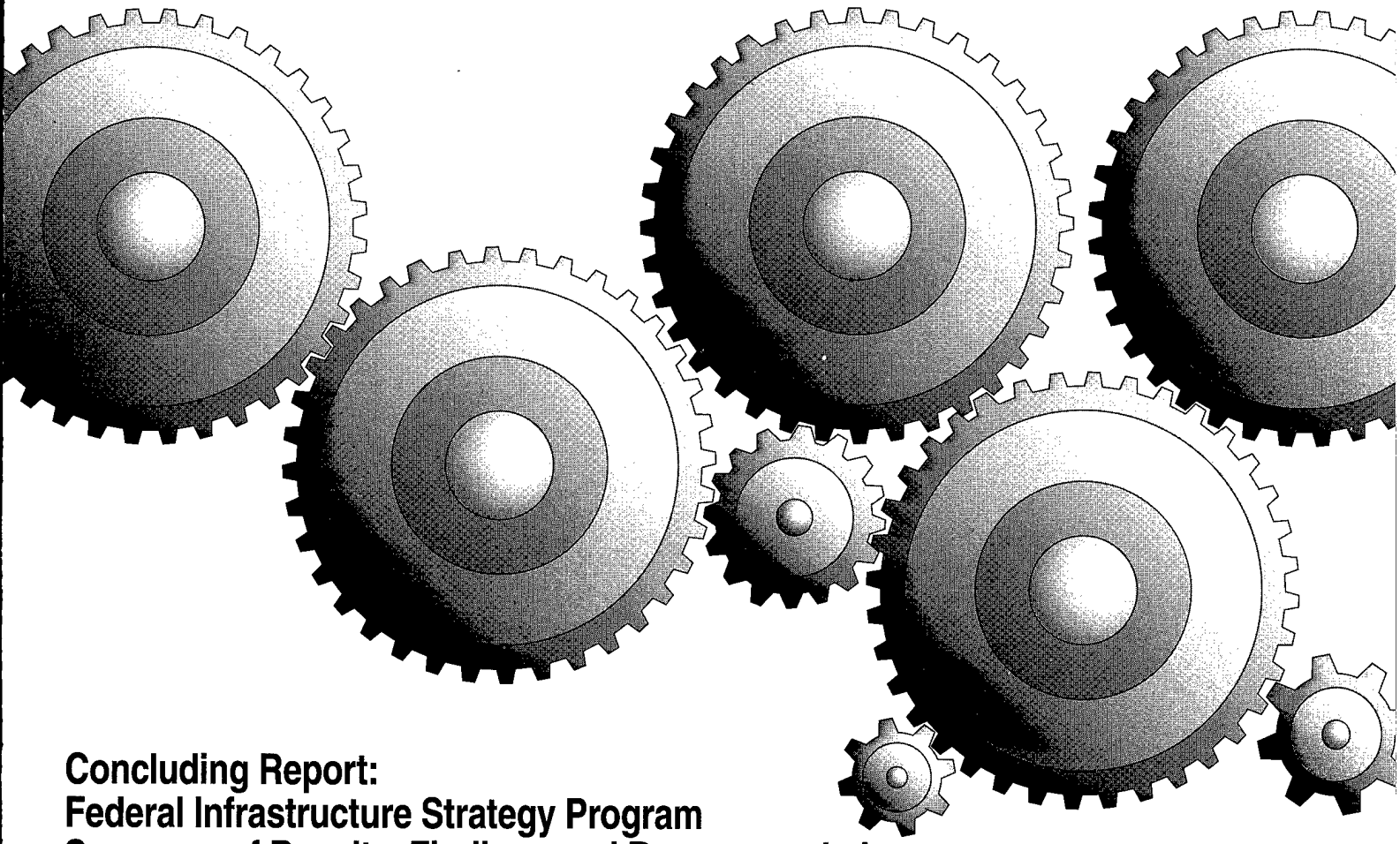
U.S. Army Corps of Engineers
Water Resources Support Center
Institute for Water Resources

LIVING WITHIN CONSTRAINTS:
AN EMERGING VISION FOR HIGH PERFORMANCE PUBLIC WORKS

19970103 039



Concluding Report:
Federal Infrastructure Strategy Program
Summary of Results, Findings and Recommendations

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

January 1995

IWR Report 95-FIS-20

Federal Infrastructure Strategy Reports

This report summarizes the results, findings and recommendations relating to the Federal Infrastructure Strategy (FIS) program, a three-year effort involving a wide range of participants in a forum on the development of integrated or multi-agency Federal infrastructure policies. It documents the results of FIS activities that took place from late 1991 through September 1994. The principles essential to the development of Federal policies are outlined, and an action plan and opportunities for interagency cooperation are presented within the context of FIS policy research.

The specific outputs of the FIS studies supporting the recommendations presented herein have been previously documented in a series of interim reports published by the U.S. Army Corps of Engineers and the U.S. Advisory Commission on Intergovernmental Relations. These interim reports were used to chronicle the strategy's development and facilitate discussions within Federal and non-Federal public works communities during the program. The results of several interagency cooperative studies following up on key FIS recommendations are scheduled for publication subsequent to this summary report. A complete listing of FIS publications appears on page iv.

Much of the policy research was accomplished in consultation with other Federal agencies, often with the assistance and leadership of independent third party experts who organized and facilitated the consultations, workshops and inquiries on specific issues. These included organizations such as the aforementioned Advisory Commission on Intergovernmental Relations, the American Public Works Association, Apogee Research, the Civil Engineering Research Foundation, the National Academy of Public Administration, the National Research Council, and The Urban Institute.

For further information on the Federal Infrastructure Strategy program, please contact:

Mr. Robert A. Pietrowsky
FIS Program Manager
703/355-3073

Dr. Eugene Z. Stakhiv
Chief, Policy and Special
Studies Division
703/355-2370

U.S. Department of the Army
Corps of Engineers
Institute for Water Resources
Casey Building, 7701 Telegraph Road
Alexandria, VA 22315-3868

The Institute's infrastructure study team included Dr. Cameron E. Gordon, Economic Studies Manager and Mr. James F. Thompson, Jr., Engineering Studies Manager. The program was overseen by Mr. Kyle Schilling, Director of the Institute.

Reports may be ordered by writing (above address) or calling Mrs. Arlene Nurthen, IWR Publications, at 703/355-3042.

"A well-functioning infrastructure is vital to sustained economic growth, to the quality of life in our communities, and to the protection of our environment and natural resources. To develop and maintain its infrastructure facilities, our Nation relies heavily on investments by the Federal Government. Our Nation will achieve the greatest benefits from its infrastructure facilities if it invests wisely and continually improves the quality and performance of its infrastructure programs. Therefore,... infrastructure investments shall be based on systematic analysis of expected benefits and costs, including both quantitative and qualitative measures..."

Executive Order No. 12893, "Principles for Federal Infrastructure Investment", January 26, 1993

PREFACE

The Federal Infrastructure Strategy (FIS) program, a three year effort exploring issues essential to evolving infrastructure policies, was undertaken in response to an Administration budget initiative and a subsequent House Report (No. 101-536) accompanying the 1991 Energy and Water Development Appropriations Act. The FIS study agenda followed up on the work of the National Council on Public Works Improvement, the Congressional Budget Office, the Congressional Office of Technology Assessment, and other related efforts.

The program was aimed at developing principles for improving the performance and efficiency of Federal infrastructure investments, including those ultimately made at state and local levels. It was designed to facilitate the sharing of policy research through a three-tier process of intergovernmental consultation, in-depth inquires, and technical studies as a catalyst for stimulating improvements in individual infrastructure programs. A primary goal was the active participation of the various Federal, state and local public works agencies, infrastructure providers, academic and related research organizations, and advocacy, professional and user groups in the coordination of information, strategies, and resources.

The Federal agency representatives brought together for this effort recognized that the existing body of work, represented by past studies, provided a comprehensive assessment of national needs and issues upon which to build. Some progress had been made and opportunities for further improvement had been identified. Yet many fundamental problems persisted and few opportunities for specific Federal agency response were created. Program participants recommended working toward specific actions to refine or implement the key findings of previous reports rather than undertaking a new study because of this large unrealized potential for improvement. Within this context, the program addressed three questions deemed essential to the development of a Federal strategy:

(1) What new government-wide or multi-agency Federal infrastructure policies and principles should be developed?

(2) What issues should these policies and principles address?

(3) Can Federal agencies use these principles to work more closely together and with other levels of government and the private sector to improve the performance of infrastructure?

The results of specific FIS activities have been documented in a series of interim reports published by the U.S. Army Corps of Engineers Institute for Water Resources (IWR) and/or the Advisory Commission on Intergovernmental Relations (ACIR) and the Building Research Board/Board on Infrastructure and the Constructed Environment of the National Research Council. This series serves as a practical and current body of knowledge on a subject that has been discussed in the past largely as an abstract macroeconomic issue linked to national productivity, international competitiveness and jobs.

Research findings were reviewed by a diverse peer group of public works experts and FIS participants, with recommendations stemming from two phases of interagency consultation approved by ACIR. Nevertheless, it is important to recognize that these documents attempt to report the views of FIS participants and do not necessarily represent the views of the U.S. Army Corps of Engineers nor any of the Federal agencies participating in the program.

DTIC QUALITY INSPECTED 2

The FIS Report Series

- *Infrastructure Report Summaries (First Edition)*
- *Toward a Federal Infrastructure Strategy: Issues and Options,* ACIR Report A-120
- *Framing a Dialogue: Strategies, Issues and Opportunities,* IWR Report FIS-93-1
- *Challenges and Opportunities for Innovation in Public Works, Volumes 1 & 2,* Reports FIS-93-2 & 3
- *Infrastructure in the 21st Century Economy: A Review of the Issues and an Outline of a Study of Impacts of Federal Infrastructure Investments,* Report FIS-93-4
- *Federal Public Works Infrastructure R&D: A New Perspective,* Report FIS-93-5
- *Funding State and Local Infrastructure: Two Reports on Public Works Financing*, Report FIS-93-6
- *High Performance Public Works: A New Infrastructure Investment Strategy for America*, ACIR/IWR Report No. SR-16
- *Infrastructure in the 21st Century Economy: An Interim Report, Volumes 1-3*, Reports FIS-94-7, 8 & 9
- *A Prototype Model for Estimating Local Public Finance Impacts*, Report FIS-94-10
- *Corps of Engineers Technology Transfer: Nondestructive Testing, Evaluation, and Rehabilitation Strategies for Roadway Pavements*, Report FIS-94-11
- *High Performance Public Works: Sourcebook of Working Documents*, ACIR/IWR Report SR-16S
- *Infrastructure Report Summaries (Second Edition)*, Report FIS-12
- *Consolidated Performance Report on the Nation's Public Works: An Update*, Report FIS-94-13
- *Impediments & Opportunities to Improve Public Works Management Practices*, Report FIS-94-14
- *Local Government Public Works Agencies: The Effect of Federal Mandates on Their Activities and Improving Their Performance*, Report FIS-94-15
- *Issues in Deferred Maintenance*, Report FIS-94-16
- *Meeting State and Local Public Works Needs: Federal Infrastructure R&D Technology Transfer*, Report FIS-94-17
- *Employment Impacts of Environmental Restoration Projects*, Report FIS-94-18 (*forthcoming*)
- *Congressional Response to Fragile Foundations: An Analysis of Infrastructure Legislation of the 101st and 102nd Congresses*, Report FIS-19 (*forthcoming*)
- *Measuring and Improving Infrastructure Performance,* National Research Council Report (*forthcoming*)
- *Infrastructure in the 21st Century Economy: A Final Report*, Apogee Research (*forthcoming*)
- *Infrastructure R&D: Technology Transfer Series*, Civil Engineering Research Foundation (*forthcoming*)

ACKNOWLEDGMENTS

This report documents the results of a series of intergovernmental analyses facilitated by the U.S. Army Corps of Engineers under a broad initiative aimed at the examination of Federal infrastructure policies. Guidance accompanying the Federal Infrastructure Strategy (FIS) initiative stressed the need to forge a collaborative partnership among Federal agencies to further the work of the National Council on Public Works Improvement and other recent national level assessments. Therefore, the FIS program was administered as an open interagency consultation. As such, it represents the first such exploration of national infrastructure issues from the shared perspective of the various Federal infrastructure agencies.

FIS outputs and products, including the documentation herein, are the direct result of the substantial efforts and contributions of hundreds of representatives from participating Federal agencies, departments and Congressional offices, state and local governments, infrastructure users, academic analysts, advocacy groups, and public and private infrastructure providers. The U.S. Army Corps of Engineers expresses its sincere thanks to all who participated and helped the program become a truly cooperative effort. The Corps was pleased to facilitate this program among many agency partners, and welcomes the opportunity for continuing collaboration and research.

Far too many individuals contributed to the program to name each and every person. However, because of their contributions, the Corps would especially like to thank the agency staff who gave of their time and provided considerable expertise during the program. At the risk of missing a few key individuals, these include: Thomas Hady, *Economic Research Service*, Charles Terell, *Soil Conservation Service*, and Carl Bausch, *Department of Agriculture*; John Kort, *Bureau of Economic Analysis*, and James Gross and Noel Raufaste, *National Institute of Standards and Technology, Department of Commerce*; Kevin Doxey, *Department of Defense*; Larry Bressler, *Western Area Power Administration*, and Carolyn Cannon and Dick Earl, *Department of Energy*; Jack Brynda, Theresa Casias, Brad Crowder, Alan Dickerson, Bob Ledzian, Lew Moore, Jim Pierce, Benedict Radecki, Edward Riekert, William Steele, and Ray Williams, *Bureau of Reclamation*, and Nancy Lopez, *U.S. Geological Survey, Department of Interior*; Harry Caldwell, Joe Canny, and Anne Mladinov, *Department of Transportation*; Frank Emerson, Penny Medford, and Lynne Pikard, *Federal Aviation Administration*; Sue Binder, Bruce Cannon, Gene Cleckley, Janet Colemen, Sheldon Edner, Ray Griffth, Kevin Heanue, Arthur (Jake) Jacoby, Tom Kozlowski, Jim Link, Jack Neissner, Tom Pasko, and Germaine Williams, *Federal Highway Administration*; Bill Gelston, *Federal Rail Administration*; Don Emerson, Edward Thomas, and Fred Williams, *Federal Transit Administration*; John Greenlees, *Department of Treasury*; Dinah Bear and Ray Clark, *former Council on Environmental Quality*; George Ames, David Berg, Anne Cole, Michael Dean, Anne Grambsch, Paul Gutherie, Patricia Haman, Art Koines, Barry Korb, Jim Kreissl, Paul Lapsley, Al McGartland, Anne Norton Miller, Timothy Oppelt and Brett Snyder, *Environmental Protection Agency*; Dan Gottschalk, *General Services Administration*; Jonathan Bruel, Randy Lyon, Norm Starler and Harold Steinberg, *Office of Management and Budget*; Bruce Baker, Christine Bonham, Gary Jones, and Paul Posner, *U.S. General Accounting Office*; Michael Deich, *Congressional Budget Office* (currently with the *National Economic Council*); and Dennis Zimmerman, *Congressional Research Service*.

The Corps would also like to express its appreciation to the many individuals who made presentations and provided critical comment at the many workshops and conferences held during the program. These speakers included: *Senator* Bob Graham; *Representatives* Bob Carr, William F. Clinger, Ray Thornton, and Bob Wise; Edward G. Rendell, *Mayor of Philadelphia*; Bill Westbrook, *Mayor of Jackson, Wyoming*; Mortimer L. Downey, *Deputy Secretary, U.S. Department of Transportation*; Thomas M. Downs, *Commissioner, New Jersey Department of Transportation* (currently *President and Chairman, Amtrak Corporation*); David Gardiner, *Assistant Administrator, U.S. Environmental Protection Agency*; John Horsley, *Deputy Assistant Secretary for Governmental Affairs, U.S. Department of Transportation*; Tad McCall, *Deputy Associate Administrator, U.S. Environmental Protection Agency*; Alicia Munnell, *Federal Reserve Bank of Boston* (currently *Deputy Assistant Secretary of the Treasury*); Robert Rafuse, *Department of Treasury*; Alice M. Rivlin, *Deputy Director* (currently *Director*), *Office of Management and Budget*; Governor William F. Winter, *Chairman, ACIR*; and, Arthur B. Baskin, *University of Illinois at Urbana Champaign*; James Blum, *Deputy Director, Congressional Budget Office*; Martin Borsykowsky, *City of New York*; James A. Broaddus, *University of Texas at Austin*; Pete Butkus, *State of Washington*; Letitia Chambers, *Chambers Associates*; David Chu, *Rand*; Robert Dawson, *Cassidy and Associates*; Philip Dearborn, *ACIR*; Jesus M. De La Garza, *Virginia Tech*; Barbara Dyer, *Alliance for Redesigning Government*; Marlene Eide, *National Association of Counties* (now on the staff of *U.S. Senator Byron L. Dorgan*); Carol Everett, *Rebuild America Coalition;* Jay Fountain, *Government Accounting Standards Board*; Francis Francois, *American Association of State Highway and Transportation Officials*; Richard Geltman, *Linton, Mields, Reisler & Cottone, Ltd.*; Michael B. Goldstein, *Dow, Lohnes and Albertson*; Albert Grant, *American Society of Civil Engineers*; Robert Goodin, *City of Rockville, Maryland*; Thomas J. Harrelson, *NAPA*; Philip Harter, *private mediator*; Neil M. Hawkins, *University of Illinois at Urbana Champaign*; Lowell Jackson, *Greenhorne & O'Mara, Inc.*; Ron Kirby, *Metropolitan Washington Council of Governments*; J. Douglas Koelemay, *Commission to Promote Investment in America's Infrastructure*; Lester Lamm, *Highway Users Federation for Safety and Mobility*; Thomas D. Larson (former *Federal Highway Administrator*), *NAPA*; Stephen C-Y. Lu, *University of Illinois at Urbana Champaign*; Paul Marchetti, *PennVEST*; David Mathiasen, *U.S. General Accounting Office*; Benjamin Mays, *Government Finance Officers Association*; William D. Michalerya, *Lehigh University*; Norm Miller, *State of New Jersey*; Robert Mulready, *Lewiston Maine*; Pete Nowak, *University of Wisconsin-Madison*; Edith Page, *Bechtel* (formerly of the *Office of Technology Assessment*); Neil Peterson, *Transportation Research Board Executive Committee*; Michael J. Pompili, *City of Columbus, Ohio*; Scott Reznick, *Commonwealth Development Associates*; George Rowe, *past President, APWA*; Mike Rugless, *Parsons Brinkerhoff*; Charles F. Seeman, Jr., *Deutsch, Kerrigan & Stiles*; Michael Shibley, *Infrastructure Partnership*; Richard H. Sullivan, *APWA*; John Thomas, *American Society for Public Administration*; C. Michael Walton, *University of Texas at Austin*; Barbara Weiss, *Government Finance Officers Association*; T.D. White, *Purdue University*; Max Whitman, *past President, APWA*; Joseph Wholey, *University of Southern California*; Chris Wye, *NAPA*; Ron Young, *Federal Accounting Standards Advisory Board*; and Ronald Zabilski, *Stone and Webster Engineering*.

The institutions and respective staffs who ably guided many of the consultations and policy research deserve special recognition for their contributions to the program. These include the *Advisory Commission on Intergovernmental Relations* and Chairman William F. Winter, former Chairman Robert B. Hawkins, Executive Director William Davis, and former Executive Director John Kincaid, and particularly, Bruce McDowell, Charles Griffiths, Jeffrey Fitzpatrick (now with *NAPA*), and consultants: Michael Bell and John Boland, *John Hopkins University*; Frank Blechman and Timothy J. Conlan, *George Mason University*; Tom Magness, *Midwest Research Institute*; and John Peterson, *Government Finance Group, Inc.*; the *American Public Works Association* and William J. Bertera, Rita Knorr (now with *ASCE*), Howard Rosen, Jim

Thorne, Eric Melvin and Hilary Green; *Apogee Research, Inc.* and Richard Mudge, Kenneth Rubin, David Albright, and consultants: David Alan Aschauer, *Bates College*; Charles R. Hulten, *University of Maryland*; and M. Ishaq Nadiri, *New York University* and the *National Bureau for Economic Research*; the *Civil Engineering Research Foundation* and Harvey Bernstein, Carl Magnell and Lisa Diehl; the *National Academy of Public Administration* and Roger Sperry, Emerson Markham, Wayne Anderson, Mark Keane, and Carole Neves; *National Research Council* and Nancy Rutledge Connery, Andrew Lemer, Dennis Chamot, Dev Mani, and its *Committee on Measuring and Improving Infrastructure Performance*, chaired by Jared Cohon, *Yale University*; and *The Urban Institute* and Blaine Liner, Harry Hatry, and the *Advisory Panel on Deferred Maintenance Issues*.

Policy guidance for the program was provided by the *Office of the Assistant Secretary of the Army (Civil Works)*, under Mr. Robert W. Page (who proposed the FIS initiative); Dr. G. Edward Dickey (1991/1993); Ms. Nancy P. Dorn (1991-1992); and, the current *Acting Assistant Secretary*, Dr. John H. Zirschky. Program execution was overseen by the Corps of Engineers *Directorate of Civil Works,* initially under the direction of MG (currently LTG) Arthur E. Williams, and more recently MG Stanley G. Genega; and through Donald Kisicki, Chief, *Office of Interagency and International Activities* and Kenneth H. Murdock, Director, *Water Resources Support Center*. The Corps *Institute for Water Resources (IWR)* had detailed management responsibility under Kyle E. Schilling, Director of the *Institute*, and Eugene Z. Stakhiv, Chief, *Policy and Special Studies Division*. The FIS program was managed by Bob Pietrowsky. He was assisted by Cameron Gordon and James F. Thompson.

Participation by the *Army (Civil Works)* included G. Edward Dickey (now *Chief of Planning* at *HQUSACE*), Robert Stearns, Michael Davis and Kevin Cook. Other *Corps of Engineers* participants included the *Deputy Chief of Engineers*: MG John F. Sobke; the *Civil Works Directorate*: Jimmy Bates, Joseph Bittner, James Crews, Robert Daniel, Rixie Hardy, and William Lockwood; the *R&D Directorate* under the direction of Dr. Robert B. Oswald: Dr. William E. Roper (*Assistant Director for Civil Works*), Charles (Chuck) Smith and David B. Mathis; the *Civil Engineering Research Laboratories* under the direction of the late Dr. Louis R. (Dick) Shaffer: Diego Echeverry, Francois Grobler, Moonja Kim, Alan Moore, Thomas Napier, Guruprasad N. Rao, and Jeffrey Walaszek; the *Institute for Water Resources*: L. George Antle, Thomas M. Ballentine, Morris W. Clark, David Grier, Harry H. Kelejian (*University of Maryland*), David Moser, Mark Pointen, Dennis Robinson, and Lim Villianos (who managed the FIS program at the outset); and the *Waterways Experiment Station* under the direction of Dr. Robert W. Whalin: Don Alexander, Don Banks, Albert J. Bush, Richard Grau and Bill McCleese.

The authors also wish to personally thank the following individuals: Bruce McDowell, Norm Starler and Robert Stearns, who provided invaluable advice and critical comments during review of the final draft of this report; Kyle Schilling, whose continuing interest in national infrastructure issues and the FIS helped provide the opportunity and context for the Corps role in the program; and Eugene Stakhiv, for his efforts as the architect of the study agenda and his ongoing role as the intellectual conscience of the program.

Many other people at *IWR* provided important word processing, logistical, and editorial support to the FIS program. In particular, special thanks are due Janice Peterson, Arlene Nurthen and Artech Services for the many hours they spent formatting, editing, and preparing the various FIS reports for publication.

While this report attempts to accurately capture the input and advice from the many groups and individuals who participated in the program, the Institute for Water Resources bears the sole responsibility for the views expressed herein. It does not necessarily represent the official views or policies of the Department of the Army or the Corps of Engineers, and does not purport to represent the views of the Administration.

TABLE OF CONTENTS

PREFACE iii

ACKNOWLEDGMENTS v

EXECUTIVE SUMMARY xi

PART 1 - SUMMARY OF RESULTS 1

I. POLICY CONTEXT 3
- BACKGROUND 3
- SPENDING ON PUBLIC WORKS 5
- THE NEED TO LIVE WITHIN CONSTRAINTS 9
- A MULTI-DIMENSIONAL CONCEPT OF PERFORMANCE 10

II. WHY A FEDERAL STRATEGY? 15

III. PARTICIPATION AND PROCESS 19

IV. STUDY AGENDA 25

V. THE FEDERAL STRATEGY 29
- PRINCIPLES AND RECOMMENDATIONS 29
- RELATED POLICY INITIATIVES 35
  - Legislative 35
  - Executive Orders 35
  - Other Initiatives 36

PART 2 - SUMMARY OF THE ISSUES 41

VI. BETTER MANAGING WHAT WE HAVE 43

VII. CHOOSING MORE EFFICIENT INVESTMENTS 47

VIII. BUDGET SENSITIVE FINANCING 53

IX. THE CRITICAL ROLE OF NEW TECHNOLOGIES 57

X. CLARIFYING ROLES THROUGH A NEW REGULATORY FEDERALISM 65

XI. AN INTEGRATED PROCESS FOR ENVIRONMENTAL DECISIONMAKING 71

XII. CONCLUDING REMARKS 77

REFERENCES 79

LIST OF FIGURES

Figure 1 Nominal and Real Total Spending for Public Infrastructure, 1960-1990 5
Figure 2 Public Spending for Infrastructure as a Percent of GDP, 1960-1990 6
Figure 3 Capital and Non-Capital Spending for Public Infrastructure, 1960-1990 7
Figure 4 Components of Federal Spending as a Percentage of GDP, 1962-2004 8
Figure 5 The Decisionmaker's Conceptual Envelope of Tradeoff Curves 9
Figure 6 Strategy Development Process 20
Figure 7 Case Studies Conducted During the Federal Infrastructure Strategy Program 28
Figure 8 Infrastructure Performance Interrelationships 31
Figure 9 Public Spending for Infrastructure as a Percent of GDP (Capital and Non-Capital) 1960-1990 44
Figure 10 "Mandatory" Programs Are Taking Over the Budget 50
Figure 11 Federal R&D Funding for FY92, Public Works Infrastructure Systems 58

LIST OF TABLES

Table A Infrastructure Strategy Summary xv
Table B Federal Infrastructure Strategy: Principles xvi
Table C Federal Infrastructure Strategy: Action Agenda Recommendations xix
Table 1 Events and Voices in the Federal Policy Debate: Chronology of Key National Infrastructure Milestones and Studies 2
Table 2 Strategy for Improving America's Public Works, National Council on Public Works Improvement 4
Table 3 Infrastructure Strategy Summary 18
Table 4 Organizations Represented at One or More FIS Study Element Activities 22
Table 5 FIS Program Study Agenda 26
Table 6 Summary of Federal Agency Activity for Public Works Infrastructure Research and Development (FY 1992) 59
Table 7 Barriers to Innovation and Transfer 60
Table 8 Matrix of the Highest Priority Public Works Problems and Needs 63
Table 9 Partial Listing of Federal Environmental Review and Permit Legislation Applicable to Water Resources Development Programs 72

EXECUTIVE SUMMARY

POLICY CONTEXT

These are difficult times for public works policymakers. The perception that America is not paying enough attention to its public works has persisted in the minds of the public since *America in Ruins* was published in 1981. This perception has been reinforced by periodic public works disasters, such as the collapse of the Mianus Bridge, the maintenance accident leading to the Chicago flood, and the inability of infrastructure facilities to withstand recent extraordinary events such as the mid-west flood and the California earthquake.

The need for action seems to be more urgent in light of these occurrences, often seeming to require immediate and substantial attention. Yet barriers to such action abound:

- Public works maintenance is often one of the first spending cuts made in times of tight budgets

- Capital investment in public works continues to be skeptically viewed by many as mostly "pork barrel" spending

- Constrained budgets at all levels of government seem to render even modest programs and projects unaffordable

- Significant advances in technology are prevalent, yet liability, regulatory and contracting concerns have resulted in relatively few innovative public works applications

- The accumulation of Federal and state regulations and mandates threaten to distort local budgets and priorities

- The implementation of necessary environmental statutes has created a complex series of public works decisionmaking processes that many times appears gridlocked

The compelling need to address these concerns can be traced to the overarching national issues which frame the current infrastructure debate: the government deficit continues to loom large; economic growth remains lethargic; America's ability to compete internationally appears to be slipping; our political institutions seem incapable of quick or rational response; and, voter consensus on key issues seems fleeting or unattainable.

Meanwhile, total investment in public works relative to the Gross Domestic Product (GDP) has steadily decreased since 1960. This relative decline is a result of diminishing capital investment due to the near completion of virtually all of the Nation's large capital programs over the last thirty years. Over this same period, spending has begun to shift to the operation and maintenance of this massive infrastructure.

It is within this policy climate that the Federal Infrastructure Strategy (FIS) was developed. Key issues facing the intergovernmental participants of the program from its inception were how large the Federal role in providing public works should be and how that role, properly defined, should be carried out.

PROGRAM DESIGN

Despite the preeminent role of state and local governments, FIS participants considered a coherent, overarching Federal Strategy essential to improving America's public works because of the pervasive Federal influence (in the form of legislation, regulations and/or financing aid) over virtually every aspect of infrastructure provision. The concept of a Federal strategy is best understood as a component of a broad national strategy (such as articulated by the National Council on Public Works Improvement) aimed at bringing Federal programs into better alignment with state, local and private sector needs, and promoting consistency and mutual reinforcement among separate but related programs.

