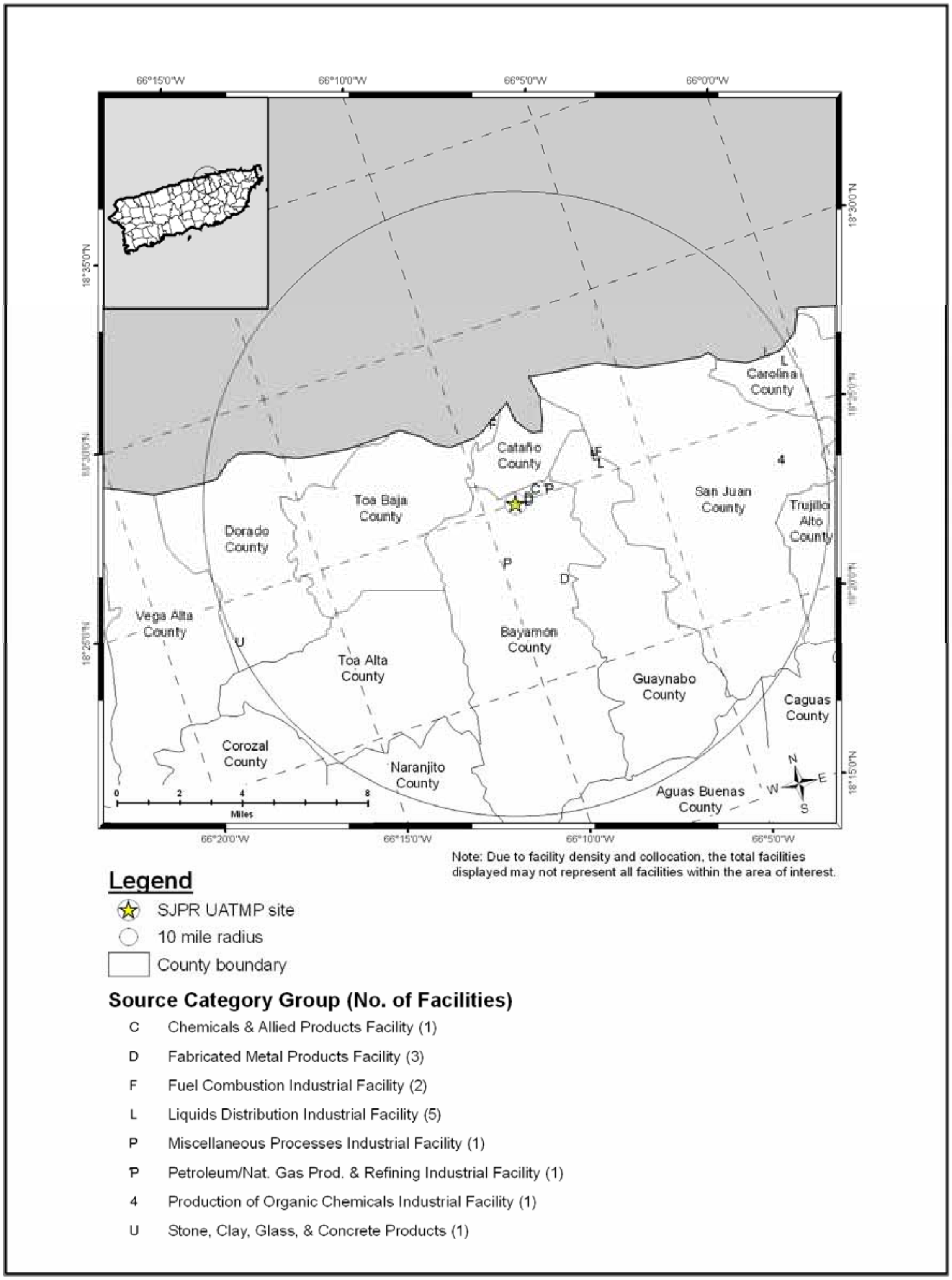


Table 21-1. Geographical Information for the Puerto Rico Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
BAPR	72-017-0003	Barceloneta	Barceloneta	San Juan-Caguas-Guaynabo, PR	18.434444, -66.579444	Residential	Rural	The Barceloneta site is a residential area surrounded by 5 pharmaceutical plants. The greater area outside the city is rural in character and the city itself is within 2 miles of the Atlantic Ocean.
SJPR	72-021-0006	San Juan	Bayamon	San Juan-Caguas-Guaynabo, PR	18.416944, -66.148056	Industrial	Suburban	The San Juan site is located at Bayamón Municipio, in the Regional Jail. The San Juan Metropolitan Area (SJMA) is affected by the emissions from stationary sources and by the heavy daily traffic. This geographical area is one of the Island's most polluted areas. The selected location is an open area representing a neighborhood scale in which the industrial area merges with the residential areas. The incidence of respiratory diseases is one of the general concerns (for the community and for the government). In general, the concentrations for the criteria pollutants are under the standards. But air toxics were not sampled for previously.

site. An industrial park and Fort Buchanan reside to the east of Highway 5. Of the fifteen point sources located within 10 miles of SJPR, liquids distribution facilities are the most numerous. However, facilities involved in fabricated metal production are located in closest proximity to the monitoring site, as Figure 21-4 shows.

Table 21-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Puerto Rico monitoring sites. County-level vehicle registration and population data for the municipios of Barceloneta and Bayamon were obtained from Air Monitoring Division of Puerto Rico's Air Quality Program and the U.S. Census Bureau. Table 21-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 21-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 21-2 presents the daily VMT for each urban area.

Table 21-2. Population, Motor Vehicle, and Traffic Information for the Puerto Rico Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
BAPR	23,038	13,912	0.60	NA	--	48,400	32,364
SJPR	220,574	145,642	0.66	NA	--	139,563	32,364

[1] Daily Average Traffic Data reflects 2004 data from the Puerto Rico Highway & Transportation Authority (BAPR) and 2003 data from the Puerto Rico Highway & Transportation Authority (SJPR)

Observations from Table 21-2 include the following:

- The county-level population and vehicle ownership were an order of magnitude higher for SJPR compared to BAPR. The county-level population for BAPR was the second lowest compared to data for other monitoring sites and the vehicle ownership for BAPR was the lowest of all other monitoring sites. The county-level population and vehicle ownership for SJPR were also on the low side compared to other monitoring sites.

- The vehicle registration to population ratios were fairly similar and on the low side compared to other monitoring sites.

- The population within 10 miles was not available for the Puerto Rico sites. As such, a 10-mile vehicle ownership estimate could be not calculated.

- Traffic values were on the high end of the range for these sites. Traffic for SJPR ranked eighth and traffic for BAPR ranked 17th highest among other monitoring sites. Traffic for BAPR was obtained from Highway 22 at State Road 140; traffic for SJPR was obtained from Highway 22 between State Roads 869 and 5.

21.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Puerto Rico on sampling days, as well as over the course of the year.

21.2.1 Climate Summary

The island of Puerto Rico is located in the northern Caribbean and experiences a tropical climate, where the air is warm and humid year-round and rainfall is abundant. Breezy winds flow from the northeast to east on average with the aid of the sub-tropical high pressure that resides over the tropical Atlantic Ocean. However, the sea-breeze is a daily occurrence (Ruffner and Bair, 1987).

21.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station to BAPR and SJPR is located at Luis Munoz Marin International Airport (WBAN 11641).

Table 21-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 21-3 is the 95 percent

Table 21-3. Average Meteorological Conditions near the Puerto Rico Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
BAPR	San Juan, PR Luis Munoz Marin Intl Airport 11641	Sampling Day	85.87 ± 1.35	79.35 ± 0.97	69.82 ± 0.88	72.94 ± 0.78	73.54 ± 1.89	1015.82 ± 0.75	6.54 ± 0.78
		All 2007	86.27 ± 0.35	80.26 ± 0.27	70.98 ± 0.27	73.96 ± 0.23	74.20 ± 0.51	1015.12 ± 0.22	6.70 ± 0.24
SJPR	San Juan, PR Luis Munoz Marin Intl Airport 11641	Sampling Day	85.86 ± 1.39	79.38 ± 1.01	69.87 ± 0.91	72.98 ± 0.80	73.61 ± 1.96	1015.86 ± 0.77	6.58 ± 0.80
		All 2007	86.27 ± 0.35	80.26 ± 0.27	70.98 ± 0.27	73.96 ± 0.23	74.20 ± 0.51	1015.12 ± 0.22	6.70 ± 0.24

confidence interval for each parameter. As shown in Table 21-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year. Even though the sites stopped sampling in June, the weather conditions on sampling days during the first half of the year were likely similar to weather conditions experienced during the second half of the year, which is reflected in the similarity of the averages in Table 21-3.

21.2.3 Composite Back Trajectories for Sampling Days

Figures 21-5 and 21-6 are composite back trajectory maps for the Puerto Rico monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 21-5 and 21-6 represents 100 miles.

Observations from Figures 21-5 and 21-6 include the following:

- The back trajectory maps for BAPR and SJPR are similar to each other.
- Back trajectories originated from the northeast, east, and southeast. Back trajectories did not originate from any other direction.
- The 24-hour air shed domains were somewhat smaller for these sites than for other monitoring sites. The furthest away a trajectory originated was nearly 500 miles away. However, most trajectories originated within 400 miles of the sites.

21.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather station closest to BAPR and SJPR were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 21-7 and 21-8 are the wind roses for the Puerto Rico monitoring sites on days that samples were collected.

Observations from Figures 21-7 and 21-8 include the following:

- The wind roses for BAPR and SJPR are very similar to each other. This is expected because the same weather station was used for both sites and because the dates of sampling were very similar.

Figure 21-5. Composite Back Trajectory Map for BAPR

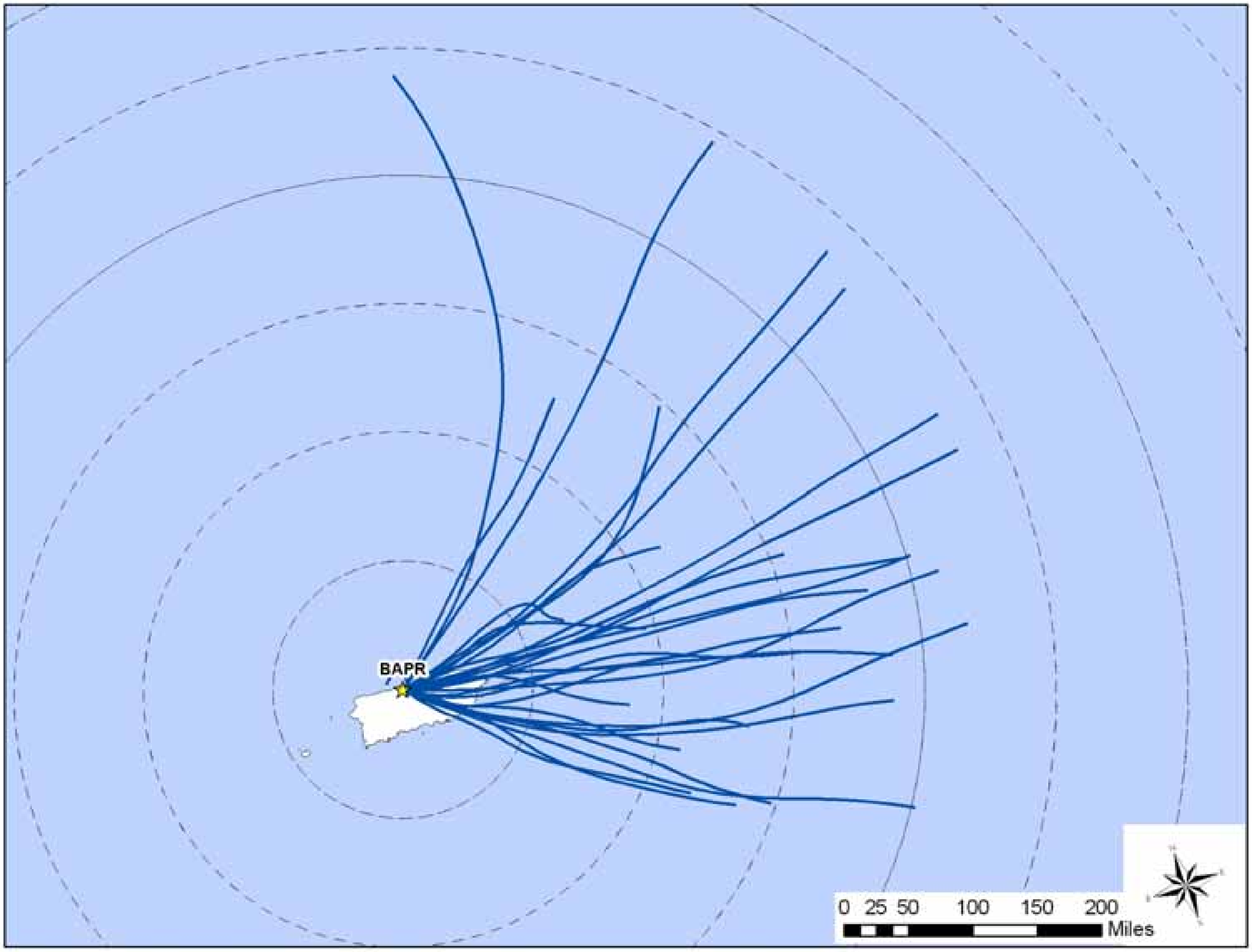


Figure 21-6. Composite Back Trajectory Map for SJPR

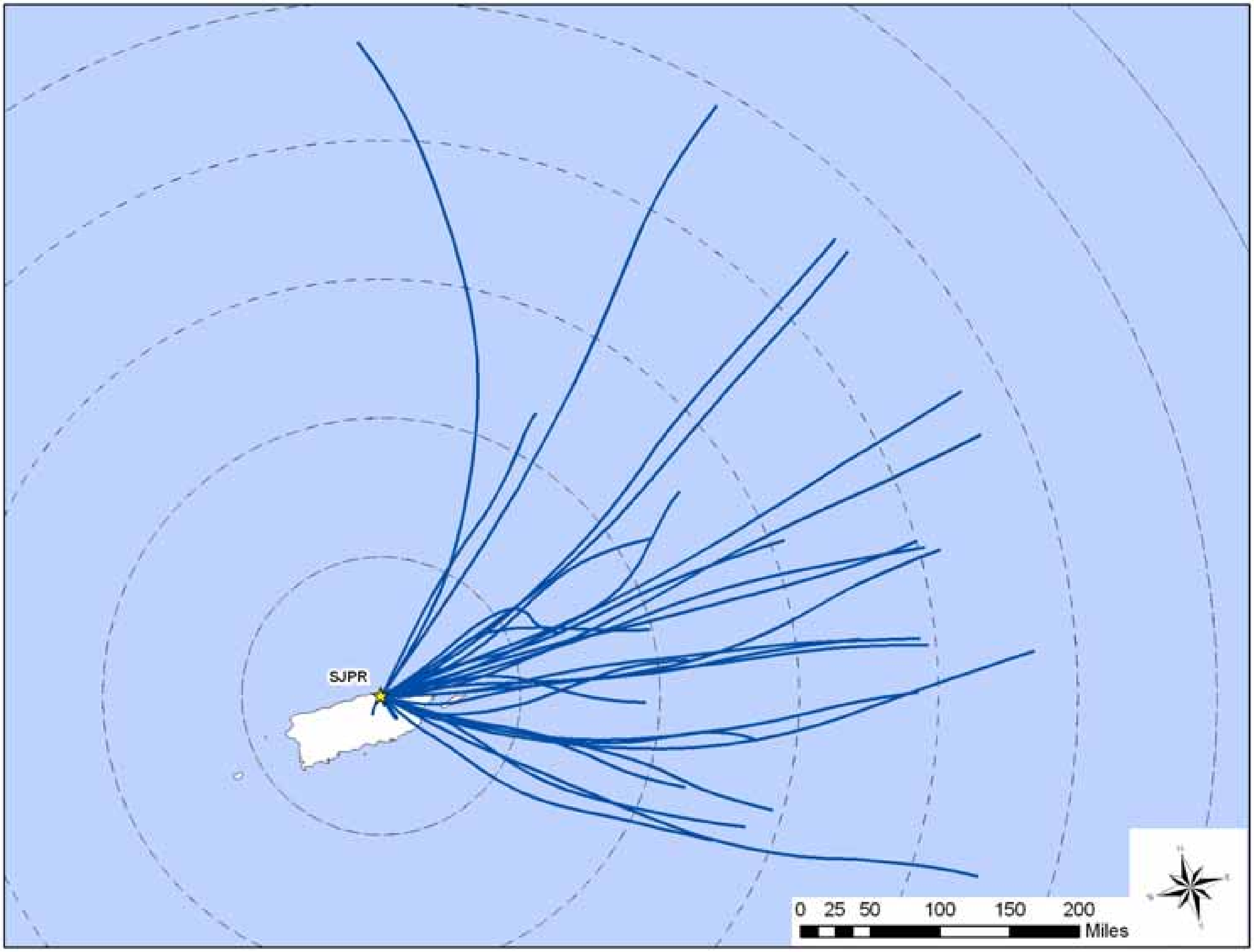


Figure 21-7. Wind Rose for BAPR Sampling Days

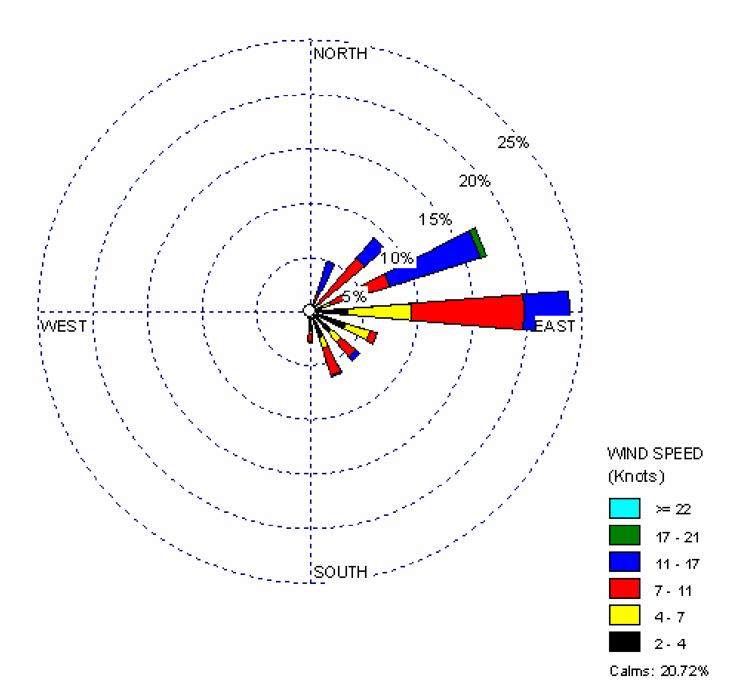
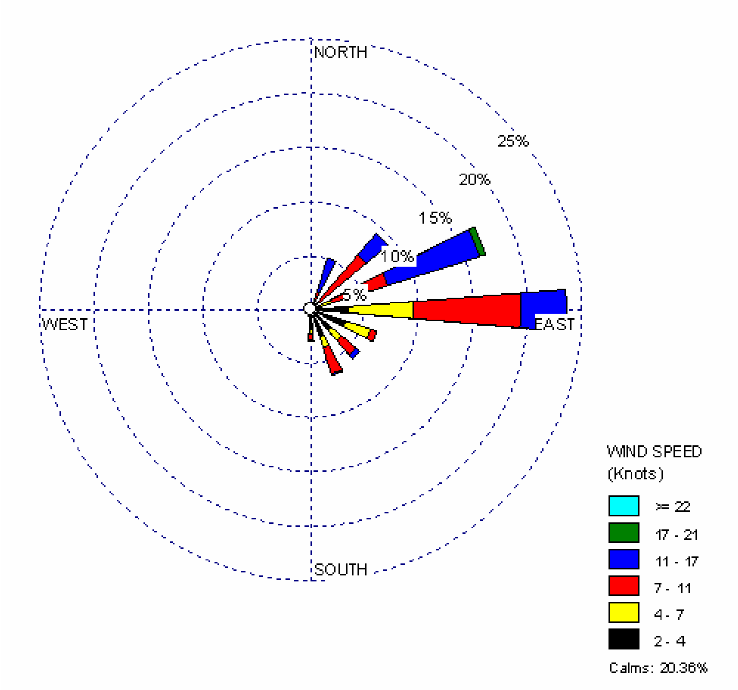


Figure 21-8. Wind Rose for SJPR Sampling Days



- Easterly and southeasterly winds were prevalent near these sites. Winds with a westerly component were not observed on sampling days.

- Calm winds were observed for nearly 20 percent of the hourly measurements.

21.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Puerto Rico monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 21-4 presents the pollutants that failed at least one screen for each Puerto Rico monitoring site and highlights each site's pollutants of interest (shaded). Both sites sampled for VOC and carbonyl compounds.

Observations from Table 21-4 include the following:

- Eleven pollutants with a total of 217 measured concentrations failed at least one screen for BAPR; thirteen pollutants with a total of 225 measured concentrations failed screens for SJPR.

- The pollutants of interest were very similar for both sites. The following pollutants of interest were common to both sites: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and *p*-dichlorobenzene. Only one pollutant of interest was different between the sites. Dichloromethane was a pollutant of interest for BAPR while tetrachloroethylene was a pollutant of interest for SJPR. BAPR was the only monitoring site for which dichloromethane was a pollutant of interest.

- Of the seven common pollutants of interest, 100 percent of the measured detections of acrolein, benzene, 1,3-butadiene, and carbon tetrachloride failed screens for BAPR and SJPR.

- Of the pollutants with at least one failed screen, 83 percent of measurements failed screens for BAPR, while 64 percent failed screens for SJPR.

Table 21-4. Comparison of Measured Concentrations and EPA Screening Values for the Puerto Rico Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Barceloneta, Puerto Rico - BAPR					
Acrolein	30	30	100.00	13.82	13.82
Carbon Tetrachloride	30	30	100.00	13.82	27.65
Benzene	30	30	100.00	13.82	41.47
1,3-Butadiene	30	30	100.00	13.82	55.30
Acetaldehyde	28	29	96.55	12.90	68.20
p-Dichlorobenzene	27	30	90.00	12.44	80.65
Dichloromethane	23	30	76.67	10.60	91.24
Formaldehyde	13	29	44.83	5.99	97.24
Acrylonitrile	4	4	100.00	1.84	99.08
Hexachloro-1,3-butadiene	1	1	100.00	0.46	99.54
Tetrachloroethylene	1	17	5.88	0.46	100.00
Total	217	260	83.46		
San Juan, Puerto Rico - SJPR					
1,3-Butadiene	29	29	100.00	12.89	12.89
Acetaldehyde	29	29	100.00	12.89	25.78
Acrolein	29	29	100.00	12.89	38.67
Benzene	29	29	100.00	12.89	51.56
Carbon Tetrachloride	29	29	100.00	12.89	64.44
Formaldehyde	29	29	100.00	12.89	77.33
p-Dichlorobenzene	28	29	96.55	12.44	89.78
Tetrachloroethylene	13	29	44.83	5.78	95.56
Dichloromethane	4	29	13.79	1.78	97.33
Xylenes	2	29	6.90	0.89	98.22
Acrylonitrile	2	2	100.00	0.89	99.11
Bromomethane	1	29	3.45	0.44	99.56
Toluene	1	29	3.45	0.44	100.00
Total	225	350	64.29		

21.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Puerto Rico monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

21.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 21-5.

Observations for BAPR from Table 21-5 include the following:

- The pollutants with the highest daily average concentrations by mass were dichloromethane (7.53 ± 4.77 μg/m^3), acetaldehyde (1.95 ± 0.35 μg/m^3), and formaldehyde (0.97 ± 0.10 μg/m^3). The concentrations of dichloromethane were significantly higher than any other pollutant of interest.

- As shown in Table 4-11, of the program-level pollutants of interest, BAPR had the fourth highest daily average concentration of *p*-dichlorobenzene. In addition, the BAPR daily average concentrations of 1,3-butadiene and carbon tetrachloride were among the 10 highest average concentrations for all NATTS and UATMP sites. However, concentrations of carbon tetrachloride are fairly uniform across the sites and the value for 1,3-butadiene is relatively low.

- Seasonal averages could only be calculated for winter and spring and annual averages were not calculated because BAPR stopped sampling in June.

Observations for SJPR from Table 21-5 include the following:

- The pollutants with the highest daily average concentrations by mass were acetaldehyde (6.35 ± 1.99 μg/m^3), formaldehyde (2.29 ± 0.21 μg/m^3), and benzene (1.48 ± 0.22 μg/m^3). The daily average concentrations of these pollutants were all higher than the daily average concentrations for BAPR.

Table 21-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Puerto Rico Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average (µg/m^3)
Barceloneta, Puerto Rico - BAPR								
Acetaldehyde	29	29	1.95 ± 0.35	1.81 ± 0.58	2.28 ± 0.51	NA	NA	NA
Acrolein	30	30	0.87 ± 0.23	1.06 ± 0.53	0.80 ± 0.26	NA	NA	NA
Benzene	30	30	0.93 ± 0.14	1.15 ± 0.32	0.83 ± 0.13	NA	NA	NA
1,3-Butadiene	30	30	0.12 ± 0.02	0.14 ± 0.03	0.12 ± 0.02	NA	NA	NA
Carbon Tetrachloride	30	30	0.62 ± 0.04	0.55 ± 0.05	0.66 ± 0.06	NA	NA	NA
p-Dichlorobenzene	30	30	0.31 ± 0.12	0.41 ± 0.31	0.27 ± 0.12	NA	NA	NA
Dichloromethane	30	30	7.53 ± 4.77	6.96 ± 6.14	8.77 ± 8.17	NA	NA	NA
Formaldehyde	29	29	0.97 ± 0.10	0.76 ± 0.12	1.10 ± 0.14	NA	NA	NA
San Juan, Puerto Rico - SJPR								
Acetaldehyde	29	29	6.35 ± 1.99	8.64 ± 5.89	5.41 ± 0.90	NA	NA	NA
Acrolein	29	29	0.72 ± 0.16	0.71 ± 0.19	0.67 ± 0.20	NA	NA	NA
Benzene	29	29	1.48 ± 0.22	1.49 ± 0.55	1.48 ± 0.23	NA	NA	NA
1,3-Butadiene	29	29	0.17 ± 0.03	0.19 ± 0.07	0.17 ± 0.03	NA	NA	NA
Carbon Tetrachloride	29	29	0.68 ± 0.05	0.57 ± 0.04	0.75 ± 0.07	NA	NA	NA
p-Dichlorobenzene	29	29	0.40 ± 0.08	0.46 ± 0.22	0.39 ± 0.07	NA	NA	NA
Formaldehyde	29	29	2.29 ± 0.21	1.81 ± 0.36	2.59 ± 0.19	NA	NA	NA
Tetrachloroethylene	29	29	0.21 ± 0.06	0.28 ± 0.13	0.19 ± 0.07	NA	NA	NA

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

- As shown in Tables 4-9 and 4-11, of the program-level pollutants of interest, SJPR had the highest daily average concentration of acetaldehyde and *p*-dichlorobenzene. In addition, the SJPR daily average concentrations of 1,3-butadiene and benzene were among the 10 highest average concentrations for all NATTS and UATMP sites.

- Seasonal averages could only be calculated for winter and spring and annual averages were not calculated because SJPR stopped sampling in June.

21.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. Although BAPR has sampled under the National Monitoring Program since 2001, a lapse in sampling occurred in 2004. SJPR began sampling in 2005 as part of the National Monitoring Program. Therefore, the trends analysis was not conducted for these sites.

21.5 Pearson Correlations

Table 21-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations from Table 21-6 include the following:

- Nearly all of the correlations between the pollutants of interest for BAPR and SJPR and the meteorological parameters were weak.
- However, strong positive correlations were calculated between formaldehyde and maximum temperature for both sites, indicating that as temperatures increase, concentrations of formaldehyde increase. Although this was also true for average temperature for BAPR, the correlation between average temperature and formaldehyde for SJPR was weaker than for BAPR.
- While the pollutants of interest exhibited weak correlations with wind speed, nearly all were negative, suggesting that concentrations of the pollutants of interest may increase as wind speeds decrease.

21.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Sections 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

Table 21-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Puerto Rico Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Barceloneta, Puerto Rico - BAPR								
Acetaldehyde	29	0.15	-0.07	-0.33	-0.26	-0.27	0.01	-0.24
Acrolein	30	-0.13	-0.12	0.05	0.00	0.20	-0.01	0.12
Benzene	30	-0.04	-0.09	-0.01	-0.05	0.11	-0.03	-0.24
1,3-Butadiene	30	-0.06	-0.13	-0.05	-0.09	0.11	-0.07	-0.18
Carbon Tetrachloride	30	0.25	0.24	0.15	0.20	-0.11	-0.12	-0.03
p-Dichlorobenzene	30	-0.25	-0.19	-0.18	-0.19	0.03	0.04	0.17
Dichloromethane	30	-0.02	-0.08	-0.06	-0.07	0.02	-0.06	-0.03
Formaldehyde	29	0.58	0.51	0.12	0.28	-0.45	-0.24	-0.25
San Juan, Puerto Rico - SJPR								
Acetaldehyde	29	-0.05	-0.17	-0.14	-0.18	0.03	-0.06	-0.39
Acrolein	29	-0.01	0.06	-0.11	-0.06	-0.22	0.25	0.17
Benzene	29	-0.02	-0.08	0.11	0.04	0.21	-0.14	-0.35
1,3-Butadiene	29	-0.03	-0.15	0.07	-0.01	0.27	-0.10	-0.42
Carbon Tetrachloride	29	0.29	0.25	-0.13	0.01	-0.42	-0.22	-0.09
p-Dichlorobenzene	29	-0.17	-0.22	-0.18	-0.22	0.05	-0.11	-0.36
Formaldehyde	29	0.51	0.33	0.01	0.14	-0.36	-0.22	-0.28
Tetrachloroethylene	29	-0.18	-0.28	-0.04	-0.14	0.29	-0.04	-0.40

21.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data for the Puerto Rico monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 21-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein from Table 21-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- The winter and spring seasonal averages of acrolein exceeded the intermediate MRL for both sites.
- Acrolein has no chronic MRL. In addition, annual averages could not be calculated for these two sites because they stopped sampling in June. Therefore, a chronic risk comparison could not be conducted.

21.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Puerto Rico monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncaner risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 21-8. The NATA data are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

Table 21-7. MRL Risk Screening Assessment Summary for the Puerto Rico Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average (µg/m^3)
BAPR	TO-15	Acrolein	7.00	0/30	0.09	**1.06 ± 0.53**	**0.80 ± 0.26**	NA	NA	--	NA
SJPR	TO-15	Acrolein	7.00	0/29	0.09	**0.71 ± 0.19**	**0.67 ± 0.20**	NA	NA	--	NA

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average
BOLD = exceedance of the intermediate or chronic MRL
-- = an MRL risk factor is not available

Table 21-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Puerto Rico

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (µg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Barceloneta, Puerto Rico (BAPR) - Census Tract ID 72017590300								
Acetaldehyde	0.000002	0.009	0.26	0.59	0.03	NA	NA	NA
Acrolein	--	0.00002	0.13	--	6.41	NA	NA	NA
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	NA	NA	NA
Benzene	0.000007	0.03	2.10	16.40	0.07	NA	NA	NA
1,3-Butadiene	0.00003	0.002	0.13	3.78	0.06	NA	NA	NA
Carbon Tetrachloride	0.000015	0.04	0.69	10.34	0.01	NA	NA	NA
***p*-Dichlorobenzene**	0.000011	0.8	0.06	0.61	<0.01	NA	NA	NA
Dichloromethane	0.00000047	1	151.02	70.99	0.15	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	1.01	0.01	0.10	NA	NA	NA
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	NA	NA	NA
Tetrachloroethylene	0.000005	0.27	0.24	1.44	<0.01	NA	NA	NA

-- = a URE or RfC is not available

Bold = pollutant of interest

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

Table 21-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Puerto Rico (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC (mg/m^3)	1999 NATA Modeled Concentration ($\mu g/m^3$)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (HQ)	2007 NATTS/UATMP Annual Average ($\mu g/m^3$)	2007 NATTS/UATMP Cancer Risk Approximation (in-a-million)	2007 NATTS/UATMP Noncancer Risk Approximation (HQ)
San Juan, Puerto Rico (SJPR) - Census Tract ID 72021030101								
Acetaldehyde	0.000002	0.009	0.35	0.78	0.03	NA	NA	NA
Acrolein	--	0.00002	0.19	--	9.50	NA	NA	NA
Acrylonitrile	0.000068	0.002	<0.01	0.02	<0.01	NA	NA	NA
Benzene	0.000007	0.03	3.38	26.38	0.11	NA	NA	NA
Bromomethane	--	0.005	0.23	--	0.04	NA	NA	NA
1,3-Butadiene	0.00003	0.002	0.19	5.64	0.09	NA	NA	NA
Carbon Tetrachloride	0.000015	0.04	0.69	10.37	0.01	NA	NA	NA
***p*-Dichlorobenzene**	0.000011	0.8	0.07	0.81	<0.01	NA	NA	NA
Dichloromethane	0.00000047	1	1.11	0.54	<0.01	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	1.20	0.01	0.12	NA	NA	NA
Tetrachloroethylene	0.000005	0.27	0.40	2.36	<0.01	NA	NA	NA
Toluene	--	0.4	7.51	--	0.02	NA	NA	NA
Xylenes	--	0.1	5.06	--	0.05	NA	NA	NA

-- = a URE or RfC is not available

Bold = pollutant of interest

NA = Not available due to the duration criteria for calculating a seasonal and/or annual average

The census tract information for the Puerto Rico monitoring sites is as follows:

- The census tract for BAPR is 72017590300, which had a population of 6,625, and represented approximately 30 percent of the Barceloneta Municipio population in 2000.
- The census tract for SJPR is 72021030101, which had a population of 6,628, and represented approximately 3 percent of the Bayamon Municipio population in 2000.

Observations for BAPR from Table 21-8 include the following:

- Dichloromethane had the highest modeled concentration and cancer risk, according to NATA. The cancer risk for this pollutant (70.99 in-a-million) was the second highest of all cancer risk estimates for any pollutant that failed a screen in a census tract with a UATMP or NATTS monitoring site.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (6.41).
- Because annual averages could not be calculated, cancer and noncancer surrogate risk approximations could not be calculated. Therefore, no additional comparisons can be made.

Observations for SJPR from Table 21-8 include the following:

- The pollutants with the highest modeled concentrations according to NATA were toluene, xylenes, and benzene. Of these, only benzene was a pollutant of interest.
- The pollutants with the highest cancer risks according to NATA were benzene, carbon tetrachloride, and 1,3-butadiene.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (1.04).
- Because annual averages could not be calculated, cancer and noncancer surrogate risk approximations could not be calculated. Therefore, no additional comparisons can be made.

21.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 21-9 and 21-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 21-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest

Table 21-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Puerto Rico

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Barceloneta, Puerto Rico (BAPR) – Barceloneta Municipio					
Dichloromethane	346.70	Hexavalent Chromium	3.04E-04		
Benzene	5.66	Dichloromethane	1.63E-04		
Formaldehyde	1.89	Benzene	4.41E-05		
Tetrachloroethylene	1.86	Arsenic, PM	4.30E-05		
Acetaldehyde	0.77	1,3-Butadiene	1.92E-05		
1,3-Butadiene	0.64	Tetrachloroethylene	1.10E-05		
Naphthalene	0.10	Naphthalene	3.29E-06		
Hexavalent Chromium	0.06	Ethylene oxide	2.69E-06		
Ethylene oxide	0.03	Cadmium, PM	2.16E-06		
POM, Group 2	0.01	Acetaldehyde	1.70E-06		
San Juan, Puerto Rico (SJPR) – Bayamon Municipio					
Benzene	103.56	Hexavalent Chromium	2.81E-03		
Formaldehyde	30.81	Benzene	8.08E-04		
Tetrachloroethylene	22.09	Arsenic, PM	3.37E-04		
Dichloromethane	16.97	1,3-Butadiene	3.37E-04		
1,3-Butadiene	11.22	Tetrachloroethylene	1.30E-04		
Acetaldehyde	10.88	Naphthalene	7.39E-05		
Naphthalene	2.17	Acetaldehyde	2.39E-05		
Hexavalent Chromium	0.65	Ethylene oxide	2.34E-05		
Ethylene oxide	0.27	POM, Group 2	1.39E-05		
POM, Group 2	0.25	Cadmium, PM	1.33E-05		

Table 21-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Puerto Rico

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risks Approximations Based on Annual Average Concentrations (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Barceloneta, Puerto Rico (BAPR) – Barceloneta Municipio					
Dichloromethane	346.70	Acrolein	4,637.93		
Acetonitrile	29.95	Chlorine	2,150.02		
Toluene	21.40	Acetonitrile	499.09		
Xylenes	13.29	Dichloromethane	346.70		
Methanol	12.28	Arsenic, PM	333.56		
Benzene	5.66	1,3-Butadiene	319.29		
Hexane	3.53	Hexavalent Chromium	253.27		
Ethylbenzene	3.32	Formaldehyde	192.87		
Hydrochloric acid	2.00	Benzene	188.55		
Formaldehyde	1.89	Xylenes	132.89		
San Juan, Puerto Rico (SJPR) – Bayamon Municipio					
Toluene	310.52	Acrolein	70,207.29		
Xylenes	177.15	1,3-Butadiene	5,609.11		
Benzene	103.56	Benzene	3,451.96		
Hexane	91.70	Formaldehyde	3,143.77		
Ethylbenzene	46.08	Arsenic, PM	2,613.70		
Formaldehyde	30.81	Hexavalent Chromium	2,344.77		
Methyl *tert*-butyl ether	30.12	Xylenes	1,771.47		
Tetrachloroethylene	22.09	Acetaldehyde	1,208.41		
Dichloromethane	16.97	Nickel, PM	1,012.43		
1,3-Butadiene	11.22	Toluene	776.30		

cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 21-10 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 21.3, SJPR and BAPR sampled for VOC and carbonyl compounds. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for an annual averages to be calculated.

Observations from Table 21-9 include the following:

- Dichloromethane was the highest emitted pollutant with a cancer URE in Barceloneta Municipio, followed by benzene and formaldehyde. Dichloromethane emissions were higher than any other pollutant emitted in Barceloneta Municipio two orders of magnitude.

- Benzene, formaldehyde, and tetrachloroethylene were the highest emitted pollutants with cancer UREs in Bayamon Municipio.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were hexavalent chromium, dichloromethane, and benzene in Barceloneta Municipio. The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were hexavalent chromium, benzene, and arsenic in Bayamon Municipio.

- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions in Barceloneta Municipio and Bayamon Municipios.

- Because annual averages could not be calculated, cancer risk approximations could not be calculated. Therefore, no additional comparisons can be made.

Observations from Table 21-10 include the following:

- Dichloromethane was the highest emitted pollutant with a noncancer RfC in Barceloneta Municipio, followed by acetonitrile and toluene. Again, dichloromethane emissions were higher than any other pollutant emitted in Barceloneta Municipio by an order of magnitude.

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Bayamon Municipio.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) in Barceloneta and Bayamon Municipios was acrolein.

- Five of the highest emitted pollutants also had the highest toxicity-weighted emissions in Barceloneta Municipio and Bayamon Municipio.

- Because annual averages could not be calculated, cancer risk approximations could not be calculated. Therefore, no additional comparisons can be made.

21.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *The pollutants of interest common to each Puerto Rico site were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, p-dichlorobenzene, and formaldehyde.*

- *Acetaldehyde had the highest daily average concentration for SJPR, while dichloromethane had the highest daily average concentration for BAPR.*

- *The winter and spring average concentrations of acrolein exceeded the intermediate MRL health benchmark for both sites.*

- *Average concentrations of dichloromethane for BAPR were higher than other program sites. However, an annual average concentration could not be calculated, due to the short sampling duration, to provide a cancer risk approximation.*

22.0 Site in Rhode Island

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Rhode Island, and integrates these concentrations with emissions, meteorological, and risk information.

22.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The Rhode Island site is located in the Providence-New Bedford-Fall River, RI-MA MSA. Figure 22-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its urban location. Figure 22-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 22-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

The PRRI monitoring site is located in south Providence. Figure 22-1 shows that the area to the west and south is residential, but areas to the north and east are more commercial. A hospital lies to the northeast, just north of Dudley Street. About a half-mile to the east, I-95 runs north-south, then turns northwestward, entering downtown Providence. Narragansett Bay and the Port of Providence are just a few tenths of a mile further to the east, on the other side of I-95. Figure 22-2 shows that a large number of point sources are located within 10 miles of PRRI. Some of the more numerous source categories include fuel combustion and surface coating processing.

Table 22-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Rhode Island monitoring site. County-level vehicle registration and population data for Providence County were obtained from Rhode Island Data Control and the U.S. Census Bureau. Table 22-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of the site is presented. An estimate of 10-mile vehicle

Figure 22-1. Providence, Rhode Island (PRRI) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 22-2. NEI Point Sources Located Within 10 Miles of PRRI

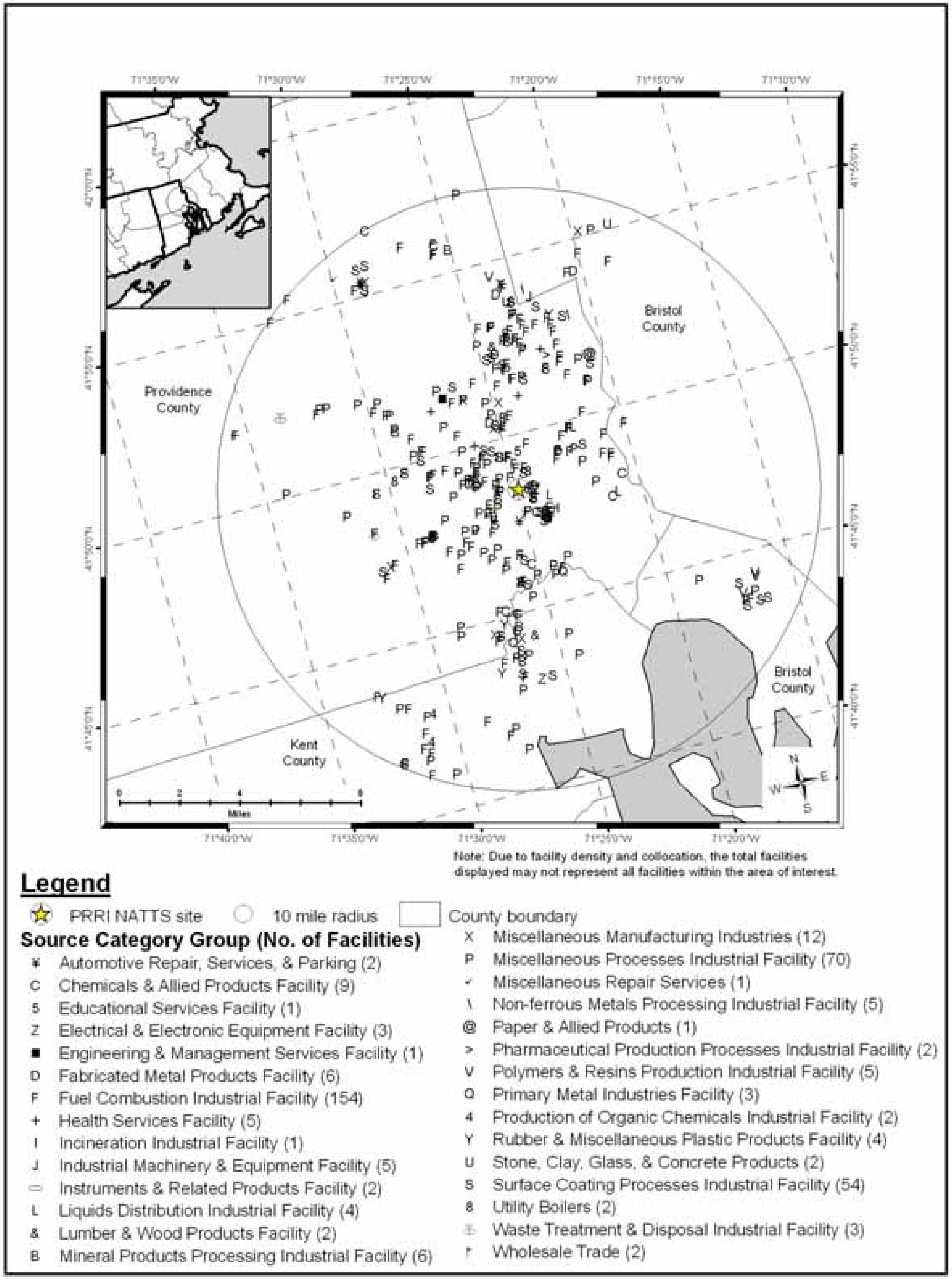


Table 22-1. Geographical Information for the Rhode Island Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
PRRI	44-007-0022	Providence	Providence	Providence-New Bedford-Fall River, RI-MA	41.807949, -71.415	Residential	Urban/City Center	The site is on the southern end of the roof of a rather spread-out, 1-story building in a fairly low-income neighborhood of south-Providence. It's approximately a half-mile from I-95 where it makes a sharp curve as it enters the city, where traffic congestion is common. Narragansett Bay and the Port of Providence are just a few tenths of a mile further to the east, on the other side of the highway. There is some industry along the Bay, including an asphalt plant right next to the curve in the highway. There is also a highway relocation project that's been under way for a couple of years.

BOLD = EPA-designated NATTS Site

Table 22-2. Population, Motor Vehicle, and Traffic Information for the Rhode Island Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
PRRI	629,435	142,334	0.23	670,441	151,607	212,100	26,744

[1] Daily Average Traffic Data reflects 2006 data from the Rhode Island DOT
BOLD = EPA-designated NATTS Site

registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 22-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 22-2 presents the daily VMT for the urban area.

Observations from Table 22-2 include the following:

- Providence County's population ranked 19th compared to all counties with NATTS or UATMP sites and its 10-mile population ranked 21st.
- The county-level vehicle registration ranked 29th compared to all counties with NATTS or UATMP sites, while its 10-mile ownership estimated ranked even lower.
- The vehicle per person ratio was the second lowest compared to other NATTS or UATMP sites, second only to BXNY.
- The traffic volume experienced near PRRI ranked third highest compared to other monitoring sites. The traffic estimate used came from I-95 near exit 18.
- The Providence area VMT was in the middle of the range among urban areas with UATMP or NATTS sites.

22.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Rhode Island on sampling days, as well as over the course of the year.

22.2.1 Climate Summary

Providence is a coastal city on the Narragansett Bay, which opens to the Rhode Island Sound and the Atlantic Ocean. The city's proximity to the Sound and the Atlantic Ocean temper cold air outbreaks, and breezes off the ocean moderate summertime heat. On average, southerly and southwesterly winds in the summer become northwesterly in the winter. Weather is fairly variable in the region as frequent storm systems affect New England (Ruffner and Bair, 1987).

22.2.2 Meteorological Conditions in 2007

Hourly meteorological data at the weather station near the site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at Theodore F. Green State Airport (WBAN 14765).

Table 22-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 22-3 is the 95 percent confidence interval for each parameter. As shown in Table 22-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

22.2.3 Composite Back Trajectories for Sampling Days

Figure 22-3 is the composite back trajectory map for the Rhode Island monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 22-3 represents 100 miles.

Observations from Figure 22-3 include the following:

- Back trajectories originated from a variety of directions at PRRI, although fewer trajectories originated from the southeast.

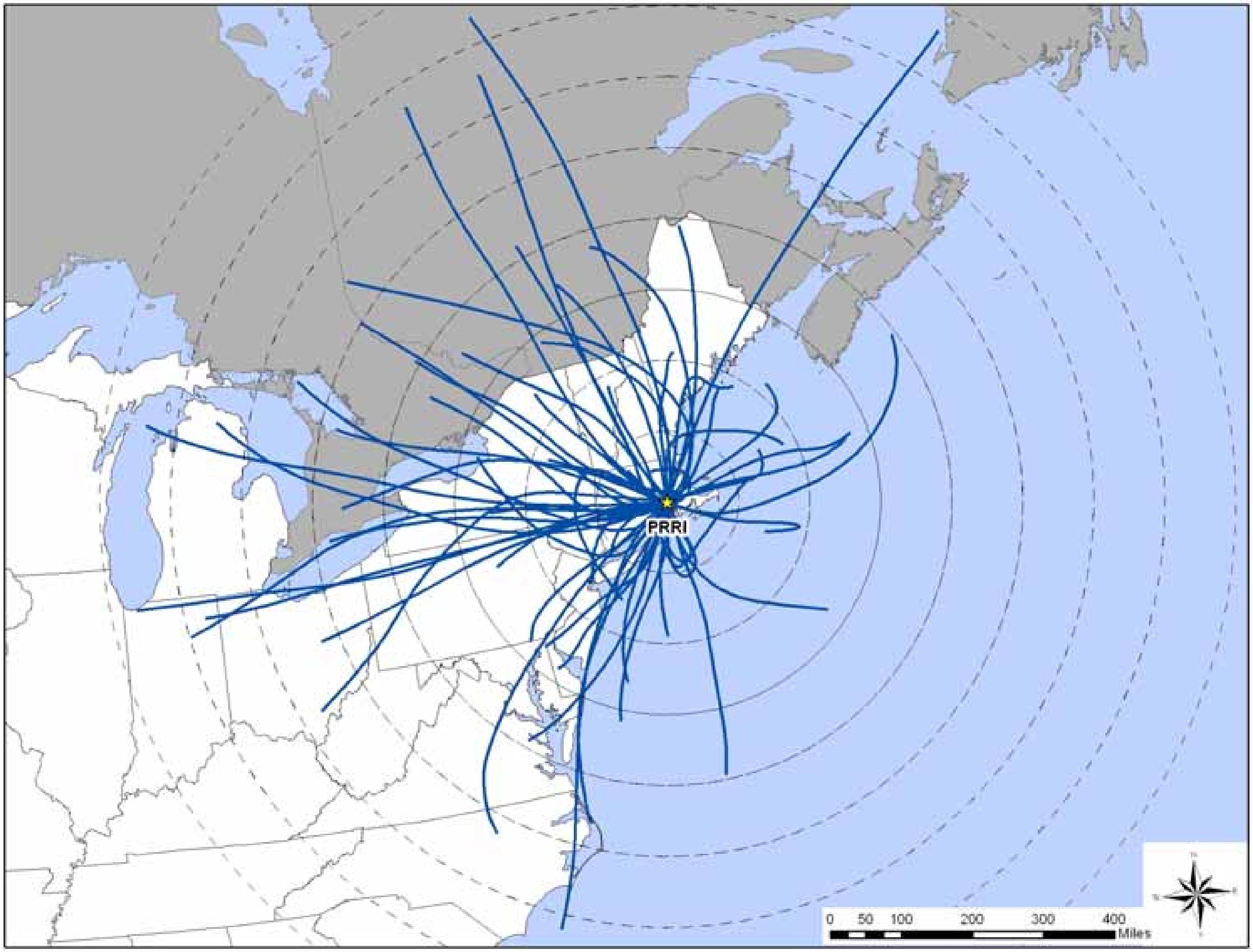
- The 24-hour air shed domain for PRRI was similar in size to other monitoring sites. The furthest away a trajectory originated was Newfoundland, Canada, or nearly 800 miles away. However, most trajectories originated within 500 miles of the site.

Table 22-3. Average Meteorological Conditions near the Rhode Island Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
PRRI	Theodore F. Green State Airport 14765	Sampling Day	59.89 ± 4.72	51.91 ± 4.48	39.40 ± 5.07	46.35 ± 4.24	65.11 ± 3.61	1017.43 ± 1.75	7.59 ± 0.67
		All 2007	60.63 ± 1.96	52.18 ± 1.82	38.59 ± 2.03	46.12 ± 1.69	63.16 ± 1.55	1016.31 ± 0.79	7.80 ± 0.29

BOLD = EPA-designated NATTS Site

Figure 22-3. Composite Back Trajectory Map for PRRI



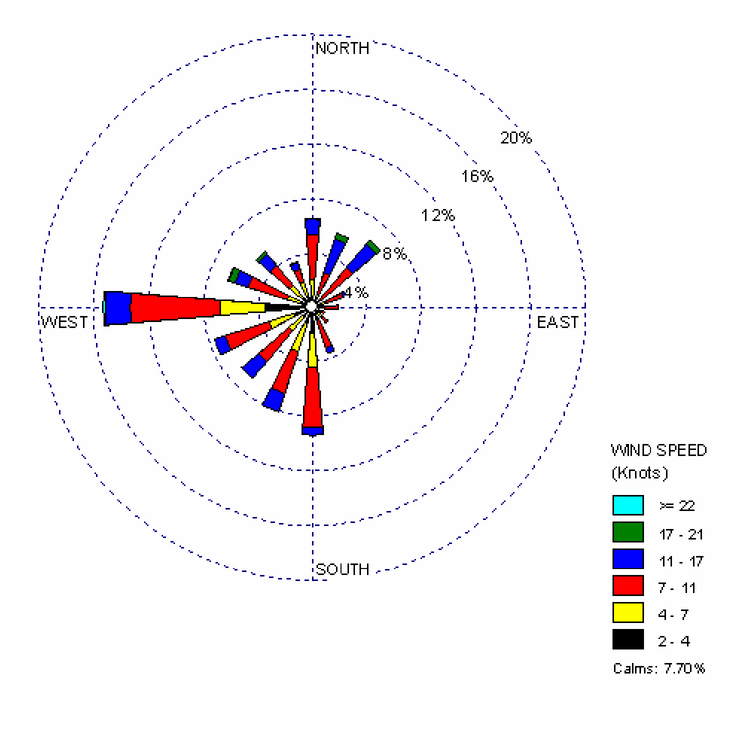
22.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at T. F. Green Airport near PRRI were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 22-4 is the wind roses for the Rhode Island monitoring site on days that samples were collected.

Observations from Figure 22-4 for PRRI include the following:

- Although winds from a variety of directions were observed near PRRI, westerly winds were prevalent (15 percent of wind observations).
- Calm winds were observed for nearly eight percent of the hourly measurements.
- Winds exceeding 11 knots made up nearly 18 percent of observations. The strongest winds originated from the west, northwest, and north.

Figure 22-4. Wind Rose for PRRI Sampling Days



22.3 Pollutants of Interest

"Pollutants of interest" were determined for the site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Rhode Island monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 22-4 presents the pollutants that failed at least one screen for the Rhode Island monitoring site and highlights the site's pollutants of interest (shaded).

Observations from Table 22-4 include the following:

- PRRI sampled for hexavalent chromium only.
- Hexavalent chromium was detected in 37 samples and failed two screens. This represents a five percent failure rate.

Table 22-4. Comparison of Measured Concentrations and EPA Screening Values for the Rhode Island Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Providence, Rhode Island - PRRI					
Hexavalent Chromium	2	37	5.41	100.00	100.00
Total	2	37	5.41		

22.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Rhode Island monitoring site. The averages presented are provided for the pollutant of interest for the site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

22.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for hexavalent chromium, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 22-5. The averages presented in Table 22-5 are shown in ng/m^3 for ease of viewing.

Observations for PRRI from Table 22-5 include the following:

- The daily average concentration of hexavalent chromium was higher than the annual average (0.022 ± 0.011 ng/m^3 vs. 0.015 ± 0.007 ng/m^3), which illustrates the effect of the substitution of 1/2 MDL. However, the confidence interval indicates that the difference is not statistically significant.

- The summer average concentration of hexavalent chromium was higher than the spring and autumn averages. However, the confidence interval indicates that the summer average is affected by outliers.

- A winter average could not be calculated due to the low number of detections (less than seven).

Table 22-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Rhode Island Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (ng/m^3)	Winter Average (ng/m^3)	Spring Average (ng/m^3)	Summer Average (ng/m^3)	Autumn Average (ng/m^3)	Annual Average[1] (ng/m^3)
Providence, Rhode Island -PRRI								
Hexavalent Chromium	37	60	0.022 ± 0.011	NR	0.015 ± 0.012	0.028 ± 0.025	0.012 ± 0.004	0.015 ± 0.007

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

22.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. PRRI has not sampled continuously for five years as part of the National Monitoring Programs; therefore, the trends analysis was not conducted.

22.5 Pearson Correlations

Table 22-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between the concentrations of hexavalent chromium and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for PRRI from Table 22-6 include the following:

- All of the correlations for PRRI were weak.

22.6 Additional Risk Screening Evaluations

The following evaluations were conducted to characterize risk at the monitoring site. Refer to Sections 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

22.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Rhode Island monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of hexavalent chromium were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the concentrations measured or calculated averages of hexavalent chromium for the PRRI monitoring site exceeded any of the MRL risk values.

Table 22-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Rhode Island Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Providence, Rhode Island - PRRI								
Hexavalent Chromium	37	0.11	0.12	0.14	0.12	0.11	0.13	-0.17

22.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutant that failed at least one screen at the Rhode Island monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 22-7. The data from NATA are presented for the census tract where the monitoring site is located. The census tract ID for PRRI is 44007000400, for which the population was 3,660 and represented 0.5 percent of the 2000 county population. The pollutant of interest for the PRRI monitoring site is bolded.

Observations for PRRI from Table 22-7 include the following:

- The modeled concentration for hexavalent chromium from NATA was less than 0.01 $\mu g/m^3$, as is the annual average.
- The cancer risk from hexavalent chromium according to NATA (1.40 in-a-million) was an order of magnitude higher than the cancer surrogate risk approximation (0.18 in-a-million).
- The noncancer risk according to NATA and the noncancer risk approximation for hexavalent chromium were both less than 0.01.

22.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 22-8 and 22-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 22-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 22-9 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors,

Table 22-7. Cancer and Noncancer Risk Summary for the Monitoring Site in Rhode Island

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (µg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Providence, Rhode Island (PRRI) - Census Tract ID 44007000400								
Hexavalent Chromium	0.012	0.0001	<0.01	1.40	<0.01	<0.01 ± <0.01	0.18	<0.01

Bold = pollutant of interest

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 22-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Rhode Island

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Providence, Rhode Island (PRRI) – Providence County					
Benzene	314.40	Benzene	2.45E-03	Hexavalent Chromium	0.18
Formaldehyde	176.20	Hexavalent Chromium	1.98E-03		
Tetrachloroethylene	93.12	1,3-Butadiene	1.26E-03		
Acetaldehyde	51.63	Nickel, PM	7.32E-04		
1,3-Butadiene	42.14	Tetrachloroethylene	5.49E-04		
Trichloroethylene	41.72	Cadmium, PM	2.91E-04		
Dichloromethane	30.22	Naphthalene	2.74E-04		
p-Dichlorobenzene	13.64	Arsenic, PM	1.76E-04		
Naphthalene	8.07	*p*-Dichlorobenzene	1.50E-04		
Nickel, PM	4.58	Acetaldehyde	1.14E-04		

Table 22-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Rhode Island

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximation Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Providence, Rhode Island (PRRI) – Providence County					
Toluene	829.38	Acrolein	415,493.94	Hexavalent Chromium	<0.01
Methyl *tert*-butyl ether	635.64	Nickel, PM	70,408.65		
Xylenes	567.30	1,3-Butadiene	21,071.44		
Methanol	328.61	Formaldehyde	17,979.35		
Benzene	314.40	Benzene	10,479.85		
Formaldehyde	176.20	Cadmium, PM	8,096.02		
Ethylbenzene	129.33	Cyanide Compounds, gas	7,867.00		
Hexane	112.71	Acetaldehyde	5,736.72		
Tetrachloroethylene	93.12	Xylenes	5,672.97		
Acetaldehyde	51.63	Chlorine	4,567.50		

respectively. As a result, although the actual value of the emissions will be the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on the site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 22.3, PRRI sampled for hexavalent chromium only. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 22-8 include the following:

- Benzene, formaldehyde, and tetrachloroethylene were the highest emitted pollutants with cancer UREs in Providence County.
- Benzene was also the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by hexavalent chromium and 1,3-butadiene.
- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for Providence County.
- Hexavalent chromium, which was the only pollutant sampled at PRRI, had the second highest toxicity-weighted emissions for Providence County. This pollutant did not appear on the list of highest emitted pollutants.

Observations from Table 22-9 include the following:

- Toluene, methyl *tert*-butyl ether, and xylenes were the highest emitted pollutants with noncancer RfCs in Providence County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, nickel, and 1,3-butadiene.
- Four of the highest emitted pollutants in Providence County also had the highest toxicity-weighted emissions.
- Hexavalent chromium did not appear on the list of highest emitted pollutants or the list of highest toxicity-weighted emissions for pollutants with noncancer toxicity factors.

22.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *Hexavalent chromium failed two screens for PRRI.*
- *Hexavalent chromium did not exceed any of the MRL health benchmarks.*

23.0 Site in South Carolina

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in South Carolina, and integrates these concentrations with emissions, meteorological, and risk information.

23.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The South Carolina site is located in Chesterfield County. Figure 23-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its rural location. Figure 23-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 23-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

CHSC is located in central Chesterfield County, about 10 miles south of the North and South Carolina border, between the towns of McBee and Chesterfield. The monitoring site is located near the Ruby fire tower and, as Figure 23-1 shows, is located just off Highway 145. The surrounding area is rural in nature and is part of the Carolina Sandhills Wildlife Refuge. Figure 23-2 shows that few point sources are located within 10 miles of CHSC.

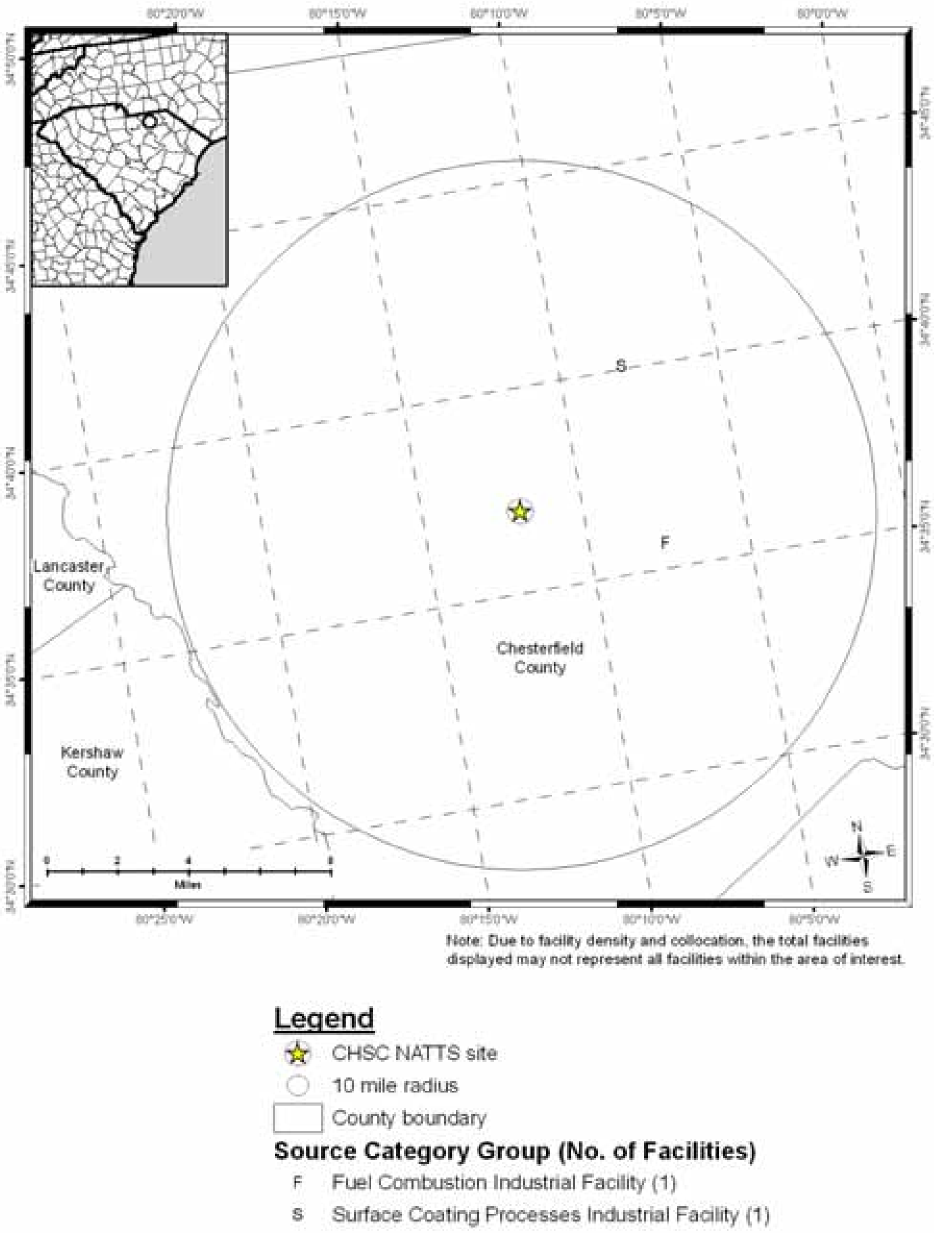
Table 23-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the South Carolina monitoring site. County-level vehicle registration and population data for Chesterfield County were obtained from the South Carolina Department of Motor Vehicles and the U.S. Census Bureau. Table 23-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of the site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site.

Figure 23-1. Chesterfield, South Carolina (CHSC) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 23-2. NEI Point Sources Located Within 10 Miles of CHSC



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 23-1. Geographical Information for the South Carolina Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
CHSC	45-025-0001	Not in a city	Chesterfield	Not in an MSA	34.617119, -80.198789	Forest	Rural	The site was chosen as a background site. It is very rural and in the middle of Carolina Sandhills Wildlife Refuge. The site is located on secondary road SC 145 between McBee and Chesterfield. Traffic on 145 is light. The nearest industry (AO Smith Water Heaters) is approximately 9 miles away. Elevation is ~450'.

BOLD = EPA-designated NATTS Site

Table 23-2. Population, Motor Vehicle, and Traffic Information for the South Carolina Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
CHSC	42,761	42,726	1.00	36,555	36,525	650	NA

[1] Daily Average Traffic Data reflects 2006 data from the South Carolina DOT
BOLD = EPA-designated NATTS Site

Table 23-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 23-2 presents the daily VMT for each urban area (where applicable).

Observations from Table 23-2 include the following:

- Chesterfield County's population was rather low compared to all counties with NATTS or UATMP sites. This is also true of its 10-mile population.
- Both the county-level and 10-mile radius vehicle registration were low compared to all counties with NATTS or UATMP sites.
- The vehicle per person ratio was one vehicle per person. While this may seem high, it ranked 16th among all NATTS and UATMP sites.
- The traffic volume experienced near CHSC ranked second lowest compared to other monitoring sites. The traffic estimate used came from State Road 145 between State Road 109 & US-1.
- VMT was unavailable for this area.

23.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in South Carolina on sampling days, as well as over the course of the year.

23.2.1 Climate Summary

The town of Chesterfield is located on the NC/SC border, north of Florence. The area boasts a temperate climate, typical of its southeast location. Winters tend to be mild and snowfall is rare, while summers are typically hot and humid, due in part to its proximity to the Atlantic Ocean (SC SCO, 2008).

23.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at Monroe Airport, Monroe, North Carolina (WBAN 53872).

Table 23-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 23-3 is the 95 percent confidence interval for each parameter. As shown in Table 23-3, average meteorological conditions on sampling days were representative of average weather conditions throughout the year.

23.2.3 Composite Back Trajectories for Sampling Days

Figure 23-3 is the composite back trajectory map for the South Carolina monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 23-3 represents 100 miles.

Observations from Figure 23-3 include the following:

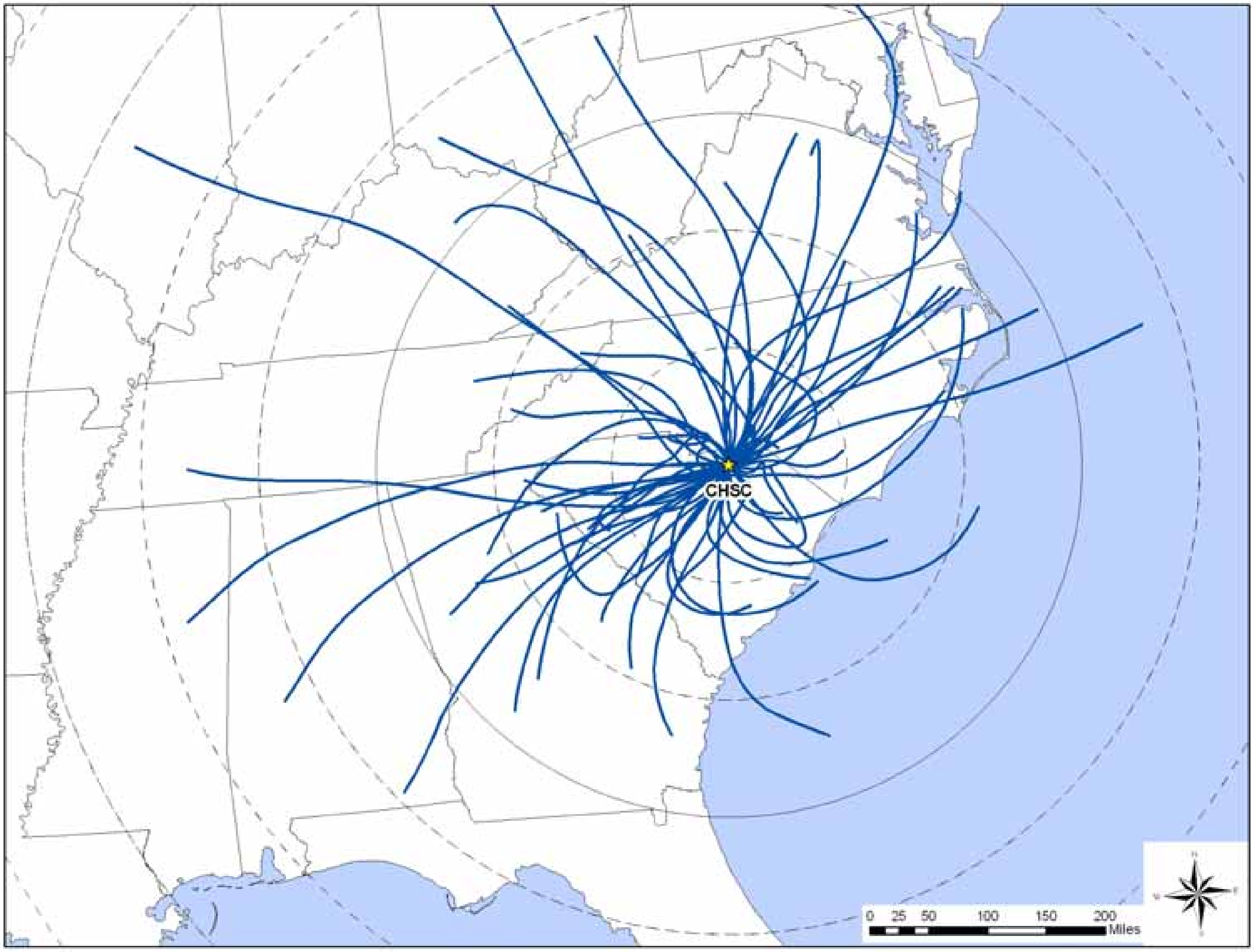
- Back trajectories originated from a variety of directions at CHSC.
- The 24-hour air shed domain for CHSC was similar in size to other monitoring sites. The furthest away a trajectory originated was central Illinois, or nearly 600 miles away. However, most trajectories originated within 400 miles of the site.

Table 23-3. Average Meteorological Conditions near the South Carolina Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CHSC	Monroe Airport, Monroe, NC 53872	Sampling Day	74.82 ± 4.00	63.02 ± 3.73	46.40 ± 4.10	54.32 ± 3.34	59.23 ± 3.45	1019.36 ± 1.44	4.68 ± 0.59
		All 2007	73.76 ± 1.63	62.57 ± 1.54	46.32 ± 1.72	54.14 ± 1.40	59.56 ± 1.40	1019.08 ± 0.60	4.97 ± 0.27

BOLD = EPA-designated NATTS Site

Figure 23-3. Composite Back Trajectory Map for CHSC



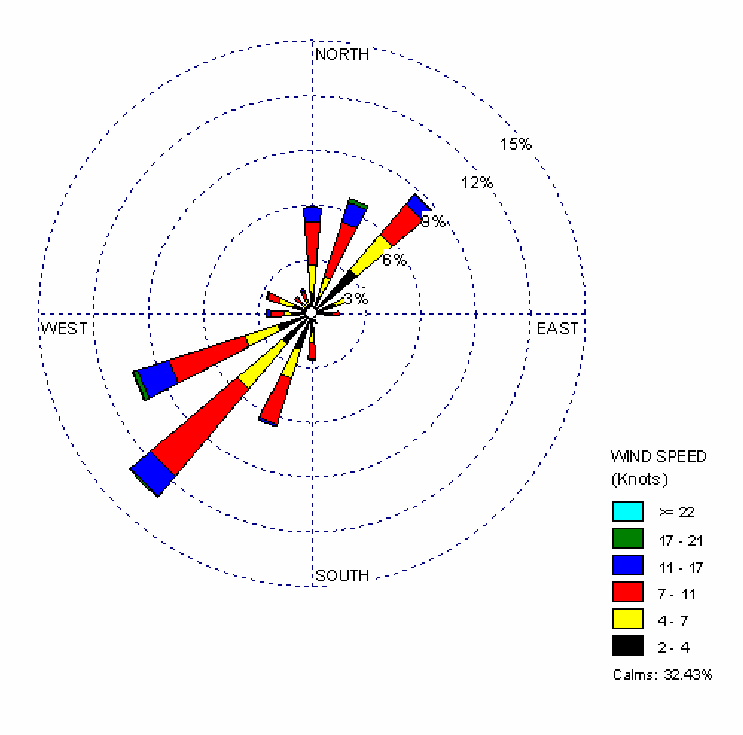
23.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at Monroe Airport near CHSC were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 23-4 is the wind rose for the CHSC monitoring site on days that samples were collected.

Observations from Figure 23-4 for CHSC include the following:

- Calm winds were prevalent near CHSC, as calm winds were observed for over one-third of the hourly measurements.
- For winds greater than 2 knots, southwesterly winds were observed most frequently.
- Winds exceeding 11 knots made up only 7 percent of observations.

Figure 23-4. Wind Rose for CHSC Sampling Days



23.3 Pollutants of Interest

"Pollutants of interest" were determined for the site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the South Carolina monitoring site were identified using the EPA risk screening process described in Section 3.2. Each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 23-4 presents the pollutants that failed at least one screen for the South Carolina monitoring site and highlights the site's pollutants of interest (shaded). CHSC sampled hexavalent chromium only.

Table 23-4. Comparison of Measured Concentrations and EPA Screening Values for the South Carolina Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Chesterfield, South Carolina - CHSC					
Hexavalent Chromium	0	17	0.00	0.00	0.00
Total	0	17	0.00		

Observations from Table 23-4 include the following:

- Hexavalent chromium was detected in 17 samples and did not fail any screens.
- In order to facilitate analysis, hexavalent chromium is considered CHSC's pollutant of interest.

23.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the South Carolina monitoring site. The averages presented are provided for the pollutants of interest for each monitoring site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

23.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 23-5. The averages presented in Table 23-5 are shown in ng/m^3 for ease of viewing.

Table 23-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the South Carolina Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (ng/m^3)	Winter Average (ng/m^3)	Spring Average (ng/m^3)	Summer Average (ng/m^3)	Autumn Average (ng/m^3)	Annual Average[1] (ng/m^3)
Chesterfield, South Carolina - CHSC								
Hexavalent Chromium	17	58	0.007 ± 0.001	NR	NR	0.005 ± 0.001	NR	0.005 ± 0.001

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for CHSC from Table 23-5 include the following:

- The daily average concentration of hexavalent chromium was slightly higher than the annual average (0.007 ± 0.001 ng/m^3 vs. 0.005 ± 0.001 ng/m^3), which illustrates the effect of the substitution of 1/2 MDL.

- Only one seasonal average (summer) of hexavalent chromium could be calculated due to the overall low number of detections.

23.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one ore more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. CHSC has not sampled continuously for five years as part of the National Monitoring Programs; therefore, the trends analysis was not conducted.

23.5 Pearson Correlations

Table 23-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of hexavalent chromium and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for CHSC from Table 23-6 include the following:

- All of the correlations for CHSC were relatively weak.

23.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Sections 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

23.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the South Carolina monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of hexavalent chromium were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured concentrations or calculated averages of hexavalent chromium exceeded any of the MRL risk values for CHSC.

23.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the South Carolina monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how

Table 23-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the South Carolina Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Chesterfield, South Carolina - CHSC								
Hexavalent Chromium	17	0.12	0.12	0.25	0.20	0.42	-0.10	0.18

cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 23-7. The data from NATA are presented for the census tract where the monitoring site is located. The census tract ID for CHSC is 45025950800, for which the population was 2,492, and represented 5 percent of the 2000 county population. The pollutants of interest for the monitoring site are bolded.

Observations for CHSC from Table 23-7 include the following:

- The modeled concentration for hexavalent chromium from NATA was less than 0.01 $\mu g/m^3$, as was the annual average.
- The cancer risk from hexavalent chromium according to NATA (0.22 in-a-million) was an order of magnitude higher than the cancer risk approximation (0.05 in-a-million), although both were fairly low.
- The noncancer risk according to NATA and the noncancer risk approximation for hexavalent chromium were both less than 0.01.

23.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 23-8 and 23-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 23-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 23-9 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk surrogate approximations based on the site's annual averages are limited to those pollutants for which the site sampled. As discussed in Section 23.3, CHSC sampled for hexavalent.

Table 23-7. Cancer and Noncancer Risk Summary for the Monitoring Site in South Carolina

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE ($\mu g/m^3$)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration ($\mu g/m^3$)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] ($\mu g/m^3$)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Chesterfield, South Carolina (CHSC) - Census Tract ID 45025950800								
Hexavalent Chromium	0.012	0.0001	<0.01	0.22	<0.01	<0.01 ± <0.01	0.05	<0.01

Bold = pollutant of interest

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 23-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in South Carolina

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximations (in-a-million)**
Chesterfield, South Carolina (CHSC) – Chesterfield County					
Benzene	56.07	Benzene	4.37E-04	Hexavalent Chromium	0.05
Formaldehyde	14.57	1,3-Butadiene	1.33E-04		
Dichloromethane	7.23	Naphthalene	6.18E-05		
Acetaldehyde	5.21	POM, Group 2	5.34E-05		
1,3-Butadiene	4.45	POM, Group 3	2.90E-05		
Trichloroethylene	2.86	Hexavalent Chromium	2.63E-05		
Naphthalene	1.82	POM, Group 5	2.12E-05		
Tetrachloroethylene	1.66	Arsenic, PM	1.99E-05		
POM, Group 2	0.97	Nickel, PM	1.23E-05		
p-Dichlorobenzene	0.92	Acetaldehyde	1.15E-05		

Table 23-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in South Carolina

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Chesterfield, South Carolina (CHSC) – Chesterfield County					
Toluene	152.24	Acrolein	40,795.44	Hexavalent Chromium	<0.01
Xylenes	131.39	1,3-Butadiene	2,224.64		
Benzene	56.07	Benzene	1,868.85		
Methanol	33.91	Formaldehyde	1,487.10		
Ethylene glycol	31.98	Cyanide Compounds, gas	1,388.57		
Ethylbenzene	27.55	Xylenes	1,313.89		
Hexane	21.50	Nickel, PM	1,180.28		
Methyl isobutyl ketone	19.98	Glycol ethers, gas	903.80		
Glycol ethers, gas	18.08	Naphthalene	605.84		
Formaldehyde	14.57	Acetaldehyde	578.49		

chromium only. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated

Observations from Table 23-8 include the following:

- Benzene, formaldehyde, and dichloromethane were the highest emitted pollutants with cancer UREs in Chesterfield County.

- Benzene was also the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by 1,3-butadiene and naphthalene.

- Five of the highest emitted pollutants also had the highest toxicity-weighted emissions for Chesterfield County.

- Hexavalent chromium, which was the only pollutant sampled at CHSC, had the sixth highest toxicity-weighted emissions for Chesterfield County. This pollutant did not appear on the list of highest emitted pollutants.

Observations from Table 23-9 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Chesterfield County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and benzene.

- Four of the highest emitted pollutants in Chesterfield County also had the highest toxicity-weighted emissions.

- Hexavalent chromium did not appear on the list of highest emitted pollutants on the list of highest toxicity-weighted emissions for pollutants with a noncancer toxicity factors. Its noncancer risk approximation was very low.

23.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *Hexavalent chromium did not fail any screens for CHSC; it was, however, considered a pollutant of interest in order to allow data analyses to be conducted.*

- ❖ *Hexavalent chromium did not exceed any of the MRL health benchmarks.*

24.0 Sites in South Dakota

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP sites in South Dakota, and integrates these concentrations with emissions, meteorological, and risk information.

24.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. CUSD is located in the town of Custer. The SFSD monitoring site is located in the Sioux Falls, SD MSA. Figures 24-1 and 24-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their rural and urban locations. Figures 24-3 and 24-4 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 24-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

CUSD is located in the town of Custer on the west side of the state, south of Rapid City. The town is located in the Black Hills and lies west of Custer State Park. The monitoring site is located just south of the Highway 89 and Highway 16 intersection, on the property of a sports complex on the outskirts of town. A residential subdivision is located just south and west of the site, as shown in Figure 24-1. Mobile sources and burning (wildfires and residential heating) are the primary emission sources in the area. As Figure 24-3 shows, no point source emission sources are located within 10 miles of the CUSD monitoring site.

SFSD is located on the east side of Sioux Falls, in eastern South Dakota. The monitoring site is located between two elementary schools in the center of a large residential area, as shown in Figure 24-2. The Hilltop water tower is just south of the site. The location of the monitoring site was selected to capture emissions from upwind sources west and northwest of the monitoring site. SFSD is approximately one half-mile from the intersection of Highway 42 and I-229. As Figure 24-4 shows, the few emission sources within 10 miles of SFSD are primarily located to

Figure 24-1. Custer, South Dakota (CUSD) Monitoring Site

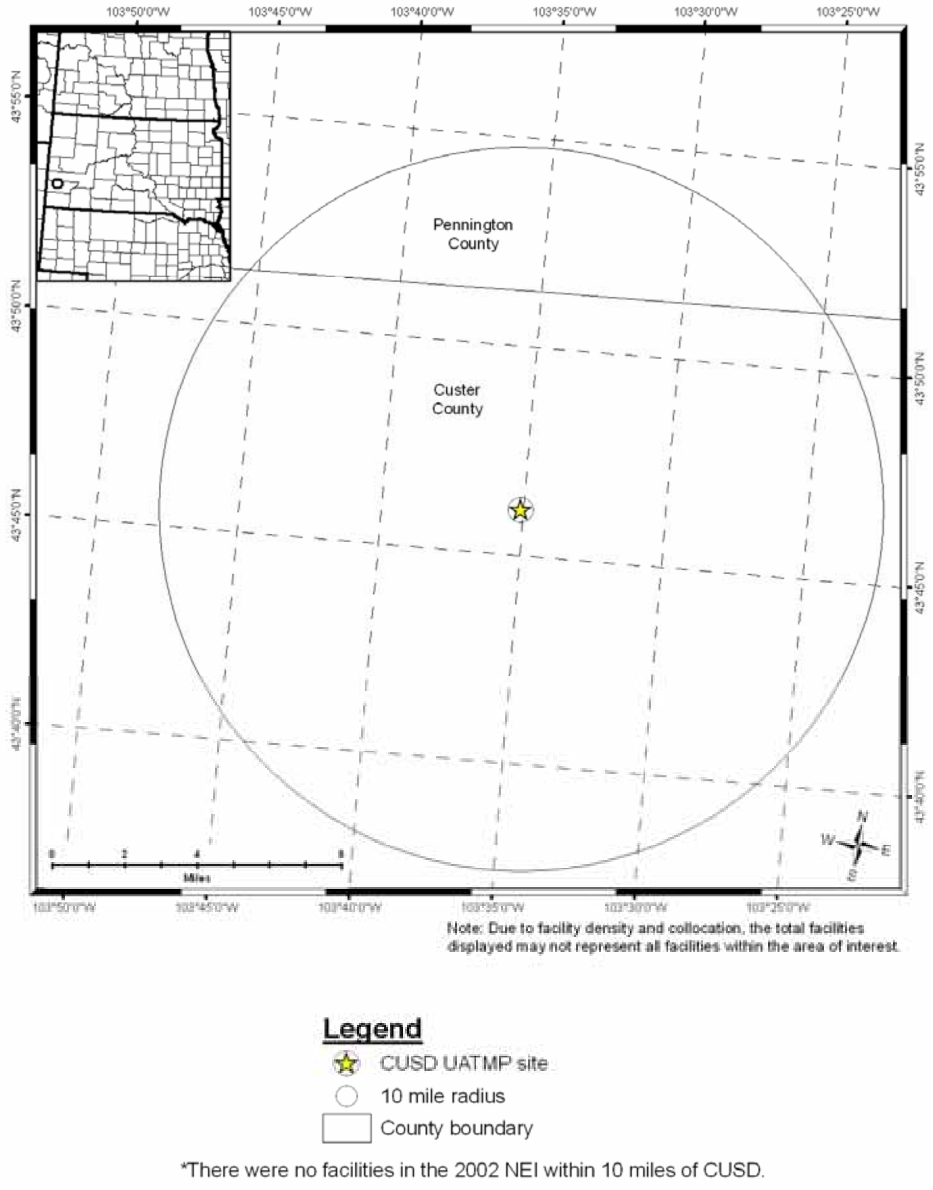
Scale: 3cm = 200m

Figure 24-2. Sioux Falls, South Dakota (SFSD) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 24-3. NEI Point Sources Located Within 10 Miles of CUSD



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

*There were no facilities in the 2002 NEI within 10 miles of CUSD.

Figure 24-4. NEI Point Sources Located Within 10 Miles of SFSD

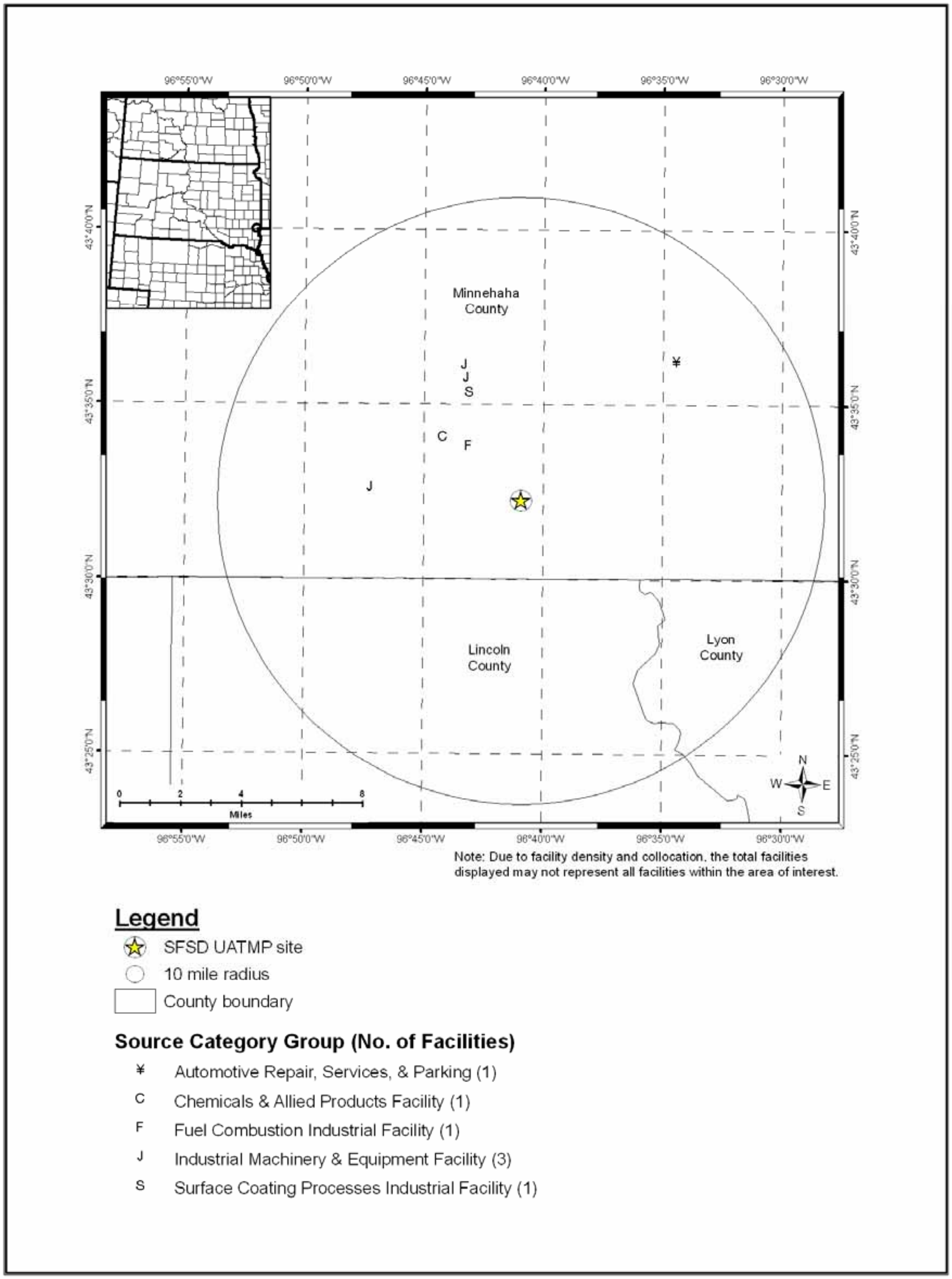


Table 24-1. Geographical Information for the South Dakota Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
CUSD	46-033-0003	Custer	Custer	Not in an MSA	43.766798, -103.584695	Residential	Suburban	The site is located on the edge of an urban area, in a pasture across the road from the last housing development on the east side of the City of Custer. The city has a population of 1,860 and is the largest city in the county. The city is located in a river valley in the Black Hills with pine covered hills on the north and south sides of the valley. The site is located in the center of the valley on the east side of the city. Major sources near the site include vehicles (highest traffic counts from May through September), forest fires (mainly during July through September), wood burning for heat, and wildland heath fires (during the winter months). The main industries in the area include tourism, logging, and mining of feldspar/quartz.
SFSD	46-099-0007	Sioux Falls	Minnehaha	Sioux Falls, SD	43.537626, -96.682001	Residential	Urban/City Center	The SFSD monitoring site is located in Sioux Falls, SD, the largest city in the state. Two grade schools are north of the site and residential areas are to the west, east, and south. The area within 1 mile of the site is mostly residential with a few retail businesses. The main industrial area of the city is about 3 miles northwest and 2 miles to the west of the site. The site was selected because it represents population exposure to chemical and particulate emissions from the industrial parts of the city. The predominant wind direction is northwest for most of the year with southeast winds during the summer months.

the northwest of the site. The industrial machinery and equipment source category is the most numerous category of point sources within 10 miles of SFSD.

