Utilizing a Streamlined Risk Based Asset Management Approach for System Wide Project Prioritization

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dallas water utilities
city of dallas

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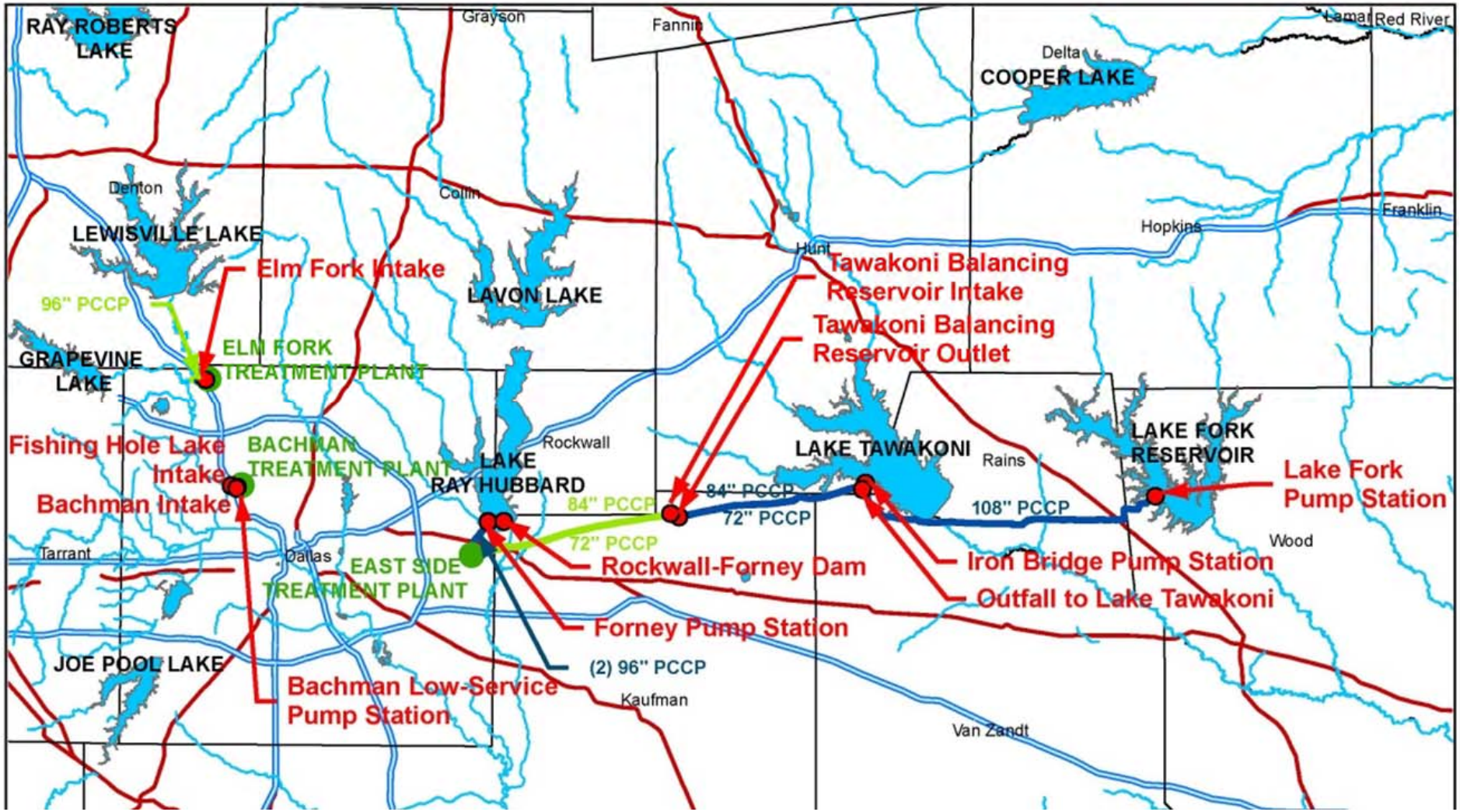
TACWA Meeting

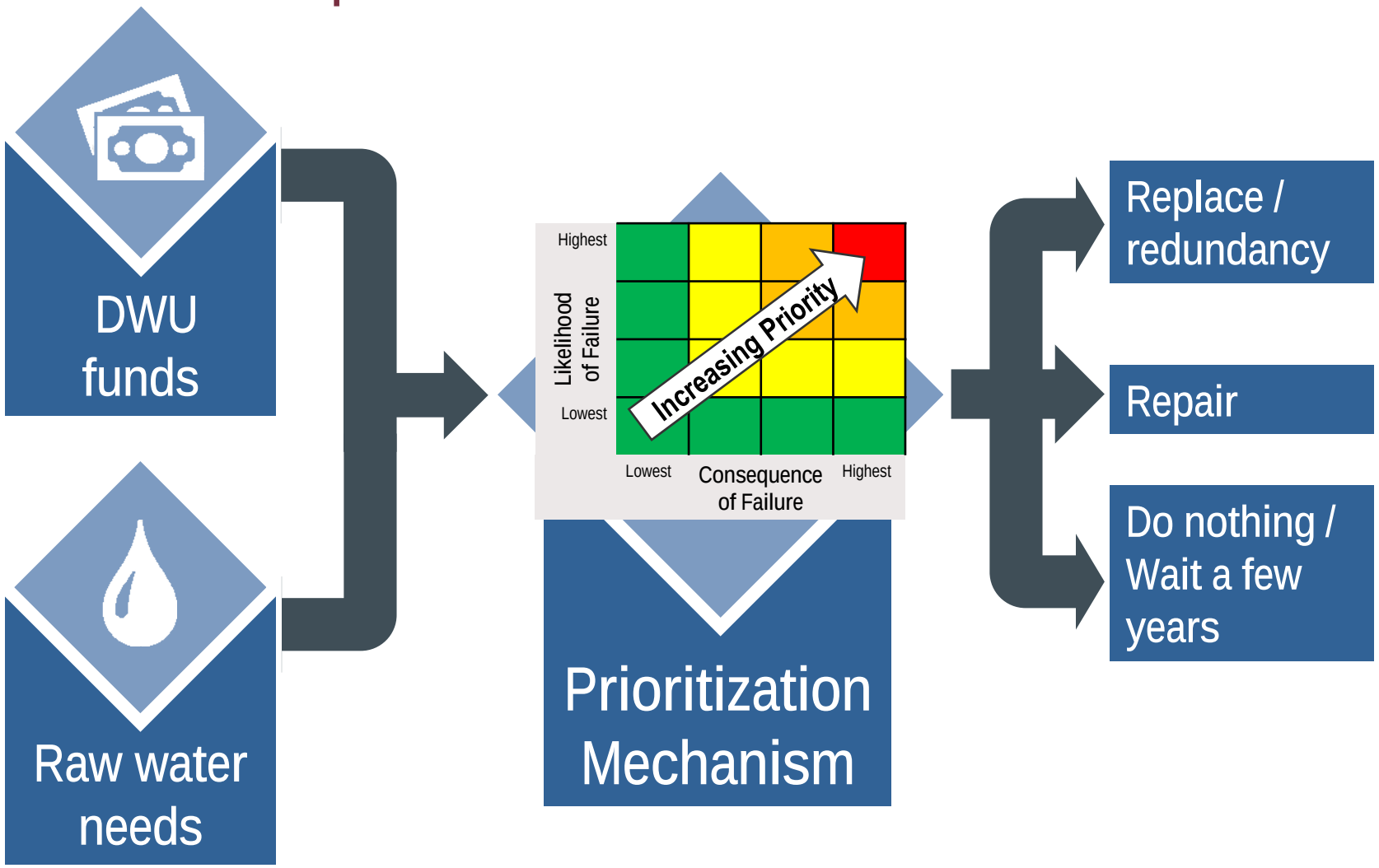
DWU has a complex water system with many different sources



DWU currently implements a typical asset management program

Context of Organization	• Stakeholder needs/expectation • Goals and objectives
Leadership	• Roles and responsibilities • AM Policy
Planning	• Risk assessment • Asset Management Plans (Capital & O&M)
Support	• IT systems & data • Training, communications, and documentation
Operations	• SOP's • Change management and outsourcing
Performance Evaluation	• Performance measures and tracking • Program audits (internal or external)
Improvement	• Process for implementing corrective actions • Preventative and predictive actions

The overall goal for the project is to develop a prioritization mechanism for critical repairs



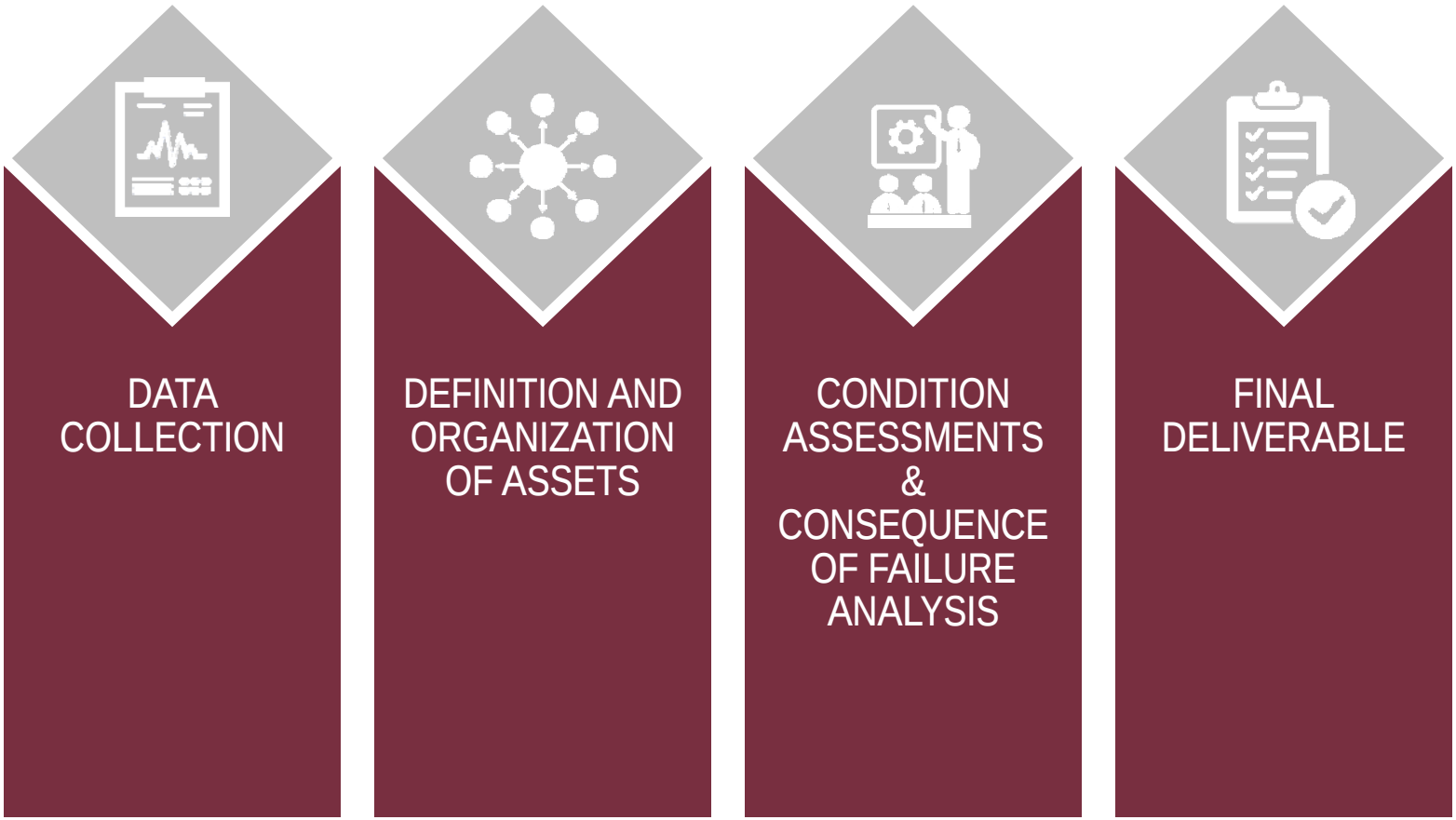
An added benefit is assisting DWU with new asset mgmt. initiatives

- Enterprise Work-order & Asset Management System (EWAMS)
- Maximo Computerized Maintenance Management System Implementation (CMMS)
- Uniform Asset Identification and Scoring

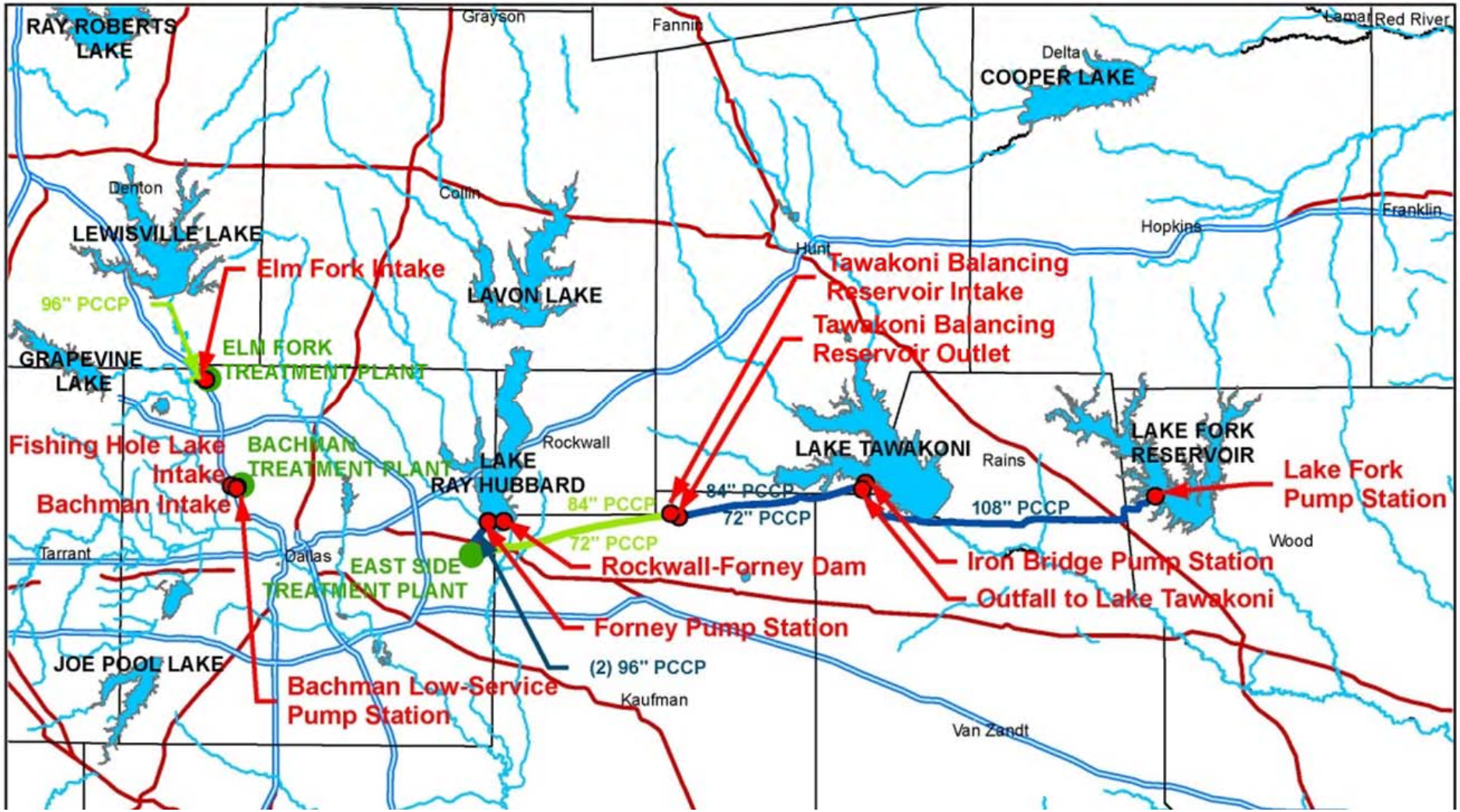
Our streamlined risk based planning approach ...

