Replacement planning for water mains
An economic approach

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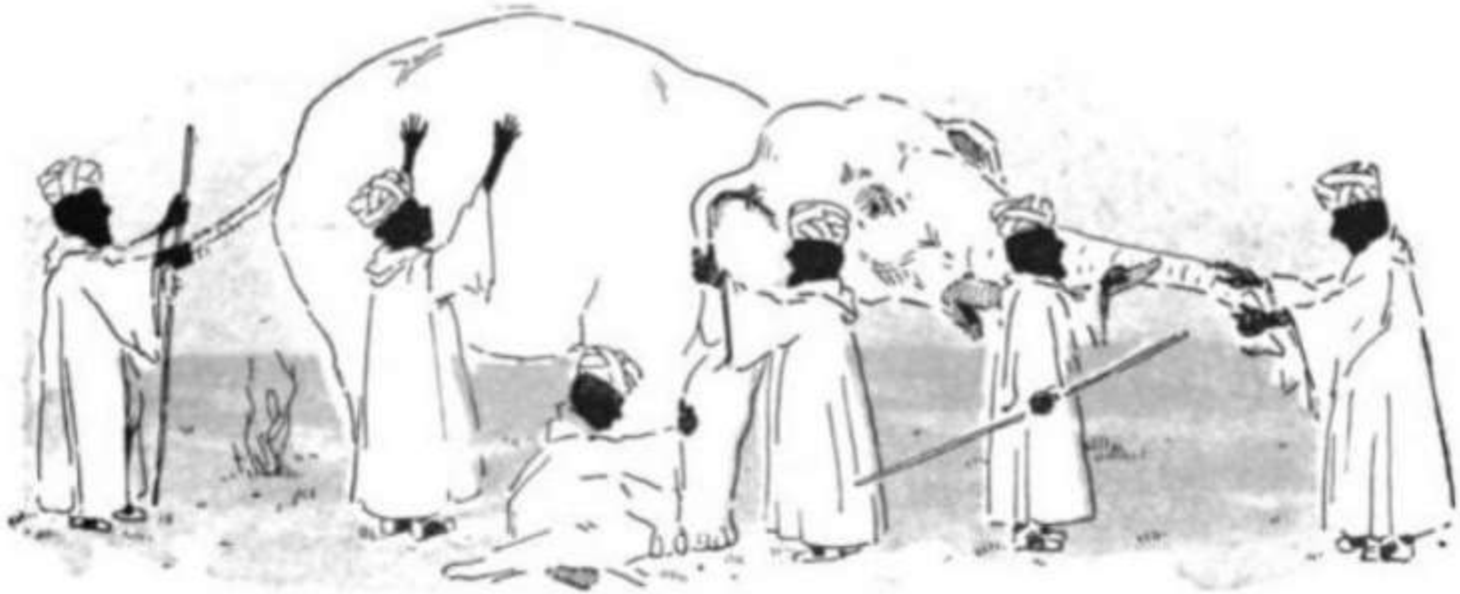
Everybody knows exactly what asset management is



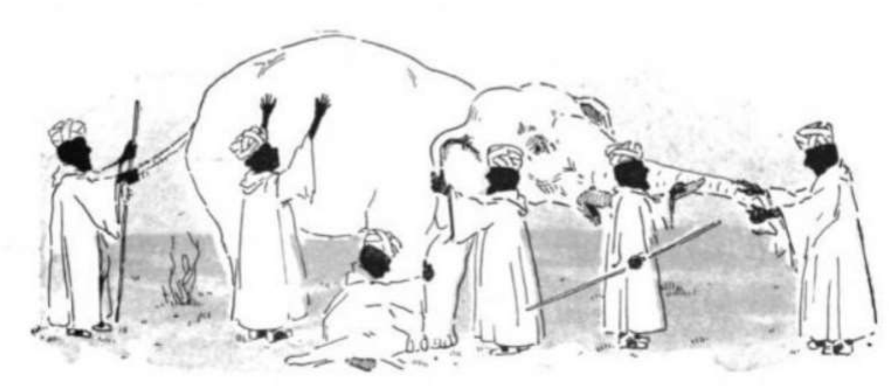
Everybody knows exactly what asset management is

Demonstrating value – “why is this good?”

Providing transparency – “show me.”

