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WASHINGTON

April 25, 1988

MEMORANDUM FOR SENATOR BAKER
KEN DUBERSTEIN
MARLIN FITZWATER
TOM GRISCOM
ALAN KRANOWITZ ✓
COLIN POWELL

FROM: NANCY RISQUE

SUBJECT: EPA National Stream Survey -- HEADS UP

The Environmental Protection Agency has circulated a study on the acidification of streams for peer review by outside scientists. One of those scientists appears to have leaked the study to the Natural Resources Defense Council (NRDC.) EPA believes NRDC is planning a Tuesday press conference to talk about the report and Sen. Leahy also may be planning to make a statement.

The NRDC will try to use the report to argue that there is now concrete scientific evidence that emissions from U.S. industries are responsible for increased acid levels in rivers and streams in Canada and the northeastern United States. They say that 7.4% of upstream reaches of waterways in the middle Atlantic states are acidic and that this requires immediate action against acid rain.

EPA stresses two points in regard to the report:

- o The peer review process isn't complete. It is inappropriate to comment on something that hasn't received that review.
- o The report only discusses the condition of streams. This data cannot be used to establish a causal relationship between acid rain and how acid a stream is. Also, the data says nothing about trends or expected rates of change.

4/25/88

Sent to Chair 4/25

EPA NATIONAL STREAM SURVEY REPORT

Q. What is the National Stream Survey? Why hasn't it been released to the public?

A. The report completes the first phase of the National Surface Water Survey, a major project under the National Acid Precipitation Assessment Program. The document is being subjected to thorough scientific peer review, as well as technical review by affected states. It is on schedule to be released to the public in early June.

Q. What is the policy significance of the EPA National Stream Survey report that shows, e.g., 7.4% of the upstream reaches in the Middle Atlantic region are acidic? Does this report alter the Administration's view on the need for action to control acid rain?

A. The results of the National Stream Survey must be placed in context. As part of the acid rain research program being conducted by the federal government under the management of the National Acid Precipitation Assessment Program (NAPAP), EPA has been engaged in a National Surface Water Survey (NSWS). The first phase of this study was designed to determine the present chemical status of surface waters in regions of the United States containing the majority of streams and lakes considered to be at risk as a result of acid deposition. The Agency has already completed earlier studies in this phase of the NSWS: The Eastern and Western Lake Surveys. These surveys, along with the National Stream Survey, contribute to one of NAPAP's principal objectives: The quantification of the extent, location, and characteristics of sensitive and acidic streams and lakes in the United States.

From the time of the Report of the Joint Envoys in 1986, this Administration has recognized that acid rain is a serious environmental problem in this country. Since then, additional findings have shown some limited regional effects. The Eastern Lakes Survey established that various percentages of the lakes in the East were acidic depending on the subregion (e.g., 5% of the lakes in the Southern New England, the Catskills and Poconos regions were determined to be acidic, with 11% of the lakes in the Adirondacks acidic, i.e., ANC<0). This latest survey found similar percentages of stream segments in the Middle Atlantic region.

Q. Why shouldn't the United States take action now?

A. This Administration has pursued a consistent policy toward acid rain. That policy consists of four components.

First, we continue to aggressively implement the Clean Air Act. This effort has led to measurable improvement in air quality. During the past 10 years, ambient levels of sulfur dioxide in the United States have declined by 37%.

Second, we have undertaken a clean coal technology program to demonstrate improved technology for coal combustion. The federal government will spend $2.5 billion on this effort during the next five years.

Third, we are continuing major research into acid rain, in order to reduce the uncertainties over its causes and its effects, under a 10-year program mandated by Congress in 1980. This year, we will spend about $85 million on acid rain research.

Fourth, as we move forward with our research, technology, and regulatory programs, we are committed to on-going policy analysis to determine if additional control measures are necessary.

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Highlights from the National Stream Survey (NSS-I) Report

- The report provides quantitative regional and subregional estimates of the extent and characteristics of acidic and low ANC streams in areas of the Mid-Atlantic (MA) and Southeast (SE) United States. (See attached maps)

- Spring samples were drawn from about 500 stream reaches at upstream and downstream sampling points.

- 51% of the reaches in both the MA and the SE are estimated to have an Acid Neutralizing Capacity (ANC) less than 200 ueq/L. Many published works cite this as an ANC level below which waters are sensitive to acidification.

- In the MA, 7.4% of the reaches were acidic at their up-stream ends. In the MA, 3% of the reaches were acidic (ANC $\leq$ 0 ueq/L) at their down-stream ends. These figures do not include the estimated 1300 reaches in Pennsylvania and West Virginia that were acidic due to acid mine drainage.

- In the SE, excluding Florida, less than 1% of the reaches were acidic at either the upstream or downstream ends. This does not include an estimated 120 reaches that were acidic due to acid mine drainage.

- In Florida a more restricted statistical design was used. Consequently, data for Florida are not strictly comparable with those for MA and SE. However, Florida stands out as a geographic area with a relatively high percentage of acidic, low ANC and low pH streams.

- A subpopulation of acidic streams was examined. After elimination of streams whose acidity could be due to sources other than acid deposition one is left with a "high interest" group of acidic streams for which acid deposition cannot be excluded as the source of the acidity. This high interest group has an estimated total length of 4250 km and comprises 4% of the total length of all reaches surveyed. These high-interest reaches are concentrated in forested upland drainages and coastal areas of the MA region that experience high levels of acid deposition.

- Stream water sulfate was significantly higher in the MA than in the SE.

- A plot of median stream sulfate vs. rates of sulfate deposition shows a strong positive linear relationship.

4/25/88

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NATIONAL SURFACE WATER SURVEY

OVERVIEW-APRIL 1988

The National Surface Water Survey (NSWS) is being conducted by the U.S. Environmental Protection Agency to provide data on the present status of lakes and streams within regions of the United States believed to be potentially susceptible to change as a result of acidic deposition. The NSWS is a phased, systematic study designed to: (1) characterize the present chemistry of these surface waters and classify them for more intensive study, (2) describe chemical temporal variability and biological resources in subsets of surface waters, and (3) provide a foundation for documenting trends in surface water chemistry through long-term monitoring.

The NSWS is not designed to establish cause and effect relationships between surface water chemistry and acidic deposition. Rather, it provides an extensive data base of known quality and with sufficient confidence levels to allow correlative relationships between present levels of acidic deposition and water quality to be examined.

Phase I of the Eastern Lake Survey was conducted in fall of 1984. The results are presented in the three-volume report, Characteristics of Lakes in the Eastern United States (EPA/600/4-86/007A, B and C). Phase I of the Western Lake Survey was conducted in the fall of 1985. The results are presented in the two-volume report, Characteristics of Lakes in the Western United States (EPA/600/4-86/054A and B). A subset of Phase I lakes in the Northeast was sampled seasonally during the period from April 1986 to April 1987. The results of this study are currently being analyzed and are scheduled to be available in late 1988-early 1989. Plans for a second survey for fall 1988 and spring and fall 1989 on these same lakes are presently being formulated. Studies on the presence/absence of fish populations and their correlation with lake water chemistry were conducted in the Upper Peninsula of Michigan in 1986 and are scheduled to be reported in late 1988.

A component of the National Stream Survey was conducted on 61 streams in the Southern Blue Ridge Province during March-June 1985. The report on this study, National Surface Water Survey: National Stream Survey Phase I Pilot Survey (EPA/600/4-86/026), was published in December 1986. Streams in the mid-Atlantic and southeastern regions were sampled during the spring 1986. A final report is scheduled for spring of 1988.

A program designed to detect trends in surface water chemistry is currently in the planning stages. This long-term monitoring program is expected to include sites selected from both the NSWS lakes and streams and from existing long-term monitoring sites.

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NATIONAL STREAM SURVEY REPORT DESCRIPTION

This report, Chemical Characteristics of Streams in the Mid-Atlantic and Southeastern United States, consists of two volumes. Volume I, Population Descriptions and Physico-chemical Relationships, provides details about the design and implementation of Phase I of the National Stream Survey (NSS-I), discusses results, and presents conclusions based on these results. Volume II, Streams Sampled, Descriptive Statistics, and Compendium of Physical and Chemical Data, contains additional estimated characteristics of the populations of streams sampled within each area, descriptive statistics for these stream populations, and a data compendium of site characteristics and chemical measurements for each stream sampled.

The purpose of this report is to describe, within the context of the survey design, the chemical characteristics of streams in the Mid-Atlantic and Southeast, the sampling and analytical protocols, and the quality of the data obtained. These aspects of the NSS-I, described in detail in Sections 2, 3, and 4, must be understood before the population descriptions and classifications fulfilling the NSS-I original objectives (Sections 5-11) can be interpreted.

The NSS-I data cannot be used alone to establish a causal relationship between the present chemical status of streams and the occurrence of acidic deposition. The data can, however, be used to determine associations among variables. The report and its accompanying data base also can be used to refine our understanding of the response of streams to acidic deposition by allowing subpopulations of streams to be selected to test hypotheses regarding aquatic response to acidic deposition. In addition to describing status and extent relative to the original NSS-I objectives, this report provides a considerable amount of interpretation. The report classifies streams according to probable sources of acid anions. The relationships between stream chemistry and atmospheric deposition are examined to determine whether observed patterns and relationships support a hypothesis of surface water acidification due to acidic deposition.

This report does not make recommendations regarding deposition loadings, nor does it address questions regarding the effects that changes in acidic deposition might have on surface waters. Furthermore, this report does not address the issues of trends in surface water quality or the rates at which surface water quality might change in the future.

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NATIONAL STREAM SURVEY REPORT BACKGROUND

1. **Context** — Phase I of the National Stream Survey (NSS-I) was conducted in spring 1986 by the U.S. Environmental Protection Agency (EPA) as part of the National Surface Water Survey (NSWS). The first phase of the NSWS was designed to determine the present chemical status of surface waters in regions of the United States that contain the majority of lakes and streams that are considered to be at risk as a result of acidic deposition. As part of the National Acid Precipitation Assessment Program (NAPAP), the NSS-I contributes directly to one of NAPAP's principal objectives: quantification of the extent, location, and characteristics of sensitive and acidic lakes and streams in the United States.

2. **Objectives** — The objectives of the NSS-I in the Mid-Atlantic and Southeast were to: (1) determine the percentage, extent (e.g., number and length), location, and chemical characteristics of streams that are presently acidic, or that have low acid neutralizing capacity (ANC) and thus might become acidic in the future; and (2) identify streams representative of important classes in each region that might be selected for more intensive study or long-term monitoring.

3. **Selection of Subregions** — The NSS-I was conducted in four mid-Atlantic and five southeastern subregions of the United States, identified on the basis of similar physiographic characteristics. The four defined mid-Atlantic subregions were the Poconos/Catskills (1D), the Northern Appalachian Plateau (2Cn), the Valley and Ridge Province (2Bn), and the Mid-Atlantic Coastal Plain (3B). The five defined southeastern subregions were the Southern Blue Ridge (2As), the Piedmont (3A), the Southern Appalachians (2X), the Ozark and Ouachita Mountains (2D), and parts of the state of Florida (3C).

On the basis of geology, deposition rates, and previous water quality data, these subregions were expected to have a significant number of streams which have low acid neutralizing capacity (ANC) or are acidic (ANC ≤0). NSS-I efforts during 1986 were concentrated in areas that do not contain abundant lakes — areas for which we do not have synoptic information regarding surface water chemistry form the National Lake Survey. The Southern Blue Ridge subregion was sampled one year earlier (spring 1985) than the remainder of the NSS-I subregions. This NSS-I Pilot was undertaken to assess the logistic and scientific feasibility of the full-scale survey.

4. **Statistical Design** — The NSS-I defined stream reaches as segments of the stream network, as represented by blue-lines on the 1:250,000-scale maps. The segments were identified as the mapped blue-line segment between two tributary confluences. Sampling points on each of these reaches were just above the downstream point of confluence ("lower node") and just below the upstream point of confluence ("upper node"). The upper node of reaches represented as headwaters was defined as the furthest upstream extent of the mapped blue-line representation.

Because not all stream reaches in the Mid-Atlantic and Southeast could be sampled, a statistical procedure was developed for selecting a subset of streams as a probability sample from which the characteristics of the total reach population could be extrapolated. A two-stage sampling procedure was used to obtain a randomized, systematic sample of approximately 500 reaches with good spatial distribution over each of the nine NSS-I subregions (50 to 80 reaches per subregion). Reaches were excluded if

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they were too large (drainage area > 60 square miles or 155 square kilometers) or were located within metropolitan areas. The population of stream reaches of interest was further refined during the study to exclude those streams affected by tidal influence or substantial pollution, such as acid mine drainage.

5. **Sampling Season** -- The NSS-I used "index" values to describe the chemical status of each stream sampled. This index value was measured during the spring season between snowmelt and leafout (approximately March 15 to May 15). The choice of the spring index sampling period involved a trade-off between minimizing within-season and episodic chemical variability and maximizing the probability of sampling chemical conditions potentially limiting for aquatic organisms.

6. **Logistics** -- Two-member sampling teams accessed stream sites by foot and by means of two- or four-wheel drive vehicles. In the Mid-Atlantic region, over 1000 samples were collected from 270 stream reaches and in the Southeast, approximately 400 samples were collected from 200 stream reaches. Field crews also made some physical and chemical measurements streamside. Samples were sent to a processing laboratory before being shipped to an analytical laboratory for extensive chemical analyses.

7. **Quality Assurance and Quality Control** -- Extensive quality assurance and data management programs were implemented to ensure that all sample collection activities, analytical methods, and data reporting procedures were performed within the limits of pre-established criteria targeted to meet specifically designed data quality objectives.