The strategy development process was designed as a bottom-up, open consultation which included the participation of a broad cross-section of constituencies. These included: representatives of Federal agencies, Congressional committees, and policy evaluation offices having infrastructure responsibilities; state and local government policymakers; nongovernment analysts, academia, infrastructure users, and advocacy groups; and, public and private public works providers.

The effort was managed by the Corps as a cooperative intergovernmental effort. Independent third party experts such as the Advisory Commission on Intergovernmental Relations, the American Public Works Association, the Civil Engineering Research Foundation, the National Academy of Public Administration, the National Research Council, and The Urban Institute were asked to organize and facilitate the various dialogues, workshops and inquiries on identified issues. The research menu consisted of approximately 30 study elements aimed at promoting the active participation of public works stakeholders within a three-tier framework of:

- Background studies
- In-depth inquiries
- Intergovernmental consultations

Program participants recommended working towards the development of specific actions to refine or implement the key findings of previous reports rather than focusing on the development of a new study. They also recommended that the FIS focus on Federally provided, leveraged, or regulated public works within the broad categories identified by the National Council on Public Works Improvement (NCPWI) in *Fragile Foundations*:

- Transportation (highways, aviation, mass transit and intermodal)

- Water (navigation, flood control, and water supply)
- Waste management (water, solid, hazardous)

Rather than struggle with trying to determine what an "optimal level" of overall infrastructure provision might be, FIS participants recognized that current spending priorities will not appreciably tilt towards public works, at least in the near term. In this regard, the infrastructure policy debate has clearly moved beyond arguments over whether America is truly underinvesting in public works, or whether public investment really matters to the economy. This is due partly to the realization that, yes, public infrastructure investment does matter to economic growth and productivity, but also reflects the reality that there is little, if any, new funding available for increased public works spending anyway.

Participants concluded that the future Federal role in providing public works would continue to decline, and that the attention of the FIS needed to be devoted to determining appropriate principles, policies and implementation strategies within the context of a more limited Federal role. The future is more likely to increasingly focus on maintaining, operating and refining the Nation's existing infrastructure systems, rather than on large new capital programs. This will involve squeezing more services out of existing facilities through technological innovation, while keeping life-cycle costs under control, and protecting, cleaning up and restoring the environment. Performance, not construction, will be the overriding goal of America's 21st century infrastructure.

THE COUNCIL'S LEGACY: A MULTI-DIMENSIONAL CONCEPT OF PERFORMANCE

It is this atmosphere that has generated much of the current interest in measuring and evaluating the performance of public works infrastructure. In fact, it was the National Council on Public Works Improvement's emphasis on "performance" in *Fragile Foundations* that represents perhaps its greatest contribution to public works policymaking in the 1990's. The Council's report card on the *Nation's Public Works* provided a performance-based assessment which emphasized not only physical (engineering) performance and service outputs, but also considered the manner by which services are delivered in terms of economic efficiency.

The Council's approach has clearly influenced current thinking on how infrastructure performance can be defined, measured, and improved, which has now evolved beyond measuring and assessing simple inputs (resources consumed) and outputs (direct products produced), and is focusing on **outcome measures** to determine the effectiveness of delivering services. As part of the FIS program, a National Research Council Committee on Measuring and Improving Infrastructure Performance formulated a service-based (rather than a standards or condition-based) concept of performance measurement framed by a broad systems approach befitting the multiplicity of objectives and stakeholders served by modern infrastructure networks. The committee noted that no comprehensive single measure of infrastructure performance has emerged, nor is one expected to be identified. Rather, measures of performance (effectiveness) are multi-dimensional, with specific elements chosen based on the local and national goals that infrastructure is meant to achieve.

Infrastructure performance is defined by the degree to which the project/network achieves a hierarchy of goals and objectives. It involves the movement of people and goods and the provision of services that support the nation's economic and cultural activities, provide a clean and healthy environment, and sustain a high quality of life. With improved infrastructure effectiveness, the desired outcome, performance

measures of efficiency, reliability, equity, sustainability, and innovation were identified by FIS participants as critical to formulating a Federal strategy within a multiobjective decisionmaking framework. Within a broader context, these measures are complemented by two overarching national performance indicators for productivity growth and international competitiveness.

THE PROPOSED STRATEGY: LIVING WITHIN CONSTRAINTS

The combined outputs of FIS research and consultations comprise elements of a Federal strategy that can be best understood as a subset of a broader national strategy set forth as a prerequisite. The FIS responds to such a national strategy through the NCPWI framework calling for a Federal-state-local-private sector partnership.

Unlike *Fragile Foundations*, however, the FIS strategy is one of **constrained optimization** - how to maximize performance and efficiency given external factors which limit the resources potentially available to public works. FIS principles are aimed at articulating the means to improve the effectiveness of public works programs within such constraints. A comparative summary of NCPWI findings and FIS principles is provided in Table A.

PRINCIPLES

The Federal Infrastructure Strategy presents possibilities for improving how Federal (and state and local) agencies formulate, evaluate, choose, finance, implement, operate and maintain infrastructure investments. The strategy is based on six principles suggested by participants in the FIS program. These principles are summarized in Table B.

The first principle, **Cost Effective Management and Maintenance**, focuses on infrastructure maintenance and the tendency to underinvest in it. The second, **High Quality Investments**, addresses the need for broadening and improving the application of investment analyses such as benefit-cost evaluations. Both principles embrace straightforward concepts - choose those investments which promise to deliver the highest total rate-of-return, and once they are built, maintain them. But unfortunately, this has not always been the case. All levels of government need to do a better job of choosing capital investments and need to explicitly incorporate maintenance considerations into infrastructure decisions and budgets from the beginning.

The third principle, **Budget Sensitive Financing**, focuses on the need to find new ways to finance infrastructure. The emphasis here is not on short-term public works funding as a one-shot (primarily employment) economic stimulus, but rather on the need to establish a stable and predictable long-term level of infrastructure funding, with public works services efficiently priced. In light of the current deficit, serious proposals for investment must consider low-capital techniques and be based on compulsory financing plans.

Fourth, the consensus view is that there are also substantial opportunities provided by **Innovative Technologies** that can help the Nation improve infrastructure performance. Significant advances in technology have occurred over the last 15 years, yet diffusion into public works has been limited.

TABLE A - INFRASTRUCTURE STRATEGY SUMMARY:
National Council on Public Works Improvement (NCPWI), and the Federal Infrastructure Strategy (FIS) Initiative

ISSUES	National Strategy *FRAGILE FOUNDATIONS* (NCPWI, 1988)	Federal Strategy *HIGH PERFORMANCE PUBLIC WORKS* (FIS, 1994)
Management	- Improve the **efficiency** and **performance** of existing facilities - Greater **incentives for maintenance**, and more rigorous use of **low-capital** and **demand management** techniques	- Adopt **performance measurement** processes and **maintenance** planning, reporting, and accounting as ongoing practices - Refocus management practices on **service delivery** and **performance outcomes**, and **manage demand** to expand capacity
Investment	- A **National commitment**, shared by all levels of government and the private sector, to **increase investment** levels - **Accelerated spending** of Federal highway, transit, aviation, and waterways trust funds	**Resource constraints** facing the Nation require a **Federal commitment** to: - Expand the use of decision support tools, including **benefit-cost** and **risk** analyses, and choose only the most **efficient** investments
Financing	- **Beneficiaries** of public works services should **finance a greater share** of infrastructure costs - Removal of **unwarranted limits** on the ability of state and local governments to help themselves through **tax exempt financing** - A rational **capital budgeting** process at all levels of government	- Adopt "**budget sensitive**" financing, including an increased use of **financial** and **affordability** analyses, with a focus on **small scale (low cost)** improvements and **demand management** - Efficiently **price** infrastructure **services** to broaden the audience for spending decisions, and adjust **grant formulas** to better account for benefit spillovers
Innovation	Accelerate **technological innovation** thru: - Additional support to **R&D activities**, and - Increased **education and training** for public works professionals	- Eliminate **barriers** to the diffusion of **new technologies** and the adoption of more **flexible design standards** - Establish new **cost-shared technology transfer** mechanisms and dissemination centers in **partnership** with the **private sector**
Regulation	- Clarification of the respective **roles** of Federal, state, and local governments to focus **responsibility** and increase **accountability** - More **flexible** administration of Federal and state **mandates** to allow **cost-effective** methods of compliance	- Require regular **inventories** and affordable **sharing of mandated costs** - Establish **baseline estimates** of the costs associated with existing mandates - Allow **local prioritization and scheduling** of compliance choices
Environmental Decisionmaking	- Base public works approvals on **performance based** measures and **peer-reviewed** science - Increased **coordination and cooperation** between the various levels of government	- Integrate & streamline **permitting** and **environmental** decisionmaking processes - Establish a consistent **environmental ethic** within Federal agencies

TABLE B - FEDERAL INFRASTRUCTURE STRATEGY: PRINCIPLES

1 - *Cost Effective Management and Maintenance.* ***Adopt and encourage performance measurement and assessment processes, and maintenance planning and reporting practices to reduce long-term costs through early identification of maintenance needs.*** Improved maintenance of the Nation's massive existing capital stock remains the key to providing a 21st century infrastructure for America. Management practices should be reformed to focus on the performance of services (as indicated by outcomes) in addition to condition improvement measures and operating inputs and outputs. System reliability measures should move beyond deterministic engineering (safety) factors and include statistical or probabilistic based risk functions. Infrastructure performance measurement and assessment processes are essential to effective decisionmaking, while planning (inventorying and tracking) and accounting for deferred maintenance are central to avoiding premature and costly rehabilitation and replacement expenditures. Budget decisions should be based on explicit reporting of the implications of unfunded maintenance. Incentives are needed to encourage the management of demand and the improvement of management practices in order to expand capacity, and as an alternative to Federal regulation.

2 - *High Quality Investments.* ***Obtain maximum benefits compared to costs from all Federal infrastructure programs (directly provided, financially assisted, or regulated) through the use of investment analysis.*** The need for new investment is necessarily constrained by deficit reduction requirements. It is imperative that the Nation fund only the most efficient investments to maximize the rate-of-return from the relatively limited resources available. Performance, not construction, should be the Federal goal, with cost-effective maintenance of existing stock, rather than large new programs, serving as the focus for investment opportunities. A full menu of decision support tools, including benefit-cost and cost effectiveness analyses, and risk assessments should be utilized to establish budget priorities for Federal infrastructure programs. These tools should be expanded, to the maximum extent possible, to incorporate environmental values into the formal analysis.

3 - *Budget Sensitive Financing.* ***Federal infrastructure investments should be identified through the preparation of financial plans and affordability analyses early in the planning process, with full consideration of both traditional and nontraditional funding sources, including demand management options to ensure efficient use.*** There are no large new untapped sources of infrastructure funding on the horizon. America should aim scarce Federal investments at smaller, more affordable facilities. Demand should be managed to stretch the life and increase the capacity of the existing capital stock. Cost sharing and grant formulas should be efficiently priced, not only as a means of financing, but also to minimize the need for new facilities, and to broaden the audience for making spending decisions beyond Federal policymakers. In addition, the availability of tax-exempt funding and opportunities for privatization or other means of revenue diversification should be fully explored.

4 - *Innovative Technologies.* ***Clear the path to the marketplace for new technologies through an explicit, singular Federal infrastructure R&D strategy that provides a stronger link between the development and adoption processes, enhances the partnership between the Federal research community and the private sector, and addresses the liability, regulatory and contracting barriers to innovation diffusion.*** Tort reform is needed to limit liability, while performance specifications should used to ease code restrictions. Intergovernmental cooperation and more cost-shared initiatives are needed between the various levels of government, academia, and industry. New technology transfer mechanisms and partnerships should be more directly tied to local public works needs and based on earlier involvement of the private sector.

5 - *Regulatory Reform.* ***The fundamental rights of all citizens should be protected through a new regulatory Federalism which more equitably and flexibly distributes the costs of meeting environmental and other performance requirements.*** The dramatic increase in Federal regulations over the last twenty years has constrained local public works priorities and budgets. Regulatory programs should be examined to identify the cumulative effects of Federal requirements and to relieve the unintended preemptive fiscal impacts on local governments. Baseline estimates of the costs to local governments associated with existing mandates should be developed. All proposed regulations affecting infrastructure should be reviewed to ensure that they are necessary and the least burdensome means for accomplishing National goals. New environmental regulations should be based on more certain and reliable information on the health and cost effects of each increment of health protection.

6 - *Integrated Environmental Decisionmaking.* ***Rethink the current sequential environmental decisionmaking processes toward an integrated, multi-media, ecosystem-based, one-stop review of public works projects.*** A consistent environmental ethic is lacking from most Federal infrastructure programs, while the existing environmental decisionmaking process remains gridlocked. The Federal government should seek a single, integrated environmental approvals and compliance process based on the framework of the National Environmental Policy Act. Such a process should incorporate a fundamental consideration of the environment into the planning and design of all infrastructure programs and projects with impact avoidance or minimization explicitly stated goals from the outset.

Breakthroughs in high performance materials, computers, communications, artificial intelligence, and other technologies can help increase infrastructure capacity, performance and efficiency while minimizing major new construction and further disruption to the environment.

Finally, there is a need to simplify regulations **(Regulatory Reform)** while integrating environmental considerations into infrastructure planning and design from the ground-up **(Integrated Environmental Decisionmaking)**. Participants recognized that regulation is about balancing tradeoffs between sometimes apparently disparate goals, in this case: protecting the health and safety of the American people, protecting the natural environment, and providing public works to maintain economic growth, national security and international competitiveness. Most participants agreed that the Federal government needs to rethink these processes and all levels of government need to better integrate environmental and cultural concerns into the planning of public works.

ACTION AGENDA

Participants in the program also recognized that while some changes can be made quickly under existing authorities, the full implementation of the proposed principles will necessarily involve legislative actions. Therefore, the strategy includes an action agenda (implementation plan) which views the pervasive Federal influence as a catalyst for change. The agenda includes three primary implementation elements: (1) leadership by the President and the Congress; (2) the issuance of guidance; and (3) government-wide support actions. Table C summarizes the recommended components of this plan.

The top priority among participants was the expressed need for Presidential and Congressional leadership in establishing clear principles to guide investment strategies. In particular, it was suggested that:

- The President consider issuing issue executive orders to establish a Federal infrastructure investment policy to be applied to Administration appropriations and authorization processes

- The Congress examine the legislative options for mandate reform, environmental integration, and the means for improving budget and authorization decisions based on investment criteria

- Federal agencies take advantage of the opportunities presented by the *Government Performance and Results Act of 1993* to reorient infrastructure programs around performance goals and the measuring and reporting of results.

EMERGING POLICIES

Products of the interagency consultation and other FIS activities were coordinated through the Office of the Assistant Secretary of the Army (for Civil Works) with the President's National Economic Council (NEC) working groups on Infrastructure Management and Finance, other Federal agencies, and Congressional interests. The FIS dialogue took place at an opportune time, concurrent with a broad range of Federal policy making activities, and coincident with the numerous reforms of Federal business and decision making processes through various Administration and Congressional initiatives.

The actions summarized in Table C are discussed throughout this report within the context of policy and legislative initiatives which have already begun to establish policies consistent with the strategy's investment, management, regulatory, and research and development principles. Some of these initiatives stem from the White House infrastructure working groups. Several can be attributed to the government-wide reforms in response to Vice-President Gore's *National Performance Review (NPR)*. Others originated as Congressional responses to a variety of national issues. The initiatives include:

- ***The Government Performance and Results Act (GPRA) of 1993*** represents a fundamental change in the manner in which Federal agencies monitor and report program performance. The Act requires each agency to develop and submit strategic and annual program performance reports, and to improve managerial accountability and flexibility. OMB has approved more than 100 agency pilots to demonstrate and evaluate the implementation of GPRA requirements.

- ***The Government Management Reform Act (GMRA) of 1994***, which follows-up on the ***Chief Financial Officers Act*** and the ***GPRA*** by requiring that agencies produce financial statements that account for all activities, spending and revenue, and that OMB publish an annual financial statement covering all Executive Branch activities.

- **Executive Order No. 12866 on *Regulatory Planning and Review*** supersedes E.O. 12291. The new Order establishes a program to reform Federal regulatory processes. It requires that all proposed regulatory actions which have an economic impact of $100 million or more be subjected to benefit-cost analysis, compared with alternatives to regulation, and chosen only if net benefits are maximized. It also requires agency regulatory plans, a centralized review process and consultation with State, local and tribal governments where regulations with significant financial cost to these entities are being considered. Several White House Memorandums on *Agency Rulemaking, Regulatory Reform,* and *Negotiated Rulemaking* serve to reinforce these requirements.

- **Executive Order No. 12875 on *Enhancing the Intergovernmental Partnership*** is aimed at reducing the imposition of unfunded Federal mandates on State, local, and tribal governments by requiring that agencies document the extent and nature of consultations with affected governments when the funds necessary to pay the cost of compliance are not Federally provided.

- **Executive Order No. 12881 on *Establishment of the National Science and Technology Council (NSTC)*** improves the coordination of Federal science, space, and technology policies. The NSTC, through its coordinating committees on Civilian Industrial Technology, Environmental and Natural Resources, and Transportation, provides the means for ensuring the establishment of clear National goals for Federal technology investments; more effective coordination of technology policy-making and R&D; and, the prioritization of technology development and transfer programs.

- **Executive Order No. 12893 on *Principles for Federal Infrastructure Investments***, which constitutes an important milestone in Federal infrastructure policymaking. It represents the first set of investment principles formally articulated by the Executive Branch for consistent application across a range of Federal agencies and programs. The Order requires agencies to develop: systematic analyses of benefits and costs for direct spending and grants for capital programs; an annual programmatic investment analysis of capital accounts in conjunction with future budget submissions; and an investment analysis justification

TABLE C - FEDERAL INFRASTRUCTURE STRATEGY: ACTION AGENDA RECOMMENDATIONS

Management and Maintenance

- **Make performance measurement processes integral** to agency decisionmaking
- **Re-focus management practices** on service delivery with performance measured by outcome-based indicators
- **Develop multi-year maintenance plans** based on periodic inventories and condition assessments
- **Explicitly consider future maintenance costs** when selecting new or replacement capital assets
- **Report unfunded maintenance** by identifying both the "dollar gap" and the performance implications

Investment Analysis

- **Broaden the use of benefit-cost and risk analyses** for budget submissions and legislative clearance
- **Expand investment analysis** to more explicitly incorporate environmental values into the decision-making process
- **Convene a White House Conference on Infrastructure Investment**
- **Seek statutory authority** for the use of investment principles to further improve budget and authorization decisions

Public Works Financing

- **Prepare and use financial plans** for all agency infrastructure programs
- **Establish financial advisory boards** to strengthen and diversify agency financing approaches
- **Review Federal tax and security laws** limiting state and local access to revenue sources
- **Review grant formulas and user fees** to ensure consistency between beneficiaries and financing sources
- **Consider establishing a public works investment section** in the President's budget

New Technologies

- **Establish new technology transfer mechanisms** and public-private demonstration partnerships
- **Establish independent test-bed and technology dissemination centers** for demonstration projects
- **Develop performance-based standards** to foster design innovation
- **Reform liability, regulatory, and procurement** procedures

Regulatory Federalism

- **Conduct regular inventories and prepare cost estimates** of existing and proposed Federal mandates
- **Analyze the incidence of costs** and **the ability of affected parties to pay** for mandated public works
- **Develop an affordable prioritization and scheduling** of non-Federal compliance
- **Provide, where possible, equitable Federal sharing** of mandated costs
- **Ensure that the formulation of any mandate relief** legislation considers these provisions

Environmental Decisionmaking

- **Integrate the current sequential approval processes** into a consolidated umbrella process
- **Imbed a stronger, more consistent environmental ethic** across Federal agencies
- **Revise legislative, regulatory, and budget procedures** to incorporate integration
- **Conduct pilot projects** under the *GPRA* on outcome-based performance measures
- **Consider legislation** to establish an integrated environmental approval process under *NEPA*

for all major legislative proposals that authorize or reauthorize infrastructure programs. Operations and maintenance activities are considered a form of infrastructure management and are subject to requirements for periodic reviews of the performance of existing facilities. Federal infrastructure categories covered by the order include transportation, water resources, energy, and environmental protection programs.

Examples of other agency, government-wide, or professional organization actions that are consistent with FIS principles are listed below (also see Section V).

- The Federal Highway Administration's ***Highway Economic Requirements System (HERS)***
- Office of Management and Budget **Circular A-131 on** ***Value Engineering***
- The Department of Energy's ***Capital Asset Management Process***
- The Department of Transportation's interagency effort on the articulation of an intermodal **National Transportation System**
- The Corps of Engineers ***National Operation and Maintenance (O&M) Plan of Improvement Environmental Service Partnerships***, and ***Evaluation of Environmental Investments Research*** *programs*
- The Federal Highway and Transit Administration's initiative on ***Integrating Environmental Considerations into Transportation Planning***
- The Environmental Protection Agency's ***Common Sense Initiative***, and **Environmental Technology Initiative**
- Last year's Capitol Hill Summit on ***Federal Capital Budgeting*** sponsored by the Advisory Commission on Intergovernmental Relations, the National Academy of Public Administration, and the Rebuild America Coalition, (in cooperation with the Corps of Engineers)
- The Federal Highway Administration's partnership with the **Civil Engineering Research Foundation (CERF)** on the **Highway Innovative Technology Evaluation Center (HITEC)**, and FHwA's **Applied Research and Technology (ART)** program
- The Corps of Engineers **Construction Productivity Advancement Research (CPAR)** and **Repair, Evaluation, Maintenance Research (REMR II)** programs
- National Science Foundation's research initiative on ***Civil Infrastructure Systems***
- The interagency collaborative **Technology Reinvestment Project** program (Departments of Defense and Energy, NIST, NSF and NASA)
- National Research Council's **National Cooperative Highway Research IDEA** program, and the recent establishment of a ***Board on Infrastructure and the Constructed Environment (BICE)***

- The National Academy of Public Administration and the American Public Works Association are working in cooperation to establish a ***Center for Infrastructure Management and Analysis***

- The American Society of Civil Engineers is planning to publish a **Journal of Infrastructure Systems**

REPORT ORGANIZATION

This report is presented in two parts. Part 1 summarizes the program results, including the brief descriptions of: Policy Context (Section I); Why A Federal Strategy? (II); Process and Participation (III); and Study Agenda (IV). The Federal Strategy is described in Section V.

Part 2 consists of six sections organized around the key issues addressed by the strategy: Better Managing What We Already Have (Section VI); Choosing More Efficient Investments (VII); Budget Sensitive Financing (VIII); The Critical Role of New Technologies (IX); Clarifying Roles Through A New Regulatory Federalism (X); and, Improving Environmental Decisionmaking (XI). Concluding remarks are contained in Section XII.

Supporting information can be found in the interim reports previously published as part of the FIS program. A complete listing of the FIS report series is presented on page iv.

Quotes from a variety of sources, including presentations at FIS-sponsored meetings, a literature review, and recent related agency initiatives, have been selected to introduce the issues presented in the various chapters of this report. Such quotes are intended only to frame the discussion presented therein, and should not be interpreted as representing the support, concurrence or approval of FIS findings and recommendations by the individual or organization quoted.

PART 1 - SUMMARY OF RESULTS

"This effort to develop an infrastructure strategy is important and timely for three reasons. First, it can help us achieve economic growth and productivity by improving infrastructure investment, decisionmaking, and management. Second, it will help us make the tough budget decisions that are important no matter what budget you're dealing with. ...Budgets are always a question of limited resources, but now the problems of using our resources effectively are more serious than ever. Third, an infrastructure strategy will help us deal with the wider implications of infrastructure such as environmental quality and safety."

Dr. Alice M. Rivlin, Deputy Director (currently Director), Office of Management and Budget, remarks at the National Conference on High Performance Public Works, July 1993

Table 1 - Events and Voices in the Federal Policy Debate: Chronology of Key National Infrastructure Milestones and Studies

1981	*America in Ruins: Beyond the Public Works Pork Barrel*, by Choate and Walters, charged that lack of maintenance was seriously endangering the ability of the Nation's infrastructure to continue meeting essential needs
1983	The failure of the Mianus, Connecticut highway bridge focuses renewed attention on the physical condition of the Nation's infrastructure
1983	*Public Works Infrastructure: Policy Considerations for 1980's* published by Congressional Budget Office
1984	*Hard Choices: A Report on the Increasing Gap Between America's Infrastructure Needs and Our Ability to Pay for Them* by University Colorado at Boulder presented to the Joint Economic Committee of Congress
1984	*Public Works Improvement Act of 1984* (P.L. 98-501) creates the National Council on Public Works Improvement (NCPWI) to assess the state of America's infrastructure
1986	*Water Resources Development Act of 1986* (P.L. 99-662) represents fundamental reform of cost- sharing principles for Federal water projects
1987	*The Nation's Public Works* series of reports published by National Council on Public Works Improvement
1988	*Fragile Foundations: A Report on America's Public Works* by NCPWI concludes that the Nation's infrastructure is barely adequate to fulfill current requirements and insufficient for future economic growth
1989	A series of articles by Dr. David Aschauer published in the Journal of Monetary Economics triggers a debate among economists and policymakers regarding the relationship between economic productivity and public investment in infrastructure
1990	*New Directions for the Nation's Public Works* published by Congressional Budget Office (CBO)
1990	*Rebuilding the Foundations: A Special Report on State and Local Public Works Financing and Management* published by Congressional Office of Technology Assessment (OTA)
1991	*Delivering the Goods - Public Works Technologies, Management, and Financing* published by OTA
1991	*How Spending for Infrastructure and Other Public Investment Affects the Economy* published by CBO
1991	*Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991* enacted as landmark first highway and transit bill since near completion of the Interstate Highway System
1992	*Paying for Highways, Airways, and Waterways: How Can Users Be Charged?* published by CBO
1993	*High Performance Public Works: A New Infrastructure Investment Strategy for America* published by the U.S. Advisory Commission on Intergovernmental Relations and the U.S. Army Corps of Engineers
1994	*Principles for Federal Infrastructure Investments* issued as Executive Order No. 12893

I. POLICY CONTEXT

"Not only have previous studies not provided very convincing answers to whether there is or has been an infrastructure shortage, but they may not have even focused on the right question in the first place. Even if there were no doubt of an infrastructure shortage, it is not clear what infrastructure policy or policies should be changed. By the same token, finding no evidence of shortage would not mean that no policy should be changed. Hence, rather than asking whether there is a shortage, it seems more helpful to ask what, if any, policies should be changed."

Dr. Edward M. Gramlich, University of Michigan, from "Infrastructure Investment: A Review Essay", Journal of Economic Literature, Vol. XXXII, September 1994.

BACKGROUND

The condition of the Nation's infrastructure has been a subject of widespread interest since the early 1980's. In 1981, Pat Choate and Susan Walter's report, *America in Ruins*, triggered a watershed of reports which debated the fundamental issues surrounding infrastructure needs, investment strategies, and the clarification of the roles of all levels of government in providing and maintaining public works (see chronology in Table 1).

The most comprehensive national study was the 1988 final report of the National Council on Public Works Improvement (the "Council", 1984-1987). Although the Council's final report concluded that the state of the Nation's infrastructure stock was not as poor as previous reports had purported, it also stated that there was a danger that, if action is not taken, further deterioration of public facilities will threaten the Nation's economic productivity.

The Council found "convincing evidence that the quality of America's infrastructure is barely adequate to fulfill current requirements, and insufficient to meet the demands of future economic growth and development." The report called for a doubling of the Nation's capital investment and for renewed attention to the maintenance of highways, roads, bridges, airports, transit systems, ports, waterways, water supply, wastewater treatment, solid waste, and hazardous waste facilities. (See Table 2 for a summary of *Fragile Foundations'* recommendations).

The perception that America is not paying enough attention to its public works has persisted in the minds of the public, despite subsequent reports by the Congressional Budget Office and the Congressional Office of Technology Assessment which challenged some of these arguments, especially the premise that the nation is underinvesting in public works and should increase spending levels by as much as 100 percent.

Table 2 - Strategy for Improving America's Public Works
National Council on Public Works Improvement

No single approach is adequate to ensure the future viability of America's infrastructure. A broad range of measures is necessary to make a meaningful difference by the turn of the century. Specifically these should include:

- A national commitment, shared by all levels of government and the private sector, to increase capital spending by as much as 100 percent above current levels
- Clarification of the respective roles of the Federal, state, and local governments in infrastructure construction and management to focus responsibility and increase accountability
- More flexible administration of Federal and state mandates to allow cost-effective methods of compliance
- Accelerated spending of Federal highway, transit, aviation, and waterways trust funds
- Increased cost-sharing of public works by those who benefit from its services
- Removal of unwarranted limits on the ability of state and local governments to help themselves through tax-exempt financing
- Stronger incentives for maintenance of capital assets
- Greater use of low-capital techniques, such as demand management, coordinated land use planning, and waste reduction and recycling
- Additional support for research and development to accelerate innovation
- Increased training of public works professionals
- A rational capital budgeting process at all levels of government

None of these steps will be easy or unopposed. But the increasing cost of delay is certain. The Council urges the President, the Congress, and the Nation's state and local leaders to act on the agenda immediately.