Table 24-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the South Dakota monitoring sites. County-level vehicle registration and population data for Custer and Minnehaha Counties were obtained from the South Dakota Motor Vehicle Division and the U.S. Census Bureau. Table 24-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring sites. Table 24-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 24-2 presents the daily VMT for each urban area (where applicable).

Table 24-2. Population, Motor Vehicle, and Traffic Information for the South Dakota Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
CUSD	7,818	15,345	1.96	5,549	10,891	2,500	NA
SFSD	175,272	212,906	1.21	167,117	203,000	4,265	2,344

[1] Daily Average Traffic Data reflects 2006 data from the South Dakota DOT (CUSD) and 2005 data from the South Dakota DOT (SFSD)

Observations from Table 24-2 include the following:

- Both county-level populations were on the low side compared to counties with NATTS or UATMP sites. Custer County's population was the lowest of all sites, while Minnehaha County was 13th lowest. CUSD's 10-mile population was second lowest (behind CAMS 85), while SFSD's 10-mile population was 14th lowest.

- Both county-level vehicle registrations were on the low side compared to counties with NATTS or UATMP sites. Custer County's registration was the second lowest of all sites, while Minnehaha County was 16th lowest. CUSD's 10-mile vehicle ownership estimate was second lowest (behind CAMS 85), while SFSD's 10-mile vehicle ownership estimate was 17th lowest.

- The vehicle-per-person ratios for these sites were fairly high, indicating that each person likely owns multiple vehicles. The ratio for CUSD is the highest among all sites, while SFSD's ratio is the fifth highest.

- The traffic volumes for the South Dakota sites ranked 5th and 7th lowest compared to other program sites. Traffic for CUSD was obtained near the intersection of Highway 16 and 89; traffic for SFSD was obtained from Bahnson Avenue near Cleveland School.

- The Sioux Falls area VMT was the third lowest among urban areas with UATMP or NATTS sites. VMT was not available for Custer.

24.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in South Dakota on sampling days, as well as over the course of the year.

24.2.1 Climate Summary

The Sioux Falls area has a continental climate, with cold winters, warm summers, and often drastic day to day variations. Precipitation varies throughout the year, but is typically sufficient for the springtime growing season. On average, a south wind blows in the summer and a northwesterly wind blows in the winter. The weather in Custer is considered semi-arid continental; annual precipitation is light. Warm summers and relatively mild winters are characteristic of this area, due to the Black Hills to the west, which allow winters to be milder in comparison to the rest of the state (Ruffner and Bair, 1987).

24.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The two closest NWS weather stations are located at Custer County Airport (near CUSD) and Joe Foss Field Airport (near SFSD), WBAN 94032 and 14944, respectively.

Table 24-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 24-3 is the 95 percent confidence interval for each parameter. As shown in Table 24-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

24.2.3 Composite Back Trajectories for Sampling Days

Figures 24-5 and 24-6 are composite back trajectory maps for the South Dakota monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 24-5 and 24-6 represents 100 miles.

Observations from Figure 24-5 for CUSD include the following:

- Back trajectories originated from a variety of directions at the CUSD monitoring site, although most trajectories originated from the west or northwest.
- The 24-hour air shed domain for CUSD was somewhat larger in size than other monitoring sites. The furthest away a trajectory originated was British Columbia, Canada, or 800 miles away. However, 75 percent of the trajectories originated within 400 miles.

Observations from Figure 24-6 for SFSD include the following:

- Back trajectories originated from a variety of directions at the SFSD site, although primarily from the northwest and southwest.
- The 24-hour air shed domain for SFSD was the largest of all the monitoring sites. The furthest away a trajectory originated was Alberta, Canada, or nearly 1,100 miles away. However, 95 percent of the trajectories originated within 700 miles of the site.

Table 24-3. Average Meteorological Conditions near the South Dakota Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CUSD	Custer County Airport 94032	Sampling Day	53.77 ± 5.80	44.17 ± 5.20	27.07 ± 3.96	36.18 ± 4.05	57.11 ± 4.32	1015.79 ± 1.95	5.74 ± 0.53
		All 2007	54.38 ± 2.18	44.06 ± 1.99	27.64 ± 1.68	36.35 ± 1.63	57.52 ± 1.59	1014.60 ± 0.72	5.73 ± 0.22
SFSD	Joe Foss Field Airport 14944	Sampling Day	55.82 ± 6.41	47.52 ± 5.82	36.72 ± 5.36	42.26 ± 5.21	68.96 ± 3.02	1017.28 ± 1.97	8.70 ± 1.03
		All 2007	57.28 ± 2.54	47.90 ± 2.40	37.28 ± 2.25	42.71 ± 2.17	69.35 ± 1.14	1016.22 ± 0.79	8.45 ± 0.39

Figure 24-5. Composite Back Trajectory Map for CUSD

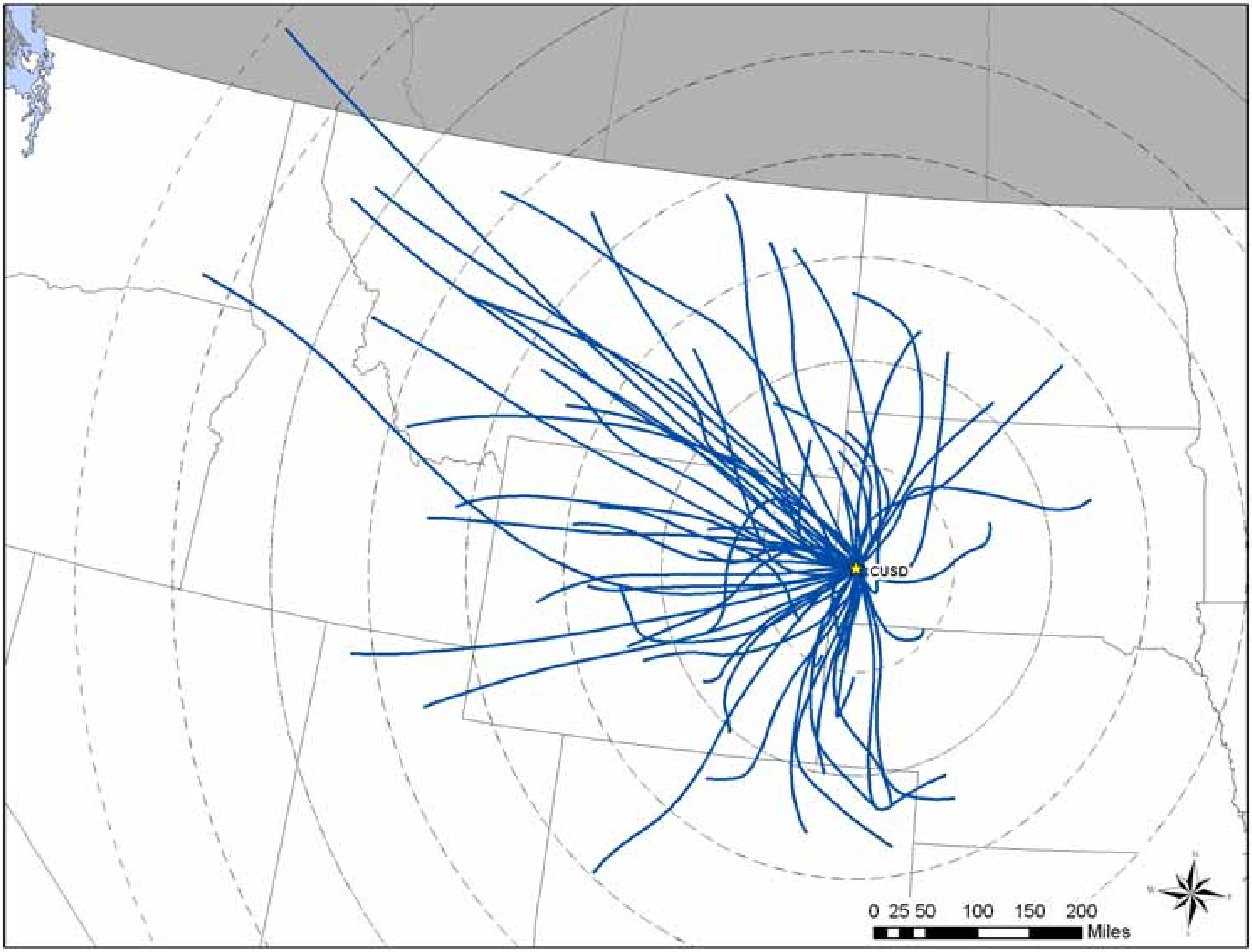
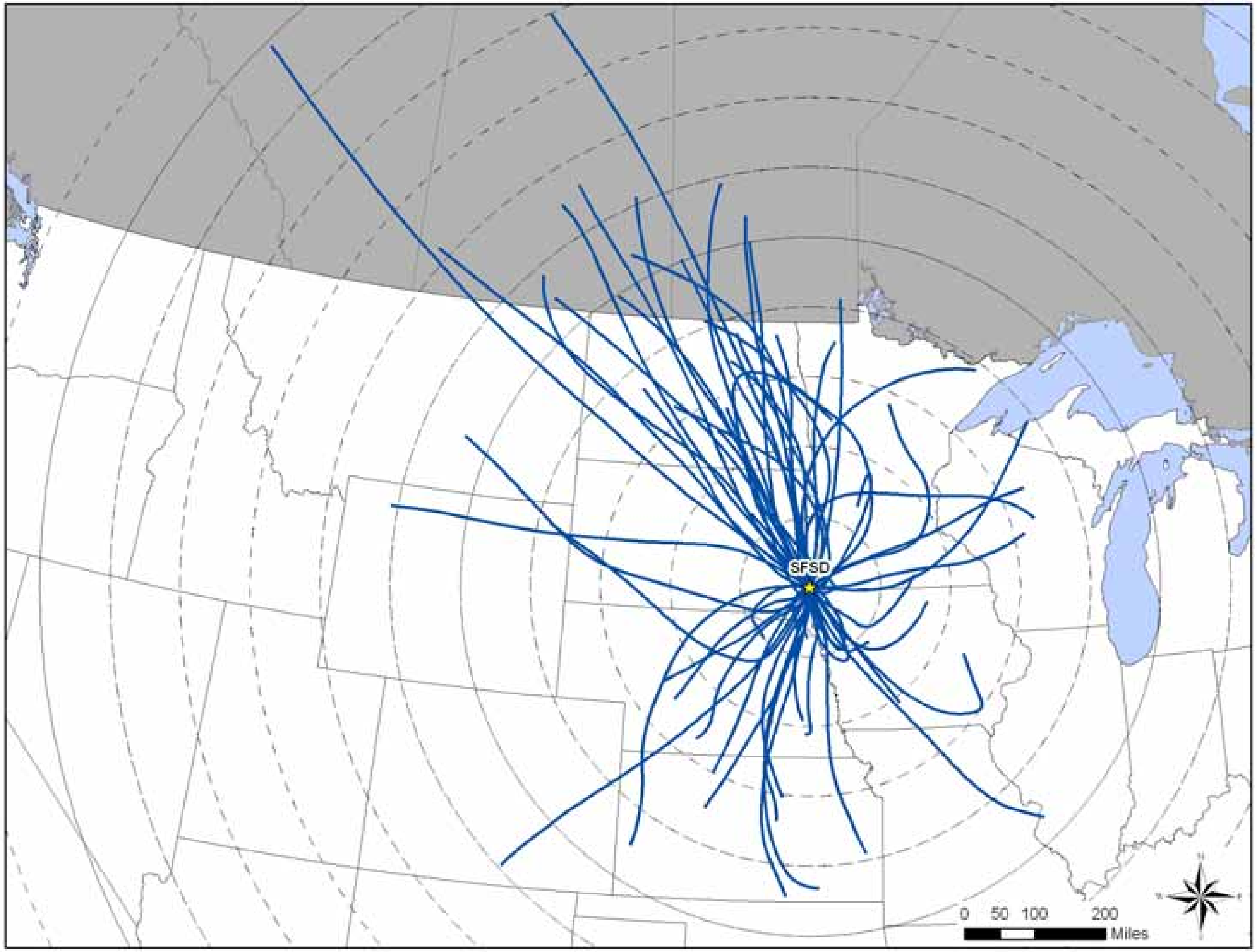


Figure 24-6. Composite Back Trajectory Map for SFSD



24.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations at Custer County (for CUSD) and Joe Foss Field Airports (for SFSD) were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 24-7 and 24-8 are the wind roses for the South Dakota monitoring sites on days that samples were collected.

Observations from Figure 24-7 for CUSD include the following:

- Westerly winds prevailed near CUSD. Northwesterly and southwesterly winds were also observed frequently.

- Calm winds were observed for nearly 16 percent of the observations.

- Winds exceeding 11 knots made up 10 percent of observations. The strongest winds most often had a westerly component.

Figure 24-7. Wind Rose for CUSD Sampling Days

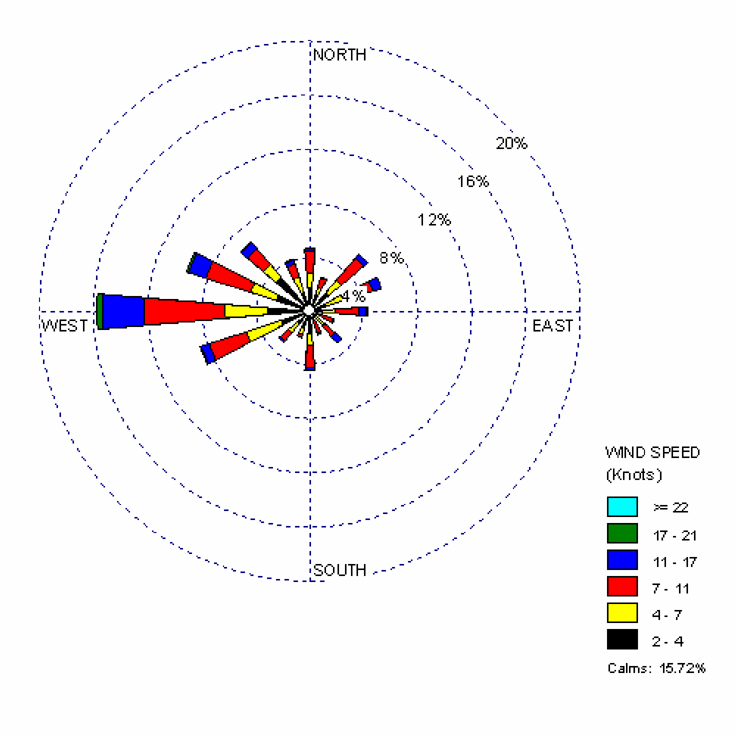
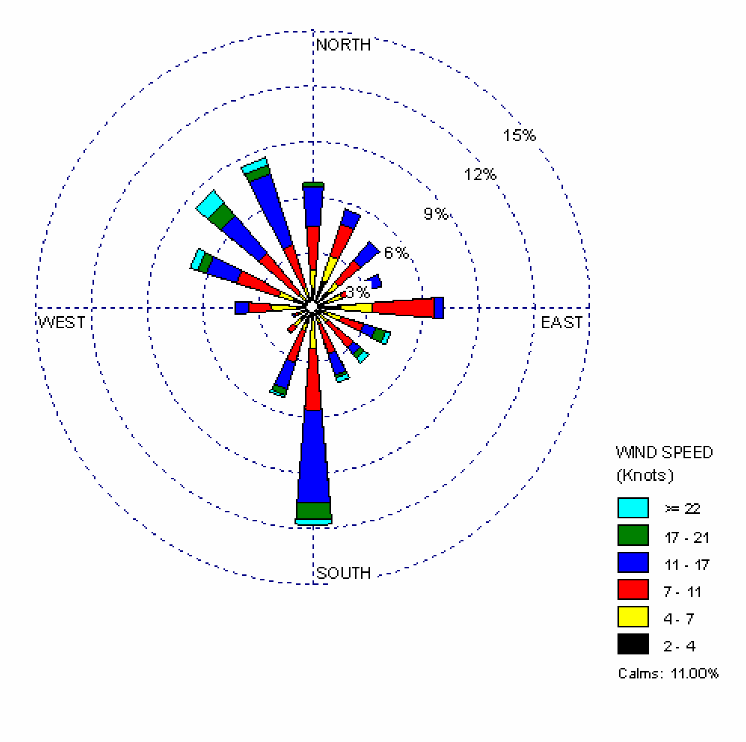


Figure 24-8. Wind Rose for SFSD Sampling Days



Observations from Figure 24-8 for SFSD include the following:

- Southerly winds prevailed near SFSD. Northwesterly winds were also observed frequently.
- Calm winds were observed for 11 percent of the observations.
- Winds exceeding 11 knots made up 31 percent of observations, the largest percentage among all UATMP and NATTS sites. Wind speeds greater than 22 knots were frequently observed with northwesterly, southeasterly, and southerly winds.

24.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the South Dakota monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 24-4 presents the pollutants that failed at least one screen for each South Dakota monitoring site and highlights each site's pollutants of interest (shaded). CUSD and SFSD sampled for VOC, SNMOC, and carbonyl compounds.

Table 24-4. Comparison of Measured Concentrations and EPA Screening Values for the South Dakota Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Custer, South Dakota - CUSD					
Acrolein	60	60	100.00	16.62	16.62
Benzene	60	60	100.00	16.62	33.24
Carbon Tetrachloride	60	60	100.00	16.62	49.86
Acetaldehyde	58	60	96.67	16.07	65.93
Formaldehyde	57	60	95.00	15.79	81.72
1,3-Butadiene	35	56	62.50	9.70	91.41
Acrylonitrile	20	20	100.00	5.54	96.95
Tetrachloroethylene	3	32	9.38	0.83	97.78
Trichloroethylene	2	4	50.00	0.55	98.34
p-Dichlorobenzene	2	13	15.38	0.55	98.89
Dichloromethane	1	60	1.67	0.28	99.17
1,1,2,2-Tetrachloroethane	1	1	100.00	0.28	99.45
n-Hexane	1	60	1.67	0.28	99.72
1,2-Dichloroethane	1	1	100.00	0.28	100.00
Total	361	547	66.00		
Sioux Falls, South Dakota - SFSD					
Carbon Tetrachloride	59	59	100.00	18.79	18.79
Acetaldehyde	59	59	100.00	18.79	37.58
Acrolein	58	58	100.00	18.47	56.05
Benzene	58	59	98.31	18.47	74.52
Formaldehyde	56	59	94.92	17.83	92.36
1,3-Butadiene	18	51	35.29	5.73	98.09
Acrylonitrile	3	3	100.00	0.96	99.04
1,2-Dichloroethane	2	2	100.00	0.64	99.68
Tetrachloroethylene	1	48	2.08	0.32	100.00
Total	314	398	78.89		

Observations from Table 24-4 include the following:

- Fourteen pollutants with a total of 361 measured concentrations failed at least one screen for CUSD. Nine pollutants with a total of 314 measured concentrations failed screens for SFSD.

- The following six pollutants of interest were common to both sites: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.

- Of the six common pollutants of interest, 100 percent of the measured detections of acrolein and carbon tetrachloride failed screens for both sites.

- Of the pollutants with at least one failed screen, nearly 79 percent of measurements failed screens for SFSD, while 66 percent failed screens for CUSD. While the failure rate appears higher for SFSD, several frequently detected pollutants only failed one screen at CUSD, increasing the number of measured detections but contributing few to the total number of failed screens.

24.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the South Dakota monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the sites, where applicable.

24.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and when the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages for the South Dakota monitoring sites are presented in Table 24-5, where applicable.

Table 24-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the South Dakota Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Custer, South Dakota - CUSD								
Acetaldehyde	60	60	1.91 ± 0.32	1.58 ± 0.36	1.32 ± 0.21	3.04 ± 0.93	1.73 ± 0.43	1.91 ± 0.32
Acrolein	60	60	0.59 ± 0.10	0.49 ± 0.16	0.42 ± 0.09	0.72 ± 0.19	0.71 ± 0.30	0.59 ± 0.10
Acrylonitrile	20	60	0.28 ± 0.05	NR	0.14 ± 0.08	0.20 ± 0.08	NR	0.11 ± 0.03
Benzene	60	60	0.66 ± 0.13	0.81 ± 0.29	0.48 ± 0.13	0.58 ± 0.16	0.81 ± 0.37	0.66 ± 0.13
1,3-Butadiene	56	60	0.07 ± 0.02	0.09 ± 0.04	0.05 ± 0.02	0.04 ± 0.01	0.09 ± 0.04	0.07 ± 0.02
Carbon Tetrachloride	60	60	0.55 ± 0.04	0.46 ± 0.09	0.61 ± 0.07	0.58 ± 0.07	0.55 ± 0.06	0.55 ± 0.04
Formaldehyde	60	60	2.03 ± 0.31	1.41 ± 0.39	1.35 ± 0.13	3.15 ± 0.79	2.20 ± 0.43	2.03 ± 0.31
Sioux Falls, South Dakota - SFSD								
Acetaldehyde	59	59	1.55 ± 0.23	2.09 ± 0.57	1.02 ± 0.15	1.55 ± 0.33	1.63 ± 0.51	1.55 ± 0.23
Acrolein	58	59	0.56 ± 0.09	0.34 ± 0.09	0.55 ± 0.15	0.79 ± 0.21	0.53 ± 0.14	0.55 ± 0.09
Benzene	59	59	0.56 ± 0.07	0.66 ± 0.13	0.51 ± 0.06	0.61 ± 0.22	0.44 ± 0.07	0.55 ± 0.07
1,3-Butadiene	51	59	0.04 ± 0.01	0.05 ± 0.02	0.04 ± 0.01	0.04 ± <0.01	0.03 ± <0.01	0.04 ± 0.01
Carbon Tetrachloride	59	59	0.57 ± 0.04	0.47 ± 0.08	0.63 ± 0.07	0.57 ± 0.08	0.59 ± 0.05	0.57 ± 0.04
Formaldehyde	59	59	3.57 ± 2.52	7.19 ± 10.38	2.28 ± 0.34	3.09 ± 0.39	2.01 ± 0.33	3.57 ± 2.52

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for CUSD from Table 24-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (2.03 ± 0.31 µg/m^3), acetaldehyde (1.91 ± 0.32 µg/m^3), and benzene (0.66 ± 0.13 µg/m^3).

- As shown in Table 4-11, of the program-level pollutants of interest, CUSD had the sixth highest daily average concentration of acrylonitrile. None of the remaining daily average concentrations of the pollutants of interest for CUSD appeared in Tables 4-9 and 4-11.

- Concentrations of acetaldehyde and formaldehyde were highest during the summer. The concentrations of the other pollutants of interest did not vary significantly from season to season.

Observations for SFSD from Table 24-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (3.57 ± 2.52 µg/m^3), acetaldehyde (1.55 ± 0.23 µg/m^3), and carbon tetrachloride (0.57 ± 0.04 µg/m^3).

- As shown in Table 4-11, of the program-level pollutants of interest, CUSD had the seventh (behind CUSD) highest daily average concentration of acrylonitrile. None of the remaining daily average concentrations of the pollutants of interest for SFSD appeared in Tables 4-9 and 4-11.

- The confidence interval for the daily average concentration of formaldehyde was rather large, indicating the influence of outliers. The winter average concentration of formaldehyde was much higher than other seasons with a very large confidence interval, indicating that the outliers were measured during this season.

- The concentrations of the other pollutants of interest did not vary significantly from season to season.

24.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. CUSD has sampled VOC, SNMOC, and carbonyls since 2002. SFSD has sampled VOC since 2000, SNMOC since 2001, and carbonyls since 2002. Figures 24-9 through 24-16 present the three-year rolling statistical metrics graphically for benzene (both methods), 1,3-butadiene, and formaldehyde for each monitoring site. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Observations from Figures 24-9 and 24-10 for benzene measurements at CUSD include the following:

- Although the magnitude of the concentrations in Figures 24-9 and 24-10 are different, the plots are very similar, reflecting the ability of the methods to report similar tendencies.

Figure 24-9. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CUSD (SNMOC)

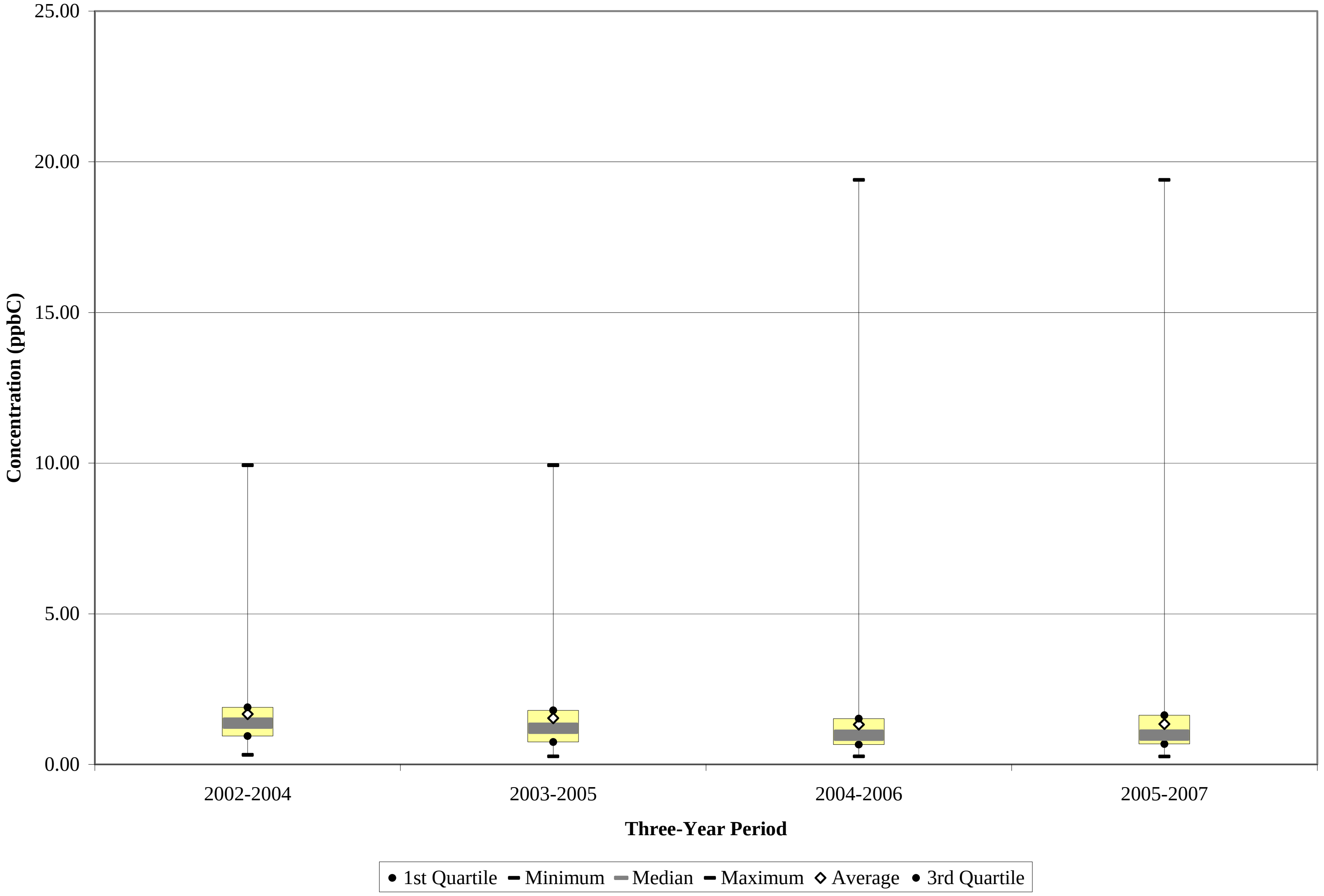


Figure 24-10. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CUSD (TO-15)

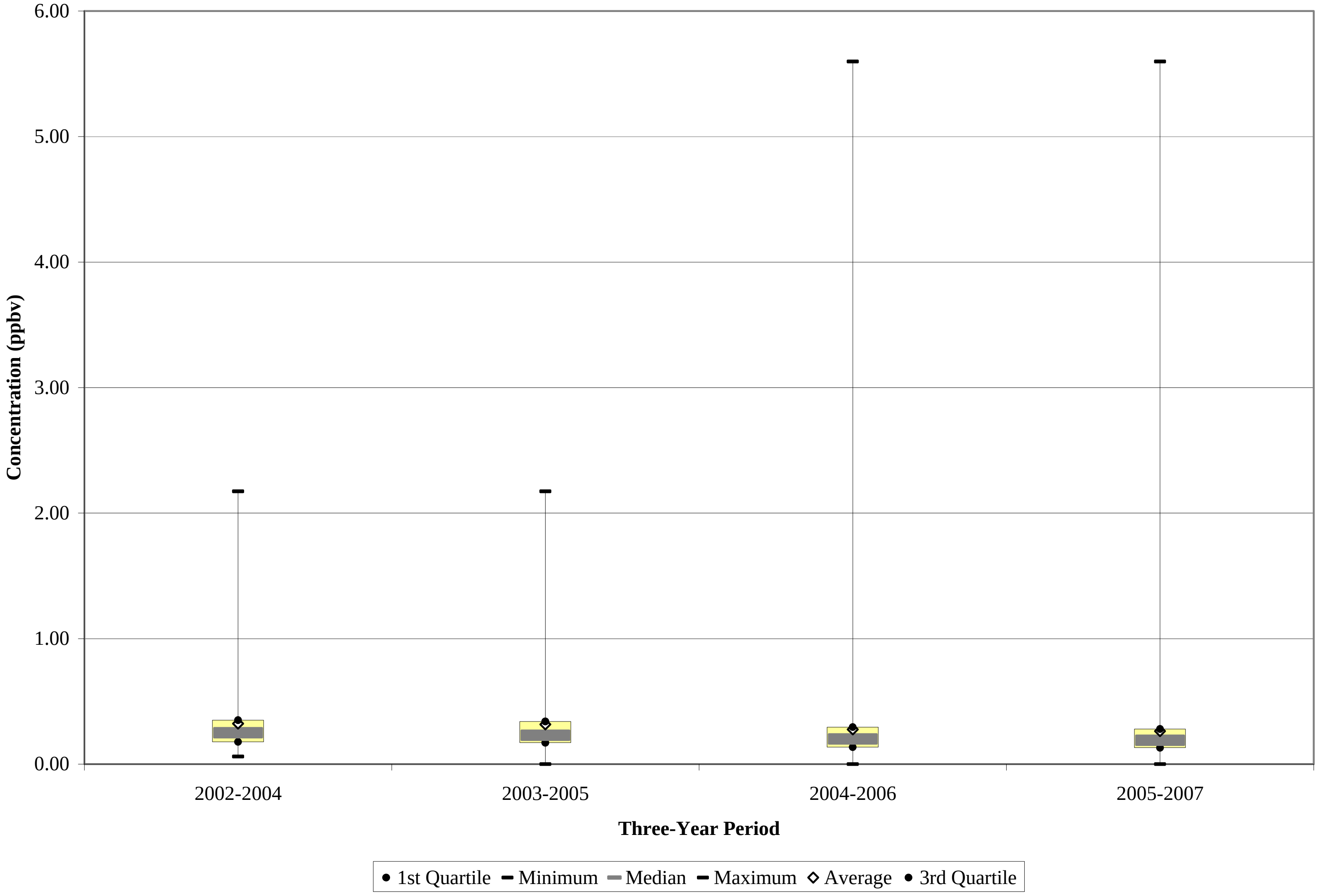


Figure 24-11. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at CUSD

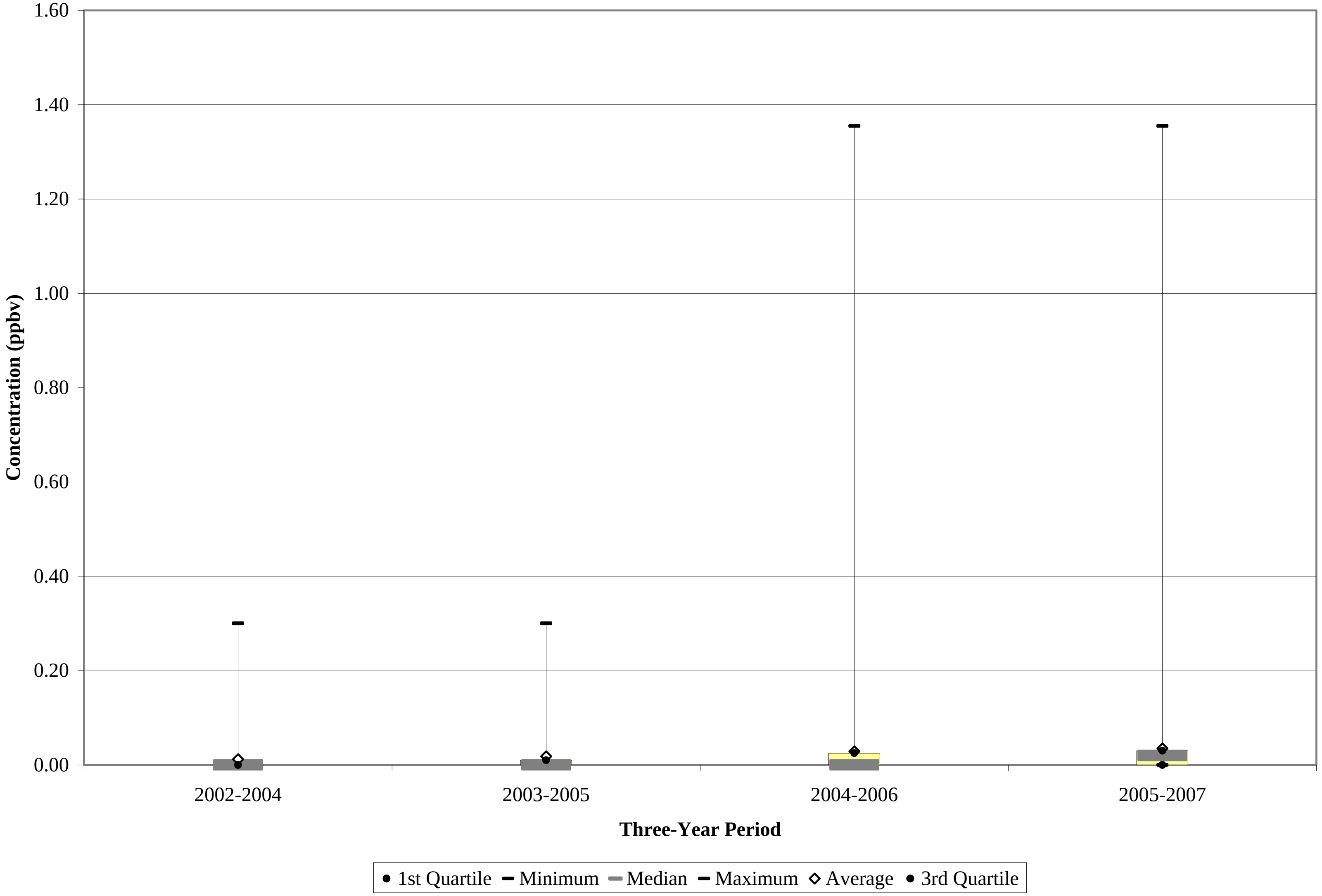


Figure 24-12. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at CUSD

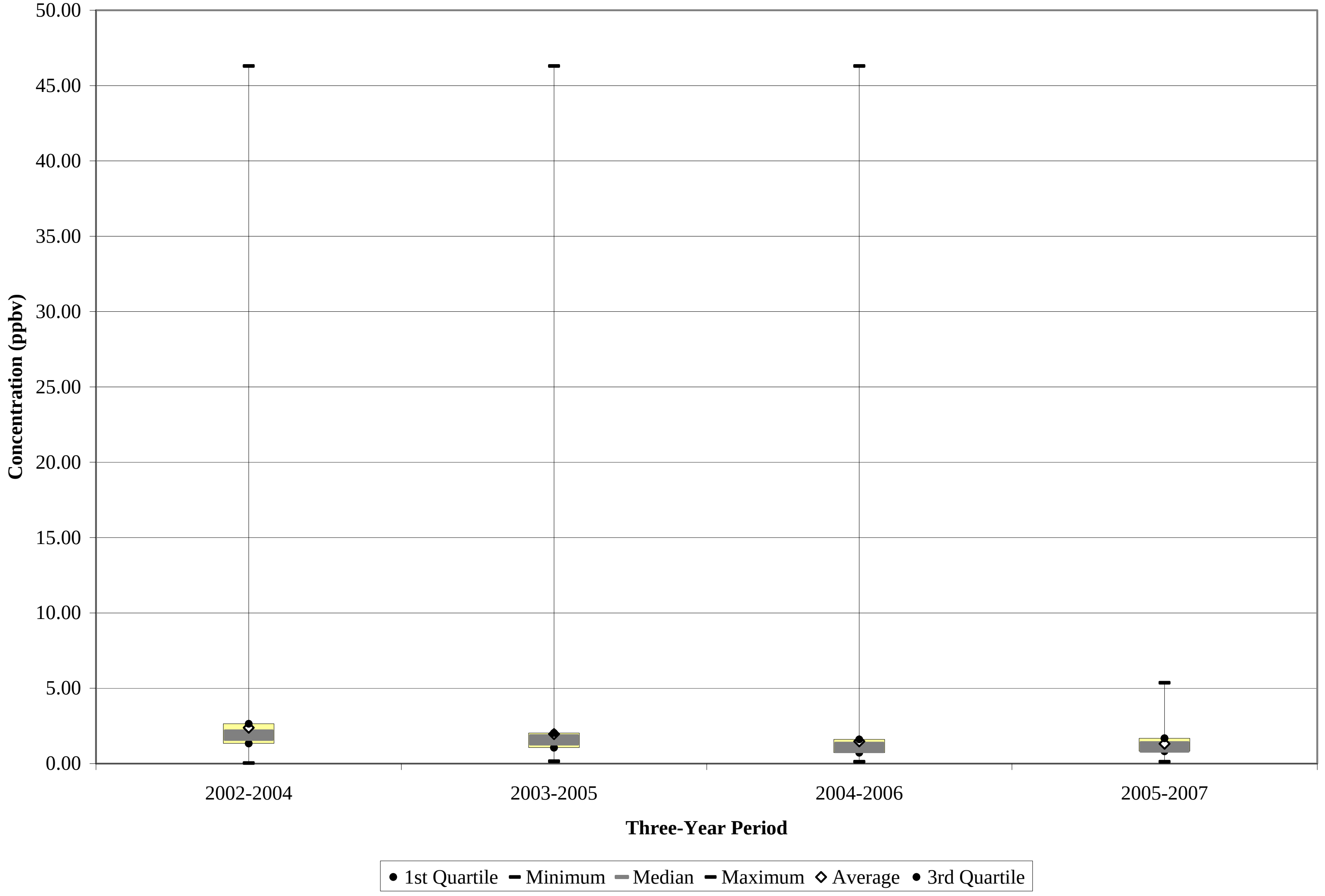


Figure 24-13. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at SFSD (SNMOC)

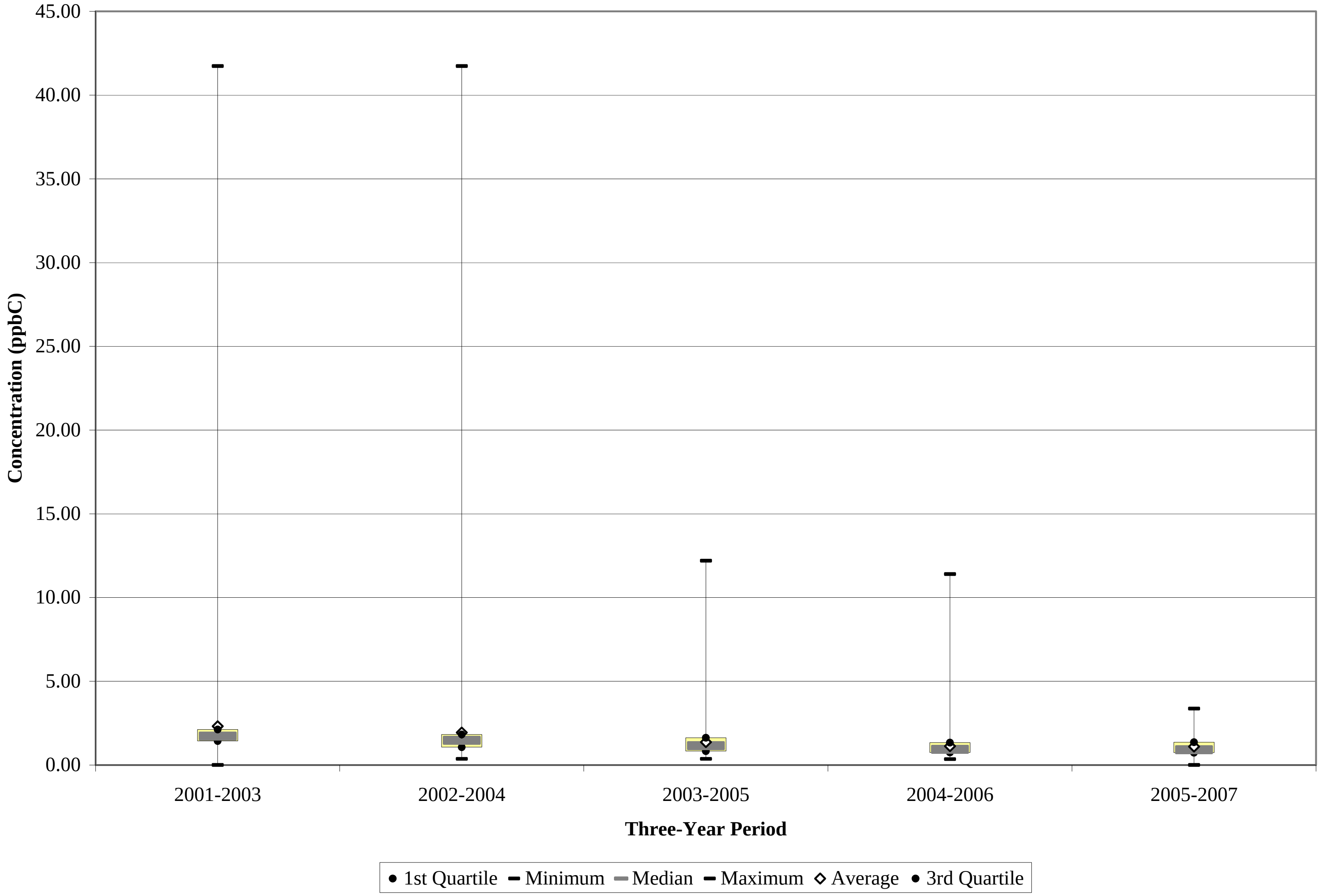


Figure 24-14. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at SFSD (TO-15)

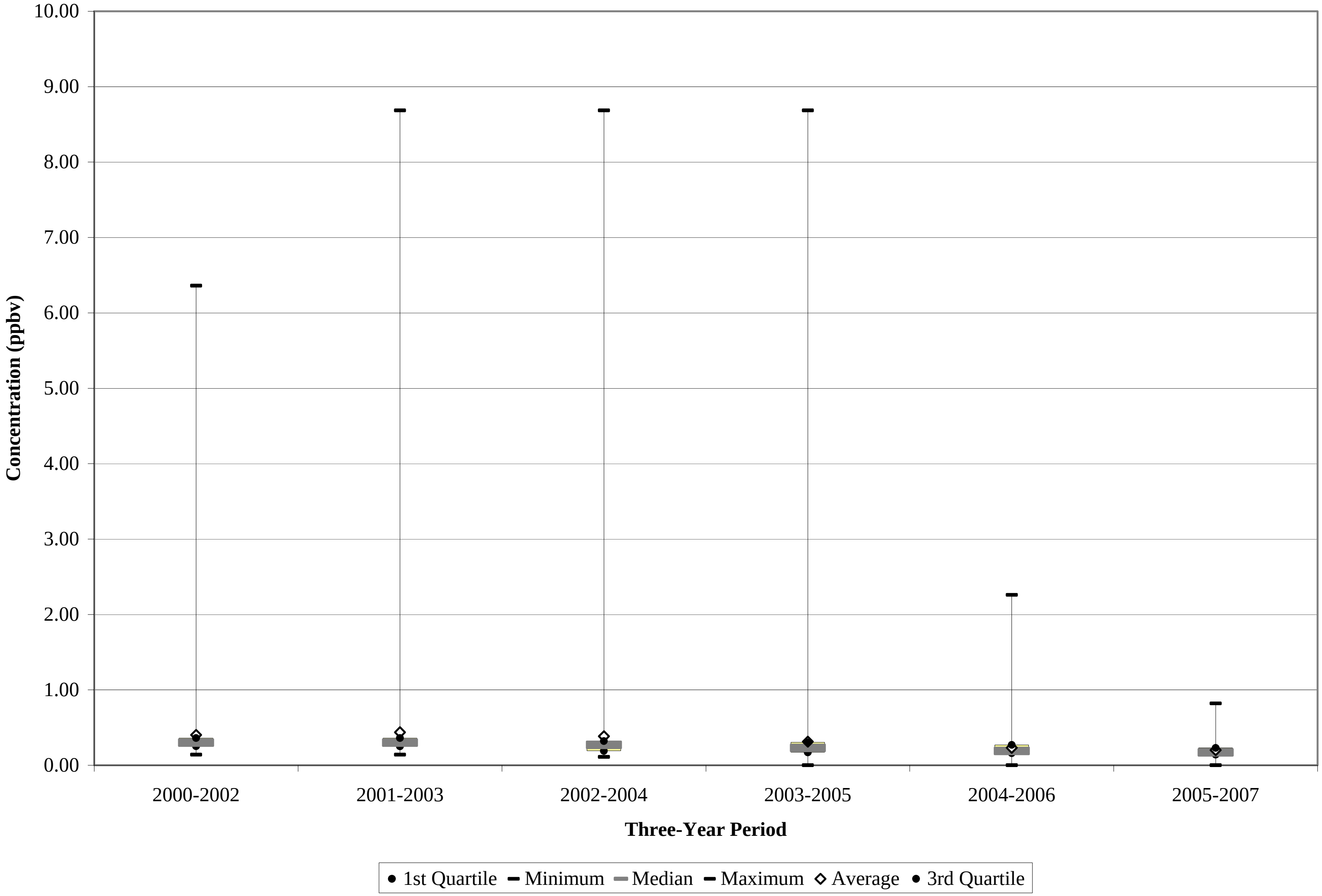


Figure 24-15. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at SFSD

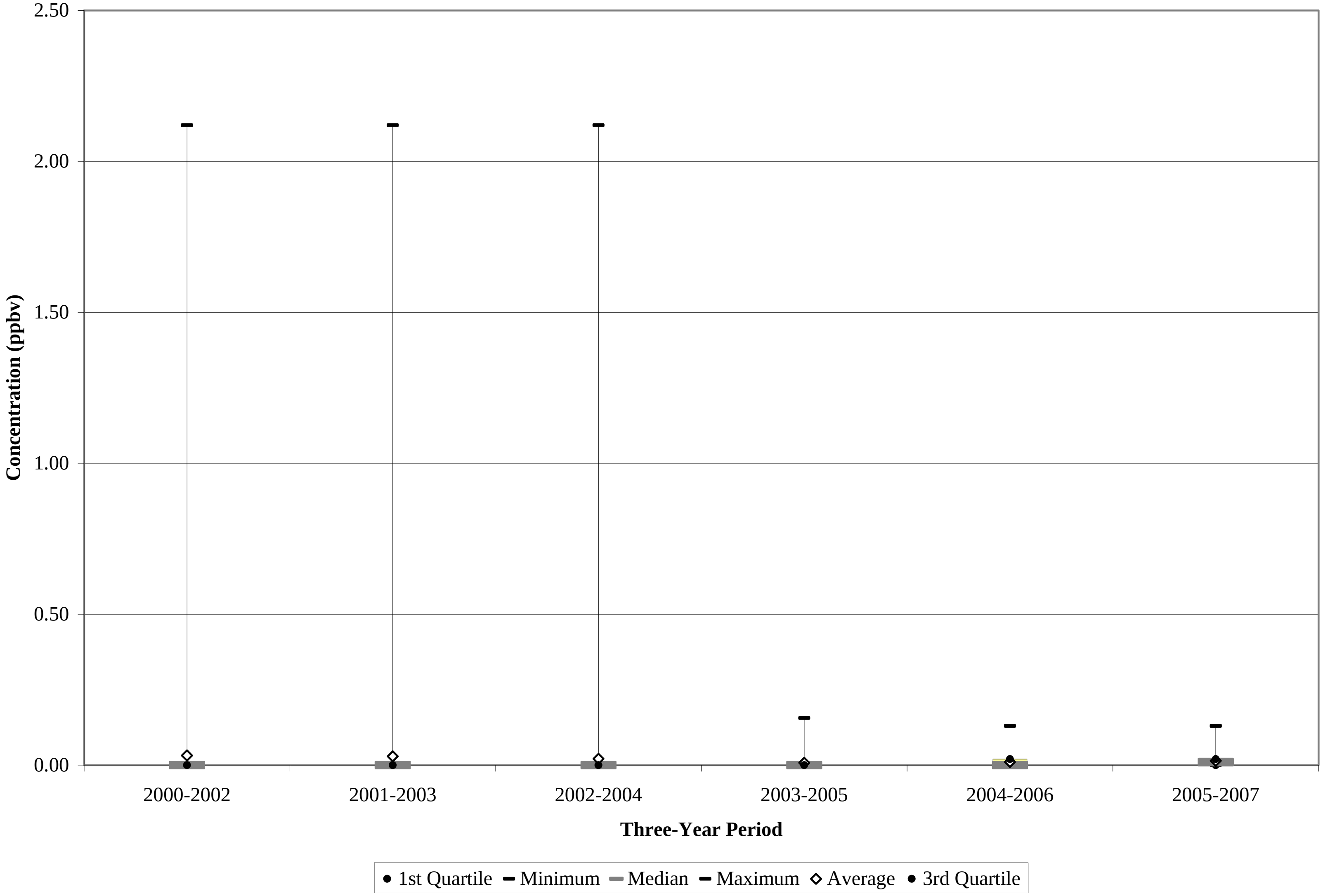
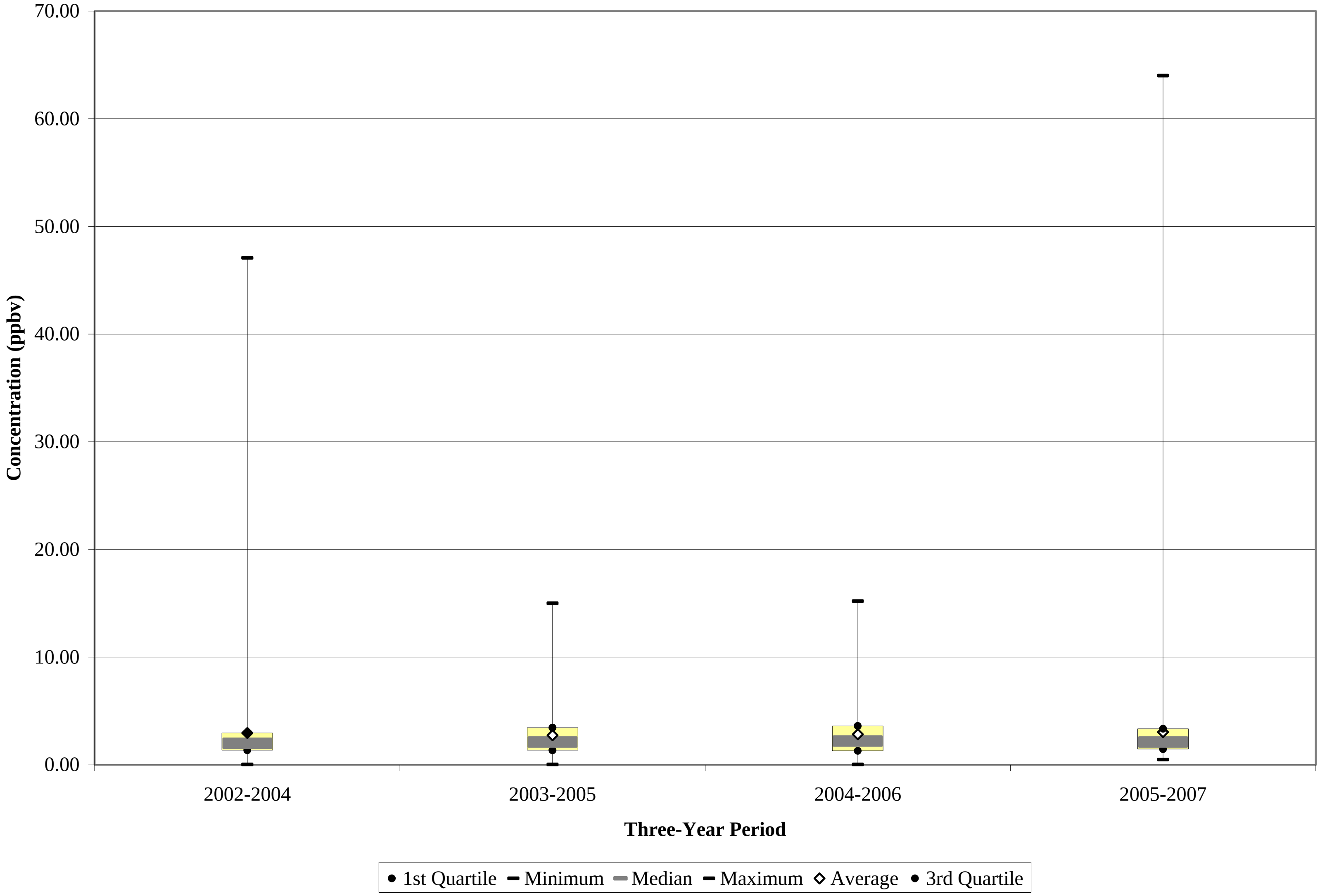


Figure 24-16. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at SFSD



- In both plots, the maximum concentration was measured between 2004 and 2007, specifically 2006.

- For each time period shown for both plots, the first quartile, the median, the average, and the 3rd quartile are very similar in value, reflecting relatively little variability in the central tendency.

- The rolling average concentrations appeared to have a slight decreasing trend over the time periods shown, although the difference is not significant, based on the calculation of confidence intervals.

- All benzene concentrations reported to AQS from the SNMOC method over the six years of sampling were measured detections. One non-detect was reported for the TO-15 method.

Observations from Figure 24-11 for 1,3-butadiene measurements at CUSD include the following:

- The rolling metrics for 1,3-butadiene look different than the rolling metrics for benzene, primarily due to the impact of the frequency of detection rather than the magnitude of the measurements.

- The minimum, first and third quartiles, and the median were all zero for the 2002-2004 time frame; the minimum, first quartile, and median were all zero for the 2003-2005 and 2004-2006 time frames; and the minimum and first quartile were zero for the 2005-2007 time frame. In addition, the average concentration was just greater than the third quartile for each three-year period.

- As the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant increased. The detection rate increased from 11 percent during the 2002-2004 time frame to 75 percent by the 2005-2007 time frame.

- As the detection rate increased, the average concentration increased as well. This is more likely an indication of the improvement of the method as opposed to an increase in overall concentrations. However, because the maximum concentration of 1,3-butadiene was measured in 2006, further sampling is required to confirm this conclusion.

- The maximum concentration of 1,3-butadiene was measured on the same day that the highest concentrations of benzene were measured.

Observations from Figure 24-12 for formaldehyde measurements at CUSD include the following:

- The maximum formaldehyde concentration shown was measured in 2004 and was more than six times the next highest concentration (measured in 2002).
- The difference between the rolling averages and the median values decreased for each time period. The increasing “closeness” in these metrics indicates decreasing variability in the central tendency.
- Although difficult to discern, a decrease is shown in the rolling average concentrations across the periods of sampling.
- All formaldehyde concentrations reported to AQS over the six years of sampling were measured detections.

Observations from Figures 24-13 and 24-14 for benzene measurements at SFSD include the following:

- Similar to the benzene plots for CUSD, the benzene plots for both methods for SFSD are similar, reflecting the ability of the methods to report similar values. This can be deceiving though, since VOC sampling began a year before SNMOC sampling.
- One difference in the Figures is that the maximum concentration measured by the TO-15 method was measured in 2003, while the maximum concentration measured by the SNMOC method was measured in 2002. This difference can be seen by comparing the two 2003-2005 time frames. However, the day the highest benzene concentration was measured by the SNMOC method, was the day the second highest benzene concentration was measured by the TO-15 method.
- For each time period shown in each plot, the first quartile, the median, the average concentration, and the third quartile were very similar to each other, reflecting relatively little variability in the central tendency.
- The rolling average concentrations have a decreasing trend since the 2002-2004 time frame.
- Nearly all benzene concentrations reported to AQS from the TO-15 and SNMOC methods were measured detections. Two non-detects were reported for each method since the onset of sampling.

Observations from Figure 24-15 for 1,3-butadiene measurements at SFSD include the following:

- The rolling metrics for 1,3-butadiene look different than the rolling metrics for benzene, primarily due to the impact of the frequency of detection rather than the magnitude of the measurements.

- Although difficult to discern, the minimum, first and third quartiles, and the median were all zero for the first four three-year periods; the minimum, first quartile, and median were all zero for the 2004-2006 time frame; and the minimum and first quartile were zero for the 2005-2007 time frame. In addition, the average concentration was greater than the third quartile until the 2004-2006 time frame.

- As the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant increased. The detection rate increased from 15 percent during the 2000-2002 and 2001-2003 time frames to 64 percent during the 2005-2007 time frame. However, the detection rate decreased to five percent during the 2002-2004 time frame.

- Although difficult to discern in Figure 24-15, the average concentration decreased across the periods until the 2004-2006 period, where slight increases were observed for each period.

- The maximum concentration of 1,3-butadiene was measured on the same day in 2002 that the highest and second highest concentrations of benzene, as measured by the SNMOC and TO-15 methods (respectively) were measured.

Observations from Figure 24-16 for formaldehyde measurements at SFSD include the following:

- The maximum formaldehyde concentration shown was measured in 2007.

- The rolling average and the median values were similar to each other for each time period. This “closeness” in these metrics indicates little variability in the central tendency.

- The rolling average concentrations changed little across the periods, ranging from 2.75 ppbv during the 2003-2005 time frame to 3.03 ppbv during the 2005-2007 time frame. This is also true of the median concentrations.

- All formaldehyde concentrations reported to AQS over the six years of sampling were measured detections.

24.5 Pearson Correlations

Table 24-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for CUSD from Table 24-6 include the following:

- Acrylonitrile exhibited very strong positive correlations with the temperature parameters, indicating that an increase in temperature results in a proportionate increase in concentrations of this pollutant. However, this pollutant was detected in less than half of the sampling collected, which can skew the correlations. Acrylonitrile also exhibited strong positive correlations with the dew point and wet bulb temperature and a strong negative correlation with relative humidity.

- 1,3-Butadiene exhibited strong negative correlations with the temperature and moisture parameters (except relative humidity), indicating that an increase in temperature and moisture content results in a proportionate decrease in concentration.

- Acetaldehyde exhibited a strong negative correlation with sea level pressure, indicating that an increase in pressure results in a proportionate decrease in concentration.

Observations for SFSD from Table 24-6 include the following:

- Most of the correlations for the pollutants of interest for SFSD were weak.

- However, acrolein exhibited strong positive correlations with the temperature and moisture parameters (except relative humidity), indicating that an increase in temperature and moisture content results in a proportionate increase in concentration.

24.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

24.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the South Dakota monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk

Table 24-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the South Dakota Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Custer, South Dakota - CUSD								
Acetaldehyde	60	0.33	0.37	0.25	0.32	-0.30	-0.63	-0.12
Acrolein	60	0.12	0.15	0.09	0.12	-0.19	-0.16	-0.06
Acrylonitrile	20	0.82	0.82	0.69	0.79	-0.50	-0.27	0.05
Benzene	60	-0.37	-0.35	-0.29	-0.35	0.24	0.02	-0.15
1,3-Butadiene	56	-0.50	-0.49	-0.43	-0.49	0.30	0.11	-0.19
Carbon Tetrachloride	60	0.12	0.13	0.12	0.12	-0.04	0.07	-0.15
Formaldehyde	60	0.40	0.45	0.32	0.40	-0.35	-0.49	-0.07
Sioux Falls, South Dakota - SFSD								
Acetaldehyde	59	-0.24	-0.28	-0.30	-0.30	-0.06	0.19	-0.28
Acrolein	58	0.50	0.52	0.54	0.54	-0.02	-0.26	-0.15
Benzene	59	-0.06	-0.06	0.01	-0.03	0.32	-0.05	-0.36
1,3-Butadiene	51	-0.18	-0.20	-0.14	-0.18	0.33	0.03	-0.10
Carbon Tetrachloride	59	0.31	0.32	0.33	0.33	-0.01	-0.21	0.05
Formaldehyde	59	-0.20	-0.21	-0.22	-0.22	-0.03	0.16	-0.01

results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 24-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Acrolein and formaldehyde exceeded one or more of the MRL risk values.

Observations about acrolein in Table 24-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- For both sites, all of the seasonal averages of acrolein exceeded the intermediate MRL.
- Acrolein has no chronic MRL. Therefore, chronic risk could not be evaluated.

Observations about formaldehyde from Table 24-7 include the following:

- One measured detection (out of 59) from SFSD (78.61µg/m^3) exceeded the ATSDR acute MRL for formaldehyde (50 µg/m^3).
- One other site (INDEM) exceeded the ATSDR acute MRL for formaldehyde; however, only one of the 16 total program exceedances occurred at SFSD.
- None of the seasonal averages of formaldehyde for SFSD exceeded the ATSDR intermediate MRL for formaldehyde (40 µg/m^3). However, it is easy to see from the confidence interval of the winter average that the concentration that exceeded the acute MRL was measured during winter.
- The annual average of formaldehyde for SFSD did not exceed the ATSDR intermediate MRL for formaldehyde (10 µg/m^3).

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction, as described in Section 3.6.1. Figure 24-17 is the pollution rose for formaldehyde for SFSD, where the acute risk factor for formaldehyde was exceeded.

Table 24-7. MRL Risk Screening Assessment Summary for the South Dakota Monitoring Sites

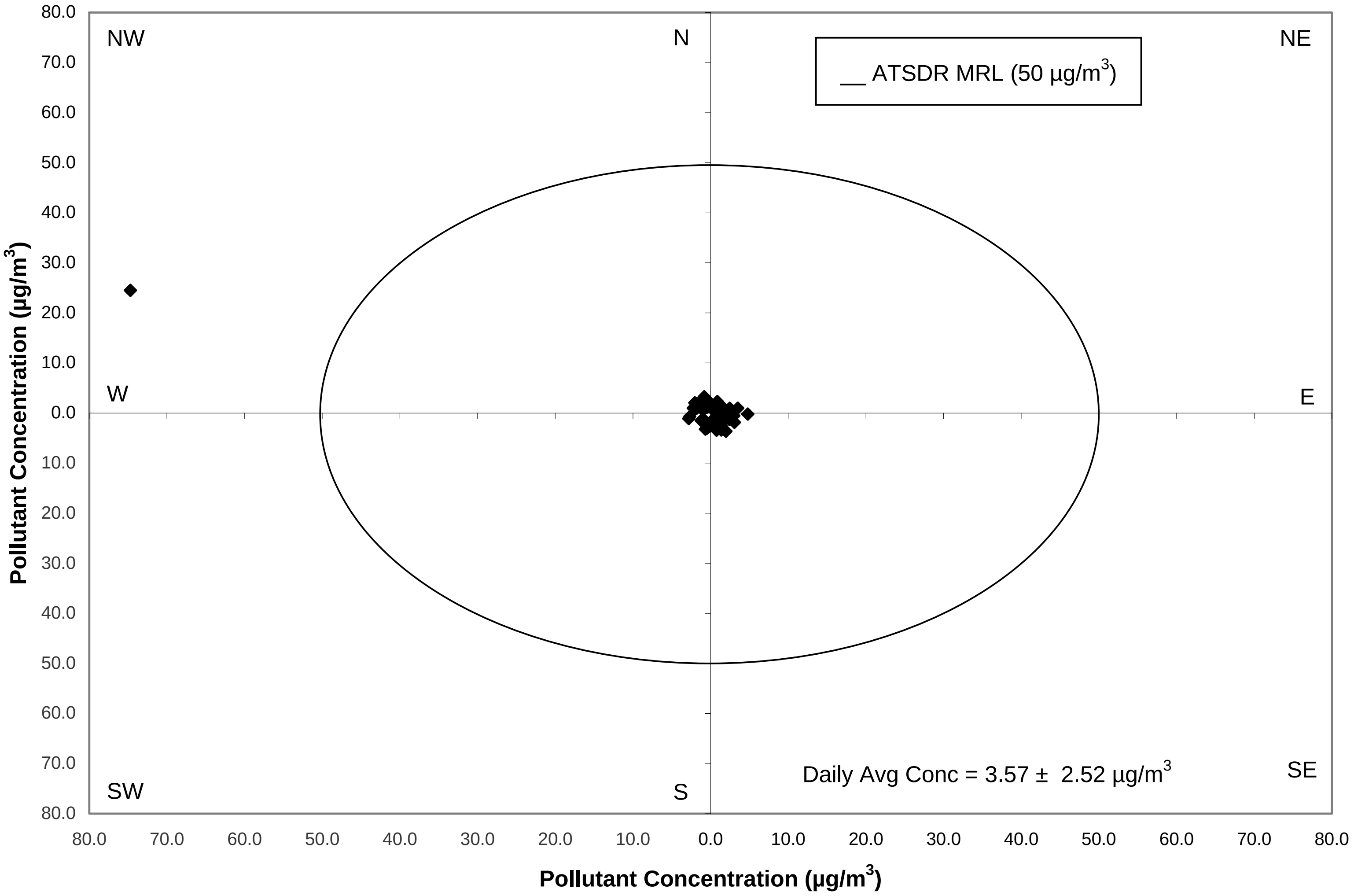
Site	Method	Pollutant	ATSDR Acute MRL ($\mu g/m^3$)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL ($\mu g/m^3$)	Winter Average ($\mu g/m^3$)	Spring Average ($\mu g/m^3$)	Summer Average ($\mu g/m^3$)	Autumn Average ($\mu g/m^3$)	ATSDR Chronic MRL ($\mu g/m^3$)	Annual Average[1] ($\mu g/m^3$)
CUSD	TO-15	Acrolein	7.00	0/60	0.09	**0.49 ± 0.16**	**0.42 ± 0.09**	**0.72 ± 0.19**	**0.71 ± 0.30**	--	0.59 ± 0.10
SFSD	TO-15	Acrolein	7.00	0/58	0.09	**0.34 ± 0.09**	**0.55 ± 0.15**	**0.79 ± 0.21**	**0.53 ± 0.14**	--	0.55 ± 0.09
SFSD	TO-11A	Formaldehyde	50.00	1/59	40	7.19 ± 10.38	2.28 ± 0.34	3.09 ± 0.39	2.01 ± 0.33	10.00	3.57 ± 2.52

BOLD = exceedance of the intermediate or chronic MRL

-- = an MRL risk factor is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Figure 24-17. Formaldehyde Pollution Rose for SFSD



Observations from the pollution rose include the following:

- The exceedance of the ATSDR acute MRL for formaldehyde occurred with a westerly wind.
- The highest concentration was significantly higher than all other measured concentrations. The pollution rose shows that this concentration is a true "outlier", deviating significantly from all the other measurements and supporting the observations in Section 24.4.1.

24.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the South Dakota monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 24-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the South Dakota sites is as follows:

- The census tract for CUSD is 46033995100, which had a population of 4,517, and represented approximately 62 percent of the Custer County population in 2000.
- The census tract for SFSD is 46099001802, which had a population of 7,498, and also represented approximately 5.1 percent of the county population in 2000.

Observations for CUSD from Table 24-8 include the following:

- The pollutants with the highest concentrations according to NATA were acetaldehyde, formaldehyde, and benzene, although all three modeled concentrations were less than 1 $\mu g/m^3$.
- Only two pollutants had cancer risks exceeding 1 in-a-million according to NATA, benzene and carbon tetrachloride.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (1.10). Most HQs were 0.01 or less.

Table 24-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in South Dakota

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (HQ)	2007 NATTS/UATMP Annual Average[1] (µg/m^3)	2007 NATTS/UATMP Cancer Risk Approximation (in-a-million)	2007 NATTS/UATMP Noncancer Risk Approximation (HQ)
Custer, South Dakota (CUSD) - Census Tract ID 46033995100								
Acetaldehyde	0.000002	0.009	0.42	0.93	0.04	1.91 ± 0.32	3.82	0.21
Acrolein	--	0.00002	0.02	--	1.10	0.59 ± 0.10	--	29.27
Acrylonitrile	0.000068	0.002	<0.01	<0.01	<0.01	0.11 ± 0.03	7.47	0.05
Benzene	0.000007	0.03	0.22	1.70	0.01	0.66 ± 0.13	4.65	0.02
1,3-Butadiene	0.00003	0.002	0.01	0.17	<0.01	0.07 ± 0.02	2.00	0.03
Carbon Tetrachloride	0.000015	0.04	0.21	3.16	0.01	0.55 ± 0.04	8.26	0.01
p-Dichlorobenzene	0.000011	0.8	<0.01	<0.01	<0.01	0.05 ± 0.01	0.53	<0.01
1,2-Dichloroethane	0.000026	2.4	<0.01	<0.01	<0.01	0.04 ± <0.01	1.13	<0.01
Dichloromethane	0.00000047	1	<0.01	<0.01	<0.01	4.43 ± 8.14	2.08	<0.01
Formaldehyde	5.5E-09	0.0098	0.27	<0.01	0.02	2.03 ± 0.31	0.01	0.21
n-Hexane	--	0.2	0.01	--	<0.01	1.57 ± 1.12	--	0.01
1,1,2,2-Tetrachloroethane	0.000058	--	<0.01	<0.01	--	0.06 ± <0.01	3.24	--
Tetrachloroethylene	0.000005	0.27	<0.01	0.01	<0.01	0.06 ± 0.01	0.29	<0.01
Trichloroethylene	0.000002	0.6	0.03	0.06	<0.01	0.09 ± 0.07	0.19	<0.01
Sioux Falls, South Dakota (SFSD) - Census Tract ID 46099001802								
Acetaldehyde	0.000002	0.009	0.67	1.50	0.07	1.55 ± 0.23	3.10	0.17
Acrolein	--	0.00002	0.02	--	1.20	0.55 ± 0.09	--	27.60
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	0.04 ± 0.01	2.48	0.02
Benzene	0.000007	0.03	0.69	5.41	0.02	0.55 ± 0.07	3.87	0.02
1,3-Butadiene	0.00003	0.002	0.06	1.81	0.03	0.04 ± 0.01	1.20	0.02
Carbon Tetrachloride	0.000015	0.04	0.21	3.11	0.01	0.57 ± 0.04	8.54	0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.66	<0.01	0.04 ± <0.01	1.11	<0.01
Formaldehyde	5.5E-09	0.0098	0.80	<0.01	0.08	3.57 ± 2.52	0.02	0.36
Tetrachloroethylene	0.000005	0.27	0.08	0.51	<0.01	0.07 ± 0.01	0.37	<0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

- The pollutants with the highest annual averages were dichloromethane, formaldehyde, and acetaldehyde.

- The pollutants with the highest cancer risk approximations were carbon tetrachloride. acrylonitrile, and benzene.

- Similar to the NATA results, acrolein was the only pollutant with a noncancer risk approximation greater than 1.0. However, the noncancer risk approximation was an order of magnitude higher than NATA (29.27).

Observations for SFSD from Table 24-8 include the following:

- The pollutants with the highest concentrations according to NATA were formaldehyde, benzene, and acetaldehyde, although all three modeled concentrations were less than 1 µg/m^3.

- The pollutants with the highest cancer risks according to NATA were benzene, carbon tetrachloride, and 1,3-butadiene.

- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (1.20).
- The pollutants with the highest annual averages were formaldehyde, acetaldehyde, and carbon tetrachloride.

- The pollutants with the highest cancer risk approximations were carbon tetrachloride, benzene, and acetaldehyde.

- Similar to the NATA results, acrolein was the only pollutant with a noncancer risk approximation greater than 1.0. However, the noncancer risk approximation was an order of magnitude higher than NATA (27.60).

24.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 24-9 and 24-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 24-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 24-10 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although

Table 24-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in South Dakota

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Custer, South Dakota (CUSD) – Custer County					
Benzene	14.72	Benzene	1.15E-04	Carbon Tetrachloride	8.26
Formaldehyde	4.93	1,3-Butadiene	3.42E-05	Acrylonitrile	7.46
Acetaldehyde	2.22	POM, Group 2	1.86E-05	Benzene	4.65
Tetrachloroethylene	1.57	Naphthalene	1.46E-05	Acetaldehyde	3.82
1,3-Butadiene	1.14	POM, Group 3	1.02E-05	1,1,2,2-Tetrachloroethane	3.24
Dichloromethane	0.55	Tetrachloroethylene	9.29E-06	Dichloromethane	2.08
Naphthalene	0.43	POM, Group 5	6.44E-06	1,3-Butadiene	2.00
POM, Group 2	0.34	Acetaldehyde	4.88E-06	1,2-Dichloroethane	1.13
p-Dichlorobenzene	0.15	Hexavalent Chromium	3.49E-06	*p*-Dichlorobenzene	0.53
POM, Group 6	0.03	POM, Group 6	3.07E-06	Tetrachloroethylene	0.29
Sioux Falls, South Dakota (SFSD) – Minnehaha County					
Benzene	134.64	Benzene	1.05E-03	Carbon Tetrachloride	8.54
Formaldehyde	52.48	1,3-Butadiene	3.69E-04	Benzene	3.87
Acetaldehyde	23.70	Naphthalene	1.43E-04	Acetaldehyde	3.10
1,3-Butadiene	12.30	POM, Group 2	1.31E-04	Acrylonitrile	2.46
Dichloromethane	11.96	Arsenic, PM	1.06E-04	1,3-Butadiene	1.20
Tetrachloroethylene	6.03	Hexavalent Chromium	8.52E-05	1,2-Dichloroethane	1.11
Naphthalene	4.20	POM, Group 3	8.08E-05	Tetrachloroethylene	0.37
p-Dichlorobenzene	3.27	Acetaldehyde	5.21E-05	Formaldehyde	0.02
POM, Group 2	2.39	Ethylene oxide	3.69E-05		
Trichloroethylene	1.03	*p*-Dichlorobenzene	3.60E-05		

Table 24-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in South Dakota

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Custer, South Dakota (CUSD) – Custer County					
Toluene	34.00	Acrolein	14,414.57	Acrolein	29.27
Xylenes	24.60	1,3-Butadiene	569.89	Acetaldehyde	0.21
Benzene	14.72	Formaldehyde	502.87	Formaldehyde	0.21
Ethylbenzene	5.76	Benzene	490.55	Acrylonitrile	0.05
Formaldehyde	4.93	Cyanide Compounds, gas	290.00	1,3-Butadiene	0.03
Hexane	4.71	Acetaldehyde	246.22	Benzene	0.02
Methanol	2.47	Xylenes	246.05	Carbon Tetrachloride	0.01
Acetaldehyde	2.22	Naphthalene	142.70	*n*-Hexane	0.01
Styrene	1.69	Toluene	85.01	Dichloromethane	<0.01
Tetrachloroethylene	1.57	Hydrochloric acid	30.03	Tetrachloroethylene	<0.01
Sioux Falls, South Dakota (SFSD) – Minnehaha County					
Toluene	320.93	Acrolein	136,549.28	Acrolein	27.60
Xylenes	237.78	1,3-Butadiene	6,149.18	Formaldehyde	0.36
Benzene	134.64	Formaldehyde	5,355.37	Acetaldehyde	0.17
Methanol	85.64	Benzene	4,487.86	1,3-Butadiene	0.02
Hydrochloric acid	63.20	Hydrochloric acid	3,160.01	Benzene	0.02
Formaldehyde	52.48	Acetaldehyde	2,633.20	Acrylonitrile	0.02
Ethylbenzene	47.42	Xylenes	2,377.78	Carbon Tetrachloride	0.01
Hexane	41.20	Cyanide Compounds, gas	1,873.33	Tetrachloroethylene	<0.01
Styrene	28.07	Naphthalene	1,399.74	1,2-Dichloroethane	<0.01
Acetaldehyde	23.70	Nickel, PM	1,315.70		

the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 24.3, CUSD and SFSD sampled for VOC, SNMOC, and carbonyl compounds. In addition, the cancer and noncancer risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 24-9 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in both Custer and Minnehaha Counties; although the emissions were an order of magnitude higher in Minnehaha County.
- Benzene and 1,3-butadiene were the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for both counties.
- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for Custer County; six of the highest emitted pollutants also had the highest toxicity-weighted emissions for Minnehaha County.
- Carbon tetrachloride was the pollutant with the highest cancer surrogate risk approximation for each site, yet appeared on none of the emissions-based lists.
- Benzene, acetaldehyde, and 1,3-butadiene appeared on all three lists for SFSD. These three pollutants and tetrachloroethylene appeared on all three lists for CUSD.

Observations from Table 24-10 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Custer and Minnehaha Counties, although the emissions were an order of magnitude higher in Minnehaha County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and formaldehyde for both counties.
- Five of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Acrolein, which had the highest noncancer risk approximations, also had the highest toxicity-weighted emissions for both sites.

24.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *The pollutants of interest common to each South Dakota monitoring site were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.*

- *Formaldehyde had the highest daily average concentration for each of the sites.*

- *Seasonal averages of acrolein exceeded the intermediate MRL health benchmark for both sites; one concentration of formaldehyde exceeded the acute MRL health benchmark for SFSD.*

25.0 Sites in Tennessee

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP sites in Tennessee, and integrates these concentrations with emissions, meteorological, and risk information.

25.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the locations of the sites and the surrounding areas. The LDTN and MSTN monitoring sites are located in Loudon, southwest of Knoxville. Loudon is within the Knoxville, TN MSA. Figures 25-1 and 25-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their rural locations. Figure 25-3 identifies point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 25-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

A branch of the Tennessee River, Watts Bar Lake, winds through the town of Loudon. LDTN is located in an area where the river is less than a half mile to the east, south, and west. The site is located in a primarily residential area on Webb Drive, a few blocks from Highway 11, as shown in Figure 25-1. However, several industrial businesses lie along the river on Blair Bend Drive, less than a half mile south of the site. The site was established to capture emissions from nearby industrial sources.

MSTN is located on the property of Loudon Middle School, between Highway 74 and Roberts Road. Although a residential subdivision is located immediately across the street from the middle school, as shown in Figure 25-2, mixed land use areas lie to the north and northeast while rural and forested areas lie to the south. This site was also established to capture emissions from nearby industrial sources.

Figure 25-3 shows that the two Tennessee monitoring sites are fairly close to each other. The LDTN and MSTN monitoring sites have nearly two dozen point sources nearby. Several of

Figure 25-1. Loudon, Tennessee (LDTN) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 25-2. Loudon, Tennessee (MSTN) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 25-3. NEI Point Sources Located Within 10 Miles of LDTN and MSTN

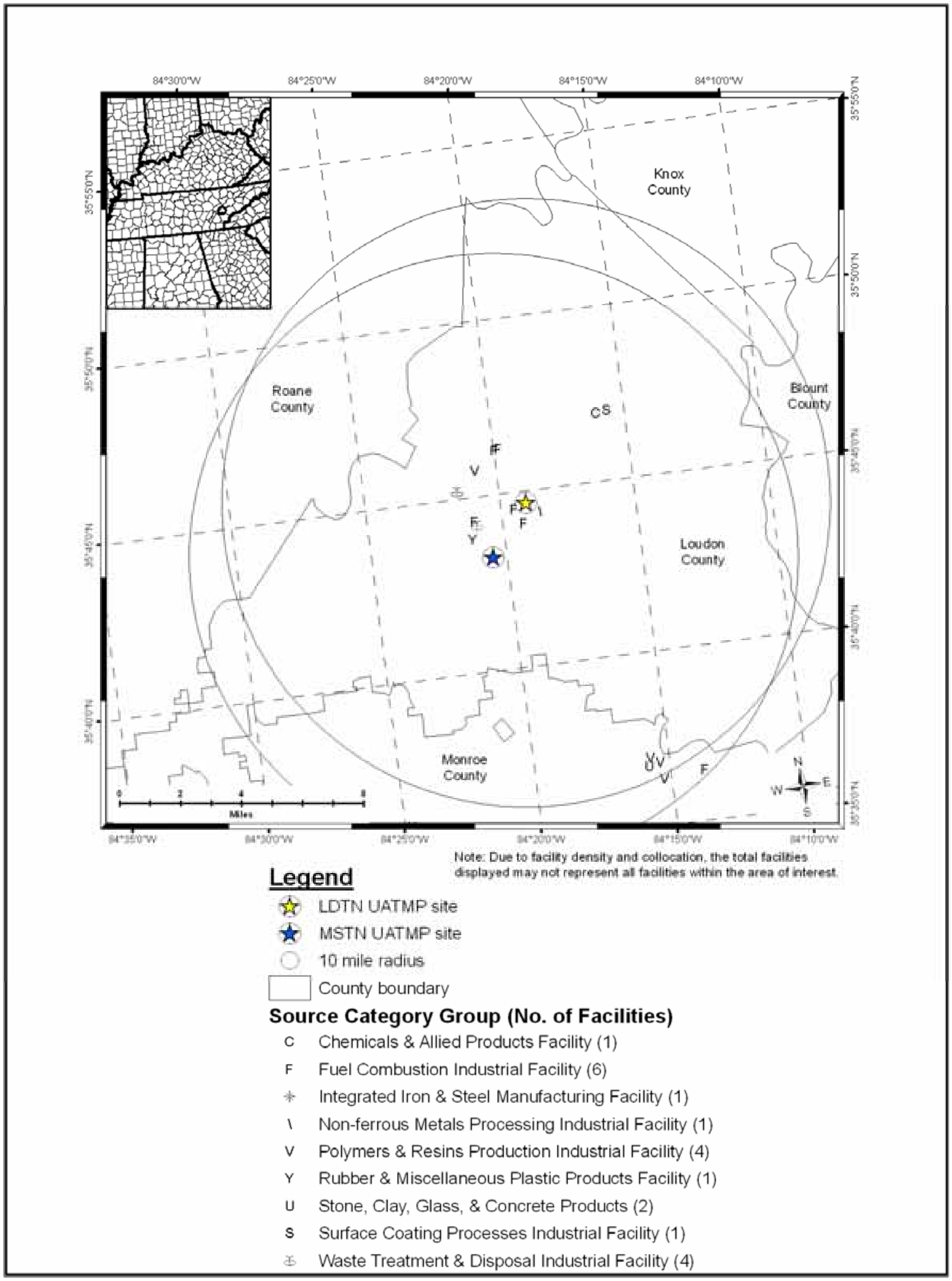


Table 25-1. Geographical Information for the Tennessee Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
LDTN	47-105-0108	Loudon	Loudon	Knoxville, TN	35.7447, -84.3174	Residential	Suburban	The site was set up due to public concern about air emissions from several sources in an industrial park. Among these sources is a very large facility that processes corn to make corn syrup, a sausage casing manufacturer, boat manufacturer, paper products manufacturer, waste metal reclamation, waste paper reclamation, and others.
MSTN	47-105-0109	Loudon	Loudon	Knoxville, TN	35.720833, -84.341667	Residential	Suburban	The second site at Loudon Middle School in Loudon, TN, was set up due to public concern about air emissions from several sources in an industrial park. This site is SW of the LDTN site and upwind of the industrial sources.

these emission sources are involved in waste treatment and disposal, polymer and resin production, or fuel combustion processes.

Table 25-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Tennessee monitoring sites. County-level vehicle registration and population data for Loudon County, Tennessee were obtained from the Tennessee Department of Safety and the U.S. Census Bureau. Table 25-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 25-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 25-2 presents the daily VMT for each urban area.

Table 25-2. Population, Motor Vehicle, and Traffic Information for the Tennessee Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
LDTN	45,448	50,519	1.11	50,501	56,136	12,945	16,430
MSTN	45,448	50,519	1.11	50,501	56,136	7,287	16,430

[1] Daily Average Traffic Data reflects 2006 data from the Tennessee DOT

Observations from Table 25-2 include the following:

- Loudon County had the seventh lowest county population and seventh lowest county-level vehicle registration compared to all counties with NATTS or UATMP sites.
- The 10-mile radius populations were the same because these sites are located in the same zip code. The 10-mile population for these sites was the ninth lowest among NATTS and UATMP sites.
- The vehicle per person ratio for these sites was greater then one vehicle per person, and the sixth highest compared to other NATTS or UATMP sites.
- LDTN experienced a higher average daily traffic volume than MSTN, although both traffic volumes were in the lowest-third compared to other program sites. LDTN

traffic volume was obtained from Highway 11 before it crosses the river (TN DOT station 056). Traffic for MSTN was also obtained from Highway 11, near the intersection with State Road 72 (TN DOT station 122).

- The Knoxville area VMT ranked eighth lowest among urban areas with UATMP or NATTS sites.

25.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Tennessee on sampling days, as well as over the course of the year.

25.2.1 Climate Summary

Loudon is located to the southwest of Knoxville in east Tennessee. Loudon is located in a valley, which is divided from the rest of the state by the Cumberland Plateau. The Appalachian and Great Smoky Mountains lie to the east and the Cumberland and Crab Orchard Mountains lie to the northwest. The Tennessee River meanders through the town of Loudon. These topographic influences affect the area's weather by moderating temperatures and affecting wind patterns. The area has ample rainfall year-round and experiences all four seasons (Ruffner and Bair, 1987 and TGA, 1997).

25.2.2 Meteorological Conditions in 2007

Hourly meteorological data at the weather station near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air concentration measurements. The closest NWS weather station to both sites is located at McGhee Tyson Airport (WBAN 13891).

Table 25-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 25-3 is the 95 percent confidence

Table 25-3. Average Meteorological Conditions near the Tennessee Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
LDTN	McGhee Tyson Airport 13891	Sampling Day	73.83 ± 4.19	63.19 ± 3.92	48.76 ± 4.07	55.37 ± 3.52	62.70 ± 2.75	1018.08 ± 1.30	4.73 ± 0.64
		All 2007	71.74 ± 1.76	60.06 ± 1.68	46.85 ± 1.73	53.54 ± 1.51	63.08 ± 1.23	1018.27 ± 0.53	4.95 ± 0.28
MSTN	McGhee Tyson Airport 13891	Sampling Day	73.38 ± 4.17	62.68 ± 3.88	48.40 ± 4.07	54.99 ± 3.50	62.99 ± 2.83	1018.26 ± 1.29	4.72 ± 0.65
		All 2007	71.74 ± 1.76	60.06 ± 1.68	46.85 ± 1.73	53.54 ± 1.51	63.08 ± 1.23	1018.27 ± 0.53	4.95 ± 0.28

interval for each parameter. As shown in Table 25-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year. Although the average and maximum temperature appear slightly warmer on sampling days, the confidence interval suggests that the difference is not significant.