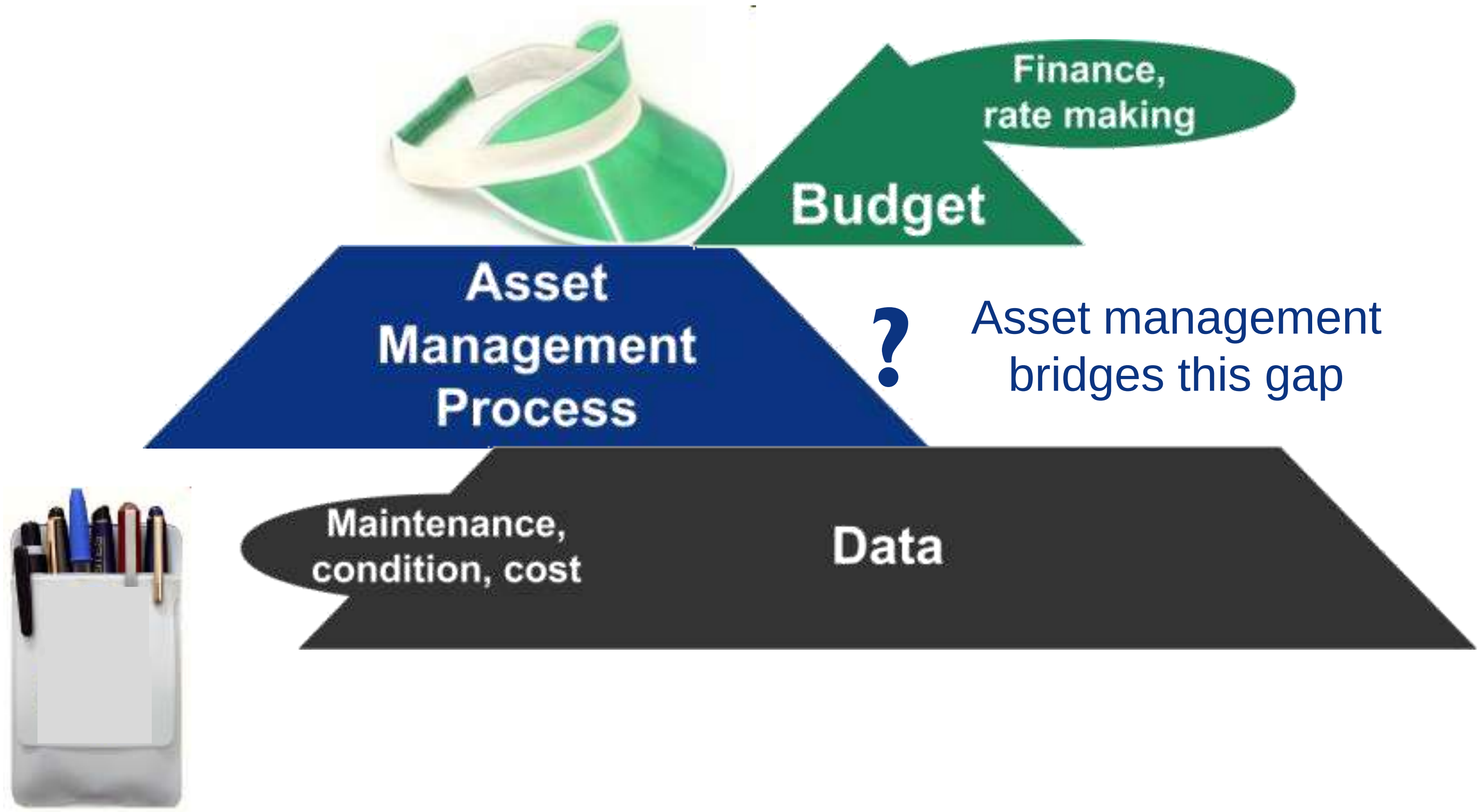
Primary tenets:

- **Customer focus**
- Data-driven
- Repeatable, defensible, challengeable



What is asset management really?

At most utilities there is a gap between engineering and finance



A typical example – aging assets

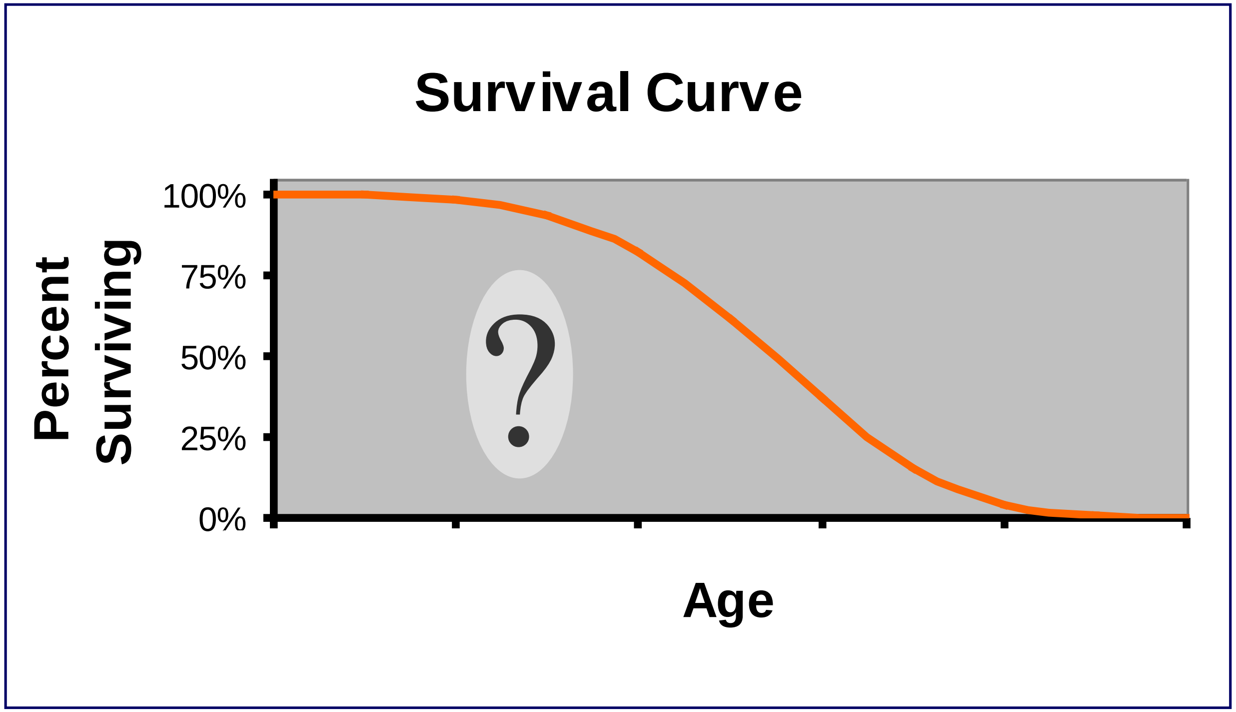
Conventional Approach (technical)

- Assess condition, consider calendar age
- Replace when:
  - Condition is poor
  - Age reaches expected life

Technical approach fails to consider risk quantitatively

What, exactly, is expected useful life?

