AAEES - Resilient Utility Management - Plan, Respond, Recover and Adapt

Combatting Aging Infrastructure Risks

NJWEA Workshop

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Hazen and Sawyer
Today’s Agenda

• Asset Management Background and Industry Trends
• Gap Analysis, Strategy & Levels of Service Development
• Business Planning
• Infrastructure Evaluation/Planning
• Financial Management/Planning
• Business Intelligence and Performance Reporting
Current Industry Asset Management Trends

**CHALLENGES**
- What is the current state of our infrastructure?
- Are our customers happy with our service?
- What are our business risks?
- Do we have optimized CIP and O&M programs?

**EXTERNAL FORCES**
- Regulatory compliance
- Growth & demand
- Public/Political pressures

**ASSET AGE & CONDITION**
- Aging/deteriorating infrastructure
- Capital/O&M justification

**COST & EFFICIENCY**
- Doing “more with less”
- Move toward a “businesslike” culture

**LEVELS OF SERVICE**
- Demand for higher levels of service
- Improve reliability and minimize failures

**UTILITY TRENDS**
- Embracing AM as an organizational model
- Focusing on capital planning and project justification
- Focusing on machine-learning/predictive analytics
- Leveraging data in a more effective way
What is Asset Management?

Asset Management is not...
- a piece of software
- management of stocks and bonds
- synonymous with “construction management” or “managing assets”
- a project with a defined beginning and end

Asset Management is...
- a formalized approach to doing business
- management of a portfolio of physical infrastructure
- A broader focus than managing assets (things you do to assets)
- A journey of continuous improvement that optimizes the delivery of value for the City and its constituents

Asset Management is the art and science of making the right decisions and optimizing the delivery of value.

Institute of Asset Management
Outcomes and Benefits of Effective Asset Management

Transparency in government
- Knowledge of asset, system, and constituent needs
- Know where resources are allocated
- Understand the impact of financial investment

Ability to “do more with less”
- Optimize existing assets before constructing new
- Lower lifecycle costs of assets
- Work smarter, not harder
- Enhance existing workflows to be more effective and efficient
- Obtain more value for the same financial investment

Proactive management of physical infrastructure

Planned expenditures to ensure financial sustainability

Long-term customer service and regulatory compliance

Equitable and defensible decisions with widespread understanding and acceptance

A failure in the heart of the Boston’s Financial District (Source: The Boston Globe)

Airline industry adopted better AM Practices in 1960s & 1970s
Before AM – 60 crashes per million takeoffs
After AM – 2 crashes per million takeoffs & 40% lower total maintenance costs
Typical Asset Management Initiatives

- Gap Analysis, Strategy & LOS Development
- Business Planning
- Infrastructure Evaluation/Planning
- Financial Management/Planning
- Business Intelligence and Performance Reporting
Gap Analysis and Strategy Development
All Asset Management Frameworks Are Aimed at Optimizing Level of Service, Risk and Life Cycle Cost
Asset Management Framework Maturity Assessment
Institute of Asset Management Maturity Assessment

Data Gathering → Staff Interviews → Scoring → Validation

- **Maturity Level 0**: The City has not recognised the need for this requirement and there is no evidence of assessment in place.
- **Maturity Level 1**: The City has identified the need for this requirement and there is evidence of intent to progress.
- **Maturity Level 2**: The City has identified the need for this requirement and has demonstrated that these are being progressed with measurable and milestones defined.
- **Maturity Level 3**: The City can demonstrate that it is systematically and consistently achieving the requirements and that there are being progressed with milestones and milestones defined.
- **Maturity Level 4**: The City can demonstrate that it is systematically and consistently achieving the requirements and that there are being progressed with milestones and milestones defined.
- **Maturity Level 5**: The City can demonstrate that it is systematically and consistently achieving the requirements and that there are being progressed with milestones and milestones defined.

