

## **PROJECT OVERVIEW**

State requested responses for Enhanced Pipe Inspection research. Visual inspection is the most common practice for inspecting pipe for HydInfra (State's Hydraulic Infrastructure inventory and inspection database) and construction inspection. Pipes are inspected at the time of construction for construction acceptance, over the life of the facility to determine a HydInfra condition code for asset management and for scoping, design and maintenance. For purposes of this project, enhanced pipe inspection is considered to be inspection methods or equipment beyond what is done during a visual inspection.

It is difficult to inspect a culvert by looking in from the pipe end. Pipe defects, like deflections, joint separations or cracks might be identified, but the extent of the problem might not be accurately measured with a visual inspection alone. There have been instances where pipes were not installed correctly, or defects went unseen, leading to costly repairs or the need to replace prematurely. Some states are using video and/or laser ring to inspect pipes and have reported that this type of inspection has resulted in improved quality of pipe installation. This project will look at the implementation activities of other state Departments of Transportation (DOTs) to utilize their experience in developing States' enhanced inspection best practices.

This project will perform enhanced pipe inspections such as video and laser ring inspections, compare results to visual inspections and document both the benefits and costs of enhanced pipe inspections. This project would compile enhanced inspection guidelines and standards used by other states and provide best practices for use by State. This Enhanced Pipe Inspection research project is an implementation project and should produce actionable best practices and specifications for the use of inspection equipment and methods that supplement visual inspections. This contract includes both development of a best practices manual for enhanced inspection and conducting inspection at select sites using multiple inspection methods for comparison. No equipment purchases are expected though a subcontractor or other arrangements may be needed to provide an experienced video inspection crew and access to equipment to conduct video, laser ring, inclinometer or other enhanced inspection methods.

## **PROJECT GOAL**

The objectives of this project are to demonstrate the value of using video and laser inspections, determine when enhanced inspection is cost effective and provide guidelines for best practices of pipe inspection. This project will look at relevance of enhanced inspection when inspecting different pipe materials (concrete, metal or plastic). This project will identify which factors influence the decision to do enhanced inspection including different types of pipe assets (culverts, storm drain or tile), different types of pipe installation methods, different types of inspection (construction acceptance, HydInfra condition inspection or inspection for roadway project scoping) or different site conditions. Comparison of inspection methods will be made at existing field installations, the major focus will be on culvert locations. The intent of this project is to develop State's Best Practices Manual for Enhanced Culvert Inspections by combining data and lessons learned from inspections, industry interviews and existing literature. The project will develop the following end-user products:

- Best practices guidance
- A new specification or modification to the existing specification
- A Best Practices Report, including the benefit/cost of different inspection methods and providing guidance on when to use enhanced inspection methods
- The Construction Specification for use in incorporating enhanced inspection for pipe acceptance

Depending on the results of the research, Contractor will update the following and incorporate the data into the guidance:

- Specification 2501 or new Specification,
- Chapter 2 in the Drainage Manual and
- Technical Memorandum on Plastic Pipe use.

State's Hydraulic Engineer/Technical Liaison, Andrea Hendrickson, will be responsible for implementing any changes.

## **PROJECT TASKS**

### **Task 1: Project Execution and Field Inspection Planning**

Under this task, Contractor will meet with State's project team to hold a Project Kickoff/Technical Advisory Panel (TAP) meeting. This meeting will be critical to discuss project approach and set a strategic direction for subsequent tasks.

### ***Anticipated Meeting Topics***

Following is a list of topics anticipated to be discussed during the Kickoff/TAP meeting:

- An overview of inspection technologies
- A summary of local vendor experience
- State's experience with inspection technologies
- State's typical inspection practice (e.g., when done, level of care, challenges)
- Proposed inspection plan and locations
- Proposed DOT interview approach
- Proposed Best Practices Manual Table of Contents
- "Next Steps"

### ***State's Involvement***

Under this task, State's staff will schedule the project kickoff and planning meeting, at a State location. In addition, State will:

- Invite appropriate staff to attend the Project Kickoff/TAP meeting
- Identify and provide existing videos for review
- Provide a sorted geodatabase of culvert assets. (If possible, Contractor would like to receive this geodatabase before the kickoff workshop. Once received, Contractor can propose field inspection locations.)
- State will provide feedback on DOTs to interview
- State will provide document style recommendations to be used during development of the Best Practices manual.

### ***Deliverables***

Under this task, Contractor will deliver the following:

- A meeting agenda, supplemental materials and a summary
- Draft inspection areas and methods (field inspection plan document for review)
- Draft interview plan
- Draft Best Practices Manual for Enhanced Culvert Inspections table of contents

### ***Schedule***

State will schedule the kickoff/TAP meeting to be held approximately three weeks after contract execution. Contractor will provide the draft deliverables at the meeting. State will review and provide comments for Contractor to finalize the deliverables.