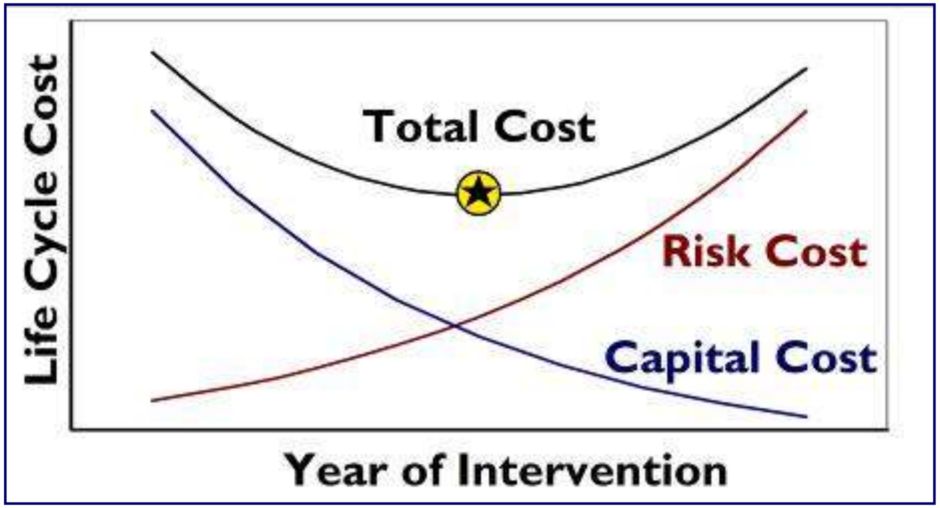
- Median Life?
- Mean Life?
- Knee of curve?
- N% failure rate?
- Other?



Economic End-of-Life

Least life cycle cost

- Optimize replacement or rehab timing
- Balance risk of failure against benefits of delaying capital expenditures

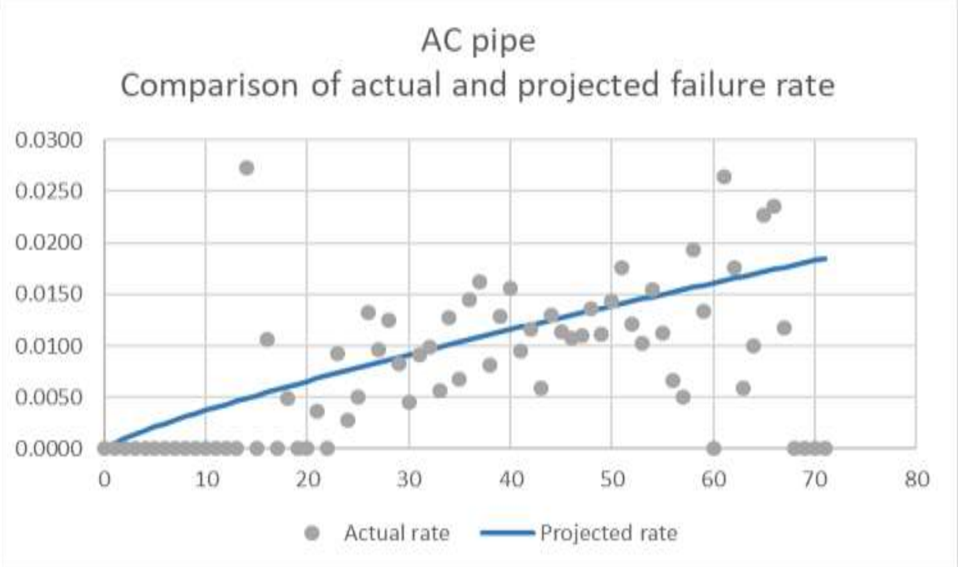


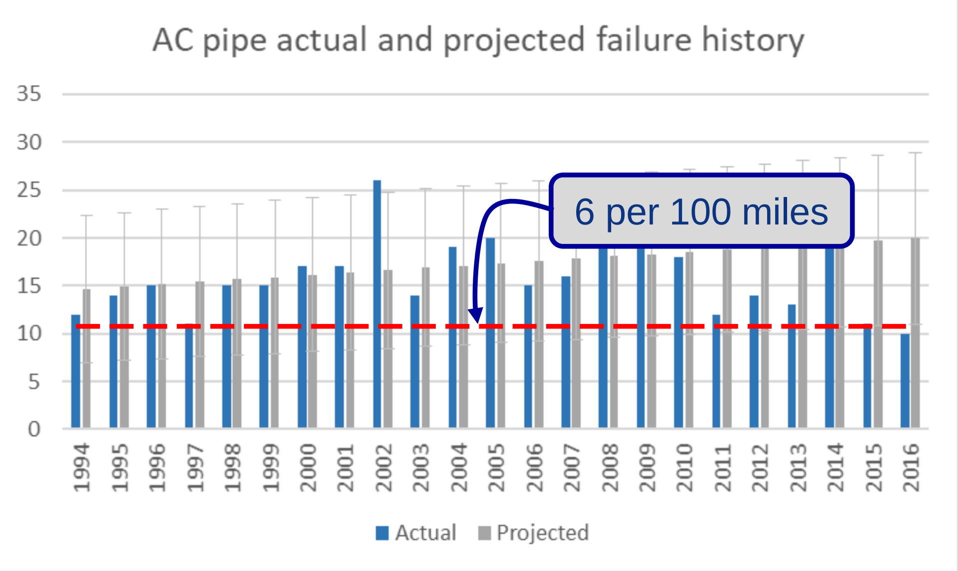
AC mains, probability of failure versus age

Data sources

- Electronic records going to back to 2000 (334 failures).
- Manual search to 1994 (101 failures).
- Before then, records are unreliable.
- Includes breaks and leaks.