Innate → Aware → Developing → Competent → Mature → Industry Leader
Implementation Roadmap Development Process

Identify and Validate Improvement Initiatives
- Initiatives based on gaps discovered during Maturity Assessment
- Aligned with each group and element of the Institute of Asset Management Framework

Prioritize Initiatives
- Define priority by desired start date
- Consider predecessors and dependencies

Develop Implementation Roadmap
- Sequence Initiatives according to priority and dependencies
- Define Start/Finish/Duration
- Assign resources and responsibilities
- Identify other key stakeholders
- Develop planning-level budget

Finalize Implementation Roadmap
- Finalize sequence of Initiatives, schedule, budget, and resources
- Develop Initiative Workplans for Immediate Priority Initiatives
- Begin communication efforts to inform and gain support

Validate
- Review with stakeholders and validate and refine
- Re-organize initiatives, as appropriate
- Confirm and update availability of resources
Program Implementation Initiatives and Implementation Roadmap
# Program Implementation Initiatives and Implementation Roadmap

<table>
<thead>
<tr>
<th>No.</th>
<th>Institute of AM Standard</th>
<th>Initiative</th>
<th>Brief Description</th>
<th>Predecessors</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Group 1: Strategy and Planning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>Asset Management Policy</td>
<td>Develop organization-wide Asset Management Policy</td>
<td>A statement of commitment to what COS must do to deliver and comply.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>Asset Management Strategy &amp; Objectives</td>
<td>Define the scope of the AM Program</td>
<td>Information for the whole asset portfolio, verification of the business units and the asset classes for which they are responsible and the supporting functions (IT, ITPM, IT, IS, IS, etc.)</td>
<td>S2</td>
<td>Immediate</td>
</tr>
<tr>
<td>S3</td>
<td>Asset Management Strategy &amp; Objectives</td>
<td>Develop the AM strategy and objectives</td>
<td>Written description of what is intended to be done (the strategy) and what must be delivered (objectives). Reinforces the alignment between strategic directions and tactical delivery.</td>
<td>S2</td>
<td>Immediate</td>
</tr>
<tr>
<td>S4</td>
<td>Demand Analysis</td>
<td>Establish strategic Levels of Service</td>
<td>List of constituent-centric statements typically driven by regulatory requirements and customer expectations that communicate COS’s commitment to deliver service at a specified level of quality and reliability.</td>
<td>S2</td>
<td>Immediate</td>
</tr>
<tr>
<td>S5</td>
<td>Strategic Planning</td>
<td>Develop a Strategic Asset Management Plan (SAMP) that encompasses IAM, DWP, W&amp;S, and associated divisions</td>
<td>Document that aligns with City-level strategic planning documents and includes an AM Policy Statement, specific AM Strategic Objectives, definition of assets covered, definition of AM framework adopted, business units impacted, and associated procedures. Takes a long-term view and considers the combination of organization needs, stakeholder expectations, and the realities of existing assets and AM capabilities. Sets the stage for system-level Asset Management Plan.</td>
<td>S2</td>
<td>Immediate / Near-term</td>
</tr>
<tr>
<td>S6</td>
<td>Asset Management Planning</td>
<td>Develop system-specific AMPs for asset systems identified in the SAMP</td>
<td>Asset management plans (paper or digital) for each major asset class will include: - Performance against levels of service - Asset condition - Future demands - Risk assessment - Life-cycle management plan - Rehabilitation and replacement needs - Capital and operating and maintenance budget forecasts</td>
<td>S5</td>
<td>Immediate / Near-term</td>
</tr>
</tbody>
</table>

- **S1**: Asset Management Policy
- **S2**: Asset Management Strategy & Objectives
- **S3**: Asset Management Strategy & Objectives
- **S4**: Demand Analysis
- **S5**: Strategic Planning
- **S6**: Asset Management Planning

**Priority**:
- Immediate
- Immediate / Near-term
- Medium-term
**Initiative Workplan Development**

**Workplan Elements**

- Executive Sponsor / Champion / Owner / Key Stakeholders
- IAM Conceptual Model Group/Element
- Priority
- Funding Strategy
- Implementation Costs
- Current State (Issues/Problem/Concerns)
- Future State ( Desired Specific/Measurable Outcomes)
- Investigation and Solution Planning Tasks (Key Activities)
Levels of Service (LOS)

- A commitment to deliver a specified level of service, quality, and reliability
- Determined by the appropriate governing body in collaboration with utility staff and customers
- Relate to funding levels
- Describe how much, of what nature, and how frequently the service should be provided
- Help determine when to maintain, replace, or rehabilitate assets
Levels of Service - Example
City of Fort Lauderdale Department of Public Works

✓ Establishes the appropriate level and type of resources to satisfy LoS requirements
✓ Establishes most efficient utilization of resources through effective planning & scheduling