25.2.3 Composite Back Trajectories for Sampling Days

Figures 25-4 and 25-5 are composite back trajectory maps for the Tennessee monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 25-4 and 25-5 represents 100 miles.

Observations from Figures 25-4 and 25-5 include the following:

- The back trajectory maps for LDTN and MSTN look very similar.
- Back trajectories originated from a variety of directions at the sites, although less frequently from the northwest, north, and northeast.
- The 24-hour air shed domains for these sites were similar in size compared to most other monitoring sites. The furthest away a trajectory originated was southern Wisconsin, or approximately 800 miles away. However, 75 percent of the trajectories originated within 300 miles of the sites.

25.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather station at McGhee Tyson Airport near LDTN and MSTN were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 25-6 and 25-7 are the wind roses for the Tennessee monitoring sites on days that samples were collected.

Observations from Figures 25-6 and 25-7 include the following:

- The wind roses for LDTN and MSTN are nearly identical. This is expected though, as the wind data are from the same weather station and these sites collected samples primarily on the same days.
- Calm winds were observed for approximately 31 percent of the hourly measurements.

Figure 25-4. Composite Back Trajectory Map for LDTN

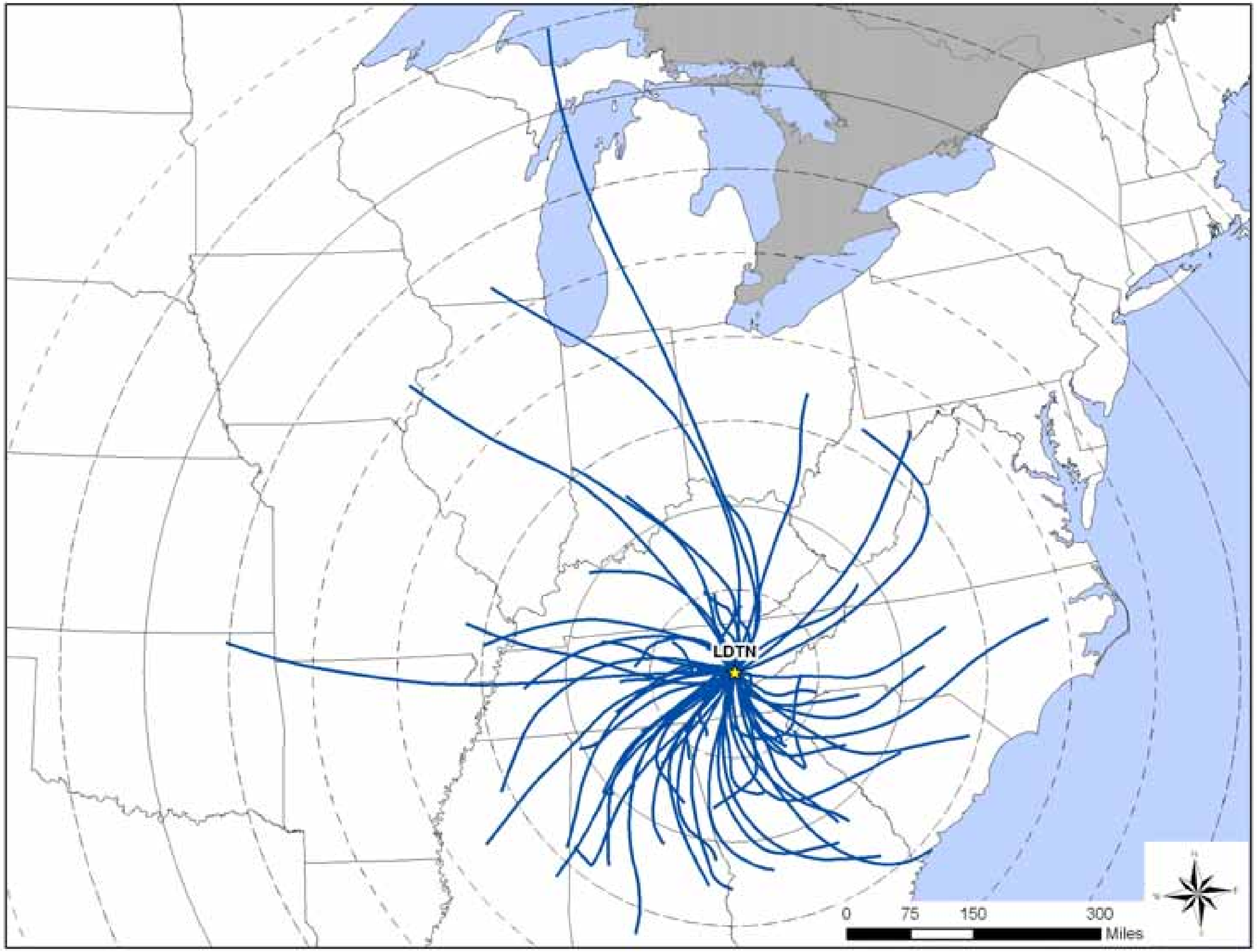


Figure 25-5. Composite Back Trajectory Map for MSTN

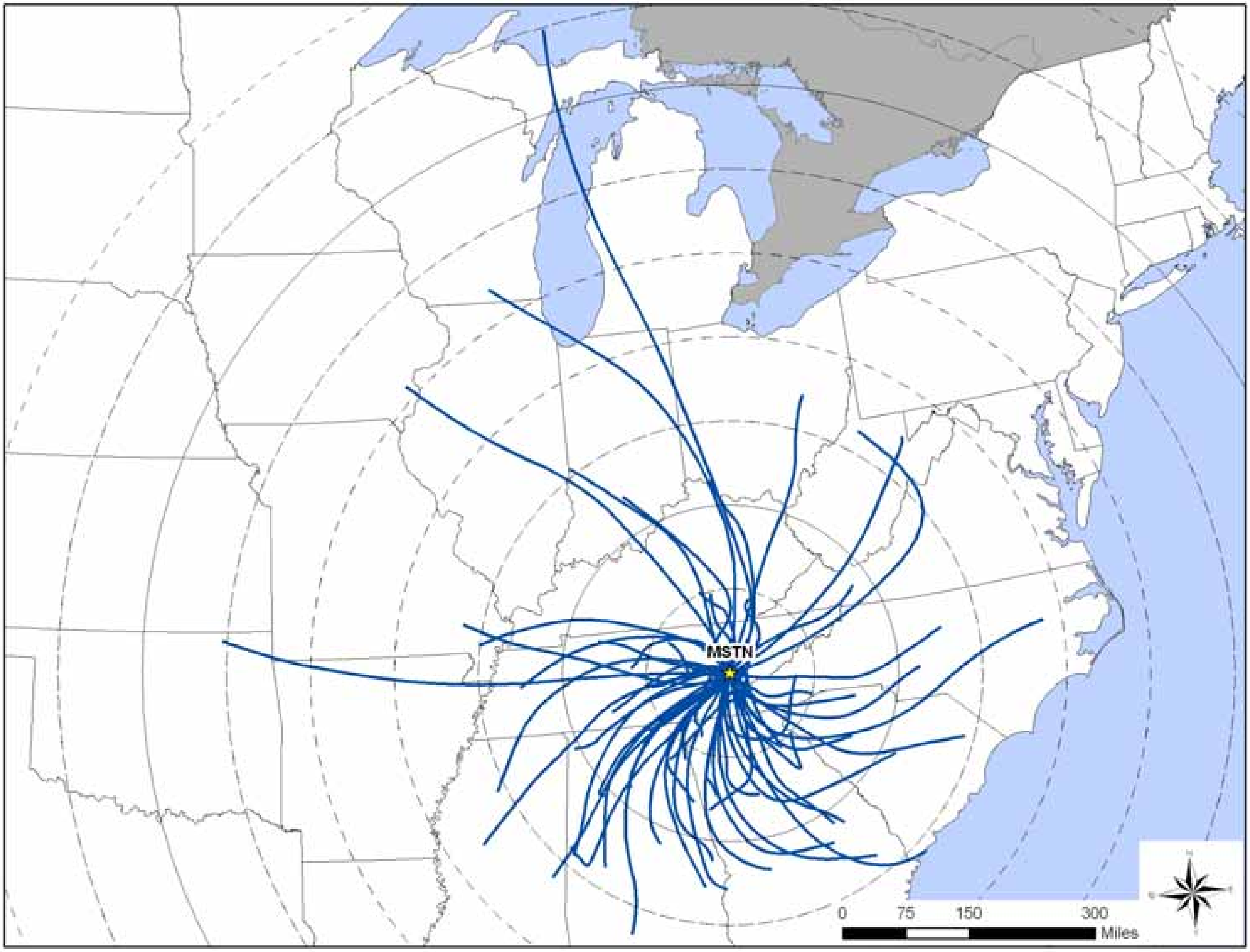


Figure 25-6. Wind Rose for LDTN Sampling Days

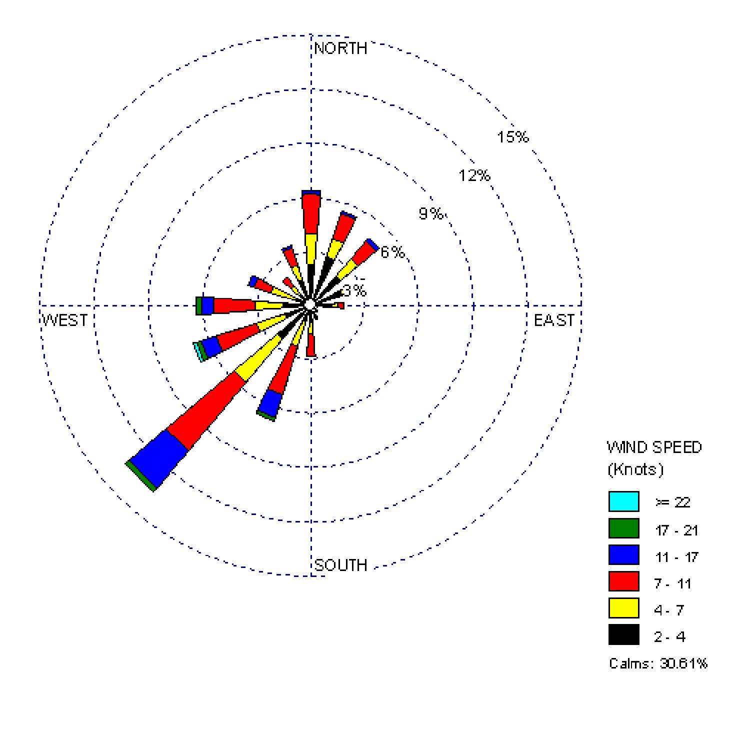
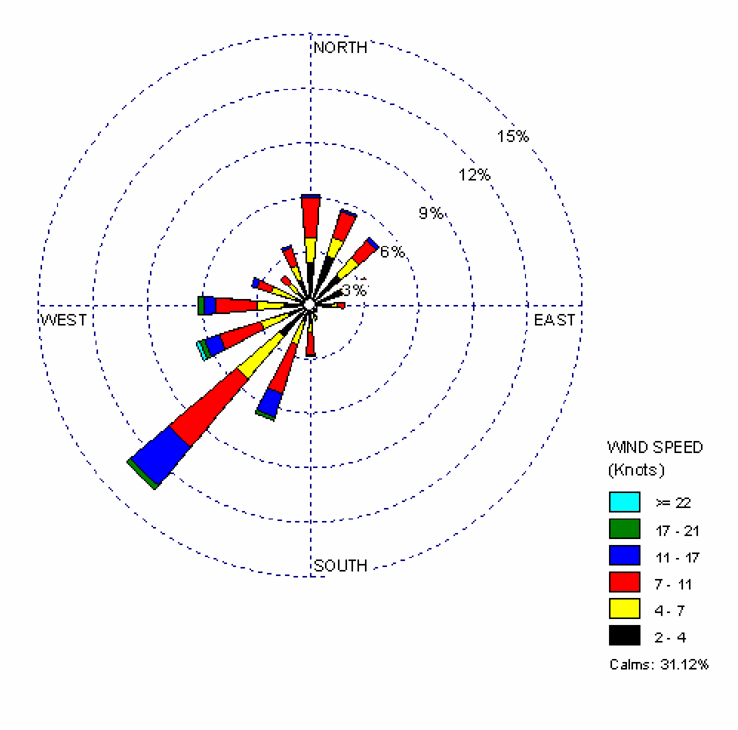


Figure 25-7. Wind Rose for MSTN Sampling Days



- For winds greater than two knots, southwesterly winds were prevalent.

- Winds exceeding 11 knots made up approximately eight percent of observations and were most often out of the southwest or west.

25.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Tennessee monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 25-4 presents the pollutants that failed at least one screen for each Tennessee monitoring site and highlights each site's pollutants of interest (shaded). LDTN and MSTN sampled for VOC and carbonyl compounds.

Observations from Table 25-4 include the following:

- Eleven pollutants failed at least one screen for both LDTN and MSTN. A total of 387 measured concentrations failed screens for LDTN, while 350 failed screens for MSTN.

- The pollutants of interest varied by site, yet the following six pollutants of interest were common to both sites: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.

- Of the six common pollutants of interest, 100 percent of the measured detections of acetaldehyde, acrolein, benzene, and carbon tetrachloride failed screens for both LDTN and MSTN.

25.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Tennessee monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J

Table 25-4. Comparison of Measured Concentrations and EPA Screening Values for the Tennessee Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Loudon, Tennessee - LDTN					
Acetaldehyde	62	62	100.00	16.02	16.02
Formaldehyde	62	62	100.00	16.02	32.04
Acrolein	60	60	100.00	15.50	47.55
Benzene	60	60	100.00	15.50	63.05
Carbon Tetrachloride	59	60	98.33	15.25	78.29
1,3-Butadiene	49	58	84.48	12.66	90.96
p-Dichlorobenzene	15	57	26.32	3.88	94.83
Carbon Disulfide	10	60	16.67	2.58	97.42
Tetrachloroethylene	4	53	7.55	1.03	98.45
Acrylonitrile	4	4	100.00	1.03	99.48
Xylenes	2	60	3.33	0.52	100.00
Total	387	596	64.93		
Loudon Middle School, Loudon, Tennessee - MSTN					
Acrolein	60	60	100.00	17.14	17.14
Benzene	60	60	100.00	17.14	34.29
Acetaldehyde	59	59	100.00	16.86	51.14
Carbon Tetrachloride	59	59	100.00	16.86	68.00
Formaldehyde	55	59	93.22	15.71	83.71
1,3-Butadiene	45	55	81.82	12.86	96.57
Acrylonitrile	4	4	100.00	1.14	97.71
p-Dichlorobenzene	3	55	5.45	0.86	98.57
Tetrachloroethylene	3	58	5.17	0.86	99.43
Chloromethylbenzene	1	1	100.00	0.29	99.71
1,2-Dichloroethane	1	1	100.00	0.29	100.00
Total	350	471	74.31		

through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at each site, where applicable.

25.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 25-5, where applicable.

Table 25-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Tennessee Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Loudon, Tennessee - LDTN								
Acetaldehyde	62	62	2.62 ± 0.42	1.42 ± 0.24	3.21 ± 1.01	3.49 ± 0.79	2.01 ± 0.49	2.62 ± 0.42
Acrolein	60	60	0.70 ± 0.14	0.47 ± 0.18	0.44 ± 0.12	0.95 ± 0.32	0.88 ± 0.32	0.70 ± 0.14
Benzene	60	60	0.78 ± 0.09	0.83 ± 0.23	0.64 ± 0.11	0.78 ± 0.18	0.88 ± 0.14	0.78 ± 0.09
1,3-Butadiene	58	60	0.06 ± 0.01	0.08 ± 0.03	0.05 ± 0.02	0.05 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
Carbon Disulfide	60	60	46.96 ± 11.56	33.79 ± 27.04	65.04 ± 31.6	40.60 ± 10.66	48.00 ± 18.32	46.96 ± 11.56
Carbon Tetrachloride	60	60	0.61 ± 0.04	0.53 ± 0.12	0.65 ± 0.06	0.64 ± 0.07	0.60 ± 0.05	0.61 ± 0.04
p-Dichlorobenzene	57	60	0.09 ± 0.03	0.05 ± 0.01	0.05 ± 0.01	0.14 ± 0.08	0.08 ± 0.02	0.09 ± 0.03
Formaldehyde	62	62	3.74 ± 0.64	1.55 ± 0.21	2.90 ± 0.73	6.02 ± 1.00	3.72 ± 1.43	3.74 ± 0.64
Loudon Middle School, Loudon, Tennessee - MSTN								
Acetaldehyde	59	59	1.49 ± 0.16	1.16 ± 0.28	1.67 ± 0.25	1.82 ± 0.38	1.25 ± 0.19	1.49 ± 0.16
Acrolein	60	60	0.75 ± 0.10	0.63 ± 0.13	0.67 ± 0.15	0.87 ± 0.25	0.81 ± 0.24	0.75 ± 0.10
Benzene	60	60	0.87 ± 0.16	1.25 ± 0.38	0.64 ± 0.11	0.63 ± 0.13	1.01 ± 0.41	0.87 ± 0.16
1,3-Butadiene	55	60	0.06 ± 0.01	0.08 ± 0.03	0.05 ± 0.01	0.04 ± 0.01	0.06 ± 0.02	0.05 ± 0.01
Carbon Tetrachloride	59	60	0.58 ± 0.03	0.49 ± 0.08	0.57 ± 0.06	0.62 ± 0.07	0.60 ± 0.04	0.57 ± 0.03
Formaldehyde	59	59	2.93 ± 0.45	1.35 ± 0.24	2.21 ± 0.27	4.92 ± 0.80	2.89 ± 0.74	2.93 ± 0.45

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for LDTN from Table 25-5 include the following:

- The pollutants with the highest daily average concentrations by mass were carbon disulfide (46.96 ± 11.56 μg/m^3), formaldehyde (3.74 ± 0.64 μg/m^3), and acetaldehyde (2.62 ± 0.42 μg/m^3).

- The daily, seasonal, and annual average concentrations of carbon disulfide are significantly higher than the averages for the other pollutants of interest.

- As shown in Tables 4-9 and 4-11, of the program-level pollutants of interest, LDTN had the ninth highest daily average concentration of acetaldehyde and the tenth highest daily average concentration of formaldehyde and tetrachloroethylene.

- The daily average concentration of carbon disulfide was the highest average concentration for this pollutant of all NATTS and UATMP sites.

- Although some of the seasonal averages of the pollutants of interest for LDTN appear to be higher in the summer or autumn, the confidence intervals indicate that the difference is not significant.

Observations for MSTN from Table 25-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (2.93 ± 0.45 μg/m^3), acetaldehyde (1.49 ± 0.16 μg/m^3), and benzene (0.87 ± 0.16 μg/m^3).

- Although carbon disulfide was not a pollutant of interest for MSTN, the daily average concentration of carbon disulfide was 4.21 ± 1.31 μg/m^3, which is an order of magnitude lower than the average for LDTN. The daily average of this pollutant was the tenth highest among of sites sampling VOC.

- None of the daily average concentrations of the program-level pollutants for MSTN were among the 10 highest concentrations for all sites, as shown in Table 4-9.

- Although some of the seasonal averages of the pollutants of interest for MSTN appear to be higher in the summer or autumn, the confidence intervals indicate that the difference is not significant. However, formaldehyde concentrations were highest in the summer.

25.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. The LDTN site has sampled VOC and carbonyls under the UATMP since 2003. Figures 25-8 through 25-10 present the three-year rolling statistical metrics graphically for benzene, 1,3-butadiene, and formaldehyde for LDTN. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Observations from Figure 25-8 for benzene measurements include the following:

- The maximum benzene concentration shown was measured in 2004.
- The median and rolling average concentrations have a decreasing trend over the time periods shown.
- The minimum concentration measured decreased for each time frame.
- All benzene concentrations reported to AQS over the five years of sampling were measured detections.

Observations from Figure 25-9 for 1,3-butadiene measurements include the following:

- The minimum, first quartile, and median concentrations for 1,3-butadiene were zero for the 2003-2005 time frame. As the MDL for 1,3-butadiene improved (i.e, decreased), the detection rate for this pollutant increased, and a larger spread between the metrics is observed. This pollutant was detected in 31 percent of samples during the 2003-2005 time frame; 59 percent of samples during 2004-2006; and 86 percent of samples during 2005-2007.
- The rolling average concentration, the median, and the third quartile increased over the sampling periods, primarily due to the decreasing number of zeros incorporated into the calculations.

Observations from Figure 25-10 for formaldehyde measurements include the following:

- The maximum formaldehyde concentration shown was measured in 2003. The maximum concentrations have decreased across the sampling period.
- The rolling average concentration is greater than the third quartile for the 2003-2005 time frame, illustrating the effects of outliers in the calculation.
- The median and rolling average concentrations became more similar each period, indicating decreasing variability in central tendency since sampling began in 2003.
- The rolling average concentrations exhibited a decreasing trend over the sampling period.

Figure 25-8. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at LDTN

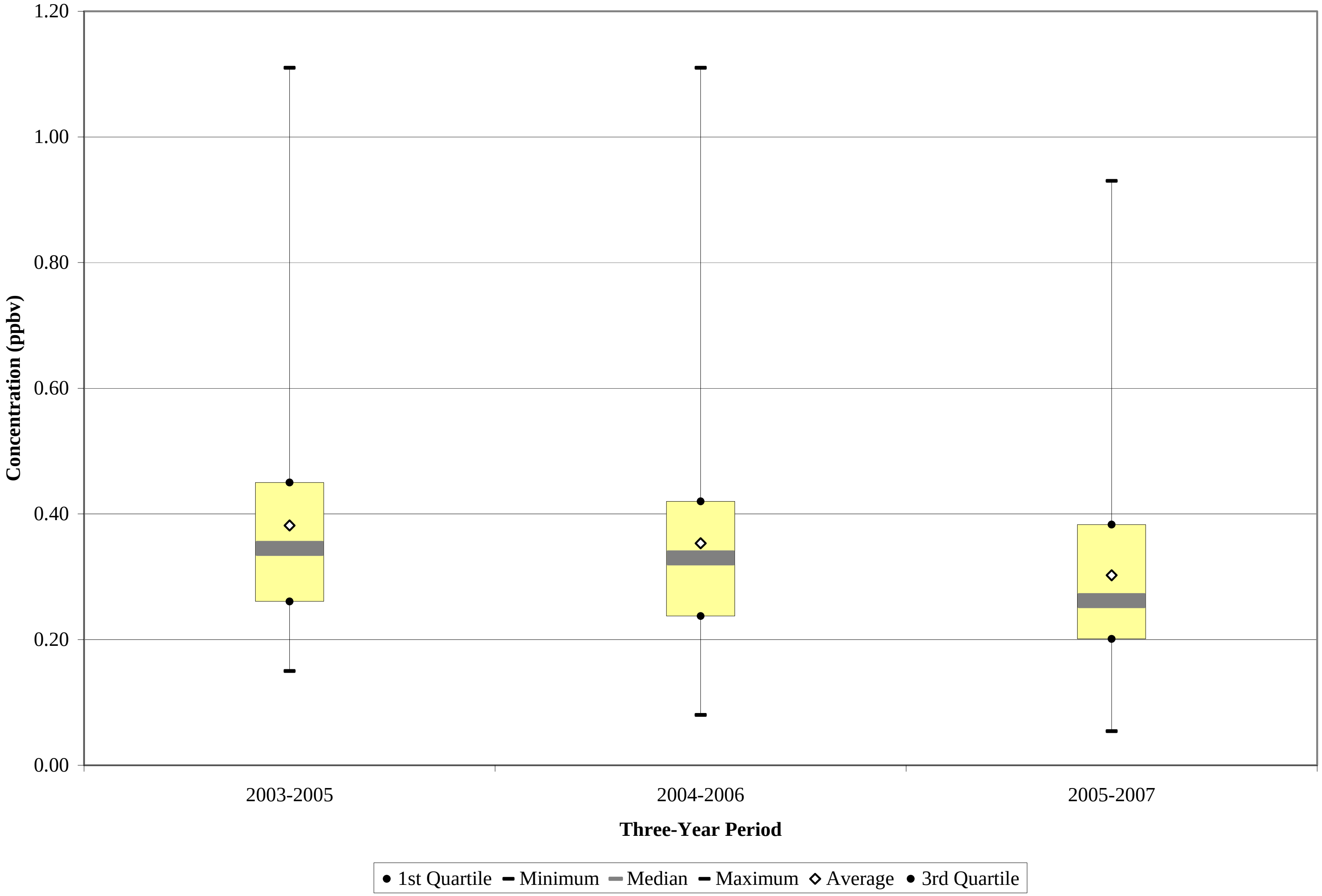


Figure 25-9. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at LDTN

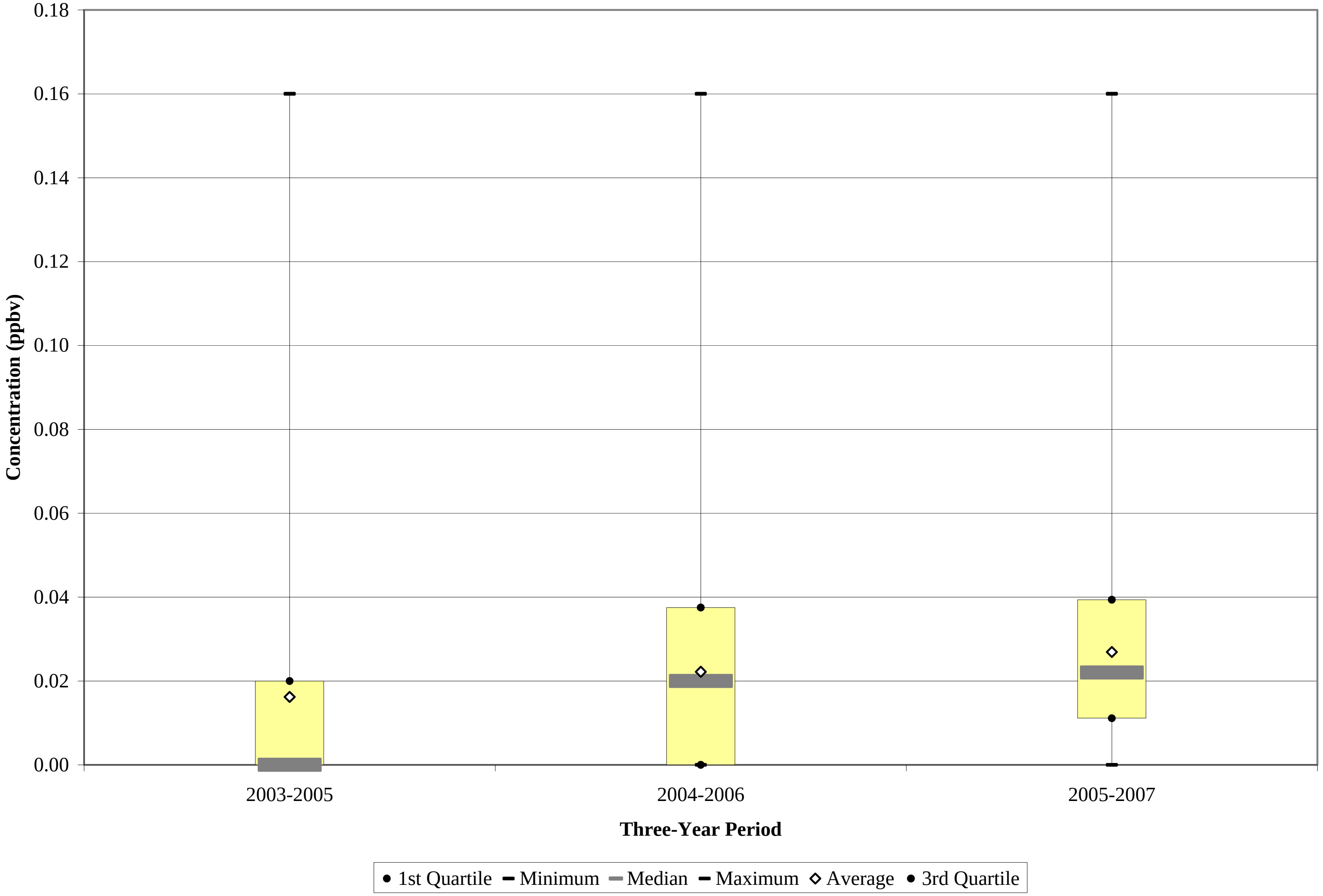
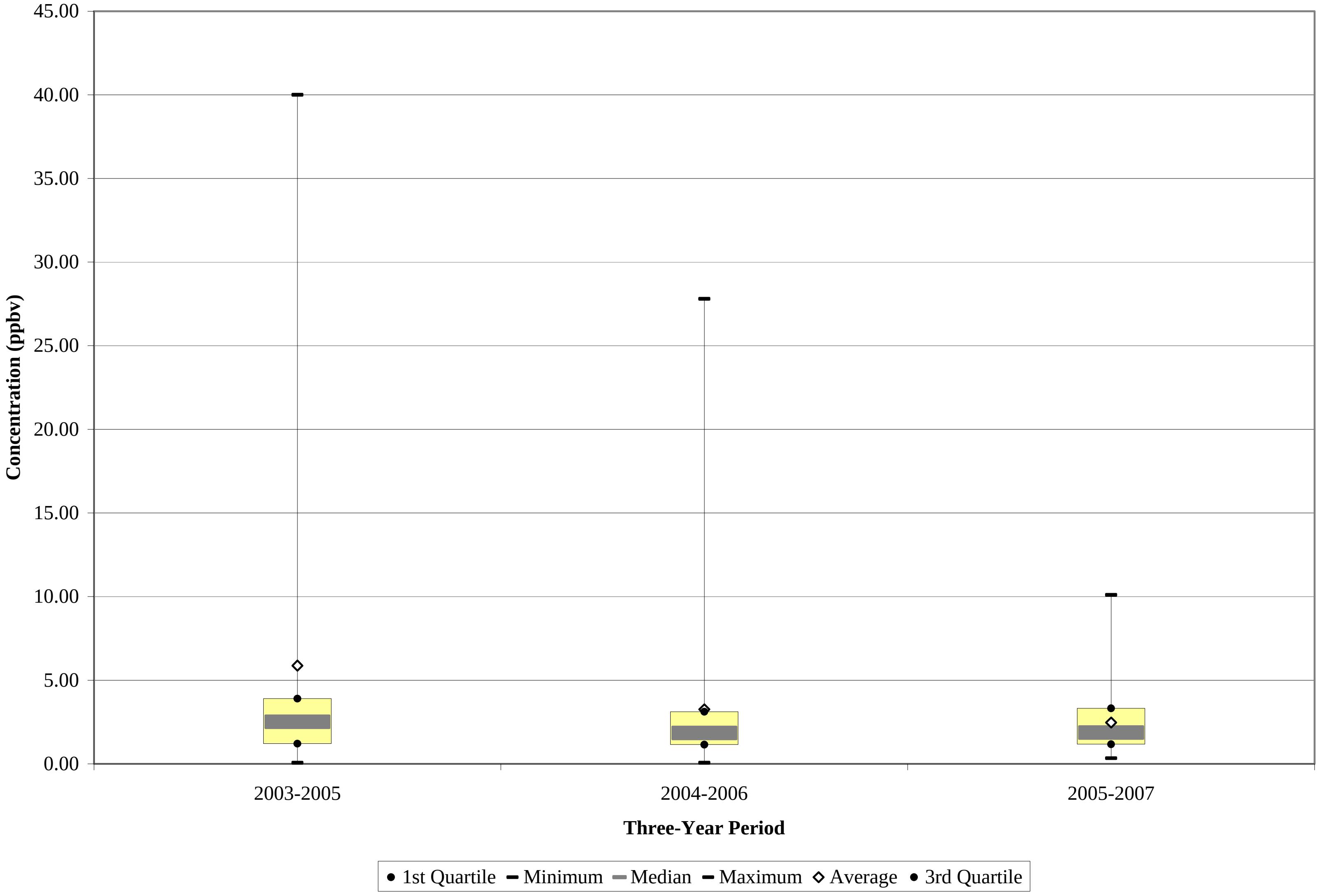


Figure 25-10. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at LDTN



- All formaldehyde concentrations reported to AQS over the six years of sampling were measured detections.

25.5 Pearson Correlations

Table 25-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for LDTN from Table 25-6 include the following:

- Formaldehyde and acetaldehyde exhibited strong positive correlations with the temperature parameters, indicating that as the temperature increases, concentrations of these pollutants proportionally increase at LDTN.

- Formaldehyde also exhibited strong positive correlations with the dew point and wet bulb temperatures, indicating that as these parameters increase, concentrations of formaldehyde proportionally increase at LDTN.

- Although not very strong, all of the correlations with scalar wind speed were negative, indicating that decreasing wind speed may result in a proportionate increases in the pollutants of interest at LDTN.

Observations for MSTN from Table 25-6 include the following:

- Formaldehyde exhibited similar tendencies at MSTN, with strong positive correlations with average, maximum, dew point, and wet bulb temperatures.

- Similar to LDTN, the correlations between the pollutants of interest and scalar wind speed were all negative.

25.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

25.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Tennessee monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As

Table 25-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Tennessee Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Loudon, Tennessee - LDTN								
Acetaldehyde	62	0.56	0.53	0.39	0.45	-0.29	-0.18	-0.21
Acrolein	60	0.36	0.35	0.32	0.33	0.02	-0.13	-0.10
Benzene	60	0.05	0.03	0.06	0.03	0.14	0.09	-0.41
1,3-Butadiene	58	-0.13	-0.15	-0.12	-0.15	0.12	0.27	-0.42
Carbon Disulfide	60	0.22	0.13	0.06	0.09	-0.17	0.03	-0.17
Carbon Tetrachloride	60	0.33	0.31	0.36	0.33	0.28	-0.29	-0.18
p-Dichlorobenzene	57	0.30	0.29	0.27	0.28	0.02	-0.08	-0.06
Formaldehyde	62	0.77	0.78	0.65	0.71	-0.18	-0.30	-0.28
Loudon Middle School, Loudon, Tennessee - MSTN								
Acetaldehyde	59	0.43	0.40	0.20	0.29	-0.46	-0.08	-0.22
Acrolein	60	0.27	0.23	0.24	0.23	0.13	0.08	-0.40
Benzene	60	-0.30	-0.32	-0.20	-0.27	0.30	0.17	-0.16
1,3-Butadiene	55	-0.36	-0.35	-0.24	-0.31	0.27	0.25	-0.23
Carbon Tetrachloride	59	0.24	0.22	0.19	0.21	0.00	-0.10	-0.01
Formaldehyde	59	0.80	0.80	0.66	0.73	-0.16	-0.26	-0.28

described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 25-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein in Table 25-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- For both sites, all of the seasonal averages of acrolein exceeded the intermediate MRL.
- Acrolein has no chronic MRL. Therefore, chronic risk could not be evaluated.

25.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Tennessee monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 25-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the Tennessee monitoring sites is as follows:

- The census tract for LDTN is 47105060200, which had a population of 9,529, and represented approximately 24.4 percent of the Loudon County population in 2000.
- The census tract for MSTN is 47105060500, which had a population of 7,898, and also represented approximately 20.2 percent of the county population in 2000.

Table 25-7. MRL Risk Screening Assessment Summary for the Tennessee Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average[1] (µg/m^3)
LDTN	TO-15	Acrolein	7.00	0/60	0.09	**0.47 ± 0.18**	**0.44 ± 0.12**	**0.95 ± 0.32**	**0.88 ± 0.32**	--	0.70 ± 0.14
MSTN	TO-15	Acrolein	7.00	0/60	0.09	**0.63 ± 0.13**	**0.67 ± 0.15**	**0.87 ± 0.25**	**0.81 ± 0.24**	--	0.75 ± 0.10

BOLD = exceedance of the intermediate or chronic MRL

-- = an MRL risk factor is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 25-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Tennessee

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration (µg/m^3)	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Loudon, Tennessee (LDTN) - Census Tract ID 47105060200								
Acetaldehyde	0.000002	0.009	1.21	2.69	0.13	2.62 ± 0.42	5.24	0.29
Acrolein	--	0.00002	0.06	--	2.99	0.70 ± 0.14	--	35.10
Acrylonitrile	0.000068	0.002	<0.01	0.06	<0.01	0.03 ± 0.01	2.05	0.02
Benzene	0.000007	0.03	0.89	6.94	0.02	0.78 ± 0.09	5.45	0.03
1,3-Butadiene	0.00003	0.002	0.03	0.76	0.01	0.06 ± 0.01	1.76	0.03
Carbon Disulfide	--	0.7	3.84	--	0.01	46.96 ± 11.56	--	0.07
Carbon Tetrachloride	0.000015	0.04	0.21	3.18	0.01	0.61 ± 0.04	9.15	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.01	0.16	<0.01	0.09 ± 0.03	0.94	<0.01
Formaldehyde	5.5E-09	0.0098	0.78	<0.01	0.07	3.74 ± 0.64	0.02	0.38
Tetrachloroethylene	0.000005	0.27	0.02	0.14	<0.01	0.26 ± 0.33	1.30	<0.01
Xylenes	--	0.1	1.15	--	0.01	1.06 ± 0.69	--	0.01
Loudon Middle School, Loudon, Tennessee (MSTN) - Census Tract ID 47105060500								
Acetaldehyde	0.000002	0.009	1.04	2.31	0.11	1.49 ± 0.16	2.98	0.17
Acrolein	--	0.00002	0.05	--	2.39	0.75 ± 0.10	--	37.49
Acrylonitrile	0.000068	0.002	<0.01	0.04	<0.01	0.03 ± <0.01	1.88	0.01
Benzene	0.000007	0.03	0.72	5.59	0.02	0.87 ± 0.16	6.12	0.03
1,3-Butadiene	0.00003	0.002	0.02	0.47	0.01	0.05 ± 0.01	1.63	0.03
Carbon Tetrachloride	0.000015	0.04	0.21	3.15	0.01	0.57 ± 0.03	8.59	0.01
Chloromethylbenzene	0.000049	--	<0.01	<0.01	--	0.03 ± <0.01	1.39	--
p-Dichlorobenzene	0.000011	0.8	0.01	0.12	<0.01	0.05 ± 0.01	0.59	<0.01
1,2-Dichloroethane	0.000026	2.4	0.01	0.26	<0.01	0.04 ± <0.01	1.10	<0.01
Formaldehyde	5.5E-09	0.0098	0.73	<0.01	0.07	2.93 ± 0.45	0.02	0.30
Tetrachloroethylene	0.000005	0.27	0.01	0.09	<0.01	0.09 ± 0.02	0.45	<0.01

BOLD = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for LDTN from Table 25-8 include the following:

- Carbon disulfide was the pollutant with the highest concentration according to NATA and among annual averages. However, the annual average was an order of magnitude higher than the modeled concentration.

- The pollutants with the highest cancer risks according to NATA were benzene, carbon tetrachloride, and acetaldehyde. These same pollutants also had the highest cancer risk approximations, although the ranking was different.

- The only pollutant with a noncancer HQ greater than 1.0 according to NATA and based on the annual average was acrolein. However, the annual average-based approximation (35.10) was an order of magnitude higher than the modeled concentration (2.99).

Observations for MSTN from Table 25-8 include the following:

- The pollutants with the highest concentrations according to NATA were acetaldehyde, formaldehyde, and benzene. The pollutants with the highest 2007 annual averages were also these three pollutants, although the order was different.

- The pollutants with the highest cancer risks according to NATA were benzene, carbon tetrachloride, and acetaldehyde. These same pollutants also had the highest cancer risk approximations, although the ranking was different.

- The only pollutant with a noncancer HQ greater than 1.0 according to NATA and based on the annual average was acrolein. However, the annual average-based approximation (37.39) was an order of magnitude higher than the modeled concentration (2.39).

25.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 25-9 and 25-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 25-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 25-10 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although

Table 25-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Tennessee

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Loudon, Tennessee (LDTN) – Loudon County					
Benzene	150.72	Benzene	1.18E-03	Carbon Tetrachloride	9.15
Acetaldehyde	67.70	1,3-Butadiene	4.72E-04	Benzene	5.45
Formaldehyde	55.51	Hexavalent Chromium	1.56E-04	Acetaldehyde	5.24
1,3-Butadiene	15.73	Acetaldehyde	1.49E-04	Acrylonitrile	2.04
Dichloromethane	3.83	Arsenic, PM	1.27E-04	1,3-Butadiene	1.76
Naphthalene	3.08	Naphthalene	1.05E-04	Tetrachloroethylene	1.30
Tetrachloroethylene	2.05	POM, Group 2	7.15E-05	*p*-Dichlorobenzene	0.94
POM, Group 2	1.30	POM, Group 3	3.40E-05	Formaldehyde	0.02
p-Dichlorobenzene	0.88	Nickel, PM	2.61E-05		
Trichloroethylene	0.48	POM, Group 5	2.30E-05		
Loudon Middle School, Loudon, Tennessee (MSTN) – Loudon County					
Benzene	150.72	Benzene	1.18E-03	Carbon Tetrachloride	8.58
Acetaldehyde	67.70	1,3-Butadiene	4.72E-04	Benzene	6.12
Formaldehyde	55.51	Hexavalent Chromium	1.56E-04	Acetaldehyde	2.98
1,3-Butadiene	15.73	Acetaldehyde	1.49E-04	Acrylonitrile	1.87
Dichloromethane	3.83	Arsenic, PM	1.27E-04	1,3-Butadiene	1.63
Naphthalene	3.08	Naphthalene	1.05E-04	Chloromethylbenzene	1.35
Tetrachloroethylene	2.05	POM, Group 2	7.15E-05	1,2-Dichloroethane	1.11
POM, Group 2	1.30	POM, Group 3	3.40E-05	*p*-Dichlorobenzene	0.59
p-Dichlorobenzene	0.88	Nickel, PM	2.61E-05	Tetrachloroethylene	0.45
Trichloroethylene	0.48	POM, Group 5	2.30E-05	Formaldehyde	0.02

Table 25-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Tennessee

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Loudon, Tennessee (LDTN) – Loudon County					
Carbon Disulfide	1,130.07	Acrolein	141,663.65	Acrolein	35.10
Toluene	407.61	Manganese, PM	10,862.32	Formaldehyde	0.38
Xylenes	290.81	1,3-Butadiene	7,867.11	Acetaldehyde	0.29
Benzene	150.72	Acetaldehyde	7,521.86	Carbon Disulfide	0.07
Hydrochloric acid	146.45	Hydrochloric acid	7,322.44	1,3-Butadiene	0.03
Styrene	89.43	Formaldehyde	5,664.57	Benzene	0.03
Ethylbenzene	71.22	Benzene	5,023.83	Carbon Tetrachloride	0.02
Acetaldehyde	67.70	Xylenes	2,908.11	Acrylonitrile	0.01
Hexane	64.94	Nickel, PM	2,511.12	Xylenes	0.01
Formaldehyde	55.51	Carbon Disulfide	1,614.39	Tetrachloroethylene	<0.01
Loudon Middle School, Loudon, Tennessee (MSTN) – Loudon County					
Carbon Disulfide	1,130.07	Acrolein	141,663.65	Acrolein	37.49
Toluene	407.61	Manganese, PM	10,862.32	Formaldehyde	0.30
Xylenes	290.81	1,3-Butadiene	7,867.11	Acetaldehyde	0.17
Benzene	150.72	Acetaldehyde	7,521.86	Benzene	0.03
Hydrochloric acid	146.45	Hydrochloric acid	7,322.44	1,3-Butadiene	0.03
Styrene	89.43	Formaldehyde	5,664.57	Carbon Tetrachloride	0.01
Ethylbenzene	71.22	Benzene	5,023.83	Acrylonitrile	0.01
Acetaldehyde	67.70	Xylenes	2,908.11	Tetrachloroethylene	<0.01
Hexane	64.94	Nickel, PM	2,511.12	*p*-Dichlorobenzene	<0.01
Formaldehyde	55.51	Carbon Disulfide	1,614.39	1,2-Dichloroethane	<0.01

the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risks based on each site's annual averages are limited to those pollutants for whicheach respective site sampled. As discussed in Section 25.3, LDTN and MSTN sampled for VOC and carbonyl compounds. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated. The Tennessee monitoring sites sampled year-round for each pollutant group mentioned above.

Observations from Table 25-9 include the following:

- Benzene, acetaldehyde, and formaldehyde were the highest emitted pollutants with cancer UREs in Loudon County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Loudon County were benzene, 1,3-butadiene, and hexavalent chromium.
- Five of the highest emitted pollutants in Loudon County also had the highest toxicity-weighted emissions.
- For both monitoring sites, carbon tetrachloride, benzene, and acetaldehyde had the highest cancer surrogate risk approximations. Carbon tetrachloride did not appear on either emissions-based list, while benzene ranked highest on both.

Observations from Table 25-10 include the following:

- Carbon disulfide, toluene, and xylenes were the highest emitted pollutants with noncancer RfCs in Loudon County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Loudon County were acrolein, manganese, and 1,3-butadiene.
- Six of the highest emitted pollutants also had the highest toxicity-weighted emissions for Loudon County.
- The pollutant with the highest noncancer risk approximation was acrolein for both sites. Acrolein was also the pollutant with the highest toxicity-weighted emissions, yet this pollutant's emissions ranked 20th.

- Carbon disulfide, the pollutant with the highest daily, seasonal, and annual average concentrations, appeared on all three lists for LDTN.

25.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *The pollutants of interest common to each Tennessee monitoring site were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.*

- *Formaldehyde had the highest daily average concentration for MSTN, while carbon disulfide had the highest daily average concentration for LDTN.*

- *Seasonal averages of acrolein exceeded the intermediate MRL health benchmark for both sites.*

26.0 Sites in Texas

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS sites in Texas, and integrates these concentrations with emissions, meteorological, and risk information.

26.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. The CAMS 35 monitoring site is located in the Houston-Galveston-Brazoria, TX CMSA. The CAMS 85 monitoring site is located in the Longview-Marshall, TX MSA. Figures 26-1 and 26-2 are composite satellite images retrieved from Google™ Maps showing the monitoring sites in their urban and rural locations. Figures 26-3 and 26-4 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. Table 26-1 describes the area surrounding each monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

The CAMS 35 monitoring site is located in Deer Park, southeast of Houston, in east Texas. The site is located at Brown Memorial Park, in a primarily residential area, as shown in Figure 26-1. Major thoroughfares surround the site, including Red Bluff Road and Beltway 8. The Houston Ship Channel is located to the north and Galveston Bay is located to the east and southeast. The east side of Houston has significant industry, including several oil refineries. As Figure 26-3 shows, no point source emission sources are located within one mile of the CAMS 35 monitoring site. However, a large number of emission sources is located roughly along a line that runs east to west just north of the site. A second cluster of emission sources is located to the southeast of the monitoring site. The most numerous source categories surrounding CAMS 35 are involved in the oil and gas sector, specifically the production of organic chemicals, liquids distribution, and the production of chemicals and allied products.

CAMS 85 is located in Karnack, Texas, about 10 miles northeast of Marshall, and about six miles west of the Texas-Louisiana border. The site is located on the property of the

Figure 26-1. Deer Park, Texas (CAMS 35) Monitoring Site

©2008 Google/©NAVTECH

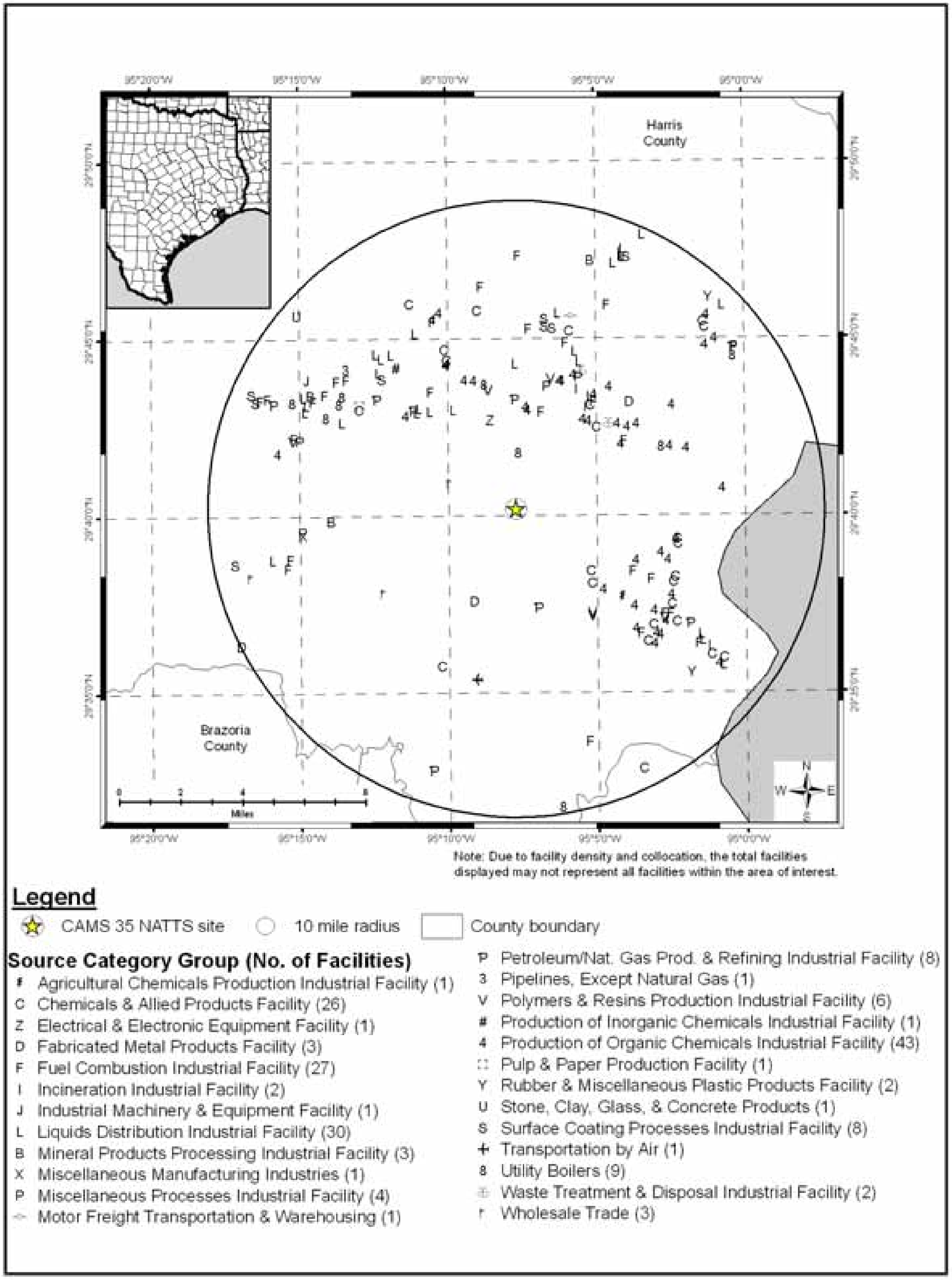
Scale: 3cm = 100m

Figure 26-2. Karnack, Texas (CAMS 85) Monitoring Site

©2008 Google/©NAVTECH

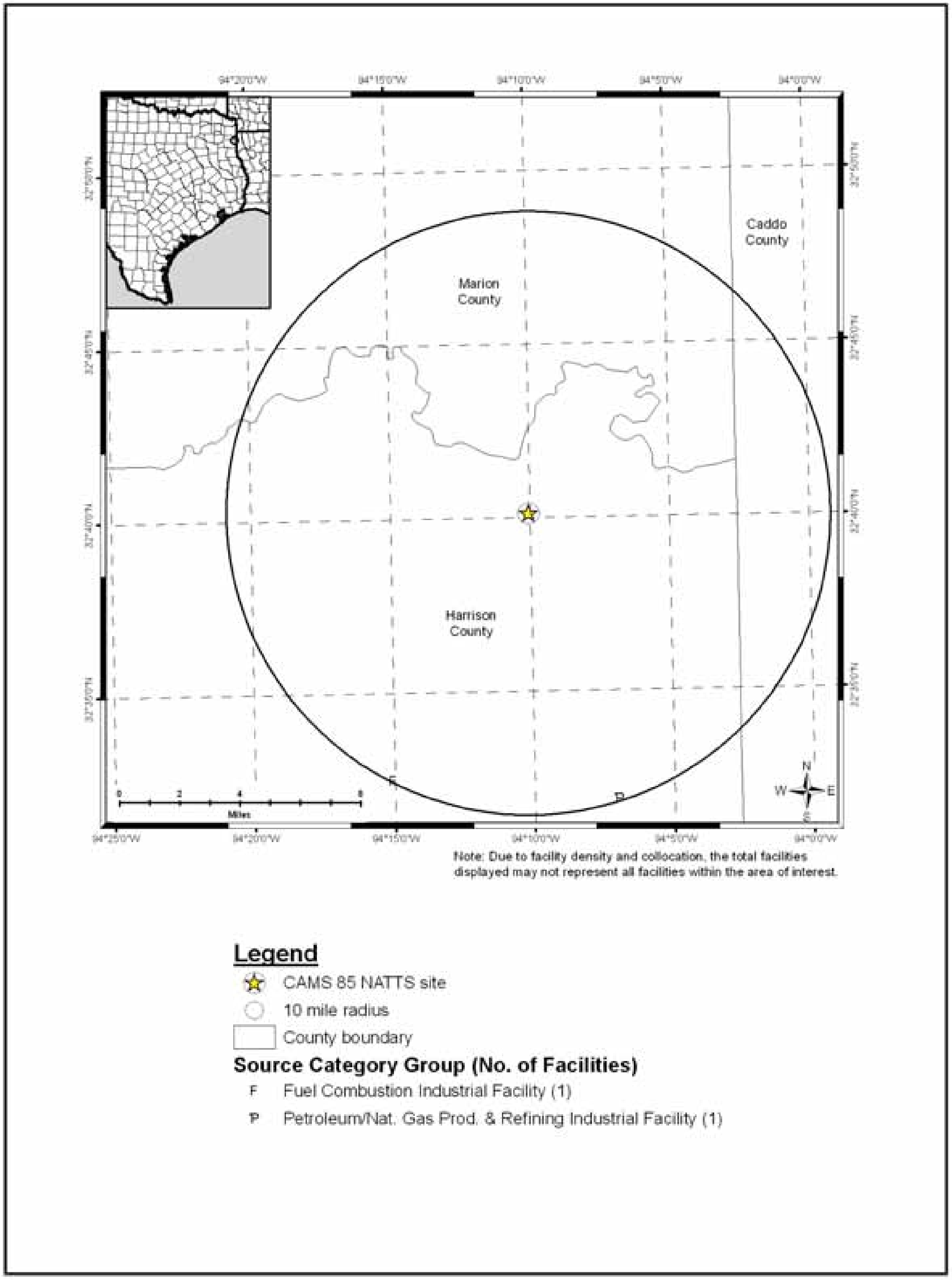
Scale: 3cm = 200m

Figure 26-3. NEI Point Sources Located Within 10 Miles of CAMS 35



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 26-4. NEI Point Sources Located Within 10 Miles of CAMS 85



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 26-1. Geographical Information for the Texas Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
CAMS 35	48-201-1039	Deer Park	Harris	Houston-Galveston-Brazoria, TX CMSA	29.670046, -95.128485	Residential	Suburban	CAMS 35 is located southeast of Houston, Texas, in Deer Park, near the intersection of Lambuth and Durant St. The site is a shelter on the northwest periphery of Brown Memorial Park. Residential housing surrounds the site to the northeast, east, and south. A medical center lies to the southwest and a stand of trees lies to the northwest. Monitoring at this location began in 1996 and additional parameters being monitored for include criteria pollutants, organic and elemental carbon, and meteorological parameters.
CAMS 85	48-203-0002	Karnack	Harrison	Longview-Marshall, TX MSA	32.669003, -94.167449	Agricultural	Rural	CAMS 85 is located in the rural town of Karnack, Texas, less than 300 meters from the intersection of Highway 134 and Spur Road 449. The site is located on the property of the Longhorn Army Ammunition Plant. Trees surround the site to the north, with open field to the east and south. The town of Karnack is located to the west of the monitoring site. NO, NO_2, NO_x, O_3, PM_{10} and $PM_{2.5}$ are monitored for in addition to VOC and meteorological parameters.

BOLD = EPA-designated NATTS Site

Longhorn Army Ammunition Plant near the intersection of Highway 134 and Spur Road 449, as shown in Figure 26-2. The surrounding area is rural and agricultural. As Figure 26-4 shows, two point source emission sources are located within 10 miles of the CAMS 85 monitoring site. Both sources are on the outer periphery of the 10-mile radius. One is involved in processes utilizing fuel combustion and the other is involved in the production and refining of petroleum and natural gas.

Table 26-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Texas monitoring sites. County-level vehicle registration and population data for Harris and Harrison Counties were obtained from the Texas Department of Transportation and the U.S. Census Bureau. Table 26-2 also includes a vehicle registration to county population ratio (vehicles per person). An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 26-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 26-2 presents the daily VMT for each urban area.

Table 26-2. Population, Motor Vehicle, and Traffic Information for the Texas Monitoring Sites

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
CAMS 35	3,935,855	3,192,222	0.81	667,537	541,414	31,130	97,774
CAMS 85	63,504	67,719	1.07	3,032	3,233	2,380	1,688

[1] Daily Average Traffic Data reflects 2001 data from the Texas DOT (CAMS 35) and 2002 data from the Texas DOT (CAMS 85)

BOLD = EPA-designated NATTS Site

Observations from Table 26-2 include the following:

- The county-level and 10-mile population and vehicle ownership is significantly higher in Harris County than Harrison County.
- Compared to other counties with monitoring sites, Harris County ranked third highest for population and fourth highest for vehicle ownership. The county-level population

and vehicle ownership for Harrison County was on the low end compared to other program sites.

- The CAMS 35 10-mile population does not reflect the magnitude of the county population, indicating that the site is not located near the center of highest population density. This is also true for CAMS 85. The 10-mile population ranked 23rd for CAMS 35 and 48th (the lowest estimated) for CAMS 85, compared to other program sites.

- The vehicle per person ratio for CAMS 85 is higher than CAMS 35 and ranked ninth highest among NATTS and UATMP sites.

- The traffic volume passing CAMS 35 is higher than the volume passing CAMS 85, but was in the middle of the range compared to other program sites. The traffic volume for CAMS 85 is the fourth lowest among all sites.

- The VMT for the Houston area ranked eight highest, while the VMT for the Longview area was the lowest among urban areas with monitoring sites.

26.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Texas on sampling days, as well as over the course of the year.

26.2.1 Climate Summary

The eastern third of Texas is characterized by a subtropical humid climate, with the climate becoming more continental in nature further north and west. The proximity to the Gulf of Mexico acts as a moderating influence as temperatures soar in the summer or dip in the winter. Areas closer to the coast, such as Houston, remain slightly cooler than neighboring areas to the north. The reverse is also true, as coastal areas are warmer in the winter than areas further inland, although East Texas winters are relatively mild. The onshore flow from the Gulf of Mexico also allows humidity levels to remain higher near the coast. The winds flow out of the Gulf of Mexico a majority of the year, with the winter months being the exception, as frontal systems allow colder air from the north to filter in. Abundant rainfall is also typical of the region, again due in part to the nearness to the Gulf of Mexico (Ruffner and Bair, 1987 and TAMU, 2007).

26.2.2 Meteorological Conditions in 2007

Hourly meteorological data at weather stations near these sites were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The two closest NWS weather stations are located at William P. Hobby Airport (near CAMS 35) and Shreveport Regional Airport (near CAMS 85), WBAN 12918 and 13957, respectively.

Table 26-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 26-3 is the 95 percent confidence interval for each parameter. As shown in Table 26-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

26.2.3 Composite Back Trajectories for Sampling Days

Figures 26-5 and 26-6 are composite back trajectory maps for the Texas monitoring sites for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 26-5 and 26-6 represents 100 miles.

Observations from Figure 26-5 for CAMS 35 include the following:

- Back trajectories originated from a variety of directions at the CAMS 35 monitoring site, although most trajectories originated from the southeast.

- The 24-hour air shed domain for CAMS 35 was somewhat smaller in size than other monitoring sites. The furthest away a trajectory originated was the Gulf of Mexico, less than 600 miles away. However, most trajectories originated within 400 miles of the site.

Table 26-3. Average Meteorological Conditions near the Texas Monitoring Sites

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CAMS 35	William P. Hobby Airport 12918	Sampling Day	79.65 ± 2.93	71.70 ± 2.87	61.75 ± 3.19	65.72 ± 2.78	73.64 ± 2.82	1017.06 ± 1.22	5.92 ± 0.69
		All 2007	78.74 ± 1.27	70.42 ± 1.27	60.22 ± 1.47	64.43 ± 1.25	72.67 ± 1.15	1017.45 ± 0.51	5.94 ± 0.28
CAMS 85	Shreveport Regional Airport 13957	Sampling Day	77.88 ± 3.62	68.61 ± 3.38	55.77 ± 3.62	61.21 ± 3.15	66.23 ± 2.63	1017.06 ± 1.27	5.58 ± 0.64
		All 2007	77.31 ± 1.54	67.05 ± 1.49	54.10 ± 1.63	59.75 ± 1.40	66.05 ± 1.13	1017.32 ± 0.53	5.52 ± 0.26

BOLD = EPA-designated NATTS Site

Figure 26-5. Composite Back Trajectory Map for CAMS 35

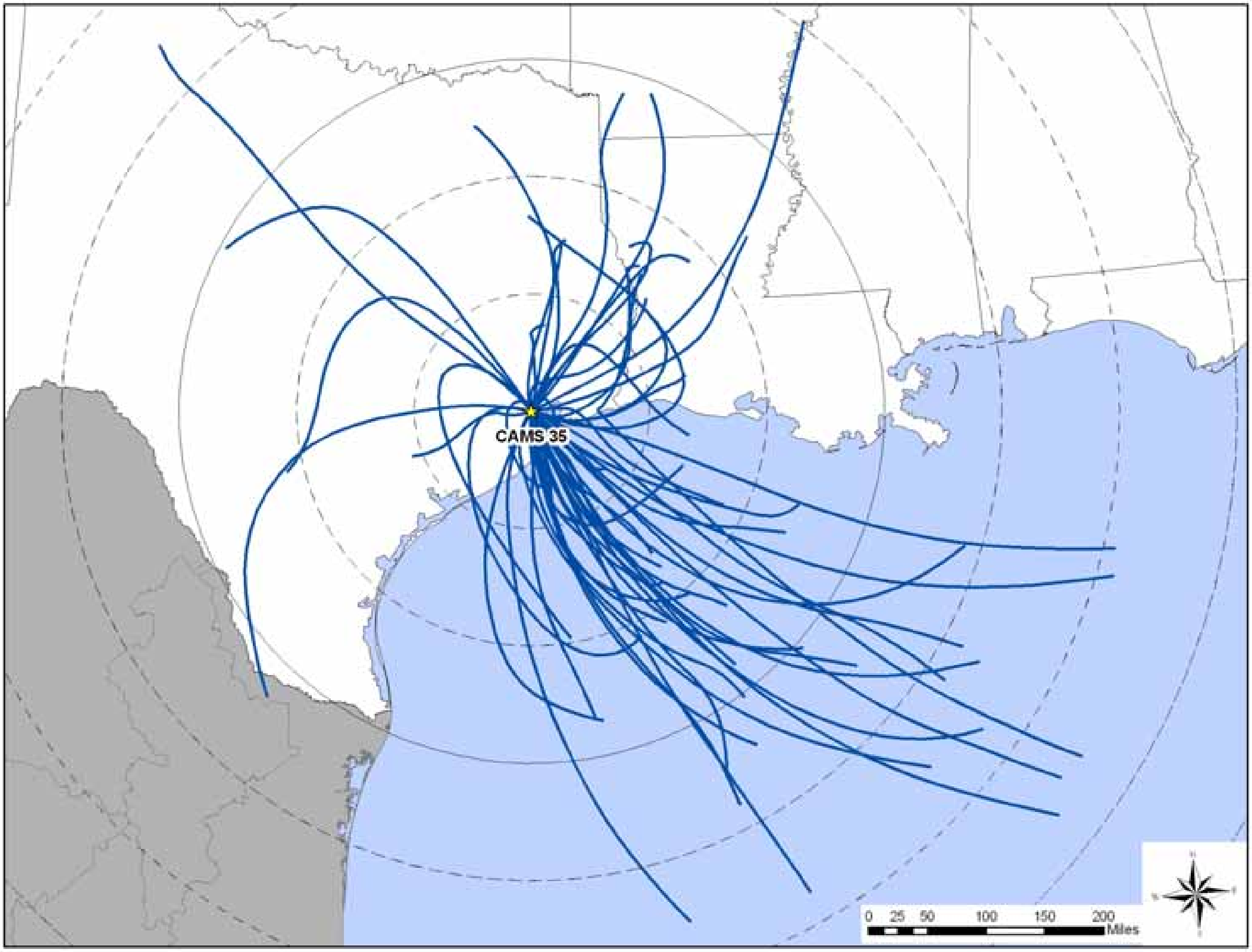
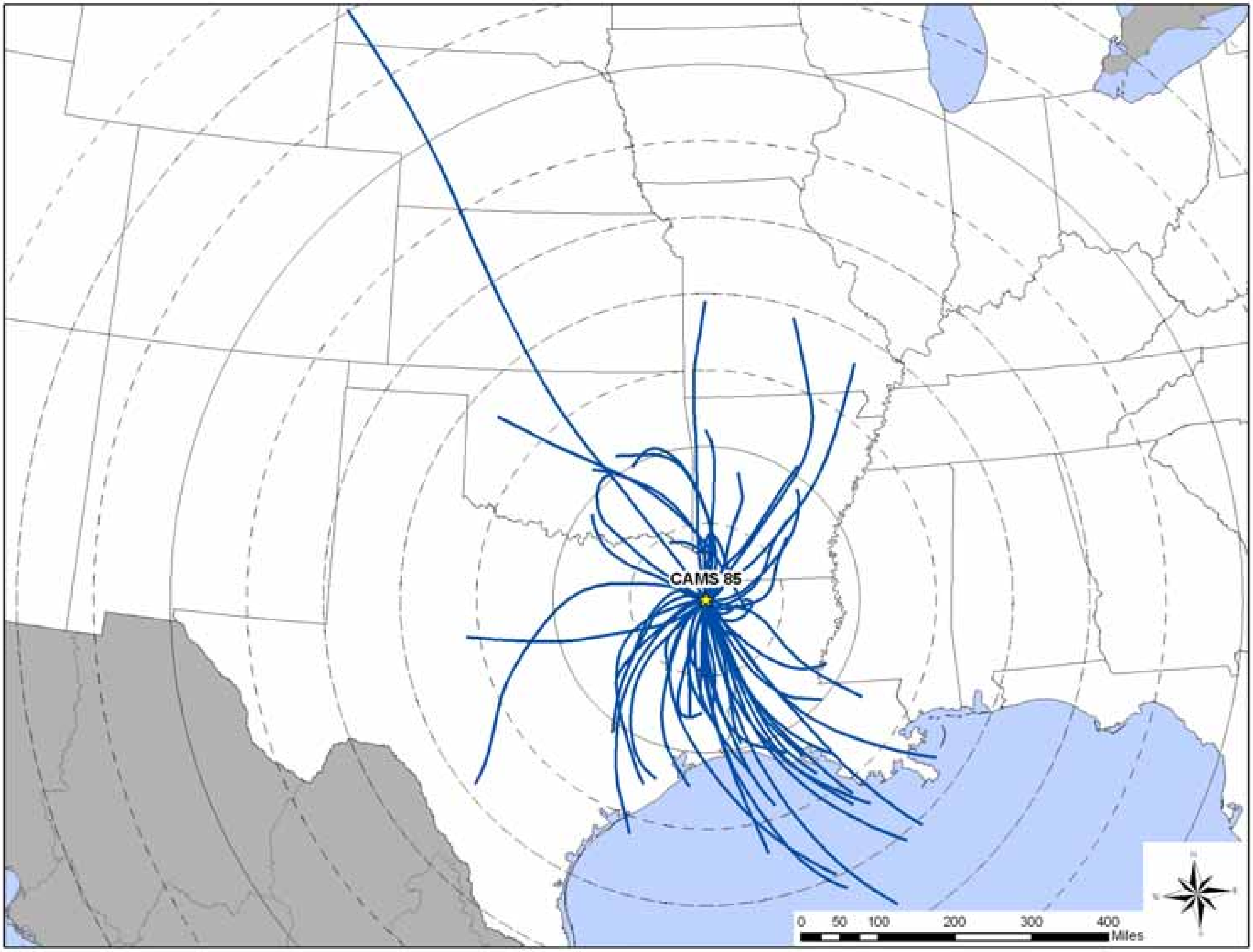


Figure 26-6. Composite Back Trajectory Map for CAMS 85



Observations from Figure 26-6 for CAMS 85 include the following:

- Back trajectories originated from a variety of directions at the CAMS 85 monitoring site, although most trajectories originated from the southeast and south.

- The 24-hour air shed domain for CAMS 85 was larger in size than CAMS 35 and many other monitoring sites. The furthest away a trajectory originated was western South Dakota, 900 miles away. However, this particular back trajectory originated nearly 400 miles further than most, as most trajectories originated within 500 miles of the site.

26.2.4 Wind Roses for Sampling Days

Hourly wind data from the weather stations at William Hobby (for CAMS 35) and Shreveport Regional Airports (for CAMS 85) near the monitoring sites were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figures 26-7 and 26-8 are the wind roses for the Texas monitoring sites on days that samples were collected.

Figure 26-7. Wind Rose for CAMS 35 Sampling Days

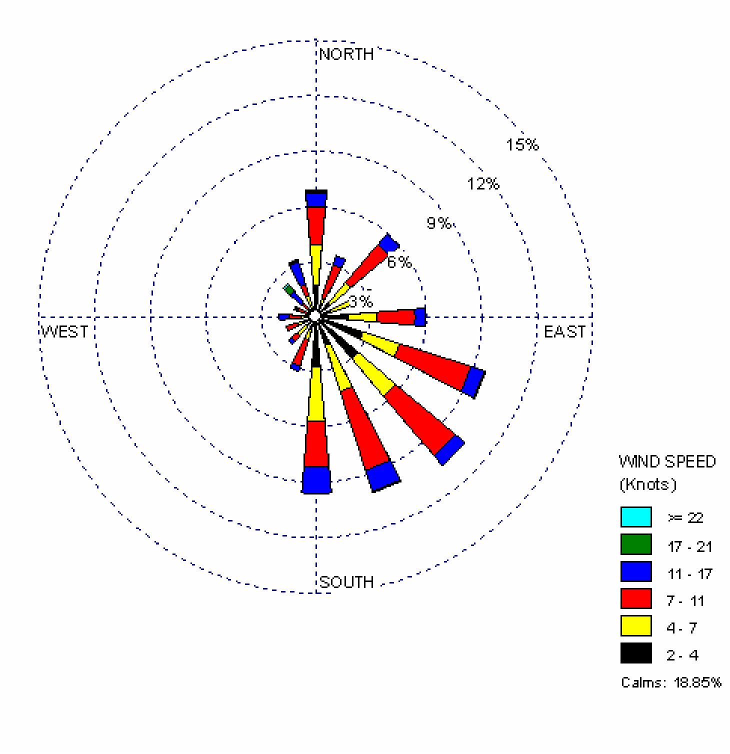
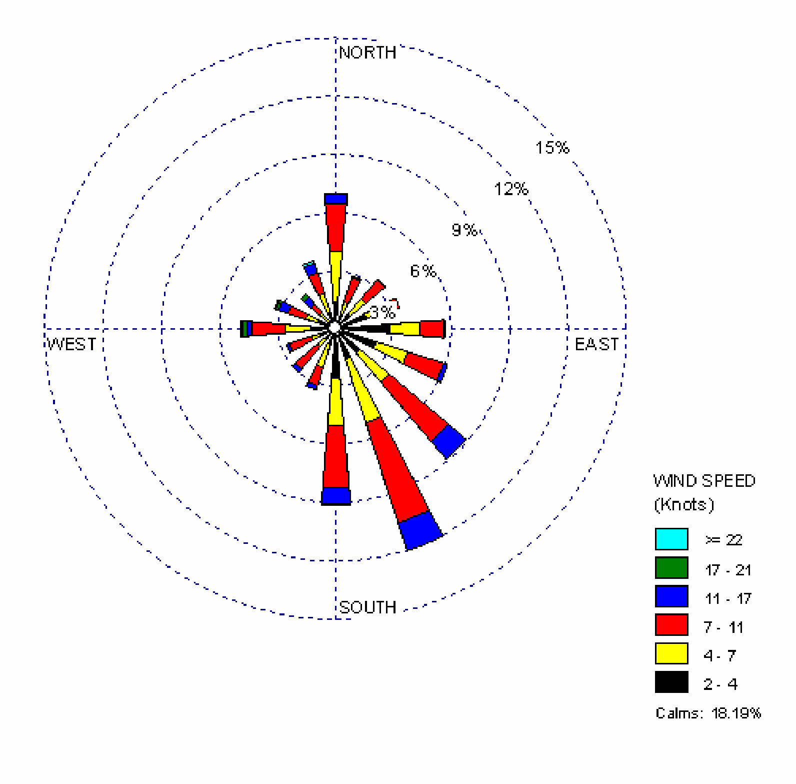


Figure 26-8. Wind Rose for CAMS 85 Sampling Days



Observations from Figures 26-7 and 26-8 include the following:

- The wind roses for CAMS 35 and CAMS 85 are very similar.
- Southeasterly and southerly winds prevailed near both sites. Northerly winds were also observed somewhat frequently near the sites.
- Calm winds were observed for 18 percent of the wind measurements near both sites.
- The strongest wind speeds were measured with westerly and northwesterly winds.

26.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Texas monitoring sites were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. Table 26-4 presents the pollutants that failed at least one screen for each Texas monitoring site and highlights each site’s pollutants of interest (shaded). The CAMS 35 and CAMS 85 monitoring sites sampled VOC only.

Table 26-4. Comparison of Measured Concentrations and EPA Screening Values for the Texas Monitoring Sites

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Deer Park, Texas - CAMS 35					
Acrolein	57	57	100.00	17.92	17.92
Carbon Tetrachloride	57	57	100.00	17.92	35.85
Benzene	57	57	100.00	17.92	53.77
1,3-Butadiene	55	57	96.49	17.30	71.07
p-Dichlorobenzene	26	52	50.00	8.18	79.25
Tetrachloroethylene	26	54	48.15	8.18	87.42
1,2-Dichloroethane	17	17	100.00	5.35	92.77
Acrylonitrile	10	10	100.00	3.14	95.91
Vinyl chloride	9	39	23.08	2.83	98.74
Methyl *tert*-Butyl Ether	2	39	5.13	0.63	99.37
1,1,2-Trichloroethane	1	5	20.00	0.31	99.69
Dichloromethane	1	57	1.75	0.31	100.00
Total	318	501	63.47		
Karnack, Texas - CAMS 85					
Carbon Tetrachloride	52	52	100.00	30.59	30.59
Benzene	52	52	100.00	30.59	61.18
Acrolein	50	50	100.00	29.41	90.59
1,3-Butadiene	10	36	27.78	5.88	96.47
Tetrachloroethylene	2	30	6.67	1.18	97.65
p-Dichlorobenzene	1	16	6.25	0.59	98.24
Vinyl chloride	1	5	20.00	0.59	98.82
1,2-Dichloroethane	1	1	100.00	0.59	99.41
Acrylonitrile	1	1	100.00	0.59	100.00
Total	170	243	69.96		

Observations from Table 26-4 include the following:

- Twelve pollutants with a total of 318 measured concentrations failed at least one screen for CAMS 35, while nine pollutants with a total of 170 measured concentrations failed screens for CAMS 85.

- The pollutants of interest varied by site, yet the following four pollutants of interest were common to both sites: acrolein, benzene, 1,3-butadiene, carbon tetrachloride.

- Of the four common pollutants of interest, 100 percent of the measured detections of acrolein, benzene, and carbon tetrachloride failed screens for both sites.

- Of the pollutants with at least one failed screen, approximately 63 percent of measurements failed screens for CAMS 35, while nearly 70 percent failed screens for CAMS 85. Thus, the failure rate appears higher for CAMS 85. However, many of the pollutants that failed screens were detected more frequently at CAMS 35, leading to a much larger number of measured detections.

26.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Texas monitoring sites. The averages presented are provided for the pollutants of interest for each site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the sites, where applicable.

26.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and when the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 26-5, where applicable.

Table 26-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Texas Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Deer Park, Texas - CAMS 35								
Acrolein	57	57	0.54 ± 0.08	0.52 ± 0.20	0.44 ± 0.08	0.61 ± 0.22	0.59 ± 0.10	0.54 ± 0.08
Acrylonitrile	10	57	0.55 ± 0.29	NR	NR	NR	NR	0.12 ± 0.07
Benzene	57	57	1.59 ± 0.32	1.29 ± 0.18	1.06 ± 0.38	1.42 ± 0.46	2.57 ± 0.87	1.59 ± 0.32
1,3-Butadiene	57	57	0.43 ± 0.34	0.26 ± 0.09	0.22 ± 0.09	0.19 ± 0.08	0.99 ± 1.24	0.43 ± 0.34
Carbon Tetrachloride	57	57	0.68 ± 0.04	0.66 ± 0.08	0.69 ± 0.07	0.68 ± 0.08	0.69 ± 0.04	0.68 ± 0.04
p-Dichlorobenzene	52	57	0.13 ± 0.03	0.08 ± 0.03	0.09 ± 0.03	0.13 ± 0.06	0.18 ± 0.06	0.12 ± 0.03
1,2-Dichloroethane	17	57	1.13 ± 0.67	NR	NR	NR	NR	0.37 ± 0.24
Tetrachloroethylene	54	57	0.26 ± 0.06	0.23 ± 0.14	0.17 ± 0.06	0.26 ± 0.15	0.33 ± 0.12	0.25 ± 0.06
Karnack, Texas - CAMS 85								
Acrolein	50	52	0.43 ± 0.07	0.35 ± 0.15	0.38 ± 0.09	0.42 ± 0.13	0.51 ± 0.16	0.41 ± 0.07
Benzene	52	52	1.15 ± 0.15	1.02 ± 0.20	0.94 ± 0.27	1.38 ± 0.22	1.30 ± 0.44	1.15 ± 0.15
1,3-Butadiene	36	52	0.04 ± 0.02	0.04 ± 0.02	0.02 ± <0.01	0.04 ± 0.05	NR	0.03 ± 0.01
Carbon Tetrachloride	52	52	0.68 ± 0.04	0.65 ± 0.07	0.72 ± 0.07	0.68 ± 0.06	0.65 ± 0.10	0.68 ± 0.04

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations from Table 26-5 include the following:

- The pollutant with the highest daily average concentration by mass was benzene for both sites (1.59 ± 0.32 µg/m^3 for CAMS 35 and 1.15 ± 0.15 µg/m^3 for CAMS 85).

- As shown in Table 4-11, of the program-level pollutants of interest, CAMS 35 had the highest daily average concentration of 1,3-butadiene; third highest daily average concentration of acrylonitrile; and fourth highest daily average concentration of benzene. In addition, CAMS 85 had the fifth highest daily average concentration of acrylonitrile.

- Concentrations of benzene were lowest during the winter and highest during the fall at CAMS 35. Although 1,3-butadiene was highest in the autumn, the very large confidence interval indicates that this average was affected by outliers.

- The concentrations of the pollutants of interest did not vary significantly from season to season at CAMS 85.

- Seasonal averages could not be calculated for acrylonitrile and 1,2-dichloroethane for CAMS 35 due to the low number of detections in each season. An autumn average for 1,3-butadiene could not be calculated for CAMS 85 for the same reason.

26.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one ore more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. The two Texas monitoring sites have not sampled continuously for five years as part of the National Monitoring Program; therefore, the trends analysis was not conducted.

26.5 Pearson Correlations

Table 26-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations from Table 26-6 include the following:

- All of the correlations for CAMS 85 were weak, with one exception. Benzene exhibited a strong negative correlation with the wind speed, indicating that concentrations of this pollutant increase with decreasing wind speed.

- The correlations for CAMS 35 were also weak, with two exceptions. Acrylonitrile exhibited a strong negative correlation with relative humidity, indicating that concentrations of this pollutant increase with decreasing moisture content. However, this correlation was based on 10 measured detections; thus, the correlations may be skewed. *p*-Dichlorobenzene also exhibited a strong negative correlation with the wind speed, indicating that concentrations of this pollutant increase with decreasing wind speed.

Table 26-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Texas Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Deer Park, Texas - CAMS 35								
Acrolein	57	0.25	0.25	0.20	0.23	-0.05	-0.13	-0.12
Acrylonitrile	10	0.02	-0.13	-0.43	-0.33	-0.66	0.26	0.05
Benzene	57	0.23	0.14	0.08	0.10	-0.14	0.11	-0.35
1,3-Butadiene	57	-0.04	-0.09	-0.14	-0.12	-0.17	0.27	-0.02
Carbon Tetrachloride	57	0.23	0.17	0.08	0.12	-0.20	-0.17	0.05
p-Dichlorobenzene	52	0.28	0.18	0.05	0.10	-0.28	-0.05	-0.57
1,2-Dichloroethane	17	0.39	0.38	0.42	0.41	0.07	-0.05	-0.07
Tetrachloroethylene	54	0.05	0.00	-0.01	-0.01	-0.04	0.19	-0.30
Karnack, Texas - CAMS 85								
Acrolein	50	0.09	0.09	0.06	0.07	-0.10	-0.06	0.09
Benzene	52	0.16	0.08	0.04	0.05	-0.11	-0.01	-0.54
1,3-Butadiene	36	0.10	0.08	0.03	0.05	-0.11	-0.03	-0.05
Carbon Tetrachloride	52	0.07	0.07	0.01	0.05	-0.11	-0.11	0.05

26.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at each monitoring site. Refer to Sections 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

26.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Texas monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 26-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein from Table 26-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- For both sites, all of the seasonal averages of acrolein exceeded the intermediate MRL.
- Acrolein has no chronic MRL. Therefore, chronic risk could not be evaluated.

26.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Texas monitoring sites and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and

Table 26-7. MRL Risk Screening Assessment Summary for the Texas Monitoring Sites

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average[1] (µg/m^3)
CAMS 35	TO-15	Acrolein	7.00	0/57	0.09	**0.52 ± 0.20**	**0.44 ± 0.08**	**0.61 ± 0.22**	**0.59 ± 0.10**	--	0.54 ± 0.08
CAMS 85	TO-15	Acrolein	7.00	0/50	0.09	**0.35 ± 0.15**	**0.38 ± 0.09**	**0.42 ± 0.13**	**0.51 ± 0.16**	--	0.41 ± 0.07

BOLD = EPA-designated NATTS Site

BOLD = exceedance of the intermediate or chronic MRL

-- = an MRL risk factor is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

noncancer surrogate risk approximations are presented in Table 26-8. The data from NATA are presented for the census tract where each monitoring site is located. The pollutants of interest for each site are bolded.

The census tract information for the Texas monitoring sites is as follows:

- The census tract for CAMS 35 is 48201342300, which had a population of 6,240 and represented 0.18 percent of the Harris County population in 2000.
- The census tract for CAMS 85 is 48203020102, which had a population of 5,492 and represented approximately nine percent of the Harrison County population in 2000.

Observations for CAMS 35 from Table 26-8 include the following:

- Benzene was the pollutant with the highest concentration according to NATA and among annual averages. The modeled concentration and the annual average for benzene were very similar.
- The pollutants with the highest cancer risks according to NATA were benzene, 1,2-dichloroethane, and acrylonitrile. By contrast, 1,3-butadiene, benzene, and carbon tetrachloride had the highest cancer risk approximations.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA and based on annual averages was acrolein.

Observations for CAMS 85 from Table 26-8 include the following:

- Similar to CAMS 35, benzene was the pollutant with the highest concentration according to NATA and among annual averages, although the modeled concentration was lower than the annual average concentration.
- The pollutants with the highest cancer risks according to NATA were benzene and carbon tetrachloride. Carbon tetrachloride and benzene also had the highest cancer risk approximations.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA and based on the annual average was acrolein. However, the annual average-based approximation (20.56) was an order of magnitude higher than the modeled concentration (1.58).

Table 26-8. Cancer and Noncancer Risk Summary for the Monitoring Sites in Texas

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (µg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Deer Park, Texas (CAMS 35) - Census Tract ID 48201342300								
Acrolein	--	0.00002	0.21	--	10.59	0.54 ± 0.08	--	26.93
Acrylonitrile	0.000068	0.002	0.08	5.23	0.03	0.12 ± 0.07	7.97	0.06
Benzene	0.000007	0.03	1.57	12.23	0.05	1.59 ± 0.32	11.15	0.05
1,3-Butadiene	0.00003	0.002	0.14	4.29	0.07	0.43 ± 0.34	12.76	0.21
Carbon Tetrachloride	0.000015	0.04	0.23	3.50	0.01	0.68 ± 0.04	10.24	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.04	0.49	<0.01	0.12 ± 0.03	1.34	<0.01
1,2-Dichloroethane	0.000026	2.4	0.19	5.04	<0.01	0.37 ± 0.24	9.55	<0.01
Dichloromethane	0.00000047	1	0.47	0.23	<0.01	0.51 ± 0.11	0.24	<0.01
Methyl *tert*-Butyl Ether	--	3	1.36	--	<0.01	0.59 ± 0.36	--	<0.01
Tetrachloroethylene	0.000005	0.27	0.18	1.10	<0.01	0.25 ± 0.06	1.24	<0.01
1,1,2-Trichloroethane	0.000016	0.4	<0.01	0.02	<0.01	0.05 ± <0.01	0.76	<0.01
Vinyl chloride	0.000008	0.1	0.16	1.41	<0.01	0.06 ± 0.02	0.51	<0.01
Karnack, Texas (CAMS 85) - Census Tract ID 48203020102								
Acrolein	--	0.00002	0.03	--	1.58	0.41 ± 0.07	--	20.56
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	0.03 ± 0.01	2.14	0.02
Benzene	0.000007	0.03	0.52	4.11	0.01	1.15 ± 0.15	8.06	0.04
1,3-Butadiene	0.00003	0.002	0.01	0.38	0.01	0.03 ± 0.01	0.96	0.02
Carbon Tetrachloride	0.000015	0.04	0.21	3.12	0.01	0.68 ± 0.04	10.16	0.02
p-Dichlorobenzene	0.000011	0.8	<0.01	0.05	<0.01	0.04 ± <0.01	0.46	<0.01
1,2-Dichloroethane	0.000026	2.4	0.01	0.27	<0.01	0.05 ± 0.01	1.24	<0.01
Tetrachloroethylene	0.000005	0.27	0.01	0.06	<0.01	0.08 ± 0.05	0.41	<0.01
Vinyl chloride	0.000008	0.1	<0.01	0.01	<0.01	0.04 ± 0.01	0.29	<0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

26.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 26-9 and 26-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 26-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 26-10 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risks based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 26.3, the Texas monitoring sites sampled for VOC only. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated. The Texas monitoring sites sampled year-round for the pollutant group mentioned above.

Observations from Table 26-9 include the following:

- Benzene and formaldehyde were the highest emitted pollutants with cancer UREs in both Harris and Harrison Counties, although the quantity of the emissions was much lower in Harrison County (CAMS 85).

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Harris County (CAMS 35) were benzene, 1,3-butadiene, and hexavalent chromium. The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Harrison County (CAMS 85) were hexavalent chromium, ethylene oxide, and benzene.

- Four of the highest emitted pollutants in Harris County (CAMS35) also had the highest toxicity-weighted emissions, while five of the highest emitted pollutants in Harrison County (CAMS 85) also had the highest toxicity-weighted emissions.