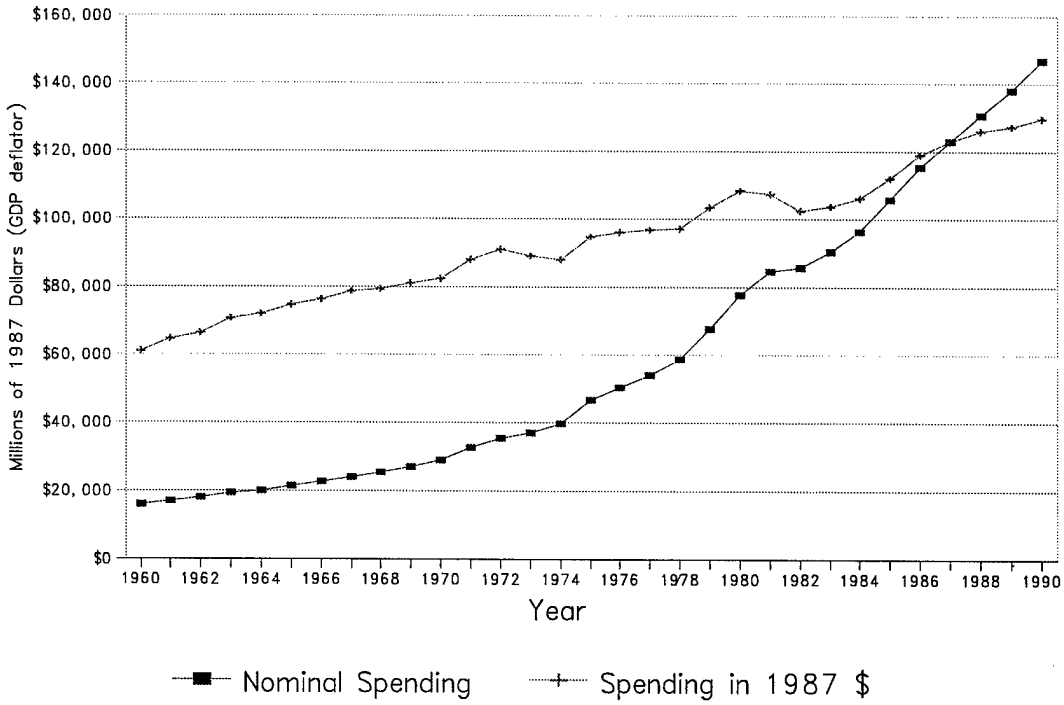
Source: Fragile Foundations, National Council on Public Works Improvement, 1988

SPENDING ON PUBLIC WORKS

Past literature on public capital's impact on economic productivity reflects much controversy over whether the Nation's level of public infrastructure investment has been sufficient. A review of the literature actually allows one to conclude that the level of public investment in America's infrastructure has been: [choose one] (a) grossly inadequate; (b) more than adequate; or, (c) about right.

The answer arrived at is largely dependent on the time period chosen for analysis, the level[s] of government examined, the public works categories included, the analytical stance taken, the level of data disaggregation, the context of the statistics used, and the perspective of the analyst. It is not surprising that it is possible to point to data supporting all three conclusions simultaneously without engaging in a contradiction merely by varying the assumptions used to adjust expenditure figures for inflation, wealth, population, and productivity (i.e. nominal or constant dollars, inflation-adjusted dollars using a range of possible price deflators, spending as a percent of GNP or GDP, per-capita spending, or investment as a percent of total government spending).

For example, measured in nominal dollars, that is dollars which are not adjusted for inflation, total infrastructure investment (including capital and non-capital spending for highways, mass transit, rail, aviation, water transport, water resources, water supply, and wastewater treatment) by all levels of government rose by over 900 percent between 1960 and 1990 (see Figure 1). Of course, examining only nominal dollars can be misleading since they ignore inflation effects, the increase in U.S. population, and the growth of the Nation's wealth.

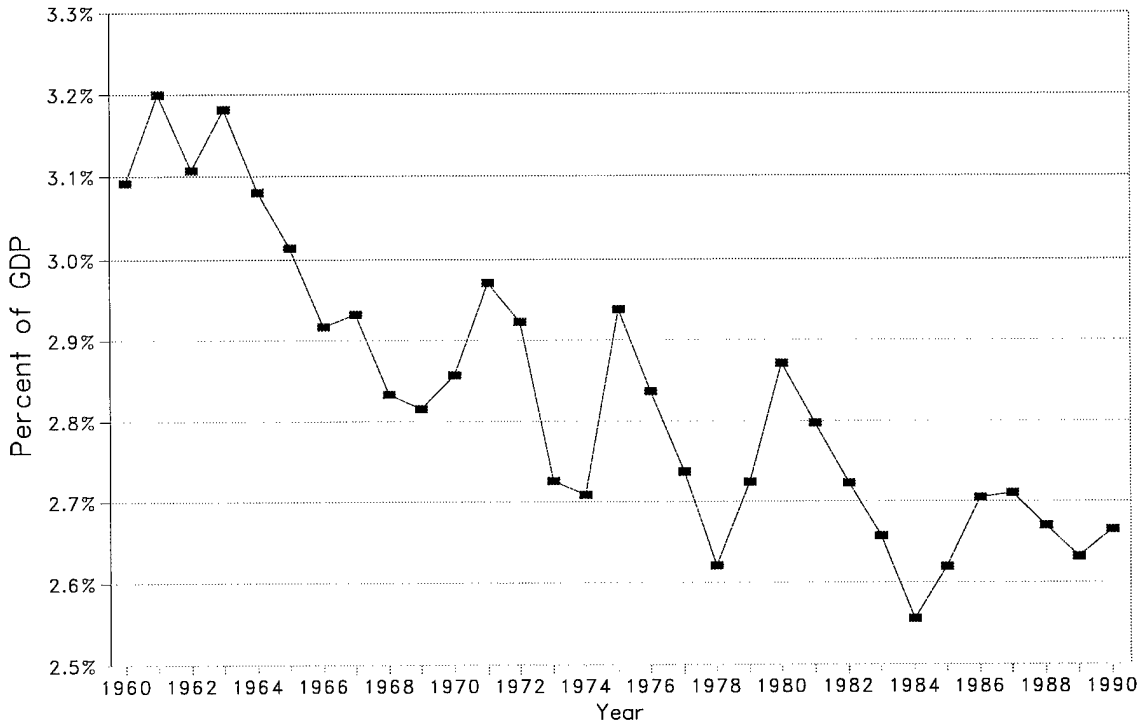


Source: Congressional Budget Office (1991)

Figure 1 - Nominal and Real Total Spending for Public Infrastructure, 1960-1990

Measured in 1987 dollars, the growth between 1960 and 1990 remains significant, representing about a one hundred percent increase (also Figure 1). Of course, inflation adjustments alone do not account for changes in the population or economy. Based on a per-capita basis (and using 1987 dollars), the increase in funding during this period falls to approximately fifty percent.

To approximate changes relative to the economy as a whole, infrastructure spending is often expressed as a percent of GNP or GDP. Such adjustments highlight a relative decline in public works spending since 1960. As a percent of GDP, for example, infrastructure spending has fallen from approximately 3.2 percent in 1960, to about 2.6 percent in 1990 (Figure 2).



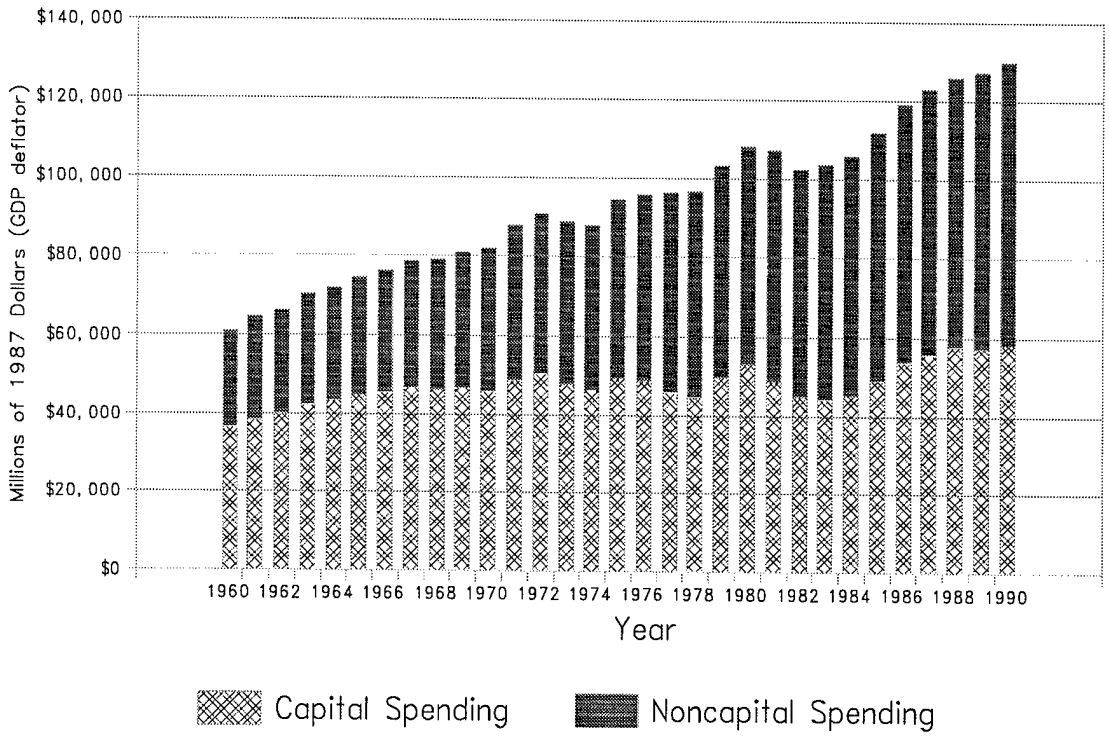
Source: Congressional Budget Office (1991)

Figure 2 - Public Spending for Infrastructure as a Percent of GDP, 1960-1990

Figure 2, however, masks an even greater relative decline in capital spending, while annual outlays for operations and maintenance (O&M) have actually increased from 1.3 to 1.5 percent of GDP between 1960 and 1990. Further disaggregation would show different growth rates for the various categories of public works, and across geographic areas. From an intergovernmental perspective, annual Federal outlays peaked in the late 1970s at approximately $30 billion (1987 dollars). Since that time expenditures by state and local governments have steadily grown.

Spending for O&M remains the key to the continued effectiveness of public works assets. In 1960, approximately three-fifths of the monies spent on public works was devoted to new investment, with the remaining two-fifths going to O&M. America was still beginning to build its new interstate highway system, and a growing and mobile population in flush economic times required the construction of new public works

systems all over the nation. By 1990, the nation was spending $130 billion; however, the relative importance of maintenance spending vis-a-vis new capital spending had been reversed with the proportion of non-capital spending accounting for more than 55 percent of total infrastructure spending (Figure 3).



Source: Congressional Budget Office (1991)

Figure 3 - Capital and Non-Capital Spending for Public Infrastructure, 1960-1990

Although all of these adjustments help provide insights into public investment data, taken as a whole they also highlight the difficulties in reaching a clear consensus on what the implications of these trends really are. And when using these trends to determine whether America is truly underinvesting in infrastructure (as a whole or within certain public works sectors), the starting place is just as unclear. Our Nation's "infrastructure" consists of many diverse components and complex networks. The economic effects of highways, harbors, airports and water treatment facilities, for example, are each quite different and each poses a unique measurement challenge.

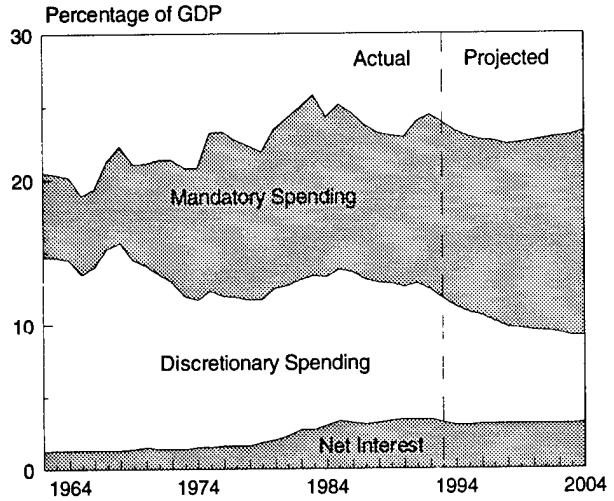
While critics of macroeconomic analyses point to a number of technical problems - such as causality, aggregation bias, and collinearity issues - many policy makers also believe that micro-level analyses have not adequately measured total infrastructure needs. The most often cited weaknesses of microanalysis includes the failure to incorporate important externalities and network effects. When it comes to trying to assess future needs, the picture becomes even more cloudy - complicated by the fact that the services delivered by important categories of public works are not generally sold on the market and because the depreciation rates for infrastructure stocks must be estimated.

Within this context, the emphasis of policy research has clearly been extended beyond the arguments of the 1980's regarding whether or not the Nation is truly underinvesting in public works (is there an infrastructure financing "gap"?), or the related debate over how much public investment really matters to the economy (what is the nature of the link between public investment and economic productivity?).

This evolution in focus is partly due to the realization that the era of ambitious new capital programs is certainly over. However, this policy shift is also a manifestation of today's budget reality. The question of whether or not there is an "investment gap" is simply not as relevant as it was ten years ago. There simply isn't much new money available for public works - not at the Federal level, or any other level of government for that matter!

Federal infrastructure programs are largely funded from domestic discretionary appropriations. Discretionary spending continues to be under tremendous budget pressure due to the growth of mandatory spending and interest on the debt (see Figure 4). The reality of this budget constraint (and the funding constraints facing other levels of government) underscores the critical need for any overarching Federal infrastructure policy to focus on doing a better job of managing what we already have and choosing only the most efficient and affordable new investments.

Components of Federal Spending as a Percentage of Gross Domestic Product, 1962-2004



Source: Congressional Budget Office (1994)

Figure 4 - Components of Federal Spending as a Percentage of GDP, 1962-2004

THE NEED TO LIVE WITHIN CONSTRAINTS

More than ever before, Federal infrastructure policies necessarily reflect decisionmaking within a framework of **constrained optimization** - how to make the best of a situation given external factors which limit the scope of action. **Scarcity** abounds - there are increasingly limited resources potentially available for public works, and only so much of that potential that citizens are willing to devote to it, and only so much that existing institutions are capable of achieving.

Thus, given that only limited Federal resources and opportunities for action are available, a Federal infrastructure strategy should provide the means for examining these constraints within a framework measuring the efficiency and effectiveness of resource tradeoffs. Figure 5 provides a graphic depiction of one such conceptual framework.

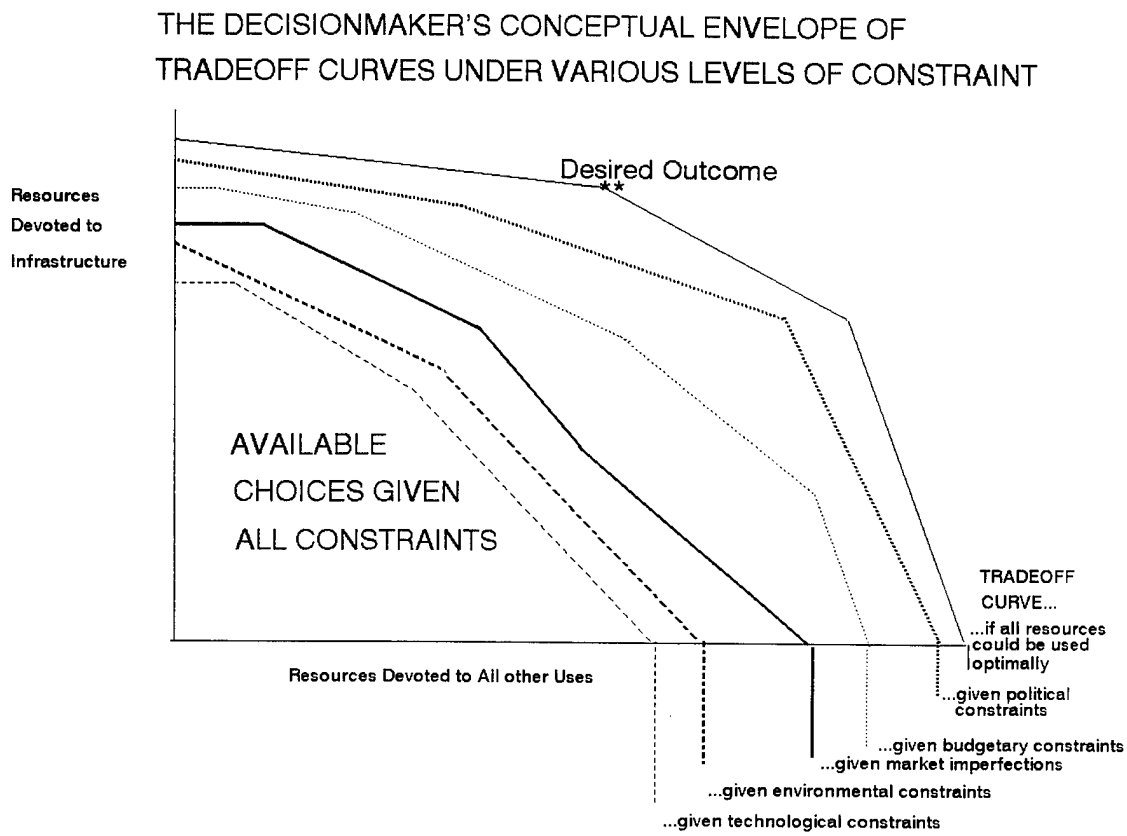


Figure 5 - The Decisionmaker's Conceptual Envelope of Tradeoff Curves

First there is the overall resource constraint which the economy and the Nation faces. The growing Federal debt, annual budget deficits, and the reality of tight budgets facing all levels of government underscores this constraint and refocuses the infrastructure debate on doing a better job of better managing what we already have, squeezing increased levels of performance out of existing facilities, and choosing only the best new investments. Central to these issues are the concepts of performance and efficiency.

Other constraints are presented by the preferences of society at large which must be considered. The public is only willing to spend so much money on infrastructure at the expense of other things. Political institutions have their own rigidities which further limit choice, such as the difficulties of coordinating policies among many different agencies. The need to accommodate the traditional objectives of infrastructure, e.g., reduction in travel time, increased safety, the generation of energy, or the disposal of waste, while at the same time protecting the environment is an example of this type of constraint. This requires sorting out those circumstances where economic development and environmental protection are truly compatible from those where trade-offs must be made among conflicting objectives. Although society's aim is to develop infrastructure consistent with environmental protection goals, the reality is often one of competing or conflicting policies and outcomes.

Finally, there are market or technology limitations, which further limit choice. The need to focus on low-capital solutions, innovative sources of financing, budget sensitive alternatives, and new R&D products, especially in the area of environmental technologies, are mechanisms to address these constraints. Limits in the technology transfer and implementation process may also constrain choices within this boundary.

Given such constraints, working towards even a rudimentary identification of the optimal levels of infrastructure investment across Federal programs remains a formidable task, with many difficult data collection, analytical, and institutional obstacles to be overcome. More manageable, but still problematic, is establishing priorities within single agencies and programs, and making trade-offs at the margin within and between programs and agencies.

A MULTI-DIMENSIONAL CONCEPT OF PERFORMANCE

It is this climate that has generated much of the current interest in measuring and evaluating the performance of public works infrastructure. In fact, it was NCPWI's emphasis on "performance" which represents perhaps its greatest legacy today. Its report card on the Nation's Public Works was a performance-based assessment which emphasized not only physical performance and delivery of services, but also considered the manner by which services are delivered in terms of economic efficiency.

Indeed, the concept of "performance" is central to the policy reforms sweeping all levels of government today. At the Federal level these range from the recommendations of Vice-President Gore's *National Performance Review*, to the requirements of the *Government Performance and Results Act of 1993*, and a number of Administration initiatives, many based on a series of Executive Orders which are discussed throughout this document.

Still, *Fragile Foundations* only hinted at a clear definition of the term "performance", saying simply that: *"The demand for and supply of public works services jointly determine performance levels and the quality of services provided"*, while suggesting an extensive list of measures that might be used in assessment. A committee organized by the National Research Council's *Board for Infrastructure and the Constructed Environment (BICE)* recently completed a FIS study on the measurement and improvement of infrastructure performance. The purpose of the study was to develop an operational understanding of how public works performance can be defined, measured, and improved.

A key finding of the BICE committee was that no comprehensive single measure of performance has emerged, nor is one expected to be identified. Therefore, the committee focused on refining the definition

of performance as a multi-dimensional function of infrastructure's effectiveness in delivering services. This concept of performance goes beyond measuring and assessing simple inputs (resources consumed) and outputs (direct products produced), and instead focuses on **outcome measures** to determine the effectiveness of meeting service goals. Effectiveness, in turn, is multi-dimensional, with specific elements such as reliability of service delivery, and cost of services on a total life-cycle basis, depending on local and national goals that infrastructure is meant to achieve.

Although infrastructure program goals are likely to involve such aspects as direct and indirect economic and social benefits, quality of life improvements, environmental protection, and reduced safety or public health risks, there is no accepted framework for broadly measuring infrastructure performance. Expanding on the *BICE's* work, the development of a framework for evaluating performance requires:

- Defining program goals and objectives
- Selecting performance measures
- Establishing or utilizing a data management system
- Development performance benchmarks
- Measuring performance in relation to these goals and benchmarks
- Applying the resulting assessment to the decision-making process

With improved infrastructure performance (effectiveness) the desired outcome, FIS participants identified the concepts of efficiency, reliability, equity, sustainability, innovation, and revenue diversification as essential to formulating a Federal strategy within a constrained decisionmaking framework. Based on a review of past work and input from the FIS consultation, the following public works goals were suggested as the primary objectives to guide the development of the strategy:

1) **Efficiency.** Apply economic analyses consistently across Federal infrastructure networks to ensure that only the most efficient programs and projects are chosen. Infrastructure affects the quality of life and the environment as well as the economy, but these effects have been difficulty to quantify. Therefore, improved methods are needed for evaluating the magnitude of environmental outputs for various kinds of public works investments.

2) **Reliability.** Improve the performance of America's existing capital stock by strengthening the links between safety, service availability and customer demand. Aim management and maintenance techniques at extending the lives of existing systems in concert with demand projections to minimize the need for new facilities. A specific need is to improve the performance measurement process for assessing the availability, condition and safety of existing public works systems.

3) **Equity.** Given that the Nation's fundamental standards of human health and safety do not vary geographically, intergenerationally, or culturally, regulatory and grant programs should be examined to identify any unintended consequences of Federal mandates and diminishing Federal financial aid. Improved mechanisms are needed to more accurately measure and assess customer satisfaction and to ensure that those

National Research Council Study on Measuring and Improving Infrastructure Performance

As part of the FIS program, the Corps asked the National Research Council (NRC) to undertake a study on measuring and improving infrastructure performance. The NRC appointed a Committee on Measuring and Improving Performance to accomplish this task. The committee focused on issues arising from **transportation, water, and waste** within urban regions. To provide a practical background for its study the committee visited three metropolitan areas selected to represent situations in which performance measures might be used: Baltimore, Maryland; Portland, Oregon; and Minneapolis-St. Paul, Minnesota.

The committee utilized a systemwide **perspective across** infrastructure categories to facilitate thinking about the interactions and tradeoffs among the various modes. The committee formulated a service-oriented, bottom-up framework for quantitatively measuring and assessing performance that stands in contrast to a traditional physical engineering, standards-based performance measurement focus. This process can be adopted to all levels of government. The field visits illustrated that **institutional setting** is crucial to performance measurement and that a variety of institutional structures are possible. Other key findings included:

- **Infrastructure performance** is defined by the degree to which the system serves multilevel community objectives. Identifying these objectives and assessing and improving performance occur through an essentially political process that should involve **multiple stakeholders**.

- **Performance measurement**, a technical component of the broader task of performance assessment, is an essential step in effective decision-making. Despite the importance of measurement, current practices of measuring comprehensive system performance are generally inadequate.

- **No adequate, single measure of performance** has been identified, nor should there be an expectation that one will emerge. Performance should be assessed on the basis of multiple measures chosen to reflect community objectives. The specific measures used may be grouped into three broad multidimensional categories: effectiveness, reliability, and cost.

- **Infrastructure performance cannot be managed if it cannot be measured**. While not every aspect of performance is quantifiable, attempts should be made to devise quantitative indicators of performance. Such **measures** should be used to develop benchmarks that policymakers can use for setting goals and comparing performance among systems.

- **Performance assessment**, the process by which objectives are defined, measures specified, and conflicts reconciled, requires **sound data**, which is often lacking. Continuing, coordinated data collection and monitoring are needed to establish benchmarking and performance assessment. Federal agencies should assure that national data sets are compatible, computerized and accessible.

- **A broad menu of multi-objective techniques** should be considered to facilitate the evaluation trade-offs during the assessment process. Lack of sufficient information is also a source of uncertainty in the assessment of system reliability and thus in decision-making. As such, the principles and methods of **risk analysis** can be applied to aspects of performance assessment.

- **Agencies should adopt infrastructure performance measurement and assessment** as an ongoing process to effective decisionmaking. In this regard, agencies should undertake a critical self-assessment to determine the nature and extent of any impediments to adoption of a performance assessment process. All measures should be periodically reviewed/revised to respond to changing needs.

- **There is a valid national interest in local infrastructure performance** because the long-run and sometimes unintended consequences of infrastructure systems frequently go far beyond the physical installations themselves. Federal infrastructure policy should be revised to accommodate local performance measurement processes within the context of this national interest.

Source: *Measuring and Improving Infrastructure Performance*, National Research Council, Committee on Measuring and Improving Infrastructure Performance, forthcoming.

who most directly benefit from public works are financially responsible for an equitable and affordable share of costs.

4) **Environmental Sustainability.** Formulate infrastructure program objectives so that more potential adverse impacts are avoided or eliminated from the outset. Reorient the regulatory process by shifting from a single-media/point source control and cleanup approach to a philosophy of avoidance and pollution prevention based on a more flexible ecosystem strategy, and fully integrate environmental decisionmaking into public works programs and processes.

5) **Innovation**. Technological, managerial, legal, institutional, and other innovations are needed to maintain and improve the nation's infrastructure. New R&D products have great potential for public works providing increased levels of infrastructure service and outputs at lower costs, especially in the areas of service and outputs at lower costs, especially in the areas of environmental technologies, telecommunications, deterioration science, non-destructive assessment technologies, and renewal engineering.

6) **Revenue Diversification**. Focus on low-capital solutions, budget sensitive alternatives, "beneficiaries pay" mechanisms, and intergovernmental funding sources to help overcome the financing challenge of maintaining even modest future spending levels, since there clearly isn't enough money available for business as usual.

Within a broader context, the above stated objectives are complemented by two key overarching goals which serve as national outcome-based performance indicators:

7) **Productivity Growth**. Most estimates confirm infrastructure's positive effect on national productivity. It is possible, however, to invest too much, as well as too little in public works. Investment policy research needs to continue focusing on describing the relationship between public works and economic growth and productivity to better define and target optimal levels of infrastructure investment.

8) **Competitiveness and Jobs**. The continued effectiveness of the Nation's infrastructure networks is vital to maintaining America's preeminent position in the global economy. Improved cross-program prioritization and additional policy research are needed, however, to ensure that public works investments are not just aimed at creating short-term jobs, but on also providing a foundation for continuing job creation and sustained economic growth.

II. WHY A FEDERAL STRATEGY?

"This strategy is called a Federal Strategy, yet most of our public works are state and local. You might think that we haven't looked very much at the whole problem, but let me assure you that we have. The Federal influence is quite pervasive, it affects not just those types of infrastructure built, operated, and maintained by Federal agencies, but all of those that are constructed with Federal aid, and those that are Federally regulated on environmental aspects, access for the handicapped, relocation and land acquisition, labor standards, even wage control. Many of the Federal practices and regulations in the past have not been consistent from one program to another, and that has posed a major problem for state and local governments... So one of the objectives of getting a consistent cross- program Federal strategy is to make it easier for the state and local people."

Dr. Bruce D. McDowell, Director, Government Policy Research, Advisory Commission for Intergovernmental Relations, remarks at "Framing a Federal Infrastructure Strategy", Transportation Research Board 73rd Annual Meeting, January 10, 1994.

Existing responsibilities for public works involve a complex array of institutions and interrelationships for which accountability is sometimes difficult to identify. The roles of the various Federal, state, local, and private sector interests vary not only by the type of infrastructure program, but also by the nature of the programmatic responsibilities involved. The complexities inherent in these relationships remain today, even as Federal aid for infrastructure has declined through the 1980's and state and local governments have assumed more responsibilities.

As pointed out in *Fragile Foundations*, most public works are provided by state and local governments, either directly or through the private sector. Most major highways are owned by local governments. Many water supply systems are privately owned and operated. Most hazardous waste disposal is privately owned and operated, and much of the ordinary trash collection is private. Why then, is a Federal strategy important?

Despite the preeminent role of state and local governments, Federal influence in the form of legislation, regulations and/or financing aid, pervades virtually every aspect of infrastructure provision. These influences include:

- Providing Federal financial assistance and grant aid to state and local governments to build, operate and maintain many facilities, such as highway, transit, water treatment and sewer systems

- Directly building, owning operating and maintaining certain key facilities, such as flood control and inland navigation facilities, deep-draft port channels, and other water resources projects

- Enacting Federal tax codes affecting the ability of state and local governments to finance public works infrastructure

- Setting engineering and environmental standards, and regulating most public works on environmental impacts, access for the handicapped, relocation and land acquisition, labor standards and even wage control

FIS participants considered a coherent, overarching Federal strategy [policy] essential to the clarification of the myriad of intergovernmental infrastructure roles and responsibilities. Such a strategy can help bring Federal programs into better alignment with state, local, and private sector needs, and promote consistency and mutual reinforcement among separate but related Federal programs.

