Asset Management
and
Criticality Assessment
for
Public Works Infrastructure

FORT WORTH

WOOLPERT

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City of Fort Worth

Asset Management

- A system of monitoring and maintaining assets of value.

- A systematic process of constructing, operating, maintaining, upgrading, rehabilitating and replacing assets cost-effectively.

—Paraphrased from Wikipedia

Asset Management

"For utilities [and public works], asset management may be defined as managing infrastructure capital assets to minimize the total cost of owning and operating them, while delivering the service levels customers desire."

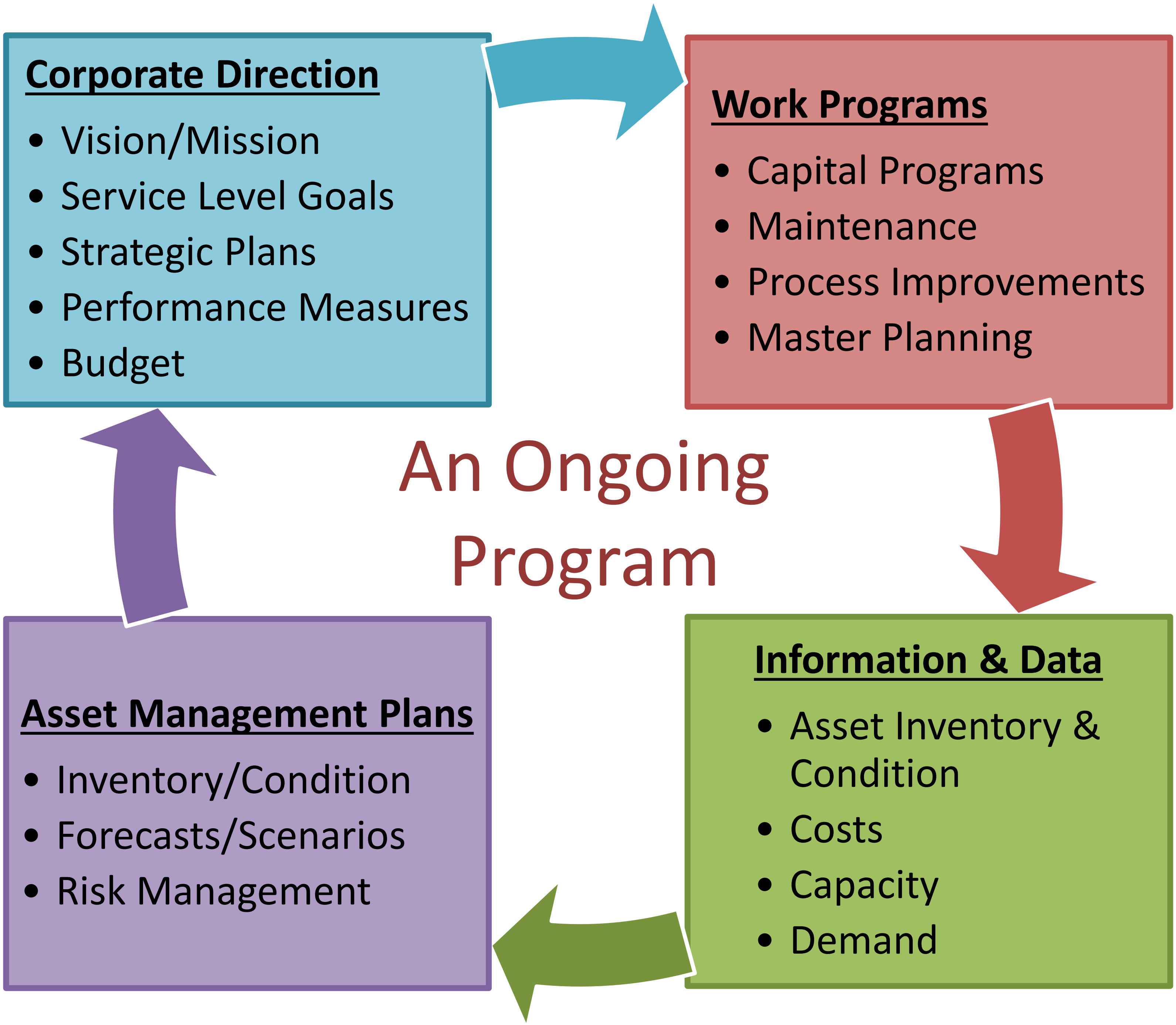
– *Adapted from EPA's Fact Sheet: "Asset Management for Sewer Collection Systems"*

Why Asset Management?

- Promotes quality infrastructure for:
  - Public health and safety
  - Our economic engine
  - Sustainability
- Promotes innovation and efficiencies
- Leads to better informed and justified investment decisions
- Supports funding justification

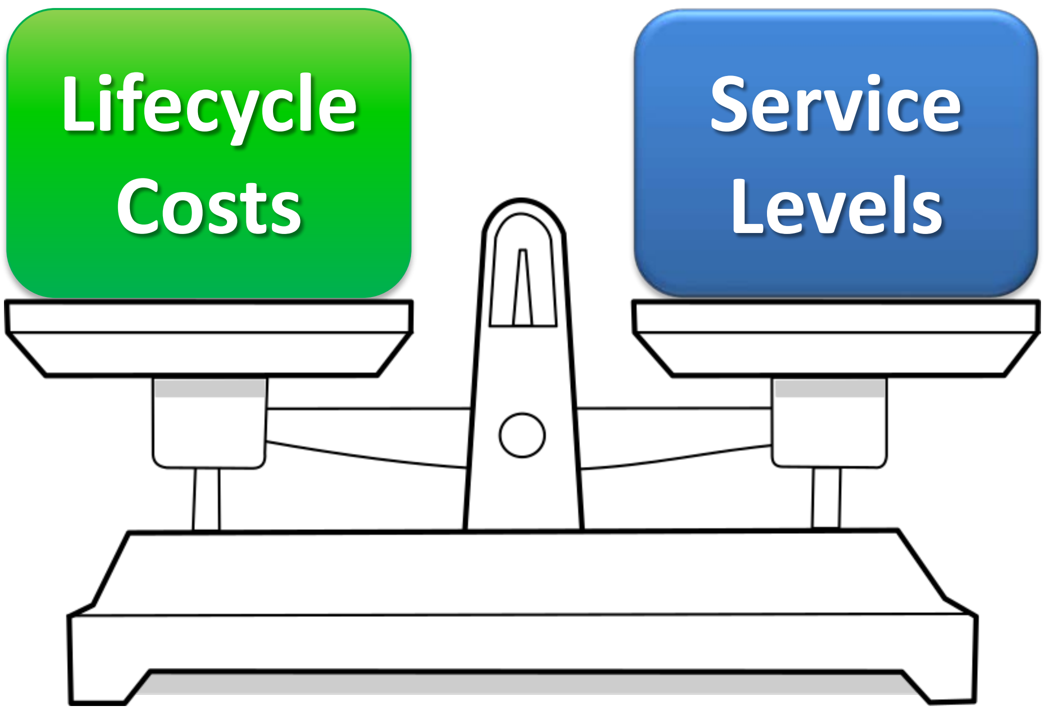
Asset Management Can Answer:

- What is the current state of my assets?
- What is my required sustained Level of Service?
- Which of my assets are critical for sustained performance?
- What are my best minimum lifecycle cost CIP and O&M strategies?
- Given the above, what is my best long-term funding strategy?


Corporate Direction
Vision/Mission
Service Level Goals
Strategic Plans
Performance Measures
Budget
Work Programs
Capital Programs
Maintenance
Process Improvements
Master Planning
An Ongoing Program
Information & Data
Asset Inventory & Condition
Costs
Capacity
Demand
Asset Management Plans
Inventory/Condition
Forecasts/Scenarios
Risk Management

