



Infrastructure Management Practices

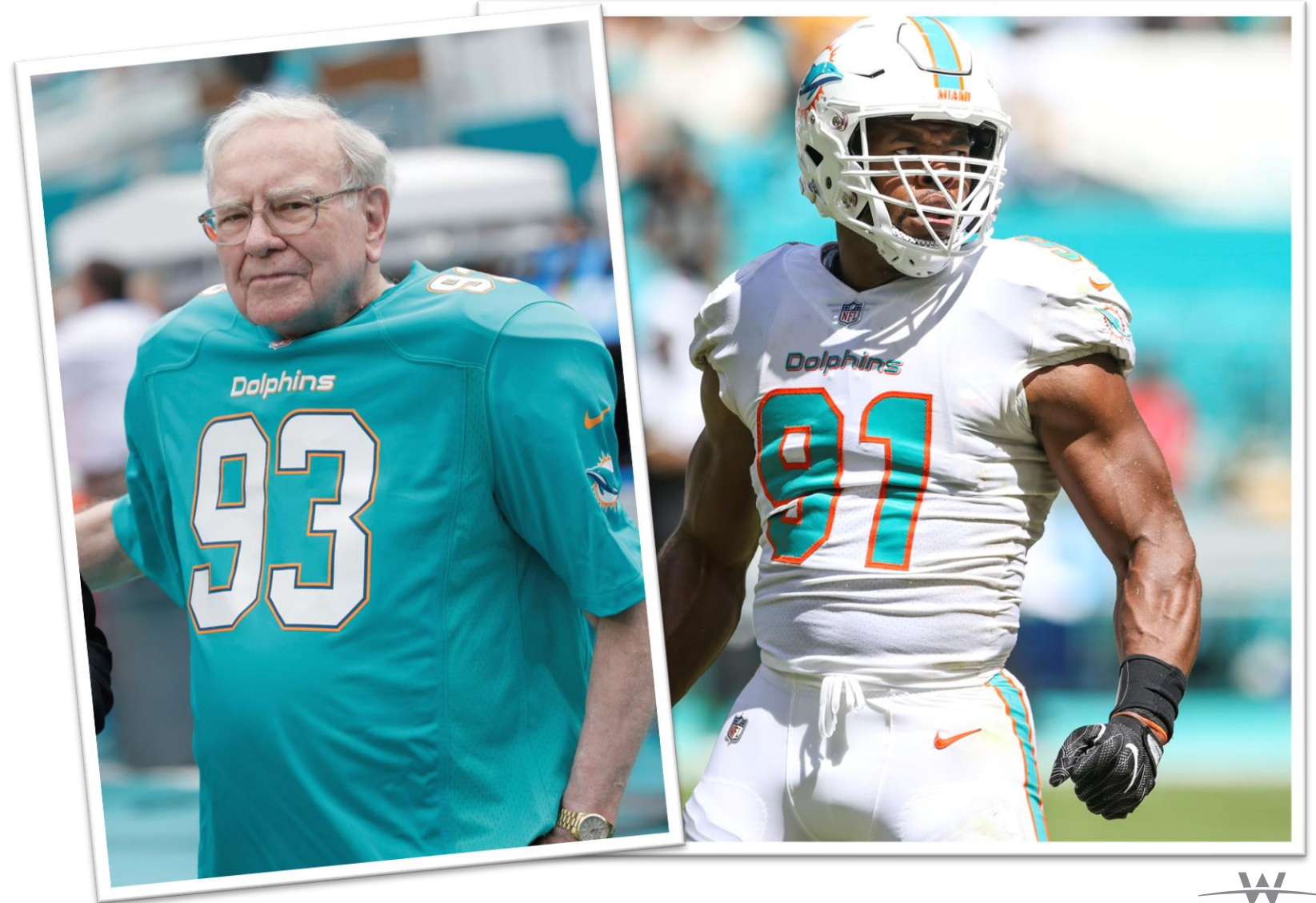
Case Study: Oklahoma City Water Utilities Trust



WOOLPERT
ARCHITECTURE | ENGINEERING | GEOSPATIAL

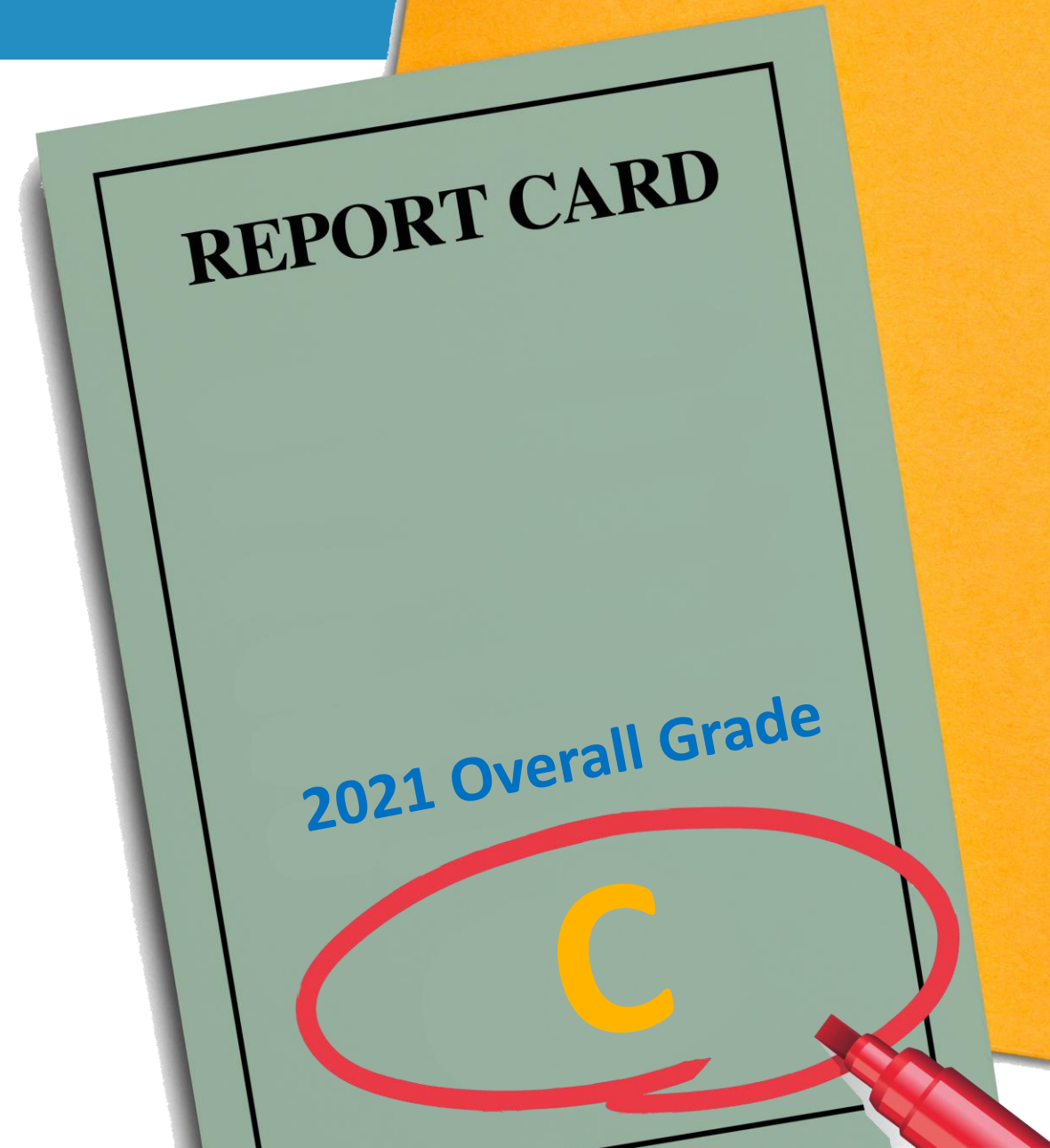
Asset Management Builds Resiliency

**Build your
resiliency plan on
a solid
infrastructure
framework**



ASCE 2021 Florida Report Card

Infrastructure Type	Grade
Stormwater	C-
Drinking Water	C
Wastewater	C
Bridges	B
Roads	C+
Dams	D-
Ports	B
Aviation	C+
Energy	C+
Solid Waste	B+



ASCE Infrastructure Recommendations

Asset	ASCE Recommendations
Drinking Water	Investment, Asset Management
Wastewater	Adequate future funding, Asset Management
Stormwater	Funding, Assess systems

The collage features several overlapping document pages with the following content:

