Asset Management Approaches to Maximize Effectiveness of Your Stormwater Program

Presenters:
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Agenda

- Typical Stormwater Asset Work
- Need for Stormwater Asset Management
- Risk-Based Linear Asset Work
- Stormwater Risk-Based Asset Management
- Case Studies
- Questions?

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SW Asset Work: Regulatory/Data Driven

- MS4 Permitting
  - Collection system/outfall
  - Water quality focused

- Data/GIS
  - Stormwater infrastructure
  - O&M focused

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SW Asset Management: Why Is It Needed?

- Regulatory
- System Knowledge
- Fiscal
- **Health & Safety**

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Overriding Issue: Flood Control

NOAA estimates an average of $8.2 Billion in damages from flooding each year in the U.S.

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Move to A More Holistic Review

- Water Quality
- Asset Inventory
- Holistic Focus

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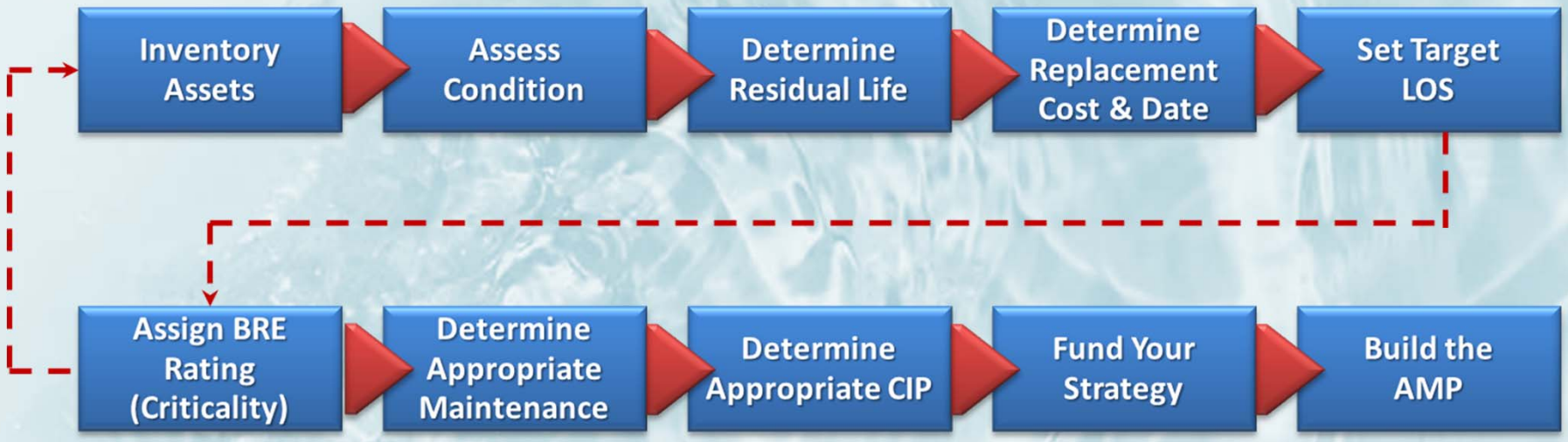
USEPA's 10 Step Asset Management Process



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Risk-Based Asset Management Process for Linear Assets based on EPA 10 Step Process

Water and sewer line assessment is well ahead of stormwater

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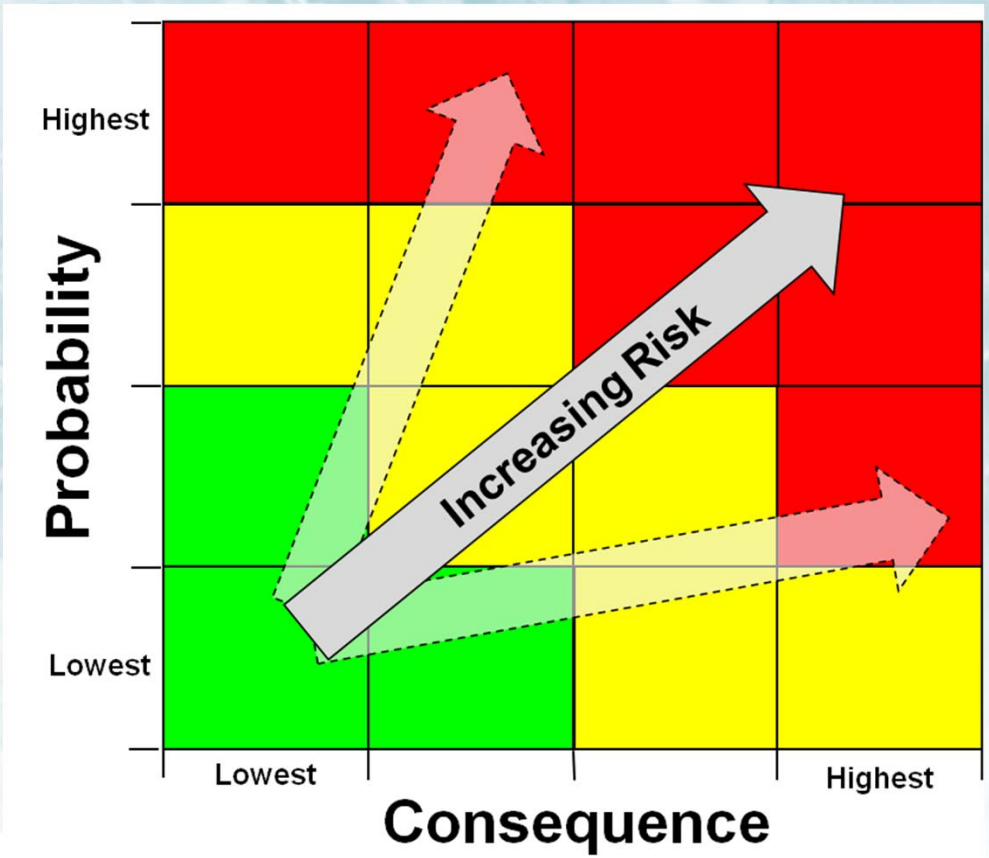
Key Focus of Asset Management Process is Risk Based Evaluations

- Risk Is a Simple Equation: Probability * Consequence



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Probability of Failure: Evaluate By Condition Assessment (desktop, visual or testing)

Condition Type	Failure Mode	Description	Assessment Method
Performance	Capacity	Does not meet demand (flow, loading, storage volume, etc.)	Test or Desktop
	Level of Service	Does not meet functional needs (regulatory permits, customer commitments)	Desktop
	Efficiency	Not lowest cost alternative (labor, maintenance, obsolescence)	Desktop
Physical	Mortality	Current state of repair and operation as influenced by age, historical maintenance and operating environment	Test, Visual, Desktop, Modeling

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Condition Assessment by Asset Type

- Define Condition Scoring Criteria for Physical and Performance
  - Pipe/Culvert/Outfall
    - Structural, Erosion, Trash, Sedimentation, Odor, Algae, Etc…

Pipes / Culverts / Outfalls	**1**	**2**	**3**	**4**	**5**
Structural (PACP)	None *(no/minor defects, failure is unlikely)*	Slight *(minor defects, pipe is unlikely to fail for 20+ years)*	Moderate *(has moderate defects and will likely fail in the next 10 - 20 years)*	Severe *(has severe defects and will likely fail in the next 5 - 10 years)*	Failure *(has failed or will likely fail in the next few years)*
Erosion	None *(No erosion near barrel observed)*	Slight *(Slight erosion near barrel, no imminent concern on condition of barrel)*	Moderate *(noticeable erosion near barrel that could lead to future collapse or pipe failure)*	Severe *(severe erosion/undercutting around barrel, collapse or failure could oocur)*	Failure
Trash	None *(No trash or debris present)*	Slight *(Limited trash and/or debris present)*	Moderate *(Trash and/or debris present, but will not cause flooding or inhibit O&M or emergency operations)*	Severe *(Trash and/or debris present that will likely cause flooding or inhibit O&M or emergency operations)*	Failure
Sedimentation	None *(No sedimentation present)*	Slight *(Limited sedimentation)*	Moderate *(Sedimentation present, but will not cause flooding or inhibit O&M or emergency operations)*	Severe *(Sedimentatoin present that will likely cause flooding or inhibit O&M or emergency operations)*	Failure

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Physical Condition Examples

Condition Score 1

Condition Score 5

Performance Examples

- Capacity
- Regulatory
- O&M/Availability
- Obsolescence

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Consequence of Asset Failure Evaluated by Triple Bottom Line (TBL) Analysis (desktop or GIS)

Triple Bottom Line

Sustainability

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Risk Supports Optimization of Capital Improvement Programs

