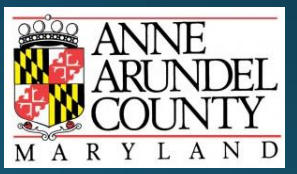
CWEA Asset Management Committee Spring Workshop

Asset Management Primer

April 19, 2017

Anne Arundel County DPW



Welcome and Introductions

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Speakers/Facilitators

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Acknowledgments

- Acknowledgments
  - Walter Graf, WERF
  - Duncan Rose, GHD (Retired)
  - Steve Albee, US EPA (Retired)

Some of the material presented here is taken from the "Fundamentals of Asset Management" Workshops by EPA & GHD

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Workshop Objective

- Provide attendees with a basic understanding of the principals of asset management, discuss strategies and tools, and present case studies.

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AGENDA

8:30–9:00	Registration
9:00 – 9:30	Welcome and AM Framework Overview (Charlie Card)
9:30 –10:00	Getting Started: Building an Asset Register (Alan Foster)
10:00 – 10:45	Asset Register Breakout Session
10:45 – 11:00	Break
11:00 – 12:00	Remaining Life and Risk Management (Ed Shea)
12:00 – 12:45	Lunch
12:45 – 1:45	Developing Risk Profile Breakout Session
1:45 – 2:15	Putting It All Together…Asset Management Plan Development (Seth Yoskowitz and Mert Muftugil)
2:15 – 2:30	Break
2:30 – 3:15	Asset Management Plan Development Breakout Session
3:15 – 4:00	Asset Management Case Studies
4:00	Closing

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Why Asset Management?

Changing Utility Business Conditions

- Increasing demand for utility services
- Aging infrastructure
- Loss of knowledge with personnel retirements
- Budget reductions/funding shortages
- Public resistance to rate increases
- Accounting requirements (GASB 34)

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Changing Utility Operating Requirements

- Demand to do more with existing resources
- Need to make every dollar work – to better use capital and operating budgets
- Regulatory agencies are beginning to require AM implementation as a condition for receiving grants and loans.
- Move from ***reactive*** to ***proactive*** work environment

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A Paradigm Shift

- Transition from *building and operating* to *managing* assets:
  - Extending asset life
  - Optimizing O&M and renewal
  - Developing accurate, long-term funding strategies

Sustain long term performance at the Lowest Cost of Ownership and the Lowest Risk!

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Three Fundamental Management Questions

1. What are my work crews doing, where are they doing it — *and why?*
2. What CIP projects should be done — *and when?*
3. When should I repair, when should I rehabilitate, and when should I replace?

These decisions typically account for over 80% of a utility's annual expenditures

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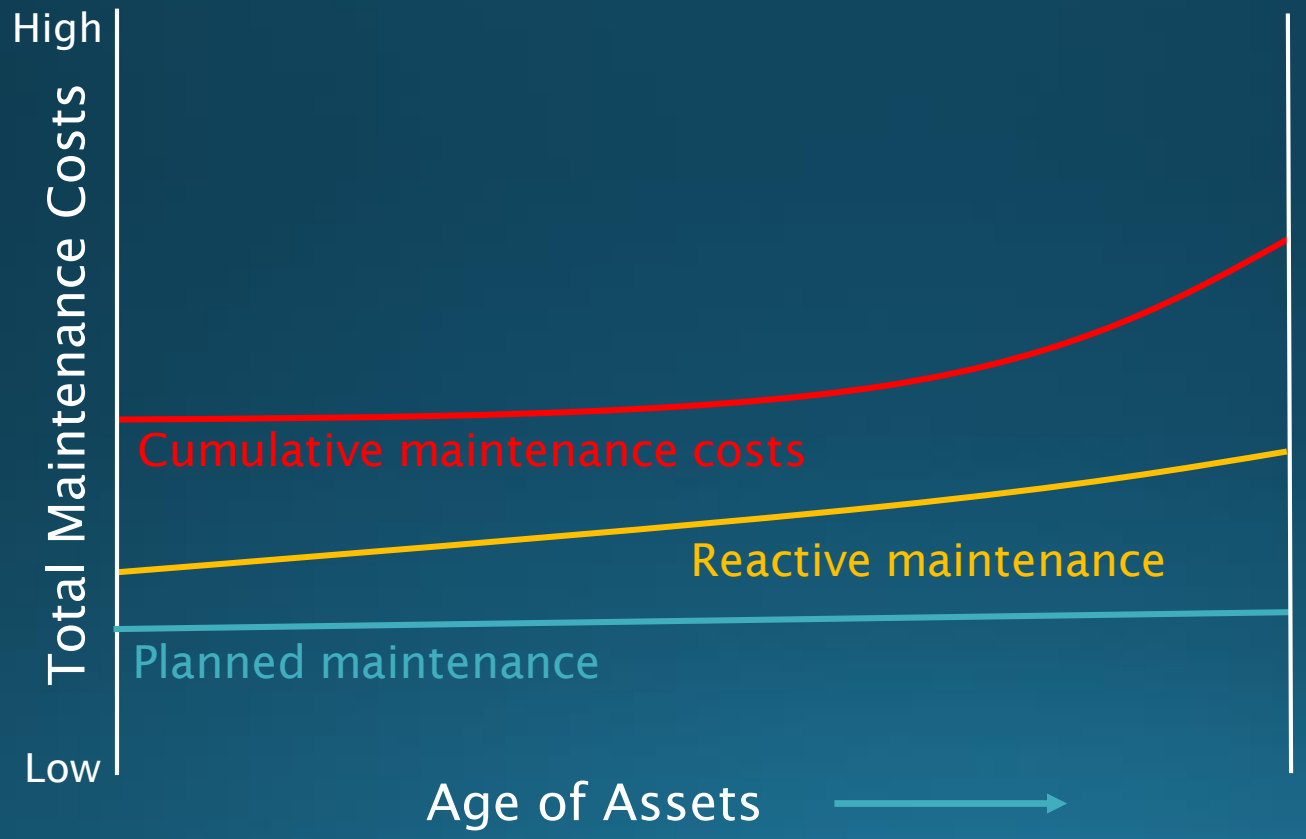
Reactive Maintenance is up to *5 times* more costly than Planned Maintenance



The right work,
the right investment,
at the right time,
for the right
reasons.

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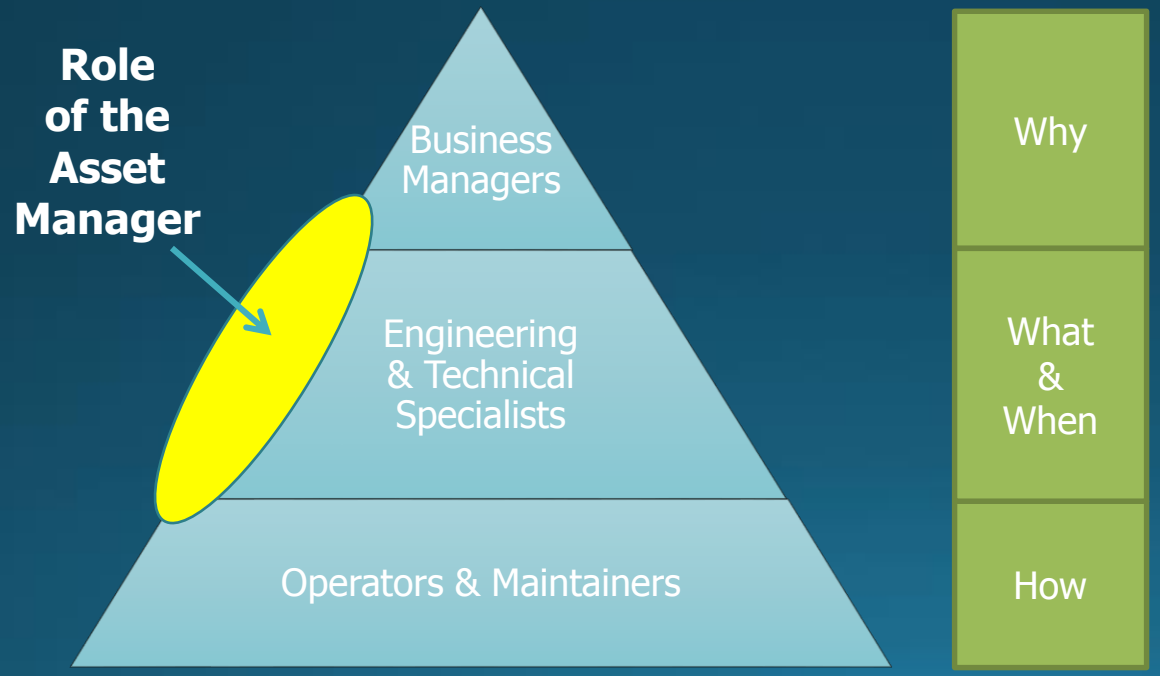
Sound easy?

Role of the Asset Manager

- The role of the Asset Manager bridges traditional boundaries.
- There is a continued need for the specialists – without them the business would not function, but the context is different.
- Implies a different and wider ranging set of competencies.



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Asset Management Frameworks

PAS55:2008
- British Standards Institute Guidance Document

ISO 55000
- Overview of principles & terminology

ISO 55001
- Management systems requirements

ISO 55002
- Management systems – Guidelines for the application of ISO 55000

EPA 5 Core Question Framework
- **Basic for initial understanding**
- **Ten Step Process to answer 5 Core Questions**

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EPA Definition - Asset Management

- *Management paradigm* and *body of management practices*
- Applied to the *entire portfolio* of infrastructure assets at all levels of the organization
- Seeking to *minimize total costs* of acquiring, operating, maintaining, and renewing assets…
- While *continuously delivering the service levels* customers desire and regulators require
- At an acceptable level of *risk* to the organization

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The goal of asset management is to:

Deliver the desired **Level of Service**, at the lowest life cycle **cost**, at an acceptable level of **risk**.

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Five Core Questions

1. What is the current state of my assets?

- What do I own and where is it located?
- What condition is it in? What is its performance?
- What is its remaining useful life? Remaining value?

2. What is my required level of service (LOS)?

- What is the demand for my services by my stakeholders?
- What do regulators require?
- What is my actual performance?

3. Which assets are critical to sustained performance?

- How does it fail? How can it fail? What does it cost to repair?
- What is the likelihood of failure?
- What are the consequences of failure?

4. What are my best O&M and CIP investment strategies?

- What alternative management options exist?
- Which are the most feasible for my organization?

5. What is my best long-term funding strategy?

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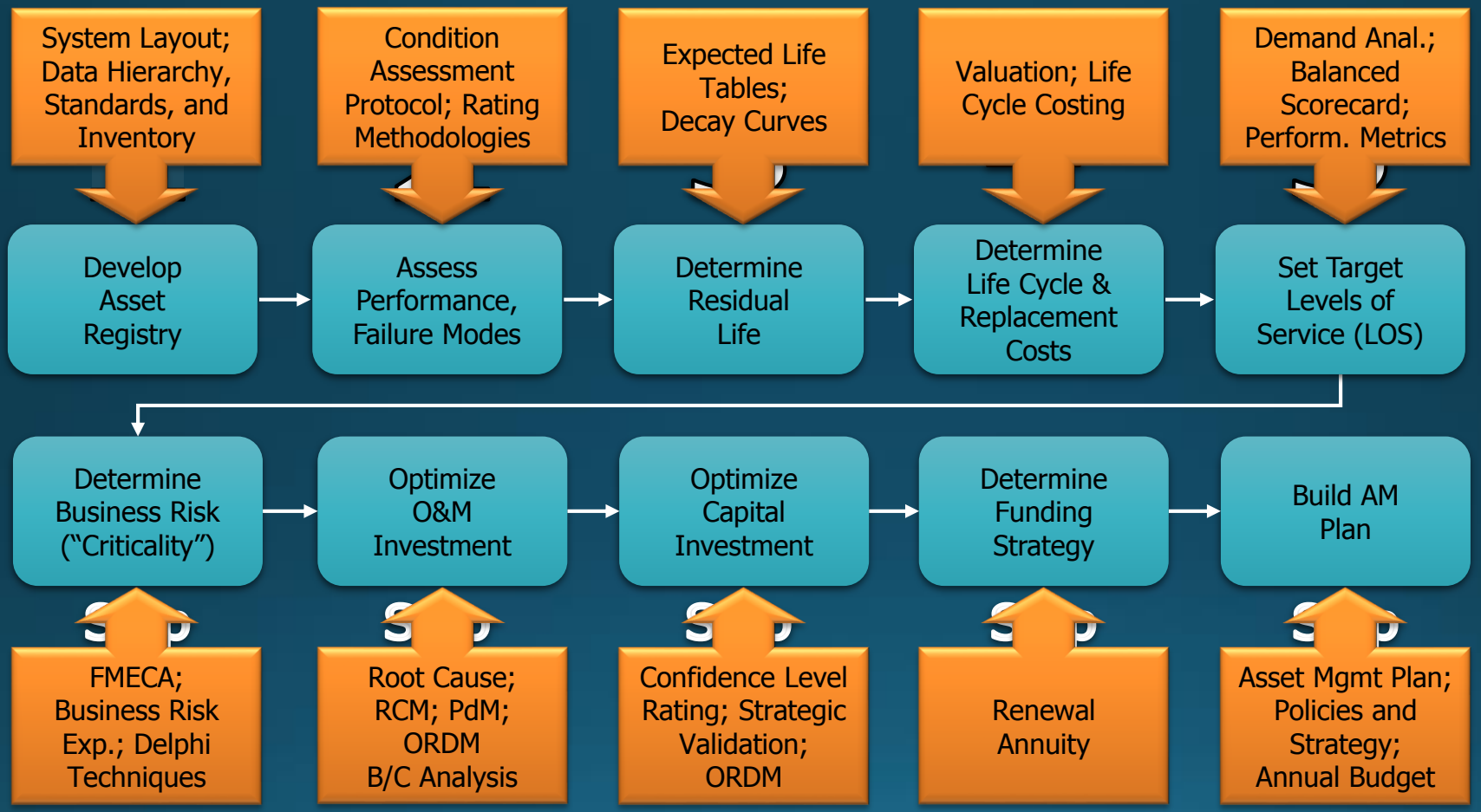
AM Plan 10-Step Process



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Core AM Program Elements

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Resources

- AWWA

http://www.awwa.org/resources-tools/water-knowledge/asset-management.aspx

- EPA

http://water.epa.gov/infrastructure/sustain/asset_management.cfm

- WRF

http://www.waterrf.org/knowledge/asset-management/Pages/default.aspx

- WE&RF

http://www.werf.org/i/ka/Strategic_Asset_Management/a/ka/StrategicAssetManagement.aspx?hkey=81661f7e-e817-47a1-9b28-40f703bd2f53

QUESTIONS

Getting Started: Building an Asset Register

What is an asset?

