APPENDIX A

INDEX OF POLICY AND SCIENCE QUESTIONS FOR
NARSTO ASSESSMENT

A.1 POLICY QUESTIONS FOR NARSTO ASSESSMENT

1. What changes have occurred to tropospheric ozone science over the last decade that might alter (or confirm) the course of current ozone air quality management strategies? 1.6 - 1.10
3.1 - 3.55
4.4 - 4.6

2. How manageable is the ozone problem for a given area? [What portion of the problem is local and what portion is transported in? What portion of the problem is essentially irreducible, and what portion is potentially controllable?] 1.6 - 1.10
3.34 - 3.40

3. Are existing emission control measures helping to bring the ozone problem under control? [For a given area, if these control measures are continued, will they lead to ozone abatement?] 1.2 - 1.6
3.2 - 3.10

4. What are the relationships between the on-going efforts to manage tropospheric ozone pollution and the scientific understanding of the issues? 1.5 - 1.7
2.8 - 2.12
4.3 - 4.19
5.1 - 5.7

5. What are alternate approaches for reducing current and future high ozone concentrations on urban (<200 km) and regional (200-2000 km) scales? 3.11 - 3.22

6. How can we best track and assess the progress and effectiveness of our ozone management efforts? 1.5 - 1.6
3.41 - 3.44
5.1 - 5.7

7. Will our efforts to manage ozone help or hinder efforts to mitigate other environmental problems, such as acid rain, fine particles, and global climate change, and vice versa? 1.3 - 1.3
3.49 - 3.55
## A.2 INDEX OF SCIENCE QUESTIONS FOR NARSTO ASSESSMENT

1. What are the most significant research developments in tropospheric ozone science over the last decade?  
   1.2 - 1.10  
   3.1 - 3.55  
   4.2 - 4.19

2. How does ozone accumulation on urban (<200 km) and regional (200-2000 km) scales depend on the source dimension and location? How does it depend on the relative contribution from urban and regional sources?  
   1.3 - 1.8  
   3.34 - 3.40

3. What are the most recent assessments of the relative contributions of VOCs, NO<sub>x</sub> and CO to ozone accumulation on urban and regional scales in North America?  
   3.11 - 3.23  
   3.46

4. What are the strengths and limitations of the current scientific methods and tools in assessing tropospheric ozone issues and developing emission management strategies?  
   3.2 - 3.3  
   3.19 - 3.23  
   3.23 - 3.31  
   3.37 - 3.40  
   3.41 - 3.44  
   3.45 - 3.48  
   4.1 - 4.19

5. What approaches are required to determine historic concentration trends of ozone and its precursors on urban and regional scales? What is required to demonstrate the effectiveness of emission control strategies over time?  
   3.2 - 3.11  
   3.41 - 3.44  
   5.1 - 5.17

6. What are the relationships between the control strategies designed to manage tropospheric ozone and those designed to manage other pollutant regimes of interest?  
   1.3  
   3.49 - 3.55
APPENDICES

APPENDIX B

REVIEW PROCESS

Successive drafts of this Assessment Document experienced progressive stages of review by its authors and by outside peers, and transcripts were recorded containing the review comments and the corresponding actions. The first draft, dated August 1998, was an internal NARSTO review draft. All groups within NARSTO were invited to provide comments, including the Executive Steering Committee (ESC), the NARSTO Technical Teams, the Critical Review Paper authors, and the Liaison Team. Written comments from this round were received from:

ESC Members:
- Dr. Daniel Albritton (NOAA/AL)
- Dr. Steven Cadle (GM)
- Mr. John Elston (NJ-DEP)
- Mr. Alfred Ferullo (PA Power and Light)
- Mr. William Frick (API)
- Dr. Donald McKay (Env. Canada)
- Dr. Peter Mueller (EPRI)

Critical Review Paper Authors:
- Dr. Marcia Dodge (consultant, chem. mech. review)
- Dr. David Parrish, (NOAA/AL, chem. measurements review)
- Dr. S.T. Rao (NY-DEC, trends review)
- Dr. Armisted Russell, (GIT, modeling review)
- Dr. Sanford Sillman (U. Mich., indicator species)
- Dr. Robert Slott, (Shell Oil, mobile sources review)

Liaison Team:
- Dr. Peter Borrell (EUROTRAC)

Others:
- Mr. John Bachmann (EPA/OAQPS).