Asset Class
- similar assets across all watersheds

CoF
- Consequences of Failure
- maximum level of inspection and preventive and corrective maintenance
- focused on the most critical infrastructure and high priority areas, addresses environmental compliance

LoS A
- LoS A

LoS B
- LoS B

LoS C
- LoS C

<table>
<thead>
<tr>
<th>Asset</th>
<th>LoS C</th>
<th>LoS B</th>
<th>LoS A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Valve</td>
<td>Inspect &amp; test once annually</td>
<td>Inspect &amp; test twice annually</td>
<td>Inspect &amp; test quarterly</td>
</tr>
<tr>
<td>Inlet</td>
<td>Clean annually</td>
<td>Clean quarterly</td>
<td>Clean monthly</td>
</tr>
<tr>
<td>Manhole</td>
<td>Clean annually</td>
<td>Clean quarterly</td>
<td>Clean monthly</td>
</tr>
<tr>
<td>Gravity Main</td>
<td>WS 1,2,3,4,6,7,8, &amp; 10 annual</td>
<td>WS 5 Semi-annual</td>
<td>WS 9 Quarterly</td>
</tr>
<tr>
<td>Pollution Control Structure</td>
<td>Inspect annually</td>
<td>Inspect quarterly</td>
<td>Inspect monthly</td>
</tr>
<tr>
<td>Pump Station</td>
<td>PS #3 quarterly</td>
<td>PS #4&amp;5 monthly</td>
<td>PS #1&amp;2 semi-weekly</td>
</tr>
</tbody>
</table>
Managing Organizational Change is Vital

Apply Throughout Development and Implementation

1. Preparing for Change
   - Awareness of the Need for Change
   - Desire to Participate and Support the Change

2. Managing Change
   - Knowledge on How to Change
   - Ability to Implement Skills and Behaviors

3. Reinforcing Change
   - Reinforcement to Sustain the Change

Stakeholder analysis
- Senior leadership team
- Workflow impact analysis
- Risk assessment
- Key messages/theme

Stakeholder roadmap
- Communication plan
- Training plan
- Organization roles and responsibilities assessment
- Resistance management plan
- Risk register

Implementation checklists
- Stakeholder interviews
- Dynamic gap analysis
- Knowledge management roadmap
- Training support
Asset Management Requires Key Organizational Roles / Responsibilities

- Asset Management Strategic Planning Committee
- Asset Manager
- AM Planning and Standards
- CIP Review and Prioritization Committee
- Service Level, Reliability, and Reporting Committee
- IT/Business Planning
- Information Technology Committee
- Infrastructure Planning
- Work Planning and Scheduling Committee
- Asset Condition and Criticality Committee
- Preventive and Reliability Centered Maint Committee
Balancing Diverse Business Drivers is the Key to Organizational Optimization for AM

1. Business process workflow optimization
2. Staffing alignment with levels of service
3. Information management / system fitness
4. Knowledge capture & management
5. Performance measurement & tracking
Typical Asset Management Systems and Data Flow
Data / System Management

Data Lifecycle Approach

- Create: What data needs to be generated?
- Collect: How should the data be collected?
- Connect: How should the data interact with other systems?
- Cleanse: Is the data accurate and complete?
- Compile: Is the data in the right place?
- Classify: Are data attributes classified effectively?
- Control: How should data be managed and who is responsible for data?
- Crunch: Is data being crunched the right way?
- Communicate: Are data driven insights being visualized and communicated?
Streamlined Data Analysis and Integration

- **LIMS**
  - Water Quality Data
  - Facility Operational Data
  - Installed and Depreciated Costs
  - Capacity & Pressure Information

