



## *EXTENDING PIPE LIFE*

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# ***Pipe Deterioration***

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EPA White Paper on “Improvement of Structural Integrity Monitoring for Drinking Water Mains”  
March, 2005

Identifies corrosion as a major mechanism of deterioration

High rates of internal and external corrosion caused by aggressive soil and/or water, microbial activity, stray currents, oxygen concentration cells and bimetallic connections

# ***Pipe Life***

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Compromised (shortened) by:

- ◆ External Corrosion
- ◆ Internal Corrosion

Internal corrosion is controlled by mortar linings and chemical treatments e.g. orthophosphates.

Presentation focuses on external corrosion.

# ***External Corrosion***

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## Prevention and Control for Existing Lines

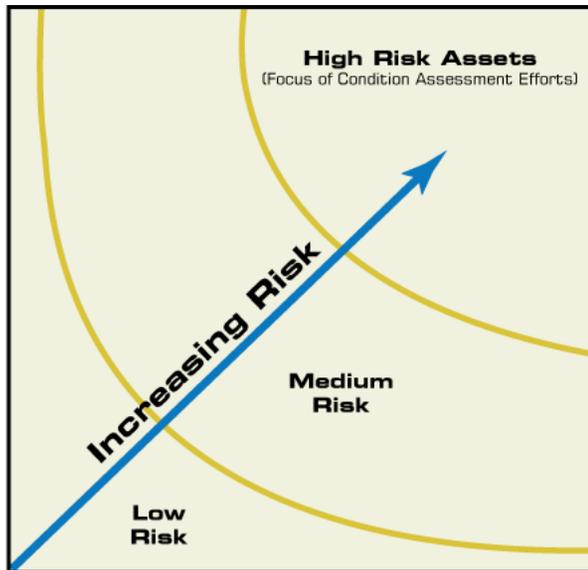
- ◆ Condition Assessment
- ◆ Cathodic Protection
- ◆ Local Hot-Spot Protection
- ◆ Stray Current Control
- ◆ Corrosion Monitoring

# Condition Assessment

- ◆ Important to define Repair, Rehabilitation and Replacement to optimize timing
  - ◆ Too Late – Expensive to maintain / many failures
  - ◆ Too Early – Expensive due to misuse of resources
- ◆ Take advantage of Public Works opportunities that expose the pipe
  - ◆ Taps
  - ◆ Line extensions
  - ◆ Other utility work

# Condition Assessments

...it's all about cost effectively understanding and managing pipeline condition & operational risk...



		Criticality					
		Scale	1	2	3	4	5
Condition	5	Green	Green	Yellow	Yellow	Red	Red
	4	Green	Green	Yellow	Yellow	Red	Red
	3	Green	Green	Green	Yellow	Yellow	Red
	2	Green	Green	Green	Green	Yellow	Yellow
	1	Green	Green	Green	Green	Green	Yellow

Objective 1: Quality Understanding of High Risk Structures (Callout for cells: Condition 5, Criticality 4; Condition 4, Criticality 4; Condition 3, Criticality 5)