8. **Report Organization** -- The NSS-I report, Chemical Characteristics of Streams in the Mid-Atlantic and Southeastern United States, consists of two volumes. Volume I, Population Descriptions and Physico-chemical Relationships, provides details about the design and implementation of the NSS-I, discusses results, and presents conclusions based on these results. Volume II, Streams Sampled, Descriptive Statistics, and Compendium of Physical and Chemical Data, contains additional estimated characteristics of the populations of streams sampled within each area, descriptive statistics for these stream populations, and a data compendium of site characteristics and chemical variables for each stream sampled.

9. **Presentation of Results** -- The purpose of this report is to document the design and methods of the NSS-I in the Mid-Atlantic and Southeast, to report the results of these studies, and to discuss the current interpretation of the results. Data presentation and discussion are made within the context of the survey design, the sampling and analytical protocols, and the quality of the data obtained. These aspects of the NSS-I, described in detail in Sections 2, 3, and 4, must be understood before drawing the conclusions based on the results as presented in Sections 5 through 11. For example, the NSS-I data cannot be used alone to establish a causal relationship between the present chemical status of streams and the occurrence of acidic deposition. The data base can be used, however, to refine our understanding of the characteristics that constitute stream sensitivity to acidic deposition by permitting subpopulations of streams to be selected for research designed to test hypotheses regarding aquatic response to acidic deposition.

To meet the primary objectives of the survey, the data from the NSS-I were used to examine the characteristics of streams in the Mid-Atlantic and Southeast, both within and among the nine subregions. Population estimates were calculated for the target population of streams with watershed areas ≤60 square miles (155 square kilometers).

Section 5 of the report describes the physical characteristics of the target population stream reaches, e.g., length, width, and elevation. The primary objectives of the survey are addressed in Section 6 which includes discussion on the regional extent of acidic and low ANC stream reaches and describes their chemical characteristics. Uncertainties in the population estimates due to temporal variability are discussed in Section 7. Section 8 discusses in more detail the chemical characteristics of the target population by examining through correlative analyses associations among variables. Section 9 classifies acidic and low ANC stream reaches according to probable sources of acid anions. Evidence for acidification because of either natural or anthropogenic sources is discussed in Section 10. Finally, Section 11 presents a summary of the major conclusions of the survey.

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FACT SHEET - pH AND SURFACE WATERS

Definitions and Perspective

pH is the most common way to express the acidity of water. Measurements of pH are represented by a scale ranging from 0 to 14. Water with a pH of 7.0 is neutral, i.e., neither acidic nor basic, while water with a pH below 7.0 is acidic on this scale. Many factors, however, can influence the pH of water in the natural environment. For example, the carbon dioxide in the atmosphere causes the pH of normal rain water to be about pH 5.6. Similarly, differences in minerals and chemicals dissolved in lake or stream water can cause the pH to range from 3.5 to 8.5.

Most aquatic organisms are sensitive to the pH of the water in which they live. Normally, organisms that live in water with a pH of 7.0 can survive even if the pH drops one unit or more. Some organisms, however, become stressed at about pH 6.0, and at pH much below 5.5 some organisms cannot survive. As a result, many researchers believe a pH of 5.5 is a critical value below which biological productivity in certain surface waters is impaired.

Implications

Research has shown that acidic deposition can decrease the pH of lakes and streams. Phase I of the National Stream Survey (NSS-I) has provided estimates of the current chemical status, including pH, of streams in regions of the eastern United States thought to be potentially susceptible to change from acidic deposition. This survey was conducted during spring when stream water pH is usually lowest relative to the rest of the year and sensitive life stages of fish are present. Thus, the survey data describe base flow conditions in streams when sensitive life stages may be exposed for long periods of time.

Limitations of Survey Results

Although the number of streams that had low pH at the time of sampling can be estimated from the data, these estimates should not be used to infer how many are, or will become, acidic <u>because of acidic deposition</u>. The population of streams estimated to have pH below 5.5 does not distinguish those that are naturally acidic from those that are acidic as a result of acidic deposition. While the data report for the NSS-I Mid-Atlantic and Southeastern Survey provides preliminary classification of streams according to probable sources of acidity, the authors appropriately emphasize that these survey data cannot be used to establish strict cause and effect relationships.

The NSS-I characterized chemistry using an index based on one or more measurements in the spring. Short of continuously monitoring the streams, however, there is no way presently to estimate how many streams may experience pH below the index value during other times of the year or during storms. Nor can the number of streams in which the pH is permanently less than 5.5 because of acidic deposition be estimated. The NSS-I and other projects are examining temporal variability in stream chemistry with the objective of modeling short-term changes in stream pH. Furthermore, even though pH is a valuable measure of stream water acidity, it is not possible to determine with a pH measurement alone which waters are naturally acidic or which are acidic because of acidic deposition.

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FACT SHEET - ACID NEUTRALIZING CAPACITY AND SURFACE WATERS

Definitions and Perspective

The acid neutralizing capacity (ANC) of a lake or stream is a measure of the water's ability to neutralize acids. It indicates the amount of acid that can be added to a sample of water without decreasing its pH below a preselected reference value. Lakes or streams to which small amounts of added acids result in large decreases in pH are said to be poorly buffered.

ANC is an important measurement because it is <u>one</u> <u>of</u> <u>many</u> chemical and physical characteristics of surface waters or their watersheds that determine the amount of acidic deposition (rain or snow) that can be assimilated by a lake or stream before it becomes acidic. Surface waters range in ANC from below zero, which means they are more acidic than the reference value, to thousands of microequivalents per liter (µeq/L) which means they are well protected from change due to acid inputs.

Researchers believe that surface waters with ANC above 200 µeq/L are not likely to become acidic given present levels of acidic deposition. When ANC is below 100 µeq/L, some waters might experience long-term acidification and others might change in pH enough to cause biological damage during storm and snowmelt events. ANC concentrations of 50 µeq/L are usually associated with a pH of about 6.0. In poorly buffered streams that have ANC of 50 µeq/L and in which the ANC is not being regenerated by biogeochemical processes within the stream or watershed, current levels of acidic deposition may cause the pH to fall to 5.5 or below. Biological effects have been observed at these pH levels. Under some conditions, pH levels between 5.5 and 6.0 also can be deleterious to certain fish species.

Implications

Although ANC can be used as a measure of the potential effects of acidic deposition, it is limited because streams with the same ANC can respond quite differently to acid loadings. Some streams may decrease in ANC and pH when acids are added, and others may not. The reason for this is that the measured ANC indicates only the neutralizing capacity of the stream water. Because a stream is an integral part of its watershed, however, acidification of a stream depends upon the neutralizing capacity of this entire watershed -- a capacity that varies from stream to stream and from region to region. Researchers now know that many factors control both ANC and the changes that could occur due to acidic deposition. The type and amount of soils, the vegetation, the rate at which water moves over land into the stream, and the occurrence of airborne alkaline dust, among other factors, all contribute to a stream's response to acidic deposition. Furthermore, ANC in some situations can be regenerated by biogeochemical processes as quickly as it is consumed by acid inputs. Therefore, even with constant acid loadings, ANC may remain relatively constant for many decades or centuries.

Limitations of Survey Results

The National Stream Survey has estimated the number of streams in several ANC classes of interest. These data alone, however, are not sufficient to prove that changes in ANC have occurred in the past or will occur in the future. Although interpretation of data from the National Stream Survey can be combined with that of other data to infer the factors <u>likely</u> to be controlling stream water chemistry, this information cannot be used to establish strict cause and effect relationships. Although ANC can be used as a selection criterion for identifying stream populations of principal interest for future studies, it should not be misconstrued to represent an accurate measure of a stream's sensitivity to change resulting from acidic deposition.

EXECUTIVE SUMMARY

Background

National Stream Survey - Phase I (NSS-I) field activities were conducted in the mid-Atlantic and southeastern United States in the spring of 1986 by the U.S. Environmental Protection Agency (EPA) as part of the National Surface Water Survey (NSWS). The first phase of the NSWS was designed to determine the present chemical status of surface waters in regions of the United States containing the majority of streams and lakes considered to be at risk as a result of acidic deposition. The NSS-I was conducted as part of the National Acid Precipitation Assessment Program (NAPAP). Like the previous EPA NSWS activities (Eastern and Western Lake Surveys), it contributes directly to one of NAPAP's principal objectives: the quantification of the extent, location, and characteristics of sensitive and acidic streams and lakes in the United States.

The NSS-I was conducted in four Mid-Atlantic and five Southeast subregions of the United States (Figure E-1), identified on the basis of similar physiographic characteristics:

- <u>Mid-Atlantic (MA) Region</u>
  - Interior Mid-Atlantic (IMA) Subregions
    - Poconos/Catskills (1D)
    - Northern Appalachians (2Cn)
    - Valley and Ridge Province (2Bn)
  - Mid-Atlantic Coastal Plain Subregion (3B) - Chesapeake area and New Jersey Pine Barrens
- <u>Southeastern (SE) Region</u>
  - Interior Southeast (ISE) Subregions
    - Southern Blue Ridge (2As) - Pilot Survey in 1985
    - Piedmont (3A)
    - Southern Appalachians (2X)
    - Ozarks/Ouachitas (2D)
  - Florida Subregion (3C)

These subregions of the United States were expected, on the basis of geology, deposition rates, and previous water quality data, to contain a significant number of streams that have low acid neutralizing capacity (ANC) or that are acidic (ANC ≤ 0). Furthermore, NSS-I efforts during 1986 were concentrated in areas where acidic deposition rates are relatively high, but where lakes are not abundant. We do not have synoptic information from the National Lake Survey (NLS) on surface water chemistry in these areas. A Pilot Survey was conducted in the Southern Blue Ridge subregion one year earlier than field activities in the remainder of the NSS-I subregions. This NSS-I Pilot Survey was designed to assess the logistic and scientific feasibility of the full-scale NSS-I Survey.

NSS-I field activities to date have not included areas of the Northeast, Upper Midwest, and West. Though these regions are expected to contain low ANC or acidic streams potentially

SUBREGIONS OF THE NATIONAL STREAM SURVEY - PHASE I

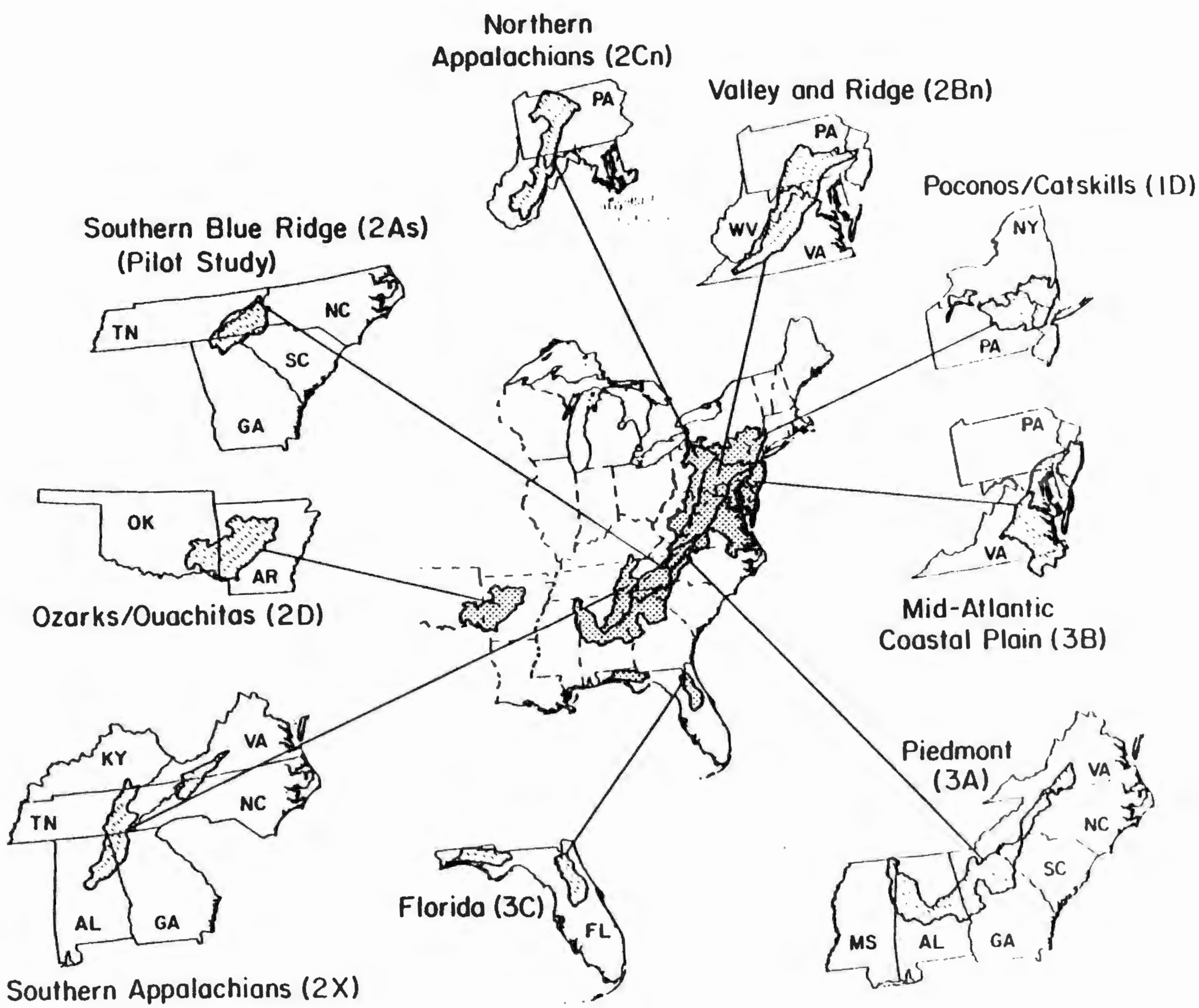

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Figure E-1. NSS-I regions and subregions.

sensitive to acidic deposition, they also contain numerous lakes that were sampled as part of EPA's Eastern and Western Lake Surveys. Furthermore, NSS-I field activities thus far have not included synoptic stream chemistry sampling in parts of the South Atlantic and Gulf Coastal Plains expected to contain predominantly low ANC surface waters--but where deposition rates are comparatively lower than in most of the Survey area, and where organic acidity is expected to play an important role. Field activities in the Florida subregion test the utility of NSS-I logistical and design protocols in lowland stream networks of the Southeast Coastal Plain.