Anything that represents a part of your infrastructure that you can perform work against

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Agenda

Definitions
Identify purpose of Asset Register
Data organization benefits
Why use GIS
Inventory - current state
Classical sources of data
Additional sources of data
Inventory – how to implement
AM Hierarchy Solutions
Examples
Effective and Intelligent Data design and management
Asset Registry upkeep
Leveraging data
Pitfalls
Conclusion and recap

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Definitions:

- An **inventory** is a simple *list* of all the assets you own. Usually not organized in a way that shows how the assets are related to each other.
- The asset **hierarchy** is how the assets are *organized*.
- The asset **register** is the inventory of the assets, uniquely identified, in hierarchical format, with all of their associated *attributes.*

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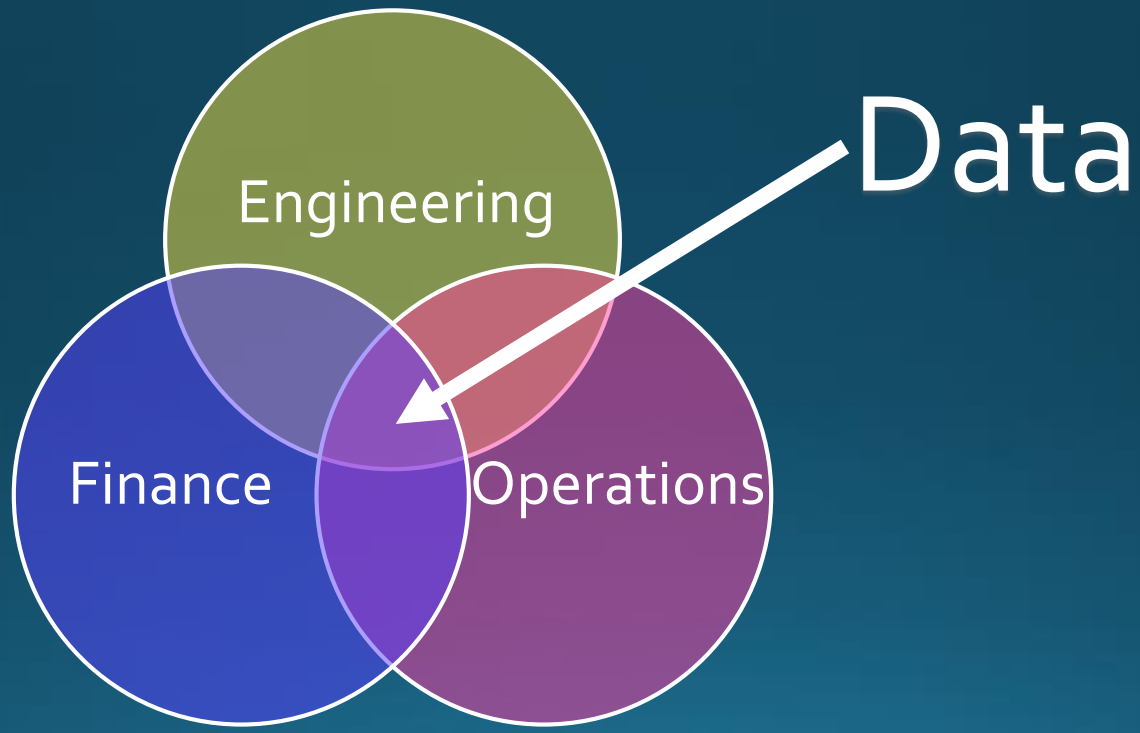
What are we capturing?



Where and how to store this data?

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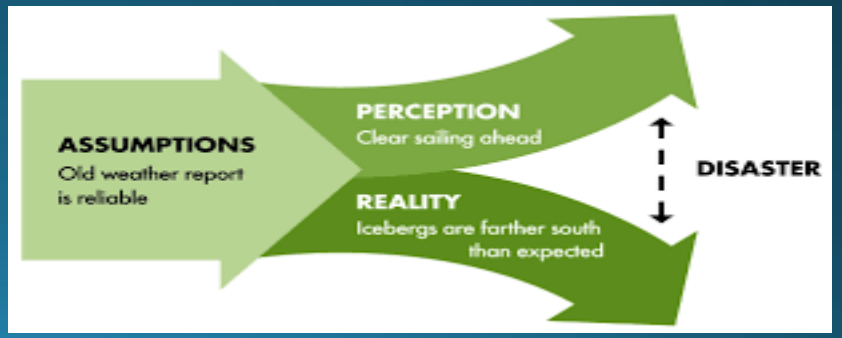
Data Organization Benefits

- Information → **Insight**
  - Internal and external stakeholders
  - Understandable formats
- Migration to **Data-Driven Decision Making** (DDDM)
- Convey data limitations and meanings of results.



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GIS Data Management: Why?

- Critical hub for all core data
  - Simple databases
  - Complex relational enterprise solutions
- Allows visualization
- Stores data related to system, preventive maintenance, and inspection programs
- Enables reporting
- Interfaces with CMMS

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Inventory:

What is the current state of my assets?

- *What* do I own?
- *Where* is it?
- What *condition* is it in? How is it *performing*?
- What is its *remaining useful life*?
- What is its *current* and *remaining economic value*?
- Scalable

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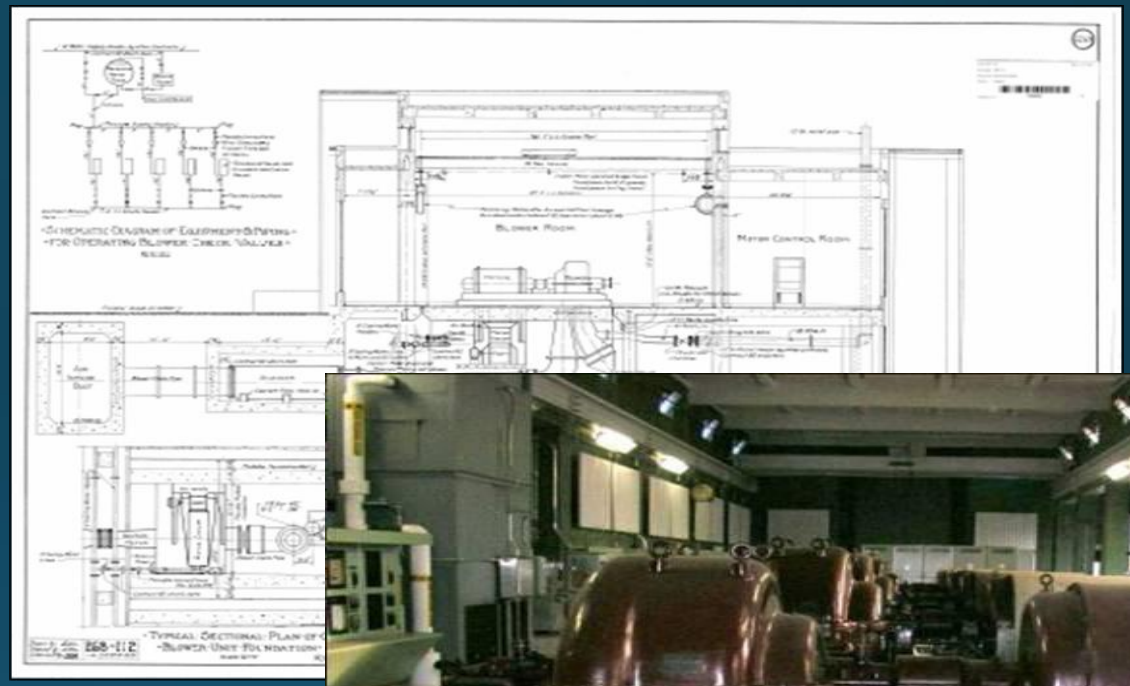
Classical Sources of Data

- As-built drawings
- Design drawings
- Manufacturers' manuals
- Bid documents
- Schedules of quantities
- Staff knowledge
- Photos and videos



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Additional Sources of Data

- SR data
- CMMS data
- Field data
- Integrate **people and processes** into your data focus

DIAL 311

esri ArcGIS Online

Collector Navigator Survey123 Workforce

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Inventory: How?

- Asset identification naming convention
- Attributes
- Network vs. non-network entities
- Database architecture and protocols
- Data collection protocols

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Asset Management Hierarchy Solutions

Type | **Linear / Vertical** infrastructure → **Asset Inventory**

Location | **Linear** infrastructure → **LGIM**

Process | **Vertical** infrastructure → **Institutional knowledge**

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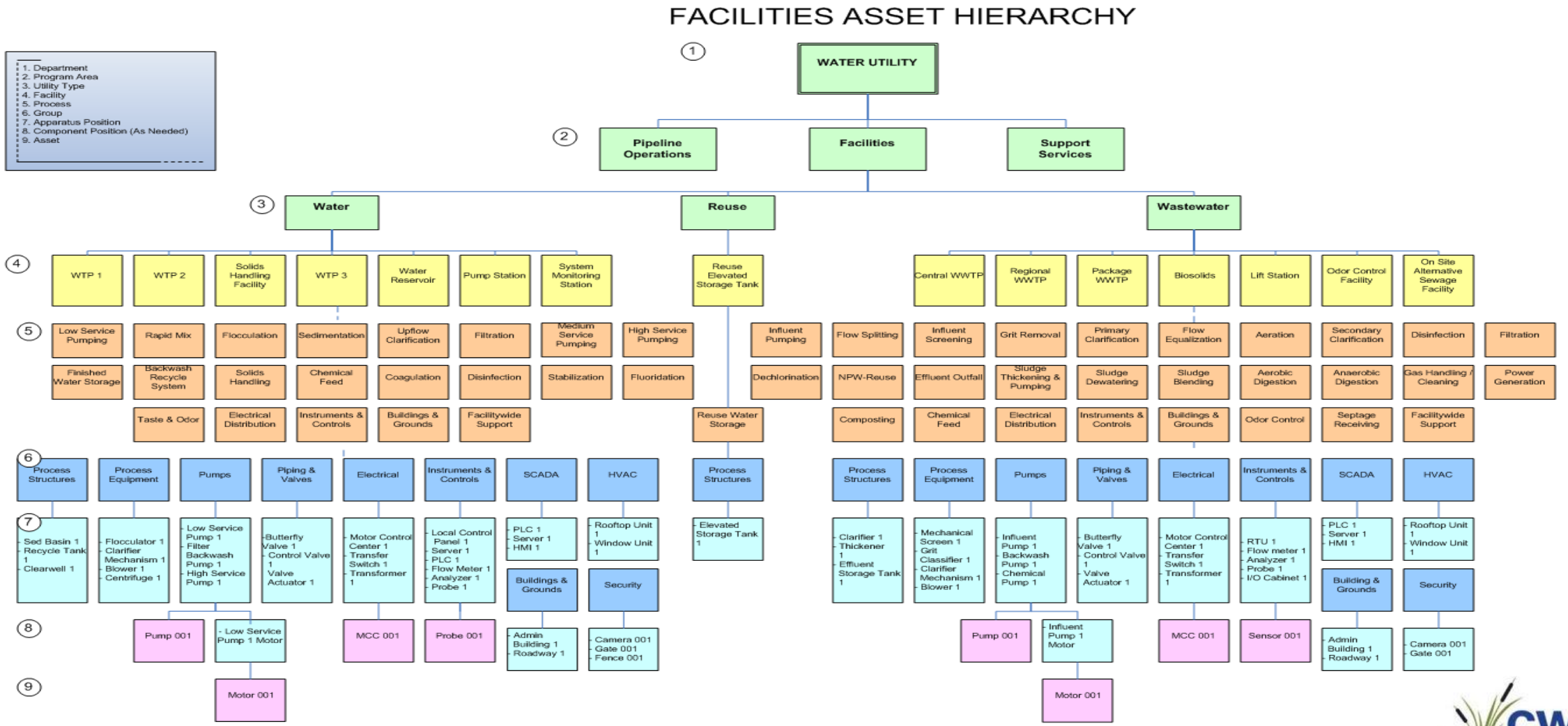
Vertical Asset Hierarchy Example