Probability of Failure x **Consequence of Failure** = **Risk Score**

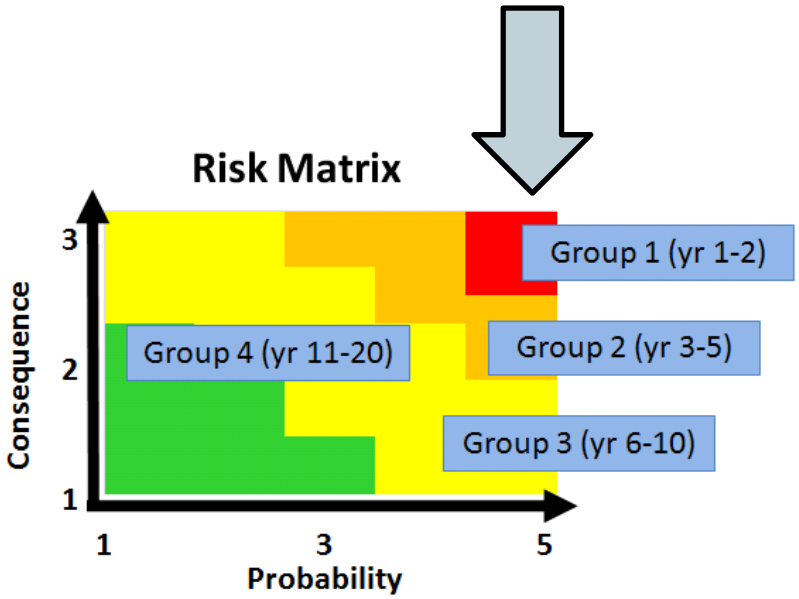
Failure Mode

- Mortality
- Level of Service
- Capacity
- Efficiency

Consequence

- Economic
- Social / Safety
- Environmental

TBL:Triple Bottom Line



"Right projects at the right time"

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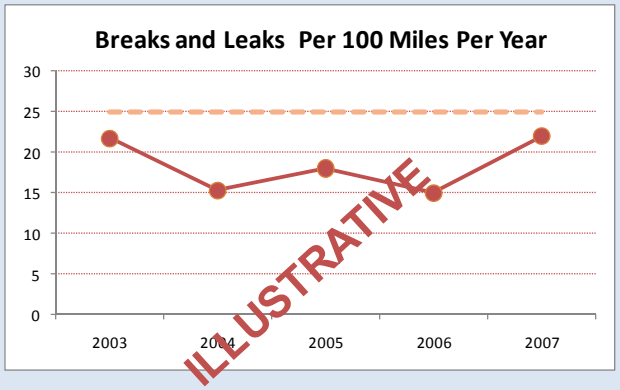
Service Levels Drive Needs and Also Build Transparency and Stakeholder Relationships

SL Category	Wastewater
Reliability	•sewer blockages / collapses •overflows •backups
Quality	•odor, water, and trash complaints
Customer Service	•event response •call center performance
Regulatory	•discharge permit compliance •water quality compliance



Current Performance Trends and Issues

- Stable performance driven by rehabilitation and renewal program of 100 miles per year.
- Continued focus on oldest cast iron pipe and worst served areas.
- 2007 performance impacted by spike of 75 third party damage incidents during downtown light rail construction .

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Sample Service Level and Supporting Maintenance Performance Measures

Strategic Plan Elements		LOS Category and Measures
1	Ensure system and asset reliability and minimize interruptions	**Stormwater Collection** • LOS X1 Collapses / Blockages Per 100 Miles • LOS X2 Property Flooding • LOS X3 Discharge Compliance • LOS X4 Event Response Time
2	Provide high quality service and effective response	

Key Performance Indicators

Operations and Maintenance

- Number of feet of sewer line cleaned
- Number of times assets were inspected
- Ratio of PM/CM work orders
- Work order completion ratio

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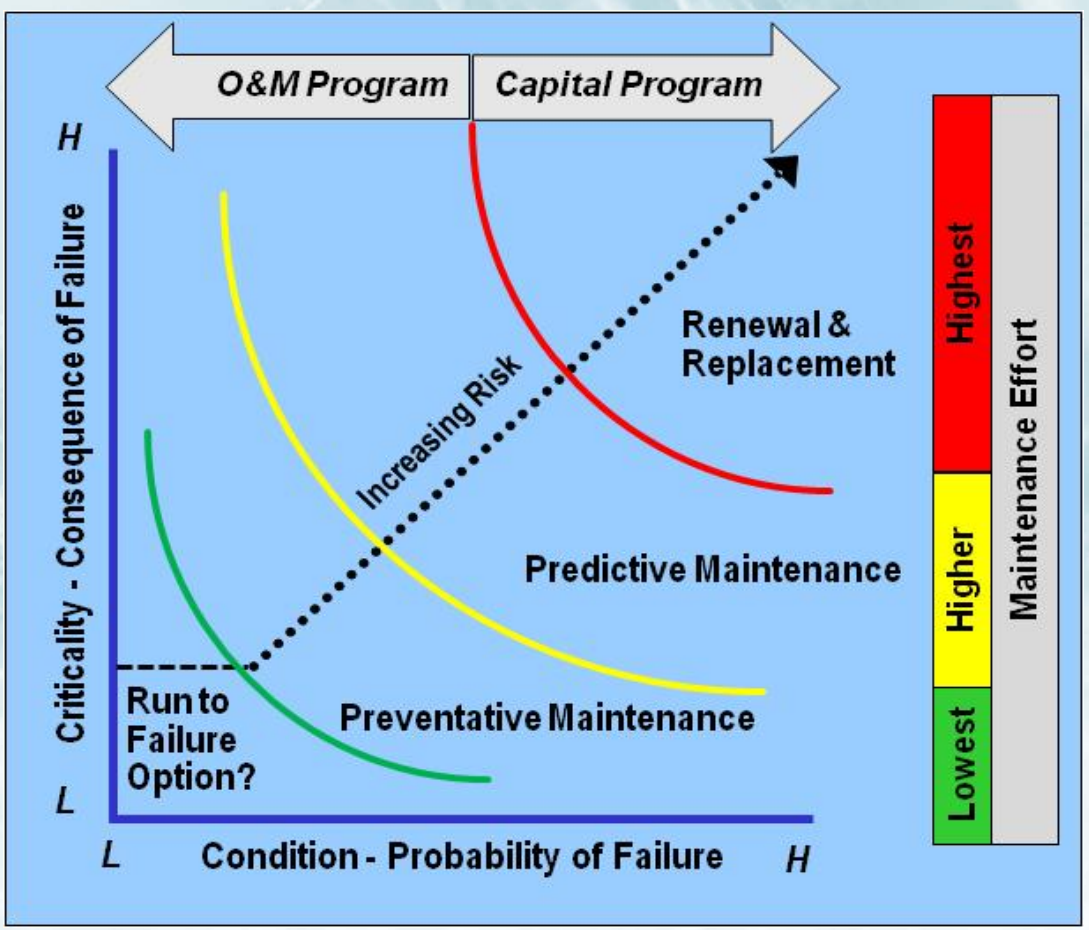
Risk Assessment Can Support Capital and Maintenance Funding Decisions



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Short and Long Term Financial Needs Developed and Compared to Current Rates

- Risk Driven and Optimized
- Cost (Replacement, Rehabilitation, and Maintenance)

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Business Case Analysis Supports Project Prioritization

- Determine which projects or project alternatives have the highest net financial benefit to the utility
- Considers the most important and measurable project costs and benefits including financial, social, and environmental
- Considers Risk for existing assets and Risk of not acting

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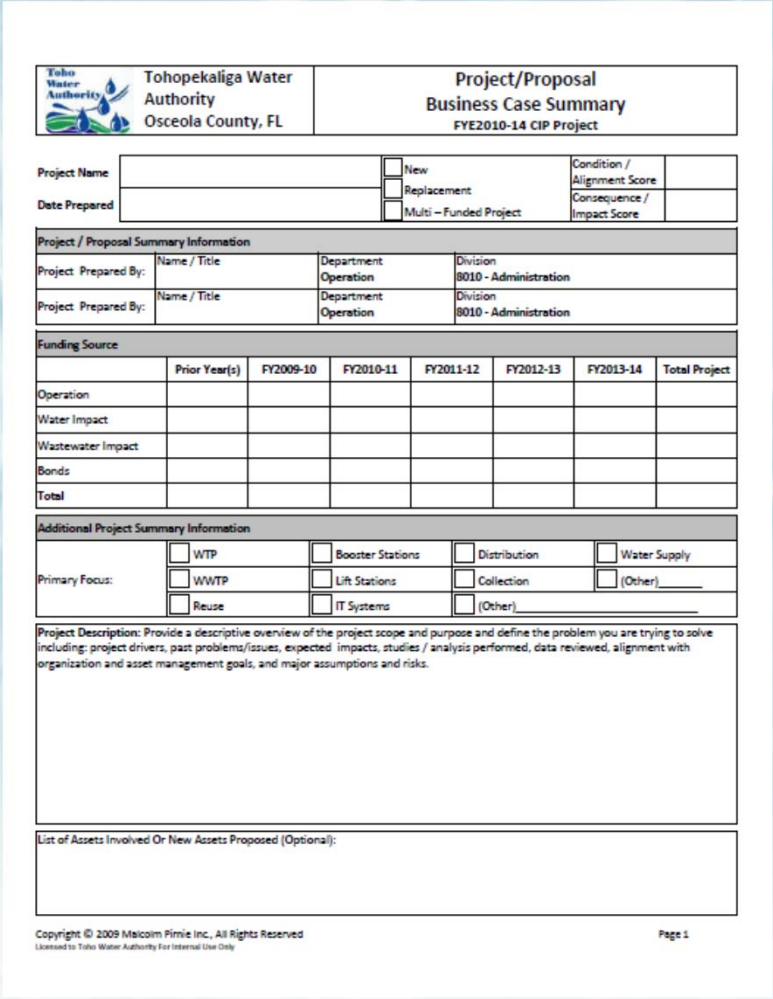
Business Case Templates Collect Information to Score/Prioritize Projects