Objectives

The objectives of the NSS-I in the Mid-Atlantic and Southeast were to:

- Determine the percentage, extent (number, length, and drainage area), location, and chemical characteristics of streams in the Mid-Atlantic and Southeast that are presently acidic, or that have low ANC and thus might become acidic in the future.
- Identify streams representative of important classes in each region that might be selected for more intensive study or long-term monitoring.

Methods

Within the NSS-I subregions, the stream resource of interest (the target resource) was identified as those streams that have drainage areas less than 155 square kilometers (60 square miles), but that are large enough to be represented as blue lines on 1:250,000-scale U.S. Geological Survey (USGS) topographic maps. Reviewers accepted this size range as a reasonable compromise that would include streams large enough to be important for fish habitat, yet still small enough to be susceptible to the impacts of acidic deposition.

Unlike lakes, which can be counted and sampled as discreet entities, streams form a hierarchical network in which small streams are tributaries to large streams. The NSS-I sampled stream reaches defined as segments of the stream network, as represented by blue lines on the 1:250,000-scale maps. These segments, or reaches, were identified as mapped blue-line segments between two tributary confluences. Sampling points on each of these reaches were just above the downstream point of confluence (lower node) and just below the upstream point of confluence (upper node). The upper node of a reach represented as a headwater was defined as the farthest upstream extent of the mapped blue line representation.

Because not all stream reaches in the mid-Atlantic and southeastern United States could be sampled, a statistical procedure was developed for selecting a subset of streams as a probability sample from which the characteristics of the total reach population could be extrapolated. A two-stage sampling procedure was used to obtain a randomized, systematic sample of approximately 500 reaches with good spatial distribution over each of the nine NSS-I subregions (50 to 80 reaches per subregion). Reaches were excluded if they were too large (drainage area > 155 km^2), were located within metropolitan areas or tidal zones, or were affected by oil field brine, acid mine drainage, or point-source pollution.

The NSS-I used index values to describe the chemical status of each stream sampled. This index value was measured during baseflow of the spring season between snowmelt and leafout (approximately March 15 to May 15). The choice of the spring index sampling period involved a trade-off between minimizing within-season and episodic chemical variability and maximizing the probability of sampling chemical conditions potentially limiting for aquatic organisms.

As a result of Pilot Survey experience, two spring season samples were judged sufficient to index chemical characteristics of streams in the Mid-Atlantic subregions. In the Southeast, where acidic deposition effects were expected to be less probable, one spring sample was taken at each site. To quantify and incorporate the variability between upstream and downstream ends of reaches, chemical and physical variables were measured at both ends.

Chemical variables measured at each sampling site included those related to biological effects (e.g., pH, extractable aluminum, and competing ligands such as fluoride and dissolved organic carbon), other variables related to potential sensitivity and related geochemistry (ANC, base cations, acid anions, and silica), and others indicative of anthropogenic disturbances or nutrient status (phosphorus, iron, ammonium, and turbidity). Samples were stabilized within 12 to 24 hours of collection and standardized quality control and quality assurance protocols were followed during sample handling, analyses, data reporting, data storage and analysis. Population frequency distributions (with 95% confidence bounds) were calculated for selected chemical and physical variables.

Selected Results

Overview

The basic results of the NSS-I are population descriptions of the location, number, length, and percentage of streams within referenced ranges of chemical concentration. The most important of these descriptions are those concerning ANC and pH. Further data interpretation includes an examination of regional patterns in the relationships among the chemical constituents within stream waters in an effort to infer the possible geochemical factors and anthropogenic impacts controlling stream chemistry. Lastly, we have examined a high-interest segment of the stream population with lowest ANC and have classified these streams according to probable sources of acidity.

Survey data such as that collected by the NSS-I cannot in itself be used to infer causal relationships (e.g., the effect of acidic deposition on stream chemistry). However, the lines of correlative evidence we present can be examined as to whether or not they support hypotheses concerning the true controls on streamwater chemistry.

Regional Chemical Characteristics

Target Population of Interest--

Physical and chemical characteristics of an estimated 57,000 stream reaches with a combined length of approximately 200,000 km (124,000 mi) were extrapolated from a probability sample of approximately 450 stream reaches in the stream population of interest within the nine NSS-I subregions. (An additional 54 reaches were visited in the field, but were found to have characteristics such as acid mine drainage or tidal effects that classified them as noninterest sites for this particular assessment.) The population of streams targeted by the NSS-I is best described as small to mid-sized streams in the low end of the size range typically managed by state fishery agencies. Stream reaches sampled by the NSS-I are typically about 3 km long. At their upstream ends, approximately half of these stream reaches are classified as headwater reaches on 1:24,000-scale topographic maps. At their downstream ends, most reaches (67%) are of Strahler Order 2 and 3. Median drainage areas at the upstream and downstream ends of the population of NSS-I target stream reaches are 1.5 km^2 and 8.1 km^2. Twenty percent of these

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reaches have drainage areas less than 0.18 km^2 at their upstream ends. For perspective, the majority of these streams have widths between 1 and 6 m and depths between 0.1 and 0.5 m.

Types of Population Descriptions--

All regional population descriptions of the NSS-I target population are based on spring baseflow index chemistry (see Methods). It is important to understand the limitations as well as the strengths of the chemical index approach. For example, the number of stream reaches that are acidic due to episodic pH depressions during storm runoff cannot be obtained or inferred directly from the distribution of index chemistry provided by the NSS-I. The number of streams experiencing acidic episodes may be much greater than the number estimated to be acidic during spring baseflow. Further studies of short-term and seasonal variability are expected to demonstrate a useful predictive relationship between index chemistry and chemistry during other times of the season or year.

We present two types of population descriptions expressing the distribution of the population of target streams over the range of ANC and pH. One type of description (Table E-1) is based on enumerating reaches with upstream and downstream chemistry in reference ranges. The population distribution estimates based on upstream and downstream sampling comprise two spring baseflow "snapshots" focusing at different positions within the streamflow network represented by blue lines on 1:250,000-scale topographic maps.

Separate distributions of chemistry at the upstream and downstream ends of target stream reaches provide a fairly complex picture of their status. It is perhaps of greater interest to combine upstream and downstream chemical measurements by interpolation along the length of reaches and to report the status of the stream resource in a second type of population estimate expressed in terms of the combined length of streams within reference categories of pH and ANC (Table E-2; Figures E-2 and E-3). We have focused our presentation on these length distributions because they may have more utility for fish habitat quality assessment. However, the tables in this Executive Summary show, separately, the upstream and downstream estimates discussed above.

Reference Values for ANC and pH--

Population proportions are reported within ranges of ANC and pH defined by reference values. ANC, a measure of the amount of acid that can be neutralized by a sample of water, is probably the most important variable measured in the NSS-I. The value of ANC = 0 is of significance because waters at or below this level have no capacity to neutralize acid inputs--they are acidic by definition.

The 50 $\mu eq\ L^{-1}$ ANC reference value forms the upper bound of a range of aquatic systems between 0 and 50 $\mu eq\ L^{-1}$ that may be considered to have very low ANC. Although there may be no special significance to the 50 $\mu eq\ L^{-1}$ level, some scientists term surface waters with ANC < 50 $\mu eq\ L^{-1}$ as "extremely acid sensitive" (Schindler, 1988). There is some evidence that streams and lakes with spring baseflow ANC (streams) or fall turnover ANC (lakes) below this level may be prone to acidic episodes during storm events or snowmelt. Low ANC is probably a necessary condition predisposing acidic episodes, although certainly not a sufficient one. Streams or lakes experiencing acidic episodes are also often subject to high atmospheric acid deposition rates, and may have watersheds that are more susceptible to episodic pH depressions due to their hydrology.

Table E-1. Population Estimates of the Percentage of NSS-I Target Stream Lower (L) and Upper (U) Reach Nodes with Spring Baseflow Index ANC and pH in Reference Ranges

	ANC Ranges ($\mu eq\ L^{-1}$)								Total (No. of Reaches)	
	≤ 0		> 0-50		> 50-200		> 200			
Region	L	U	L	U	L	U	L	U	L	U
Interior MA	1.3	5.4	7.3	15.1	32.0	28.7	59.4	50.9	25,715	24,945
MA Coastal Plain	6.8	11.8	12.7	18.3	21.4	25.6	59.0	44.2	11,287	11,284
Interior SE	*	0.7	5.8	6.8	40.6	44.1	53.6	48.4	18,720	18,686
Florida	14.5	39.2	43.0	30.8	23.7	7.6	18.8	22.4	1,555	1,727
Total NSS-I Area	2.3	6.1	8.9	13.5	32.5	32.5	56.3	47.9	57,277	56,642

	pH Ranges								Total (No. of Reaches)	
	≤ 5.0		> 5.0-5.5		> 5.5-6.0		> 6.0			
Region	L	U	L	U	L	U	L	U	L	U
Interior MA	1.1	3.9	0.8	4.6	3.2	6.9	94.9	84.6	25,715	24,945
MA Coastal Plain	6.8	11.8	6.4	11.7	8.5	25.8	78.3	50.7	11,287	11,284
Interior SE	*	*	*	1.9	2.7	6.7	97.3	91.4	18,720	18,686
Florida	14.5	31.2	9.4	18.7	38.0	21.9	38.1	28.2	1,555	1,727
Total NSS-I Area	2.2	5.0	1.9	5.5	5.0	11.1	90.9	78.4	57,277	56,642

*No samples observed in this range; estimated percentage is less than 1%.

MA = Mid-Atlantic
SE = Southeast

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Table E-2. Population Estimates of the Combined Length (km) and Percentage of NSS-I Target Stream Reaches with Spring Baseflow ANC (μeq L^{-1}) in Specified Ranges

Region	ANC Ranges (μeq L^{-1}) ≤ 0	> 0-50	> 50-200	> 200	Total Length (km)
Interior MA	2,322 (3.3)	5,102 (7.3)	23,787 (34.2)	38,294 (55.2)	69,505
MA Coastal Plain	2,527 (6.3)	7,108 (17.6)	11,453 (28.4)	19,202 (47.7	40,290
Interior SE	117 (0.1)	3,940 (4.5)	37,738 (43.5)	45,057 (51.9)	86,852
Florida	461 (12.0)	1,894 (49.2)	584 (15.2)	908 (23.6)	3,847
Total NSS-I Area	5427 (2.7)	18,044 (9.0)	73,562 (36.7)	103,461 (51.6)	200,494

Region	pH Ranges ≤ 5.0	> 5.0-5.5	> 5.5-6.0	> 6.0	Total Length (km)
Interior MA	2,229 (3.2)	2,480 (3.6)	3,799 (5.5)	60,997 (87.7)	69,505
MA Coastal Plain	3,147 (7.8)	6,417 (15.9)	9,141 (22.7)	21,585 (53.6)	40,290
Interior SE	* (*)	722 (0.8)	5,023 (5.8)	81,107 (93.4)	86,852
Florida	521 (13.6)	1,186 (30.8)	1,120 (29.1)	1,020 (26.5)	3,847
Total NSS-I Area	5,897 (2.9)	10,805 (5.4)	19,083 (9.5)	164,709 (82.2)	200,494

*No samples observed in this range; estimated percentage is less than 1%.