DEFECT TYPE	COUNT
Blow Out	109
Circumferential Crack	106
Collar	34
Fitting	18
Longitudinal Crack	14
Small Hole	26
Third-party	13
Unknown	13
Total	333





Consequence of failure

What happens if this asset fails?

- Must be based on costs **from the customers' perspective**.
- Consequences are defined in terms of drivers.
- Defined in the same terms for every asset class.

Common Drivers…

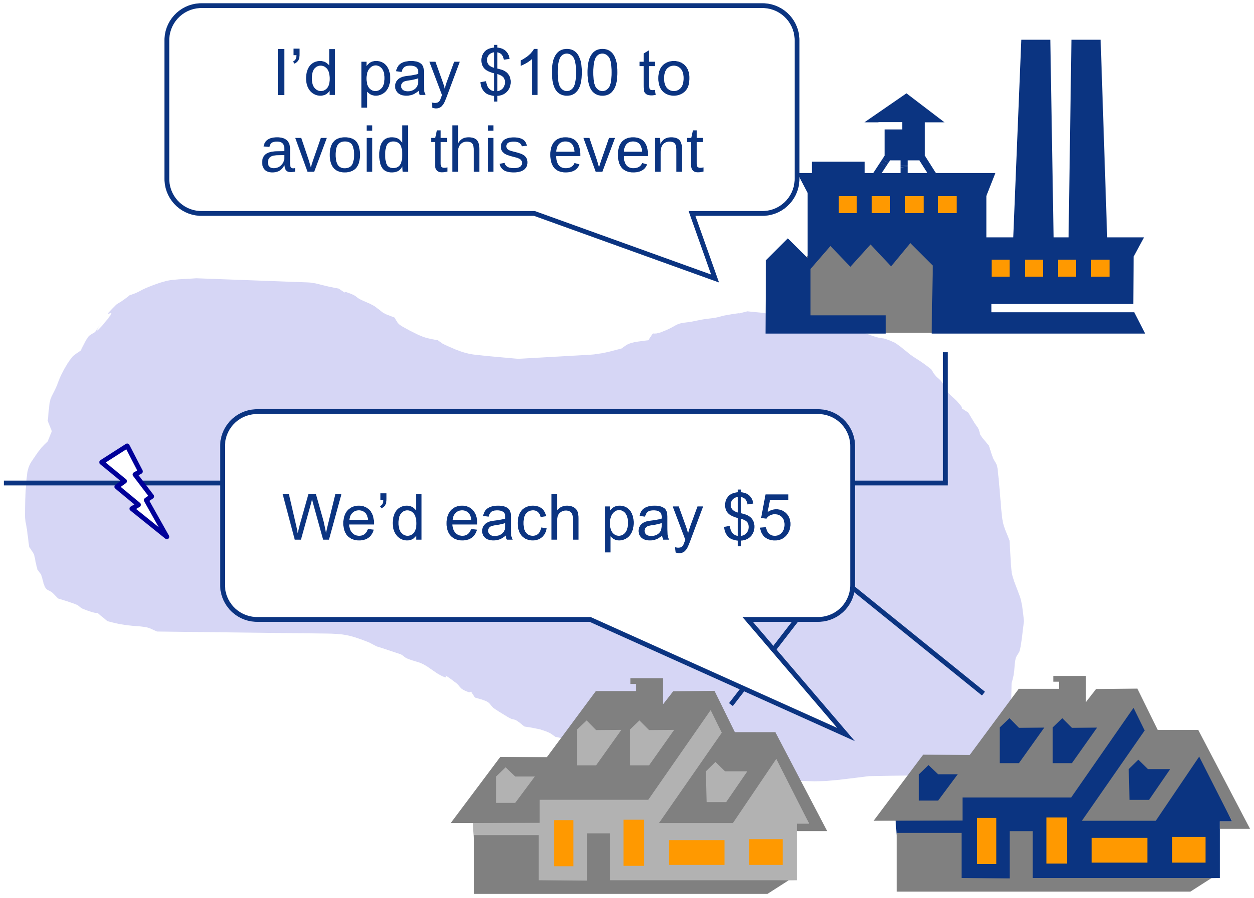
Environment

Traffic

Reliability

Financial

Customer costs – the idea



Failure scenarios

75.0%

Pipe breaks and requires repair

Direct costs		
Repair cost	$60,000	$60,000
Zoning	Commercial	$25,000
Slope	Unknown	$0
Max of Zoning/Slope	Zoning	$25,000
Road repair	Unknown	$500
Conveyance	24"	$100,000
Indirect costs		
Traffic impact	Unknown	$500
Total scenario consequence cost ($)		$186,000