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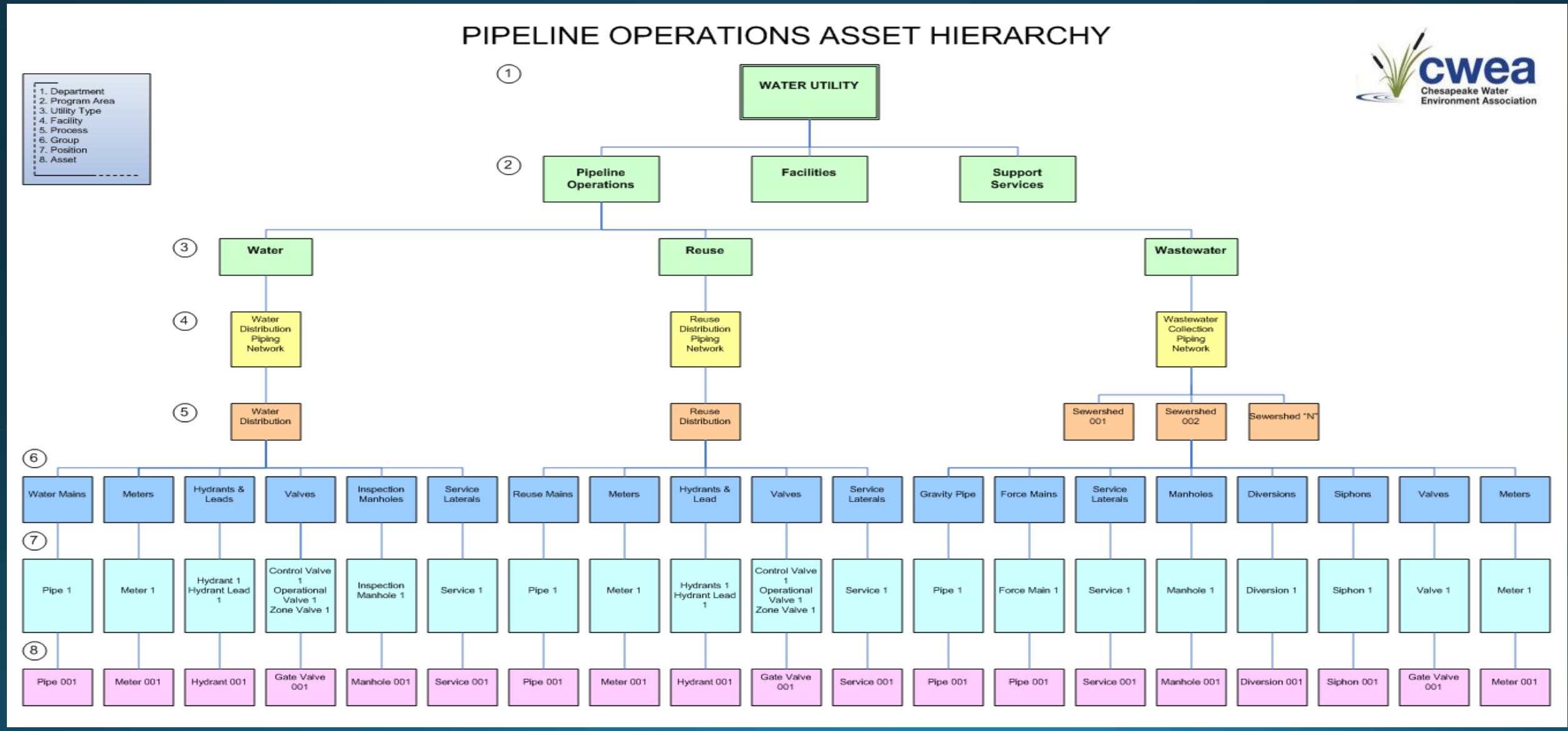
Linear Asset Hierarchy Example



Effective and Intelligent Data Design and Management

- Intentional design is a must
  - What are the "must haves"?
    - Condition
    - Age
    - Material
    - Other
- Process analysis
- Gap analysis
- Future - proof

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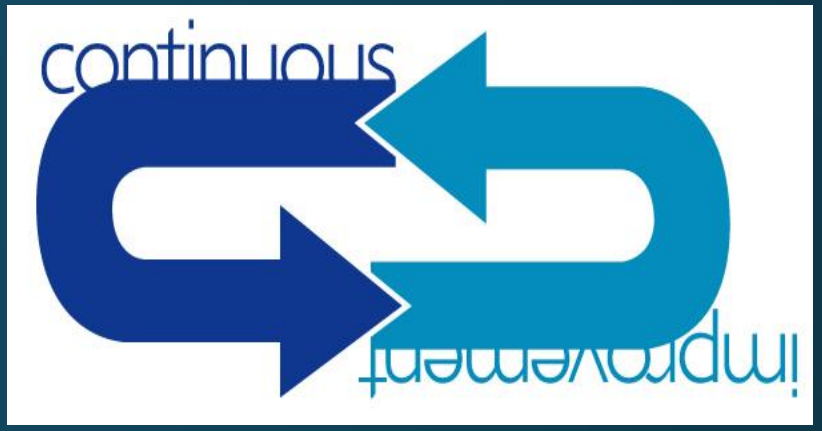
Asset Registry



- Updates
- Implement, maintain, and administer **Solutions & Tools**
  - Training non-technical personnel
- What gets measured, gets done

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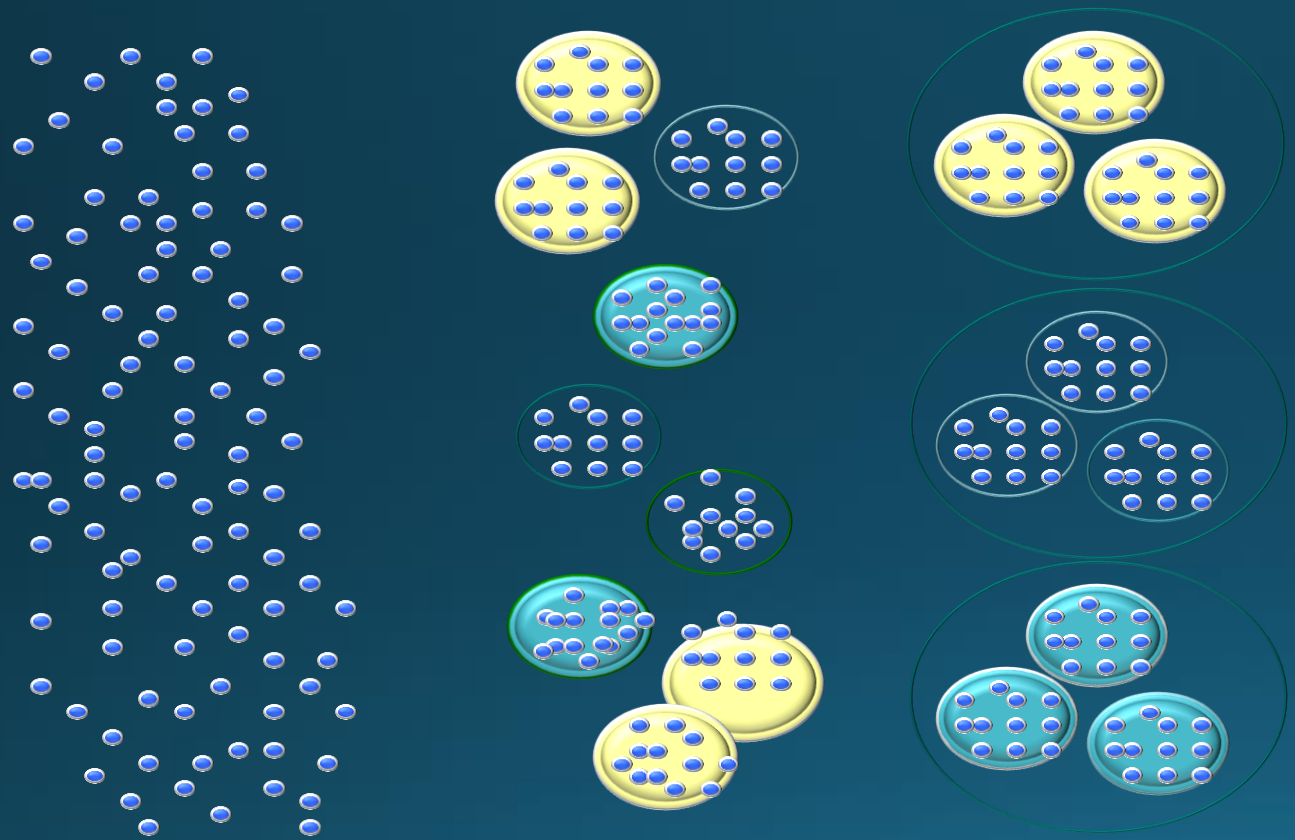
Leveraging your Asset Registry

Raw Data	Data Subsets	Information	Knowledge	Value Creation



Reports & Experience

Assets
People Process

Decisions

Profitability
Sustainability
High Performance
Organization

Business Processes	Query Databases	High Performance

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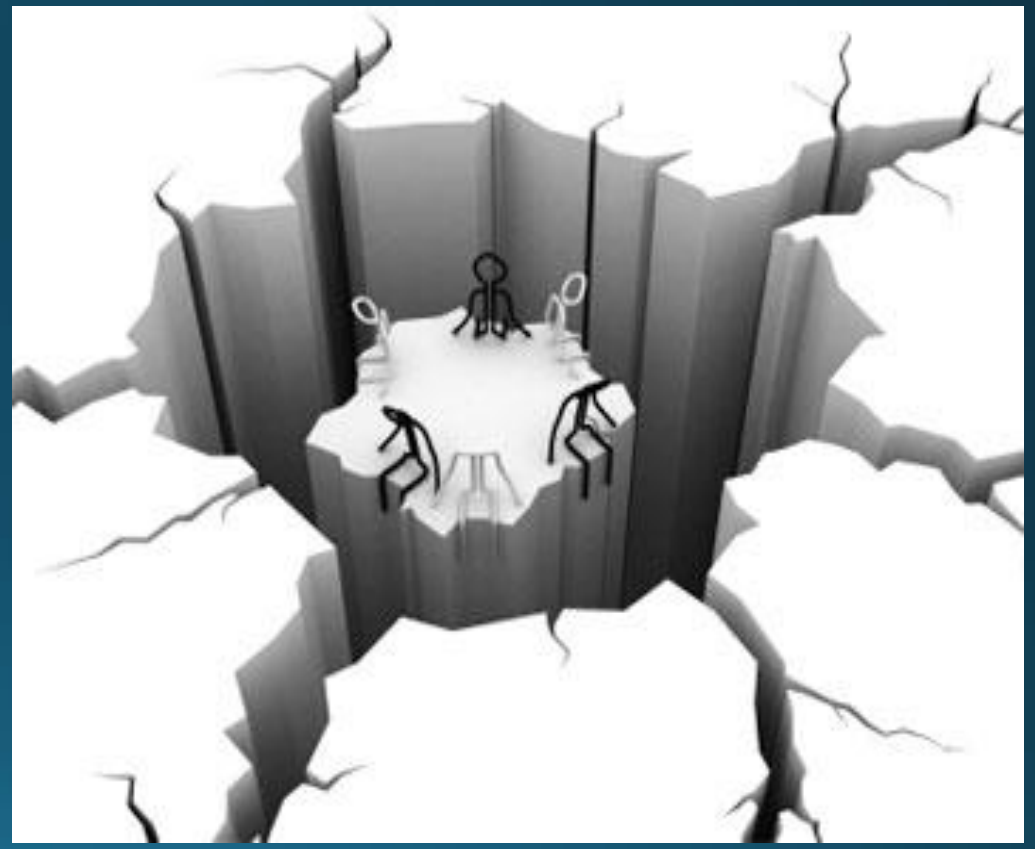
Avoid Common Pitfalls

- Trying to make all data spatial
- Waiting for your data to be perfect and complete
- Setting unrealistic goals
- Reinventing the wheel
- Implementing change without buy-in
- Accepting the status quo



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Conclusion & Recap

- Purpose of register
- Sources of data
- AM Hierarchy Solutions
- Effective and Intelligent Data design and management
- Asset Registry upkeep
- Manage expectations
  - Budget/resource constraints
  - Data quality constraints
- Not Static
  - Always be Improving and Growing
- Be Patient!

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QUESTIONS

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Getting Started: Building an Asset Register

Breakout Session

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Agenda

- Introduction (5 min)
- Linear Asset Hierarchy (10 min)
- Discussion (10)
- Vertical Asset Hierarchy (10 min)
- Discussion (10)

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Linear Assets: Water Infrastructure

Item	Asset? (Y|N)	Attribute? (Y|N)	In Network? (Y|N)	Extraneous? (Y|N)	Other? Specify.
Pipes/Mains					
Blow-off valves					
Phone number of contractor					
System valves					
Meters					
Last inspection date					
Hydrants					
Weather on install day					
Hydrant valves					
Hydrant laterals					
Manholes					
Lateral connections					
Vaults					
Backflow prevention devices					
Warehouse					
Spare parts					
Trucks					
Backhoes					
Equipment used					
Original Cost of asset					
Replacement Cost of asset					
Accessibility of main					
Location of main line segments					
Hydrant flow test results					
Hydrant manufacturer					
Performance history of broken pipes					
Age of pipes by area					
Condition of pipes					

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Linear Assets: Water Infrastructure

BREAKOUT INSTRUCTIONS

- Consider this list of sample items. Identify by checking the column whether they are assets, attributes, part of the water network, extraneous items or other.

10 Minutes

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Linear Assets: Water Infrastructure

Item	Asset? (Y|N)	Attribute? (Y|N)	In Network? (Y|N)	Extraneous? (Y|N)	Other? Specify.
Pipes/Mains	Y		Y		
Blow-off valves	Y		Y		
Phone number of contractor					
System valves	Y		Y		
Meters	Y		Y		
Last inspection date		Y			
Hydrants	Y		Y		
Weather on install day				Y	
Hydrant valves	Y				
Hydrant laterals	Y				
Manholes	Y				
Lateral connections	Y		Y		
Vaults	Y				
Backflow prevention devices	Y				
Warehouse	Y				Not a linear asset
Spare parts	Y				
Trucks	Y				
Backhoes	Y				
Equipment used				Y	track on WO
Original Cost of asset		Y			
Replacement Cost of asset		Y			
Accessibility of main		Y			
Location of main line segments		Y			
Hydrant flow test results		Y			
Hydrant manufacturer		Y			
Performance history of broken pipes		Y			
Age of pipes by area		Y			
Condition of pipes		Y			
Material of pipes		Y			

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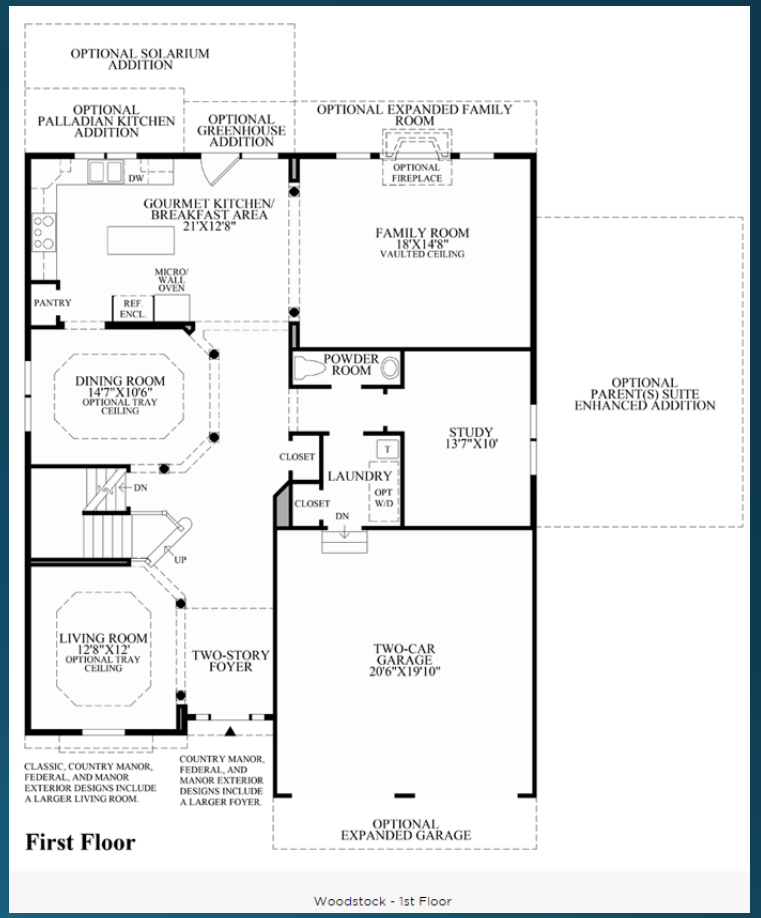
Vertical Assets: House Details