### **Task 2: Industry Interviews and Literature Search**

Under this task, Contractor will conduct a series of interviews and a literature search to document best practices when conducting enhanced inspections. The Task 2 activities, coupled with review of inspection video, will serve as the basis for a Best Practices Manual for Enhanced Culvert Inspection.

#### ***Industry Interviews***

Contractor's project team will contact up to 10 DOTs to interview staff on experiences with enhanced inspection technologies. In conjunction to DOT interviews, Contractor will draw from national experience to investigate the current state of the inspection industry. Interview Topics include:

- Inspection practice and policy for new construction
- Inspection practice for condition inspection of existing assets
- Inspection benchmarking
- Innovative and routine technologies used for inspection
- Typical service delivery mechanisms (e.g., hire out vs. in-house)
- Lessons learned when utilizing different inspection technologies

#### ***Literature Search***

Contractor will review current inspection literature to identify best practices for enhanced inspection methods. In Contractor's experience, the following resources offer excellent guidance on best practices:

- International Infrastructure Management Manual (Institute of Public Works Engineering of Australia [IPWEA], 2015)

- Condition Assessment Strategies and Protocols - Appendix F: Review of Condition Assessment Tools and Techniques (Water Environmental Research Foundation [WERF], 2007)
- Culvert Repair Practices Manual (Federal Highway Administration [FHWA], 1995)
- Culvert Inspection Manual (FHWA, 1986)
- International Infrastructure Management Manual (IPWEA, 2015)
- Pipeline Assessment and Certification Reference Manual (NASSCO, 2015)

### ***Meetings***

Under this task, Contractor will hold a conference call to provide a status update and discuss findings with State's project management team.

### ***Deliverables***

Under this task, Contractor will deliver:

- A revised "Draft Best Practices Manual for Enhanced Culvert Inspections" table of contents based on results of interviews, literature search and State's comments
- A list of interviewees, copies of questions, actual notes from interviews and a brief summary of each interview
- A draft literature search for review and later incorporation into final Best Practices Manual
- A summary of items completed under this task

### **Task 3: Field Inspections and Video Review**

To develop the manual, Contractor will need to review a sample of inspection data for common culvert materials (i.e., concrete, plastic and metal). State has agreed to make a sample of existing inspection videos available for review and incorporation into the Best Practices Manual. Consequently, the full inspection data set will be a combination of existing video and new data. New data will include direct measure, visual/ field note, closed-circuit televised (CCTV) and laser profile data.

### ***Existing Video Review***

Contractor will review 30 inspection video files to better understand typical inspection practice and condition for State culverts. If possible, Contractor will review:

- 10 existing video files of concrete culverts. Ideally, video files should show culverts in both poor and good condition and of different size.
- 10 existing video files of plastic (e.g., High Density Polyethylene [HDPE]) culverts. Ideally, video files should show culverts in both poor and good condition and of different size.
- 10 existing video files of metal (e.g., Corrugated Metal Pipe [CMP]) culverts. Ideally, video files should show culverts in both poor and good condition and of different size.

### ***New Inspection***

Contractor understands that the culverts to be inspected are generally located in the Metro District, District 6 or District 7. Based on the video review, and other culverts with known defects, Contractor will oversee inspection of at least 10 culverts. Up to five culverts will receive laser scan inspection. At least five culverts will receive traditional video inspection. Where access is feasible, safe and not requiring traffic control signage, five of the culverts will receive direct measurement and visual/ field note inspections. Note that laser scan inspection is a very specialized application. Contractor will need State's assistance in identifying culverts that are cost-effective to conduct laser scan inspection. Locations to inspect may include:

- Culverts with known deformations
- Culverts with holes in the wall and voids visible behind the pipe wall
- Culverts with wall erosion that cannot be understood by traditional CCTV inspection

### ***Subcontractor Involvement***

Contractor will utilize the services of subcontractors for the CCTV and Laser Scan Inspections. Specialty Inspection subcontractors that will be engaged for Task 3 include:

- RedZone Robotics
- VisuSewer

### ***State's Involvement***

Under this task, State will:

- Obtain permission and legal access to State's culvert assets
- Engage participation of other interested State staff
- Provide coordinates, maps or drawings of facilities to be inspected, if available.
- Provide concurrence with proposed field inspections (approval of field inspection plan)

### ***Site Selection Criteria***

- Each site selected for field inspection will include on average up to 200 lineal feet of culvert.
- Inspection sites will not require cleaning or dewatering prior to inspection.
- If person-entry is required, pipes are stable and safe for entry.
- CCTV and Laser Ring inspection sites will require traffic controls that are no more severe than shoulder access.
- Inspections will occur during the day. No overnight inspections are required.
- Other inspections will be of short duration, not requiring traffic control, other than flashing lights and personal protection equipment.