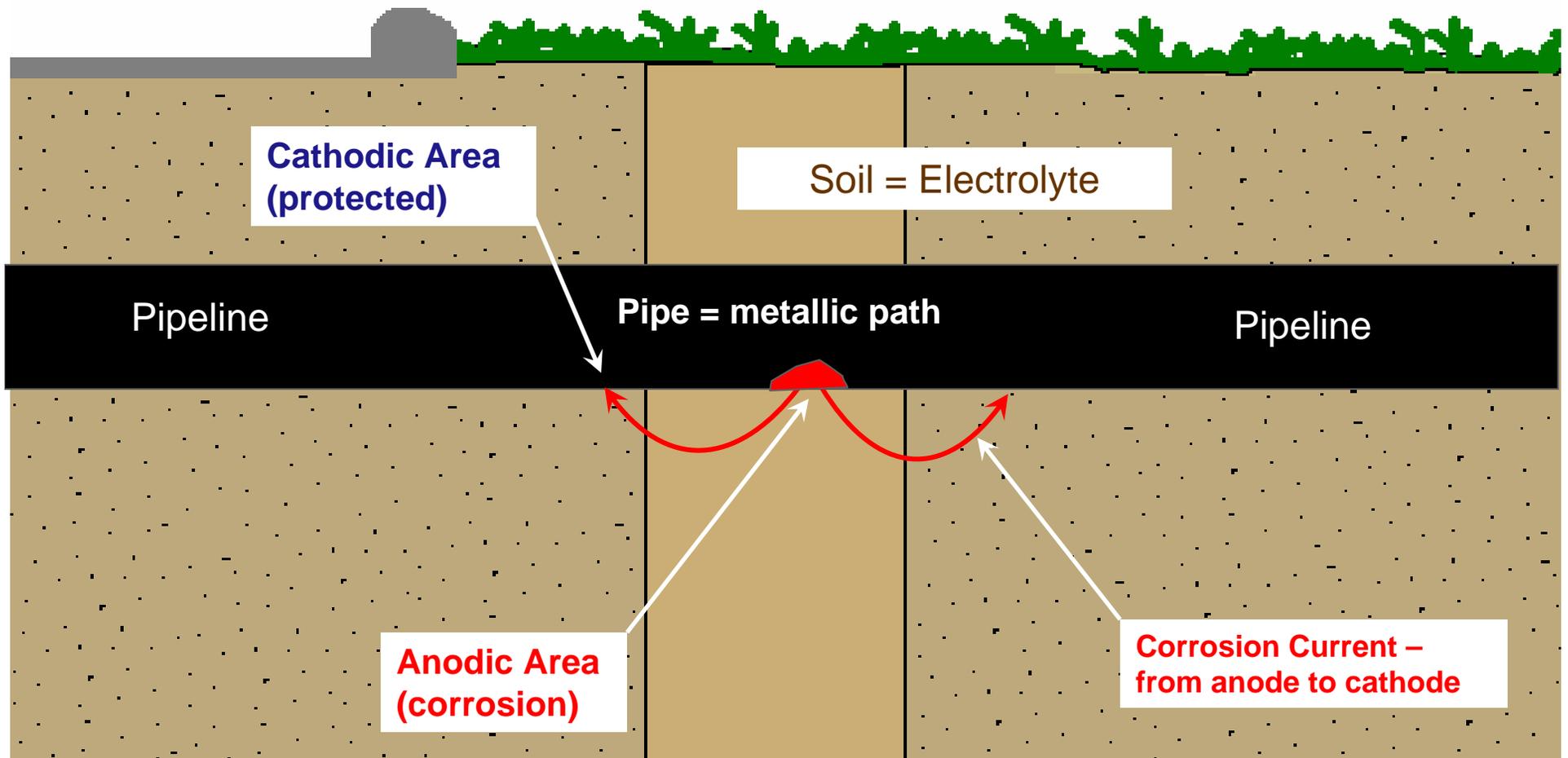
Objective 2: Cost Effective Inspection, Data Extrapolation (Callout for cells: Condition 4, Criticality 2; Condition 3, Criticality 2; Condition 3, Criticality 3)

# ***Condition Assessment***

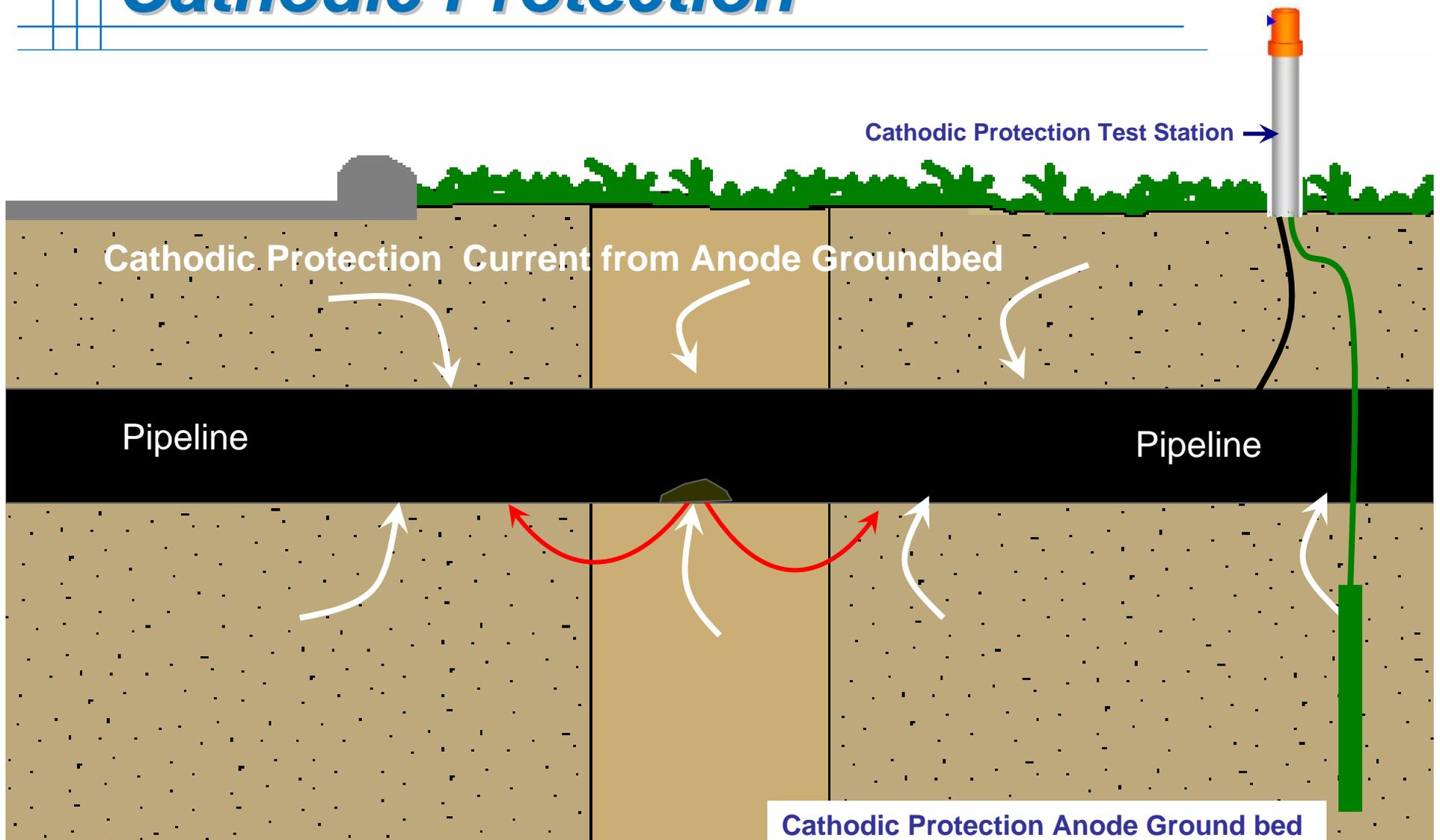
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- ◆ Failure Analysis
- ◆ Soil and Water Testing
  - ◆ Chemical Properties
  - ◆ Electrical Properties
- ◆ Physical Inspection whenever Pipe Exposed
- ◆ Testing of Coupons from Service Taps
- ◆ Pipe Corrosion Surveys
  - ◆ At Grade
  - ◆ Internal
- ◆ Best Practice: Use all Tools
- ◆ Purpose: Assess Remaining Life

