



Resiliency of Drainage & Stormwater Infrastructure

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What is Resiliency?

Resiliency is the ability to **prepare and plan for**, **absorb, accommodate, recover** from, or more successfully adapt to actual or potential **adverse events** as appropriate for the importance of the site.

— The TRB AFB70(2) Resilient and Sustainable Buried Structures Subcommittee

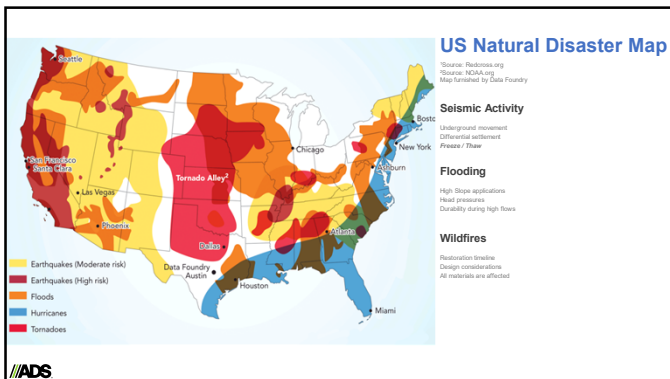
Key Points

1. Anticipate
2. Endure
3. Rapidly Recover

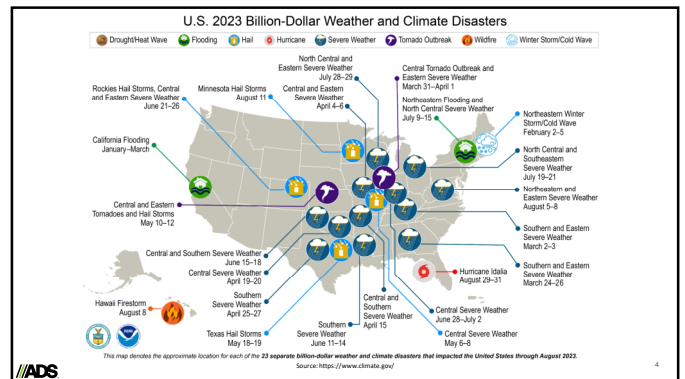
Capability to **mitigate** against significant all-hazards risks and incidents and to expeditiously **recover** and reconstitute critical services with minimum damage to public safety and health, the economy, and national security.

— The American Society of Civil Engineers (ASCE)

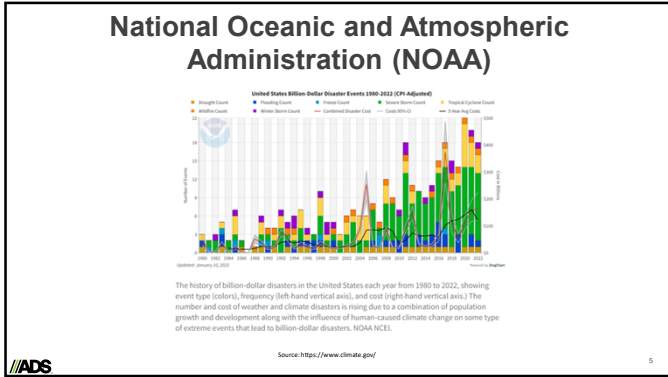
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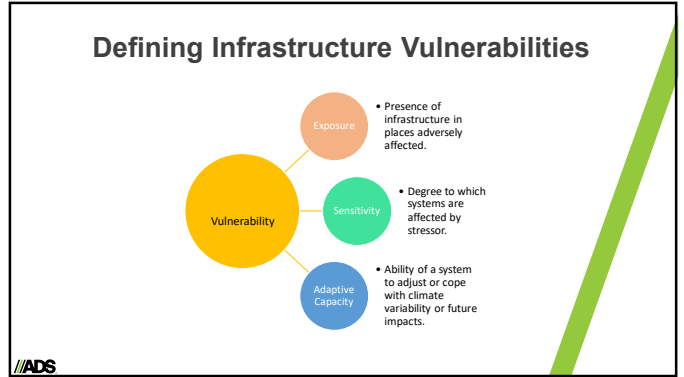
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Drainage Infrastructure


A conveyance [and/or storage] system for excess stormwater that protects transportation and other infrastructure assets from the destructive forces of water.