- **GIS**
  - Linear Asset Risk, LCC & EUL

- **CMMS**
  - Vertical Asset Risk, LCC & EUL

- **SCADA**
  - Customer Complaints

- **HYDRAULIC MODEL**
  - Management Reporting & Decision Support

- **FMIS**
  - R&R Planning

- **CIS**
  - Rate Planning
Infrastructure
Evaluation/Planning
Core Asset Management Tool – GIS (Linear Assets)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Purpose</th>
</tr>
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<tbody>
<tr>
<td>Length</td>
<td>• Calculate asset value</td>
</tr>
<tr>
<td></td>
<td>• Indicate complexity of maintenance</td>
</tr>
<tr>
<td></td>
<td>• Calculate defects per foot of pipe</td>
</tr>
<tr>
<td></td>
<td>• Necessary for hydraulic modeling</td>
</tr>
<tr>
<td>Diameter</td>
<td>• Calculate asset value</td>
</tr>
<tr>
<td></td>
<td>• Macro understanding of system performance</td>
</tr>
<tr>
<td></td>
<td>• Necessary for hydraulic modeling</td>
</tr>
<tr>
<td>Material</td>
<td>• Calculate asset value</td>
</tr>
<tr>
<td></td>
<td>• Maintenance and repair methods</td>
</tr>
<tr>
<td></td>
<td>• Deterioration rates</td>
</tr>
<tr>
<td>Depth</td>
<td>• Calculate repair costs</td>
</tr>
<tr>
<td>Installation Date</td>
<td>• Calculate asset value</td>
</tr>
<tr>
<td></td>
<td>• Indicate quality of material and installation</td>
</tr>
<tr>
<td></td>
<td>• Future planning</td>
</tr>
<tr>
<td></td>
<td>• C-Factor determination for hydraulic modeling</td>
</tr>
</tbody>
</table>
• Focus on **Core Functions 1st:**
  - Asset Inventory Completeness
  - Work Order Management
  - Risk Assessment
  - Cost Accounting

• **Phase In Supporting Functions:**
  - Parts Management
  - Purchasing
  - Fleet Management

• **Key Technical Elements:**
  - GIS Integration
  - Reporting

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Core Asset Management Tool – CMMS (Vertical Assets)

**Typical Asset Hierarchy**

1. Organization
2. Network
3. Utility Type
4. Facility
5. Process
6. Group
7. Asset
8. Asset - Child

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**Asset Attribute Prioritization**

- **High Cost, High Value**
- **Low Cost, Low Value**
- **High Cost, Low Value**
- **Low Cost, High Value**
Asset Risk – How is it Defined?

Risk is defined as the quantification of the likelihood of failure (condition) times the quantification of the consequence of such failure (criticality), factoring in any required adjustments for redundancy or risk mitigation.
Facility Risk Assessment

Physical Condition

Performance Condition

Likelihood of Failure (LoF)

Consequence of Failure (CoF)

Risk Score

<table>
<thead>
<tr>
<th>Probability of Failure (PoF)</th>
<th>1 Very Good</th>
<th>2 Good</th>
<th>3 Fair</th>
<th>4 Poor</th>
<th>5 Very Poor</th>
<th>Criticality Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Low Impact</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>2 Low Impact</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>3 Medium Impact</td>
<td>7%</td>
<td>63%</td>
<td>27%</td>
<td>0%</td>
<td>0%</td>
<td>117%</td>
</tr>
<tr>
<td>4 High Impact</td>
<td>2%</td>
<td>10%</td>
<td>4%</td>
<td>1%</td>
<td>0%</td>
<td>17%</td>
</tr>
<tr>
<td>5 High Impact</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Condition Totals

9% 93% 31% 1% 0% 134% 134%

Risk Score = PoF * CoF

Pump Station Risk Results

Low

Medium

High
Data Collection Strategies, Tools, and Technologies

- ESRI Survey-123
- Review, reconcile, and add asset inventory data
- Perform condition assessment
- Embed and link data, photos, as-builts
- Increase efficiency
  - Reduces time on site by 25%
  - Reduces time to transfer & QC data by 25%
  - Increases data quality
360° Photos Can Easily Link to Inspection Forms

Wet Well Inspection
Risk-Based Inspection and Maintenance

Benefits:

- Better estimate of EUL
- Avoid critical failures
- Optimize inventory and resources
Pipe Network Criticality (CoF)

| CRITERIA                  | CLASS 1 - Minor Criticality | CLASS 2 - Moderate Criticality | CLASS 3 - High Criticality |
|---------------------------|----------------------------|-------------------------------|----------------------------
| Traffic                   | Located on a road categorized as Interstate | Located on a road categorized as Primary |                        |
| Educational Services      | Serving a college, university, or a high school | Serving a middle school, private school, elementary school, or technical school |                |
| Health Services           | Serving a medical facility, hospital, EMS, fire station, dialysis center, or authorized needs | Serving an assisted living center, nursing homes, or adult day care |                |
| Military Services         | Serving Military Facilities | —                             |                |
| Municipality Services     | Serving Critical Municipal Facilities (Courthouse, City Hall etc.) | —                             |                |
| Entertainment Services    | Serving Virginia Beach Amphitheater/Sportsplex/Convention Center | Serving a community youth organization |                |