# Galvanic Corrosion



# Cathodic Protection



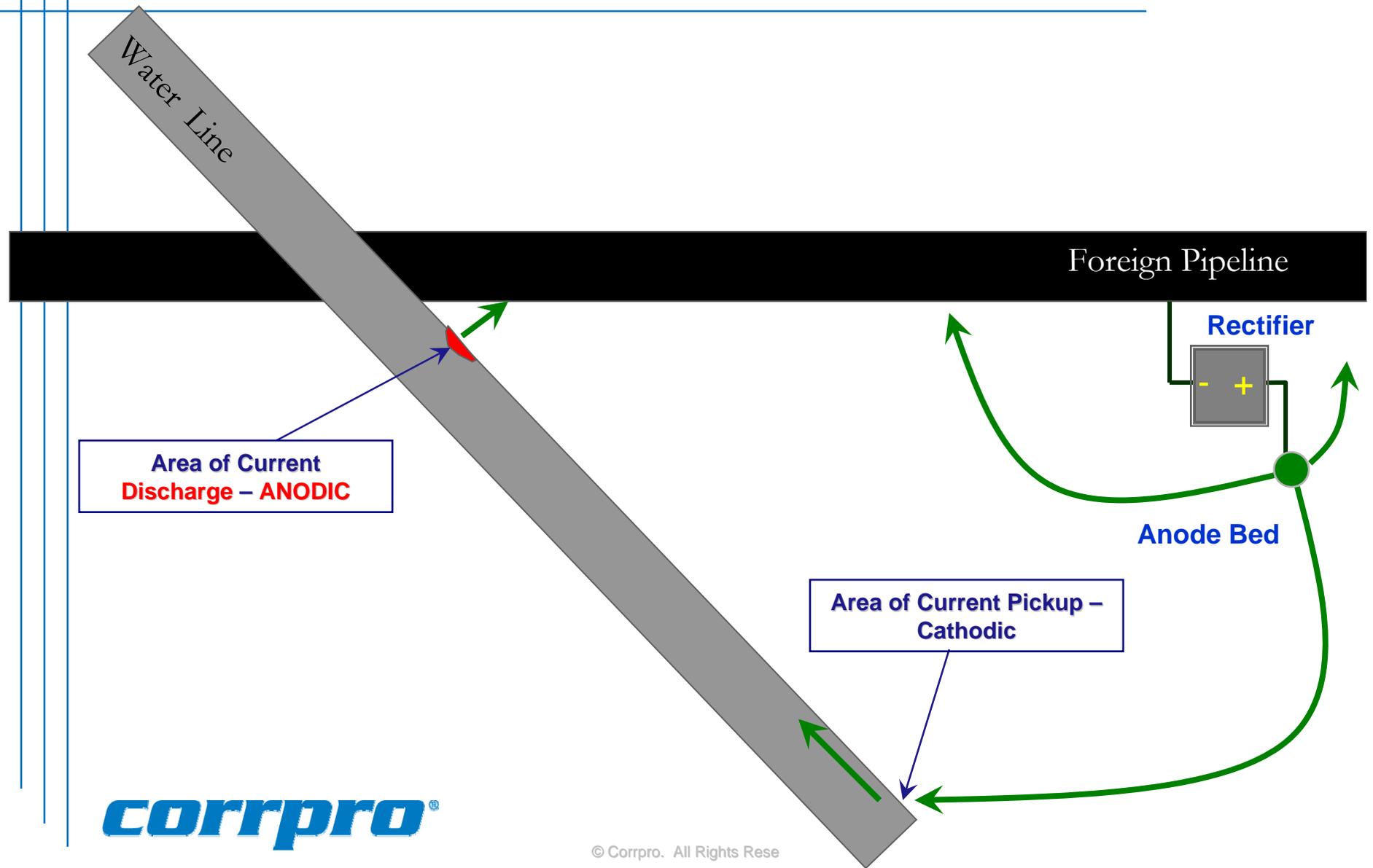
# *Local Hot-Spot Protection*



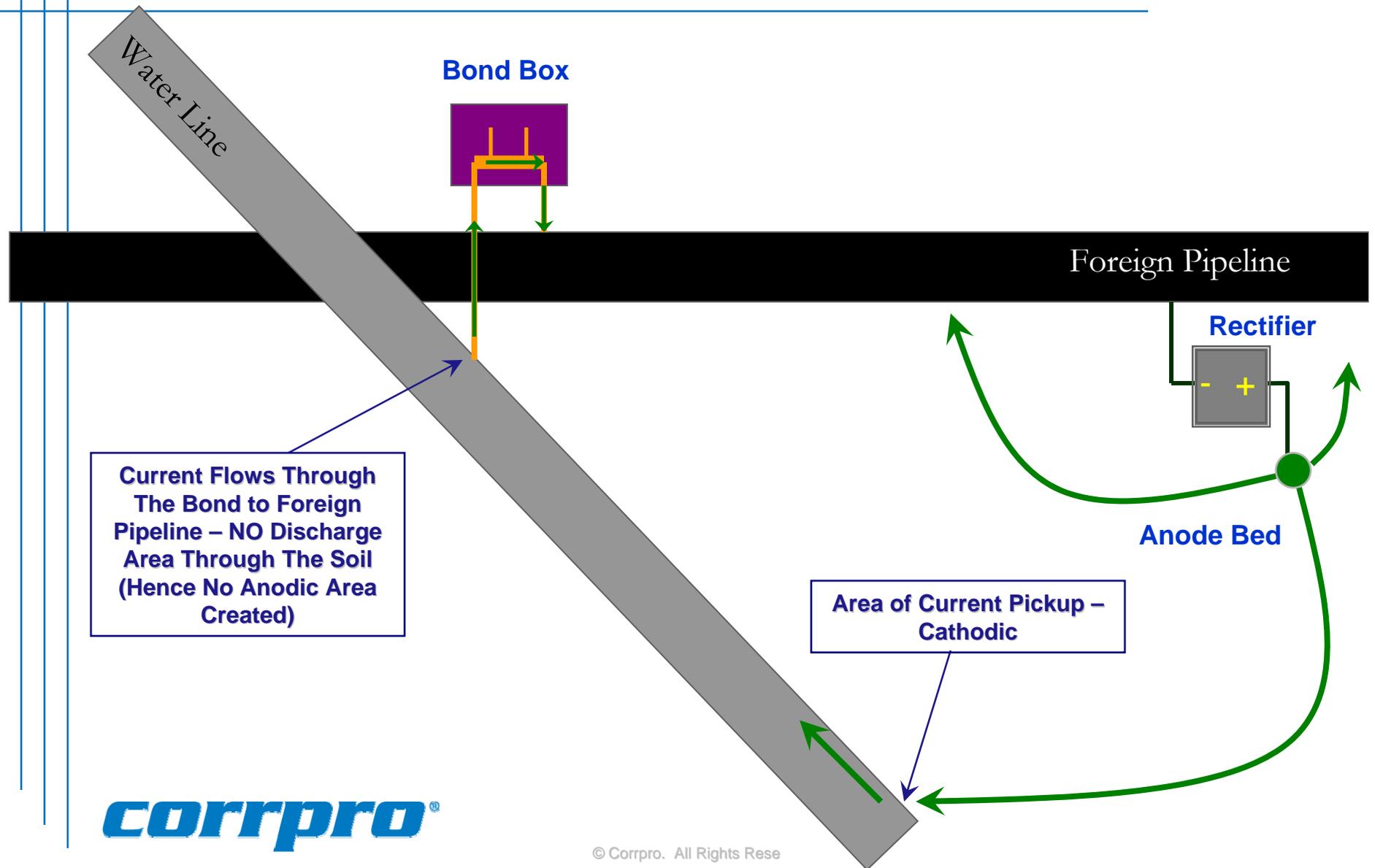