MA = Mid-Atlantic
SE = Southeast

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NSS-I INTERPOLATED LENGTH DISTRIBUTION - ANC

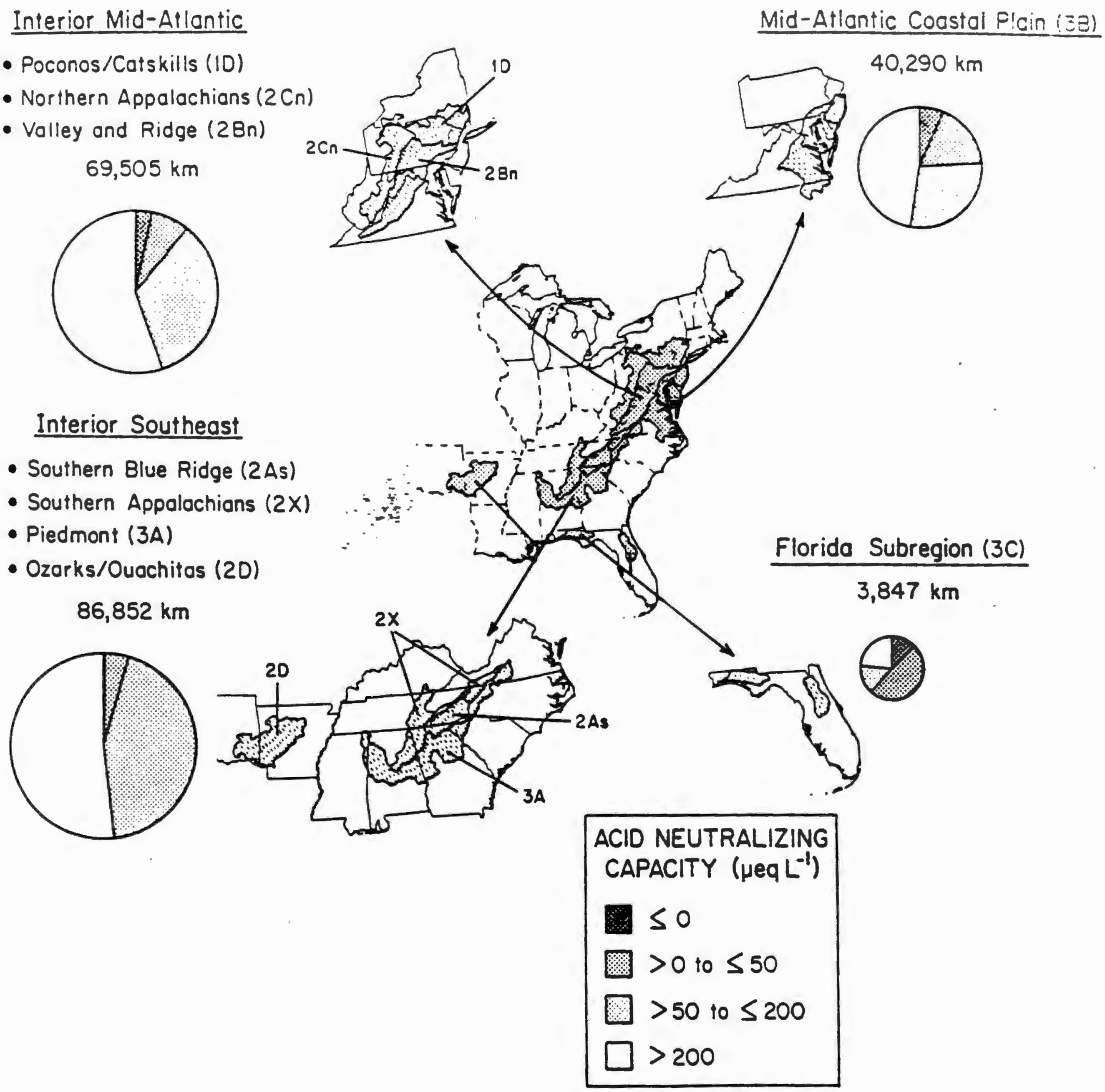

Figure E-2. Population estimates for ANC in eastern United States streams. Pie diagram area is proportional to the combined length of target streams in each region.

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NSS-I INTERPOLATED LENGTH DISTRIBUTION – pH

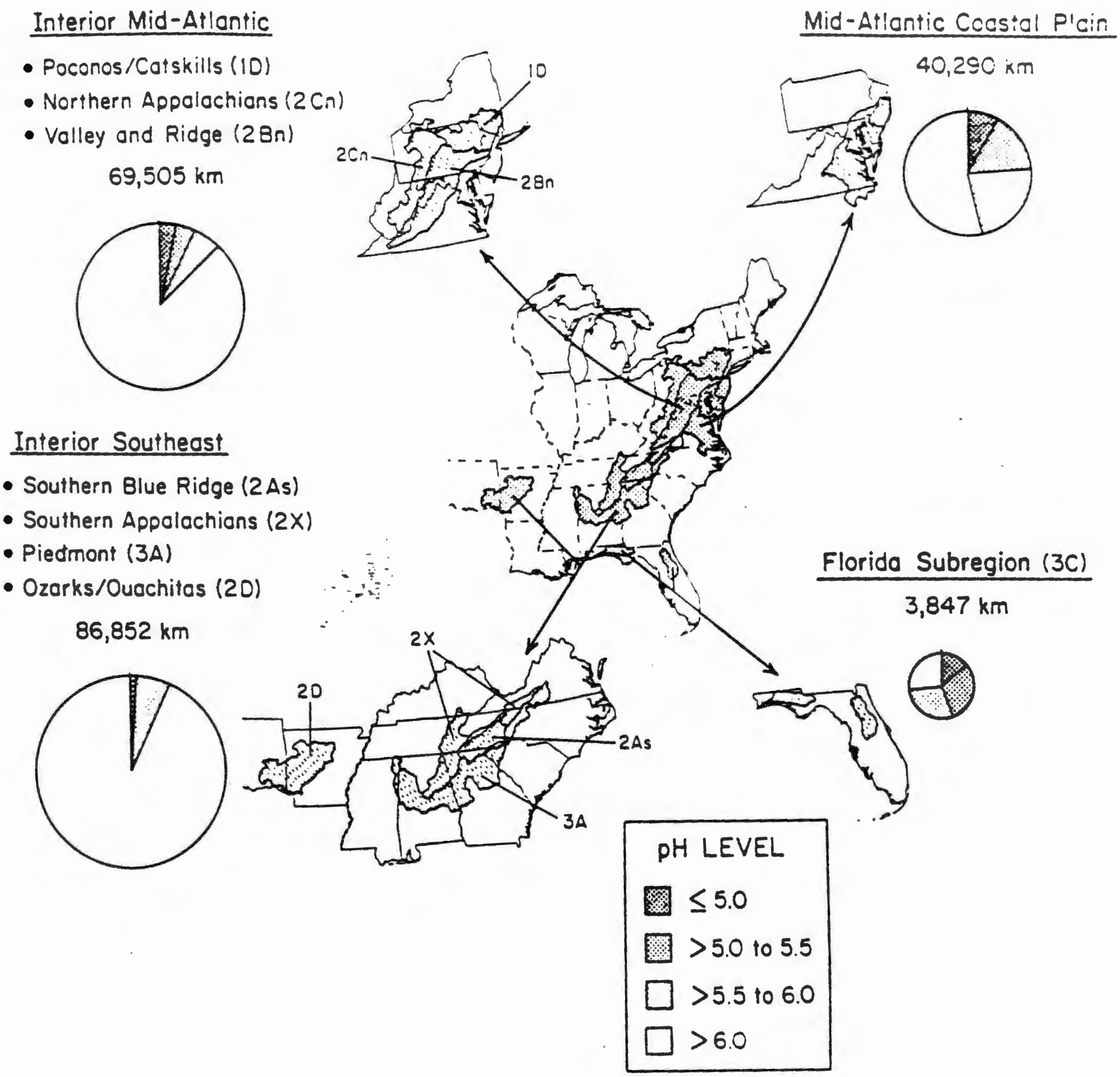

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Figure E-3. Population estimates for pH in eastern United States streams. Pie diagram area is proportional to the combined length of target streams in each region.

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The 200 μeq L^{-1} ANC reference value is of interest because it has been frequently cited in acid deposition literature as a value above which aquatic systems are unlikely to be sensitive to acidification. It should be kept in mind that sensitivity to acid deposition impacts is dependent on other factors besides the ANC of the stream water itself. A stream is an integral part of its watershed; as such, its sensitivity to acid deposition is dependent upon the ability of watershed geology, soils, and vegetation to neutralize incoming acidity.

The variable pH is an inverse measure (negative logarithm) of hydrogen ion concentration. A one-unit decrease in pH represents a ten-fold increase in hydrogen ion concentration. Whereas ANC is a measure of the capacity of a water sample to neutralize acids, pH is a measure of the strength of the acidity.

The pH reference values of 5.0, 5.5, and 6.0 are defined for convenience in comparing results with those of other studies (e.g., EPA's Eastern and Western Lake Surveys) that have reported results referencing these values. The pH reference values bear some relationship to critical values below which populations of different types of fish are not sustained in freshwater ecosystems. Because of the influence of pH on the solubility and chemical form of aluminum, it is difficult to separate the effects of low pH from those of aluminum toxicity. Interpretation of critical pH values are further confounded because of the effect of dissolved organic compounds and calcium in reducing the toxicity of aluminum. However, several researchers have reported that waters with pH chronically below 4.0 are virtually devoid of fish, and waters with pH chronically below 4.5 contain few fish species. Estimates for critical values below which salmonid fish populations (e.g., trout) are not sustained range from pH 4.7 to 5.5. Estimates for smallmouth bass and blueback herring are between 5.0 and 5.7. Except for effects reported on several species of dace, shiners, and minnows, pH levels above 6.0 have not been associated with adverse impacts on fisheries. However, recent research on blueback herring, striped bass, and yellow perch suggests that under certain conditions of aluminum concentration, pH between 6.0 and 6.5 can lead to increased egg and larval mortality.

Population Distribution Estimates for ANC--

The estimated number and percentage of upstream and downstream reach ends (nodes) within the four ranges of ANC are presented for reference in Table E-1. It is evident that acidic (ANC ≤ 0) reaches are concentrated in the Interior Mid-Atlantic, the Mid-Atlantic Coastal Plain, and Florida. It is also evident that the target population has generally lower ANC at the upstream reach ends, reflecting a commonly observed pattern of increasing buffering capacity in the downstream direction because of increased time in contact with watershed rock and soils, plus the presence of more landuse impacts and weatherable soils in lowland areas. To simplify discussion of the data, we will focus on the length distributions that combine upstream and downstream chemistry to yield estimates of the combined length of the stream resource within the ANC reference ranges (Table E-2 and Figure E-2). In Figure E-2, the size of each pie diagram is proportional to the total combined length of stream reaches in the target populations within each of the four regions. Population estimates for the Florida subregion are not strictly comparable with those from other subregions, because the Florida sample was drawn from a more restrictive target population focused only on the portion of this state with expected ANC less than 200 μeq L^{-1}, rather than 400 μeq L^{-1} (the criterion for all the other subregions). In addition, the total size of the target population in Florida may be underestimated because many reaches visted were dry or lacked flowing water at the time of sampling. Florida estimates are summarized separately from the other subregions in the following discussion.

Proportions of the target stream reach population with spring index ANC ≤ 200 μeq L^{-1} were similar in the Mid-Atlantic Region and the Interior Southeast Region. Note that the Interior Southeast Region excludes Florida, whereas the Mid-Atlantic Region combines the Interior Mid-Atlantic and the Mid-Atlantic Coastal Plain. Approximately half the combined reach length in the Mid-Atlantic and Interior Southeast regions had ANC ≤ 200 μeq L^{-1}.

Acidic (ANC ≤ 0) and very low ANC (0 to 50 μeq L^{-1}) baseflow conditions were observed primarily in the Mid-Atlantic Coastal Plain and the Interior Mid-Atlantic Region. Acidic reaches (ANC ≤ 0) made up 6%, or 2527 km, of the length of the target stream resource in the Mid-Atlantic Coastal Plain, and were observed mostly in the New Jersey Pine Barrens and on the Coastal Plain west of Chesapeake Bay. Approximately 3%, or 2,322 km, of the target stream length in the Interior Mid-Atlantic Region was acidic during spring baseflow, whereas acidic reaches were rare in the Interior Southeast Region (approximately 0.1% or 117 km). Acidic reaches in these interior subregions were observed largely in forested upland watersheds with drainage areas less than 20 km^2.

The estimates of acidic stream reaches in the previous paragraph do not include streams within the size range of the NSS-I target reaches that were acidic and receive acid mine drainage. We estimate 3,500 km in Pennsylvania and West Virginia, and 1,100 km in the Interior Southeastern subregions within this acid mine drainage category. Acidic streams impacted by acid mine drainage comprised approximately 10% of the total number of reaches within the target stream size range in the Northern Appalachian Plateau (subregion 2Cn).

Very low ANC reaches (ANC 0 - 50 μeq L^{-1}) make up a rather large fraction (17.6%, or 7,108 km) of the target stream resource in the MACP. In the IMA, 7.3% (5,102 km) of stream reaches were estimated within this very low ANC range. In the ISE, 4.5% (3,940 km) were within this range. However, stream reaches in the moderately low ANC range (50 - 200 μeq L^{-1}) were abundant in the Interior Southeast, where nearly 38,000 km (43.5%) were within this range. In the Mid-Atlantic, 23,787 km (34.2%) of the Interior, and 11,453 km (28.4%) of the Coastal Plain streams were within this low ANC range.

The Florida subregion stands out as a geographic area with a relatively high percentage of acidic and very low ANC streams. It is also an area where there are many highly colored streams with high concentrations of dissolved organic carbon (DOC) likely to be contributing to the observed acidity. An estimated 12% (461 km) of streams in the portion of Florida surveyed were acidic and nearly 50% (1,894 km) had ANC between 0 and 50 μeq L^{-1}. Whereas the acidic and very low ANC reaches in the Florida peninsula were typically high in DOC and strongly colored, many of those in the Florida panhandle were clear or slightly colored and had very low ionic strength, with very low sulfate, nitrate, and DOC concentrations.

Population Distribution Estimates for pH--

The estimated number and percentage of upstream and downstream reach ends (nodes) within the four ranges of pH are presented for reference in Table E-2. Population distribution estimates for pH mirrored those for ANC, which is not surprising in light of the relationship between ANC and hydrogen ion concentration. As observed for ANC below a reference value of 0 μeq L^{-1}, reaches with spring baseflow index pH less than 5.5 were concentrated largely in the Mid-Atlantic, the Interior Mid-Atlantic, and Florida. Again, the general downstream increase in buffering was reflected in the larger percentages of reaches with low pH at their upstream ends (compared with their downstream ends). To simplify discussion of this upstream and downstream pH data, we will focus in this Executive Summary on population estimates that use both upstream and downstream data to yield estimates of the combined length of target reaches within the several pH reference ranges (Table E-1 and Figure E-3). For reasons mentioned in the previous section, Florida estimates are discussed separately from the other subregions.