- Recommendations for Action:**
 - Support the passage of the national Water Resources Development Act (WRDA) of 2017 to support the Harbor Maintenance Trust Fund, re-authorize the National Dam Safety Program, and develop a Water Infrastructure Finance Innovation Act (WIFIA) program.
 - Provide full support of the National Dam Rehabilitation and Repair Act.
 - Require federal agencies that own, operate or regulate dams to meet the standards of Federal Guidelines for Dam Safety.
 - Enact legislation providing the North Carolina Dam Safety Office with statutory authority to require Emergency Action Plans (EAPs) for all jurisdictional high hazard dams and increase the NC Dam Safety Program budget and staff levels to accommodate for current and future inspection needs and permitting reviews, and work toward achieving goals of the ASCE "Model Dam Safety Program".
 - Establish state and federal dam rehabilitation loan and grant programs for privately owned dams.
 - Include dam failure inundation mapping as part of the National Dam Safety Program.
 - Increase state and federal public relations efforts to...
- Recommendations:**
 - Encourage asset management practices, and change the predominant mindset from building new roadway infrastructure to maintaining the existing infrastructure.
 - In designing new highway projects, place more emphasis on incorporating the principles of operation and maintenance to ensure quality assurance throughout the entire service life of an asset.
 - Invest and support the use of new technologies to advance the overall design, build, maintain, and operate processes of the transportation network.
 - Use remote sensing technologies and automated systems to accurately and efficiently obtain data for as-built modeling and asset inventories.
 - Implement roadway and roadside technologies that aid engineers, planners, policy makers, law enforcement, and traveling public in the highway network.
 - Develop a diverse funding strategy that will sustain high levels of quality and service for users without burdening taxpayers.
 - Promote sustainable public-private partnerships and optimize third-party contracts through transparency.
 - Employ mileage-based user fees and other road pricing method when applicable.
 - Take a holistic approach in managing the transportation network.
 - Look at highway design and urban planning as a seamless, integrated effort.
 - Utilize the principles of unconventional interchange and intersection design, roundabout corridors, and complete streets.
- Recommendations:**
 - Expand and develop permanent funding sources for stormwater improvements. Two-thirds of the State's population lives in areas where dedicated stormwater funding does not exist. State-funded sources of money such as the N.C. Clean Water Management Trust Fund typically can only make grants to 10% of the needs expressed in its grant applications.
 - Continue to develop an infrastructure databases for efficient maintenance and improvement planning. Most larger cities are making notable progress toward this goal, but more work needs to be done on a statewide basis.
 - Continue National Pollutant Discharge and Elimination System (NPDES) Phase II implementation of current and future communities.
 - Continue to develop standards for inspection and maintenance of Best Management Practices (BMPs). North Carolina Department of Environment and Natural Resources (NCEM) Manual, which has expanded its guidelines for pollutant removal.
- Recommendations:**
 - Maintain the existing North Carolina gasoline user fee and promote the use of tax dollars in bridge construction projects.
 - Evaluate and expand the Express Design Build program to identify cost effective bridge replacements throughout the state.
 - Expand the utility of bridge rating software to identify bridge maintenance versus bridge replacement.
 - Continue to engage policy makers on the importance of bridge maintenance and bridge closures.
- Recommendations for Action:**
 - Support the increased use of state funding - through grants and loans - for wastewater infrastructure.
 - Develop a statewide infrastructure plan.
 - Develop a statewide infrastructure database to document funding needs and expenditures.
 - Engage the state's utility managers in developing sound and equitable rates that are based upon the need for repairs and replacement of capital infrastructure, and build reserves to maintain a minimum level across State.
 - Implement a public education campaign to help our state's citizens recognize and accept the need for asset management funding.
 - Implement a support life-cycle cost analysis principals to evaluate the total costs of projects; rates that can support life-cycle cost analysis principals to evaluate the total costs of projects; rates that can support life-cycle cost analysis principals to evaluate the total costs of projects;
 - Encourage the use of life-cycle cost analysis principals to evaluate the total costs of projects;
 - Ensure that money earmarked for the wastewater infrastructure is used for its intended purpose and pass legislation for consequences if allocated or used for other purposes;
 - Provide incentives for asset management and detailed rehabilitation and replacement planning for utilities to prioritize needs.



Why Change?



The first rule of business, protect your investment.

- *Etiquette of the Banker 1777*



Why Change?



Benefits of Asset Management

Stormwater: growing annual funding gap of \$8 *billion* just to comply with current regulations.

Wastewater: ...the total gap will grow to more than \$434 *billion* by 2029.

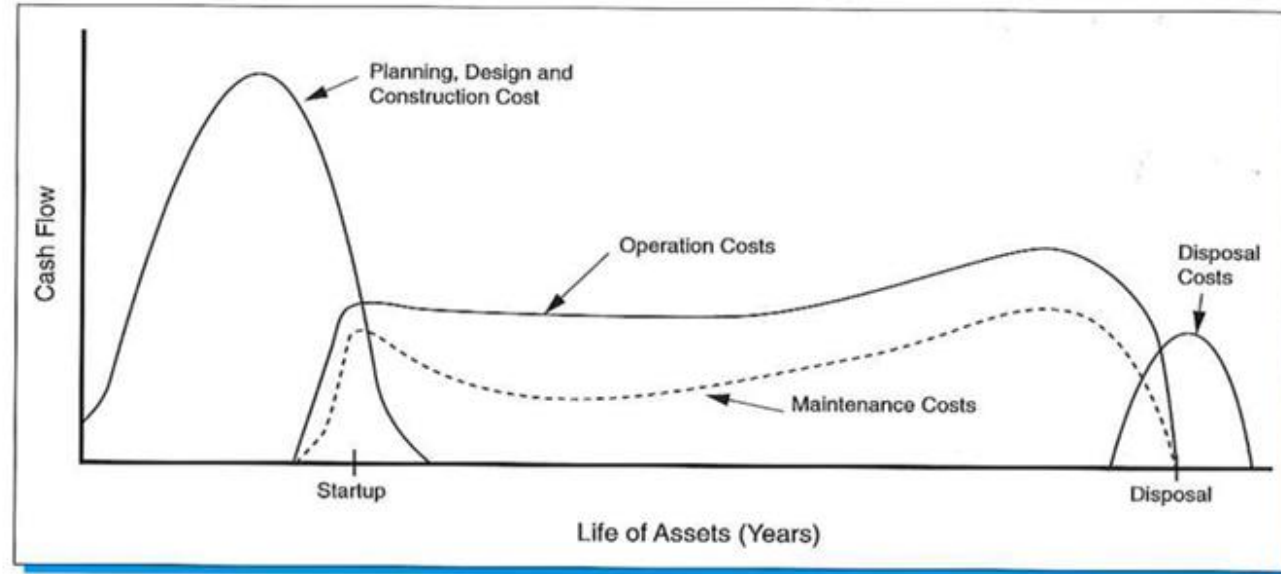
Water: *only 21%* of all U.S. utilities report being able to fully cover the cost of providing drinking water services.



“2021 Report Card for America’s Infrastructure”
– American Society of Civil Engineers



Benefits of Asset Management



Life Cycle Costs occur over all phases

60% - 80% of life cycle costs in
"Use Phase"

Longest and most costly phase

"Financial accounting may suggest a 1-2 percent amount annually of the entire pipe network valuation as a total cost of condition assessment and risk mitigation activities."

- Greg Baird, President of the Water Finance Research Foundation

Benefits of Asset Management

Condition State Distribution



Assetic Predictor (Brightly) Graphic

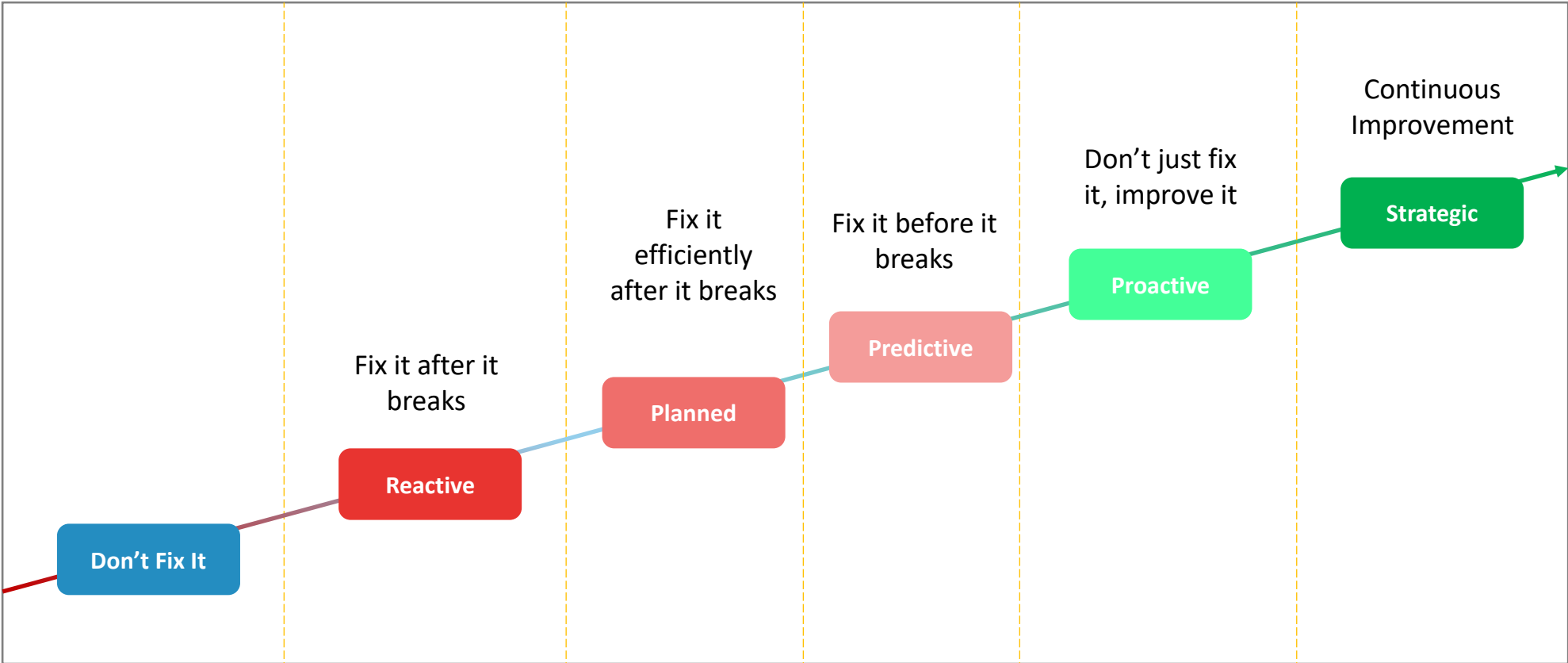
“Our team has delivered an average ROI on ISO 55000-based asset management programs well in excess of 25 percent”.