Full Business Case Includes:

1. Funding Sources
2. Project Summary and Description
3. Strategic Plan Alignment
4. Service Level Impacts
5. Project Alternatives Evaluated
6. Condition, Consequence of Failure and Risk Analysis
7. Project Cost Estimates
8. Project Priority Scoring



Tohopekaliga Water Authority
Osceola County, FL

Project/Proposal Business Case Summary
FYE2010-14 CIP Project

Project Name		☐ New		Condition / Alignment Score	
Date Prepared		☐ Replacement		Consequence / Impact Score	
		☐ Multi – Funded Project			

Project / Proposal Summary Information

Project Prepared By:	Name / Title	Department: Operation	Division: 8010 - Administration
Project Prepared By:	Name / Title	Department: Operation	Division: 8010 - Administration

Funding Source

	Prior Year(s)	FY2009-10	FY2010-11	FY2011-12	FY2012-13	FY2013-14	Total Project
Operation							
Water Impact							
Wastewater Impact							
Bonds							
Total							

Additional Project Summary Information

Primary Focus:	☐ WTP	☐ Booster Stations	☐ Distribution	☐ Water Supply
	☐ WWTP	☐ Lift Stations	☐ Collection	☐ (Other)_____
	☐ Reuse	☐ IT Systems	☐ (Other)_____	

Project Description: Provide a descriptive overview of the project scope and purpose and define the problem you are trying to solve including: project drivers, past problems/issues, expected impacts, studies / analysis performed, data reviewed, alignment with organization and asset management goals, and major assumptions and risks.

List of Assets Involved Or New Assets Proposed (Optional):

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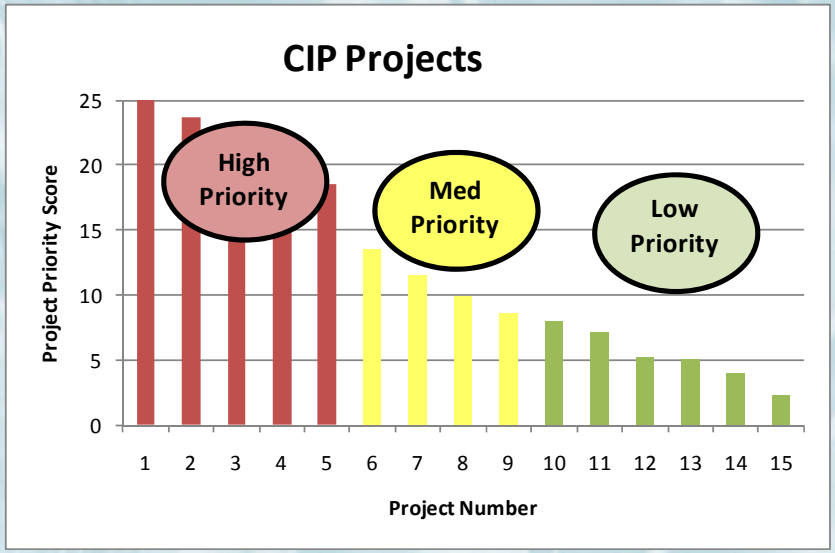
Common Set of 10 Criteria Established to Prioritize All Projects Based on Risk and TBL

1. Asset Physical Condition
2. Asset Performance Condition
3. Strategic Alignment
4. Financial Returns
5. Economic / Financial Considerations
6. Public Image Impacts
7. Service Level/Reliability Impacts
8. Public/Employee Safety Impacts
9. Environmental Impacts
10. Efficiency/Energy Impacts



Criteria are weighted to calculate an overall score

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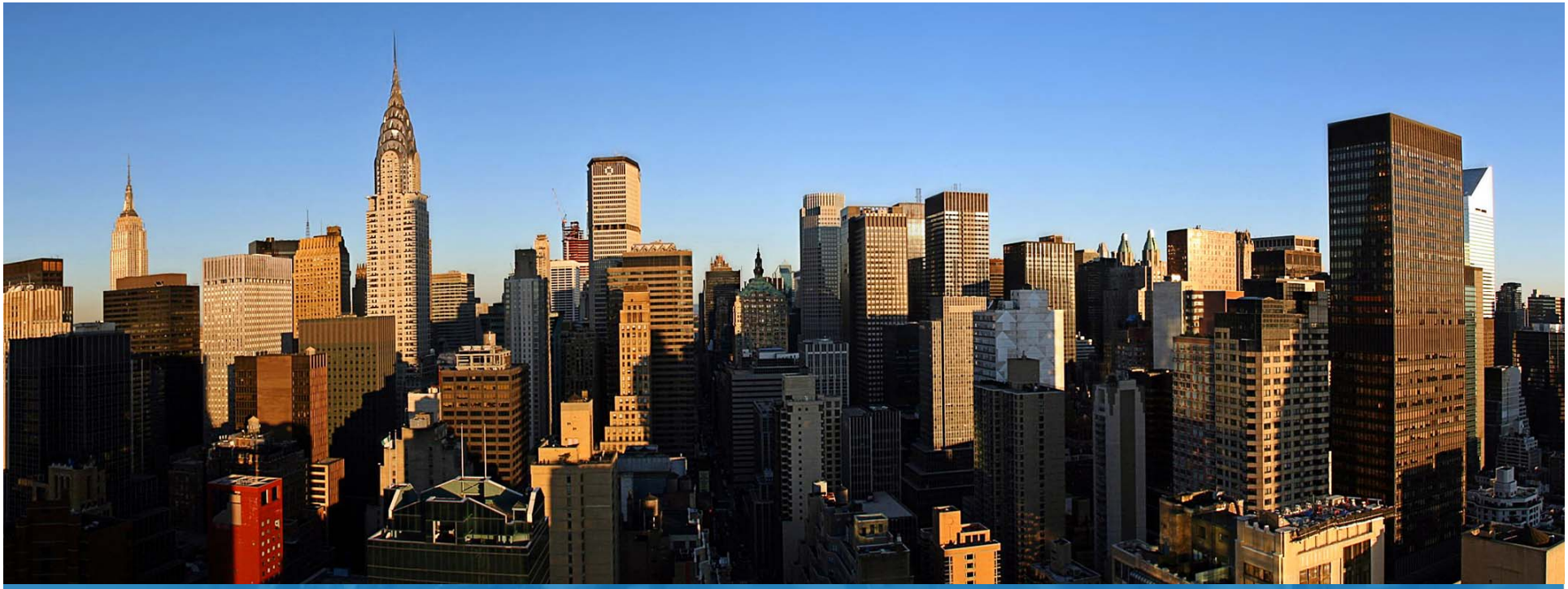
Questions?



New York DEP

Buried Infrastructure Asset Management Program

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NYCDEP Pipeline Funding Needs Assessment: Scope and Objectives

- Evaluate useful life and condition for water, sewer (combined) gravity mains, and stormwater mains using existing information.
- Utilize and configure the KANEW Predictive Model to forecast the 50 year renewal and replacement needs.
- Create guide documents and tools for NYCDEP for the overall process