Reaches with pH of 5.5 or less (combining the two lowest pH categories) made up an estimated 24% (9,564 km) of the target stream length in the Mid-Atlantic Coastal Plain. These low pH reaches were observed primarily in the New Jersey Pine Barrens and on the Coastal Plain west of Chesapeake Bay. Potential sources of acidity in streams of this and other regions are discussed in the following sections of this Executive Summary. In the Interior Mid-Atlantic Region, an estimated 4,709 km (6.8%) of target reach length had pH $\leq$ 5.5. These low pH reaches were observed largely in upland forested watersheds with drainage areas less than 30 km^2. The combined reach length with pH $\leq$ 5.5 in the Interior Southeast was proportionately small, with an estimated 722 km (< 1%) of the target population in this category.

The greatest combined length of target reaches in the pH category between 5.5 and 6.0 was estimated in the Mid-Atlantic Coastal Plain (9,141 km or 22.7%). The Interior Mid-Atlantic and the Interior Southeast Regions had similar percentages of their length in this range (5.5% and 5.8%, respectively).

Reaches with spring baseflow index pH greater than 6.0 predominated in the Interior Mid-Atlantic (88% of combined length) and the Interior Southeast (93% of combined length). In contrast, reaches with pH greater than 6.0 made up a little more than half (54%) of the combined length of target streams in the Mid-Atlantic Coastal Plain.

The Florida subregion stands out as an area with a relatively high estimated percentage of its combined target reach length having spring baseflow index pH $\leq$ 5.5 (1707 km, or 44%). Another 1,120 km (29%) were estimated in the pH category between 5.5 and 6.0, leaving only 26.5% of the combined reach length in this subregion with pH greater than 6.0. Note the previous discussion regarding the comparability of Florida results with those in other regions. The potential sources of acidity in streams of Florida and the other areas surveyed by the NSS-I are discussed in later sections of this Executive Summary.

Population Distribution Estimates for Sulfate--

Sulfate is an important chemical constituent for study in stream water because it is often associated with hydrogen ion as sulfuric acid in streams acidified by mine drainage and atmospheric deposition. Stream reaches within NSS-I subregions of the Mid-Atlantic Region had substantially higher spring baseflow index sulfate concentrations than did those in the Southeast. Subregion median stream water sulfate concentrations ranged from 125 to 238 $\mu eq\ L^{-1}$ in the four Mid-Atlantic subregions, whereas those of the five subregions in the southeastern United States ranged from 10 to 71 $\mu eq\ L^{-1}$. The potential sources of sulfate in stream water include wet and dry atmospheric deposition (natural and anthropogenic sources), nonatmospheric anthropogenic sources (e.g., agriculture), and the weathering of naturally occuring sulfur-bearing minerals (which can be accelerated by mining activities). The potential role of sulfate from several sources is discussed in the following paragraphs as it pertains to the observed pH and ANC in stream reaches of the NSS-I target population.

Chemical Relationships

Regional variation in ANC among streams within NSS-I subregions was associated more closely with differences in base cation concentrations than differences in concentration of mineral acid or organic acid anions. This result suggests that watershed geochemical and hydrologic characteristics controlling the supply of mineral weathering products are very important in determining the regional patterns in streamwater ANC and therefore buffering of acid inputs.

The only direct way to conclusively demonstrate surface water acification is through historic data on water quality. Because of a lack of such data on a regional scale for the streams of interest in the NSS-I, a second approach for assessing whether streams in the Mid-Atlantic and Southeast have been acidified involves an indirect method of inferring past changes in ANC through an examination of present water chemistry. Previous researchers have used the ANC deficit (nonmarine base cation concentration minus ANC) as a rough measure of surface water acidification resulting from either natural or anthropogenic causes. It is important to recognize that ANC deficits, in themselves, reflect simply a presence of strong acid anions in water at the time of sampling. It is the presence of these strong acid anions (which impart no acid neutralizing capacity) and their association with base cations or hydrogen ion, that allows the base cation sum to exceed the ANC.

ANC deficits can be observed in stream water for a number of reasons: (1) they may reflect a reduction in ANC caused by the addition of a strong acid (like sulfuric acid) to the stream, as might occur with acid deposition onto a poorly buffered watershed; (2) they may reflect an increase in base cation concentration (with no change in ANC) in the stream resulting from the accelerated weathering of watershed soils and rock (this can be due to acidic deposition); (3) they may result from an addition of base cations in neutral salts (e.g. $CaSO4$), with no change in ANC; or finally (4) they may result from a combination of all these mechanisms. The last combination of factors is the most likely for a heterogeneous assemblage of streams subject to a wide range of influences.

In order to interpret a portion of the observed ANC deficit as a measure of the amount of historic change in ANC, one must first assume that the ANC deficits are due largely to titration by strong acids and that the base cation concentration in streams has remained constant over time. If these assumptions are correct (they are more likely in poorly buffered waters of low ionic strength), several conditions must also be met before the ANC deficit in a given stream could be interpreted as a measure: (1) an atmospheric source of strong acids can be demonstrated to be of sufficient magnitude to cause the observed ANC change, (2) other potential sources of strong acid anions can be quantified or ruled out as unlikely (e.g., sulfide weathering, organic acidity), and (3) concentrations of acids not derived from atmospheric deposition (e.g., organics from watershed sources) have remained relatively constant over time.

All NSS-I subregions had streams with an ANC deficit. The largest ANC deficits observed in stress of the four mid-Atlantic subregions (Poconos/Catskills, Northern Appalachians, Valley and Ridge, and Mid-Atlantic Coastal Plain). The observation of smaller ANC deficits in streams of most Southeast subregions, compared with those of the Mid-Atlantic, is generally consistent with the lower atmospheric acid deposition rates and greater sulfate adsorption capacities of soils in the southeastern United States. Sulfate was the dominant strong acid anion in most acidic and low ANC streams and was observed to be in sufficient concentration to account for the observed ANC deficits in the majority of stream reaches in all subregions except Florida and the Mid-Atlantic Coastal Plain.

The distribution of sulfate concentrations in streams of the eastern United States not affected by large terrestrial sulfate sources corresponds well with sulfate deposition rates. A plot of population median stream sulfate concentrations versus rates of sulfate deposition in the nine NSS-I subregions shows a strong positive linear relationship. When compared with data from the NLS, however, it is apparent that a group of southeastern streams and lakes have lower sulfate concentrations than expected, given the sulfate deposition rates in their respective

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subregions. These observations are consistent with other research showing substantial sulfate retention in watersheds of some parts of the Southeast.

Sources of Acidity in Acidic and Low ANC streams

Potential sources of acidity were examined for the subpopulation of acidic and low ANC ($\leq$ 200 μeq L^{-1}) streams within the NSS-I target population. Stream reaches affected by acid mine drainage and organic acids were identified by site visits and examination of stream chemical data. After elimination of categories of streams for which sources of acid anions other than acid deposition largely mask the potential effects of acid deposition, a high-interest group of streams remained. Acid deposition cannot be ruled out as a major source of acidity in these streams.

Based on interpolations between upper and lower node chemistry, acidic reaches within the high-interest subpopulation had an estimated combined length of 4,455 km. Most of these reaches (3,243 km) were observed in the Mid-Atlantic subregions, where they comprised 4% of the total length of target stream reaches. Somewhat less than one-third (1,212 km) of these high-interest acidic reaches had chemistry influenced but not dominated by organic anions. Most of these organic-influenced reaches are located in the New Jersey Pine Barrens and in the low-gradient headwaters of reaches in the Glaciated Plateau of Pennsylvania and New York. Estimates based upon the first NSS-I sample visit alone (rather than the average of the two spring visits) were slightly higher than 4,455 km because of a seasonal trend of increasing spring baseflow ANC. Based on the earlier spring sample, a combined length of 7,481 km of acidic stream reaches were within the high-interest subpopulation of streams for which acid deposition impacts cannot be ruled out. Again, most of these reaches were observed in the Mid-Atlantic subregions, where they comprised 6.6% of the total length of the target stream resource. These reaches are located primarily in the forested upland drainages and coastal areas of the Mid-Atlantic Region that experience high rates of atmospheric sulfate deposition. Specifically, most reaches within the high-interest group of acidic streams are located:

- In upland forested drainages of the Allegheny Plateau, in the ridges of the Valley and Ridge physiographic province, and in the Glaciated Plateau and Forested Plateau (included in NSS-I subregions 1D, 2Bn, and 2Cn). An estimated 695 (9.7%) of 7190 reaches on ridges of the Valley and Ridge geographic area and 499 (11%) of 4548 reaches in forested drainages of the Allegheny Plateau were acidic at their upstream nodes.

- In the Pine Barrens of New Jersey (within the Mid-Atlantic Coastal Plain, subregion 3B). Seventy-nine percent of upstream nodes and 93% of downstream nodes were in this high-interest subgroup; approximately one-third of these had chemistry influenced but not dominated by organic anions.

Historic data suggests that streams in the Pine Barrens may have been naturally acidic at least since the early 1900's. There is no reason, however, to believe that most of the upland forested reaches have always been acidic.

Identified within the NSS-I target population was a group of non-acidic stream reaches with very low ANC (> 0 - $\leq$ 50 μeq L^{-1}) for which the predominant sulfate source appears to be acid deposition. Based on interpolation between upper and lower node chemistry, an estimated 15,590 km of target reach length is within this group. Approximately two-thirds of these reaches were observed in the Mid-Atlantic subregions, where they made up approximately 9.6% of the combined length of the target population. Calculations of these totals based on the earlier spring sample did not differ from those based on the average from two spring visits. These very low ANC streams are located primarily on upland, forested sites of the Allegheny Plateau, Valley and Ridge Province, Blue Ridge Mountains, and Cumberland Plateau. In addition, a large number of these reaches were found in Coastal Plain areas--Eastern and Western Mid-Atlantic Coastal Plain, New Jersey Pine Barrens, and East and West Gulf Coastal Plain.

Clean Air

The Administration has taken several decisive steps to further the agreements reached with Canada on acid rain in previous summits.

- The President has requested the full $2.5 billion in advance appropriations for the Innovative Control Technology development program he announced last March. The Congress has responded by appropriating $975 million for the retrofit/repowering solicitation recently issued by the Department of Energy. Further appropriations will be considered in upcoming Congressional budgets.

- The President has accepted the regulatory reform recommendations of his Task Force on Regulatory Relief and federal agencies are now proceeding to complete the development of the regultory reform package. This signals a renewed determination to build the partnership between the government and private sector that is needed to bring new technologies to the marketplace where they can fill both energy and environmental needs.

- The Administration continues to believe that the need for additional controls on US powerplants is not justified. The Clean Air Act has been a powerful tool to reduce sulfur emissions and it remains the main weapon that the US will use in addressing existing and any future air quality issues.

- The ICT program, when carried out with the policy articulated by the President and the Congress, is the most cost-effective method to meet both our energy and environmental needs.

ISSUE SUMMARY

EDISON ELECTRIC INSTITUTE The association of electric companies
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U.S. CLEAN AIR AND ACID RAIN POLICIES

- **The Clean Air Act is working.** The United States is a world leader in air pollution control. According to the Environmental Protection Agency, since the peak year of 1973, U.S. sulfur dioxide emissions have come down 27 percent. Electric utility emissions have been reduced 18 percent despite a 76 percent increase in utility coal use. From 1975 to 1986, the average sulfur content of coal purchased and burned by the electric utility industry has decreased by 37 percent. The U.S. electric utility industry operates 146 scrubbers and 44 additional units are planned or under construction. Neither Canada nor Mexico has any scrubbers in operation or under construction.

- **The United States has made and will continue to make a significant investment to improve air quality.** According to the Department of Commerce Bureau of Economic Analysis, the overall price tag for all air pollution control in the United States now exceeds $29 billion each year. The Department of Energy reports that U.S. coal-burning electric utilities alone have committed more than $60 billion during the last decade to reduce sulfur dioxide.

- **There is no environmental crisis from acid rain.** The National Acid Precipitation Assessment Program Interim Assessment concludes that rain acidity at current levels does not threaten the environment, that current emission control programs effectively protect human health, and that acid rain will not cause irreparable harm to the environment in the foreseeable future. Almost 1,000 reputable scientists from 40 universities in the United States, Canada, and England; 12 national agencies; 4 national laboratories; 11 state research agencies; and 18 private research institutions are involved in research for this interagency program.

- **Acid rain legislation compliance costs would be extremely expensive.** The Congressional Budget Office estimates that Title II of S. 1894 would cost the electric utility industry $6.2 billion annually. The Congressional Research Service estimates that the cost could be as high as $8 billion annually.

- **Acid rain legislation would have a negative ripple effect on our economy.** A Business Roundtable analysis of S. 1894 shows that the proposed amendments to the Clean Air Act would increase pollution control expenditures by at least $32 billion a year and would, at a minimum, jeopardize 300,000 to 600,000 U.S. jobs. Resulting total national environmental costs would exceed $100 billion annually. This bill would be the most expensive environmental legislation ever adopted and the least cost effective.

- **The existing national ambient air quality standards for sulfur dioxide protect public health and welfare with an adequate margin of safety.** The U.S. Environmental Protection Agency must periodically review the ambient air quality standards and revise them as appropriate. EPA, based on its scientific review, recently announced that the current standards are indeed adequate and no revision is required.

- more -

- **If coal is to continue to have a major role in electricity generation, the United States must go forward with its commitment to develop innovative clean coal technologies.** Clean coal technologies offer the opportunity to continue reliance on domestic coal for electricity generation without job dislocation, economic disruption and higher electricity rates. Many will control nitrogen oxide as well as sulfur dioxide emissions. They will enable continued reductions in emissions. Electric utilities will turn to these technologies, especially in the late 1990s, when replacing aging plants and building new capacity. A costly acid rain bill at this time would perpetuate reliance on current, inefficient technology by diverting billions of dollars away from the development of new technologies.