[Map showing criticality zones]
Pipe Cohort EUL Using Break Rate and LOS

![Graph showing different materials and their corresponding EUL values based on break rate and LOS.](image-url)
Risk and LOS Prioritization

Cumulative Miles Below Break Rate

- **\( \leq \text{Target Br:} \) 1,100 miles**
- **1 to 2.5x Target Br:** 200 miles
- **2.5 to 3x Target Br:** 25 miles
- **> 3x Target Br:** 200 miles

Cumulative Pipe Miles

Current Break Rate (breaks/100 miles/yr)
LOS Assessment and Funding Analysis

Annual Funding Analysis

Break Rate

Millions

Budget
System Break Rate
$2M System Break Rate
No Funding
Unlimited Funding
Financial Management/Planning
CIP Prioritization Leveraging Risk Assessment

1. Asset Prioritization through Risk Analysis

2. Project Scoping and Bundling

3. Project Prioritization

### Risk Assessment

<table>
<thead>
<tr>
<th>Risk Score = PoF * CoF</th>
<th>Probability of Failure (PoF)</th>
<th>Criticality Totals</th>
<th>Pump Station Risk Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very Good</td>
<td>1</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>3</td>
<td>Fair</td>
<td>1</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>Poor</td>
<td>1</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>Very Poor</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consequence of Failure (CoF)</th>
<th>Condition Totals</th>
<th>Criticality Totals</th>
<th>Probability of Failure (PoF)</th>
<th>Pump Station Risk Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Impact</td>
<td>9</td>
<td>93</td>
<td>93%</td>
<td>7</td>
</tr>
<tr>
<td>Medium Impact</td>
<td>93</td>
<td>93</td>
<td>93%</td>
<td>126</td>
</tr>
<tr>
<td>High Impact</td>
<td>93</td>
<td>93</td>
<td>93%</td>
<td>134</td>
</tr>
</tbody>
</table>

- **Probability of Failure (PoF)**: Very Good (0%), Good (0%), Fair (0%), Poor (0%), Very Poor (0%)
- **Criticality Totals**: Very Good (1), Good (1), Fair (1), Poor (1), Very Poor (1)
- **Pump Station Risk Results**: Low (7), Medium (126), High (134)

### Annual R&R Cost Projection

- **Total**: $334M

### Condition Totals

- **Probability of Failure (PoF)**: Very Good (93), Good (93), Fair (93), Poor (93), Very Poor (93)
- **Criticality Totals**: Very Good (93), Good (93), Fair (93), Poor (93), Very Poor (93)
- **Probability of Failure (PoF)**: Very Good (93), Good (93), Fair (93), Poor (93), Very Poor (93)
- **Total Risk Score**: 134

### Risk Score Calculation

- **Risk Score = PoF * CoF**
- **Probability of Failure (PoF)**: Very Good (0%), Good (0%), Fair (0%), Poor (0%), Very Poor (0%)
- **Criticality Totals**: Very Good (1), Good (1), Fair (1), Poor (1), Very Poor (1)
- **Pump Station Risk Results**: Low (7), Medium (126), High (134)

### Total Project Prioritization

- **Total Project Prioritization Score**: 134

### Summary

CIP Prioritization leverages risk assessment through project scoping and bundling, with cost projections and prioritization criteria.
CIP Planning and Prioritization Process

Creating a level playing field for apples-to-apples comparison of projects across all organizational Divisions, Branches, and ASSETS

1. Identify and develop criteria & definitions
2. Assign & Validate Weighting
3. Develop Criteria Scoring Definitions
4. Develop BCE Templates
5. Conduct CIP Pilot Testing
6. Update Process Flow
7. PM System Integration

Aligned with Strategic Objectives and Asset Management Program
Prioritization Aligned with Triple-Bottom-Line

Newport News Water Works

**CONSEQUENCE OF FAILURE**

**SOCIAL**
1. Safety
2. Public Benefit/Perception
3. Service Level/Reliability
4. Community/Growth
5. Process Effectiveness/Institutional Knowledge