Table 26-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Sites in Texas

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Deer Park, Texas (CAMS 35) – Harris County					
Benzene	2,217.79	Benzene	1.73E-02	1,3-Butadiene	12.76
Formaldehyde	1,309.32	1,3-Butadiene	1.51E-02	Benzene	11.15
1,3-Butadiene	504.56	Hexavalent Chromium	6.67E-03	Carbon Tetrachloride	10.24
Dichloromethane	491.73	Naphthalene	3.55E-03	1,2-Dichloroethane	9.55
Acetaldehyde	463.35	Arsenic, PM	3.23E-03	Acrylonitrile	7.96
Tetrachloroethylene	436.54	Tetrachloroethylene	2.58E-03	*p*-Dichlorobenzene	1.34
1,3-Dichloropropene	284.92	Ethylene oxide	2.53E-03	Tetrachloroethylene	1.24
Naphthalene	104.39	1,2-Dichloroethane	1.94E-03	1,1,2-Trichloroethane	0.77
Trichloroethylene	90.55	Cadmium, PM	1.53E-03	Vinyl chloride	0.51
p-Dichlorobenzene	88.48	Acrylonitrile	1.36E-03	Dichloromethane	0.24
Karnack, Texas (CAMS 85) – Harrison County					
Benzene	150.03	Hexavalent Chromium	1.24E-03	Carbon Tetrachloride	10.16
Formaldehyde	55.20	Ethylene oxide	1.23E-03	Benzene	8.06
Acetaldehyde	46.57	Benzene	1.17E-03	Acrylonitrile	2.12
1,3-Butadiene	21.65	1,3-Butadiene	6.49E-04	1,2-Dichloroethane	1.25
Ethylene oxide	13.97	Arsenic, PM	3.73E-04	1,3-Butadiene	0.96
Dichloromethane	11.20	Naphthalene	3.64E-04	*p*-Dichlorobenzene	0.46
Naphthalene	10.71	Cadmium, PM	2.02E-04	Tetrachloroethylene	0.41
Tetrachloroethylene	5.74	Acetaldehyde	1.02E-04	Vinyl chloride	0.29
1,3-Dichloropropene	5.50	Beryllium, PM	9.61E-05		
Trichloroethylene	2.20	Chloromethylbenzene	6.43E-05		

Table 26-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Sites in Texas

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Deer Park, Texas (CAMS 35) – Harris County					
Toluene	5,444.57	Acrolein	2,687,004.98	Acrolein	26.93
Methyl *tert*-butyl ether	5,164.71	Chlorine	1,460,835.50	1,3-Butadiene	0.21
Xylenes	3,632.56	1,3-Butadiene	252,280.21	Acrylonitrile	0.06
Hexane	2,627.18	Formaldehyde	133,604.32	Benzene	0.05
Benzene	2,217.79	Nickel, PM	97,233.43	Carbon Tetrachloride	0.02
Methanol	2,024.57	Manganese, PM	83,395.60	Tetrachloroethylene	<0.01
Hydrochloric acid	1,422.38	Benzene	73,926.48	Vinyl chloride	<0.01
Formaldehyde	1,309.32	Hydrochloric acid	71,119.04	Dichloromethane	<0.01
Ethylbenzene	879.63	Hexamethylene-1,6-diisocyanate, gas	62,650.00	Methyl *tert*-Butyl Ether	<0.01
1,1,1-Trichloroethane	815.29	Acrylic acid	53,518.71	1,2-Dichloroethane	<0.01
Karnack, Texas (CAMS 85) – Harrison County					
Toluene	286.81	Acrolein	200,031.63	Acrolein	20.55
Xylenes	268.44	Chlorine	86,241.00	Benzene	0.04
Ethylene glycol	162.87	Manganese, PM	17,645.94	Carbon Tetrachloride	0.02
Benzene	150.03	Hexamethylene-1,6-diisocyanate, gas	12,040.00	1,3-Butadiene	0.02
Hydrofluoric acid	71.42	Mercury, PM	11,359.43	Acrylonitrile	0.02
Methanol	68.04	1,3-Butadiene	10,824.10	Vinyl chloride	<0.01
Ethylbenzene	67.26	Formaldehyde	5,632.65	Tetrachloroethylene	<0.01
Chloromethane	62.37	Cadmium, PM	5,616.04	*p*-Dichlorobenzene	<0.01
Hexane	59.30	Acetaldehyde	5,174.06	1,2-Dichloroethane	<0.01
Formaldehyde	55.20	Benzene	5,000.83		

- For CAMS 35, 1,3-butadiene, benzene, and carbon tetrachloride had the highest cancer surrogate risk approximations. Benzene and 1,3-butadiene appear on both emissions-based lists, while carbon tetrachloride did not appear on either emissions-based list.

- For CAMS 85, carbon tetrachloride, benzene, and acrylonitrile had the highest cancer surrogate risk approximations. Carbon tetrachloride and acrylonitrile did not appear on either emissions-based list, although benzene did.

Observations from Table 26-10 include the following:

- Toluene was the highest emitted pollutant with a noncancer RfC in both counties, although it did not appear on the lists of highest toxicity weighted emissions or noncancer risk approximations.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties were acrolein and chlorine.

- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions for Harris County (CAMS 35), while two of the highest emitted pollutants also had the highest toxicity-weighted emissions for Harrison County (CAMS 85).

- The pollutant with the highest noncancer risk approximation was acrolein for both sites. Acrolein was also the pollutant with the highest toxicity-weighted emissions for both counties, yet this pollutant's emissions ranked 33rd in Harris County (CAMS 35) and 29th in Harrison County (CAMS 85).

26.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- ❖ *The pollutants of interest common to each Texas monitoring site were acrolein, benzene, 1,3-butadiene, and carbon tetrachloride.*

- ❖ *Benzene had the highest daily average concentration for both of the sites.*

- ❖ *Seasonal averages of acrolein exceeded the intermediate MRL health benchmark for both sites.*

27.0 Site in Utah

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Utah, and integrates these concentrations with emissions, meteorological, and risk information.

27.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The Utah site is located in the Ogden-Clearfield, UT MSA. Figure 27-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its urban location. Figure 27-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 27-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

BTUT is located in Bountiful, in northern Utah. Bountiful is north of Salt Lake City, and is situated in a valley between the Great Salt Lake to the west and the Wasatch Mountains to the east. Figure 27-1 shows that BTUT is located on the property of Viewmont High School, in a primarily residential area. The site is located about a quarter of a mile from I-15, which runs north-south through most of the surrounding urban area including Salt Lake City, Clearfield, and Ogden. Figure 27-2 shows that most of the emission sources near the Bountiful site are located to the south of the site. A number of these emission sources are involved in processes utilizing fuel combustion, petroleum and natural gas production and refining, and fabricated metal production.

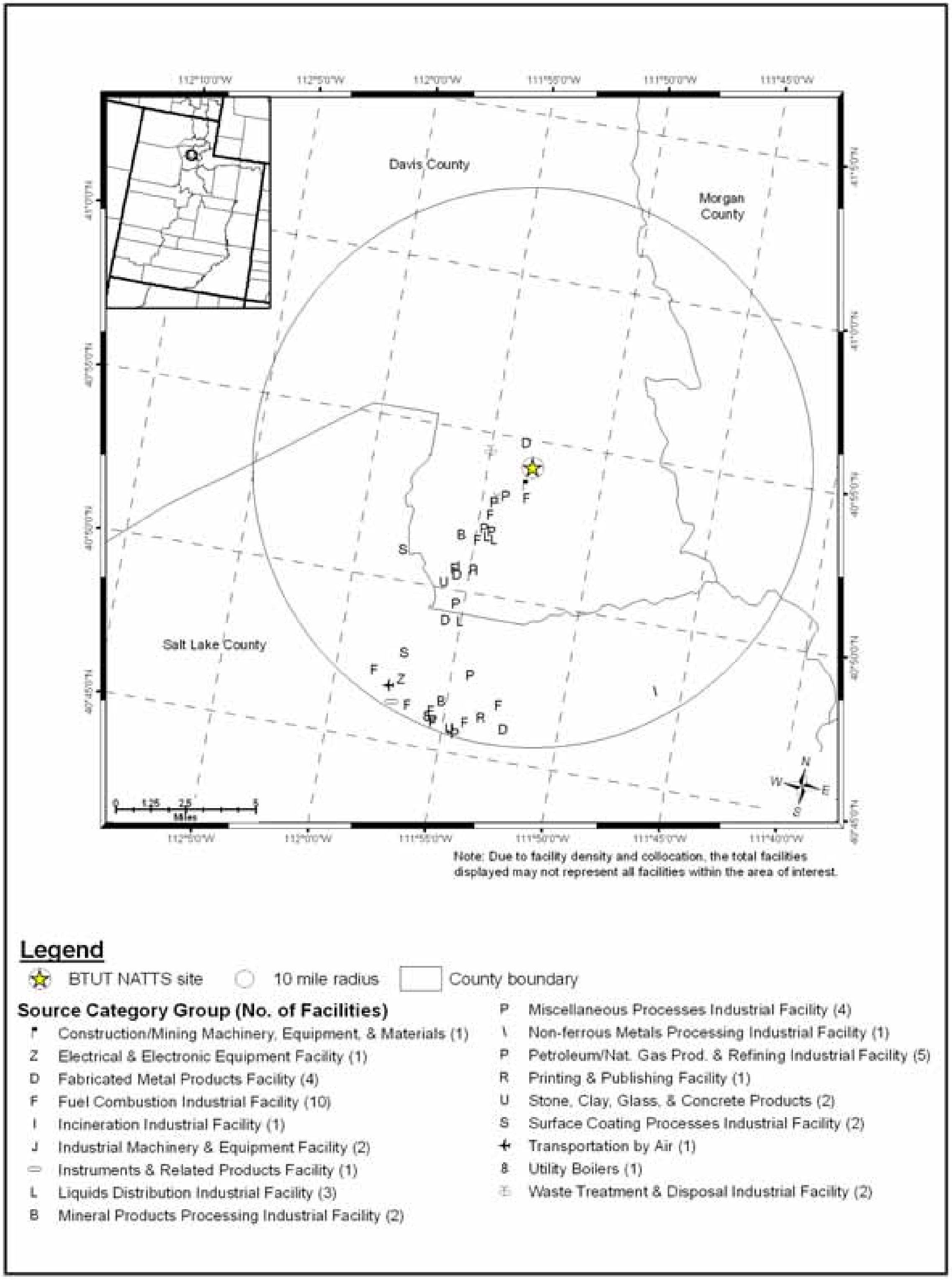
Table 27-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Utah monitoring site. County-level vehicle registration and population data for Davis County, Utah were obtained from the Utah Tax Commission and the U.S. Census Bureau. Table 27-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the

Figure 27-1. Bountiful, Utah (BTUT) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 100m

Figure 27-2. NEI Point Sources Located Within 10 Miles of BTUT



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 27-1. Geographical Information for the Utah Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
BTUT	49-011-0004	Bountiful	Davis	Ogden-Clearfield, UT	40.902967, -111.884467	Residential	Suburban	The Bountiful Viewmont site is located in a suburban area of the Ogden-Clearfield MSA, at 171 West 1370 North in Bountiful, Utah. This site is a relocation of the BOUT site, which was about 1.1 miles south of the new site. The site is located on the grounds of Viewmont High School, adjacent to a parking lot, tennis courts, and a football field. The surrounding neighborhood is made up of residential properties. BTUT is a SLAMS neighborhood-scale site for monitoring population exposure to SO_2, CO, NO_2, and $PM_{2.5}$; and a NAMS neighborhood-scale site for monitoring maximum ozone concentrations. Speciated $PM_{2.5}$ sampling, meteorological monitoring, and NATTS air toxics sampling are also done at the Bountiful Viewmont site. Several petroleum refineries are located two to five miles away from the site, as are several sand and gravel mining operations.

BOLD = EPA-designated NATTS Site

Table 27-2. Population, Motor Vehicle, and Traffic Information for the Utah Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
BTUT	288,146	230,868	0.80	251,597	201,584	17,310	10,373

[1] Daily Average Traffic Data reflects 2006 data from the Utah DOT

BOLD = EPA-designated NATTS Site

population within 10 miles of the site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 27-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 27-2 presents the daily VMT for the urban area.

Observations from Table 27-2 include the following:

- Davis County's population was in the middle of the range, as was its 10-mile population, compared to all counties with NATTS or UATMP sites.
- The county-level vehicle registration and 10-mile ownership estimated both ranked 33rd compared to all counties with NATTS or UATMP sites.
- The vehicle per person ratio was slightly below average (0.90) compared to other NATTS or UATMP sites.
- The traffic volume experienced near BTUT was in the mid-to-low range compared to other monitoring sites. The traffic estimate used came from I-15 near 500 West.
- The Ogden-Layton area VMT was the sixth lowest among urban areas with UATMP or NATTS sites.

27.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Utah on sampling days, as well as over the course of the year.

27.2.1 Climate Summary

The Salt Lake City area has a semi-arid continental climate, with large seasonal variations. The area is dry, located on the west side of the Wasatch Mountains, and the Great

Salt Lake tends to have a moderating influence on the city's temperature. Moderate winds flow out of the southeast on average (Ruffner and Bair, 1987).

27.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air concentration measurements. The closest NWS weather station is located at Salt Lake City International Airport (WBAN 24127).

Table 27-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 27-3 is the 95 percent confidence interval for each parameter. As shown in Table 27-3, average meteorological conditions on sampling days appear warmer than the entire year. Extra samples were collected in June and August, which may explain this difference.

27.2.3 Composite Back Trajectories for Sampling Days

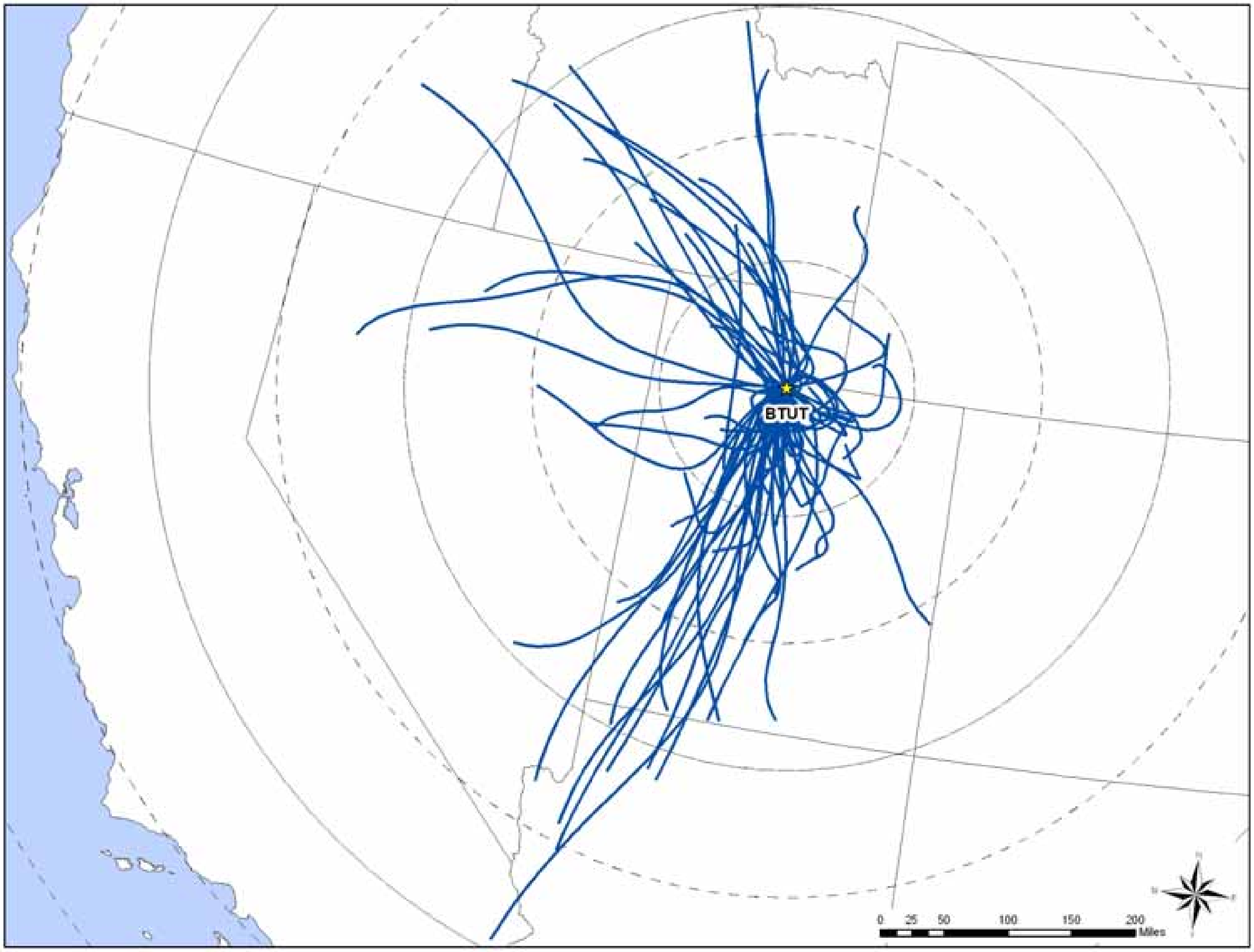
Figure 27-3 is the composite back trajectory map for the Utah monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 27-3 represents 100 miles.

Table 27-3. Average Meteorological Conditions near the Utah Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
BTUT	Salt Lake City International 24127	Sampling Day	68.16 ± 5.40	57.05 ± 5.00	32.21 ± 2.47	44.31 ± 3.16	47.74 ± 5.01	1014.48 ± 2.01	7.58 ± 0.73
		All 2007	64.70 ± 2.37	54.08 ± 2.16	31.44 ± 1.10	42.62 ± 1.39	50.66 ± 2.14	1015.39 ± 0.87	6.99 ± 0.30

BOLD = EPA-designated NATTS Site

Figure 27-3. Composite Back Trajectory Map for BTUT



Observations from Figure 27-3 include the following:

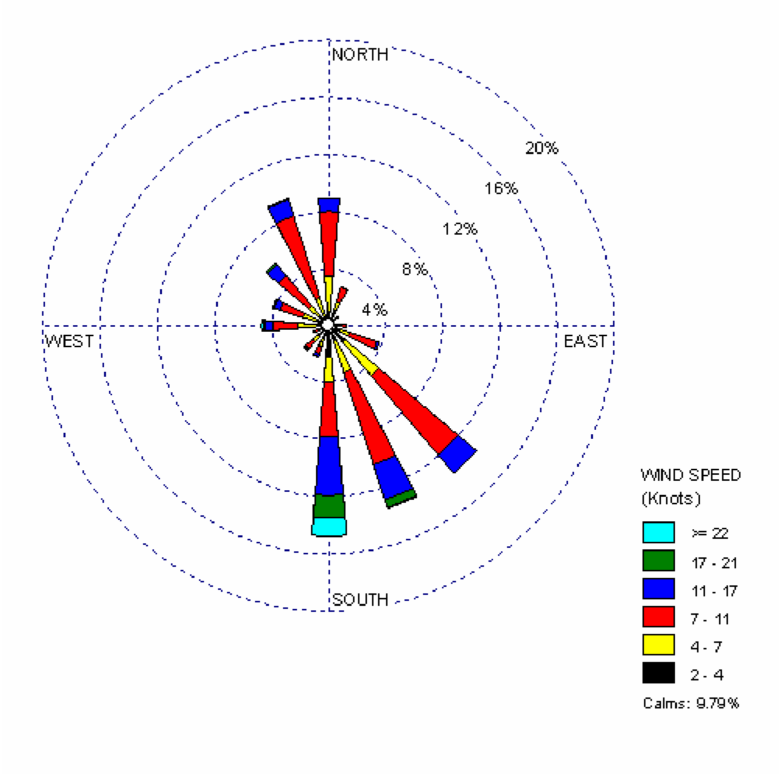
- Back trajectories originated from a variety of directions at BTUT. The majority of trajectories originated from the south and southwest, although another cluster of trajectories originated from the northwest.

- The 24-hour air shed domain for BTUT was slightly smaller in size compared to other monitoring sites. The furthest away a trajectory originated was southern California, nearly 500 miles away. However, most trajectories originated within 300 miles of the site.

27.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at the Salt Lake City International Airport near BTUT were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce a customized wind rose. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 27-4 is the wind rose for the Utah monitoring site on days that samples were collected.

Figure 27-4. Wind Rose for BTUT Sampling Days



Observations from Figure 27-4 for BTUT include the following:

- Although winds from a variety of directions were observed near BTUT, southerly and southeasterly winds were prevalent near BTUT.

- Calm winds were observed for nearly 10 percent of the hourly measurements.

- Winds exceeding 11 knots made up nearly 18 percent of observations. The strongest winds were generally out of the south.

27.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Utah monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 27-4 presents the pollutants that failed at least one screen for the Utah monitoring site and highlights the site's pollutants of interest (shaded). BTUT sampled for VOC, carbonyls, SNMOC, metals (PM_{10}), and hexavalent chromium.

Observations from Table 27-4 include the following:

- Seventeen pollutants with a total of 499 measured concentrations failed at least one screen for BTUT.

- Eleven pollutants were identified as pollutants of interest for BTUT: acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, cadmium, carbon tetrachloride, *p*-dichlorobenzene, formaldehyde, manganese, and tetrachloroethylene.

- Of the eleven pollutants of interest, acetaldehyde, acrolein, benzene, and carbon tetrachloride failed 100 percent of screens.

- Sixty-four percent of measured detections failed screens (of the pollutants that failed at least one screen) for BTUT.

Table 27-4. Comparison of Measured Concentrations and EPA Screening Values for the Utah Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Bountiful, Utah - BTUT					
Acetaldehyde	60	60	100.00	12.02	12.02
Formaldehyde	58	60	96.67	11.62	23.65
Acrolein	55	55	100.00	11.02	34.67
Benzene	55	55	100.00	11.02	45.69
Carbon Tetrachloride	55	55	100.00	11.02	56.71
Arsenic (PM_{10})	52	57	91.23	10.42	67.13
1,3-Butadiene	50	54	92.59	10.02	77.15
Manganese (PM_{10})	42	57	73.68	8.42	85.57
Tetrachloroethylene	27	52	51.92	5.41	90.98
p-Dichlorobenzene	17	47	36.17	3.41	94.39
Cadmium (PM_{10})	8	57	14.04	1.60	95.99
Nickel (PM_{10})	8	57	14.04	1.60	97.60
Hexavalent Chromium	5	53	9.43	1.00	98.60
Acrylonitrile	4	4	100.00	0.80	99.40
1,2-Dichloroethane	1	1	100.00	0.20	99.60
Toluene	1	55	1.82	0.20	99.80
1,1,2,2-Tetrachloroethane	1	1	100.00	0.20	100.00
Total	499	780	63.97		

27.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Utah monitoring site. The averages presented are provided for the pollutants of interest for the site. Complete site-specific summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

27.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 27-5, where applicable.

Table 27-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Utah Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	Annual Average[1] (µg/m^3)
Bountiful, Utah - BTUT								
Acetaldehyde	60	60	2.24 ± 0.54	2.20 ± 0.99	1.43 ± 0.30	2.43 ± 0.62	2.85 ± 1.74	2.24 ± 0.54
Acrolein	55	55	0.59 ± 0.09	0.34 ± 0.13	0.52 ± 0.16	0.73 ± 0.16	0.75 ± 0.21	0.59 ± 0.09
Arsenic (PM$_{10}$)	57	57	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Benzene	55	55	1.29 ± 0.23	1.56 ± 0.73	0.90 ± 0.19	1.12 ± 0.28	1.71 ± 0.38	1.29 ± 0.23
1,3-Butadiene	54	55	0.11 ± 0.03	0.17 ± 0.08	0.07 ± 0.02	0.06 ± 0.01	0.14 ± 0.04	0.10 ± 0.03
Cadmium (PM$_{10}$)	57	57	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Carbon Tetrachloride	55	55	0.55 ± 0.03	0.51 ± 0.05	0.56 ± 0.08	0.58 ± 0.06	0.56 ± 0.04	0.55 ± 0.03
p-Dichlorobenzene	47	55	0.25 ± 0.16	0.11 ± 0.06	0.14 ± 0.14	0.12 ± 0.09	0.57 ± 0.54	0.22 ± 0.14
Formaldehyde	60	60	3.48 ± 0.83	2.70 ± 0.99	2.16 ± 0.40	5.09 ± 1.91	3.67 ± 2.01	3.48 ± 0.83
Manganese (PM$_{10}$)	57	57	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.02 ± <0.01	0.01 ± <0.01	0.01 ± <0.01
Nickel (PM$_{10}$)	57	57	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Tetrachloroethylene	52	55	0.34 ± 0.15	0.30 ± 0.15	0.20 ± 0.09	0.18 ± 0.09	0.68 ± 0.59	0.32 ± 0.15

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for BTUT from Table 27-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (3.48 ± 0.83 µg/m^3), acetaldehyde (2.24 ± 0.54 µg/m^3), and benzene (1.29 ± 0.23 µg/m^3). The annual averages for these pollutants were the same as their respective daily averages.

- As shown in Tables 4-9 through 4-11, of the program-level pollutants of interest, the following pollutants for BTUT were among the 10 highest average concentrations for all NATTS and UATMP sites: benzene, 1,3-butadiene, *p*-dichlorobenzene, tetrachloroethylene, arsenic, and manganese.

- Concentrations of 1,3-butadiene were higher in the winter and autumn. Although formaldehyde concentrations appear highest in the summer and autumn, the large confidence intervals indicate that the difference is not significant. This is also true of the autumn *p*-dichlorobenzene and tetrachloroethylene average concentrations. Most of the concentrations of the pollutants of interest for BTUT did not vary significantly by season.

27.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. BTUT has sampled carbonyls, VOC, metals, and SNMOC under the UATMP and/or NATTS since 2003. Figures 27-5 through 25-9 present the three-year rolling statistical metrics graphically for arsenic, benzene (TO-15 and SNMOC methods), 1,3-butadiene, and formaldehyde for BTUT, respectively. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Observations from Figure 27-5 for arsenic measurements include the following:

- The maximum arsenic concentration shown was measured in 2004. The maximum concentration measured in 2004 was nearly twice the next highest concentration. The three highest measurements since sampling began in 2003, were all measured in 2004.

- Overall, the central tendency did not vary significantly, as indicated by the closeness of the first and third quartiles, the median, and the average concentrations.

- The average concentration is very similar to the third quartile for each time period shown. Given that the third quartile represents the value below which 75 percent of concentrations fall below, the average shown for each period was likely influenced by outliers, such as the maximum concentrations shown for each period.

- The rolling average concentrations of arsenic have decreased over the time periods shown.

- All but one arsenic concentration reported to AQS over the five years of sampling were measured detections.

Figure 27-5. Three-Year Rolling Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BTUT

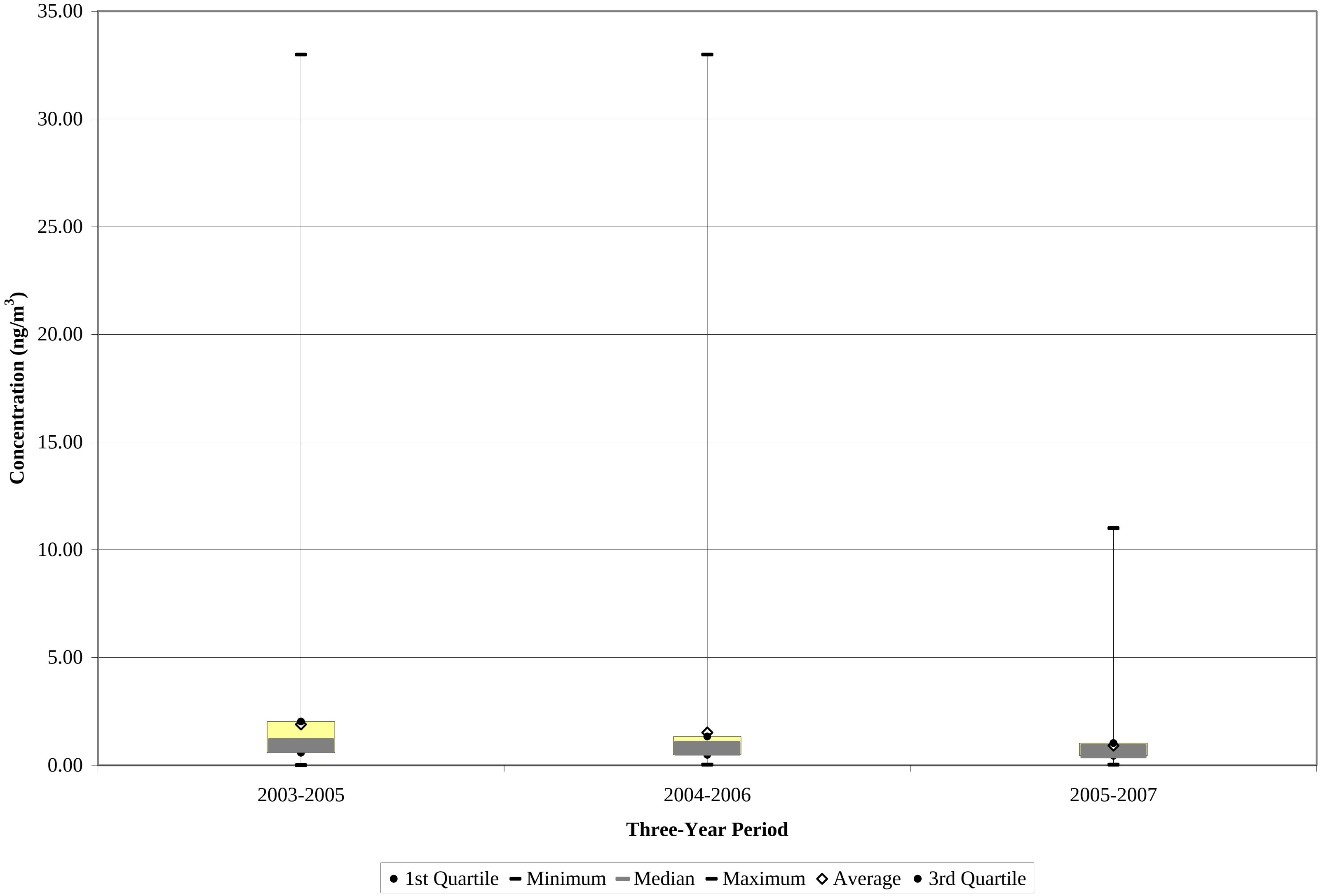


Figure 27-6. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at BTUT (SNMOC)

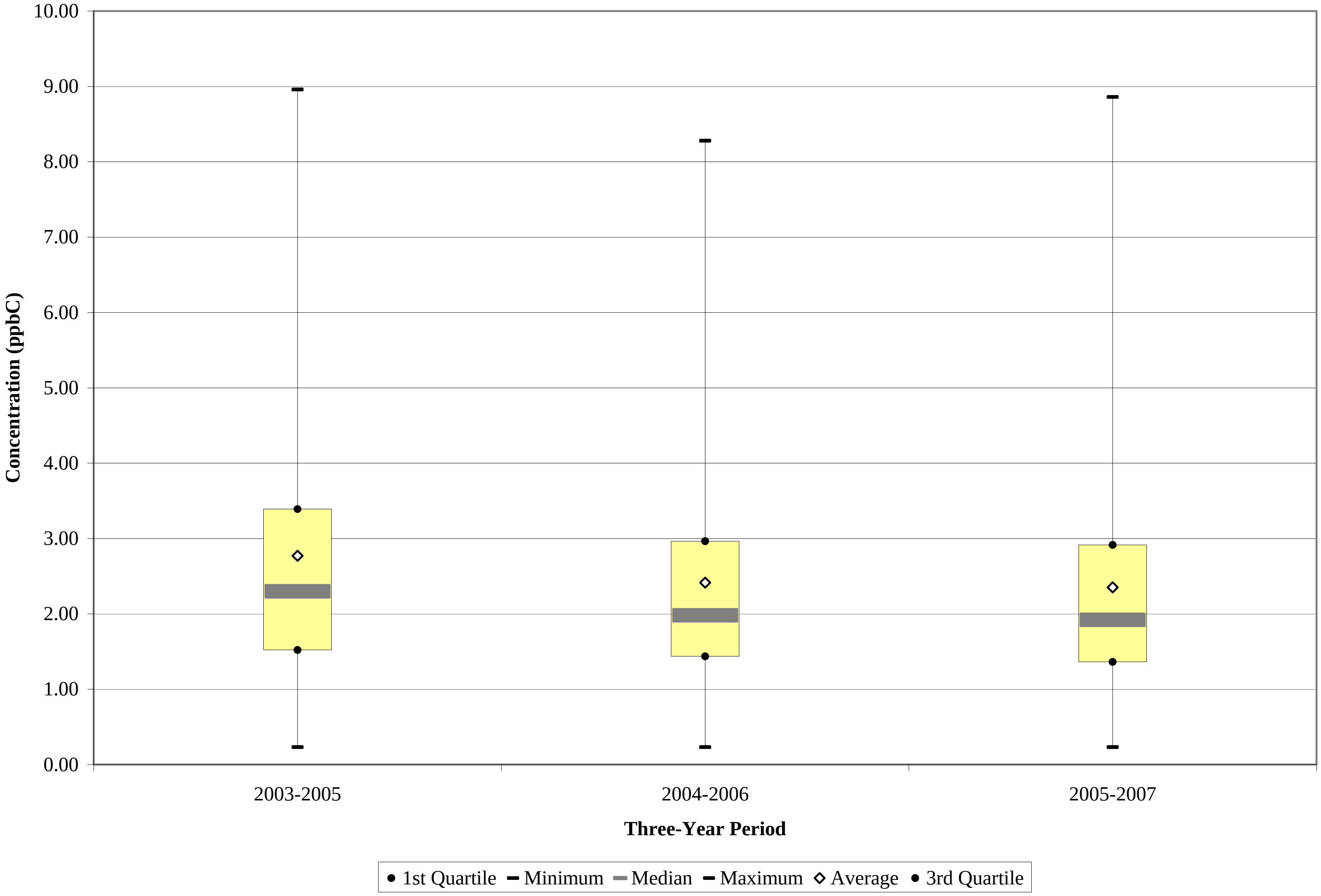


Figure 27-7. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at BTUT (TO-15)

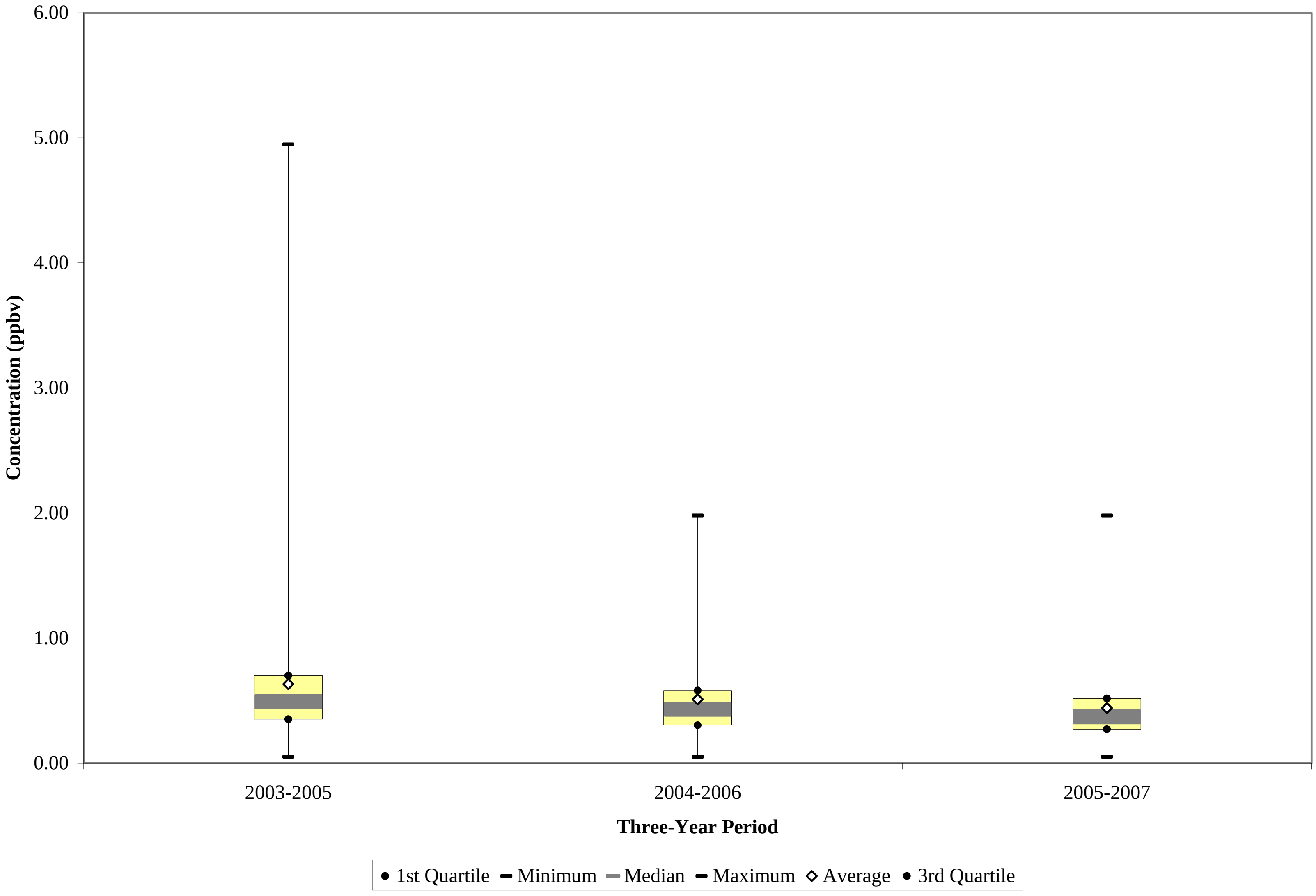


Figure 27-8. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at BTUT

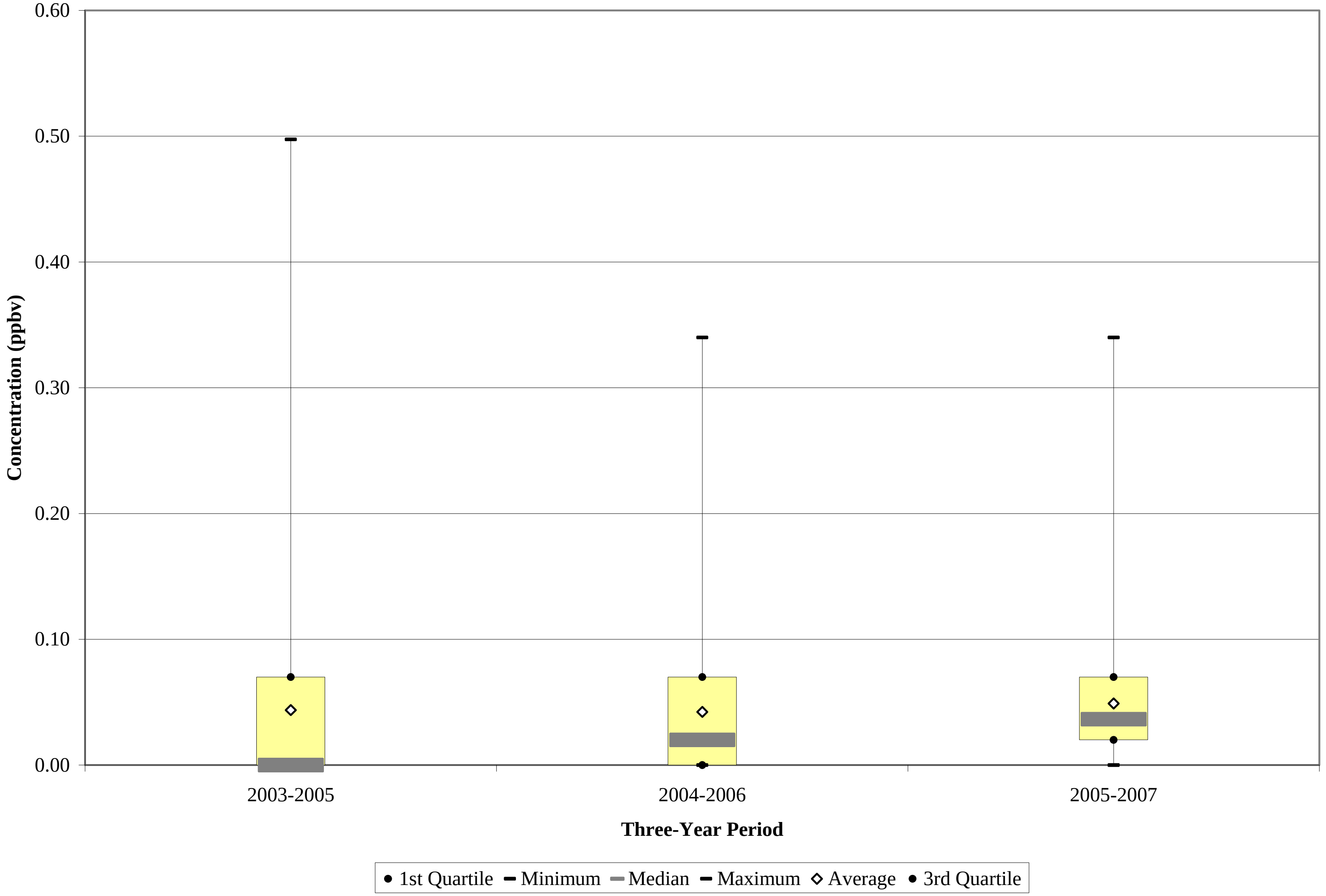
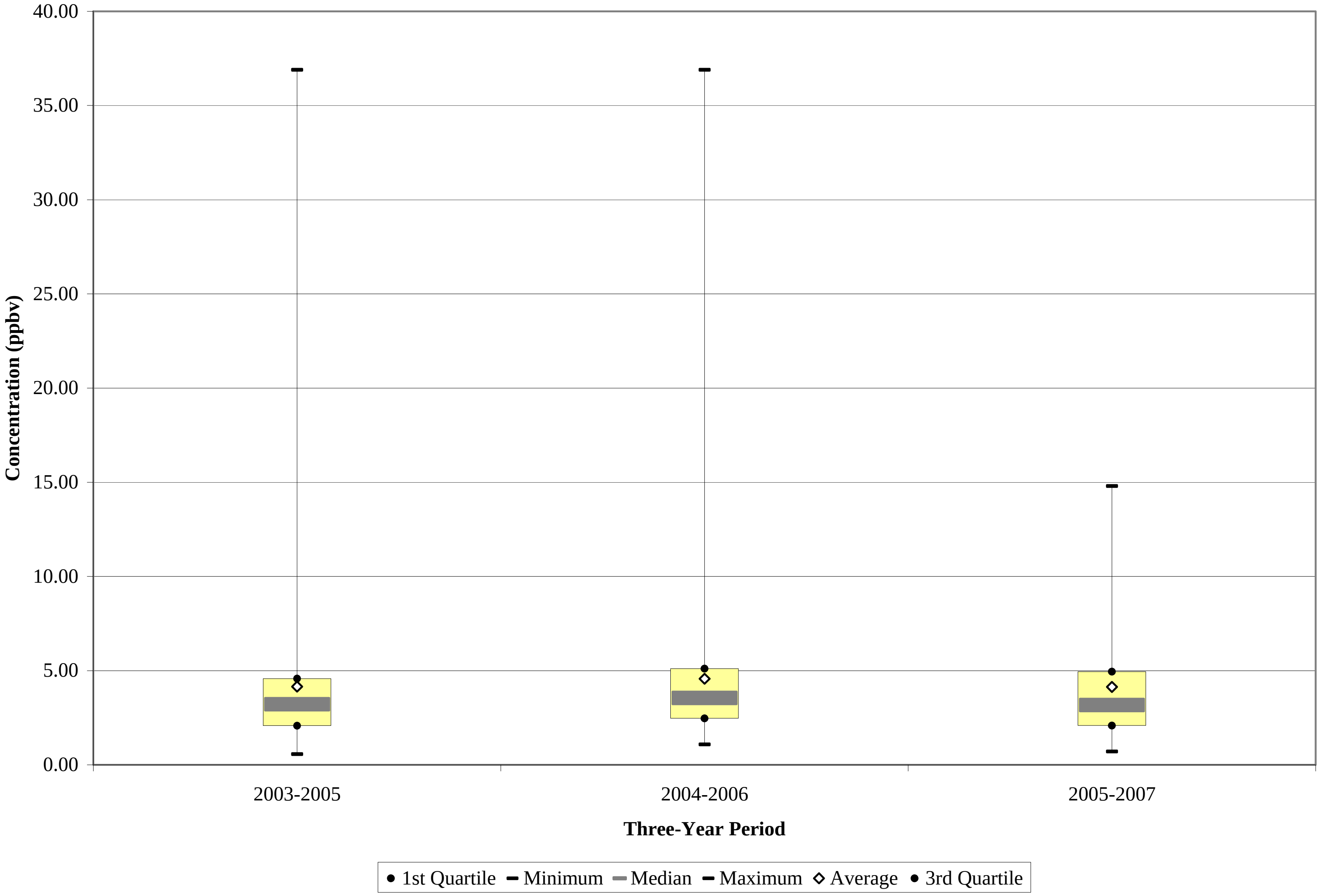


Figure 27-9. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at BTUT



Observations from Figure 27-6 for benzene (as measured by the SNMOC method) include the following:

- The range of benzene concentrations is similar for each time period.
- The median, first and third quartiles, and rolling average concentrations have decreased slightly over the time periods shown. However, the calculation of confidence intervals shows that the decrease is not significant.
- All benzene concentrations reported to AQS over the five years of sampling were measured detections.

Observations from Figure 27-7 for benzene (as measured by the TO-15 method) include the following:

- Compared to benzene measurements from the SNMOC method, the central tendency is less variable for the Method TO-15 measurements, as indicated by the closeness of the first and third quartiles, the median, and the average concentrations.
- The maximum benzene concentration from the 2003-2005 time frame is more than double the maximum benzene concentrations from the 2004-2006 and 2005-2007 time frames.
- Similar to the benzene measurements from the SNMOC method, the median, first and third quartiles, and rolling average concentrations have decreased slightly over the time periods shown. However, the calculation of confidence intervals shows that the decrease is significant.
- All benzene concentrations reported to AQS over the five years of sampling were measured detections.

Observations from Figure 27-8 for 1,3-butadiene measurements include the following:

- The plot for 1,3-butadiene is similar to plots of 1,3-butadiene for other program sites.
- The minimum, first quartile, and median concentrations for 1,3-butadiene were zero for the 2003-2005 time frame. As the MDL for 1,3-butadiene improved (i.e., decreased), the detection rate for this pollutant increased, and a larger spread between the metrics is observed. This pollutant was detected in 43 percent of samples during the 2003-2005 time frame; 57 percent of samples during 2004-2006; and 82 percent of samples during 2005-2007.
- The median and rolling average concentrations show a slight increase over the time frames due to the inclusion of less zeros.

Observations from Figure 27-9 for formaldehyde measurements include the following:

- The maximum formaldehyde concentration shown was measured in 2004, and is more than twice the second highest concentration, which is the maximum concentration shown for the 2005-2007 period.
- The rolling average concentration increased slightly from 2003-2005 to 2004-2006, then decreased to the previous level in 2005-2007. This is also true of the median concentration.
- All formaldehyde concentrations reported to AQS over the five years of sampling were measured detections.

27.5 Pearson Correlations

Table 27-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for BTUT from Table 27-6 include the following:

- Most of the correlations between the pollutants of interest and the meteorological parameters for BTUT were weak.
- The exceptions include the strong positive correlations calculated between manganese and the temperature and moisture parameters (except relative humidity). This indicates that as temperature and moisture content increase, concentrations of manganese also increase.
- 1,3-Butadiene exhibited a strong positive correlation with sea level pressure, indicating that concentrations of this pollutant increase with increasing surface pressure.
- Benzene and 1,3-butadiene both exhibited strong negative correlations with wind speed. In addition, all but one of the pollutants of interest exhibited negative correlations with wind speed, suggesting that concentrations of the pollutants of interest may increase as wind speeds decrease.

27.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the monitoring site. Refer to Sections 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

Table 27-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Utah Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Bountiful, Utah - BTUT								
Acetaldehyde	60	-0.04	-0.06	-0.02	-0.06	0.06	0.30	-0.35
Acrolein	55	0.31	0.28	0.39	0.33	-0.20	0.00	-0.28
Arsenic (PM_{10})	57	-0.25	-0.28	-0.19	-0.28	0.31	0.32	-0.45
Benzene	55	-0.14	-0.19	-0.03	-0.16	0.25	0.37	-0.55
1,3-Butadiene	54	-0.41	-0.45	-0.30	-0.43	0.45	0.59	-0.52
Cadmium (PM_{10})	57	0.06	0.03	-0.03	0.02	-0.04	0.07	-0.05
Carbon Tetrachloride	55	0.12	0.15	0.12	0.15	-0.17	-0.20	0.12
p-Dichlorobenzene	47	0.11	0.09	0.14	0.11	-0.02	0.02	-0.16
Formaldehyde	60	0.17	0.18	0.08	0.15	-0.18	0.04	-0.16
Manganese (PM_{10})	57	0.56	0.53	0.42	0.51	-0.47	-0.17	-0.11
Nickel (PM_{10})	57	-0.08	-0.07	0.11	-0.02	0.24	-0.11	0.00
Tetrachloroethylene	52	0.12	0.09	0.12	0.10	-0.04	0.05	-0.17

27.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Utah monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 27-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk values.

Observations about acrolein from Table 27-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- All of the seasonal averages of acrolein exceeded the intermediate MRL.
- Acrolein has no chronic MRL. Therefore, a chronic risk comparison could not be conducted.

27.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Utah monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 27-8. The data from NATA are presented for the census tract where the monitoring site is located. The pollutants of interest for the site are bolded.

Table 27-7. MRL Risk Screening Assessment Summary for the Utah Monitoring Site

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average[1] (µg/m^3)
BTUT	TO-15	Acrolein	7.00	0/55	0.09	**0.34 ± 0.13**	**0.52 ± 0.16**	**0.73 ± 0.16**	**0.75 ± 0.21**	--	0.59 ± 0.09

BOLD = EPA-designated NATTS Site
BOLD = exceedance of the intermediate or chronic MRL
-- = an MRL risk factor is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 27-8. Cancer and Noncancer Risk Summary for the Monitoring Site in Utah

			1999 NATA			2007 NATTS/UATMP		
Pollutant	**Cancer URE (µg/m^3)**	**Noncancer RfC (mg/m^3)**	**Modeled Concentration (µg/m^3)**	**Cancer Risk (in-a-million)**	**Noncancer Risk (HQ)**	**Annual Average[1] (µg/m^3)**	**Cancer Risk Approximation (in-a-million)**	**Noncancer Risk Approximation (HQ)**
Bountiful, Utah (BTUT) - Census Tract ID 49011126600								
Acetaldehyde	0.000002	0.009	1.13	2.52	0.12	2.24 ± 0.54	4.47	0.25
Acrolein	--	0.00002	0.08	--	4.04	0.59 ± 0.09	--	29.35
Acrylonitrile	0.000068	0.002	<0.01	0.05	<0.01	0.04 ± 0.01	2.46	0.02
Arsenic (PM_{10})	0.0043	0.00003	<0.01	1.22	0.01	<0.01 ± <0.01	4.55	0.04
Benzene	0.000007	0.03	1.52	11.87	0.05	1.29 ± 0.23	9.04	0.04
1,3-Butadiene	0.00003	0.002	0.11	3.37	0.05	0.10 ± 0.03	3.13	0.05
Cadmium (PM_{10})	0.0018	0.00002	<0.01	0.11	<0.01	<0.01 ± <0.01	0.51	0.01
Carbon Tetrachloride	0.000015	0.04	0.21	3.15	0.01	0.55 ± 0.03	8.30	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.36	<0.01	0.22 ± 0.14	2.42	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.71	<0.01	0.04 ± <0.01	1.10	<0.01
Formaldehyde	5.5E-09	0.0098	1.23	0.01	0.12	3.48 ± 0.83	0.02	0.36
Hexavalent Chromium	0.012	0.0001	<0.01	0.68	<0.01	<0.01 ± <0.01	0.37	<0.01
Manganese (PM_{10})	--	0.00005	<0.01	--	0.01	0.01 ± <0.01	--	0.20
Nickel (PM_{10})	0.00016	0.000065	<0.01	0.05	<0.01	<0.01 ± <0.01	0.31	0.03
1,1,2,2-Tetrachloroethane	0.000058	--	0.04	2.40	--	0.05 ± <0.01	3.15	--
Tetrachloroethylene	0.000005	0.27	0.11	0.68	<0.01	0.32 ± 0.15	1.61	<0.01
Toluene	--	0.4	3.25	--	0.01	5.34 ± 3.45	--	0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

The census tract information for the Utah monitoring site is as follows:

- The census tract for BTUT is 49011126600.
- This census tract had a population of 5,116, which represented approximately 2.1 percent of the county population in 2000.

Observations for BTUT from Table 27-8 include the following:

- The pollutants with the highest concentrations according to NATA were toluene, benzene, and formaldehyde.
- The pollutants with the highest cancer risks according to NATA were benzene, 1,3-butadiene, and carbon tetrachloride.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (4.04).
- The pollutants with the highest annual averages were toluene, formaldehyde, and acetaldehyde.
- The pollutants with the highest cancer risk approximations were benzene, carbon tetrachloride, and arsenic. The cancer risk approximation for benzene was similar to the cancer risk estimate from NATA.
- Similar to the NATA results, acrolein was the only pollutant with a noncancer risk approximation greater than 1.0. However, the noncancer risk approximation was an order of magnitude higher than NATA.

27.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 27-9 and 27-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 27-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 27-10 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer tables.

Table 27-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Utah

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Bountiful, Utah (BTUT) – Davis County					
Benzene	233.83	Benzene	1.82E-03	Benzene	9.04
Formaldehyde	77.82	1,3-Butadiene	6.38E-04	Carbon Tetrachloride	8.30
Acetaldehyde	30.72	Naphthalene	1.46E-04	Arsenic	4.55
Dichloromethane	29.18	Hexavalent Chromium	8.77E-05	Acetaldehyde	4.47
1,3-Butadiene	21.27	Tetrachloroethylene	7.93E-05	1,1,2,2-Tetrachloroethane	3.16
Tetrachloroethylene	13.44	Acetaldehyde	6.76E-05	1,3-Butadiene	3.13
p-Dichlorobenzene	5.35	*p*-Dichlorobenzene	5.89E-05	Acrylonitrile	2.45
Naphthalene	4.29	POM, Group 2	5.64E-05	*p*-Dichlorobenzene	2.42
Trichloroethylene	2.90	Acrylonitrile	3.05E-05	Tetrachloroethylene	1.61
POM, Group 2	1.03	Arsenic, PM	2.85E-05	1,2-Dichloroethane	1.11

Table 27-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Utah

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Bountiful, Utah (BTUT) – Davis County					
Toluene	672.00	Acrolein	235,092.14	Acrolein	29.35
Xylenes	488.76	Hexamethylene-1,6-diisocyanate, gas	12,645.00	Formaldehyde	0.36
Benzene	233.83	1,3-Butadiene	10,636.72	Acetaldehyde	0.25
Hexane	114.98	Manganese, PM	9,089.83	Manganese	0.20
Ethylbenzene	105.71	Formaldehyde	7,941.13	1,3-Butadiene	0.05
Methanol	93.60	Benzene	7,794.19	Benzene	0.04
Methyl isobutyl ketone	87.02	Xylenes	4,887.58	Arsenic	0.04
Formaldehyde	77.82	Chlorine	4,710.00	Nickel	0.03
1,1,1-Trichloroethane	51.70	Cyanide Compounds, gas	3,913.33	Acrylonitrile	0.02
Glycol ethers, gas	39.55	Acetaldehyde	3,413.50	Cadmium	0.01

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 27.3, BTUT sampled for VOC, carbonyls, SNMOC, metals (PM_{10}), and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 27-9 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Davis County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, 1,3-butadiene, and naphthalene.
- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- Benzene was the highest emitted pollutant, had the highest toxicity-weighted emissions, and had the highest cancer risk approximation. Carbon tetrachloride and arsenic had the second and third highest cancer surrogate risk approximations. Carbon tetrachloride appeared on neither emissions-based list, while arsenic had the tenth highest toxicity-weighted emissions.

Observations from Table 27-10 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Davis County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, hexamethylene-1,6-diisocyanate (gas), and 1,3-butadiene.
- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- Acrolein, which had the highest noncancer risk approximation, also had the highest toxicity-weighted emissions.

27.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *The pollutants of interest for BTUT were acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, cadmium, carbon tetrachloride, p-dichlorobenzene, formaldehyde, manganese, and tetrachloroethylene.*

- *Formaldehyde had the highest daily average concentration among the pollutants of interest.*

- *Seasonal averages of acrolein exceeded the ATSDR intermediate MRL health benchmark.*

28.0 Site in Vermont

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Vermont, and integrates these concentrations with emissions, meteorological, and risk information.

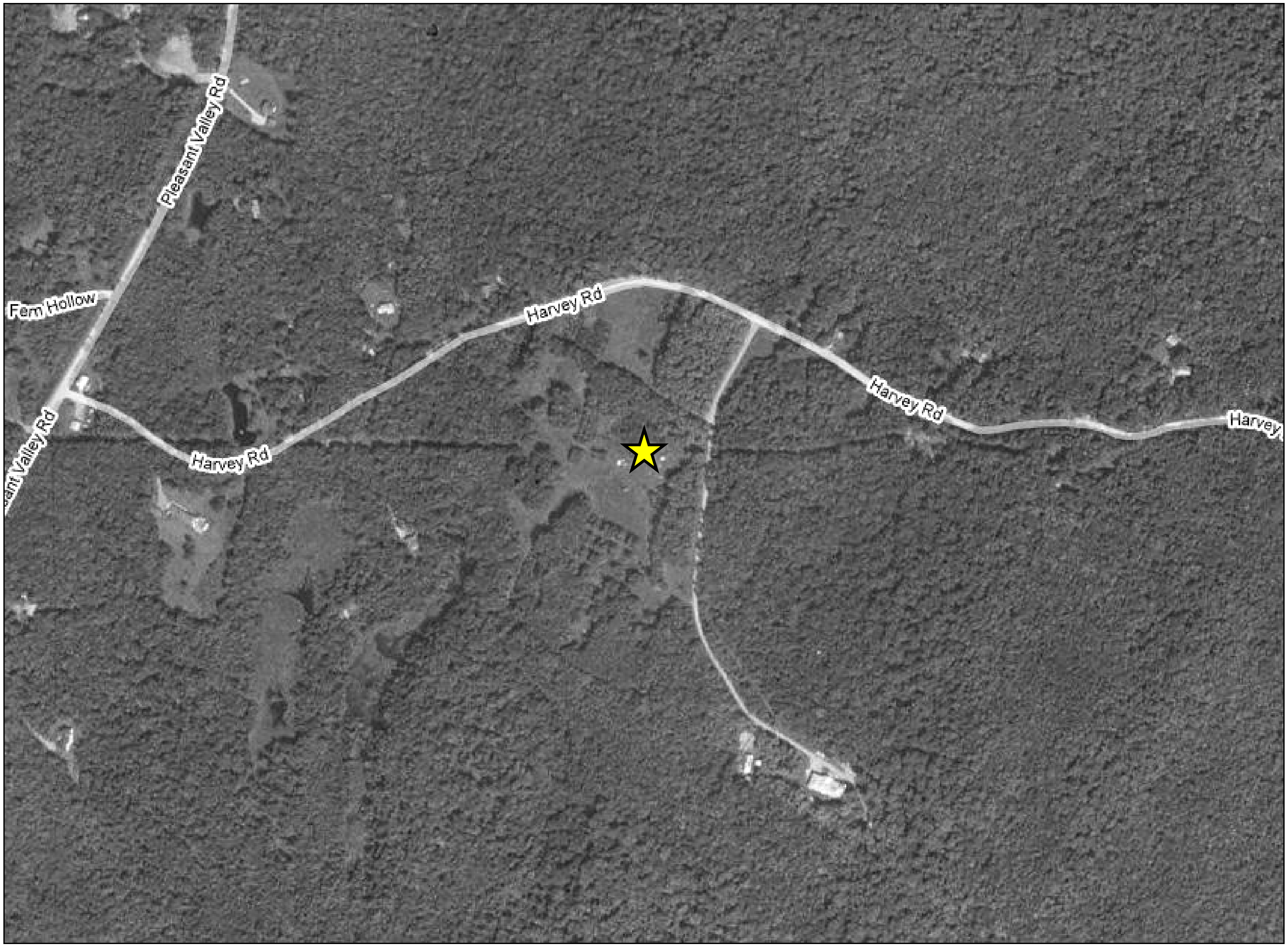
28.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The Vermont site is located in the Burlington-South Burlington, VT MSA. Figure 28-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its rural location. Figure 28-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 28-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

The UNVT monitoring is located on the Proctor Maple Research Farm in Underhill, Vermont, east of the Burlington area. Mount Mansfield, the highest peak in Vermont, lies to the east in Underhill State Park, less than three miles away. The Underhill Artillery Range is a few miles to the south. Figure 28-1 shows that the area surrounding the site is rural in nature and heavily forested. This site is intended to serve as a background site for the region for trends assessment, standards compliance, and long-range transport assessment. As Figure 28-2 shows, UNVT is located near only four point sources. These emission sources are involved in a variety of activities.

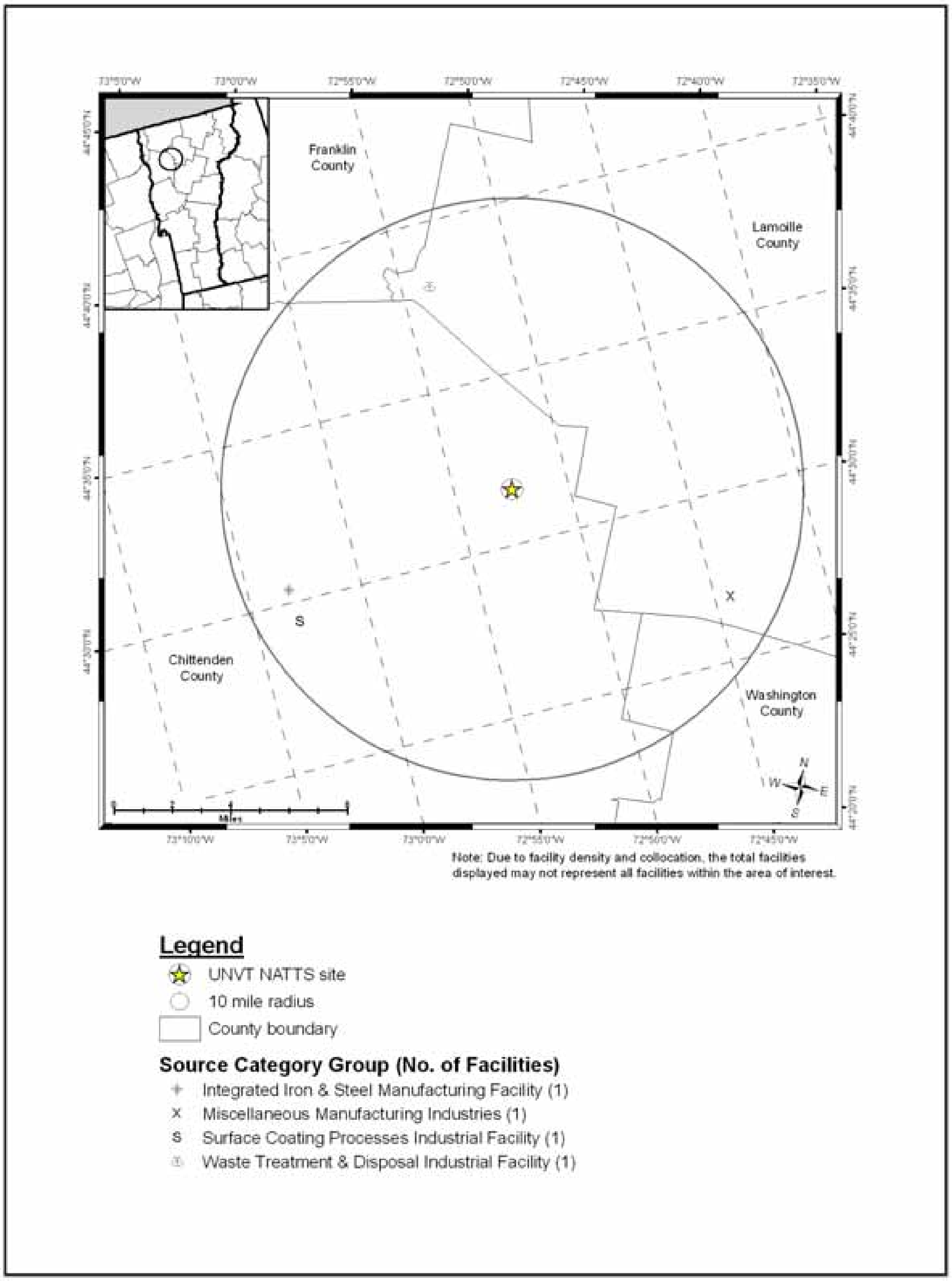
Table 28-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Vermont monitoring site. County-level vehicle registration data for Chittenden County were not available from the State of Vermont. Thus, state-level vehicle registration, from the Energy Information Administration (EIA), was allocated to the county level using the proportion of county-level population. County-level population information for this county was obtained from the

Figure 28-1. Underhill, Vermont (UNVT) Monitoring Site



Scale: 3cm = 200m

Figure 28-2. NEI Point Sources Located Within 10 Miles of UNVT



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 28-1. Geographical Information for the Vermont Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
UNVT	50-007-0007	Underhill	Chittenden	Burlington-South Burlington, VT	44.52839, -72.86884	Forest	Rural	This site was established in 1988 and is located at the western slope of Mount Mansfield at the north end in Underhill, VT. The site is rural in nature and located 5 km southwest of the summit of Mount Mansfield, 6 km from Route 15, and 26 km east of Burlington. This monitoring location meets all siting requirements and criteria and has been approved Vermont Air Pollution Control Division and EPA Region I. The monitoring objective for ozone, $PM_{2.5}$, PM_{10}, PM speciation and future trace-level monitoring is regional scale background levels. The monitoring objectives for the VOC, Carbonyl , metals and CR+6 sample collection and analysis are to assess background levels on a regional scale for short and long-term trends, comparison to applicable state standards and federal guidelines and assessment of contribution of transported pollutants. WS/WD & Temp/RH data is collected from a 10.0 meter tower.

BOLD = EPA-designated NATTS Site

Table 28-2. Population, Motor Vehicle, and Traffic Information for the Vermont Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
UNVT	151,826	122,119	0.95	33,940	32,105	1,200	3,013

[1] Daily Average Traffic Data reflects 2005 data from the Chittenden County Metro Planning Organization
BOLD = EPA-designated NATTS Site

U.S. Census Bureau. Table 28-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of the site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 28-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 28-2 presents the daily VMT for the urban area.

Observations from Table 28-2 include the following:

- Chittenden County's population was in the mid-to-low range compared to all counties with NATTS or UATMP sites. This is also true of its vehicle registration.
- Both the 10-mile radius population and vehicle registration ranked seventh lowest compared to all counties with NATTS or UATMP sites.
- The vehicle per person ratio was nearly one vehicle per person. While this may seem high, it ranked 22nd among all NATTS and UATMP sites.
- The traffic volume experienced near UNVT ranked third lowest compared to other monitoring sites. The traffic estimate used came from Pleasant Valley Road, north of Harvey Road.
- VMT for the Burlington area ranked fourth lowest compared to urban areas with NATTS and UATMP monitoring sites.

28.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Vermont on sampling days, as well as over the course of the year.

28.2.1 Climate Summary

The city of Burlington resides just to the east of Lake Champlain in northwest Vermont. Lake Champlain has a moderating affect on the city, keeping the city slightly warmer than it could be given its New England location. The state of Vermont is affected by most storm systems that track across the country, producing variable weather. Average annual winds come from the south, ahead of advancing weather systems. However, these storm systems are moderated somewhat due to the Adirondacks to the west and Green Mountains to the east (Ruffner and Bair, 1987).

28.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at Morrisville-Stowe Street Airport (WBAN 54771).

Table 28-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 28-3 is the 95 percent confidence interval for each parameter. As shown in Table 28-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

28.2.3 Composite Back Trajectories for Sampling Days

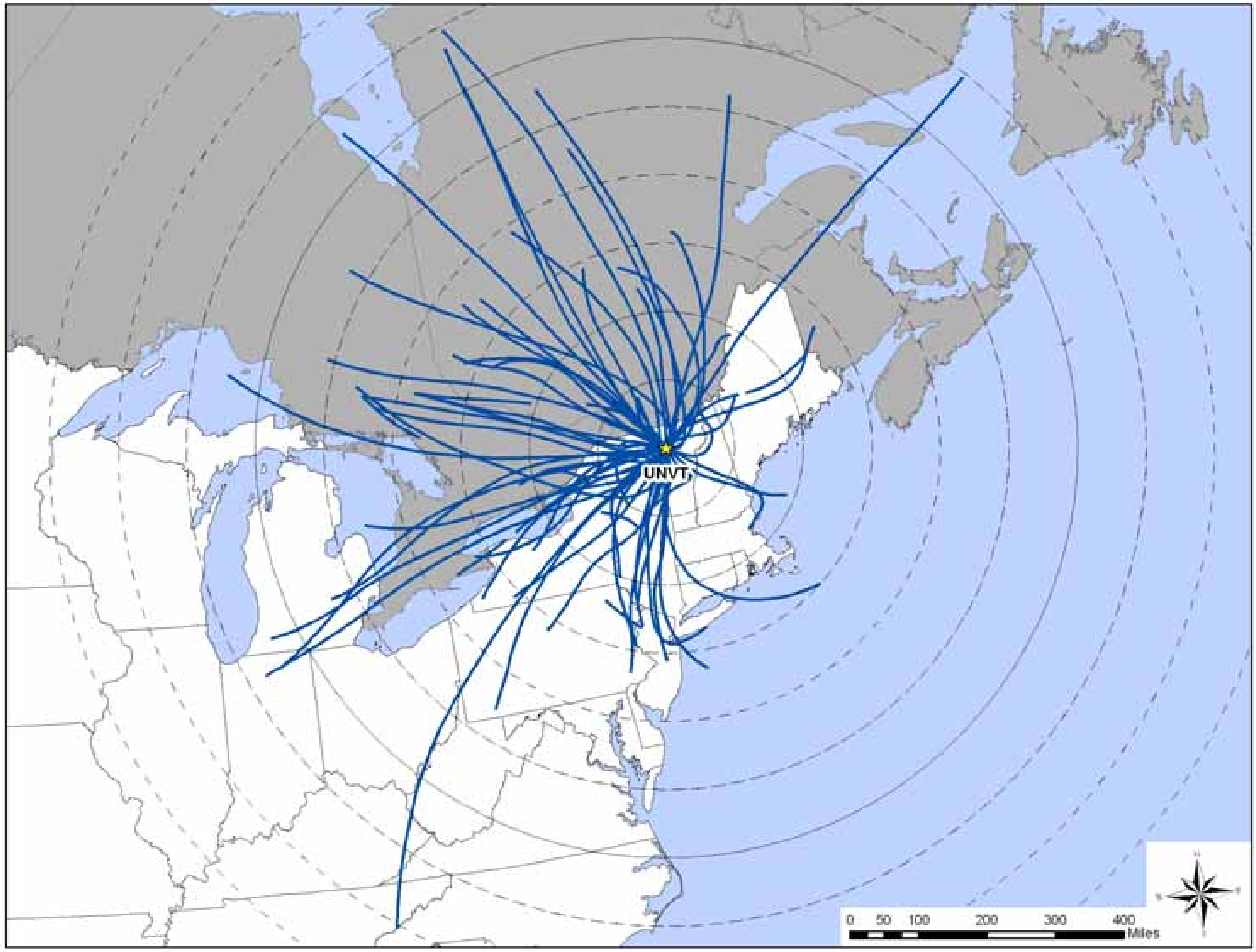
Figure 28-3 is the composite back trajectory map for the Vermont monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 28-3 represents 100 miles.

Table 28-3. Average Meteorological Conditions near the Vermont Monitoring Site

Site	**Closest NWS Station and WBAN**	**Average Type**	**Average Maximum Temperature (°F)**	**Average Temperature (°F)**	**Average Dew Point Temperature (°F)**	**Average Wet Bulb Temperature (°F)**	**Average Relative Humidity (%)**	**Average Sea Level Pressure (mb)**	**Average Scalar Wind Speed (kt)**
UNVT	Morrisville-Stowe State Airport 54771	Sampling Day	54.94 ± 5.49	44.56 ± 5.07	34.35 ± 5.18	40.09 ± 4.71	70.44 ± 2.93	1016.94 ± 1.81	3.03 ± 0.50
		All 2007	53.03 ± 2.31	43.10 ± 2.13	33.27 ± 2.13	38.83 ± 1.97	71.48 ± 1.19	1016.55 ± 0.80	3.17 ± 0.22

BOLD = EPA-designated NATTS Site

Figure 28-3. Composite Back Trajectory Map for UNVT



Observations from Figure 28-3 include the following:

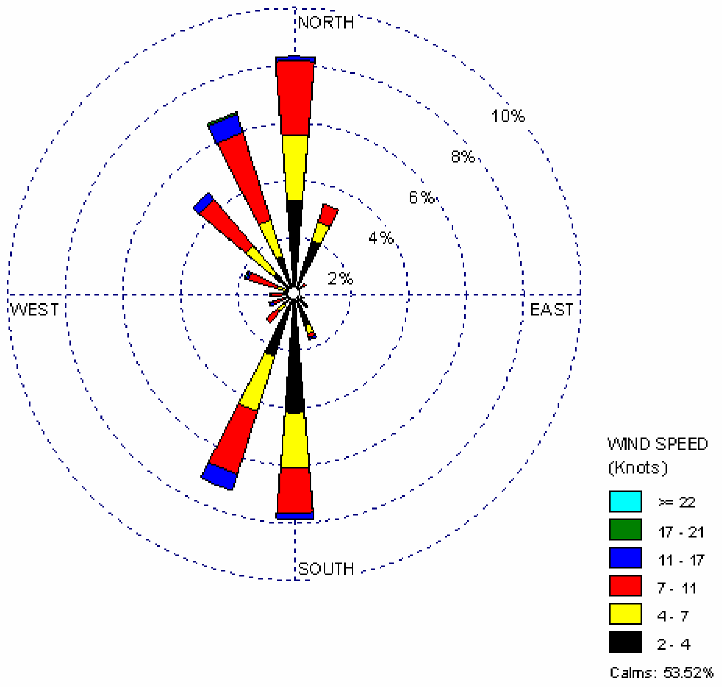
- Back trajectories originated from a variety of directions at UNVT, although there were fewer trajectories originating from the east and southeast.

- The 24-hour air shed domain for UNVT was similar in size compared to other monitoring sites. The furthest away a trajectory originated was east Tennessee, or nearly 800 miles away. However, most trajectories originated within 500 miles of the site.

28.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station near UNVT were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce customized wind roses. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 28-4 is the wind rose for the Vermont monitoring site on days that samples were collected.

Figure 28-4. Wind Rose for UNVT Sampling Days



Observations from Figure 28-4 for UNVT include the following:

- Calm winds were prevalent near UNVT, as calm winds were observed for over one-half of the hourly measurements.
- For winds greater than 2 knots, northerly and southerly winds were observed most frequently.
- Winds exceeding 11 knots made up less than three percent of observations.

28.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Vermont monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 28-4 presents the pollutants that failed at least one screen for the Vermont monitoring site and highlights the site's pollutants of interest (shaded). UNVT sampled for hexavalent chromium only.

Table 28-4. Comparison of Measured Concentrations and EPA Screening Values for the Vermont Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Underhill, Vermont - UNVT					
Hexavalent Chromium	0	11	0.00	0.00	0.00
Total	0	11	0.00		

Observations from Table 28-4 include the following:

- Hexavalent chromium was detected in 11 samples, but did not fail any screens.
- In order to facilitate analysis, hexavalent chromium was considered UNVT's pollutant of interest.

28.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Vermont monitoring site. The averages presented are provided for the pollutants of interest for the monitoring site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

28.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for hexavalent chromium, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 28-5, where applicable. The averages presented in Table 28-5 are shown in ng/m^3 for ease of viewing.

Table 28-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Vermont Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (ng/m^3)	Winter Average (ng/m^3)	Spring Average (ng/m^3)	Summer Average (ng/m^3)	Autumn Average (ng/m^3)	Annual Average[1] (ng/m^3)
Underhill, Vermont - UNVT								
Hexavalent Chromium	11	60	0.016 ± 0.011	NR	NR	NR	NR	0.006 ± 0.002

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for UNVT from Table 28-5 include the following:

- The daily average concentration of hexavalent chromium was higher than the annual average (0.016 ± 0.011 ng/m^3 vs. 0.006 ± 0.002 ng/m^3), which illustrates the effect of the substitution of 1/2 MDL.

- Compared to other program sites sampling hexavalent chromium, the daily average concentration for UNVT was the fifth lowest.

- Seasonal averages of hexavalent chromium could not be calculated due to the low number of detections in each season.

28.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. UNVT has not sampled continuously for five years as part of the National Monitoring Programs; therefore, the trends analysis was not conducted.

28.5 Pearson Correlations

Table 28-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for UNVT from Table 28-6 include the following:

- All of the correlations for UNVT were relatively weak.

28.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

28.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Vermont monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk

Table 28-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Vermont Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Underhill, Vermont - UNVT								
Hexavalent Chromium	11	0.02	0.25	0.40	0.35	0.48	-0.11	-0.31

results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured concentrations or calculated average of hexavalent chromium exceeded any of the MRL risk values for UNVT.

28.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutant of interest for the Vermont monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 28-7. The data from NATA are presented for the census tract where the monitoring site is located. The pollutant of interest for the site are bolded.

The census tract information for UNVT is as follows:

- The UNVT monitoring site is located in census tract 50007002900.
- The population for the census tract where the UNVT monitoring site is located was 6,037, which represented four percent of Chittenden County’s population in 2000.

Observations for UNVT from Table 28-7 include the following:

- The NATA-modeled concentration for hexavalent chromium was less than 0.01 μg/m^3, as was the annual average.
- The cancer risk from hexavalent chromium according to NATA (0.02 in-a-million) was slightly lower than the cancer risk approximation (0.08 in-a-million), although both were low.
- The noncancer risk according to NATA and the noncancer risk approximation for hexavalent chromium were both less than 0.01.

Table 28-7. Cancer and Noncancer Risk Summary for the Monitoring Site in Vermont

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average[1] (µg/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Underhill, Vermont (UNVT) - Census Tract ID 50007002900								
Hexavalent Chromium	0.012	0.0001	<0.01	0.02	<0.01	<0.01 ± <0.01	0.08	<0.01

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Bold = pollutant of interest

28.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 28-8 and 28-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 28-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 28-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 28.3, UNVT sampled for hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 28-8 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Chittenden County.
- Benzene was also the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by 1,3-butadiene and arsenic.
- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for Chittenden County.
- Hexavalent chromium, which was the only pollutant sampled at UNVT, had the fifth highest toxicity-weighted emissions for Chittenden County. This pollutant did not appear on the list of highest emitted pollutants.

Table 28-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Vermont

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Underhill, Vermont (UNVT) – Chittenden County					
Benzene	228.09	Benzene	1.78E-03	Hexavalent Chromium	0.08
Formaldehyde	62.58	1,3-Butadiene	6.19E-04		
Acetaldehyde	22.11	Arsenic, PM	1.91E-04		
1,3-Butadiene	20.63	Naphthalene	1.44E-04		
Dichloromethane	14.44	Hexavalent Chromium	1.31E-04		
Tetrachloroethylene	7.53	POM, Group 5	9.15E-05		
Naphthalene	4.23	POM, Group 2	8.47E-05		
p-Dichlorobenzene	3.19	Acetaldehyde	4.86E-05		
Trichloroethylene	1.67	Tetrachloroethylene	4.44E-05		
POM, Group 2	1.54	*p*-Dichlorobenzene	3.50E-05		

Table 28-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Vermont

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Underhill, Vermont (UNVT) – Chittenden County					
Toluene	521.82	Acrolein	466,998.33	Hexavalent Chromium	<0.01
Xylenes	381.07	Manganese, PM	41,238.28		
Benzene	228.09	1,3-Butadiene	10,317.46		
Methanol	93.71	Benzene	7,603.10		
Ethylbenzene	86.95	Formaldehyde	6,385.40		
Hexane	63.53	Chlorine	5,031.08		
Formaldehyde	62.58	Xylenes	3,810.72		
Ethylene glycol	29.17	Acetaldehyde	2,456.94		
Hydrochloric acid	26.23	Nickel, PM	1,655.21		
Acetaldehyde	22.11	Arsenic, PM	1,482.37		

Observations from Table 28-9 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Chittenden County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, manganese, and 1,3-butadiene.
- Four of the highest emitted pollutants Chittenden County also had the highest toxicity-weighted emissions.
- Hexavalent chromium did not appear on the list of highest emitted pollutants or the list of highest toxicity-weighted emissions for pollutants with a noncancer toxicity factor. Its noncancer risk approximation was very low.

28.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *Hexavalent chromium did not fail any screens for UNVT. However, it was considered a pollutant of interest in order to allow data analyses to be conducted.*
- *Hexavalent chromium did not exceed any of the MRL health benchmarks.*

29.0 Site in Washington

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Washington, and integrates these concentrations with emissions, meteorological, and risk information.

29.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The Washington site is located in the Seattle-Tacoma-Bellevue, WA MSA. Figure 29-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its urban location. Figure 29-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 29-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

The SEWA monitoring is located in Seattle, at the southeast corner of the Beacon Hill Reservoir. The reservoir and the Jefferson Park Golf Course to the east are separated by Beacon Avenue. The reservoir, golf course, a middle school, and the VA Puget Sound Health Care System, located to the south, are surrounded by residential neighborhoods, as shown in Figure 29-1. Interstate-5 (I-5), which runs north-south through Seattle, is less than a mile to the west and intersects with I-90. I-90 runs east-west across Seattle, a couple of miles to the northwest of the site. The area to the west of I-5 is industrial. As Figure 29-2 shows, SEWA is located near several industrial point sources. These emission sources are involved in a variety of activities, including surface coating, liquids distribution, and waste disposal. The point source located closest to SEWA is involved in producing fabricated metal products.

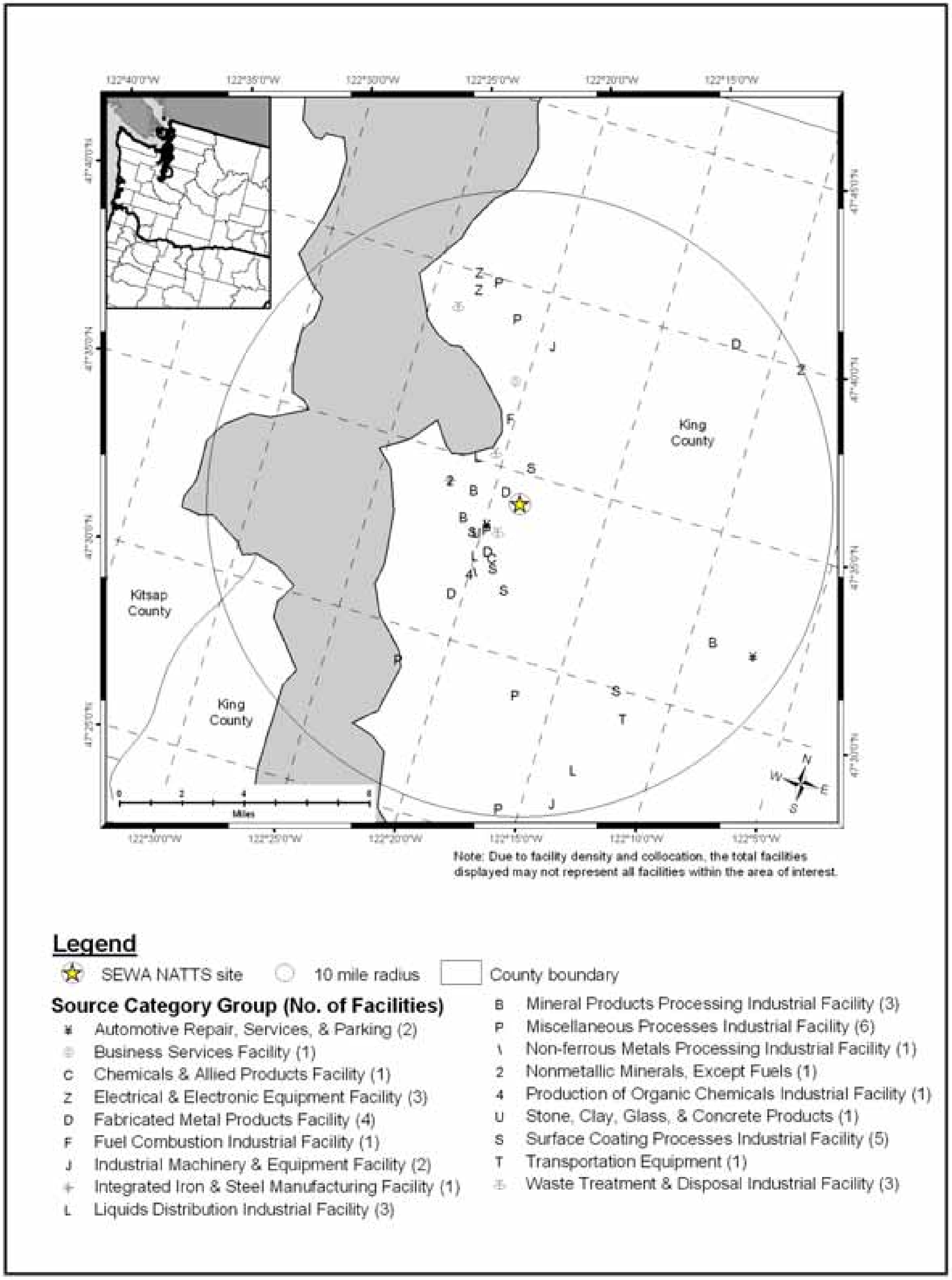
Table 29-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Washington monitoring site. County-level vehicle registration and population data for King County were obtained from the Washington Department of Licensing and the U.S. Census

Figure 29-1. Seattle, Washington (SEWA) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 200m

Figure 29-2. NEI Point Sources Located Within 10 Miles of SEWA



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 29-1. Geographical Information for the Washington Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
SEWA	53-033-0080	Seattle	King	Seattle-Tacoma-Bellevue, WA	47.5683, -122.3081	Industrial	Suburban	The Beacon Hill site is centrally located within the Seattle urban area. The site is isolated within the confines of the city's water reservoir. The neatest roads are at least 1 km away. It is surrounded by residential neighborhoods, Jefferson Park and a middle school. It is about 100 meters above sea level. The hill is part of a larger ridge defining the eastern edge of an area of light industry including a major seaport, an airport and warehousing and trucking activity about 4 km west of the site. Interstate freeways and arterial roads carrying large amounts of traffic are closely situated 2 to 4 km northwest of the site. The site is considered to be representative of 24 hour average $PM_{2.5}$ levels within a 20 km radius (Goswami 2002).

BOLD = EPA-designated NATTS Site

Table 29-2. Population, Motor Vehicle, and Traffic Information for the Washington Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
SEWA	1,859,284	1,766,228	0.95	893,502	848,783	232,000	69,967

[1] Daily Average Traffic Data reflects 2006 data from the Washington State DOT

BOLD = EPA-designated NATTS Site

Bureau. Table 29-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 29-2 also contains annual average daily traffic information as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 29-2 presents the daily VMT for the urban area.

Observations from Table 29-2 include the following:

- SEWA's county and 10-mile populations were in the upper to mid-range compared to other counties with NATTS or UATMP sites. This is also true for its county-level and 10-mile vehicle ownership.
- The vehicle per person ratio was in the middle of the range compared to other NATTS or UATMP sites.
- The traffic volume experienced near SEWA ranked second highest compared to other monitoring sites. The traffic estimate used came from I-5 near exit 162.
- The Seattle area VMT was the 12th highest among urban areas with UATMP or NATTS sites.

29.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Washington on sampling days, as well as over the course of the year.

29.2.1 Climate Summary

Seattle is located between the Puget Sound and Lake Washington, and is situated between the Olympic Mountains to the west and the Cascades to the east. The city experiences a mild climate as the mountains moderate storm systems that move into the Pacific Northwest and both the mountains and the sound shield the city from the temperature extremes. Although the city is known for being rainy, the actual precipitation totals tend to be lower compared to many locations east of the Rocky Mountains (Ruffner and Bair, 1987).

29.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at Boeing Field/King County International Airport (WBAN 24234).