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Water's Impact on Soil

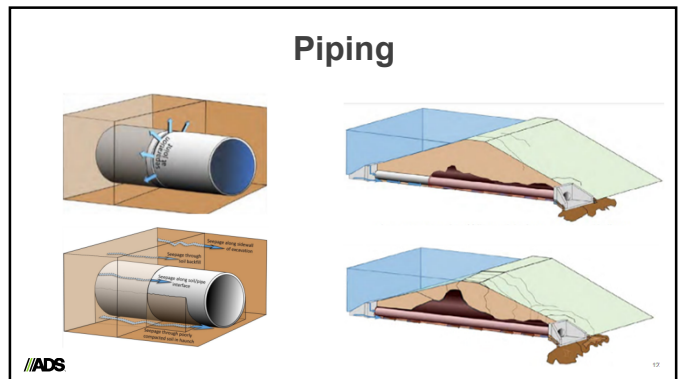
Soil Strength/Consolidation
 Changing Moisture Conditions
 Differential Settlement
 Soil Erosion/Infiltration
 Voids and Washouts



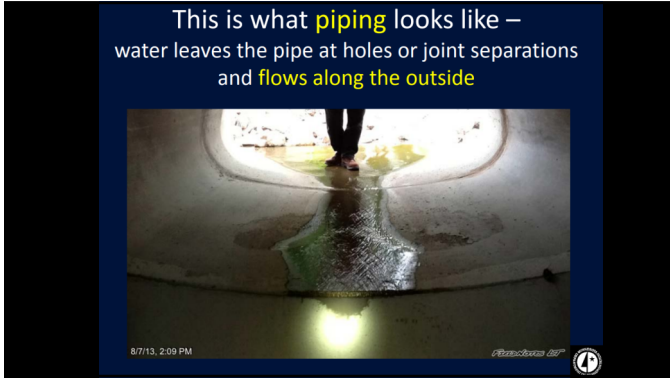
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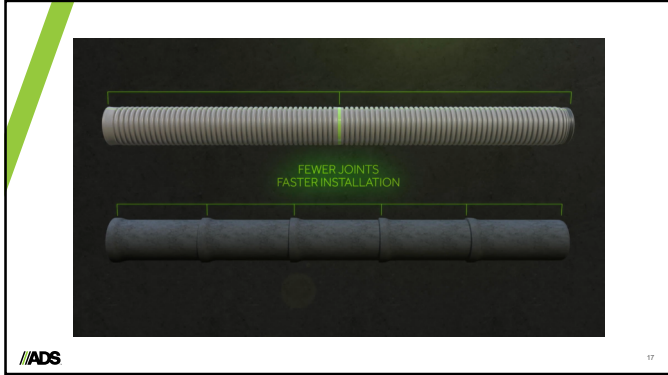
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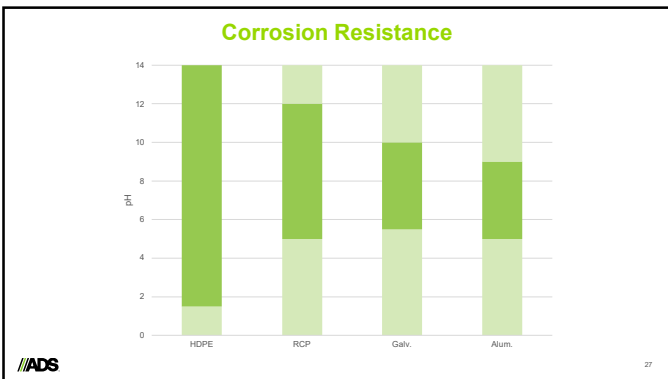
EFFECTS OF CORROSION

- Reduction of rebar cross section
- Reduction of rebar load capacity
- Increase in volume of corrosion product will cause expansion, cracking, and spalling

BEFORE CORROSION **BUILD-UP OF CORROSION PRODUCTS** **FURTHER CORROSION. SURFACE CRACKS, STAINS.** **EVENTUAL SPALLING. CORRODED BAR EXPOSED.**

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Hydraulic Risk:

*Improve Capacity
Manage Blockages*

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Hydrologic Modeling

Any one can make a culvert large enough, but it is the province of the engineer to design one of sufficient but not extravagant size.

— Byrne, *A Treatise on Highway Construction* 4th ed. 1902
Credit as found by the Mr. Sheen presentation Oregon EWRC/ASCE

A TREATISE
OF
HIGHWAY CONSTRUCTION

BY
A. BYRNE, CHIEF ENGINEER
OF THE
BUREAU OF HIGHWAYS, U.S. DEPARTMENT OF AGRICULTURE

WITH
ILLUSTRATIONS BY
J. H. WILSON, CHIEF
ENGINEER, U.S. DEPARTMENT OF AGRICULTURE

NEW YORK:
JOHN WILEY & SONS,
1902.