- Saves time for data capture, organization, and consolidation
- Characterizes risk and allows for sensitivity analyses of projects and repairs
- Develops a defensible and consistent prioritization method for CIP planning

The project can be broken into 4 main components

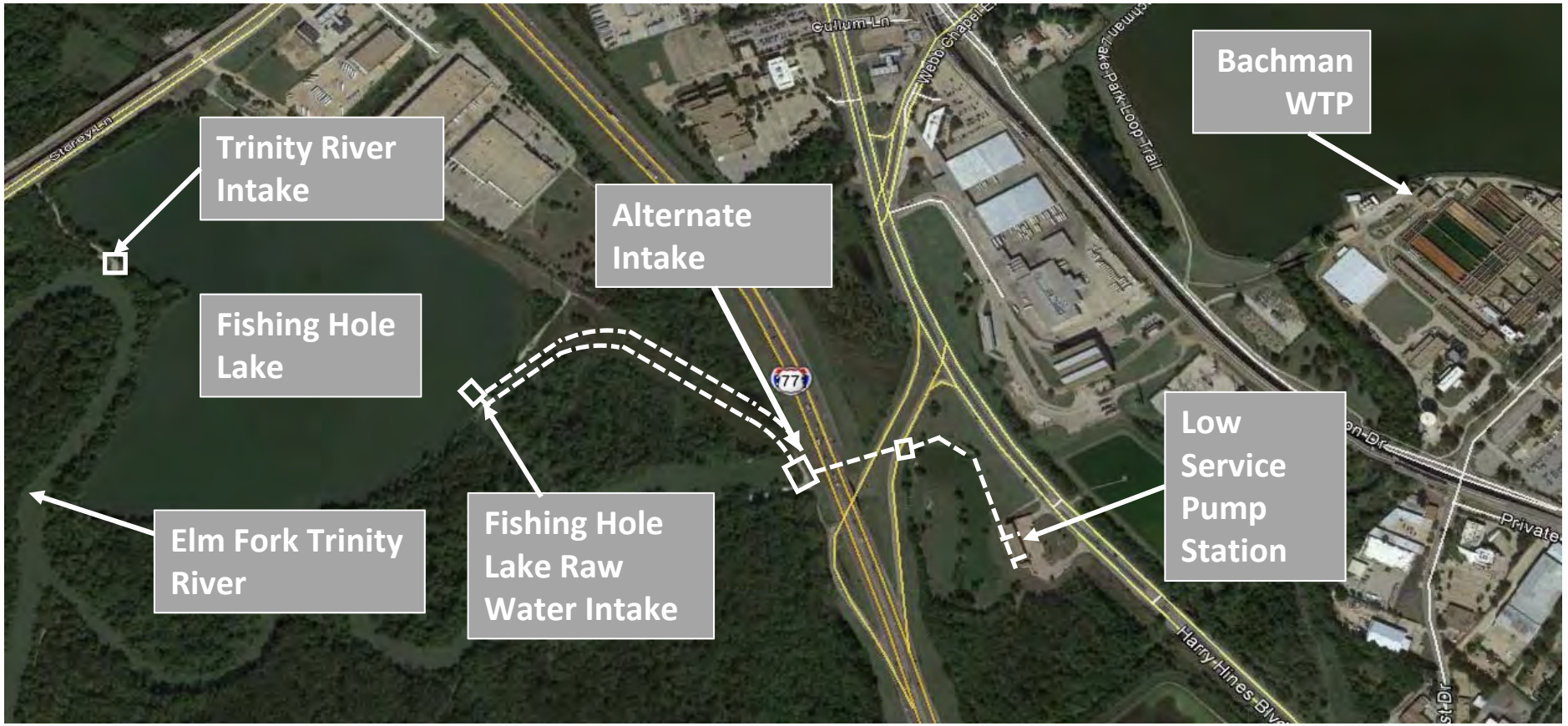


Water facilities can be divided geographically into Eastern and Western groups

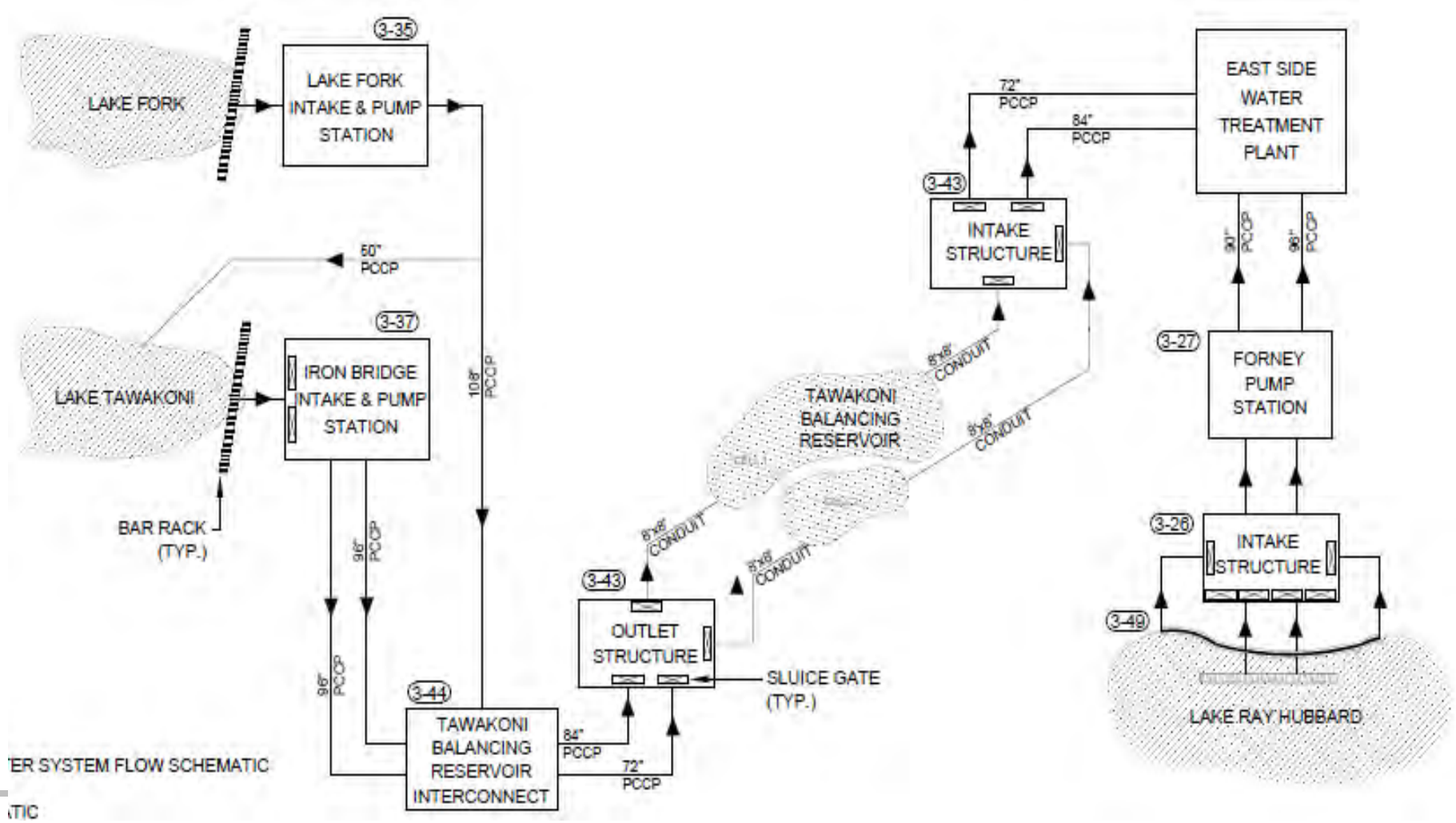


Elm Fork WTP is the primary Western WTP

Bachman WTP is the secondary Western WTP



The eastern facilities consist of one WTP and multiple raw water sources



ER SYSTEM FLOW SCHEMATIC

TIC

The Tawakoni interconnect is a 168-inch pipeline

Lake Fork is a significantly large pump station with room for expansion

The project followed a stepwise approach for prioritizing repairs

- Summarize and review existing DWU asset information
- Develop asset hierarchy and naming convention
- Standard scoring for Likelihood of Failure (LOF)
- Standard scoring Consequence of Failure (COF)
- WRF BRE Tool to rank all assets

The WRF SIMPLE tool is a non-proprietary tool and available to all WRF members

Actionable information

Complete asset management program

S - Sustainable

I - Infrastructure

M - Management

P - Program

L - Learning

E - Environment

Here is the online interface for the SIMPLE Tool

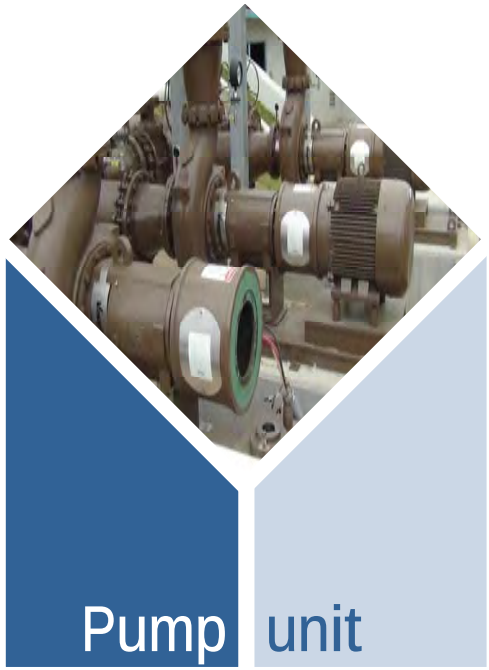
The BRE tool is used for tracking and mapping scores for each asset

			Likelihood of Failure			Consequence of Failure				
	Asset ID	Asset Name	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
4	11-BS-B1-MH-48-1	Manhole	67%		6.7	4	5	3	4.0	26.5
5	11-BS-B1-PNL-5-1	Pump Control Panel	38%		3.8	10	3	5	6.2	23.4
6	11-BS-B1-MH-48-2	Manhole	60%		6.0	4	3	3	3.4	20.1
7	11-BS-B1-PNL-5-2	Flow meter control panel	49%		4.9	8	3	1	4.1	19.6
8	11-BS-B1-PU -5-1	Submersible Pump #1	30%		3.0	10	3	5	6.2	18.5
9	11-BS-B1-PU -5-2	Submersible Pump #2	30%		3.0	10	3	5	6.2	18.5
10	11-BS-B1-PU -5-3	Submersible Pump #3	30%		3.0	10	3	5	6.2	18.5
11	11-PLV-B1-DIP-10-1	Piping, fittings, and couplings	26%		2.6	10	3	7	6.9	17.8
12	11-BS-B1-RTU-5-1	Remote Terminal Unit/Pump Control Panel	33%		3.3	7	3	6	5.5	17.7
13	11-BS-0-X-X-X	Perimeter Fencing	60%		6.0	3	3	1	2.3	13.8
14	11-BS-X-X-X-X	Burl Street Lift Station Structure	60%		6.0	3	3	1	2.3	13.8
15	11-PLV-B1-S-X-X	local manual switch for ventillator			7.4	3	1	1	1.7	12.5

The first step was to...

- Summarize and review existing DWU asset information
- Develop asset hierarchy and naming convention
- Standard scoring for Likelihood of Failure (LOF)
- Standard scoring Consequence of Failure (COF)
- WRF BRE Tool to rank all assets

To DWU, an asset is considered the “lowest maintainable unit”



We reviewed and updated asset inventory for each facility

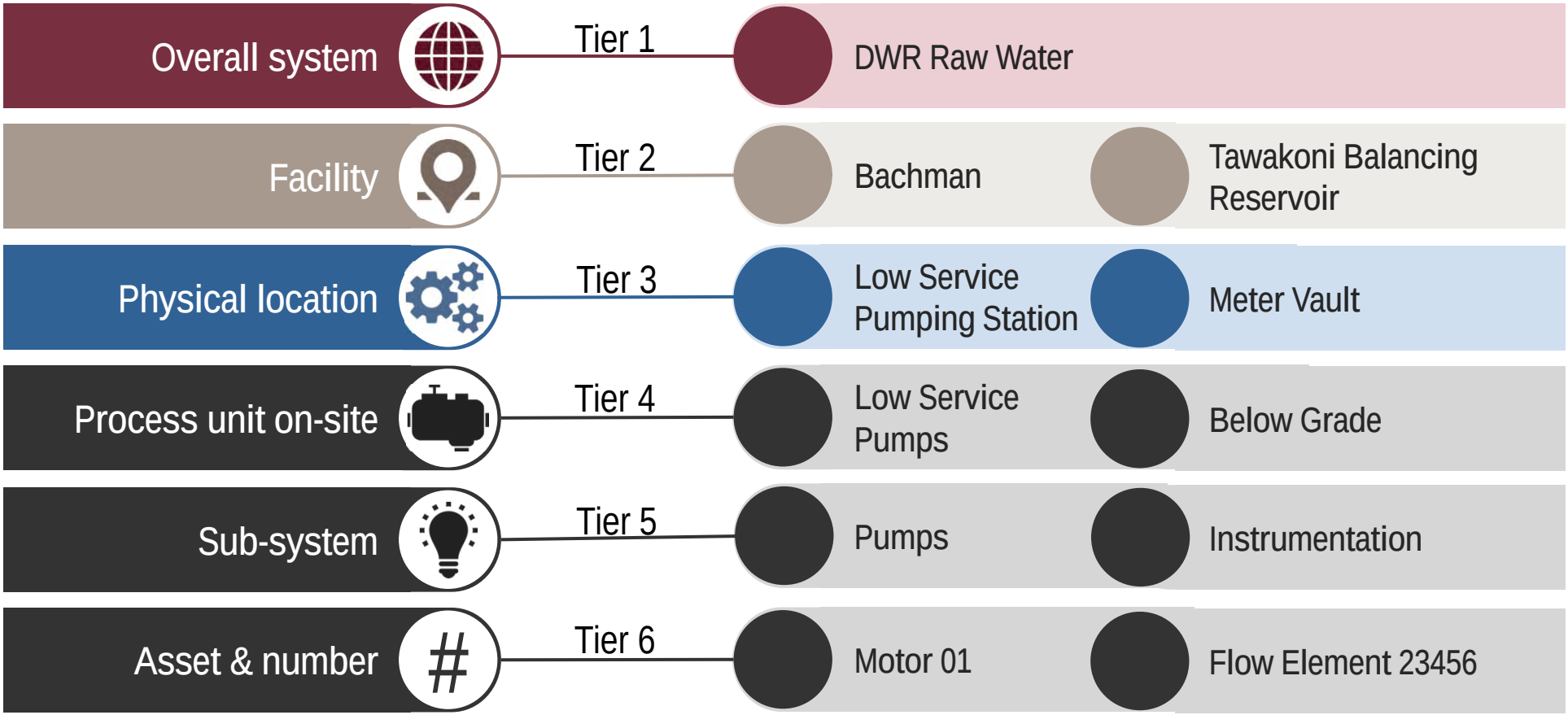
Asset ID	Install Year	Refurb Year	Make	Model	Capacity	Dimensions
DWR-BAC-PS1-PMP-R01-PMP-01	1994	2015	Sim-Flo	14-M-270 4-stage	1250 GPM	30-inch
DWR-BAC-PS1-PMP-R01-PMP-02	1994	2015	Sim-Flo	14-M-270 4-stage	1250 GPM	30-inch
DWR-BAC-PS1-PMP-R01-MTR-01	1994		Westinghouse		800 HP	

Based on record drawings (and preliminary field visits)

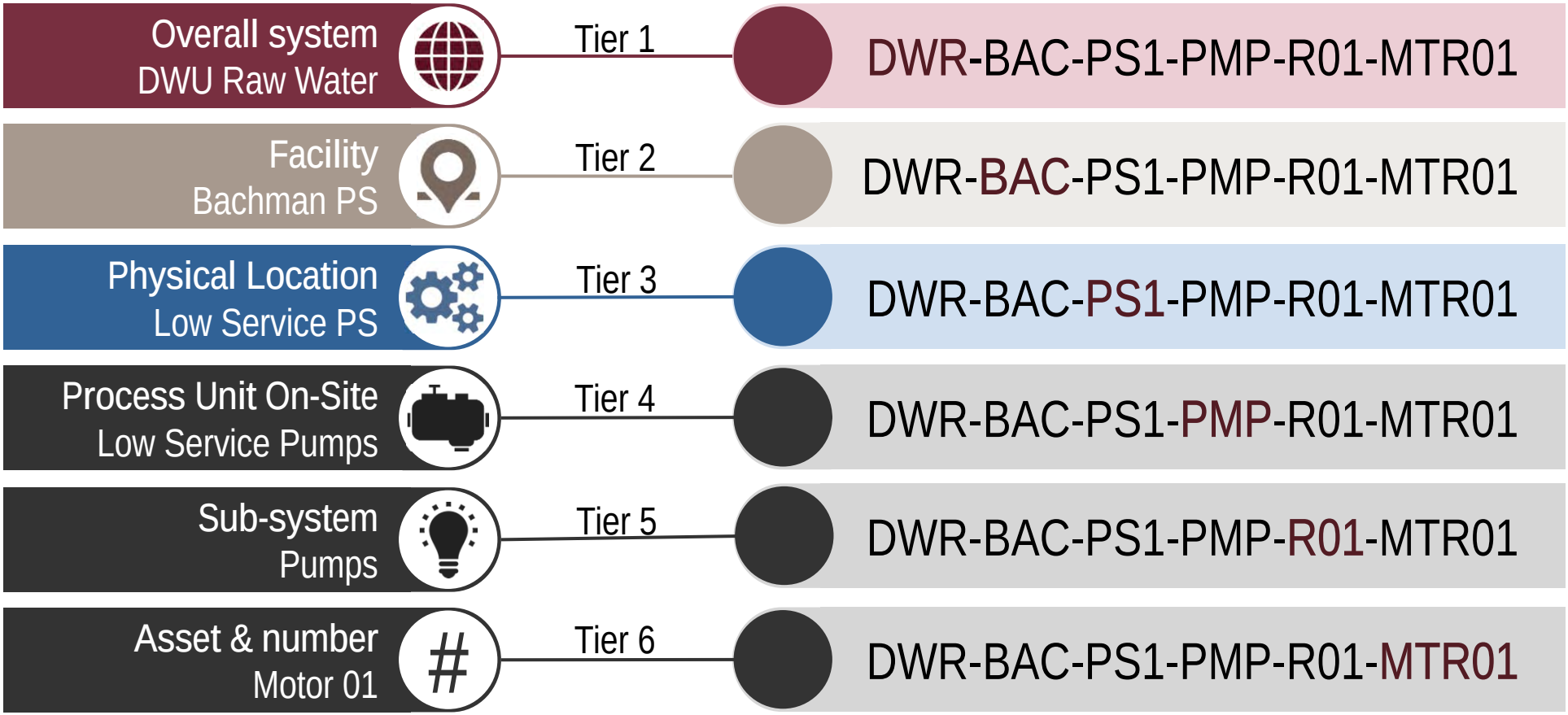
Once we had a baseline list of assets we needed to...