Table 29-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 29-3 is the 95 percent confidence interval for each parameter. As shown in Table 29-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

29.2.3 Composite Back Trajectories for Sampling Days

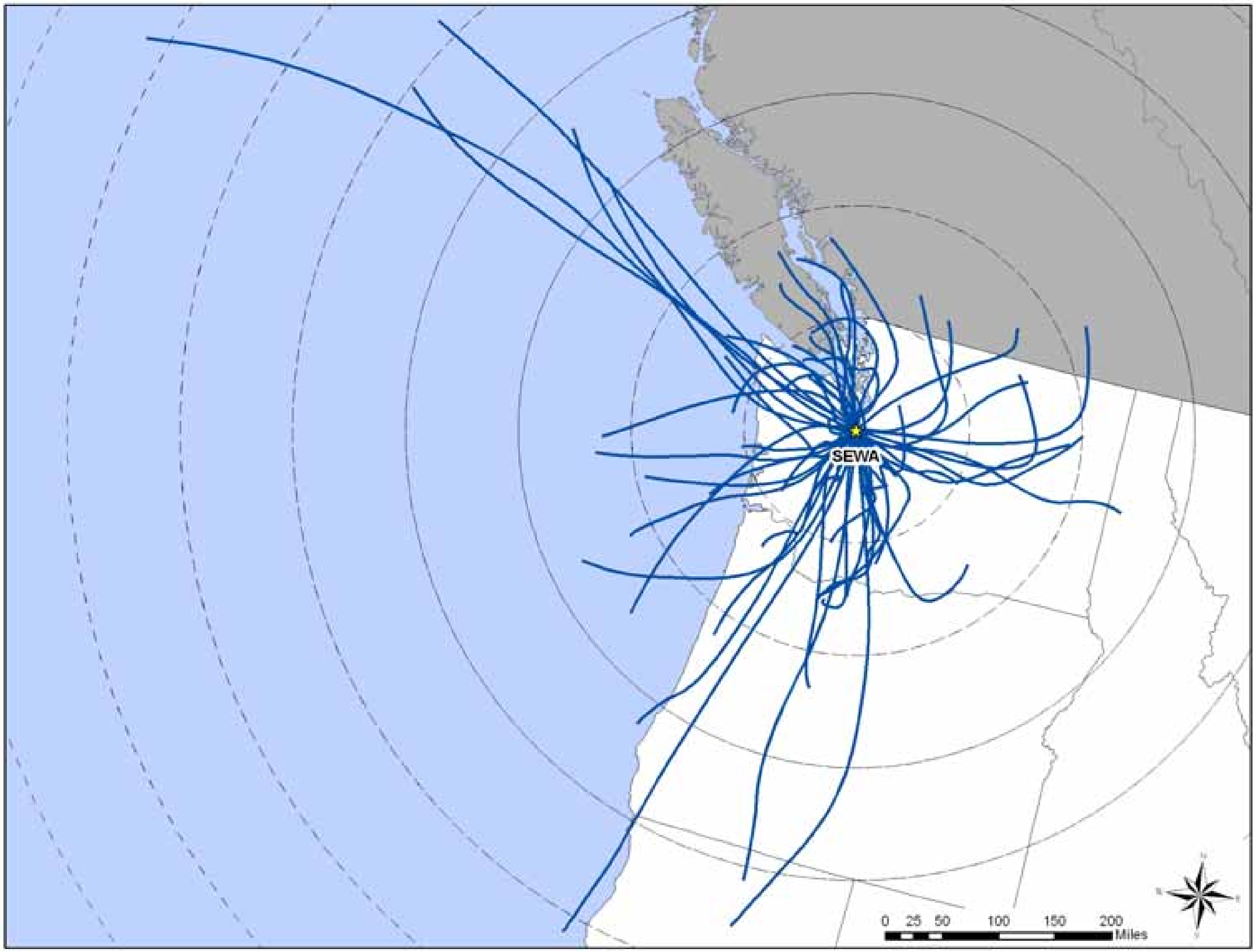
Figure 29-3 is the composite back trajectory map for the Washington monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 29-3 represents 100 miles.

Table 29-3. Average Meteorological Conditions near the Washington Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
SEWA	Boeing Field/ King County Intl Airport, Seattle 24234	Sampling Day	59.43 ± 3.11	52.69 ± 2.68	42.94 ± 2.11	47.80 ± 2.17	71.96 ± 2.73	1017.88 ± 1.64	4.59 ± 0.52
		All 2007	59.16 ± 1.23	52.37 ± 1.04	42.88 ± 0.80	47.61 ± 0.84	72.49 ± 1.09	1018.00 ± 0.68	4.79 ± 0.23

BOLD = EPA-designated NATTS Site

Figure 29-3. Composite Back Trajectory Map for SEWA



Observations from Figure 29-3 include the following:

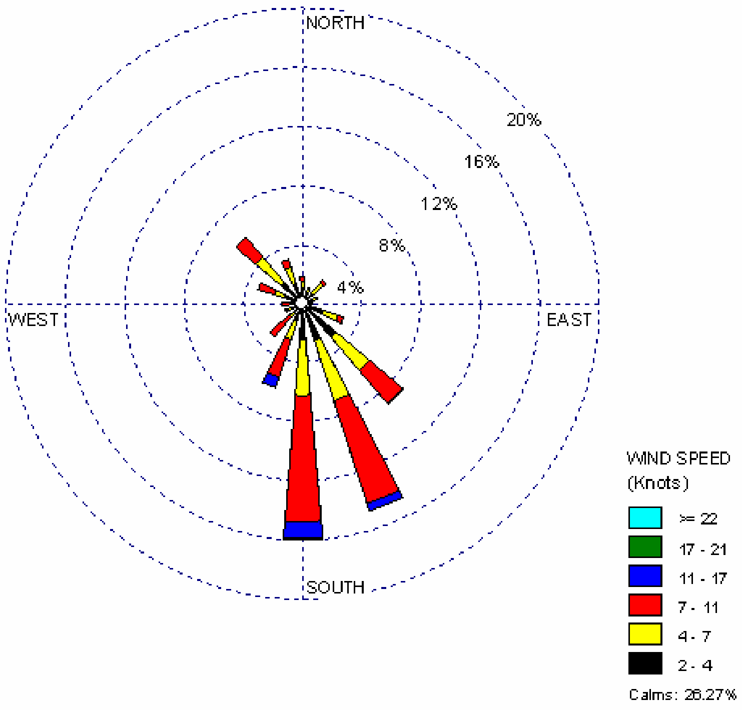
- Back trajectories originated from a variety of directions at SEWA, although infrequently from the southeast.

- The 24-hour air shed domain for SEWA was comparable in size to other monitoring sites. The furthest away a trajectory originated was more than 700 miles away, over the Pacific Ocean. However, most trajectories originated within 300 miles of the site.

29.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at King County International near SEWA were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce a customized wind rose. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 29-4 is the wind rose for the Washington monitoring site on days that samples were collected.

Figure 29-4. Wind Rose for SEWA Sampling Days



Observations from Figure 29-4 for SEWA include the following:

- Calm winds were prevalent near SEWA and were observed for more than 26 percent of the hourly wind measurements.
- Southerly and south-southeasterly winds were frequently observed near SEWA.
- Winds exceeding 11 knots made up less than three percent of observations and were most frequently measured for winds with a southerly component.

29.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Washington monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 29-4 presents the pollutants that failed at least one screen for the Washington monitoring site and highlights the site's pollutants of interest (shaded). SEWA sampled for VOC, carbonyls, metals (PM_{10}), and hexavalent chromium.

Observations from Table 29-4 include the following:

- Thirteen pollutants with a total of 446 measured concentrations failed at least one screen for SEWA.
- The following 10 pollutants were identified as pollutants of interest for SEWA: acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, manganese, nickel, and tetrachloroethylene.
- Of the 10 pollutants of interest, four failed 100 percent of screens for SEWA.
- Approximately 67 percent of measured detections failed screens (of the pollutants that failed at least one screen) for SEWA.

Table 29-4. Comparison of Measured Concentrations and EPA Screening Values for the Washington Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Seattle, Washington - SEWA					
Arsenic (PM_{10})	60	60	100.00	13.45	13.45
Carbon Tetrachloride	60	60	100.00	13.45	26.91
Benzene	60	60	100.00	13.45	40.36
Acrolein	58	58	100.00	13.00	53.36
1,3-Butadiene	56	60	93.33	12.56	65.92
Acetaldehyde	41	59	69.49	9.19	75.11
Manganese (PM_{10})	37	60	61.67	8.30	83.41
Nickel (PM_{10})	20	60	33.33	4.48	87.89
Tetrachloroethylene	17	59	28.81	3.81	91.70
Formaldehyde	15	59	25.42	3.36	95.07
Hexavalent Chromium	11	56	19.64	2.47	97.53
1,2-Dichloroethane	6	6	100.00	1.35	98.88
Acrylonitrile	5	5	100.00	1.12	100.00
Total	446	662	67.37		

29.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Washington monitoring site. The averages presented are provided for the pollutants of interest for the site. Complete site-specific statistical summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

29.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for the pollutants of interest, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual average concentrations are presented in Table 29-5, where applicable.

Table 29-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Washington Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average ($\mu g/m^3$)	Winter Average ($\mu g/m^3$)	Spring Average ($\mu g/m^3$)	Summer Average ($\mu g/m^3$)	Autumn Average ($\mu g/m^3$)	Annual Average[1] ($\mu g/m^3$)
Seattle, Washington - SEWA								
Acetaldehyde	59	59	0.93 ± 0.32	0.69 ± 0.18	0.58 ± 0.25	1.40 ± 1.13	1.05 ± 0.33	0.93 ± 0.32
Acrolein	58	60	0.36 ± 0.05	0.26 ± 0.03	0.38 ± 0.09	0.32 ± 0.10	0.45 ± 0.11	0.35 ± 0.05
Arsenic (PM_{10})	60	60	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Benzene	60	60	0.79 ± 0.13	0.95 ± 0.28	0.61 ± 0.15	0.49 ± 0.10	1.12 ± 0.31	0.79 ± 0.13
1,3-Butadiene	60	60	0.09 ± 0.02	0.11 ± 0.03	0.05 ± 0.01	0.05 ± 0.01	0.13 ± 0.04	0.09 ± 0.02
Carbon Tetrachloride	60	60	0.69 ± 0.04	0.69 ± 0.07	0.71 ± 0.06	0.64 ± 0.09	0.71 ± 0.07	0.69 ± 0.04
Formaldehyde	59	59	0.93 ± 0.31	0.80 ± 0.21	0.52 ± 0.20	1.31 ± 1.11	1.11 ± 0.33	0.93 ± 0.31
Manganese (PM_{10})	60	60	0.01 ± <0.01	0.01 ± 0.01	0.01 ± <0.01	0.02 ± 0.01	0.01 ± 0.01	0.01 ± <0.01
Nickel (PM_{10})	60	60	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Tetrachloroethylene	59	60	0.16 ± 0.03	0.18 ± 0.06	0.12 ± 0.02	0.11 ± 0.03	0.22 ± 0.08	0.16 ± 0.03

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for SEWA from Table 29-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (0.93 ± 0.31 $\mu g/m^3$), acetaldehyde (0.93 ± 0.32 $\mu g/m^3$), and benzene (0.79 ± 0.13 $\mu g/m^3$). The annual averages for these pollutants were the same as their respective daily averages.

- As shown in Table 4-11, of the program-level pollutants of interest, SEWA had the highest daily average concentration of carbon tetrachloride. However, the concentrations of this pollutant did not vary significantly among the sites.

- Of the eight sites sampling PM_{10} metals, SEWA had the sixth highest daily average arsenic concentration, but the second highest daily average manganese concentration, as shown in Table 4-10.

- Most of the concentrations of the pollutants of interest for SEWA did not vary significantly by season. Although the acetaldehyde and formaldehyde concentrations were highest in the summer, the large confidence interval indicates that these concentrations were likely affected by outliers.

29.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. SEWA has not sampled continuously for five years as part of the National Monitoring Programs; therefore, the trends analysis was not conducted.

29.5 Pearson Correlations

Table 29-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for SEWA from Table 29-6 include the following:

- Most of the correlations between the pollutants of interest for SEWA were weak.

- The one exception was calculated between nickel and scalar wind speed (-0.50), indicating that concentrations of nickel may increase as wind speeds decrease.

29.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

29.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data for the Washington monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As

Table 29-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Washington Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Seattle, Washington - SEWA								
Acetaldehyde	59	0.21	0.22	0.26	0.24	0.00	-0.13	-0.36
Acrolein	58	0.13	0.11	0.08	0.10	-0.07	-0.03	-0.38
Arsenic (PM_{10})	60	-0.09	-0.10	0.00	-0.05	0.25	0.05	-0.37
Benzene	60	-0.32	-0.34	-0.22	-0.30	0.40	0.12	-0.45
1,3-Butadiene	60	-0.35	-0.38	-0.27	-0.34	0.39	0.14	-0.44
Carbon Tetrachloride	60	-0.23	-0.24	-0.20	-0.23	0.17	-0.03	-0.17
Formaldehyde	59	0.17	0.17	0.22	0.20	0.02	-0.11	-0.38
Manganese (PM_{10})	60	0.00	0.04	0.09	0.06	0.07	-0.17	-0.02
Nickel (PM_{10})	60	0.45	0.41	0.33	0.39	-0.28	-0.22	-0.50
Tetrachloroethylene	59	-0.20	-0.21	-0.11	-0.17	0.33	0.06	-0.47

described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of these comparisons are summarized in Table 29-7. Where a seasonal or annual average exceeds the applicable MRL, the concentration is bolded. Only acrolein exceeded one or more of the MRL risk factors.

Observations about acrolein from Table 29-7 include the following:

- None of the preprocessed daily measurements of acrolein exceeded the acute MRL.
- All of the seasonal averages of acrolein exceeded the intermediate MRL.
- Acrolein has no chronic MRL. Therefore, a chronic risk comparison could not be conducted.

29.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants that failed at least one screen at the Washington monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 29-8. The data from NATA are presented for the census tract where the monitoring site is located. The pollutants of interest for the Washington monitoring site are bolded.

The census tract information for the SEWA monitoring site is as follows:

- The census tract for SEWA is 53033010000.
- This census tract had a population of 8,139 in 2000 and represented approximately 0.1 percent of the King County population.

Table 29-7. MRL Risk Screening Assessment Summary for the Washington Monitoring Site

Site	Method	Pollutant	ATSDR Acute MRL (µg/m^3)	# of Exceedances/ # of Measured Detections	ATSDR Intermediate MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)	ATSDR Chronic MRL (µg/m^3)	Annual Average[1] (µg/m^3)
SEWA	TO-15	Acrolein	7.00	0/58	0.09	**0.26 ± 0.03**	**0.38 ± 0.09**	**0.32 ± 0.10**	**0.45 ± 0.11**	--	0.35 ± 0.05

BOLD = EPA-designated NATTS Site

BOLD = exceedance of the intermediate or chronic MRL

-- = an MRL risk factor is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 29-8. Cancer and Noncancer Risk Summary for the Monitoring Site in Washington

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average[1] (µg/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Seattle, Washington (SEWA) - Census Tract ID 53033010000								
Acetaldehyde	0.000002	0.009	2.83	6.25	0.31	0.93 ± 0.32	1.86	0.10
Acrolein	--	0.00002	0.22	--	10.96	0.35 ± 0.05	--	17.66
Acrylonitrile	0.000068	0.002	<0.01	0.22	<0.01	0.03 ± <0.01	1.89	0.01
Arsenic (PM$_{10}$)	0.0043	0.00003	<0.01	0.12	<0.01	<0.01 ± <0.01	3.27	0.03
Benzene	0.000007	0.03	3.72	29.02	0.12	0.79 ± 0.13	5.52	0.03
1,3-Butadiene	0.00003	0.002	0.25	7.60	0.12	0.09 ± 0.02	2.62	0.04
Carbon Tetrachloride	0.000015	0.04	0.23	3.44	0.01	0.69 ± 0.04	10.32	0.02
1,2-Dichloroethane	0.000026	2.4	0.04	1.05	<0.01	0.04 ± <0.01	1.12	<0.01
Formaldehyde	5.5E-09	0.0098	2.96	0.01	0.30	0.93 ± 0.31	0.01	0.10
Hexavalent Chromium	0.012	0.0001	<0.01	7.45	0.01	<0.01 ± <0.01	0.58	<0.01
Manganese (PM$_{10}$)	--	0.00005	<0.01	--	0.01	0.01 ± <0.01	--	0.25
Nickel (PM$_{10}$)	0.00016	0.000065	<0.01	0.06	0.01	<0.01 ± <0.01	0.34	0.03
Tetrachloroethylene	0.000005	0.27	0.24	1.43	<0.01	0.16 ± 0.03	0.79	<0.01

Bold = pollutant of interest

-- = a URE or RfC is not available

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for SEWA from Table 29-8 include the following:

- The pollutants with the highest concentrations according to NATA were benzene, formaldehyde, and acetaldehyde.
- The pollutants with the highest cancer risks according to NATA were benzene, 1,3-butadiene, and hexavalent chromium.
- The only pollutant with a noncancer HQ greater than 1.0 according to NATA was acrolein (10.96).
- The pollutants with the highest annual averages were formaldehyde, acetaldehyde, and benzene.
- The pollutants with the highest cancer surrogate risk approximations were carbon tetrachloride, benzene, and arsenic.
- Similar to the NATA results, acrolein was the only pollutant with a noncancer surrogate risk approximation greater than 1.0 (17.66).

29.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 29-9 and 29-10 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 29-9 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 29-10 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in section 29.3, SEWA sampled for VOC, carbonyls, metals (PM_{10}), and hexavalent chromium. In addition, the cancer and noncancer

Table 29-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Washington

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Seattle, Washington (SEWA) – King County					
Benzene	2,923.39	Benzene	2.28E-02	Carbon Tetrachloride	10.32
Formaldehyde	934.78	1,3-Butadiene	7.77E-03	Benzene	5.52
Acetaldehyde	331.30	Naphthalene	2.21E-03	Arsenic	3.27
1,3-Butadiene	259.07	POM, Group 2	1.44E-03	1,3-Butadiene	2.62
Tetrachloroethylene	138.17	Hexavalent Chromium	1.15E-03	Acrylonitrile	1.88
Dichloromethane	114.89	POM, Group 3	9.27E-04	Acetaldehyde	1.86
Naphthalene	65.02	Tetrachloroethylene	8.15E-04	1,2-Dichloroethane	1.12
Trichloroethylene	46.08	Acetaldehyde	7.29E-04	Tetrachloroethylene	0.79
p-Dichlorobenzene	37.69	*p*-Dichlorobenzene	4.15E-04	Hexavalent Chromium	0.58
POM, Group 2	26.10	Arsenic, PM	3.39E-04	Nickel	0.34

Table 29-10. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Washington

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Seattle, Washington (SEWA) – King County					
Toluene	5,946.83	Acrolein	2,765,000.43	Acrolein	17.66
Xylenes	3,977.64	1,3-Butadiene	129,536.33	Manganese	0.25
Benzene	2,923.39	Benzene	97,446.39	Acetaldehyde	0.10
Methanol	943.62	Formaldehyde	95,385.82	Formaldehyde	0.10
Ethylbenzene	942.44	Xylenes	39,776.40	1,3-Butadiene	0.04
Formaldehyde	934.78	Acetaldehyde	36,810.83	Nickel	0.03
Hexane	924.09	Naphthalene	21,673.25	Benzene	0.03
Acetaldehyde	331.30	Manganese, PM	16,987.49	Arsenic	0.03
Ethylene glycol	323.55	Toluene	14,867.08	Carbon Tetrachloride	0.02
Methyl isobutyl ketone	277.23	Glycol ethers, gas	7,938.13	Acrylonitrile	0.01

surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 29-9 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Seattle.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, 1,3-butadiene, and naphthalene.
- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- Carbon tetrachloride was the pollutant with the highest cancer surrogate risk approximation, followed by benzene and arsenic. Carbon tetrachloride appeared on neither emissions-based list; arsenic appeared on the list of highest toxicity-weighted emissions but not the list of highest emitted pollutants; and benzene appeared on all three lists.
- Four of the 10 pollutants with the highest cancer risk approximations, also appear on both emissions-based lists (acetaldehyde, benzene, 1,3-butadiene, and tetrachloroethylene).

Observations from Table 29-10 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Seattle.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and benzene.
- Five of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- Acrolein, which had the highest noncancer risk approximation, also had the highest toxicity-weighted emissions.
- Formaldehyde, acetaldehyde, and benzene appeared on all three lists.

29.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *The pollutants of interest for SEWA were acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, manganese, nickel, and tetrachloroethylene.*

- *Formaldehyde and acetaldehyde had the highest daily average concentrations for SEWA.*

- *Seasonal averages of acrolein exceeded the intermediate MRL health benchmark.*

30.0 Site in Wisconsin

This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Wisconsin, and integrates these concentrations with emissions, meteorological, and risk information.

30.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. The Wisconsin site is located in Mayville, northwest of Milwaukee and northeast of Madison. Figure 30-1 is a composite satellite image retrieved from Google™ Maps showing the monitoring site in its rural location. Figure 30-2 identifies point source emission locations within 10 miles of the site as reported in the 2002 NEI for point sources. Table 30-1 describes the area surrounding the monitoring site and provides supplemental geographical information such as land use, location setting, and locational coordinates.

The MVWI monitoring site is located to the east of Horicon National Wildlife Refuge. The surrounding area is rural and agricultural in nature. The site serves as a rural background site. However, the area is impacted by nearby urban areas, and as such, could show the impacts on the wildlife sanctuary. Highway 33 to the north and Highway 67 to the west intersect less than a mile from the site, as Figure 30-1 shows. Figure 30-2 shows that most of the point sources surrounding MVWI are located to the west and northwest of the site. The majority of these emission sources are involved in surface coating processes or processes employing fuel combustion.

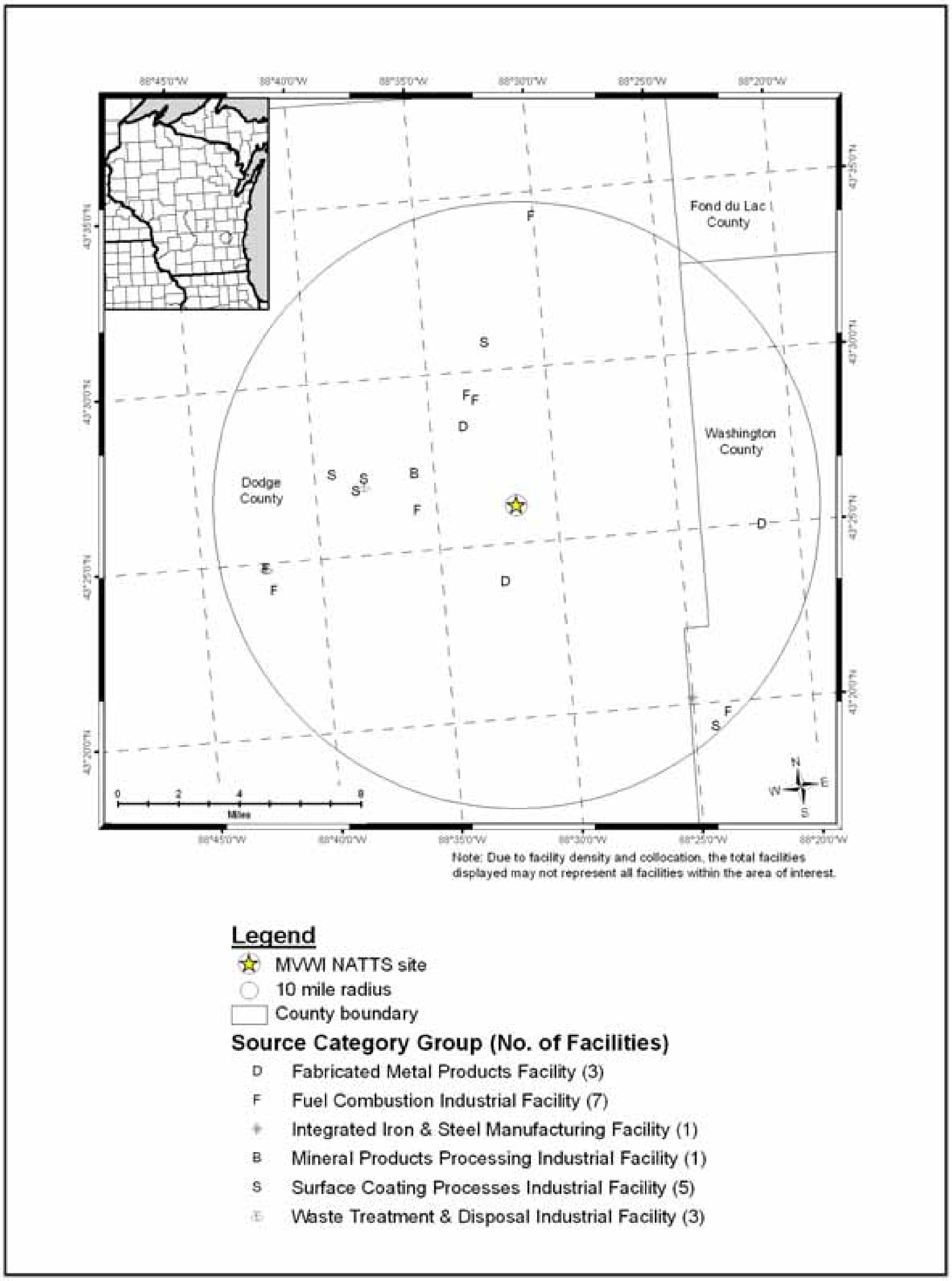
Table 30-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Wisconsin monitoring site. County-level vehicle registration and population data for Dodge County were obtained from the Wisconsin Department of Transportation and the U.S. Census Bureau. Table 30-2 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of the site is presented. An estimate of

Figure 30-1. Mayville, Wisconsin (MVWI) Monitoring Site

©2008 Google/©NAVTECH

Scale: 3cm = 1 mile

Figure 30-2. NEI Point Sources Located Within 10 Miles of MVWI



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 30-1. Geographical Information for the Wisconsin Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Description of the Immediate Surroundings
MVWI	55-027-0007	Mayville	Dodge	Beaver Dam, WI	43.435, -88.527778	Agricultural	Rural	Mayville is a designated rural NATTS site. The Mayville air monitoring station is a multi-parameter site located in rural southeast Wisconsin. The site is located approximately 45 miles northwest of Milwaukee. The Mayville site is located directly to the east of the Horicon National Wildlife Refuge. The monitoring station provides an excellent location for a rural background air toxics monitoring station. The site is rural but is located within an area affected by a major urban area. The site also shows impact on an important wildlife sanctuary. Current sampling at the site compliments and supports the air toxics monitoring effort at the site. It will in some cases allow for comparison of the monitoring methodologies ($PM_{2.5}$ metals vs. PM_{10} metals). The station was originally established for the study of ozone, fine particulate matter and regional haze. Sampling for hexavalent chromium began in March 2005.

BOLD = EPA-designated NATTS Site

Table 30-2. Population, Motor Vehicle, and Traffic Information for the Wisconsin Monitoring Site

Site	2007 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10-mile Vehicle Ownership	Annual Average Traffic Data[1]	VMT (thousands)
MVWI	87,786	92,255	1.05	24,804	26,067	3,500	NA

[1] Daily Average Traffic Data reflects 2004 data from the Wisconsin DOT
BOLD = EPA-designated NATTS Site

10-mile vehicle registration was calculated by applying the county-level vehicle registration to population ratio to the 10-mile population surrounding the monitoring site. Table 30-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 30-2 presents the daily VMT for the urban area (where applicable).

Observations from Table 30-2 include the following:

- Dodge County's population was rather low compared to all counties with NATTS or UATMP sites. This is also true of its 10-mile population.
- Both the county-level and 10-mile radius vehicle registrations were low compared to counties with NATTS or UATMP sites.
- The vehicle per person ratio was slightly greater than one vehicle per person. This ratio ranked 10th highest among all NATTS and UATMP sites.
- The traffic volume experienced near MVWI ranked sixth lowest compared to other monitoring sites. The traffic estimate used came from the intersection of Highway 33 and Highway 67.
- VMT was unavailable for this area.

30.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Wisconsin on sampling days, as well as over the course of the year.

30.2.1 Climate Summary

The town of Mayville is located to the northwest of Milwaukee. This area experiences a highly variable, continental climate as weather systems frequently push across the region.

Wintertime temperature extremes are moderated somewhat by the proximity to Lake Michigan. Lake effect snows can occur with winds with an easterly component, although they are more common closer to the coast (Ruffner and Bair, 1987).

30.2.2 Meteorological Conditions in 2007

Hourly meteorological data at a weather station near this site were retrieved for all of 2007. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. Meteorological data were also used to calculate correlations between meteorological parameters and ambient air measurements. The closest NWS weather station is located at West Bend Municipal Airport (WBAN 04875).

Table 30-3 presents average temperature (average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) on days samples were collected and for the entire year. Also included in Table 30-3 is the 95 percent confidence interval for each parameter. As shown in Table 30-3, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year. Sea level pressure was not recorded at the West Bend Municipal Airport.

30.2.3 Composite Back Trajectories for Sampling Days

Figure 30-3 is the composite back trajectory map for the Wisconsin monitoring site for the days on which samples were collected. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 30-3 represents 100 miles.

Observations from Figure 30-3 include the following:

- Back trajectories originated from a variety of directions at MVWI, although less frequently from the east.

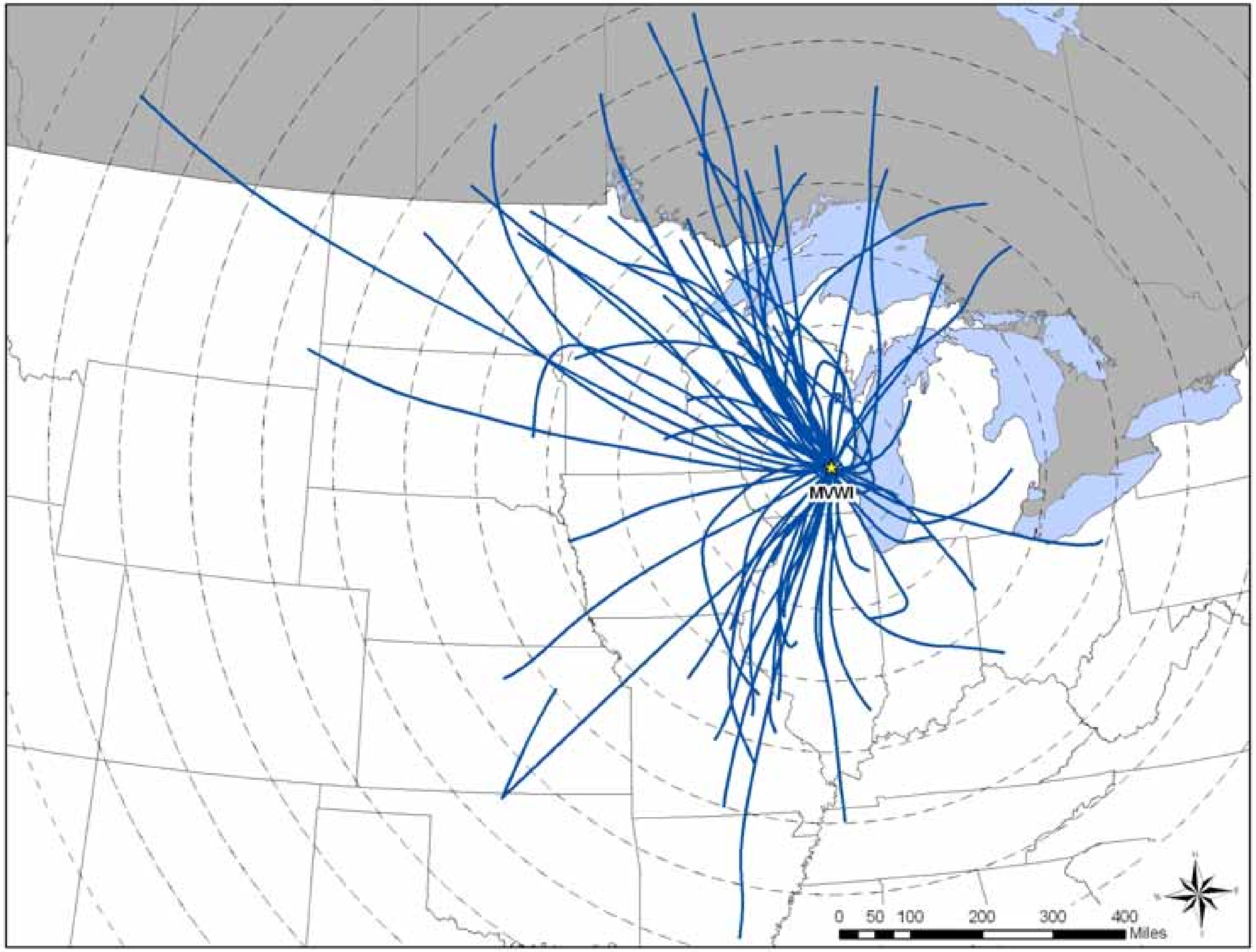
- The 24-hour air shed domain for MVWI was one of the largest in size compared to other monitoring sites. The furthest away a trajectory originated was south Alberta, Canada, or nearly 1,100 miles away. However, most trajectories originated within 500 miles of the site.

Table 30-3. Average Meteorological Conditions near the Wisconsin Monitoring Site

Site	Closest NWS Station and WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
MVWI	West Bend Municipal Airport 04875	Sampling Day	56.65 ± 5.53	48.63 ± 4.98	39.47 ± 4.81	44.76 ± 4.90	73.12 ± 3.16	NA	5.76 ± 0.74
		All 2007	55.52 ± 2.30	47.55 ± 2.11	38.98 ± 2.07	44.31 ± 2.08	74.49 ± 1.26	NA	5.74 ± 0.34

NA = Sea level pressure was not recorded at the West Bend Municipal Airport
BOLD = EPA-designated NATTS Site

Figure 30-3. Composite Back Trajectory Map for MVWI



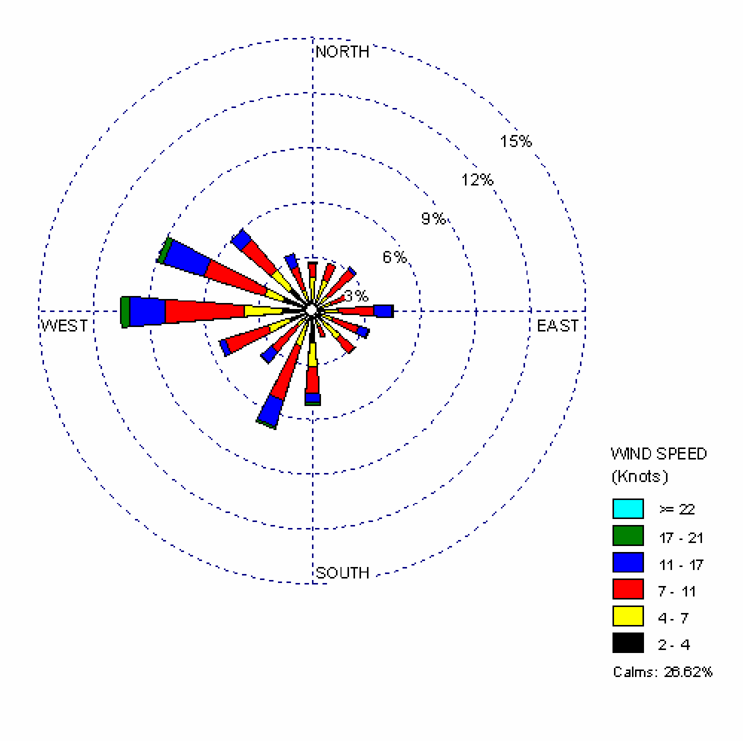
30.2.4 Wind Rose for Sampling Days

Hourly wind data from the weather station at West Bend Municipal Airport near MVWI were uploaded into a wind rose software program, WRPLOT (Lakes, 2006) to produce a customized wind rose. A wind rose shows the frequency of wind directions on a 16-point compass, and uses different shading to represent wind speeds. Figure 30-4 is the wind rose for the Wisconsin monitoring site on days that samples were collected.

Observations from Figure 30-4 for MVWI include the following:

- Calm winds were prevalent near MVWI, as calm winds were observed for nearly 27 percent of the hourly measurements.
- For winds greater than two knots, westerly and northwesterly winds were observed most frequently.
- Winds exceeding 11 knots made up 12 percent of observations.

Figure 30-4. Wind Rose for MVWI Sampling Days



30.3 Pollutants of Interest

"Pollutants of interest" were determined for each site in order to allow analysts and readers to focus on a risk-based subset of pollutants. The pollutants of interest for the Wisconsin monitoring site were identified using the EPA risk screening process described in Section 3.2. In brief, each pollutant's measured concentration was compared to its associated risk screening value. If the daily concentration was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 30-4 presents the pollutants that failed at least one screen for the Wisconsin monitoring site and highlights the site's pollutants of interest (shaded). MVWI sampled for hexavalent chromium only.

Table 30-4. Comparison of Measured Concentrations and EPA Screening Values for the Wisconsin Monitoring Site

Pollutant	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Mayville, Wisconsin - MVWI					
Hexavalent Chromium	0	29	0.00	0.00	0.00
Total	0	29	0.00		

Observations from Table 30-4 include the following:

- Hexavalent chromium was detected in 29 samples, but did not fail any screens.
- In order to facilitate analysis, hexavalent chromium is considered MVWI's pollutant of interest.

30.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Wisconsin monitoring site. The averages presented are provided for the pollutant of interest for the site. Complete site-specific summaries are provided in Appendices J through O. In addition, concentration averages for select pollutants are presented from previous sampling years in order to characterize concentration trends at the site, where applicable.

30.4.1 2007 Concentration Averages

Daily, seasonal, and annual concentration averages were calculated for hexavalent chromium, as described in Section 3.3. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November and where the completeness was greater than or equal to 85 percent. Daily, seasonal, and annual averages are presented in Table 30-5, where applicable. The averages presented in Table 30-5 are shown in ng/m^3 for ease of viewing.

Table 30-5. Daily, Seasonal, and Annual Average Concentrations of the Pollutants of Interest for the Wisconsin Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily Average (ng/m^3)	Winter Average (ng/m^3)	Spring Average (ng/m^3)	Summer Average (ng/m^3)	Autumn Average (ng/m^3)	Annual Average[1] (ng/m^3)
Mayville, Wisconsin - MVWI								
Hexavalent Chromium	29	60	0.016 ± 0.005	NR	NR	0.016 ± 0.006	0.007 ± 0.002	0.010 ± 0.003

NR = Not reportable due to the detection criteria for calculating a seasonal average

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Observations for MVWI from Table 30-5 include the following:

- The daily average concentration of hexavalent chromium was slightly higher than the annual average (0.016 ± 0.005 ng/m^3 vs. 0.010 ± 0.003 ng/m^3), which illustrates the effect of the substitution of 1/2 MDL.

- MVWI had the fourth lowest daily average concentration of hexavalent chromium among sites sampling this pollutant.

- Only summer and autumn seasonal average concentrations of hexavalent chromium could be calculated due to the low number of detections.

30.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the NATTS core compounds since 2003 (a total of five consecutive years) or longer, as described in Section 3.6.4. MVWI has not sampled continuously for five years as part of the National Monitoring Programs; therefore, the trends analysis was not conducted.

30.5 Pearson Correlations

Table 30-6 is a summary of the Pearson correlation coefficients that were calculated to determine the degree of correlation between concentrations of the pollutants of interest and select meteorological parameters. (Refer to Section 3.4 for more information on Pearson correlations.)

Observations for MVWI from Table 30-6 include the following:

- All of the correlations for MVWI were relatively weak.

30.6 Additional Risk Screening Evaluations

The following screening evaluations were conducted to characterize risk at the Wisconsin monitoring site. Refer to Section 3.3 and 3.6.5 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

30.6.1 Risk Screening Assessment Using MRLs

A risk screening was conducted by comparing the concentration data from the Wisconsin monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of one year or greater. The preprocessed daily measurements of the pollutants that failed at least one screen were compared to the acute MRL; the seasonal averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured concentrations or calculated averages of hexavalent chromium exceeded any of the MRL risk values for MVWI.

Table 30-6. Pearson Correlations Between Selected Meteorological Parameters and the Pollutants of Interest for the Wisconsin Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Mayville, Wisconsin - MVWI								
Hexavalent Chromium	29	0.17	0.13	0.30	0.23	0.43	--	-0.36

-- = Sea level pressure was not recorded at the West Bend Municipal Airport

30.6.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutant of interest for the Wisconsin monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by reviewing cancer and noncancer risk estimates from NATA and calculating cancer and noncancer surrogate risk approximations (refer to Section 3.6.5 regarding the criteria for an annual average and how cancer and noncancer surrogate risk approximations are calculated). Concentration and risk estimates from NATA, annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 30-7. The data from NATA are presented for the census tract where the monitoring site is located. The pollutants of interest are bolded.

The census tract information for MVWI is as follows:

- The MVWI monitoring site is located in census tract 55027961400.
- The population for the census tract where the MVWI monitoring site is located was 4,065, which represented about 4.7 percent of Dodge County's population in 2000.

Observations for MVWI from Table 30-7 include the following:

- The modeled concentration for hexavalent chromium from NATA was less than 0.01 $\mu g/m^3$, as was the annual average.
- The cancer risk from hexavalent chromium according to NATA and the cancer risk approximation were both fairly low.
- The noncancer risk according to NATA and the noncancer risk approximation for hexavalent chromium were both less than 0.01.

30.6.3 Risk-Based Emissions Assessment

In addition to the risk assessments discussed above, Tables 30-8 and 30-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 30-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 30-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), as calculated from the annual averages. The pollutants in these tables are

Table 30-7. Cancer and Noncancer Risk Summary for the Monitoring Site in Wisconsin

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC (mg/m^3)	1999 NATA			2007 NATTS/UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average[1] ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Mayville, Wisconsin (MVWI) - Census Tract ID 55027961400								
Hexavalent Chromium	0.012	0.0001	<0.01	0.07	<0.01	<0.01 ± <0.01	0.12	<0.01

Bold = pollutant of interest

[1] An annual average was calculated for the pollutants presented in this table without regard to the detection rate or number of corresponding seasonal averages. Program completeness and sampling duration criteria were applied.

Table 30-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Monitoring Site in Wisconsin

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Mayville, Wisconsin (MVWI) – Dodge County					
Benzene	170.23	Benzene	1.33E-03	Hexavalent Chromium	0.12
Formaldehyde	31.34	POM, Group 3	2.85E-04		
Dichloromethane	14.94	1,3-Butadiene	2.42E-04		
Tetrachloroethylene	14.82	Naphthalene	1.45E-04		
Acetaldehyde	12.20	Tetrachloroethylene	8.74E-05		
1,3-Butadiene	8.06	POM, Group 2	8.48E-05		
1,3-Dichloropropene	6.30	Hexavalent Chromium	4.53E-05		
Trichloroethylene	5.09	*p*-Dichlorobenzene	3.61E-05		
Naphthalene	4.26	Arsenic, PM	3.49E-05		
p-Dichlorobenzene	3.28	POM, Group 5	2.73E-05		

Table 30-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Monitoring Site in Wisconsin

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Mayville, Wisconsin (MVWI) – Dodge County					
Toluene	348.46	Acrolein	86,692.17	Hexavalent Chromium	<0.01
Xylenes	189.79	Manganese, PM	5,762.97		
Benzene	170.23	Benzene	5,674.30		
1,1,1-Trichloroethane	52.15	1,3-Butadiene	4,030.48		
Ethylbenzene	39.93	Formaldehyde	3,198.29		
Hexane	38.91	Xylenes	1,897.92		
Methanol	37.22	Bromomethane	1,760.01		
Formaldehyde	31.34	Naphthalene	1,418.89		
Glycol ethers, gas	22.90	Cyanide Compounds, gas	1,380.00		
Methyl isobutyl ketone	17.13	Acetaldehyde	1,355.02		

limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions are the same, the highest emitted pollutants in the cancer table may be different from the noncancer table.

Each site sampled for specific types of pollutants. Therefore, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 30.3, MVWI sampled for hexavalent chromium only. In addition, the cancer and noncancer surrogate risk approximations are limited to those sites sampling for a long enough period for annual averages to be calculated.

Observations from Table 30-8 include the following:

- Benzene, formaldehyde, and dichloromethane were the highest emitted pollutants with cancer UREs in Dodge County.
- Benzene was also the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by POM Group 3 and 1,3-butadiene.
- Five of the highest emitted pollutants in Dodge County also had the highest toxicity-weighted emissions.
- Hexavalent chromium, which was the only pollutant sampled at MVWI, had the seventh highest toxicity-weighted emissions for Dodge County. This pollutant did not appear on the list of highest emitted pollutants.

Observations from Table 30-9 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Dodge County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, manganese, and benzene.
- Three of the highest emitted pollutants Dodge County also had the highest toxicity-weighted emissions.
- Hexavalent chromium did not appear on the list of highest emitted pollutants on the list of highest toxicity-weighted emissions for pollutants with a noncancer toxicity factor. Its noncancer risk approximation was very low.

30.7 Summary of the 2007 Monitoring Data

Results from several of the treatments described in this section include the following:

- *Hexavalent chromium did not fail any screens for MVWI. However, it was considered a pollutant of interest in order to allow data analyses to be conducted.*

- *Hexavalent chromium did not exceed any of the MRL health benchmarks.*

31.0 Data Quality

This section discusses the data quality of the ambient air concentrations for the 2007 NATTS and UATMP dataset. In accordance with the Data Quality Objectives (DQOs) presented in ERG's EPA-approved QAPP, the following quality assessments were performed: completeness, precision, and accuracy (also called bias). Completeness statistics were presented in Section 2.0. The goal of 85 percent completeness was met by all but one site. As indicators of the reliability and representativeness of experimental measurements, both precision and accuracy are considered when interpreting ambient air monitoring data.

The quality assessments presented in this section show that the 2007 monitoring data are of a known and high quality. The method precision for the collocated and duplicate analyses varied from site to site, however the analytical precision level for replicate analyses met the data quality objectives. Audit samples show that ERG is meeting the accuracy requirements of the NATTS TAD.

31.1 Method Precision

Precision refers to the agreement between independent measurements performed according to identical protocols and procedures. Method precision, which includes s*ampling and analytical precision,* quantifies random errors associated with collecting ambient air samples and analyzing the samples in the laboratory and presents the most representative metric of precision. Method precision is evaluated by comparing concentrations measured in duplicate or collocated samples collected from the same air parcel. A *duplicate* sample is a sample collected simultaneously with a primary sample using the same sampling system (i.e., two separate samples through the same sampling system at the same time). This simultaneous collection is typically achieved by teeing the line from the sampler to two canisters and doubling the flow rate applied to achieve integration over the 24-hour collection period. *Collocated* samples are samples collected simultaneously using two independent collection systems at the same location at the same time.

Both approaches provide valuable, but different, assessments of method precision:

- Analysis of duplicate samples provides information on the potential for variability (or precision) expected from a single collection system, but does not provide information on the variability expected between different collection systems (inter-system assessment).
- Analysis of collocated samples provides information on the potential for variability (or precision) expected between different collection systems, but does not provide information on the variability expected from single collection systems (intra-system assessment).

During the 2007 sampling year, duplicate and collocated samples were collected on at least 10 percent of the scheduled sampling days, as outlined in the QAPP. Most of these samples were analyzed in replicate. Collocated systems were not provided under the national contract for sites sampling SVOC and were the responsibility of the participating agency. As such, duplicate/collocated samples were not collected for most SVOC sites because there were few collocated samplers and the samplers used were not equipped to collect duplicate samples. Therefore, the method precision data for SVOC is based on only two sites for 2007 (RUCA and SDGA), as they were the only sites with collocated systems.

Method precision was calculated by comparing the concentrations of the two duplicates/collocates for each compound. Three parameters were used to quantify random errors indicated by duplicate/collocated analyses of samples:

- ***Average concentration difference*** simply quantifies how duplicate or collocated analytical results differ, on average, for each pollutant and each sample. When interpreting central tendency estimates for specific pollutants sampled during the 2007 monitoring effort, participating agencies are encouraged to compare central tendencies to the average concentration differences. If a pollutant’s average concentration difference exceeds or nearly equals its central tendency, the analytical method may not be capable of precisely characterizing the concentrations. Therefore, data interpretation for these pollutants should be made with caution. Average concentration differences are calculated by subtracting the first analytical result from the second analytical result and averaging the difference for each pollutant.

- ***Relative percent difference (RPD)*** expresses concentration differences relative to the average concentrations measured during duplicate or collocated analyses. The RPD is calculated as follows:

$$\frac{X_1 - X_2}{\overline{X}} \times 100 = RPD$$

Where:

X_1 is the ambient air concentration of a given pollutant measured in one sample;
X_2 is the concentration of the same pollutant measured during duplicate or collocated analysis; and
$\overline{X}$ is the arithmetic mean of X_1 and X_2.

As this equation shows, duplicate or collocated analyses with low variability have lower RPDs (and better precision), and duplicate or collocated analyses with high variability have higher RPDs (and poorer precision).

- ***Coefficient of Variation (CV)*** provides a relative measure of data dispersion compared to the mean.

$$CV = \frac{\sigma}{\overline{\overline{X}}} \times 100$$

Where:

σ is the standard deviation of the sets of duplicate or collocated results;
$\overline{X}$ is the arithmetic mean of the sets of duplicate or collocated results;

The CV is used to determine the imprecision in survey estimates introduced from analysis. A coefficient of one percent would indicate that the analytical results could vary slightly due to sampling error, while a variation of 50 percent means that the results are more imprecise. The CV for two duplicate or collocated samples was calculated for each pollutant and each site.

The following approach was employed to estimate how precisely the ERG laboratory analyzed samples:

- CVs, RPDs, and concentration differences were calculated for every duplicate or collocated analysis performed during the program. In cases where pollutants were not detected during duplicate/collocated analyses, non-detects were replaced with 1/2 the MDL.

- To make an overall estimate of method precision, program-average CVs, RPDs, and absolute concentration differences were calculated for each pollutant by averaging the values from the individual duplicate or collocated analyses. The expression “average variability” or “median variability” for a given dataset refers to the average or median CV.

For each of the above calculations used to assess method precision, the substitution of 1/2 MDL was made for all cases where one sample yielded a measurement and the other yielded a non-detect. This substitution often resulted in higher CVs and RPDs.

Table 31-1 presents the 2007 Monitoring Program average method precision for VOC, SNMOC, carbonyl compounds, metals, hexavalent chromium, and SVOC, presented as RPD and CV. The overall carbonyl compounds and metals method precision (the average for all sites) met the program DQOs, which are 15 percent CV and 25 percent RPD. The overall VOC, SNMOC, hexavalent chromium, and SVOC method precision were above the program DQOs. The CVs and RPDs that exceed the program DQOs were driven largely by several factors:

1) the inclusion of measurements below the MDL,
2) the substitution of ½ MDLs for non-detects,
3) concentration differences for very small concentrations may yield large CVs and RPDs (i.e., 0.001 ng/m^3 and 0.002 ng/m^3 is 100 percent).

Tables 31-2 through 31-13, 31-15 through 31-18, 31-20 through 31-31, and 31-33 through 31-37 present average concentration differences, RPDs, and CVs as estimates of method precision for VOC, SNMOC, carbonyls, and metal compounds, respectively. Tables 31-14, 31-19, 31-32, and 31-38 present the average CVs per pollutant, per site, and per method. Table 31-39 presents the average CV for hexavalent chromium per site. Pollutants exceeding the 15 percent control limit for CV and/or the 25 percent control limit for RPD are bolded.

Table 31-1. Method Precision by Analytical Method

Method	Average Coefficient of Variation (%)	Average Relative Percent Difference (%)
VOC	28.25	39.96
SNMOC	20.45	28.95
Carbonyl Compounds	10.24	11.74
Metals	11.13	15.73
Hexavalent Chromium	25.00	35.36
SVOC	36.10	53.63

31.1.1 VOC Method Precision

Table 31-2 presents the method precision for all duplicate and collocated VOC samples. The average concentration differences observed for duplicate and collocated analyses of VOC ranged from 0.001 ppbv (*trans*-1,3-dichloropropene) to 4.37 ppbv (acetonitrile). Thirty-six out of 60 VOC showed greater variation than the target CV of 15 percent.

Table 31-2. VOC Method Precision: 306 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	273	**53.08**	4.37	**37.53**
Acetylene	306	13.63	0.14	9.64
Acrolein	305	**36.73**	0.14	**25.98**
Acrylonitrile	30	**42.98**	0.02	**30.39**
tert-Amyl Methyl Ether	8	**59.25**	0.002	**41.90**
Benzene	304	15.51	0.08	10.97
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	12	**56.26**	0.13	**39.78**
Bromoform	7	**69.07**	0.01	**48.84**
Bromomethane	282	19.49	0.04	13.78
1,3-Butadiene	290	21.11	0.04	14.93
Carbon Disulfide	255	**33.43**	0.12	**23.64**
Carbon Tetrachloride	305	14.31	0.04	10.12
Chlorobenzene	23	14.01	0.002	9.91
Chloroethane	235	**34.61**	0.04	**24.47**
Chloroform	249	23.88	0.08	**16.89**
Chloromethane	306	8.35	0.08	5.91
Chloromethylbenzene	2	**51.38**	0.00	**36.33**
Chloroprene	6	**118.66**	0.02	**83.91**
Dibromochloromethane	20	**74.11**	0.03	**52.40**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	2	**58.73**	0.003	**41.53**
o-Dichlorobenzene	7	**57.75**	0.004	**40.83**
p-Dichlorobenzene	246	**28.95**	0.04	**20.47**
Dichlorodifluoromethane	304	7.48	0.07	5.29
1,1-Dichloroethane	1	**68.61**	0.004	**48.52**
1,2-Dichloroethane	30	**38.36**	0.02	**27.12**
1,1-Dichloroethene	2	**165.85**	0.07	**117.28**
cis-1,2-Dichloroethylene	1	**128.68**	0.03	**90.99**
trans-1,2-Dichloroethylene	6	13.50	0.002	9.54
Dichloromethane	305	20.75	0.08	14.67
1,2-Dichloropropane	1	**28.40**	0.002	**20.08**
cis-1,3-Dichloropropene	1	**43.74**	0.004	**30.93**
trans-1,3-Dichloropropene	1	11.97	0.001	8.46
Dichlorotetrafluoroethane	305	19.68	0.04	13.91
Ethyl Acrylate	0	NA	NA	NA

Table 31-2. VOC Method Precision: 306 Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	304	19.03	0.05	13.45
Hexachloro-1,3-butadiene	3	**27.60**	0.004	**19.51**
Methyl Ethyl Ketone	299	**39.04**	0.28	**27.61**
Methyl Isobutyl Ketone	265	**37.79**	0.06	**26.72**
Methyl Methacrylate	29	**43.16**	0.03	**30.52**
Methyl *tert*-Butyl Ether	74	**43.88**	0.08	**31.03**
n-Octane	280	24.30	0.04	**17.18**
Propylene	306	24.71	0.58	**17.47**
Styrene	272	**31.51**	0.05	**22.28**
1,1,2,2-Tetrachloroethane	1	**120.13**	0.01	**84.94**
Tetrachloroethylene	275	**27.60**	0.05	**19.52**
Toluene	306	23.21	0.31	**16.41**
1,2,4-Trichlorobenzene	5	**64.93**	0.01	**45.91**
1,1,1-Trichloroethane	304	14.89	0.03	10.53
1,1,2-Trichloroethane	3	**55.73**	0.01	**39.41**
Trichloroethylene	110	**38.01**	0.06	**26.88**
Trichlorofluoromethane	303	8.92	0.05	6.31
Trichlorotrifluoroethane	303	10.34	0.04	7.31
1,2,4-Trimethylbenzene	302	20.29	0.04	14.35
1,3,5-Trimethylbenzene	293	17.81	0.04	12.59
Vinyl chloride	67	**52.74**	0.09	**37.29**
m,p-Xylene	303	21.13	0.09	14.94
o-Xylene	304	18.64	0.05	13.18

The VOC method precision for all collocated samples are presented in Table 31-3. The range of variability was 4.04 percent (chlorobenzene) to 84.94 percent (1,1,2,2-tetrachloroethane). The median variability was 24.92 percent.

Table 31-3. VOC Method Precision: 168 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	136	**72.81**	8.69	**51.48**
Acetylene	168	13.93	0.11	9.85
Acrolein	168	**35.59**	0.10	**25.17**
Acrylonitrile	19	**32.81**	0.03	**23.20**
tert-Amyl Methyl Ether	6	**43.66**	0.002	**30.87**
Benzene	166	19.66	0.07	13.90
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	11	**46.98**	0.19	**33.22**
Bromoform	7	**69.07**	0.01	**48.84**

Table 31-3. VOC Method Precision: 168 Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Bromomethane	154	15.40	0.002	10.89
1,3-Butadiene	163	**26.81**	0.01	**18.96**
Carbon Disulfide	124	**55.06**	0.11	**38.93**
Carbon Tetrachloride	168	10.20	0.01	7.22
Chlorobenzene	22	5.72	0.002	4.04
Chloroethane	137	**38.18**	0.01	**27.00**
Chloroform	136	**28.53**	0.08	**20.18**
Chloromethane	168	8.05	0.04	5.69
Chloromethylbenzene	2	**51.38**	0.002	**36.33**
Chloroprene	5	**115.81**	0.03	**81.89**
Dibromochloromethane	20	**74.11**	0.03	**52.40**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	1	**58.73**	0.003	**41.53**
o-Dichlorobenzene	7	**57.75**	0.004	**40.83**
p-Dichlorobenzene	148	**37.44**	0.01	**26.48**
Dichlorodifluoromethane	166	6.13	0.03	4.34
1,1-Dichloroethane	1	**68.61**	0.004	**48.52**
1,2-Dichloroethane	24	**45.98**	0.03	**32.51**
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	6	13.50	0.002	9.54
Dichloromethane	168	**25.87**	0.04	**18.30**
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	1	**43.74**	0.004	**30.93**
trans-1,3-Dichloropropene	1	11.97	0.001	8.46
Dichlorotetrafluoroethane	168	**27.98**	0.02	**19.79**
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	166	23.63	0.02	**16.71**
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	165	**40.30**	0.36	**28.49**
Methyl Isobutyl Ketone	146	**40.84**	0.03	**28.88**
Methyl Methacrylate	20	**40.00**	0.01	**28.28**
Methyl *tert*-Butyl Ether	39	**60.34**	0.03	**42.67**
n-Octane	155	**28.39**	0.01	**20.07**
Propylene	168	**32.92**	1.02	**23.28**
Styrene	153	**35.63**	0.01	**25.19**
1,1,2,2-Tetrachloroethane	1	**120.13**	0.01	**84.94**
Tetrachloroethylene	153	**34.90**	0.02	**24.68**
Toluene	168	**30.79**	0.37	**21.77**
1,2,4-Trichlorobenzene	4	**94.02**	0.01	**66.48**
1,1,1-Trichloroethane	166	17.55	0.003	12.41
1,1,2-Trichloroethane	1	**72.49**	0.005	**51.26**
Trichloroethylene	78	**41.30**	0.01	**29.20**
Trichlorofluoromethane	166	8.99	0.03	6.36
Trichlorotrifluoroethane	166	11.44	0.01	8.09
1,2,4-Trimethylbenzene	166	**26.67**	0.02	**18.86**

Table 31-3. VOC Method Precision: 168 Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,3,5-Trimethylbenzene	162	22.80	0.01	**16.12**
Vinyl chloride	50	**63.01**	0.02	**44.55**
m,p-Xylene	165	**27.18**	0.05	**19.22**
o-Xylene	166	24.86	0.02	**17.58**

Table 31-4 presents the method precision results for all duplicate analyses for VOC. The variability ranged from 6.12 percent (chloromethane) to 117.28 percent (1,1-dichloroethene). The median variability was 16.44 percent.

Table 31-4. VOC Method Precision: 138 Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	137	**34.86**	0.38	**24.65**
Acetylene	138	13.33	0.17	9.43
Acrolein	137	**37.88**	0.17	**26.78**
Acrylonitrile	11	**51.45**	0.02	**36.38**
tert-Amyl Methyl Ether	2	**90.43**	0.002	**63.94**
Benzene	138	11.36	0.09	8.03
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	1	**74.80**	0.01	**52.89**
Bromoform	0	NA	NA	NA
Bromomethane	128	23.25	0.07	**16.44**
1,3-Butadiene	127	15.41	0.07	10.90
Carbon Disulfide	131	13.47	0.13	9.53
Carbon Tetrachloride	137	18.42	0.07	13.02
Chlorobenzene	1	**38.89**	0.003	**27.50**
Chloroethane	98	**30.74**	0.07	**21.74**
Chloroform	113	19.58	0.07	13.85
Chloromethane	138	8.66	0.11	6.12
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	1	**130.06**	0.02	**91.96**
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	1	**58.73**	0.003	**41.53**
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	98	20.47	0.07	14.47
Dichlorodifluoromethane	138	8.72	0.10	6.16
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	6	**28.83**	0.002	**20.39**
1,1-Dichloroethene	2	**165.85**	0.07	**117.28**
cis-1,2-Dichloroethylene	1	**128.68**	0.03	**90.99**

Table 31-4. VOC Method Precision: 138 Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	137	15.63	0.11	11.05
1,2-Dichloropropane	1	**28.40**	0.002	**20.08**
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	137	11.37	0.06	8.04
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	138	14.42	0.08	10.20
Hexachloro-1,3-butadiene	3	**27.60**	0.004	**19.51**
Methyl Ethyl Ketone	134	**37.79**	0.19	**26.72**
Methyl Isobutyl Ketone	119	**34.74**	0.10	**24.56**
Methyl Methacrylate	9	**55.81**	0.10	**39.47**
Methyl *tert*-Butyl Ether	35	**32.12**	0.12	**22.71**
n-Octane	125	20.21	0.07	14.29
Propylene	138	16.50	0.14	11.66
Styrene	119	**27.39**	0.08	**19.37**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	122	20.30	0.07	14.36
Toluene	138	15.63	0.26	11.06
1,2,4-Trichlorobenzene	1	**35.84**	0.01	**25.34**
1,1,1-Trichloroethane	138	12.23	0.06	8.65
1,1,2-Trichloroethane	2	**47.35**	0.01	**33.48**
Trichloroethylene	32	**33.08**	0.13	**23.39**
Trichlorofluoromethane	137	8.86	0.08	6.27
Trichlorotrifluoroethane	137	9.31	0.07	6.58
1,2,4-Trimethylbenzene	136	13.90	0.07	9.83
1,3,5-Trimethylbenzene	131	13.19	0.06	9.33
Vinyl chloride	17	**35.63**	0.23	**25.20**
m,p-Xylene	138	15.09	0.13	10.67
o-Xylene	138	12.42	0.08	8.78

Due to the focus on QA for the NATTS program in the NATTS TAD, Tables 31-5 through 31-13 present the VOC method precision results for all of the NATTS sites that sampled VOC (BTUT, CAMS 35, CAMS 85, DEMI, GPCO, NBIL, PXSS, S4MO, and SEWA, respectively). Shaded rows present results for the NATTS core compounds.

Table 31-5 presents the method precision results from VOC duplicate analysis for BTUT. Variability ranged from 1.82 percent (chloromethane) to 29.50 percent (acetonitrile), with an average variability of 9.50 percent.

Table 31-5. VOC Method Precision: 12 Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	12	**41.73**	0.83	**29.50**
Acetylene	12	6.18	0.05	4.37
Acrolein	12	**32.03**	0.08	**22.65**
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	12	7.49	0.03	5.30
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	12	7.81	0.001	5.52
1,3-Butadiene	12	12.03	0.01	8.51
Carbon Disulfide	12	**33.11**	0.19	**23.41**
Carbon Tetrachloride	12	15.78	0.01	11.16
Chlorobenzene	0	NA	NA	NA
Chloroethane	9	7.73	0.001	5.46
Chloroform	11	**30.50**	0.01	**21.57**
Chloromethane	12	2.58	0.01	1.82
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	12	22.20	0.02	**15.69**
Dichlorodifluoromethane	12	3.66	0.02	2.59
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	12	5.15	0.01	3.64
1,2-Dichloropropane	1	**28.40**	0.002	**20.08**
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	12	5.33	0.001	3.77
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	12	8.17	0.01	5.78
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	12	19.97	0.03	14.12
Methyl Isobutyl Ketone	12	15.97	0.004	11.30
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	12	6.93	0.002	4.90
Propylene	12	6.84	0.02	4.84
Styrene	12	21.83	0.01	**15.44**

Table 31-5. VOC Method Precision: 12 Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	12	12.38	0.005	8.75
Toluene	12	10.24	0.09	7.24
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	12	3.57	0.001	2.53
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	6	5.40	0.001	3.82
Trichlorofluoromethane	12	3.88	0.01	2.74
Trichlorotrifluoroethane	12	2.63	0.003	1.86
1,2,4-Trimethylbenzene	12	8.73	0.01	6.17
1,3,5-Trimethylbenzene	12	9.01	0.002	6.37
Vinyl chloride	4	**32.69**	0.002	**23.12**
m,p-Xylene	12	6.77	0.02	4.78
o-Xylene	12	6.40	0.01	4.53

Table 31-6 presents the method precision results from the VOC collocated analysis for CAMS 35. Variability ranged from 0.87 percent (bromodichloromethane) to 78.18 percent (dibromochloromethane), with a median variability of 14.53 percent.

Table 31-6. VOC Method Precision: 48 Collocated Samples for Deer Park, TX (CAMS 35)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	31	**21.87**	0.02	**15.46**
Acetylene	48	12.84	0.11	9.08
Acrolein	48	**53.73**	0.11	**37.99**
Acrylonitrile	13	**27.78**	0.03	**19.64**
tert-Amyl Methyl Ether	3	**28.27**	0.002	**19.99**
Benzene	48	10.25	0.05	7.25
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	1	1.24	<0.001	0.87
Bromoform	1	**54.34**	0.003	**38.42**
Bromomethane	48	15.75	0.003	11.14
1,3-Butadiene	48	20.55	0.03	14.53
Carbon Disulfide	21	**53.19**	0.01	**37.61**
Carbon Tetrachloride	48	6.36	0.01	4.50
Chlorobenzene	10	5.32	0.002	3.76
Chloroethane	42	**35.83**	0.01	**25.34**
Chloroform	46	19.93	0.01	14.10
Chloromethane	48	6.92	0.04	4.89

Table 31-6. VOC Method Precision: 48 Collocated Samples for Deer Park, TX (CAMS 35) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	2	**103.38**	0.01	**73.10**
Dibromochloromethane	2	**110.57**	0.005	**78.18**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	1	**66.43**	0.004	**46.97**
p-Dichlorobenzene	44	24.90	0.004	**17.60**
Dichlorodifluoromethane	48	4.52	0.02	3.20
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	19	20.61	0.01	14.57
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	48	14.73	0.01	10.41
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	48	11.00	0.002	7.78
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	48	15.61	0.01	11.04
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	48	**30.84**	0.09	**21.81**
Methyl Isobutyl Ketone	40	**41.01**	0.01	**29.00**
Methyl Methacrylate	12	**53.26**	0.02	**37.66**
Methyl *tert*-Butyl Ether	32	**26.90**	0.03	**19.02**
n-Octane	46	**25.07**	0.01	**17.73**
Propylene	48	16.44	0.31	11.63
Styrene	41	21.05	0.005	14.89
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	44	**27.23**	0.005	**19.25**
Toluene	48	17.23	0.19	12.18
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	48	8.25	0.001	5.84
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	18	17.66	0.002	12.48
Trichlorofluoromethane	48	4.58	0.01	3.24
Trichlorotrifluoroethane	48	5.09	0.01	3.60
1,2,4-Trimethylbenzene	48	23.51	0.01	**16.63**
1,3,5-Trimethylbenzene	46	**27.15**	0.004	**19.20**
Vinyl chloride	30	15.45	0.004	10.92
m,p-Xylene	48	18.03	0.03	12.75
o-Xylene	48	16.71	0.01	11.82

Table 31-7 presents the method precision results from the VOC collocated analysis for CAMS 85. Variability ranged from 7.44 percent (carbon tetrachloride) to 134.52 percent (propylene), with an average variability of 50.50 percent.

Table 31-7. VOC Method Precision: 2 Collocated Samples for Karnack, TX (CAMS 85)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	0	NA	NA	NA
Acetylene	2	**41.10**	0.30	**29.06**
Acrolein	2	18.18	0.03	12.86
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	2	**33.33**	0.18	**23.57**
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	2	NA	NA	NA
1,3-Butadiene	2	**127.27**	0.07	**90.00**
Carbon Disulfide	0	NA	NA	NA
Carbon Tetrachloride	2	10.53	0.01	7.44
Chlorobenzene	0	NA	NA	NA
Chloroethane	2	**66.67**	0.01	**47.14**
Chloroform	2	**40.00**	0.01	**28.28**
Chloromethane	2	21.82	0.12	**15.43**
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	2	NA	NA	NA
Dichlorodifluoromethane	2	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	2	**175.00**	0.14	**123.74**
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	2	**66.67**	0.07	**47.14**
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	2	**66.67**	0.01	**47.14**
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	2	**54.55**	0.03	**38.57**
Hexachloro-1,3-butadiene	0	NA	NA	NA

Table 31-7. VOC Method Precision: 2 Collocated Samples for Karnack, TX (CAMS 85) (Continued)

Pollutant	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbv)**	**Coefficient of Variation (%)**
Methyl Ethyl Ketone	2	15.79	0.06	11.16
Methyl Isobutyl Ketone	0	NA	NA	NA
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	1	**165.81**	0.05	**117.24**
n-Octane	2	**31.58**	0.03	**22.33**
Propylene	2	**190.24**	12.09	**134.52**
Styrene	2	**28.57**	0.01	**20.20**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	2	**177.78**	0.16	**125.71**
Toluene	2	10.53	0.04	7.44
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	2	**66.67**	0.01	**47.14**
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	0	NA	NA	NA
Trichlorofluoromethane	2	NA	NA	NA
Trichlorotrifluoroethane	2	NA	NA	NA
1,2,4-Trimethylbenzene	2	**40.00**	0.02	**28.28**
1,3,5-Trimethylbenzene	2	NA	NA	NA
Vinyl chloride	1	**167.90**	0.13	**118.72**
m,p-Xylene	2	**42.86**	0.06	**30.30**
o-Xylene	2	**54.55**	0.03	**38.57**

Table 31-8 presents the method precision results from VOC collocated analysis for DEMI. These results show a low- to high-level of variability, ranging from 0.97 percent (*trans*-1,2-dichloroethylene) to 85.65 percent (vinyl chloride). The average CV, which was within the program DQO, was 12.93 percent.

Table 31-8. VOC Method Precision: 10 Collocated Samples for Dearborn, MI (DEMI)

Pollutant	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbv)**	**Coefficient of Variation (%)**
Acetonitrile	10	20.76	0.05	14.68
Acetylene	10	6.45	0.04	4.56
Acrolein	10	**41.93**	0.09	**29.65**
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	10	6.38	0.01	4.51
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA

Table 31-8. VOC Method Precision: 10 Collocated Samples for Dearborn, MI (DEMI) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Bromoform	0	NA	NA	NA
Bromomethane	10	14.00	0.001	9.90
1,3-Butadiene	10	5.11	0.001	3.61
Carbon Disulfide	7	**38.41**	0.01	**27.16**
Carbon Tetrachloride	10	8.12	0.01	5.74
Chlorobenzene	10	6.42	0.002	4.54
Chloroethane	10	18.50	0.003	13.08
Chloroform	10	**50.00**	0.09	**35.35**
Chloromethane	10	8.18	0.05	5.78
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	10	10.30	0.001	7.29
Dichlorodifluoromethane	10	6.38	0.03	4.51
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	1	1.37	<0.001	0.97
Dichloromethane	10	14.45	0.01	10.22
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	10	7.37	0.001	5.21
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	10	6.72	0.002	4.75
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	10	**42.55**	0.10	**30.09**
Methyl Isobutyl Ketone	10	**32.85**	0.01	**23.23**
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	8	7.38	0.001	5.22
Propylene	10	8.55	0.04	6.04
Styrene	9	16.28	0.001	11.51
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	8	5.93	0.002	4.20
Toluene	10	9.66	0.02	6.83
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	10	13.81	0.002	9.76
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	4	15.88	0.002	11.23
Trichlorofluoromethane	10	6.11	0.02	4.32

Table 31-8. VOC Method Precision: 10 Collocated Samples for Dearborn, MI (DEMI) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Trichlorotrifluoroethane	9	**37.56**	0.02	**26.56**
1,2,4-Trimethylbenzene	10	8.71	0.003	6.16
1,3,5-Trimethylbenzene	10	8.55	0.001	6.05
Vinyl chloride	1	**121.13**	0.01	**85.65**
m,p-Xylene	10	6.85	0.01	4.84
o-Xylene	10	8.84	0.003	6.25

Table 31-9 presents the method precision results from VOC duplicate analysis for GPCO. The variability ranged from 0.71 percent (dichlorotetrafluoroethane) to 91.96 percent (chloroprene). The average variability was 18.68 percent.

Table 31-9. VOC Method Precision: 12 Duplicate Samples for Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	12	15.33	0.13	10.84
Acetylene	12	3.98	0.08	2.82
Acrolein	12	**72.87**	0.34	**51.52**
Acrylonitrile	2	**109.32**	0.03	**77.30**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	12	4.76	0.02	3.36
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	1	**74.80**	0.01	**52.89**
Bromoform	0	NA	NA	NA
Bromomethane	12	13.20	0.002	9.34
1,3-Butadiene	12	6.41	0.004	4.54
Carbon Disulfide	12	4.00	0.05	2.83
Carbon Tetrachloride	12	11.78	0.01	8.33
Chlorobenzene	1	**38.89**	0.003	**27.50**
Chloroethane	8	22.25	0.003	**15.73**
Chloroform	12	3.67	0.001	2.60
Chloromethane	12	3.39	0.02	2.40
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	1	**130.06**	0.02	**91.96**
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	12	19.96	0.004	14.11
Dichlorodifluoromethane	12	3.88	0.02	2.74

Table 31-9. VOC Method Precision: 12 Duplicate Samples for Grand Junction, CO (GPCO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	1	5.59	0.001	3.95
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	1	**128.68**	0.03	**90.99**
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	12	4.12	0.01	2.91
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	12	1.01	<0.001	0.71
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	12	3.93	0.004	2.78
Hexachloro-1,3-butadiene	1	9.83	0.002	6.95
Methyl Ethyl Ketone	12	**63.98**	0.51	**45.24**
Methyl Isobutyl Ketone	12	**40.17**	0.04	**28.40**
Methyl Methacrylate	9	**55.81**	0.10	**39.47**
Methyl *tert*-Butyl Ether	1	**72.60**	0.01	**51.33**
n-Octane	12	6.13	0.005	4.33
Propylene	12	9.88	0.08	6.99
Styrene	12	**27.67**	0.02	**19.57**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	12	9.51	0.01	6.72
Toluene	12	6.32	0.08	4.47
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	12	2.03	<0.001	1.43
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	6	**28.63**	0.004	**20.24**
Trichlorofluoromethane	12	3.77	0.01	2.66
Trichlorotrifluoroethane	12	3.31	0.003	2.34
1,2,4-Trimethylbenzene	12	13.75	0.01	9.72
1,3,5-Trimethylbenzene	12	17.74	0.004	12.54
Vinyl chloride	1	19.94	0.002	14.10
m,p-Xylene	12	4.84	0.02	3.42
o-Xylene	12	5.18	0.01	3.66

Table 31-10 presents the method precision results from VOC collocated analysis for NBIL. The variability, in terms of CV, ranged from 0.76 percent (acrylonitrile) to 90.75 percent (bromoform). The average and median CV were 31.18 percent and 26.52 percent, respectively.

Table 31-10. VOC Method Precision: 12 Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	11	**108.29**	0.48	**76.57**
Acetylene	12	21.40	0.11	**15.13**
Acrolein	12	**35.62**	0.05	**25.19**
Acrylonitrile	1	1.07	<0.001	0.76
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	12	21.94	0.04	**15.52**
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	10	**92.73**	0.39	**65.57**
Bromoform	1	**128.34**	0.03	**90.75**
Bromomethane	11	16.45	0.002	11.63
1,3-Butadiene	10	**36.03**	0.01	**25.48**
Carbon Disulfide	10	**55.14**	0.01	**38.99**
Carbon Tetrachloride	12	15.58	0.02	11.01
Chlorobenzene	0	NA	NA	NA
Chloroethane	10	**27.03**	0.01	**19.11**
Chloroform	12	**106.28**	0.85	**75.15**
Chloromethane	12	7.32	0.04	5.18
Chloromethylbenzene	1	**90.60**	0.003	**64.07**
Chloroprene	0	NA	NA	NA
Dibromochloromethane	8	**95.23**	0.14	**67.34**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	7	**28.95**	0.004	**20.47**
Dichlorodifluoromethane	12	6.10	0.03	4.31
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	1	12.63	0.001	8.93
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	12	**18.55**	0.02	13.12
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	12	7.63	0.001	5.39
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	12	**38.97**	0.02	**27.56**
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	12	**66.29**	1.63	**46.88**
Methyl Isobutyl Ketone	10	**57.43**	0.03	**40.61**
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	8	**59.39**	0.01	**41.99**
Propylene	12	19.41	0.05	13.72

Table 31-10. VOC Method Precision: 12 Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Styrene	9	**59.37**	0.01	**41.98**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	12	**30.92**	0.01	**21.86**
Toluene	12	**46.21**	0.12	**32.68**
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	12	8.33	0.002	5.89
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	7	**62.58**	0.01	**44.25**
Trichlorofluoromethane	12	14.24	0.04	10.07
Trichlorotrifluoroethane	12	4.92	0.01	3.48
1,2,4-Trimethylbenzene	12	**58.43**	0.04	**41.31**
1,3,5-Trimethylbenzene	10	**54.62**	0.01	**38.62**
Vinyl chloride	1	**68.24**	0.01	**48.25**
m,p-Xylene	12	**52.70**	0.07	**37.27**
o-Xylene	12	**40.50**	0.03	**28.63**

Table 31-11 presents the method precision results from VOC duplicate analysis for PXSS. The variability ranges from 0.95 percent (chloroflorm) to 118.59 percent (acetonitrile). The median variability was 12.41 percent.

Table 31-11. VOC Method Precision: 6 Collocated Samples for Phoenix, AZ (PXSS)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	6	**167.71**	5.31	**118.59**
Acetylene	6	2.95	0.04	2.09
Acrolein	6	17.74	0.17	12.54
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	6	9.89	0.07	6.99
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	2	**66.67**	0.004	**47.14**
Bromomethane	5	**46.57**	0.004	**32.93**
1,3-Butadiene	6	10.78	0.003	7.62
Carbon Disulfide	6	**83.80**	0.08	**59.26**
Carbon Tetrachloride	6	3.87	0.001	2.74
Chlorobenzene	0	NA	NA	NA
Chloroethane	6	12.96	0.001	9.16
Chloroform	6	1.34	0.002	0.95
Chloromethane	6	3.19	0.01	2.26

Table 31-11. VOC Method Precision: 6 Collocated Samples for Phoenix, AZ (PXSS) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	4	13.57	0.002	9.60
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	4	**52.27**	0.004	**36.96**
p-Dichlorobenzene	6	17.37	0.01	12.28
Dichlorodifluoromethane	6	1.60	0.01	1.13
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	6	18.99	0.05	13.43
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	1	**43.74**	0.004	**30.93**
trans-1,3-Dichloropropene	1	11.97	0.001	8.46
Dichlorotetrafluoroethane	6	**34.57**	0.002	**24.45**
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	6	18.73	0.04	13.25
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	6	**39.10**	0.64	**27.65**
Methyl Isobutyl Ketone	6	19.97	0.03	14.12
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	6	17.02	0.01	12.03
Propylene	6	10.30	0.12	7.28
Styrene	6	21.83	0.01	**15.44**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	6	13.39	0.01	9.46
Toluene	6	6.72	0.14	4.75
1,2,4-Trichlorobenzene	4	**94.02**	0.01	**66.48**
1,1,1-Trichloroethane	6	**25.02**	0.003	**17.69**
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	2	14.29	0.002	10.10
Trichlorofluoromethane	6	5.53	0.01	3.91
Trichlorotrifluoroethane	6	6.62	0.002	4.68
1,2,4-Trimethylbenzene	6	18.89	0.02	13.36
1,3,5-Trimethylbenzene	6	18.57	0.01	13.13
Vinyl chloride	3	**60.56**	0.005	**42.83**
m,p-Xylene	6	21.16	0.12	14.96
o-Xylene	6	15.39	0.04	10.89

Table 31-12 presents the method precision results from VOC duplicate analysis for S4MO. The variability ranged from 10.89 percent (dichlorotetrafluoroethane) to 72.14 percent (trichloroethylene), with a median CV of 23.72 percent.

Table 31-12. VOC Method Precision: 12 Duplicate Samples for St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	11	**75.39**	0.37	**53.31**
Acetylene	12	**34.43**	0.11	**24.34**
Acrolein	11	**67.23**	0.21	**47.54**
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	12	**30.28**	0.04	**21.41**
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	11	**25.78**	0.01	**18.23**
1,3-Butadiene	11	**25.62**	0.01	**18.11**
Carbon Disulfide	11	**38.09**	0.09	**26.94**
Carbon Tetrachloride	11	**36.02**	0.02	**25.47**
Chlorobenzene	0	NA	NA	NA
Chloroethane	7	**54.03**	0.02	**38.20**
Chloroform	11	**33.54**	0.01	**23.72**
Chloromethane	12	**36.17**	0.10	**25.57**
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	9	22.77	0.003	**16.10**
Dichlorodifluoromethane	12	**37.37**	0.10	**26.43**
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	11	**36.47**	0.02	**25.79**
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	11	15.40	0.002	10.89
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	12	**29.57**	0.01	**20.91**
Hexachloro-1,3-butadiene	0	NA	NA	NA

Table 31-12. VOC Method Precision: 12 Duplicate Samples for St. Louis, MO (S4MO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Methyl Ethyl Ketone	11	**41.08**	0.10	**29.05**
Methyl Isobutyl Ketone	10	**41.77**	0.02	**29.53**
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	1	**80.12**	0.003	**56.66**
n-Octane	11	**41.58**	0.01	**29.40**
Propylene	12	**33.06**	0.08	**23.38**
Styrene	9	**29.22**	0.004	**20.66**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	11	16.53	0.004	11.69
Toluene	12	**28.07**	0.10	**19.85**
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	12	21.59	0.003	**15.27**
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	1	**102.02**	0.02	**72.14**
Trichlorofluoromethane	11	**36.82**	0.05	**26.03**
Trichlorotrifluoroethane	12	17.74	0.02	12.55
1,2,4-Trimethylbenzene	12	24.75	0.01	**17.50**
1,3,5-Trimethylbenzene	10	**25.40**	0.002	**17.96**
Vinyl chloride	1	**83.82**	0.01	**59.27**
m,p-Xylene	12	**32.38**	0.02	**22.89**
o-Xylene	12	**29.02**	0.01	**20.52**

The method precision results from the VOC collocated analysis for SEWA are shown in Table 31-13. In terms of CV, the variability ranged from 3.85 percent for chloromethane to 99.37 percent for dichlorotetrafluoroethane.

Table 31-13. VOC Method Precision: 14 Collocated Samples for Seattle, WA (SEWA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	10	17.06	0.02	12.06
Acetylene	14	9.60	0.07	6.79
Acrolein	14	**54.91**	0.10	**38.83**
Acrylonitrile	1	**27.52**	0.003	**19.46**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	14	11.19	0.03	7.91
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	12	9.02	0.001	6.38

Table 31-13. VOC Method Precision: 14 Collocated Samples for Seattle, WA (SEWA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,3-Butadiene	14	10.75	0.01	7.60
Carbon Disulfide	9	**35.29**	0.01	**24.95**
Carbon Tetrachloride	14	9.21	0.01	6.52
Chlorobenzene	0	NA	NA	NA
Chloroethane	12	**66.91**	0.01	**47.31**
Chloroform	14	**45.83**	0.01	**32.41**
Chloromethane	14	5.45	0.03	3.85
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	9	15.17	0.001	10.72
Dichlorodifluoromethane	14	7.00	0.03	4.95
1,1-Dichloroethane	1	**68.61**	0.004	**48.52**
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	5	**25.62**	0.004	**18.12**
Dichloromethane	14	9.36	0.01	6.62
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	14	**140.53**	0.18	**99.37**
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	14	13.37	0.01	9.45
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	14	**73.86**	0.24	**52.23**
Methyl Isobutyl Ketone	13	**26.14**	0.01	**18.49**
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	14	16.34	0.003	11.55
Propylene	14	18.65	0.07	13.19
Styrene	14	**80.77**	0.04	**57.11**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	12	18.08	0.003	12.79
Toluene	14	17.07	0.07	12.07
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	14	13.67	0.002	9.66
1,1,2-Trichloroethane	1	**72.49**	0.005	**51.26**
Trichloroethylene	9	**43.02**	0.01	**30.42**
Trichlorofluoromethane	14	6.84	0.02	4.84
Trichlorotrifluoroethane	14	9.74	0.01	6.89

Table 31-13. VOC Method Precision: 14 Collocated Samples for Seattle, WA (SEWA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,2,4-Trimethylbenzene	14	16.01	0.01	11.32
1,3,5-Trimethylbenzene	14	14.21	0.003	10.05
Vinyl chloride	0	NA	NA	NA
m,p-Xylene	14	17.92	0.02	12.67
o-Xylene	14	14.05	0.01	9.94

Table 31-14 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all UATMP and NATTS sites sampling VOC. The results from duplicate and collocated samples show low- to high-level variability among sites, ranging from an average CV of 7.44 percent at CANJ to 50.50 percent at CAMS 85. The average pollutant-specific CV ranged from 5.29 percent (dichlorodifluoromethane) to 117.28 percent (1,1-dichloroethene). The overall average was 28.25 percent. This is higher than the program DQO of 15 percent overall CV per site.