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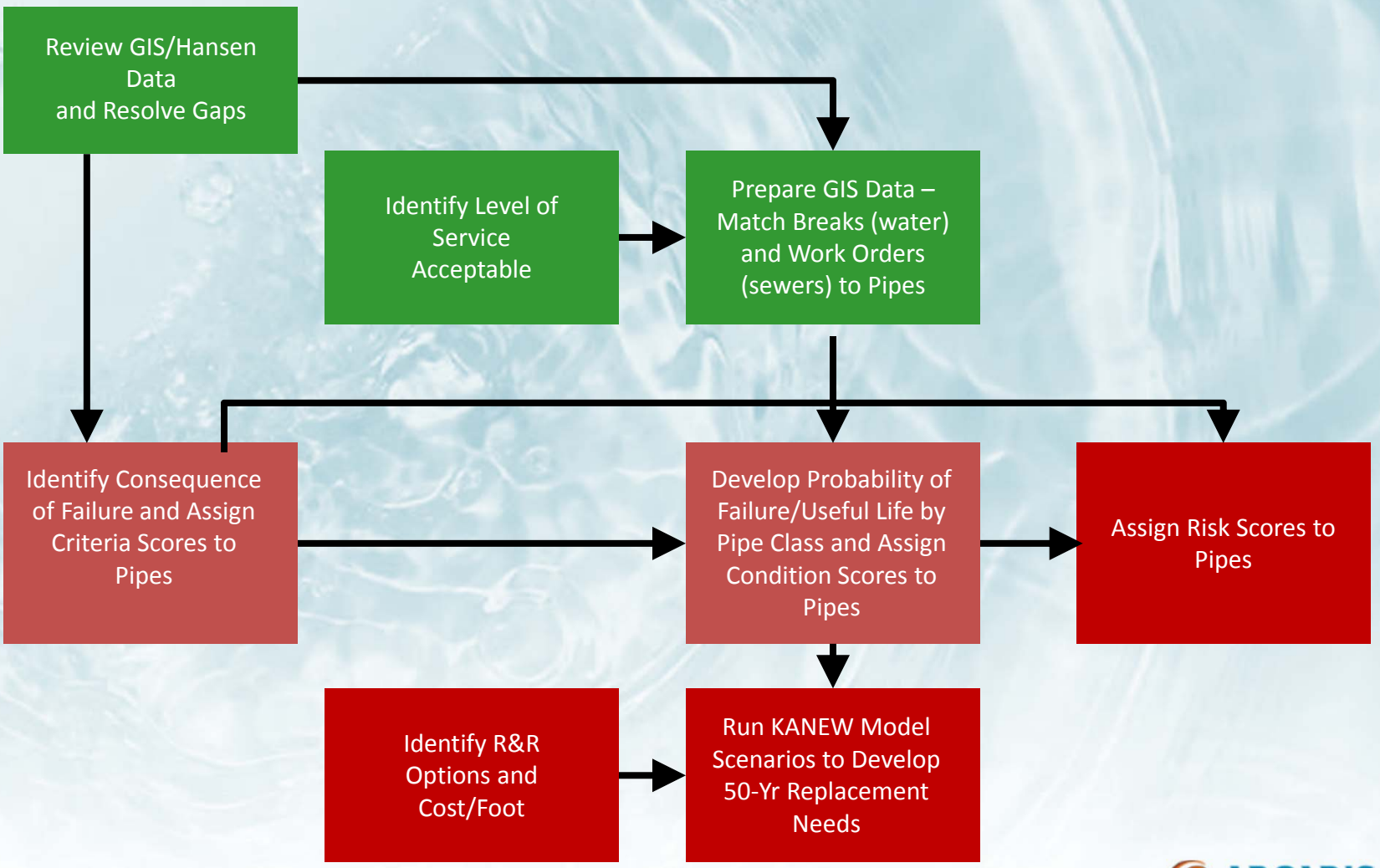
Overall Project Process



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Methodology for *Consequence of Failure*

Modified WRc Criteria Used Analysis Performed in GIS

Convert A,B,C to 3, 2, 1 for risk scoring purposes

Class A (3)

- Consequence of failure very high
- At least two times as expensive as rehab
- Social costs and potential health hazards

Class B (2)

- Less critical
- Preemptive action still desirable

Class C (1)

- Not necessarily cost effective to avoid collapse

COF Ranking	Typical Pipe Percentages
3=Highest	10 – 15%
2=Moderate	15-20%
1=Lowest	65 – 75%

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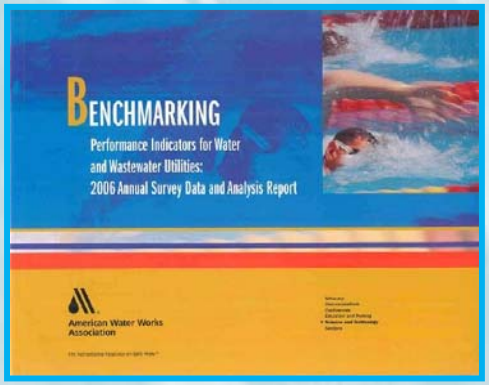
Establishing Service Levels to Define End of Pipe Life

Utility	Service Level (SL)	SL Measure	AWWA Study - Large Utilities
Water	Reliability (Break Rate)	Breaks / 100 miles / year	Top Q =16 Median = 33 Bottom Q = 68
Sanitary	Efficiency (Work Order Rate)	WOs / 100 miles / year	N/A Internal Comparison
Stormwater	Efficiency (Work Order Rate)	WOs / 100 miles / year	N/A Internal Comparison



- Levels can be established or different COF values

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Assigning Combined Stormwater Main Condition Score Example

- Condition Score 1 (very good) to 5 (very poor)
- Consistent with PACP scoring scale
- Scores assigned based on performance versus current system average service level.

Condition Criteria	Metric: Service Level	Current WO level				
		1	2	3	4	5
Current WO Efficiency Rate	Work Orders /100 mi / yr	< 1.6	1.7 to 2.24	2.25 to 3.2	3.3 to 4.16	> 4.16

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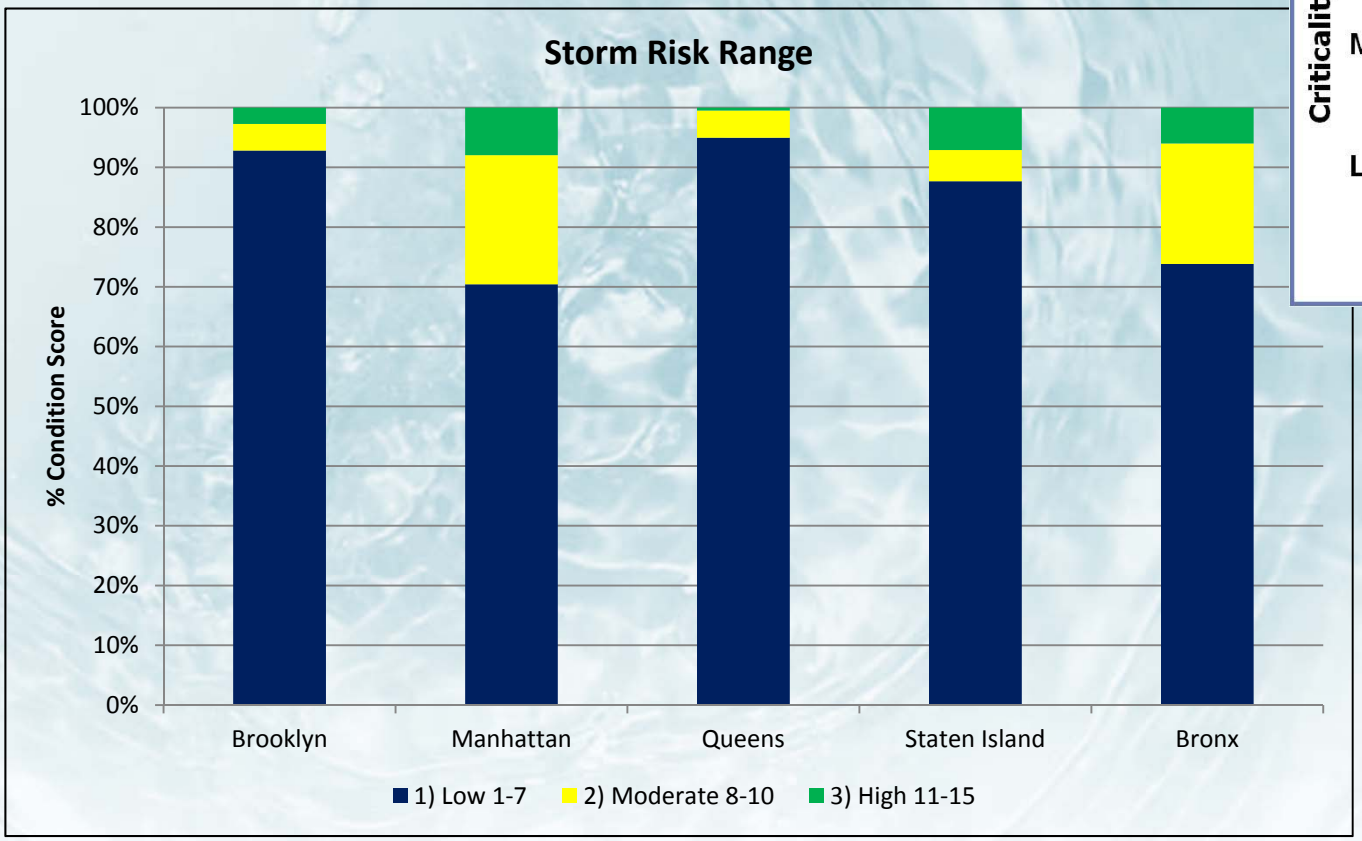
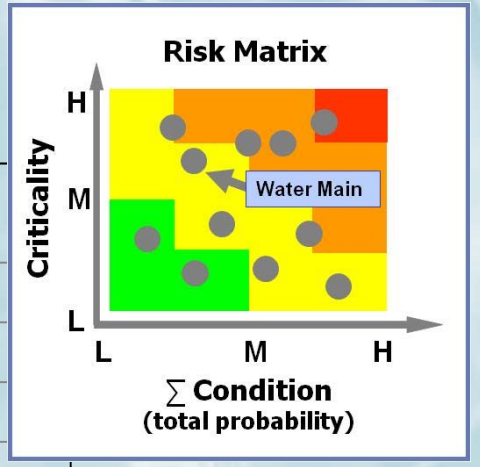
Sample Risk Results