Based largely on the work of the National Council on Public Works Improvement, McDowell and Bell proposed a series of criteria for evaluating public works roles. These criteria, also reflect the Kestenbaum Commission's principles for defining the Federal governments roles, and the subsequent work of the Congressional Budget Office, the Evans-Robb Report, and several reports by the Advisory Commission on Intergovernmental Relations (ACIR) on criteria for shifting Federal responsibilities. These criteria include whether:

- The activity is national in scope

- Enumerated constitutional powers must be exercised

- Fiscal magnitude requires a Federal role

- Jurisdictional limits of states render multi-state approach impractical

- Uniform national application of policy cannot be otherwise achieved

- Negative spillovers among states must be minimized or mitigated

- Program efficiency can be significantly improved by a Federal role

- Redistribution of national resources is needed for geographic or demographic equity and program effectiveness

Any Federal strategy should necessarily acknowledge these many responsibilities and needs to fit within the context of a broader national strategy which should be set forth as a prerequisite. In fact, the framework for a national strategy already exists - it was articulated by NCPWI. The Council set forth a national infrastructure strategy in *Fragile Foundations* based on a Federal-state-local-private sector partnership.

Of course, all government agencies responsible for national public works programs are continuing to face significant changes in their roles. Such role changes can be characterized as evolutionary rather than revolutionary, with the movement towards programs becoming more, rather than less, intergovernmental.

Current responsibilities provide the context for future roles, with the Federal roles constantly evolving in response to national needs. Changes that have occurred during the 1980's and early 1990's can be expected to set the stage for additional public works reforms over the next decade. Changes occurring in the 1980's included:

- Cost sharing was expanded for Federal water resource projects
- Trust funds were used to support Federal programs for mass transit, inland waterways, and harbor maintenance programs
- Federal drinking water standards were established and strengthened
- Federal grants for wastewater treatment facilities were phased out, and the states established revolving loan funds (with Federal assistance) to help finance local wastewater treatment facilities
- Most Federal aid for local, state and regional planning/coordination was discontinued

In addition, other legislative and administrative changes in the 1990's have also affected the ways Federal infrastructure agencies perform their responsibilities. These include:

- The passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 has placed greater emphasis on intergovernmental planning and performance-based management, and has also increased the flexibility offered to state and local governments in spending between traditional transportation modes
- The 1990 Clean Air Act Amendments and ISTEA shifted the transportation focus in metropolitan areas where air quality does not meet Federal standards by linking transportation plans to the approval (by U.S. EPA) of State Implementation Plans (SIPs) for cleaning the air.
- The number of Federal block grants, which had grown from one in 1965 to 14 in 1991, now also include two new programs created since then: (1) DOT's Surface Transportation Program (from ISTEA), and (2) FAA's state block grants for airports
- U.S. EPA has established the Environmental Financial Advisory Board (EFAB) to address the demands on local governments resulting from environmental mandates
- Executive Order No. 12291, subsequent OMB Regulatory Impact Analysis Guidance, and, more recently, Executive Order No. 12866 have required cost-benefit analysis of Federal regulations having a significant effect on the economy

The products of research and outputs of the FIS program comprise a Federal strategy that is best understood as an important subset of a broader National strategy. Within this context, FIS recommendations respond to the NCPWI framework, but do not necessarily comply with the Council's specific recommendations. Table 3 provides a summary display and comparison of FIS principles with the previous NCPWI recommendations.

Table 3 - INFRASTRUCTURE STRATEGY SUMMARY:
National Council on Public Works Improvement (NCPWI), and
the Federal Infrastructure Strategy (FIS) Initiative

ISSUES	National Strategy *FRAGILE FOUNDATIONS* (NCPWI, 1988)	Federal Strategy *HIGH PERFORMANCE PUBLIC WORKS* (FIS, 1994)
Management	- Improve the **efficiency** and **performance** of existing facilities - Greater **incentives for maintenance**, and more rigorous use of **low-capital** and **demand management** techniques	- Adopt **performance measurement** processes and **maintenance** planning, reporting, and accounting as ongoing practices - Refocus management practices on **service delivery** and **performance outcomes** and **manage demand** to expand capacity
Investment	- A **National commitment**, shared by all levels of government and the private sector, to **increase investment** levels - **Accelerated spending** of Federal highway, transit, aviation, and waterways trust funds	**Resource constraints** facing the Nation require a **Federal commitment** to: - Expand the use of decision support tools, including **benefit-cost** and **risk** analyses, and choose only the most **efficient** investments
Financing	- **Beneficiaries** of public works services should **finance a greater share** of infrastructure costs - Removal of **unwarranted limits** on the ability of state and local governments to help themselves through **tax exempt financing** - A rational **capital budgeting** process at all levels of government	- Adopt "**budget sensitive**" financing, including an increased use of **financial** and **affordability** analyses, with a focus on **small scale (low cost)** improvements and **demand management** - Efficiently **price** infrastructure **services** to broaden the audience for spending decisions, and adjust **grant formulas** to better account for benefit spillovers
Innovation	Accelerate **technological innovation** thru: - Additional support to **R&D activities**, and - Increased **education and training** for public works professionals	- Eliminate **barriers** to the diffusion of **new technologies** and the adoption of more **flexible design standards** - Establish new **cost-shared technology transfer** mechanisms and dissemination centers in **partnership** with the **private sector**
Regulation	- Clarification of the respective **roles** of Federal, state, and local governments to focus **responsibility** and increase **accountability** - More **flexible** administration of Federal and state **mandates** to allow **cost-effective** methods of compliance	- Require regular **inventories** and affordable **sharing** of **mandated costs** - Establish **baseline estimates** of the costs associated with existing mandates - Allow **local prioritization and scheduling** of compliance choices
Environmental Decisionmaking	- Base public works approvals on **performance based** measures and **peer-reviewed** science - Increased **coordination and cooperation** between the various levels of government	- Integrate & streamline **permitting** and **environmental** decisionmaking processes - Establish a consistent **environmental ethic** within Federal agencies

III. PARTICIPATION AND PROCESS

"A recent article in U.S. News and World Report suggested the public works investment is strictly pork, all politically driven. There will always be a political component to infrastructure investing, but that is not the point. The objective is to have a system that at least provides for more rational investment, so that whether decisions are being made by the Federal government, the states, or local governments, there are criteria that can eliminate the wasteful, gold-plated projects that often are accused of being pork barrel investments."

Representative William F. Clinger, remarks at the Capitol Hill Summit on Federal Capital Budgeting, March 11, 1994

It was recognized early in the FIS program that the development of any Federal strategy must necessarily involve all stakeholders in the provision of public works. Therefore, the strategy development process was designed as a bottom-up, open consultation which included the participation of a broad cross-section of constituencies. These included:

- Representatives of Federal agencies as well as Congressional committees and policy evaluation units having infrastructure responsibilities
- State and local government policymakers
- Nongovernmental analysts, academia, infrastructure users, and advocacy groups
- Public and private public works providers and other practitioners

Program participants also realized that the existing body of work represented by past studies provided a comprehensive assessment of national needs and issues upon which to build. Therefore, they recommended working towards the development of specific actions to refine or implement the key findings of previous reports rather than focusing on the development of a new study.

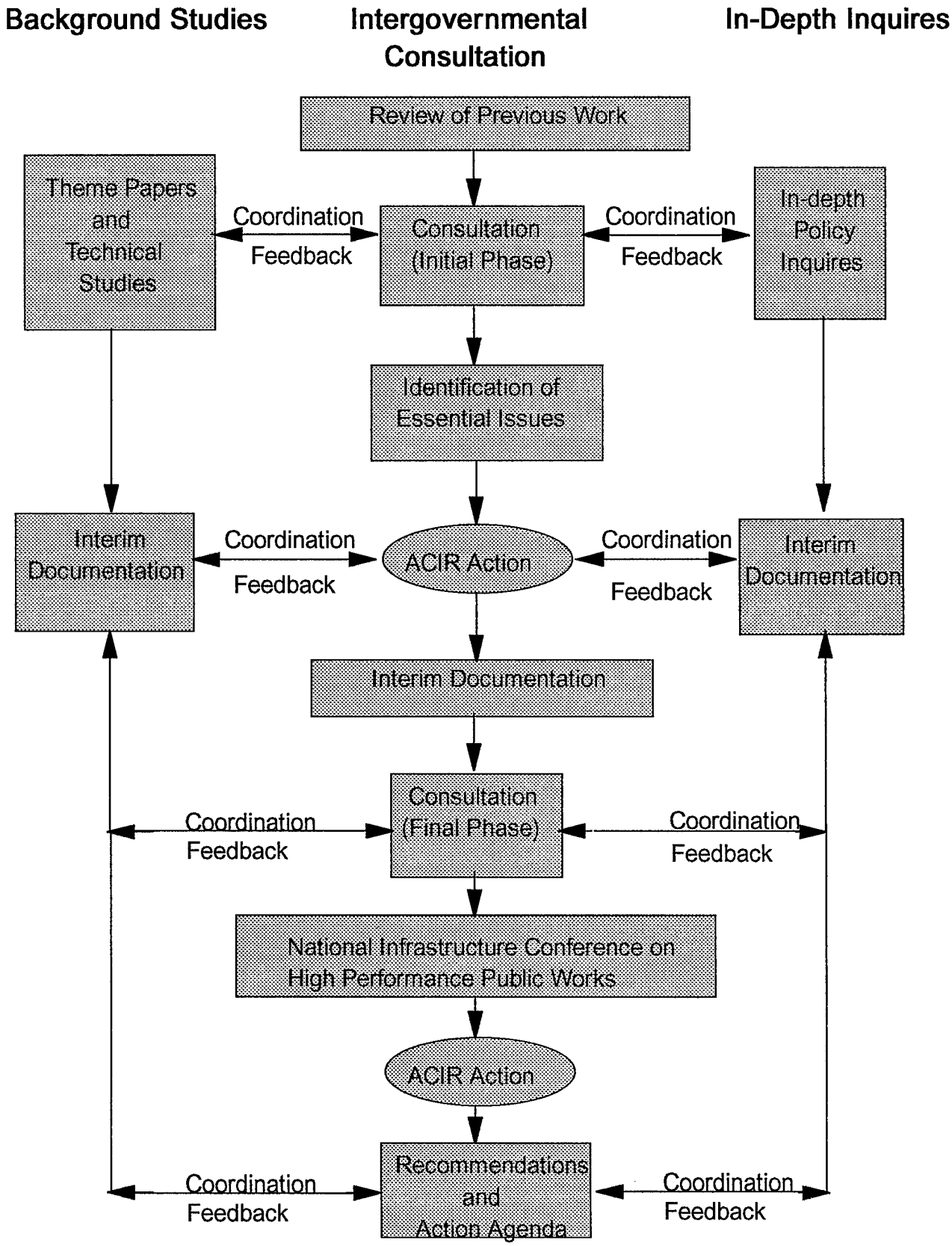


Figure 6 - Strategy Development Process

In addition, participants recommended that the FIS should focus primarily on Federally provided, leveraged, or regulated public works within the broad categories identified by the National Council on Public Works Improvement:

- transportation (highways, aviation, mass transit and intermodal)
- water (navigation, flood control and water supply)
- waste management (water, solid, hazardous)

The effort was managed by the Corps as a cooperative intergovernmental effort. The thrust of the approach was one of interagency partnership, with independent third party experts asked to facilitate and organize the various dialogues, workshops and inquiries on the identified issues. As displayed in Figure 6, the strategy development process utilized a three-tier structure to pursue the FIS policy research agenda. A primary focus of the process was to promote the active participation of a broad range of public works stakeholders. The three tracks consisted of:

- **Background Studies**. The commission of theme papers and technical studies on specific public works issues to serve as the basis for subsequent interagency discussions or follow up, in-depth policy inquiries

- **Intergovernmental Consultation.** Two phases of coordination were used to (1) facilitate the identification of issues essential to strategy development, and (2) develop statements of principles and guidelines for the most important topics, along with recommendations and proposed action agenda for application of the principles.

- **In-Depth Inquiries.** A series of policy studies were undertaken on topics requiring a mixture of substantive research and interagency input to establish the technical and management foundations of the strategy formulation process

The intergovernmental consultation involved approximately 30 Federal agencies and departments and units of Congress, including the Departments of Transportation, Interior, Commerce, Energy, Treasury, and Agriculture, the Environmental Protection Agency, General Services Administration, Federal Accounting Standards Board, the Council of Economic Advisors, General Accounting Office, Congressional Budget Office, Congressional Infrastructure Caucus, Office of Technology Assessment, and the House and Senate Public Works Committees. In addition, more than 100 other organizations representing state and local governments and public works practitioners were included in the consultation. Both phases of the coordination were facilitated by the Advisory Commission on Intergovernmental Relations and guided by interagency work groups. A complete listing of organizations who were represented in the process is presented as Table 4.

The first phase of the dialogue consisted of a series of workshops with the various infrastructure constituencies and concluded with a synthesis meeting of all four groups of participants and the subsequent publication an interim report, *Toward a Federal Infrastructure Strategy: Issues and Options*. The report documented the policy areas and opportunities for interagency cooperation in support of a Federal strategy. Recommendations from the consultation were endorsed by the Commission in June 1992.

Table 4 -Organizations Represented at

Congress
Senate Environment and Public Works Committee
House Committee on Public Works and Transportation
House Committee on the Budget
House Subcommittee on Economic Development
Joint Committee on Taxation
Office of Senator Byron L. Dorgan
Office of Senator Bob Graham
Office of Representative Bob Carr
Office of Representative William F. Clinger
Office of Representative Ray Thornton
Office of Representative Bob Wise
Congressional Budget Office
Congressional Infrastructure Caucus
Congressional Office of Technology Assessment
Congressional Research Service
General Accounting Office

Executive Branch
Council of Economic Advisors
Council on Environmental Quality
National Economic Council
Office of Management and Budget
Environmental Protection Agency
Federal Accounting Standards Advisory Board
General Services Administration
Department of Agriculture
  Animal and Plant Health Inspection Service
  Economic Research Service
  Soil Conservation Service
Department of Commerce
Department of Defense (Office of the Secretary)
  Department of Army
    Office of the Assistant Secretary (Civil Works)
    Corps of Engineers
Department of Energy
Department of Health and Human Services
Department of Interior (Office of the Secretary)
  Bureau of Reclamation
  U.S. Fish and Wildlife Service
  U.S. Geological Survey
Department of Transportation
  Office of the Secretary
  United States Coast Guard
  Federal Aviation Administration
  Federal Highway Administration
  Federal Railroad Administration
  Federal Transit Administration
  Maritime Administration
Department of Treasury

Other Government Agencies
Administrative Conference of the United States
Competitiveness Policy Council
Federal Reserve Bank of Boston
Federal Reserve Bank of Cleveland
Tennessee Valley Authority
The World Bank

State Government
Arizona Department of Transportation
New Jersey
  Dept. of Environmental Protection & Energy
  Department of Transportation
  Washington Office
Ohio House of Representatives
  Ways & Means Committee
Washington Department of Community Development
  Public Works Trust fund
Academy for State and Local Government
Council of State Governments

Local Government
Boston Water and Sewer Commission
City of Atlanta, Georgia
  Department of Planning and Development
City of Baltimore, Maryland
City of Berkeley, California
City of Billings Montana
City of Cincinnati, Ohio
City of Columbus, Ohio
City of Jackson, Wyoming
City of Lewiston, Maine
City of New York, New York
  Metropolitan Transit Authority
  Office of Management and Budget
City of Miami, Florida
City of Minneapolis, Minnesota
City of Pittsburgh, Pennsylvania
City of Portland, Oregon
City of Richmond, Virginia
City of Rockville, Maryland
City of Round Rock, Texas
City of Sacramento, California
City of San Jose, California
City of St. Paul, Minnesota
City of Wakefield, Massachusetts
City of Waukegan, Illinois
Denver Regional Transportation District
Foster City, California
International City/County Management Assoc.
Lehigh County (Pennsylvania) Authority
Los Angeles County, California
Maryland Department of Fiscal Services
Metropolitan Washington Council of Governments
Metropolitan Water Reclamation District of Chicago
Metropolitan Minneapolis - St. Paul Council of Governments
Metropolitan Minneapolis - St. Paul Airports Commission
Metropolitan Washington Airports Authority
National Association of Counties
National Association of Regional Councils
National Association of Towns and Townships
National Conference of State Legislatures
National League of Cities
Northwest Indiana Regional Planning Commission
Snohomish County, Washington
Warren County Mississippi

One Or More FIS Study Element Activity

Research Groups
Building Futures Council
Civil Engineering Research Foundation
Committee for Economic Development
Economic Policy Institute
ENO Transportation Foundation
Governmental Accounting Standards Board
Infrastructure Institute
Manufacturers' Alliance
Midwest Research Institute
National Academy of Public Administration
National Research Council
  Building Research Board
  Transportation Research Board
National Trust for Historic Preservation
RAND
Triangle Research Institute
Upjohn Institute of Employment Studies
The Urban Institute

Academic Institutions
American University
Arizona State University
Bates College
Carnegie Mellon University
Columbia University
George Mason University
Harvard University
Johns Hopkins University
Lehigh University
New York University
Ohio State University
Pennsylvania State University
Purdue University
University of Illinois
University of Maryland
University of Minnesota
University of Wisconsin
University of New Mexico
University of Pennsylvania
University of Southern California
Virginia Polytechnic Institute and State University
University of Washington
Yale University

Policy Advocates
Advocates for Highway and Auto Safety
Campaign for New Transportation Priorities
Construction Industry Institute
International Public Works Foundation
National Industrial Transportation League
National Wildlife Federation
Public Securities Association
Rebuild America Coalition
Surface Transportation Policy Project
Water Environment Federation

Private Companies and Users
AMTRAK
Apogee Research
Agenda Communications, Inc.
Bechtel Corporation
Bell Atlantic Network Services, Inc.
Bovis, Inc.
Cambridge Systematics, Inc.
Chambers Associates, Inc.
Commonwealth Development Associates
Deutch, Kerrigan & Stiles
Dow, Lohnes & Albertson
Federal Home Loan Bank of San Francisco
Greenhorne & O'Mara
Government Finance Group, Inc.
Hickling Corporation
Jack Faucett Associates
KPMG Peat Marwick
Lemna Corporation
Linton, Mields, Reisler and Cottone, Ltd.
Louis Dreyfus, Inc.
National Grange
Parsons/Brinkerhoff
Rapoza Associates
R.W. Beck and Associates
Scott Paper Company
Stone & Webster Engineering Corporation
Sverdrup Corporation
U.S. Chamber of Commerce
Wade Miller Associates
WEFA Associates

Professional Associations, Provider and User Groups
American Association of Port Authorities
American Assoc. of State Highway & Trans. Officials
American Consulting Engineers Council
American Planning Association
American Public Transit Association
American Public Works Association
American Road and Transportation Builders Association
American Society of Civil Engineers
American Society of Public Administration
American Trucking Association
American Waterways Operators, Inc.
American Water Works Association
Associated General Contractors of America
Association of American Railroads
Community Transportation Association
Council of Infrastructure Financing Authorities
Government Finance Officers Association
Building and Construction Trade Council
Highway Users Federation
International Longshoremen's and Warehousemen's Union
National Association of State Treasurers
National Society of Professional Engineers
National Solid Waste Management Association
National Stone Association
Portland Cement Association

The second round of the consultation moved beyond the broad overview of Federal infrastructure policy to the examination of key issues identified in the first phase of the dialogue. ACIR relied on interagency task forces composed of representatives of Federal, state, local and private sector interests to develop statements of principles and guidelines for six topics:

- Enhancing the overall quality of infrastructure investments
- Applying benefit-cost analysis to public works investments
- Improving the planning and reporting of maintenance
- Reforming Federal regulation of infrastructure
- Improving environmental decisionmaking for public works
- Diversifying the financing of infrastructure

This phase of strategy development took place concurrently with a cabinet-level initiative by the National Economic Council to articulate and implement the Administration's infrastructure policy. Therefore, FIS products were shared with the White House Infrastructure Management and Finance working groups through the Office of the Assistant Secretary of the Army (Civil Works) and ACIR.

The FIS consultation culminated in a National Conference on High Performance Public Works sponsored by the Corps and ACIR in July 1993. Conference participants reviewed the six task force statements along with a recommended strategy and proposed action agenda. Input received at the conference generally confirmed the suggested principles and action agenda and helped to refine and complete the recommendations.

Results were documented in the report *High Performance Public Works: A New Infrastructure Investment Strategy for America*, published by the Corps and ACIR in November of 1993. ACIR subsequently endorsed the recommendations and action agenda at the Commission's 14 February 1994 meeting.

A follow-up document, *Sourcebook of Working Documents*, was subsequently published (September 1994) to accompany the *High Performance Public Works* report. The *Sourcebook* contains selected government documents and other reference materials of interest to planning, designing, and executing infrastructure policies.

IV. STUDY AGENDA

"The Department of Transportation's goal is to ensure that scarce Federal, state and local financial resources are used wisely, and that the Nation and the economy get the highest rate-of-return they can from our investments. [This] strategic infrastructure study is an important step in moving us toward that goal, helping us identify and encourage good practice in infrastructure management, and developing a consensus among the broad spectrum of interested parties about the issues and best practices."

Mortimer L. Downey, Deputy Secretary, U.S. Department of Transportation, remarks at the National Infrastructure Conference on High Performance Public Works, July 1993

During the formative stages of strategy development, key recommendations of the National Council on Public Works Improvement, the Congressional Budget Office and Office of Technology Assessment, and other related work were examined to guide the formulation of the FIS research agenda. Eventually, a broad consensus emerged from the interagency consultation on the public works issue areas that were deemed essential to the development of a Federal infrastructure policy:

- Improved infrastructure management
- Strategies for more efficient investments
- Financing reform
- Development and application of innovative technologies
- Clarification of roles and responsibilities
- Improved environmental decisionmaking

These results were used to refine and pursue a research menu consisting of approximately 30 study elements within the three-tier framework, including a second consultation phase focusing on specific policy topics. Table 5 summarizes key FIS studies within this agenda. Interim reports documenting the findings of the various technical studies and inquiries were distributed as they became available in order to facilitate the dialogue among FIS participants.

Table 5 - FIS Program Study Agenda
(With Principal Facilitating Organizations)

Infrastructure Management

- *Improving the Maintenance of Infrastructure* (ACIR[1])
- *Impediments and Opportunities to Improve Local Public Works Management Practices* (APWA/NAPA[2])
- *Issues in Deferred Maintenance* (The Urban Institute[3])
- *Measuring and Improving Infrastructure Performance* (NRC, BRB/BICE[4])

Investment Strategies and Analyses

- *Improving the Quality of Infrastructure Investments* (ACIR[1])
- *Applying Benefit-Cost Analysis to Investment Options* (ACIR[1])
- *The Economic Impacts of Federal Infrastructure Investments* (Apogee Research [5])

Infrastructure Finance

- *Improving the Financing of Infrastructure* (ACIR[1])
- *State Programs for Community Infrastructure: Innovations in Financing* (The Urban Institute)
- *The Effect of Federal Tax Policy on Public Works Investment* (Apogee Research)
- *Local Public Finance Impacts* (IWR[6])

Infrastructure Technology

- *Challenges and Opportunities for Innovation in Public Works Infrastructure* (CERL[7])
- *Federal Public Works Infrastructure R&D: A New Perspective* (CERF[8])
- *Technology Transfer: Nondestructive Testing and Rehabilitation Strategies for Roadway Pavements* (WES[9])
- *National Infrastructure R&D Needs: Municipal Public Works Users* (CERF[3])

Roles and Responsibilities/Environmental Decisionmaking

- *Making Federal Regulations of Infrastructure More Effective, Efficient, and Equitable* (ACIR[1])
- *The Effect of Federal Mandates on Improving the Performance of Local Public Works Activities* (NAPA/APWA[2])
- *Improving Environmental Decisionmaking for Public Works* (ACIR[1])
- *Employment Impacts of Environmental Restoration* (Apogee Research[10])

[1] Advisory Commission on Intergovernmental Relations with interagency task force
[2] American Public Works Association; National Academy of Public Administration
[3] With study advisory group
[4] National Research Council, Building Research Board/Board on Infrastructure and the Constructed Environment
[5] With interagency review group
[6] U.S. Army Corps of Engineers Institute for Water Resources
[7] U.S. Army Construction Engineering Research Laboratory
[8] ASCE's Civil Engineering Research Foundation
[9] U.S. Army Waterways Experiment Station
[10] For U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, IWR

Issues addressing rationales for Federal investment, measuring and improving performance, revenue diversification, regulatory and administrative reform, and management improvement were addressed primarily through the work of ACIR, the American Public Works Association, Apogee Research, National Academy of Public Administration, the Corps Institute for Water Resources, National Research Council, and The Urban Institute.

Topics on the innovative use of new technologies were guided largely by the Civil Engineering Research Foundation - the research affiliate of the American Society of Civil Engineers - in coordination with the Federal Laboratory Consortium, Corps of Engineers laboratories, and a Federal advisory group.

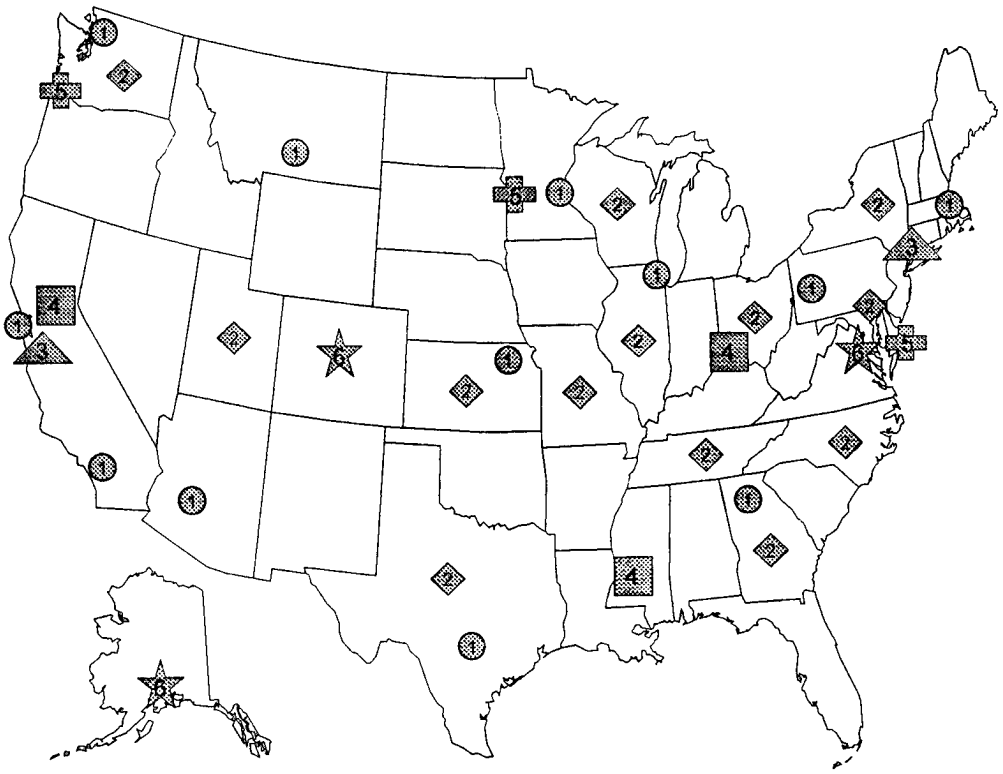
A number of the FIS studies explicitly engaged in case studies with state and local governments. Figure 7 displays the geographic distribution of these case studies.

As an outgrowth of FIS activities, several Federal agencies pooled their resources on cooperative, cost-shared studies. These include:

- Work by the Civil Engineering Research Foundation on infrastructure technology transfer co-sponsored by the Federal Highway Administration, Bureau of Reclamation, and the Environmental Protection Agency, in coordination with the National Institute of Standards and Technology

- A study on improving the measurement of economic productivity impacts from infrastructure investments with the Department of Transportation (Federal Aviation, Highway, Railroad, and Transit Administrations), Department of Agriculture, Bureau of Economic Analysis, Bureau of Reclamation, Department of Energy, and the Environmental Protection Agency

- In addition, the Environmental Protection Agency also sponsored research on the economic effects of environmental restoration projects



LEGEND:

Improving Local Public Works Management Practices -- 12 Municipalities/Counties

Atlanta, GA	Foster City, CA	Pittsburgh, PA	St. Paul, MN
Arizona DOT	Lawrence, KS	Round Rock, TX	Wakefield, MA
Billings, MT	Los Angeles, CA	Snohomish Co., WA	Waukegan, IL

State Programs for Community Infrastructure Innovation -- 13 States

Georgia	Kansas	North Carolina	Tennessee	Utah	Wisconsin
Illinois	Maryland	New York	Ohio	Texas	Washington

Issues in Deferred Maintenance -- 2 Cities
New York, NY and San Jose, CA

Technology Transfer Demonstration -- 2 Cities and 1 County
Berkeley, CA; Cincinnati, OH; and Warren County, MS

Measuring and Improving Infrastructure Performance -- 3 Cities
Baltimore MD; Minneapolis, MN; and Portland, OR

Employment Impacts of Environmental Restoration -- 3 Sites
Anacostia River, Washington, D.C. and Maryland;
Boulder Creek, Colorado; and Denali National Park, Alaska

Figure 7 - Case Studies Conducted During the Federal Infrastructure Strategy Program

V. THE FEDERAL STRATEGY

"For more than a decade one major report after another has identified issues, obstacles and potential solutions for improving the performance of our Nation's public works. Despite these many policy studies, the Nation has not yet made the commitment necessary to implement an overarching [Federal] infrastructure strategy that addresses the many problems that have been identified. Now is the time to act. I am optimistic that we can get the ball rolling because several supportive initiatives are coming together."