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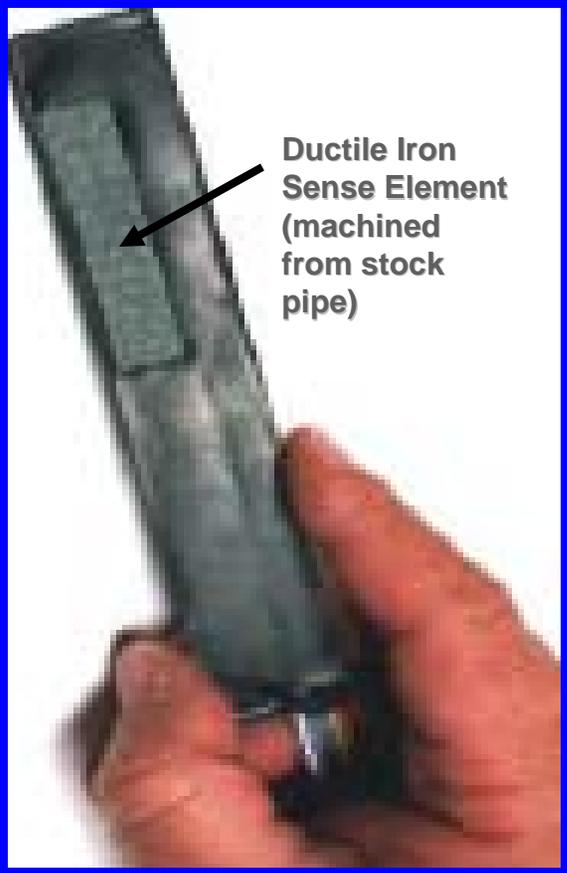
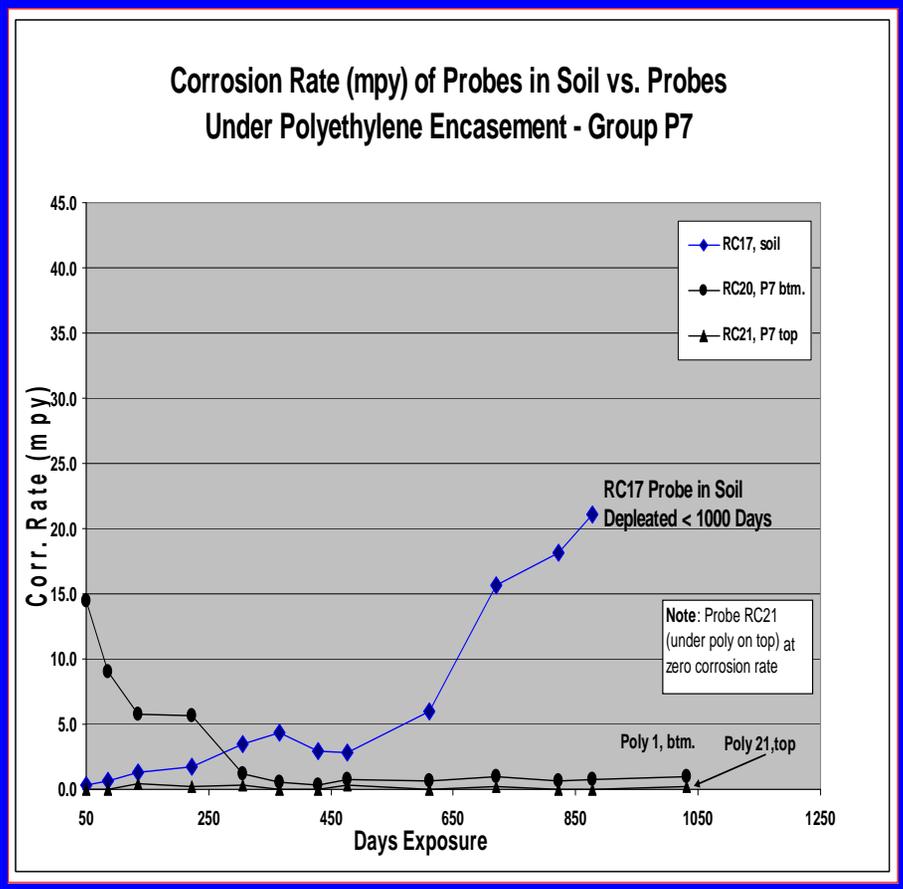
# Stray Current Corrosion