# # #

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April 21, 1988

TO: **EDITORS AND WRITERS**

FROM: **Susan K. Roth, Public Information**
(202)778-6659

SUBJECT: **U.S. CLEAN AIR AND ACID RAIN POLICIES**

In the weeks and months ahead, you may be writing about U.S. clean air and acid rain policies. At that time you may wish to consider the following information:

- **The Clean Air Act is working.** The United States is a world leader in air pollution control. According to the Environmental Protection Agency, since the peak year of 1973, U.S. sulfur dioxide emissions have come down 27 percent. Electric utility emissions have been reduced 18 percent despite a 76 percent increase in utility coal use. From 1975 to 1986, the average sulfur content of coal purchased and burned by the electric utility industry has decreased by 37 percent. The U.S. electric utility industry operates 146 scrubbers and 44 additional units are planned or under construction. Neither Canada nor Mexico has any scrubbers in operation or under construction.

- **The United States has made and will continue to make a significant investment to improve air quality.** According to the Department of Commerce Bureau of Economic Analysis, the overall price tag for all air pollution control in the United States now exceeds $29 billion each year. The Department of Energy reports that U.S. coal-burning electric utilities alone have committed more than $60 billion during the last decade to reduce sulfur dioxide.

- **There is no environmental crisis from acid rain.** The National Acid Precipitation Assessment Program Interim Assessment concludes that rain acidity at current levels does not threaten the environment, that current emission control programs effectively protect human health, and that acid rain will not cause irreparable harm to the environment in the foreseeable future. Almost 1,000 reputable scientists from 40 universities in the United States, Canada, and England; 12 national agencies; 4 national laboratories; 11 state research agencies; and 18 private research institutions are involved in research for this interagency program.

- more -

- **Acid rain legislation compliance costs would be extremely expensive.** The Congressional Budget Office estimates that Title II of S. 1894 would cost the electric utility industry $6.2 billion annually. The Congressional Research Service estimates that the cost could be as high as $8 billion annually.

- **Acid rain legislation would have a negative ripple effect on our economy.** A Business Roundtable analysis of S. 1894 shows that the proposed amendments to the Clean Air Act would increase pollution control expenditures by at least $32 billion a year and would, at a minimum, jeopardize 300,000 to 600,000 U.S. jobs. Resulting total national environmental costs would exceed $100 billion annually. This bill would be the most expensive environmental legislation ever adopted and the least cost effective.

- **The existing national ambient air quality standards for sulfur dioxide protect public health and welfare with an adequate margin of safety.** The U.S. Environmental Protection Agency must periodically review the ambient air quality standards and revise them as appropriate. EPA, based on its scientific review, recently announced that the current standards are indeed adequate and no revision is required.

- **If coal is to continue to have a major role in electricity generation, the United States must go forward with its commitment to develop innovative clean coal technologies.** Clean coal technologies offer the opportunity to continue reliance on domestic coal for electricity generation without job dislocation, economic disruption and higher electricity rates. Many will control nitrogen oxide as well as sulfur dioxide emissions. They will enable continued reductions in emissions. Electric utilities will turn to these technologies, especially in the late 1990s, when replacing aging plants and building new capacity. A costly acid rain bill at this time would perpetuate reliance on current, inefficient technology by diverting billions of dollars away from the development of new technologies.

# # #

The Edison Electric Institute is the association of investor-owned electric utilities. Its members generate and distribute approximately three-fourths of the nation's electricity.

NEWS
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HOLD FOR A.M. RELEASE
April 25, 1988

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UNITED STATES CONTROLS SULFUR DIOXIDE EMISSIONS WITH 146 STACK GAS SCRUBBERS, ACCORDING TO EEI SURVEY

WASHINGTON (APRIL 25) -- The United States operates more power plant stack gas "scrubbers" than any other country in the world, according to a survey released by the Edison Electric Institute. Stack gas scrubbers, also known as flue gas desulfurization systems, control sulfur dioxide emissions at coal-fired power plants.

According to the report, "Location of Power Plant Scrubbers in North America," the United States operates 146 scrubbers, representing 64,327 megawatts of generating capacity, and 44 additional units are planned or under construction. Neither Canada nor Mexico has any scrubbers in operation or under construction.

"The United States can be proud of its record in achieving emission reductions," said John J. Kearney, EEI Senior Vice President - Energy and Environment. "The electric utility industry remains committed to achieving clean air through compliance with the existing Clean Air Act. In addition to operating 146 scrubbers, many power plants use a variety of other approaches to meet emission standards, such as the use of low-sulfur fuels, coal washing and coal blending. In the last 10 years, the average sulfur content of coal used by utilities has decreased by 37 percent," he said.

According to the U.S. Environmental Protection Agency, from the peak year of 1973 to 1986, total SO_2 emissions dropped 27 percent. Electric power plant SO_2 emissions were down 18 percent during the same period while utility coal use soared by 76 percent.

- more -

Compliance with the Clean Air Act has been expensive. According to the Department of Commerce Bureau of Economic Analysis, the overall price tag for all air pollution control in the United States now exceeds $29 billion each year. EPA reports that the electric utility industry alone spends about $10 billion annually. All pollution controls account for more than one-third of a new coal-fired power plant's cost. A single "scrubber" may cost $100 million or more, and capital costs for adding scrubbers on older plants could equal or exceed the original plant investment.

"The electric utility will continue to bring down emissions with additional scrubbers and the development of clean coal technologies. These advanced technologies bring the promise of sulfur dioxide as well as nitrogen oxide control. They will provide an efficient and effective way to control emissions without job dislocation, economic disruption and higher electricity costs associated with proposed acid rain legislation. They will help our nation meet its energy and environmental goals," Kearney said.

The Edison Electric Institute is the association of investor-owned electric utilities. Its members generate and distribute approximately three-fourths of the nation's electricity.

# # #

January 1988

UTILITY FGD SYSTEMS

Operational

Company	Unit	State	Capacity MW	Year in Service
Alabama Electric Coop.	Tombigbee 2	AL	255	1978
Alabama Electric Coop.	Tombigbee 3	AL	255	1979
Alamito Co.	Springerville 1	AZ	425	1985
Arizona Electric Power Coop.	Apache 2	AZ	194	1978
Arizona Electric Power Coop.	Apache 3	AZ	194	1979
Arizona Public Service Co.	Cholla 1	AZ	116	1962*
Arizona Public Service Co.	Cholla 2	AZ	235	1978
Arizona Public Service Co.	Cholla 4	AZ	350	1981
Arizona Public Service Co.	Four Corners 1	NM	190	1963*
Arizona Public Service Co.	Four Corners 2	NM	191	1963*
Arizona Public Service Co.	Four Corners 3	NM	253	1964*
Arizona Public Service Co.	Four Corners 4	NM	818	1969*
Arizona Public Service Co.	Four Corners 5	NM	818	1970*
Associated Electric Coop.	Thomas Hill 3	MO	730	1982
Basin Electric Power Coop.	Antelope Valley 1	ND	455	1984
Basin Electric Power Coop.	Antelope Valley 2	ND	455	1986
Basin Electric Power Coop.	Laramie River 1	WY	570	1980
Basin Electric Power Coop.	Laramie River 2	WY	570	1981
Basin Electric Power Coop.	Laramie River 3	WY	570	1982
Big Rivers Electric Corp.	DB Wilson 1	KY	440	1986
Big Rivers Electric Corp.	Green 1	KY	242	1980
Big Rivers Electric Corp.	Green 2	KY	240	1981
Central Illinois Public Service Co.	Newton 1	IL	590	1977
Central Illinois Light Co.	Duck Creek 1	IL	396	1976
Central Louisiana Electric Co.	Dolet Hills 1	LA	720	1986
Cincinnati Gas & Electric Co.	East Bend 2	KY	648	1981
Colorado-Ute Electric Assn.	Craig 1	CO	446	1980
Colorado-Ute Electric Assn.	Craig 2	CO	446	1979
Colorado-Ute Electric Assn.	Craig 3	CO	446	1984
Columbus & Southern Ohio Electric Co.	Conesville 5	OH	375	1976
Columbus & Southern Ohio Electric Co.	Conesville 6	OH	375	1978
Cooperative Power Assn.	Coal Creek 1	ND	550	1980
Cooperative Power Assn.	Coal Creek 2	ND	550	1981

* Retrofits

UTILITY FGD SYSTEMS

Operational

Company	Unit	State	Capacity MW	Year in Service
Delmarva Power & Light Co.	Delaware City 1	DE	28	1956*
Delmarva Power & Light Co.	Delaware City 2	DE	28	1956*
Delmarva Power & Light Co.	Delaware City 3	DE	75	1961*
Deseret Gen. & Trans Coop.	Bonanza 1	UT	440	1986
Duquesne Light Co.	Elrama 1-4	PA	510	1952*
Duquesne Light Co.	FR Phillips 1-4	PA	411	1960*
East Kentucky Power Corp.	HL Spurlock 2	KY	508	1981
Grand Haven Board Light & Power	JB Sims 3	MI	81	1983
Grand River Dam Authority	GRDA 2	OK	575	1986
Hoosier Energy REC	Merom 1	IN	490	1983
Hoosier Energy REC	Merom 2	IN	490	1982
Houston Lighting & Power Co.	WA Parish 8	TX	605	1982
Houston Lighting & Power Co.	Limestone 1	TX	750	1985
Houston Lighting & Power Co.	Limestone 2	TX	750	1986
Indianapolis Power & Light Co.	Petersburg 3	IN	530	1977
Indianapolis Power & Light Co.	Petersburg 4	IN	526	1986
Jacksonville Electric Auth.	St. Johns River 1	FL	612	1987
Kansas City Power & Light Co.	La Cygne 1	KS	755	1973
Kansas Power & Light Co.	Jeffrey 1	KS	720	1978
Kansas Power & Light Co.	Jeffrey 2	KS	720	1980
Kansas Power & Light Co.	Jeffrey 3	KS	720	1983
Kansas Power & Light Co.	Lawrence 4	KS	114	1960*
Kansas Power & Light Co.	Lawrence 5	KS	403	1971
Kentucky Utilities Co.	Green River 1&2	KY	60	1950*
Lakeland Light & Water Dept.	McIntosh 3	FL	364	1982
Los Angeles Dept. of Water & Power	Intermountain 1	UT	820	1986
Los Angeles Dept. of Water & Power	Intermountain 2	UT	820	1987
Louisville Gas & Electric Co.	Cane Run 4	KY	155	1962*
Louisville Gas & Electric Co.	Cane Run 5	KY	167	1966*
Louisville Gas & Electric Co.	Cane Run 6	KY	239	1969*
Louisville Gas & Electric Co.	Mill Creek 1	KY	293	1972*
Louisville Gas & Electric Co.	Mill Creek 2	KY	306	1974*
Louisville Gas & Electric Co.	Mill Creek 3	KY	391	1978
Louisville Gas & Electric Co.	Mill Creek 4	KY	465	1982
Marquette Board Light & Power	Shiras 3	MI	44	1983

UTILITY FGD SYSTEMS

Operational

Company	Unit	State	Capacity MW	Year in Service
Michigan South Central Power Agency	JR Endicott 1	MI	55	1982
Minnesota Power & Light	Clay Boswell 4	MN	554	1980
Minnkota Power Coop.	MR Young 2	ND	440	1977
Monongahela Power Co.	Pleasants 1	WV	684	1979
Monongahela Power Co.	Pleasants 2	WV	684	1980
Montana-Dakota Utilities	Coyote 1	ND	456	1981
Montana Power Co.	Colstrip 1	MT	358	1975
Montana Power Co.	Colstrip 2	MT	358	1976
Montana Power Co.	Colstrip 3	MT	778	1984
Montana Power Co.	Colstrip 4	MT	778	1986
Muscatine Power & Water	Muscatine 9	IA	171	1983
New York State Electric & Gas Corp.	Somerset 1	NY	643	1984
Nevada Power Co.	Reid Gardner 1	NV	122	1965*
Nevada Power Co.	Reid Gardner 2	NV	122	1968*
Nevada Power Co.	Reid Gardner 3	NV	122	1976
Nevada Power Co.	Reid Gardner 4	NV	250	1983
Northern Indiana Public Ser.	RM Schahfer 17	IN	393	1983
Northern Indiana Public Ser.	RM Schahfer 18	IN	393	1986
Northern States Power Co.	Riverside (MN) 7	MN	150	1987
Northern States Power Co.	Sherburne County 1	MN	720	1976
Northern States Power Co.	Sherburne County 2	MN	720	1977
Northern States Power Co.	Sherburne County 3	MN	860	1987
Orlando Utilities Comm.	CH Stanton 1	FL	450	1987
Pacific Power & Light Co.	Jim Bridger 2	WY	510	1975*
Pacific Power & Light Co.	Jim Bridger 4	WY	510	1979
Pacific Power & Light Co.	Wyodak 1	WY	345	1978*
Pennsylvania Power Co.	Bruce Mansfield 1	PA	835	1976
Pennsylvania Power Co.	Bruce Mansfield 2	PA	835	1977
Pennsylvania Power Co.	Bruce Mansfield 3	PA	835	1980
Philadelphia Electric Co.	Cromby 1	PA	188	1954*
Philadelphia Electric Co.	Eddystone 1	PA	354	1960*
Philadelphia Electric Co.	Eddystone 2	PA	354	1960*