Asset management delivers the ROI through improved levels of service



Benefits of Asset Management

Performance Measures



Rewards:

Short Term Savings	Overtime Heroes	No Surprises	Quality of Life	Best in Class
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Motivator:

Meet Budget	Emergency Repairs	Avoid Failures	Functional	Growth
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Behavior:

Decaying	Responding	Org. Discipline	Org. Learning	Innovation
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Benefits of Asset Management

Documented benefits

- Economic sustainability
- Resilience to natural hazards
- Well defined costs and budgets
- Higher levels of service
- Maximization of the value of assets
- Mobilization of resources and political will to act
- Effective communication
- Environmental sustainability
- Improved credit ratings
- Government transparency
- Social equity



“Managing Infrastructure Assets for Sustainable Development”

- *United Nations*

What is Infrastructure Management?

1. Stakeholders

- Engineering
- Operations
- Management
- Information Technology
- Finance
- Human Resources
- Public Outreach
- Customer Service



What is Infrastructure Management?

3. Condition Assessment

- Structural condition
- Maintenance condition
- Remaining Useful Life



What is Infrastructure Management?

4. System Value

- Replacement value
- Life Cycle costs

\$500,000,000?

\$200,000,000?

\$1,000,000,000?

\$800,500,000?

\$250,000,000?

\$600,000,000?

\$750,000,000?

\$800,000,000?

\$3,000,000,000?

\$950,000,000?



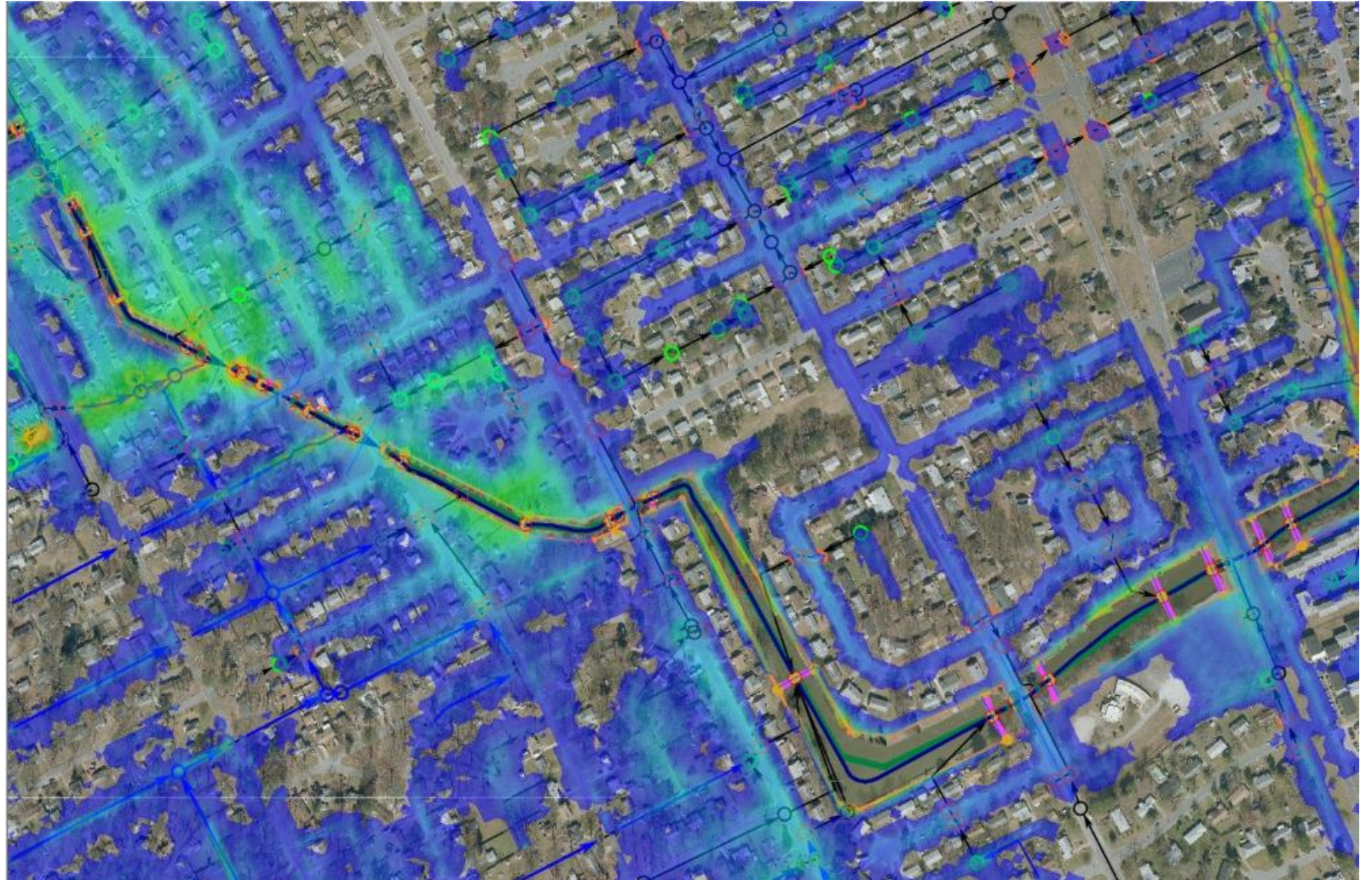
What is Infrastructure Management?

5. Level of Service Goals

Program Goals

System Goals

- Strategic / Operational
- Tactical / Maintenance



What is Infrastructure Management?

6. Failure Modes

Capacity/Level of Service

- The system cannot convey the design flows

Structural

- The system fails due to poor condition

Maintenance

- The system is filled with sediment/debris, valves are not operable

Financial

- System replacement is more cost effective than leaving in service or failure carries a very high consequence



What is Infrastructure Management?