- Summarize and review existing DWU asset information
- **Develop asset hierarchy and naming convention**
- Standard scoring for Likelihood of Failure (LOF)
- Standard scoring Consequence of Failure (COF)
- WRF BRE Tool to rank all assets

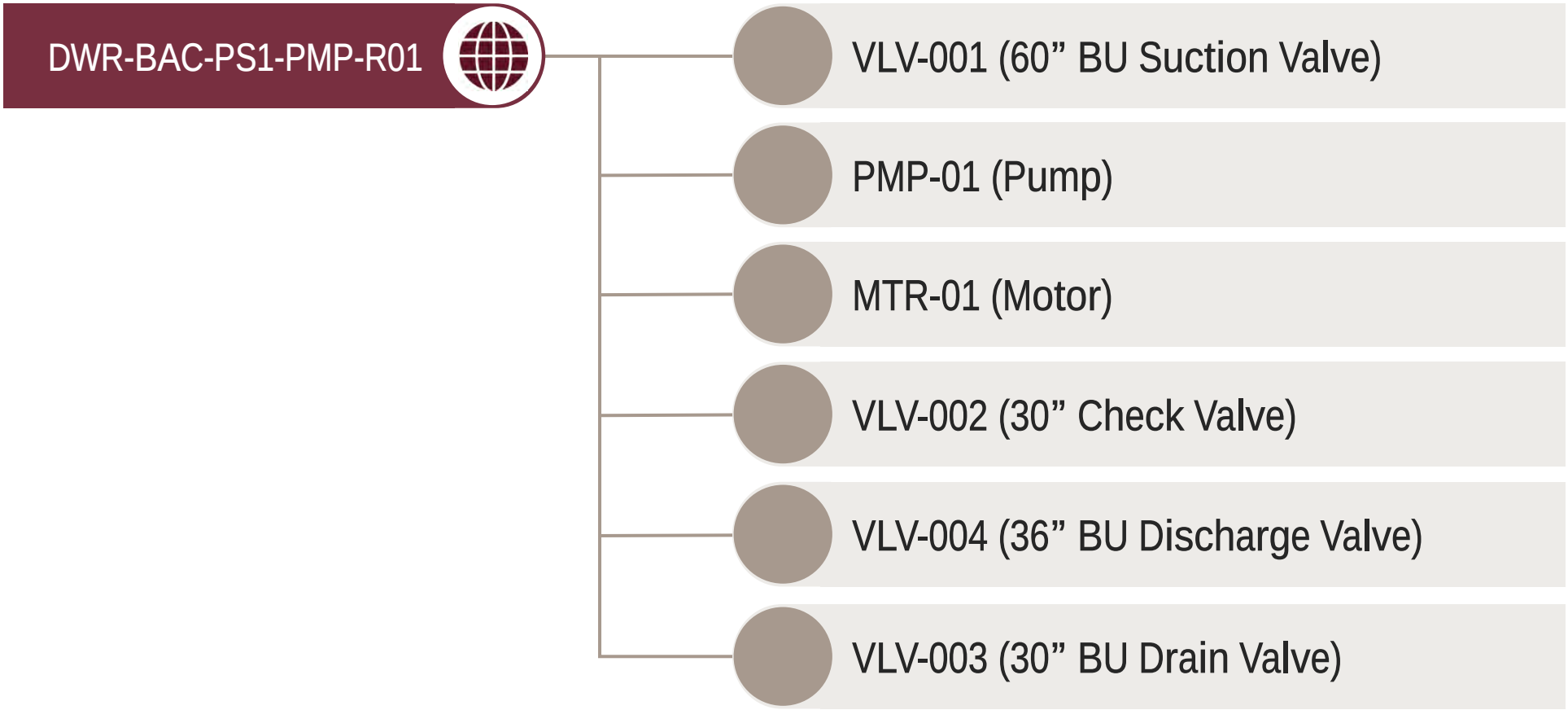
We expanded their original hierarchy to 6 tiers



For simplicity, codes and abbreviations were assigned



Here is an example of all of the assets associated with a pump

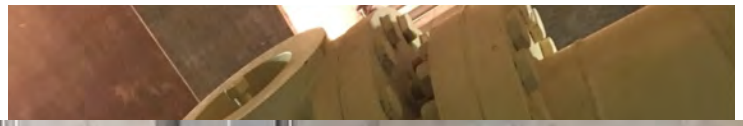


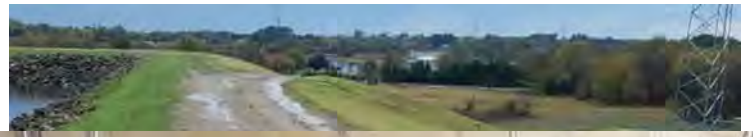
Here is how it looks on our master spreadsheet

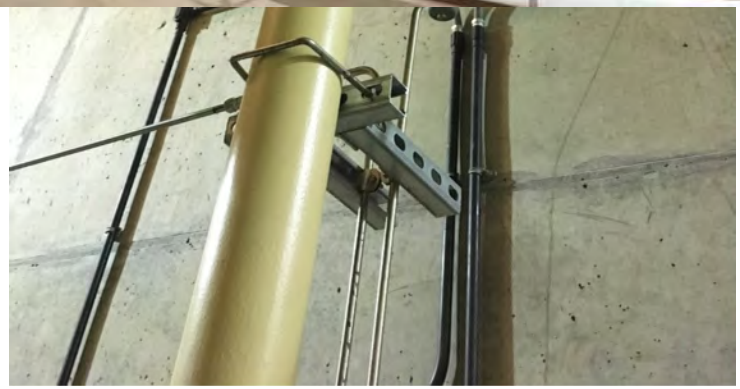
DWR-BAC-PS1-PMP-R01	Raw Water Low Service Pump 1		
		DWR-BAC-PS1-PMP-R01-PMP-01	Low Service Pump
		DWR-BAC-PS1-PMP-R01-MTR-01	Westinghouse 800 HP Motor 1
		DWR-BAC-PS1-PMP-R01-VLV-001	60" Butterfly Valve
		DWR-BAC-PS1-PMP-R01-VLV-002	30" Check Valve
		DWR-BAC-PS1-PMP-R01-VLV-003	30" Butterfly Valve
		DWR-BAC-PS1-PMP-R01-VLV-004	36" Butterfly Valve
		DWR-BAC-PS1-PMP-R01-DMP	30" Butterfly Valve Dampening System
		DWR-BAC-PS1-PMP-R01-OPS	30" Butterfly Valve Manual Valve Operator
		DWR-BAC-PS1-PMP-R01-ACT	36" Butterfly Valve Electric Actuator
		DWR-BAC-PS1-PMP-R01-VLV-005	6" Gate Valve
		DWR-BAC-PS1-PMP-R01-CRS	6" Crispin Flow 606-1F

We further defined the asset inventory during preliminary field visits

Some items were not captured initially such as in-house installations







We also came across items that would not be considered traditional assets

With all assets organized the LOF scoring needed to be compatible

Summarize and review existing DWU asset information

Develop asset hierarchy and naming convention

Standard scoring for Likelihood of Failure (LOF)

Standard scoring Consequence of Failure (COF)

WRF BRE Tool to rank all assets

There is a standardized condition scoring for the BRE Tool for LOF

RANK & DESCRIPTION OF CONDITION	
1	VERY GOOD CONDITION
2	MINOR DEFECTS ONLY
3	MAINTENANCE REQUIRED TO RETURN TO ACCEPTED LEVEL OF SERVICE
4	REQUIRES RENEWAL
5	ASSET UNSERVICEABLE

DWUs EWAMS identifies their own Asset Condition Standards for LOF

Score	Physical Condition (definitions)
5	FAILED - Asset is no Longer Able to Function in Current Condition
4	POOR - Asset is Highly Unreliable or Inefficient
3	FAIR - Asset has Significant Defects that will Affect Reliability or Efficiency
2	ACCEPTABLE - Asset has Minor Defects
1	GOOD - Asset is in Good Condition (No Defects)

We incorporated EWAMS standardized condition scoring into BRE Tool for LOF

- CONSOLIDATED GRAPHIC

LOF scores consider multiple elements

Element	Description				
Physical Condition	Good – Asset is in good condition with no defects	Acceptable – Asset has minor defects	Fair – Asset has significant defects that will affect reliability and efficiency	Poor – Asset is highly unreliable or inefficient	Failed – Asset is no longer able to function in current condition
Operational Performance	Exceeds current requirements	Meets current requirements but with room for improvement	Obvious concerns: cost/benefit questions	Difficult to sustain performance	Failing, not capable of sustaining performance
Reliability	Infrequent breakdown	Occasional breakdown	Periodic breakdown	Recurrent breakdown	Virtually inoperable
Availability	Out of service only for very short periods	Out of service for moderate period; moderately difficult to return to service	Increasingly difficult to return to service; parts becoming a challenge	Extensive downtime duration; difficult to return to service; parts, difficult to acquire	Virtually impossible to return to service; no longer available
Maintainability	Largely preventive maintenance with some corrective maintenance beginning to show up; baseline monitoring	Increasing minor maintenance required; periodic corrective maintenance including some repair shortening of monitoring intervals	Scheduled maintenance becoming frequent; frequency of work orders increasing substantially with short monitoring intervals	Work orders well above average for type of asset; recurrent minor repair; close monitoring required	Maintenance is frequent with recurrent patterns of failure; asset must be virtually constantly monitored to sustain performance
SCORE	1	2	3	4	5

Condition assessments were conducted with DWU O&M Staff

Field assessments with DWU

- Maintenance and reliability
- Performance
- Work order reports

Photographs of each asset

GPS coordinates

Multi-disciplined team

- Electrical / Instrumentation
- Structural
- Civil / Mechanical

Where possible we asked for DWU staff to operate equipment

Lake Fork Intake

There were challenges...

Inconsistent naming

Level of detail of
small vs. large assets

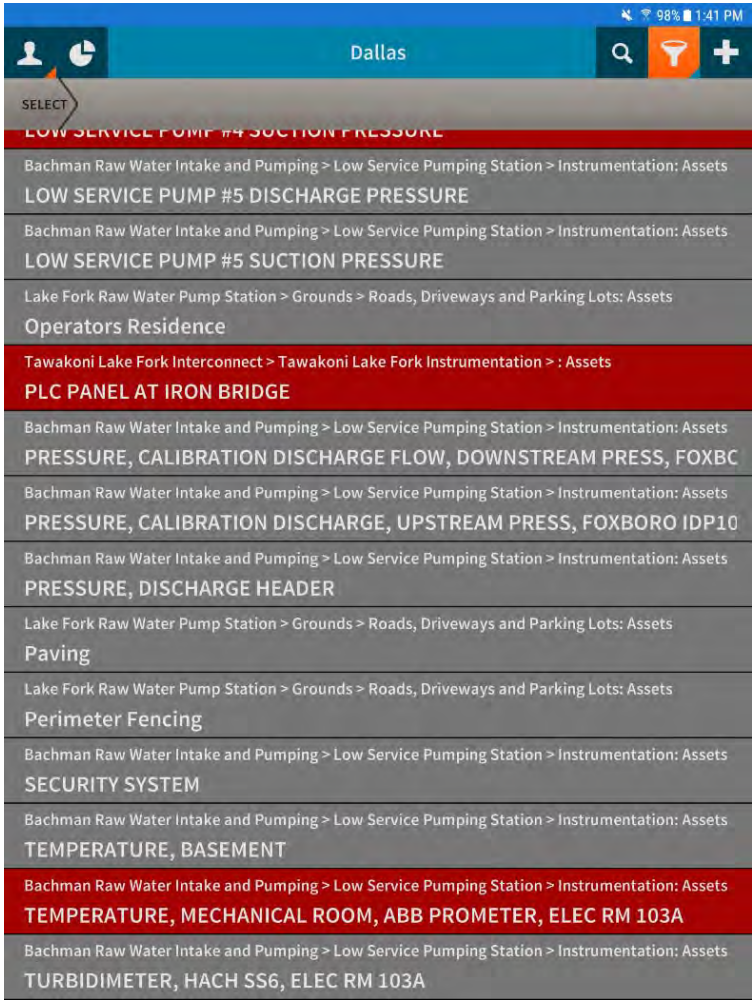
Adding assets in the field

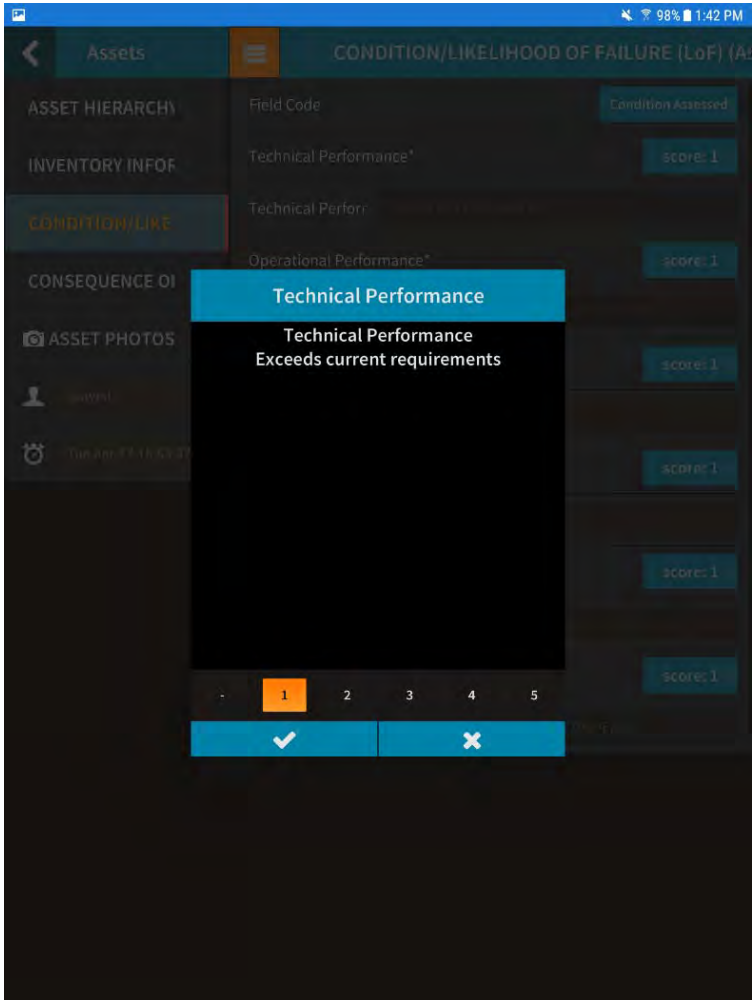
Multi-disciplined team scoring same asset differently

- Electrical / Instrumentation
- Structural
- Civil / Mechanical

So why is everyone looking at their large phone in the pictures?