**ENVIRONMENTAL**
1. Regulatory/Environmental
2. Efficiency/Energy

**ECONOMIC**
1. Financial
2. O&M

**PROBABILITY OF FAILURE**
1. Physical Condition
2. Process/Performance Condition

**BUSINESS RISK EXPOSURE**
Develop BCE Templates

- Summary Information
- Project Driver
- Project Description and Justification
- Project Financial Analysis
- Project Schedule Detail
- Alternatives Evaluation
- Project Constraints / Dependencies
- Supporting Narrative
- Prioritization Analysis
### Physical Condition Criteria

The current state of repair and operation for a collective group of assets included in a project. Condition scores should be based on documented observation of physical and operational condition as reflected by: service/operating conditions, historical maintenance, and overall age. The physical condition is a mechanism to assess the probability of failure for a collective group of assets in a project. When applying scores, consider probability of asset failure should the proposed project not be implemented, and the existing assets continue to deteriorate.

For infrastructure projects, this evaluation is typically based on results from a visual inspection, historic data and/or feedback from O&M staff and may include more advanced condition assessment if available (i.e. oil sampling, vibration analysis, thermography, etc.). For non-aging infrastructure projects, this would be determined based on internal or external consulting studies and/or information contained in business cases.

For projects where formal condition assessment information is available (typically aging infrastructure projects) initial scoring should be based on an average physical condition scores for all assets included in the project. Adjustments can then be made to reflect the aggregated project and supporting justification should be provided in the prioritization analysis section of the business case.

<table>
<thead>
<tr>
<th>12. PRIORITIZATION ANALYSIS</th>
<th>Project Manager Evaluation Score (1-5)</th>
<th>Justification / Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criteria</strong></td>
<td></td>
<td>To be completed by Project Manager/Business Case Owner</td>
</tr>
<tr>
<td>Physical Condition</td>
<td></td>
<td></td>
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<tr>
<td>Process Performance Condition</td>
<td></td>
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<tr>
<td>Strategic Plan Alignment</td>
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<tr>
<td>Regulatory/Environmental</td>
<td></td>
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<tr>
<td>O&amp;M</td>
<td></td>
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<tr>
<td>Service Level / Reliability</td>
<td></td>
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<tr>
<td>Safety</td>
<td></td>
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<tr>
<td>Public Benefit</td>
<td></td>
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<tr>
<td>Financial</td>
<td></td>
<td></td>
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<tr>
<td>Efficiency / Energy</td>
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<td></td>
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<tr>
<td>Process Effectiveness / Institutional Knowledge</td>
<td></td>
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</tbody>
</table>
### Project Scoring Framework

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Physical Condition</th>
</tr>
</thead>
</table>
| Project Manager Evaluation Score (1-5) | Overall Rating – Excellent Condition
| Justification / Explanation | To be completed by Project Manager/Business Case Owner |
|                               | 5
|                               | Effective life exceeded and/or excessive level of maintenance required |
|                               | A high risk of breakdown or imminent failure with serious impact on performance |
|                               | No additional life expectancy with immediate replacement or rehabilitation needed |
|                               | Could initiate immediate funding request due to “Urgent Necessity” in the near term |
|                               | Replacement or major rehabilitation needed immediately |
|                               | Overall Rating – Good
|                               | Sound and well maintained, showing only slight signs of normal wear |
|                               | Delivering full efficiency with little or no performance deterioration |
|                               | Only minor renewal or rehabilitation may be needed in the near term |
|                               | Could be addressed with preventive measures |
|                               | Overall Rating – Moderate
|                               | Functionally sound and acceptable and showing signs of normal wear |
|                               | May have minor failures or diminished efficiency and with some performance deterioration |
|                               | Moderate renewal or rehabilitation needed in the short term |
|                               | Overall Rating – Poor
|                               | Functions but requires a high level of maintenance to remain operational |
|                               | Shows abnormal wear and is likely to cause significant performance deterioration in the near term |
|                               | Replacement or major rehabilitation needed in the short term |
|                               | Overall Rating – Very Poor
|                               | Effective life exceeded and/or excessive level of maintenance required |
|                               | A high risk of breakdown or imminent failure with serious impact on performance |
|                               | No additional life expectancy with immediate replacement or rehabilitation needed |
|                               | Could initiate immediate funding request due to “Urgent Necessity” in the near term |
|                               | Replacement or major rehabilitation needed immediately |