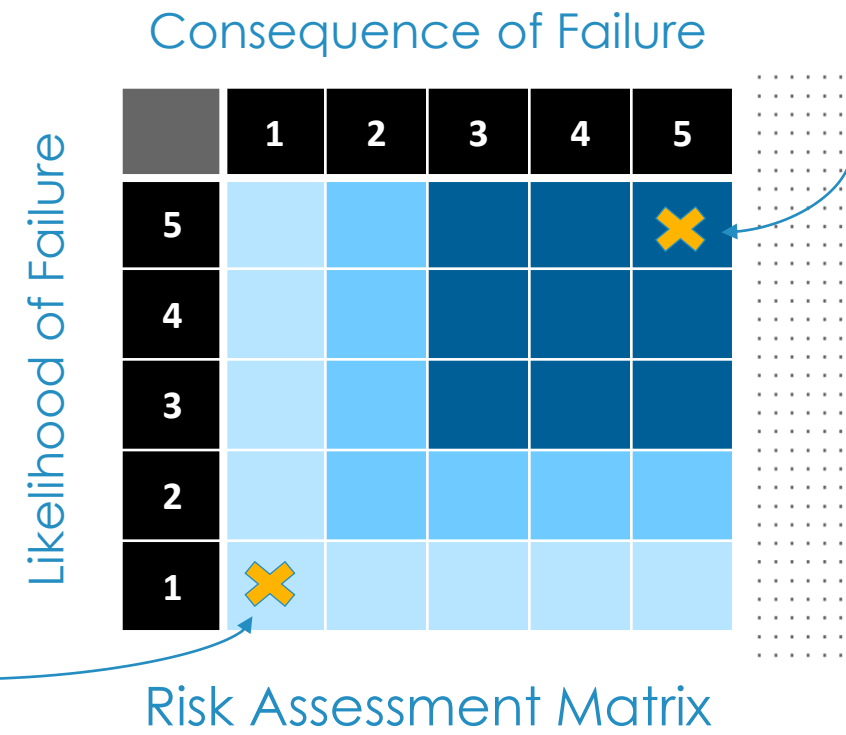
7. Risk-based decision-making

Likelihood of Failure

- Condition
- Age
- Material

Consequence of Failure

- Proximity to roads and structures
- Proximity to waterways
- Line size



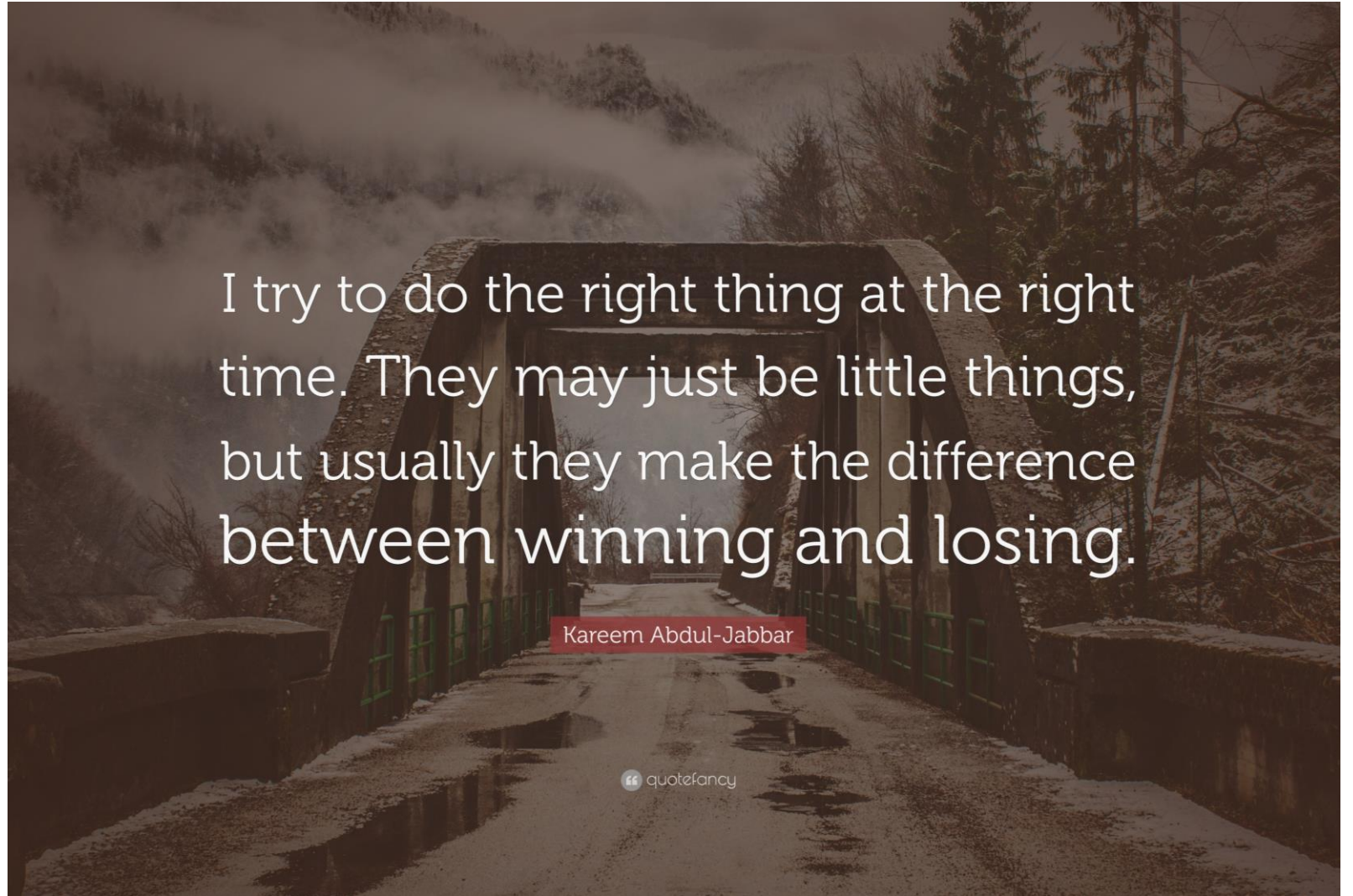
Asset in good condition with little to no impact if failure occurs

Imminent failure with a significant impact due to failure

What is Infrastructure Management?

Simply put, infrastructure management is

- Doing the right things—at the right times—for the right reasons— to the right parts of the system.
- Planned repair and replacement of infrastructure based on risk



I try to do the right thing at the right time. They may just be little things, but usually they make the difference between winning and losing.

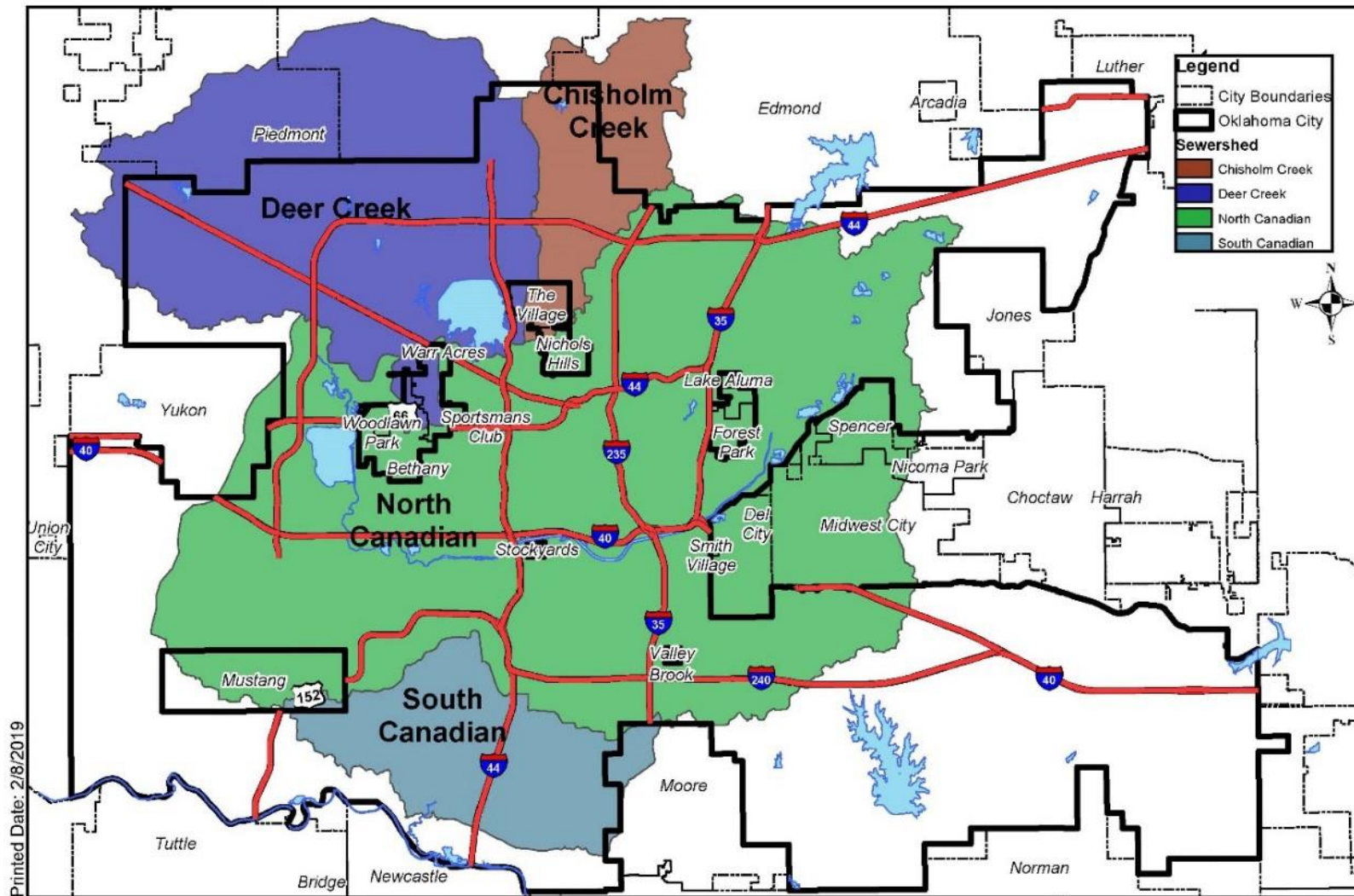
Kareem Abdul-Jabbar

quote fancy

Oklahoma City Water Utilities Trust Asset Management Program



OCWUT Sanitary Sewer System



The City of
OKLAHOMA CITY
Utilities Department

CITY OF OKLAHOMA CITY SEWERSHEDS

This utility map is for reference only. The information may not represent what actually has been constructed. OCWUT explicitly disclaims any representation of the accuracy of the information and assumes no liability for any errors, omissions, or inaccuracies in the map regardless of how caused. This utility map may not under any circumstances, be copied, reproduced or published in any form or media, or transferred to another without written permission of OCWUT.



Issues



1. OCWUT Stakeholders

Primary:

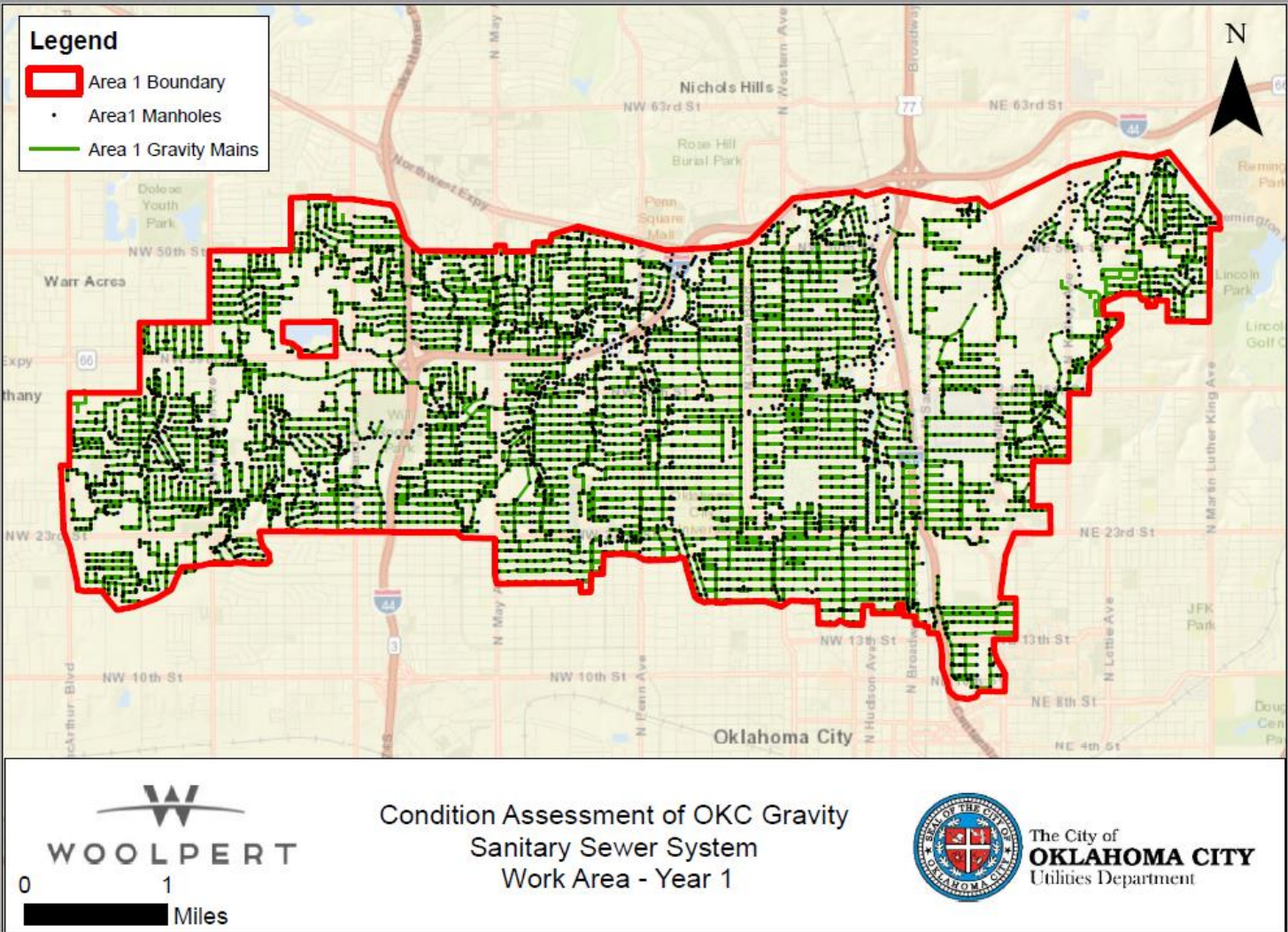
- Management
- Engineering
- Line maintenance
- Information Technology
- Public Outreach