25.0%

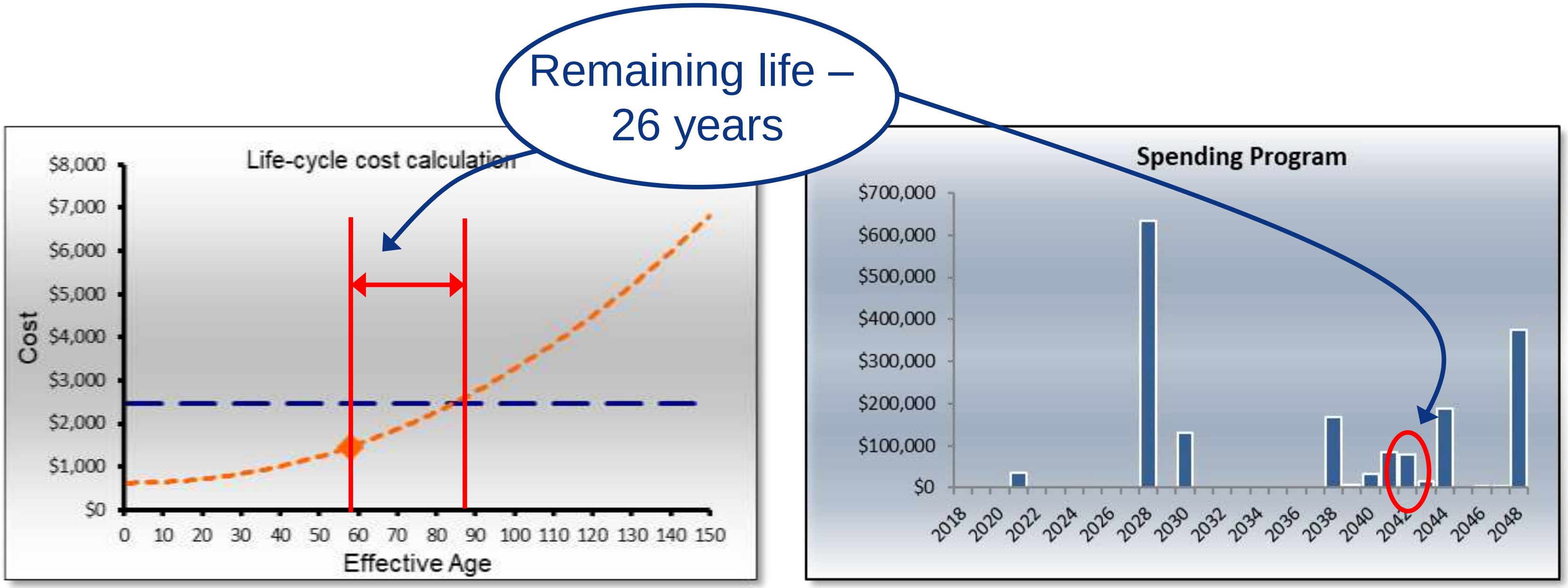
Pipe breaks and leads to loss of service

Direct costs		
Repair cost	$60,000	$60,000
Zoning	Commercial	$25,000
Slope	Unknown	$0
Max of Zoning/Slope	Zoning	$25,000
Road repair	Unknown	$500
Conveyance	24"	$100,000
Indirect costs		
Traffic impact	Unknown	$500
Negative pressure, BWN	Yes	$25,000
Police stations	No	$0
Fire stations	No	$0
Schools	No	$0
Hospitals	No	$0
Assisted living centers	No	$0
Electrical substations	No	$0
Olympic pipeline	No	$0
City parks	No	$0
Wetlands	No	$0
Streams	No	$0
Duration not served (hours)	8.0	
Demand not served (gpm)	2.5	$1,560
Demand w/ low pressure (gpm)	11.3	$7,043
Total scenario consequence cost ($)		$219,603

Calculating economic life, creating a long-range plan

Now all the pieces are in place…

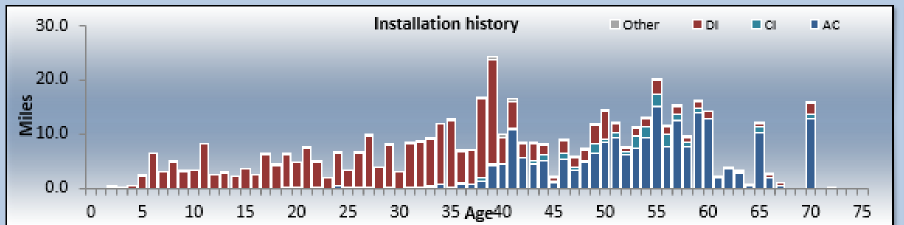
- Each asset is evaluated individually to determine remaining life.
- Forms the basis for long-range spending projection.