In a Nutshell…

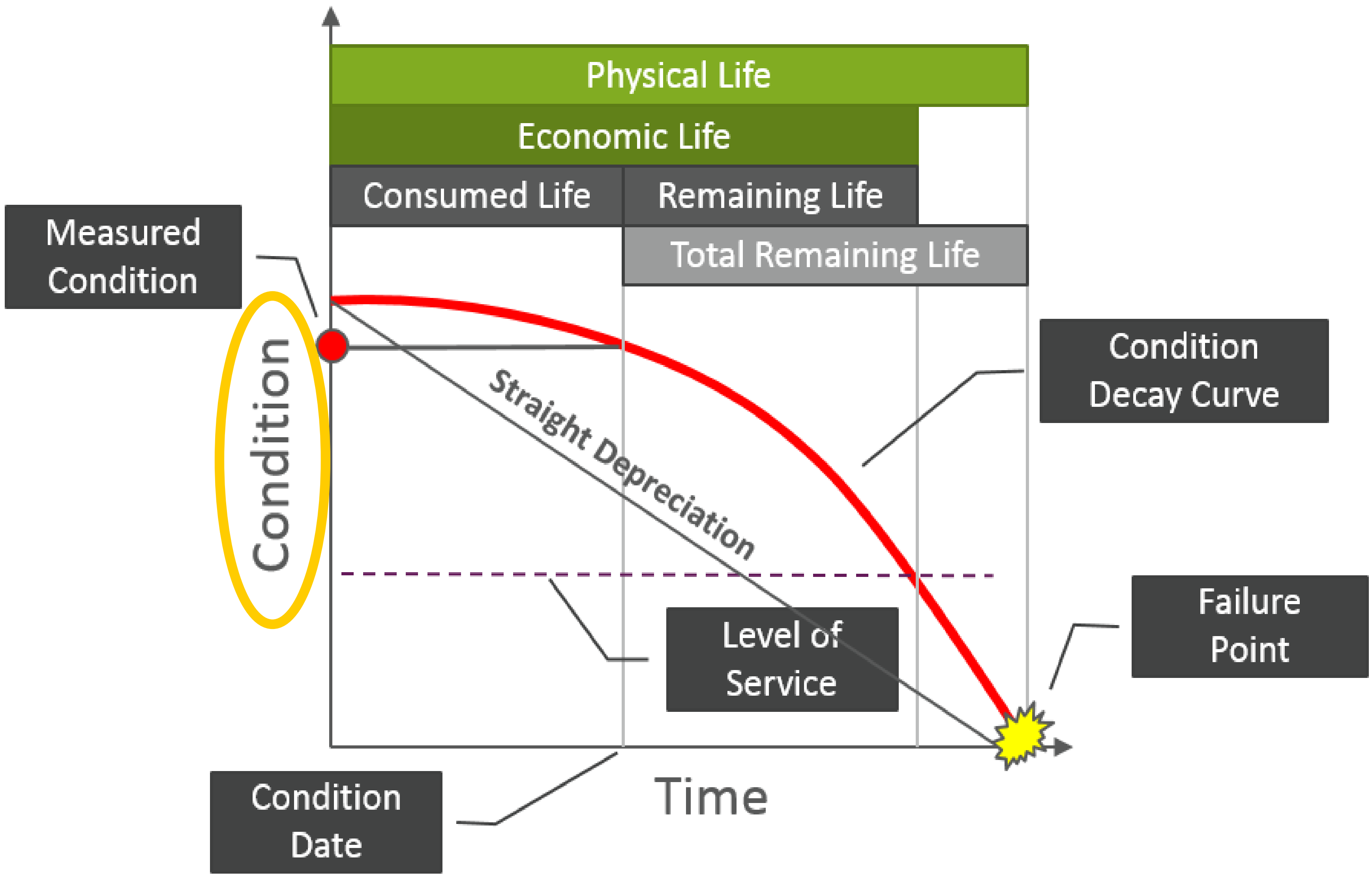
Asset management is balancing the **total cost of ownership** with **sustainable levels of service**.



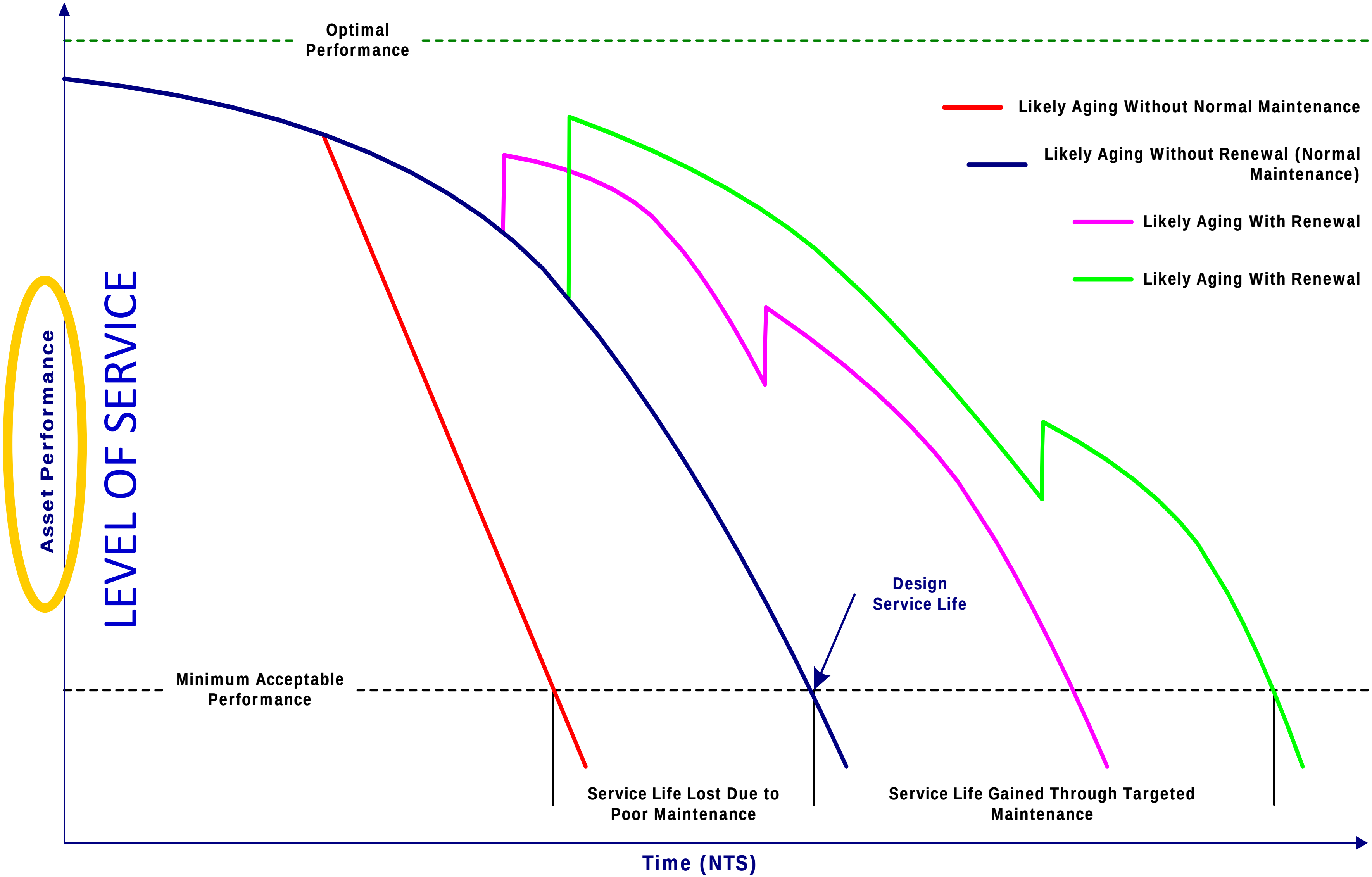
Level of Service

- **Transportation Infrastructure** and **Supply Utilities** have service levels set by customers: pressure, voltage, road condition, etc.
- **Collection Utilities** historically have little demand: just make it go away (although **Sanitary Sewer** LOS now subject to EPA)
- **Storm Drain** LOS is “don’t flood me” [often]
- **Public Works** do not have federal mandates for LOS and similarly do not have independent revenue stream needed to meet LOS demands