Secondary:

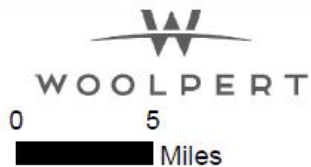
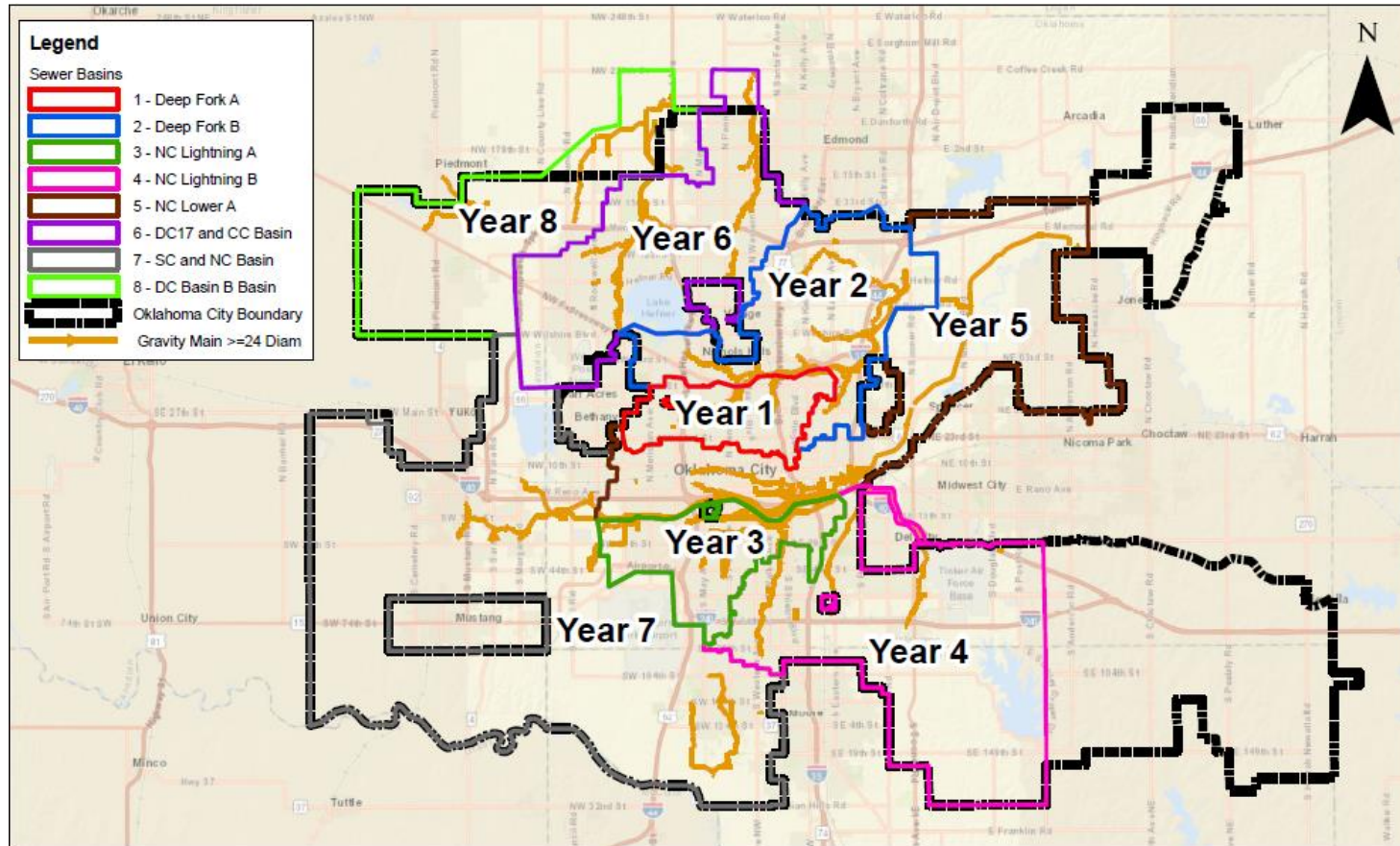
- Finance
- Customer Service
- Board of Trustees
- Customers



2. Asset Registry & 4. System Value



3. Condition Assessment



Condition Assessment of OKC Gravity
Sanitary Sewer System
Annual Work Areas



5. Level of Service Goals

Strategic System Goal	Short-term (years 1-5)	Mid-term (years 6-8)	Long-term (years 8+)
Maintain regulatory compliance	Maintain compliance with state and federal regulations	Maintain compliance with state and federal regulations and employ “Best Practices”	Maintain compliance with state and federal regulations and be recognized as an industry leader
Reduce Sanitary Sewer Overflows (SSOs)	No increase in SSOs annually over the previous 5-year period average (baseline average) or Do not exceed 8 SSOs per 100 miles of pipe	Reduce SSOs by 25% annually over the baseline average or Do not exceed 6 per 100 miles of pipe	Reduce SSOs by 50% annually over the baseline average or Do not exceed 4 per mile of pipe
Provide quick response time for service calls	Initial response to service calls within 1 hour	Initial response to service calls within 1 hour	Initial response to service calls within 1 hour
Reduce number of backups due to OCWUT assets	No increase in backups annually over the previous 5-year period average (baseline average)	Reduce backups by 25% annually over the baseline average	Reduce backups by 50% annually over the baseline average
Reduce infiltration/inflow and/or increase system capacity	No Increase over 5-year period over the previous 5-year period average (baseline average)	Reduce by 5% annually over the baseline average	Reduce by 10% annually over the baseline average

System Level of Service Goals



5. Level of Service Goals

Strategic Program Goal	Short-term (Year 1)	Mid-term (years 2-8)	Long-term (years 8+)
Inspect or assess collection system	Inspect or assess all assets within the Year 1 Area (approximately 10% of the total system)	Inspect or assess all assets within the Year 2 - 8 Areas (approximately 10% of the total system, annually)	Establish and follow inspection and assessment schedule for entire system
	Acquire and configure tools necessary to effectively analyze condition data	Refine configuration of analytical tools to effectively analyze condition data	Annually review, refine, and acquire tools necessary to effectively analyze condition data
	Establish and implement protocols for risk-based decision making	Review and revise protocols for risk-based decision-making prior to end of mid-term period	Annually review and revise protocols for risk-based decision-making
	Create Annual O&M Work Plan and CIP Report	Create and implement Annual O&M Work Plans and CIP Reports	Continue to create and implement Annual O&M Work Plans and CIP Reports
Complete identified operation and maintenance actions		Clean the most critical lines identified in the Annual O&M work plan	Evaluate Year 1 – 8 cleaning goals and achievements and establish long-term goals
		Remove roots in the most critical lines identified in the Annual O&M work plan	Evaluate Year 1 – 8 root removal goals and achievements and establish long-term goals
		Treat grease in the most critical lines identified in the Annual O&M work plan	Evaluate Year 1 – 8 grease treatment goals and achievements and establish long-term goals
		Perform point repairs on the most critical lines identified in the Annual O&M work plan	Evaluate Year 1 – 8 point repair goals and achievements and establish long-term goals
		Perform maintenance actions on the most critical manholes identified in the Annual O&M work plan	Evaluate Year 1 – 8 manhole maintenance goals and achievements and establish long-term goals
Complete identified Capital Improvement Projects		Rehabilitate the most critical lines identified in Annual CIP Report	Evaluate Year 1 – 8 line rehabilitation goals and achievements and establish long-term goals
		Replace the most critical lines identified in the Annual CIP Report	Evaluate Year 1 – 8 line replacement goals and achievements and establish long-term goals
		Rehabilitate / replace the most critical manholes identified in the Annual CIP Report	Evaluate Year 1 – 8 manhole rehabilitation/replacement goals and achievements and establish long-term goals