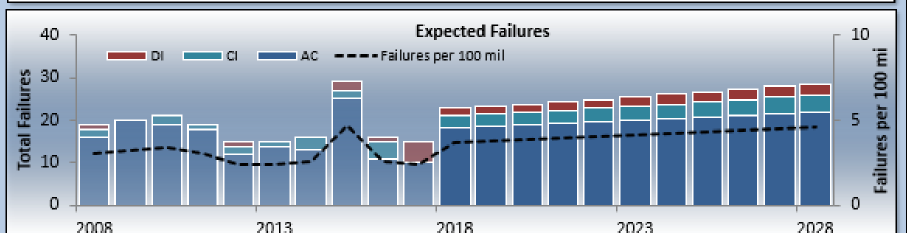


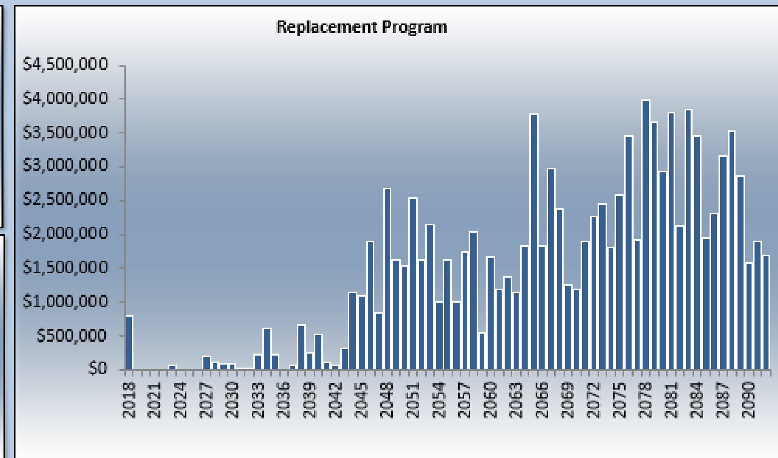
Economic life tool

Population Charts

RE-CALCULATE







Object	Facili	Asset Class	Exist Ty	Diame	Leng	A	Consequ e Co	Ne te	Optimal Interventi	Replace Cost	Refurbishn Cost	Lifecy Cos	Years Interven	Opportun YTR	BC R	Lifecy Inter
25	155405	Water Main	AC	6	14	54	$62,777	$7	Replacement	$4,814		$120	146	117		200
26	155391	Water Main	AC	6	14	54	$62,777	$7	Replacement	$5,133		$127	146	117		200
27	133168	Water Main	AC	6	222	54	$98,600	$174	Replacement	$78,517		$1,964	110	82		200
28	155410	Water Main	DI	8	23	54	$65,336	$4	Replacement	$8,284		$206	146	146		200
29	155412	Water Main	AC	6	213	24	$60,633	$19	Replacement	$75,473		$1,873	176	150		200
30	144650	Water Main	DI	8	16	54	$65,336	$3	Replacement	$5,806		$144	146	146		200
31	155408	Water Main	AC	6	72	54	$60,633	$35	Replacement	$25,594		$635	146	120		200
32	155328	Water Main	DI	8	20	54	$65,308	$3	Replacement	$7,115		$177	146	146		200
33	155396	Water Main	AC	6	199	54	$59,098	$94	Replacement	$70,517		$1,749	146	123		200
34	155395	Water Main	AC	6	19	54	$60,633	$9	Replacement	$6,832		$170	146	120		200
35	144660	Water Main	AC	6	15	54	$62,777	$8	Replacement	$5,452		$135	146	118		200
36	117836	Water Main	AC	6	368	54	$44,927	$132	Replacement	$130,166		$3,219	146	146		200
37	155384	Water Main	AC	6	10	54	$44,927	$4	Replacement	$3,682		$91	146	146		200
38	155392	Water Main	Unknown	6	9	54	$59,934	$0	Replacement	$3,080						
39	155292	Water Main	DI	8	19	54	$71,293	$3	Replacement	$6,549		$163	146	146		200
40	155381	Water Main	DI	8	13	54	$71,293	$2	Replacement	$4,637		$115	146	146		200
41	133194	Water Main	DI	8	44	54	$71,293	$8	Replacement	$15,576		$387	146	146		200
42	117861	Water Main	DI	6	15	18	$55,332	$1	Replacement	$5,381		$133	182	182		200
43	155387	Water Main	AC	6	468	54	$93,370	$348	Replacement	$165,743		$4,141	115	86		200
44	144652	Water Main	AC	8	4	70	$107,341	$6	Replacement	$1,345		$34	86	59		200
45	155385	Water Main	DI	6	14	54	$53,390	$2	Replacement	$4,991		$124	146	146		200
46	155359	Water Main	DI	8	12	54	$65,890	$2	Replacement	$4,319		$107	146	146		200
47	155380	Water Main	DI	8	62	0	$65,890	$0	Replacement	$21,913		$544	200	200		200

Population | Asset | Sandbox | Intervention Costs | Failure Curves | Consequences | Criticality | Critical Cus

Does this mean the City of Bellevue should stop replacing water mains?

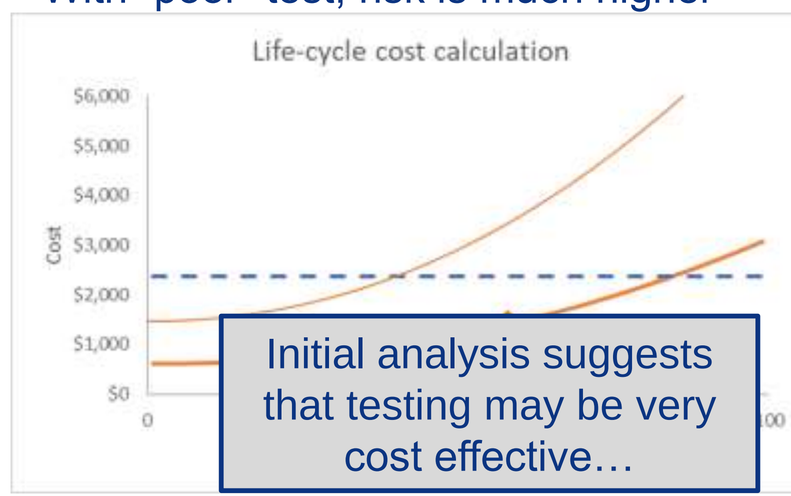
The City is still evaluating results and assumptions – this is *one piece* of information.