Tablets were used for data capture and scoring in the field





Following the condition assessments we needed to identify the COF score

- Summarize and review existing DWU asset information
- Develop asset hierarchy and naming convention
- Standard scoring for Likelihood of Failure (LOF)
- **Standard scoring for Consequence of Failure (COF)**
- WRF BRE Tool to rank all assets

EWAMS also identifies standards for consequence of failure score

Score	Loss of Service (definitions)
5	Large scale service disruption or violation / no redundant backup
4	Localized service disruption or minor violation / no redundant backup
3	Risk of service disruption or violation / part of system with redundancy
2	Efficiency reduction (higher cost to operate)
1	No impact on core business

Consequence of Failure scoring consists of three key criteria

The COF score takes into account economic impacts

Score	Financial impact	Economic impact
1	Moderate cost	<$100k
2	High cost	<$500k
3	High cost; diverts $	<$2 million
4	Painful change of priorities	<$10 million
5	Likely to trigger rate Increase, staff changes	>$10 million

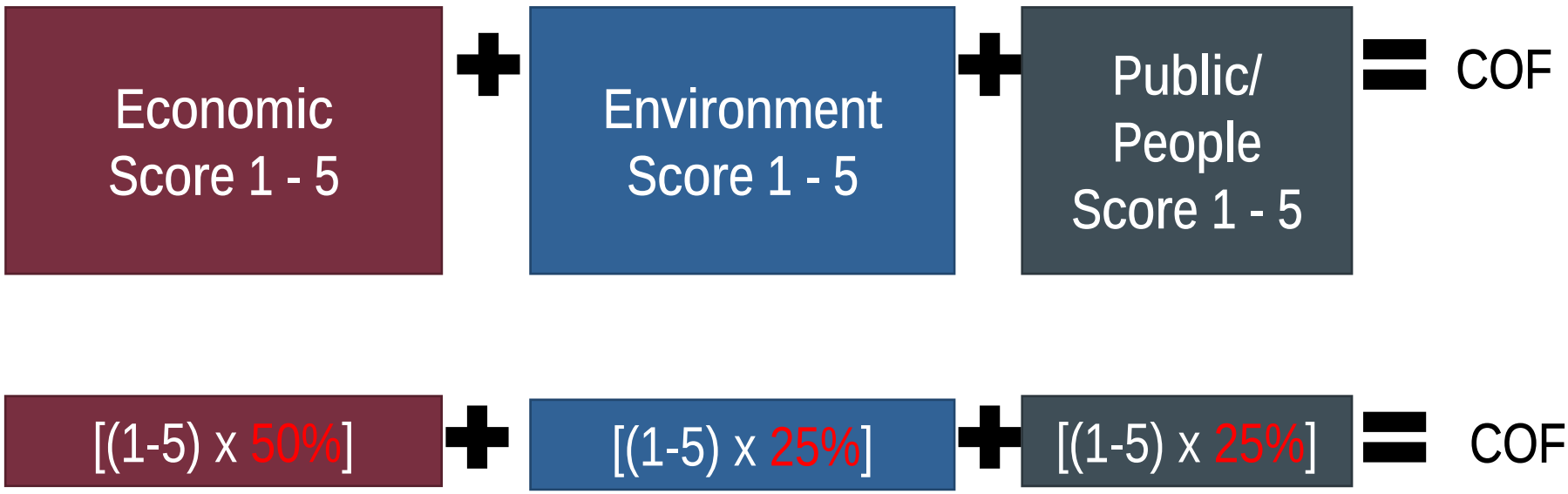
Public impact takes into account multiple items including...

Score	Loss of service	Safety	Agency image
1	Can be out of service indefinitely	No impact	No media or no consequence
2	Cannot be down a month	Minor injury	Neutral coverage
3	Cannot be down a week	Moderate injury & some sickness	Adverse media
4	Cannot be down 8 hours	Major injury, sickness	Continual; political opposition
5	Cannot be down 1 hour	Potential Fatality, widespread & chronic sickness	Nationally adverse media

Environmental and regulatory considerations include...

Score	Odor/water quality	Regulatory compliance	Environmental hazard
1	No complaints	No consequence	Short duration, small quantity onsite
2	A few complaints	Minor violation – reporting only	Short duration, some offsite spillage
3	Moderate complaints	Regulatory sanction possible	Many inconvenienced; moderate health and habitat issues
4	Extensive complaints	Regulatory sanction likely	Severe health and habitat issues; some mandatory vacation of premises
5	Extensive, system-wide complaints	Extensive regulatory sanction virtually assured	Large areas vacated/closed to public access; intensive specialized containment cleanup required

Each Triple Bottom Line score is weighted to determine COF



Once LOF and COF scores are determined we can rank repairs

- Summarize and review existing DWU asset information
- Develop asset hierarchy and naming convention
- Standard scoring for Likelihood of Failure (LOF)
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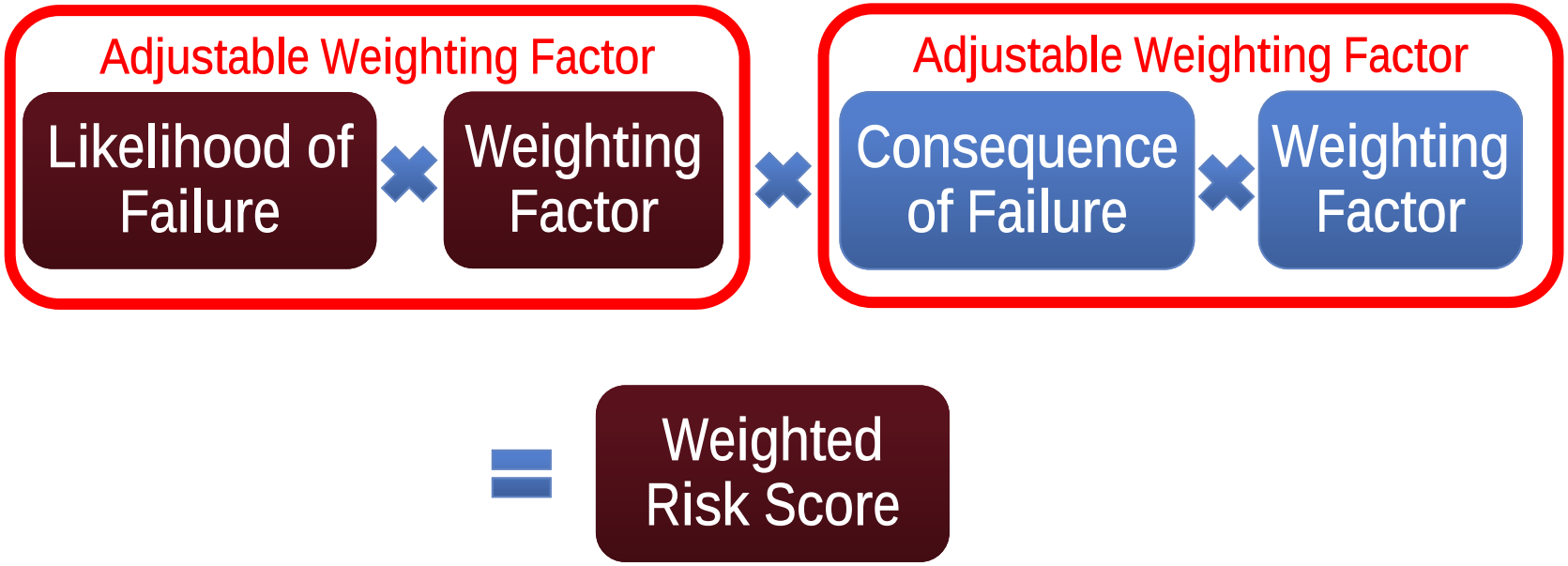
- **WRF BRE Tool to rank all assets**

The core risk score accounts for both LOF and COF

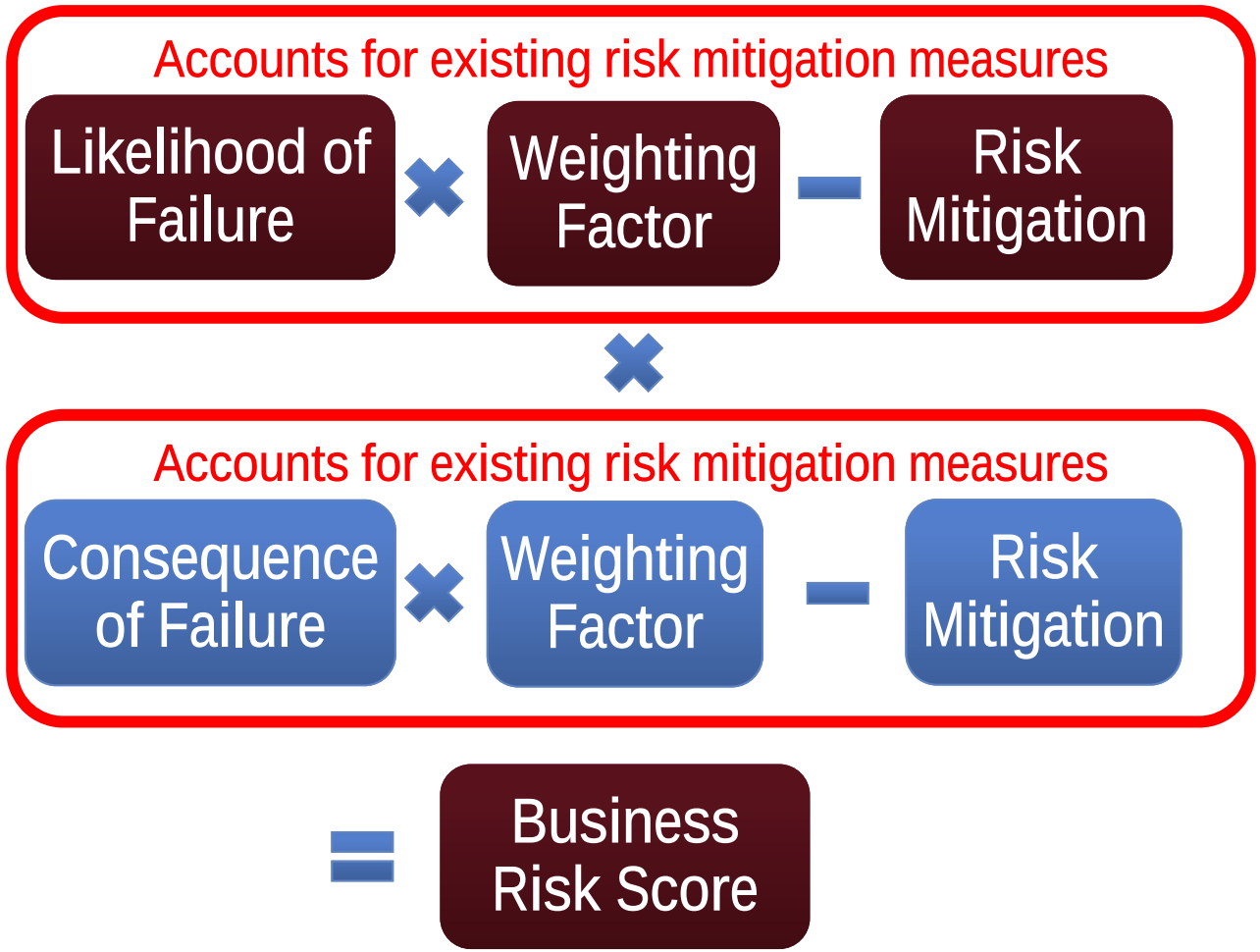
The weighted risk score adds a bonus percentage to either LOF and COF



Existing risk mitigation measures can significantly reduce risk

Measure	Meaning (General Guidelines/Considerations)
Redundant Assets	A duplicate/similar and separate asset exists, and is available for immediate use to provide full functionality.
Spare Parts	Major components of the asset are readily available to return full functionality within an acceptable time period.
Alternative Operations	Other assets and procedures exist to provide similar function.
Emergency Agreement	Procedures and agreements are in place with outside party that replace asset function.

