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Innovative rehabilitation technology demonstration and evaluation program

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ABSTRACT

As water and wastewater water utility owners seek innovative rehabilitation technologies to extend the service life of their assets there is a need to provide accurate performance and cost information on innovative technologies as they come to market. To meet this need, the US Environmental Protection Agency created a field demonstration program to evaluate innovative and emerging technologies to increase the effectiveness of the operation, maintenance, and renewal of aging drinking water distribution and wastewater conveyance systems. This program has resulted in the development of a technology demonstration and evaluation process that evaluates each aspect of pre-installation, installation and post-installation activities in order to provide information that is beneficial to water and wastewater water utility owners, technology manufacturers, and consultants and service providers. To date, two technologies indentified as innovative water rehabilitation techniques have been demonstrated. It is recommended that additional innovative and novel technologies be demonstrated under a similar program in the future to determine their applicability, while providing accurate performance and cost information to water and wastewater utility owners.

1. Introduction

Even though techniques alternative to open-cut construction used for infrastructure rehabilitation have continuously developed over the past 40 years, the average rate of system renewal is still not adequate to keep up with the increasing needs of water utility owners (Sterling et al., 2009). Many water utility owners are seeking innovative technologies, such as trenchless techniques, to extend the service life of assets and repair larger portions of their systems. However, information on emerging technologies is not always easy to obtain. This need was identified by stakeholders at an US Environmental Protection Agency (EPA) workshop on Innovation and Research for Water Infrastructure and the lack of knowledge on the performance of innovative technologies was identified as an area of needed research (EPA, 2006, 2007).

To meet this need, research is being conducted as part of the EPA's Aging Water Infrastructure Research Program to evaluate the performance of innovative and emerging technologies that can increase the effectiveness of the operation and maintenance (O&M), and renewal of aging drinking water distribution and wastewater conveyance systems (EPA, 2007). This research includes a field demonstration program of innovative rehabilitation technologies, which is intended to make the capability of these technologies better known to water and wastewater utility owners. The benefits of the program are summarized below:

1.1. Benefits to water and wastewater utility owners

- Reduced risk of experimenting with new technologies and new materials on their own.
- Increased awareness of innovative and emerging technologies and their capabilities.
- Assistance in setting up strategic and tactical rehabilitation plans and programs.
- Identification of design and quality assurance/quality control (QA/QC) issues.

1.2. Benefits to manufacturers/technology developers

- Opportunity to advance technology development and commercialization.
- Opportunity to accelerate the adoption of new technologies in the US.
- Opportunity to lay the groundwork for design standards and accelerate market growth.

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1.3. Benefits to consultants and service providers

- Opportunity to compare performance and cost of similar products in a consistent manner.
- Access to standards and specifications for new technologies.
- Education of best practices on pre- and post-installation procedures and testing.

This paper presents the critical aspects of the demonstration program approach, technology evaluation metrics, and innovative technology selection criteria, and describes the results from two technology demonstrations completed under this program.

2. Demonstration approach

The overall demonstration approach was outlined prior to each demonstration to provide consistency and guiding principles for conducting and documenting the field demonstrations in a manner that will encourage acceptance of the test results by water and wastewater utility owners.

2.1. Overview of the program

The field demonstration of emerging and innovative technologies requires clear and repeatable criteria so that the technologies can be understood and evaluated. A demonstration protocol was required to provide a consistent approach for conducting the demonstrations and it needed to address the following issues to ensure acceptance by water and wastewater utility owners. Many of these issues were identified at a US EPA International Technology Forum (ITF) organized at the beginning of the project:

- Integration of input from the ITF for defining the standards new technologies must meet before they are considered acceptable (Sterling et al., 2009).
- Independent verification of the claims of technology vendors.
- Sharing information about innovative technologies among peer user groups.
- Supporting water utility owners and manufacturers in bringing new products to a diverse market.

The protocol was written in the form of a quality assurance project plan (QAPP), which outlined the approach to plan, coordinate, and execute the field demonstration with the specific objectives of evaluating, under field conditions, the performance and cost of innovative technologies. The following steps had to be completed for each demonstration study:

1. Prepare and obtain EPA approval for the QAPP.
2. Gather technology data for method meeting the technology and site selection criteria.
3. Secure commitments from a utility owner and manufacturer for the demonstration.
4. Conduct and document the field demonstration as outlined in the QAPP.
5. Process and analyze the results of the field demonstration.
6. Prepare a report, presentation and peer-reviewed paper summarizing the results.

Special aspects of the EPA demonstration program that are intended to add value to the water and wastewater rehabilitation industry are described below.

2.1.1. Consistent design methodology

Leadership in the area of design standard development for innovative rehabilitation technologies has been slow to evolve in North America. The design of a liner can be non-structural, semi-structural, or fully structural (AWWA, 2001) and depend on the level and type of deterioration in the host pipe (ASTM, 2009). The topic of host pipe deterioration and how it affects liner design has been covered in numerous other references including Boot et al. (1996), Boot and Toropova (1999), and Boot and Gumbel (2007) to name a few. This determination can be subjective with little guidance provided by the expert community. An important role of the EPA demonstration program is to identify design parameters and specifications for the selected technologies so that a consistent design methodology can be used based on the vendor recommendations or industry defined standards.

2.1.2. Appropriate QA/QC procedures

Successful rehabilitation projects depend largely on proper installation QC and inspection and assessment QA activities. QA requirements vary by technology and in some cases there are no clear industry quality standards. This demonstration program is designed to examine current QA practices and identify areas of need and for improvement. For technologies lacking industry quality standards, QA/QC procedures recommended by the vendor and the utility owner are reviewed and adopted as appropriate to the field demonstration project.

2.1.3. Technology assessments

The demonstration program assesses short-term effectiveness of the selected technologies in comparison with the respective vendor specifications and identifies conditions under which the technology can be best applied. As part of the assessment, suggestions are made for necessary improvements for the technology, the installation procedures, and QA/QC procedures. The assessments are accomplished using the following six metrics to evaluate the capabilities and limitations and document rehabilitation technology application, performance, and costs.

2.1.3.1. Technology maturity metrics.

- Maturity is assessed as emerging, innovative, or conventional. Technologies available overseas, but not widely used in the US, are considered emerging.
- Interest is in the demonstration of technologies that are commercially available and represent more than an incremental improvement over conventional methods.
- Availability and strength of supporting performance data (full-scale data carry more weight than pilot-scale data) and patent citation.
- Feedback from utility owners and consultants with experience from previous projects.

2.1.3.2. Technology feasibility metrics.

- Determination of the nature of the problem in the pipe (e.g., structural, semi-structural, or non-structural) and the ability of the technology in meeting the requirements.
- Suitability to the hydraulic and operating conditions of the pipe, the type of pipe material, and any challenging pipe configurations (e.g., non-circular pipes, bends, valves, etc.).
- Formal consideration of anticipated failure modes and documentation of design methods.

2.1.3.3. Technology complexity metrics.

- Adaptability to and widespread benefit for small- to medium-sized water utility owners.
- Level of training required for installation, pre- and post-installation, and maintenance.

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