Edward G. Rendell, Mayor of Philadelphia, remarks at the National Infrastructure Conference on High Performance Public Works, July 1993

The combined outputs of FIS studies and evaluations comprise principles which reinforce larger national public works goals. These goals include: increasing performance, improving economic efficiency and productivity, environmental sustainability, enhancing quality-of-life, improving international competitiveness, stimulating innovation, better aligning Federal programs with state, local and private sector needs, and developing more consistency and greater effectiveness among Federal programs.

Although the issues discussed in *Fragile Foundations* remain relevant, potential solutions need to reflect the policy context of today. Federal infrastructure programs, which are largely funded from domestic discretionary appropriations, continue to be under considerable budget pressure due to the growth of mandatory spending and interest on the debt. The reality of this budget constraint underscores the need for Federal policy to focus on ways to improve performance by better managing what we already have, and choosing only the most justified new investments.

The resulting strategy recognizes that a sound public infrastructure forms a key part of the Nation's capital stock and thus plays a vital role in encouraging a more productive and competitive national economy. In, addition public works are essential to meeting immediate as well as long-term public demands for safety, health, and a clean and healthy environment. This applies to public works infrastructure broadly defined, including transportation, water, waste management, and environmental protection facilities, as well as other categories such as public buildings.

PRINCIPLES AND RECOMMENDATIONS

The Federal Infrastructure Strategy offers opportunities for improving how Federal (and state and local) agencies formulate, evaluate, choose, implement, operate and maintain infrastructure investments. The strategy is based on six principles:

The first principle, **Cost Effective Management and Maintenance**, focuses on infrastructure maintenance and the tendency to underinvest in it. The second, **High Quality Investments**, addresses the need for broadening and improving the application of investment analyses such as benefit-cost evaluations. Both principles embrace straightforward concepts - choose those investments which promise to deliver the highest total rate-of-return, and once they are built, maintain them. But unfortunately, this has not always been the case. All levels of government need to do a better job of choosing capital investments and need to explicitly incorporate maintenance considerations into infrastructure decisions and budgets from the beginning.

The third principle, **Budget Sensitive Financing**, focuses on the need to find new ways to finance infrastructure. The emphasis here is not on short-term public works funding as a one-shot (primarily employment) economic stimulus, but rather on the need to establish a stable and predictable long-term level of infrastructure funding, with public works services efficiently priced. In light of the current deficit, serious proposals for investment must consider low-capital techniques and be based on compulsory financing plans.

Fourth, the consensus view is that there are also substantial opportunities provided by **Innovative Technologies** that can help the Nation improve infrastructure performance. Significant advances in technology have occurred over the last 15 years, yet diffusion into public works has been limited. Breakthroughs in high performance materials, computers, communications, artificial intelligence, and other technologies can help increase infrastructure capacity, performance and efficiency while minimizing major new construction and further disruption to the environment.

Finally, there is a need to simplify regulations **(Regulatory Reform)** while integrating environmental considerations into infrastructure planning and design from the ground-up **(Integrated Environmental Decisionmaking)**. Participants recognized that regulation is about balancing tradeoffs between sometimes apparently disparate goals, in this case: protecting the health and safety of the American people, protecting the natural environment, and providing public works to maintain economic growth, national security and international competitiveness. Most participants agreed that the Federal government needs to rethink these processes and all levels of government need to better integrate environmental and cultural concerns into the planning of public works.

Figure 8 displays key interrelationships of these principles within the context of the guiding FIS objectives (efficiency, reliability, equity, sustainability, innovation and financing) as applied to capital infrastructure investments, the operation and maintenance of existing facilities, and the regulation of public works.

Participants in the FIS program recognized that while some changes can be made quickly under existing authorities, the full application of the strategy's principles will necessarily involve legislative actions. The strategy includes three primary implementation elements:

(1) Leadership by the President and the Congress through the issuance of Executive Orders and legislative proposals

(2) The issuance of Executive Branch guidance largely through Office of Management and Budget (OMB) circulars affecting the budget, legislative clearance, and regulatory review processes

INFRASTRUCTURE PERFORMANCE: INTERRELATIONSHIPS

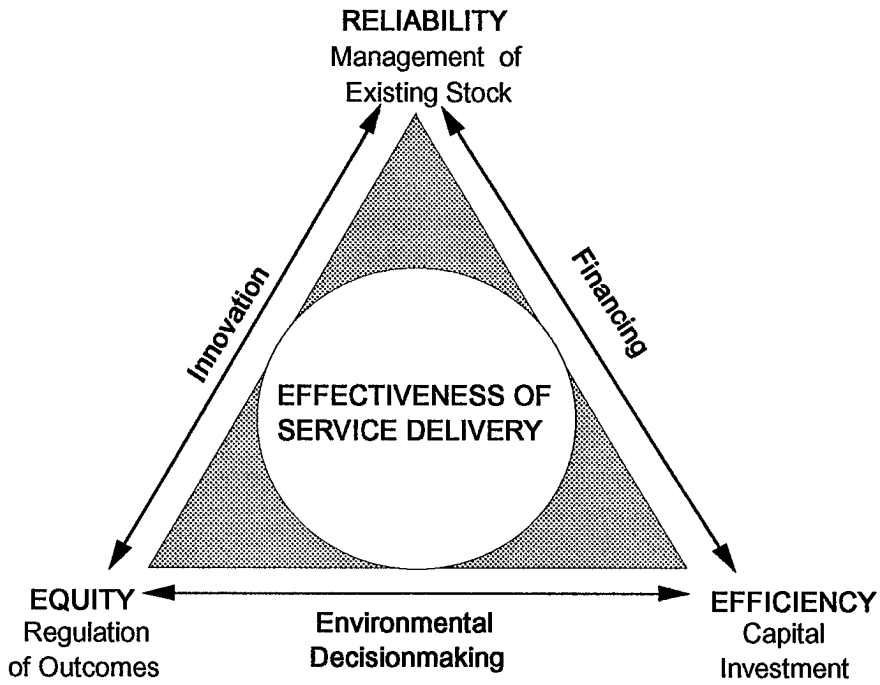


Figure 8 - Infrastructure Performance Interrelationships

(3) Government-wide support actions for these actions through individual and cooperative efforts of various Federal agencies, departments and offices that affect public works policy

The principles and recommendations suggested by FIS participants are outlined in the paragraphs below, followed by a summary of recent initiatives which have established policies consistent with the intent of the proposed strategy. Additional discussion of each element of the strategy is presented in Sections VI - XI.

***Principle 1* - Cost Effective Management and Maintenance. Reduce long-term non-capital spending by adopting and encouraging maintenance planning and reporting practices to ensure early identification of maintenance needs, and to help public officials make more informed budget decisions by reporting on the implications of unfunded maintenance.** Maintaining the Nation's massive existing capital stock remains the key to America's 21st century infrastructure. Management practices should be reformed to focus on the performance of services (as indicated by outcomes) rather than merely operating inputs and outputs. System reliability should move beyond deterministic engineering safety factors, and should include statistical or probabilistic based risk functions or composite (i.e., demand peak or return frequency) indicators. Planning (inventorying, tracking and accounting) for and reporting on deferred maintenance are central to avoiding premature and costly rehabilitation and replacement expenditures. Incentives are

needed to improve management practices and to encourage demand management techniques (in order to expand capacity and as an alternative to Federal regulation). Specifically:

- **Public works management practices** should be focused on the delivery of services and program outcomes within a multi-dimensional framework of performance including economic efficiency, reliability of service delivery, environmental sustainability and life-cycle costing

- **Multi-year maintenance plans** should be developed and updated based on a periodic inventory and condition assessment of public works assets

- **Future maintenance costs** should be explicitly considered when selecting new or replacement capital assets, including low-maintenance alternatives which will reduce life-cycle costs

- **Unfunded (or deferred) maintenance** should be reported, not only by identifying the "dollar gap", but also the performance implications of the unfunded work, including risks to health and safety and likely economic losses

- **Manage the demand** for services through a variety of pricing mechanisms in order to increase capacity, stretch project lives, and minimize the need for new facilities

***Principle 2* - High Quality Investments. Obtain maximum benefits compared to costs from all Federal infrastructure programs (directly provided, financially assisted, or regulated) by requiring that they be subjected to investment analysis.** It is imperative that the Nation fund only the most efficient investments to maximize the rate-of-return from the relatively limited resources available. A complete menu of decision support tools should be utilized by Federal agencies to evaluate investment priorities for public works programs and projects. The current state-of-the-art of benefit-cost analysis, including a range of traditional evaluation techniques, provides the best choice for government-wide application. Macro-economic analyses are useful as complementary means for estimating total rates-of return for systems and programs at the National level and for identifying externalities and non-linear effects. Performance, not construction, should be the primary Federal goal, with the cost-effective maintenance of existing stock, rather than large new programs, serving as the focus for investment opportunities. In particular:

- **The use of benefit-cost, cost-effectiveness, and risk analyses** should be expanded in conjunction with budget submissions (Circular A-11) and legislative clearance (Circular A-19), thus enhancing the comparison of investments among diverse programs, projects and regulations

- **The application of benefit-cost analysis** should be broadened to include greater emphasis on the valuation of environmental and other non-monetized effects

- **A White House Conference on Infrastructure Investment** would highlight the importance of the issue and motivate Federal agencies and their partners to work more closely together on expanding and improving the quality of analyses

- **Legislative barriers** to benefit-cost analysis should be reduced while statutory authority for the principles of investment analysis should be sought to institutionalize their use

Principle 3 - ***Budget Sensitive Financing. Financial planning and affordability analyses should be used to select Federal infrastructure investment with full consideration of both traditional and nontraditional funding sources, including demand management options.*** There are no large new untapped sources of infrastructure funding on the horizon. America must aim scarce Federal investments at smaller, more affordable facilities. Investments should also be efficiently priced, not only as a means of financing, but also to minimize the need for new facilities, and to broaden the audience for spending decisions beyond Federal policymakers. In addition, the formulas for Federal grant aid should be adjusted to better account for benefit spillovers, and the availability of tax-exempt funding and revenue diversification should be expanded. Specifically:

- **Financial plans** should be prepared and used to prioritize Federal infrastructure investments

- **Financial advisory boards** should be established after the models of EPA's Environmental Financial Advisory Board (EFAB), or the Army's Inland Waterway Users Board to help strengthen, diversify, and innovate agency financing approaches

- **Federal/state tax and security laws** limiting access to revenue sources should be reviewed to identify unintended barriers to innovative funding mechanisms

- **Pricing formulas for infrastructure services** should be reviewed with an eye toward better managing demand (increase capacity) and ensuring that beneficiaries pay an equitable share for services received

- **A public works investment section in the President's budget**, funded by a series of broad, flexible categorical infrastructure trust funds and supported by dedicated revenue sources, should be designed for multi-year investment stability

Principle 4 - ***Innovative Technologies. Clear the path to the marketplace for new technologies through an explicit, singular Federal infrastructure R&D strategy that provides a stronger link between the development and adoption processes, enhances the partnership between the Federal research community and the private sector, and addresses the liability, regulatory and contracting barriers to innovation diffusion.*** Significant administrative and legal roadblocks have impeded the transfer of Federally developed technologies to local public works users. These barriers include the fear of liability litigation, the multiplicity of government regulations, the high cost of insurance, code restrictions, and complicated public procurement policies. Federal agencies and research organizations should work to mobilize increased private sector interest in accelerating the diffusion of new public works technologies. Tort reform is needed to limit liability, while performance specifications used to ease code restrictions. The establishment of new technology dissemination mechanisms based on the research priorities of public works practitioners are essential to his effort. In summary:

- **Technology transfer mechanisms** based on user needs should be aimed at fostering new cost-shared intergovernmental and public-private demonstration partnerships, with greater incentives for private sector investment in R&D

- **Test-bed and technology dissemination centers** should be established in partnership with industry and academia for the peer evaluation of demonstration projects within a risk-shared environment

- **Technology diffusion barriers** should be eliminated through the use of more flexible design standards, alternate ways to bid contracts, and reform of the procurement process

- **Intergovernmental cooperation** should be increased to ensure the efficient allocation of R&D funds, and to facilitate the sharing of new technologies

***Principle 5* - The fundamental rights of all citizens should be protected through a new regulatory Federalism which equitably and flexibly distributes the costs of meeting environmental and other performance requirements.** The dramatic increase in Federal regulations over the last twenty years has constrained local public works priorities and budgets. Regulatory programs should be reviewed to identify the cumulative effects of Federal requirements and to relieve any unintended preemptive fiscal impacts on local governments. Within existing legislation, existing and proposed regulations affecting infrastructure should be analyzed to ensure that they are necessary, the least burdensome, most flexible forms of regulation that accomplish National regulatory goals. In addition, FIS participants encouraged the Administration and Congress to consider mandate relief legislation which would require:

- **Regular inventory and cost estimates** of all existing and proposed Federal mandates

- Analyses of the **incidence of costs** and **the ability of affected parties to pay**

- **An affordable prioritization and scheduling** of non-Federal compliance

- **Federal sharing** of mandated costs

***Principle 6* - Integrated Environmental Decisionmaking. Rethink the current sequential environmental decisionmaking processes toward adoption of an integrated, multi-media, ecosystem-based review of public works projects.** A consistent environmental ethic is missing from many Federal infrastructure programs, while public works decisions often appear gridlocked. The various incremental, media-based environmental review processes should be integrated, to the maximum extent possible, into one process. A fundamental consideration of the environment should be incorporated into the planning and design of all public works programs and projects with impact avoidance or minimization explicitly stated goals from the outset. In summary:

- **The current sequential approval processes** should be integrated into an umbrella process using outcome-based performance standards, improved science, and risk-based priorities for compliance

- **A stronger, more consistent environmental planning ethic** should be embedded across Federal agencies

- **Legislative review, regulatory review, and budget submission procedures** should be revised to incorporate the principles of integration

- **Pilot projects** under the *Government Performance and Results Act of 1993* should be conducted to advance the development of outcome-based performance measures of environmental programs

- **Environmental legislation** should be sought to fully establish an integrated environmental review and approval process based on the *National Environmental Policy Act (NEPA)*

RELATED POLICY INITIATIVES

Products of the interagency consultation and other FIS activities were coordinated through the Office of the Assistant Secretary of the Army (for Civil Works) and ACIR with the President's National Economic Council (NEC) working groups on Infrastructure Management and Finance, other Federal agencies, and Congressional interests. The FIS dialogue took place at an opportune time, concurrent with a broad range of Federal policy making activities, and coincident with the numerous reforms of Federal business and decision making processes through various Administration and Congressional initiatives.

The actions summarized below include those policy and legislative initiatives which have begun to establish policies consistent with the strategy's investment, management, regulatory, and technology development principles. Some of these initiatives stem from the White House infrastructure working groups. Several can be attributed to the government-wide reforms in response to Vice-President Gore's *National Performance Review (NPR)*. Others originated as Congressional responses to a variety of national issues.

Legislative

The Government Performance and Results Act (GPRA) of 1993 includes requirements for each agency to develop and submit strategic and annual program performance reports, and to improve managerial accountability and flexibility. OMB has approved more than 100 agency pilots to demonstrate and evaluate the implementation of GPRA requirements.

The Government Management Reform Act (GMRA) of 1994 follows-up on the ***Chief Financial Officers Act*** and the ***GPRA*** by requiring that agencies produce financial statements that account for all activities, spending and revenue, and that OMB publish an annual financial statement covering all Executive Branch activities.

The *Federal Mandate Accountability and Reform Act of 1994 (S.993)*, proposed in the 103rd Congress, called for greatly strengthening the Congressional fiscal notes process and included a Senate "Point-of-Order" provision for future mandate legislation.

Several bills aimed at establishing a Federal Capital Budget were also introduced in the 103rd Congress:

- **H.R. 1182** and **H.R. 1050** proposed to generally split the Federal budget into two or more categories designed to distinguish capital from operating spending. Reclassification of spending would be joined with other budgetary requirements such as a prohibition of borrowing to support the operating budget, or separate performance or other reports by Federal agencies

- **H.R. 484** went a step further with its definition of capital by also including "developmental" investments, such as education and R&D spending

Executive Orders

No. 12866 on *Regulatory Planning and Review* requires that all proposed regulatory actions which have an economic impact of $100 million or more be subjected to benefit-cost analysis, compared with

alternatives to regulation, and chosen only if net benefits are maximized. It also requires agency regulatory plans, a centralized review process and consultation with State, local and tribal governments where regulations with significant financial cost to these entities are being considered. Several White House Memorandums on *Agency Rulemaking, Regulatory Reform,* and *Negotiated Rulemaking* serve to reinforce these requirements.

No. 12875 on *Enhancing the Intergovernmental Partnership* is aimed at reducing the imposition of unfunded Federal mandates on State, local, and tribal governments by requiring that agencies document the extent and nature of consultations with affected governments when the funds necessary to pay the cost of compliance are not Federally provided.

No. 12881 on *Establishment of the National Science and Technology Council (NSTC)* improves the coordination of Federal science, space, and technology policies. The NSTC, through its coordinating committees on Civilian Industrial Technology, Environmental and Natural Resources, and Transportation, provides the means for insuring the establishment of clear National goals for Federal technology investments; more effective coordination of technology policy-making and R&D; and, the prioritization of technology development and transfer programs.

No. 12893 on *Principles for Federal Infrastructure Investments* requires agencies to develop: systematic analyses of benefits and costs for direct spending and grants for capital programs; an annual programmatic investment analysis of capital accounts in conjunction with future budget submissions; and an investment analysis justification for all major legislative proposals that authorize or reauthorize infrastructure programs. Operation and maintenance activities are considered a form of infrastructure management and are subject to requirements for periodic reviews of the performance of existing facilities. Federal infrastructure categories covered by the order include transportation, water resources, energy, and environmental protection programs.

No. 12898 on *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* requires each Federal agency to make achieving environmental justice an explicit part of its mission. It creates an interagency working group on environmental justice, and requires each agency to develop an strategy that identifies and addresses disproportionately high and adverse human health or environmental effects of programs, policies and activities on minority and low-income populations.

No. 12906 on *Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure* recognizes the link between geographic information and national goals for economic development, natural resources stewardship, and environmental protection. The E.O. strengthens OMB Circular A-16 by designating the Federal Geographic Data Committee to coordinate the Federal governments development of the National Spatial Data Infrastructure (NSDI). It also establishes a National Geospatial Data Clearinghouse and a standardized documentation of data electronically accessible to the clearinghouse network.

Other Initiatives

The Federal Highway Administration has developed the ***Highway Economic Requirements System (HERS)*** as an incremental benefit-cost investment simulation model to provide an economic dimension to traditional engineering-based investment analyses. FHwA plans to introduce *HERS* in the 1995 biennial report on the Nation's highway and bridge system which is used to develop national highway infrastructure

investment assessments. The model has been shared with the other departments within DOT and other Federal infrastructure agencies. It is also expected to be made available to the State Departments of Transportation as a tool available in support of DOT's implementation of Executive Order No. 12893, *Principles for Federal Infrastructure Investment.*

The Office of Management and Budget's Circular A-131 on *Value Engineering (VE)* requires Federal agencies to use value engineering as a management tool to reduce program and acquisition costs, including for infrastructure facilities design and construction. Agency responsibilities are overseen by a senior management official designated to coordinate VE activities, including: the development of annual plans for using VE, the measurement of the net life-cycle cost savings from value engineering, and the preparation of annual reports to OMB.

The Department of Energy's *Capital Asset Management Process (CAMP)* provides a credible, standardized, auditable procedure for reviewing mission and facility obsolescence, assessing infrastructure condition, and prioritizing the maintenance projects. *CAMP* is an integrated process which identifies asset maintenance and technical support requirements on a life-cycle planning basis, thus providing managers with a comprehensive look at DOE's capital inventory and serving as a vehicle to effectively plan and prioritize public works infrastructure maintenance.

The Department of Transportation's interagency effort on the ***National Transportation System*** is fostering a vision for the nation's transportation future based on an intermodal, seamless, more efficient network that will enhance interstate commerce and national defense, support national safety and environmental protection goals, encourage application of modern technology, allow funding and program flexibility, and be better coordinated with the private sector.

The Corps of Engineers *National Operation and Maintenance (O&M) Program Plan of Improvement* is working to increase the performance and efficiency of the Corps existing water resources infrastructure. This review of current O&M practices is identifying improvements to current management practices and investigating new methods for monitoring and measuring performance, and prioritizing and budgeting work. A key component addresses the development of operational performance indicators for the hierarchy of program reporting requirements. The O&M Plan of Improvement is serving as the basis for an OMB approved GPRA performance pilot.

The Federal Highway and Transit Administrations are cooperating on strengthening the linkages between the public works planning process, project development, and environmental decisionmaking through an initiative on ***Integrating Environmental Considerations into Transportation Planning***. The effort is focusing on the use of interagency coordination mechanisms and analytical tools to develop strategies for fully integrating environmental decisionmaking into transportation programs.

The Environmental Protection Agency is moving to alleviate the burdens on local governments by increasing flexibility in the regulatory process and streamlining its permit program. After working with state and local governments and interest groups, EPA developed and published a strategic plan with national environmental goals which shift the emphasis of EPA from pollution control to one encompassing pollution prevention. EPA's ***Common Sense Initiative*** with six major U.S. industries is aimed at creating more cost-effective pollution control and prevention strategies, such as allowing companies to trade pollution credits.

The Corps of Engineers ***Evaluation of Environmental Investments Research Program (EEIRP)*** is addressing the lack of accepted methods for assessing the effectiveness (does the project achieve its objective?) and efficiency (is it achieved in the least cost manner?) of investments in the protection or restoration of environmental resources. *EEIRP* is focusing on the development of methodologies to improve the evaluation of environmental restoration and mitigation projects, and the development of an overall framework that provides decision-makers with more quantitative information to facilitate the allocation of funds among alternative projects and programs.

The Advisory Commission on Intergovernmental Relations (ACIR), the National Academy of Public Administration and the Rebuild America Coalition sponsored a Capitol Hill Mini-Summit on ***Federal Capital Budgeting*** (in cooperation with the **Corps of Engineers**). Based on subsequent interest, ACIR is considering a second summit on ***Financing Public Works.*** ACIR also continues to promote improved Federal mandate cost estimating and intergovernmental regulatory impact analysis, and is coordinating the development of a program to establish national outcome goals, performance indicators and benchmarks for Federal infrastructure programs.

The Federal Highway Administration's partnership with the **Civil Engineering Research Foundation (CERF)** on the ***Highway Innovative Technology Evaluation Center (HITEC)*** program is aimed at developing improved opportunities to move the innovative products of R&D more rapidly into practice. This national evaluation center was established by CERF under a 4-year, $3 million cooperative agreement with FHwA. New highway products, processes, and services are being evaluated in partnership with private industry. The center also serves as a technology clearing house. **The Federal Highway Administration** is also seeking to accelerate the testing, evaluation and implementation of innovative highway technologies through its ***Applied Research and Technology (ART) Program.***

The Corps of Engineers ***Construction Productivity Advancement Research (CPAR)*** program is a cost-shared partnership between the Corps of Engineers and the U.S. construction industry, academic institutions, state and local governments, and other groups to facilitate the application of advanced technologies through cooperative R&D, field demonstrations, licensing agreements, and other means of technology transfer. Research ideas and proposals are generated by industry and CPAR projects are cost-shared between the Corps and a non-Federal partner. In addition, **the Corps** ***Repair, Evaluation and Maintenance Research Program (REMR II)*** is developing technology to maintain and extend the service life of existing water resources projects. *REMR II* focuses technology requirements which cannot, in many cases, be met with technologies applicable to new construction.

The collaborative ***Technology Reinvestment Project*** program (**Departments of Defense and Energy, National Institute of Standards and Technology, National Science Foundation, and National Aeronautics and Space Administration**) concentrates on developing dual-use technologies for the commercial and defense industries, while the **Environmental Protection Agency's** ***Environmental Technology Initiative (ETI)*** seeks to speed the development of innovative technologies through a funding program on environmental protection and pollution prevention research.

The National Science Foundation's research initiative on ***Civil Infrastructure Systems (CIS)*** is based on an "intelligent renewal" approach which focuses strategically and holistically on the optimal performance of systems, rather than on individual components. The objective of the program is to enhance system performance and the longevity of existing and future facilities through the creation and diffusion of new

scientific and engineering knowledge. The proposal includes basic research in deterioration science, assessment technologies, renewal engineering, and institutional effectiveness and productivity.

The National Research Council's ***National Cooperative Highway Research Program--Innovations Deserving Exploratory Analysis*** **(NCHRP-IDEA)** focuses on new technologies, methods, or processes for application to highways and intermodal surface transportation. In addition, the **NRC** recently created a new research body with a broad public works perspective, the ***Board on Infrastructure and the Constructed Environment (BICE)***. The *BICE* was formed upon the disestablishment of two predecessor boards within the NRC's ***Commission on Engineering and Technical Systems (CETS)***: the ***Building Research Board*** and the ***Geotechnical Board***. The *BICE* brings together a wide range of scientific, engineering, social science and public policy expertise focusing on the broad areas of infrastructure systems and services, national policies related to sustainable cities, development of new technologies for construction and infrastructure renewal, and other issues of interest to the Federal government.

The National Academy of Public Administration and the **American Public Works Association** are working in cooperation to establish a ***Center for Infrastructure Management and Analysis (CIMA)***. The center would provide a continuing capability for infrastructure policy research with a truly cross-cutting, national perspective. *CIMA* would sponsor interagency and intergovernmental committee work, training and education conferences, national cooperative research, policy development, and publications and clearinghouse functions focused on:

- investment analysis
- managing construction and maintenance
- working with other organizations to ensure that public works programs are consistent with broad local, state or national goals
- creating the institutional capacity for effective public works management

CIMA is envisioned as providing a "neutral ground" forum for policy dialogue, and will have a representative governing board involving and supporting the many organizations involved in infrastructure investment and management.

The American Society of Civil Engineers (ASCE) is planning to publish a ***Journal of Infrastructure Systems*** on a quarterly basis beginning in 1995. This journal, which will not be associated with ASCE's various divisions, will be aimed at cross-disciplinary topics about the broad topic of civil infrastructure systems. It is especially notable as a barometer of the growing interest in the use of a system-wide perspective across infrastructure categories to facilitate research on the interactions and tradeoffs between modes. It is also an indicator that the level of cross-cutting infrastructure research and professional activity will likely increase in the future.

PART 2 - SUMMARY OF THE ISSUES

"Probably more than any other nation, the United States has had a dream about capital. Early in its history, the nation put much of its wealth into harbors, lighthouses, canals, railroads, airports, urban and agricultural systems, sanitary systems. From the beginning, the nation has been clear on the need to spend money today to get a good return tomorrow. [However], public trust in the Federal government's ability to make sound capital investments has been eroding rapidly. We need to reemphasize this long tradition of investing because we are in danger of losing it.... We have to have deficit reduction and new investment. As long as these two things are seen as mutually exclusive, we will be at a dead end."

Thomas M. Downs, Commissioner, New Jersey Department of Transportation (currently President and Chairman of AMTRAK), representing the Infrastructure Subcouncil of the Competitiveness Policy Council at the FIS Conference on High Performance Public Works, July 1993

VI. BETTER MANAGING WHAT WE HAVE

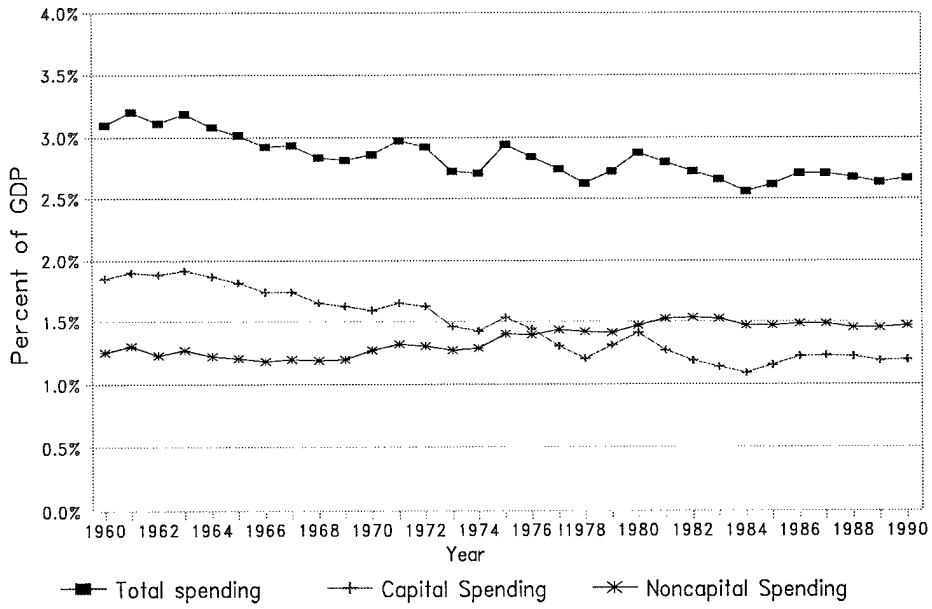
"The American Public Works Association and the [Federal Infrastructure Strategy] task forces are on parallel tracks. The objective of improving maintenance is the heart of public works. We are always confronted with the problem of maintaining what we build. The political problem is that we do not have a ribbon cutting for a rehabilitated sewer. We have "Friends of the Library", but we don't have "Friends of the Sewer."