Woodstock House Plan

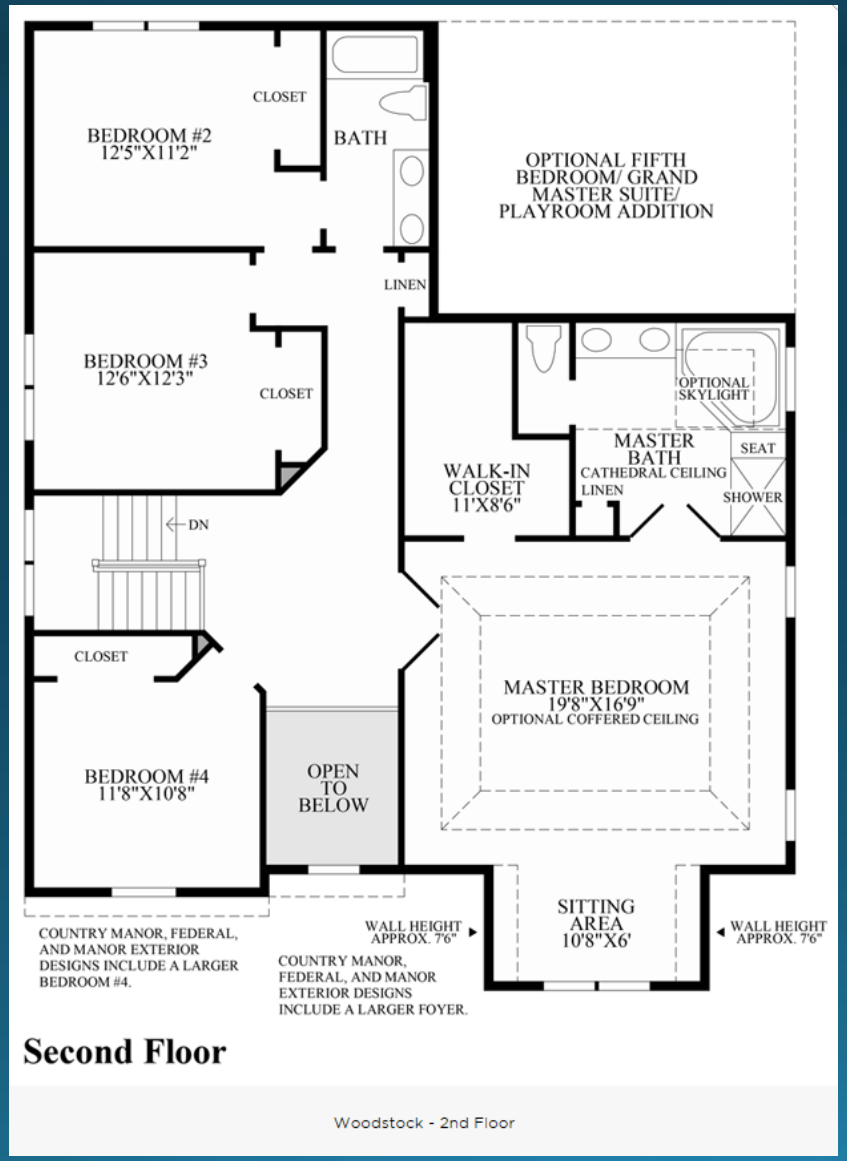
Here's a house available to build in Anne Arundel County. The Woodstock is shown below and includes floor plans for the 1st and 2nd floor.



Vertical Assets: House Details

Sample Types of Assets

- Walls
- Doors
- Windows
- Stairs
- Roof
- Flooring
- Heating Unit
- Plumbing
- Security System
- Air Conditioner
- Sink
- Appliances



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Vertical Assets: House Details

- View the sample house plan
- Brainstorm how you would develop a hierarchy for this house.
- Using the information provided, use the post it notes to create an asset hierarchy.
- Consider how this would apply to developing an asset hierarchy for a Wastewater Treatment Plant.

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Linear Assets: House

BREAKOUT INSTRUCTIONS

- Using the information provided, brainstorm your list of assets and asset hierarchy
- Consider how this would apply to developing an asset hierarchy for a Wastewater Treatment Plant.
- Use the post it notes to create an asset hierarchy based on the sample floor plans.

10 Minutes

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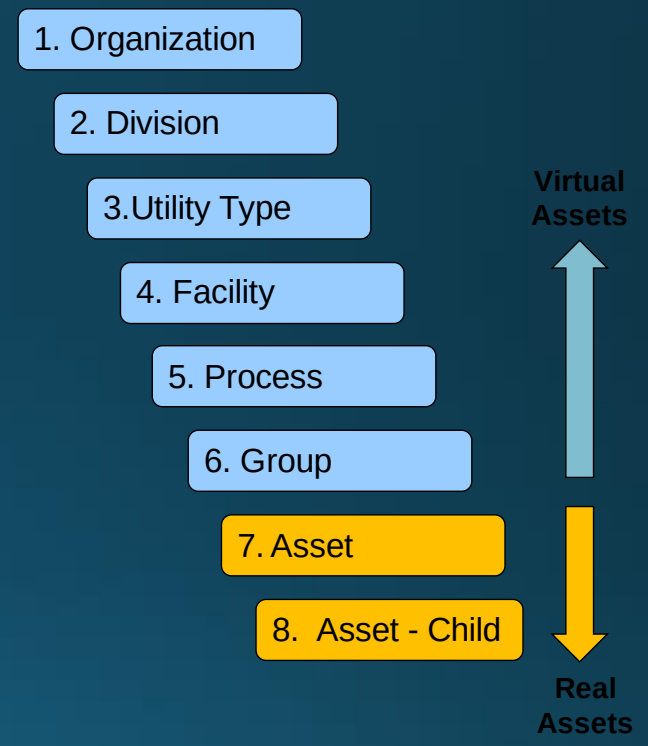
HINTS

Asset hierarchy assigns a parent-child relationship between assets and also defines the lowest level of assets. The purpose and role of the asset hierarchy include:

- uniquely identify assets – only in one place in the hierarchy
- work order management – support planning and scheduling work
- cost accounting – support assigning costs associated with maintaining the assets and roll-up of those costs
- assigning asset condition and criticality to an asset or group of assets



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Risk Management

Risk Management - Agenda

- Business Risk Exposure Framework - Overview
- Assigning CoF and LoF Scores to Assets
- Prioritizing Infrastructure Renewal
- Risk Mitigation
- Breakout Session

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Business Risk Exposure Framework

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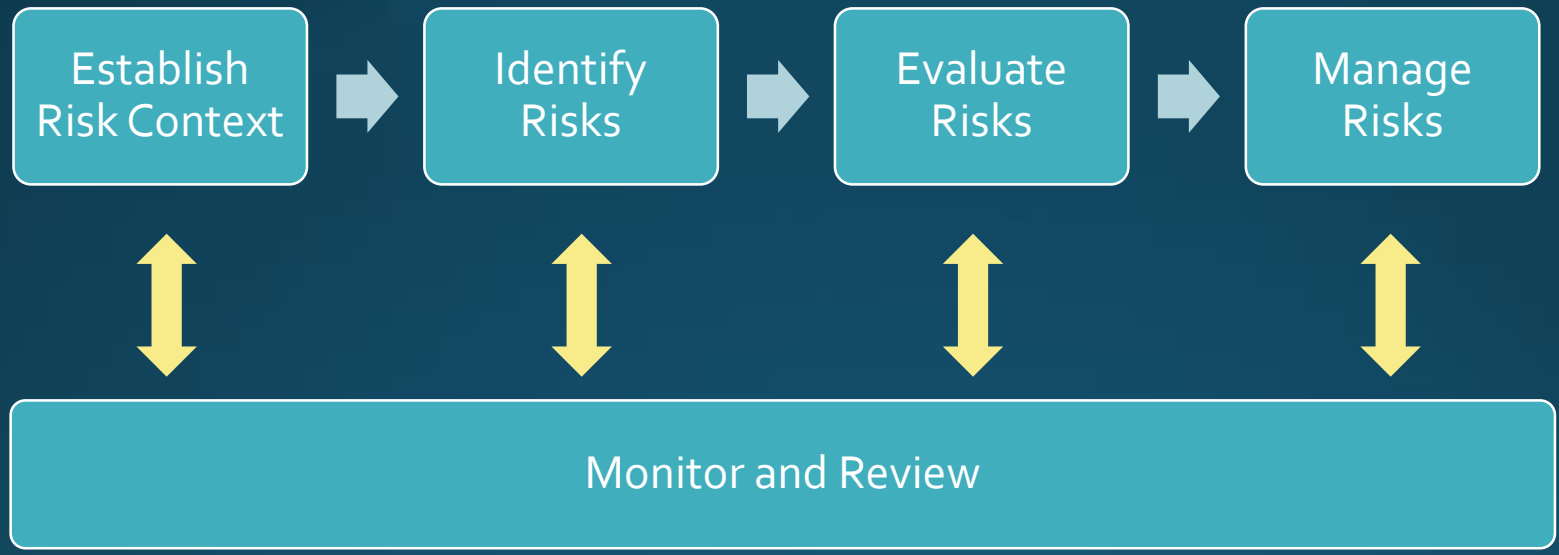
Steps in Implementing a Risk Framework



Source: International Infrastructure Management Manual – 2011 Edition

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Establish Risk Management Context

Corporate	• Guides Policy • Executive Management Team
Activity	• Guides Strategies • Asset Managers
Operational	• Guides Specific Actions • Operations and Technical Staff

Source: International Infrastructure Management Manual – 2011 Edition

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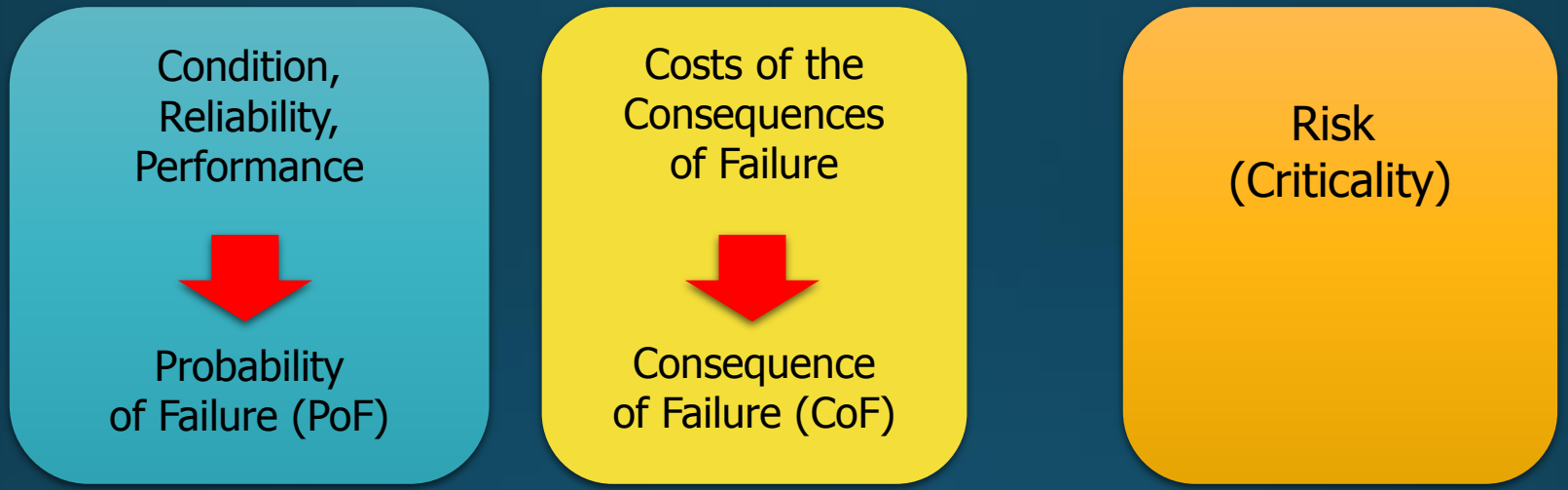
Simple Risk (Criticality) Metric



PoF x CoF = Risk

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Let's Clarify Terms

Ambiguous:

- "Risk"
- "Criticality"

Preferred:

- Probability of failure
- Consequence of failure
- *"Business risk exposure"*

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The Four Major *Failure* Modes

Failure Mode	*Definition*	*Tactical Aspects*	*Management Strategy*
Capacity	Volume of demand exceeds design capacity	Growth, system expansion	Redesign
LOS	Functional requirements exceed design capacity	Codes & permits: NPDES*, CSOs, OSHA, noise, odor, life safety; service, etc.	O&M optimization, renewal
Mortality	Consumption of asset reduces performance below acceptable level	Physical deterioration due to age, usage (including operator error), acts of nature	O&M optimization, renewal
Efficiency	Operations costs exceed that of feasible alternatives	Pay-back period	Replace

*NPDES is National Pollutant Discharge Elimination System, CSOs are combined sewer overflows, and OSHA is Occupational Safety and Health Administration

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Probability of Failure (PoF)

- PoF is directly related to the *failure mode*
- We *cannot* absolutely determine PoF
- Sometimes we have good data, sometimes we do not
- We can estimate a *range of failure* — how early (pessimistic) and how late (optimistic)

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What are Sources of Probability of Failure?