There is clearly a strong case for targeted replacements:

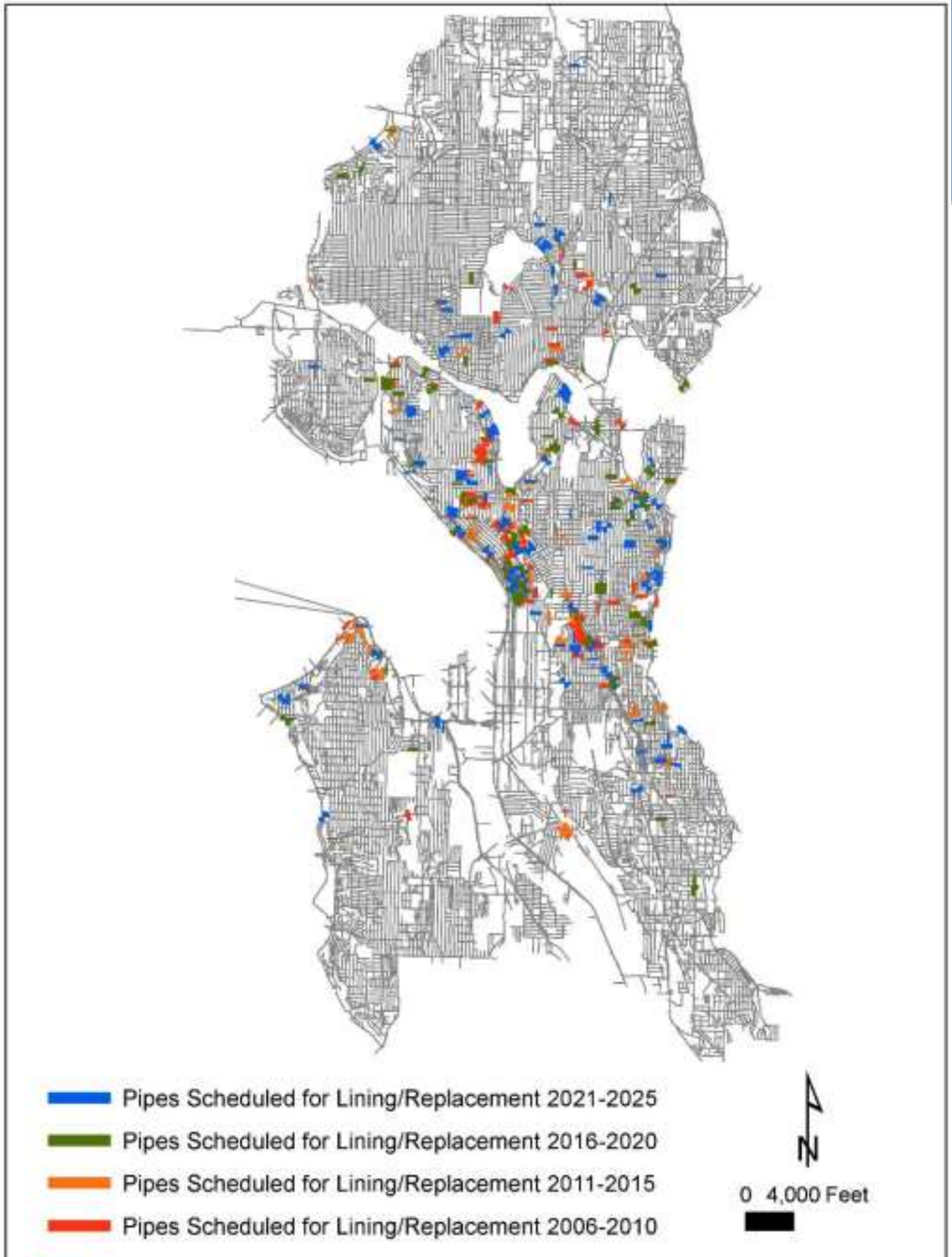
- Opportunistic, e.g., piggyback on roads work.
- “Poor” result from Echologics test implies high multiplier on failure probability, reducing remaining economic life – to zero in some cases.

Base life-cycle cost calculation

With “poor” test, risk is much higher



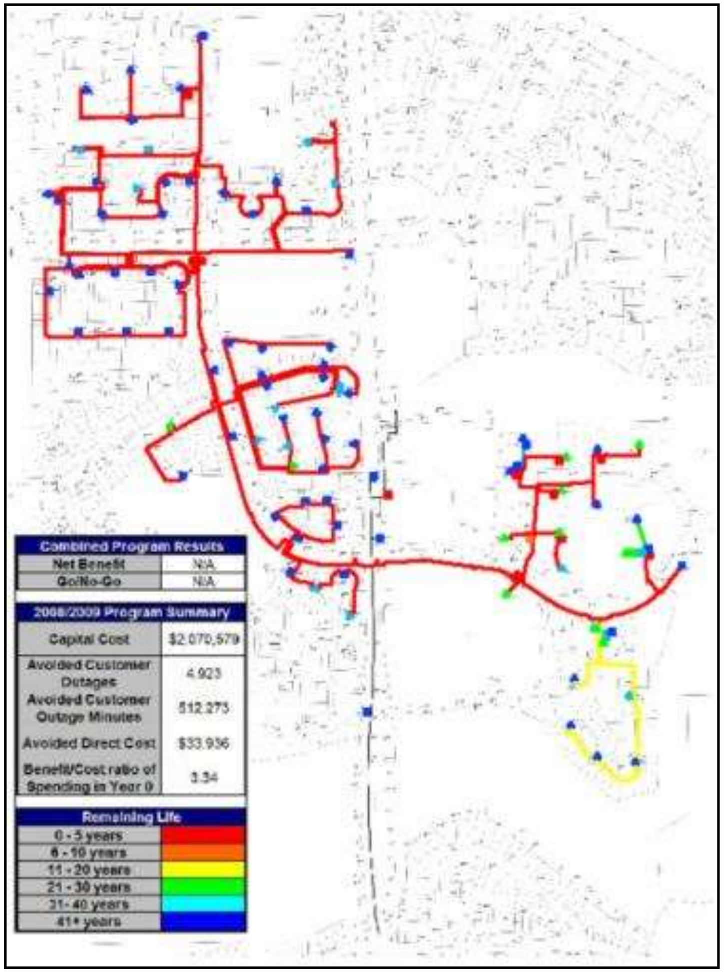
Initial analysis suggests that testing may be very cost effective…