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Structural Risk

Design Conservatively (LRFD)
Validate Design (Post-Installation Inspection)
Monitor Performance (Asset Management)

*Protect Vulnerabilities in
High Risk Areas Through Design*

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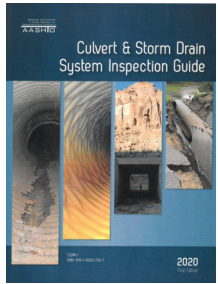
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AASHTO Culvert & Storm Drain Inspection Guide

- Voted and Passed By AASHTO Committee on Bridges and Structures
- Update From **1986**
- 5 Sections:
 - Section 1: Intro
 - Section 2: Design & Performance Characteristics
 - Section 3: Inspection Procedure
 - Section 4: Condition Rating System
 - Section 5: Asset Mgmt
 - Appendices: Details



Source: AASHTO Used with permission.

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Table 4.2.1.1—Rating Beams and Associated Action

	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
CONDITION	Like new, with little or no deterioration, structurally sound and functionally adequate.	Some deterioration, but structurally sound and functionally adequate.	Significant deterioration, functional inadequacy or both, requiring maintenance or repair.	Very poor conditions that require immediate repair. Severe deterioration, failure or failure which could threaten public safety.
ACTION INDICATED	No action is recommended, note in inspection report only.	No immediate action is recommended, but more frequent inspection may be warranted. Maintenance personnel should be alerted.	Team Leader (Inspector) evaluates need for corrective action and makes recommendation in inspection report.	Corrective action is required and urgent. Engineering evaluation is required to specify appropriate repair.

<p>Condition Ratings Table Titles</p> <ul style="list-style-type: none"> Approach Roadway Embankment Channel Alignment and Protection End Treatments and Appurtenant Structures Concrete Footings and Invert Slab Barrel Alignment Plastic Barrel Concrete Barrel Corrugated Metal Barrel Masonry Barrel Timber Barrel Joints Seams of Corrugated Metal Plate Manholes, Catch Basins, and Burred Junctions 	<p>Table No.</p> <ul style="list-style-type: none"> 4.2.2-1 4.4.2-1 4.5.2-1 4.6.2-1 4.7.2-1 4.8.2-1 4.9.2-1 4.10.2-1 4.11.2-1 4.12.2-1 4.13.2-1 4.14.1-1 4.15.1-1 4.17.1-1
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Source: AASHTO. Used with permission.

Table 4.2.1.2—Rating Pipes and Associated Action

	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
CONDITION	Like new, with little or no deterioration, structurally sound and functionally adequate.	Some deterioration, but structurally sound and functionally adequate.	Significant deterioration, functional inadequacy or both, requiring maintenance or repair.	Very poor conditions that require immediate repair. Severe deterioration, failure or failure which could threaten public safety.
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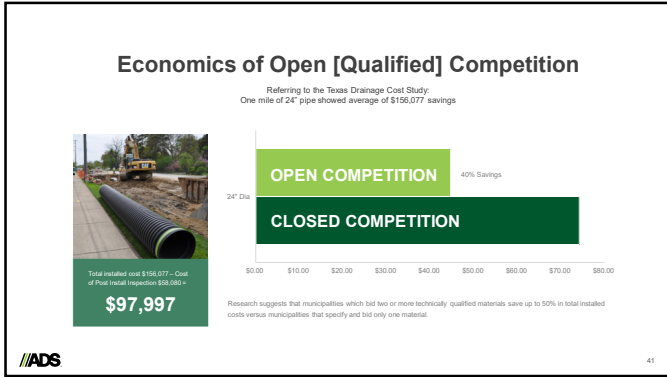
Rapid Recovery

Leverage sourcing efficiencies
Maximize spending efficiency
Minimize installation time
Utilize adaptable repair methods

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Material Logistics

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Your Opportunity

1. Consider infrastructure exposure to adverse events, severity of risk
2. Resilient infrastructure endures erosion, corrosion, hydraulic, structural risks
3. Leverage logistic efficiencies of rapid recovery

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Thank You

To learn more about resiliency at ADS, go to adspipe.com/resiliency

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