- CMMS*—*mean time between failures* (MTBF)
- Vendor and industry information
- Other *failure records* (hard copies)
- Our brilliant *memories* (staff)
- Our *SCADA** system* (if we have one and if it keeps records on this asset)

*CMMS is computerized maintenance management system
**SCADA is supervisory control and data acquisition

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Linking Probability of Failure to Age of Asset

% of Effective Life Consumed	*PoF* Rating*
0	1
10	2
20	3
30	4
40	5
50	6
60	7
70	8
80	9
90	10

*PoF is probability of failure

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Linking Probability of Failure to Condition

	Condition Rating & Residual Life Factor									
Asset Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Civil	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
Pressure pipework	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
Sewers	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
Pumps	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
Valves	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
Motors	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
Electrical	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
Controls	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
Building assets	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0
Land	1	1	1	1	1	1	1	1	1	1

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Linking Probability of Failure to Direct Observation Tables

*Assessment**	*Probability Weighting*	*Description*
Almost certain	100	Expected to occur within a year
Very high	75	Likely to occur within a year
High	50	Estimated 50% chance of occurring in any year
Quite likely	20	Expected to occur within 5 years Estimated 20% chance of occurring in any year
Moderate	10	Expected to occur within 10 years Estimated 10% chance of occurring in any year
Low	2	Expected to occur within 50 years
Very low	1	Expected to occur within 100 years

* Likelihood of occurrence within a year

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Linking Probability of Failure to Anecdotal / Institutional Memory

- Stormwater pipe installation date
  - Represents variance of installation quality through different periods of development

Score	LoF Definition
5	Records show that the pipe was installed between 1973 and 1986.
4	Records show that the pipe was installed before 1963.
3	Records show that the pipe was installed after 1963 but before 1973.
2	Records show that the pipe was installed after 1986 but before 2001.
1	Records show that the pipe was installed after 2001.

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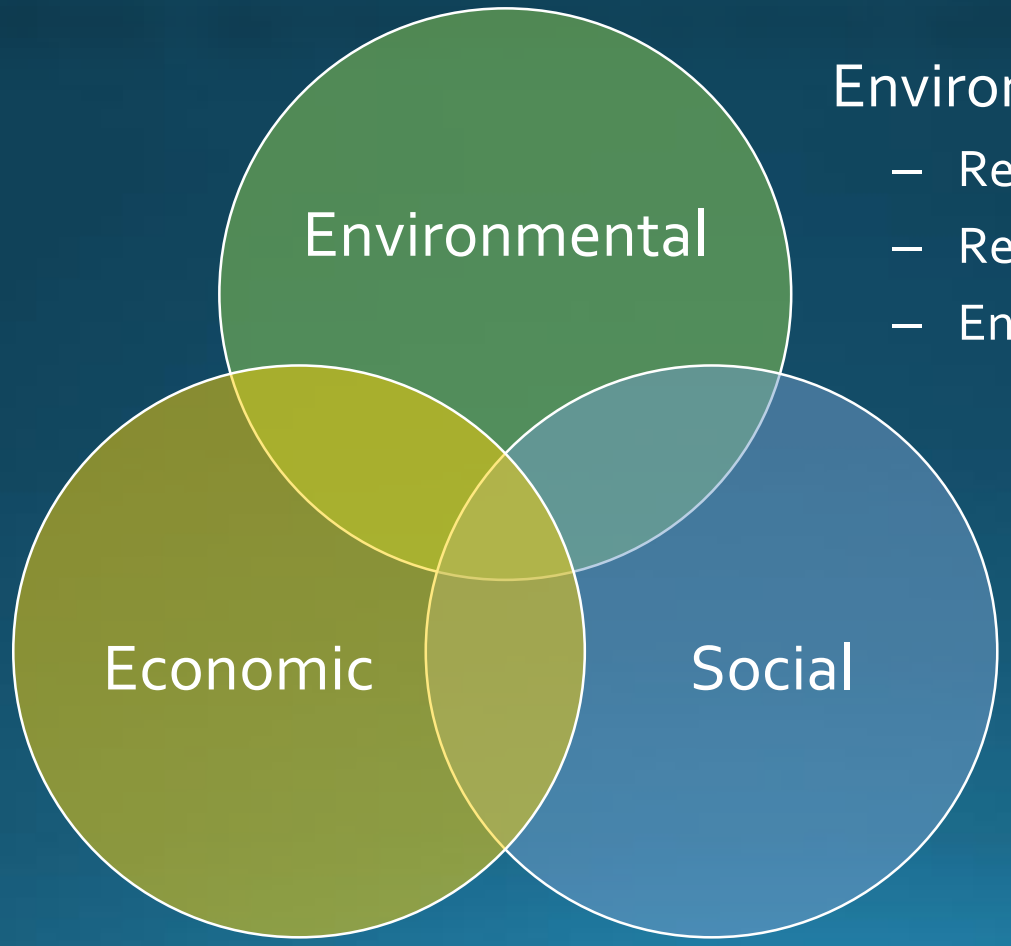
Consequence of Failure (CoF) is Evaluated Using a Triple Bottom Line Approach



Environmental

- Regulatory Compliance
- Regulatory Violations
- Environmental Impact

Economic

- Direct Cost (external)
- Indirect Cost (internal)

Social/Community

- Health & Safety
- Levels of Service
- Public Image

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Quantifying *Consequence of Failure*

Simple

Consequence of Failure			
CoF Rating	**Description**	**% Affected**	**Level**
1	Minor Component Failure	0-25%	Asset
2	Major Component Failure	25-50%	Asset
3	Major Asset	0-25%	Asset
4	Multiple Asset Failure	25-50%	Facility / Sub-System
5	Major Facilty Failure	50-100%	Facility
6	Minor Sanitory System Failure	20-40%	Total System
7	Medium	40-60%	Total System
8	Intermediate	60-80%	Total System
9	Significant	80-90%	Total System
10	Total	90-100%	Total System

Sophisticated

- **Direct Costs to the Local Government**
  - Repair and return to service costs
  - Service outage mitigation costs
  - Utility emergency response costs
  - Public safety costs
  - Admin & legal costs of damage settlements
  - (Lost product costs)
- **Direct Customer Costs**
  - Property damage costs (including restoration of business)
  - Service outage costs
  - Service outage mitigation and substitution costs
  - Access impairment and travel delay costs
  - Health damages
- **Community Costs**
  - Emotional strain/welfare
  - Environmental Pollution, erosion, sedimentation
  - Destruction of/damage to habitat
  - “Attractability” (tourist, economic)

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Quantifying *Consequence of Failure*

- Stormwater pipe capacity
  - Represents severity of flooding impacts from failure

Score	CoF Definition
5	The pipe capacity is determined to be greater than 67 cubic feet per second - cfs (44 million gallons per day - mgd).
3	The pipe capacity is determined to be greater than or equal to 22 cfs (14 mgd) and less than or equal to 67 cfs (44 mgd).
1	The pipe capacity is determined to be less than 22 cfs (44 mgd).

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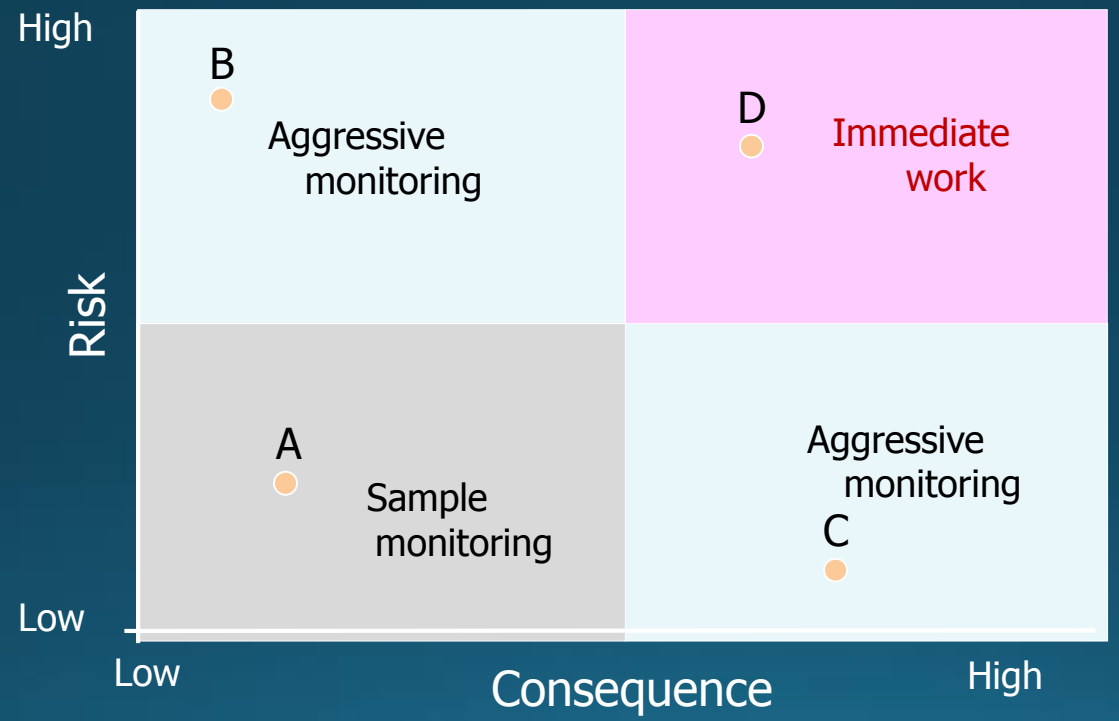
Scoring the Consequence of Failure

Consequence of Failure – Wastewater						
Social/Community/Organizational						
Loss of Service – Impact	Can be out of service indefinitely	Cannot be down a month	Cannot be down a week	Cannot be down 1 day	Cannot be down 8 hours	Cannot be down 1 hour
Safety	No impact	Minor inconvenience	Minor injury	Moderate injury and some sickness	Major injury, sickness, some death	Substantial death, widespread injury and sickness
Agency Image	No Media or no consequence	Neutral coverage	Adverse media	Widely adverse media	Continual; political opposition	National adverse media
Economic/Financial						
Economics, Hassle Factor	Low cost & low hassle	Low cost & high hassle	High cost; low hassle	High cost, high hassle & diverts $	Painful change of priorities	Likely trigger rate increase; staff changes
Environmental						
Spill, Flood, Odor	Short duration, sm qty. onside; no complaints	Backups; small no. of complaints	Aggressive complaints and liability	Substantial liability, many impacted	Has not happened at this scale before	Sustained, lg. qty., offsite, many complaints
Process & Effluent Quality	No impact SS; BOD; MPN; Cake	Routine adjustment	Significant corrective action	Significant adj. with uncertainty	Major process recovery with lag time and uncertainty	Loss of process control
Permit Compliance	No consequence	Violated daily standard	Violated weekly standard	Violated Monthly Standard	Damage reversible in six months	Permit jeopardized; damage reversible in 5 yrs or more
Score	**1**	**3**	**5**	**7**	**9**	**10**

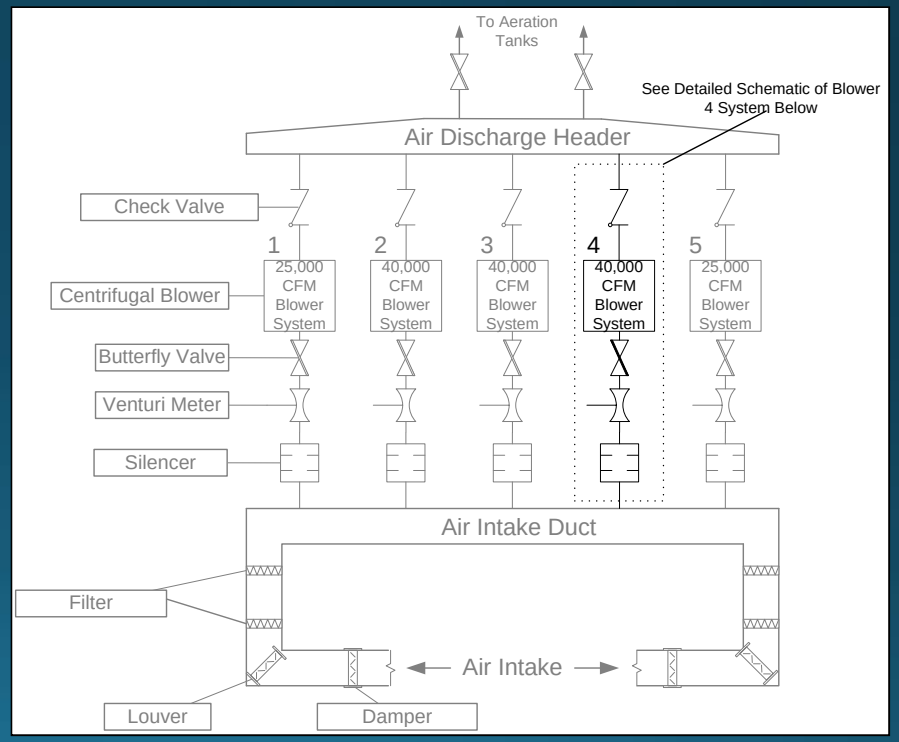
Business Risk Exposure Drives Work Program

Work program response



Introducing "Redundancy" into the Risk Metric

- *Redundancy* or *"risk mitigation"* significantly reduces the risk metric
- BRE = PoF x CoF *x R*
- Where
  - PoF is probability of failure
  - CoF is consequence of failure
  - R is a *redundancy or risk mitigation factor (≤1.0)*



Example of Assigning Weight to Redundancy

Type Redundancy	*Percent Redundancy*	*Percent PoF Reduction*
Partial	50	50
Full	100	90
Double	200	98

Set weights considering operating circumstances, where possible

- *True redundancy* (peak vs. average)
- Age and condition of equipment
- Nature of operating environment
- Nature of failure modes (evident, hidden, random)