Program Level of Service Goals



6. Failure Modes

Projectv2 - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:3,000

InfoMaster WMS InfoMaster SFM ArcGIS Online Settings

InfoMaster Sewer, Sewer Collection Net

IM Facility Explorer

Table Of Contents

Layers

- ssGravityMain
- CCTV Analysis Results (GM_CCTV_1)
 - Defects
 - Connections
 - Continuous
- Gravity Main
- OKCLakes2015

IM Operation Center

Gravity Main "SGV0058918"

General Info Survey CC

1. ID

OBJECTID	4454
FacilityID	SGV0058918
FromStruct	SMH0053326
ToStruct	SMH0023946
LegacyID	41450000

2. Vertical Asset

Condition Assessment - Gravity Main "SGV0058918" (2 Inspections)

Survey Import GM_CCTV_1 CapPlan GM_REHAB_1

Defects Connections Continuous Draft Rehab. Final Rehab. Type Filter: CONSTRUCTION,... Score Filter: 0 1 2 3 4 5

Upstream Manhole 'SMH0023946' Downstream Manhole 'SMH0053326'

Inspections Defects Connections Continuous Draft Rehab. Final Rehab. ConditionScore

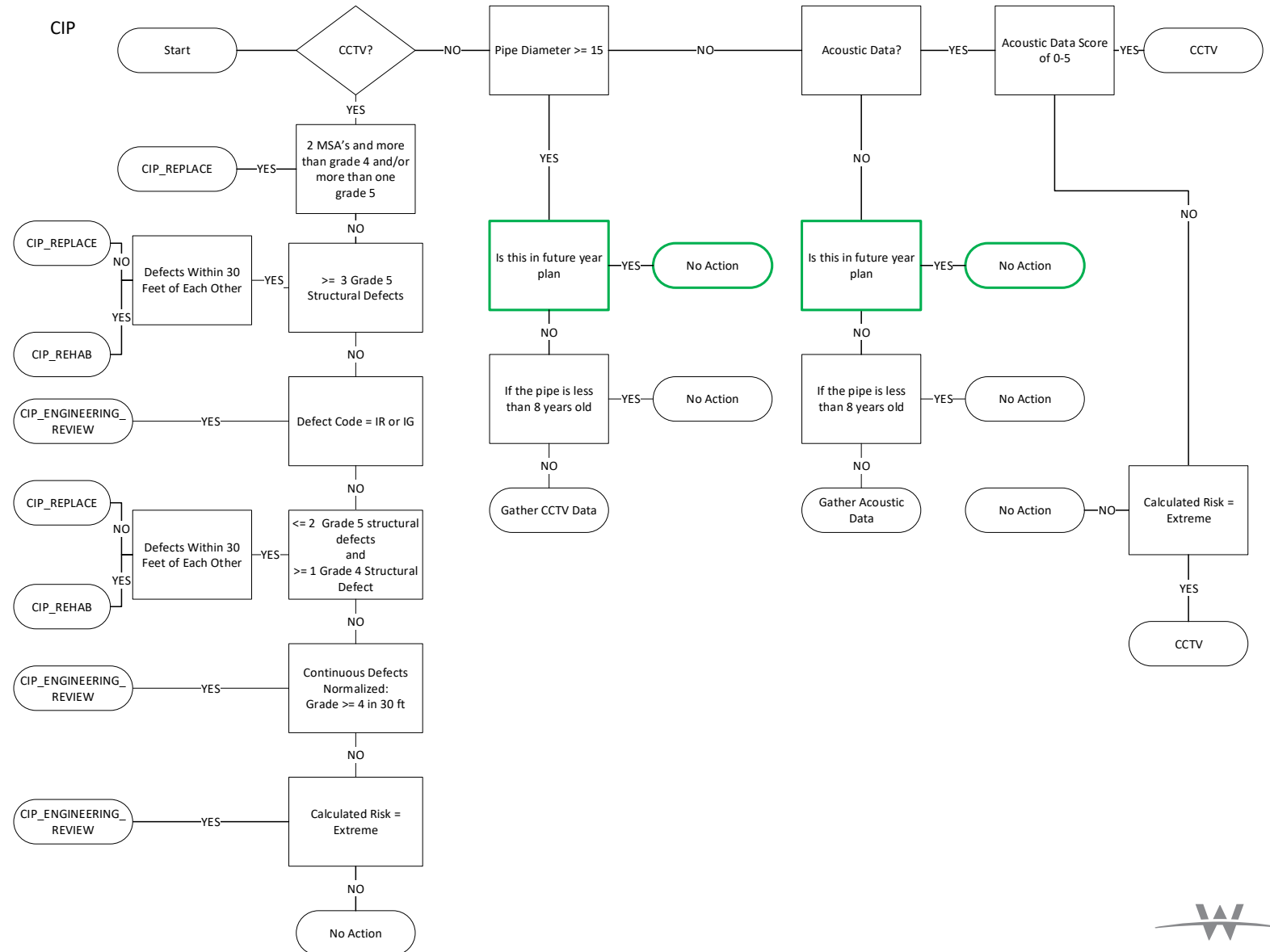
Repair_Num...	RehabMethod	Distance	Repair_End	Length	Unit_Co
1	0061	SERVICE	12	13	1
2	0062	LINING	16.9	17.9	1
3	0063	LINING	29.2	30.2	1
4	0064	CLEANING	29.3	30.3	1
5	0065	LINING	37.3	38.3	1
6	0066	POINT REP...	52.7	53.7	1
7	0067	POINT REP...	55.1	56.1	1
8	0068	LINING	56.4	57.4	1
9	0069	LINING	58.3	59.3	1
10	0070	POINT REP...	63.2	64.2	1
11	0071	POINT REP...	70.8	71.8	1
12	0072	LINING	73.4	74.4	1
13	0073	LINING	77.7	78.7	1

Inspection 28 (GM_CCTV_1) (2/1/2019)