### ***Deliverables***

Under this task, Contractor will deliver:

- Copies of field notes and other written data from field inspections.
- A brief summary of Task 3 components.

### **Task 4: Inspection Results Evaluation**

Under this task, Contractor will compile and analyze results from review of existing videos and new enhanced inspections. Following Task 3, inspection results will be shared with State's project team.

### ***Inspection Results to Discuss***

- Common defects observed based on culvert size and materials
- Risk and vulnerability observations
- Recommended changes to existing inspection practice based on review of existing inspection videos
- Recommended application of inspection methods based on review of new inspection data.

### ***Deliverables***

Under this task, Contractor will deliver:

- A written summary of the Task 3 video review and summary of field inspections including dates, locations, inspection methods in a short memorandum, with evaluation and conclusions and a presentation to State.
- The Video/Laser scan inspection results for culverts inspected in 2016. Inspection data will be provided to State on a portable hard drive. Inspection data may include CCTV video, laser scan data, digital photography or field notes.

### **Task 5: Best Practices Manual Development**

Contractor will incorporate findings from video review, field inspections, interviews and literature search into the development of State's Best Practices Manual for Enhanced Culvert Inspection. The objectives of this project are to demonstrate the value of using video and laser inspections, determine when enhanced inspection is cost effective and provide guidelines for best practices of pipe inspection. The project will look at relevance of enhanced inspection when inspecting different pipe materials (concrete, metal or plastic). The project will identify which factors influence the decision to do enhanced inspection, including different types of pipe assets (culverts, storm drain or tile), different types of pipe installation methods, different types of inspection (construction acceptance, HydInFra condition inspection or inspection for roadway project scoping) or different site conditions. Comparison of inspection methods will be made at existing field installations, the major focus will be on culvert locations.

The intent of this project is to develop State's Best Practices Manual for Enhanced Culvert Inspections by combining data and lessons learned from inspections, industry interviews and existing literature. An outline and draft table of contents will be developed at the outset of the project, revised based on the findings and used as the basis for writing and reviewing the Best Practices Manual. A suitable style guide will be proposed by Contractor, and is subject to acceptance by State's Project Coordinator and Technical Liaison.

***Best Practices Manual Topics***

- Feasible inspection methods, equipment and technologies
- Conducting inspections for construction and condition inspection applications
- Comparison of different types of inspection, including a cost-benefit applications
- Summary of inspection guidance, standards and benchmarking
- Summary of lessons learned from interviews
- Recommendations for preparing specifications to procure inspection contractors
- The manual will include guide specifications for up to three enhanced culvert inspection methods

***Deliverables***

Under this task, Contractor will deliver:

- Best Practices Manual review meeting agenda, materials and summary.
- A Draft Best Practices Manual for Enhanced Culvert Inspection for State's review.
- A Final Draft Best Practices Manual for Enhanced Culvert Inspection, incorporating State's comments, and approved by State's Project Coordinator and Technical Liaison for publication by State's editor. The approved Manual will be processed by State's Contract Editors. The editors will review the document to ensure that it meets the publication standards. This editorial review must be completed within the contract timeframe because the editors will provide editorial comments and request information from Contractor.

***State's Involvement***

Under this task, State will provide a style template for the manual.

**Task 6: Communications Planning and Training**

Once the Best Practices Manual is developed, Contractor will assist State with communicating and training staff on best practices for culvert inspection. Contractor will work with State's Project Manager to prepare a communications plan.

***State's Involvement***

Under this task, State's management team will be available to introduce, coordinate and facilitate the presentation to a selected audience.

***Meetings***

Under this task, Contractor will participate in up to three meetings with State's staff. If feasible, Contractor will host up to three web-based meetings to present the best Practices Manual.

***Deliverables***

Under this task, Contractor will deliver:

- A communications plan
- A PowerPoint version of the presentation, used for web-based meetings
- Web-based recorded training presentation

**PROJECT SCHEDULE**

<b><u>Task</u></b>	<b><u>Schedule/Delivery Date</u></b>
Contract execution	Anticipated by June 6, 2016
Task 1	June – July 2016, including State's review
Task 2	July 2016, including State's review
Task 3	July – September 2016
Task 4	September – October 2016, including State's review
Task 5	October, 2016 – January, 2017, including State's review
Task 6	December, 2016 – May, 2017