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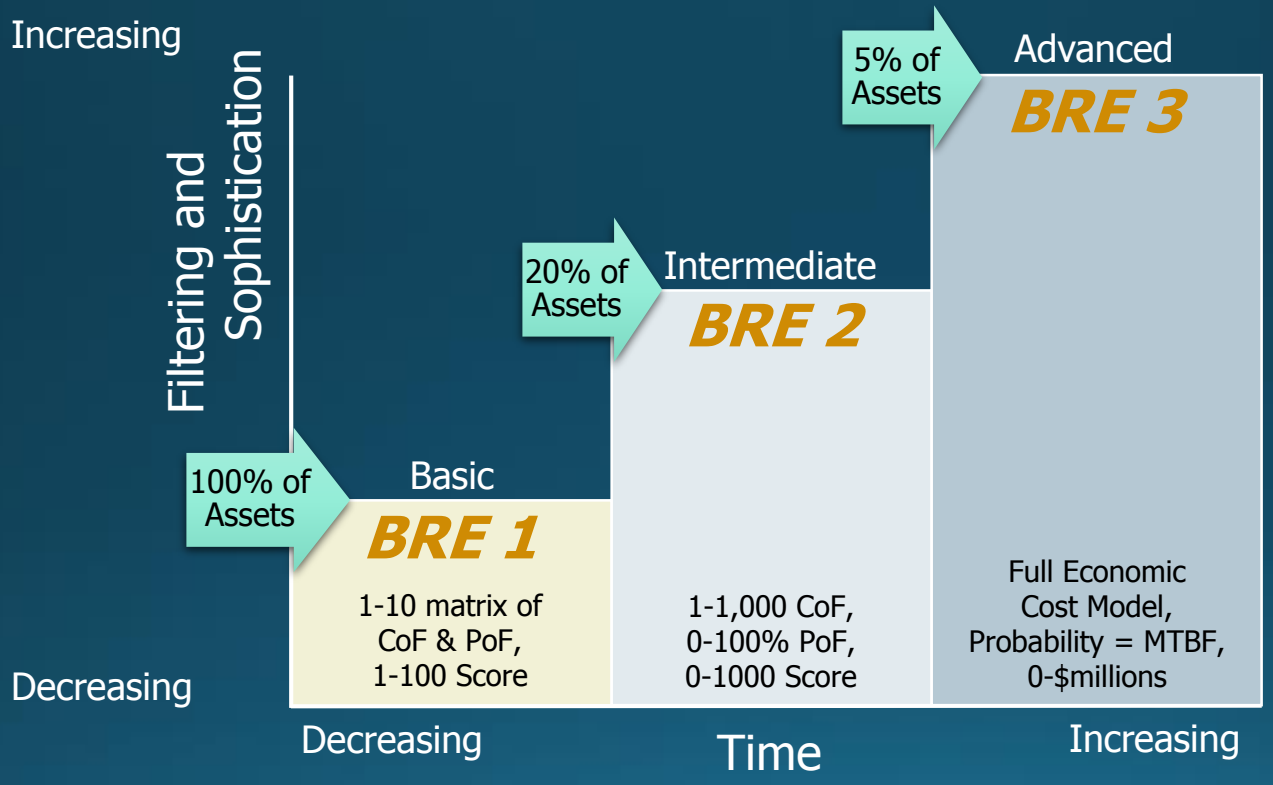
Step-By-Step BRE Methodology

Levels of Filtering and Sophistication



BRE is business risk exposure, CoF is consequence of failure, PoF is probability of failure, MTBF is mean time between failures

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Level 1 - Simple

BRE rating = probability x consequence

Asset No.	*% Probability*	*Consequence*	*Risk Mitigation Factor*	*Risk Rating*
1	.60	4	0.50	1.2
2	.70	2	1.00	1.4
3	.40	5	1.00	2.0
4	.66	10	1.00	6.6*
5	.95	7	1.00	6.7*
6	.10	10	0.90	0.9

* Requires further investigation

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Separating Risk Mitigation from CoF – Buried Assets

Does not include numerical Risk Mitigation Factor

Suggested mitigation tactics do not quantify risk reduction

Asset	Likelihood of Failure	Consequence of Failure	Relative Risk Rating	Risk Mitigation
Pipeline in NPS Park	3	4	12	• Inspect pipe & measure settlement • Develop Emergency Response Plan
Original Manholes	3	4	12	• Physical inspection of all manholes • Reduce infiltration
Pipeline in Busy Street in Historic Neighborhood	2	4	8	• Add rehab to 10-year CIP
Pipeline Near WRRF, Mostly in ROW	*2*	*3*	*6*	• Risk values assumed - Inspection results not yet received
Pipe & Manholes Replaced in 2010 w/ Roadway Project	1	4	4	• Continue current cleaning & inspection program

Notes: Likelihood and Consequence of Failure scores are "eyeballed," and not derived from a detailed risk framework.

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Advanced BRE Analysis

SCORE	1	2	3	4	5
Category: Social/Community/Organizational					
Community & Organizational Impact	☐ Routine Disruption	☐ Very Limited Impact	☐ Minor Impact	☑ Moderate Impact ~ 5% of Customers	☐ Major Impact - Many Customers
	$500	**$5,000**	**$50,000**	**$500,000**	**$5,000,000**
Category: Economic/Financial					
Total Cost of Impact	☐ Under $5,000	☐ $5,000 - $50,000	☐ $250,000 - $1,000,000	☐ $1,000,000 - $5,000,000	☑ >$5,000,000
	$500	**$5,000**	**$50,000**	**$500,000**	**$5,000,000**
Category: Environmental/Regulatory					
Environmental Impact to Flora & Fauna	☐ No Discernable Impact	☑ Minor Spill/Violation	☐ Moderate Spill/Violation	☐ Major Spill/Violation with Rapid Recovery	☐ Major Spill/Violation with Extended Recovery
	$500	**$5,000**	**$50,000**	**$500,000**	**$5,000,000**
					$5,505,000

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Key Points From This Session

Given my system, which assets are critical to sustained performance?

Key Points:

- Not all assets fail the same way
- Not all assets have the same likelihood of failure
- Not all assets have the same consequence of failure
- Understanding failure drives acquisition, maintenance and renewal management decisions.

Associated Techniques:

- Failure analysis ("root cause" analysis; failure mode, effects and criticality analysis; reliability-centered analysis)
- Failure codes
- Probability of failure
- Consequence of failure
- Business risk exposure
- Asset list by business risk exposure level
- Asset functionality statements

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QUESTIONS

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Risk Breakout Exercise

Score the CoF and LoF for each asset

Number	Asset Description	Consequence of Failure (or Criticality) Score 1-5	Condition	Likelihood of Failure Score 1-5	Risk Rating (CoF x LoF)
1	48" PCCP Water Transmission Main, constructed in 1977, located in an established easement adjacent to a secondary road.		External inspection in 2005 showed some evidence of corrosion.		
2	42" RCP combined interceptor sewer, constructed in 1954 along the river bank, located in National Park Service property with recent upgrade of amenities and high public use.		CCTV inspection in 2007 showed segments with high water level caused by a sag in several sewer segments that had settled. A 2015 CCTV inspection observed a similar condition.		
3	8" PVC sanitary sewer, constructed 1985, serving 40 homes.		2005 and 2010 CCTV inspection showed roots at 3 or more locations, and pipe was cleaned after inspections.		
4	Water Pumping Station roof, originally constructed 1950, slate shingles		Recently, a leak occurred inside the building during a heavy rainstorm. A visual inspection of the roof observed from standing on truck in parking lot showed a few missing shingles.		
5	500 sf stormwater bioretention facility constructed in 2014 to remove pollutants in runoff from a new housing development.		After the last few big storms, it took 5 or 6 days for the BMP to drain.		

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Add a risk mitigation strategy and reduction factor to each asset

Number	Asset Description	Consequence of Failure (or Criticality) Score 1-5	Condition	Likelihood of Failure Score 1-5	Risk Mitigation	Risk Reduction Factor	Risk Rating (CoF x LoF)
1	48" PCCP Water Transmission Main, constructed in 1977, located in an established easement adjacent to a secondary road.		External inspection in 2005 showed some evidence of corrosion.				
2	42" RCP combined interceptor sewer, constructed in 1954 along the river bank, located in National Park Service property with recent upgrade of amenities and high public use.		CCTV inspection in 2007 showed segments with high water level caused by a sag in several sewer segments that had settled. A 2015 CCTV inspection observed a similar condition.				
3	8" PVC sanitary sewer, constructed 1985, serving 40 homes.		2005 and 2010 CCTV inspection showed roots at 3 or more locations, and pipe was cleaned after inspections.				
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5	500 sf stormwater bioretention facility constructed in 2014 to remove pollutants in runoff from a new housing development.		After the last few big storms, it took 5 or 6 days for the BMP to drain.				

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Asset management plan development

Putting it all together…

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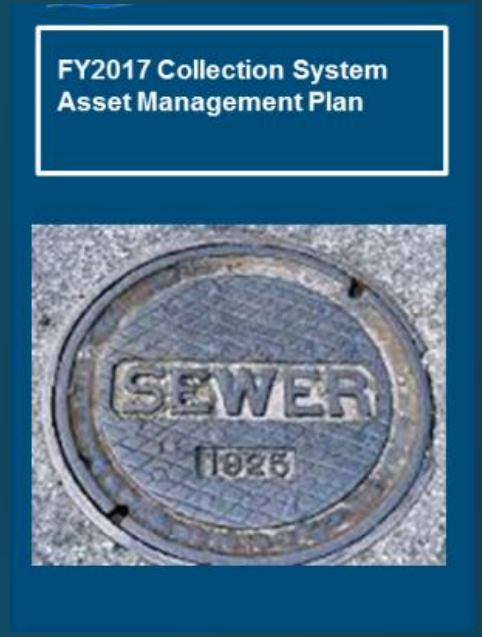
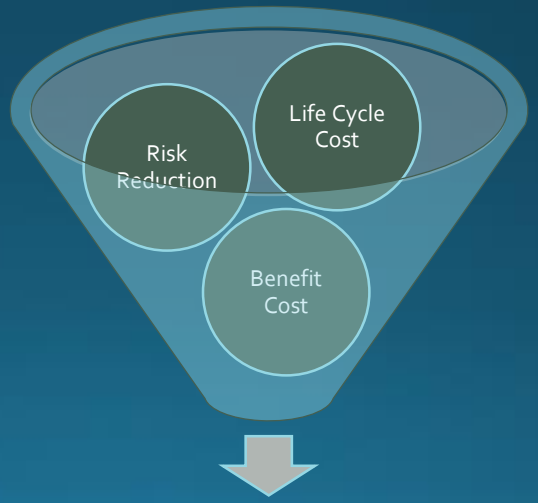
What is an Asset Management Plan?

Asset Management Plan Content

- Infrastructure Improvement Plan
- Business Improvement Plan
- Financial Plan
- Organizational Challenges

The AMP identifies needs and recommends management strategies. It is an input into the budgeting process.





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What is the AMP used for?

1. Current State of the Assets
2. Infrastructure Improvement Plan
3. Business Improvement Plan
4. Long term capital and O&M projection (Nessie Curve)
5. Funding Plan
6. Challenges to AM Plan Implementation

The AM Plan tells the story…

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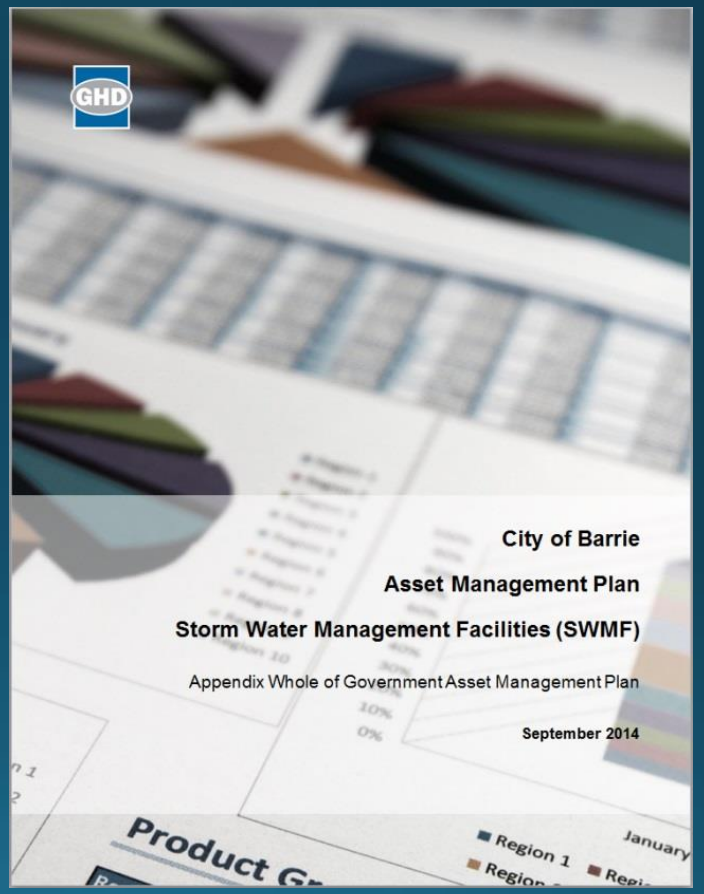
What is the AMP used for?

1. Identify proactive maintenance, monitoring and capital renewal investments to minimize asset lifecycle cost
2. Understand and prioritize needed work and associated costs to enable effective programming and budgeting
3. Support more comprehensive discussion with councils, commissions and boards regarding required levels of investment to support necessary service levels
4. Galvanize AM team resources and efforts toward an integrated output



What other uses can you think of?