In November 1998, the Assessment Report was revised based on comments from the first set of reviews. A second draft was produced, dated December 1998, and offered for external review by the National Research Council (a division of the National Academy of Sciences) as well as to the NARSTO-ESC. The second draft was also placed on the NARSTO Web site for public access. Comments were received on the second draft from:

Mr. John Dege (DuPont)
Mr. Edward Edwards (Dunn-Edwards)
Dr. James Meagher (NOAA/AL)
EPA/OAQPS staff
NARSTO Executive Assembly
(verbatim comments at meeting)
NARSTO Fine Particle Workshop
(verbatim comments at meeting)
Mr. Ralph Scanlan (PA-DEP)
Dr. Frances Sharples (OSTP)
Dr. Sanford Sillman (U. Mich.)
TVA research staff
Ms. Susan Weirman (MARAMA).

The comments from the second review were incorporated at the author's team meeting in October 1999. The NRC review comments were published in January 2000, and incorporated into a third draft during February, which was prepared in a semifinal, page-layout format.

The semifinal draft was posted on the NARSTO Web site for final comments during the spring of 2000. These comments were processed, and appropriate modifications were made to the semifinal draft to produce the published version.

The Assessment Document authors acknowledge with thanks the insight, information, and critical analysis provided by the reviewers.

APPENDIX C

GLOSSARY

[This glossary is provided as a reference for the numerous abbreviations and acronyms used to identify agencies, regulations, field studies, air quality models, analytical tools, units of measure, and specific terms used in the study of air quality. It is assumed that the reader has a basic knowledge of chemistry and mathematical techniques.]