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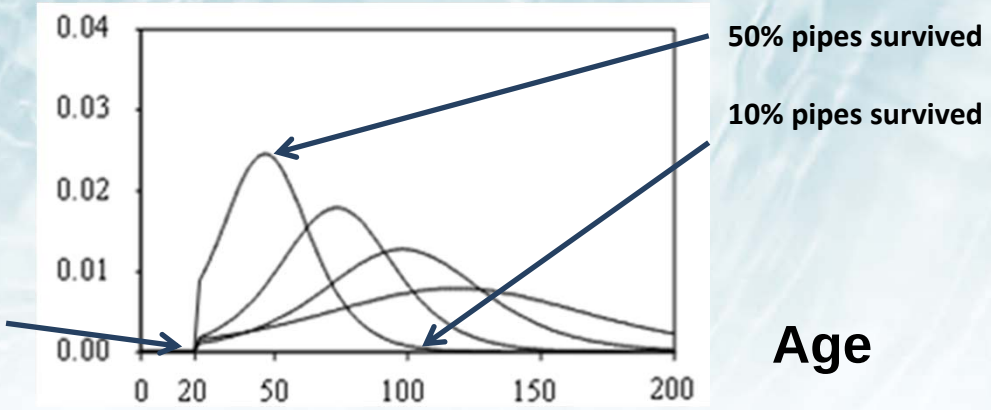
How does KANEW Modeling Work?

- Define EUL for each pipe group
- Probabilistic ageing model embedded in the KANEW software
- Spreads mains life over time based A certain %will reach it earlier; a certain after, following a probability distribution similar to the familiar normal distribution; with adjustments.

% of L of cohort



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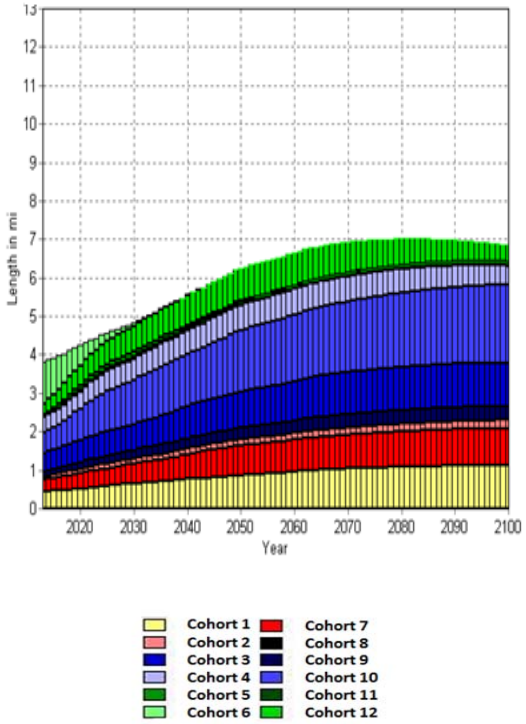
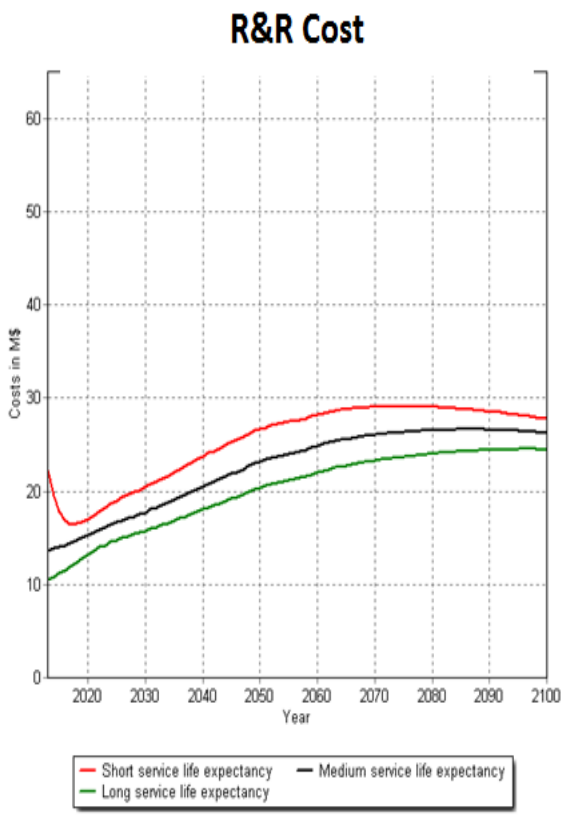
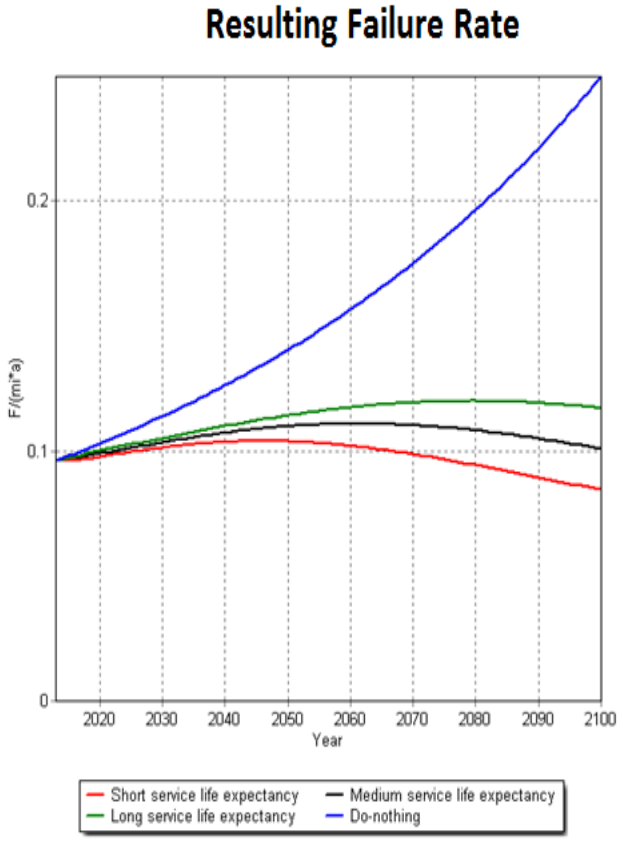
KANEW Output Example: Needs, Costs and Failure Rates for Stormwater Pipes







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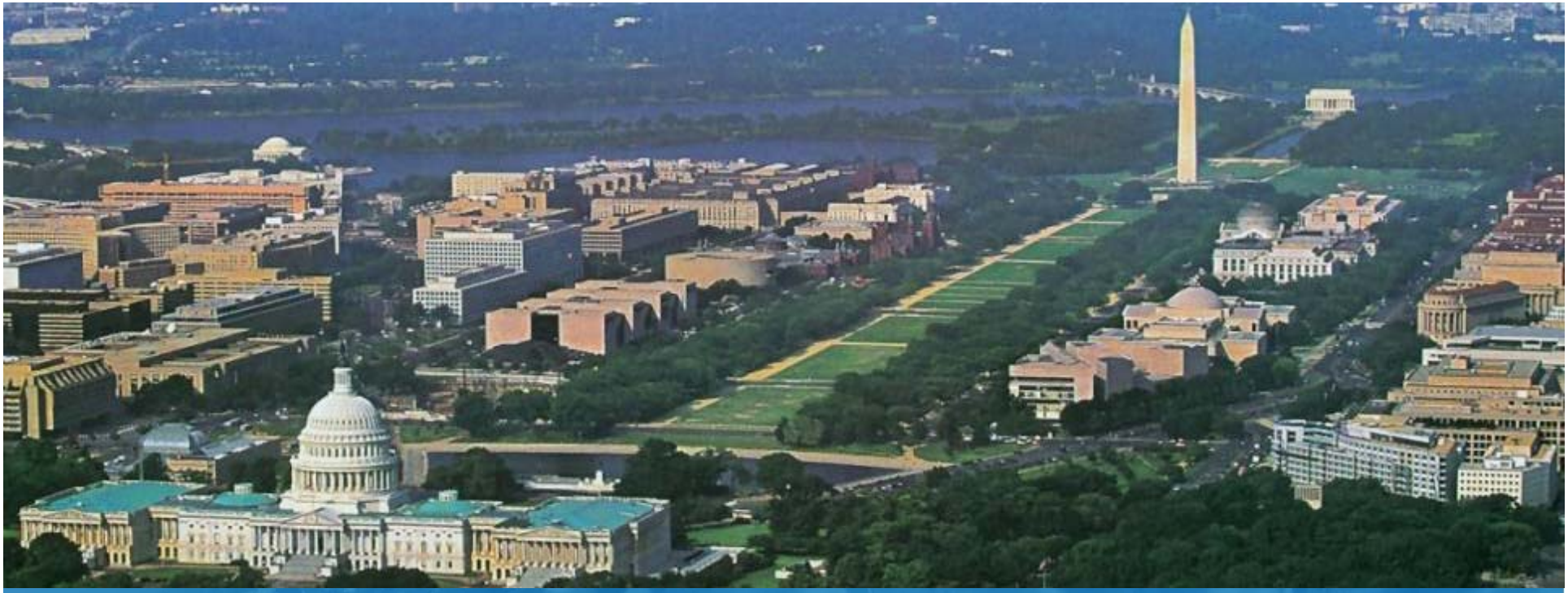