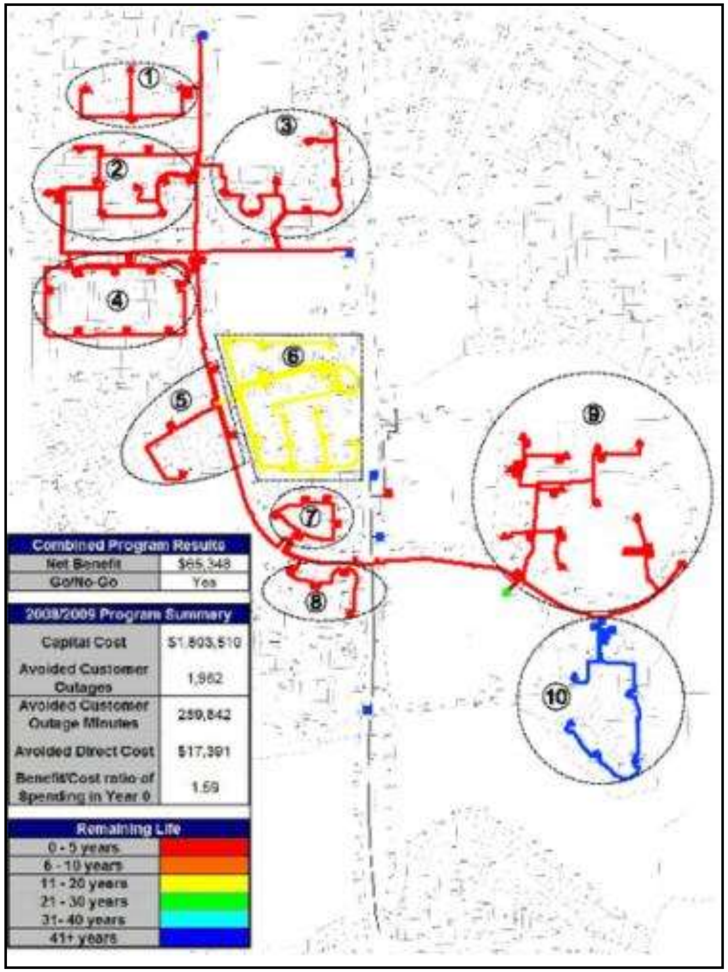


Example 20-year replacement program, integrated with GIS

Grouping multiple assets to create a project

While I'm in the neighborhood, should I also replace other equipment?



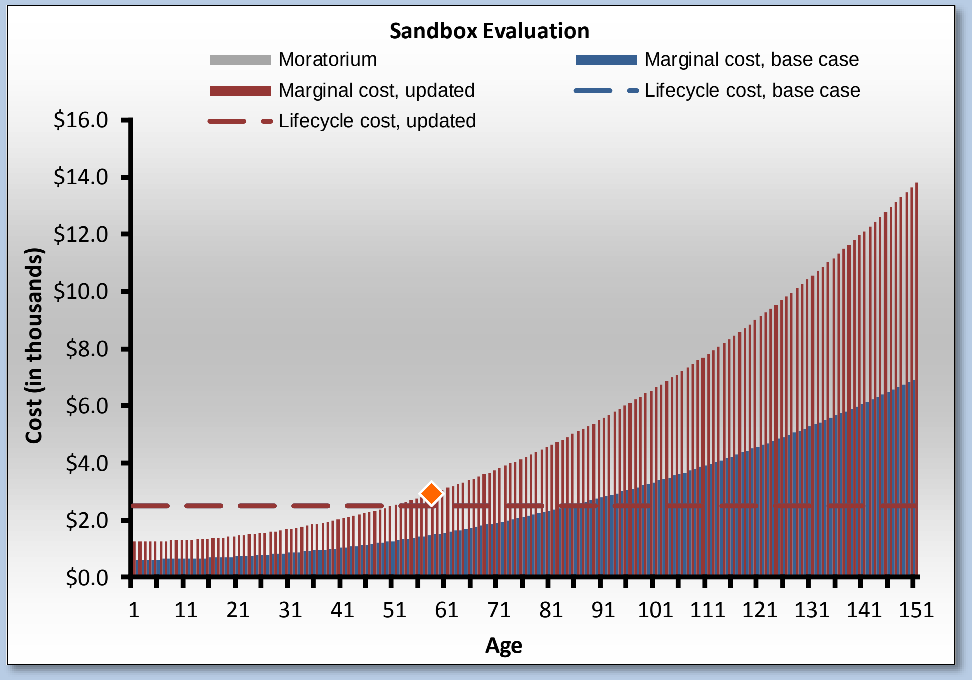


The “Sandbox”

User Defined Sandbox 150672

SANDBOX RESULTS	
Years to replacement (#)	0
Near term risk ($)	$2,934
Remaining economic value ($)	$0
Cost of ownership ($)	$101,137
Minimum lifecycle cost ($)	$2,478

EXISTING ASSET		
ASSUMPTION	BASE CASE	USER ENTERED
Effective age (years)	58	
Pipe material	AC	
Pipe length (ft)	266.62	
Pipe diameter (in)	12.00	
Replacement cost (actual)	$94,382	
Replacement moratorium (yrs)	N/A	
Maintenance cost ($)	$0	
Consequence of failure ($)	$340,638	
Failure curve shape, AC (#)	3.1	
Failure curve scale, AC (#)	102	
Failure curve random, AC (#)	0.01	
Failure curve base mult, AC (#)	1.00	
Failure multipliers (#)	1.00	2.00



USER COMMENTS

After poor test result

Thank you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