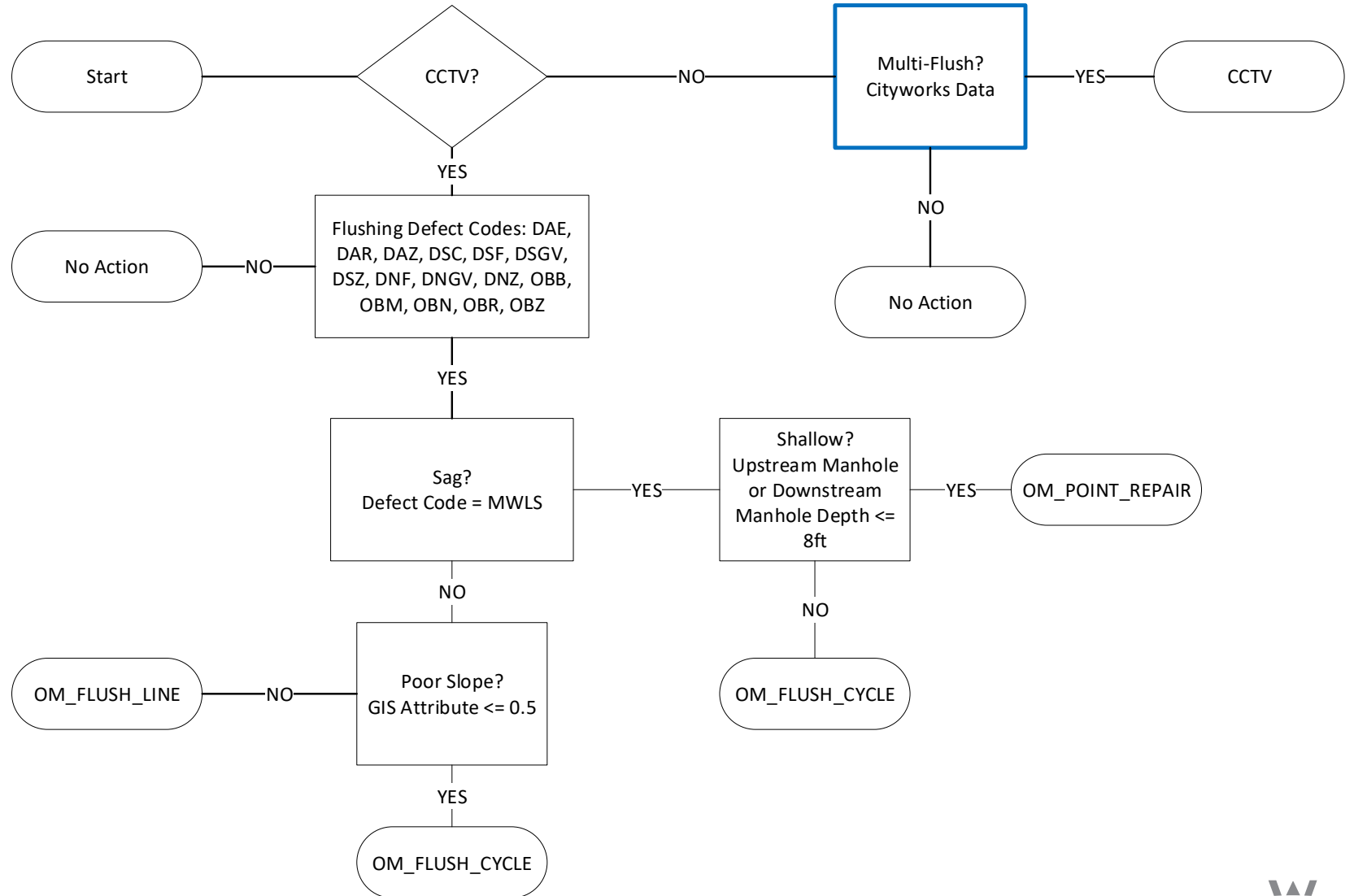
6. Failure Modes

Gravity Sewer CIP Decision Tree



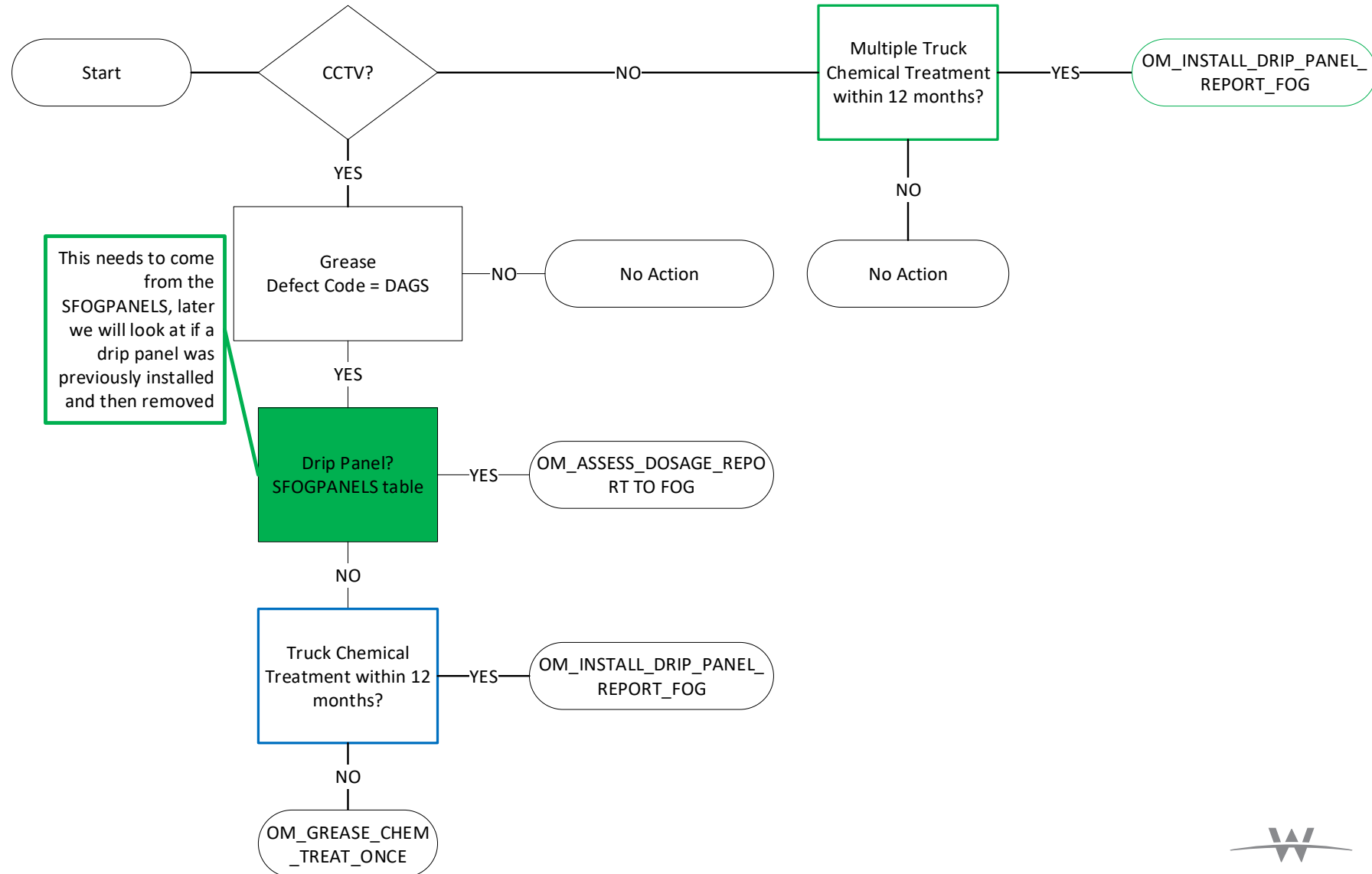
6. Failure Modes

Flushing



6. Failure Modes

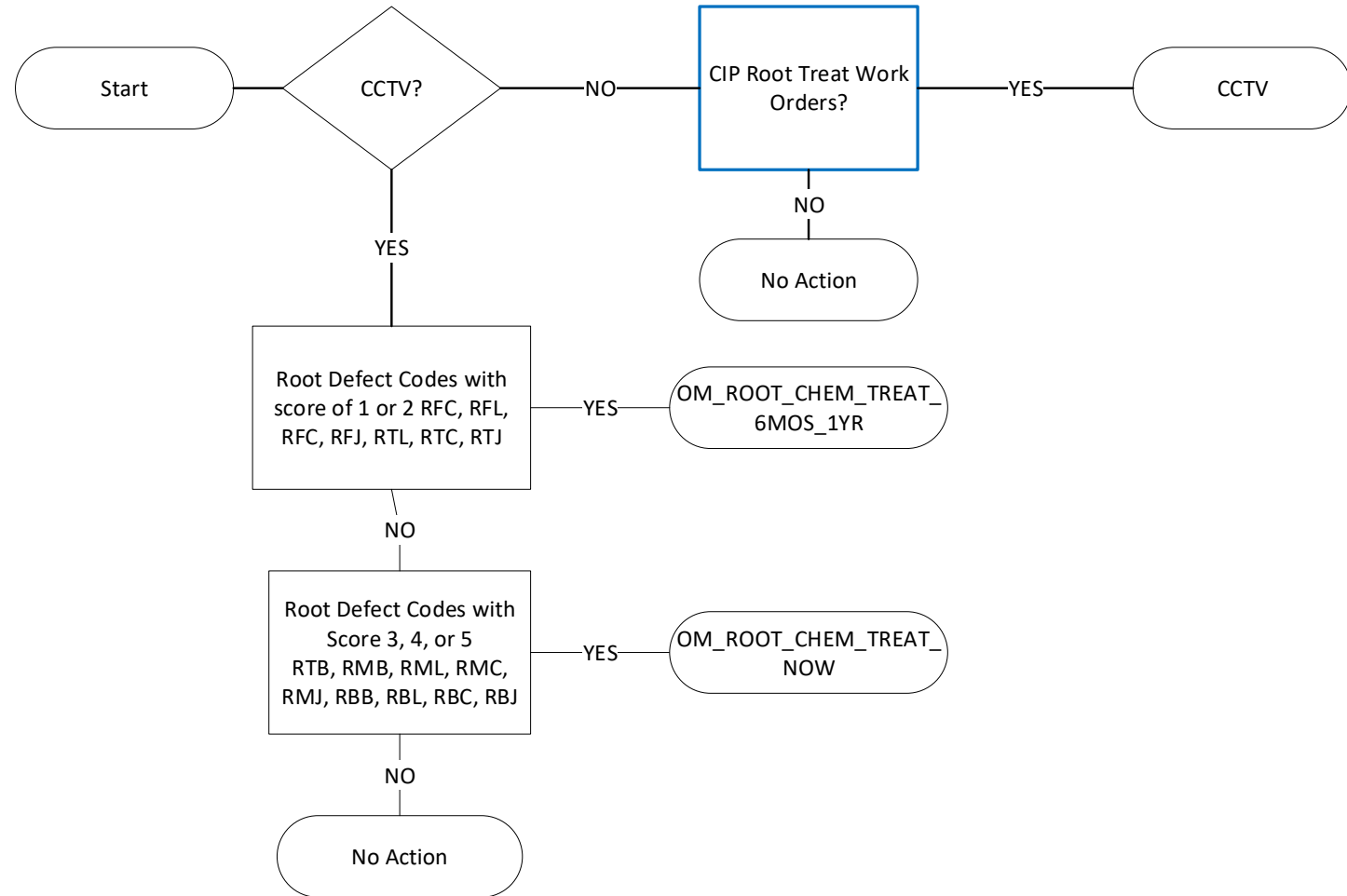
Grease



6. Failure Modes



Roots



7. Risk Based Decision Making

	LOF - Low	LOF - M. Low	LOF - Medium	LOF - M. High	LOF - High	
COF - High	Medium	High	High	Extreme	Extreme	
COF - M. High	Medium	Medium	High	High	Extreme	
COF - Medium	Low	Medium	Medium	High	High	
COF - M. Low	Low	Low	Medium	Medium	High	
COF - Low	Negligible	Low	Low	Medium	Medium	

7. Risk Based Decision Making

Gravity Sewer Likelihood of Failure Categories

Category	%	Driver
PACP Structural Score	50	Social
PACP O&M Score	15	Cost
Acoustic Inspection	15	Cost
Work Order History	10	Cost
Age	5	DEQ
Material	5	Cost
Aerial Crossing *	0	DEQ
Total	100	

* Not scored at this time



7. Risk Based Decision Making

Gravity Sewer Consequence of Failure Categories

Category	%	Driver
Prox to Lakes	15	DEQ
Prox to Buildings	13	Cost
Prox to Rivers	12	DEQ
Prox to Streetcars	10	Social
Prox to Bridges	9	Cost
Prox to Highways	9	Cost
Prox to Railroads	8	Cost
Depth of Flow	7	Cost

Category	%	Driver
Pavement Type	5	Social
Depth of Pipe	4	Cost
Prox to Parks	3	Social
Pipe Diameter	2	Cost
Prox to Section Line		
Road	1	Social
Prox to Standard		
Streets	1	Social
Zoning	1	Social
Total	100	