DC Water

MS4 Outfall Inventory Program

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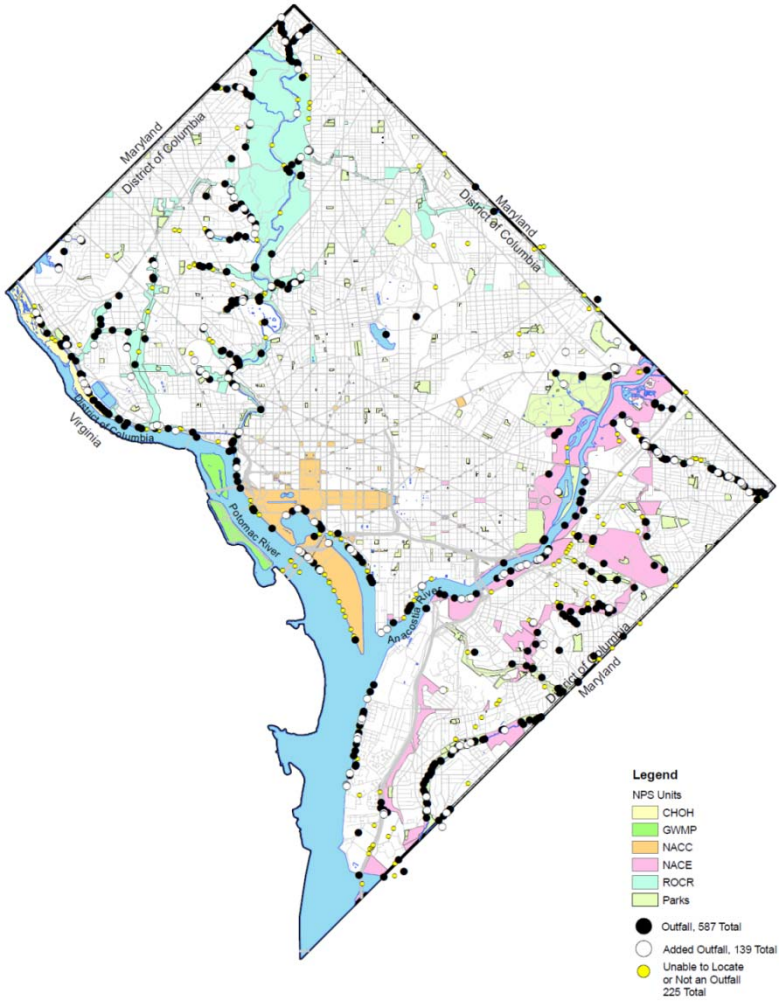
MS4 Outfall Program Goals

- Develop and implement an Outfall Repair Schedule to ensure all outfalls are in good repair by 2022
- Total MS4 Outfalls = 587



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Field Data Collection

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Condition Assessment Criteria

Condition Assessment:			
Pipe: ☐ Good/Stable ☐ Clogged: Debris/Sediment/Plants ☐ Cracked ☐ Open Joints ☐ Broken ☐ Submerged: Partial / Fully ☐ Separated Joints ☐ Collapsed ☐ Other:	**Headwall:** ☐ Good/Stable ☐ Deteriorated ☐ Separated from Pipe ☐ Collapsed ☐ Erosion Behind Headwall ☐ Other:	**Discharge Pool:** ☐ None ☐ Natural Stream ☐ Energy Dissipation (rip-rap or other) ☐ Hardened (concrete or other) ☐ Other:	**Pool Water** ☐ N/A ☐ Clear/Good **Quality**: ☐ Oils ☐ Foam/Suds ☐ Illicit Discharge ☐ Sewage ☐ Turbid (Cloudy): ☐ Color: Red/Brown/Orange/Green/Gray ☐ Odor: Gas / Sewage / H_2S / Rancid ☐ Trash: Light / Medium / Heavy ☐ Other:
Defect Severity Rating:			
Pipe: ☐ Like New/Good ☐ Moderate ☐ Bad ☐ Failed/Near Fail ☐ Other:	**Headwall:** ☐ Like New/Good ☐ Moderate ☐ Bad ☐ Failed/Near Fail ☐ Other:	**Streambank/Pool:** ☐ Stable ☐ Moderate ☐ Bad ☐ Failed/Near Fail ☐ Stream Restoration ☐ Other:	**Defect Severity Ratings:** **Like New/Good/Stable** – Likely to remain stable. **Moderate** – Stable, no repairs needed at this time but monitor for worsening condition and/or schedule for frequent re-inspection. **Bad** – Repairs needed to prevent continuing erosion. Place on CIP list for future repair. **Failed/Near Fail** – Place on list for immediate repair; public safety issue, roadway loss imminent, or major contributor to sediment loading.
Criticality Ranking:			
Pipe: ☐ 1-Normal ☐ 2-Important ☐ 3-Critical ☐ If 2or 3, describe why:	**Headwall:** ☐ 1-Normal ☐ 2-Important ☐ 3-Critical ☐ If 2or 3, describe why:	**Streambank/Pool:** ☐ 1-Normal ☐ 2-Important ☐ 3-Critical ☐ If 2or 3, describe why:	**Criticality Rankings:** **Normal** – Non-critical infrastructure; insignificant social, public safety, environmental, or economic impact if fails. **Important** – Significant social, public safety, environmental, or economic impact if fails. **Critical** – Extreme social, public safety, environmental, or economic impact if fails.

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Outfall Ranking Example #1

Outfall Ranking Example #2

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Achieving Objectives

Which Outfalls to Fix?

Total Score	No. of Outfalls	Percent	Repair Priority
0-3	511	87%	None
4-8	67	12%	Medium
9-11	9	1%	High
Total	**587**	**100%**	

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Schiphol Airport, Amsterdam

Stormwater Asset Management Program

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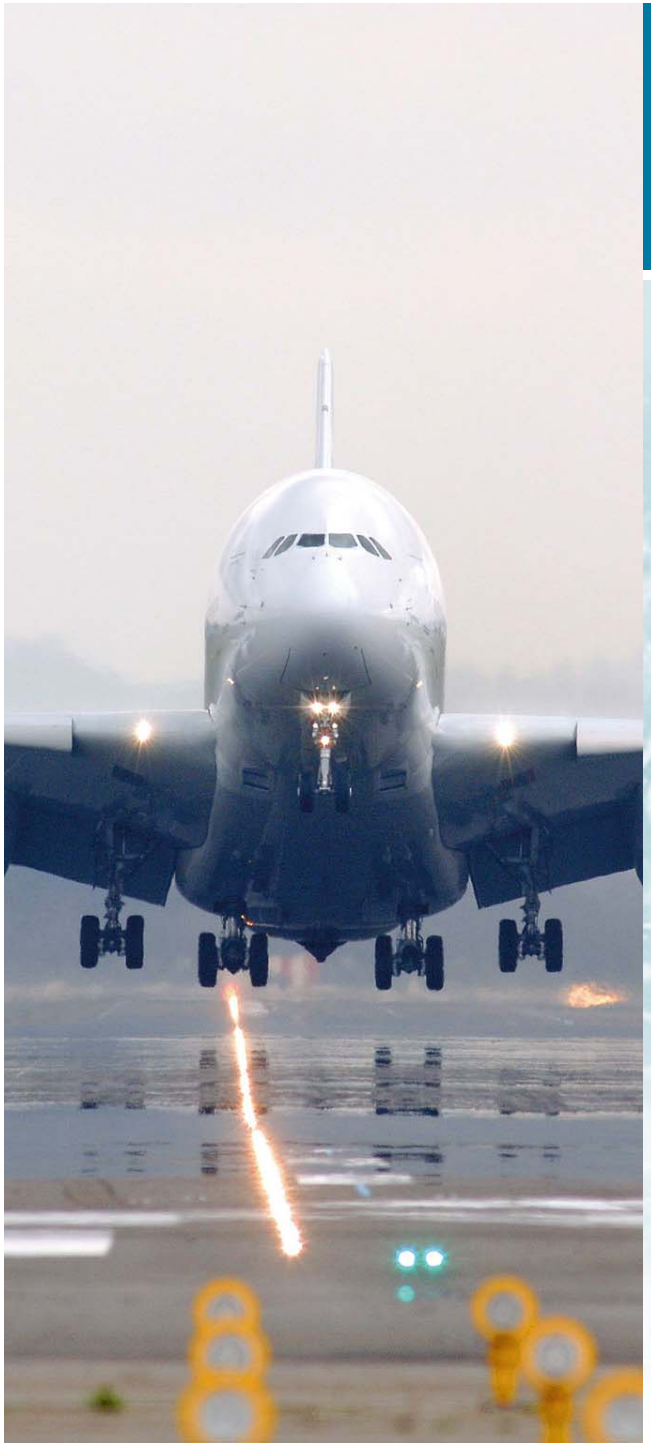