The business risk score considers LOF, COF, and risk mitigation

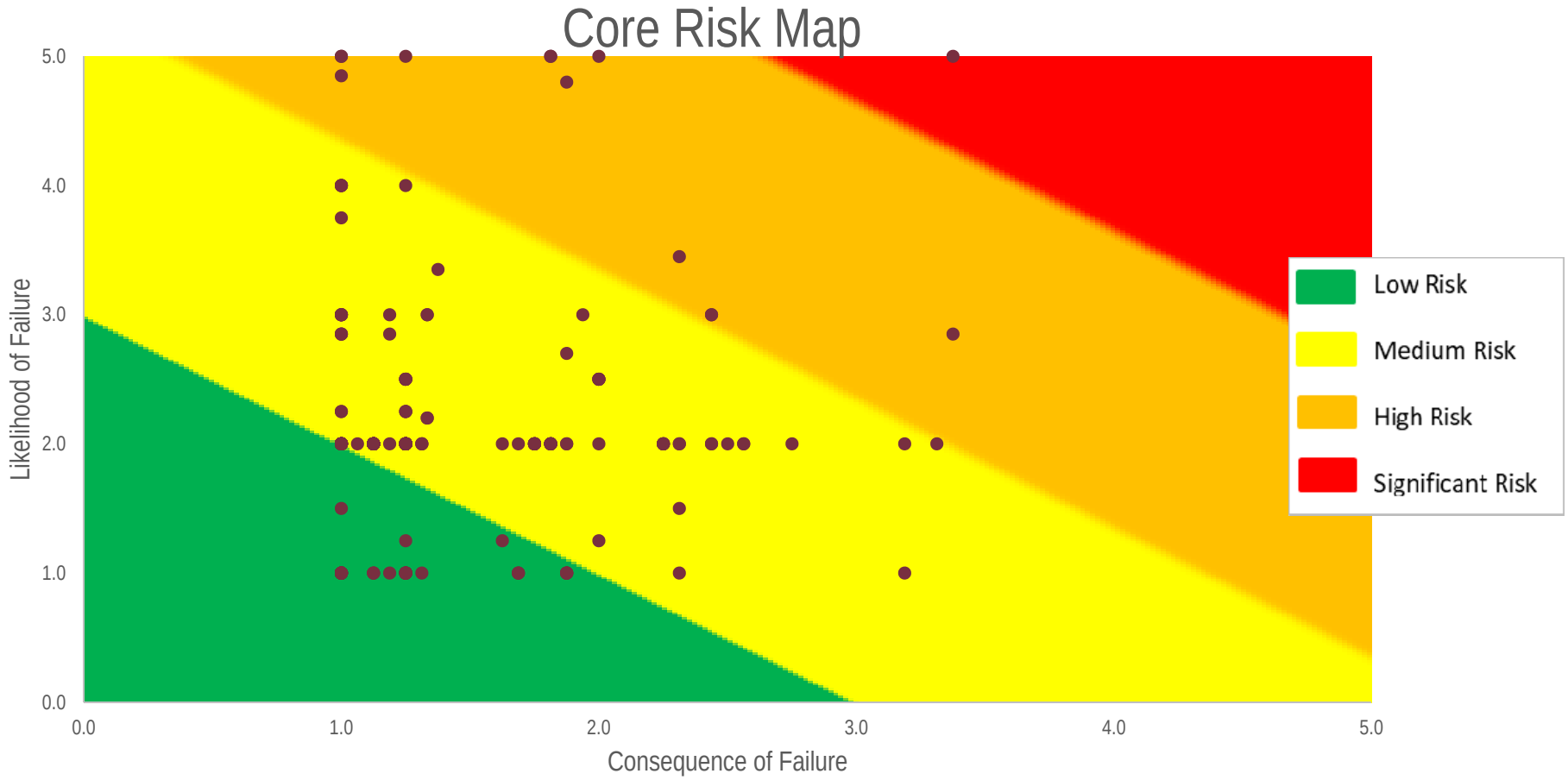


Projects are determined based on Business Risk Score

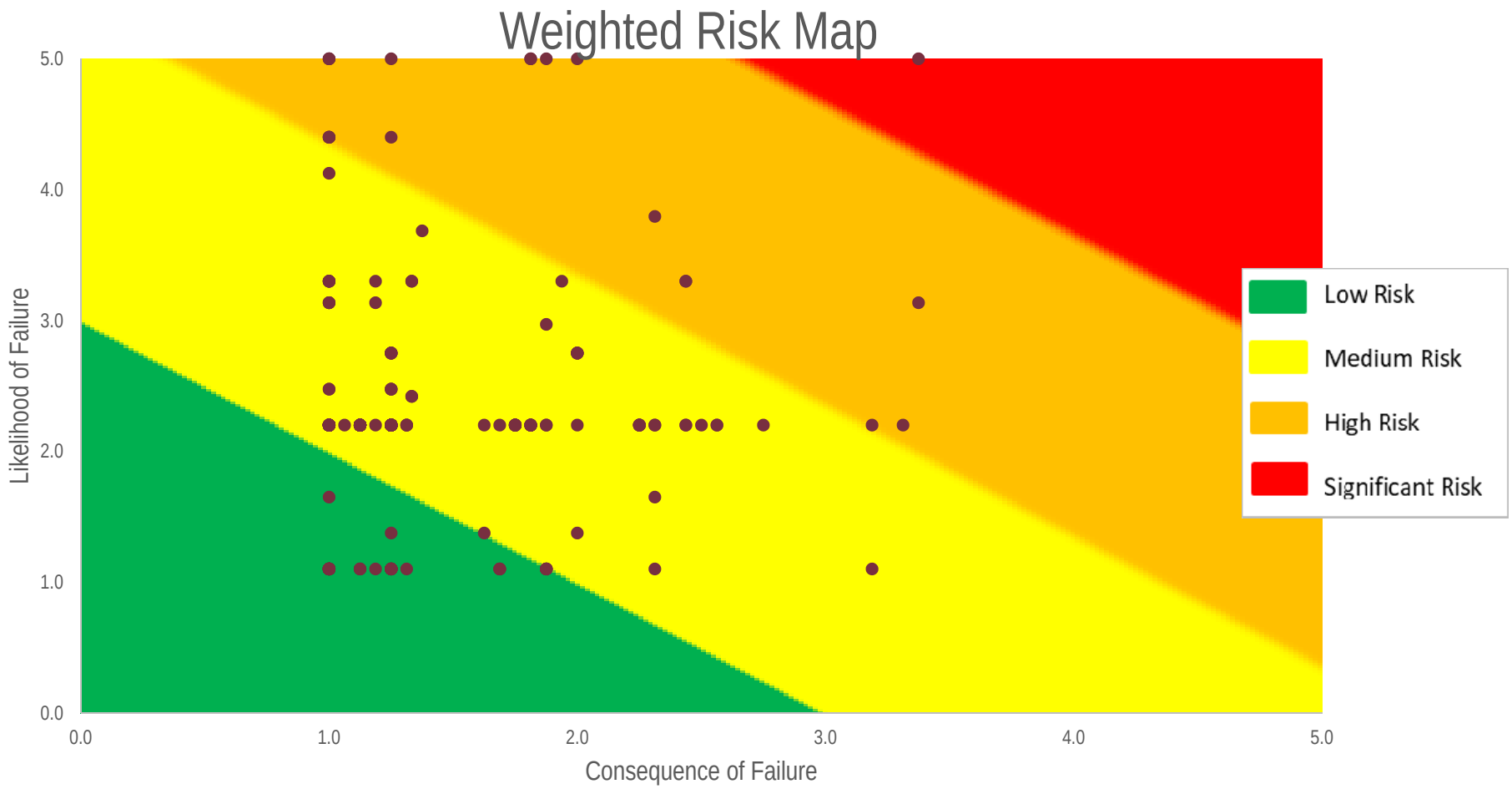
Priority given to higher scores

Sequence Number	Asset Name	Core Risk Score	Weighted Risk Score	Overall Business Risk Score
130	embankment	***16.88***	***18.56***	***16.88***
128	low service pump station guard shack	***10.00***	***11.00***	***10.00***
209	Area Lighting and Electrical service	***9.06***	***9.97***	***9.06***
18	Low Service Raw Water Pump #2	***4***	***4.40***	***4***

We produced 3 maps for each facility



Here is the weighted risk map



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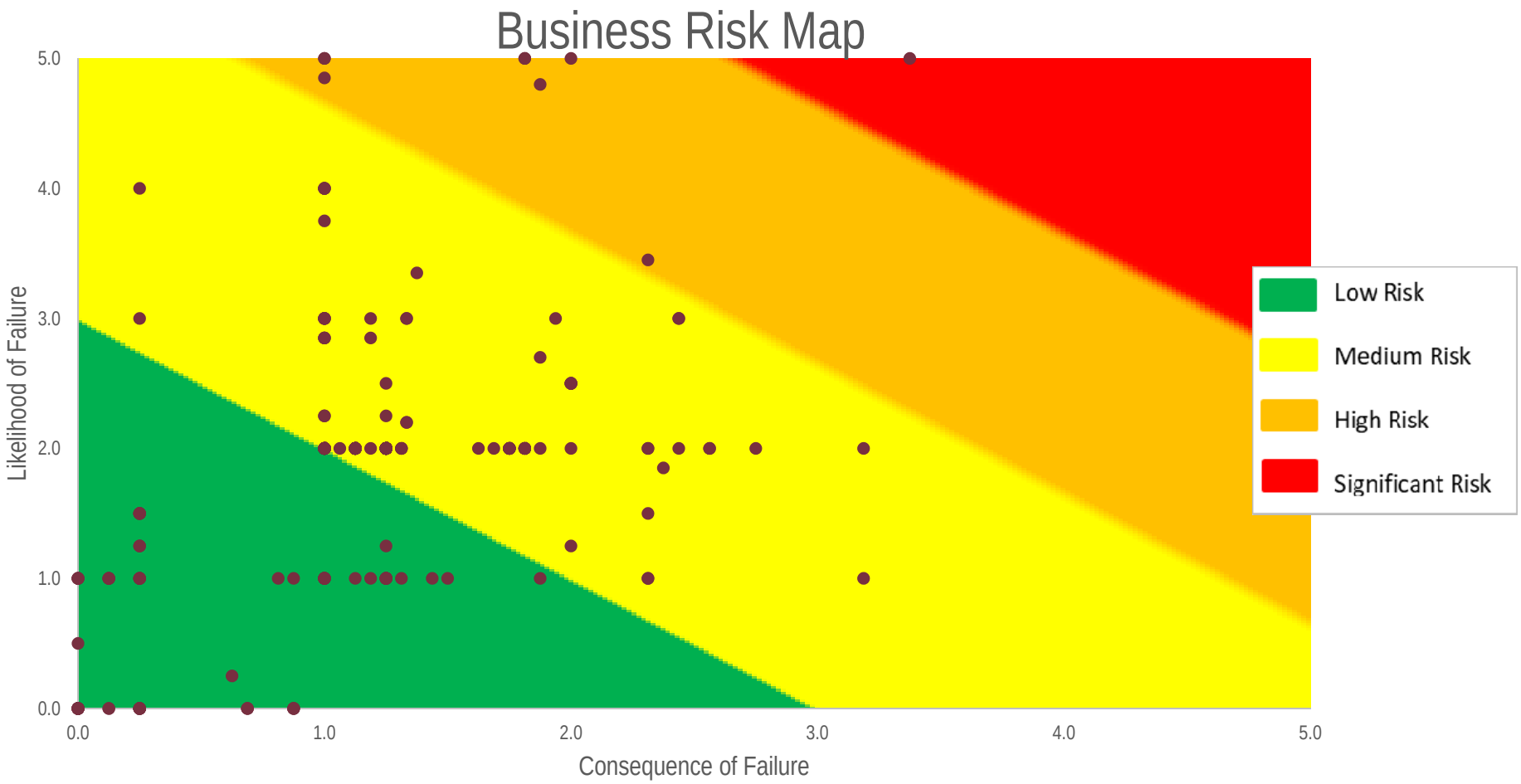
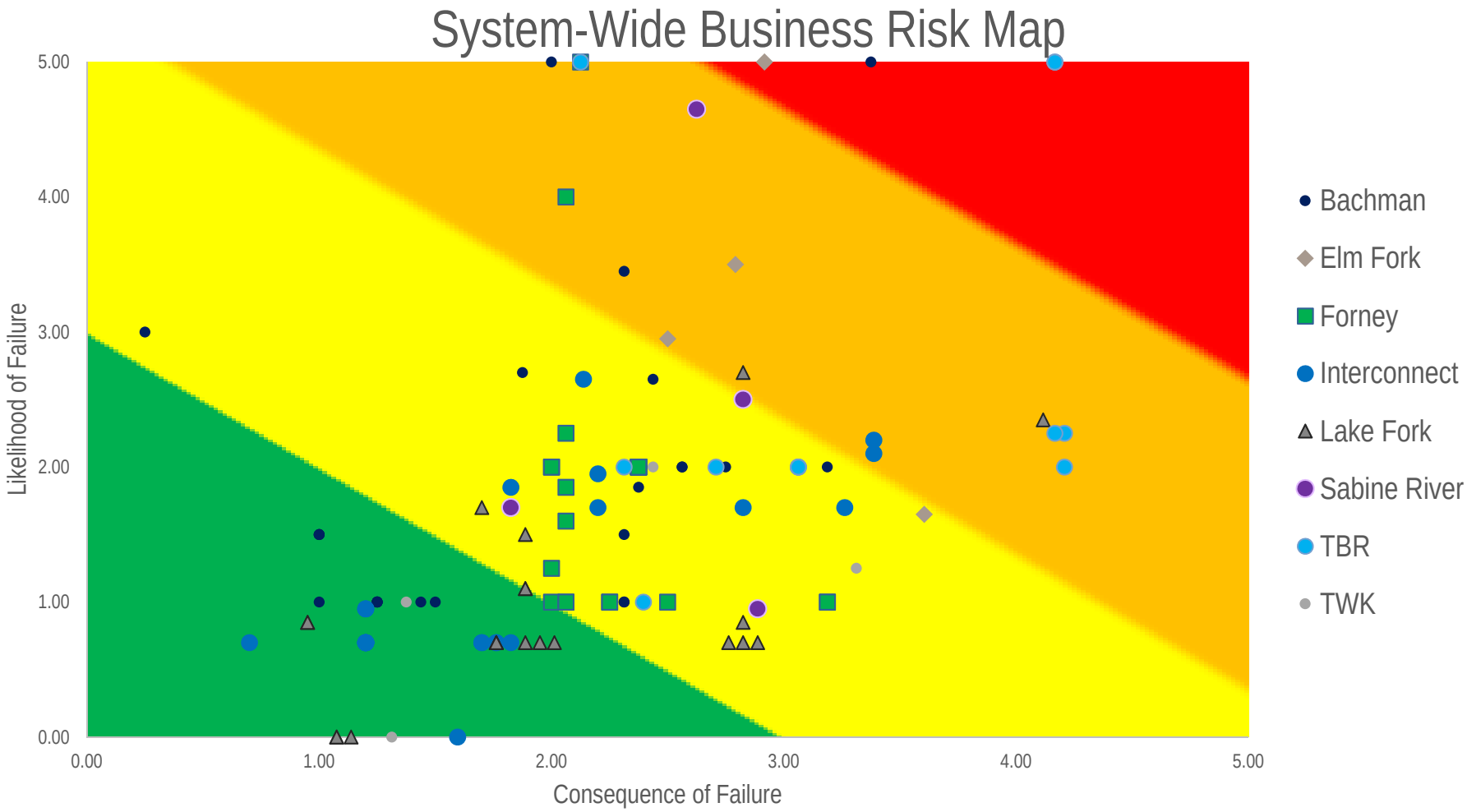


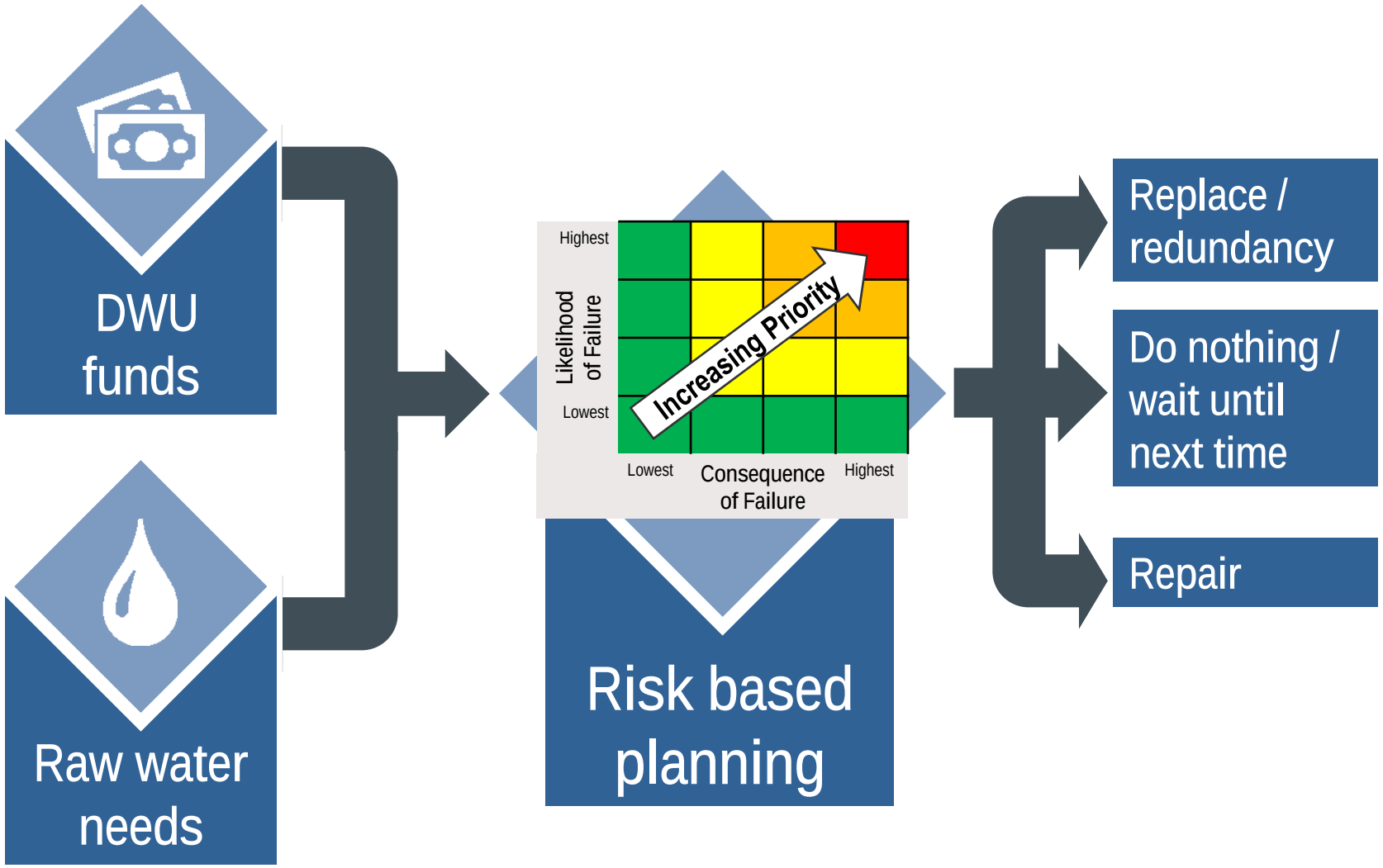
We added a dashboard for sensitivity analysis

Category	Weight/Adjustment Factor
LOF	
Physical Condition	25%
Operational performance	25%
Reliability	20%
Availability	15%
Maintainability	15%
Total (must = 100%)	**100%**
COF	
Social/Community/Organizational	25%
Economic/Financial	50%
Environmental	25%
Total (must = 100%)	**100%**
WEIGHTED RISK	
Likelihood of Failure	10%
Consequence of Failure	0%
Total	**10%**
RISK MITIGATION	
Redundant Assets	1.0
Spare Parts	0.6
Alternative Operation	0.3
Emergency Agreement	0.1
Total (must = 2)	**2**

We consolidated all data into a system wide risk map



With this risk based information, we can develop future plans



Our streamlined risk based planning approach ....

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- Characterizes risk and allows for sensitivity analysis of projects and repairs
- Develops a defensible and consistent prioritization method for CIP planning



QUESTIONS?