Robert H. Goodin, Director of Public Works, Rockville, Maryland, representing the American Public Works Association at the National Infrastructure Conference on High Performance Public Works, July 1993

Total public investment in public works relative to the Gross Domestic Product (GDP) has steadily decreased since 1960. This relative decline is directly attributed to the fall in new capital investment, which has dropped from 1.9% of the GDP in 1960 to 1.2% in 1990 (based on spending for highways, mass transit, rail, aviation, water transport, water resources, water supply, and wastewater treatment). This relative decrease is primarily due to the near completion of virtually all of the Nation's large public works programs over the last thirty years, including the Interstate Highway System, the Wastewater Treatment Program, and the National Airport Network. However, over this same period, spending has begun to shift to the operation and maintenance (O&M) of this massive infrastructure, with O&M spending between 1960 and 1990 creeping up from 1.3 to 1.5 percent of the GDP (Figure 9).

The U.S. has now clearly emerged from the transition between the "nation building" era of the past to the "stewardship" period of today and tomorrow. In fact, O&M spending has exceeded new capital spending since 1976. Although America will not stop building new facilities, it is unlikely that there will be any public works programs in the foreseeable future of the national scale comparable to the creation of the inland waterways system, or the opening of the western United States by supplying Federal water and energy.

The future is more likely to focus increasingly on maintaining or improving service levels through the operation of this massive infrastructure. This will involve squeezing more services out of existing facilities through technological innovation, while keeping costs under control, and protecting, cleaning up and restoring the environment. Performance, not construction, will be the overriding goal of America's 21st century infrastructure. Relatively speaking, even Federal aid for maintenance can be expected to decline in the future as increasingly tight budgets will pressure the divestment of underutilized system elements or the transfer of facilities traditionally owned and operated by the Federal government to other levels of government or the private sector.



Source: Congressional Budget Office (1991)

Figure 9 - Public Spending for Infrastructure as a Percent of GDP (Capital and Non-Capital) 1960-1990

Principles. The maintenance of existing infrastructure - roads, bridges, water and sewer systems, dams and reservoirs, buildings, and other public facilities, has often not received adequate attention -whether the infrastructure is owned by Federal, state or local governments. Seldom, for example, are the likely cost and service consequences of deferring maintenance reported. This is especially so in times of constrained budgets.

Maintenance is too important to be scheduled only when the need for repair arises. Maintenance should be planned and reported, with the objective of enabling public assets to continue delivering quality service in the most cost effective manner. The term "maintenance" applied here is used broadly. It includes preventive, corrective, routine, and renewal maintenance, and even rehabilitation and replacement if a component has deteriorated to a point where partial of full replacement is cost effective.

Small-scale improvements, low-capital measures, and demand management techniques should be used more extensively to maintain future service levels while minimizing outlays. In particular, user and congestion fees should be considered as alternatives for increasing capacity and not viewed solely as a means for cost recovery.

Urban Institute Study of "Deferred Maintenance"

The Urban Institute, in a FIS study commissioned by the Corps of Engineers, examined deferred maintenance practices in state, local and Federal governments. Conduct of the study included coordination with a study advisory panel which included representatives from:

- Federal infrastructure agencies
- Local public works departments and commissions
- Federal Accounting Standards Advisory Board
- Government Accounting Standards Board
- Professional associations representing public works and the private sector

O&M programs ranging from the Federal (Army Corps of Engineers, and the Department of Energy) to the local level (City of New York and City of San Jose, CA) were analyzed.

The study confirmed that maintenance has become an increasingly important part of infrastructure programs at all levels of government. Given maintenance's relative invisibility (except when a system failure occurs), it is also often the first expense item to be deferred, a short-term stop-gap which often leads to greater expenditures in the long-run.

"Deferred maintenance" was defined as maintenance and repair needed to bring current assets up to a minimum acceptable physical condition level not including improvements in capacity or capability beyond the original design. The study panel developed four basic steps to ensure full reporting of deferred maintenance:

- Assessment of the condition of the assets
- Determination of a minimum acceptable condition level for each asset
- Estimation of the cost to bring those assets back to acceptable condition
- Estimation of the consequences of deferring maintenance

The study found that the first and third steps were the ones most prevalent in government practice while significant progress needed to be made in the second and fourth steps. To improve such practices, the study recommended that public agencies explicitly prioritize their outstanding deferred maintenance balances, provide information on the consequences of continued deferral, standardize reporting and analysis where many different agencies and programs exist, and report on their maintenance program annually.

Source: Issues in Deferred Maintenance by The Urban Institute, IWR Report FIS-16-94

Recommendations. Public works management practices need to be refocused on performance outcomes. Agencies should encourage maintenance planning aimed at reducing long-term costs through early identification of maintenance needs. Reporting unaccomplished maintenance would help public officials better prioritize maintenance needs and make more informed budget decisions by more explicitly considering the implications of unfunded maintenance. In order to accomplish this, Federal agencies should:

(1) Develop and update multi-year maintenance plans based on a periodic inventory and condition assessment of public works assets

(2) Use condition assessments to prioritize maintenance needs, with maintenance budget decisions fully documented and reported to upper management, elected officials and the public

(3) Condition assessments and system reliability measures should move beyond deterministic engineering (safety) factors and include statistical or probabilistic based risk functions or composite (i.e., demand peak, return frequency) indicators.

(4) Explicitly consider future maintenance costs when selecting new or replacement capital assets, including low-maintenance alternatives which may initially cost more, but will reduce overall life-cycle costs

(5) Include in reports of unfunded maintenance not only the "dollar gap", but also the performance implications of the unfunded work, including risks to health and safety and likely economic losses

(6) Utilize a variety of pricing mechanisms to manage demand at existing facilities in order to increase capacity, lengthen useful project lives, and lessen the need for capital improvements

Recent legislative and executive branch actions have begun to establish the use of performance-based maintenance and management practices through the ***Government Performance and Results Act (GPRA) of 1993.*** The act has several components, including requirements for strategic plans, annual performance reports, and improving managerial accountability and flexibility. The *GPRA* utilizes a series of agency pilots to demonstrate and evaluate the implementation of its various requirements (see below).

GPRA Performance Pilots

The *GPRA* requires Federal agencies to develop strategic plans, set performance goals, and report annually to Congress and the Office of Management and Budget (OMB) the precise results that the program achieves. Many of the practical applications of these requirements should result in fundamental changes to the manner in which Federal agencies monitor and report program performance.

In recognition of the operational uncertainties associated with these reforms, implementation is phased in over a number of years until government-wide application is realized in the year 2000. Consistent with this phased implementation schedule, the law calls for agencies to conduct pilot projects to demonstrate and evaluate the implementation of *GPRA* requirements. Three sets of pilot projects are called for: (1) Performance Goals and Measurement; (2) Managerial Accountability and Flexibility; and, (3) Performance Budgeting. Over 100 agency proposals have been approved by OMB as performance pilots.

The Corps of Engineers pilot is based on the work of the *National Operation and Maintenance (O&M) Program Plan of Improvement*. This program is aimed at increasing the performance and efficiency of the Corps existing civil works infrastructure. The program is also consistent with the provisions of **Executive Order No. 12893 on *Principles for Federal Infrastructure Investments*** regarding periodic review of management practices.

The goal of the program is to guide the Corps O&M function into a more cost-effective and efficient posture. The program is organized around four specific areas:

- Program Development and Budget Execution
- Standardized Organizational Structure
- Standardized Operating Procedures
- Performance Measurement and Data Management

This comprehensive review has already resulted in changes to current management practices. Initial implementation of new ways for prioritizing and budgeting O&M work is manifested in the President's FY96 budget request. The standardized organizational structure will decentralize decisionmaking and focus accountability, resulting in an initial Corps-wide reduction of 175 positions, , elimination of at least one management layer at each Corps district office, and a doubling of the employee to supervisor ratio. Finally, a performance measurement system focusing on "results" and "outcomes" is being installed that will link national program performance indicators with measures at the project level.

VII. CHOOSING MORE EFFICIENT INVESTMENTS

"Things are coming together for a new focus on infrastructure and how to manage it well. The [Federal Infrastructure Strategy] task force recommendations on improved analysis, including increased use of benefit-cost analysis, is an approach that I have favored for a long time, and now is the time to renew our effort to make it happen."

Dr. Alice M. Rivlin, Deputy Director (currently Director), U.S. Office of Management and Budget, at the Infrastructure Conference on High Performance Public Works, July 1993

It is indisputable that Federal, state and local governments have been investing proportionally less in public works since 1960 as a percentage of GDP. Overall infrastructure investment by these three levels of government has shrunk from 3.2 percent of GDP in 1961 to 2.65 percent in 1990 (see Figure 2). During the 1980's the basic question being asked was: What impact has this relative decline in infrastructure investment had on the Nation's economic growth and productivity? A related question was: Is the Nation underinvesting in public infrastructure?

In the 1990's, however, a new paradigm has emerged. While spending on all domestic discretionary programs (in real terms), including infrastructure, has remained relatively stable for a number of years, and defense spending cycled through some ups and downs, the tremendous growth of mandatory spending has created extraordinary budget pressure on all spending (Figure 10). Although many policy analysts concede that reducing the Federal deficit at the expense of infrastructure investment may be counterproductive to the Nation's productivity growth and competitiveness goals, the current era of shrinking capital signals that increases in Federal infrastructure spending is not a viable option.

Today, the realization that there is little, if any, new funding available for increased spending on public works has elevated other important questions to the top of policymakers lists: (1) How can we ensure the highest rates of return on Federal infrastructure investments? (2) Are we able to identify optimal levels of investment? (3) What are the investment priorities within each infrastructure category? (4) What are the relative rates of return across different categories of public works? (5) When investments are indicated, what are the implications regarding who should pay? (6) Do we need a common language among Federal agencies on these issues? (7) Should we be collecting new data to facilitate decisionmaking? And, (8) Can these relationships help us determine the priorities of investment among and between various programs and projects, or between capital spending and maintenance activities?

RESEARCH ON THE ECONOMIC IMPACTS OF INFRASTRUCTURE INVESTMENT

Every year, the Federal government invests, through grants and direct expenditures, over $50 billion in the nation's infrastructure. Despite the size of these sums, there remains considerable uncertainty regarding just how infrastructure spending affects the growth and productivity of the national economy.

Part of this uncertainty has to do with the fact that the infrastructure sector encompasses many different activities, each one taking place over time and across a wide range of locations throughout the nation. Infrastructure spending has both broad national "macro" effects and distinct local "micro" effects, and the relationship between the two is exceedingly complex since national impacts often derive from synergies transcending the sum of the parts.

The FIS sought to bridge this gap between the "macro" and "micro" dimensions by bringing together different Federal infrastructure agencies to design, review and oversee a multi-component research effort on the growth and productivity impacts of Federal infrastructure investments (see footnote below listing agency participants).[1] The questions which this research sought to answer are:

- What is the causal relationship between infrastructure investment and economic activity?

- Do different sectors of the economy benefit differentially from investment in public infrastructure?

- Is there an appropriate level of public investment in public infrastructure, and is the nation currently investing too much, too little, or just enough?

To answer these questions, the FIS pursued three contrasting methodological approaches focusing on different, but related dimensions of infrastructure's economic impact. The research addressed the various econometric problems which have been suggested as biasing or increasing the variance in past macroeconomic estimates, including: simultaneous equations bias, aggregation bias, and model misspecification. The three research tracks selected were based on a cost function model; an endogenous growth model; and a general equilibrium model:

1. **An econometric estimation of how public capital changes production costs at an industry level** was undertaken by Dr. Ishaq Nadiri at New York University using econometric cost-functions. The Federal Highway Administration funded this portion of the effort.

2. **A model was developed to analyze how public capital changes the long-run growth path of the economy**. This was a more "macro" level analysis designed to estimate optimal overall levels of public capital investment and examine possible differential effects caused when such investment is financed with, say, debt rather than taxes. Dr. David Aschauer of Bates College used an endogenous growth model to pursue this task.

3. **A model was formulated to simulate the different ways in which public capital flows through the economy** in order to tell the story of the "micro" and short-run effects of infrastructure investment. Dr. Charles Hulten of the University of Maryland at College Park has developed a Computable General Equilibrium (CGE) model to complete this task.

RESEARCH ON THE ECONOMIC IMPACTS OF INFRASTRUCTURE INVESTMENT
(Continued)

The three tracks were executed on a consistent data base with feedback between the researchers to ensure maximum comparability and/or complementarity across the studies. Preliminary results from this effort include:

- Both "macro" (e.g. econometric) and "micro" (benefit/cost) analyses have a role to play in formulating national infrastructure policy. In general, the researchers concluded that benefit-cost analysis is sufficient where there are no significant benefit spill-over externalities anticipated from the investment, while macro-analysis should be considered as a supplement to B/C analysis where there is a reasonable expectation of such spillovers

- Macro analysis may fail badly when time series data are used because of the combined effects of simultaneous equations and aggregation bias. There are techniques which can be used to minimize this anomaly, and they should be used when applicable. Likewise, benefit-cost analysis may sometimes be misleading when there are very significant benefit spillovers and externalities

- Public infrastructure investments can have significant cumulative impacts over time and far into the future, even though the year-to-year impact may be very small. In addition, even sound investments can have significantly reduced payoffs if financed through distortionary or inefficient tax/debt vehicles

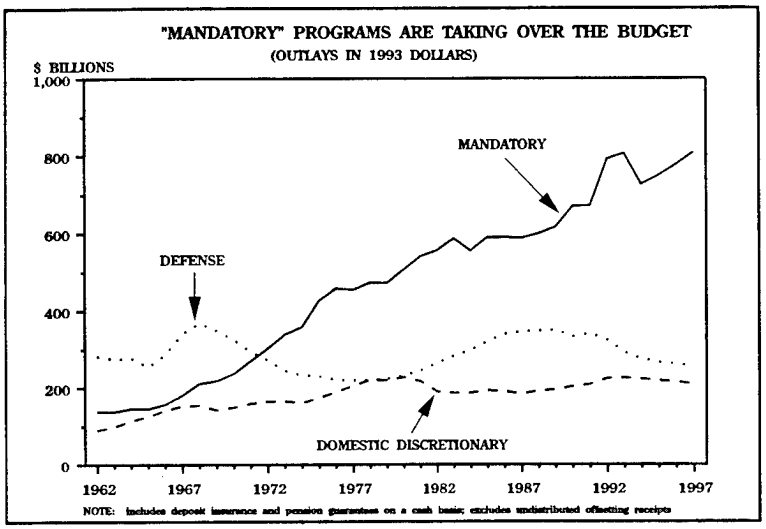
- The empirical results of the research confirm that public infrastructure investment is important to national economic development. However, this conclusion must be qualified by the observation that, because infrastructure investments are "lumpy", a small incremental increase in spending may have little or no effect on output, even though, on average, it matters very much

- Empirical results also indicate that currently there is no apparent systematic underinvestment in the nation's public works.

---

[1]Apogee Research, Inc. was contracted to lead the effort, while Federal agencies represented at study review meetings included the Departments of Transportation (Federal Aviation, Highway, Railroad, and Transit Administrations), Agriculture, Commerce (Bureau of Economic Analysis), and Interior (Bureau of Reclamation), and the Environmental Protection Agency. Representatives of the Office of Management and Budget also attended some of the meetings

Source: Infrastructure in the 21st Century Report Series: IWR Reports FIS-93-4, FIS-94-7, 8, 9, and the final report (forthcoming)



Source: Budget of the United States Government, Fiscal Year 1993

Figure 10 - "Mandatory" Programs Are Taking Over the Budget

While determining the economic merits of individual projects can be relatively straightforward, satisfactory answers to the above questions at the programmatic level remain elusive. Much of the problem is due to the difficulties associated with empirically measuring the economic contributions of public goods, limitations in data, and the complexities of measuring system-wide impacts of very different types of infrastructure. Nevertheless, there is agreement, particularly in a time of large government budget deficits, that the Federal government must do a better job of analyzing and choosing investments, since it is likely that not all projects and programs have the same impact.

Principles. It is essential that the Federal government identify, scale, and fund public works that will yield the highest possible benefits as compared to costs. Given the current scarcity of Federal, state and local funds, the efficiency of each and every infrastructure investment must be maximized. More attention needs to be focused on improving the productivity of infrastructure spending, the methods for investment analysis, and the quality of the data used to support these analyses.

Of the various tests currently available to be applied to infrastructure investments, benefit-cost analysis and cost effectiveness assessments were identified by participants as the most effective and broadly applicable analytical tools. These analyses should be used more broadly to: develop and support initial decision strategies for programs and projects; compare and prioritize investment options in support of programmatic and budget decisions; identify the optimum level of spending and reduce investment risks; and evaluate post-investment decisions to determine whether to continue, adjust or redirect current investment levels.

Executive Order No. 12893 - Principles for Federal Infrastructure Investment

Historically, benefit-cost (B/C) analysis has not been used consistently across all Federal infrastructure programs for investment decisionmaking. Formal benefit-cost analysis within the Federal government can be traced to the passage of the Flood Control Act of 1936 which required comparing costs of a Federal water project with its benefits "to whomsoever they may accrue." Since then, Federal water resources agencies have developed a series of detailed analytical frameworks, currently known as the "Principles and Guidelines" (P&G), which institutionalized the use of benefit-cost analysis for evaluating water resources investments.

Benefit-cost techniques have also been employed as a decisionmaking tool on a variety of other Federal programs. For example, Federal regulatory actions have been subject to B/C analyses according to Executive Order No. 12291, and more recently, Executive Order 12866. OMB Circular A-94 establishes guidelines and discount rates to be used in Federal B/C analyses, exclusive of the water resources programs subject to the P&G.

Executive Order No. 12893 constitutes an important milestone in Federal infrastructure policy making. It represents the first set of investment principles formally articulated by the Executive Branch for consistent application across a range of Federal infrastructure agencies and programs.

The Order requires that major agency direct spending and grants for infrastructure be subjected to a benefit-cost analysis, with a full analysis of alternatives including pricing, demand management and privatization. An annual programmatic investment analysis of capital budget accounts is required with all future budget submissions, beginning with agency requests for Fiscal Year 1996. In addition, an investment analysis justification is required of all major infrastructure legislative proposals. A major investment is defined as one with budgetary resources in excess of $50 million.

Operation and maintenance (O&M) activities are considered a form of infrastructure management and are subject to the order's requirements for periodic reviews to improve the performance of existing facilities. Other principles require agencies to seek private sector participation in infrastructure investment and management, and to encourage state and local recipients of Federal grants to implement management systems in support these principles.

Infrastructure categories covered by the Order include transportation, water resources, energy, and environmental protection programs. Agencies in the process of complying with the E.O. include the Departments of Agriculture, Army (Corps of Engineers), Energy, Interior, Transportation, and the Environmental Protection Agency.

Source: Executive Order No. 12893, Principle for Federal Infrastructure Investment, 26 January 1994

Recommendations. The key to improving the quality of proposed infrastructure investments is to require that they be subjected to investment analyses. Much can be accomplished within existing legislation to establish government-wide policies and practices which broaden and improve the use of these techniques.

(1) Expand the use of benefit-cost, cost-effectiveness, and risk uncertainty analyses by Federal agencies involved with directly provided, assisted, or regulated infrastructure programs

(2) Improve the accuracy and credibility of the analyses prepared by these agencies, including greater emphasis on the valuation of environmental and other non-monetized outputs

(3) Promote greater consistency in the use of these analytical methods, thus enhancing its ability to compare and choose investments among diverse programs, projects and regulations

VIII. BUDGET SENSITIVE FINANCING

"Pricing [infrastructure] is a difficult challenge. Historically, the focus has been on cost recovery. Experience has shown, however, that cost recovery is the wrong focus of pricing policy. The focus should be on the efficient use of existing resources. Efficient pricing leads to minimizing the requirement for new capital expenditures. When you make the best use of existing facilities, you don't need to build new ones as fast."

Dr. G. Edward Dickey, Acting Assistant Secretary of the Army for Civil Works, at the National Infrastructure Conference on High Performance Public Works, July 1993

Although the era of large new national public works programs is largely over, the need to efficiently operate, maintain and modernize America's massive existing infrastructure remains a formidable task. The potential for evolving communication and information management technologies to improve the efficiency of infrastructure service, and the need to restore, protect, and sustain the natural environment provide the context for this challenge. This undertaking must involve an intergovernmental partnership since state and local governments continue to be the largest providers of public works infrastructure.

The options available when selecting among potential financing mechanisms for capital or non-capital spending include:

(1) current revenues
(2) borrowing (pledging future revenues)
(3) intergovernmental assistance
(4) private sector options

When approaching these choices, governments typically have relied on a limited number of traditional revenue sources, such as the general fund (revenue from local property taxes, and various forms of sales and income taxes), long-term borrowing (general obligation and revenue bonds), dedicated taxes (such as the gasoline tax), and Federal grant assistance. In addition, governments often finance publicly provided utilities such as water treatment or waste disposal through user charges based on consumption or service availability.

Declining assistance from Federal grants, increasing difficulties in raising sufficient funds through traditional mechanisms, greater acceptance of the "beneficiary pays" principle, and technological advances have combined to increase the use of "nontraditional" sources of revenues. At the local level, one of the strongest forces driving this search for additional funding has been the rapid growth of unfunded Federal

mandates (see Chapter X). Nontraditional mechanisms include: developer extractions; special taxing districts; user charges; greater reliance on revolving loan funds, investment pools and bond banks; and public/private revenue partnerships. As technology for recording usage and levying requisite charges (such as highway user fees) improves, other opportunities will present themselves to better manage demand and to more accurately link charges to those who benefit. In addition, pricing policies are increasingly being viewed not only as a means to recover costs, but to also broaden the audience for spending decisions, manage demand, and to expand the capacity of existing facilities, thus reducing the levels of future outlays.

Improving Infrastructure Financing

Infrastructure facilities are usually large, expensive to build and costly to maintain. Their long lives usually require that funding be collected up front through debt issuance. This financing role has typically fallen most heavily on State and local governments, with the Federal government providing direct and indirect subsidies. The FIS program examined the issue of the proper Federal role in infrastructure finance through a number of vehicles:

The Effects of Federal Tax Policy on Public Works Investment. This study by **Apogee Research** addressed the question of whether or not various changes made to the law governing tax-exempt bonds issued by State and local governments have adversely affected issuance of debt to finance the building of infrastructure. The report found that direct linkages were difficult to untangle but that while the cost of infrastructure debt issuance has generally increased over time, such issuance has increased steadily nonetheless.

State Programs for Community Infrastructure. This report by **The Urban Institute** examined and described four types of programs used in 15 States to leverage limited infrastructure funds. These programs include grant and loan assistance programs to needy local communities with pressing public works needs; technical assistance regimes; bond banks, in which small bond issues are bundled together to reap economies of scale in issuance cost and improve overall risk profile, thus lowering interest costs; and privatization.

Improving the Financing of Infrastructure. The **Advisory Commission on Intergovernmental Relations (ACIR)** assembled an intergovernmental task force on infrastructure financing as part of the FIS consultation. Their charge as a group was to develop principles and guidelines for improving the efficiency of infrastructure finance. The findings of the task force emphasized the need to establish a financial planning process that is applied consistently to all Federal programs, whether provided directly, through federal aid, or through regulation. The purpose of such an analysis are to gauge the financial feasibility and relative effectiveness of alternative infrastructure proposals from the viewpoint of all the parties responsible for funding the improvement (and its subsequent operation and maintenance), and to identify the most affordable options. Participants believed that preparing this analysis at an early stage in the review would be an effective means of holding costs down. They recommended that the financial planning criteria be applied throughout the process, thus helping identify and shape not only the financing mechanism, but the project itself.

Principles. Financial planning should not be brought in just at the end of the process, as an afterthought or simply as an implementation element, accepting all the goals, programs, and projects that may have been developed without considerations of their financial consequences. Rather, a financial planning process

should be established and used early in program/project planning to evaluate a full range of public works funding mechanisms, including corporatization and privatization options. Full cost recovery should no longer be the primary goal of pricing policies. Instead, pricing should be used to minimize the need for new facilities, and to broaden the audience for spending decisions. Funding mechanisms should be chosen after an evaluation of alternatives using a consistent set of financial planning criteria, giving full consideration to both traditional and nontraditional funding sources, and including demand management options to ensure efficient use.

Recommendations. Federal infrastructure investment should be aimed at choosing affordable facilities that are: efficiently priced, budget sensitive, and funded to the extent practical by those who benefit, now and in the future. The following steps should be taken toward these goals:

1) **Financial Planning.** Financial plans should be prepared early in the planning of all Federally provided, assisted, and regulated infrastructure in accordance with the above principles.

2) **Financial Advisory Boards.** Financial advisory boards should be established after the models of EPA's Environmental Financial Advisory Board (EFAB), or the Inland Waterway Users Board to help improve, diversify, and innovate agency financing approaches.

3) **Pricing.** Cost-sharing and grant formulas should be reviewed for the full range of Federal infrastructure programs in order to ensure that those who directly benefit from project services pay their share of project costs, with the Federal match approximating benefit spillovers external to the direct beneficiaries. A full menu of pricing instruments should be actively pursued in this regard, broadly including demand management tools such as user or congestion fees.

4) **Remove Legislative Barriers.** Federal/state tax and security laws limiting access to revenue sources such as tax-exempt bonds should be reviewed for unintended barriers to innovative funding mechanisms.

5) **Investment Budgeting.** The expanded use of a public works investment section, such as the Special Analysis D required by Title II of P.L. 98-501, should be considered for the Federal budget. It could be funded by a series of broad, flexible categorical infrastructure trust funds supported by dedicated revenue sources designed for multi-year investment stability. Only spending justified by investment analysis should be eligible to be included in the budget.

In their report, *Investing in Our Future*, the Public Infrastructure Subcouncil to the Competitiveness Policy Council strongly endorsed establishing a long range national infrastructure investment plan that would establish stable and predictable future levels of funding. Although not explicitly part of the FIS recommendations, the specific financing mechanisms presented in the Subcouncil's report warrant review:

- Adoption of a Federal capital budget
- Creation of a National Infrastructure Bank
- Establishment of a Capital Investment Block Grant Program
- Use of the National Infrastructure Corporation proposed by Senator Moynihan in 1991
- Increased use of new public works and telecommunications technologies
- Reorganization of Congressional committees/creation of an infrastructure Commission
- Building public awareness.

Corps of Engineers Environmental Service Partnerships Program

The Corps **Environmental Service Partnerships Program** provides support to small and/or disadvantaged communities that do not have the capabilities or resources to fully evaluate whether privatization of a particular environmental infrastructure facility or service is economically feasible and financially viable. Authority for this demonstration program stems from House Report 101-536 accompanying the 1991 Energy and Water Development Appropriations Act (Public Law No. 101-514).

The House Report directed the Corps to work with the Environmental Protection Agency, the Department of Energy, and other Federal agencies in *a partnership with state and local governments to initiate jointly financed market feasibility studies on the opportunities for public-private financing capabilities of local service-related infrastructure*. The program was also intended to encourage the involvement of the private sector in the planning, design, financing, construction, operation and maintenance of non-Federal water-dependent environmental infrastructure.

Market feasibility studies are jointly financed, with the non-Federal sponsor contributing a minimum of 50 percent (including in-kind services) of the total study cost. The maximum Corps of Engineers contribution to the feasibility study is $100,000, and the studies are normally completed in less than one year. Since Fiscal Year 1991 the Corps has initiated approximately 100 studies. Prior to 1993 these also included some larger communities and both water and non-water resources environmental infrastructure.

More recently, the focus has been limited to small (population less than 500,000) or disadvantaged communities, and on water related problems. Several types of options have been considered as part of typical feasibility analysis, including, but not limited to: Contract Services, Turnkey Projects, Developer Financing, Private Ownership, and Merchant Facilities.

In addition, work has been completed on computer models that local communities can use to request proposals for environmental services from the private sector, and to develop estimates of cost and revenue data for alternative facilities.

The Corps has generally found that market feasibility studies serve as a catalyst to communities to further pursue opportunities for public-private partnerships. Most local governments have subsequently undertaken additional studies, and procured private sector engineering and design services. Several sponsors have utilized the Corps market feasibility studies as the primary input to subsequent public works decisions, and have implemented various environmental infrastructure improvements for water supply and water distribution systems, water treatment, and solid waste management and recycling programs.

IX. THE CRITICAL ROLE OF NEW TECHNOLOGIES

"Today, the products of technological innovation in many fields are all around us: Organ transplants have become almost commonplace in hospitals around the country. A daunting array of new food products with long shelf-lives entice us at supermarkets. Computers that now fit comfortably on one's lap pack more power than the room sized machines commonly available just two decades ago. In contrast, our infrastructure relies for the most part on technologies that emerged initially in the 19th century."