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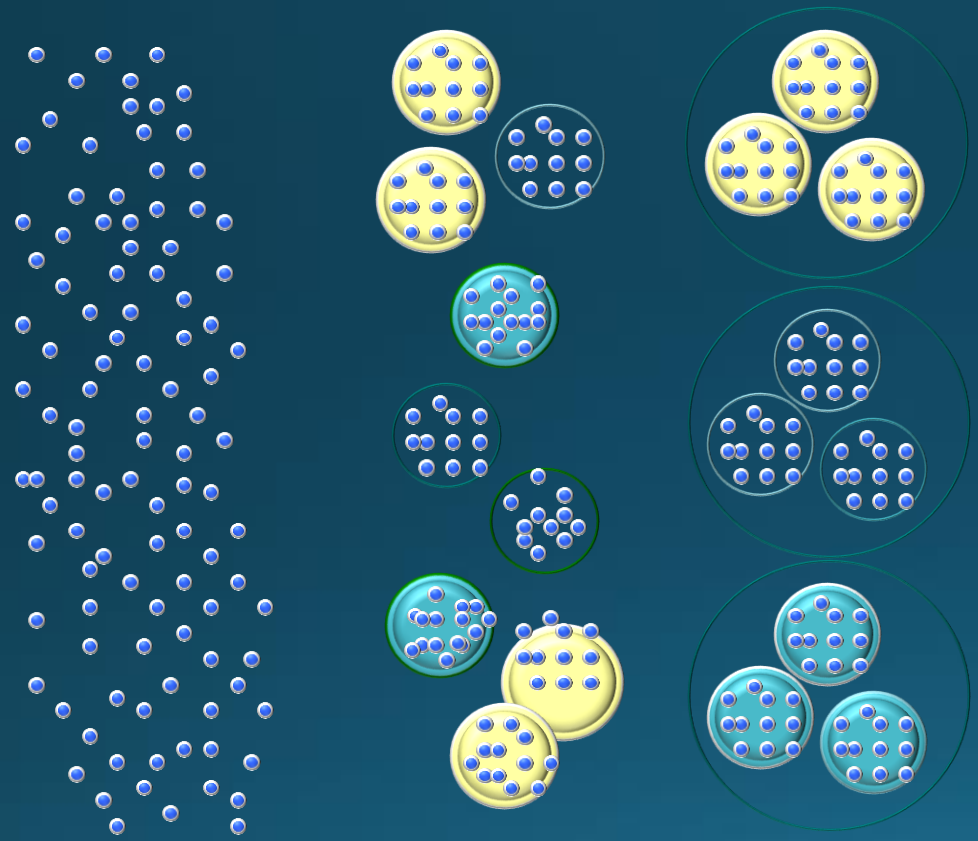
Turning data into knowledge

Raw data	Data subsets	Information	Knowledge	Value creation



Reports and experience

- Assets
- People
- Process
- Results

Decisions

- Best use of funds
- Sustainable operations
- High performance
- Organizational alignment

Business processes	Query databases	High performance

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An AMP is a launch pad!

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Types of AMPs – How do I know what's right for my utility?

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Fit-for-Purpose

ONE SIZE DOES NOT FIT ALL

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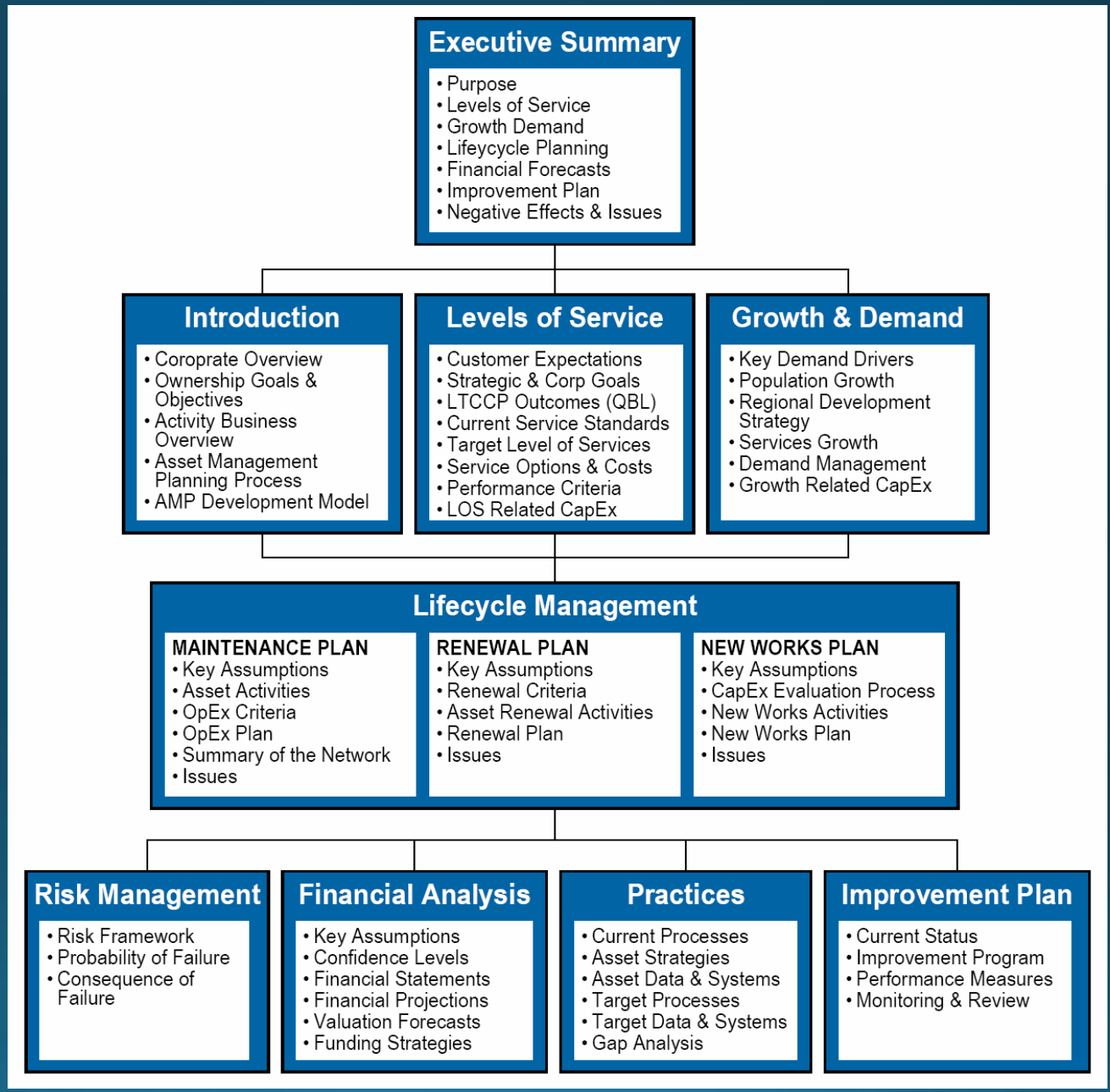
Asset management plans content organization



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Asset Management Plan content organization example

Q1 – What is the State of our Assets?

- Asset Description
- Asset Statistics
- Management Strategy Groups
- Management Strategies
- Condition Assessment
- Probability of Failure
- Consequence of Failure

Q2 – What is Required Level of Service?

- Levels of Service targets and calculations
- Levels of Service measures and performance

Q3 – What Assets are Critical to Sustained Performance?

- Business Risk Exposure

Q4 – What is Our Infrastructure Improvement Plan?

- CIP Information and Integration
- Operations and Maintenance
- Needed Projects

Q5 – What Will it Cost to Implement the Asset Management Plan?

- Cost Estimates
- Year-by-Year Cost Projections

Q6 – What Business Improvement Opportunities Should be Pursued?

- Areas of Evaluation
- Areas of Implementation

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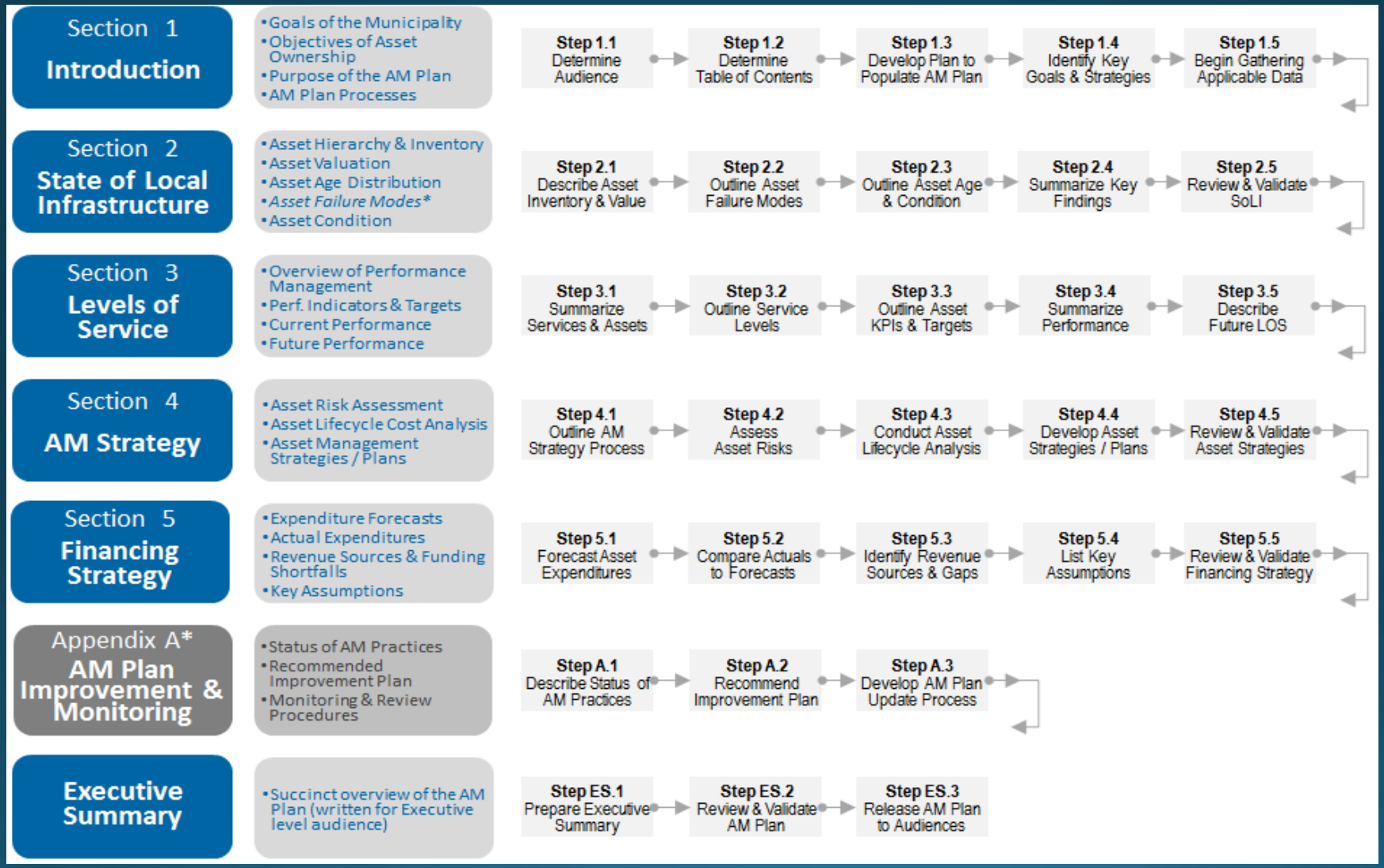
Asset Management Plan content organization example



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Asset Management Plan content organization example

1. Asset Inventory
2. Condition Assessment
3. Failure Modes
4. Residual Lives
5. Management Strategies
6. Estimates of Replacement Costs
7. Levels of Service
8. Business Risk Exposure
9. 30-Year Investment Projection
10. 5-Year Investment Projection
11. Energy Usage Improvements
12. Water Audit

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Asset Management Plan content organization example

1. Introduction to Asset Management

Life Cycle Management Plan

- Life cycle analysis overview
- Asset inventory
- Asset hierarchy
- Valuation and Replacement Cost
- Condition Assessment

2. Asset Management Practices

- Management Strategy Groups
- Failure Modes

3. Future Demand

- Population Changes
- Economic Driver Changes
- Climate and Coastal Condition Changes

4. Levels of Service

5. Business Risk Exposure

6. Financial Summary

- 30-Year Investment Projection
- 5-Year Investment Projection

7. Improvement Plan

- Data Confidence and Quality Assessment
- Business Improvement Recommendations

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Asset Management Plan content organization example

1. Service Area Description

2. Levels of Service

- Existing
- Future

3. Asset Inventory

- Asset Register
- Asset Definition
- Asset Hierarchy
- Asset Inventory Listing
- Installation Profile
- Asset Life Consumption Profile

4. Asset Valuation

5. Risk Assessment

- Probability of Failure
- Consequence of Failure
- System Redundancy
- Business Risk Exposure

6. Management Strategies

7. Financial Projection

8. Improvement Plan Recommendations

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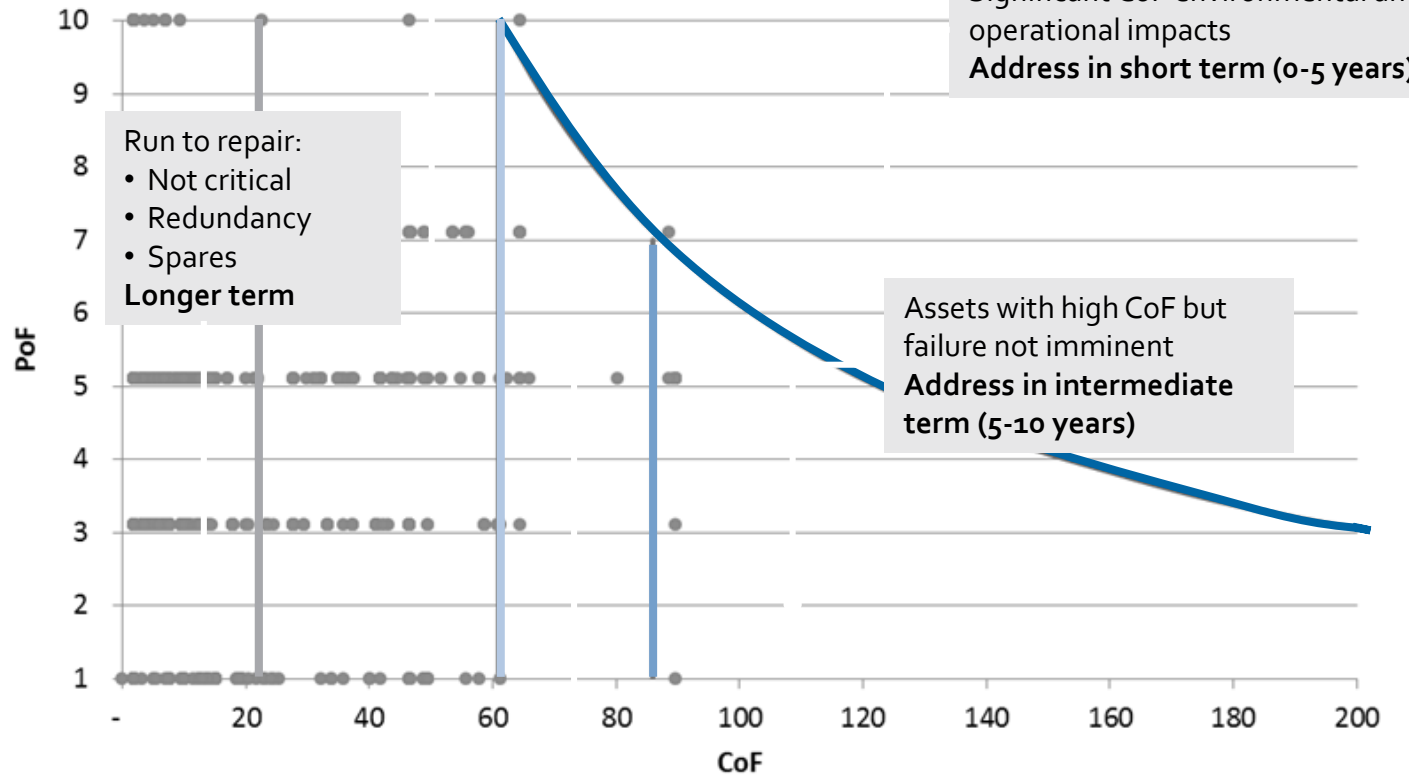
Common element - risk management