Table 31-14. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site

Pollutant	**Average**	**Barceloneta, PR (BAPR)**	**Bountiful, UT (BTUT)**	**Deer Park , TX (CAMS 35)**	**Karnack , TX (CAMS 85)**	**Camden, NJ (CANJ)**	**Chester, NJ (CHNJ)**	**Pryor, OK (CNEP)**	**Custer, SD (CUSD)**	**Dearborn, MI (DEMI)**	**Elizabeth, NJ (ELNJ)**
Acetonitrile	***37.53***	12.74	**29.50**	**15.46**	NA	12.90	**18.97**	2.13	**20.47**	14.68	**43.73**
Acetylene	*9.64*	13.01	4.37	9.08	**29.06**	2.98	5.81	4.00	6.02	4.56	**17.70**
Acrolein	***25.98***	**27.06**	**22.65**	**37.99**	12.86	13.01	**33.43**	8.80	**17.68**	**29.65**	**33.13**
Acrylonitrile	***30.39***	**61.22**	NA	**19.64**	NA	NA	**15.23**	NA	**15.33**	NA	NA
tert-Amyl Methyl Ether	***41.90***	NA	NA	**19.99**	NA	**63.94**	NA	**19.78**	NA	NA	NA
Benzene	*10.97*	8.69	5.30	7.25	**23.57**	2.12	5.75	13.65	7.44	4.51	12.04
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***39.78***	NA	NA	0.87	NA	NA	NA	NA	NA	NA	NA
Bromoform	***48.84***	NA	NA	**38.42**	NA	NA	NA	NA	NA	NA	NA
Bromomethane	*13.78*	**33.09**	5.52	11.14	NA	12.08	10.10	7.78	**18.76**	9.90	13.14
1,3-Butadiene	*14.93*	7.60	8.51	14.53	**90.00**	3.15	14.37	14.52	**15.38**	3.61	13.34
Carbon Disulfide	***23.64***	10.05	**23.41**	**37.61**	NA	2.79	5.19	7.70	4.17	**27.16**	10.08
Carbon Tetrachloride	*10.12*	7.98	11.16	4.50	7.44	**18.63**	**28.99**	7.25	5.07	5.74	**15.24**
Chlorobenzene	*9.91*	NA	NA	3.76	NA	NA	NA	3.82	NA	4.54	NA
Chloroethane	***24.47***	**50.50**	5.46	**25.34**	**47.14**	**22.31**	**26.30**	5.25	4.62	13.08	**47.66**
Chloroform	***16.89***	8.88	**21.57**	14.10	**28.28**	7.49	**27.88**	4.16	11.08	**35.35**	5.50
Chloromethane	*5.91*	7.30	1.82	4.89	**15.43**	3.65	1.33	3.87	3.07	5.78	9.32
Chloromethylbenzene	***36.33***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	***83.91***	NA	NA	**73.10**	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	***52.40***	NA	NA	**78.18**	NA	NA	NA	**15.71**	NA	NA	NA
1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***41.53***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	***40.83***	NA	NA	**46.97**	NA	NA	NA	**38.57**	NA	NA	NA
p-Dichlorobenzene	***20.47***	8.73	**15.69**	**17.60**	NA	5.02	**40.22**	**23.82**	4.56	7.29	11.76
Dichlorodifluoromethane	*5.29*	9.31	2.59	3.20	NA	2.98	3.01	5.26	2.44	4.51	8.91
1,1-Dichloroethane	***48.52***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 31-14. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average**	**Barceloneta, PR (BAPR)**	**Bountiful, UT (BTUT)**	**Deer Park , TX (CAMS 35)**	**Karnack , TX (CAMS 85)**	**Camden, NJ (CANJ)**	**Chester, NJ (CHNJ)**	**Pryor, OK (CNEP)**	**Custer, SD (CUSD)**	**Dearborn, MI (DEMI)**	**Elizabeth, NJ (ELNJ)**
1,2-Dichloroethane	***27.12***	NA	NA	14.57	**123.74**	NA	NA	NA	NA	NA	3.95
1,1-Dichloroethene	***117.28***	NA	NA	NA	NA	NA	NA	NA	NA	NA	**117.28**
cis-1,2-Dichloroethylene	***90.99***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	*9.54*	NA	NA	NA	NA	NA	NA	NA	NA	0.97	NA
Dichloromethane	*14.67*	6.27	3.64	10.41	**47.14**	7.36	6.03	7.75	5.76	10.22	11.67
1,2-Dichloropropane	***20.08***	NA	**20.08**	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	***30.93***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	*8.46*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	*13.91*	7.09	3.77	7.78	**47.14**	0.91	2.82	**24.42**	4.21	5.21	**18.86**
Ethyl Acrylate	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	*13.45*	6.34	5.78	11.04	**38.57**	3.73	10.05	8.83	12.31	4.75	10.86
Hexachloro-1,3-butadiene	***19.51***	NA	NA	NA	NA	NA	**32.07**	NA	NA	NA	NA
Methyl Ethyl Ketone	***27.61***	**16.81**	14.12	**21.81**	11.16	6.74	**46.31**	**26.22**	**36.94**	**30.09**	**23.25**
Methyl Isobutyl Ketone	***26.72***	NA	11.30	**29.00**	NA	6.59	**18.55**	**16.88**	**52.69**	**23.23**	14.54
Methyl Methacrylate	***30.52***	NA	NA	**37.66**	NA	NA	NA	**23.22**	NA	NA	NA
Methyl *tert*-Butyl Ether	***31.03***	4.78	NA	**19.02**	**117.24**	0.00	NA	NA	NA	NA	14.21
n-Octane	***17.18***	14.22	4.90	**17.73**	**22.33**	2.07	**27.35**	8.66	11.13	5.22	9.02
Propylene	***17.47***	11.35	4.84	11.63	**134.52**	2.19	3.93	**19.07**	8.93	6.04	10.48
Styrene	***22.28***	**22.37**	**15.44**	14.89	**20.20**	14.41	**27.45**	10.70	**16.33**	11.51	**42.95**
1,1,2,2-Tetrachloroethane	***84.94***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	***19.52***	**38.72**	8.75	**19.25**	**125.71**	2.55	**28.35**	**21.39**	9.86	4.20	10.22
Toluene	***16.41***	7.42	7.24	12.18	7.44	4.43	10.05	**15.02**	8.24	6.83	11.03
1,2,4-Trichlorobenzene	***45.91***	NA	NA	NA	NA	NA	**25.34**	NA	NA	NA	NA
1,1,1-Trichloroethane	*10.53*	7.02	2.53	5.84	**47.14**	1.89	6.38	14.07	7.69	9.76	**15.03**
1,1,2-Trichloroethane	***39.41***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	***26.88***	9.36	3.82	12.48	NA	5.34	**38.57**	**18.39**	NA	11.23	**28.28**

Table 31-14. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Deer Park , TX (CAMS 35)	Karnack , TX (CAMS 85)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Pryor, OK (CNEP)	Custer, SD (CUSD)	Dearborn, MI (DEMI)	Elizabeth, NJ (ELNJ)
Trichlorofluoromethane	*6.31*	8.18	2.74	3.24	NA	3.22	3.56	5.28	4.83	4.32	10.02
Trichlorotrifluoroethane	*7.31*	8.43	1.86	3.60	NA	1.79	3.52	5.69	2.33	**26.56**	8.47
1,2,4-Trimethylbenzene	*14.35*	9.50	6.17	**16.63**	**28.28**	4.28	**16.79**	10.59	9.13	6.16	8.30
1,3,5-Trimethylbenzene	*12.59*	4.81	6.37	**19.20**	NA	2.18	**17.05**	3.77	8.67	6.05	3.38
Vinyl chloride	***37.29***	14.10	**23.12**	10.92	**118.72**	5.24	NA	7.05	**35.36**	**85.65**	NA
m,p-Xylene	*14.94*	7.74	4.78	12.75	**30.30**	1.64	9.42	9.86	**22.76**	4.84	10.34
o-Xylene	*13.18*	4.88	4.53	11.82	**38.57**	3.50	9.81	9.39	8.48	6.25	8.05
Average	***28.25***	*14.41*	*9.50*	***18.77***	***50.50***	*7.44*	***17.06***	*12.23*	*12.55*	*12.93*	***18.58***

Table 31-14. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Loudon, TN (LDTN)**	**Loudon, TN (MSTN)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Phoenix, AZ (PXSS)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**	**Sioux Falls, SD (SFSD)**
Acetonitrile	***37.53***	10.84	13.99	**39.39**	**24.25**	**76.57**	8.16	**118.59**	**53.31**	12.06	10.78
Acetylene	*9.64*	2.82	3.26	**15.41**	2.72	**15.13**	14.36	2.09	**24.34**	6.79	**15.26**
Acrolein	***25.98***	**51.52**	**22.51**	**26.74**	**34.42**	**25.19**	12.84	12.54	**47.54**	**38.83**	**27.69**
Acrylonitrile	***30.39***	**77.30**	9.78	NA	NA	0.76	**39.41**	NA	NA	**19.46**	NA
tert-Amyl Methyl Ether	***41.90***	NA	**63.94**	NA	**63.94**	NA	NA	NA	NA	NA	NA
Benzene	*10.97*	3.36	10.66	**21.73**	9.20	**15.52**	7.29	6.99	**21.41**	7.91	8.56
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***39.78***	**52.89**	NA	NA	NA	**65.57**	NA	NA	NA	NA	NA
Bromoform	***48.84***	NA	NA	11.47	NA	**90.75**	NA	**47.14**	NA	NA	NA
Bromomethane	*13.78*	9.34	**28.53**	9.11	8.33	11.63	7.18	**32.93**	**18.23**	6.38	**36.49**
1,3-Butadiene	*14.93*	4.54	**21.94**	**23.36**	8.63	**25.48**	5.29	7.62	**18.11**	7.60	**23.33**
Carbon Disulfide	***23.64***	2.83	6.86	5.53	6.80	**38.99**	4.54	**59.26**	**26.94**	**24.95**	9.52
Carbon Tetrachloride	*10.12*	8.33	5.94	14.73	5.42	11.01	**15.84**	2.74	**25.47**	6.52	6.72
Chlorobenzene	*9.91*	**27.50**	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroethane	***24.47***	**15.73**	10.72	**22.63**	**18.55**	**19.11**	**24.36**	9.16	**38.20**	**47.31**	8.15
Chloroform	***16.89***	2.60	**16.56**	6.53	9.73	**75.15**	8.30	0.95	**23.72**	**32.41**	3.37
Chloromethane	*5.91*	2.40	3.98	3.66	4.38	5.18	3.69	2.26	**25.57**	3.85	3.17
Chloromethylbenzene	***36.33***	NA	NA	NA	8.59	**64.07**	NA	NA	NA	NA	NA
Chloroprene	***83.91***	**91.96**	NA	**50.74**	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	***52.40***	NA	NA	**65.39**	NA	**67.34**	NA	9.60	NA	NA	NA
1,2-Dibromoethane	*NA*	NA	NA		NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***41.53***	NA	NA	**41.53**	NA	NA	NA	NA	NA	NA	**41.53**
o-Dichlorobenzene	***40.83***	NA	NA	NA	NA	NA	NA	**36.96**	NA	NA	NA
p-Dichlorobenzene	***20.47***	14.11	11.33	**17.84**	**43.31**	**20.47**	**22.60**	12.28	**16.10**	10.72	NA
Dichlorodifluoromethane	*5.29*	2.74	1.82	7.16	3.76	4.31	4.60	1.13	**26.43**	4.95	2.38
1,1-Dichloroethane	***48.52***	NA	NA	NA	NA	NA	NA	NA	NA	**48.52**	NA

Table 31-14. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Loudon, TN (LDTN)**	**Loudon, TN (MSTN)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Phoenix, AZ (PXSS)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**	**Sioux Falls, SD (SFSD)**
1,2-Dichloroethane	***27.12***	3.95	NA	NA	NA	8.93	9.85	NA	NA	NA	NA
1,1-Dichloroethene	***117.28***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	***90.99***	**90.99**	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	*9.54*	NA	NA	NA	NA	NA	NA	NA	NA	**18.12**	NA
Dichloromethane	*14.67*	2.91	**16.46**	**32.17**	**18.54**	13.12	**21.94**	13.43	**25.79**	6.62	8.80
1,2-Dichloropropane	***20.08***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	***30.93***	NA	NA	NA	NA	NA	NA	**30.93**	NA	NA	NA
trans-1,3-Dichloropropene	*8.46*	NA	NA	NA	NA	NA	NA	8.46	NA	NA	NA
Dichlorotetrafluoroethane	*13.91*	0.71	3.63	4.86	13.95	5.39	**18.02**	**24.45**	10.89	**99.37**	5.89
Ethyl Acrylate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	*13.45*	2.78	10.20	10.61	11.71	**27.56**	7.58	13.25	**20.91**	9.45	**16.26**
Hexachloro-1,3-butadiene	***19.51***	6.95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Ethyl Ketone	***27.61***	**45.24**	**46.31**	**23.07**	**25.57**	**46.88**	**32.57**	**27.65**	**29.05**	**52.23**	**24.38**
Methyl Isobutyl Ketone	***26.72***	**28.40**	**50.78**	**36.23**	**28.72**	**40.61**	**19.49**	14.12	**29.53**	**18.49**	**22.60**
Methyl Methacrylate	***30.52***	**39.47**	NA	**43.59**	NA	NA	NA	NA	NA	NA	NA
Methyl *tert*-Butyl Ether	***31.03***	**51.33**	**30.84**	NA	NA	NA	NA	NA	**56.66**	NA	NA
n-Octane	***17.18***	4.33	14.70	**37.12**	**26.86**	**41.99**	6.36	12.03	**29.40**	11.55	**23.06**
Propylene	***17.47***	6.99	**34.49**	**19.84**	10.15	13.72	2.26	7.28	**23.38**	13.19	**28.74**
Styrene	***22.28***	**19.57**	14.41	7.13	6.56	**41.98**	7.04	**15.44**	**20.66**	**57.11**	**18.16**
1,1,2,2-Tetrachloroethane	***84.94***	NA	NA	NA	**84.94**	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	***19.52***	6.72	6.66	7.88	**20.52**	**21.86**	14.22	9.46	11.69	12.79	**18.31**
Toluene	***16.41***	4.47	**27.40**	**21.54**	**37.99**	**32.68**	**17.15**	4.75	**19.85**	12.07	10.82
1,2,4-Trichlorobenzene	***45.91***	NA	NA	NA	NA	NA	NA	**66.48**	NA	NA	NA
1,1,1-Trichloroethane	*10.53*	1.43	6.03	5.35	6.22	5.89	5.14	**17.69**	**15.27**	9.66	**18.10**
1,1,2-Trichloroethane	***39.41***	NA	4.68	NA	NA	NA	NA	NA	NA	**51.26**	NA
Trichloroethylene	***26.88***	**20.24**	NA	**32.57**	**38.41**	**44.25**	NA	10.10	**72.14**	**30.42**	NA

Table 31-14. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Loudon, TN (LDTN)**	**Loudon, TN (MSTN)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Phoenix, AZ (PXSS)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**	**Sioux Falls, SD (SFSD)**
Trichlorofluoromethane	*6.31*	2.66	2.73	7.86	4.51	10.07	3.76	3.91	**26.03**	4.84	1.85
Trichlorotrifluoroethane	*7.31*	2.34	2.03	3.54	3.91	3.48	**23.56**	4.68	12.55	6.89	2.42
1,2,4-Trimethylbenzene	*14.35*	9.72	**16.74**	11.18	**17.20**	**41.31**	13.01	13.36	**17.50**	11.32	8.23
1,3,5-Trimethylbenzene	*12.59*	12.54	11.71	13.84	**21.95**	**38.62**	11.90	13.13	**17.96**	10.05	7.37
Vinyl chloride	***37.29***	14.10	NA	**50.81**	NA	**48.25**	NA	**42.83**	**59.27**	NA	NA
m,p-Xylene	*14.94*	3.42	14.78	9.10	**15.09**	**37.27**	9.05	14.96	**22.89**	12.67	6.90
o-Xylene	*13.18*	3.66	**15.23**	10.12	**17.32**	**28.63**	8.74	10.89	**20.52**	9.94	5.21
Average	***28.25***	***18.68***	***16.52***	***20.85***	***19.48***	***31.18***	*12.82*	***19.51***	***27.49***	***21.04***	*14.14*

Table 31-14. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tulsa, OK (TUOK)	Tupelo, MS (TUMS)
Acetonitrile	***37.53***	**29.57**	**123.00**	**71.87**	**70.66**	**49.15**	**55.49**
Acetylene	*9.64*	4.19	9.77	3.73	**15.91**	9.79	8.40
Acrolein	***25.98***	**21.48**	**56.18**	9.03	**17.65**	**17.32**	**17.63**
Acrylonitrile	***30.39***	NA	NA	NA	**21.43**	**54.72**	NA
tert-Amyl Methyl Ether	***41.90***	NA	NA	NA	**19.78**	NA	NA
Benzene	*10.97*	4.90	**23.45**	5.82	**22.30**	**18.81**	6.94
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***39.78***	NA	NA	NA	NA	NA	NA
Bromoform	***48.84***	NA	NA	**56.44**	NA	NA	NA
Bromomethane	*13.78*	10.88	10.74	6.14	6.10	10.52	10.43
1,3-Butadiene	*14.93*	1.22	**18.73**	2.77	7.83	**21.82**	4.89
Carbon Disulfide	***23.64***	13.22	**118.45**	**47.56**	**33.85**	**59.30**	4.24
Carbon Tetrachloride	*10.12*	9.73	3.60	2.70	8.95	13.20	10.23
Chlorobenzene	*9.91*	NA	NA	NA	NA	NA	NA
Chloroethane	***24.47***	NA	**32.91**	**27.08**	**43.65**	**39.80**	6.80
Chloroform	***16.89***	**23.57**	**26.15**	7.02	NA	2.28	**19.52**
Chloromethane	*5.91*	6.11	7.21	2.42	3.42	11.63	8.19
Chloromethylbenzene	***36.33***	NA	NA	NA	NA	NA	NA
Chloroprene	***83.91***	NA	**85.85**	**117.87**	NA	NA	NA
Dibromochloromethane	***52.40***	NA	NA	NA	**78.18**	NA	NA
1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***41.53***	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	***40.83***	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	***20.47***	10.56	**37.67**	**24.05**	**55.56**	**47.10**	12.98
Dichlorodifluoromethane	*5.29*	6.55	8.26	1.40	3.21	4.88	6.38
1,1-Dichloroethane	***48.52***	NA	NA	NA	NA	NA	NA

Table 31-14. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average**	**San Juan, PR (SJPR)**	**Schiller Park. IL (SPIL)**	**Tulsa, OK (TOOK)**	**Tulsa, OK (TSOK)**	**Tulsa, OK (TUOK)**	**Tupelo, MS (TUMS)**
1,2-Dichloroethane	***27.12***	NA	NA	NA	3.95	11.38	**63.80**
1,1-Dichloroethene	***117.28***	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	***90.99***	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	*9.54*	NA	NA	NA	NA	NA	NA
Dichloromethane	*14.67*	**17.30**	**43.58**	4.28	10.13	**20.45**	9.72
1,2-Dichloropropane	***20.08***	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	***30.93***	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	*8.46*	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	13.91	9.43	4.75	8.04	2.81	9.05	**18.31**
Ethyl Acrylate	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	13.45	11.48	**19.83**	5.37	**36.58**	**19.66**	14.31
Hexachloro-1,3-butadiene	**19.51**	NA	NA	NA	NA	NA	NA
Methyl Ethyl Ketone	**27.61**	7.79	**30.07**	7.95	**36.42**	**31.30**	**17.83**
Methyl Isobutyl Ketone	**26.72**	5.83	**37.89**	9.04	**60.26**	**32.08**	**34.44**
Methyl Methacrylate	**30.52**	NA	NA	8.68	NA	NA	NA
Methyl *tert*-Butyl Ether	**31.03**	1.16	NA	**17.14**	**43.29**	**16.64**	NA
n-Octane	**17.18**	7.87	**26.20**	9.15	8.49	**33.60**	**31.41**
Propylene	**17.47**	3.86	**22.65**	3.96	8.68	**31.86**	10.19
Styrene	**22.28**	5.43	**50.98**	11.37	**62.47**	**17.19**	**27.57**
1,1,2,2-Tetrachloroethane	**84.94**	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	**19.52**	6.61	**32.13**	**24.76**	**15.48**	5.35	**23.97**
Toluene	**16.41**	9.18	**22.22**	7.09	**54.68**	**48.53**	6.44
1,2,4-Trichlorobenzene	**45.91**	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	10.53	13.82	**19.82**	3.97	10.54	5.33	12.13
1,1,2-Trichloroethane	**39.41**	NA	NA	NA	NA	NA	**62.28**
Trichloroethylene	**26.88**	NA	**45.34**	10.24	**42.89**	**54.13**	9.36

Table 31-14. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tulsa, OK (TUOK)	Tupelo, MS (TUMS)
Trichlorofluoromethane	*6.31*	4.86	**17.89**	2.19	4.40	7.79	7.02
Trichlorotrifluoroethane	*7.31*	9.96	6.09	**20.59**	3.06	9.01	6.35
1,2,4-Trimethylbenzene	*14.35*	1.42	**18.67**	7.04	**34.67**	**28.77**	7.01
1,3,5-Trimethylbenzene	*12.59*	3.03	13.81	5.07	**23.89**	**24.09**	14.32
Vinyl chloride	***37.29***	NA	NA	**29.01**	**28.28**	**24.01**	NA
m,p-Xylene	*14.94*	11.00	**24.01**	7.25	**51.99**	**19.72**	13.97
o-Xylene	*13.18*	8.18	**21.28**	8.51	**33.98**	**21.78**	13.35
Average	***28.25***	*9.34*	***31.85***	***16.57***	***27.37***	***23.77***	***17.45***

31.1.2 SNMOC Method Precision

The SNMOC method precision for duplicate and collocated samples is presented in Table 31-15. The average concentration differences observed for duplicate and collocated sample analysis ranged from 0.003 ppbC (*cis*-2-hexene) to 29.32 ppbC (TNMOC). The variation ranged from 1.37 percent (*trans*-2-hexene) to 91.12 percent (4-methyl-1-pentene).

Table 31-15. SNMOC Method Precision: 60 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	60	8.68	0.17	6.14
Benzene	60	18.84	0.28	13.32
1,3-Butadiene	38	**27.80**	0.03	**19.66**
n-Butane	58	6.83	0.28	4.83
cis-2-Butene	52	23.58	0.03	**16.67**
trans-2-Butene	58	22.36	0.05	**15.81**
Cyclohexane	60	12.96	0.04	9.17
Cyclopentane	60	16.91	0.05	11.95
Cyclopentene	11	**54.05**	0.14	**38.22**
n-Decane	58	**26.16**	0.22	**18.50**
1-Decene	0	NA	NA	NA
m-Diethylbenzene	38	**46.32**	0.13	**32.75**
p-Diethylbenzene	15	**68.12**	0.18	**48.17**
2,2-Dimethylbutane	55	22.43	0.05	**15.86**
2,3-Dimethylbutane	56	12.33	0.05	8.72
2,3-Dimethylpentane	58	19.27	0.06	13.62
2,4-Dimethylpentane	57	15.31	0.04	10.82
n-Dodecane	54	**46.71**	0.17	**33.03**
1-Dodecene	29	**74.26**	0.24	**52.51**
Ethane	60	9.53	0.87	6.74
Ethylbenzene	60	19.41	0.10	13.72
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	60	15.92	0.34	11.26
m-Ethyltoluene	56	**26.75**	0.10	**18.92**
o-Ethyltoluene	44	**41.53**	0.13	**29.37**
p-Ethyltoluene	54	**40.04**	0.38	**28.31**
n-Heptane	60	8.11	0.04	5.73
1-Heptene	49	**32.43**	0.06	**22.93**
n-Hexane	59	12.24	0.12	8.66
1-Hexene	50	**41.20**	0.07	**29.13**
cis-2-Hexene	2	2.32	0.003	1.64
trans-2-Hexene	2	1.94	0.004	1.37
Isobutane	60	9.16	0.21	6.47
Isobutene/1-Butene	42	20.85	0.30	14.75
Isopentane	50	23.51	2.68	**16.63**

Table 31-15. SNMOC Method Precision: 60 Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isoprene	52	19.34	0.15	13.67
Isopropylbenzene	24	**40.01**	0.81	**28.29**
2-Methyl-1-butene	52	15.76	0.07	11.14
2-Methyl-2-butene	39	**34.16**	0.09	**24.15**
3-Methyl-1-butene	6	9.58	0.07	6.77
Methylcyclohexane	55	17.26	0.05	12.21
Methylcyclopentane	60	8.82	0.07	7.27
2-Methylheptane	42	**43.70**	0.06	**30.90**
3-Methylheptane	49	14.46	0.02	10.23
2-Methylhexane	45	**37.18**	0.17	**26.29**
3-Methylhexane	60	19.10	0.10	13.51
3-Methylpentane	60	11.81	0.08	8.28
2-Methylpentane	59	**32.46**	0.37	**22.95**
4-Methyl-1-pentene	1	**128.86**	0.19	**91.12**
2-Methyl-1-pentene	9	**33.59**	0.10	**23.75**
n-Nonane	59	23.61	0.12	**16.70**
1-Nonene	27	**31.67**	0.05	**20.17**
n-Octane	60	11.37	0.03	8.04
1-Octene	32	**46.46**	0.07	**32.85**
n-Pentane	60	10.45	0.33	7.39
1-Pentene	58	**28.11**	0.31	**19.87**
cis-2-Pentene	34	**39.40**	0.07	**27.86**
trans-2-Pentene	50	15.71	0.03	11.11
a-Pinene	47	**56.77**	0.33	**40.14**
b-Pinene	13	**88.10**	0.69	**62.30**
Propane	60	6.58	0.55	4.65
n-Propylbenzene	51	**38.25**	0.07	**27.05**
Propylene	60	21.03	0.30	14.87
Propyne	0	NA	NA	NA
Styrene	19	**38.43**	0.11	**27.18**
SNMOC	60	11.43	8.44	8.08
TNMOC (w/unknowns)	60	20.38	29.32	14.41
Toluene	60	17.83	1.05	12.61
n-Tridecane	8	**87.69**	0.20	**62.00**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	44	**29.99**	0.05	**21.21**
1,2,4-Trimethylbenzene	60	**27.23**	0.15	**19.25**
1,3,5-Trimethylbenzene	43	**30.60**	0.06	**21.63**
2,2,3-Trimethylpentane	38	**43.84**	0.08	**31.00**
2,2,4-Trimethylpentane	60	12.04	0.15	8.19
2,3,4-Trimethylpentane	59	20.96	0.07	14.82
n-Undecane	59	**34.92**	0.21	**24.69**
1-Undecene	16	**77.84**	0.09	**55.04**
m-Xylene/*p*-Xylene	60	21.21	0.54	15.00
o-Xylene	60	14.75	0.08	10.43

Table 31-16 presents the method precision for duplicate SNMOC samples. The variation ranged from 1.37 (*trans*-2-hexene) to 91.12 (4-methyl-1-pentene), with an average CV of 18.23 percent and a median CV of 13.34 percent. For SNMOC, there was only one collocated site, NBIL. The SNMOC precision data for the collocated samples at NBIL is shown in Table 31-18.

Table 31-16. SNMOC Method Precision: 48 Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	48	7.06	0.15	4.99
Benzene	48	16.75	0.26	11.85
1,3-Butadiene	33	**25.57**	0.03	**18.08**
n-Butane	46	3.62	0.16	2.56
cis-2-Butene	45	19.40	0.03	13.72
trans-2-Butene	46	22.65	0.05	**16.02**
Cyclohexane	48	9.72	0.04	6.88
Cyclopentane	48	16.28	0.05	11.51
Cyclopentene	7	**47.41**	0.13	**33.53**
n-Decane	46	15.69	0.06	11.09
1-Decene	0	NA	NA	NA
m-Diethylbenzene	28	**46.92**	0.12	**33.18**
p-Diethylbenzene	11	**52.50**	0.19	**37.12**
2,2-Dimethylbutane	44	17.12	0.04	12.11
2,3-Dimethylbutane	44	7.08	0.03	5.01
2,3-Dimethylpentane	46	15.14	0.04	10.71
2,4-Dimethylpentane	45	12.22	0.03	8.64
n-Dodecane	43	**43.24**	0.12	**30.57**
1-Dodecene	22	**83.46**	0.27	**59.02**
Ethane	48	3.12	0.20	2.20
Ethylbenzene	48	14.19	0.07	10.04
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	48	15.70	0.34	11.10
m-Ethyltoluene	44	20.43	0.06	14.45
o-Ethyltoluene	36	**36.52**	0.09	**25.82**
p-Ethyltoluene	43	**33.04**	0.43	**23.36**
n-Heptane	48	6.08	0.03	4.30
1-Heptene	40	**31.62**	0.06	**22.36**
n-Hexane	47	12.78	0.13	9.04
1-Hexene	43	**36.08**	0.07	**25.51**
cis-2-Hexene	2	2.32	0.003	1.64
trans-2-Hexene	2	1.94	0.004	1.37
Isobutane	48	4.60	0.12	3.25
Isobutene/1-Butene	35	16.56	0.31	11.71
Isopentane	38	22.99	2.83	**16.26**
Isoprene	45	13.54	0.06	9.57
Isopropylbenzene	20	**35.80**	1.00	**25.32**
2-Methyl-1-butene	41	15.08	0.05	10.66

Table 31-16. SNMOC Method Precision: 48 Duplicate Samples (Continued)

Pollutant	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbC)**	**Coefficient of Variation (%)**
2-Methyl-2-butene	32	**33.76**	0.09	**23.87**
3-Methyl-1-butene	6	9.58	0.07	6.77
Methylcyclohexane	43	16.63	0.05	11.76
Methylcyclopentane	48	6.84	0.05	5.62
2-Methylheptane	33	**43.77**	0.07	**30.95**
3-Methylheptane	39	12.86	0.02	9.09
2-Methylhexane	35	**39.53**	0.18	**27.95**
3-Methylhexane	48	18.32	0.08	12.95
3-Methylpentane	48	8.71	0.07	6.42
2-Methylpentane	47	**33.68**	0.35	**23.81**
4-Methyl-1-pentene	1	**128.86**	0.19	**91.12**
2-Methyl-1-pentene	9	**33.59**	0.10	**23.75**
n-Nonane	47	13.12	0.03	9.28
1-Nonene	21	22.33	0.03	14.78
n-Octane	48	8.61	0.03	6.09
1-Octene	27	**38.38**	0.06	**27.14**
n-Pentane	48	8.39	0.33	5.93
1-Pentene	46	23.39	0.31	**16.54**
cis-2-Pentene	29	**35.77**	0.08	**25.29**
trans-2-Pentene	41	14.48	0.03	10.24
a-Pinene	36	**59.62**	0.33	**42.16**
b-Pinene	10	**75.54**	0.71	**53.42**
Propane	48	3.09	0.39	2.19
n-Propylbenzene	40	**31.82**	0.05	**22.50**
Propylene	48	22.84	0.34	**16.15**
Propyne	0	NA	NA	NA
Styrene	15	**32.53**	0.10	**23.00**
SNMOC	48	9.69	7.58	6.85
TNMOC (w/unknowns)	48	16.83	26.16	11.90
Toluene	48	13.40	1.14	9.48
n-Tridecane	7	**73.69**	0.17	**52.11**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	36	**28.90**	0.04	**20.44**
1,2,4-Trimethylbenzene	48	19.50	0.09	13.79
1,3,5-Trimethylbenzene	35	**29.96**	0.05	**21.18**
2,2,3-Trimethylpentane	29	**46.96**	0.09	**33.21**
2,2,4-Trimethylpentane	48	8.77	0.06	5.30
2,3,4-Trimethylpentane	47	21.63	0.07	**15.30**
n-Undecane	48	**27.14**	0.11	**19.19**
1-Undecene	13	**78.89**	0.08	**55.78**
m-Xylene/*p*-Xylene	48	16.27	0.54	11.50
o-Xylene	48	8.26	0.04	5.84

Due to the focus on QA for the NATTS program, Tables 31-17 and 31-18 present the SNMOC method precision for NATTS sites (BTUT and NBIL, respectively). Shaded rows present results for the NATTS core compounds. Table 31-17 shows that the SNMOC variation for the duplicate samples at BTUT ranged from 0.61 percent (acetylene) to 91.12 percent (4-methyl-1-pentene). The average CV was 10.84 percent, which is within the program DQO. Table 31-18 shows the SNMOC precision for the collocated samples at NBIL. The variability ranged from 7.14 percent for *n*-hexane to 91.69 percent for *n*-tridecane.

Table 31-17. SNMOC Method Precision: 12 Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbC)**	**Coefficient of Variation (%)**
Acetylene	12	0.86	0.05	0.61
Benzene	12	7.21	0.17	5.10
1,3-Butadiene	12	4.80	0.01	3.40
n-Butane	12	1.29	0.33	0.91
cis-2-Butene	12	4.82	0.02	3.41
trans-2-Butene	12	10.82	0.03	7.65
Cyclohexane	12	4.78	0.04	3.38
Cyclopentane	12	8.22	0.03	5.82
Cyclopentene	2	**27.00**	0.10	**19.09**
n-Decane	12	6.68	0.07	4.72
1-Decene	0	NA	NA	NA
m-Diethylbenzene	6	**28.62**	0.09	**20.24**
p-Diethylbenzene	6	**32.54**	0.16	**23.01**
2,2-Dimethylbutane	12	5.57	0.02	3.94
2,3-Dimethylbutane	12	3.72	0.05	2.63
2,3-Dimethylpentane	12	5.76	0.05	4.07
2,4-Dimethylpentane	12	3.79	0.03	2.68
n-Dodecane	12	**29.80**	0.10	**21.07**
1-Dodecene	8	**57.67**	0.13	**40.78**
Ethane	12	1.13	0.13	0.80
Ethylbenzene	12	9.39	0.09	6.64
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	12	5.02	0.27	3.55
m-Ethyltoluene	12	11.23	0.09	7.94
o-Ethyltoluene	12	23.92	0.09	**16.91**
p-Ethyltoluene	12	8.49	0.03	6.00
n-Heptane	12	3.38	0.06	2.39
1-Heptene	11	**49.07**	0.14	**34.70**
n-Hexane	12	3.31	0.20	2.34
1-Hexene	12	18.06	0.03	12.77
cis-2-Hexene	2	2.32	0.003	1.64
trans-2-Hexene	2	1.94	0.004	1.37
Isobutane	12	1.42	0.21	1.00
Isobutene/1-Butene	12	8.52	0.20	6.02

Table 31-17. SNMOC Method Precision: 12 Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isopentane	8	12.16	1.43	8.60
Isoprene	12	13.68	0.06	9.67
Isopropylbenzene	8	9.22	0.01	6.52
2-Methyl-1-butene	12	9.01	0.03	6.37
2-Methyl-2-butene	10	22.08	0.05	**15.61**
3-Methyl-1-butene	2	10.33	0.11	7.30
Methylcyclohexane	12	1.96	0.05	1.38
Methylcyclopentane	12	3.93	0.09	3.90
2-Methylheptane	12	16.47	0.05	11.65
3-Methylheptane	12	7.67	0.03	5.42
2-Methylhexane	12	16.35	0.11	11.56
3-Methylhexane	12	6.14	0.05	4.34
3-Methylpentane	12	3.96	0.10	2.82
2-Methylpentane	12	4.91	0.09	3.47
4-Methyl-1-pentene	1	**128.86**	0.19	**91.12**
2-Methyl-1-pentene	8	12.37	0.02	8.74
n-Nonane	12	7.49	0.04	5.30
1-Nonene	8	**38.65**	0.07	**33.32**
n-Octane	12	3.51	0.03	2.48
1-Octene	9	**47.71**	0.08	**33.73**
n-Pentane	12	3.92	0.24	2.77
1-Pentene	12	**30.94**	1.00	**21.88**
cis-2-Pentene	10	9.14	0.02	6.46
trans-2-Pentene	12	4.01	0.02	2.84
a-Pinene	10	**32.10**	0.13	**22.70**
b-Pinene	2	**35.20**	0.44	**24.89**
Propane	12	0.99	0.43	0.70
n-Propylbenzene	12	11.97	0.03	8.47
Propylene	12	4.11	0.12	2.90
Propyne	0	NA	NA	NA
Styrene	2	**55.54**	0.21	**39.27**
SNMOC	12	3.78	4.22	2.67
TNMOC (w/unknowns)	12	13.27	21.30	9.39
Toluene	12	5.81	0.35	4.11
n-Tridecane	1	**61.78**	0.18	**43.69**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	12	15.55	0.05	10.99
1,2,4-Trimethylbenzene	12	8.35	0.09	5.90
1,3,5-Trimethylbenzene	12	12.23	0.07	8.65
2,2,3-Trimethylpentane	12	16.41	0.06	11.60
2,2,4-Trimethylpentane	12	4.42	0.11	2.94
2,3,4-Trimethylpentane	12	7.56	0.03	5.35
n-Undecane	12	17.22	0.13	12.18
1-Undecene	7	24.06	0.03	**17.01**
m-Xylene/*p*-Xylene	12	5.38	0.19	3.81
o-Xylene	12	4.10	0.05	2.90

Table 31-18. SNMOC Method Precision: 12 Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	12	15.16	0.23	10.72
Benzene	12	**27.18**	0.33	**19.22**
1,3-Butadiene	5	**36.70**	0.03	**25.95**
n-Butane	12	19.71	0.73	13.93
cis-2-Butene	7	**40.27**	0.03	**28.47**
trans-2-Butene	12	21.18	0.03	14.98
Cyclohexane	12	**25.93**	0.06	**18.33**
Cyclopentane	12	19.43	0.03	13.74
Cyclopentene	4	**80.62**	0.20	**57.01**
n-Decane	12	**68.08**	0.88	**48.14**
1-Decene	0	NA	NA	NA
m-Diethylbenzene	10	**43.90**	0.16	**31.04**
p-Diethylbenzene	4	**114.98**	0.16	**81.31**
2,2-Dimethylbutane	11	**43.66**	0.10	**30.87**
2,3-Dimethylbutane	12	**33.36**	0.14	**23.59**
2,3-Dimethylpentane	12	**35.77**	0.16	**25.29**
2,4-Dimethylpentane	12	**27.63**	0.10	**19.54**
n-Dodecane	11	**60.62**	0.36	**42.86**
1-Dodecene	7	**37.45**	0.12	**26.48**
Ethane	12	**35.17**	3.54	**24.87**
Ethylbenzene	12	**40.27**	0.21	**28.48**
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	12	16.78	0.36	11.86
m-Ethyltoluene	12	**52.04**	0.24	**36.80**
o-Ethyltoluene	8	**61.57**	0.27	**43.53**
p-Ethyltoluene	11	**68.05**	0.20	**48.12**
n-Heptane	12	16.19	0.07	11.45
1-Heptene	9	**35.69**	0.04	**25.24**
n-Hexane	12	10.09	0.12	7.14
1-Hexene	7	**61.69**	0.09	**43.62**
cis-2-Hexene	0	NA	NA	NA
trans-2-Hexene	0	NA	NA	NA
Isobutane	12	**27.39**	0.56	**19.37**
Isobutene/1-Butene	7	**38.03**	0.27	**26.89**
Isopentane	12	**25.60**	2.10	**18.10**
Isoprene	7	**42.53**	0.51	**30.07**
Isopropylbenzene	4	**56.83**	0.07	**40.19**
2-Methyl-1-butene	11	18.49	0.16	13.08
2-Methyl-2-butene	7	**35.74**	0.08	**25.28**
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	12	19.78	0.05	13.99
Methylcyclopentane	12	16.70	0.12	13.85
2-Methylheptane	9	**43.40**	0.04	**30.69**
3-Methylheptane	10	20.86	0.03	14.75
2-Methylhexane	10	**27.78**	0.12	**19.65**
3-Methylhexane	12	22.25	0.16	**15.73**

Table 31-18. SNMOC Method Precision: 12 Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
3-Methylpentane	12	24.19	0.14	**15.68**
2-Methylpentane	12	**27.60**	0.43	**19.51**
4-Methyl-1-pentene	0	NA	NA	NA
2-Methyl-1-pentene	0	NA	NA	NA
n-Nonane	12	**65.58**	0.50	**46.37**
1-Nonene	6	**69.01**	0.16	**41.72**
n-Octane	12	22.39	0.06	**15.83**
1-Octene	5	**78.77**	0.09	**55.70**
n-Pentane	12	18.72	0.34	13.24
1-Pentene	12	**46.97**	0.33	**33.22**
cis-2-Pentene	5	**53.91**	0.05	**38.12**
trans-2-Pentene	9	20.62	0.03	14.58
a-Pinene	11	**45.37**	0.33	**32.08**
b-Pinene	3	**125.79**	0.61	**88.95**
Propane	12	20.54	1.21	14.52
n-Propylbenzene	11	**63.97**	0.15	**45.24**
Propylene	12	13.76	0.13	9.73
Propyne	0	NA	NA	NA
Styrene	4	**62.04**	0.11	**43.87**
SNMOC	12	18.41	11.87	13.02
TNMOC (w/unknowns)	12	**34.57**	41.95	**24.45**
Toluene	12	**35.52**	0.68	**25.11**
n-Tridecane	1	**129.67**	0.30	**91.69**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	8	**34.34**	0.08	**24.29**
1,2,4-Trimethylbenzene	12	**58.12**	0.40	**41.10**
1,3,5-Trimethylbenzene	8	**33.16**	0.10	**23.45**
2,2,3-Trimethylpentane	9	**31.34**	0.05	**22.16**
2,2,4-Trimethylpentane	12	**25.09**	0.50	**19.75**
2,3,4-Trimethylpentane	12	18.28	0.04	12.93
n-Undecane	11	**66.01**	0.63	**46.68**
1-Undecene	3	**74.67**	0.11	**52.80**
m-Xylene/*p*-Xylene	12	**41.00**	0.54	**28.99**
o-Xylene	12	**40.70**	0.24	**28.78**

Table 31-19 presents the average CV per pollutant, per pollutant per site, per site, and the overall CV for all UATMP and NATTS sites sampling SNMOC. The results from duplicate and collocated samples show low- to high-level variability among sites, ranging from an average CV of 10.84 percent at BTUT to 29.26 percent at NBIL, with an average of 20.45 percent. This overall average exceeds the 15 percent CV program DQO.

Table 31-19. SNMOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site

Pollutant	**Average**	**Bountiful, UT (BTUT)**	**Custer, SD (CUSD)**	**Gulfport, MS (GPMS)**	**Northbrook, IL (NBIL)**	**Sioux Falls, SD (SFSD)**
Acetylene	*6.14*	0.61	2.45	1.28	10.72	**15.62**
Benzene	*13.32*	5.10	**17.20**	**16.25**	**19.22**	8.84
1,3-Butadiene	***19.66***	3.40	**18.88**	8.11	**25.95**	**41.94**
n-Butane	*4.83*	0.91	1.13	1.68	13.93	6.50
cis-2-Butene	***16.67***	3.41	14.29	7.44	**28.47**	**29.74**
trans-2-Butene	***15.81***	7.65	**15.43**	13.68	14.98	**27.30**
Cyclohexane	*9.17*	3.38	7.71	11.16	**18.33**	5.25
Cyclopentane	*11.95*	5.82	**19.88**	7.81	13.74	12.53
Cyclopentene	***38.22***	**19.09**	**52.50**	**46.41**	**57.01**	**16.10**
n-Decane	***18.50***	4.72	9.96	**21.19**	**48.14**	8.49
1-Decene	NA	NA	NA	NA	NA	NA
m-Diethylbenzene	***32.75***	**20.24**	**45.96**	**45.12**	**31.04**	**21.40**
p-Diethylbenzene	***48.17***	**23.01**	**33.91**	**54.45**	**81.31**	NA
2,2-Dimethylbutane	***15.86***	3.94	10.99	**16.34**	**30.87**	**17.16**
2,3-Dimethylbutane	*8.72*	2.63	6.70	7.52	**23.59**	3.17
2,3-Dimethylpentane	*13.62*	4.07	**16.23**	14.75	**25.29**	7.77
2,4-Dimethylpentane	*10.82*	2.68	11.39	12.23	**19.54**	8.28
n-Dodecane	***33.03***	**21.07**	**26.39**	**49.47**	**42.86**	**25.38**
1-Dodecene	***52.51***	**40.78**	**80.20**	**39.56**	**26.48**	**75.53**
Ethane	*6.74*	0.80	0.60	0.40	**24.87**	7.01
Ethylbenzene	*13.72*	6.64	6.80	13.42	**28.48**	13.29
2-Ethyl-1-butene	NA	NA	NA	NA	NA	NA
Ethylene	*11.26*	3.55	3.14	**17.99**	11.86	**19.73**
m-Ethyltoluene	***18.92***	7.94	12.78	**26.47**	**36.80**	10.60
o-Ethyltoluene	***29.37***	**16.91**	**22.23**	**39.91**	**43.53**	**24.24**
p-Ethyltoluene	***28.31***	6.00	**18.19**	**54.06**	**48.12**	**15.21**
n-Heptane	*5.73*	2.39	6.30	5.01	11.45	3.52
1-Heptene	***22.93***	**34.70**	**22.07**	**20.83**	**25.24**	11.84
n-Hexane	*8.66*	2.34	12.40	4.95	7.14	**16.45**
1-Hexene	***29.13***	12.77	**16.78**	**21.60**	**43.62**	**50.89**
cis-2-Hexene	*1.64*	1.64	NA	NA	NA	NA
trans-2-Hexene	*1.37*	1.37	NA	NA	NA	NA
Isobutane	*6.47*	1.00	3.03	3.89	**19.37**	5.09
Isobutene/1-Butene	*14.75*	6.02	8.09	**25.61**	**26.89**	7.12
Isopentane	***16.63***	8.60	14.26	**25.07**	**18.10**	**17.11**
Isoprene	*13.67*	9.67	6.82	5.33	**30.07**	**16.47**
Isopropylbenzene	***28.29***	6.52	10.82	**69.10**	**40.19**	14.83
2-Methyl-1-butene	*11.14*	6.37	13.54	5.39	13.08	**17.34**
2-Methyl-2-butene	***24.15***	**15.61**	**16.18**	**22.28**	**25.28**	**41.41**
3-Methyl-1-butene	*6.77*	7.30	7.90	5.11	NA	NA
Methylcyclohexane	*12.21*	1.38	11.67	**26.63**	13.99	7.37

Table 31-19. SNMOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average**	**Bountiful, UT (BTUT)**	**Custer, SD (CUSD)**	**Gulfport, MS (GPMS)**	**Northbrook, IL (NBIL)**	**Sioux Falls, SD (SFSD)**
Methylcyclopentane	*7.27*	3.90	8.79	6.35	13.85	3.43
2-Methylheptane	***30.90***	11.65	**23.97**	**60.69**	**30.69**	**27.49**
3-Methylheptane	*10.23*	5.42	**15.89**	7.23	14.75	7.83
2-Methylhexane	***26.29***	11.56	**30.53**	**36.96**	**19.65**	**32.77**
3-Methylhexane	*13.51*	4.34	**16.45**	**18.26**	**15.73**	12.74
3-Methylpentane	*8.28*	2.82	8.29	9.83	**15.68**	4.75
2-Methylpentane	***22.95***	3.47	**18.99**	**46.68**	**19.51**	**26.11**
4-Methyl-1-pentene	***91.12***	**91.12**	NA	NA	NA	NA
2-Methyl-1-pentene	***23.75***	8.74	NA	**38.76**	NA	NA
n-Nonane	***16.70***	5.30	6.68	**16.49**	**46.37**	8.64
1-Nonene	***20.17***	**33.32**	9.96	6.57	**41.72**	9.27
n-Octane	*8.04*	2.48	6.38	8.30	**15.83**	7.19
1-Octene	***32.85***	**33.73**	**23.67**	**17.82**	**55.70**	**33.32**
n-Pentane	*7.39*	2.77	7.19	5.44	13.24	8.32
1-Pentene	***19.87***	**21.88**	14.52	10.48	**33.22**	**19.28**
cis-2-Pentene	***27.86***	6.46	**20.65**	**20.09**	**38.12**	**53.96**
trans-2-Pentene	*11.11*	2.84	10.27	11.61	14.58	**16.24**
a-Pinene	***40.14***	**22.70**	**20.92**	**70.28**	**32.08**	**54.72**
b-Pinene	***62.30***	**24.89**	**78.88**	**56.48**	**88.95**	NA
Propane	*4.65*	0.70	1.45	0.48	14.52	6.11
n-Propylbenzene	***27.05***	8.47	14.77	**31.75**	**45.24**	**35.02**
Propylene	*14.87*	2.90	3.46	**31.45**	9.73	**26.79**
Propyne	NA	NA	NA	NA	NA	NA
Styrene	***27.18***	**39.27**	**33.12**	6.14	**43.87**	13.49
SNMOC	*8.08*	2.67	3.13	**15.89**	13.02	5.72
TNMOC (w/unknowns)	*14.41*	9.39	6.39	**23.30**	**24.45**	8.53
Toluene	*12.61*	4.11	4.19	**21.75**	**25.11**	7.86
n-Tridecane	***62.00***	**43.69**	**54.96**	**57.68**	**91.69**	NA
1-Tridecene	NA	NA	NA	NA	NA	NA
1,2,3-Trimethylbenzene	***21.21***	10.99	11.97	**32.45**	**24.29**	**26.33**
1,2,4-Trimethylbenzene	***19.25***	5.90	**16.92**	**22.37**	**41.10**	9.97
1,3,5-Trimethylbenzene	***21.63***	8.65	13.21	**32.15**	**23.45**	**30.72**
2,2,3-Trimethylpentane	***31.00***	11.60	**31.50**	**64.17**	**22.16**	**25.55**
2,2,4-Trimethylpentane	*8.19*	2.94	3.76	6.23	**19.75**	8.29
2,3,4-Trimethylpentane	*14.82*	5.35	13.22	**28.65**	12.93	13.98
n-Undecane	***24.69***	12.18	13.87	**31.67**	**46.68**	**19.06**
1-Undecene	***55.04***	**17.01**	NA	**39.72**	**52.80**	**110.62**
m-Xylene/*p*-Xylene	*15.00*	3.81	11.01	**25.75**	**28.99**	5.44
o-Xylene	*10.43*	2.90	3.04	11.26	**28.78**	6.16
Average	***20.45***	*10.84*	***16.43***	***23.27***	***29.26***	***19.36***

31.1.3 Carbonyl Compounds Method Precision

Table 31-20 presents the method precision for duplicate and collocated carbonyl samples. The average concentration difference ranged from 0.004 ppbv for 2,5-dimethylbenzaldehyde to 0.17 ppbv for formaldehyde.

Table 31-20. Carbonyl Method Precision: 352 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	352	6.91	0.08	4.89
Acetone	352	10.77	0.09	6.94
Benzaldehyde	352	11.36	0.005	8.07
Butyraldehyde	352	8.09	0.01	5.72
Crotonaldehyde	352	7.74	0.01	5.48
2,5-Dimethylbenzaldehyde	1	21.81	0.004	**15.42**
Formaldehyde	352	7.10	0.17	5.02
Hexaldehyde	346	12.98	0.01	9.18
Isovaleraldehyde	73	18.77	0.01	13.27
Propionaldehyde	350	8.19	0.01	5.79
Tolualdehydes	344	12.77	0.005	9.03
Valeraldehyde	349	14.42	0.01	10.20

The carbonyl method precision results for the 148 collocated samples are presented in Table 31-21. The CV for carbonyl compounds ranged from 7.71 percent (crotonaldehyde) to 15.42 percent (2,5-dimethylbenzaldehyde).

Table 31-21. Carbonyl Method Precision: 148 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	148	16.26	0.11	11.50
Acetone	148	15.55	0.10	9.52
Benzaldehyde	148	13.53	0.01	9.76
Butyraldehyde	148	11.21	0.01	7.93
Crotonaldehyde	148	10.89	0.01	7.71
2,5-Dimethylbenzaldehyde	1	21.81	0.004	**15.42**
Formaldehyde	148	11.89	0.18	8.40

Table 31-21. Carbonyl Method Precision: 148 Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Hexaldehyde	148	16.47	0.02	11.64
Isovaleraldehyde	34	15.71	0.01	11.11
Propionaldehyde	148	11.20	0.02	7.92
Tolualdehydes	146	19.77	0.01	13.98
Valeraldehyde	148	18.02	0.01	12.74

Table 31-22 presents method precision results from the 204 duplicate carbonyl samples. The data show a low- to mid-level variability, ranging from 4.31 percent (acetaldehyde) to 20.16 percent (isovaleraldehyde), with an average of 9.27 percent.

Table 31-22. Carbonyl Method Precision: 204 Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	204	6.09	0.12	4.31
Acetone	204	13.69	0.09	9.49
Benzaldehyde	204	12.09	0.004	8.55
Butyraldehyde	204	9.18	0.01	6.49
Crotonaldehyde	204	7.27	0.01	5.14
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	204	8.41	0.28	5.95
Hexaldehyde	198	16.75	0.01	11.84
Isovaleraldehyde	39	**28.51**	0.004	**20.16**
Propionaldehyde	202	8.77	0.01	6.20
Tolualdehydes	198	14.30	0.004	10.11
Valeraldehyde	201	19.46	0.01	13.76

Due to the focus on QA for the NATTS program, Tables 31-23 through 31-31 present carbonyl method precision data for the NATTS sites (BTUT, DEMI, GPCO, NBIL, PXSS, S4MO, SEWA, SKFL, and SYFL, respectively). Shaded rows present results for NATTS core compounds. Table 31-23 shows that the carbonyl compound variation for the duplicate samples at BTUT ranged from 1.72 percent (acetaldehyde) to 14.67 percent (hexaldehyde), with an average of 5.13 percent.

Table 31-23. Carbonyl Method Precision: 12 Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	12	2.44	0.04	1.72
Acetone	12	2.41	0.08	1.78
Benzaldehyde	12	8.78	0.01	6.21
Butyraldehyde	12	4.67	0.01	3.30
Crotonaldehyde	12	4.50	0.003	3.18
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	12	6.16	0.13	4.36
Hexaldehyde	12	20.74	0.01	14.67
Isovaleraldehyde	4	8.09	0.003	5.72
Propionaldehyde	12	2.87	0.01	2.03
Tolualdehydes	12	11.07	0.01	7.83
Valeraldehyde	12	7.96	0.01	5.63

Table 31-24 shows the carbonyl method precision results for the collocated samples at DEMI. The average concentration difference between collocated samples ranged from 0.004 ppbv (2,5-dimethylbenzaldehyde) to 0.57 ppbv (acetaldehyde), and the average variability was 19.23 percent.

Table 31-24. Carbonyl Method Precision: 4 Collocated Samples for Dearborn, MI (DEMI)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	4	**35.26**	0.57	**24.93**
Acetone	4	14.58	0.15	10.31
Benzaldehyde	4	**27.62**	0.06	**22.14**
Butyraldehyde	4	24.55	0.07	**17.36**
Crotonaldehyde	4	14.94	0.05	10.68
2,5-Dimethylbenzaldehyde	1	21.81	0.004	**15.42**
Formaldehyde	4	16.64	0.33	11.77
Hexaldehyde	4	**31.90**	0.10	**22.56**
Isovaleraldehyde	0	NA	NA	NA
Propionaldehyde	4	**31.52**	0.17	**22.29**
Tolualdehydes	3	**29.43**	0.01	**20.81**
Valeraldehyde	4	**47.01**	0.06	**33.24**

Table 31-25 shows the carbonyl method precision results for the duplicate samples at GPCO. The duplicate variability ranged from 0.46 percent (acetaldehyde) to 11.26 percent (valeraldehyde). The average variability was 4.68 percent, which is within the program DQO.

Table 31-25. Carbonyl Method Precision: 12 Duplicate Samples for Grand Junction, CO (GPCO)

Pollutant	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbv)**	**Coefficient of Variation (%)**
Acetaldehyde	12	0.65	0.01	0.46
Acetone	12	3.85	0.07	2.56
Benzaldehyde	12	10.31	0.01	7.29
Butyraldehyde	12	3.17	0.002	2.24
Crotonaldehyde	12	2.80	0.002	1.98
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	12	2.77	0.09	1.96
Hexaldehyde	12	11.82	0.002	8.36
Isovaleraldehyde	2	11.76	0.001	8.32
Propionaldehyde	12	3.70	0.01	2.61
Tolualdehydes	12	2.82	0.001	2.00
Valeraldehyde	12	15.92	0.004	11.26

Table 31-26 presents the carbonyl method precision results for collocated samples at NBIL. The variability ranged from 29.10 percent for hexaldehyde to 67.70 percent for acetaldehyde, with an average CV of 45.20 percent. All pollutants have RPD and CV outside the program DQO.

Table 31-26. Carbonyl Method Precision: 12 Collocated Samples for Northbrook, IL (NBIL)

Pollutant	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbv)**	**Coefficient of Variation (%)**
Acetaldehyde	12	**95.74**	0.40	**67.70**
Acetone	12	**102.48**	0.49	**62.58**
Benzaldehyde	12	**52.23**	0.02	**36.94**
Butyraldehyde	12	**58.13**	0.03	**41.10**
Crotonaldehyde	12	**55.85**	0.02	**39.49**
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	12	**93.74**	0.91	**66.28**

Table 31-26. Carbonyl Method Precision: 12 Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Hexaldehyde	12	**41.15**	0.01	**29.10**
Isovaleraldehyde	0	NA	NA	NA
Propionaldehyde	12	**58.47**	0.04	**41.35**
Tolualdehydes	12	**49.25**	0.02	**34.82**
Valeraldehyde	12	**46.16**	0.01	**32.64**

The method precision results for the carbonyl analysis of the collocated samples at PXSS are shown in Table 31-27. In terms of CV, the variability ranged from 1.59 percent (acetone) to 49.96 percent (hexaldehyde).

Table 31-27. Carbonyl Method Precision: 6 Collocated Samples for Phoenix, AZ (PXSS)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	6	3.13	0.07	2.21
Acetone	6	3.04	0.16	1.59
Benzaldehyde	6	20.53	0.02	14.51
Butyraldehyde	6	10.86	0.03	7.68
Crotonaldehyde	6	3.46	0.01	2.45
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	6	5.36	0.25	3.79
Hexaldehyde	6	**70.66**	0.11	**49.96**
Isovaleraldehyde	2	NA	NA	NA
Propionaldehyde	6	8.12	0.02	5.74
Tolualdehydes	6	**41.82**	0.04	**29.57**
Valeraldehyde	6	**44.69**	0.05	**31.60**

Table 31-28 shows the carbonyl method precision results for duplicate samples at S4MO. Only one compound (hexaldehyde) was outside the specifications for CV, with an overall average CV of 6.27 percent.

Table 31-28. Carbonyl Method Precision: 12 Duplicate Samples for St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	12	7.22	0.19	5.11
Acetone	12	10.87	0.15	6.47
Benzaldehyde	12	10.11	0.004	7.15
Butyraldehyde	12	6.46	0.01	4.57
Crotonaldehyde	12	7.43	0.01	5.25
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	12	2.38	0.08	1.68
Hexaldehyde	12	23.78	0.01	**16.82**
Isovaleraldehyde	2	NA	NA	NA
Propionaldehyde	12	8.31	0.01	5.87
Tolualdehydes	12	5.88	0.002	4.16
Valeraldehyde	12	7.88	0.003	5.57

The method precision results for the carbonyl analysis of the collocated samples at SEWA are shown in Table 31-29. In terms of CV, the variability ranged from 1.13 percent (isovaleraldehyde) to 9.19 percent (crotonaldehyde), with an average variability of 5.02 percent.

Table 31-29. Carbonyl Method Precision: 14 Collocated Samples for Seattle, WA (SEWA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	14	4.03	0.03	2.85
Acetone	14	3.39	0.04	2.00
Benzaldehyde	14	9.76	0.004	6.90
Butyraldehyde	14	5.34	0.005	3.78
Crotonaldehyde	14	12.99	0.01	9.19
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	14	10.24	0.08	7.24
Hexaldehyde	14	3.34	0.001	2.36
Isovaleraldehyde	2	1.60	0.001	1.13
Propionaldehyde	14	11.03	0.01	7.80
Tolualdehydes	14	8.16	0.002	5.77
Valeraldehyde	14	8.82	0.003	6.24

Table 31-30 presents the carbonyl method precision results for duplicate samples at SKFL. Only one compound (isovaleraldehyde) was outside the specifications for CV, with the overall average (10.89 percent) falling within the specifications.

Table 31-30. Carbonyl Method Precision: 12 Duplicate Samples for Pinellas Park, FL (SKFL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	14	4.62	0.03	3.27
Acetone	14	8.77	0.06	5.99
Benzaldehyde	14	7.20	0.002	5.09
Butyraldehyde	14	5.10	0.004	3.61
Crotonaldehyde	14	3.21	0.004	2.27
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	14	2.38	0.02	1.68
Hexaldehyde	14	7.24	0.002	5.12
Isovaleraldehyde	3	**97.74**	0.01	**69.11**
Propionaldehyde	14	4.72	0.003	3.34
Tolualdehydes	14	13.69	0.003	9.68
Valeraldehyde	14	15.02	0.003	10.62

Table 31-31 shows carbonyl method precision results for duplicate samples at SYFL. The average RPD and CV do not meet the NATTS requirements for most compounds.

Table 31-31. Carbonyl Method Precision: 14 Duplicate Samples for Plant City, FL (SYFL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	14	**29.04**	0.93	**20.54**
Acetone	14	**44.51**	0.31	**35.01**
Benzaldehyde	14	**43.03**	0.01	**30.43**
Butyraldehyde	14	**42.90**	0.10	**30.33**
Crotonaldehyde	14	17.44	0.04	12.33
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	14	**40.89**	3.10	**28.92**
Hexaldehyde	14	**61.77**	0.08	**43.68**
Isovaleraldehyde	3	**110.47**	0.02	**78.11**

Table 31-31. Carbonyl Method Precision: 14 Duplicate Samples for Plant City, FL (SYFL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propionaldehyde	14	**34.68**	0.11	**24.52**
Tolualdehydes	12	**31.29**	0.01	**22.12**
Valeraldehyde	14	**69.53**	0.10	**49.17**

Table 31-32 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all UATMP and NATTS sites sampling carbonyl compounds. The duplicate and collocated sample results show low- to high-level variability among the sites, ranging from an average CV of 2.76 percent at INDEM to 45.20 percent at NBIL, with an overall average of 10.24 percent. This is within the 15 percent CV program DQO.

Table 31-32. Carbonyl Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site

Pollutant	Average	St. Petersburg, FL (AZFL)	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Dearborn, MI (DEMI)
Acetaldehyde	*7.36*	3.66	4.54	1.72	2.68	6.48	1.39	**24.93**
Acetone	*9.50*	3.87	9.69	1.78	3.21	7.07	4.39	10.31
Benzaldehyde	*9.06*	5.49	7.46	6.21	4.91	5.65	5.97	**22.14**
Butyraldehyde	*7.10*	2.89	**15.44**	3.30	3.71	1.74	2.37	**17.36**
Crotonaldehyde	*6.23*	3.81	6.99	3.18	6.24	5.98	2.68	10.68
2,5-Dimethylbenzaldehyde	***15.42***	NA	NA	NA	NA	NA	NA	**15.42**
Formaldehyde	*6.99*	13.64	6.79	4.36	5.56	6.44	4.49	11.77
Hexaldehyde	*11.75*	13.97	NA	14.67	5.96	8.63	9.16	**22.56**
Isovaleraldehyde	***17.44***	3.72	NA	5.72	10.10	12.86	4.56	NA
Propionaldehyde	*6.93*	2.12	**22.58**	2.03	2.52	7.98	4.13	**22.29**
Tolualdehydes	*11.76*	6.53	**24.42**	7.83	7.91	13.31	12.69	**20.81**
Valeraldehyde	*13.32*	5.98	**45.13**	5.63	**17.84**	10.74	7.28	**33.24**
Average	*10.24*	5.97	**15.89**	5.13	6.42	7.90	5.37	**19.23**

Table 31-32. Carbonyl Method Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site (Continued)

Pollutant	Average	Elizabeth, NJ (ELNJ)	Davie, FL (FLFL)	Tampa, FL (GAFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Indianapolis, IN (IDIN)	Gary, IN (INDEM)
Acetaldehyde	*7.36*	0.61	2.97	3.41	0.46	2.96	0.89	0.91
Acetone	*9.50*	4.22	**19.59**	**22.26**	2.56	8.41	0.62	1.03
Benzaldehyde	*9.06*	7.00	2.89	12.89	7.29	6.13	7.75	4.20
Butyraldehyde	*7.10*	6.60	1.94	9.29	2.24	4.50	4.33	2.44
Crotonaldehyde	*6.23*	6.92	1.94	6.36	1.98	5.55	5.79	3.40
2,5-Dimethylbenzaldehyde	***15.42***	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*6.99*	1.04	2.98	9.35	1.96	5.20	3.40	0.43
Hexaldehyde	*11.75*	10.27	8.32	**17.16**	8.36	6.42	4.83	1.96
Isovaleraldehyde	***17.44***	4.56	NA	**45.65**	8.32	6.73	**38.89**	NA
Propionaldehyde	*6.93*	4.05	4.66	3.63	2.61	2.67	2.92	3.24
Tolualdehydes	*11.76*	5.98	5.24	**19.08**	2.00	6.91	10.30	6.56
Valeraldehyde	*13.32*	6.21	NA	14.46	11.26	8.98	4.90	3.39
Average	*10.24*	5.22	5.61	14.87	4.46	5.86	7.69	2.76

Table 31-32. Carbonyl Method Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site (Continued)

Pollutant	Average	Indianapolis, IN (ININ)	Loudon, TN (LDTN)	Loudon, TN (MSTN)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Winter Park, FL (ORFL)	Phoenix, AZ (PXSS)
Acetaldehyde	*7.36*	2.90	0.47	1.30	**67.70**	7.80	8.54	2.21
Acetone	*9.50*	2.42	2.43	1.41	**62.58**	3.03	14.53	1.59
Benzaldehyde	*9.06*	10.21	2.77	5.84	**36.94**	9.95	14.40	14.51
Butyraldehyde	*7.10*	3.34	2.87	2.13	**41.10**	7.56	11.55	7.68
Crotonaldehyde	*6.23*	4.29	3.36	1.73	**39.49**	9.98	3.98	2.45
2,5-Dimethylbenzaldehyde	***15.42***	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*6.99*	5.94	1.90	1.31	**66.28**	5.93	5.52	3.79
Hexaldehyde	*11.75*	6.96	2.16	3.09	**29.10**	5.01	7.14	**49.96**
Isovaleraldehyde	***17.44***	NA	2.62	6.29	NA	3.14	3.93	NA
Propionaldehyde	*6.93*	6.73	3.20	2.44	**41.35**	7.83	7.14	5.74
Tolualdehydes	*11.76*	**36.26**	7.17	5.76	**34.82**	8.43	6.72	**29.57**
Valeraldehyde	*13.32*	6.93	**18.32**	5.46	**32.64**	10.92	6.16	**31.60**
Average	*10.24*	8.60	4.30	3.34	**45.20**	7.23	8.15	14.91

Table 31-32. Carbonyl Sampling and Analytical Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site (Continued)

Pollutant	**Average**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**	**Sioux Falls, SD (SFSD)**	**San Juan, PR (SJPR)**	**Pinellas Park, FL (SKFL)**	**Schiller Park, IL (SPIL)**
Acetaldehyde	*7.36*	5.11	2.85	1.77	2.30	3.27	**50.90**
Acetone	*9.50*	6.47	2.00	2.35	**18.59**	5.99	**35.01**
Benzaldehyde	*9.06*	7.15	6.90	8.00	4.71	5.09	9.00
Butyraldehyde	*7.10*	4.57	3.78	2.37	6.18	3.61	12.68
Crotonaldehyde	*6.23*	5.25	9.19	4.52	1.89	2.27	**15.98**
2,5-Dimethylbenzaldehyde	***15.42***	NA	NA	NA	NA	NA	NA
Formaldehyde	*6.99*	1.68	7.24	3.59	0.45	1.68	8.54
Hexaldehyde	*11.75*	**16.82**	2.36	3.17	**17.99**	5.12	**23.37**
Isovaleraldehyde	***17.44***	NA	1.13	**25.71**	NA	**69.11**	NA
Propionaldehyde	*6.93*	5.87	7.80	2.51	1.89	3.34	3.97
Tolualdehydes	*11.76*	4.16	5.77	**18.28**	6.50	9.68	14.89
Valeraldehyde	*13.32*	5.57	6.24	9.59	13.33	10.62	10.86
Average	*10.24*	6.27	5.02	7.44	7.38	10.89	**18.52**

Table 31-32. Carbonyl Sampling and Analytical Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site (Continued)

Pollutant	**Average**	**Plant City, FL (SYFL)**	**Tulsa , OK (TOOK)**	**Tulsa , OK (TSOK)**	**Tulsa , OK (TUOK)**	**Tupelo, MS (TUMS)**	**Indianapolis, IN (WPIN)**
Acetaldehyde	*7.36*	**20.54**	0.76	1.22	0.56	1.62	3.42
Acetone	*9.50*	**35.01**	1.78	7.97	1.73	7.30	2.38
Benzaldehyde	*9.06*	**30.43**	2.33	4.15	6.76	10.75	3.10
Butyraldehyde	*7.10*	**30.33**	1.00	3.32	2.41	3.11	6.57
Crotonaldehyde	*6.23*	12.33	0.77	2.95	3.69	5.82	4.16
2,5-Dimethylbenzaldehyde	***15.42***	NA	NA	NA	NA	NA	NA
Formaldehyde	*6.99*	**28.92**	2.02	0.67	1.87	3.46	2.50
Hexaldehyde	*11.75*	**43.68**	5.82	4.10	2.96	11.30	3.77
Isovaleraldehyde	***17.44***	**78.11**	9.08	NA	NA	NA	8.63
Propionaldehyde	*6.93*	**24.52**	1.51	2.21	3.34	5.76	4.11
Tolualdehydes	*11.76*	**22.12**	6.54	4.59	4.27	4.39	8.44
Valeraldehyde	*13.32*	**49.17**	6.54	8.04	6.61	8.83	3.65
Average	*10.24*	**34.11**	3.47	3.92	3.42	6.23	4.61

31.1.4 Metals Method Precision

The method precision for all collocated metals samples are presented in Table 31-33. The average CV values, as well as the average RPD values, show low- to high-level variability with average CVs ranging from 4.66 percent for arsenic to 39.35 percent for mercury, with an overall average at 11.13 percent.

Table 31-33. Metal Method Precision: 198 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	198	7.23	0.08	5.11
Arsenic	198	6.40	0.08	4.66
Beryllium	195	23.94	0.003	**16.93**
Cadmium	198	14.82	0.05	10.48
Chromium	198	8.32	0.21	5.88
Cobalt	198	14.07	0.07	9.95
Lead	198	6.68	0.46	4.73
Manganese	197	7.01	1.29	4.96
Mercury	193	**55.65**	1.60	**39.35**
Nickel	198	17.52	0.42	12.39
Selenium	198	11.34	0.07	8.02

Due to the focus on QA for the NATTS program, Tables 31-34 through 31-37 present the method precision results from collocated PM_{10} metals at the NATTS sites (BOMA, BTUT, S4MO, and SEWA, respectively). Shaded rows present results for NATTS core compounds. Variability ranged from 0.39 percent for antimony at SEWA to 95.87 percent for mercury at BTUT.

Table 31-34. Metal Method Precision: 60 Collocated Samples at Boston, MA (BOMA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	60	8.55	0.08	6.04
Arsenic	60	4.55	0.02	3.45
Beryllium	57	**31.14**	0.001	**22.02**
Cadmium	60	21.10	0.03	14.92
Chromium	60	7.70	0.16	5.45

Table 31-34. Metal Method Precision: 60 Collocated Samples at Boston, MA (BOMA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Cobalt	60	9.10	0.01	6.44
Lead	60	8.26	0.37	5.84
Manganese	59	6.74	0.27	4.77
Mercury	59	**50.14**	0.03	**35.46**
Nickel	60	12.64	0.31	8.94
Selenium	60	7.69	0.02	5.44

Table 31-35. Metal Method Precision: 6 Collocated Samples at Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	6	4.96	0.08	3.51
Arsenic	6	9.77	0.12	6.91
Beryllium	6	**32.25**	0.01	**22.80**
Cadmium	6	4.34	0.02	3.07
Chromium	6	13.02	0.35	9.21
Cobalt	6	12.61	0.06	8.92
Lead	6	5.00	0.33	3.54
Manganese	6	10.54	2.30	7.45
Mercury	5	**135.58**	7.89	**95.87**
Nickel	6	**39.28**	1.07	**27.78**
Selenium	6	**27.62**	0.10	**19.53**

Table 31-36. Metal Method Precision: 22 Collocated Samples at St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	22	6.53	0.10	4.62
Arsenic	22	6.29	0.08	4.64
Beryllium	22	17.62	0.001	12.46
Cadmium	22	15.35	0.09	10.86
Chromium	22	7.26	0.17	5.13
Cobalt	22	20.40	0.04	14.42
Lead	22	8.16	0.79	5.77
Manganese	22	7.27	1.09	5.14

Table 31-36. Metal Method Precision: 22 Collocated Samples at St. Louis, MO (S4MO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Mercury	19	**45.48**	0.03	**32.16**
Nickel	22	11.47	0.14	8.11
Selenium	22	11.29	0.12	7.98

Table 31-37. Metal Method Precision: 2 Collocated Samples at Seattle, WA (SEWA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	2	0.55	0.01	0.39
Arsenic	2	3.46	0.05	2.45
Beryllium	2	NA	NA	NA
Cadmium	2	8.96	0.02	6.33
Chromium	2	3.70	0.13	2.62
Cobalt	2	3.88	0.01	2.74
Lead	2	0.79	0.07	0.56
Manganese	2	1.07	0.30	0.76
Mercury	2	6.06	0.001	4.29
Nickel	2	9.89	0.28	7.00
Selenium	2	1.58	0.01	1.12

Table 31-38 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all UATMP and NATTS sites sampling metals. The results from collocated samples show low- to high-level variability among sites, ranging from 2.82 percent at SEWA to 18.96 percent at BTUT, with an overall average of 11.13 percent.

Table 31-38. Metal Method Precision: Coefficient of Variation for all Collocated Samples by Site

Pollutant	Average	Boston, MA (BOMA)	Bountiful, UT (BTUT)	St. Louis, MO (S4MO)	Seattle, WA (SEWA)	Tulsa, OK (TOOK)
Antimony	*5.11*	6.04	3.51	4.62	0.39	11.01
Arsenic	*4.66*	3.45	6.91	4.64	2.45	5.85
Beryllium	***16.93***	**22.02**	**22.80**	12.46	NA	10.43
Cadmium	*10.48*	14.92	3.07	10.86	6.33	**17.23**
Chromium	*5.88*	5.45	9.21	5.13	2.62	7.01
Cobalt	*9.95*	6.44	8.92	14.42	2.74	**17.24**
Lead	*4.73*	5.84	3.54	5.77	0.56	7.92
Manganese	*4.96*	4.77	7.45	5.14	0.76	6.66
Mercury	***39.35***	**35.46**	**95.87**	**32.16**	4.29	**28.98**
Nickel	*12.39*	8.94	**27.78**	8.11	7.00	10.11
Selenium	*8.02*	5.44	**19.53**	7.98	1.12	6.01
Average	*11.13*	*10.80*	***18.96***	*10.12*	*2.82*	*11.68*

31.1.5 Hexavalent Chromium Method Precision

The hexavalent chromium method precision results are shown in Table 31-39. All the sites shown are NATTS sites except the ININ site. The average concentration differences observed for collocated analyses of hexavalent chromium ranged from 0.001 ng/m^3 at MVWI to 0.01 ng/m^3 at several sites. The average RPD was higher than the program DQO specified 25 percent, with an overall average RPD of 35.36 percent. The RPD ranged from 11.21 percent at PXSS to 96.66 percent at WADC. The CV ranged from 7.93 percent at PXSS to 68.35 percent at WADC, with an overall average of 25.00 percent, which is outside the 15 percent program DQO.

Table 31-39. Hexavalent Chromium Method Precision: Collocated Samples

Site	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
BOMA	8	22.01	0.01	**15.57**
BTUT	58	23.99	0.01	**16.96**
BXNY	2	16.63	0.01	11.76
CHSC	4	**65.89**	0.01	**46.59**

Table 31-39. Hexavalent Chromium Method Precision: Collocated Samples (Continued)

Site	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
DEMI	14	20.50	0.003	14.50
GPCO	12	**26.28**	0.003	**18.58**
HAKY	8	**40.80**	0.004	**28.85**
ININ	12	**32.28**	0.01	**22.83**
MVWI	4	**27.64**	0.001	**19.54**
NBIL	8	19.22	0.01	13.59
PRRI	8	**48.80**	0.004	**34.50**
PXSS	12	11.21	0.01	7.93
S4MO	10	24.93	0.003	**17.63**
SDGA	8	17.68	0.003	12.50
SEWA	12	19.00	0.01	13.44
SYFL	10	**80.94**	0.01	**57.23**
UNVT	6	**41.99**	0.004	**29.69**
WADC	6	**96.66**	0.01	**68.35**
Average	*11*	***35.36***	*0.01*	***25.00***

* Over half of the measured detections were under the detection limit.

31.1.6 SVOC Method Precision

The method precision results for the collocated semivolatiles samples are shown in Table 31-40. Both sites evaluated in this section are NATTS sites (RUCA and SDGA). The average concentration differences observed for semivolatile compounds ranged from 0.02 ng/m^3 for dibenz(a,h)anthracene to 10.74 ng/m^3 for naphthalene. The average CV ranged from 11.30 percent for phenanthrene to 82.83 percent for coronene, with an overall average of 36.10 percent, which is outside the 15 percent program DQO.

Table 31-40. SVOC Method Precision: 50 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	48	**42.93**	0.31	**30.35**
Acenaphthylene	31	**36.13**	0.47	**25.55**
Anthracene	27	**81.92**	0.29	**57.93**
Benzo (a) anthracene	42	**53.84**	0.03	**38.07**

Table 31-40. SVOC Method Precision: 50 Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Benzo (a) pyrene	39	**51.24**	0.09	**36.23**
Benzo (b) fluoranthene	37	**58.69**	0.05	**41.50**
Benzo (e) pyrene	30	**98.95**	0.05	**69.97**
Benzo (g,h,i) perylene	42	**57.69**	0.04	**40.80**
Benzo (k) fluoranthene	31	**82.34**	0.04	**58.23**
Chrysene	49	16.29	0.03	11.52
Coronene	25	**117.14**	0.05	**82.83**
Dibenz (a,h) anthracene	7	**46.95**	0.02	**33.20**
Fluoranthene	49	17.12	0.17	12.10
Fluorene	49	18.05	0.45	12.76
Indeno(1,2,3-cd)pyrene	24	**67.41**	0.04	13.11
Naphthalene	50	20.75	10.74	14.67
Perylene	4	**114.81**	0.04	**81.18**
Phenanthrene	50	15.98	0.81	11.30
Pyrene	48	20.76	0.14	14.68

Table 31-41 presents the method precision results for semivolatiles analysis of the collocated samples for RUCA. In terms or CV, the variability of each pollutant is above the program criteria, with an average variability of 40.25 percent.

Table 31-41. SVOC Method Precision: 42 Collocated Samples at Rubidoux, CA (RUCA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	41	**33.16**	0.53	**23.44**
Acenaphthylene	25	**62.07**	0.80	**43.89**
Anthracene	22	**94.81**	0.55	**67.04**
Benzo (a) anthracene	35	**46.13**	0.04	**32.62**
Benzo (a) pyrene	32	**43.05**	0.09	**30.44**
Benzo (b) fluoranthene	32	**43.45**	0.08	**30.72**
Benzo (e) pyrene	26	**64.81**	0.06	**45.83**
Benzo (g,h,i) perylene	35	**60.62**	0.06	**42.87**
Benzo (k) fluoranthene	28	**64.97**	0.06	**45.94**
Chrysene	41	**29.68**	0.07	**20.99**
Coronene	21	**63.74**	0.05	**45.07**

Table 31-41. SVOC Method Precision: 42 Collocated Samples at Rubidoux, CA (RUCA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Dibenz (a,h) anthracene	5	**86.72**	0.05	**61.32**
Fluoranthene	41	**31.03**	0.32	**21.94**
Fluorene	41	**30.69**	0.75	**21.70**
Indeno(1,2,3-cd)pyrene	21	**33.73**	0.06	**23.85**
Naphthalene	42	**31.76**	15.30	**22.46**
Perylene	2	**199.61**	0.07	**141.15**
Phenanthrene	42	**29.21**	1.50	**20.66**
Pyrene	40	**32.35**	0.25	**22.88**

The semivolatiles method precision results for SDGA are shown in Table 31-42. In terms of CV, the variability ranged from 1.95 percent (phenanthrene) to 120.59 percent (coronene), with an average of 31.96 percent.

Table 31-42. SVOC Method Precision: 8 Collocated Samples at Decatur, GA (SDGA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	7	**52.69**	0.09	**37.26**
Acenaphthylene	6	10.20	0.15	7.21
Anthracene	5	**69.03**	0.03	**48.81**
Benzo (a) anthracene	7	**61.56**	0.01	**43.53**
Benzo (a) pyrene	7	**59.42**	0.10	**42.02**
Benzo (b) fluoranthene	5	**73.93**	0.01	**52.28**
Benzo (e) pyrene	4	**133.10**	0.04	**94.11**
Benzo (g,h,i) perylene	7	**54.77**	0.02	**38.72**
Benzo (k) fluoranthene	3	**99.71**	0.01	**70.51**
Chrysene	8	2.90	0.003	2.05
Coronene	4	**170.54**	0.05	**120.59**
Dibenz (a,h) anthracene	2	7.17	0.002	5.07
Fluoranthene	8	3.20	0.02	2.27
Fluorene	8	5.41	0.15	3.82
Indeno(1,2,3-cd)pyrene	3	**101.08**	0.01	2.38
Naphthalene	8	9.75	6.18	6.89

Table 31-42. SVOC Method Precision: 8 Collocated Samples at Decatur, GA (SDGA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Perylene	2	**30.00**	0.01	**21.21**
Phenanthrene	8	2.75	0.12	1.95
Pyrene	8	9.16	0.04	6.48

31.2 Analytical Precision

Analytical precision is a measurement of random errors associated with the process of analyzing environmental samples. These errors may result from various factors, but typically originate from random "noise" inherent to analytical instruments. Laboratories can easily evaluate analytical precision by comparing concentrations measured during replicate analysis of ambient air samples. The number of observations from Tables 31-43 through 31-83, in comparison to the respective tables listed for duplicate or collocated analyses in Tables 31-2 through 31-42, is approximately twice as high because each sample produces a replicate for each duplicate (or collocated) sample. Overall, the replicate analyses of both duplicate and collocated samples of VOC, SNMOC, carbonyl compounds, and hexavalent chromium suggest the analytical precision level is within the program DQOs.

31.2.1 VOC Analytical Precision

In Table 31-43, the analytical precision results from replicate analyses of all duplicate and collocated samples show that for most of the pollutants, the VOC analysis precision was within the program DQO of 15 percent for CV. The analytical precision of the VOC analytical method, in terms of average concentration difference, ranged from 0.001 ppbv for bromomethane and chloroprene to 0.32 ppbv for acetonitrile. In terms of CV, the overall average variability was 16.92 percent and the median CV was 9.48 percent. The low median CV shows that most of the pollutant variabilities were low. The relatively high average variability was likely due to the substitution of non-detects with 1/2 the MDL.

Table 31-43. VOC Analytical Precision: 596 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	528	13.03	0.32	9.21
Acetylene	594	6.40	0.06	4.52
Acrolein	596	9.55	0.03	6.75
Acrylonitrile	57	**46.21**	0.01	**32.68**
tert-Amyl Methyl Ether	15	**57.45**	0.004	**40.62**
Benzene	594	7.70	0.02	5.44
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	18	**40.58**	0.07	**28.69**
Bromoform	13	**52.49**	0.01	**37.12**
Bromomethane	553	11.18	0.001	7.90
1,3-Butadiene	570	8.93	0.003	6.32
Carbon disulfide	596	7.88	0.01	5.57
Carbon Tetrachloride	500	6.63	0.06	4.69
Chlorobenzene	584	7.69	0.01	5.44
Chloroethane	63	**30.75**	0.004	**21.74**
Chloroform	457	14.93	0.002	10.56
Chloromethane	492	13.19	0.02	9.33
Chloromethylbenzene	582	5.42	0.03	3.84
Chloroprene	3	12.15	0.001	8.59
Dibromochloromethane	10	**122.61**	0.03	**86.70**
1,2-Dibromoethane	38	**74.21**	0.01	**52.47**
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	6	**50.05**	0.004	**35.39**
p-Dichlorobenzene	28	24.53	0.002	**17.35**
Dichlorodifluoromethane	476	13.58	0.004	9.60
1,1-Dichloroethane	584	4.78	0.02	3.38
1,2-Dichloroethane	4	**56.47**	0.004	**39.93**
1,1-Dichloroethene	50	20.35	0.002	14.39
cis-1,2-Dichloroethylene	4	13.85	0.002	9.79
trans-1,2-Dichloroethylene	2	**156.02**	0.11	**110.32**
Dichloromethane	25	13.52	0.01	9.56
1,2-Dichloropropane	582	7.62	0.01	5.39
cis-1,3-Dichloropropene	4	19.05	0.004	13.47
trans-1,3-Dichloropropene	3	**25.81**	0.02	**18.25**
Dichlorotetrafluoroethane	15	6.44	0.01	4.55
Ethyl Acrylate	580	14.70	0.002	10.39
Ethyl *tert*-Butyl Ether	2	7.87	0.01	5.57
Ethylbenzene	12	4.91	0.005	3.47
Hexachloro-1,3-butadiene	584	7.67	0.01	5.42
Methyl Ethyl Ketone	16	**27.25**	0.02	**19.27**
Methyl Isobutyl Ketone	582	11.64	0.08	8.23
Methyl Methacrylate	510	13.70	0.01	9.69
Methyl *tert*-Butyl Ether	59	**25.92**	0.01	**18.33**
n-Octane	128	24.77	0.003	**17.52**
Propylene	550	13.29	0.004	9.40

Table 31-43. VOC Analytical Precision: 596 Replicate Analyses for all Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Styrene	594	6.54	0.03	4.63
1,1,2,2-Tetrachloroethane	521	13.53	0.004	9.57
Tetrachloroethylene	10	**63.32**	0.003	**44.78**
Toluene	548	11.23	0.004	7.94
1,2,4-Trichlorobenzene	582	6.69	0.06	4.73
1,1,1-Trichloroethane	22	**29.89**	0.005	**21.13**
1,1,2-Trichloroethane	584	12.43	0.002	8.79
Trichloroethylene	12	**42.87**	0.004	**30.32**
Trichlorofluoromethane	230	16.54	0.003	11.70
Trichlorotrifluoroethane	596	4.92	0.01	3.48
1,2,4-Trimethylbenzene	593	7.37	0.01	5.21
1,3,5-Trimethylbenzene	592	8.13	0.004	5.75
Vinyl chloride	564	10.87	0.002	7.69
m,p-Xylene	137	**32.60**	0.003	**23.05**
o-Xylene	595	8.31	0.02	5.88

Table 31-44 shows the analytical precision results from replicate analyses of all collocated VOC samples. The replicate results from collocated samples show variation for the pollutants ranging from 0.001 percent (bromomethane, chloroprene, and 1,1,1-trichloroethane) to 0.54 percent (acetonitrile), as indicated by average concentration differences. The overall average variability was 14.70 percent, which is within the program DQO.

Table 31-44. VOC Analytical Precision: 316 Replicate Analyses for all Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	252	12.30	0.54	8.70
Acetylene	314	6.81	0.05	4.82
Acrolein	316	11.72	0.03	8.29
Acrylonitrile	35	**25.70**	0.01	**18.17**
tert-Amyl Methyl Ether	11	**37.67**	0.004	**26.64**
Benzene	314	7.56	0.02	5.34
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	17	23.47	0.10	**16.60**
Bromoform	13	**52.49**	0.01	**37.12**
Bromomethane	292	10.32	0.001	7.29
1,3-Butadiene	307	9.29	0.003	6.57
Carbon disulfide	316	8.14	0.01	5.75

Table 31-44. VOC Analytical Precision: 316 Replicate Analyses for all Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Carbon Tetrachloride	232	8.17	0.08	5.77
Chlorobenzene	316	8.85	0.01	6.26
Chloroethane	52	**33.43**	0.004	**23.64**
Chloroform	258	14.21	0.003	10.05
Chloromethane	255	13.80	0.03	9.76
Chloromethylbenzene	314	5.84	0.03	4.13
Chloroprene	3	12.15	0.001	8.59
Dibromochloromethane	9	**121.12**	0.03	**85.64**
1,2-Dibromoethane	35	**47.46**	0.01	**33.56**
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	4	**35.90**	0.004	**25.39**
p-Dichlorobenzene	16	**28.23**	0.002	**19.97**
Dichlorodifluoromethane	279	12.08	0.002	8.54
1,1-Dichloroethane	316	5.20	0.03	3.68
1,2-Dichloroethane	2	**68.61**	0.004	**48.52**
1,1-Dichloroethene	41	12.05	0.002	8.52
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	13	15.34	0.002	10.85
1,2-Dichloropropane	314	8.62	0.01	6.10
cis-1,3-Dichloropropene	3	14.37	0.01	10.16
trans-1,3-Dichloropropene	3	**25.81**	0.02	**18.25**
Dichlorotetrafluoroethane	3	6.04	0.01	4.27
Ethyl Acrylate	312	17.43	0.003	12.33
Ethyl *tert*-Butyl Ether	2	7.87	0.01	5.57
Ethylbenzene	0	NA	NA	NA
Hexachloro-1,3-butadiene	316	8.12	0.01	5.74
Methyl Ethyl Ketone	0	NA	NA	NA
Methyl Isobutyl Ketone	314	13.09	0.14	9.26
Methyl Methacrylate	276	13.78	0.01	9.74
Methyl *tert*-Butyl Ether	31	22.59	0.005	**15.97**
n-Octane	62	7.98	0.005	5.64
Propylene	297	12.47	0.004	8.82
Styrene	314	6.59	0.03	4.66
1,1,2,2-Tetrachloroethane	288	12.86	0.004	9.09
Tetrachloroethylene	1	**120.13**	0.01	**84.94**
Toluene	293	12.44	0.003	8.80
1,2,4-Trichlorobenzene	314	7.27	0.06	5.14
1,1,1-Trichloroethane	8	10.82	0.001	7.65
1,1,2-Trichloroethane	316	14.12	0.002	9.98
Trichloroethylene	6	**44.33**	0.003	**31.35**
Trichlorofluoromethane	152	14.02	0.002	9.91
Trichlorotrifluoroethane	316	5.44	0.02	3.85
1,2,4-Trimethylbenzene	314	7.78	0.01	5.50
1,3,5-Trimethylbenzene	314	7.77	0.01	5.49

Table 31-44. VOC Analytical Precision: 316 Replicate Analyses for all Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Vinyl chloride	308	9.65	0.002	6.82
m,p-Xylene	94	**33.72**	0.003	**23.84**
o-Xylene	315	9.27	0.01	6.55

Table 31-45 shows the analytical precision results from replicate analyses of all duplicate VOC samples. The variation of the replicate results from the duplicate samples ranged from 3.06 percent (1,1-dichloroethane) to 110.32 percent (*trans*-1,2-dichloroethylene), as represented by the CV. The overall average variability was 18.32 percent and the median CV was 8.51 percent.

