

Risk Assessment and Management of Water Supply System - Infrastructure Initiative for the 21st Century

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1. Introduction

Both drinking water and wastewater infrastructure are critical to providing essential services to not only protect public health and the environment, but is essential to a strong economy. There has been a significant investment in water infrastructure in the United States. There are over 16,000 wastewater plants serving 190 million people utilizing over 600,000 miles (965,000 km) of sewers. Drinking water is provided by nearly 160,000 large and small drinking water systems serving 264 million people via 1,000,000 miles (1,609,000 km) distribution pipes.

2. Problem Overview

The current problem in the United States is that the water infrastructure is aging and spending has not been adequate to repair, replace, or rehabilitate drinking water distribution systems and wastewater collection systems. The American Society of Civil Engineers Report Card in 2005 rated both the drinking water and wastewater infrastructure as “D-.” It was stated that there is a risk in reversing the public health, environmental and economic gains of the past three decade if the infrastructure is allowed to continue deteriorating. Sanitary sewer overflows caused by broken pipes are thought to be responsible for releasing as much as 10 billion gallons of raw sewage yearly. The difference between projected needs and required spending to improve the water infrastructure ranges from \$ 0 to over \$13 billion per year for drinking water and \$ 3 billion to over \$ 26 billion for wastewater collection systems. The U.S. EPA has responded to this problem as part of its Sustainable Infrastructure Strategy. This strategy is based upon **Four Pillars**:

- better management,
- water efficiency
- full cost pricing, and
- watershed approach
-

There are also cross-cutting themes to be found under each Pillar:

- innovation
- partnerships
- technology
- research

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3. Program Description

The purpose of the “*Innovation and Research for Water Infrastructure for the 21st Century*” research program is to generate innovative technologies for the most cost effective:

- Operation, maintenance, and replacement of aging and failing drinking water and wastewater systems and
- Design of new drinking water and wastewater systems.

This research initiative will focus on both the drinking water distribution system and wastewater collection system integrity. The research focus areas are:

- Condition Assessment
 - Gravity Sewers
 - Pressure Pipes (Distribution Systems and Force Mains)
- System Rehabilitation
 - Gravity Sewers
 - Pressure Pipes
- Advanced Concepts (Design & Management)
 - Distribution, Collection and Water Reuse Systems
 - Treatment Systems

The Wastewater Collection Systems research program goal is to develop and demonstrate innovative technologies for:

- Improved inspection and condition assessment
- Cost-effective rehabilitation and replacement
- Sewerage system designs, e.g., real-time control, watershed approach
- Improved performance and service life extension

The Drinking Water Distribution System research program goal is to develop and demonstrate innovative technologies for:

- Improved inspection and condition assessment
- Cost-effective rehabilitation and replacement
- Sewerage system designs, e.g., real-time control, watershed approach
- Improved performance and service life extension

The program will consist of a wide variety of projects and institutional approaches. The research projects will include: (1) full scale, long term demonstration assessments, (2) state of the technology evaluations, (3) applied research (pilot scale), and (4) basic research that includes proof of concept and bench scale projects. Another aspect of this research program is the development of “Centers of Excellence.” These Centers will be competitively selected among academic institutions or consortiums among several universities that will establish nationally and internationally recognized expertise to work collaboratively with the U.S. EPA and key stakeholders.

It is the goal of the “*Innovation and Research for Water Infrastructure for the 21st Century*” research program to reduce the amount of treated drinking water lost, extend the service life of installed infrastructure, reduce sewer overflows, reduce high risk water main breaks, reduce the amount of untreated wastewater entering surface waters, and optimize the operation, design, and cost efficiency of the infrastructure, thus improving public health, protecting the environment, and improving the economy.

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Innovation and Research for Water Infrastructure for the 21st Century

Purpose

Generate **innovative** technologies for more cost effective:

- Operation, maintenance, and replacement of aging and failing drinking water and wastewater systems
- Design of new drinking water and wastewater systems.