Real time / periodic condition monitoring (as applicable)

Significant risk zone:
Significant CoF environmental and operational impacts
Address in short term (0-5 years)

Run to repair:
- Not critical
- Redundancy
- Spares

Longer term



Assets with high CoF but failure not imminent
Address in intermediate term (5-10 years)

Assets with moderate CoF that could migrate to the significant zone
Monitor Frequently

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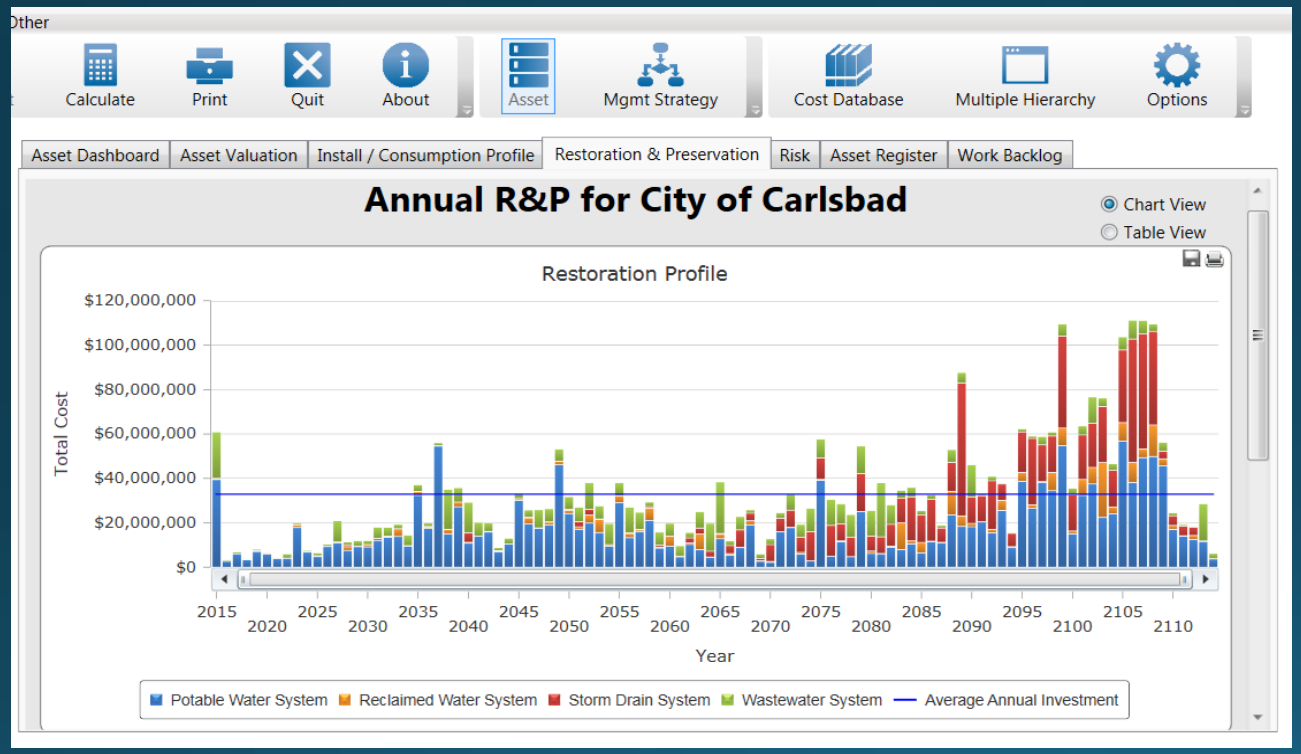
Common element - budget and financial plan



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Uncommon element – challenges to implementing plan

Example asset renewal and enhancement recommendations content

SWMF	Results & Comments	Recommended Actions	Priority
LV20	• Based on visual inspection data, the Sediment Forebay is Condition = 1, Failed • Risk Exposure = 3.00 (Extreme) • Wet Cell, Offline SWMF • Inspection, bathymetric survey and vegetation analysis completed by GHD in 2012. Results include: - Pond Volume is 4,484 M3 - Sediment Volume is 970 m3 - Volume for 5% decrease in SS removal efficiency is 1,200 m3 - Clean out not yet required • Inspection comments are: Good circulation in permanent pool, stagnant water in sediment forebay; excess sediment accumulation in forebay; full visual inspection of inlet made difficult by excess vegetation; non-standard lock used at one of the gates, could not be opened with 104 or 103 key; "No Trespassing" sign suggested • Most recent inspection comments: Overgrown vegetation in forebay; sediment accumulation observed through overgrown vegetation; beaver dam visible in main cell; minor erosion downstream of outlet headwall; no vehicle or construction access (overgrown vegetation/no access road) • Additional comments: There is no clarification of its end state upon assumption from development; there is environmental sensitivity in the area; the discharge from the pond is loaded with sediment; there is a high sand load from development that occurred; significant sediment and decaying vegetation collected in forebay	• Further assess the SWMF & identify options - Protect the natural environment during any renewal operations - Remove overgrown vegetation from the pond - Drain the pond and conduct a detailed sediment survey and visual inspection to reduce sources of error and uncertainty associated a pond full of water - Collect sediment samples and submit to a laboratory for analysis prior to sediment removal - Clean out the accumulated sediment (estimated to be 970 m3 – not yet critical) • Analyze Options & Optimize Solution - Develop analysis input parameters such as costs and benefits (e.g., risk reduction), and timing - Determine the optimal solution by conducting cost / benefit analysis • Define & Program the Project - Define Project Scope of Work, Schedule and Budget - Program project, obtain funding and implement - Complete a detailed pond bottom survey after the sediment removal	1 ($175k for Renewal)

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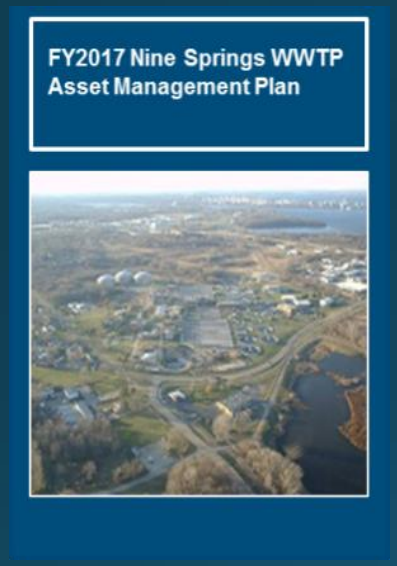
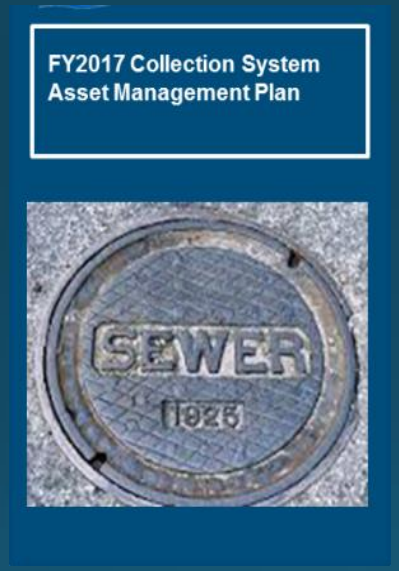
AMPs can be developed for different asset classes and at different hierarchy levels



Facility Assets



Linear Assets

Enterprise

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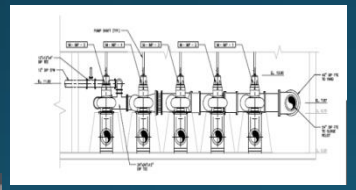
How is the AMP populated?

Existing Electronic Data

GIS/BIM

Field Collection



Drawing & Manuf. O&M Review

Staff Knowledge

Probability of Failure (POF)
x
Consequence of Failure (COF)
x
Mitigation
=
Risk

Business Intelligence

Year Installed

Material

Replacement Cost

Estimated Life

Asset Description	Asset Class	Manufacturer	Model	Serial Number
Pump #1,Mech - Chops	CENTRIFUGAL PUMP		AFPK1032.W404W	P0658916
Pump #2,Mech - Chops	CENTRIFUGAL PUMP		AFP41.2W284W	A0460254
Motor,Pump #1,Mech - Chops	MOTOR			
Motor,Pump #2,Mech - Chops	MOTOR			
Portable Generator,Elect - Chops	EMERGENCY GENERATOR			
Valves,Mech - Chops	GATE VALVE			
Motor,Pump #1,Mech - Huckleberry	MOTOR	WEG	030180T3E286T	10063054662
Motor,Pump #2,Mech - Huckleberry	MOTOR	WEG	030180T3E286T	10063054663
Motor,Mech - Queen Anne	MOTOR	US ELECTRIC		C0380836732 001 F-1
Unit Heater,HVAC - Stage Harbor	HEATER UNIT	CHROMA LOX	3	
Unit Heater,HVAC - Stage Harbor	HEATER UNIT	CHROMA LOX	3	
Motor,Mech - Mill Pond	MOTOR	RELIANCE	45BC03J30X	
Motor,Mech - Mill Pond	MOTOR	RELIANCE	45BC03J30X	
Motor,Pump #2,Mech - Queen Anne	MOTOR	US ELECTRIC		C0380836732 001 F-2
Pump #1,Mech - Queen Anne	CENTRIFUGAL PUMP	FAIRBANKS MORSE		K4H1-080809-1
Pump #2,Mech - Queen Anne	CENTRIFUGAL PUMP	FAIRBANKS MORSE		K4H1-080809-0
Ejector,Mech - Mill Pond	SEWAGE EJECTOR	YEOMANS		66970-1
Ejector,Mech - Mill Pond	SEWAGE EJECTOR	YEOMANS		66970-1
Backup Pump,Mech - Queen Anne,@WPCF	PUMP			
Sump Pump,Mech - Queen Anne	SUMP PUMP			

Asset Register Enhanced with AM Data

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AMP Drives Performance

Most Importantly…

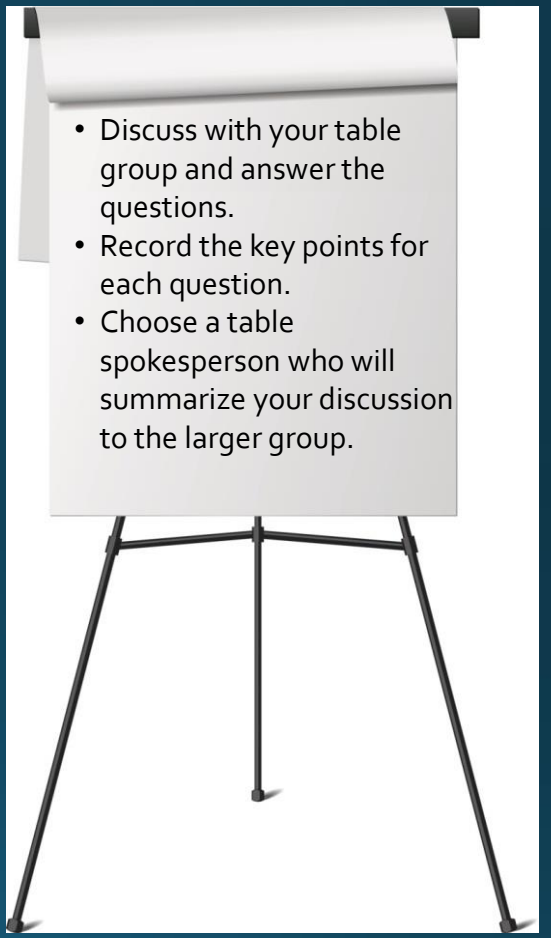
The Asset Management Plan tells the **Story** of the assets

QUESTIONS

AMP Table/Group Exercise

You are on the Asset Management team for your mid-size utility, which provides water, wastewater, and stormwater services to wholesale and retail customers. There is significant rate pressure although your organization has been able to secure modest annual increases over the past five years. The utility commission is starting to ask tougher questions about how assets are being managed and what the long term plan is for utility investment. Last year, due to weather factors and other causes, you saw a significant spike in pipe breaks. There are currently no regulatory compliance failures but this is a growing concern for the organization as there have been a few 'close calls' recently. The GM is particularly concerned about this issue. For customers, flooding from recent heavy rain storms has become the number one issue based on customer feedback and information collected during customer call responses. Your organization is just starting to implement asset management practices and you are starting to work on its first Asset Management Plan.

1. For this scenario, summarize the main objectives and primary purposes of the AMP to this organization
2. How would you organize the content of the AMP to best achieve the objectives and purposes? Why?
3. What are the most important content sections in this scenario? Why?



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