Dr. Andrew C. Lemer, National Research Council, remarks at the FIS Workshop on Innovation in Public Works, sponsored by the U.S. Army Construction Engineering Research Laboratory, Champaign Illinois, March 1992

The public works professional, academic, and research communities have all expressed concern over a perceived lag in infrastructure innovation. Although data linking this concern to R&D spending levels are difficult to interpret, it is generally accepted that technological innovation needs to play a more essential role in improving the performance of the Nation's public works. Significant advances in technology have occurred over the last 15 years, yet innovation in public works are relatively few. It is becoming increasingly clear that breakthroughs in high performance materials, computers, communications, and other technologies have the potential to significantly increase infrastructure capacity without major new construction or further disruption to the environment.

Federal infrastructure research and development (R&D), while found to be more extensive than previously documented, still represents a relatively small share of the overall Federal R&D budget. A study of Federal infrastructure R&D by the Civil Engineering Research Foundation (CERF) estimated public works R&D to be $1.2 billion in Fiscal Year 1992, or approximately 1.6 percent of the total Federal R&D expenditures. Of this total, the overwhelming majority of funding supported applied research (71%), with basic research, primarily funded through the National Science Foundation, representing about 16 percent. Also within this total, the allocations vary significantly between functional modes. As shown in Figure 11, Federal funding was distributed between five R&D categories: transportation received the most funding (36%), followed by energy (20%), water (18%), waste management (16%), and buildings (10%).

In light of the importance of R&D investment, what is the Federal role in infrastructure research? What barriers impede the diffusion of new technologies into practice? How are the Federal laboratories currently transferring prototype public works technologies into practice? And in which technologies should the Federal government invest? These are some of the issues that FIS participants identified as needing attention.

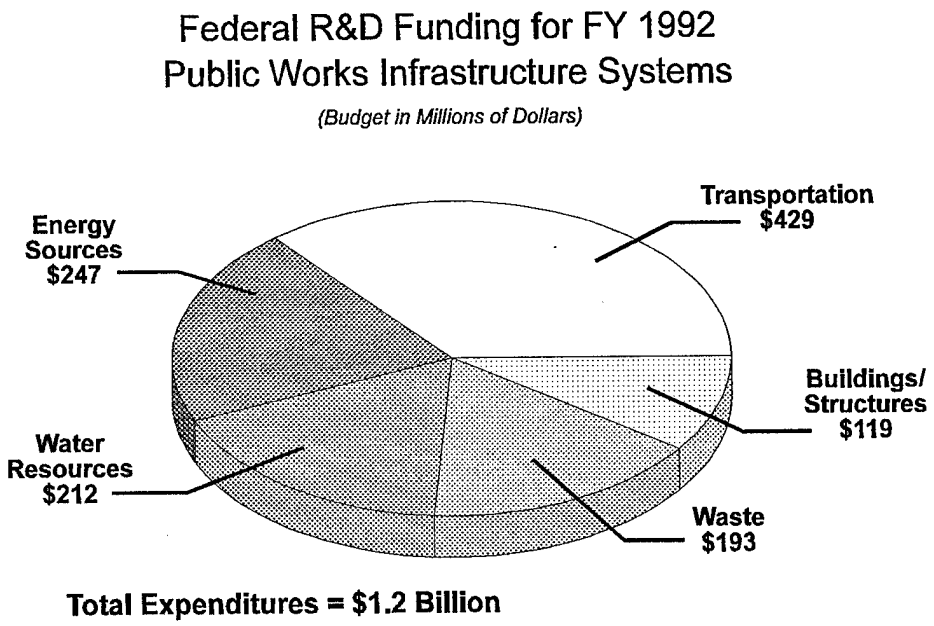


Figure 11 - Federal R&D Funding for FY92, Public Works Infrastructure Systems

In the absence of a national public works research agenda, the typical agency R&D focus is on agency mission-related infrastructure components. Scientists at most Federal laboratories do not have a clear understanding of the concept of public works infrastructure, nor do they possess an understanding that their mission related research products could be applied to improve the performance of the public works community. This lack of understanding became apparent during a national survey of 257 Federal laboratories for the FIS program by the CERF.

Only 32 of the 257 laboratories surveyed acknowledged the conduct of infrastructure research. Additionally, in only thirteen of the laboratories was this research identified as representing more than half of their effort, and this research was primarily mission-related residing within the Bureau of Reclamation, Department of Energy, Department of Transportation, Environmental Protection Agency, National Institute of Standards and Technology, Department of Agriculture, Veterans Administration, and the U.S. Army Corps of Engineers (see Table 6). This lack of specific emphasis on public works research has resulted in a fragmented approach to infrastructure R&D with no single Federal focus, objective, or goal to develop, evaluate, and transfer infrastructure technologies.

State and local governments benefit from R&D products only after a very long process of development, testing, evaluation, commercialization and marketing. This length of time, coupled with the relative lack of investment in public works R&D, and other barriers, such as the fear of liability litigation, the multiplicity of government regulations, code restrictions, and complicated public procurement policies, make this area unattractive for researchers. Major barriers impeding the diffusion of Federally developed technology into practice are described in Table 7.

Table 6: Summary of Federal Agency Activity for Public Works Infrastructure Research and Development (FY 1992)

AGENCY	R&D BUDGET	
	Total (million $'s)	Allocated to PWI R&D
Army Construction Engineering Research Lab	70-100	>90%
EPA Engineering Laboratories	10-20	>90%
VA Rehabilitation R&D Center	2	>90%
USDA/FS Timber Bridge Information Resource Center	2	>90%
DOT/FHWA Turner-Fairbank Highway Resource Center	228	67-90%
Army Waterways Experiment Station	100-150	67-90%
Bureau of Reclamation	5-10	67-90%
DOE-Idaho National Engineering Laboratory	300	50-67%
DOE-Argonne National Laboratory	100-150	50-67%
NIST, Building & Fire Research Laboratory	20-40	50-67%
DOE-Pacific Northwest Laboratory	400-500	30-50%
Naval Civil Engineering Laboratory	40-70	33-50%
DOT/FRA-Transportation Test Center	10-20	33-50%
DOE-Brookhaven National Laboratory	300	10-33%
DOT/RSPA Transportation Systems Center	100-150	10-33%
Army Cold Regions Research and Engineering Lab	20-40	10-33%
Air Force Civil Engineering Laboratory	20-40	10-33%
Army Institute for Water Resources	10-20	10-33%
USDA/FS-Forest Products Laboratory	10-20	10-33%
Army Hydrologic Engineering Center	4	10-33%
National Science Foundation	2700	<10%
DOE-Los Alamos National Laboratory	1000	<10%
USDA-Agricultural Research Service	660	<10%
DOE-Sandia National Laboratory	550	<10%
DOE-Lawrence Berkeley Laboratory	200-250	<10%
National Oceanic & Atmospheric Administration	102	<10%
National Institute for Occupational Safety & Health	70-100	<10%
USDA/ARS-Northern Plains Area	40-70	<10%
Army Topographic Engineering Center	20-40	<10%
Bureau of Mines Albany Research Laboratory	5-10	<10%
DOT/FAA Technical Center	5-10	<10%
Naval Academy	3	<10%

Table 7: Barriers to Innovation Transfer

Barrier	Methods to Overcome
Lack of a Federal initiative (focus) for defining the policy and vision for national infrastructure technology (R&D). Diverse and fragmented governmental structure and private sector organizations dealing with infrastructure; fragmented R&D efforts throughout the nation.	Create a national infrastructure policy that will: (1) Act as a catalyst for innovation; (2) Keep abreast of international R&D for new technologies; (3) Foster intergovernmental partnerships between State and local governments to develop improved fiscal and political tools for promoting innovation.
Inadequate technology transfer mechanisms. Lack of public and private sector R&D cooperation; lack of R&D partnerships between the public and private sectors.	Greater emphasis on user technology needs in the formulation of research priorities; develop improved technology transfer partnering mechanisms in conjunction with greater incentives to reward R&D investment by the private sector.
Lack of public awareness. Public opposition; discordance with widespread cultural values; "not invented here" syndrome; emphasis on short-term benefits, not long-term benefits to the nation.	Active partnership with community groups; building awareness and support groups; communicate with Congress; create mechanisms to resolve controversy; effective education related to key technologies and relevant research; communicate the importance of innovation in a national context.
Complexity of regulations. Governmental technical standards and regulations are complex and sometimes contradictory; increasing rate of legal challenges; obsolescence of regulations.	Developing flexible (performance-based) standards to accommodate technological and design innovation; regular review and appropriate revision of regulations affecting major technologies.
Reluctance to innovate for fear of legal liability. Conservative approaches intended to reduce potential risks; highly visible and publicized failures are penalized while successes go unrewarded; reluctance of financial institutions to fund infrastructure projects with unusual potential risks.	Risk-sharing to encourage innovation; peer evaluation of innovation; demonstrations of innovation, adequately monitored and documented; dissemination of the findings of the demonstrations to all potential users.
Inadequate organizational management for innovation adoption. Resistance to innovation that did not involve the user in defining the problem and specifying the solution; resistance to change; lack of flexibility in regulations; emphasis on short-term, high-visibility results; tendency to cut funding for "unglamorous" public works programs in favor of more visible programs.	Promote top management commitment; nurture active change agents; empower active technology gatekeepers and technology transfer task forces; comprehensive user training programs; promote Total Quality Management (TQM) of all the processes in innovation and technology transfer; innovative financing of public works projects.

Source: Challenges and Opportunities for Innovation in the Public Works Infrastructure, U.S. Army Corps of Engineers Construction Engineering Research Laboratories for the Institute for Water Resources, IWR Reports FIS-93-2 and 3.

The cumulative effect of these barriers results in a gap between infrastructure needs and the availability of R&D products. The most critical of these barriers is the lack of more effective technology transfer mechanisms. Technologies are developed to meet identified needs. Successful transfer requires meeting the needs at the lowest possible price. New products that are not applied do not represent true innovation.

Many past technology transfers for infrastructure applications have not been successful due to the lack of industrial partnerships. Public works agencies by nature either lease or purchase commercialized technologies. They do not have the capability to package and commercialize laboratory prototype technologies into user friendly products. Thus, transferring any technology into use requires identifying the need and early partnership with the private/industrial sector to commercialize the technologies.

A key aspect of the FIS technology transfer study undertaken by the Civil Engineering Research Foundation (CERF) was the identification of those problems and needs within the public works community that are not being adequately addressed by either Federal or private research. While reaching that objective, the study also examined how closely Federal and private sector research priorities match public works needs (see box). The results of this analysis, which was based on a nationwide survey of municipal public works agencies, resulted in a list of 56 high priority problems and needs (see Table 8).

Principles. An explicit, singular Federal emphasis on public works infrastructure R&D is needed to realize the full potential of new technologies to revitalize and re-engineer America's infrastructure. Such a focus should develop a stronger link between the development and adoption processes for R&D products and the technology need priorities of local public works users. Tight Federal budgets will likely constrain future R&D spending. Therefore, improved technology transfer partnerships are needed between the research community, public works practitioners, and commercial manufacturers, along with greater incentives for private sector investment in infrastructure R&D.

Recommendations. Key provisions of a comprehensive Federal infrastructure R&D policy should include the following elements:

- Public works technology transfer mechanisms that better reflect local user technology needs and earlier involvement of the private industrial sector

- Breaking down the legal, regulatory, and procurement barriers to the use of innovative technologies. Flexible standards are needed to accommodate technological and design innovation, in conjunction with alternate ways to bid contracts, and reform of the procurement process

- Technology dissemination as part of the Federal R&D process for the peer evaluation of demonstration projects with risks shared between the public and private sectors

- Intergovernmental cooperation and increased cost sharing between the various levels of government, academia, and industry to fund and transfer the adoption of new technologies.

The establishment of a cabinet-level National Science and Technology Council (NSTC) to coordinate Federal science, space, and technology policies provides the means for addressing many of the aforementioned principles. It can ensure that clear National goals for Federal technology investments are established, that technology policy-making and R&D are more effectively coordinated, and that

Civil Engineering Research Foundation's FIS Study on Infrastructure R&D Technology Transfer

This study was a cooperative effort facilitated by the Civil Engineering Research Foundation (CERF) between the Bureau of Reclamation, Federal Highway Administration, Environmental Protection Agency, National Institute of Science and Technology, American Public Works Association, and the Corps of Engineers. The study objectives were to develop and evaluate mechanisms to transfer technology into practice within the local public works community, and to identify potential demonstration projects.

A five step technology transfer process was applied: (1) Problem Identification, Classification, and Priority, (2) Problem and Technology Matching, (3) Market Survey, (4) Partner Identification, and, (5) Technology Demonstration. Data developed as part of this effort was an outgrowth of a national survey, sent to public works directors nationwide.

Survey results provided a prioritized listing of problems and needs over seven public works areas: buildings, hazardous waste, power and energy, solid waste, transportation, water resources, and wastewater. Problems were defined in terms of frequency of occurrence and criticality of need. The study resulted in identifying 56 high priority infrastructure technology need areas (see Table 8), the development of an infrastructure R&D needs document, the assembly of a short list of existing Federally developed technologies identified as having market potential, and the identification of partners willing to consider participating in a demonstration or commericialization of a Federal technology, including the involvement of infrastructure users, providers, and researchers. These research outputs are predicated on the conclusion that identifying areas requiring infrastructure research is a natural bi-product of the technology transfer process.

A key component of the technology transfer process is the identification of local public works problems requiring the advancement of new infrastructure technologies. The technology requirements are then matched with the available Federal and domestic and foreign commercial technologies. The resulting data base contains listings of technology transfer opportunities, underutilized and non-cost effective technologies, and those technology shortfalls which will require development efforts by the research community. A series of FIS reports prepared by CERF serve to document the study recommendations regarding the demonstration and transfer of Federal technologies to the public works community:

- Federal laboratories have developed innovative technologies that can make important contributions to improve and restore America's public works infrastructure. The technologies assessed in this study that establish a market niche will improve the infrastructure at state and local levels

- All players in the infrastructure arena would benefit from a catalog or database of research and development projects and information; ideally, the information would be in the form of a well-recognized catalog or an online, user-friendly database where information retrieval would be simple and fast

- There is a noticeable communications gap in the public works infrastructure field between researchers and users. The Federal laboratories are the more centralized element of the two, and therefore would be easier for the dispersed public works community to reach. The public works officials, however, are so overburdended by daily concerns that benefits arising from increased communication with researchers cannot compete with other priorities. Increased communication between the two communities would positively affect both

- The study has also produced some valuable databases including one that assesses America's public works infrastructure problems and needs, one that points out public works problems and needs that require additional technological research, and one that collates some of the Federal and private infrastructure research and development being conducted. Further study built on these databases and based on the methodologies utilized in this project will help broaden the technology transfer efforts initiated in this study.

Important ancillary data was also captured as part of the survey. These observations include:

- the majority rate the condition of their infrastructure in fair to good condition
- public works receive average or higher priority, but funding is perceived as adequate
- future public works resourcing is likely to remain at about today's absolute levels
- only 42% of public works agencies have a process facilitating technology adaption
- only 25% of the agencies are experimenting with new technologies
- special contracting for innovation is lacking (less than 200 municipalities have such provisions)

Source: Federal Infrastructure R&D: Technology Transfer Series, (forthcoming)

Table 8 - Highest Priority Public Works Problems and Needs
(Listed per infrastructure system in order of priority)

BUILDINGS

ADA Compliance
Maintenance of Building Systems
Construction/Demolition Worksite Safety
Excavation Safety
Flood Protection
Lighting Efficiency
Construction/Demo Scheduling & Estimating
HVAC & Plumbing

POWER AND ENERGY

Leak Detection for Underground Storage Tanks
Leak Treatment for Underground Storage Tanks
Leak Detection for Utility Pipelines
Above-Ground Alternatives for Underground Storage Tanks
Repair of Utility Pipelines
Clean Air Act Compliance
Efficiency of Small Generators
Waste Separation in Waste-to-Energy Plants

TRANSPORTATION

Maintenance and Repair of Pavements
Drainage of Highways and Roadways
Asphalt Performance for Pavements
Inspection and Management of Pavements
Maintenance and Repair of Bridges
Roadway Markings and Signs
Roadway Snow Removal and De-Icing
Road Crew Safety

WASTEWATER

Repair and Rehabilitation of Collection Systems
Leak Detection in Collection Systems
Standards & Regulations for Treatment Systems
Management of Worker Health and Safety
Maintenance and Repair of Treatment Systems
Land Applications for Sludge Disposal
Composting/Recycling of Sludge
Monitoring of Treatment Systems

SOLID WASTE

Management of Residential Collection
Source Reduction by Composting
Separate Tech. In Materials Recovery
Separation of Waste in Residential Collection
Source Reduction of Litter
Equip. Maintenance for Residential Collection
Materials Recovery by Paper Recycling
Waste Management for RCRA Compliance

WATER RESOURCES

NPDES Compliance for Stormwater
Leak Detection & Repair of Transmission Lines
SDWA Compliance for Potable Water
Stormwater Flood Management
Stormwater Runoff Quality
Flood Damage Reduction
Groundwater Monitoring and Detection
Groundwater Well Drilling and Maintenance

HAZARDOUS WASTE

Recycling and Reuse of Hazardous Waste
Worker Safety in Materials Handling
Alternatives to Landfill Disposal
Management and Regulations
Residential Hazardous Waste
Spills/Site Clean-Up Technologies
Groundwater Pollution Monitoring/Containment
Hazard Identification of Materials

Source: Federal Infrastructure R&D: Technology Transfer Series, Civil Engineering Research Foundation for the U.S. Corps of Engineers Institute for Water Resources (forthcoming)

cross-agency sharing of R&D budget proposals with OSTP and OMB will facilitate the prioritization of technology development and transfer programs.

In addition, many Federal agencies and organizations are currently working to include the private/industrial sector in technology development and technology transfer efforts. IWR's own experiences confirm this emphasis: the Corps technology transfer process for ***IWR-MAIN***, a state-of-the-art water forecasting system, is being accomplished through a public-private partnership. IWR is guiding the process through an *IWR-MAIN* Users Group which includes the American Water Works Association (AWWA), the American Public Works Association (APWA), and the private sector (Planning and Management Consultants, Ltd.).

Although there is no single Federal focus on the transfer of infrastructure technologies, there are several significant agency initiatives:

- **The National Science Foundation (NSF)** operates ***Engineering Research Centers*** which develop technologies cooperatively with academia and industry

- All Federal agencies have access to the ***Cooperative Research and Development Agreements (CRDA)*** which permit the Federal laboratories to work with industry to cooperatively develop and market new technologies

- The collaborative ***Technology Reinvestment Project*** **(Department of Defense, Department of Energy, National Institute of Standards and Technology, National Science Foundation, and National Aeronautics and Space Administration)** concentrates on developing dual-use technologies for the commercial and defense industries

- A program sponsored by the **U.S. Army Corps of Engineers**, the ***Construction Productivity Advancement Program (CPAR)***, supports cooperative development and demonstration of construction technologies

- **The Environmental Protection Agency's** ***Environmental Technology Initiative (ETI)*** seeks to speed the development of innovative technologies through a funding program focussing on environmental and pollution prevention research

- The **Federal Highway Administration** facilitates the evaluation of Federal and commercially developed highway technologies through the ***Highway Innovative Technology Evaluation Center (HITEC)***, a cooperative effort with the **Civil Engineering Research Foundation** and the transportation industry

- The **National Research Council's** ***National Cooperative Highway Research Program--Innovations Deserving Exploratory Analysis (NCHRP-IDEA)*** seeks to introduce new technologies, methods, or processes for application to highways and intermodal surface transportation

X. CLARIFYING ROLES THROUGH A NEW REGULATORY FEDERALISM

"It is not just that the Federal government has no more money; local and state governments don't either. So what is occurring is a reallocation of the funds in local budgets. It is not the water, sewer, and rail requirements, individually, that we must worry about; it's the cumulative impact of all these, and more, on local governments."

Michael J. Pompili, Assistant Health Commissioner, City of Columbus, Ohio, remarks at the National Conference on High Performance Public Works, July 1993

Although the goals and accomplishments of many Federal regulations are salutary, local governments claim that certain mandates impose heavy fiscal burdens on non-Federal governments and that the combined costs of all Federal mandates and regulations are growing much faster than Federal aid. According to a survey commissioned by the U.S. Conference of Mayors, 314 cities spent nearly $6.5 billion to comply with Federal mandates in 1993, while compliance with mandates is projected to cost $54 billion from 1994 through 1998

For example, the State of California estimates that Federal mandates impose approximately $8 billion annually, mostly from implementing regulations associated with environmental and health protection and social programs. The state of Ohio expects to spend almost $3 billion complying with environmental mandates over the next decade, and New York City estimates it will spend $4.6 billion to meet rules on ocean dumping and safe drinking water. Local governments purport that costs of this magnitude distort local budgets and priorities, squeezing resources for other vital public services like education, law enforcement, and public health (see box discussion). The Congressional Budget Office has offered more modest figures, estimating that the financial impact on local governments from unfunded Federal programs has risen from $225 million in 1986 to $2.8 billion in 1991.

Nevertheless, Federal laws and regulations can have other non-fiscal effects that are as important as their financial impacts. These include delays in the construction, maintenance, or expansion of public facilities, the prescription of inflexible procedures that are poorly adapted to local circumstance, the blurring of accountability, and unnecessary conflict with the institutional responsibilities of state and local governments. Such unintended consequences reflect weaknesses in the Federal regulatory and policy making processes, which sometimes fail to recognize the cumulative effects of mandates. Although policies undertaken to ameliorate such problems have been effective in certain instances, these problems ultimately undermine Federal regulatory goals.

Estimating the Costs of Federal Mandates

Defining and estimating the costs and true burdens of "unfunded mandates" is no easy task. For example, in some cases, both States and the Federal government have similar requirements for local governments within their jurisdiction. Are these to be considered State mandates, Federal mandates, or both? Likewise, there are many cases where the Federal government requires certain actions by other governments only if those governments accept Federal grant money. Should these grant requirements be defined as mandates?

Partly because of these definitional problems, and partly because estimating the costs of complying with mandates is very difficult, no systematic estimates of such costs have been completed. However, a number of local governments have compiled their own estimates. While neither comparable to one another, comprehensive in coverage, nor above debate, such numbers do provide some order of magnitude. ACIR recently assembled a number of these estimates which are summarized below:

	Annual Costs ($'s millions)	Percent of 1991 Own-Source General Revenues
Federal Mandate Costs:		
State of Tennessee (1993)	153.7	3.5%
State of Ohio (1992)	260.1	1.7%
City of Columbus, OH (1991)	62.1	10.6%
City of Chicago, IL (1991)	191.2	8.3%
Anchorage, AK (1993)	22.5	0.6%

As noted above, these figures are not directly comparable to one another and far from definitive. By themselves, they also do not give any indication of how mandate costs may change in the future (though some of the jurisdictions did estimate projected costs in figures not presented here).

Finally, no benefit estimates have been done to compare with these costs. With these caveats in mind, the numbers above suggest that mandates carry significant absolute costs, but that their burden relative to ability to pay varies widely. Older cities, with smaller and slower growing revenue bases, may be more impacted by mandates than States with their broader tax bases and ability to pass mandates along. Even here, it may be difficult to generalize: places like Anchorage, with its significant income from oil production and limited industrial development appear to be very lightly affected by mandates.

Source: Assessing Mandate Effects on State and Local Governments, Philip M. Dearborn, Intergovernmental Perspective, ACIR, 1994

Principles. In order to minimize regulatory problems while still accomplishing national objectives the following principles were suggested by FIS participants for enacting or promulgating new regulations and revising existing statues and rules:

(1) **Partnership.** Effective regulation in an intergovernmental framework requires mutual cooperation and genuine partnership among the Federal, state and local governments

(2) **Good Science.** Regulations need to be based on more certain and reliable information on the health and cost effects of each increment of environmental protection

(3) **Holistic Environmental Approach.** The present separate media-based Federal focus sometimes works against understanding the interconnections between impacts, and can result in spending on what are perceived by local governments to be less important problems while their more serious needs are neglected

(4) **Performance-Based Regulation.** Limited resources at all levels of government require that Federal regulatory objectives are clearly defined, appropriate performance standards are established, incentives and other market mechanisms are used, and that cost effective methods are applied to achieve outcomes

(5) **One Size Does Not Fit All.** Congress should design, and agencies should administer regulatory programs in a manner that promotes effective but flexible implementation, recognizing differences in state and local institutional structures, resources, conditions, and responsibilities

(6) **Cost-Sharing.** Budgetary stresses at all levels of government requires new intergovernmental partnerships with affordable and predictable cost shares

Recommendations. Within existing legislation, participants suggested that existing and proposed regulations affecting infrastructure be reviewed to ensure that they are necessary, the least burdensome, and most flexible forms of regulation that accomplish national goals. In addition, the following provisions were considered important to potential mandate relief legislation:

- Baseline estimates of the costs associated with existing mandates
- Regular inventory and cost estimates of all proposed Federal mandates
- Analysis of the incidence of costs and the ability of affected parties to pay
- Reducing the number of mandates through fewer enactments or equitable Federal sharing of mandated costs
- An affordable prioritization and scheduling of non-Federal compliance for those future mandates which are constitutionally justified

Recent policy initiatives addressing FIS principles include Executive Order No. 12866 entitled *Regulatory Planning and Review*. This order, which revised a previous order (No. 12291) on regulatory planning, put forth a process which begins to address concerns over the economic impacts of Federal regulations. The thrust of the order is that Federal agencies should reduce the number of regulations issued

Study of the Effect of Federal Mandates on the Implementation of Improved Local Public Works Management Practices

The National Academy of Public Administration (NAPA) joined with the **American Public Works Association (APWA)** to identify and analyze the effects of Federal, state and local impediments that might prevent state and local governments from implementing improved public works management practices. The APWA *Manual of Public Works Management Practices* was used to identify and evaluate potential impediments. Joint APWA/NAPA visits were made to twelve state, county, and local governments.

Although no Federal legislative or administrative requirements were found to be absolute roadblocks to implementing any of APWA's 400 public works management practices, the NAPA project team concluded that Federal mandates have expanded the missions of local public works agencies, complicated their service operations and construction projects, shifted heavy costs to their local governments, and substituted Federal priorities in the allocation of scarce resources. **Notwithstanding these impacts, local governments expressed clear support for the goals of mandates, especially for environmental programs. They were, however, very critical of aspects of Federal implementation strategies such as priorities, timetables, processes, and the administration and enforcement of the programs.** Interviews with local officials revealed the following:

- Local public works and government officials overarching and foremost grievance is that mandates are imposing **heavy financial burdens** at a time when municipal finances are already severely strained, and while Federal grants are paying a decreasing share of the cost

- As Federal mandates have preempted local resources, **infrastructure construction and maintenance** are the expenditures cut most often by cities

- The **environmental protection mandates** on a clean water, safe drinking water, resource conservation and recovery, and clean air, and the **Americans With Disabilities Act**, are perceived to be the heaviest regulatory hits

- **Environmental protection mandates** on asbestos, lead paint abatement, underground storage tanks, and endangered species also generate heavy costs in many communities

- Local criticisms of the environmental programs are frequently aimed at **Federal standards** which are considered to be unrealistically high, or for which the **scientific underpinning** is questionable, and the **lack of flexibility** to adapt their construction and operational plans to local conditions

- In contrast to the environmental programs whose goals are generally supported by local officials, two other Federal laws -- the **Fair Labor Standards Act** and the **Davis-Bacon Act** are considered by some local officials to be examples of intrusion by the Federal government which drive up infrastructure costs

- For most local communities, the **lion's share** of the costs they would have to incur to comply with current mandates still lies in the **future**

Source: Public Works Management Practices, Volume 1: A Public Works Perspective of the Roadblocks and Opportunities to Improve Performance, American Public Works Association, IWR Report FIS-94-14; and *Volume 2: The Effect of Federal Mandates On Their Activities and Improving Their Performance*, National Academy on Public Administration, IWR Report FIS-94-15.

by limiting them to those that are required by law, are necessary to interpret law, or are made necessary by compelling public need.

Specifically, the new order requires agencies to consider alternatives to regulation and to analyze benefits and costs of "major" regulations, defined as those with an economic impact greater than $100 million. It also requires that each agency develop a *Regulatory Plan* which lays out the goal, legal basis, statement of need, and schedule of action for all proposed regulations, and establishes a centralized review process with OMB acting as the monitor for proposed regulations, and the Vice President leading an interagency working group that reviews regulatory issues.

The order also enhances public disclosure requirements and public involvement in the regulatory review process. Before issuing a notice of proposed rulemaking, each agency must seek to involve "those who are intended to benefit from and those expected to be burdened by any regulation (including, specifically, state, local and tribal officials)," and that all regulations be "simple and easy to understand."

In addition, bipartisan support for legislation providing more fundamental mandate relief is growing in Congress. The *Federal Mandate Accountability and Reform Act of 1994 (S.993)* introduced by Senator Kempthorne (R-Idaho) passed out of the Government Affairs Committee and was headed to the Senate floor at the close of the 103rd Congress. It is likely to be re-introduced during the 104th Congress. The bill would have established the presumption that any legislation imposing a Federal mandate of more than $50 million on a state or local government must include an estimate of the mandate's cost, and must provide for the funding mechanism to pay for implementation of its requirements. Such requirements would not apply to the laws or Federal rules enforcing civil and constitutional rights, national security or treat obligations, emergencies, or voluntary programs.