RESEARCH & DEVELOPMENT

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Background

U.S. water infrastructure is critical for providing essential services

- Protect public health and the environment
- Support our economy

Significant investment in water infrastructure

- Over 16,000 POTWs, serving 190 million people
- About 54,000 community water systems, serving 264 million people
- 600,000 miles wastewater sewers
- 1,000,000 miles water distribution lines

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Current Problem

American Society of Civil Engineers 2005 Infrastructure Report Card

- "D-" for drinking water "...New solutions are needed...(we) risk reversing the public health, environmental and economic gains of the past three decades."
- "D-" for wastewater "...Sanitary sewer overflows, caused by blocked or broken pipes, result in the release of as much as 10 billion gallons of raw sewage yearly"

U.S. Conference of Mayors 2005 National City Water Survey

- "aging water resources infrastructure" rated top priority

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The "Gap"

The difference between projected needs and spending trends
(\$ billion per year)

	Drinking Water	Wastewater	Total
Congressional Budget Office	0-8.3	3.2-11.1	3.2-19.4
Water Infrastructure Network	9.4	9.2	18.6
EPA Gap Analysis Report	2.3-13.2	1.6-13.5	3.9-26.7

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Sustainable Infrastructure Initiative

- Responding to the 2002 "Gap" Report
- Water Infrastructure Gap Forum in 2003
- Sustainable Infrastructure Strategy
 - **Four Pillars:** better management, water efficiency, full cost pricing, watershed approach
 - **Cross Cutting Themes:** innovation, partnerships, technology, research

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Research Initiative

- Wastewater Collection Systems Research
- Drinking Water Distribution Systems Research

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Wastewater Collection Systems



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Wastewater Collection Systems

Develop and demonstrate innovative technologies for:

- Improved inspection and condition assessment
- Cost-effective rehabilitation and replacement
- Sewerage system designs, e.g., real-time control, watershed approach
- Improved performance and service life extension

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Drinking Water Distribution Systems



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Drinking Water Distribution Systems

Develop and demonstrate innovative technologies for:

- Leak detection/location
- Assessment of high risk mains
- Cost-effective rehabilitation and replacement
- Distribution system designs, e.g., dual systems with wastewater/stormwater reuse

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Research Focus Areas

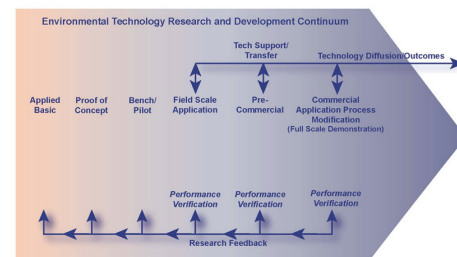
- Condition Assessment
 - Gravity Sewers
 - Pressure Pipes (Distribution Systems and Force Mains)
- System Rehabilitation
 - Gravity Sewers
 - Pressure Pipes
- Advanced Concepts (Design & Management)
 - Distribution, Collection and Water Reuse Systems
 - Treatment Systems

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Program & Project Types

- Technology Demonstration Programs
- “State of the Technology” Assessments
- Applied Research – Decision Support
- Basic Research – Advanced Designs
- “Center of Excellence”

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Program & Project Types (cont'd)

- Technology Demonstration Programs
 - Emerging and innovative inspection technologies and rehabilitation technologies
 - Innovative sanitary sewer and collection system designs
 - Wastewater separation/reuse/dual system designs

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Program & Project Types (cont'd)

- “State of the Technology” Assessments
 - Optimization of internal camera inspections
 - Emerging inspection and rehabilitation technologies
 - Innovative sewer and collection/distribution system designs
 - Understanding forensics of sewer/water main degradation and failure

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Program & Project Types (cont'd)

- Applied Research
 - Cross-sector application of advanced and remote sensing techniques
 - Evaluation and improvement of decision support systems
 - Improvement of repair and rehabilitation materials

Program & Project Types (cont'd)

- Basic Research
 - Exploration of advanced techniques (molecular and isotope tracers) for condition assessment
 - Development of new and innovative pipe and system design approaches
 - Center-based, academic research

Program & Project Types (cont'd)

- “Center of Excellence”
 - Competitively awarded, academic research center
 - Collaboration among several universities
 - Establish nationally recognized expertise
 - Cooperative research program with EPA and key stakeholders

Program & Project Types (cont'd)

- Cross-Cutting Areas
 - Cost, cost-effectiveness, cost-benefit, and life-cycle costing;
 - Performance and outcome measurement;
 - Technology baseline development;
 - Decision-support systems;
 - Systems modeling; and
 - Integrated management systems.

Possible Goals/Outcomes

- Closing the “gap”...reducing life-cycle costs
- Extending service life of installed infrastructure
- Reducing sewer overflows, back-ups, failures
- Reducing I&I and plant WWF bypasses
- Reducing high risk water main breaks
- Improving condition assessment and decision-making capabilities
- Reducing potable water leakage & intrusion potential
- Use of performance/cost data for decision support
- Incentives for adoption of innovative technologies