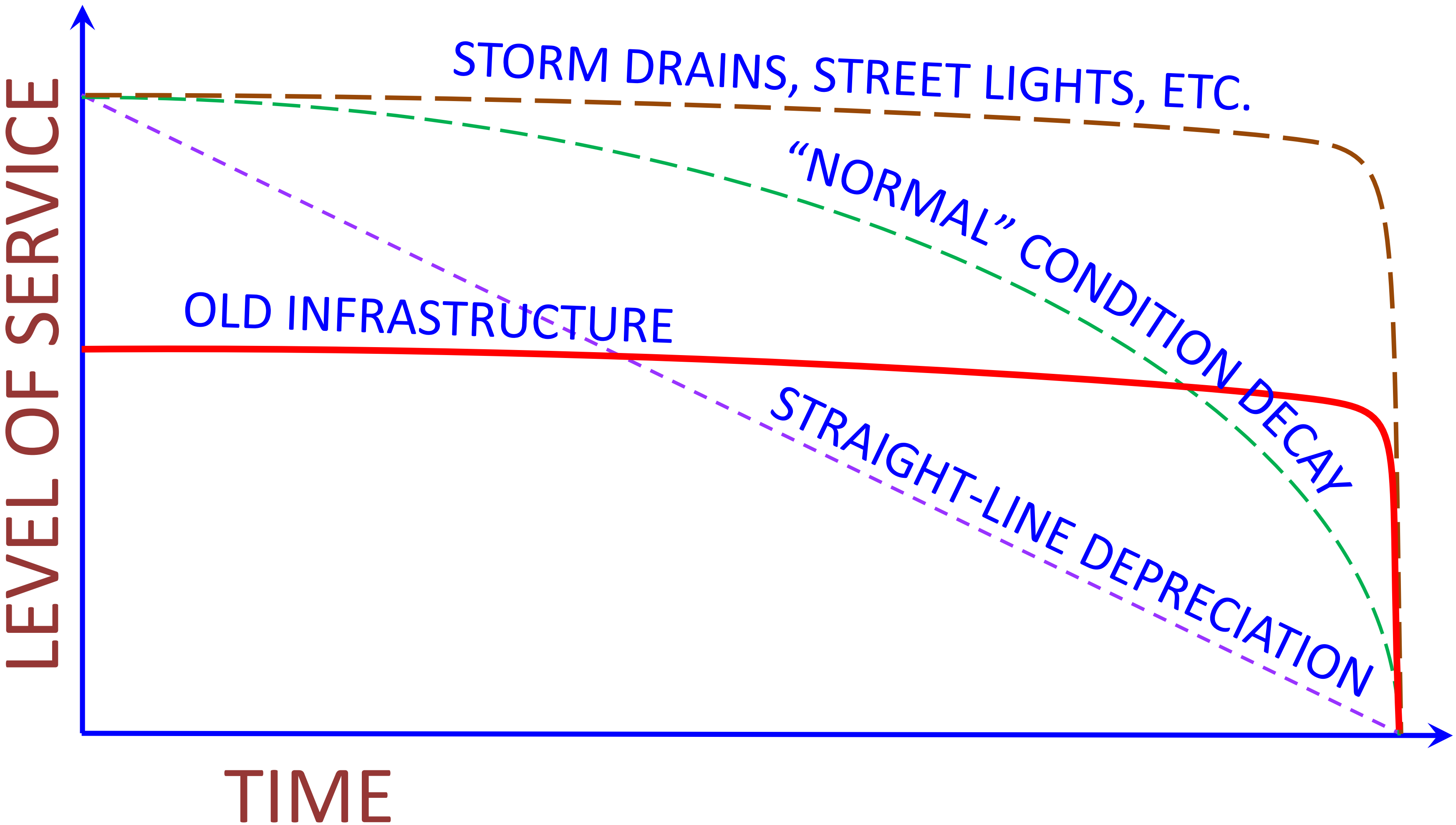
Asset Depreciation



Life-Cycle Decision Support



Asset Decay Curves



In Summary

Asset Management is an integrative optimization process that enables a utility or public works department to determine how to minimize the total life-cycle cost of owning and operating infrastructure assets while continuously delivering the service levels that customers desire. It also provides a systematic basis to justify rate structures and funding requests.

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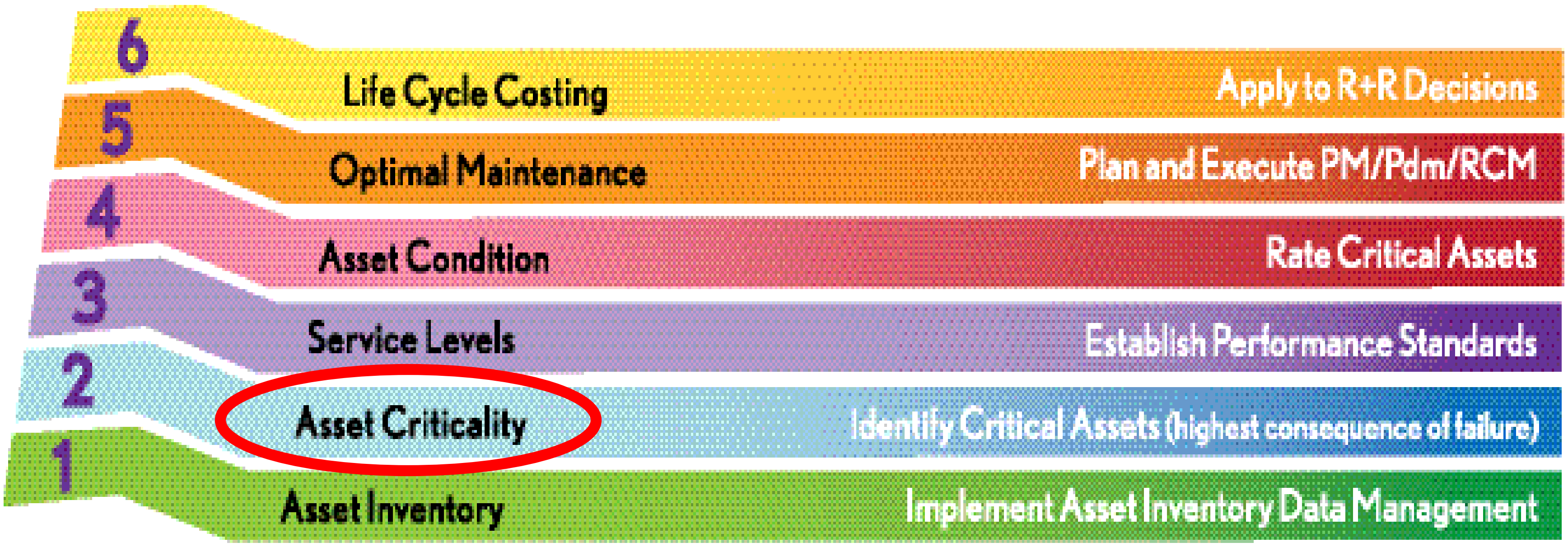
Overview of the Asset Management Elements

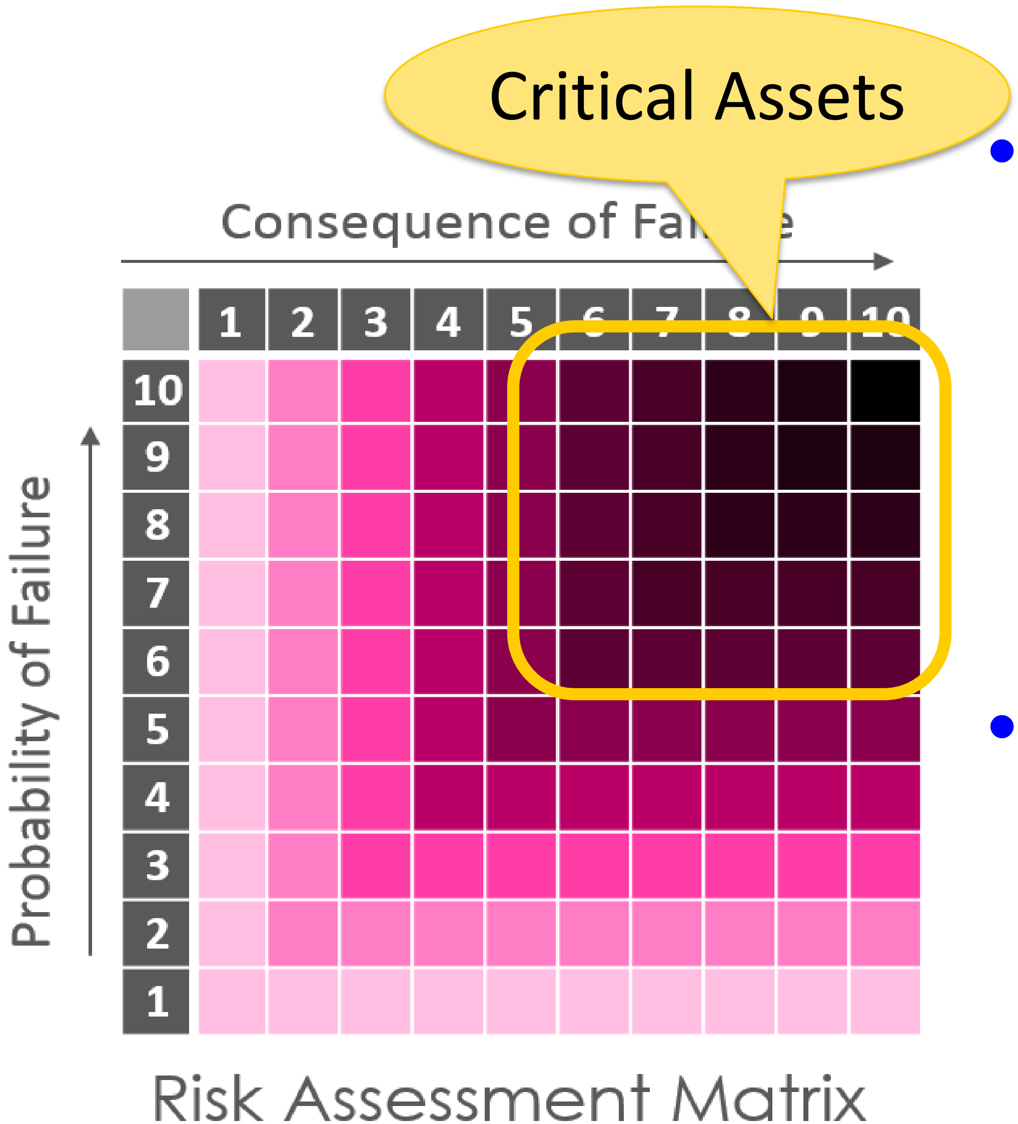


- *Also, Performance Management and Monitoring*

Asset Criticality

- Focuses on:
  - Managing overall risk
  - Identifying the assets that pose the most risk
  - Data collection activities and frequency
  - Condition assessment → remaining useful life
- Ties maintenance to capital planning, strengthening their interdependence
- Enables informed decision making

Business Risk Exposure



- Risk is defined as **Probability of Failure** (PoF) multiplied by **Consequence of Failure** (CoF).
- **PoF** and **CoF** are scored based on applicable factors available from GIS.