Table 31-45. VOC Analytical Precision: 280 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	276	13.76	0.09	9.73
Acetylene	280	5.99	0.06	4.23
Acrolein	280	7.37	0.02	5.21
Acrylonitrile	22	**66.73**	0.02	**47.19**
tert-Amyl Methyl Ether	4	**90.43**	0.003	**63.94**
Benzene	280	7.84	0.02	5.54
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	1	**74.80**	0.01	**52.89**
Bromoform	0	NA	NA	NA
Bromomethane	261	11.97	0.002	8.47
1,3-Butadiene	263	8.58	0.003	6.07
Carbon disulfide	280	7.61	0.01	5.38
Carbon Tetrachloride	268	5.09	0.04	3.60
Chlorobenzene	268	6.44	0.005	4.55
Chloroethane	11	24.05	0.002	**17.00**
Chloroform	199	15.60	0.002	11.03
Chloromethane	237	12.59	0.01	8.90
Chloromethylbenzene	268	4.97	0.03	3.51
Chloroprene	0	NA	NA	NA
Dibromochloromethane	1	**130.06**	0.02	**91.96**
1,2-Dibromoethane	3	**136.63**	0.01	**96.61**
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	2	**71.26**	0.004	**50.39**
p-Dichlorobenzene	12	9.73	0.003	6.88

Table 31-45. VOC Analytical Precision: 280 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Dichlorodifluoromethane	197	15.08	0.01	10.66
1,1-Dichloroethane	268	4.33	0.02	3.06
1,2-Dichloroethane	2	**44.33**	0.003	**31.35**
1,1-Dichloroethene	9	**28.65**	0.002	**20.26**
cis-1,2-Dichloroethylene	4	13.85	0.002	9.79
trans-1,2-Dichloroethylene	2	**156.02**	0.11	**110.32**
Dichloromethane	12	6.24	0.03	4.41
1,2-Dichloropropane	268	6.61	0.01	4.67
cis-1,3-Dichloropropene	1	**28.40**	0.002	**20.08**
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	12	7.23	0.001	5.11
Ethyl Acrylate	268	11.74	0.001	8.30
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	12	4.91	0.005	3.47
Hexachloro-1,3-butadiene	268	7.18	0.01	5.07
Methyl Ethyl Ketone	16	**27.25**	0.02	**19.27**
Methyl Isobutyl Ketone	268	10.19	0.03	7.21
Methyl Methacrylate	234	13.63	0.01	9.64
Methyl *tert*-Butyl Ether	28	**34.23**	0.04	**24.21**
n-Octane	66	**33.17**	0.003	**23.45**
Propylene	253	14.12	0.004	9.98
Styrene	280	6.50	0.03	4.60
1,1,2,2-Tetrachloroethane	233	14.26	0.003	10.09
Tetrachloroethylene	9	6.52	0.001	4.61
Toluene	255	10.12	0.005	7.16
1,2,4-Trichlorobenzene	268	6.07	0.06	4.29
1,1,1-Trichloroethane	14	**36.24**	0.01	**25.63**
1,1,2-Trichloroethane	268	10.60	0.002	7.49
Trichloroethylene	6	**40.44**	0.01	**28.59**
Trichlorofluoromethane	78	19.91	0.004	14.08
Trichlorotrifluoroethane	280	4.40	0.01	3.11
1,2,4-Trimethylbenzene	279	6.97	0.01	4.93
1,3,5-Trimethylbenzene	278	8.46	0.003	5.98
Vinyl chloride	256	12.09	0.001	8.55
m,p-Xylene	43	**30.75**	0.004	**21.75**
o-Xylene	280	7.36	0.02	5.21

Due to the focus on QA for the NATTS program, Tables 31-46 through 31-54 present the analytical precision data results from VOC replicate analyses for all the samples taken at the NATTS sites (BTUT, CAMS 35, CAMS 85, DEMI, GPCO, NBIL, PXSS, S4MO, and SEWA, respectively). Shaded rows present results for the NATTS core compounds. These results show low- to high-level variability among the sites, as represented by CV, ranging from 0.76 percent (for acrylonitrile at NBIL) to 105.82 percent (for dibromochloromethane at BTUT), with an average of 10.89 percent. This is within the program DQO of 15 percent overall CV per site.

Table 31-46. VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT)

Compound	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	24	6.04	0.09	4.27
Acetylene	24	4.99	0.04	3.53
Acrolein	24	6.02	0.01	4.25
Acrylonitrile	1	**55.53**	0.01	**39.27**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	24	5.21	0.03	3.68
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	24	8.94	0.001	6.32
1,3-Butadiene	24	6.74	0.003	4.77
Carbon disulfide	24	4.30	0.05	3.04
Carbon Tetrachloride	24	5.81	0.004	4.10
Chlorobenzene	0	NA	NA	NA
Chloroethane	17	12.35	0.001	8.73
Chloroform	23	16.17	0.003	11.43
Chloromethane	24	5.27	0.03	3.73
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	1	**149.66**	0.01	**105.82**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	24	6.63	0.002	4.69
Dichlorodifluoromethane	24	4.42	0.02	3.13
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	24	4.62	0.01	3.27
1,2-Dichloropropane	1	**28.40**	0.002	**20.08**
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	24	11.23	0.002	7.94
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	24	4.10	0.01	2.90
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	24	6.82	0.03	4.82

Table 31-46. VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Compound	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbv)**	**Coefficient of Variation (%)**
Methyl Isobutyl Ketone	24	7.30	0.003	5.16
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	24	5.82	0.004	4.12
Propylene	24	6.71	0.05	4.75
Styrene	24	7.11	0.002	5.02
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	24	6.11	0.003	4.32
Toluene	24	4.48	0.05	3.17
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	24	2.46	<0.001	1.74
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	12	3.26	0.001	2.31
Trichlorofluoromethane	24	5.15	0.01	3.64
Trichlorotrifluoroethane	24	5.48	0.01	3.87
1,2,4-Trimethylbenzene	24	4.29	0.004	3.03
1,3,5-Trimethylbenzene	24	4.40	0.001	3.11
Vinyl chloride	8	20.08	0.001	14.20
m,p-Xylene	24	4.16	0.02	2.94
o-Xylene	24	4.99	0.01	3.53

Table 31-47. VOC Analytical Precision: 80 Replicate Analyses for Collocated Samples for Deer Park, TX (CAMS 35)

Compound	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbv)**	**Coefficient of Variation (%)**
Acetonitrile	47	16.33	0.02	11.54
Acetylene	80	6.22	0.03	4.40
Acrolein	82	8.61	0.02	6.09
Acrylonitrile	22	8.21	0.04	5.81
tert-Amyl Methyl Ether	4	**25.66**	0.01	**18.15**
Benzene	80	6.00	0.02	4.24
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	3	8.31	0.001	5.88
Bromoform	3	**34.86**	0.002	**24.65**
Bromomethane	82	9.51	0.002	6.73
1,3-Butadiene	82	8.00	0.01	5.65
Carbon disulfide	31	13.59	0.002	9.61
Carbon Tetrachloride	82	6.61	0.01	4.68
Chlorobenzene	22	10.83	0.003	7.65
Chloroethane	70	15.52	0.004	10.97
Chloroform	77	11.85	0.004	8.38
Chloromethane	80	5.17	0.03	3.66

Table 31-47. VOC Analytical Precision: 80 Replicate Analyses for Collocated Samples for Deer Park, TX (CAMS 35) (Continued)

Compound	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	5	**119.73**	0.02	**84.66**
Dibromochloromethane	4	**43.48**	0.01	**30.75**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	2	11.24	0.01	7.95
o-Dichlorobenzene	3	**66.43**	0.004	**46.97**
p-Dichlorobenzene	74	9.48	0.001	6.71
Dichlorodifluoromethane	82	4.89	0.02	3.46
1,1-Dichloroethane	1	**68.61**	0.004	**48.52**
1,2-Dichloroethane	33	12.18	0.01	8.61
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	2	**33.33**	0.004	**23.57**
Dichloromethane	80	7.88	0.01	5.57
1,2-Dichloropropane	2	13.53	0.01	9.57
cis-1,3-Dichloropropene	2	7.87	0.04	5.57
trans-1,3-Dichloropropene	2	8.23	0.02	5.82
Dichlorotetrafluoroethane	79	12.69	0.002	8.97
Ethyl Acrylate	2	7.87	0.01	5.57
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	82	7.25	0.004	5.13
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	82	7.82	0.02	5.53
Methyl Isobutyl Ketone	67	10.34	0.003	7.31
Methyl Methacrylate	16	13.99	0.01	9.89
Methyl *tert*-Butyl Ether	48	8.51	0.01	6.02
n-Octane	79	15.34	0.004	10.84
Propylene	80	6.13	0.11	4.34
Styrene	69	10.55	0.002	7.46
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	72	12.77	0.003	9.03
Toluene	80	5.71	0.03	4.04
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	82	7.56	0.001	5.35
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	28	9.67	0.002	6.84
Trichlorofluoromethane	82	5.67	0.01	4.01
Trichlorotrifluoroethane	82	5.07	0.005	3.58
1,2,4-Trimethylbenzene	80	6.19	0.003	4.38
1,3,5-Trimethylbenzene	78	9.72	0.002	6.88
Vinyl chloride	52	7.87	0.002	5.56
m,p-Xylene	82	6.10	0.01	4.31
o-Xylene	82	8.00	0.01	5.65

Table 31-48. VOC Analytical Precision: 4 Replicate Analyses for Collocated Samples for Karnack, TX (CAMS 85)

Compound	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	0	2.53	0.02	1.79
Acetylene	4	2.30	0.04	1.63
Acrolein	4	15.20	0.03	10.75
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	4	4.71	0.03	3.33
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	4	NA	NA	NA
1,3-Butadiene	4	7.69	0.01	5.44
Carbon disulfide	0	7.17	0.09	5.07
Carbon Tetrachloride	4	**33.33**	0.01	**23.57**
Chlorobenzene	0	NA	NA	NA
Chloroethane	4	NA	NA	NA
Chloroform	4	**53.33**	0.01	**37.71**
Chloromethane	4	5.11	0.03	3.62
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	4	20.00	0.01	14.14
Dichlorodifluoromethane	4	4.13	0.03	2.92
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	4	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	4	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	4	**33.33**	0.01	**23.57**
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	4	5.88	0.01	4.16
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	4	6.52	0.02	4.61
Methyl Isobutyl Ketone	0	NA	NA	NA
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	2	NA	NA	NA
n-Octane	4	19.05	0.01	13.47
Propylene	4	NA	NA	NA

Table 31-48. VOC Analytical Precision: 4 Replicate Analyses for Collocated Samples for Karnack, TX (CAMS 85) (Continued)

Compound	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Styrene	4	14.29	0.01	10.10
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	4	NA	NA	NA
Toluene	4	3.62	0.02	2.56
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	4	**33.33**	0.01	**23.57**
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	0	NA	NA	NA
Trichlorofluoromethane	4	3.23	0.02	2.28
Trichlorotrifluoroethane	4	10.00	0.01	7.07
1,2,4-Trimethylbenzene	4	NA	NA	NA
1,3,5-Trimethylbenzene	4	NA	NA	NA
Vinyl chloride	2	NA	NA	NA
m,p-Xylene	4	2.33	0.01	1.64
o-Xylene	4	5.88	0.01	4.16

Table 31-49. VOC Analytical Precision: 24 Replicate Analyses for Collocated Samples for Dearborn, MI (DEMI)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	24	7.69	0.02	5.44
Acetylene	24	5.07	0.03	3.59
Acrolein	24	5.11	0.01	3.61
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	24	5.46	0.01	3.86
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	24	7.63	0.001	5.40
1,3-Butadiene	24	4.83	0.001	3.41
Carbon disulfide	17	6.63	0.002	4.69
Carbon Tetrachloride	24	4.33	0.004	3.06
Chlorobenzene	24	4.21	0.002	2.98
Chloroethane	24	16.76	0.003	11.85
Chloroform	24	7.21	0.01	5.10
Chloromethane	24	4.36	0.02	3.09
Chloromethylbenzene	2	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA

Table 31-49. VOC Analytical Precision: 24 Replicate Analyses for Collocated Samples for Dearborn, MI (DEMI) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	24	6.89	0.001	4.87
Dichlorodifluoromethane	24	3.96	0.02	2.80
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	1	1.37	<0.001	0.97
Dichloromethane	24	6.24	0.004	4.41
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	24	7.18	0.001	5.08
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	24	4.39	0.002	3.10
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	23	19.86	0.02	14.04
Methyl Isobutyl Ketone	24	8.20	0.003	5.80
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	21	12.09	0.001	8.55
Propylene	24	6.26	0.02	4.42
Styrene	21	7.91	0.001	5.59
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	21	10.87	0.002	7.69
Toluene	24	5.10	0.01	3.60
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	24	10.08	0.002	7.13
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	11	18.71	0.002	13.23
Trichlorofluoromethane	24	3.87	0.01	2.74
Trichlorotrifluoroethane	23	17.00	0.01	12.02
1,2,4-Trimethylbenzene	24	5.12	0.002	3.62
1,3,5-Trimethylbenzene	24	4.21	0.001	2.98
Vinyl chloride	2	NA	NA	NA
m,p-Xylene	24	4.60	0.004	3.25
o-Xylene	24	5.32	0.002	3.76

Table 31-50. VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	24	6.93	0.11	4.90
Acetylene	24	5.26	0.08	3.72
Acrolein	24	6.85	0.03	4.84
Acrylonitrile	2	**109.32**	0.03	**77.30**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	24	5.87	0.03	4.15
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	1	**74.80**	0.01	**52.89**
Bromoform	0	NA	NA	NA
Bromomethane	24	10.46	0.001	7.39
1,3-Butadiene	24	5.19	0.004	3.67
Carbon disulfide	24	4.10	0.06	2.90
Carbon Tetrachloride	24	8.17	0.01	5.78
Chlorobenzene	1	**38.89**	0.003	**27.50**
Chloroethane	16	10.34	0.001	7.31
Chloroform	24	6.71	0.001	4.75
Chloromethane	24	4.64	0.02	3.28
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	1	**130.06**	0.02	**91.96**
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	24	6.32	0.001	4.47
Dichlorodifluoromethane	24	4.66	0.02	3.29
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	1	5.59	0.001	3.95
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	1	**128.68**	0.03	**90.99**
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	24	4.83	0.005	3.42
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	24	3.74	0.001	2.64
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	24	5.58	0.01	3.94
Hexachloro-1,3-butadiene	1	9.83	0.002	6.95
Methyl Ethyl Ketone	24	6.05	0.03	4.28
Methyl Isobutyl Ketone	24	8.81	0.01	6.23
Methyl Methacrylate	16	**43.27**	0.07	**30.59**
Methyl *tert*-Butyl Ether	1	**72.60**	0.01	**51.33**
n-Octane	24	7.69	0.004	5.43
Propylene	24	4.21	0.02	2.97

Table 31-50. VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO) (Continued)

Pollutant	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbv)**	**Coefficient of Variation (%)**
Styrene	24	3.33	0.004	2.36
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	24	6.21	0.004	4.39
Toluene	24	5.22	0.07	3.69
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	24	5.63	0.001	3.98
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	12	7.11	0.001	5.03
Trichlorofluoromethane	24	4.51	0.01	3.19
Trichlorotrifluoroethane	24	3.86	0.004	2.73
1,2,4-Trimethylbenzene	24	4.92	0.01	3.48
1,3,5-Trimethylbenzene	24	7.53	0.002	5.33
Vinyl chloride	2	NA	NA	NA
m,p-Xylene	24	5.41	0.03	3.83
o-Xylene	24	5.26	0.01	3.72

Table 31-51. VOC Analytical Precision: 18 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL)

Pollutant	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ppbv)**	**Coefficient of Variation (%)**
Acetonitrile	17	**39.57**	0.18	**27.98**
Acetylene	18	10.63	0.07	7.52
Acrolein	18	21.26	0.03	**15.04**
Acrylonitrile	1	1.07	<0.001	0.76
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	18	9.91	0.01	7.01
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	14	**38.63**	0.19	**27.32**
Bromoform	1	**124.46**	0.02	**88.01**
Bromomethane	15	8.23	0.001	5.82
1,3-Butadiene	14	14.35	0.003	10.14
Carbon disulfide	14	9.79	0.003	6.92
Carbon Tetrachloride	18	7.23	0.01	5.11
Chlorobenzene	0	NA	NA	NA
Chloroethane	14	14.10	0.002	9.97
Chloroform	18	**25.17**	0.38	**17.80**
Chloromethane	18	5.40	0.03	3.82
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	12	**36.54**	0.08	**25.84**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA

Table 31-51. VOC Analytical Precision: 18 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	13	16.27	0.002	11.51
Dichlorodifluoromethane	18	6.16	0.03	4.36
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	2	14.36	0.002	10.15
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	18	10.36	0.01	7.33
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	18	7.26	0.001	5.13
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	18	19.30	0.01	13.65
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	18	**26.16**	1.03	**18.49**
Methyl Isobutyl Ketone	17	**35.78**	0.01	**25.30**
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	12	5.42	0.002	3.83
Propylene	18	9.12	0.02	6.45
Styrene	14	**25.07**	0.003	**17.73**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	18	12.38	0.003	8.75
Toluene	18	13.81	0.04	9.77
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	18	9.50	0.002	6.72
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	13	20.73	0.004	14.66
Trichlorofluoromethane	18	7.70	0.02	5.44
Trichlorotrifluoroethane	18	6.07	0.01	4.30
1,2,4-Trimethylbenzene	18	18.43	0.01	13.03
1,3,5-Trimethylbenzene	14	17.91	0.003	12.67
Vinyl chloride	2	**54.28**	0.01	**38.38**
m,p-Xylene	18	17.45	0.02	12.34
o-Xylene	18	15.85	0.01	11.21

Table 31-52. VOC Analytical Precision: 12 Replicate Analyses for Collocated Samples for Phoenix, AZ (PXSS)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	12	8.99	0.13	6.36
Acetylene	12	3.64	0.02	2.57
Acrolein	12	11.72	0.08	8.29
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	12	12.68	0.03	8.97
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	4	17.78	0.001	12.57
Bromomethane	10	12.83	0.001	9.07
1,3-Butadiene	12	5.68	0.003	4.01
Carbon disulfide	12	5.07	0.003	3.58
Carbon Tetrachloride	12	8.33	0.003	5.89
Chlorobenzene	0	NA	NA	NA
Chloroethane	12	6.69	0.001	4.73
Chloroform	12	6.31	0.003	4.46
Chloromethane	12	3.51	0.01	2.48
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	8	4.55	0.001	3.22
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	1	**37.74**	0.002	**26.69**
o-Dichlorobenzene	8	3.85	<0.001	2.72
p-Dichlorobenzene	12	10.43	0.002	7.38
Dichlorodifluoromethane	12	2.73	0.01	1.93
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	12	8.43	0.01	5.96
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	1	**43.74**	0.004	**30.93**
trans-1,3-Dichloropropene	1	3.85	0.000	2.73
Dichlorotetrafluoroethane	11	**31.48**	0.002	**22.26**
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	12	12.94	0.01	9.15
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	12	9.64	0.10	6.82
Methyl Isobutyl Ketone	12	11.14	0.01	7.88
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	12	9.71	0.002	6.86
Propylene	12	2.96	0.02	2.09

Table 31-52. VOC Analytical Precision: 12 Replicate Analyses for Collocated Samples for Phoenix, AZ (PXSS) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Styrene	12	8.13	0.003	5.75
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	12	11.76	0.004	8.31
Toluene	12	15.32	0.13	10.84
1,2,4-Trichlorobenzene	8	10.82	0.001	7.65
1,1,1-Trichloroethane	12	12.77	0.001	9.03
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	4	6.93	0.001	4.90
Trichlorofluoromethane	12	3.55	0.01	2.51
Trichlorotrifluoroethane	12	4.34	0.001	3.07
1,2,4-Trimethylbenzene	12	12.55	0.01	8.87
1,3,5-Trimethylbenzene	12	10.64	0.002	7.52
Vinyl chloride	5	**40.38**	0.003	**28.55**
m,p-Xylene	12	13.39	0.03	9.47
o-Xylene	12	11.67	0.01	8.25

Table 31-53. VOC Analytical Precision: 22 Replicate Analyses for Duplicate Samples for St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	21	20.46	0.04	14.47
Acetylene	22	5.07	0.04	3.59
Acrolein	22	3.59	0.01	2.54
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	22	3.49	0.01	2.47
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	22	6.80	0.001	4.81
1,3-Butadiene	22	11.99	0.003	8.48
Carbon disulfide	22	3.20	0.02	2.26
Carbon Tetrachloride	22	2.93	0.003	2.07
Chlorobenzene	0	NA	NA	NA
Chloroethane	12	**25.52**	0.003	**18.05**
Chloroform	22	5.93	0.001	4.19
Chloromethane	22	3.54	0.02	2.50
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA

Table 31-53. VOC Analytical Precision: 22 Replicate Analyses for Duplicate Samples for St. Louis, MO (S4MO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	18	6.88	0.001	4.86
Dichlorodifluoromethane	22	3.33	0.02	2.35
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	22	7.74	0.01	5.47
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	22	13.61	0.002	9.62
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	22	3.41	0.002	2.41
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	22	3.49	0.01	2.47
Methyl Isobutyl Ketone	19	8.12	0.002	5.74
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	1	**80.12**	0.003	**56.66**
n-Octane	22	17.58	0.004	12.43
Propylene	22	4.03	0.01	2.85
Styrene	18	10.78	0.002	7.62
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	22	9.69	0.002	6.85
Toluene	22	3.85	0.01	2.72
1,2,4-Trichlorobenzene	1	**58.58**	0.01	**41.42**
1,1,1-Trichloroethane	22	9.18	0.002	6.49
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	3	**66.52**	0.01	**47.04**
Trichlorofluoromethane	22	2.74	0.01	1.94
Trichlorotrifluoroethane	22	3.65	0.004	2.58
1,2,4-Trimethylbenzene	22	2.98	0.002	2.11
1,3,5-Trimethylbenzene	19	17.53	0.002	12.40
Vinyl chloride	1	**83.82**	0.01	**59.27**
m,p-Xylene	22	2.06	0.002	1.45
o-Xylene	22	3.54	0.002	2.50

Table 31-54. VOC Analytical Precision: 28 Replicate Analyses for Collocated Samples for Seattle, WA (SEWA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	20	10.57	0.02	7.48
Acetylene	28	8.33	0.05	5.89
Acrolein	28	18.22	0.04	12.88
Acrylonitrile	2	**55.67**	0.01	**39.36**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	28	8.56	0.02	6.06
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	24	7.88	0.001	5.57
1,3-Butadiene	28	8.91	0.003	6.30
Carbon disulfide	18	**25.27**	0.49	**17.87**
Carbon Tetrachloride	28	5.34	0.01	3.78
Chlorobenzene	1	**51.08**	0.003	**36.12**
Chloroethane	24	19.53	0.004	13.81
Chloroform	27	16.39	0.004	11.59
Chloromethane	28	4.50	0.02	3.18
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	1	**53.82**	0.003	**38.06**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	17	10.91	0.001	7.71
Dichlorodifluoromethane	28	4.40	0.02	3.11
1,1-Dichloroethane	1	**68.61**	0.004	**48.52**
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	9	14.70	0.002	10.40
Dichloromethane	28	9.11	0.01	6.44
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	28	21.05	0.02	14.88
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	28	11.93	0.01	8.43
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	28	20.01	0.11	14.15
Methyl Isobutyl Ketone	25	13.46	0.003	9.52
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	28	14.97	0.003	10.58
Propylene	28	8.19	0.03	5.79

Table 31-54. VOC Analytical Precision: 28 Replicate Analyses for Collocated Samples for Seattle, WA (SEWA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Styrene	28	20.84	0.01	14.74
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	26	14.92	0.002	10.55
Toluene	28	10.63	0.05	7.51
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	28	11.00	0.002	7.78
1,1,2-Trichloroethane	1	**72.49**	0.005	**51.26**
Trichloroethylene	17	16.39	0.002	11.59
Trichlorofluoromethane	28	5.31	0.01	3.75
Trichlorotrifluoroethane	28	5.66	0.01	4.00
1,2,4-Trimethylbenzene	28	9.17	0.004	6.48
1,3,5-Trimethylbenzene	28	10.63	0.002	7.52
Vinyl chloride	1	**68.24**	0.01	**48.25**
m,p-Xylene	28	19.88	0.02	14.06
o-Xylene	28	12.28	0.01	8.68

Table 31-55 shows the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all UATMP and NATTS sites sampling VOC. The average site CV ranged from 4.69 percent at SJPR and TUMS to 17.54 percent at CHNJ, with an overall program average CV of 9.21 percent. This meets the 15 percent CV program DQO.

Table 31-55. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Deer Park , TX (CAMS 35)	Karnack , TX (CAMS 85)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Pryor, OK (CNEP)	Custer, SD (CUSD)	Dearborn, MI (DEMI)	Elizabeth, NJ (ELNJ)
Acetonitrile	*9.21*	8.12	4.27	11.54	1.79	5.56	7.95	4.38	5.64	5.44	14.12
Acetylene	*4.52*	6.15	3.53	4.40	1.63	3.12	5.56	4.19	2.87	3.59	7.71
Acrolein	*6.75*	5.86	4.25	6.09	10.75	8.47	6.68	5.39	3.99	3.61	7.43
Acrylonitrile	***32.68***	**61.22**	**39.27**	5.81	NA	**47.81**	**40.10**	**61.22**	NA	NA	NA
tert-Amyl Methyl Ether	***40.62***	**63.94**	NA	**18.15**	NA	**63.94**	NA	2.07	NA	NA	NA
Benzene	*5.44*	11.19	3.68	4.24	3.33	5.88	7.88	6.89	3.76	3.86	6.35
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***28.69***	NA	NA	5.88	NA	NA	NA	NA	NA	NA	NA
Bromoform	***37.12***	NA	NA	**24.65**	NA	NA	NA	NA	NA	NA	NA
Bromomethane	*7.90*	10.71	6.32	6.73	NA	7.44	6.92	6.12	9.13	5.40	13.83
1,3-Butadiene	*6.32*	5.98	4.77	5.65	5.44	5.03	5.85	8.89	6.32	3.41	6.87
Carbon disulfide	*4.59*	3.84	3.04	9.61	5.07	3.60	4.71	4.07	2.16	4.69	4.39
Carbon Tetrachloride	*5.47*	6.20	4.10	4.68	**23.57**	7.40	6.64	5.79	2.95	3.06	6.49
Chlorobenzene	***24.28***	NA	NA	7.65	NA	NA	NA	10.36	NA	2.98	NA
Chloroethane	*10.69*	6.51	8.73	10.97	NA	10.92	6.67	4.48	14.02	11.85	14.97
Chloroform	*9.21*	3.33	11.43	8.38	**37.71**	12.59	7.77	**15.91**	**20.21**	5.10	9.34
Chloromethane	*3.94*	6.47	3.73	3.66	3.62	3.41	4.34	4.18	2.69	3.09	5.11
Chloromethylbenzene	*8.59*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	***86.70***	NA	NA	**84.66**	NA	NA	NA	**89.09**	NA	NA	NA
Dibromochloromethane	***52.47***	NA	**105.82**	**30.75**	NA	NA	**105.82**	**17.96**	NA	NA	NA
1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***35.39***	NA	NA	7.95	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	***19.97***	NA	NA	**46.97**	NA	NA	NA	10.15	NA	NA	NA
p-Dichlorobenzene	*9.62*	6.88	4.69	6.71	14.14	13.15	**35.20**	**17.79**	10.46	4.87	9.76
Dichlorodifluoromethane	*3.50*	6.43	3.13	3.46	2.92	2.87	3.80	4.25	2.54	2.80	3.78
1,1-Dichloroethane	***39.93***	NA	NA	**48.52**	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	*14.39*	NA	NA	8.61	NA	NA	NA	NA	NA	NA	3.95
1,1-Dichloroethene	*9.79*	NA	NA	NA	NA	NA	NA	NA	NA	NA	9.79

Table 31-55. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average**	**Barceloneta, PR (BAPR)**	**Bountiful, UT (BTUT)**	**Deer Park , TX (CAMS 35)**	**Karnack , TX (CAMS 85)**	**Camden, NJ (CANJ)**	**Chester, NJ (CHNJ)**	**Pryor, OK (CNEP)**	**Custer, SD (CUSD)**	**Dearborn, MI (DEMI)**	**Elizabeth, NJ (ELNJ)**
cis-1,2-Dichloroethylene	***110.32***	NA	NA	NA	NA	NA	**129.66**	NA	NA	NA	NA
trans-1,2-Dichloroethylene	*10.85*	NA	NA	**23.57**	NA	NA	NA	NA	NA	0.97	NA
Dichloromethane	*5.35*	4.41	3.27	5.57	NA	3.64	5.58	7.65	5.66	4.41	3.82
1,2-Dichloropropane	*13.47*	NA	**20.08**	9.57	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	***18.25***	NA	NA	5.57	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	*4.27*	NA	NA	5.82	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	*10.19*	5.11	7.94	8.97	**23.57**	12.90	4.97	**22.69**	4.61	5.08	11.71
Ethyl Acrylate	*5.57*	NA	NA	5.57	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	*5.35*	3.47	2.90	5.13	4.16	7.64	5.52	6.60	4.70	3.10	5.66
Hexachloro-1,3-butadiene	***19.51***	NA	NA	NA	NA	NA	**32.07**	NA	NA	NA	NA
Methyl Ethyl Ketone	*8.68*	**18.78**	4.82	5.53	4.61	6.19	**21.12**	5.93	4.41	14.04	4.61
Methyl Isobutyl Ketone	*9.59*	7.15	5.16	7.31	NA	6.50	7.78	6.43	**20.16**	5.80	8.35
Methyl Methacrylate	***18.41***	NA	NA	9.89	NA	NA	NA	8.21	NA	NA	NA
Methyl *tert*-Butyl Ether	***18.31***	**17.82**	NA	6.02	NA	7.03	**25.67**	NA	NA	NA	3.93
n-Octane	*9.49*	8.32	4.12	10.84	13.47	11.71	14.11	12.39	9.32	8.55	10.92
Propylene	*4.45*	6.00	4.75	4.34	NA	2.55	6.68	3.72	3.24	4.42	5.01
Styrene	*9.60*	10.42	5.02	7.46	10.10	10.82	13.60	5.54	11.94	5.59	**25.57**
1,1,2,2-Tetrachloroethane	***84.94***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	*8.01*	4.61	4.32	9.03	NA	7.12	6.92	6.13	14.30	7.69	7.20
Toluene	*4.67*	3.00	3.17	4.04	2.56	6.34	6.67	5.85	2.96	3.60	4.88
1,2,4-Trichlorobenzene	***24.80***	NA	NA	NA	NA	NA	**25.34**	NA	NA	NA	NA
1,1,1-Trichloroethane	*8.84*	10.12	1.74	5.35	**23.57**	8.80	9.27	11.15	5.66	7.13	12.33
1,1,2-Trichloroethane	***30.32***	NA	NA	NA	NA	NA	NA	**24.77**	NA	NA	NA
Trichloroethylene	*12.06*	NA	2.31	6.84	NA	9.79	13.30	11.67	NA	13.23	NA
Trichlorofluoromethane	*3.48*	4.47	3.64	4.01	2.28	2.49	4.06	4.71	2.86	2.74	3.97
Trichlorotrifluoroethane	*5.28*	4.49	3.87	3.58	7.07	5.50	10.05	4.57	3.81	12.02	4.70
1,2,4-Trimethylbenzene	*5.64*	2.79	3.03	4.38	NA	11.25	**16.02**	2.76	8.60	3.62	5.49

Table 31-55. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average**	**Barceloneta, PR (BAPR)**	**Bountiful, UT (BTUT)**	**Deer Park , TX (CAMS 35)**	**Karnack , TX (CAMS 85)**	**Camden, NJ (CANJ)**	**Chester, NJ (CHNJ)**	**Pryor, OK (CNEP)**	**Custer, SD (CUSD)**	**Dearborn, MI (DEMI)**	**Elizabeth, NJ (ELNJ)**
1,3,5-Trimethylbenzene	*7.59*	5.39	3.11	6.88	NA	14.22	8.36	4.74	**15.39**	2.98	4.98
Vinyl chloride	***24.40***	NA	14.20	5.56	NA	**20.71**	NA	9.53	**26.94**	NA	NA
m,p-Xylene	*5.87*	2.93	2.94	4.31	1.64	4.78	13.63	5.61	10.51	3.25	4.08
o-Xylene	*5.54*	3.09	3.53	5.65	4.16	7.18	12.89	4.87	5.03	3.76	6.23
Average	*9.21*	*10.16*	*8.99*	*11.13*	*9.42*	*10.52*	***17.54***	*11.47*	*7.96*	*5.33*	*7.80*

Table 31-55. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Loudon, TN (LDTN)**	**Loudon, TN (MSTN)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Phoenix, AZ (PXSS)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**	**Sioux Falls, SD (SFSD)**
Acetonitrile	*9.21*	4.90	2.84	4.57	**20.79**	**27.98**	**23.98**	6.36	14.47	7.48	**15.73**
Acetylene	*4.52*	3.72	2.64	4.10	5.09	7.52	3.33	2.57	3.59	5.89	6.28
Acrolein	*6.75*	4.84	5.11	6.03	6.68	**15.04**	5.91	8.29	2.54	12.88	5.16
Acrylonitrile	***32.68***	**77.30**	14.90	5.39	NA	0.76	**49.71**	NA	NA	**39.36**	NA
tert-Amyl Methyl Ether	***40.62***	NA	**63.94**	NA	**63.94**	NA	NA	NA	NA	NA	NA
Benzene	*5.44*	4.15	4.75	4.58	5.89	7.01	5.47	8.97	2.47	6.06	5.49
Bromochloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***28.69***	**52.89**	NA	NA	NA	**27.32**	NA	NA	NA	NA	NA
Bromoform	***37.12***	NA	NA	3.93	NA	**88.01**	NA	12.57	NA	NA	NA
Bromomethane	*7.90*	7.39	8.80	5.47	**16.19**	5.82	8.75	9.07	4.81	5.57	12.06

Table 31-55. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Loudon, TN (LDTN)	Loudon, TN (MSTN)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Phoenix, AZ (PXSS)	St. Louis, MO (S4MO)	Seattle, WA (SEWA)	Sioux Falls, SD (SFSD)
1,3-Butadiene	*6.32*	3.67	3.95	10.14	5.85	10.14	9.87	4.01	8.48	6.30	5.12
Carbon disulfide	*4.59*	2.90	3.55	3.39	3.19	6.92	3.37	3.58	2.26	**17.87**	6.08
Carbon Tetrachloride	*5.47*	5.78	3.81	3.22	5.48	5.11	5.75	5.89	2.07	3.78	4.72
Chlorobenzene	***24.28***	**27.50**	NA	NA	NA	NA	NA	NA	NA	**36.12**	NA
Chloroethane	*10.69*	7.31	10.87	12.66	6.33	9.97	**18.04**	4.73	**18.05**	13.81	9.43
Chloroform	*9.21*	4.75	10.79	2.59	11.88	**17.80**	8.02	4.46	4.19	11.59	4.36
Chloromethane	*3.94*	3.28	2.51	3.11	4.89	3.82	3.29	2.48	2.50	3.18	6.52
Chloromethylbenzene	*8.59*	NA	NA	NA	8.59	NA	NA	NA	NA	NA	NA
Chloroprene	***86.70***	**91.96**	NA	**50.74**	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	***52.47***	NA	NA	**40.90**	NA	**25.84**	**78.18**	3.22	NA	**38.06**	NA
1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***35.39***	NA	**59.25**	**41.53**	NA	NA	NA	**26.69**	NA	NA	**41.53**
o-Dichlorobenzene	***19.97***	NA	NA	NA	NA	NA	NA	2.72	NA	NA	NA
p-Dichlorobenzene	*9.62*	4.47	3.61	9.31	3.81	11.51	**17.03**	7.38	4.86	7.71	**16.34**
Dichlorodifluoromethane	*3.50*	3.29	2.41	3.04	4.67	4.36	3.42	1.93	2.35	3.11	3.53
1,1-Dichloroethane	***39.93***	NA	14.18	NA	NA	NA	NA	NA	NA	**48.52**	NA
1,2-Dichloroethane	*14.39*	3.95	NA	NA	NA	10.15	9.34	NA	NA	NA	NA
1,1-Dichloroethene	*9.79*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	***110.32***	**90.99**	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	*10.85*	NA	NA	NA	NA	NA	NA	NA	NA	10.40	NA
Dichloromethane	*5.35*	3.42	3.78	4.74	8.10	7.33	5.05	5.96	5.47	6.44	7.07
1,2-Dichloropropane	*13.47*	NA	NA	NA	10.76	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	***18.25***	NA	NA	NA	NA	NA	NA	**30.93**	NA	NA	NA
trans-1,3-Dichloropropene	*4.27*	NA	NA	NA	NA	NA	NA	2.73	NA	NA	NA
Dichlorotetrafluoroethane	*10.19*	2.64	4.08	14.95	5.91	5.13	14.89	**22.26**	9.62	14.88	12.52
Ethyl Acrylate	*5.57*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 31-55. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Loudon, TN (LDTN)**	**Loudon, TN (MSTN)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Phoenix, AZ (PXSS)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**	**Sioux Falls, SD (SFSD)**
Ethylbenzene	*5.35*	3.94	4.60	5.86	5.57	13.65	6.36	9.15	2.41	8.43	7.85
Hexachloro-1,3-butadiene	***19.51***	6.95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Ethyl Ketone	*8.68*	4.28	6.42	5.53	5.14	**18.49**	**17.79**	6.82	2.47	14.15	6.06
Methyl Isobutyl Ketone	*9.59*	6.23	5.96	7.90	6.04	**25.30**	9.41	7.88	5.74	9.52	12.28
Methyl Methacrylate	***18.41***	**30.59**	NA	**26.00**	NA	NA	NA	NA	NA	NA	NA
Methyl *tert*-Butyl Ether	***18.31***	**51.33**	**30.84**	NA	NA	NA	NA	NA	**56.66**	NA	NA
n-Octane	*9.49*	5.43	4.15	7.87	**19.81**	3.83	5.16	6.86	12.43	10.58	**23.69**
Propylene	*4.45*	2.97	2.89	4.22	4.60	6.45	3.56	2.09	2.85	5.79	4.44
Styrene	*9.60*	2.36	3.73	5.09	4.68	**17.73**	7.03	5.75	7.62	14.74	12.12
1,1,2,2-Tetrachloroethane	***84.94***	NA	NA	NA	**84.94**	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	*8.01*	4.39	5.65	8.00	13.31	8.75	11.09	8.31	6.85	10.55	14.59
Toluene	*4.67*	3.69	3.88	3.20	4.43	9.77	4.50	10.84	2.72	7.51	4.49
1,2,4-Trichlorobenzene	***24.80***	NA	NA	NA	NA	NA	NA	7.65	**41.42**	NA	NA
1,1,1-Trichloroethane	*8.84*	3.98	4.56	9.53	6.32	6.72	6.97	9.03	6.49	7.78	9.78
1,1,2-Trichloroethane	***30.32***	NA	9.43	NA	NA	NA	14.08	NA	NA	**51.26**	NA
Trichloroethylene	*12.06*	5.03	NA	**25.32**	7.13	14.66	11.87	4.90	**47.04**	11.59	NA
Trichlorofluoromethane	*3.48*	3.19	2.25	3.16	4.80	5.44	3.38	2.51	1.94	3.75	3.57
Trichlorotrifluoroethane	*5.28*	2.73	3.02	3.52	5.47	4.30	13.94	3.07	2.58	4.00	5.06
1,2,4-Trimethylbenzene	*5.64*	3.48	4.27	6.42	2.05	13.03	4.73	8.87	2.11	6.48	4.79
1,3,5-Trimethylbenzene	*7.59*	5.33	6.62	10.72	3.89	12.67	8.77	7.52	12.40	7.52	9.11
Vinyl chloride	***24.40***	NA	NA	9.43	**71.65**	**38.38**	NA	**28.55**	**59.27**	**48.25**	NA
m,p-Xylene	*5.87*	3.83	3.98	5.75	3.42	12.34	4.80	9.47	1.45	14.06	6.07
o-Xylene	*5.54*	3.72	4.85	6.88	4.55	11.21	5.76	8.25	2.50	8.68	5.42
Average	*9.21*	*14.11*	*9.25*	*10.23*	*12.66*	*14.06*	*11.79*	*8.32*	*10.73*	*14.31*	*9.40*

Table 31-55. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tulsa, OK (TUOK)	Tupelo, MS (TUMS)
Acetonitrile	*9.21*	4.05	8.65	3.70	5.37	5.00	14.88
Acetylene	*4.52*	2.61	6.27	3.51	3.70	10.15	3.94
Acrolein	*6.75*	3.87	8.11	3.00	**15.70**	6.22	3.62
Acrylonitrile	***32.68***	NA	NA	NA	8.64	6.00	NA
tert-Amyl Methyl Ether	***40.62***	NA	NA	NA	**29.49**	**19.53**	NA
Benzene	*5.44*	5.52	5.72	3.97	3.96	4.99	5.46
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***28.69***	NA	NA	NA	NA	NA	NA
Bromoform	***37.12***	NA	NA	**56.44**	NA	NA	NA
Bromomethane	*7.90*	2.76	8.54	9.00	5.48	4.15	11.16
1,3-Butadiene	*6.32*	2.45	7.66	4.91	5.63	7.32	10.53
Carbon disulfide	*4.59*	1.42	3.73	2.11	5.70	5.14	3.07
Carbon Tetrachloride	*5.47*	2.17	3.14	5.01	5.02	7.57	2.78
Chlorobenzene	***24.28***	NA	NA	NA	NA	**61.09**	NA
Chloroethane	*10.69*	13.11	10.41	11.48	12.74	11.15	7.99
Chloroform	*9.21*	6.95	4.60	3.14	1.41	2.28	8.87
Chloromethane	*3.94*	1.52	6.21	2.68	5.43	7.38	3.27
Chloromethylbenzene	*8.59*	NA	NA	NA	NA	NA	NA
Chloroprene	***86.70***	NA	**85.85**	**117.87**	NA	NA	NA
Dibromochloromethane	***52.47***	NA	NA	NA	**78.18**	NA	NA
1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***35.39***	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	***19.97***	NA	NA	NA	**20.02**	NA	NA
p-Dichlorobenzene	*9.62*	3.25	6.99	6.43	11.95	2.44	9.38
Dichlorodifluoromethane	*3.50*	2.45	6.23	2.24	4.17	4.64	3.15

Table 31-55. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tulsa, OK (TUOK)	Tupelo, MS (TUMS)
1,2-Dibromoethane	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***35.39***	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	***19.97***	NA	NA	NA	**20.02**	NA	NA
p-Dichlorobenzene	*9.62*	3.25	6.99	6.43	11.95	2.44	9.38
Dichlorodifluoromethane	*3.50*	2.45	6.23	2.24	4.17	4.64	3.15
1,1-Dichloroethane	***39.93***	NA	NA	NA	NA	NA	**48.52**
1,2-Dichloroethane	*14.39*	NA	NA	NA	3.95	11.38	**63.80**
1,1-Dichloroethene	*9.79*	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	***110.32***	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	*10.85*	NA	NA	NA	8.46	NA	NA
Dichloromethane	*5.35*	2.14	3.50	5.04	3.27	11.18	7.18
1,2-Dichloropropane	*13.47*	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	***18.25***	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	*4.27*	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	*10.19*	2.38	5.21	6.52	8.00	**17.08**	11.32
Ethyl Acrylate	*5.57*	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	*5.35*	3.42	2.24	4.34	3.13	3.29	3.42
Hexachloro-1,3-butadiene	***19.51***	NA	NA	NA	NA	NA	NA
Methyl Ethyl Ketone	*8.68*	2.81	**26.87**	3.88	3.91	5.47	2.81
Methyl Isobutyl Ketone	*9.59*	7.04	**24.62**	3.80	5.61	6.69	7.04
Methyl Methacrylate	***18.41***	NA	NA	8.68	**27.09**	NA	NA
Methyl *tert*-Butyl Ether	***18.31***	3.84	NA	6.55	6.80	3.20	3.84
n-Octane	*9.49*	5.38	3.28	5.49	5.83	5.83	5.38
Propylene	*4.45*	3.41	6.79	3.61	4.28	5.58	3.41
Styrene	*9.60*	3.65	6.86	5.90	11.45	**17.34**	3.65

Table 31-55. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average**	**San Juan, PR (SJPR)**	**Schiller Park. IL (SPIL)**	**Tulsa, OK (TOOK)**	**Tulsa, OK (TSOK)**	**Tulsa, OK (TUOK)**	**Tupelo, MS (TUMS)**
Propylene	*4.45*	3.41	6.79	3.61	4.28	5.58	3.41
Styrene	*9.60*	3.65	6.86	5.90	11.45	**17.34**	3.65
1,1,2,2-Tetrachloroethane	***84.94***	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	*8.01*	5.81	2.23	13.98	7.37	10.21	5.81
Toluene	*4.67*	4.64	2.68	4.58	4.55	3.22	4.64
1,2,4-Trichlorobenzene	***24.80***	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	*8.84*	12.80	7.71	7.88	11.04	**16.59**	12.80
1,1,2-Trichloroethane	***30.32***	NA	NA	**51.26**	4.68	**24.77**	NA
Trichloroethylene	*12.06*	**23.57**	4.44	5.40	6.20	7.55	**23.57**
Trichlorofluoromethane	*3.48*	1.60	4.93	2.50	4.77	4.40	1.60
Trichlorotrifluoroethane	*5.28*	1.93	3.94	12.53	2.86	4.59	1.93
1,2,4-Trimethylbenzene	*5.64*	2.40	4.75	5.21	4.83	3.52	2.40
1,3,5-Trimethylbenzene	*7.59*	3.46	5.25	4.19	5.87	9.64	3.46
Vinyl chloride	***24.40***	NA	NA	14.28	5.44	7.33	NA
m,p-Xylene	*5.87*	3.55	2.05	4.20	**15.11**	3.94	3.55
o-Xylene	*5.54*	4.20	2.99	3.32	4.33	6.14	4.20
Average	*9.21*	*4.69*	*9.14*	*11.31*	*9.55*	*9.32*	*4.69*

31.2.2 SNMOC Analytical Precision

Table 31-56 presents analytical precision results from replicate analyses of all duplicate and collocated SNMOC samples. The average concentration differences observed for replicate analyses of SNMOC ranged from 0.01 (*cis*-2-pentene) to 2.50 (TNMOC) ppbC. For most of the pollutants, the SNMOC analytical precision was within the program DQO of 15 percent. The overall average variability was 10.81 percent.

Table 31-56. SNMOC Analytical Precision: 112 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	112	2.89	0.05	2.05
Benzene	112	4.67	0.06	3.30
1,3-Butadiene	74	16.21	0.02	11.46
n-Butane	108	1.68	0.07	1.19
cis-2-Butene	101	14.62	0.02	10.34
trans-2-Butene	108	7.82	0.02	5.53
Cyclohexane	112	7.47	0.02	5.28
Cyclopentane	112	10.37	0.02	7.33
Cyclopentene	21	21.47	0.07	**15.18**
n-Decane	107	11.98	0.04	8.47
1-Decene	0	NA	NA	NA
m-Diethylbenzene	76	24.80	0.05	**17.54**
p-Diethylbenzene	31	**42.74**	0.07	**30.22**
2,2-Dimethylbutane	103	10.40	0.02	7.36
2,3-Dimethylbutane	104	7.13	0.02	5.04
2,3-Dimethylpentane	109	10.78	0.03	7.62
2,4-Dimethylpentane	107	8.70	0.02	6.15
n-Dodecane	101	16.00	0.04	11.31
1-Dodecene	51	23.11	0.06	**16.34**
Ethane	112	0.83	0.07	0.59
Ethylbenzene	112	12.23	0.05	8.65
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	112	1.97	0.05	1.39
m-Ethyltoluene	104	6.98	0.02	4.94
o-Ethyltoluene	86	**25.88**	0.04	**18.30**
p-Ethyltoluene	100	18.06	0.03	12.77
n-Heptane	111	6.66	0.03	4.71
1-Heptene	94	21.26	0.04	**15.03**
n-Hexane	110	6.12	0.06	4.33
1-Hexene	96	**27.98**	0.05	**19.78**
cis-2-Hexene	6	**56.70**	0.09	**40.09**
trans-2-Hexene	5	**36.85**	0.07	**26.06**
Isobutane	112	2.08	0.04	1.47
Isobutene/1-Butene	80	8.05	0.15	5.69

Table 31-56. SNMOC Analytical Precision: 112 Replicate Analyses for all Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isopentane	92	2.70	0.28	1.91
Isoprene	101	7.89	0.03	5.58
Isopropylbenzene	53	15.16	0.02	10.72
2-Methyl-1-butene	96	8.16	0.02	5.77
2-Methyl-2-butene	78	11.23	0.03	7.94
3-Methyl-1-butene	12	10.13	0.07	7.16
Methylcyclohexane	103	10.80	0.04	7.64
Methylcyclopentane	112	5.57	0.02	4.01
2-Methylheptane	80	**26.05**	0.05	**18.42**
3-Methylheptane	87	14.53	0.02	10.27
2-Methylhexane	81	18.38	0.08	13.00
3-Methylhexane	112	8.64	0.04	6.11
3-Methylpentane	112	5.22	0.03	3.54
2-Methylpentane	110	7.48	0.09	5.29
4-Methyl-1-pentene	1	**128.86**	0.19	**91.12**
2-Methyl-1-pentene	18	11.02	0.02	7.79
n-Nonane	109	7.99	0.02	5.65
1-Nonene	47	**42.76**	0.07	**30.67**
n-Octane	112	5.56	0.02	3.93
1-Octene	60	23.21	0.03	**16.41**
n-Pentane	112	2.08	0.07	1.47
1-Pentene	108	4.99	0.02	3.53
cis-2-Pentene	70	9.55	0.01	6.75
trans-2-Pentene	97	12.37	0.02	8.75
a-Pinene	85	20.91	0.14	14.79
b-Pinene	26	9.25	0.10	6.54
Propane	112	1.13	0.09	0.80
n-Propylbenzene	94	18.94	0.03	13.39
Propylene	112	2.89	0.03	2.04
Propyne	0	NA	NA	NA
Styrene	33	**31.35**	0.15	**22.17**
SNMOC	112	1.52	1.14	1.07
TNMOC (w/unknowns)	112	2.11	2.50	1.49
Toluene	112	3.30	0.12	2.33
n-Tridecane	15	**27.45**	0.06	**19.41**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	82	19.36	0.03	13.69
1,2,4-Trimethylbenzene	112	7.37	0.03	5.21
1,3,5-Trimethylbenzene	80	13.97	0.03	9.88
2,2,3-Trimethylpentane	70	**27.35**	0.04	**19.34**
2,2,4-Trimethylpentane	112	4.68	0.04	3.42
2,3,4-Trimethylpentane	111	9.09	0.03	6.43
n-Undecane	110	14.01	0.05	9.90
1-Undecene	31	**57.44**	0.06	**40.62**
m-Xylene/*p*-Xylene	112	8.00	0.07	5.66
o-Xylene	112	6.56	0.03	4.64

Table 31-57 presents analytical precision results from SNMOC replicate analyses for all of the duplicate samples. These results show low- to high-level variability, ranging from 0.56 percent (ethane) to 91.12 percent (4-methyl-1-pentene). The overall average variability was 10.47 percent. For SNMOC, there was only one collocated site, NBIL. The SNMOC precision data for the replicate samples at NBIL is shown in Table 31-59.

Table 31-57. SNMOC Analytical Precision: 96 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	96	2.83	0.05	2.00
Benzene	96	4.95	0.07	3.50
1,3-Butadiene	66	13.49	0.02	9.54
n-Butane	92	1.58	0.07	1.12
cis-2-Butene	90	12.01	0.02	8.49
trans-2-Butene	92	6.63	0.02	4.69
Cyclohexane	96	7.74	0.03	5.47
Cyclopentane	96	8.30	0.02	5.87
Cyclopentene	16	17.05	0.08	12.05
n-Decane	92	13.65	0.04	9.65
1-Decene	0	NA	NA	NA
m-Diethylbenzene	62	**28.57**	0.06	**20.20**
p-Diethylbenzene	25	**48.73**	0.07	**34.45**
2,2-Dimethylbutane	90	8.10	0.02	5.73
2,3-Dimethylbutane	88	7.36	0.02	5.20
2,3-Dimethylpentane	93	9.93	0.03	7.02
2,4-Dimethylpentane	91	9.73	0.02	6.88
n-Dodecane	87	17.67	0.05	12.50
1-Dodecene	43	23.29	0.06	**16.47**
Ethane	96	0.79	0.05	0.56
Ethylbenzene	96	12.45	0.05	8.80
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	96	2.15	0.06	1.52
m-Ethyltoluene	88	6.62	0.02	4.68
o-Ethyltoluene	73	**26.26**	0.05	**18.57**
p-Ethyltoluene	86	12.14	0.03	8.58
n-Heptane	95	6.85	0.03	4.84
1-Heptene	83	18.59	0.04	13.14
n-Hexane	94	6.90	0.07	4.88
1-Hexene	87	22.69	0.04	**16.04**
cis-2-Hexene	5	**26.48**	0.05	**18.72**
trans-2-Hexene	5	**36.85**	0.07	**26.06**
Isobutane	96	1.94	0.03	1.37
Isobutene/1-Butene	70	7.68	0.16	5.43
Isopentane	76	2.77	0.31	1.96
Isoprene	90	5.15	0.03	3.64

Table 31-57. SNMOC Analytical Precision: 96 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isopropylbenzene	45	16.63	0.02	11.76
2-Methyl-1-butene	80	7.21	0.02	5.10
2-Methyl-2-butene	66	10.55	0.03	7.46
3-Methyl-1-butene	12	10.13	0.07	7.16
Methylcyclohexane	87	12.58	0.04	8.89
Methylcyclopentane	96	6.09	0.03	4.31
2-Methylheptane	68	**30.59**	0.06	**21.63**
3-Methylheptane	75	14.64	0.02	10.35
2-Methylhexane	69	14.27	0.07	10.09
3-Methylhexane	96	8.37	0.04	5.92
3-Methylpentane	96	5.55	0.03	3.70
2-Methylpentane	94	8.08	0.09	5.71
4-Methyl-1-pentene	1	**128.86**	0.19	**91.12**
2-Methyl-1-pentene	18	11.02	0.02	7.79
n-Nonane	93	7.86	0.02	5.56
1-Nonene	41	**33.13**	0.05	**23.98**
n-Octane	96	5.65	0.02	3.99
1-Octene	56	15.20	0.02	10.75
n-Pentane	96	2.14	0.08	1.51
1-Pentene	92	5.29	0.03	3.74
cis-2-Pentene	60	10.15	0.02	7.17
trans-2-Pentene	85	13.42	0.02	9.49
a-Pinene	71	22.76	0.12	**16.10**
b-Pinene	20	8.25	0.10	5.83
Propane	96	0.94	0.08	0.67
n-Propylbenzene	80	17.33	0.03	12.26
Propylene	96	3.09	0.03	2.19
Propyne	0	NA	NA	NA
Styrene	29	**33.41**	0.18	**23.62**
SNMOC	96	1.52	1.18	1.08
TNMOC (w/unknowns)	96	2.14	2.79	1.51
Toluene	96	3.60	0.15	2.54
n-Tridecane	13	**31.23**	0.07	**22.09**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	72	22.69	0.03	**16.04**
1,2,4-Trimethylbenzene	96	6.99	0.03	4.94
1,3,5-Trimethylbenzene	69	15.09	0.03	10.67
2,2,3-Trimethylpentane	60	**30.56**	0.05	**21.61**
2,2,4-Trimethylpentane	96	5.45	0.04	3.95
2,3,4-Trimethylpentane	95	10.61	0.03	7.50
n-Undecane	96	16.27	0.06	11.50
1-Undecene	26	**61.08**	0.06	**43.19**
m-Xylene/*p*-Xylene	96	9.03	0.08	6.38
o-Xylene	96	7.27	0.03	5.14

Due to the focus on QA for the NATTS program, Tables 31-58 and 31-59 present the analytical precision results from SNMOC replicate analyses for all the duplicate and collocated samples at NATTS sites (BTUT and NBIL), respectively. Shaded rows present results for the NATTS core compounds. These results show low- to high-level variability at these sites, as represented by CV, ranging from 0.25 percent (for propane at BTUT) to 91.12 percent (for 4-methyl-1-pentene at BTUT), with an average of 8.57 percent. This is within the 15 percent program DQO.

Table 31-58. SNMOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	24	1.30	0.06	0.92
Benzene	24	3.75	0.12	2.65
1,3-Butadiene	24	8.27	0.02	5.85
n-Butane	24	1.04	0.13	0.74
cis-2-Butene	24	4.42	0.01	3.12
trans-2-Butene	24	4.80	0.02	3.39
Cyclohexane	24	2.42	0.03	1.71
Cyclopentane	24	4.47	0.02	3.16
Cyclopentene	4	11.98	0.04	8.47
n-Decane	24	8.91	0.06	6.30
1-Decene	0	NA	NA	NA
m-Diethylbenzene	15	**26.94**	0.06	**19.05**
p-Diethylbenzene	12	8.19	0.01	5.79
2,2-Dimethylbutane	24	4.64	0.02	3.28
2,3-Dimethylbutane	24	2.80	0.02	1.98
2,3-Dimethylpentane	24	3.82	0.04	2.70
2,4-Dimethylpentane	24	3.42	0.02	2.42
n-Dodecane	24	9.94	0.03	7.03
1-Dodecene	15	**32.12**	0.07	**22.71**
Ethane	24	0.38	0.04	0.27
Ethylbenzene	24	4.67	0.05	3.30
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	24	1.71	0.13	1.21
m-Ethyltoluene	24	4.63	0.03	3.28
o-Ethyltoluene	24	10.62	0.03	7.51
p-Ethyltoluene	24	6.32	0.02	4.47
n-Heptane	24	3.62	0.06	2.56
1-Heptene	23	**27.74**	0.09	**19.62**
n-Hexane	24	3.33	0.12	2.36
1-Hexene	23	19.24	0.03	13.61
cis-2-Hexene	4	13.35	0.02	9.44
trans-2-Hexene	4	2.99	0.01	2.11

Table 31-58. SNMOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isobutane	24	0.57	0.06	0.40
Isobutene/1-Butene	24	6.04	0.13	4.27
Isopentane	16	2.46	0.43	1.74
Isoprene	24	3.75	0.04	2.65
Isopropylbenzene	16	9.43	0.01	6.67
2-Methyl-1-butene	24	5.36	0.02	3.79
2-Methyl-2-butene	20	11.63	0.04	8.23
3-Methyl-1-butene	4	12.22	0.12	8.64
Methylcyclohexane	24	3.17	0.06	2.24
Methylcyclopentane	24	2.16	0.02	1.41
2-Methylheptane	24	12.67	0.03	8.96
3-Methylheptane	24	5.48	0.02	3.87
2-Methylhexane	24	5.08	0.06	3.59
3-Methylhexane	24	3.13	0.03	2.21
3-Methylpentane	24	2.21	0.04	1.29
2-Methylpentane	24	2.24	0.08	1.59
4-Methyl-1-pentene	1	**128.86**	0.19	**91.12**
2-Methyl-1-pentene	16	11.02	0.02	7.79
n-Nonane	24	4.06	0.02	2.87
1-Nonene	15	24.55	0.04	**19.33**
n-Octane	24	3.25	0.02	2.30
1-Octene	18	14.04	0.04	9.93
n-Pentane	24	1.28	0.08	0.91
1-Pentene	24	2.06	0.06	1.46
cis-2-Pentene	21	5.29	0.01	3.74
trans-2-Pentene	24	5.27	0.02	3.73
a-Pinene	18	13.17	0.07	9.31
b-Pinene	4	13.92	0.18	9.84
Propane	24	0.35	0.11	0.25
n-Propylbenzene	24	9.23	0.02	6.53
Propylene	24	2.05	0.05	1.45
Propyne	0	NA	NA	NA
Styrene	4	**57.27**	0.30	**40.50**
SNMOC	24	0.85	1.37	0.60
TNMOC (w/unknowns)	24	2.73	4.74	1.93
Toluene	24	2.75	0.23	1.94
n-Tridecane	2	20.00	0.04	14.14
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	24	9.38	0.02	6.63
1,2,4-Trimethylbenzene	24	3.09	0.03	2.19
1,3,5-Trimethylbenzene	24	5.74	0.02	4.06
2,2,3-Trimethylpentane	24	12.47	0.04	8.82
2,2,4-Trimethylpentane	24	3.73	0.08	2.23
2,3,4-Trimethylpentane	24	6.19	0.03	4.38
n-Undecane	24	10.91	0.06	7.71

Table 31-58. SNMOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
1-Undecene	14	11.15	0.01	7.88
m-Xylene/*p*-Xylene	24	5.07	0.14	3.58
o-Xylene	24	3.25	0.04	2.30

Table 31-59. SNMOC Analytical Precision: 16 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	16	3.16	0.06	2.23
Benzene	16	3.56	0.03	2.52
1,3-Butadiene	8	**27.09**	0.02	**19.15**
n-Butane	16	2.06	0.07	1.46
cis-2-Butene	11	**25.09**	0.02	**17.74**
trans-2-Butene	16	12.60	0.02	8.91
Cyclohexane	16	6.41	0.01	4.54
Cyclopentane	16	18.65	0.03	13.18
Cyclopentene	5	**39.18**	0.07	**27.71**
n-Decane	15	5.32	0.02	3.76
1-Decene	0	NA	NA	NA
m-Diethylbenzene	14	9.73	0.02	6.88
p-Diethylbenzene	6	18.78	0.04	13.28
2,2-Dimethylbutane	13	19.60	0.03	13.86
2,3-Dimethylbutane	16	6.23	0.01	4.40
2,3-Dimethylpentane	16	14.16	0.03	10.01
2,4-Dimethylpentane	16	4.57	0.01	3.23
n-Dodecane	14	9.29	0.02	6.57
1-Dodecene	8	22.38	0.02	**15.83**
Ethane	16	1.03	0.14	0.73
Ethylbenzene	16	11.37	0.03	8.04
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	16	1.25	0.03	0.89
m-Ethyltoluene	16	8.44	0.01	5.97
o-Ethyltoluene	13	24.34	0.04	**17.21**
p-Ethyltoluene	14	**41.73**	0.05	**29.51**
n-Heptane	16	5.90	0.03	4.17
1-Heptene	11	**31.95**	0.03	**22.60**
n-Hexane	16	3.02	0.02	2.13
1-Hexene	9	**49.14**	0.08	**34.75**
cis-2-Hexene	1	**117.15**	0.18	**82.84**
trans-2-Hexene	0	NA	NA	NA
Isobutane	16	2.64	0.05	1.87
Isobutene/1-Butene	10	9.54	0.10	6.75
Isopentane	16	2.43	0.15	1.72

Table 31-59. SNMOC Analytical Precision: 16 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isoprene	11	18.83	0.01	13.31
Isopropylbenzene	8	9.28	0.01	6.56
2-Methyl-1-butene	16	11.95	0.02	8.45
2-Methyl-2-butene	12	13.98	0.03	9.89
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	16	3.69	0.01	2.61
Methylcyclopentane	16	3.48	0.02	2.81
2-Methylheptane	12	7.89	0.01	5.58
3-Methylheptane	12	14.09	0.03	9.96
2-Methylhexane	12	**34.82**	0.12	**24.62**
3-Methylhexane	16	9.71	0.05	6.87
3-Methylpentane	16	3.87	0.02	2.91
2-Methylpentane	16	5.10	0.08	3.60
4-Methyl-1-pentene	0	NA	NA	NA
2-Methyl-1-pentene	0	NA	NA	NA
n-Nonane	16	8.53	0.01	6.03
1-Nonene	6	**81.27**	0.13	**57.47**
n-Octane	16	5.24	0.02	3.71
1-Octene	4	**55.25**	0.06	**39.07**
n-Pentane	16	1.87	0.02	1.32
1-Pentene	16	3.80	0.01	2.68
cis-2-Pentene	10	7.16	0.01	5.06
trans-2-Pentene	12	8.16	0.01	5.77
a-Pinene	14	13.52	0.20	9.56
b-Pinene	6	12.26	0.10	8.67
Propane	16	1.89	0.11	1.33
n-Propylbenzene	14	**25.35**	0.03	**17.93**
Propylene	16	2.07	0.01	1.46
Propyne	0	NA	NA	NA
Styrene	4	23.13	0.03	**16.35**
SNMOC	16	1.50	1.00	1.06
TNMOC (w/unknowns)	16	2.02	1.33	1.43
Toluene	16	2.12	0.04	1.50
n-Tridecane	2	16.09	0.01	11.38
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	10	6.08	0.01	4.30
1,2,4-Trimethylbenzene	16	8.89	0.02	6.29
1,3,5-Trimethylbenzene	11	9.46	0.02	6.69
2,2,3-Trimethylpentane	10	14.51	0.02	10.26
2,2,4-Trimethylpentane	16	1.62	0.02	1.28
2,3,4-Trimethylpentane	16	3.00	0.01	2.12
n-Undecane	14	4.96	0.01	3.51
1-Undecene	5	**46.51**	0.07	**32.89**
m-Xylene/*p*-Xylene	16	3.89	0.02	2.75
o-Xylene	16	3.70	0.01	2.62

Table 31-60 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all UATMP and NATTS sites sampling SNMOC. The average site CV ranged from 6.74 percent at BTUT to 12.72 percent at SFSD, with an overall program average CV of 10.81 percent. This overall average variability is within the 15 percent CV program DQO.

Table 31-60. SNMOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	**Average**	**Bountiful, UT (BTUT)**	**Custer, SD (CUSD)**	**Gulfport, MS (GPMS)**	**Northbrook, IL (NBIL)**	**Sioux Falls, SD (SFSD)**
Acetylene	*2.05*	0.92	2.02	1.92	2.23	3.14
Benzene	*3.30*	2.65	1.92	2.40	2.52	7.02
1,3-Butadiene	*11.46*	5.85	2.75	8.55	**19.15**	**21.01**
n-Butane	*1.19*	0.74	1.28	1.05	1.46	1.41
cis-2-Butene	*10.34*	3.12	11.73	5.05	**17.74**	14.06
trans-2-Butene	*5.53*	3.39	4.81	4.75	8.91	5.80
Cyclohexane	*5.28*	1.71	6.63	5.18	4.54	8.36
Cyclopentane	*7.33*	3.16	10.23	6.62	13.18	3.47
Cyclopentene	***15.18***	8.47	5.64	**29.71**	**27.71**	4.39
n-Decane	*8.47*	6.30	13.48	10.57	3.76	8.26
1-Decene	NA	NA	NA	NA	NA	NA
m-Diethylbenzene	***17.54***	**19.05**	14.31	**15.98**	6.88	**31.47**
p-Diethylbenzene	***30.22***	5.79	11.17	**32.57**	13.28	**88.29**
2,2-Dimethylbutane	*7.36*	3.28	7.30	5.33	13.86	7.02
2,3-Dimethylbutane	*5.04*	1.98	9.91	3.80	4.40	5.11
2,3-Dimethylpentane	*7.62*	2.70	9.41	8.01	10.01	7.95
2,4-Dimethylpentane	*6.15*	2.42	7.33	9.93	3.23	7.85
n-Dodecane	*11.31*	7.03	**19.00**	9.18	6.57	14.79
1-Dodecene	***16.34***	**22.71**	9.65	**24.30**	**15.83**	9.21
Ethane	*0.59*	0.27	0.38	0.47	0.73	1.10
Ethylbenzene	*8.65*	3.30	12.67	6.50	8.04	12.72
2-Ethyl-1-butene	NA	NA	NA	NA	NA	NA
Ethylene	*1.39*	1.21	0.97	1.03	0.89	2.88
m-Ethyltoluene	*4.94*	3.28	6.03	4.44	5.97	4.97
o-Ethyltoluene	***18.30***	7.51	**21.63**	**17.77**	**17.21**	**27.37**
p-Ethyltoluene	*12.77*	4.47	6.19	10.99	**29.51**	12.69
n-Heptane	*4.71*	2.56	2.92	5.25	4.17	8.65
1-Heptene	***15.03***	**19.62**	11.85	10.36	**22.60**	10.75
n-Hexane	*4.33*	2.36	8.01	3.52	2.13	5.63
1-Hexene	***19.78***	13.61	**16.07**	9.32	**34.75**	**25.17**
cis-2-Hexene	***40.09***	9.44	NA	**28.01**	**82.84**	NA
trans-2-Hexene	***26.06***	2.11	NA	**50.01**	NA	NA
Isobutane	*1.47*	0.40	1.59	0.51	1.87	3.00

Table 31-60. SNMOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulfport, MS (GPMS)	Northbrook, IL (NBIL)	Sioux Falls, SD (SFSD)
Isobutene/1-Butene	*5.69*	4.27	6.49	6.43	6.75	4.53
Isopentane	*1.91*	1.74	1.92	2.05	1.72	2.12
Isoprene	*5.58*	2.65	4.35	2.54	13.31	5.03
Isopropylbenzene	*10.72*	6.67	**15.79**	**21.22**	6.56	3.37
Isopentane	*5.77*	3.79	7.55	3.16	8.45	5.89
Isoprene	*7.94*	8.23	8.95	10.34	9.89	2.31
Isopropylbenzene	*2.05*	0.92	2.02	1.92	2.23	3.14
2-Methyl-1-butene	*3.30*	2.65	1.92	2.40	2.52	7.02
2-Methyl-2-butene	*11.46*	5.85	2.75	8.55	**19.15**	**21.01**
2-Methylheptane	***18.42***	8.96	**16.51**	**22.79**	5.58	**38.25**
3-Methylheptane	*10.27*	3.87	11.01	9.38	9.96	**17.15**
2-Methylhexane	*13.00*	3.59	**15.56**	12.97	**24.62**	8.26
3-Methylhexane	*6.11*	2.21	7.38	6.90	6.87	7.20
3-Methylpentane	*3.54*	1.29	3.29	2.73	2.91	7.48
2-Methylpentane	*5.29*	1.59	7.61	9.93	3.60	3.72
4-Methyl-1-pentene	***91.12***	**91.12**	NA	NA	NA	NA
2-Methyl-1-pentene	*7.79*	7.79	NA	NA	NA	NA
n-Nonane	*5.65*	2.87	6.44	5.00	6.03	7.92
1-Nonene	***30.67***	**19.33**	12.64	**30.03**	**57.47**	**33.90**
n-Octane	*3.93*	2.30	5.94	3.65	3.71	4.08
1-Octene	***16.41***	9.93	4.37	5.15	**39.07**	**23.53**
n-Pentane	*1.47*	0.91	0.85	2.42	1.32	1.87
1-Pentene	*3.53*	1.46	2.57	4.41	2.68	6.54
cis-2-Pentene	*6.75*	3.74	8.83	8.21	5.06	7.91
trans-2-Pentene	*8.75*	3.73	9.70	7.02	5.77	**17.52**
a-Pinene	*14.79*	9.31	12.93	**24.46**	9.56	**17.68**
b-Pinene	*6.54*	9.84	2.36	5.30	8.67	NA
Propane	*0.80*	0.25	0.18	0.60	1.33	1.64
n-Propylbenzene	*13.39*	6.53	12.75	8.02	**17.93**	**21.72**
Propylene	*2.04*	1.45	1.70	1.25	1.46	4.35
Propyne	NA	NA	NA	NA	NA	NA
Styrene	***22.17***	**40.50**	**21.23**	**19.80**	**16.35**	12.96
SNMOC	*1.07*	0.60	0.97	1.26	1.06	1.48
TNMOC (w/unknowns)	*1.49*	1.93	1.54	1.00	1.43	1.57
Toluene	*2.33*	1.94	2.36	2.25	1.50	3.62
n-Tridecane	***19.41***	14.14	5.13	**46.99**	11.38	NA
1-Tridecene	NA	NA	NA	NA	NA	NA
1,2,3-Trimethylbenzene	*13.69*	6.63	12.71	7.82	4.30	**37.00**
1,2,4-Trimethylbenzene	*5.21*	2.19	8.47	3.94	6.29	5.16
1,3,5-Trimethylbenzene	*9.88*	4.06	11.80	13.27	6.69	13.56
2,2,3-Trimethylpentane	***19.34***	8.82	**23.69**	**33.42**	10.26	**20.52**
2,2,4-Trimethylpentane	*3.42*	2.23	3.79	4.96	1.28	4.82
2,3,4-Trimethylpentane	*6.43*	4.38	6.52	5.90	2.12	13.21

Table 31-60. SNMOC Analytical Precision: Coefficient of Variation for all Replicate Analyses, All Sites (Continued)

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulfport, MS (GPMS)	Northbrook, IL (NBIL)	Sioux Falls, SD (SFSD)
n-Undecane	*9.90*	7.71	11.07	**19.64**	3.51	7.59
1-Undecene	***40.62***	7.88	NA	11.08	**32.89**	**110.62**
m-Xylene/*p*-Xylene	*5.66*	3.58	14.56	2.49	2.75	4.90
o-Xylene	*4.64*	2.30	8.37	2.60	2.62	7.30
Average	*10.81*	*6.74*	*8.13*	*10.15*	*10.50*	*12.72*

31.2.3 Carbonyl Compounds Analytical Precision

Table 31-61 presents the analytical precision results from replicate analyses of duplicate and collocated samples, which shows that laboratory carbonyl analytical precision is within the control limits of 15 percent CV. The overall average variability was 3.08 percent. In terms of average concentration difference, the carbonyl precision ranged from 0.001 ppbv for benzaldehyde to 0.02 ppbv for formaldehyde.

Table 31-61. Carbonyl Analytical Precision: 818 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	818	0.65	0.01	0.46
Acetone	818	0.65	0.01	0.46
Benzaldehyde	818	3.60	0.001	2.55
Butyraldehyde	818	2.48	0.003	1.75
Crotonaldehyde	818	3.06	0.002	2.17
2,5-Dimethylbenzaldehyde	9	21.81	0.004	**15.42**
Formaldehyde	818	0.79	0.02	0.56
Hexaldehyde	806	3.71	0.002	2.62
Isovaleraldehyde	175	5.22	0.002	3.69
Propionaldehyde	814	2.97	0.003	2.10
Tolualdehydes	801	4.19	0.002	2.96
Valeraldehyde	812	3.21	0.002	2.27

Table 31-62 shows analytical precision the results from replicate analyses of all collocated carbonyl samples collected at DEMI, IDIN, INDEM, ININ, LDTN, MSTN, NBIL, PXSS, SEWA, SPIL, TOOK, TSOK, TUOK, and WPIN. The analytical precision results from collocated samples show variation for the pollutants ranging from 0.48 percent (acetone) to 37.26 percent (2,5-dimethylbenzaldehyde). The overall average variability was 4.83 percent.

Table 31-62. Carbonyl Analytical Precision: 408 Replicate Analyses for all Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	408	0.80	0.01	0.56
Acetone	408	0.70	0.01	0.48
Benzaldehyde	408	3.48	0.002	2.46
Butyraldehyde	408	2.30	0.004	1.63
Crotonaldehyde	408	3.22	0.002	2.28
2,5-Dimethylbenzaldehyde	9	**52.69**	0.01	**37.26**
Formaldehyde	408	0.70	0.02	0.49
Hexaldehyde	408	3.82	0.003	2.70
Isovaleraldehyde	96	3.41	0.002	2.41
Propionaldehyde	408	2.77	0.004	1.96
Tolualdehydes	404	4.55	0.002	3.22
Valeraldehyde	408	3.46	0.002	2.45

Table 31-63 shows the analytical precision results from replicate analyses of all duplicate carbonyl samples. The analytical precision results from duplicate samples show variation for the pollutants ranging from 0.37 percent (acetaldehyde) to 5.49 percent (isovaleraldehyde). The overall average variability was 2.12 percent.

Table 31-63. Carbonyl Analytical Precision: 410 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	410	0.52	0.01	0.37
Acetone	410	0.62	0.01	0.43
Benzaldehyde	410	3.90	0.001	2.75
Butyraldehyde	410	2.40	0.002	1.70

Table 31-63. Carbonyl Analytical Precision: 410 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Crotonaldehyde	410	2.70	0.002	1.91
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	410	0.76	0.02	0.54
Hexaldehyde	398	3.67	0.001	2.59
Isovaleraldehyde	79	7.76	0.001	5.49
Propionaldehyde	406	2.53	0.002	1.79
Tolualdehydes	397	4.48	0.001	3.17
Valeraldehyde	404	3.57	0.001	2.52

Due to the focus on QA for the NATTS program, Tables 31-64 through 31-72 present the analytical precision results from carbonyl replicate analyses of duplicate and collocated samples at NATTS sites (BTUT, DEMI, GPCO, NBIL, PXSS, S4MO, SEWA, SKFL, and SYFL, respectively). Shaded rows present results for the NATTS core compounds. The analytical precision results from the NATTS replicate samples show low- to high-level variability among the sites, ranging from 0.16 percent for acetaldehyde at GPCO to 37.26 percent for 2,5-dimethylbenzaldehyde at DEMI. The average CV, 2.53 percent, is well within the program DQO of 15 percent overall CV per site.

Table 31-64. Carbonyl Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	24	0.36	0.003	0.25
Acetone	24	0.31	0.01	0.18
Benzaldehyde	24	4.42	0.002	3.12
Butyraldehyde	24	2.00	0.003	1.41
Crotonaldehyde	24	2.41	0.002	1.71
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	24	0.45	0.01	0.32
Hexaldehyde	24	3.03	0.002	2.14
Isovaleraldehyde	8	2.51	0.001	1.78

Table 31-64. Carbonyl Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propionaldehyde	24	2.67	0.004	1.89
Tolualdehydes	24	4.57	0.002	3.23
Valeraldehyde	24	2.54	0.001	1.79

Table 31-65. Carbonyl Analytical Precision: 120 Replicate Analyses for Collocated Samples for Dearborn, MI (DEMI)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	120	0.41	0.01	0.29
Acetone	120	0.41	0.01	0.30
Benzaldehyde	120	3.73	0.003	2.63
Butyraldehyde	120	1.17	0.004	0.83
Crotonaldehyde	120	3.17	0.003	2.24
2,5-Dimethylbenzaldehyde	9	**52.69**	0.01	**37.26**
Formaldehyde	120	0.77	0.03	0.55
Hexaldehyde	120	3.16	0.02	2.24
Isovaleraldehyde	28	3.09	0.003	2.19
Propionaldehyde	120	1.70	0.01	1.20
Tolualdehydes	118	3.75	0.003	2.65
Valeraldehyde	120	3.68	0.01	2.60

Table 31-66. Carbonyl Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	24	0.22	0.004	0.16
Acetone	24	0.30	0.01	0.23
Benzaldehyde	24	1.80	0.002	1.28
Butyraldehyde	24	1.58	0.002	1.12
Crotonaldehyde	24	2.21	0.001	1.56
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	24	0.54	0.02	0.38
Hexaldehyde	24	4.89	0.001	3.46
Isovaleraldehyde	4	5.26	0.001	3.72

Table 31-66. Carbonyl Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propionaldehyde	24	1.98	0.002	1.40
Tolualdehydes	24	3.21	0.001	2.27
Valeraldehyde	24	2.97	0.001	2.10

Table 31-67. Carbonyl Analytical Precision: 24 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	24	1.07	0.002	0.75
Acetone	24	1.51	0.003	0.83
Benzaldehyde	24	3.71	0.001	2.62
Butyraldehyde	24	2.07	0.001	1.46
Crotonaldehyde	24	4.33	0.001	3.07
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	24	0.69	0.004	0.49
Hexaldehyde	24	2.56	0.001	1.81
Isovaleraldehyde	0	NA	NA	NA
Propionaldehyde	24	2.72	0.001	1.92
Tolualdehydes	24	4.76	0.001	3.37
Valeraldehyde	24	3.77	0.001	2.67

Table 31-68. Carbonyl Analytical Precision: 12 Replicate Analyses for Collocated Samples for Phoenix, AZ (PXSS)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	12	1.50	0.03	1.06
Acetone	12	0.65	0.04	0.37
Benzaldehyde	12	2.80	0.003	1.98
Butyraldehyde	12	3.62	0.01	2.56
Crotonaldehyde	12	3.43	0.01	2.42
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	12	0.68	0.03	0.48
Hexaldehyde	12	2.42	0.004	1.71
Isovaleraldehyde	4	4.00	0.002	2.83

Table 31-68. Carbonyl Analytical Precision: 12 Replicate Analyses for Collocated Samples for Phoenix, AZ (PXSS) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propionaldehyde	12	3.40	0.01	2.40
Tolualdehydes	12	2.30	0.002	1.63
Valeraldehyde	12	3.17	0.004	2.24

Table 31-69. Carbonyl Analytical Precision: 24 Replicate Analyses for Duplicate Samples for St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	24	0.48	0.01	0.34
Acetone	24	0.57	0.01	0.39
Benzaldehyde	24	3.88	0.002	2.75
Butyraldehyde	24	2.62	0.003	1.85
Crotonaldehyde	24	2.98	0.002	2.10
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	24	0.62	0.02	0.44
Hexaldehyde	24	4.49	0.001	3.18
Isovaleraldehyde	4	6.67	0.001	4.71
Propionaldehyde	24	3.05	0.003	2.16
Tolualdehydes	24	5.65	0.002	4.00
Valeraldehyde	24	3.61	0.001	2.55

Table 31-70. Carbonyl Analytical Precision: 28 Replicate Analyses for Collocated Samples for Seattle, WA (SEWA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	28	0.87	0.004	0.62
Acetone	28	0.42	0.003	0.17
Benzaldehyde	28	3.07	0.001	2.17
Butyraldehyde	28	2.80	0.003	1.98
Crotonaldehyde	28	2.88	0.002	2.04
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	28	1.13	0.01	0.80
Hexaldehyde	28	3.15	0.001	2.22
Isovaleraldehyde	4	5.56	0.004	3.93

Table 31-70. Carbonyl Analytical Precision: 28 Replicate Analyses for Collocated Samples for Seattle, WA (SEWA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propionaldehyde	28	3.70	0.003	2.62
Tolualdehydes	28	4.76	0.002	3.36
Valeraldehyde	28	3.84	0.002	2.72

Table 31-71. Carbonyl Analytical Precision: 28 Replicate Analyses for Duplicate Samples for Pinellas Park, FL (SKFL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	28	0.81	0.01	0.57
Acetone	28	0.74	0.005	0.48
Benzaldehyde	28	3.42	0.001	2.42
Butyraldehyde	28	2.28	0.002	1.62
Crotonaldehyde	28	1.98	0.002	1.40
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	28	0.73	0.01	0.51
Hexaldehyde	28	3.15	0.001	2.22
Isovaleraldehyde	7	**45.02**	0.003	**31.83**
Propionaldehyde	28	2.09	0.001	1.48
Tolualdehydes	27	14.53	0.002	10.27
Valeraldehyde	28	3.54	0.001	2.50

Table 31-72. Carbonyl Analytical Precision: 28 Replicate Analyses for Duplicate Samples for Plant City, FL (SYFL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	28	0.66	0.01	0.47
Acetone	28	1.11	0.01	0.79
Benzaldehyde	28	3.91	0.001	2.76
Butyraldehyde	28	2.13	0.002	1.51
Crotonaldehyde	28	1.79	0.003	1.27
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	28	0.82	0.05	0.58
Hexaldehyde	28	2.08	0.002	1.47
Isovaleraldehyde	6	4.93	0.004	3.49

Table 31-72. Carbonyl Analytical Precision: 28 Replicate Analyses for Duplicate Samples for Plant City, FL (SYFL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propionaldehyde	28	2.36	0.003	1.67
Tolualdehydes	24	2.96	0.001	2.09
Valeraldehyde	28	3.75	0.004	2.65

Table 31-73 presents the average CV per pollutant, per pollutant per site, per site, and the overall CV for all UATMP and NATTS sites sampling carbonyl compounds. The replicate results from duplicate and collocated samples show low- to high-level variability among the sites, ranging from 1.55 percent at ELNJ to 5.03 percent at SKFL. The average CV was 4.96 percent, which is well with in the requested 15 percent overall CV per site.

Table 31-73. Carbonyl Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	Average	St. Petersburg, FL (AZFL)	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Dearborn, MI (DEMI)
Acetaldehyde	*0.45*	0.61	0.13	0.25	0.53	0.34	0.42	0.29
Acetone	*0.46*	0.40	0.17	0.18	0.43	0.21	0.30	0.30
Benzaldehyde	*2.63*	3.02	3.13	3.12	2.48	2.65	2.41	2.63
Butyraldehyde	*1.67*	1.86	0.94	1.41	1.48	1.90	2.03	0.83
Crotonaldehyde	*2.06*	2.26	3.74	1.71	2.77	1.21	1.60	2.24
2,5-Dimethylbenzaldehyde	***37.26***	NA	NA	NA	NA	NA	NA	**37.26**
Formaldehyde	*0.52*	0.78	0.74	0.32	0.42	0.44	0.61	0.55
Hexaldehyde	*2.64*	2.79	NA	2.14	2.75	4.00	1.81	2.24
Isovaleraldehyde	*4.26*	5.30	NA	1.78	2.83	4.19	4.72	2.19
Propionaldehyde	*1.87*	1.44	1.77	1.89	2.12	1.50	2.47	1.20
Tolualdehydes	*3.19*	2.45	4.50	3.23	2.53	3.13	3.27	2.65
Valeraldehyde	*2.49*	3.35	3.20	1.79	3.01	3.39	2.29	2.60
Average	*4.96*	*2.21*	*2.04*	*1.62*	*1.94*	*2.09*	*1.99*	*4.58*

Table 31-73. Carbonyl Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average**	**Elizabeth, NJ (ELNJ)**	**Davie, FL (FLFL)**	**Tampa, FL (GAFL)**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Indianapolis, IN (IDIN)**	**Gary, IN (INDEM)**
Acetaldehyde	*0.45*	0.41	0.24	0.14	0.16	0.58	0.71	0.30
Acetone	*0.46*	0.48	NA	0.68	0.23	0.64	0.47	0.46
Benzaldehyde	*2.63*	2.80	4.16	2.70	1.28	3.17	2.38	2.54
Butyraldehyde	*1.67*	0.86	0.97	2.89	1.12	2.08	2.83	1.19
Crotonaldehyde	*2.06*	1.69	2.83	1.01	1.56	1.68	2.18	2.88
2,5-Dimethylbenzaldehyde	***37.26***	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*0.52*	0.39	0.90	0.60	0.38	0.37	0.55	0.28
Hexaldehyde	*2.64*	2.64	NA	2.57	3.46	2.15	3.36	3.02
Isovaleraldehyde	*4.26*	2.28	NA	1.35	3.72	6.44	1.20	NA
Propionaldehyde	*1.87*	1.59	NA	1.64	1.40	2.39	2.26	2.56
Tolualdehydes	*3.19*	3.16	2.83	2.08	2.27	2.68	2.90	4.01
Valeraldehyde	*2.49*	0.74	3.07	1.77	2.10	3.01	3.10	1.35
Average	*4.96*	*1.55*	*2.14*	*1.58*	*1.61*	*2.29*	*1.99*	*1.86*

Table 31-73. Carbonyl Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average**	**Indianapolis, IN (ININ)**	**Loudon, TN (LDTN)**	**Loudon, TN (MSTN)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Winter Park, FL (ORFL)**	**Phoenix, AZ (PXSS)**
Acetaldehyde	*0.45*	0.73	0.64	0.33	0.75	0.24	0.52	1.06
Acetone	*0.46*	0.33	0.93	0.25	0.83	0.50	0.79	0.37
Benzaldehyde	*2.63*	3.19	2.51	3.32	2.62	3.16	2.56	1.98
Butyraldehyde	*1.67*	2.08	2.01	1.12	1.46	1.16	2.55	2.56
Crotonaldehyde	*2.06*	2.59	1.38	1.69	3.07	2.10	1.15	2.42
2,5-Dimethylbenzaldehyde	***37.26***	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*0.52*	0.51	0.85	0.27	0.49	0.29	0.73	0.48
Hexaldehyde	*2.64*	3.22	2.26	3.35	1.81	2.47	2.85	1.71
Isovaleraldehyde	*4.26*	NA	2.73	3.13	NA	4.03	1.97	2.83
Propionaldehyde	*1.87*	3.05	1.76	1.69	1.92	1.45	1.94	2.40
Tolualdehydes	*3.19*	3.35	2.71	2.87	3.37	2.29	2.68	1.63
Valeraldehyde	*2.49*	3.47	3.27	2.09	2.67	3.10	1.73	2.24
Average	*4.96*	*2.25*	*1.91*	*1.83*	*1.90*	*1.89*	*1.77*	*1.79*

Table 31-73. Carbonyl Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	St. Louis, MO (S4MO)	Seattle, WA (SEWA)	Sioux Falls, SD (SFSD)	San Juan, PR (SJPR)	Pinellas Park, FL (SKFL)	Schiller Park, IL (SPIL)	Plant City, FL (SYFL)
Acetaldehyde	*0.45*	0.34	0.62	0.53	0.25	0.57	0.89	0.47
Acetone	*0.46*	0.39	0.17	0.37	0.41	0.48	0.88	0.79
Benzaldehyde	*2.63*	2.75	2.17	3.49	2.03	2.42	1.30	2.76
Butyraldehyde	*1.67*	1.85	1.98	1.87	2.11	1.62	0.53	1.51
Crotonaldehyde	*2.06*	2.10	2.04	2.00	2.03	1.40	3.86	1.27
2,5-Dimethylbenzaldehyde	***37.26***	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*0.52*	0.44	0.80	0.35	0.66	0.51	0.32	0.58
Hexaldehyde	*2.64*	3.18	2.22	2.28	2.72	2.22	2.37	1.47
Isovaleraldehyde	*4.26*	4.71	3.93	3.72	NA	**31.83**	NA	3.49
Propionaldehyde	*1.87*	2.16	2.62	1.38	1.23	1.48	1.11	1.67
Tolualdehydes	*3.19*	4.00	3.36	2.09	3.14	10.27	4.11	2.09
Valeraldehyde	*2.49*	2.55	2.72	2.87	2.94	2.50	2.03	2.65
Average	*4.96*	*2.23*	*2.06*	*1.90*	*1.75*	*5.03*	*1.74*	*1.70*

Table 31-73. Carbonyl Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tulsa, OK (TUOK)	Tupelo, MS (TUMS)	Indianapolis, IN (WPIN)
Acetaldehyde	*0.45*	0.20	0.24	0.44	0.28	0.71
Acetone	*0.46*	0.42	0.33	0.63	0.37	0.39
Benzaldehyde	*2.63*	1.93	2.78	2.70	2.24	2.39
Butyraldehyde	*1.67*	1.09	1.63	1.13	2.08	2.35
Crotonaldehyde	*2.06*	1.87	0.96	2.70	2.15	2.02
2,5-Dimethylbenzaldehyde	***37.26***	NA	NA	NA	NA	NA
Formaldehyde	*0.52*	0.22	0.53	0.66	0.74	0.41
Hexaldehyde	*2.64*	4.12	2.86	2.99	2.55	2.26
Isovaleraldehyde	*4.26*	1.20	0.90	2.57	NA	3.45
Propionaldehyde	*1.87*	1.43	1.05	1.77	2.76	2.61
Tolualdehydes	*3.19*	3.20	4.29	3.86	1.48	2.73
Valeraldehyde	*2.49*	2.57	2.01	1.37	1.83	2.82
Average	*4.96*	*1.66*	*1.60*	*1.89*	*1.65*	*2.01*

31.2.4 Metals Analytical Precision

The analytical precision results for all collocated metals samples are presented in Table 31-74. The average CV values, as well as the average RPD values, show low- to high-level variability among the sites, with average CVs ranging from 1.14 percent for lead to 33.74 percent for mercury, with an overall average of 6.26 percent.