7. Risk Based Decision Making

**Example Map of Defect Display Within InfoMaster
Year 1 Area**

Gravity Main Defects and Connections are Mapped
Year 1 CIP Report
March 2020

0 300 600 900 Feet

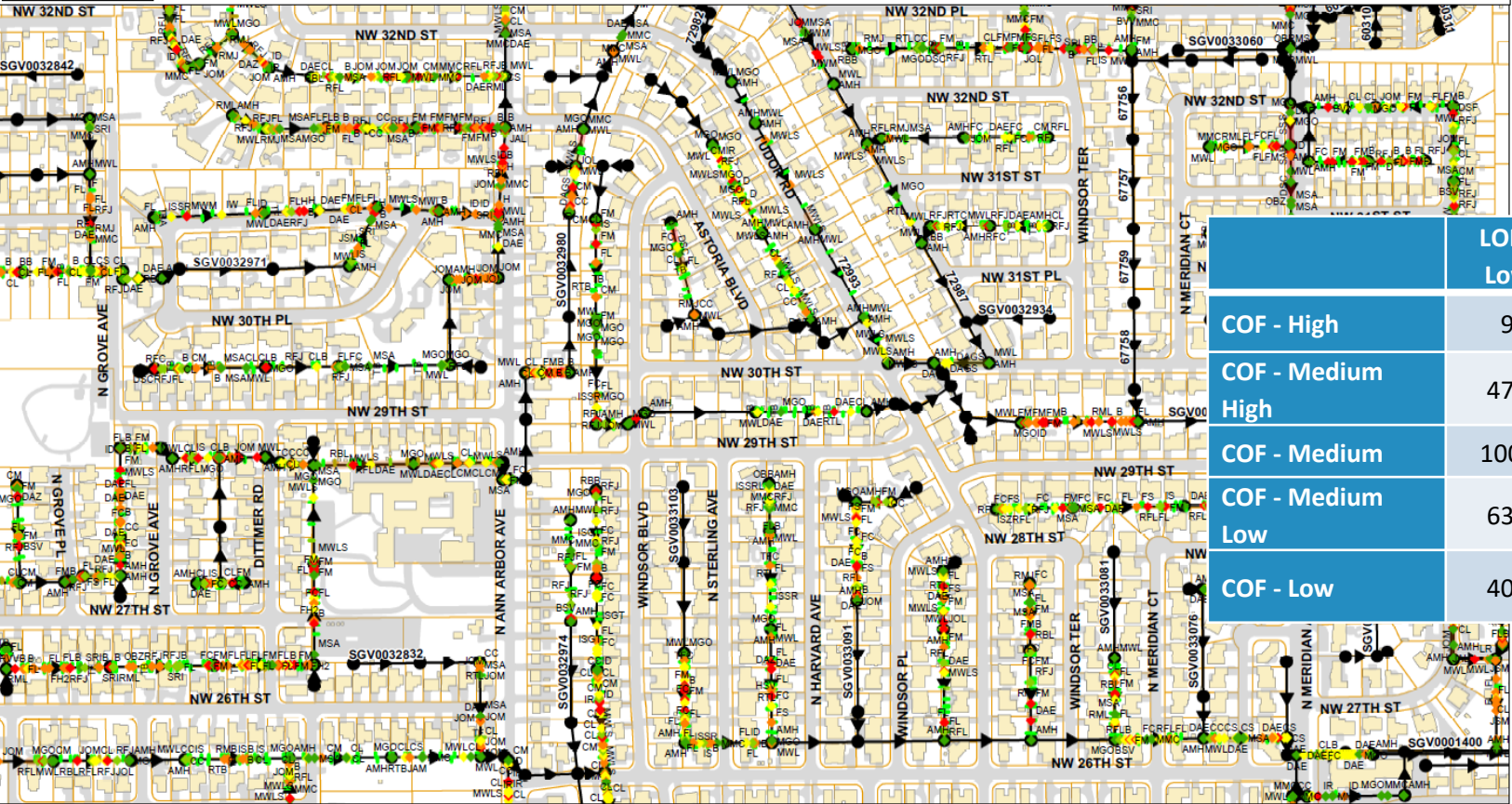


Legend

Defects → Gravity Main
Score

- 0 (Green diamond)
- 1 (Yellow diamond)
- 2 (Orange diamond)
- 3 (Red diamond)
- 4 (Dark red diamond)
- 5 (Red diamond)

● Manhole

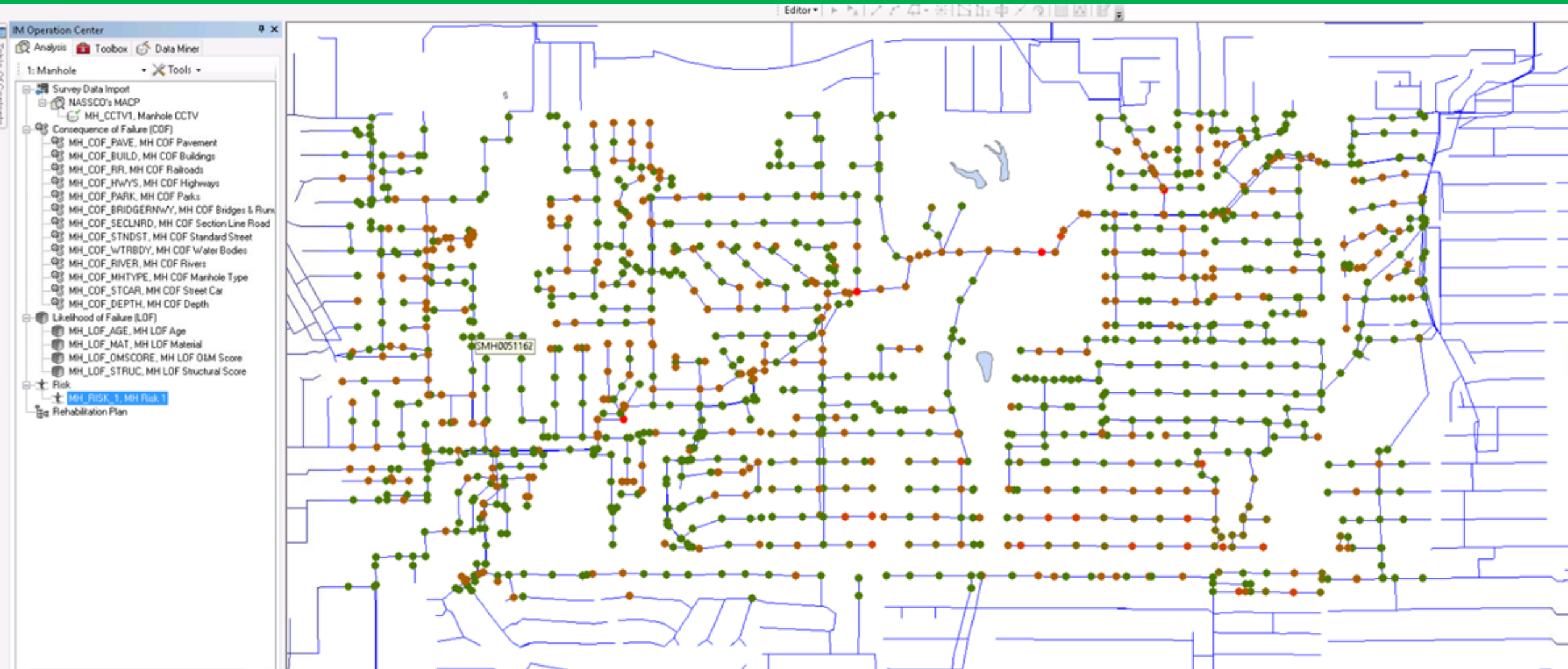


**Number of Gravity Mains
within Each Risk Combination**

	LOF - Low	LOF - Medium Low	LOF - Medium High	LOF - High
COF - High	9	12	5	4
COF - Medium High	472	630	221	109
COF - Medium Low	1002	1257	312	155
COF - Low	635	704	247	102
COF - Low	409	420	100	35



7. Risk Based Decision Making



Manhole Risk Map



7. Risk Based Decision Making

Summary of O&M Recommendations

O&M Recommendation ¹		Count of Assets	Sum of Length (LF)
Pipe Activities	Flushing-Related	1,151	299,755
	FOG-Related	428	107,055
	Root-Related	1,466	390,619
	Additional Inspection	1,529	325,724
	No O&M Action	3,241	636,346
Manhole Activities	Manhole Cleaning-Related	415	---
	Install I&I Preventer	1,456	---
	Additional Inspection	1,541	---
	No O&M Action	4,009	---

Note 1: Some assets have recommendations for multiple types of O&M activities.



OCWUT Benefits

Long Term	Lower overall lifecycle cost of the sewer gravity system
Mid Term	Reduction in the number of service disruptions and ad hoc infrastructure failures
Mid Term	Reduction of sanitary sewer overflows
Long Term	Increased available capacity from existing infrastructure
Short Term	Finding “unanticipated” issues (cross connections, sink holes, etc.)



OCWUT Lessons Learned

Needed O&M is probably more than you expect – think dollars

- More routine maintenance than anticipated
- Value in routine cleaning

Don't put your head in the sand – include all items in plan

- Educate leaders early on
- Be aware of “sticker shock”

Don't over complicate on your first run with decision trees

- Keep them accurate, but simple
- Refine as you go

Resources are still a challenge

- The move from reactive to proactive maintenance requires time and resources
- May need to outsource catch up work



Father Guido Sarducci's Five Minute College

1. **Protect** your investment
2. There is a better way
3. It may be complex, but it isn't complicated
4. There are ways to control implementation costs
5. There is a return on your investment with every step



Thank you!



WOOLPERT

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Contact Information

Hal Clarkson, PE, CFM, IAM

803.214.5881

hal.clarkson@woolpert.com

Mark Tomczyk, PE

305.351.2948

mark.tomczyk@woolpert.com