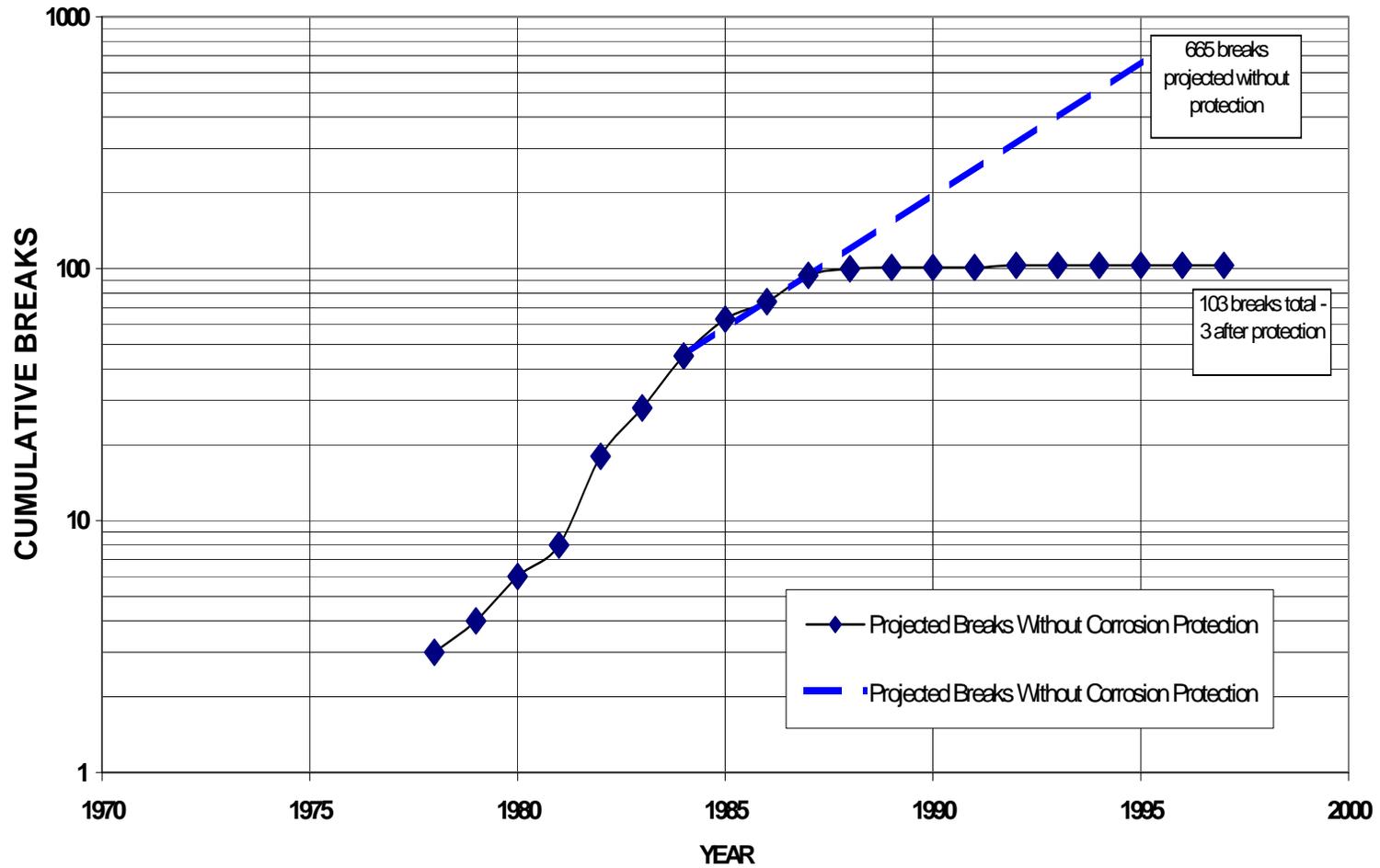
# Stray Current Control Using Bonds



# Corrosion Monitoring

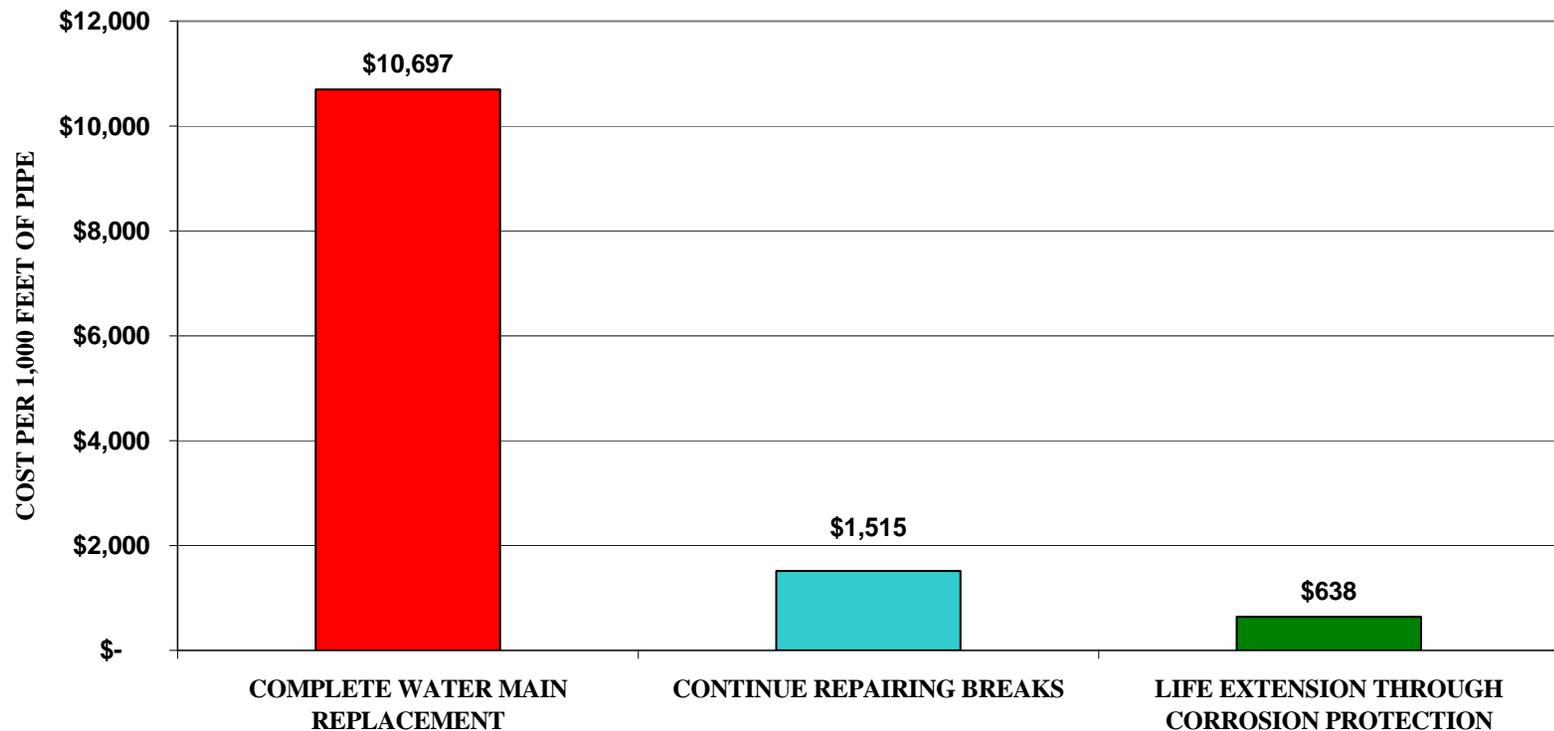


# Effectiveness of Well Designed Programs



# Effectiveness of Well Designed Programs

**Annualized Costs – 20y