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city of dallas

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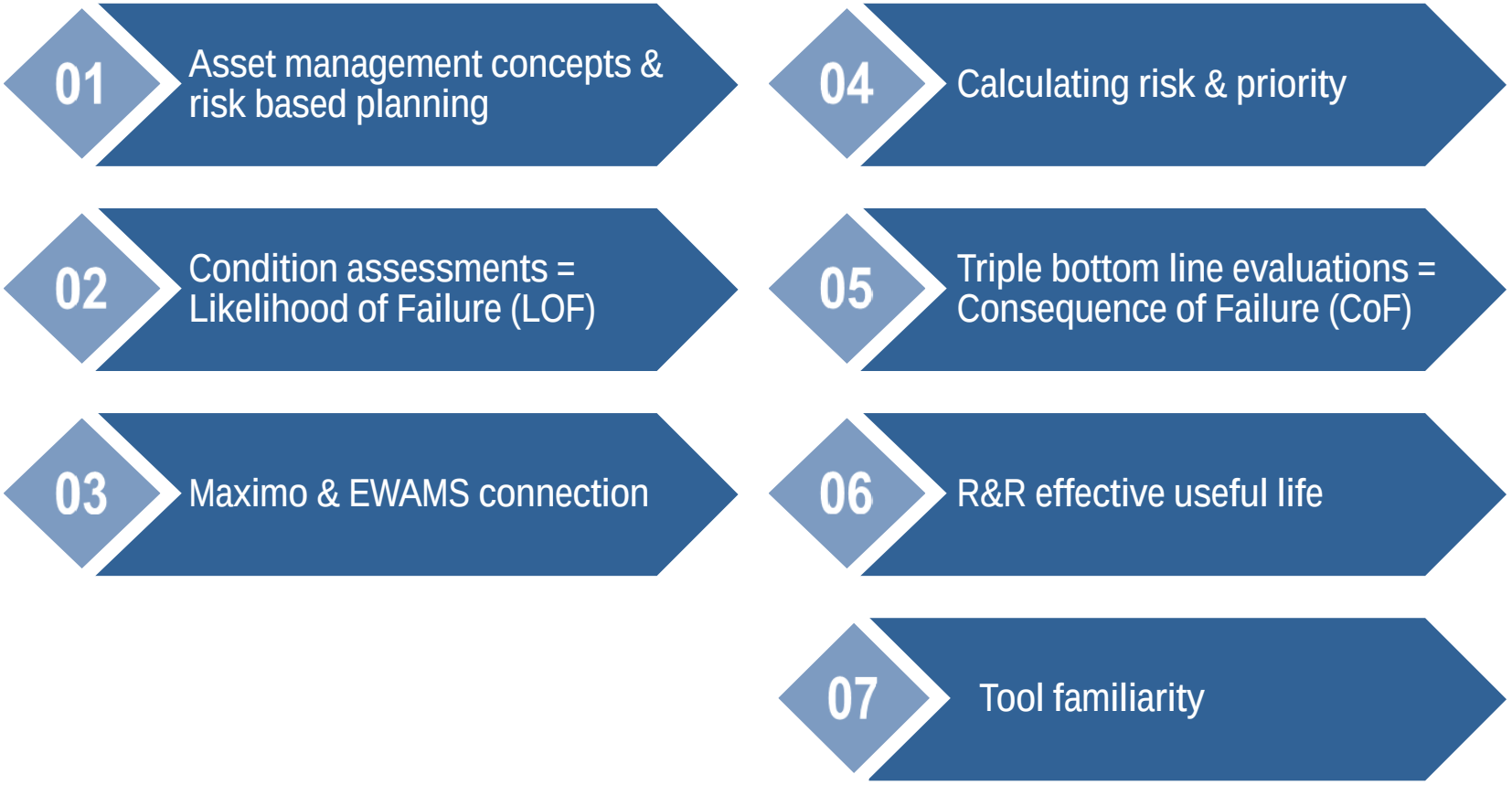
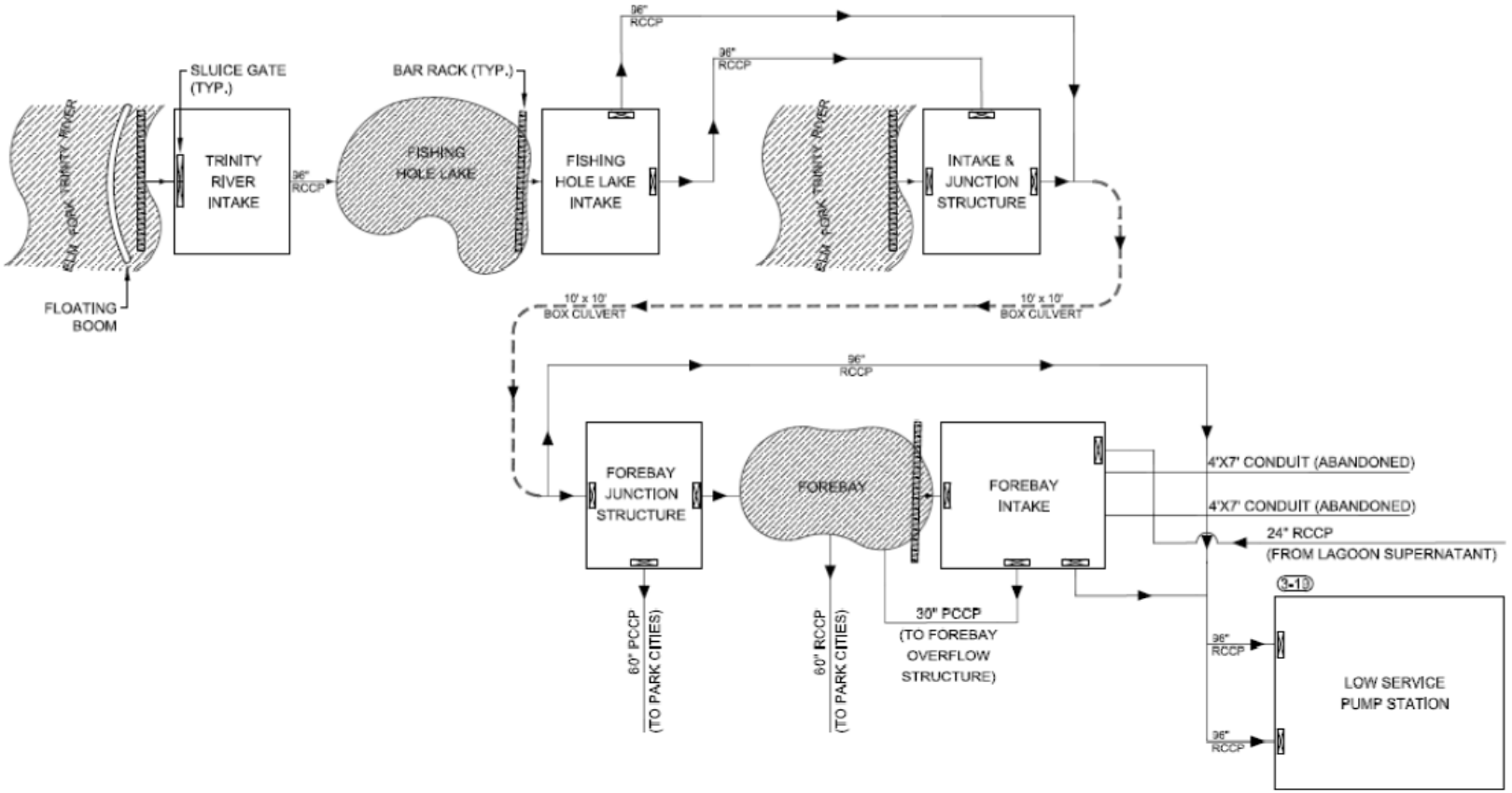
TACWA Meeting

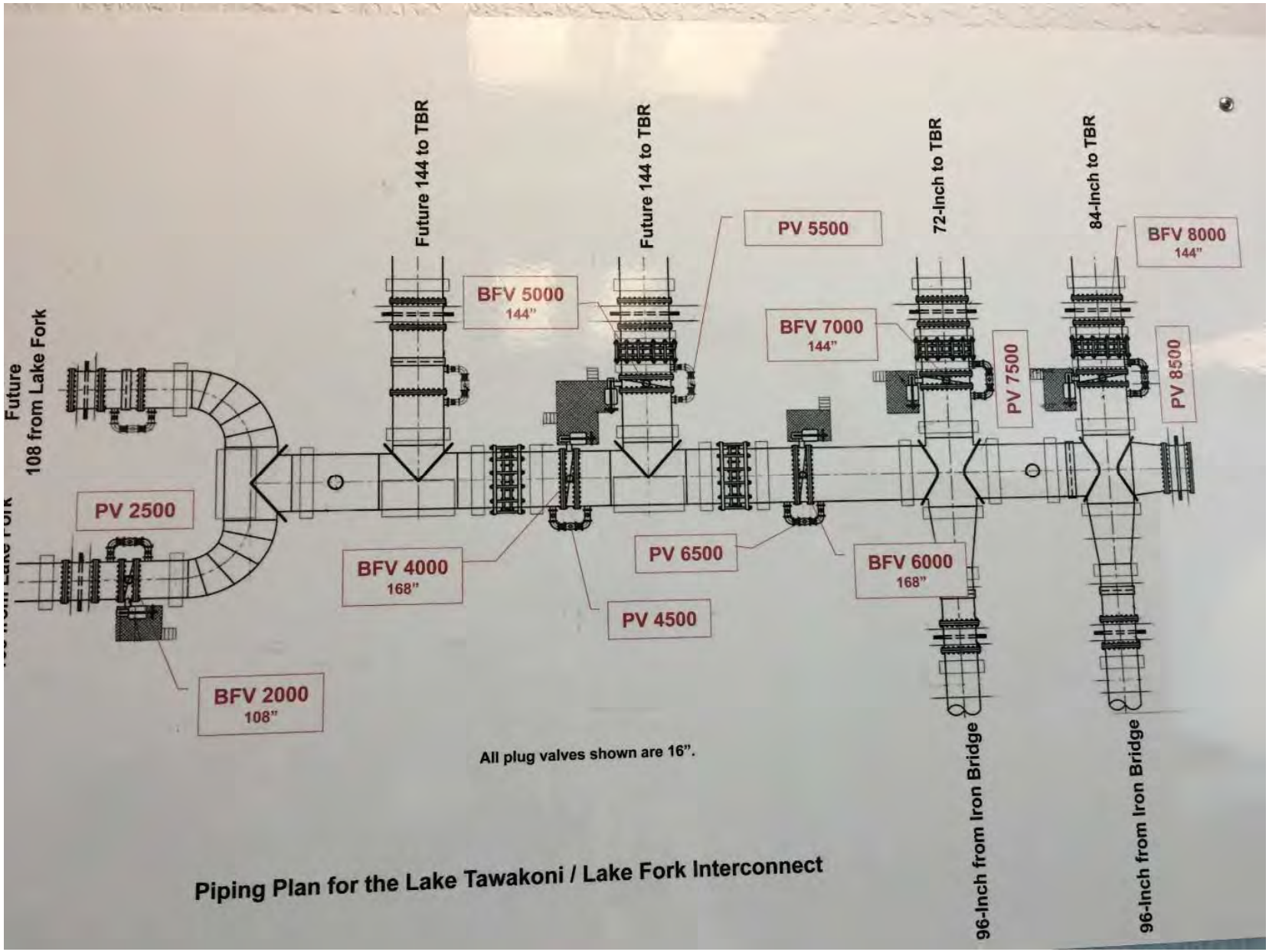
Effective communication is key to the following approach



Western Facility: Bachman WTP Raw Water System

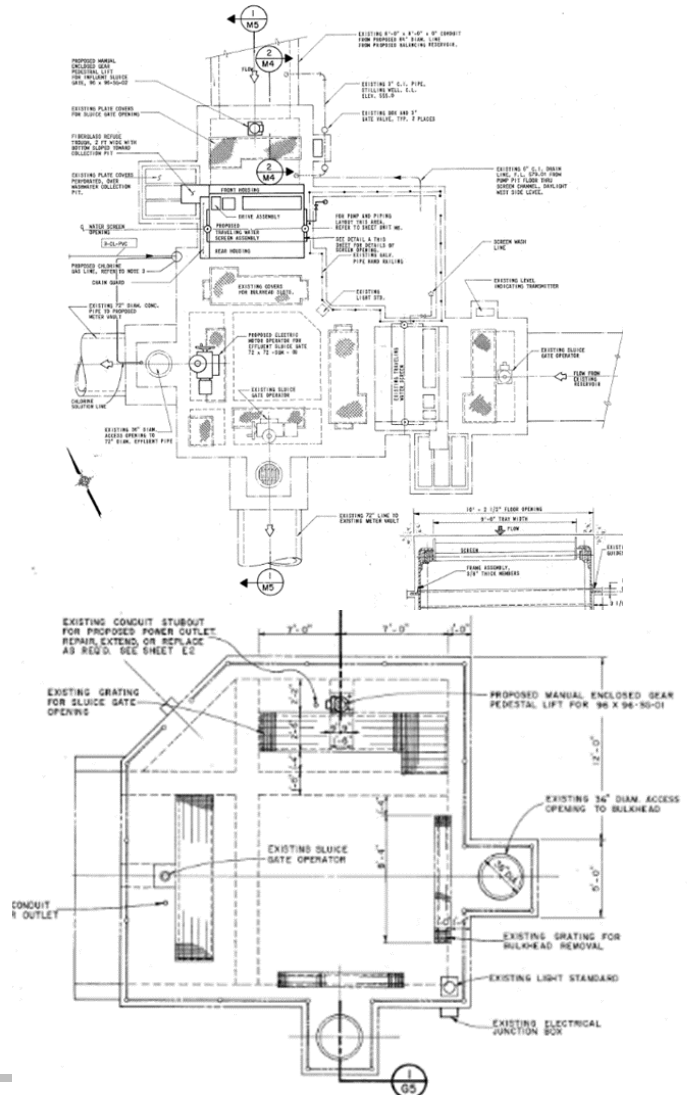


FLOW SCHEMATIC

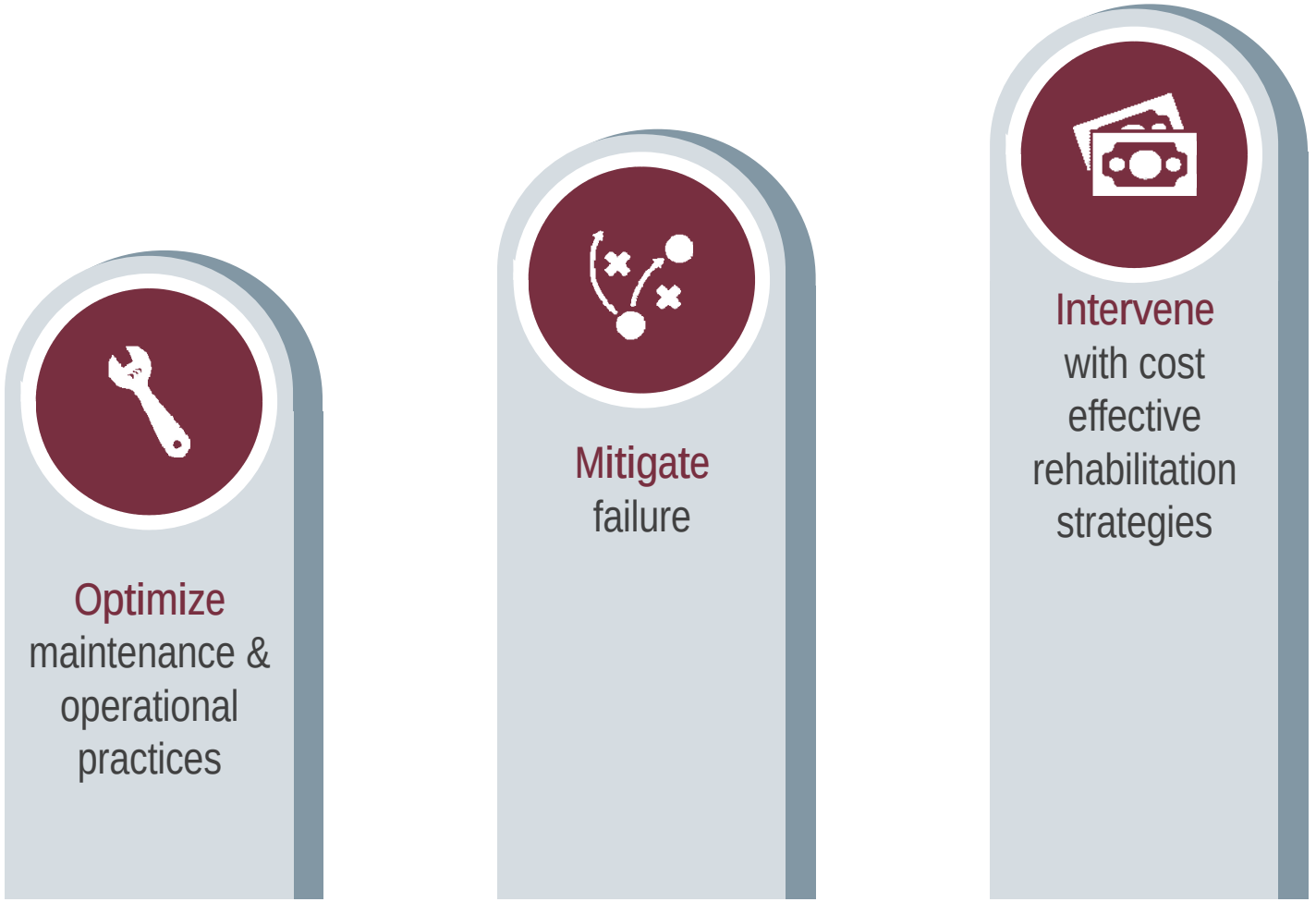

Future 144 to TBR
Future 144 to TBR
72-Inch to TBR
84-Inch to TBR
PV 5500
BFV 8000
144"
BFV 5000
144"
BFV 7000
144"
PV 7500
PV 8500
Future
108 from Lake Fork
PV 2500
BFV 4000
168"
PV 6500
BFV 6000
168"
PV 4500
BFV 2000
108"
All plug valves shown are 16".
96-Inch from Iron Bridge
96-Inch from Iron Bridge
Piping Plan for the Lake Tawakoni / Lake Fork Interconnect