Criticality Assessment

FORT WORTH STORMWATER’S EXPERIENCE

Probability of Failure

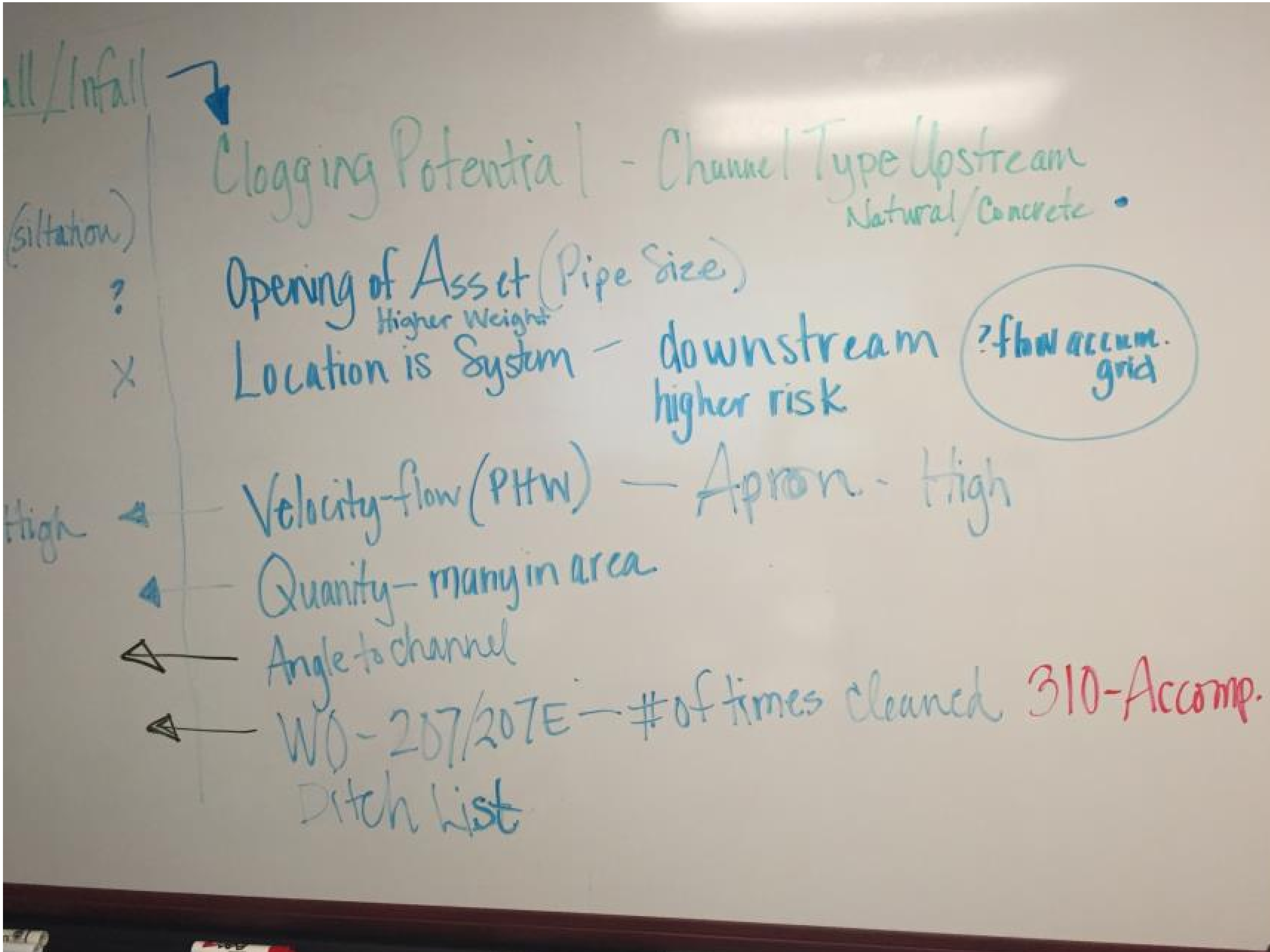
- What types of failure are most likely—functional (clogging) or structural?
- What is likely to cause those failures?
- What factors best capture those causes?
- How much weight should each factor have?
- Straight-line depreciation used since no comprehensive condition assessment.

Consequence of Failure

- If a failure occurs, what happens?
- For functional failure, consequences focus on what is subject to flooding
- For structural failure, repair difficulty and cost plays large role
- Are there nearby critical facilities (fire stations, hospitals, CBD, etc.) at risk?

Determining Asset Criticality Factors

- Fort Worth Stormwater’s experience
- Developed by GIS, Engineering and Field Operations staff
  - Several work sessions
  - Determined assets to be evaluated
  - Brainstormed criticality factors
- Reviewed later for feasibility
  - Availability of data (e.g. perched outfalls)
  - Can be easily analyzed by GIS tools
  - Repeatable annually


all/Infall
Clogging Potential - Channel Type Upstream
Natural/Concrete
(siltation)
Opening of Asset (Pipe Size)
Higher Weight
?
Location is System - downstream
higher risk
? flow accum. grid
X
High
Velocity-flow (PHW) — Apron. - High
Quanity- many in area
Angle to channel
WO - 207/207E - # of times cleaned 310-Accomp.
Ditch List

Assets Considered

- **Pipes** – our primary focus
  - Mains, Culverts and “Transitions”
- **Inlets** – clogging failure most common issue
- **Outfalls** – scour and erosion most common
- **Infalls** – clogging failure most common
- **Channels** – future (after mapping)
- ~~Drains~~ – not many; slotted & french
- ~~Manholes~~ – very few ever fail

Stormwater Asset Summary

Asset Class		Type	Count	Length	
				(Feet)	(Miles)
Pipe			21,921	4,031,330	763.50
	Culvert	Line	3,785	382,601	72.46
	Gravity Main & Transition	Line	18,136	3,648,729	691.04
Inlet		Point	26,362		
Outfall		Point	7,627		
Infall		Point	6,012		

Estimated Effective Life

Asset Class	Material	EEL (Years)
Gravity Mains, Transitions and Culverts	RCP, CIP	100
	Cast Iron, Concrete, HDPE, PVC, Corrugated Metal with Tar Lining	75
	Corrugated Iron, Corrugated Metal, Metal, Masonry, VCP, Wood, Other, Unknown	50
Inlets	ALL	75
Infalls	ALL	75
Outfalls	ALL	75
Channels	Not Yet Evaluated	??

PIPES Probability of Failure

- Percent Consumed 30 %
  - Based on Estimated Effective Life
  - Straight-Line Depreciation
  - **Condition Assessment** Better If Available
- Capacity 30 %
  - Based on Pipe Grade
- Operating Environment 20 %
  - Based on Zoning and Activity Areas
- Pipe Material 20 %
  - Double Counted with Percent Consumed