POSTSCRIPT

As this report goes to final publication, the President is preparing to sign the *Unfunded Mandates Reform Act of 1995* into law. The stated purposes of this Act are to:

(1) Strengthen the partnership between the Federal Government and the state, local, and tribal governments

(2) End the imposition, in the absence of full consideration by Congress, of Federal mandates on state, local, and tribal governments without adequate Federal funding, in a manner that may displace other essential State, local, and tribal governmental priorities

(3) Provide for the development of information about the nature and size of mandates in proposed legislation; and, establish a mechanism to bring such information to the attention of the Congress before the Senate and House of Representatives vote on proposed legislation

(4) Promote informed and deliberate decisions by Congress on the appropriateness of Federal mandates in any particular instance

(5) Require that Congress consider whether to provide funding to assist state, local, and tribal governments in complying with Federal mandates, and to require the analysis and dissemination of the impact of private sector mandates

(6) Establish a point-of-order vote on the consideration in the Senate and House of Representatives of legislation containing significant Federal intergovernmental mandates without providing adequate funding to comply with such mandates

(7) Require that Federal agencies (a) develop a process to enable state, local, and tribal governments to provide input when regulations are being developed, and (b) prepare and consider estimates of the budgetary impact of regulations containing Federal mandates before adopting such regulations

(8) Begin consideration of the effect of previously imposed Federal mandates.

XI. AN INTEGRATED PROCESS FOR ENVIRONMENTAL DECISIONMAKING

"The Intermodal Surface Transportation Efficiency Act and the resulting Federal regulations on metropolitan and statewide planning have set the stage for the next evolutionary step in transportation planning. An important part of this evolution is the creation of stronger, more effective linkages between the planning process, project development, and environmental considerations."

Grace Crunican and Jane F. Garvey, Deputy Administrators, of the Federal Transit and Federal Highway Administrations, respectively, in their August 1, 1994 invitation letter for a National Conference on Integrating Environmental Considerations into Transportation Planning

Federal Environmental laws and review processes have clearly reduced the adverse environmental effects of public works projects over the past two decades. Virtually all Americans recognize and support the need to protect the health and safety of our people and the need to protect the natural environment. Nevertheless, there are many reasons why accommodating public works needs and meeting environmental goals within the Federal review process has become difficult.

Although society's aim is to develop infrastructure consistent with environmental protection goals, practical application often results in competing or conflicting policies and outcomes. The reality is that our current lifestyle choices - how and where we live, travel, manufacture, farm, consume, dispose, and transport - continue to threaten the health of the environment. The term "sustainable development" is central to many of the arguments on either side of this debate. Unfortunately, few can agree on its definition and the term itself has become a lightening rod in the discussion of ways to sort out those circumstances where economic development and environmental protection are truly compatible from those where trade-offs have to be made.

Much of the explanation can also be directed at how Federal environmental protection statutes incrementally evolved, beginning with the National Environmental Protection Act (NEPA) in 1969, followed by a series of individual laws addressing the protection of individual media, such as the Clean Water and Clean Air Acts of the 1970's. The result is not a singular Federal decisionmaking process, but rather a series of overlapping and sometimes conflicting processes, each with its own planning, data, and documentation requirements. For example, the environmental review, approval, and permit processes for Federal water resources projects evolved from more than 60 individual acts (see Table 9) and additional subsequent amending legislation.

As necessary environmental protection statutes and requirements have been enacted and promulgated they have created a series of complex decision-making processes with many separate, often sequential, sometimes inconsistent and duplicative steps by many different agencies. This has often drawn out the process of making final infrastructure and environmental decisions, limited the flexibility to solve problems, increased the unpredictability of the process, and sometimes led to inefficient uses of resources (see box on ACIR study). Local governments claim that these difficulties also sometimes create unaffordable, unachievable or ineffective compliance requirements, thereby increasing tensions within and among the various levels of government. The lack of a singular environmental ethic, whereby consideration of the environment is imbedded into all agency business from the first step of everything we do, is a key contributing factor to these problems.

Table 9 - Partial Listing of Federal Environmental Review and Permit Legislation Applicable to Water Resources Development Programs

Abandoned Shipwreck Act	Food Security Act
American Indian Religious Freedom Act	Forest Conservation
Anadromous Fish Conservation Act	Hazardous Substance Response Revenue Act
Antiquities Act	Historic Sites Act
Archeological and Historic Preservation Act	Land and Water Conservation Fund Act
Archeological Resources Protection Act	Marine Mammal Protection Act
Bald Eagle Protection Act	Marine Protection, Research, and Sanctuaries Act
Clean Air Act	Migratory Bird Conservation Act
Clean Water Act	National Environmental Policy Act
Coastal Barrier Improvement Act	National Historic Preservation Act
Coastal Barrier Resources Act	National Ocean Pollution Planning Act
Coastal Wetlands Planning Protection and Restoration Act	National Trails System Act
Coastal Zone Management Act	Native American Graves Protection and Repatriation Act
Comprehensive Environmental, Response, Compensation and Liability Act	Noise Control Act
Deepwater Port Act	Northwest Power Act
Endangered Species Act	Outer Continental Shelf Lands Act
Environmental Programs Assistance Act	Pollution Prevention Act
Environmental Quality Improvement Act	Port and Tanker Safety Act
Estuary Protection Act	Resource Conservation and Recovery Act
Farmland Protection Act	Various Rivers and Harbors Acts
Federal Facilities Compliance Act	Safe Drinking Water Act
Federal Insecticide, Fungicide, and Rodenticide Act	Soil and Water Resources Conservation Act
Federal Land Policy and Management Act	Solid Waste Disposal Act
Federal Power Act	Submerged Land Act
Federal Water Project Recreation Act	Surface Mining Control and Reclamation Act
Fish and Wildlife Conservation Act	Toxic Substances Control Act
Fish and Wildlife Coordination Act	Various Water Resources Development Acts
Fish and Wildlife Conservation on Military Reservations	Water Resources Planning Act
Various Flood Control Acts	Water Resources Research Act
	Watershed Protection and Flood Protection Act
	Wild and Scenic Rivers Act

Source: Draft Environmental Desk Reference, U.S. Army Corps of Engineers, Institute for Water Resources, May 1994; and *Intergovernmental Decisionmaking for Environmental Protection and Public Works*, U.S. Advisory Commission on Intergovernmental Relations, Report No. A-122, November 1992

Principles. The process of reviewing, coordinating, and making environmental decisions for infrastructure should be guided by the following principles:

- **Legitimate and Compatible Goals.** The provision of public works and environmental protection are both legitimate, high priority national goals. Reducing the conflict between them depends on acknowledging the validity of both goals and seeking common ground within the context of sustainable development

- **Environmental Ethic.** Many problems encountered in obtaining environmental approvals for public works can be traced to inadequate consideration of environmental factors in the earliest states of planning. A fundamental, government-wide environmental ethic should be institutionalized throughout the Federal infrastructure agencies so that environmental quality factors will be routinely and actively pursued throughout agency analytical and decisionmaking processes

- **Integrated Environmental Process.** A single, integrated, multimedia environmental analysis and compliance process based on the framework of the National Environmental Policy Act (NEPA) should be established within and among all Federal agencies

- **Performance-Based Evaluation of Outcomes.** Environmental protection is too often aimed at achieving only "end of the pipe" regulatory compliance standards rather than as an opportunity for sustaining natural systems. Instead, the response to environmental goals should be evaluated using performance measures of environmental outcomes and based on a broad ecosystem perspective for effectively and efficiently reducing risk

- **Intergovernmental Partnerships.** Multiple Federal agencies and a wide variety of state and local governments regulate different or overlapping aspects of a single infrastructure project. It is essential, therefore, for all government units to be working within consistent principles and guidelines. Such consistency must address national goals for both environmental quality and public works and should be based on an open process of intergovernmental participation

Recommendations. In accordance with the principles set forth above the following steps are suggested toward development of an integrated environmental decisionmaking process applicable to all Federal agencies that administer, provide financial assistance to, or regulate public works:

(1) Institutionalize, to the extent possible within existing legislation, an integrated, multimedia, ecosystem-based environmental decisionmaking process based on a multi-objective evaluation framework (i.e., such as the water resources *Principles and Guidelines or Principles and Standards*), and utilizing the NEPA review mechanisms as a "one-stop" umbrella coordination vehicle.

(2) Government-wide guidance to assist in implementing environmental integration policies and to imbed a stronger environmental ethic across Federal agencies. Legislative review, regulatory review, and budget submission procedures should be revised to support the integration policies.

(3) Each Federal infrastructure and environmental agency should internally review its environmental decisionmaking processes to incorporate the principles of integration.

Study of Intergovernmental Decisionmaking for Environmental Protection and Public Works by the Advisory Commission on Intergovernmental Relations

This 1992 study by the Advisory Commission on Intergovernmental Relations identifies conflicts between proposed state and local public works projects and the Federal environmental decisionmaking process. The Commission found considerable frustration generated by overlapping requirements and delays that make planning more difficult and costly for local public officials and agencies without always enhancing environmental protection.

ACIR enumerated five main reasons for the current difficulties in environmental decisionmaking:

(1) Some environmental standards, or their application are unnecessarily arbitrary

(2) Federal decisionmaking frequently has many sequential steps and many veto points, and is too detailed, pervasive, and distant from the site to always be efficient, effective, and realistic

(3) There are many agencies having different environmental responsibilities, multiple veto points, and diverse triggers for vetoes, but not always enough data, analyses, expertise, funding, and personnel to coordinate their activities

(4) Mechanisms for balancing diverse needs and values and avoiding impasses and litigation are underdeveloped

(5) Frequently, there is a failure to internalize full environmental costs within the total projects costs that should be shared among all of the benefited parties.

In response to these problems, ACIR looked to the *National Environmental Policy Act (NEPA)* as the appropriate process for resolving many of the difficulties, but recognized that "new legislation would be required to realize the full potential of this crosscutting environmental law."

ACIR also recommended the public works agencies do a better job of considering the environment at all stages of a project, and that Federal, state and local governments improve their coordination of overlapping requirements, with more realistic and certain schedules for existing processes.

Source: Intergovernmental Decisionmaking for Environmental Protection and Public Works, U. S. Advisory Commission on Intergovernmental Relations Report A-122, November 1992

(4) A consortium of Federal agencies should conduct OMB pilot projects under the *Government Performance and Results Act of 1993* to further advance the development of outcome-based performance measures of environmental programs.

(5) As a long term goal, environmental statutes should be revised to more fully support an integrated environmental review and approval process.

A recent study by the National Research Council (NRC), *In Our Own Backyard*, goes a step further than the technology and ecosystem aspects of environmental decisionmaking by focusing on the cultural implications of public works as a prescription for improving infrastructure provision. A NRC committee, drawing on its members' experience and observations in cities around the country, held workshop colloquia

in three communities: Phoenix, Arizona; Cincinnati, Ohio; and Boston, Massachusetts (see box). The NRC committee raised the notion that infrastructure development needs to be viewed from a comprehensive, holistic viewpoint and not as a collection of independent, incremental, and sometimes inconsistent decisions and regulations.

National Research Council - Commission on Engineering and Technical Systems: Report of the Committee on Infrastructure

The committee's workshops in Phoenix, Cincinnati, and Boston highlighted how a city's location, history, economy, and culture influence its infrastructure and are influenced by it. The locally focused, cross-modal and service-oriented perspective of this study marked an important departure from most earlier work. Committee members spoke to private citizens and representatives of the business communities and governments, who were grappling with issues of infrastructure development and management.

From this experience, the committee extracted three broad principles for dealing with local infrastructure issues, principles that can lead toward "win-win" situations, in which parties with potentially opposing interests seek a way to resolve conflict such that all parties gain. At their core, these principles represent recommendations for what works: good planning, management, and community relations. Within the context of the past several decades, applying these principles means a shift toward a broader view and broader participation in infrastructure.

1 - **Geography Matters**. The specific physical, social, economic, and environmental characteristics of a region should be the primary factors shaping that region's infrastructure and management. National policy must deal effectively with local concerns, allowing solutions to be tailored to the natural environment, social patterns, and locally assesses needs and aspirations of the region.

2 - **The Paradigm is Broadening.** The pattern of infrastructure management must change from uncoordinated functional subsystems to incorporate a recognition that infrastructure is a multimodal and multipurpose system, as well as an stimulus for community development. National policies and programs should be structured to foster a new paradigm that applies across infrastructure modes and brings together the interests of diverse regions within the context of equity among cities and regions.

3 - **Value the "Public" in Public Works.** Infrastructure serves the public, and effective public involvement and broad intersectoral and interdisciplinary partnerships in infrastructure development and management are needed to apply the broader paradigm. Public education is an essential element of future infrastructure management. Public works providers should include community peer review of plans and progress as a regular part of major infrastructure decisionmaking.

The committee recommended that responsible government agencies and the Congress act to enable and encourage broad adoption of these principles in managing the Nation's infrastructure.

Source: In Our Own Backyard: Principles for Effective Improvement of the Nation's Infrastructure, Building Research Board, National Research Council, 1993

XII. CONCLUDING REMARKS

The Federal Infrastructure Strategy (FIS) created a forum on public works issues through a series of intergovernmental consultations and research initiatives which brought together representatives from diverse groups of public works and regulatory agencies, congressional offices, infrastructure providers, academic and research institutions, and advocacy, professional and user organizations.

Participants built upon an extensive body of past work by the National Council on Public Works Improvement, the Congressional Budget Office, the Congressional Office of Technology Assessment, and a wide range of other agencies, institutions, and organizations.

Despite the myriad of financial, regulatory, institutional, environmental and management issues identified as constraining decisionmakers at all levels of government, FIS participants were remarkably optimistic regarding the nation's ability to improve the effectiveness of its public works systems.

Finding the money is not necessarily the most critical impediment to improving infrastructure performance. In fact, the empirical results of the FIS economic research indicate that there is no systematic underinvestment in the nations's infrastructure.

Rather, the more problematic issues appear as efficiency, reliability or technical constraints. Many of the issues are institutional as the roles and responsibilities of all government agencies have continued to evolve while infrastructure investment and management policies are being debated and reformulated.

Meanwhile, deficit reduction, government performance, mandate relief, environmental protection, and a declining Federal financing role have worked to shape a new paradigm in which:

- The future Federal role in providing public works is likely to continue declining, while decisionmaking (and cost-sharing) become more intergovernmental

- Future public works programs will focus increasingly on:

  (1) enhancing the service levels of existing facilities through improved maintenance/management practices and technological innovation;

  (2) keeping costs under control; and

  (3) protecting, cleaning up and restoring the environment.

- Improved performance, not necessarily construction, will be the overriding infrastructure goal of the future

- A hierarchy of multi-dimensional measures of performance will be used operationally, with specific indicators based on service outcomes that reflect the perspectives of both local customers and national-level goals

- All infrastructure spending (capital and O&M) will be subjected to more and more stringent investment analysis requirements to ensure that only the most justified programs/projects are funded

- Applications of new technologies will play the critical role in increasing the lives of existing facilities and reducing life-cycle costs

- A new approach to Federal regulatory mandates will emerge to permanently:

  (1) Reduce the number and cost of Federal mandates and preemptions of state and local authority

  (2) Increase the flexibility for spending increasingly scarce Federal grant funding

FIS research confirmed that opportunities presented by improved management practices, expanded use of investment analyses, budget-sensitive financing, innovative technologies, regulatory reforms and the use of streamlined environmental decisionmaking processes can improve the performance of America's infrastructure within the context of this new paradigm.

Many administration and legislative initiatives have begun to establish policies consistent with this new direction. Thus far, the most significant of these initiatives are:

- The *Government Performance Results Act of 1993*

- Executive Order No. 12893 on *Principles for Infrastructure Investment*, and

- The pending bipartisan legislation on *Mandate Relief*

In addition, the FIS process itself has confirmed that Federal agencies can and do work closely together and with other levels of government and the private sector to solve public works problems. Examples of such ongoing collaborations abound in the public works community, as documented throughout the FIS series of reports (page iv) and summarized herein.

REFERENCES

American Public Works Association. *Public Works Management Practices*, APWA Special Report No. 59, Chicago, IL, August 1991.

Bear, Dinah. *The National Environmental Policy Act*, Intergovernmental Perspective, Summer 1992, Vol. 18, No. 3, U.S. Advisory Commission on Intergovernmental Relations, Washington, DC.

Browner, Carol M. *Partners in Protecting the Public*, Washington Post, May 30, 1994.

Carlin, Alan. *The United States Experience with Economic Incentives to Control Pollution*, U.S. Environmental Protection Agency, Washington, DC, July 1992.

Choate, Pat, and Susan Walter. *America in Ruins: Beyond the Public Works Pork Barrel*, Council of State Planning Agencies, Washington, DC, 1981.

Civil Engineering Research Foundation. *Constructed Civil Infrastructure Systems R&D: A European Perspective*, CERF Report No. 94-5010, Washington, DC, 1994.

Claiborne, William. *Unfunded Mandates Occupy Center Stage*, Washington Post, May 18, 1994.

Commission to Promote Investment in America's Infrastructure. *Financing the Future*, Washington, DC, February 1993.

Competitiveness Policy Council. *"Financing", Investing in Our Future: Report of the Public Infrastructure Subcouncil to the Competitiveness Policy Council*, Washington, DC, March 1993.

Congressional Budget Office. *Public Works Infrastructure: Policy Considerations for the 1980's*, Washington, DC, April 1983.

Congressional Budget Office. *New Directions for the Nation's Public Works*, Washington, DC, September 1988.

Congressional Budget Office. *How Spending for Infrastructure and Other Public Investments Affects the Economy*, Washington, DC, July 1991.

Congressional Budget Office. *Paying for Highways, Airways, and Waterways: How Can Users Be Charged?*, Washington, DC, May 1992.

Congressional Budget Office. *Reducing Entitlement Spending*, Washington, DC, September 1994.

Congressional Office of Technology Assessment, *Rebuilding the Foundations: A Special Report on State and Local Public Works Financing and Management*, Washington, DC, 1990.

Congressional Office of Technology Assessment, *Delivering the Goods - Public Works Technologies, Management, and Financing*, Washington, DC, April 1991.

Council on Environmental Quality. *NEPA Integration: Effective, Efficient Environmental Compliance in the 1990's*, Washington, DC, December 1991.

Dearborn, Philip M. *Assessing Mandate Effects on State and Local Governments*, Intergovernmental Perspective, U.S. Advisory Commission on Intergovernmental Relations, Washington, DC, *forthcoming*.

Executive Order No. 12612, on *Federalism*, October 26, 1987.

Executive Order No. 12866, on *Regulatory Planning and Review*, September 30, 1993.

Executive Order No. 12875, on *Enhancing the Intergovernmental Partnership*, October 26, 1993.

Executive Order No. 12881, on the *Establishment of the National Science and Technology Council (NSTC)*, November 23, 1993.

Executive Order No. 12893, on *Principles for Federal Infrastructure Investments*, January 27, 1994.

Executive Order No. 12898, on *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*.

Executive Order No. 12906, on *Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure*, April 11, 1994.

Hatry, Harry P. and Steinthal, Bruce G. *Guide to Selecting Maintenance Strategies for Capital Facilities*, The Urban Institute, Washington, DC, 1984.

Godwin, Steven R. and Peterson, George, E. *Guide to Assessing Capital Stock Condition*, The Urban Institute, Washington, DC, 1984.

Gramlich, Edward M. *Infrastructure Investment: A Review Essay*, Journal of Economic Literature, Vol. XXXII, pages 1176-1196, September 1994.

Long, Bruce D. *Water Resources Development at a Crossroads*, pages 258-263, American Water Resources Association, National Forum on Water Management Policy, June 28 - July 1, 1992, Washington, DC, 1993.

McDowell, Bruce D. and Bell, Michael E. *Alternative Infrastructure Strategies and Implementation Techniques*, Appendix E, *Framing the Dialogue: Strategies, Issues and Opportunities*, IWR Report 93-FIS-1, May 1993.

McDowell, Bruce D. and Bell, Michael E. *The Value of Infrastructure to America*, Appendix D, *Framing the Dialogue: Strategies, Issues and Opportunities*, IWR Report 93-FIS-1, May 1993.
McDowell, Bruce D. *Public Works for Tomorrow*, Intergovernmental Perspective, Summer 1992, Vol. 18, No. 3, U.S. Advisory Commission on Intergovernmental Relations, Washington, DC.

Meyer, Michael D. *Planning: The Challenge of Being the Glue*, a resource paper for the Transportation Research Board Intermodal Planning Steering Committee Meeting, Washington DC, July 28, 1992.

National Council on Public Works Improvement. *Fragile Foundations*, Washington, DC, September 1988.

National Performance Review. *Putting Customers First: Standards for Serving the American People*, Report of the National Performance Review, Washington, DC, September 1994.

National Performance Review. *Creating a Government That Works Better & Costs Less: Status Report*, Report of the National Performance Review, Washington, DC, September 1994.

National Research Council, Board on Infrastructure and the Constructed Environment, Committee on Measuring and Improving Infrastructure Performance. *Measuring and Improving Infrastructure Performance*, Washington, DC, forthcoming.

National Research Council, Building Research Board, Committee on Infrastructure. *In Our Own Backyard: Principles for Effective Improvement of the Nation's Infrastructure*, Washington, DC, 1993.

Office of Management and Budget, City of New York. *Asset Condition and Maintenance Schedules for Major Portions of the City's Capital Plant: Agency Reconciliation of Maintenance Schedules and Executive Summary*, New York, NY, 1993.

Public Infrastructure Subcouncil. *Investing in Our Future: Report of the Public Infrastructure Subcouncil to the Competitiveness Policy Council*, Washington, DC, March 1993

Rivlin, Alice M. *Budgeting for Performance*, Intergovernmental Perspective, Fall 1993-Winter 1994, Vol. 20, No. 1, U.S. Advisory Commission on Intergovernmental Relations,
Washington, DC.

University of Colorado at Boulder. *Hard Choices: A Report on the Increasing Gap Between America's Infrastructure Needs and Our Ability to Pay for Them*, Boulder CO, February 1984.

U.S. Advisory Commission on Intergovernmental Relations. *Toward a Federal Infrastructure Strategy: Issues and Options*, Report A-120, Washington, DC, August 1992.

____. *Intergovernmental Decisionmaking for Environmental Protection and Public Works*, Report A-122, Washington, DC, November 1992.

____. *High Performance Public Works: Sourcebook of Working Documents*, Report SR-16S, Washington, DC, September 1994.

____. *High Performance Public Works: A New Infrastructure Investment Strategy for America*, Report SR-16, Washington, DC, November 1993.

U.S. Conference of Mayors and Price Waterhouse. *Impact of Unfunded Federal Mandates on U.S. Cities: A 314 City Survey*, October 26, 1993.

U.S. Department of the Army, Corps of Engineers. *National Operation and Maintenance Program Plan of Improvement: Performance Plan for Fiscal Year 1995,* Pilot Project, Government Performance and Results Act of 1993, Washington, DC, August 1994.

U.S. Department of the Army, Corps of Engineers, Institute for Water Resources. *Framing the Dialogue: Strategies, Issues and Opportunities*, IWR Report FIS-93-1, May 1992.

____. *Challenges and Opportunities for Innovation in Public Works, Volumes 1 & 2*, prepared by the U.S. Army Corps of Engineers Construction Engineering Research Laboratories, IWR Reports FIS-2 & 3, June 1992.

____. *Infrastructure in the 21st Century Economy: A Review of the Issues and an Outline of a Study of the Impacts of Federal Infrastructure Investments*, IWR Report FIS-93-4, July 1993.

____. *Federal Public Works Infrastructure R&D: A New Perspective*, prepared by the Civil Engineering Research Foundation in conjunction with the University of Illinois, IWR Report FIS-93-5, July 1993.

____. *Funding State and Local Infrastructure: Two Reports on Public Works Financing*, prepared by Apogee Research and The Urban Institute, IWR Report FIS-93-6, August 1993.

____. *National Operations and Maintenance Program Plan of Improvement: Policy and Procedures Options Study for Project Operations and Maintenance*, IWR Report 93-R-6, August 1993.

____. *Infrastructure in the 21st Century Economy: An Interim Report, Volumes 1-3*, IWR Reports FIS-94-7, 8 & 9, prepared by Cameron Gordon, Policy and Special Studies Division, Institute for Water Resources (Vol. 1), and Apogee Research (Vols. 2 & 3), March 1994.

____. *A Prototype Model for Estimating Local Public Finance Impacts*, prepared by Dennis P. Robinson, Harry H. Kelejian, Navigation Division, Institute for Water Resources, IWR Report FIS-94-10, June 1994.

____. *Corps of Engineers Technology Transfer: Nondestructive Testing, Evaluation and Rehabilitation Strategies for Roadway Pavements*, prepared by the U.S. Army Corps of Engineers Waterways Experiment Station, Pavement Systems Division, Geotechnical Laboratory, IWR Report FIS-94-11, June 1994.

____. *Infrastructure Summaries (Second Edition)*, prepared by Apogee Research, IWR Report FIS-12, July 1994.

____. *Consolidated Performance Report on the Nation's Public Works: An Update*, prepared by Apogee Research, IWR Report FIS-94-13, July 1994.

____. *Public Works Management Practices: Volume I - A Public Works Perspective of the Roadblocks and Opportunities to Improve Performance*, prepared by the American Public Works Association, IWR Report FIS-94-14, July 1994.

____. *Public Works Management Practices: Volume II - Local Government Public Works Agencies: The Effect of Federal Mandates on Their Activities and Improving Their Performance*, prepared by the National Academy of Public Administration, IWR Report FIS-94-15, July 1994.

____.*Issues in Deferred Maintenance*, prepared by The Urban Institute, IWR Report FIS-94-16, September 1994.

_____. *National Infrastructure R&D Needs: Municipal Public Works Users*, prepared by the Civil Engineering Research Foundation, IWR Report FIS 94-17, October 1994.

____. *Employment Impacts of Environmental Restoration Projects*, prepared by Apogee Research for the U.S. Environmental Protection Agency and the Corps of Engineers, (*forthcoming*).

____. *Congressional Response to Fragile Foundations: An Analysis of Infrastructure Legislation of the 101st and 102nd Congresses*, (*forthcoming*).

____. *Improving the Measurement and Performance of Infrastructure*, prepared by the National Research Council, (*forthcoming*).

_____. *Infrastructure in the 21st Century Economy: A Final Report*, prepared by Apogee Research (*forthcoming*)

____. *Federal Infrastructure R&D: Technology Transfer Series*, prepared by the Civil Engineering Research Foundation (*forthcoming*).

____. *Environmental Desk Reference*, Draft Policy Study, May 1994.

U.S. Department of Energy. *Capital Asset Management Process*, Order DOE 4320.2A, Washington, DC, February 10, 1994.

U.S. Department of Transportation. *The Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance Report of the Secretary of Transportation to the United States Congress*, Federal Highway Administration and Federal Transit Administration, FHWA-PL-93-017, Washington, DC, 1993.

U.S. Department of Transportation. Announcement of *A National Conference on Integrating Environmental Considerations into Transportation Planning*, Federal Highway Administration and Federal Transit Administration, Washington, DC, August 1, 1994.

U.S. Department of Transportation. *Highway Economic Requirements System*, distribution of review documentation, Federal Highway Administration, Washington, DC, September 13, 1994.

U.S. General Accounting Office. *Budget Issues: Incorporating an Investment Component in the Federal Budget*, AIMD-94-40, Washington, DC, November 1993.

U.S. Office of Management and Budget. *Value Engineering*, Circular A-131, May 21, 1993.

U.S. Office of Management and Budget. *Government Performance and Results Act Implementation*, Circular A-11, 1994.

Van Daniker, Relmond P. and Kwiatkowski, Vernon. *Infrastructure Assets: An Assessment of User Needs and Recommendations for Financial Reporting*, Governmental Accounting Standards Board Research Report, Washington, DC, 1986.

Vallianos, L. and Stakhiv, Eugene Z., U.S. Army Corps of Engineers, Institute for Water Resources. *Developing a Federal Infrastructure Strategy*, Water Resources Update, The Universities Council on Water Resources, Autumn 1991, issue number 86, pages 15-19.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1995 - 399-393 - 814/40171

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
January 1995

3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
LIVING WITHIN CONSTRAINTS: AN EMERGING VISION FOR HIGH PERFORMANCE PUBLIC WORKS

5. FUNDING NUMBERS

6. AUTHOR(S)
Pietrowsky, Robert A.; Gordon, Cameron; Thompson, James F.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USACE, Water Resources Support Center
Institute for Water Resources
Policy Division
7701 Telegraph Road, Casey Building
Alexandria, VA 22315-3868

8. PERFORMING ORGANIZATION REPORT NUMBER
IWR Rpt. 95-FIS-20

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
USACE, Headquarters
Directorate of Civil Works
Office of Interagency & International Activities
20 Massachusetts Ave., NW
Washington, DC 20314-1000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (703 487-4650)

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release; Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This is the concluding report of the Federal Infrastructure Strategy (FIS) Program, a three-year study exploring the development of integrated or multi-agency Federal infrastructure policies. It documents the results of FIS activities, including the findings of the intergovernmental coordination facilitated by the Advisory Commission on Intergovernmental Relations (ACIR), and approximately 30 other research elements. The principles essential to the development of a Federal strategy are outlined, an action agenda recommended, and the opportunities for further interagency cooperation are presented within the context of FIS policy research.

14. SUBJECT TERMS
Infrastructure, Federal Infrastructure Strategy, investment, economic efficiency, performance, outputs & outcomes, financing, technology transfer

15. NUMBER OF PAGES
94

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT
Unclassified

18. SECURITY CLASSIFICATION OF THIS PAGE
Unclassifed

19. SECURITY CLASSIFICATION OF ABSTRACT
Unclassifed

20. LIMITATION OF ABSTRACT
Unlimited