The Balancing Reservoir looks like an easy assessment at first glance

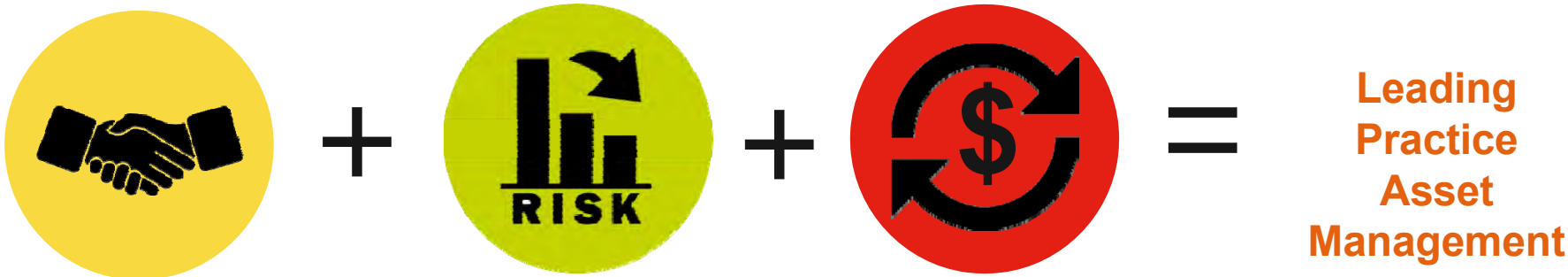
When taking a closer look, there were significant asset challenges



Our Asset Management Plan targets important project goals



Leading Practice Concepts of Asset Management



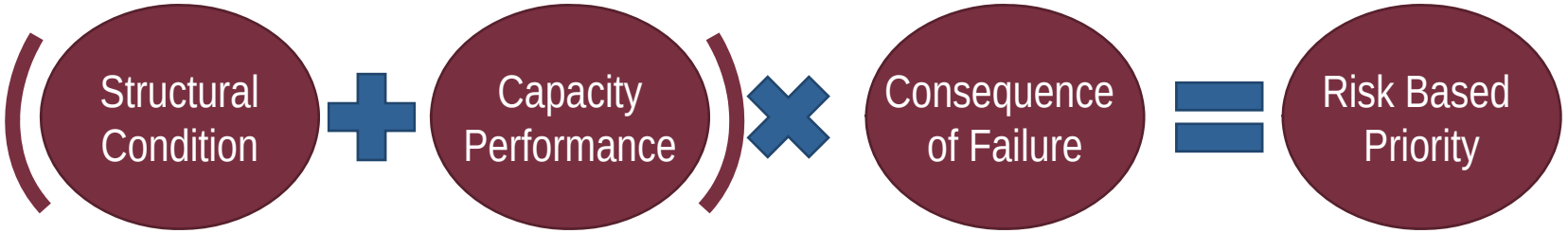
Levels of Service Based on Customer and Stakeholder Expectations

Risk Management Based on Likelihood and Consequence of Failure

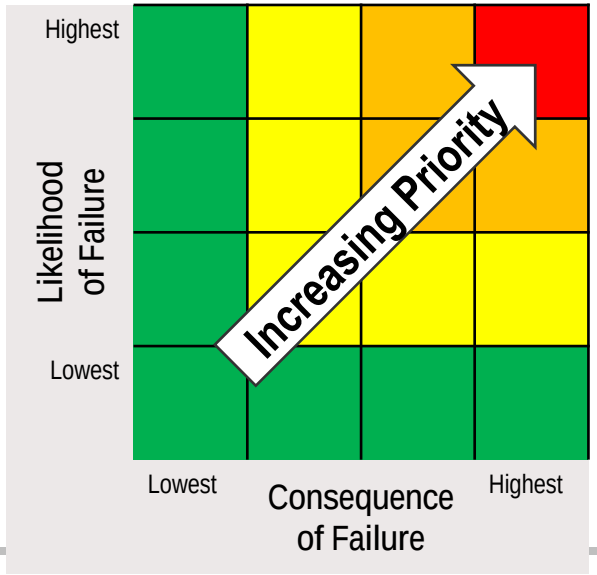
CIP Using Life Cycle Cost, Business Cases and Prioritization

Leading Practice Asset Management

Now we have a utility specific risk based prioritization



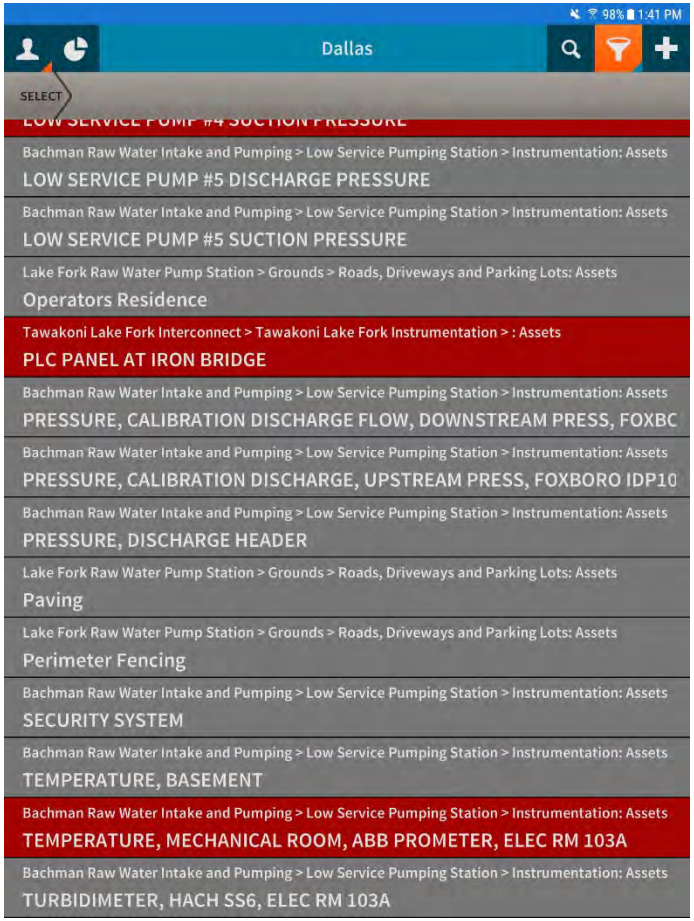
Likelihood of Failure (LOF)