UTILITY FGD SYSTEMS

Operational

Company	Unit	State	Capacity MW	Year in Service
Plains Electric G & T Coop.	Plains Escalante 1	NM	233	1984
Platte River Power Auth.	Rawhide 1	CO	250	1984
Public Service Co. of Indiana	Gibson 5	IN	676	1982
Public Service New Mexico	San Juan (NM) 1	NM	347	1976
Public Service New Mexico	San Juan (NM) 2	NM	329	1973*
Public Service New Mexico	San Juan (NM) 3	NM	517	1979
Public Service New Mexico	San Juan (NM) 4	NM	515	1982
Salt River Project	Coronado 1	AZ	411	1979
Salt River Project	Coronado 2	AZ	411	1980
San Miguel Electric Coop.	San Miguel 1	TX	447	1982
Seminole Electric Coop.	Seminole 1	FL	680	1984
Seminole Electric Coop.	Seminole 2	FL	680	1985
Sierra Pacific Power Co.	North Valmy 2	NV	290	1985
Sikeston Bd. of Mun. Util.	Sikeston 1	MO	260	1981
South Carolina Public Ser. Auth.	Cross 2	SC	530	1984
South Carolina Public Ser. Auth.	Winyah 2	SC	315	1977
South Carolina Public Ser. Auth.	Winyah 3	SC	315	1980
South Carolina Public Ser. Auth.	Winyah 4	SC	315	1981
South Mississippi Elec. Power Coop.	Morrow 1	MS	203	1978
South Mississippi Elec. Power Coop.	Morrow 2	MS	203	1978
Southern Illinois Power Coop.	Marion 4	IL	173	1978
Southern Indiana Gas & Electric Co.	AB Brown 1	IN	265	1979
Southern Indiana Gas & Electric Co.	AB Brown 2	IN	265	1986
Southwestern Electric Power Co.	Pirkey 1	TX	720	1985
Springfield Utilities	Southwest 1	MO	195	1976
Springfield Water, Light & Power	Dallman 3	IL	192	1978
Sunflower Electric Coop.	Holcomb 1	KA	319	1983
Tampa Electric Co.	Big Bend 4	FL	458	1985
Tennessee Valley Auth.	Paradise 1	KY	704	1963*
Tennessee Valley Auth.	Paradise 2	KY	704	1963*
Tennessee Valley Auth.	Widows Creek 7	AL	575	1960*
Tennessee Valley Auth.	Widows Creek 8	AL	550	1964*
Texas Municipal Power Agency	Gibbons Creek 1	TX	443	1983

January 1988

UTILITY FGD SYSTEMS

Operational

Company	Unit	State	Capacity MW	Year in Service
Texas Utilities	Sandow 4	TX	545	1981
Texas Utilities	Martin Lake 1	TX	750	1977
Texas Utilities	Martin Lake 2	TX	750	1978
Texas Utilities	Martin Lake 3	TX	750	1979
Texas Utilities	Monticello 3	TX	750	1978
United Power Association	Stanton 10	ND	60	1982
Utah Power & Light Co.	Hunter 1	UT	446	1978
Utah Power & Light Co.	Hunter 2	UT	446	1980
Utah Power & Light Co.	Hunter 3	UT	446	1983
Utah Power & Light Co.	Huntington 1	UT	446	1977
Utah Power & Light Co.	Naughton 3	WY	326	1971*
West Penn Power Co.	Mitchell 3	PA	299	1963*
West Texas Utilities Co.	Oklaunion 1	TX	723	1986

Total MW Capacity - 64,327
Total Operating FGD Systems - 146

UTILITY FGD SYSTEMS

Under Construction

Company	Unit	State	Capacity MW	Year in Service
East Kentucky Power Coop.	JK Smith 1	KY	650	2000
Jacksonville Electric Auth.	St. Johns River 2	FL	612	1988
Louisville Gas & Electric Co.	Trimble County 1	KY	495	1988
Lower Colorado River Auth.	Fayette 3	TX	415	1988
Pacific Power & Light	Jim Bridger 3	WY	510	1976*
Public Service Co. of Colorado	Cherokee 4	CO	350	1968*
Salt River Project	Coronado 3	AZ	411	1990
Texas Utilities	Forest Grove 1	TX	750	1997
Texas Utilities	Twin Oak 1	TX	750	1994
Texas Utilities	Twin Oak 2	TX	750	1995
Tucson Electric Power Co.	Springerville 2	AZ	425	1989

Total MW Capacity - 6,118
Total FGD Systems Under Construction - 11

* Retrofits

January 1988

UTILITY FGD SYSTEMS

Planned

Company	Unit	State	Capacity MW	Year in Service
Alamito Co.	Springerville 3	AZ	425	N/S
Arizona Public Service Co.	Cholla 5	AZ	375	2005
Basin Electric Power Corp.	Antelope Valley 3	ND	550	1992
Central Power & Light Co.	Coleto Creek 2	TX	720	N/S
Cincinnati Gas & Electric Co.	William A. Zimmer 1	OH	1300	1991
Colorado Springs Dept. of Public Util.	Ray Nixon 2	CO	250	N/S
Delmarva Power & Light Co.	Nanticoke 1	MD	550	1996
Deseret Gen. & Trans. Coop.	Bonanza 2	UT	440	N/S
Houston Lighting & Power	Malakoff 1	TX	690	1996
Houston Lighting & Power	Malakoff 2	TX	690	1998
Los Angeles Dept. of Water & Power	White Pine 1	NV	820	1993
Los Angeles Dept. of Water & Power	White Pine 2	NV	820	1995
Lower Colorado River Auth.	Fayette 4	TX	415	N/S
Nevada Power Co.	Harry Allen 1	NV	295	1996
Nevada Power Co.	Harry Allen 2	NV	295	1998
Nevada Power Co.	Harry Allen 3	NV	295	2000
Nevada Power Co.	Harry Allen 4	NV	295	2002
Oklahoma Gas & Electric Co.	Sooner 3	OK	550	N/S
Oklahoma Gas & Electric Co.	Sooner 4	OK	550	N/S
Pacific Power & Light Co.	Jim Bridger 1	WY	510	1974*
Public Service Co. of Colorado	Pawnee 2	CO	552	1994
San Antonio City Public Service Board	CPSB 1	TX	470	1992
San Antonio City Public Service Board	CPSB 2	TX	470	1994
San Antonio City Public Service Board	CPSB 3	TX	470	1997
San Miguel Electric Coop.	San Miguel 2	TX	419	1995
South Carolina Public Service	Cross 1	SC	530	N/S
Southwestern Electric Power Co.	Walker County 1	TX	720	N/S
Southwestern Public Service Co.	South Plains 1	TX	572	N/S

* Retrofit

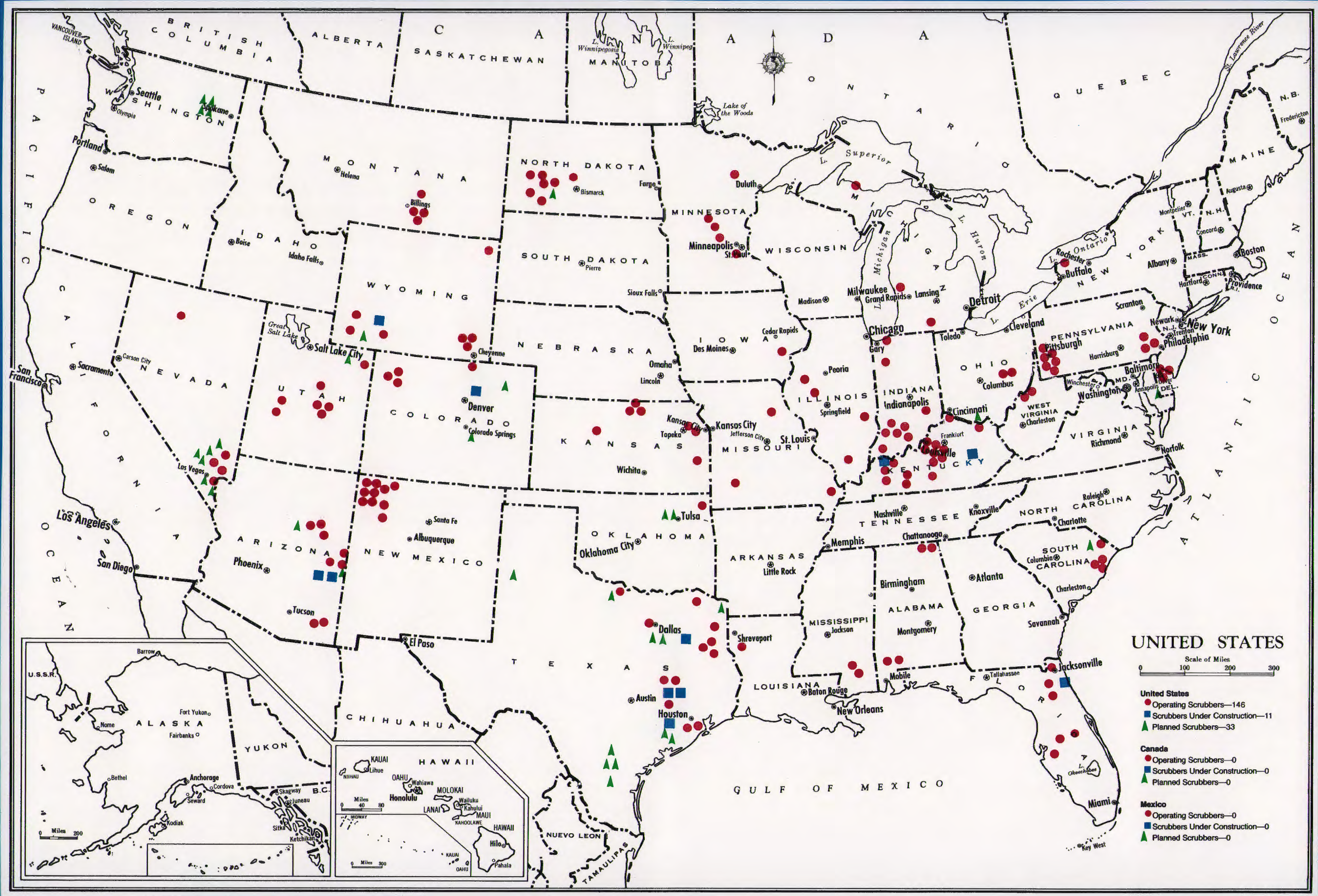
UTILITY FGD SYSTEMS

Planned

Company	Unit	State	Capacity MW	Year in Service
Washington Water Power Co.	Creston 1	WA	570	N/S
Washington Water Power Co.	Creston 2	WA	570	N/S
Washington Water Power Co.	Creston 3	WA	570	N/S
Washington Water Power Co.	Creston 4	WA	570	N/S
West Texas Utilities Co.	Oklaunion 2	TX	723	2004

Total MW Capacity - 18,041
Total FGD Systems Planned - 33

LOCATION OF POWER PLANT SCRUBBERS IN NORTH AMERICA
January 1988



CLEAN AIR FILE

April 22, 1988

MEMORANDUM: Acid Rain and Great Lakes Water Quality Agreement

FROM: David L. Swanson

Over the last several months, the Administration has attempted to forge a consensus between various departments and agencies on the what additional actions it should take in upcoming discussions on acid rain with Canada. In previous meetings, the Administration has for the first time acknowledged that acid rain is:

- A serious environmental problem in both the US and Canada; and
- A serious transboundary problem.

In addition, following the recommendations of the Special Envoys, the US has announced and undertaken significant new efforts including:

- Requesting $2.5 billion in federal appropriations for the Clean Coal Program ($975 million of which has been appropriated);
- Establishment of stronger consultative ties with Canada through the Innovative Control Technology Advisory Panel;
- Adoption of recommendations from the President's Task Force on Regulatory Relief on incentives and disincentives to demonstration and deployment of Innovative Control Technologies.

In recent months, there has been continued pressure from the Canadians for the US to go further. While no one in the Administration has been willing to cross a well-defined border line by recommending that the US agree to specific emission targets or to a specific schedule for deploying new technologies, there has been pressure in some quarters to "do something else" for Canada.

In recent Domestic Policy Council meetings, our best information tells us that there is an attempt underway to see if the existing Agreement on Great Lakes Water Quality (GLWQA) can be used as a model in developing a new bilateral approach with Canada on acid rain. This memorandum is a discussion of what the GLWQA is and where problems could arise if a similar approach were taken by the US and Canada on acid rain.

Brief History of the GLWQA

In 1909, the US and Great Britain (acting for the Dominion of Canada) entered into the Boundary Waters Treaty. The Treaty was an attempt to:

- Prevent disputes between the US and the UK on matters having to do with the boundary waters (the Great Lakes),
- Settle all questions then pending between the US and Canada regarding use of the boundary waters; and
- Establish a procedure by which future problems could be addressed in a consistent and mutually acceptable manner.

The Treaty created the International Joint Commission (3 members appointed by the President and 3 by Great Britain on the recommendation of Canada). The IJC was empowered to settle matters referred to it by both countries and to make recommendations to both governments on problems it identified.

In the 1960's, both the US and Canadian governments became concerned over a rapid deterioration of the Great Lakes. Both governments, acting under the procedures established in the Boundary Waters Treaty of 1909, requested the International Joint Commission to review pollution in the Great Lakes and report back to both governments.

That report resulted in the US and Canada adopting the Great Lakes Water Quality Agreement in 1972. In the most general terms, the GLWQA reaffirmed the obligations of both countries under the 1909 Treaty not to pollute boundary waters and set forth new objectives and procedures to be followed by both parties in meeting the then current problems in Great Lakes water quality. The 1972 Agreement was updated, strengthened and re-ratified in 1978.