Table 31-74. Metal Analytical Precision: 384 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	384	1.84	0.02	1.30
Arsenic	384	2.86	0.03	1.89
Beryllium	379	20.40	0.003	14.42
Cadmium	384	3.46	0.01	2.45
Chromium	384	4.52	0.11	3.20
Cobalt	384	2.48	0.01	1.76
Lead	384	1.62	0.10	1.14
Manganese	383	2.51	0.51	1.77
Mercury	372	**47.72**	0.04	**33.74**
Nickel	384	4.74	0.12	3.36
Selenium	384	5.37	0.03	3.80

Due to the focus on QA for the NATTS program, Tables 31-75 through 31-78 present the analytical precision results from collocated metals at the NATTS sites (BOMA, BTUT, S4MO, and SEWA, respectively). Shaded rows present results for the NATTS core compounds. Table 31-75 presents analytical precision results for the collocated sample analysis for BOMA. The variability ranged from 0.95 percent (antimony) to 35.80 percent (mercury).

Table 31-75. Metal Analytical Precision: 112 Collocated Samples at Boston, MA (BOMA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	112	1.35	0.01	0.95
Arsenic	112	4.11	0.02	2.45
Beryllium	107	**32.94**	0.001	**23.29**
Cadmium	112	1.80	0.002	1.28
Chromium	112	2.71	0.06	1.92

Table 31-75. Metal Analytical Precision: 112 Collocated Samples at Boston, MA (BOMA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Cobalt	112	1.75	0.003	1.23
Lead	112	1.49	0.05	1.05
Manganese	111	2.24	0.09	1.59
Mercury	110	**50.63**	0.02	**35.80**
Nickel	112	2.93	0.08	2.07
Selenium	112	6.61	0.01	4.67

Table 31-76 presents analytical precision results for the collocated sample analysis for BTUT. The variability ranged from 1.78 percent (manganese) to 31.15 percent (mercury), with an average variability of 8.09 percent.

Table 31-76. Metal Analytical Precision: 12 Collocated Samples at Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	12	2.90	0.04	2.05
Arsenic	12	3.37	0.06	2.36
Beryllium	12	**34.64**	0.01	**24.50**
Cadmium	12	4.48	0.01	3.17
Chromium	12	6.37	0.11	4.51
Cobalt	12	3.89	0.02	2.75
Lead	12	3.09	0.13	2.19
Manganese	12	2.52	0.52	1.78
Mercury	10	**44.05**	0.14	**31.15**
Nickel	12	6.43	0.15	4.54
Selenium	12	14.09	0.08	9.96

Table 31-77 shows metals analytical precision results for the replicate results for collocated samples at S4MO. The average RPD and CV are within the NATTS requirements for all but one pollutant (mercury).

Table 31-77. Metal Analytical Precision: 46 Collocated Samples at St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	46	1.04	0.02	0.73
Arsenic	46	0.94	0.01	0.66
Beryllium	46	15.94	0.001	11.27
Cadmium	46	1.11	0.01	0.79
Chromium	46	5.26	0.13	3.72
Cobalt	46	1.56	0.002	1.10
Lead	46	0.61	0.07	0.43
Manganese	46	1.48	0.18	1.05
Mercury	38	**43.70**	0.02	**30.90**
Nickel	46	1.14	0.01	0.81
Selenium	46	1.35	0.01	0.95

Table 31-78 presents analytical precision results for the collocated sample analysis for SEWA. The variability ranged from 0.93 percent (lead) to 48.50 percent (mercury), with an average variability of 7.58 percent.

Table 31-78. Metal Analytical Precision: 4 Collocated Samples at Seattle, WA (SEWA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	4	2.18	0.04	1.54
Arsenic	4	3.80	0.05	2.45
Beryllium	4	9.09	0.001	6.43
Cadmium	4	8.33	0.02	5.89
Chromium	4	4.84	0.17	3.42
Cobalt	4	2.83	0.01	2.00
Lead	4	1.31	0.11	0.93
Manganese	4	3.82	1.05	2.70
Mercury	4	**68.59**	0.02	**48.50**
Nickel	4	10.66	0.30	7.54
Selenium	4	2.88	0.01	2.03

Table 31-79 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all UATMP and NATTS sites sampling metals. The results from collocated samples show low- to high-level variability among sites, ranging from 4.76 percent at S4MO to 8.09 percent at BTUT, with an overall average of 6.26 percent.

Table 31-79. Metal Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	**Average**	**Boston, MA (BOMA)**	**Bountiful, UT (BTUT)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**	**Tulsa, OK (TOOK)**
Antimony	*1.30*	0.95	2.05	0.73	1.54	1.23
Arsenic	*1.89*	2.45	2.36	0.66	2.45	1.53
Beryllium	*14.42*	**23.29**	**24.50**	11.27	6.43	6.62
Cadmium	*2.45*	1.28	3.17	0.79	5.89	1.11
Chromium	*3.20*	1.92	4.51	3.72	3.42	2.42
Cobalt	*1.76*	1.23	2.75	1.10	2.00	1.70
Lead	*1.14*	1.05	2.19	0.43	0.93	1.12
Manganese	*1.77*	1.59	1.78	1.05	2.70	1.75
Mercury	***33.74***	**35.80**	**31.15**	**30.90**	**48.50**	**22.36**
Nickel	*3.36*	2.07	4.54	0.81	7.54	1.82
Selenium	*3.80*	4.67	9.96	0.95	2.03	1.36
Average	*6.26*	*6.94*	*8.09*	*4.76*	*7.58*	*3.91*

31.2.5 Hexavalent Chromium Analytical Precision

Table 31-80 presents the hexavalent chromium analytical precision results. All the sites shown are NATTS sites except the ININ site. The range of variability for hexavalent chromium was 3.81 percent (ININ) to 15.83 percent (MVWI), with the overall average coefficient of variation of 7.26 percent.

Table 31-80. Hexavalent Chromium Analytical Precision: Replicate Analyses for Collocated Samples

Site	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
BOMA	16	12.43	0.002	8.79
BTUT	122	10.04	0.002	7.10
BXNY	4	10.59	0.01	7.49
CHSC	4	10.54	0.001	7.45
DEMI	26	10.29	0.002	7.27
GPCO	24	10.55	0.002	7.46
HAKY	14	8.09	0.001	5.72
ININ	20	5.38	0.001	3.81
MVWI	6	22.38	0.002	**15.83**
NBIL	16	6.30	0.001	4.46
PRRI	12	16.55	0.001	11.70
PXSS	22	5.67	0.004	4.01
S4MO	20	16.19	0.002	11.45
SDGA	16	5.51	0.001	3.89
SEWA	24	6.68	0.004	4.72
SYFL	12	7.95	0.001	5.62
UNVT	8	7.48	0.001	5.29
WADC	10	12.06	0.002	8.53
Average	*21*	*10.26*	*0.002*	*7.26*

* Over half of the detects were under the detection limit.

31.2.6 SVOC Analytical Precision

The analytical precision results for the replicate analyses of the collocated SVOC samples is shown in Table 31-81. Both sites evaluated in this section are NATTS sites (RUCA and SDGA). The average concentration differences observed for SVOC ranged from 0.005 ng/m^3 for benzo(a) anthracene to 3.04 ng/m^3 for naphthalene. The average CV ranged from 2.67 percent for phenanthrene to 69.05 percent for dibenz (a,h) anthracene, with an overall average of 21.26 percent, which is outside the 15 percent program DQO.

Table 31-81. SVOC Analytical Precision: 98 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	95	5.64	0.13	3.99
Acenaphthylene	57	**68.28**	0.08	**48.28**
Anthracene	51	**25.03**	0.13	**17.70**
Benzo (a) anthracene	81	15.72	0.005	11.11
Benzo (a) pyrene	78	**43.15**	0.08	**30.51**
Benzo (b) fluoranthene	75	**45.05**	0.02	**31.85**
Benzo (e) pyrene	62	**53.47**	0.02	**37.81**
Benzo (g,h,i) perylene	80	12.24	0.01	8.66
Benzo (k) fluoranthene	68	**43.22**	0.01	**30.56**
Chrysene	94	5.10	0.01	3.61
Coronene	51	**43.65**	0.03	**30.86**
Dibenz (a,h) anthracene	11	**97.66**	0.03	**69.05**
Fluoranthene	96	5.11	0.07	3.61
Fluorene	96	5.54	0.22	3.92
Indeno(1,2,3-cd)pyrene	53	24.41	0.02	**17.26**
Naphthalene	98	4.28	3.04	3.03
Perylene	11	**63.72**	0.02	**45.05**
Phenanthrene	98	3.78	0.28	2.67
Pyrene	94	6.12	0.05	4.33

Table 31-82 shows the analytical precision results for the SVOC analysis for collocated samples for RUCA. The average CV ranged from 4.38 percent for phenanthrene to 82.88 percent for perylene, with an overall average of 23.06 percent, which is outside the 15 percent program DQO.

Table 31-82. SVOC Analytical Precision: 90 Collocated Samples at Rubidoux, CA (RUCA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	87	8.45	0.21	5.98
Acenaphthylene	51	**36.04**	0.07	**25.48**
Anthracene	47	**47.99**	0.26	**33.93**
Benzo (a) anthracene	73	24.48	0.01	**17.31**
Benzo (a) pyrene	71	**33.27**	0.05	**23.52**
Benzo (b) fluoranthene	68	**34.94**	0.02	**24.71**

Table 31-82. SVOC Analytical Precision: 90 Collocated Samples at Rubidoux, CA (RUCA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Benzo (e) pyrene	57	**39.13**	0.03	**27.67**
Benzo (g,h,i) perylene	72	17.17	0.01	12.14
Benzo (k) fluoranthene	61	**34.79**	0.02	**24.60**
Chrysene	86	6.54	0.01	4.62
Coronene	45	**46.46**	0.02	**32.85**
Dibenz (a,h) anthracene	8	**94.19**	0.04	**66.60**
Fluoranthene	88	8.12	0.13	5.74
Fluorene	88	8.23	0.37	5.82
Indeno(1,2,3-cd)pyrene	49	**41.75**	0.01	**29.52**
Naphthalene	90	6.47	4.24	4.57
Perylene	7	**117.21**	0.03	**82.88**
Phenanthrene	90	6.20	0.51	4.38
Pyrene	86	8.12	0.08	5.74

Table 31-83 shows the analytical precision results for the semivolatiles analysis for collocated samples for SDGA. The average CV ranged from 0.96 percent for phenanthrene to 71.50 percent for dibenz (a,h) anthracene, with an overall average of 19.46 percent, which is outside the 15 percent program DQO.

Table 31-83. SVOC Analytical Precision: 8 Collocated Samples at Decatur, GA (SDGA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	8	2.83	0.05	2.00
Acenaphthylene	6	**100.52**	0.08	**71.08**
Anthracene	4	2.07	0.01	1.47
Benzo (a) anthracene	8	6.95	0.002	4.92
Benzo (a) pyrene	7	**53.02**	0.10	**37.49**
Benzo (b) fluoranthene	7	**55.15**	0.02	**39.00**
Benzo (e) pyrene	5	**67.81**	0.01	**47.95**
Benzo (g,h,i) perylene	8	7.31	0.01	5.17
Benzo (k) fluoranthene	7	**51.65**	0.01	**36.52**
Chrysene	8	3.66	0.003	2.59
Coronene	6	**40.83**	0.03	**28.87**

Table 31-83. SVOC Analytical Precision: 8 Collocated Samples at Decatur, GA (SDGA) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Dibenz (a,h) anthracene	3	**101.12**	0.02	**71.50**
Fluoranthene	8	2.09	0.02	1.48
Fluorene	8	2.85	0.06	2.01
Indeno(1,2,3-cd)pyrene	4	7.07	0.02	5.00
Naphthalene	8	2.10	1.85	1.48
Perylene	4	10.22	0.003	7.23
Phenanthrene	8	1.36	0.05	0.96
Pyrene	8	4.13	0.02	2.92

31.3 Accuracy

Laboratories typically evaluate their accuracy (or bias) by analyzing external audit samples and comparing the measured concentrations obtained to the known concentrations of those audit samples. Accuracy, or bias, indicates the extent to which experimental measurements represent their corresponding “true” or “actual” values.

Laboratories participating in the NATTS program are provided with proficiency test (PT) audit samples on a quarterly basis for VOC, carbonyls, and metals, which are used to quantitatively measure analytical accuracy. Tables 31-84 through 31-86 present ERG’s results from the 2007 NATTS PT audit samples for carbonyls, metals, and VOC, respectively. The acceptable percent difference from the true values is ± 25 percent, and the values exceeding this criteria are bolded in the tables. While there are a few values outside the program DQOs, there are no compounds that are consistently over for multiple audits. Shaded rows present results for NATTS core compounds.

Table 31-84. Carbonyl NATTS PT Audit Samples – Percent Difference from True Value

Pollutant	April, 2007	November, 2007
Acetaldehyde	-6.4	2.7
Formaldehyde	-12.0	5.6

Table 31-85. Metals NATTS PT Audit Samples – Percent Difference from True Value

Pollutant	April, 2007	July, 2007	October, 2007	December, 2007
Antimony	-23.2	-17.6	-24.1	**-33.0**
Arsenic	16.0	13.0	14.3	2.8
Beryllium	16.3	17.2	**34.0**	7.9
Cadmium	9.8	6.2	15.2	-10.2
Lead	6.3	0.0	4.4	-16.8
Manganese	0.7	-24.0	-7.3	-24.4
Mercury	10.2	Not included	Not included	Not included
Nickel	7.6	-11.2	-3.9	**-26.6**

Table 31-86. VOC NATTS PT Audit Samples – Percent Difference from True Value

Pollutant	April, 2007	July, 2007	September, 2007	December, 2007
Acrolein	**-34.3**	-16.0	5.8	14.6
Benzene	-3.9	-1.0	-12.5	Not included
1,3-Butadiene	-8.0	-3.0	14.2	6.9
Carbon Tetrachloride	17.9	-1.7	11.9	13.7
Chloroform	5.3	2	20.0	Not included
1,2-Dibromoethane	-2.5	7.8	0.9	9.9
1,2-Dichloroethane	12.8	0.0	8.5	9.3
Dichloromethane	0.8	5.3	10.4	15.0
1,2-Dichloropropane	-3.9	-1.0	-5.0	Not included
cis-1,3-Dichloropropene	-2.9	8.0	-2.7	Not included
trans-1,3-Dichloropropene	-6.2	9.8	-1.4	Not included
1,1,2,2-Tetrachloroethane	-7.9	0.9	-10.3	-1.0
Tetrachloroethylene	-9.2	3.1	-5.1	Not included
Trichloroethylene	-0.8	4.3	9.2	9.3
Vinyl Chloride	5.8	1.1	-3.8	Not included

The accuracy of the 2007 monitoring data can also be assessed qualitatively by reviewing the accuracy of the monitoring methods and how they were implemented:

- The sampling and analytical methods used in the 2007 monitoring effort have been approved by EPA for accurately measuring ambient levels of various compounds—an approval that is based on many years of research into the development of ambient air monitoring methodologies.

- When collecting and analyzing ambient air samples, all field sampling staff and laboratory analysts strictly followed quality control and quality assurance guidelines detailed in the respective monitoring methods. This strict adherence to the well-documented sampling and analytical methods suggests, though certainly does not prove, that the 2007 monitoring data accurately represent ambient air quality.

32.0 Summary of Results and Recommendations

The following discussion summarizes the results of the data analyses contained in this report and presents recommendations applicable to future air monitoring efforts. As demonstrated by the data analyses discussed throughout this report, NATTS and UATMP monitoring data offer a wealth of information for assessing air quality by evaluating trends, patterns, correlations, and the potential for health risk and should ultimately assist a wide range of audiences understand the complex nature of air pollution.

32.1 Summary of Results

Analyses of the 2007 monitoring data identified the following notable results, observations, trends, and patterns in the program-level and state-specific air pollution data:

32.1.1 National-level Summary

- *Ambient air concentration data sets generally met data quality objectives for completeness.* Completeness, or the number of valid samples collected compared to the number expected from a 1-in-6 or 1-in-12 day sampling schedule, measures the reliability of the sampling and analytical equipment as well as the efficiency of the program. Typically, a completeness of 85-100 percent is desired for a complete data set. Only one out of 100 data sets failed to comply with the data quality objective of 85 percent completeness. Thirty-five data sets achieved 100 percent completeness.

- *Nearly half of all participating monitoring sites are NATTS sites.* Twenty-three of the 50 sites are EPA-designated NATTS sites (BOMA, BTUT, BXNY, CAMS 35, CAMS 85, CELA, CHSC, DEMI, GPCO, HAKY, MVWI, NBIL, PRRI, PXSS, ROCH, RUCA, S4MO, SDGA, SEWA, SKFL, SYFL, UNVT, and WADC).

- *Total number of samples collected and analyzed.* Over 6,000 samples were collected and 190,745 valid measurements of air toxics were obtained.

- *Ambient air concentrations of urban air toxics.* Nearly 81 percent of the measured concentrations were less than 1 µg/m^3. Less than 3 percent of the concentrations were greater than 5 µg/m^3.

- *Detects.* The detection of a given pollutant is subject to the analytical methods used and the limitations of the instruments. Simply stated, a method detection limit is the lowest concentration of a substance that can be measured and reported with 99 percent confidence that the pollutant concentration is greater than zero. For 2007, only two pollutants, 2-ethyl-1-butene and propyne, were not detected at any of the participating monitoring sites.

- *Program-level Pollutants of Interest.* The pollutants of interest at the program level, based on the number of exceedances, or "failures," of the preliminary risk screening values, included: acetaldehyde, acrolein, acrylonitrile, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene, formaldehyde, manganese, and tetrachloroethylene. The pollutants of interest varied among the individual sites.

- *Pearson Correlations.* Pearson Correlations were computed between each pollutant of interest and various meteorological parameters. Generally, the meteorological parameters had weak correlations with the program-level pollutants of interest across all sites. The Pearson Correlations tended to be stronger at the individual sites.

- *BTEX Profiles.* The concentration ratios for the BTEX compounds measured at most of the monitoring sites bear some resemblance to the ratios reported in the roadside study (Conner, et al., 1995). The BTEX ratios for the BAPR and GPCO monitoring sites appear to be the most similar to the roadside study profile, indicating the influence of motor vehicle emissions.

- *Risk Screening using ATSDR MRLs*. Daily measurements (measured at SFSD and INDEM), seasonal averages (calculated for INDEM), and one annual average (calculated for INDEM) of formaldehyde exceeded the ATSDR acute, intermediate, and chronic MRLs, respectively. All of the site-specific seasonal averages of acrolein exceeded the ATSDR intermediate MRL.

- *Surrogate Cancer Risk Approximations.* The surrogate cancer risk approximation calculated for SPAZ for acrylonitrile (52 in-a-million) was the highest of all annual average-based cancer risk approximations. By comparison, NATA-modeled cancer risk was highest for arsenic at ININ (208 in-a-million), dichloromethane at BAPR (71 in-a-million), and benzene at TOOK (30 in-a-million).

- *Surrogate Noncancer Risk Approximations.* Four sites exhibited noncancer risk approximations for acrolein that were greater than 50 (PXSS, CNEP, SPAZ, and TUOK). In total, 27 sites had noncancer risk approximations for acrolein that were greater than 1.0. Noncancer risk (HQ) based on NATA was highest for acrolein for ELNJ (35.46). In addition, a noncancer risk approximation greater than 1.0 was also calculated for formaldehyde at INDEM.

- *Emissions and Toxicity Weighted Emissions.* The pollutant (with a cancer URE) that tended to have the highest county-level emissions for most participating counties was benzene. This pollutant also tended to have the highest toxicity-weighted emissions. Acrolein tended to have the highest toxicity-weighted emissions of pollutants with noncancer RfCs, although it was not emitted in high enough quantities to rank in the top 10 emissions for any participating county. Toluene was often the highest emitted pollutant with a noncancer risk factor, although it rarely had top 10 toxicity-weighted emissions.

32.1.2 State-level Summary

Arizona.

- The Arizona monitoring sites are located in Phoenix. PXSS is a NATTS site; SPAZ is a UATMP site.

- Back trajectories originated from a variety of directions at PXSS. The back trajectories primarily originated from the southwest and north at SPAZ. The air shed domains were somewhat smaller in size compared to other monitoring sites, as the farthest away a back trajectory originated was less than 400 miles.

- The wind rose shows that easterly winds were prevalent near PXSS and calm winds were prevalent near SPAZ.

- PXSS sampled for VOC, carbonyls, SVOC, metals (PM_{10}), and hexavalent chromium. SPAZ sampled for VOC only.

- The pollutants of interest common to both sites were acrolein, benzene, 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene, and tetrachloroethylene.

- Of the pollutants of interest for PXSS, formaldehyde had the highest daily average concentration. In addition, PXSS had the highest daily average concentration of acrolein, benzene, manganese (PM_{10}), and tetrachloroethylene among all NATTS and UATMP sites sampling these compounds.

- Of the pollutants of interest for SPAZ, benzene had the highest daily average concentration. In addition, SPAZ had the highest daily average concentration of acrylonitrile among all NATTS and UATMP sites sampling this compound.

- Correlations between the pollutants of interest for PXSS and SPAZ and the meteorological parameters were mostly weak. Strong negative correlations were calculated between 1,3-butadiene and maximum and average temperatures. Strong negative correlations were also calculated for 1,3-butadiene and benzene and maximum and average temperatures.

- The seasonal averages of acrolein that could be calculated for PXSS and SPAZ exceeded the ATSDR intermediate risk factor.

- According to NATA, benzene had the highest cancer risk estimate for both PXSS and SPAZ while acrolein was the only pollutant with a noncancer HQ greater than 1.0. Cancer and noncancer surrogate risk approximations could not be calculated for these compounds due to the short sampling duration.

- Benzene was the highest emitted pollutant with a cancer risk factor in Maricopa County, Arizona, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in Maricopa County.

California.

- The two California monitoring sites are located in Los Angeles (CELA) and Rubidoux (RUCA) and are both NATTS sites.

- Back trajectories primarily originated from the northwest and northeast at CELA and RUCA. The air shed domains were somewhat smaller in size compared to other monitoring sites, as the farthest away a back trajectory originated was 500 miles.

- The wind roses show that westerly winds were prevalent near RUCA and calm winds were prevalent near CELA.

- CELA and RUCA sampled for SVOC only.

- Naphthalene was the only SVOC to fail screens at the California sites and is therefore the only pollutant of interest for these sites.

- The daily average concentrations of naphthalene were similar for both sites. Compared to other program sites sampling SVOC, CELA and RUCA had the third and fourth highest daily average concentrations of naphthalene, respectively.

- The Pearson correlations for naphthalene were generally weak at the California sites.

- None of the SVOC daily measurements or concentration averages for the California sites exceeded any of the MRL risk values.

- The NATA-modeled concentration of naphthalene was slightly higher for CELA than RUCA, which translated into slightly higher cancer and noncancer risks. Because sampling did not begin until the spring, annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for naphthalene.

- Formaldehyde was the highest emitted pollutant with a cancer risk factor in both Los Angeles and Riverside Counties, while benzene had the highest cancer toxicity-weighted emissions.

- Toluene was the highest emitted pollutant with a noncancer risk factor in Riverside County, while 1,1,1-trichloroethane was the highest emitted pollutant in Los Angeles County. Acrolein had the highest noncancer toxicity-weighted emissions in both counties.

Colorado.

- The NATTS site in Colorado is located in Grand Junction.

- Back trajectories originated from a variety of directions at GPCO, although less frequently from the east. The 24-hour air shed domain GPCO was somewhat smaller in size than other monitoring sites, as the furthest away a trajectory originated was nearly 500 miles away.

- The wind rose shows that easterly, east-southeasterly, and southeasterly winds were prevalent near GPCO.

- GPCO sampled for VOC, carbonyls, and hexavalent chromium.

- The following pollutants were identified as pollutants of interest for GPCO: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and tetrachloroethylene.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for GPCO, followed by acetaldehyde and benzene. Benzene and 1,3-butadiene concentrations were highest in autumn and winter.

- Correlations between 1,3-butadiene and the temperature parameters support the trends shown by the seasonal averages. Strong positive correlations were calculated for1,3-butadiene and benzene and sea level pressure. Additionally, all of the correlations with wind speed were negative.

- All four seasonal averages of acrolein exceeded the intermediate MRL risk factor.

- Benzene had the highest NATA-modeled cancer risk for GPCO, and the second highest cancer risk approximation. 1,2-Dibromoethane had the highest cancer risk approximation, although the annual average includes only one valid measured detection.

- Acrolein had the highest NATA-modeled noncancer risk and noncancer risk approximation for GPCO, although the noncancer risk approximation was an order of magnitude higher.

- Benzene was the highest emitted pollutant with a cancer risk factor in Mesa County, Colorado, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in Mesa County.

Washington D.C.

- The Washington D.C. monitoring site is a NATTS site.

- Back trajectories originated from a variety of directions at WADC, although less frequently from the south. The 24-hour air shed domain for WADC was similar in size to other monitoring sites, with the longest trajectory originating nearly 700 miles away.

- The wind rose shows that southerly winds were prevalent near WADC.

- WADC sampled for hexavalent chromium only. Although hexavalent chromium did not fail any screens, analyses were still conducted on samples for this pollutant.

- Seasonal averages of hexavalent chromium did not vary significantly from season to season. Compared to other program sites sampling hexavalent chromium, WADC had the second lowest daily average concentration.

- Correlations between concentrations of hexavalent chromium and selected meteorological parameters were weak.

- None of the daily measurements or concentration averages of hexavalent chromium exceeded any of the MRL risk values.

- Cancer and noncancer risks for hexavalent chromium were low according to NATA. The same is also true of the cancer and noncancer surrogate risk approximations.

- Benzene was the highest emitted pollutant with a cancer risk factor in the District of Columbia, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in the District.

Florida.

- Two of the Florida monitoring sites are located in the Tampa area (GAFL and SYFL); two are located in the St. Petersburg area (AZFL and SKFL); one is located near Orlando (ORFL); and one is located near Ft. Lauderdale (FLFL). Two monitoring sites in the Tampa/St. Petersburg area are NATTS sites (SKFL and SYFL).

- Back trajectories originated from a variety of directions near the monitoring sites, although the majority originated from the east at each site.

- Although the wind roses were different for each site, easterly and northeasterly winds were prevalent among the sites.

- All six Florida monitoring sites sampled for carbonyl compounds. SYFL also sampled hexavalent chromium.

- Acetaldehyde and formaldehyde were the only pollutants to fail screens for each of the Florida sites.

- SYFL had the highest daily averages of acetaldehyde and formaldehyde among the Florida sites.

- Sampling has been conducted at AZFL, GAFL, and ORFL for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the rolling average concentration of formaldehyde increased slightly for the 2004-2006 and 2005-2007 periods; the maximum formaldehyde concentration measured in 2005 at GAFL appears to be impacting the statistical values for periods incorporating that year's data; while the range of concentrations measured at ORFL increased, the average rolling formaldehyde concentration decreased.

- Negative Pearson correlations were calculated between acetaldehyde and the temperature and moisture variables. Both acetaldehyde and formaldehyde exhibited negative correlations with the wind speed. In addition, formaldehyde exhibited strong positive correlations with temperature at AZFL.

- None of the daily measurements or concentration averages for the Florida sites exceeded any of the MRL risk values.

- The cancer risk for acetaldehyde from NATA ranged from 2.66 in-a-million (AZFL) to 4.37 in-a-million (ORFL), while the cancer surrogate risk approximations for acetaldehyde ranged from 2.85 in-a-million (AZFL) to 5.46 in-a-million (SYFL).

- Cancer risk from formaldehyde was 0.01 in-a-million for all six Florida sites, according to NATA. The surrogate cancer risk approximations from formaldehyde were 0.02 in-a-million or less for all six Florida sites.

- The noncancer risk from NATA and the noncancer surrogate risk approximations for both acetaldehyde and formaldehyde were less than 1.0 for the Florida sites.

- Benzene was the highest emitted pollutant with a cancer risk factor in all four Florida counties. Benzene also had the highest cancer toxicity-weighted emissions for three of the four counties (naphthalene had the highest cancer toxicity-weighted emissions in Broward County).

- Toluene was the highest emitted pollutant with a noncancer risk factor in three of the four counties (xylenes were highest in Broward County). Acrolein had the highest noncancer toxicity-weighted emissions for all four counties.

Georgia.

- The SDGA monitoring site located south of Atlanta is a NATTS site.

- Back trajectories originated from a variety of directions at SDGA. The 24-hour air shed domain for SDGA was somewhat larger in size compared to other monitoring sites, as the longest trajectory originated nearly 900 miles away.

- The wind rose shows that easterly and northwesterly winds were prevalent near SDGA.

- SDGA sampled for SVOC and hexavalent chromium. Naphthalene was the only pollutant to fail screens for SDGA.

- Because SDGA did not begin sampling SVOC until April, seasonal averages of naphthalene could only be calculated for summer and autumn.

- Naphthalene exhibited strong negative correlations with wind speed.

- None of the daily measurements or concentration averages of naphthalene exceeded any of the MRL risk values.

- Because annual averages could not be calculated, cancer and noncancer surrogate risk approximations for naphthalene were not calculated

- Benzene was the highest emitted pollutant with a cancer risk factor in De Kalb County, while methyl isobutyl ketone was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in De Kalb County.

***Illinois*.**

- The Illinois monitoring sites are located near Chicago. NBIL is a NATTS site; SPIL is a UATMP site.

- Back trajectories originated from a variety of directions at the sites, although back trajectories primarily originated from the southwest and northwest. The air shed domains were larger in size compared to other monitoring sites, as the farthest away a back trajectory originated was approximately 1000 miles.

- The wind roses show that winds from a variety of directions were observed near the monitoring sites, although southeasterly winds were observed the least.

- NBIL sampled for VOC, carbonyls, SNMOC, metals (PM_{10}), and hexavalent chromium, while SPIL sampled for VOC and carbonyls only.

- The pollutants of interest common to both sites were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, *p*-dichlorobenzene, and tetrachloroethylene.

- Of the pollutants of interest for NBIL, benzene had the highest daily average concentration. Of the pollutants of interest for SPIL, formaldehyde had the highest daily average concentration.

- VOC sampling has been conducted at NBIL and SPIL for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the rolling average concentration of 1,3-butadiene appears to have increased slightly since the onset of sampling at both sites, although this is likely attributable to the increased detection rate due to lowered detection limits; the rolling average concentrations of benzene have decreased at both sites.

- Correlations between the pollutants of interest for NBIL and SPIL and the meteorological parameters were mostly weak. However, the majority of the correlations with the temperature and moisture parameters were positive and most of the correlations with scalar wind speed were negative.

- The seasonal averages of acrolein exceeded the ATSDR intermediate MRL risk factor.

- According to NATA, benzene had the highest cancer risk estimates for both NBIL and SPIL and acrolein was the only pollutant with a noncancer HQ greater than 1.0. Carbon tetrachloride had the highest cancer surrogate risk approximation for both sites, while acrolein had the highest noncancer surrogate risk approximation for both sites.

- Benzene was the highest emitted pollutant with a cancer risk factor in Cook County, Illinois, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in Cook County.

Indiana.

- Three Indiana monitoring sites are located in Indianapolis (IDIN, ININ, WPIN), and the fourth is located near Chicago (INDEM). All four are UATMP sites.

- Back trajectories originated from a variety of directions at the Indiana sites, although the predominant direction of trajectory origin was from the southwest and northwest. The air shed domain for INDEM was larger in size compared to the other Indiana monitoring sites.

- The wind roses show that winds from a variety of directions were observed near the Indianapolis sites, although winds with a westerly component were observed more frequently. Although winds from a variety of directions were also observed near INDEM, westerly, south-southwesterly, and southerly winds were observed most frequently. Calm winds were observed more often near INDEM than the Indianapolis monitoring sites.

- ININ sampled for carbonyls, metals (PM_{10}), and hexavalent chromium; IDIN sampled for carbonyls and metals (PM_{10}); WPIN and INDEM sampled for carbonyls only.

- The pollutants of interest common to all four monitoring sites were acetaldehyde and formaldehyde, due in part to the differences in pollutants sampled. Manganese and arsenic were also pollutants of interest for ININ and IDIN, which sampled pollutants other than carbonyl compounds.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for all four sites. The concentrations of formaldehyde for INDEM were the highest among all NATTS & UATMP monitoring sites.

- Concentrations of the pollutants of interest, especially the carbonyls, tended to increase with increasing dry bulb, dew point, and wet bulb temperatures at the Indianapolis sites. In addition, concentrations of the pollutants of interest for all four sites, especially the carbonyls, tended to increase with decreasing relative humidity and wind speed.

- Concentrations of formaldehyde exceeded the ATSDR acute, intermediate, and chronic MRL risk factors for INDEM.

- According to NATA, arsenic had the highest cancer risk estimate for IDIN and ININ. The cancer risk estimate for arsenic for ININ was 208 in-a-million, which is the highest cancer risk estimate among all census tracts with UATMP or NATTS sites from NATA for any given air toxic pollutant. The cancer risk for IDIN was much lower. Arsenic was also the only pollutant with a noncancer HQ greater than 1.0 at any of the sites (ININ), according to NATA.

- According to NATA, acetaldehyde had the highest cancer risk estimates for WPIN and INDEM.

- Benzene was the highest emitted pollutant with a cancer risk factor in Marion and Lake Counties, while coke oven emissions had the highest cancer toxicity-weighted emissions for both counties.

- Toluene was the highest emitted pollutant with a noncancer risk factor in Marion County, while acrolein had the highest noncancer toxicity-weighted emissions. In Lake County, hydrochloric acid was the highest emitted pollutant with a noncancer risk factor, while manganese had the highest noncancer toxicity-weighted emissions.

***Kentucky*.**

- The Hazard, Kentucky monitoring site is a NATTS site.

- Back trajectories originated primarily from the south and southwest. The 24-hour air shed domain for HAKY was similar in size to other monitoring sites, with the longest trajectory originating more than 700 miles away.

- The wind rose shows that calm winds were prevalent near HAKY.

- HAKY sampled for hexavalent chromium only. One measurement of hexavalent chromium failed screens for HAKY.

- Seasonal averages of hexavalent chromium did not vary significantly from season to season. Compared to other program sites sampling hexavalent chromium, HAKY had the sixth lowest daily average concentration.

- Correlations between concentrations of hexavalent chromium and selected meteorological parameters were weak.

- None of the daily measurements or concentration averages of hexavalent chromium exceeded any of the MRL risk values.

- Cancer and noncancer risks for hexavalent chromium were low according to NATA. The same was also true of the cancer and noncancer surrogate risk approximations.

- Benzene was the highest emitted pollutant with a cancer risk factor in Perry County, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions.

Massachusetts.

- The Massachusetts monitoring site is a NATTS site in Dudley Square, Boston.

- Back trajectories originated from a variety of directions at BOMA, although less frequently from the southeast. The 24-hour air shed domain for BOMA was similar in size to other monitoring sites, with the longest trajectory originating nearly 800 miles away.

- The wind rose shows that southwesterly and westerly winds were prevalent near BOMA.

- BOMA sampled for metals (PM_{10}) and hexavalent chromium. Arsenic, nickel, and manganese were identified as the pollutants of interest for BOMA.

- Of the pollutants of interest, manganese had the highest daily average concentration. Seasonal averages of the pollutants of interest did not vary significantly from season to season.

- Metals sampling has been conducted at BOMA for at least five consecutive years; thus three-year rolling metrics were calculated for arsenic. In brief, the rolling average concentration of arsenic appeared to have a decreasing trend over the time periods shown.

- Correlations between concentrations of the pollutants of interest and selected meteorological parameters were weak.

- None of the daily measurements or concentration averages of the pollutants of interest exceeded any of the MRL risk values.

- Cancer risk approximations based on the annual averages for arsenic and nickel were an order of magnitude higher than the NATA cancer risk estimates. Similar to the NATA results, noncancer risk approximations based on the annual averages for the pollutants of interest were low.

- Benzene was the highest emitted pollutant with a cancer risk factor in Suffolk County, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions.

Michigan.

- DEMI is a NATTS site located in Dearborn, Michigan near Detroit. ITCMI is a UATMP site located in Sault St. Marie, Michigan and is operated by the Intertribal Council of Michigan.

- Back trajectories originated from a variety of directions at the Michigan sites, although the predominant direction of trajectory origin was from the south and northwest for DEMI and northwest and southwest for ITCMI. The air shed domain for ITCMI was larger in size compared to DEMI.

- The wind rose for DEMI shows that winds from a variety of directions were observed near the monitoring site, although southeasterly winds were observed the least. Although winds from a variety of directions were also observed near ITCMI, easterly and northwesterly winds were observed most frequently.

- DEMI sampled for VOC, carbonyls, and hexavalent chromium, while ITCMI sampled for SVOC only. As such, there could be no similarity in the sites' pollutants of interest.

- The pollutants of interest for DEMI were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, *p*-dichlorobenzene, and tetrachloroethylene. Naphthalene was the only pollutant to fail screens for ITCMI.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for DEMI. This was also the second highest daily average concentration of formaldehyde among sites sampling carbonyls.

- Acetaldehyde and formaldehyde concentrations tended to be highest during the warmer seasons at DEMI.

- Seasonal averages of naphthalene did not vary significantly from season to season at ITCMI. Compared to other program sites sampling SVOC, ITCMI had the lowest daily average concentration of naphthalene.

- Carbonyl and VOC sampling has been conducted at DEMI for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the rolling average concentration of benzene has decreased; the rolling average concentration of 1,3-butadiene appears unchanged since the onset of sampling, although the effects of the increased detection rate can be seen in the other statistical metrics; the similarity in the median and rolling average concentrations of formaldehyde indicate little variability in the central tendency.

- The majority of the correlations with the temperature and moisture parameters were positive and most of the correlations with scalar wind speed were negative for both sites. At DEMI, formaldehyde and acetaldehyde exhibited strong positive correlations with the temperature and moisture parameters (except relative humidity).

- All four seasonal averages of acrolein exceeded the intermediate MRL risk factor for DEMI.

- According to NATA, benzene had the highest cancer risk estimate for DEMI and acrolein was the only pollutant with a noncancer HQ greater than 1.0. Acetaldehyde had the highest cancer risk approximation for DEMI, while acrolein had the highest noncancer risk approximation.

- For ITCMI, the surrogate cancer risk approximation for naphthalene was greater than 1-in-a-million, while the cancer risk estimate from NATA was slightly less. The noncancer risk estimate from NATA and the surrogate noncancer risk approximation for naphthalene were both low.

- Benzene was the highest emitted pollutant with a cancer risk factor in Wayne and Chippewa Counties. Benzene also had the highest toxicity-weighted emissions in Chippewa County, while coke oven emissions had the highest cancer toxicity-weighted emissions for Wayne County.

- Toluene was the highest emitted pollutant with a noncancer risk factor in both counties, while acrolein had the highest noncancer toxicity-weighted emissions.

Mississippi.

- The two UATMP sites in Mississippi are located in Gulfport (GPMS) and Tupelo (TUMS).

- Back trajectories originated from a variety of directions at the Mississippi sites. The predominant direction of trajectory origin for GPMS was from offshore, particularly from the southeast, while the predominant direction of trajectory origin for TUMS was from the southeast, south, and southwest. The 24-hour air shed domain for GPMS was smaller than the air shed domain for TUMS.

- The wind rose for GPMS shows that calm winds prevailed near this site, although northerly and southeasterly winds were also observed frequently. Calm winds also prevailed near TUMS, with frequent southerly and northerly winds as well.

- GPMS and TUMS both sampled for VOC and carbonyls. GPMS also sampled SNMOC.

- The pollutants of interest common to both sites were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for both sites.

- While concentrations of most of the pollutants of interest for GPMS and TUMS did not vary significantly from season to season, formaldehyde was highest during the summer.

- Carbonyl and VOC sampling has been conducted at GPMS for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the average rolling concentration of benzene fluctuated across the sampling periods; the rolling average concentration of 1,3-butadiene appeared to change little over the last several three-year periods, although the effects of the increased detection rate can be seen in the other statistical metrics; a slight decrease was evident in the average formaldehyde concentration from 2001-2003 to 2002-2004, then a slight increase for 2003-2005 and 2004-2006, and little change for 2005-2007. Note that the data included for 2005 was part of the post-Hurricane Katrina monitoring effort.

- Carbonyl and VOC sampling has been conducted at TUMS for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the rolling average and median concentrations of benzene have been decreasing since the onset of sampling, although the range of concentrations measured has increased; the median and average rolling concentrations of 1,3-butadiene became more similar over the last three periods, indicating a decreasing variability in the central tendency; the average concentration of formaldehyde decreased from the 2001-2003 time frame until the 2004-2006 time frame, while an increase is shown for 2005-2007. Note that a portion of the data included for 2005 was part of the post-Hurricane Katrina monitoring effort.

- At GPMS, formaldehyde exhibited strong positive correlations with the temperature parameters; 1,3-butadiene exhibited strong negative correlations with the temperature and moisture parameters; and acetaldehyde exhibited a strong negative correlation with the moisture parameters. In addition, nearly all of the correlations with scalar wind speed were negative.

- At TUMS, formaldehyde exhibited strong positive correlations with the temperature parameters; acrylonitrile exhibited strong positive correlations with the temperature and moisture parameters; and all of the correlations with scalar wind speed were negative.

- All four seasonal averages of acrolein exceeded the intermediate MRL risk factor for GPMS and TUMS.

- According to NATA, benzene had the highest cancer risk estimate for GPMS and TUMS and acrolein was the only pollutant with a noncancer HQ greater than 1.0. Carbon tetrachloride had the highest cancer risk approximations for these sites, while acrolein had the highest noncancer risk approximations.

- Benzene was the highest emitted pollutant with a cancer risk factor in Harrison County. Benzene also had the highest toxicity-weighted emissions in this county. Dichloromethane was the highest emitted pollutant with a cancer risk factor in Lee County, while hexavalent chromium had the highest cancer toxicity-weighted emissions for this county.

- Toluene was the highest emitted pollutant with a noncancer risk factor in Lee County, while hydrochloric acid was the highest emitted pollutant with a noncancer risk factor in Harrison County. Acrolein had the highest noncancer toxicity-weighted emissions for both counties.

Missouri.

- The NATTS site in Missouri is located in St. Louis.

- Back trajectories originated from a variety of directions at S4MO, although the bulk of the trajectories originated from the southwest and northwest. The 24-hour air shed domain for S4MO was similar in size to other monitoring sites.

- The wind rose for S4MO shows that calm winds prevailed near this site, although south-southeasterly and southerly winds were also observed frequently.

- S4MO sampled for VOC, carbonyls, metals (PM_{10}), and hexavalent chromium.

- The following pollutants were identified as pollutants of interest for S4MO: acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, cadmium, carbon tetrachloride, formaldehyde, manganese, *p*-dichlorobenzene, and tetrachloroethylene.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for S4MO, followed by acetaldehyde and benzene. S4MO had the highest daily average concentration of arsenic (PM_{10}) and the third highest concentration of manganese (PM_{10}), among all the monitoring sites sampling PM_{10} metals.

- At S4MO, formaldehyde concentrations were highest in the summer and lowest in the winter. Also, acetaldehyde concentrations were highest in the summer and fall and lowest in the winter.

- Carbonyl, VOC, and metals sampling have been conducted at S4MO for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the average rolling concentrations of arsenic have changed little over the sampling periods; the median and average rolling concentration of benzene have a slight decreasing trend over the sampling periods; as the detection rate for 1,3-butadiene increased (due to lower detection limits), the spread between the statistical metrics increased; and the median and average concentrations of formaldehyde exhibited a slight decreasing trend over the sampling period.

- Formaldehyde exhibited strong positive correlations with the temperature and moisture parameters and nearly all of the correlations with scalar wind speed were negative.

- All four seasonal averages of acrolein exceeded the intermediate MRL risk factor.

- Benzene had the highest NATA-modeled cancer risk for S4MO, while carbon tetrachloride had the highest cancer risk approximation. Acrolein had the highest NATA-modeled noncancer risk and noncancer risk approximation.

- Benzene was the highest emitted pollutant with a cancer risk factor in St. Louis (city), while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in St. Louis (city).

***New Jersey*.**

- The four UATMP sites in New Jersey are located in Camden (CANJ), Chester (CHNJ), Elizabeth (ELNJ), and New Brunswick (NBNJ).

- Back trajectories originated from a variety of directions at the New Jersey sites, although less frequently from the east and southeast. The predominant direction of trajectory origin was from the southwest and northwest.
- The wind roses for the New Jersey sites show that southerly, southwesterly, and westerly winds were frequently recorded near CANJ; calm winds were observed for nearly 60 percent of observations near CHNJ and NBNJ; and westerly, southwesterly, and northeasterly winds were frequently observed near ELNJ.

- All four New Jersey sites sampled for VOC and carbonyls.

- The pollutants of interest common to all four sites were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and tetrachloroethylene.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for CANJ, CHNJ, and NBNJ. Acetaldehyde had the highest daily average concentration for ELNJ.

- Compared to other program sites, ELNJ had the second highest daily average concentration of acetaldehyde; the fourth highest daily average concentration of formaldehyde; and the tenth highest daily average concentration of benzene. CANJ had the ninth highest daily average concentration of formaldehyde, acrolein, and *p*-dichlorobenzene.

- While concentrations of most of the pollutants of interest for the New Jersey sites did not vary significantly from season to season, formaldehyde was highest during the summer at CANJ and NBNJ; concentrations of acetaldehyde were highest during the summer and autumn; and concentrations of 1,3-butadiene were highest in autumn and winter at ELNJ.

- Carbonyl and VOC sampling have been conducted at CANJ for at least five consecutive years; thus three-year rolling metrics were calculated. CANJ has been a UATMP site longer than any other (since 1994). In brief, a slight decreasing trend in the average and median concentration of benzene is evident beginning around the 1997-1999 time frame through the end of the sampling period; the minimum and first quartile for 1,3-butadiene were both zero for all time frames except 2005-2007, reflecting the influence of many non-detects; beginning with the 1998-2000 time frame, the average concentration of formaldehyde began to decrease.

- Carbonyl and VOC sampling have been conducted at CHNJ for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the average, maximum, and median concentrations of benzene have decreased slightly; although the detection rate of 1,3-butadiene increased over the sampling period, the detection rate is still rather low compared to other monitoring sites; the average and median concentrations of formaldehyde have also have decreased slightly.

- Carbonyl and VOC sampling have been conducted at ELNJ for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the average and median concentrations of benzene have decreased; although the average and median concentrations of 1,3-butadiene have decreased slightly across much of the sampling period, concentrations increased slightly during the 2005-2007 time frame; concentrations of formaldehyde have been increasing at ELNJ.

- Carbonyl and VOC sampling have been conducted at NBNJ for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the average and median concentrations of benzene have decreased; although the average and median concentrations of 1,3-butadiene have increased across much of the sampling period, this is likely due to the increased detection rate (due to lowered detection limits); the maximum concentration of formaldehyde, measured in 2004, was nearly four times the maximum concentrations shown for other periods not including 2004.

- Acetaldehyde exhibited strong positive correlations with the temperature and moisture variables for ELNJ. While this was also true for acetaldehyde and the temperature parameters for CANJ, the correlations were not quite as strong.

- Formaldehyde exhibited strong positive correlations with the temperature and moisture variables for CANJ. While this was also true for *p*-dichlorobenzene and the temperature parameters for CANJ, although the correlations were not as strong.

- Carbon tetrachloride exhibited strong positive correlations with the temperature and moisture variables for NBNJ.

- Weak, moderate, and strong negative correlations were calculated for the pollutants of interest for the New Jersey monitoring sites and wind speed.

- All four seasonal averages of acrolein exceeded the intermediate MRL risk factor for each of the New Jersey monitoring sites.

- According to NATA, benzene had the highest cancer risk estimate for all four New Jersey monitoring sites and acrolein was the only pollutant with a noncancer HQ greater than 1.0. Carbon tetrachloride had the highest cancer risk approximation for CANJ and NBNJ, while acetaldehyde had the highest cancer risk approximation for ELNJ and CHNJ. Acrolein had the highest noncancer risk approximations for three of the four sites (noncancer approximations could not be calculated for VOC for CHNJ).

- Benzene was the highest emitted pollutant with cancer UREs in Union, Middlesex, Morris, and Camden Counties. Benzene also had the highest toxicity-weighted emissions in each county.

- Toluene was the highest emitted pollutant with a noncancer risk factor in all four counties, while acrolein had the highest noncancer toxicity-weighted emissions for each county.

New York.

- The two New York monitoring sites, located in Rochester (ROCH) and New York City (BXNY), are both NATTS sites.

- Back trajectories originated from a variety of directions at BXNY, although rarely from the east and southeast. Trajectories primarily originated from the southwest and west at ROCH. Due to the late start date, the composite trajectory maps include approximately a quarter of the back trajectories that would be shown for a site sampling for the entire year.

- Winds from a variety of directions were observed near BXNY, although southerly and northwesterly winds were observed the most. Winds from the south, southwest, and west were observed more frequently than winds from other directions near ROCH.

- BXNY and ROCH sampled for hexavalent chromium only.

- Hexavalent chromium failed one screen for ROCH, and did not fail any screens for BXNY.

- Compared to other program sites sampling hexavalent chromium, ROCH and BXNY had the sixth and eighth highest daily average concentration of hexavalent chromium, respectively.

- All of the Pearson correlations for BXNY were weak. The correlations for ROCH were higher, although the low number of measured detections may have skewed the correlations.

- None of the daily measurements or concentration averages for hexavalent chromium exceeded any of the MRL risk values.

- The NATA-modeled concentration and risk estimates for hexavalent chromium for the two New York monitoring sites were similar to each other. Annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for hexavalent chromium due to the sampling duration criteria.

- Tetrachloroethylene was the highest emitted pollutant with a cancer risk factor in the Bronx, while benzene was the highest emitted pollutant with a cancer risk factor in Monroe County. Naphthalene had the highest cancer toxicity-weighted emissions in the Bronx while benzene had the highest cancer toxicity-weighted emissions in Monroe County.

- Toluene was the highest emitted pollutant with a noncancer risk factor in Monroe County, while methanol was the highest emitted pollutant the Bronx. Acrolein had the highest noncancer toxicity-weighted emissions for both counties.

Oklahoma.

- Three Oklahoma monitoring sites are located in Tulsa (TOOK, TSOK, TUOK), and the fourth is located outside Tulsa, in Pryor (CNEP). All four are UATMP sites.

- Although back trajectories originated from a variety of directions at the Oklahoma sites, a majority of the trajectories originated from the south or northwest. The 24-

hour air shed domains for these four sites were somewhat larger in size than other monitoring sites as the furthest away a trajectory originated was greater than 900 miles away.

- The wind roses show that southerly winds prevailed near each monitoring site.

- The three Tulsa sites sampled for VOC, carbonyls, and metals (TSP); CNEP sampled for VOC.

- The pollutants of interest common to all four sites were acrolein, benzene, 1,3-butadiene, and carbon tetrachloride. If CNEP, which is the limiting factor partly due to sampling only VOC, is excluded, the list of common pollutants also includes acetaldehyde, formaldehyde, *p*-dichlorobenzene, tetrachloroethylene, arsenic, and manganese.

- Of the pollutants of interest, acrolein had the highest daily average concentration for CNEP. CNEP had the second highest daily average concentration of acrolein among all NATTS and UATMP sites.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for all three Tulsa sites. The Tulsa sites had the fourth, sixth, and seventh highest daily average concentrations of acrolein among all NATTS and UATMP sites. TOOK and TUOK also had the second and eighth highest daily average concentration of benzene.

- 1,3-Butadiene exhibited strong negative Pearson correlations with the maximum, average, and dew point temperatures at CNEP. At the Tulsa sites, formaldehyde and acetaldehyde exhibited strong positive correlations with the maximum, average, dew point, and wet bulb temperatures; manganese exhibited strong negative correlations with relative humidity for all three sites.

- All four seasonal averages of acrolein exceeded the intermediate MRL for all four sites.

- For CNEP, the cancer risk estimates from NATA for some pollutants, such as benzene, were very similar to the cancer risk approximations, but very different for others, such as acrylonitrile.

- According to NATA, benzene had the highest cancer risk estimates for the Tulsa sites. Benzene also had the highest cancer risk approximations for these sites. Acrolein had the highest NATA-modeled noncancer risk and noncancer risk approximation for TOOK, TSOK, and TUOK.

- Benzene was the highest emitted pollutant with a cancer risk factor in Mayes and Tulsa Counties. Arsenic had the highest cancer toxicity-weighted emissions for

Mayes County, while benzene had the highest cancer toxicity-weighted emissions for Tulsa County.

- Toluene was the highest emitted pollutant with a noncancer risk factor in both counties, while acrolein had the highest noncancer toxicity-weighted emissions.

Puerto Rico.

- The two UATMP sites in Puerto Rico are located in Barceloneta (BAPR) and San Juan (SJPR).
- Back trajectories originated from the northeast, east, and southeast of the monitoring sites. Back trajectories did not originate from any other directions.
- The wind roses show that easterly and southeasterly winds were prevalent near these monitoring sites.
- BAPR and SJPR both sampled for VOC and carbonyls.
- The pollutants of interest common to both sites were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and *p*-dichlorobenzene.
- Of the pollutants of interest, dichloromethane had the highest daily average concentration for BAPR and acetaldehyde had the highest daily average concentration for SJPR. SJPR had the highest daily average concentration of acetaldehyde and *p*-dichlorobenzene among all monitoring sites.
- Average concentrations of dichloromethane for BAPR were higher than other program sites. However, an annual average concentration could not be calculated, due to the short sampling duration, to provide a cancer risk approximation.
- Seasonal averages could only be calculated for winter and spring and annual averages were not calculated because BAPR and SJPR stopped sampling in June.
- Strong positive Pearson correlations were calculated between formaldehyde and maximum temperature for both sites. Although this trend was also true of average temperature for BAPR, the correlation between average temperature and formaldehyde at SJPR was weaker. While the pollutants of interest exhibited weak correlations with wind speed, nearly all were negative.
- The winter and spring seasonal averages of acrolein exceeded the intermediate MRL for BAPR and SJPR.
- According to NATA, dichloromethane had the highest concentration and cancer risk for BAPR, which was the second highest cancer risk estimate for any pollutant that

failed a screen in a census tract with a UATMP or NATTS monitoring site. The only pollutant with a noncancer HQ greater than 1.0 for BAPR was acrolein.

- According to NATA, benzene had the highest cancer risk estimates for the SJPR monitoring site, while acrolein had the highest NATA-modeled noncancer risk.

- Because annual averages could not be calculated, cancer and noncancer surrogate risk approximations for the Puerto Rico monitoring sites could not be calculated.

- Dichloromethane was the highest emitted pollutant with a cancer risk factor in the Barceloneta Municipio, while benzene was the highest emitted pollutant with a cancer risk factor in the Bayamon Municipio. Hexavalent chromium had the highest toxicity-weighted emissions in both municipios.

- Dichloromethane was the highest emitted pollutant with a noncancer risk factor in the Barceloneta Municipio, while toluene was the highest emitted pollutant with a noncancer risk factor in the Bayamon Municipio. Acrolein had the highest toxicity-weighted emissions in both municipios.

Rhode Island.

- The Rhode Island monitoring site is located in Providence and is a NATTS site.

- Back trajectories originated from a variety of directions at PRRI, although infrequently from the southeast. The 24-hour air shed domain for PRRI was similar in size to other monitoring sites.

- The wind rose shows that westerly winds were prevalent near PRRI.

- PRRI sampled for hexavalent chromium only. Hexavalent chromium failed two screens for this site.

- Compared to other program sites sampling hexavalent chromium, PRRI had the eighth lowest daily average concentration.

- Correlations between concentrations of hexavalent chromium and selected meteorological parameters were weak.

- None of the daily measurements or concentration averages of hexavalent chromium exceeded any of the MRL risk values.

- The cancer risk from hexavalent chromium according to NATA was an order of magnitude higher than the cancer risk approximation. The noncancer risk according to NATA and the noncancer risk approximation for hexavalent chromium were both low.

- Benzene was the highest emitted pollutant with a cancer risk factor in Providence County, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in Providence County.

South Carolina.

- The South Carolina monitoring site is located in near Chesterfield and is a NATTS site.

- Back trajectories originated from a variety of directions at CHSC. The 24-hour air shed domain for CHSC was similar in size to other monitoring sites.

- The wind rose shows that calm winds were prevalent near CHSC. For winds greater than two knots, southwesterly winds were observed most frequently.

- CHSC sampled for hexavalent chromium only. Although hexavalent chromium did not fail any screens, analyses were still conducted on samples for this pollutant.

- Compared to other program sites sampling hexavalent chromium, CHSC had the lowest daily average concentration.

- Correlations between concentrations of hexavalent chromium and selected meteorological parameters were weak.

- None of the daily measurements or concentration averages of hexavalent chromium exceeded any of the MRL risk values.

- The cancer and noncancer risks according to NATA and the surrogate risk approximations for hexavalent chromium were low.

- Benzene was the highest emitted pollutant with a cancer risk factor in Chesterfield County, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions.

South Dakota.

- The two UATMP sites in South Dakota are located in Sioux Falls (SFSD) and Custer (CUSD).

- Back trajectories originated from a variety of directions at the South Dakota sites. The predominant direction of trajectory origin for CUSD was west or northwest, while the predominant direction of trajectory origin for SFSD was from the southwest and northwest. The 24-hour air shed domain for CUSD was smaller than the air shed domain for SFSD. The air shed domain for SFSD was the largest of all monitoring sites.

- The wind rose for CUSD shows that westerly winds were prevalent near this site, while southerly and northwesterly winds prevailed near SFSD.

- CUSD and SFSD sampled for VOC, SNMOC, and carbonyl compounds.

- The pollutants of interest common to both sites were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for both sites. CUSD and SFSD had the sixth and seventh highest daily average concentrations of acrylonitrile, respectively, compared to all monitoring sites sampling VOC.

- Concentrations of acetaldehyde and formaldehyde were highest during the summer at CUSD. The concentrations of the other pollutants of interest did not vary significantly from season to season for CUSD or SFSD.

- Carbonyl, SNMOC, and VOC sampling has been conducted at CUSD for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the central tendency statistics for benzene were very similar in value, reflecting relatively little variability in the concentrations measured for each period; the rolling average concentration of 1,3-butadiene increased over time, demonstrating the effects of the increased detection rate; the increasing “closeness” of the central tendency statistics indicated a decreasing variability in the formaldehyde concentrations, as did the range of concentrations detected.

- Carbonyl, SNMOC, and VOC sampling has been conducted at SFSD for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the average rolling concentrations of benzene have decreased since the 2002-2004 time frame; although the range of 1,3-butadiene concentrations decreased over time, the central tendency statistics were very low, demonstrating the effects of large numbers of non-detects; the rolling average concentrations of formaldehyde changed little across the periods.

- At CUSD, acrylonitrile exhibited strong positive correlations with the average, maximum, dew point, and wet bulb temperatures and a strong negative correlation with relative humidity; 1,3-butadiene exhibited strong negative correlations with the temperature and moisture parameters; and acetaldehyde exhibited a strong negative correlation with sea level pressure.

- Although most of the correlations of the pollutants of interest were weak at SFSD, acrolein exhibited strong positive correlations with the temperature and moisture parameters.

- All four seasonal averages of acrolein exceeded the intermediate MRL risk factor for CUSD and SFSD. Additionally, one measured detection of formaldehyde exceeded the ATSDR acute MRL.

- According to NATA, carbon tetrachloride had the highest cancer risk estimate for CUSD, while benzene had the highest cancer risk estimate for SFSD. Acrolein was the only pollutant with a noncancer HQ greater than 1.0. Carbon tetrachloride had the highest cancer risk approximations for these sites, while acrolein had the highest noncancer risk approximations.

- Benzene was the highest emitted pollutant with a cancer risk factor in both Custer and Minnehaha Counties. Benzene also had the highest toxicity-weighted emissions in both counties.

- Toluene was the highest emitted pollutant with a noncancer risk factor in Custer and Minnehaha Counties, while acrolein had the highest noncancer toxicity-weighted emissions for both counties.

Tennessee.

- The Tennessee monitoring sites (LDTN and MSTN) are UATMP sites located in Loudon, southwest of Knoxville.

- Back trajectories originated from a variety of directions at the sites, although less frequently from the northwest, north, and northeast. The air shed domains were similar in size compared to other monitoring sites, as the farthest away a back trajectory originated was approximately 800 miles.

- The wind roses show that calm winds were prevalent near the monitoring sites, although southwesterly winds were observed the most for winds greater than two knots.

- LDTN and MSTN sampled for VOC and carbonyl compounds.

- The pollutants of interest common to both sites were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.

- Of the pollutants of interest for LDTN, carbon disulfide had the highest daily average concentration. The daily average concentration of carbon disulfide for LDTN was the highest average concentration for this pollutant of all NATTS and UATMP sites.

- Of the pollutants of interest for MSTN, formaldehyde had the highest daily average concentration. In addition, formaldehyde concentrations were highest in the summer.

- Carbonyl and VOC sampling has been conducted at LDTN for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the median and average rolling concentrations of benzene have a decreasing trend over the sampling periods; the central tendency statistics for 1,3-butadiene have increased over the sampling periods, due to the increasing detection rate (and the decreased MDL); and the average rolling concentration of formaldehyde decreased over the sampling periods.

- Formaldehyde exhibited strong positive Pearson correlations with average, maximum, dew point, and wet bulb temperatures at both sites. Acetaldehyde also exhibited strong positive correlations with the temperature parameters at LDTN. In addition, all of the correlations between the pollutants of interest and scalar wind speed were negative at both sites.

- The seasonal averages of acrolein exceeded the ATSDR intermediate MRL risk factor for both sites.

- According to NATA, benzene had the highest cancer risk estimates for both LDTN and MSTN and acrolein was the only pollutant with a noncancer HQ greater than 1.0. Carbon tetrachloride had the highest cancer risk approximation for both sites, while acrolein had the highest noncancer risk approximation for both sites.

- Benzene was the highest emitted pollutant with a cancer risk factor in Loudon County, while carbon disulfide was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in Loudon County.

Texas.

- The Texas monitoring sites are NATTS sites located in Deer Park (CAMS 35) and (CAMS 85).

- Back trajectories originated from a variety of directions at the Texas monitoring site, although most trajectories originated from the southeast at CAMS 35 and from the southeast and south at CAMS 85. The 24-hour air shed domain for CAMS 85 was larger in size than CAMS 35 and most other monitoring sites, as the farthest away a back trajectory originated was 900 miles.

- The wind roses show that southeasterly and southerly winds prevailed near both sites, although northerly winds were also observed somewhat frequently near the sites.

- The CAMS 35 and CAMS 85 monitoring sites sampled VOC only.

- The pollutants of interest common to both sites were acrolein, benzene, 1,3-butadiene, and carbon tetrachloride.

- Of the pollutants of interest, benzene had the highest daily average concentration for both sites.

- CAMS 35 had the highest daily average concentration of 1,3-butadiene, third highest daily average concentration of acrylonitrile, and fourth highest daily average concentration of benzene among sites sampling VOC. In addition, CAMS 85 had the fifth highest daily average concentration of acrylonitrile.

- Concentrations of benzene were lowest during the winter and highest during the fall at CAMS 35. The rest of the concentrations of the pollutants of interest did not vary significantly from season to season at the Texas sites.

- Benzene exhibited a strong negative Pearson correlation with wind speed at CAMS 85. Acrylonitrile exhibited a strong negative correlation with relative humidity, and *p*-dichlorobenzene exhibited a strong negative correlation with wind speed at CAMS 35.

- The seasonal averages of acrolein exceeded the ATSDR intermediate MRL risk factor for both sites.

- According to NATA, benzene had the highest cancer risk estimates for both sites and acrolein was the only pollutant with a noncancer HQ greater than 1.0. Carbon tetrachloride had the highest cancer risk approximation for CAMS 85, while 1,3-butadiene had the highest cancer risk approximation for CAMS 35. Acrolein had the highest noncancer risk approximation for both sites.

- Benzene was the highest emitted pollutant with a cancer risk factor in Harris and Harrison Counties, while toluene was the highest emitted pollutant with a noncancer risk factor in both counties. Benzene had the highest cancer toxicity-weighted emissions in Harris County, while hexavalent chromium had the highest cancer toxicity-weighted emissions in Harrison County. Acrolein had the highest noncancer toxicity-weighted emissions for both counties.

Utah.

- The NATTS site in Utah is located in Bountiful.

- The majority of trajectories originated from the south and southwest of BTUT, although another cluster of trajectories originated from the northwest. The 24-hour air shed domain for BTUT was slightly smaller in size compared to other monitoring sites as the furthest away a trajectory originated was nearly 500 miles away.

- The wind rose shows that southerly and southeasterly winds were prevalent near BTUT.

- BTUT sampled for VOC, carbonyls, SNMOC, metals (PM_{10}), and hexavalent chromium.

- The following pollutants were identified as pollutants of interest for BTUT: acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, cadmium, carbon tetrachloride, *p*-dichlorobenzene, formaldehyde, manganese, and tetrachloroethylene.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for BTUT, followed by acetaldehyde and benzene. Additionally, BTUT had the third highest daily average concentration of arsenic (PM_{10}) and fourth highest concentration of manganese (PM_{10}) among sites sampling PM_{10} metals.

- Concentrations of 1,3-butadiene were higher in the winter and autumn. Most of the concentrations of the pollutants of interest for BTUT did not vary significantly by season.

- Carbonyl, VOC, SNMOC, and metals sampling have been conducted at BTUT for at least five consecutive years; thus three-year rolling metrics were calculated. In brief, the average rolling concentrations of arsenic have decreased; the median and average rolling concentrations of benzene have a slight decreasing trend over the sampling periods, based on measurements from both methods; as the detection rate for 1,3-butadiene increased (due to lower detection limits), the rolling average concentrations increased; and the average rolling concentrations of formaldehyde increased slightly from 2003-2005 to 2004-2006, then decreased to the previous level over the 2005-2007 time frame.

- Strong positive Pearson correlations were calculated between manganese and the temperature and moisture parameters (except relative humidity). 1,3-Butadiene exhibited a strong positive correlation with sea level pressure. Benzene and 1,3-butadiene both exhibited strong negative correlations with wind speed, although all correlations with wind speed were negative.

- All four seasonal averages of acrolein exceeded the intermediate MRL risk factor.

- Benzene had the highest NATA-modeled cancer risk and the highest cancer risk approximation for BTUT. Acrolein had the highest NATA-modeled noncancer risk and noncancer risk approximation.

- Benzene was the highest emitted pollutant with a cancer risk factor in Davis County, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in Davis County.

Vermont.

- The Vermont monitoring site is located in Underhill and is a NATTS site.

- Back trajectories originated from a variety of directions at UNVT, although less frequently from the east and southeast. The 24-hour air shed domain for UNVT was similar in size to other monitoring sites.

- The wind rose shows that calm winds were prevalent near UNVT. For winds greater than two knots, northerly and southerly winds were observed most frequently.

- UNVT sampled for hexavalent chromium only. Although hexavalent chromium did not fail any screens, analyses were still conducted on samples for this pollutant.

- Compared to other program sites sampling hexavalent chromium, UNVT had the fifth lowest daily average concentration.

- Correlations between concentrations of hexavalent chromium and selected meteorological parameters were weak.

- None of the daily measurements or concentration averages of hexavalent chromium exceeded any of the MRL risk values.

- The cancer and noncancer risks according to NATA and the surrogate risk approximations for hexavalent chromium were low.

- Benzene was the highest emitted pollutant with a cancer risk factor in Chittenden County, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions.

Washington.

- The NATTS site in Washington is located in Seattle.

- Back trajectories originated from a variety of directions at SEWA, although infrequently from the southeast. The 24-hour air shed domain for SEWA was comparable in size to other monitoring sites.

- The wind rose shows that southerly and south-southeasterly winds were prevalent near SEWA.

- SEWA sampled for VOC, carbonyls, metals, and hexavalent chromium.

- The following pollutants were identified as pollutants of interest for SEWA: acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, manganese, nickel, and tetrachloroethylene.

- Of the pollutants of interest, formaldehyde and acetaldehyde had the highest daily average concentrations for SEWA.

- All of the Pearson correlations with wind speed were negative.

- All four seasonal averages of acrolein exceeded the intermediate MRL risk factor.

- Benzene had the highest NATA-modeled cancer risk for SEWA, and the second highest cancer risk approximation. Carbon tetrachloride had the highest cancer risk approximation.

- Acrolein had the highest NATA-modeled noncancer risk and noncancer risk approximation for SEWA.

- Benzene was the highest emitted pollutant with a cancer risk factor in King County, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in King County.

Wisconsin.

- The Wisconsin monitoring site is located in Mayville and is a NATTS site.

- Back trajectories originated from a variety of directions at MVWI, although less frequently from the east. The 24-hour air shed domain for MVWI was one of the largest in size compared to other monitoring sites.

- The wind rose shows that calm winds were prevalent near MVWI. For winds greater than two knots, westerly and northwesterly winds were observed most frequently.

- MVWI sampled for hexavalent chromium only. Although hexavalent chromium did not fail any screens, analyses were still conducted on samples for this pollutant.

- Compared to other program sites sampling hexavalent chromium, MVWI had the fourth lowest daily average concentration.

- Correlations between concentrations of hexavalent chromium and selected meteorological parameters were weak.

- None of the daily measurements or concentration averages of hexavalent chromium exceeded any of the MRL risk values.

- The cancer and noncancer risks according to NATA and the surrogate risk approximations for hexavalent chromium were low.

- Benzene was the highest emitted pollutant with a cancer risk factor in Dodge County, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions.

32.1.3 Composite Site-level Summary

$ Twenty-two pollutants were identified as site-specific pollutants of interest. Acetaldehyde and formaldehyde were the two most common pollutants of interest among the monitoring sites. All sites (33) that sampled carbonyls had acetaldehyde and formaldehyde as pollutants of interest. Benzene, acrolein, 1,3-butadiene, and carbon tetrachloride were the most common VOC pollutants of interest. Every site that sampled VOC (27) had these as pollutants of interest.

$ Among the site-specific pollutants of interest, formaldehyde frequently had the highest daily average concentration among the monitoring sites; formaldehyde had the highest daily average concentration for 25 sites. Acetaldehyde had the next highest daily average concentration at five sites.

$ Pearson correlations calculated between formaldehyde and the temperature parameters (maximum and average temperature) for many of the monitoring sites were moderately strong and positive. This indicates that as temperatures increase, concentrations of formaldehyde also increase. At some of these same sites, the summer formaldehyde average concentration tended to be higher than other seasons, supporting this observation.

$ Pearson correlations calculated between most of the pollutants of interest and the scalar wind speed at most monitoring sites tended to be negative. This indicates that as wind speed decreases, concentrations of the pollutants of interest increase.

$ Carbon tetrachloride often had relatively high cancer risk approximations based on annual averages among the monitoring sites, but tended to have relatively low emissions and toxicity-weighted emissions according to the NEI emissions inventory. This suggests that this pollutant is present in “background” levels of ambient air; that is, it is consistently present at similar levels at any given location. Although production of this pollutant has declined sharply over the last 30 years due to its role as an ozone depleting substance, it has a relatively long atmospheric lifetime.

$ Acrolein emissions and mass concentrations were relatively low when compared to other pollutants. However, due to the high toxicity of this pollutant, low mass concentrations translated into very high noncancer surrogate risk approximations. This trend was also evident when the acrolein emissions were toxicity-weighted; the toxicity-weighted value was often several orders of magnitude higher than other pollutants. Acrolein is a national noncancer risk driver according to NATA.

$ Several characterization parameters presented, such as average daily traffic volume near the monitoring sites, are provided in AQS by the agency responsible for the site. Because many of these parameters were 10 years old or more, updating such information has been a recommendation in previous years’ UATMP reports. This allows the data to more accurately reflect current conditions near the sites, and in turn provides higher quality information for understanding the dynamics surrounding each monitoring site. This year, more recent traffic volume data were obtained from state and local agencies. As a result, the impacts of motor vehicle emissions were more visible in the analyses conducted.

$ When comparing the highest emitted pollutants for a specific county with the pollutants with the highest toxicity-weighted emissions, the lists tended to be more similar for the pollutants with cancer UREs than for pollutants with noncancer RfCs.

32.1.4 Data Quality Summary

Method precision was analyzed for the 2007 NATTS and UATMP monitoring efforts using relative percent difference (RPD), coefficient of variation (CV), and average concentration difference calculations based on duplicate, collocated, and replicate samples. The overall method precision for some methods was well within data quality objective specifications and monitoring method guidelines (TO-11A and IO-3.5), while other methods exceeded the data quality objective specifications (TO-15/SNMOC, TO-13A, and hexavalent chromium). Sampling and analytical method accuracy is assured by using proven methods, as demonstrated by third-party analysis of proficiency test audit samples, and following strict quality control and quality assurance guidelines.

32.2 Recommendations

In light of the results of the data analyses from the 2007 NATTS and UATMP, a number of recommendations for future ambient air monitoring efforts are presented below.

- *Encourage EPA to promulgate ambient air standards for HAPs.* Several of the pollutants sampled during the 2007 program year exceeded risk screening factors developed by various government agencies. One way to reduce the risk to human health would be to develop standards similar to the NAAQS for pollutants that frequently exceed published risk screening levels.

- *Incorporate/Update Risk in State Implementation Plans (SIPs).* Use risk calculations to design State Implementation Plans (SIPs) to implement policies that will reduce the potential for human health risk. This would be easier to enforce if ambient standards for certain HAPs were developed (refer to above recommendation).

- *Encourage state/local/tribal agencies to develop and/or verify HAP and VOC emission inventories.* State/local/tribal agencies should use the data collected from the NATTS and UATMP sites to develop and validate emissions inventories, or at the very least, identify and/or verify emission sources of concern. Ideally, state/local/tribal agencies would compare the ambient monitoring results with an emission inventory for source category completeness. The emissions inventory could then be used to develop modeled concentrations useful to compare against ambient monitoring data.

- *Continue to identify and implement improvements to the sampling and analytical methods.* The improvements made to the analytical methods prior to the 1999-2000 UATMP allowed for the measurement of ambient air concentrations of 11 pollutants that were not measured during previous programs. This improvement provides sponsoring agencies and a variety of interested parties with important information about air quality within their urban areas. Further research is encouraged to identify other method improvements that would allow the characterization of an even wider range of components in urban air pollution and enhance the ability of the methods to quantify all cancer and noncancer pollutants to at least their levels of concern (risk screening concentrations).

- *Require consistency in sampling and analytical methods.* The development of the NATTS program is evidence that there are inconsistencies in collection and analytical methods that make data comparison difficult across agencies. Encouraging agencies to use documented, consistent methods is integral to the identification of trends and the impacts of regulation.

- *Strive to develop standard conventions for interpreting air monitoring data.* The lack of consistent approaches to present and summarize ambient air monitoring data complicates direct comparisons between different studies. Thought should be given to the feasibility of establishing standard approaches for analyzing and reporting air monitoring data for programs with similar objectives.

- *Prepare a report* characterizing multiple years of NATTS and UATMP data and then update it yearly to better assess trends and better understand the nature of U.S. urban air pollution. The value of assessing NATTS and UATMP data from the National Monitoring Programs is that the data is of known and high quality, using laboratory analyses based on consistent methods from a single laboratory.

- *Consider more rigorous study of the impact of automobile emissions on ambient air quality using multiple year of data.* Because many NATTS and UATMP sites have generated years of continuous data, a real opportunity exists to evaluate the importance and impact of automobile emissions on ambient air quality. Suggested areas of study include additional signature compound assessments and parking lot characterizations.

- *Encourage continued participation in the National Monitoring Programs.* Ongoing ambient air monitoring at fixed locations can provide insight into long-term trends in urban air quality and the potential for urban air pollution to cause adverse health effects among the general population. Therefore, state and local agencies should be strongly encouraged to either 1) develop and implement their own ambient air monitoring programs based on proven, consistent sampling and analysis methods and

EPA technical and quality assurance guidance, or 2) consider participation in the UATMP.

- *Encourage year-round participation in the National Monitoring Programs.* Many of the analyses presented in the 2007 report require a full year of data to be most useful and representative of conditions experienced at each specified location. Therefore, state and local agencies should be strongly encouraged to implement year-long ambient air monitoring programs in addition to participating in future monitoring efforts.

- *Encourage the monitoring of additional pollutant groups based on the results of data analyses in the annual report.* The risk-based analysis where county-level emissions are weighted based on toxicity identifies those pollutants whose emission may result in adverse health effects in a specific area. If a site is not sampling for a pollutant or pollutant group identified as particularly hazardous in a given area, the agency responsible for that site should consider sampling for those compounds.

- *Encourage case studies based on findings from the annual report.* Often, the annual report identifies an interesting tendency or trend, or highlights an event at a particular site(s). For example, the 2006 annual report included an observation of high hexavalent chromium concentrations on July 4, 2006. Further examination of the data in conjunction with meteorological phenomena and potential emissions events or incidents, or further site characterization may help identify state and local agencies pinpoint issues affecting air quality in their area.

33.0 References

ATSDR, 1990. Toxicological Profile for Acrolein. December 1990.

ATSDR, 2007a. “Air Comparison Values in ug/m3.” Annmarie DePasquale via Naida Gavrelis. Aug28, 2007.

ATSDR, 2007b. Agency for Toxics Substances and Disease Registry (ATSDR). Minimal Risk Levels for Hazardous Substances. November 2007. Internet address: http://www.atsdr.cdc.gov/mrls/index.html

ATSDR, 2007c. Toxicological Profile for Acrolein. August 2007. Internet address: http://www.atsdr.cdc.gov/toxprofiles/tp124.html#bookmark01

Conner, et al., 1995. ATransportation-Related Volatile Hydrocarbon Source Profiles Measured in Atlanta.@ Teri L. Conner, William A. Lonneman, Robert L. Seila. Journal of the Air and Waste Management Association, 45: 383-394. 1995.

Draxler, R.R. and Rolph, G.D., 2003. HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (http://www.arl.noaa.gov/ready/hysplit4.html). NOAA Air Resources Laboratory. Silver Spring. MD.

EIA, 2007. Energy Information Administration. Motor Vehicle Registration by State. December 2007.

EPA, 1998. ATechnical Assistance Document for Sampling and Analysis of Ozone Precursors." U.S. Environmental Protection Agency, National Exposure Laboratory. EPA/600-R-98/161. September 1998.

EPA, 1999a. ACompendium Method TO-11A: Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC).@ U.S. Environmental Protection Agency, Center for Environmental Research and Information. EPA/625/R-96/010b. January, 1999.

EPA, 1999b. ACompendium Method TO-15: Determination of Volatile Organic Compounds (VOC) in Ambient Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS).@ U.S. Environmental Protection Agency, Center for Environmental Research and Information. EPA/625/R-96/010b. January, 1999.

EPA, 1999c. ACompendium Method TO-13: Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air Using Gas Chromatography/Mass Spectrometry (GC/MS).@ U.S. Environmental Protection Agency, Center for Environmental Research and Information. EPA/625/R-96/010b. January 1999.

EPA, 1999d. ACompendium Method IO-3.5: Determination of Metals in Ambient Particulate Matter Using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS)." U.S. Environmental Protection Agency, Center for Environmental Research and Information. EPA/625/R-96/010a. June 1999.

EPA, 2003. "NMOC, UATMP, PAMS, HAPS and NATTS Support." U.S. Environmental Protection Agency, Contract No. 68-D-03-049. September 2003.

EPA, 2005a. 40 CFR Part 136, Appendix B. Definition and Procedure Determination of the Method Detection Limit, Revision 1.11.

EPA, 2005b. Health Effects Information Used in Cancer and Noncancer Risk Characterization for the 1999 National-scale Assessement. www.epa.gov/ttn/atw/nata1999/99pdfs/healtheffectsinfo.pdf

EPA, 2006a. 2002 National Emissions Inventory (NEI) Data and Documentation. Data retrieved from ftp://ftp.epa.gov/EmisInventory/2002finalnei/

EPA, 2006b. Standard Operating Procedure for the Determination of Hexavalent Chromium in Ambient Air Analyzed by Ion Chromatography (IC). June 2006. Internet address: http://www.epa.gov/ttn/amtic/airtox.html.

EPA, 2006c. The National-Scale Air Toxics Assessment (NATA) for 1999. Internet address: http://www.epa.gov/ttn/nata_1999/

EPA, 2006d. A Preliminary Risk-based Screening Approach for Air Toxics Monitoring Data Sets. Air, Pesticides, and Toxics Management Division. Atlanta, GA. February 2006. Internet address: http://www.epa.gov/docs/region04/air/airtoxic/Screening-041106-KM.pdf

EPA, 2007a. Technical Assistance for the National Ambient Air Toxics Trends and Assessment Program. Emissions - Revision 1, Office of Air Quality Planning and Standards (OAQPS), Modeling, and Analysis Division (EMAD). RTP, NC. 336 pp. November 1, 2007.

EPA, 2007b. "1990-2002 NEI HAP Trends: Success of CAA Air Toxic Programs in Reducing HAP Emissions and Risk. Paper presented at the 16th Annual International Emission Inventory Conference. Raleigh, NC. May 2007. Internet address: http://www.epa.gov/ttn/chief/conference/ei16/session6/a.pope.pdf.

EPA, 2007c. Pollutants and Sources. EPA TTN Air Toxics Web Site. Last updated June 6, 2007. Internet address: http://www.epa.gov/ttn/atw/pollsour.html.

EPA, 2008a. What are Mobile Sources? Internet Address: http://www.epa.gov/otaq/inventory/overview/examples.htm.

EPA, 2008b. EPA Climate change website. http://epa.gov/climatechange/fq/science.html#5

EPA, 2008c. EPA High Global Warming Potential (GWP) Gases website. http://epa.gov/highgwp/

EPA, 2008d. EPA TTN AQS website. http://www.epa.gov/ttn/airs/airsaqs/

EPA, 2008e. Mobile Source Emissions – Past, Present, and Future (Hydrocarbons). www.epa.gov/otaq/invntory/overview/pollutants/hydrocarbons.htm

EPA, 2008f. National Air Toxics Assessments Index website. http://www.epa.gov/ttn/atw/natamain/index.html.

ERG, 2006/2007. Eastern Research Group, Inc. ASupport for the EPA National Monitoring Programs (NMOC, UATMP, PAMS, HAPs, and NATTS), Quality Assurance Project Plan, Category 1, 2006/2007.@ Internet address: http://www.ergweb2.com/uatmp/user/index.cfm.

FHWA, 2006. Federal Highway Administration, Highway Statistics 2005. Internet Address: http://www.fhwa.dot.gov/policy/ohim/hs05/pdf/hm71.pdf.

FLDOT, 2007. Florida Department of Transportation, Transportation Statistics Office. Internet address: http://dot.state.fl.us/planning/statistics/trafficdata/AADT/aadtinfo.pdf.

Gary, 2007. Gary Chamber of Commerce website. Internet address: http://www.garychamber.com/geoclimate.asp

Lakes, 2006. Lakes Environmental, WRPLOT View. Internet address: http://www.weblakes.com/lakewrpl.html. 2006.

NLM, 2008. U.S. National Library of Medicine. Internet address: http://toxtown.nlm.nih.gov/text_version/chemicals.php?id=10.

NOAA, 2008. NOAA ESRL Chemical Sciences Division Climate Forcing website. http://www.esrl.noaa.gov/csd/greenhouse.html

NRC, 1991. ARethinking the Ozone Problem in Urban and Regional Air Pollution. @National Research Council: National Academy Press, 1991.

SC SCO, 2008. South Carolina State Climate Office. Internet address: http://www.dnr.sc.gov/climate/sco/ClimateData/cli_sc_climate.php.

TAMU, 2007. Texas A & M University, Office of State Climatologist. Internet address: http://www.met.tamu.edu/osc/TXclimat.htm.

Taylor, S.L, et all, 1999. S.L. Taylor, M.E. Payton, W.R. Raun. “Relationship between Mean Yield, Coefficient of Variation, Mean Square Error and Plot Size in Wheat Field Experiments.” (http://nue.okstate.edu/Index_Publications/MSE_Taylor_1999.htm).

TGA, 1997. Tennessee Geographic Alliance, University of Tennessee Knoxville. Tennessee Atlas Online. Internet address: http://web.utk.edu/~tga/atlas/Atlas.html.

ODOT, 2007. Oregon Department of Transportation, Transportation Data. Internet address: http://www.oregon.gov/ODOT/TD/TDATA/tsm/vmtpage.shtml.

Rogers and Yau, 1989. AA Short Course in Cloud Physics.@ R. R. Rogers and M. K. Yau. Pergamon Press. 1989.

Ruffner and Bair, 1987. AThe Weather Almanac.@ James A. Ruffner and Frank E. Bair. Gale Research Company. 1987.

Stockcharts.com Internet address: http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:moving_averages.

TCEQ, 2002. Texas Commission on Environmental Quality (TCEQ). SIP Modeling Document. June 2002. Internet address: http://www.tceq.state.tx.us/assets/public/implementation/air/sip/sipdocs/2002-12-HGB/tsdpart1.pdf

US Census Bureau, 2007. Metropolitan and Micropolitan Statistical Areas. Internet address: http://www.census.gov/population/www/estimates/metroarea.html

Warneck, 1988. AChemistry of the Natural Atmosphere.@ Peter Warneck Academic Press, Inc. 1998.

WRCC, 2006. Western Region Climate Center. Climate Narrative of Each State. Internet address: http://www.wrcc.dri.edu/CLIMATEDATA.html

Weather Questions.com. Internet address: http://www.weatherquestions.com/What_is_the_troposphere.htm

Wildernet, 2007. Wildernet. Internet address: http://www.wildernet.com/pages/area.cfm?areaname=Kentucky&CU_ID=1

United States
Environmental Protection
Agency

Office of Air Quality Planning and Standards
Emissions, Monitoring and Analysis Division
Research Triangle Park, NC

Publication No. EPA-454/R-08-008a
December 2008