Gravity/Culvert/Transition

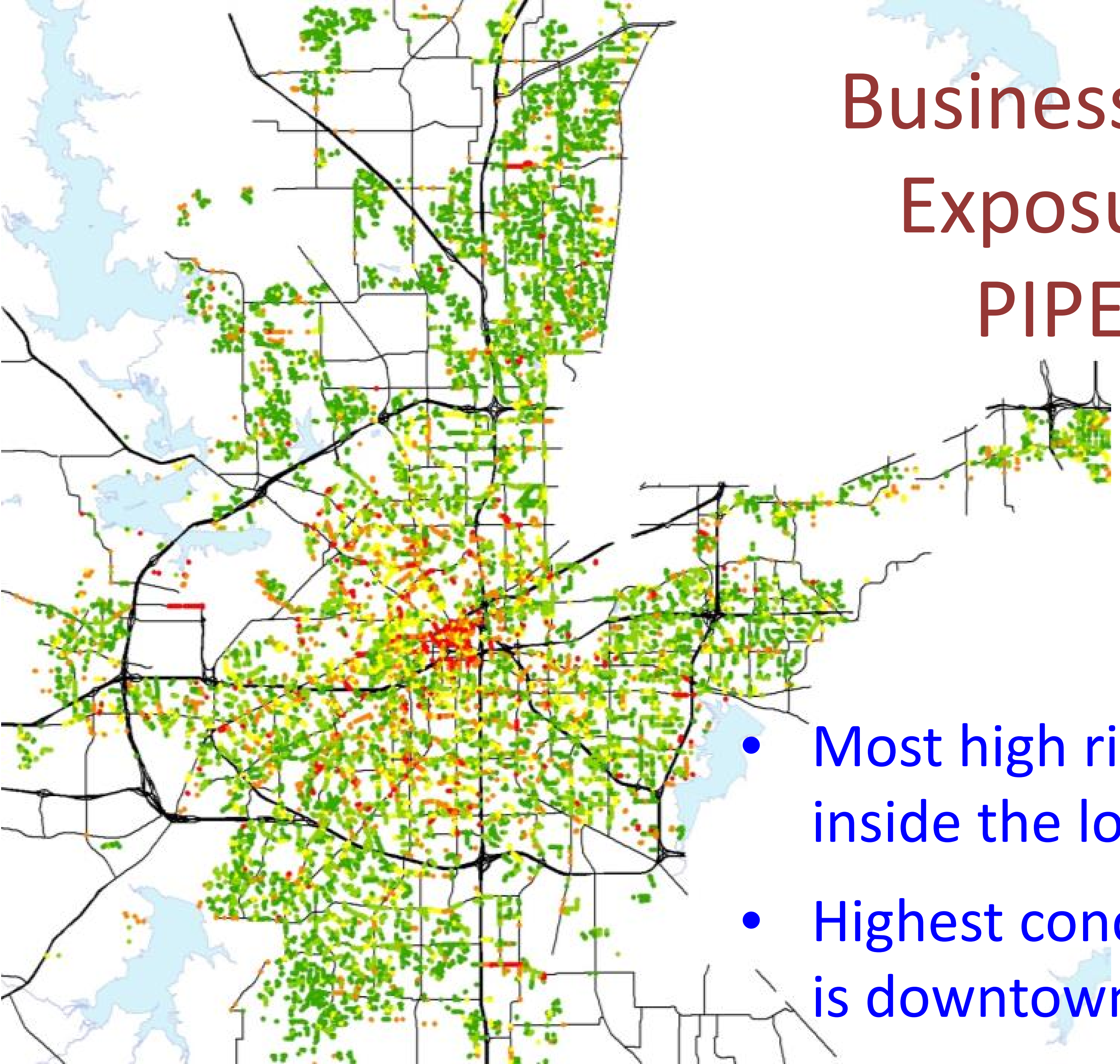
POF Factor	Weight	Rating	Description	Notes
Percent Consumed	~~4~~ 3	Age/EEL	Actual Age ÷ EEL	NULL IO_DATE = 1970
Capacity	~~1~~ 3	1	A	Source: BGE Graded_Pipes output A is excellent and F is failure Null pipe grades will be reassigned in Scenario Analysis (IO Toolset) with the following criteria: 1. Percent Consumed ≤ 5 = A grade 2. Percent Consumed > 5 = F grade
		2	B	
		3	C	
		4	D	
		5	F	
Operating Environment (High Traffic /Density)	2	1	Zoning A (all sizes), B, R-1 or R-2 single- or two-family residential districts	CFWGIS.DBO.ADM_ZONING w/ query: ZONING = 'A-10' OR ZONING = 'A-2.5' OR ZONING = 'A-2.5A' OR ZONING = 'A-21' OR ZONING = 'A-43' OR ZONING = 'A-5' OR ZONING = 'A-7.5' OR ZONING = 'AR' OR ZONING = 'B' OR ZONING = 'R-1' OR ZONING = 'R-2'
		2	All other zoning districts	CFWGIS.DBO.ADM_ZONING w/ query: ZONING <> 'A-10' AND ZONING <> 'A-2.5' AND ZONING <> 'A-2.5A' AND ZONING <> 'A-21' AND ZONING <> 'A-43' AND ZONING <> 'A-5' AND ZONING <> 'A-7.5' AND ZONING <> 'AR' AND ZONING <> 'B' AND ZONING <> 'R-1' AND ZONING <> 'R-2'
		+1	Within Central City	CFWGIS.DBO.ADM_CENTRAL_CITY_BOUNDARY
		+1	Within Growth Center	CFWGIS.DBO.ADM_GROWTH_CENTERS
		+1	Within TIF, Urban Village and/or Commercial Corridor	CFWGIS.DBO.ADM_TIFS CFWGIS.DBO.ADM_URBAN_VILLAGES CFWGIS.DBO.ADM_COMMERCIAL_CORRIDORS
		Create a field for each factor and assign a value by using 'Select by Location'. Sum of each field is the Operating Environment score. Maximum rating is 5.		
Pipe Material	~~3~~ 2	1	HDPE, RCP and DIP	
		2	PVC, Other, Corrugated Metal with Tar Liner	
		3	All Others	Cast Iron, Concrete, Wood, VCP, Masonry, Corru-gated Iron, Corrugated Metal, Metal, and Unknown. Should we consider 5 points for this class?
Total	10			

- Report table includes rating details
- Notes by GIS staff provide details of the analysis
- Allows us to update analysis annually

PIPES Consequence of Failure

*Considers Both **Flood Damage** and **Repair Cost***

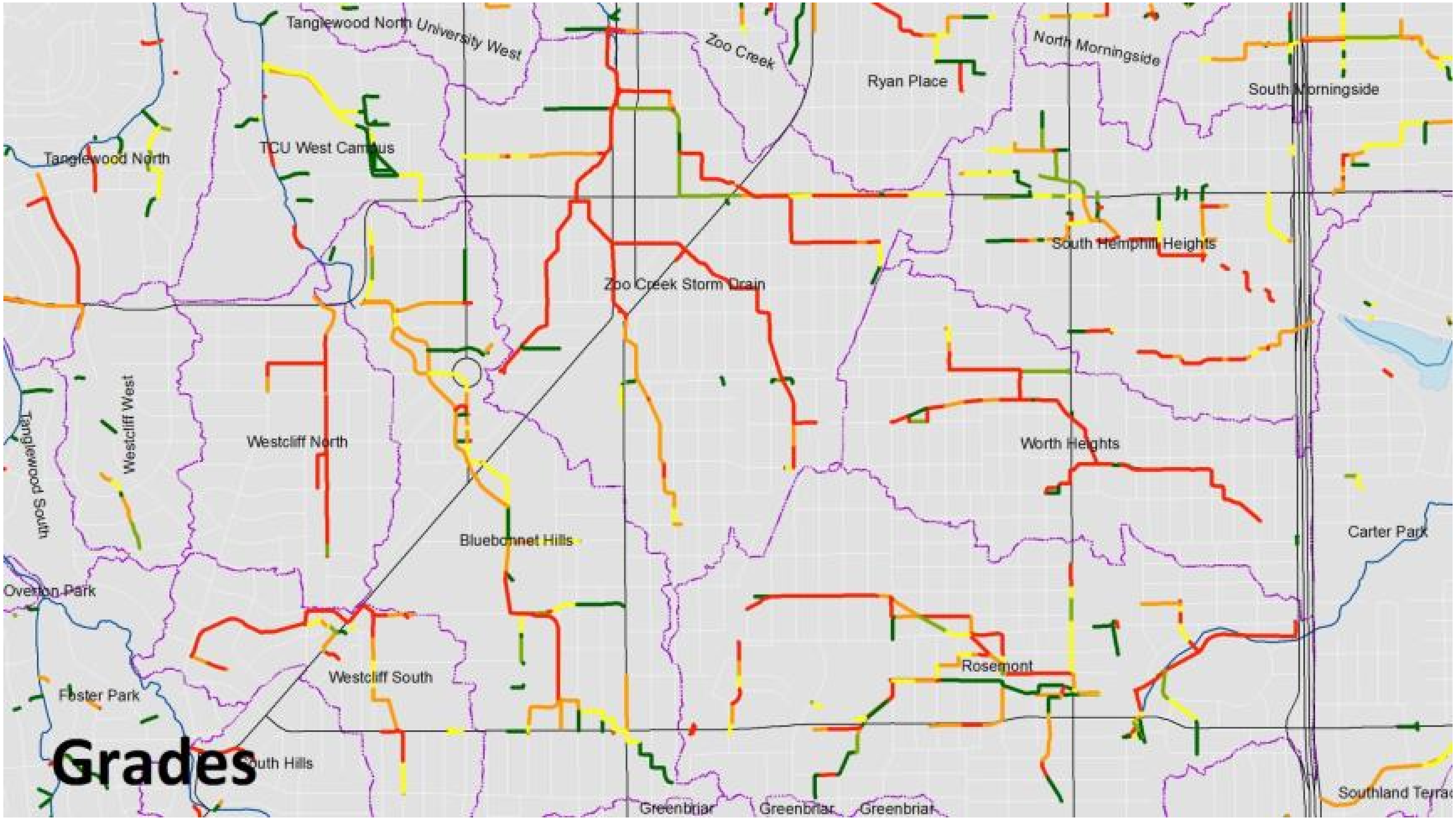
• Pipe Size	40 %
• Proximity to Buildings	20 %
• Proximity to Roadways	20 %
• Critical Areas Served	20 %