The 1972 Great Lakes Water Quality Agreement

Article I -- Definitions

Article II -- General Water Quality Objectives (GWQO)

Upon signature of the parties, the GWQO were adopted. They are general, largely aesthetic requirements regarding pollutant contents of the boundary waters.

Article III -- Specific Water Quality Objectives (SWQO)

Standards

Upon signature of the parties, the SWQO were adopted. The SWQO are specific standards for concentrations of pollutants and the standards are set forth in Annex I of the GLWQA. Allowable concentrations are established for microbiology, dissolved oxygen, total dissolved solids, taste and odor, pH, iron, phosphorous and radioactivity. Interim objectives and standards are established for temperature, mercury and other toxic heavy metals, persistent organic contaminants, settleable and suspended materials and oil, petrochemicals and immiscible substances. In addition, the parties agreed to consult within one year to address appropriate SWQO for an additional 18 substances.

Amendments to Standards

Amendments to the SWQO could be proposed by the IJC but would be implemented only upon the written approval of each of the parties.

Article IV -- Standards and Other Regulatory Requirements

By their signature, the parties agreed to make their individual water quality standards and other regulatory requirements consistent with achievement of the SWQO and the GWQO. In addition, each party agreed to undertake efforts to ensure that the States and Provincial Government standards and regulatory requirements were similarly consistent with the water quality objectives.

Article V -- Programs and Other Measures

The parties agreed to implement the programs and other measures (including new legislation and regulations) within 3 years and 9 months. These programs and other measures would control all aspects of pollution input to the boundary waters.

Article VI -- Powers, Responsibilities and Functions of the International Joint Commission

The IJC was instructed to assist in the implementation of the GLWQA. It was given responsibilities to gather, analyze and disseminate data on boundary waters quality. It could provide advice and recommendations to the parties including recommendations on the water quality objectives, legislation, programs and other regulatory measures and intergovernmental agreements. In was authorized to conduct investigations requested by the parties and it was, in the course of these investigations, given broad powers to conduct hearings, compel the testimony of witnesses and the production of documents and to verify independently data and other information provided to it.

Article VII -- Joint Institutions

The IJC was directed to establish a Great Lakes Water Quality Board and a Research Advisory Board (IJC appointed after consultation with each party).

Article VIII -- Submission and Exchange of Information

The IJC was authorized to obtain, at its request, any information relating to boundary waters from either party and either party is required to make its information available on request to the other.

Article IX -- Consultation and Review

An ongoing consultative process was established with a commitment that each would consult on appropriate remedial actions for problems identified.

ARticle X -- Implementation

The parties committed themselves to seeking:

- Appropriations of necessary funds;

- Enactment of additional legislation necessary to implement the agreement; and

- The cooperation of the State and Provincial Governments in all matters relating to this Agreement.

Article XI -- Existing Rights and Obligations

No diminishment of rights and obligations of parties as set forth in the Boundary Waters Treaty.

Article XII -- Amendment

Only the parties by agreement can amend this agreement.

Article XIII -- Entry into Force and Termination

Agreement in force upon signature.

The 1978 Great Lakes Water Quality Agreement

On November 22, 1978, the US and Canada signed an updated GLWQA. They were reacting to 6 years of experience under the 1972 Agreement and the political and technical need to expand coverage under the Agreement by establishing new standards for previously named pollutants as well as new standards for many previously not covered.

The basic thrust of the 1978 Agreement remained the same. In fact, the actions taken in 1978 strengthened the role of the IJC and the commitment of both the US and Canada to the policies and procedures established under the GLWQA. The message carried by the 1978 Agreement was the GLWQA was working and we want to make it work even better.

Some of the significant departures from the 1972 Agreement included the following:

1. PURPOSE

The 1972 Agreement did not contain a statement of Purposes. In 1978, the Agreement adds a section specifying that the purpose of the Parties in entering into this Agreement is to "restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem." To achieve this purpose, both Parties pledged "to make a maximum effort to develop programs, practices and technology necessary for a better understanding of the Great Lakes Basin Ecosystem and to eliminate or reduce to the maximum extent practicable the discharge of pollutants into the Great Lakes System." (emphasis added)

The Parties adopted the policy that, among other things, "the discharge of toxic substances in toxic amounts be prohibited and the discharge of any or all persistent toxic substances be virtually eliminated."

2. ARTICLE VII -- POWERS, RESPONSIBILITIES AND FUNCTIONS OF THE INTERNATIONAL JOINT COMMISSION

The IJC was generally accorded the same responsibilities as under the 1972 Agreement. However, it was given the additional responsibility of specifically "tendering advice and recommendations to the Parties in connection with matters covered under the Annexes to this Agreement." This effectively moved the IJC into direct responsibilities for making recommendations for specific standards for specific pollutants covered in the Annexes to the Agreement.

The IJC was also directed to utilize principally the services of the Water Quality Board and the Science Advisory Board in carrying out its responsibilities.

3. ANNEX 1 -- SPECIFIC OBJECTIVES

In addition to modifying, in some cases, previously established pollution limits, the 1978 Agreement established more than 30 new standards for organic and inorganic compounds. In addition, the new SWQO included specific limits for radiological pollutants.

4. ANNEX 2 -- LIMITED USE ZONES

The 1978 Agreement established "Limited Use Zones" and required each Party to identify all that currently exist and could come into existence in the future. Limited Use Zones are areas in the vicinity of present and future municipal, industrial and tributary point sources and are areas which contain chronic levels of pollution which are, because of natural phenomenon, unlikely, despite the best efforts of the Parties, to achieve compliance with the Specific Objectives.

The Parties agreed to consult and develop scientific guidelines for determining the maximum portions of the boundary waters which can be occupied by limited use zones.

MAJOR CONCERNS

The thrust of the GLWQA in 1972 was to respond to a major, unequivocal, environmental threat. There was no doubt that the Great Lakes were in some difficulty and that the water quality in the Great Lakes was a visible and major public concern. The environmental movement was also in its infancy, at least as far as mature regulatory programs for water quality were concerned. Water quality standards for open bodies of water such as the

Great Lakes for all practical purposes did not exist. It was natural and politically necessary for the Administration, the Congress and the Canadians to respond in the manner they did. And there can be no question that it was effective. The new agreement signed in 1978 recognized progress made under the 1972 Agreement and make certain improvements in standards and organization.

The model presented by the GLWQA presents numerous problems when one attempts to apply it to current concerns between the US and Canada over acid rain. In the discussion that follows, it is assumed that a body similar to the IJC is created to carry out similar responsibilities over acid rain issues, the Acid Rain Commission (ARC). Some of the problems that could occur are enumerated below.

I. <u>Objectives and Standards</u> -- The Clean Air Act is a mature, comprehensive and well understood prescription for clean air in the US. Many legal issues have been fought out with the result that affected parties can relate to the CAA requirements in a predictable and businesslike manner. New air quality issues that arise under the CAA are dealt with in the normal regulatory process by EPA, are addressed by the Congress in new legislation or are litigated in the courts.

Adopting the basic structure of the GLWQA would add an additional burden. Under the Agreement, the ARC could initiate its own studies and make recommendations to either the US or Canada or it could respond to the request of either Party for studies, recommendations or other views. This could have the following affects on the existing process:

- Standard setting for transboundary movement of pollutants could well occur largely outside the current CAA process. Once the ARC recommendations were made, the burden would shift significantly and the disaffected party would find it very difficult to overcome the domestic and international momentum behind the new standards.

- There is no up front requirement that the ARC standards would have to be consistent with US law and no requirement that the standard setting process by the ARC would have to be consistent with US administrative law procedures.

- Given the past record of US-Canadian cooperative efforts on acid rain, there is very little likelihood that the ARC recommendations could accommodate the differences between the US and Canada. The US program is premised on new technology being made available to meet future environmental and economic needs. The

Canadian approach is to use the existing menu of technologies, including hydro, nuclear and liquid and gaseous fossil fuels, to meet the challenge.

- An approach that puts the major policy making responsibilities in the hands of the ARC could well be the most effective means identified to date to shortcut the CAA processes and procedures by those who oppose current US efforts on acid rain. This includes organizations in the US as well as virtually all interested parties in Canada, including the government.

II. Effect On the US Clean Coal Program

The current US Clean Coal Program is premised on the belief that the demonstration and deployment of new innovative control technologies is the most cost and environmentally effective means of reducing long term emissions while at the same time providing new technology to meet future needs. This policy has been established after long and detailed review of the Administration and much discussion with the Congress. It is now well along and industry is responding enthusiastically to the program.

Adopting the GLWQA approach would have the following effects on the US Clean Coal Program:

- There would be a new round of uncertainty as to what standards would apply to existing and new units, what requirements would be imposed on sources in areas currently under pressure by acid rain activists (including the Ohio River valley and the southeast) and what position the government could take regarding the current jointly funded effort with industry to demonstrate and deploy new innovative control technologies. Utilities in these areas would be faced with additional uncertainty as to what standards would apply and would face additional difficulties in planning for their and their customers future needs.

- The new policy modeled on the GLWQA will have an unknown effect on current Congressional deliberations regarding amendments to the CAA. Will the GLWQA process reinvigorate those in Congress who seek acid rain controls? Will the Administration be seen as moving one step closer to admitting that the only solution to the largely political problem with Canada is a regulatory based control program?

- There is every likelihood that sources of private capital for new technology development and deployment will dry up or come at much higher cost given the significant new element of economic and regulatory risk posed by the GLWQA approach.

III. Requirements As They Apply To Each Country

Each country has up until now fashioned an approach that meets the political, economic and environmental requirements in their own country. At the same time, through the Special Envoy's, they have been able to demonstrate their mutual determination to fashion a solution to the problem despite the differences in approach between the two countries. Those two approaches have developed out of vastly different economic, environmental and political circumstances in each country. The US, for example, is not able to exploit the same natural resource base as Canada. We have virtually no hydro capacity that we could develop, we do not have large natural gas resources and we do not have the political willingness to abandon the effort to spur development in the Ohio River Valley or other areas which would be devastated by poorly conceived acid rain policy.

Under the GLWQA, new issues arise regarding the burdens and responsibilities of each country. These include:

- Is there parity between each party? Does each have equal responsibility to act to implement the ARC recommendations? This means both at the State and Provincial Government level. And is the imposition of new requirements on both sides triggered on each side having their program in place?

- How does one resolve the differences between each side on the cost and environmental benefits to each party? Does each side have to equally bear the pain? Is this even a good policy given the differences between the two sides?

- Will there be requirements that each side may adopt different solutions but they must be equally effective?

- Will there be requirements that an approach recommended by the ARC cannot create disincentives to programs already adopted and implemented by either country?

- How does one value the investments by government and the private sector in meeting the goals of both countries?

- How will each side view the opinions of industry on how best to meet the mutual objectives of both parties?

- Will the ARC be required to evaluate the effectiveness and applicability to the other party of actions already taken by each party?

- Will the ARC be responsible to both governments? Will they be required to appear before both legislatures? Will they be required to justify their budgets and recommendations before both legislatures? Will the Congress and the Canadian Parliament be permitted or required to evaluate and issue periodic reports on the ARC process and recommendations including the fitness of ARC members in each country as to fitness for ARC membership?

IV. <u>Relationship Of ARC and GLWQA Approach To NAPAP</u>

The US and Canada have invested considerable efforts and funds in coming to a more complete factual understanding of the causes and effects of acid rain on both countries. This has been carried out through the NAPAP process. The NAPAP has been successful in focusing scientists in both countries on a common scientific approach to issues raised in each country. While no one has been completely satisfied with the political implications of NAPAP findings, it has been a source of coherence in an area which has been fraught with confusion arising out of the many voices of scientific inquiry.

There are significant questions regarding how the ARC will obtain adequate information in carrying out its responsibilities. They include:

- Will NAPAP continue with its current assignment?

- Will the ARC be required to obtain its technical information from the NAPAP process?

- If the ARC chooses to commission its own studies, how will it resolve any potential conflicts with NAPAP results?

- How will the ARC avoid "tilting the playing field" by commissioning scientific studies that would produce the results it is looking for?

V. <u>Organizational Issues</u>

There is undoubtedly interest in creating an ARC as a means of providing an international forum for acid rain concerns to be voiced. While some may argue that this may take some political pressure off the United States, the opposite is more likely. Currently, new issues regarding clean air, such as acid rain, are addressed under the legislative and regulatory framework of the

Clean Air Act. Business and environmental interests know the law and legal processes and have become skilled in arguing their cases. The courts have developed an expertise over the years. In sum, the Clean Air Act is an understandable framework for all interests.

The creation of the ARC poses new organizational and institutional issues for both government and the interest groups. They include:

- How will the ARC be organized and staffed? Are ARC commissioners part time or full time? Are they confirmed by the Senate? Are the staffing arrangements set up so that both the US and Canada have separate staffs?

- Is the ARC required to follow policy on issues before the ARC that is established by the Administration and the Congress?

- Which Department or Agency of the executive branch oversees the work of the ARC -- EPA or the State Department?

- Is the responsibility of the ARC to negotiate on behalf of the US or to seek a consensus on information that is critical to US policy in relationship to Canada?

- When the ARC makes a recommendation, what obligation does the Congress and the Administration have to implement that recommendation?

- To what degree does EPA surrender jurisdiction over US sources of transboundary emissions to the ARC? Does this require amending the Clean Air Act?

- Are decisions by EPA to either implement or not implement ARC recommendations subject to challenge in US courts?

- Because of the requirement that the US implement ARC recommendations, are data assembled by the ARC considered to have higher standing than data accumulated by EPA in furtherance of their obligations under the Clean Air Act?