Cycle**  
**Life Extension 58% less expensive**  
**compared to repairing breaks**



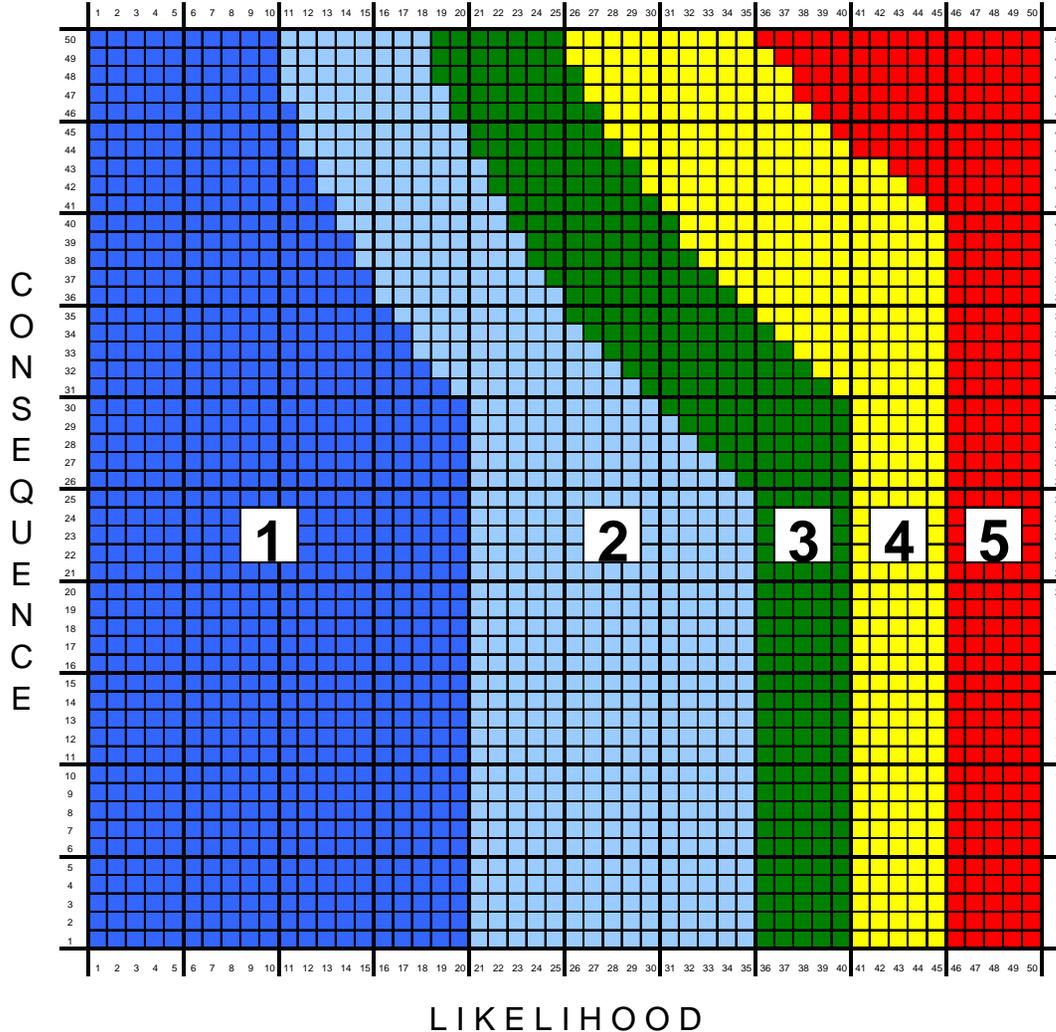
# ***Effectiveness of Well Designed Programs***

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## ***Benefit to Cost Ratios***

