Integrating Resiliency at CDOT

Maintenance & Operations Fact Sheet

COLORADO
Department of Transportation

The Concept and Value

Based on the I-70 Corridor Risk & Resilience Pilot Study from 2017—which identified minor culverts as having the highest User Risk of all analyzed assets—CDOT plans to demonstrate how data from a previous maintenance inspection effort can be used to identify a subset of culverts that are high-risk and also on critical routes. A team of CDOT and FHWA subject matter experts have:

- Identified approximately 1000 minor culverts statewide,
- Re-inspected the culverts and captured the data in a live spreadsheet and ESRI-based application, and
- Proposed mitigation efforts for high-risk culverts based on deficiencies found

The goal of the process is a list of potential projects or maintenance strategies that, if completed, would result in positive benefit/cost and reduce overall risk statewide.

The final step in this process should involve seeking funding through the EOC to complete some, if not all, proposed projects; however, Maintenance Sections could also determine that some of the necessary mitigation work would be incorporated into routine maintenance activities.

RESILIENCE

AASHTO Adopted Definition:
Resiliency is "the ability to prepare and plan for, absorb, recover from, or more successfully adapt to adverse events."

Colorado Resilience Working Group Definition:

Resilience is the ability of communities to rebound, positively adapt to, or thrive amidst changing conditions or challenges – including disasters and climate change – and maintain quality of life, healthy growth, durable systems, and conservation of resources for present and future.

How To

A 4-step process was developed and executed by a core group of inspectors from Maintenance Sections in each Region:

1. Identify a high-risk subset of culverts from previous inspection effort
2. Re-inspect culverts
3. Run a baseline Owner and User Risk
4. Recommend a list of risk mitigation projects for culverts that meet target benefit/cost to EMT

Resources were identified and/or developed to help the project team complete the steps outlined above and develop the deliverables for this case study:

- ESRI-based Application (Field Maps) to collect inspection data (Collector App)
- Culvert Rating Guide
- Statewide database of minor culverts
- Virtual training session with video demonstrations for performing inspections and entering data into the Collector App
- Live Google Spreadsheet to collect/update data from all Regions
- Risk data: information from StreamStats, a Regression calculation and results from GIS-based risk analysis to aid in baseline risks for all culverts

This was the most involved and intricate of the Resiliency case studies, and the CDOT Maintenance Staff played an integral role in meeting the level of effort required. Over 20 staff from Maintenance were trained and deployed to reinspect the culverts, and their interdisciplinary team coordination and various skills contributed to successful data collection and the project team's ability to move forward in this process.

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Case Study Results

Issues arose during the first three steps in this case study process. This lengthened the overall case study timeline, but valuable insights and lessons learned were discovered and documented for future reference. However, based on the resolutions to the issues encountered, it was determined that this process can be repeated, implemented and used in the future to inspect additional culverts and mitigate risks found.

Process Issues / Lessons Learned

- Inspection training: make sure the inspectors understand the rating scale, 1 is bad, 9 is good.
- Technical issues with Collector App; determine if it is the best method for future inspections
- Outdated/missing information; inspections should be conducted on a regular basis, and the Google spreadsheet should be a living document and kept up to date
- StreamStats data issues: use StreamStats data for basins greater than 400 acres and a newly developed Regression Calculation for all other basins (utilizing drainage design standards)

Key Takeaways / Recommendations

- One group within CDOT should "own" this process and the data associated with it (suggestion is Maintenance)
- Inspections must be thorough and all required information (for Google sheet and Collector App) must be collected, quality checked for accuracy and completeness before submitting inspection updates
- Continuous feedback and communication in future inspection/data gathering efforts (between inspectors, GIS teams, Maintenance) will play a key role in keeping this process successful and the data valid
- CDOT should develop a strategy to fund this program through the EOC and ultimately present to the Transportation Commission for consideration; the strategy should include prioritizing high-risk culverts on critical routes that—if washed out or damaged—would cause a significant closure or delay

Culvert Rating Guide

Rating	Description
9	No deficiencies
8	No noticeable or noteworthy deficiencies that affect the condition of the culvert. Insignificant scrape marks caused by drift.
7	Shrinkage cracks, light scaling, and insignificant spalling which does not expose reinforcing steel. Insignificant damage caused by drift with no misalignment and not requiring corrective action. Some minor scouring has occurred near curtain walls, wingwalls, or pipes. Metal culverts have a smooth symmetrical curvature, with superficial corrosion and no pitting.
6	Deterioration or initial disintegration, minor chloride contamination, cracking with some leaching, or spalls on concrete or masonry walls and slabs. Local minor scouring at curtain walls, wingwalls, or pipes. Metal culverts have a smooth curvature, non-symmetrical shape, significant corrosion or moderate pitting.
5	Moderate to major deterioration/disintegration, extensive cracking and leaching, or spalls on concrete or masonry walls and slabs. Minor settlement or misalignment. Noticeable scouring or erosion at curtain walls, wingwalls, or pipes. Metal culverts have significant distortion and deflection in one section, significant corrosion or deep pitting.
4	Large spalls, heavy scaling, wide cracks, considerable efflorescence, or opened construction joint permitting loss of backfill. Considerable settlement or misalignment. Considerable scouring or erosion at curtain walls, wingwalls or pipes. Metal culverts have significant distortion and deflection throughout, extensive corrosion or deep pitting.
3	Any condition identified in Code 4, but which is excessive in scope. Severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slab. Integral wingwalls nearly severed from culvert. Severe scour or erosion at curtain walls, wingwalls, or pipes. Metal culverts have extreme distortion and deflection in one section, extensive corrosion, or deep pitting with scattered perforations.
2	Integral wingwalls collapsed, severe settlement of roadway due to loss of fill. Section of culvert may have failed and cannot support embankment. Complete undermining at curtain walls and pipes. Corrective action required to maintain traffic. Metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion.
1,0	Culvert has failed

Contacts and Resources

For questions, please contact:

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Additional resources include:

Resiliency website (links/how to find information for data sources)

- Minor Culvert Spreadsheet
- Culvert Study Logic Flow Technical Memo
- Inspection Rating Guide
- Final Training PowerPoint