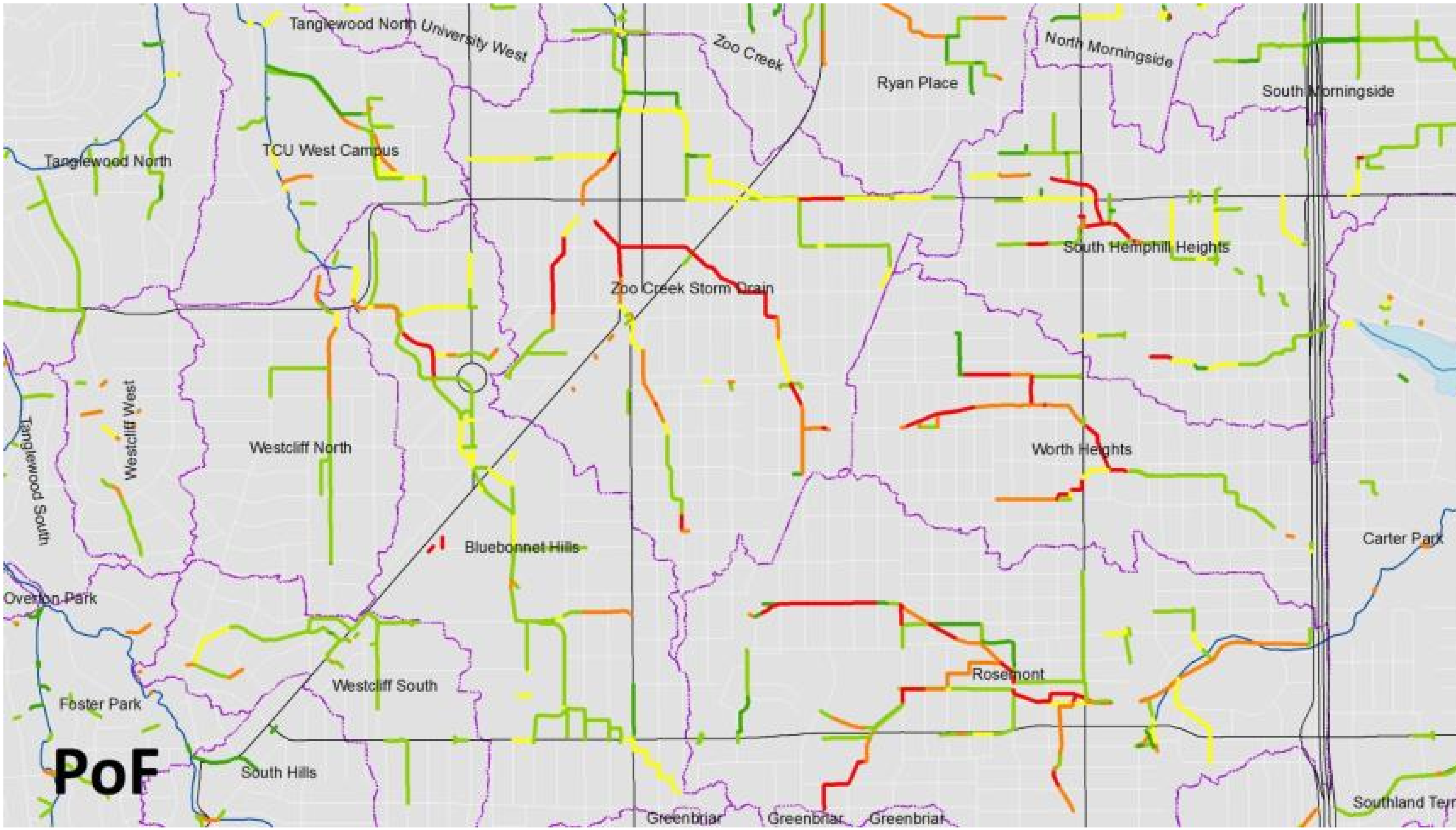
Business Risk Exposure: PIPES

- Most high risk pipes inside the loop
- Highest concentration is downtown area

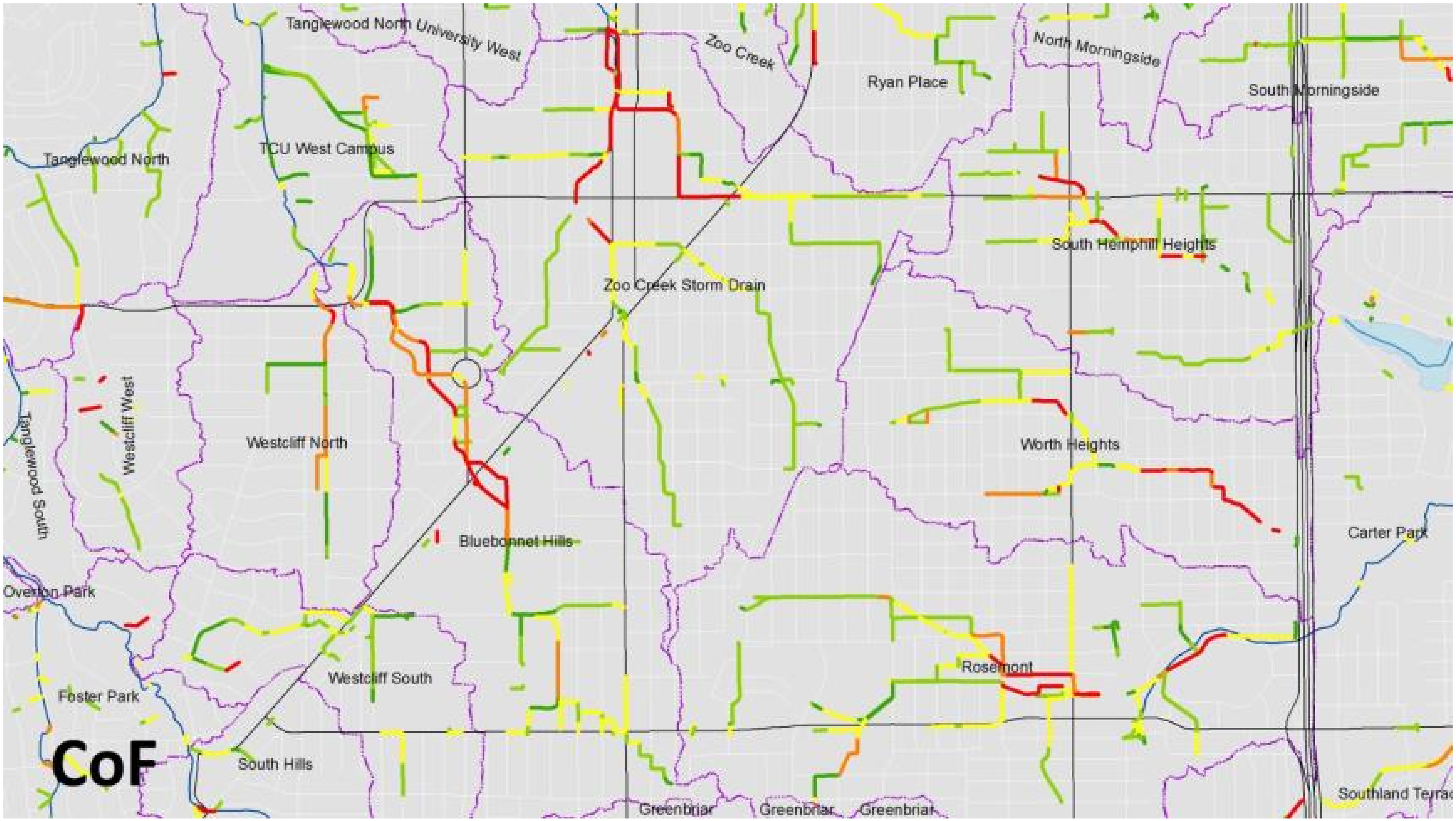
Pipe Grades


Tanglewood North
University West
Zoo Creek
Ryan Place
North Morningside
South Morningside
TCU West Campus
Tanglewood North
South Hemphill Heights
Zoo Creek Storm Drain
Westcliff West
Tanglewood South
Westcliff North
Worth Heights
Carter Park
Bluebonnet Hills
Overton Park
Rosemont
Westcliff South
Foster Park
Grades
Greenbriar
Greenbriar
Greenbriar