Schiphol → Baseline

Schiphol Strategy

Primary process Schiphol Airport

Exploitation of the airport

- Risk based maintenance management
- Other activities

Water management

- Storm water
- Open water system
- environment

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Criticality of Schiphol Infrastructure

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Schiphol Risk Analysis

Veiligheid & ARBO	Milieu	Imago	Operationele beschikbaarheid	Techniache kosten	1000 jaar	100 jaar	15 jaar (10yr)	5 jaar	Jaar	Kwartaal	Maand	Week
Geen	Geen vervuiling	Geen	Geen	€ 0,-								
Pleister	Lichte vervuiling	1 klacht	1 minuut	€ 150,-								
doktersbezoek	Matige vervuiling	10 klachten	5 minuten	€ 1.500,- (€ 5.000)								
lang verzuim	Vervuiling	Lokale pers	1 uur	€ 15.000,-								
ziekenhuis	Ernstige vervuiling	Regionale pers	1 dag	€ 150.000,-			(€ 17.000*)					
invaliditeit	Zeer ernstige vervuiling	Landelijke pers	1 week	€ 1,5 mio								
meerdere doden	Calamiteit	Internationale pers	1 maand	€ 15 mio								

Risk without preventative measures = €403,000 per year

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Schiphol Risk Analysis

Veiligheid & ARBO	Milieu	Imago	Operationele beschikbaarheid	Technische kosten	1000 jaar	100 jaar	15 jaar (30yr)	5 jaar	Jaar	Kwartaal	Maand	Week
Geen	Geen vervuiling	Geen	Geen	€ 0,-								
Pleister	Lichte vervuiling	1 klacht	1 minuut	€ 150,-								
doktersbezoek	Matige vervuiling	10 klachten	5 minuten	€ 1.500,- (€ 5.000)								
lang verzuim	Vervuiling	Lokale pers	1 uur	€ 15.000,-								
ziekenhuis	Ernstige vervuiling	Regionale pers	1 dag	€ 150.000,-			(€ 5.667)					
invaliditeit	Zeer ernstige vervuiling	Landelijke pers	1 week	€ 1,5 mio								
meerdere doden	Calamiteit	Internationale pers	1 maand	€ 15 mio								

Cost of preventative measures (TV inspection) = €28,571 per year

Risk with preventative measures = €134,333 per year

Preventative Measures Reduce Risk Cost by 1/3

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Chesterfield County, VA

Watershed Management Program

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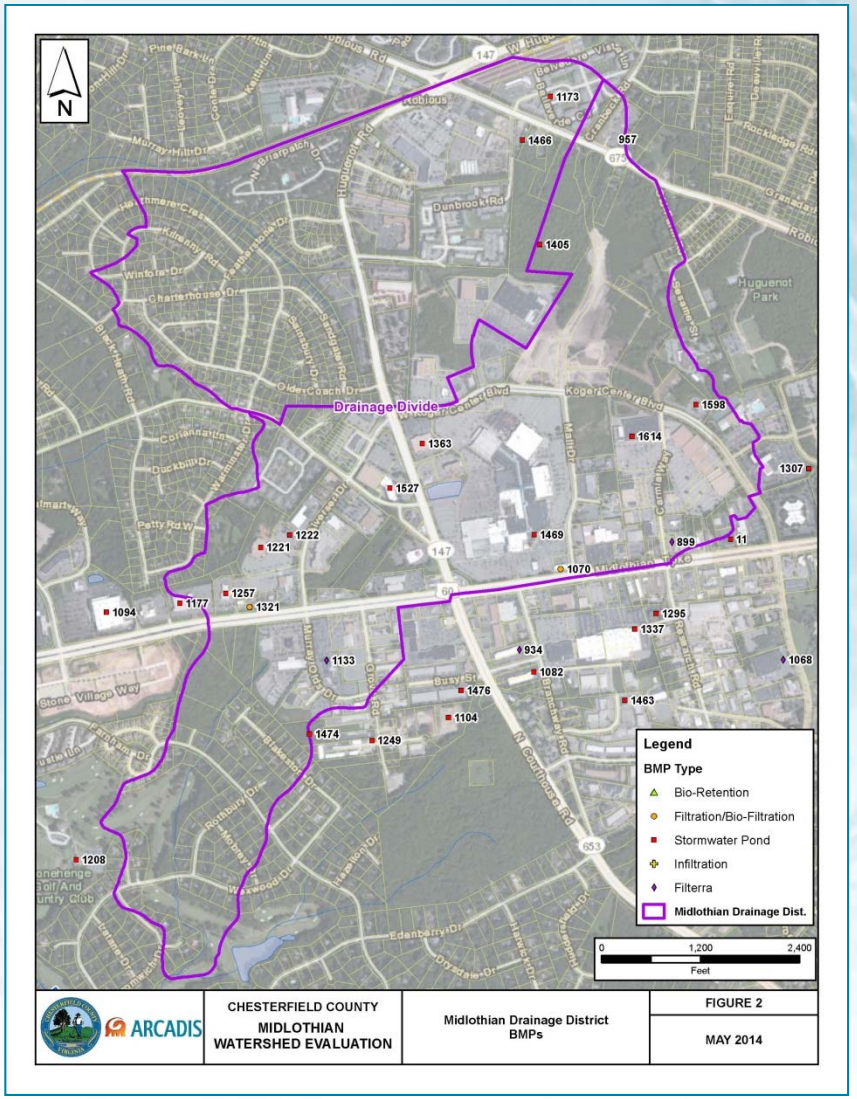
Midlothian Drainage District



- Less than 2 square miles in area
- District contains 37 stormwater structures
- Risk-based SW asset assessment is “beta test” for rest of county

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Stormwater Assets

Stormwater Assets:

- Detention basins – 6
- Retention basins – 4
- Storm filters – 3
- Underground pipe – 1
- Filterra – 23
- **Streams/Channels – 2**

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Asset Condition Ratings

- Pipes / Culverts / Outfalls
- BMPs / GI
- Open Channels / Streams

Object ID	Location ID	Asset ID	Technology/ Type	Structure Number	Condition Assessment Rating					Inspection Comments
					Structural Problem	Erosion/ Sedimentation	Vegetation	Clogging Trash	Pretreatment Device	
1	278	1363	Detention	-	3	2	4	4		Fenced but unlocked, 3' to top of trash rack, odorous
2	3278	1598	Detention	WCVE	5	2	3	2		2 concrete outlet structures with slot drains at grade. No inlet into pond, berm around perimeter
3	3298	1614	Retention	Home Depot		2	4	4	3	Fenced but unlocked, section of fence missing. Heavily silted, oil sheen on water
4	8162	1469	Detention	-		1	4			Locked behind 6' fence. Property management said Chesterfield County has the key. Pond is overgrown and doesn't appear to have any inlet or outlet structures
5	8555	1221	Extended Detention	# 1	2	3	4	2	1	Sedimentation issue: 1 inlet causing scour, 2 others are silted in
6	8559	1222	Extended Detention	# 2	2	4	5	2	1	Concrete inlet pointed directly at outlet, PVC inlet silted
7	8561	899	Filterra	F1	2	2	3	2	1	Curb inlet coming in
8	8566	1070	Storm Filter	17	2	1	1	4	1	Sedimentation issue
9	8568	1466	Detention	-	4	5	5	5	1	Completely overgrown and silted in
10	8580	1173	Retention	#1	2	2	2	2		Fenced in, could not gain access. Four roof drains appear to drain in to pond as well as whatever over land surface flow enters
11	8580	1630	Retention	#2	2	2	3	3		Fenced in, could not gain access

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WQ Improvement vs Risk-Based Need

FY2015 – FY2019
Capital Improvement Program
Project Request Form

Project Name: James River HS BMP Retrofits

Department: Environmental Engineering **Division:** Stormwater

Countywide Strategic Goal (Primary): MS4 Permit/TMDL Compliance

Department Priority: Yes

Project Requested in Previous Years? (Y ☐ / N ☒)

Project Funded Previously? (Y ☐ / N ☒)
(If yes, are estimated costs different than in previous submissions? Why?) N/A

Project Status, if Previously Funded: N/A

Is this a LEED Certified Project? (Y ☐ / N ☒)
(See Sustainable Building Guidelines)
N/A

Project Statement/Description:
Retrofit of existing stormwater infrastructure of the two ponds at the north end of the James River High School to reduce onsite runoff and nutrient loading

Project Justification and Benefits:
(Include information concerning how the project aligns with priority guidelines listed in instructions)
- Compliance with MS4 permit requirements
- Improved stormwater quality, reduced runoff
- Beautification of High School
- Increased science, biology, and environmental education opportunities for students
- Increased traffic safety with the addition of integrated vehicle speed control measures

Impact if Project Is Not Completed:
- Potential violation of MS4 permit requirements, including fines and/or consent order

Facility Plan (discuss project's priority in applicable Plan):
- This project is one of several projects required to achieve permit compliance

Operating Cost Savings Expected:
- (N/A)

Location/Site Status:
(Include magisterial district and how location will be obtained (proffered, purchased, etc.)
- The project is located in the Midlothian district and is on county-owned land. No land acquisition or additional easements are required. However, some coordination with VDOT and utilities may be required for site construction.