3-D Three dimensional
4DDA Four dimensional data assimilation
AHC Anthropogenic hydrocarbons
AIRS Aerometric Information Retrieval System, maintained by the U.S. Environmental Protection Agency
AL Aeronomy Laboratory, U.S. National Oceanic and Atmospheric Administration
API American Petroleum Institute
AQMS Air Quality Modeling System
ARB Air Resources Board (California)
BEIS Biogenic Emissions Inventory System; BEIS2 denotes second version
CAA U.S. Clean Air Act (42 USC 7401-7677 et seq.)
CAQMS Community Air Quality Modeling System
CASTNET Clean Air Status and Trends Network
CCME Canadian Council of Ministers of the Environment
CEMS Continuous Emission Monitoring System
CEPA/FPAC Canadian Environmental Protection Agency, Federal/Provincial Advisory Committee
CH$_4$ Methane
C$_2$H$_4$ Ethene (ethylene)
CIT California Institute of Technology
CO Carbon monoxide
EKMA Empirical Kinetic Modeling Approach
EMFAC7 Mobile-source emission model used in California
EPA U.S. Environmental Protection Agency
EPRI (Formerly) Electric Power Research Institute
EPS Emissions Processor System
Eulerian A three-dimensional, grid-based, space-fixed reference system used as a basis for model formulation
FREDS Flexible Regional Emission Data System
FRM Federal Reference Method (United States)
GEMAP Geocoded Emissions Modeling and Projection System
GIS Geographical information system
GM General Motors
H$_2$O Water
H$_2$O$_2$ Hydrogen peroxide
HC Hydrocarbon
HNO$_3$ Nitric acid
HO (or OH)  Hydroxyl radical
HO₂  Hydroperoxyl radical
hv  Photon
IMECA  Indice Metropolitano de la Calidad del Aire (Mexican Metropolitan Air Quality Index)
IRPA  Integrated Process Rate Analysis
LEV  Low emission vehicle
M  Any atmospheric molecule that collisionally deactivates vibrationally excited reaction intermediates
MAPPER  Measurement-Based Analysis of Preferences in Planned Emissions Reduction
MARAMA  Mid Atlantic Regional Air Management Association
MC2  Compressible Community Model
MEPPS  Model 3 – Emissions Processing and Projection System
MIR  Maximum Incremental Reactivity
MM5  Mesoscale Meteorological Model version 5
MOBILE5  Mobile-source emission model used in North America except in California
MOR  Maximum Ozone Reactivity
MSA  Metropolitan Statistical Area
NAAQO  National Ambient Air Quality Objective (Canada)
NAAQS  National Ambient Air Quality Standard (United States)
NAPAP  U.S. National Acid Precipitation Assessment Program
NAPS  National Air Pollution Surveillance program of the Canadian Environmental Protection Agency
NARSTO  (Formerly) North American Research Strategy for Tropospheric Ozone
NHC  Naturally occurring hydrocarbons
NH₃  Ammonia
NH₄NO₃  Ammonium nitrate
NJ-DEP  New Jersey Department of Environmental Protection
NLEV  National low emission vehicle
NMHC  Non-methane hydrocarbons
N₂O₅  Nitrogen pentoxide
NOAA  U. S. National Oceanic and Atmospheric Administration
NO  Nitric oxide
NO₂  Nitrogen dioxide
NO₃  Nitrate radical
NO₃⁻  Nitrate ion
NOₓ  Nitric oxide (NO) + nitrogen dioxide (NO₂)
NOₓᵧ  Sum of all reactive, oxygen-containing nitrogen species: (NO + NO₂ + PAN + HNO₃ + NO₃ + N₂O₅ + NO₃⁻ + organic nitrates + .....
NOₓᵧ - NOₓ
NRC  U.S. National Research Council, a subset of the U.S. National Academy of Sciences
NY-DEC  New York State Department of Environmental Conservation
O₂  Oxygen
O₃  Ozone
OAQPS  U.S. EPA Office of Air Quality Planning and Standards
OBM  Observation-based model
OH  Hydroxyl radical
OPE  Ozone production efficiency
OSTP  U.S. President’s Office of Science and Technology Policy
OTA  U.S. Office of Technology Assessment

APPENDICES - 6
OTAG  Ozone Transport Assessment Group
PAMS  Photochemical Assessment Monitoring Stations
PAN   Peroxyacetyl nitrate
Pb    Lead
PBL   Planetary Boundary Layer
PM    Particulate matter
PM$_{2.5}$ PM equal to and less than 2.5 micrometers in aerodynamic diameter
ppb, ppm Parts per billion, parts per million
R     Any alkyl radical
$r^2$ Correlation coefficient squared
RAMS  Regional Atmospheric Modeling System
RH    Any hydrocarbon molecule
RIR   Relative Incremental Reactivity
RO    Alkoxyl radical
RO$_2$ Peroxy radical
RONO$_2$ Alkyl or organic nitrate
SCAQS Southern California Air Quality Study
SCION Southeastern Consortium Intermediate Oxidant Network
SENIOR Southeastern Network for Intensive Oxidant Research
SIP   State Implementation Plan
SMOKE Sparse Matrix Operator Kernel Emission processing code
SO$_2$ Sulfur dioxide
SON   Spatial Ozone Network
SOS   Southern Oxidant Study
THC   Total hydrocarbons
TLEV  Transitional low emission vehicle
Troposphere The layer of the atmosphere between 0 and 20 km in elevation
UAM   Urban Airshed Model; UAM-IV and UAM-V denote model versions
ULEV  Ultra low emission vehicle
UV    Ultraviolet
VKT   Vehicle kilometers traveled
VOC   Volatile organic compound
WGAQOG CEPA/FPAC Working Group on Air Quality Objectives and Guidelines
WMO   World Meteorological Organization