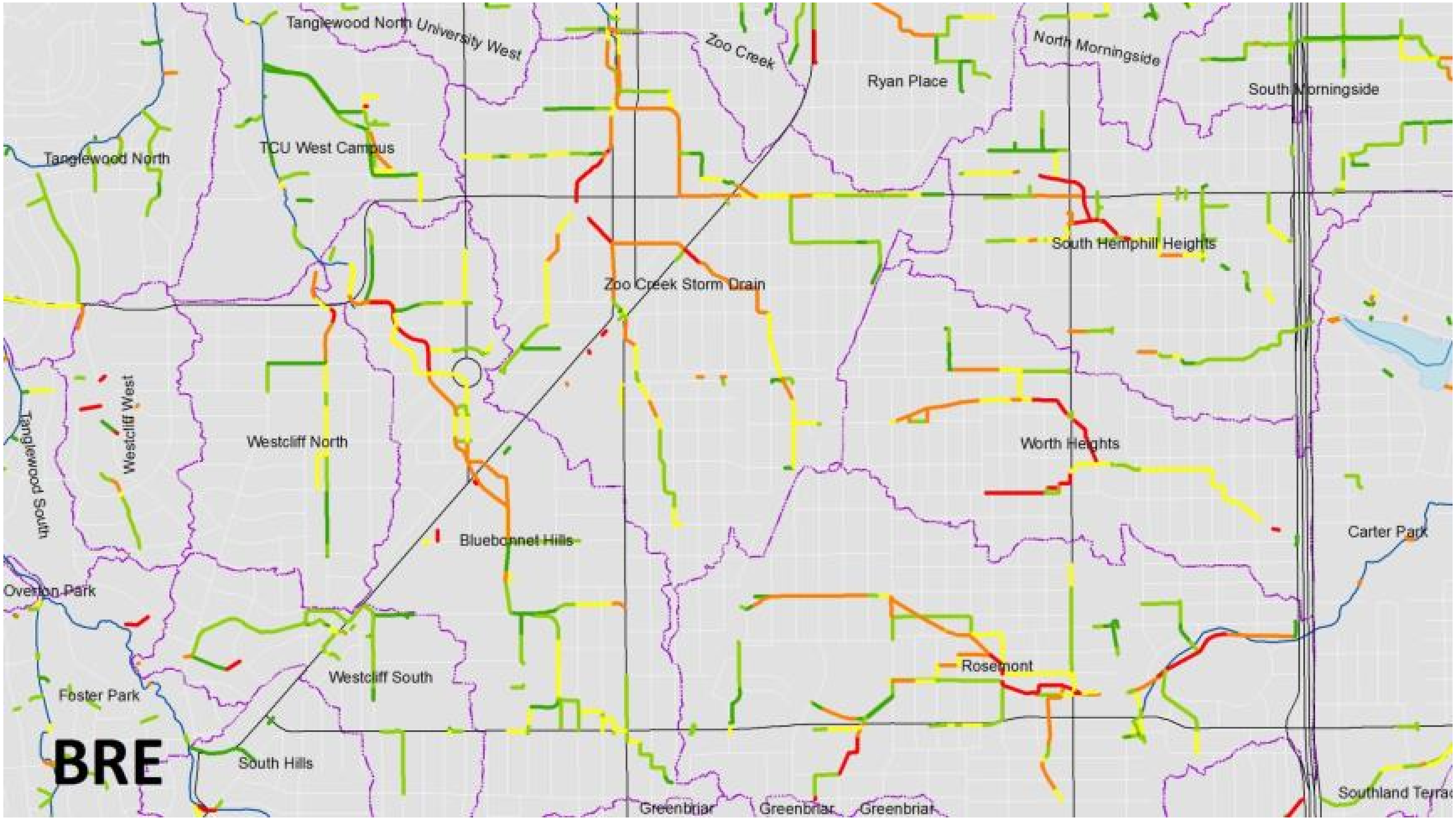
Probability of Failure



Consequence of Failure

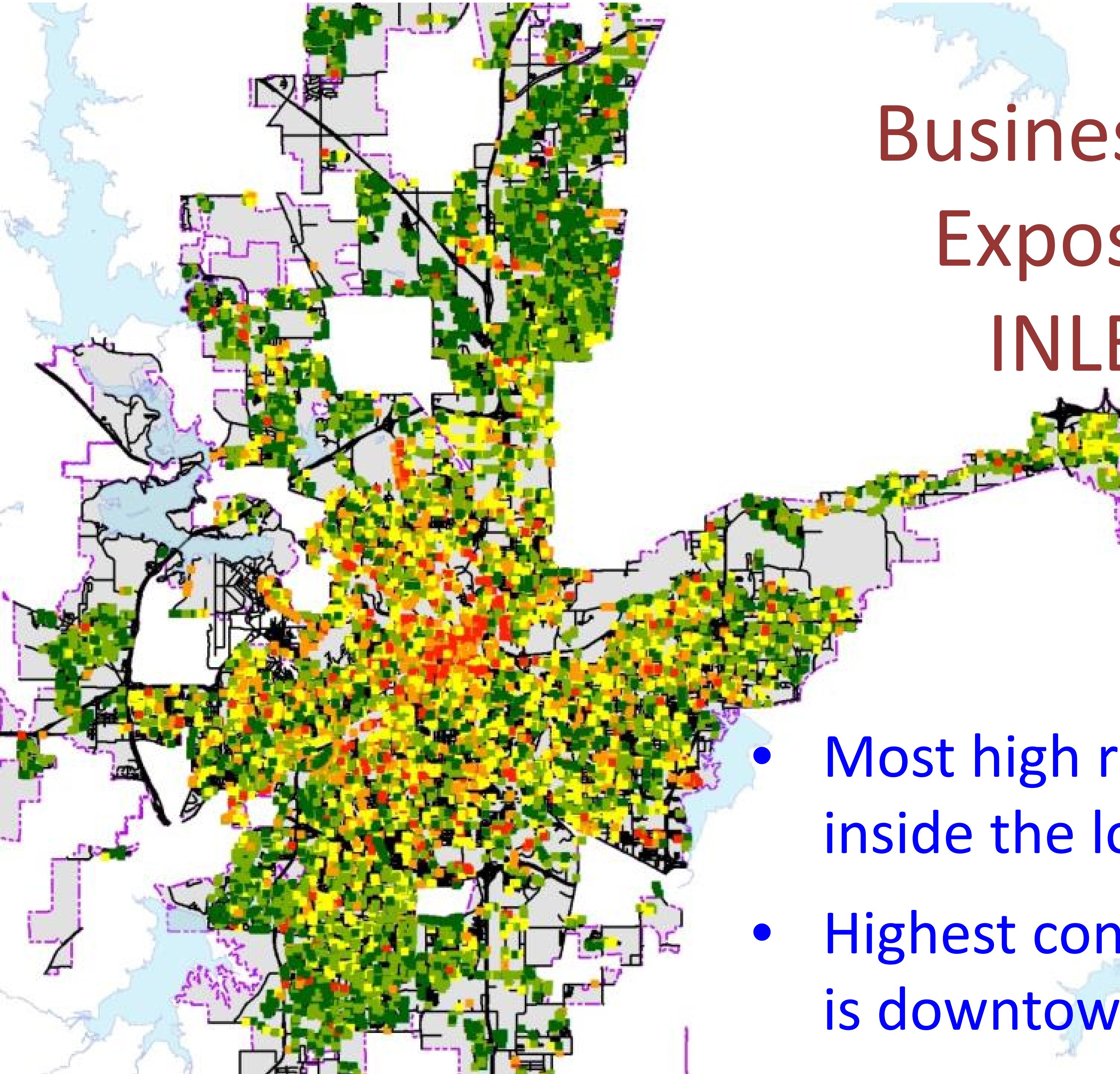


Business Risk Exposure



INLETS

- Functional failure (clogging) of much greater frequency than structural failure
- PoF focuses on inlet size, inlet type and off-street vs. on-street
- CoF focuses on proximity of structures and critical facilities
- Redundancy included as consequence factor



Business Risk Exposure: INLETS

- Most high risk inlets inside the loop
- Highest concentration is downtown area

OUTFALLS

- Erosion and scour are greatest issues.
- Each outfall pipe considered separately.
- PoF weighted toward pipe system outfalls vs. culverts.
- Velocity is other key PoF factor.
- CoF considers distance from roadway both to identify failure before it becomes significant, as well as access difficulty.