City of Houston	8.2
Marin Water District	8.9
East Bay MUD (all facilities)	6.5
East Bay MUD (steel lines)	24.0
Chicago Area Utility	25.0

# New Construction



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**DDM™ Risk Based  
“Design Decision  
Model”**

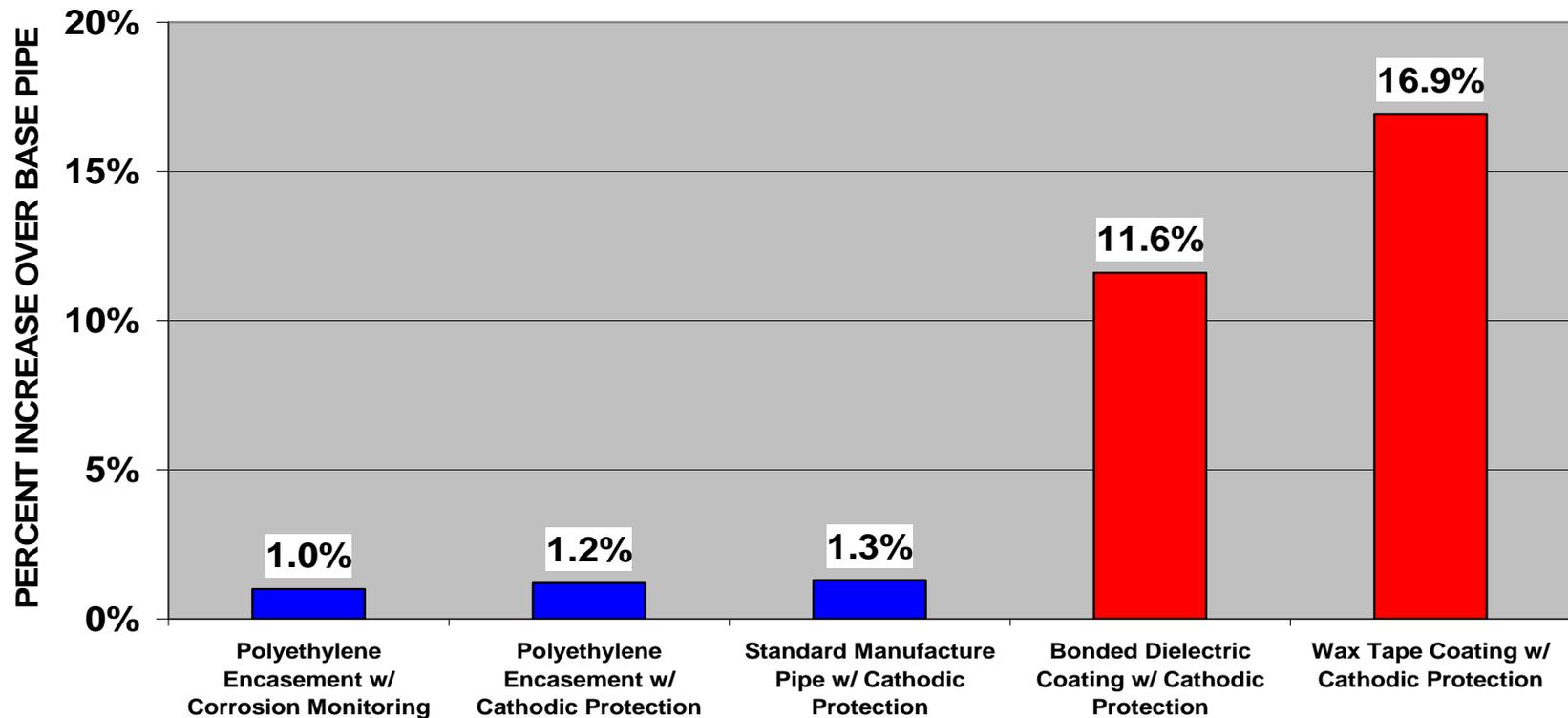
**100+ Year  
Pipe Service Life**

**2 Dimensional, 50 Point  
Likelihood &  
Consequence Scoring**

**Evolution of AWWA  
C105 10-Point System**

# New Construction Cost Impact

**100-YEAR LIFE CYCLE COST  
AVERAGE FOR 30", 42" AND 54" DUCTILE IRON  
25,000 Feet Project, Houston TX, 1000 Ohm-Cm Resistivity**



# ***Life Extension***

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- ◆ Continuous Improvement Process
- ◆ Participation Needed from:
  - ◆ Utility Maintenance Personnel
  - ◆ Crew Foreman
  - ◆ Engineers
  - ◆ Management

# Summary

- ◆ Corrosion is inevitable (unless you do something about it)
- ◆ Corrosion is predictable
- ◆ Corrosion is often the root cause of pipe failures
- ◆ Proven, cost effective corrosion control strategies exist:
  - ◆ For new pipelines
  - ◆ For existing pipelines
- ◆ Corrosion detection and control can be cost effectively installed & monitored
  - ◆ Suitably designed, corrosion control is construction and maintenance friendly
- ◆ Corrosion control is key to effective infrastructure management
- ◆ ***If it doesn't break, you don't have to fix it!***