#### CIP Projects

- **High Priority**
- **Medium Priority**
- **Low Priority**

<table>
<thead>
<tr>
<th>Project Priority Score</th>
<th>Project Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

- Overall Rating – Excellent Condition
  - Recently installed asset
  - Fully operable, well maintained, and consistent with current standards
  - Little to no wear shown and no repairs are necessary
  - Does not impact overall performance and meets all expected future requirements
Business Intelligence and Performance Reporting
Performance Reporting and Business Intelligence
Data Analytics and Visualization using Business Intelligence Applications

1. Realize
   Data Capture & Validation
   - Support connectivity and engagement
   - Develop performance benchmarks and baselines
   - Identify key performance indicators and metrics

2. Organize
   Curation & Integration
   - Support connectivity and integration
   - Develop performance benchmarks and baselines
   - Identify key performance indicators and metrics
   - Information accessibility

3. Analyze
   Data Analytics
   - Transform data into actionable intelligence
   - Predictive process operations and O&M needs
   - Root cause analysis
   - Proactive action on process operations

4. Visualize
   Reporting & Visualization
   - Optimize staff engagement and data transparency
   - Track progress toward strategic goals

5. Optimize
   BI & Knowledge Sharing
   - Improve financial execution
   - Enhance customer experience
   - Optimize operations
   - Manage risks and operations costs
Visualization Tools like Power BI Provide a Flexible Platform to Answer any Question with Available Data

- Does my current CIP accurately reflect the actual project implementation schedule?
- Based on my project schedules, will I be over or under budget?
- Do I have enough staff to execute my plan?
- How will my capital needs change if I experience lower than anticipated growth?

Enables Rapid Response to Changing Conditions
Digital Asset Management Plans

Business Intelligence Applications Allow for Dynamic Plan Development

- Identify long-term R&R needs based on risk assessment information
- Identify and updated capital and maintenance priorities
- Track CIP execution
- Monitor operational information at the asset level
- Track maintenance program effectiveness
- Conduct performance benchmarking
- Monitor process status and improvements
Machine Learning Enhances a Utility’s Ability to Address Challenges Across its Operations

**ML Toolbox**

1. Data Quality Check
2. Correlation Analysis
3. Missing Value Inference
4. Prediction Modeling
5. Variable Importance
6. Sensitivity Analysis
7. Scenario Analysis

**Projects Highlighted**

- **City of Raleigh, NC**
  - Wet weather prediction and plant optimization
- **Chino Basin Desalter Authority, CA**
  - RO Membrane Optimization in Chino II
- **Jefferson County, AL**
  - Predict Sewer Asset Deterioration Rate
- **Salt River, AZ**
  - Water Supply Prediction
- **Miami Beach, FL**
  - Lead Service Line Identification
- **Metro Water Recovery, CO**
  - Cake %TS prediction
- **Dayton, OH**
  - H₂S Release Explanation
- **City of Burlington, NC**
  - PFAS forensics

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PVSC Phase 1: Decant Facility GeoBIM

Decant Facility BIM integrated with 3D GIS Scene in PVSC Enterprise GIS
## Tangible Impacts

<table>
<thead>
<tr>
<th>Current State</th>
<th>Enhanced State</th>
</tr>
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<tbody>
<tr>
<td>Varying levels of awareness and knowledge of AM</td>
<td>Unified understanding, culture shift, and formal organizational roles</td>
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<tr>
<td>Disparate and immature IT tools and systems</td>
<td>Enterprise systems, decision support tools, reporting and visualizations</td>
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<td>Reactive and time-based maintenance</td>
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<td>Prioritization of future needs is largely based on institutional knowledge</td>
<td>Long-range funding strategy across asset classes based on risk</td>
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</tbody>
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**Staff and Culture**

- Varying levels of awareness and knowledge of AM
- Unified understanding, culture shift, and formal organizational roles

**Processes, Systems, and Data**

- Disparate and immature IT tools and systems
- Enterprise systems, decision support tools, reporting and visualizations

**Operations and Maintenance**

- Reactive and time-based maintenance
- Blend of preventive, predictive, and reliability-centered maintenance

**Capital and Financial Planning**

- Prioritization of future needs is largely based on institutional knowledge
- Long-range funding strategy across asset classes based on risk
AAEES - Resilient Utility Management - Plan, Respond, Recover and Adapt

Combatting Aging Infrastructure Risks

NJWEA Workshop

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