INFALLS

- Clogging considered the major issue
- Primarily culverts
- PoF considers channel type (structural, earthen, or natural) for debris potential
- PoF also based on City's "ditch list"
- Smaller pipes have higher PoF but larger pipes have higher CoF
- Redundancy considered as CoF factor

Asset Management

REPLACEMENT COST

Replacement Cost

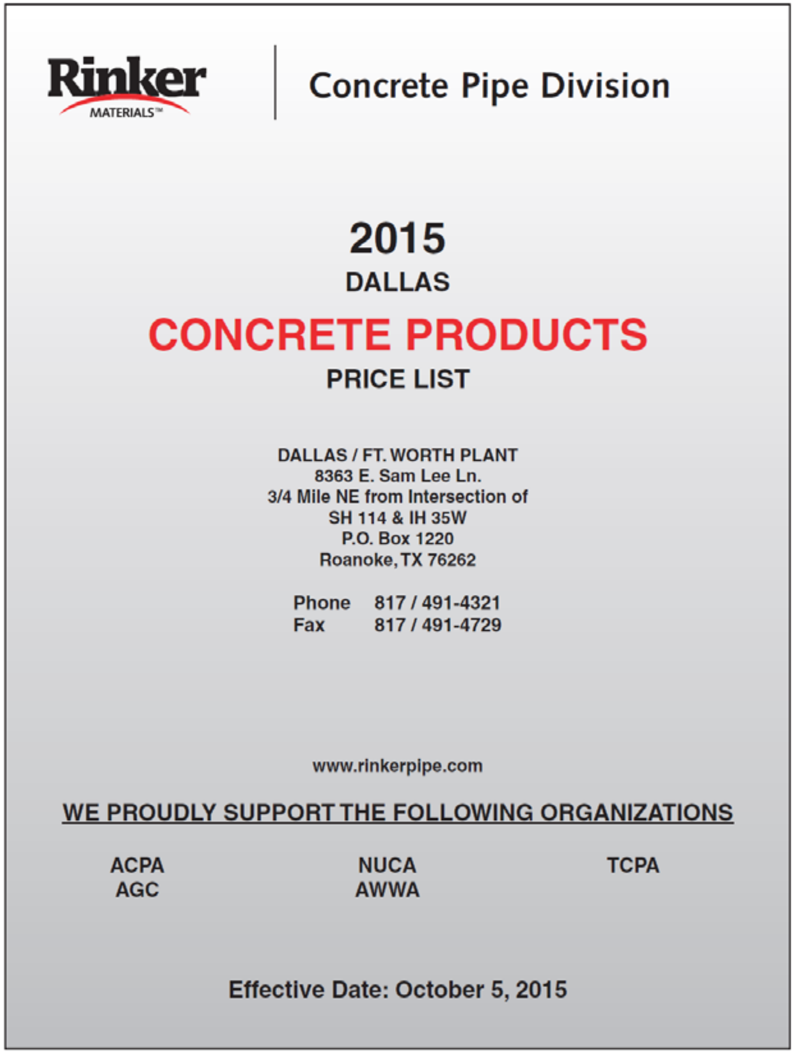
- Cost information is imperative in the valuation of assets and life-cycle costing.
- Can use depreciated value for current assets.
- But for financial programming, replacement cost is needed.
  - Most often project construction costs are used
  - Can use present-day costs or future costs
- Can be used to put value on entire system, or can limit to most critical assets.

Replacement Cost Issues

- Stormwater projects often require replacing numerous utilities and re-paving roadways.
- Using this approach citywide would yield costs so high as to lose credibility.
- “Asset” costs for storm drains developed using RCP & box manufacturer’s price list.
- Expected to still yield astronomically high number, but much more defensible.
- Important tool for advocating funding needs.

Replacement Cost Source

- City “installed” prices from 2014 developer agreement were low.
- Used 2015 purchase prices instead.
- Used RCP prices.
- For all other shapes, used box prices for same width x height.



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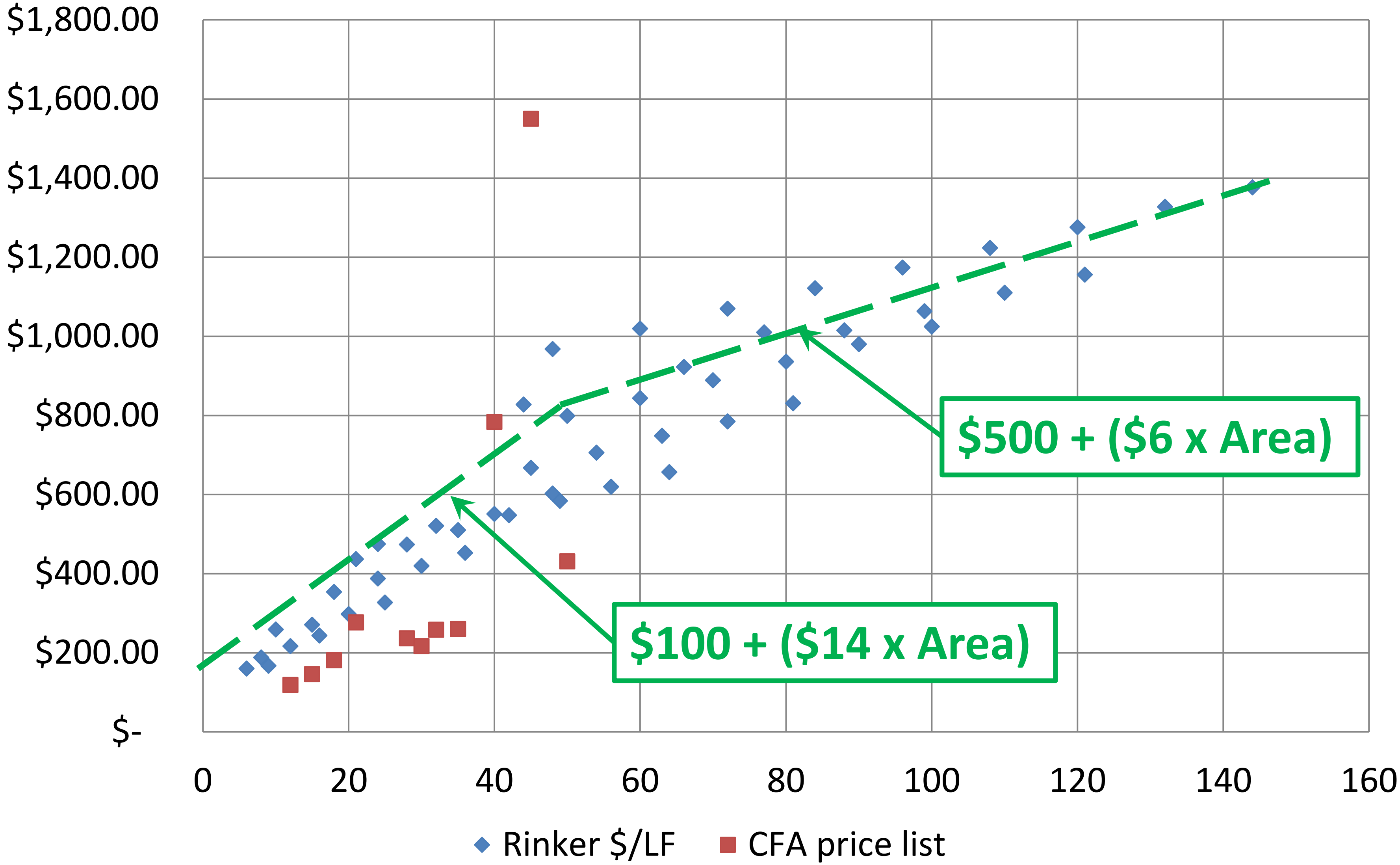
Replacement Pipe Costs

Dia. (in)	Cost per LF	Dia. (in)	Cost per LF	Dia. (in)	Cost per LF
≤ 21"	$ 43.00	**42"***	$ 148.00	**84"**	$ 556.00
24"*	$ 54.00	**48"***	$ 180.00	**90"**	$ 664.00
27"*	$ 62.00	**54"***	$ 241.00	**96"**	$ 753.00
30"*	$ 73.00	**60"**	$ 285.00	**108"**	$ 1,000.00**
33"*	$ 90.00	**66"**	$ 350.00	**120"**	$ 1,275.00**
36"*	$ 107.00	**72"**	$ 409.00	**132"**	$ 1,500.00**
39"*	$ 134.00	**78"**	$ 486.00	* Or smaller sizes	** Estimated

Box Replacement Cost Determination



Other Replacement Costs

Infrastructure Feature	Replacement Cost
All curb inlets up to 10’ length	$3,000.00
All curb inlets > 10’ length	$6,000.00
All drop inlets	$3,500.00
Infalls and Outfalls (round)	$100 * DIAM_IN
Infalls and Outfalls (other)	$1,200 * WIDTH_FT
Manholes	$10,000

Current Status

- Maintenance and engineering staff to vet PoF and CoF factors for infalls and outfalls
- GIS Staff to analyze infalls, outfalls and system replacement cost or value.
- Before beginning a channel mapping program, plan to develop criticality assessment factors to identify data needs.
- Traffic Management adopting criticality assessment process.

Criticality Moving Forward

- Routine updates annually
- Channel criticality after mapping
- Develop condition assessment program to use condition instead of straight-line depreciation

Criticality in Practice

- Prioritize Emergency Response
- Highlight Capital Projects Needs
- Rank Condition Assessment Needs
- Drive Preventative Maintenance
- Permitting and Reporting
- Helps with FEMA's CRS rating


Plan
Design
Build
Start
O&M
Rehab
Retire
Identify
City of
Fort Worth
Stormwater
Asset
Management

Questions?