Other Departments Impacted/Involved, if applicable:
(Is another department impacted by this project, or is it shared with another department?)
- VDOT and Utilities may be impacted by this project during construction. Coordination with School will be necessary.

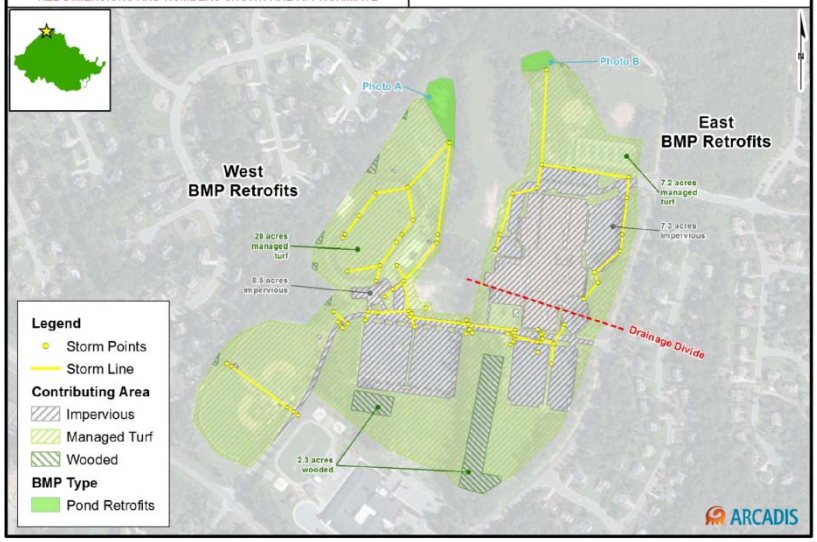
Outside Funding Source for Project, if known (Grants, Donations, Federal/State Reimbursements):

BMP PROJECT DESCRIPTION
James River HS BMP Retrofits

District: Midlothian
Treatment: 99 lbs/yr N 18 lbs/yr P 7,300 lb/yr TSS
Cost: $ 600,000

Description:
Retrofit existing ponds. May derive additional permit compliance from one-time dredging.

PLANNING-LEVEL CONCEPTUAL DESIGN
ALL DIMENSIONS AND NUMBERS SHOWN ARE APPROXIMATE



Achieving Objectives

Which Assets to Repair/Retrofit?

Total Score	No. of Assets	Percent	Repair Priority
1-6	39	74%	None
7-9	12	23%	Low
10-12	2	4%	Medium
13-15	0	0%	High
Total	**53**	**100%**	

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State DOT

MS4 Asset Management Program

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MS4 Program Compliance

- Asset inventory and inspection program
- SW Asset Management Guidelines document
- Guidelines for Stormwater Asset Condition, Consequence of Failure and Risk Assessment

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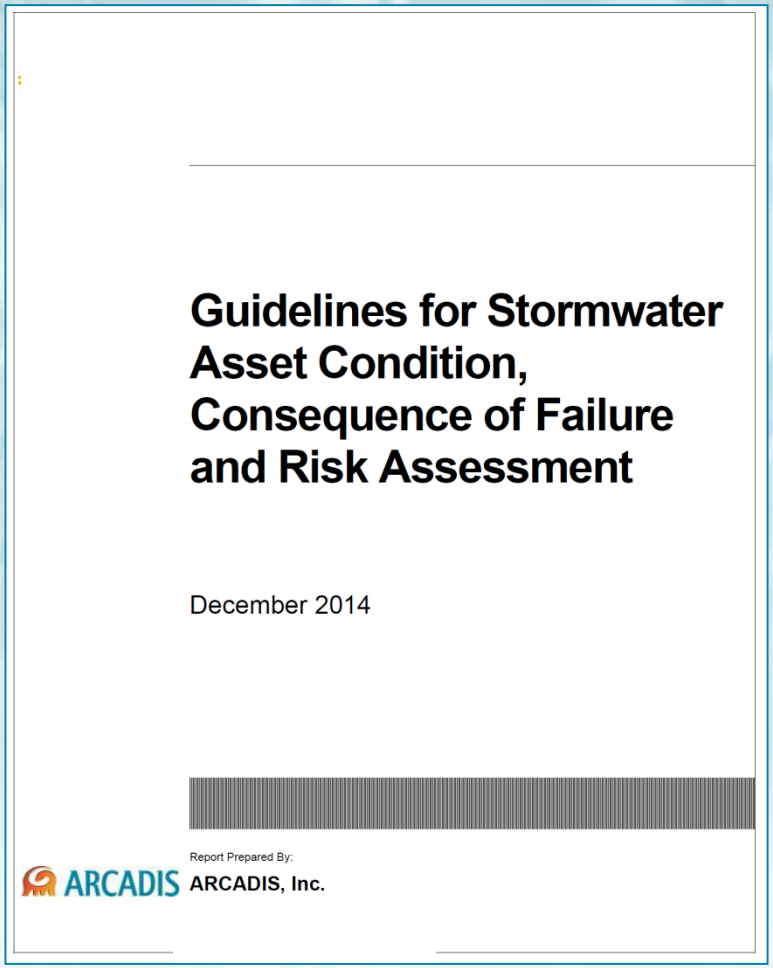
Asset Management Components

1. Purpose and Overview
2. Asset Definition and Hierarchy
3. Asset Physical Condition Assessment
4. Asset Performance Condition Assessment
5. Asset Consequence of Failure and Redundancy
6. Asset Risk



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Physical Condition/Performance Assessments

- Pipe systems
- Open linear systems
- Post-construction structures and controls

Open Linear System – Tier 1 Visual Condition Assessment		
Criteria	**Rating**	**Description**
Vegetation/ obstructions	1 – Excellent	There are no obstructions or vegetation in the channel
	2 – Good	There are minimal obstructions or vegetation blocking the channel
	3 – Fair	The channel is obstructed by minor log jams, snags or vegetation
	4 – Poor	Obstructions or vegetation growth have obstructed over 20% of the channel
	5 – Very Poor	Obstructions or vegetation growth has obstructed over 50% of the channel
Encroach-ments	1 – Excellent	No trash, debris, excavations, structures, or other obstructions present
	2 – Good	Limited trash, debris, excavations, structures, or other obstructions present
	3 – Fair	Some trash, debris, excavation, structures, or other obstructions present, but it will not inhibit O&M or emergency operations
	4 – Poor	Trash, debris, excavation, structures, or other obstructions present that may inhibit O&M or emergency operations
	5 – Very Poor	Trash, debris, excavation, structures, or other obstructions present that will inhibit O&M or emergency operations
Revetments and banks	1 – Excellent	Existing riprap protection is properly maintained and is undamaged
	2 – Good	No riprap displacement or scouring activity evident but vegetation must be removed
	3 – Fair	Vegetation is hiding some rock protection, some scour activity is undercutting banks, or channel flow is slightly impeded
	4 – Poor	Dense vegetation is hiding rock protection, scour activity is undercutting banks, or channel flow is impeded
	5 – Very Poor	Dense vegetation is hiding rock protection, scour activity is undercutting banks, and channel flow is impeded

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Roadway Culvert Asset Example

Condition	Criteria	Condition Score	Evaluation Method
Physical	Structural	2	Visual
	Erosion	2	Visual
	Trash	1	Visual
	Sedimentation	2	Visual
	Odor	1	Visual
	Algae	1	Visual
Performance	Capacity	5	Visual
	Regulatory	1	Desktop
	O&M	2	Desktop
	Obsolescence	2	Desktop
	Overall Score	5	Very Poor

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Risk Assessment Example

District	Location	R-O-W	Group	Type	Physical Score	Performance Score	Condition Score	COF Score	Risk Score
2	City name	DOT	Pipe	Pipe	3	5	5	3	15
2	City name	DOT	Pipe	Outfall	1	5	5	3	15
2	City name	City	Pipe	Pipe	2	2	2	2	4
2	City name	DOT	Open Linear	Ditch	4	5	5	4	20
2	City name	DOT	Post-construct. Structure	Filter strip	2	3	3	2	6

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Summary

- Switch from Reactive to Proactive
- Holistic, Data Driven Evaluation of Stormwater Assets
- Takes Bias Out of Capital Planning
- Positions You for Future Regulatory Compliance Using TBL Analysis

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Questions?

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