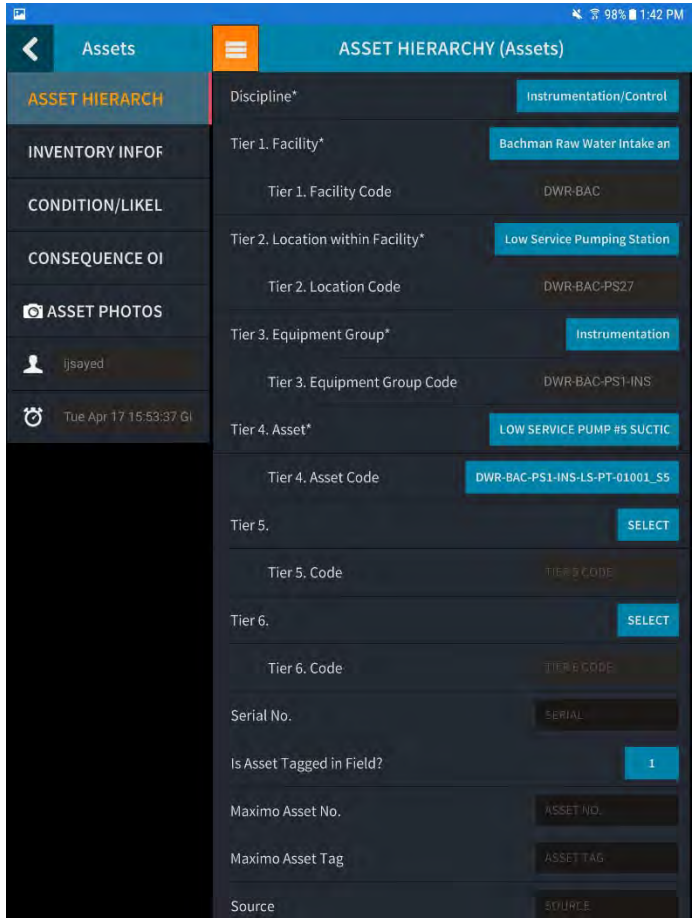


Using Asset Hound Tool for Condition Assessments

Arcadis, Asset Hound – Arcadis Field Condition Assessment / EDMS Tablet tool

Asset Hound provides
1. Asset list and status
2. Asset hierarchy

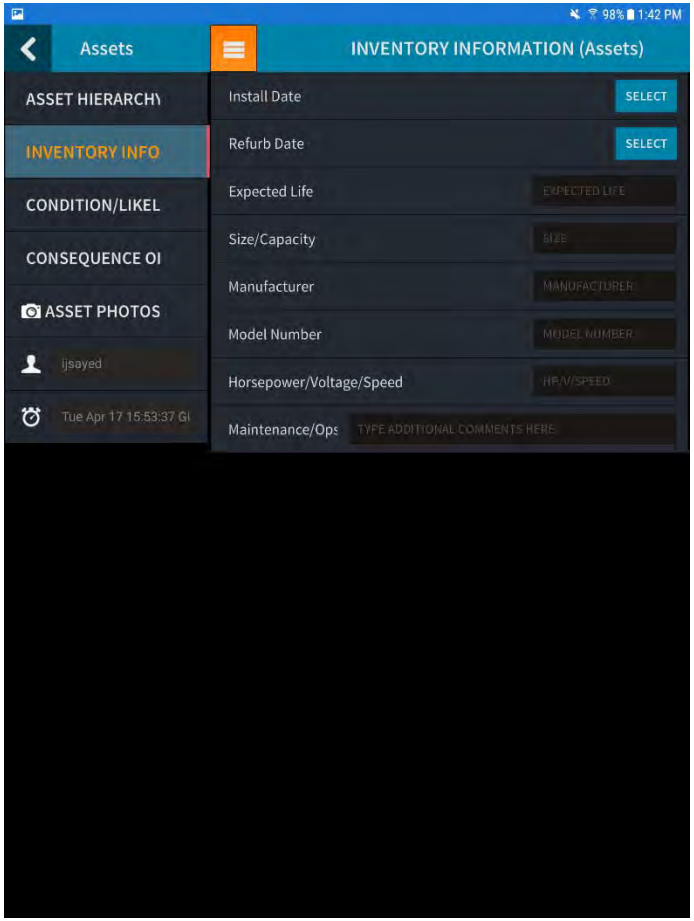


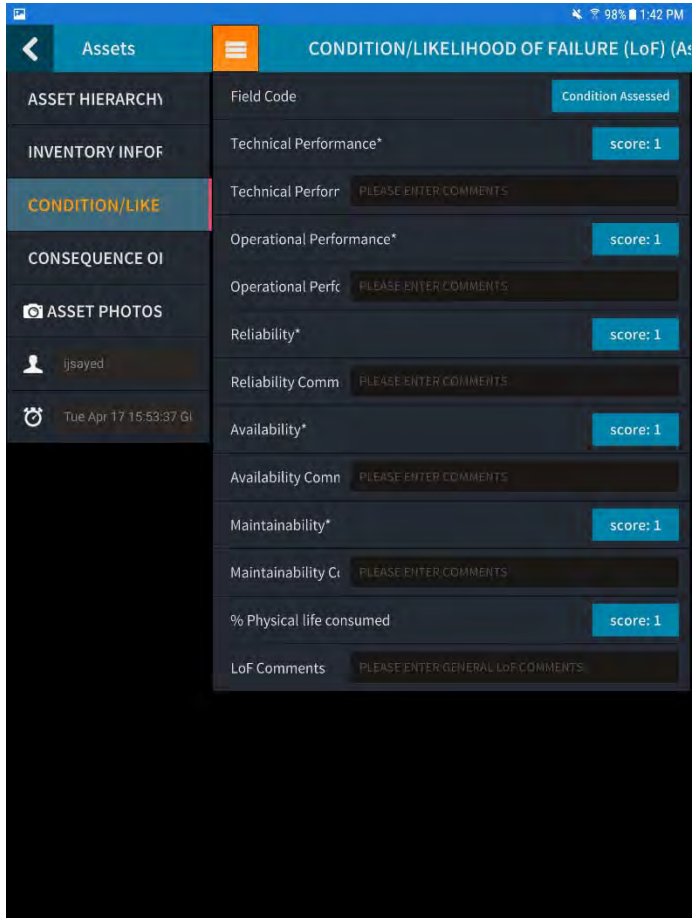


Asset Hound provides

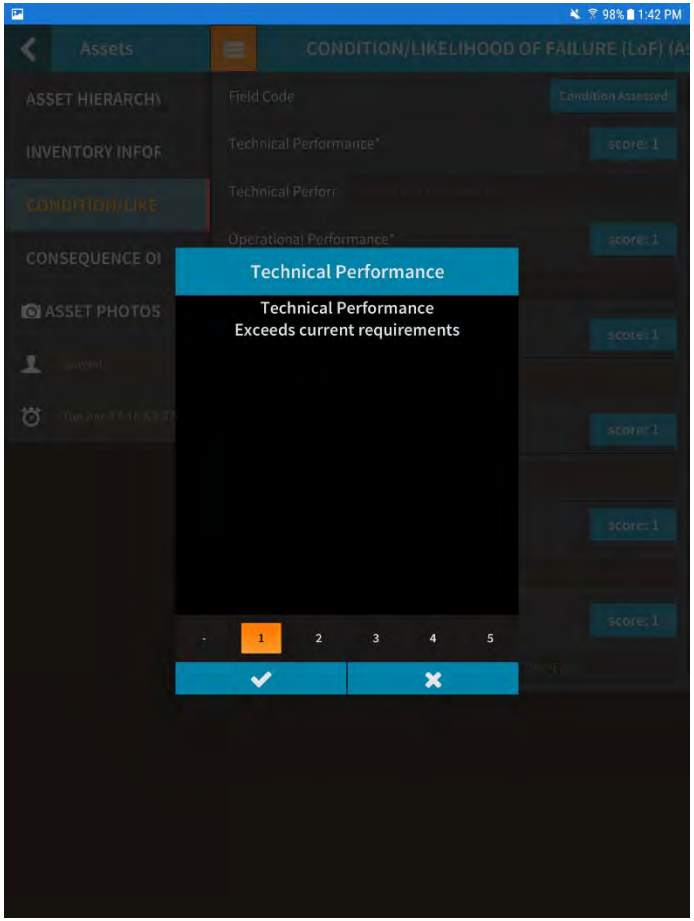
1. Asset background information

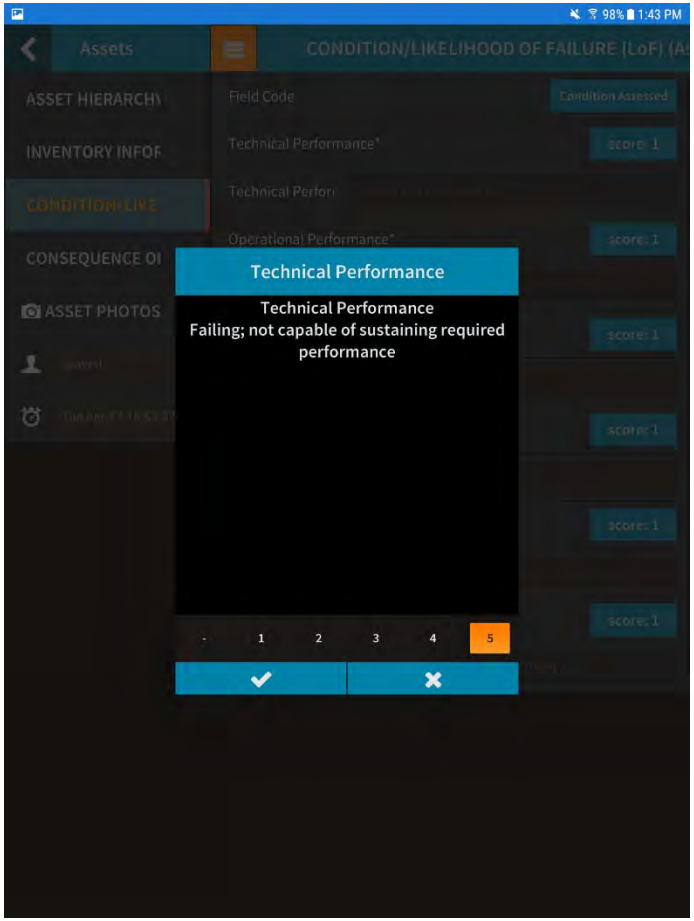
2. Asset condition assessments





Asset Hound provides
1. Asset scoring support

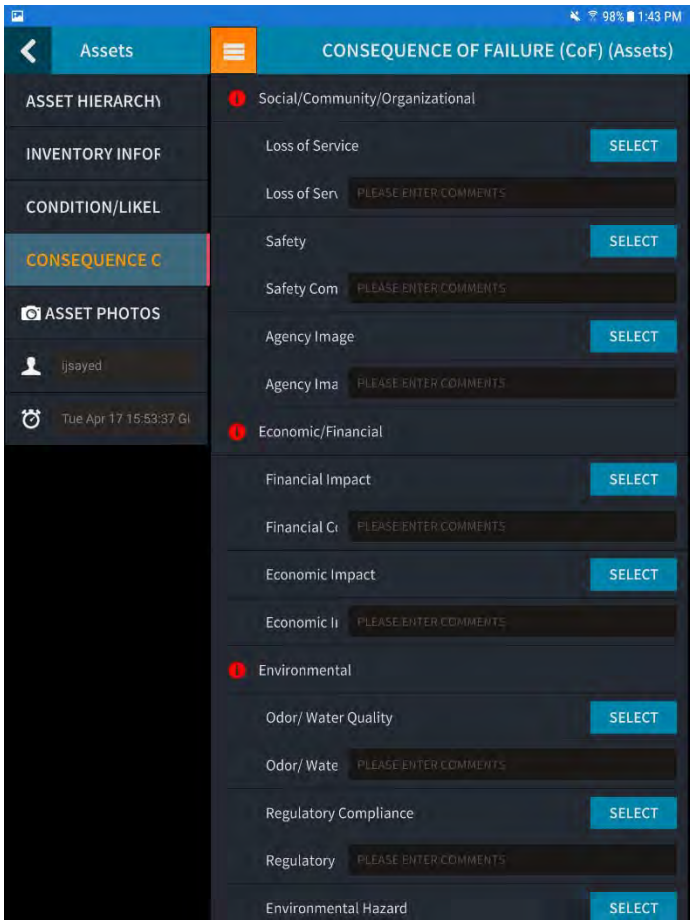


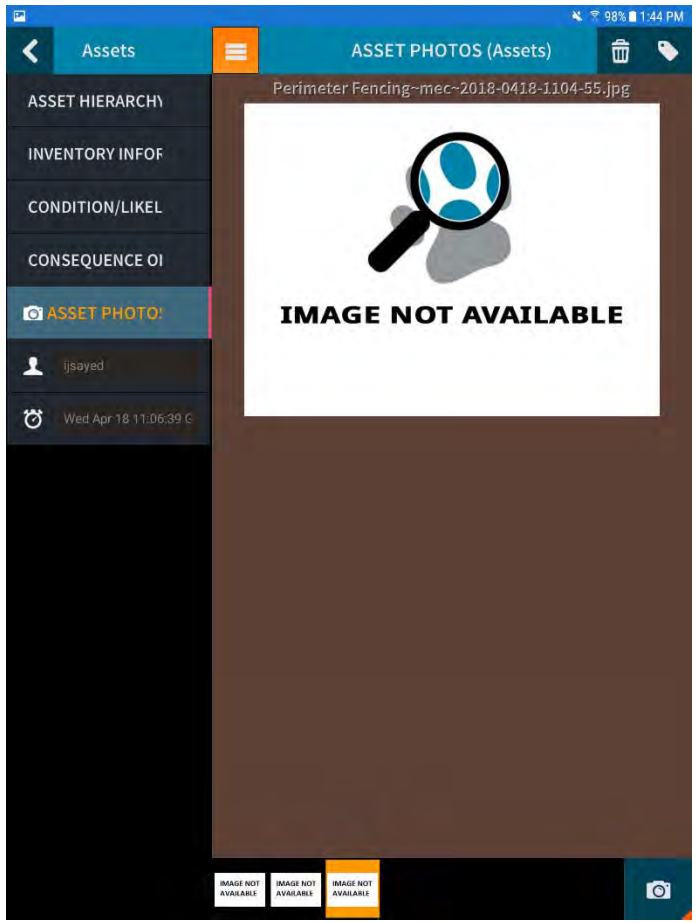


Asset Hound provides

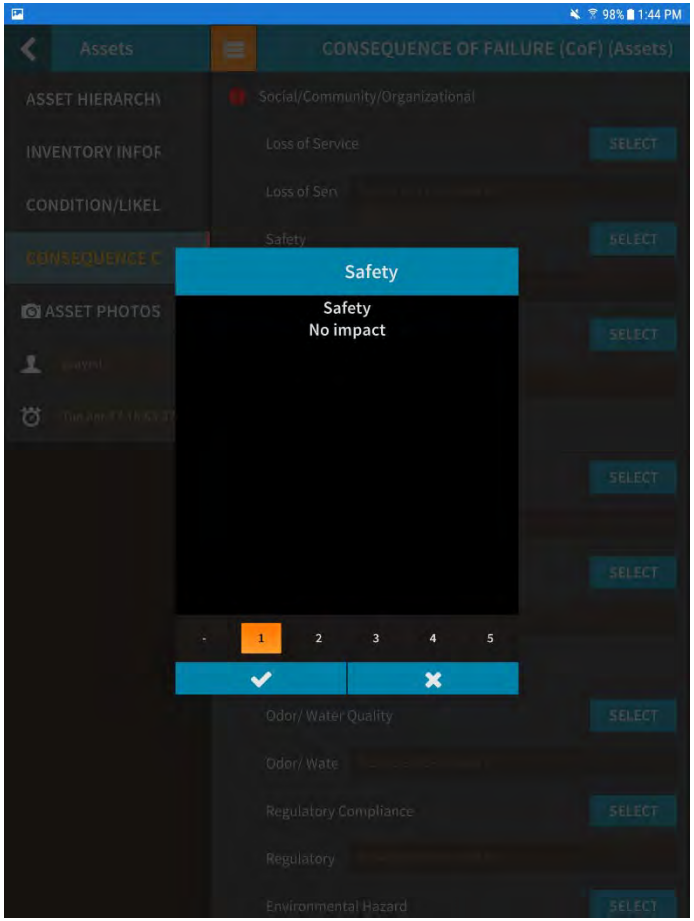
1. Consequence of Failure Scoring

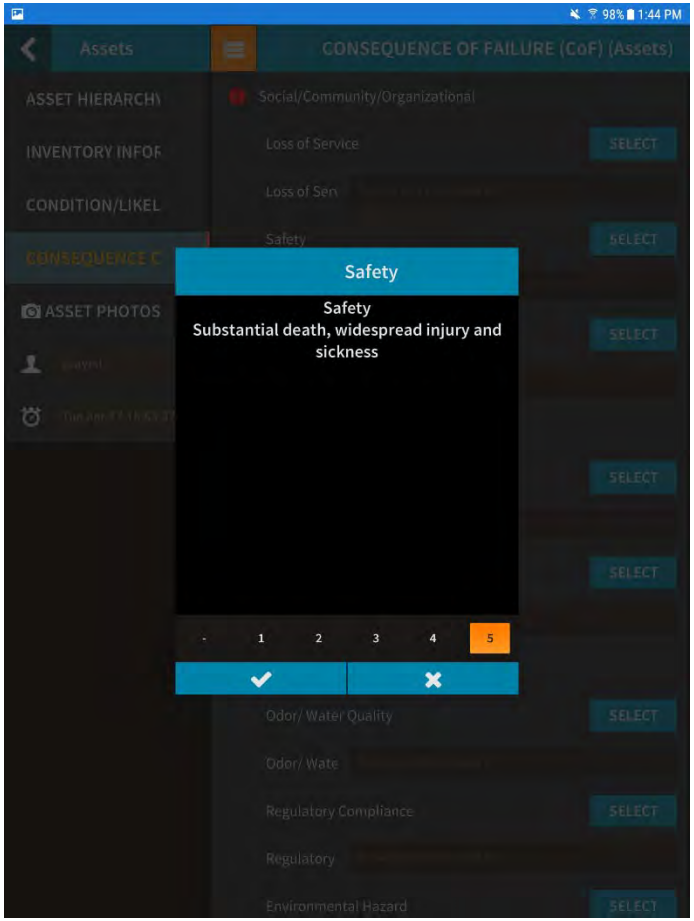
2. Asset pictures (GPS)





Asset Hound provides
1. Operational Scoring





EWAMS Asset Criticality Standards

Term	Meaning (General Guidelines/Considerations)
5	Large Scale Service Disruption or Violation / No Redundant Backup
4	Localized Service Disruption or Minor Violation / No Redundant Backup
3	Risk of Service Disruption or Violation / Part of System with Redundancy
2	Efficiency Reduction (Higher Cost to Operate)
1	No Impact on Core Business

When we have projects competing for money, we need to be able to describe the project impacts in common terms. This is not a permanent numerical rating or reflection of current operating conditions. It is a tool for thoughtful analysis of the relative impacts of proposed projects and the consequences (risks) of deferring them.

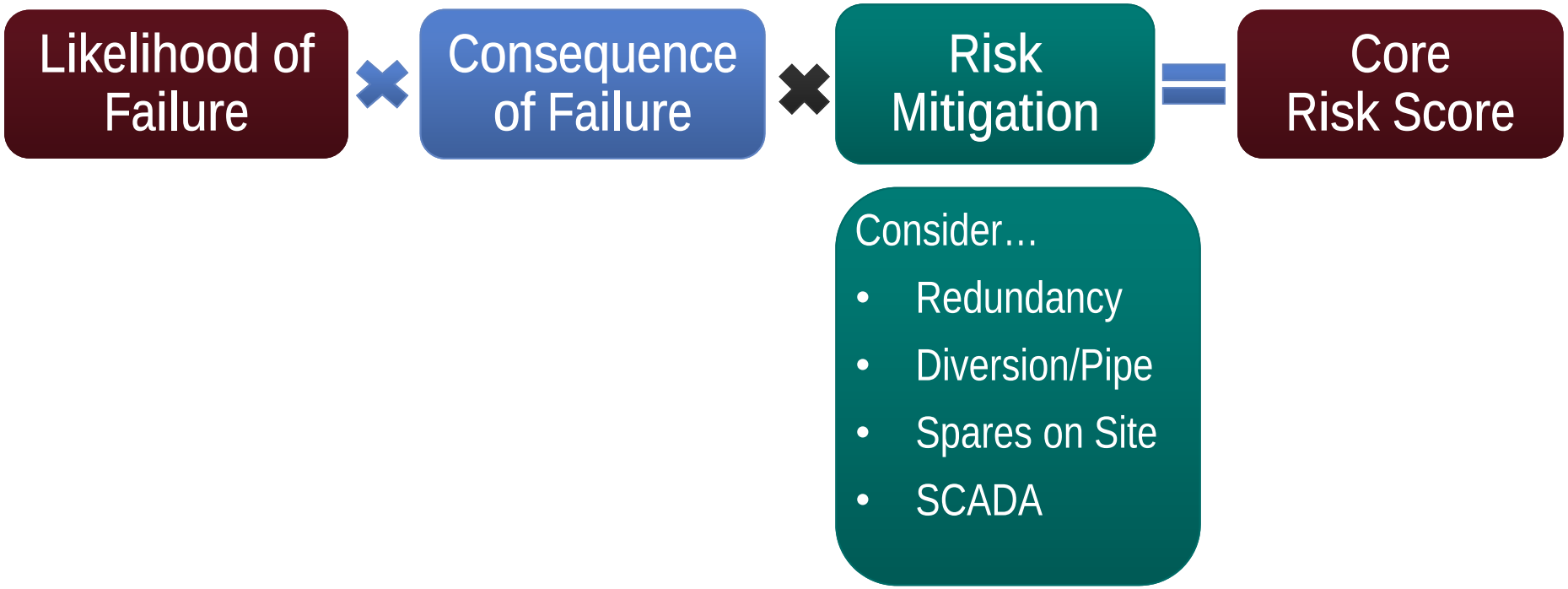
Criticality ratings assume assets are operational. Situational changes in criticality should be part of routine planning discussions (e.g., an asset is temporarily more critical while backups are down.)

DWUs EWAMS identifies their own Asset Condition Standards

Term	Meaning (General Guidelines/Considerations)
5	FAILED - Asset is no Longer Able to Function in Current Condition
4	POOR - Asset is Highly Unreliable or Inefficient
3	FAIR - Asset has Significant Defects that will Affect Reliability or Efficiency
2	ACCEPTABLE - Asset has Minor Defects
1	GOOD - Asset is in Good Condition (No Defects)

This is not a substitute for a condition index or an estimate of remaining years of useful life, both of which are meaningful within a class of asset. This is just a communication tool and mechanism for evaluating failure risk when crafting maintenance strategy or considering R&R.

But the BRE Tool incorporates risk mitigation into the calculation



The Business Risk Exposure worksheet tracks assessment ratings and

		Likelihood of Failure			Consequence of Failure				
Asset ID	Asset Name	% Effective Life Consumed (based on composite performance score)	OVERRIDE FIELD* Expected Remaining Effective Life (Yrs)	LoF	Social/ Community	Economic/ Financial	Environmental	COF Score	Core Risk Score (worst = 100)
11-BS-B1-MH-48-1	Manhole	67%		6.7	4	5	3	4.0	26.5
11-BS-B1-PNL-5-1	Pump Control Panel	38%		3.8	10	3	5	6.2	23.4
11-BS-B1-MH-48-2	Manhole	60%		6.0	4	3	3	3.4	20.1
11-BS-B1-PNL-5-2	Flow meter control panel	49%		4.9	8	3	1	4.1	19.6
11-BS-B1-PU -5-1	Submersible Pump #1	30%		3.0	10	3	5	6.2	18.5
11-BS-B1-PU -5-2	Submersible Pump #2	30%		3.0	10	3	5	6.2	18.5
11-BS-B1-PU -5-3	Submersible Pump #3	30%		3.0	10	3	5	6.2	18.5
11-PLV-B1-DIP-10-1	Piping, fittings, and couplings	26%		2.6	10	3	7	6.9	17.8
11-BS-B1-RTU-5-1	Remote Terminal Unit/Pump Control Panel	33%		3.3	7	3	6	5.5	17.7
11-BS-0-X-X-X	Perimeter Fencing	60%		6.0	3	3	1	2.3	13.8
11-BS-X-X-X-X	Burl Street Lift Station Structure	60%		6.0	3	3	1	2.3	13.8
11-PLV-B1-S-X-X	local manual switch for ventillator			7.4	3	1	1	1.7	12.5

We can assign useful life based on industry sources & experiences

Item Name	Anticipated Life (years)	Source
RCP	50	WEF, Collection Systems 2010 , p. 299
ABS	70	AWWA
SS	135	Donghao Stainless Steel tubing for 304 Semi-Industrial SS
DIP	50	WEF, Collection Systems 2010 , p. 299
VCP	66	AWWA
CIP	50	WEF, Collection Systems 2010 , p. 299
PLP	90	AWWA
PVC	90	WEF, Collection Systems 2010 , p. 299
HDPE	100	WEF, Collection Systems 2010 , p. 299
Steel	37	AWWA
Civil	75	USEPA/GHD Asset Management Training Workshop
Pumps	40	USEPA/GHD Asset Management Training Workshop
Valves	30	USEPA/GHD Asset Management Training Workshop
Motors	35	USEPA/GHD Asset Management Training Workshop
Electrical	30	USEPA/GHD Asset Management Training Workshop
Controls	25	USEPA/GHD Asset Management Training Workshop

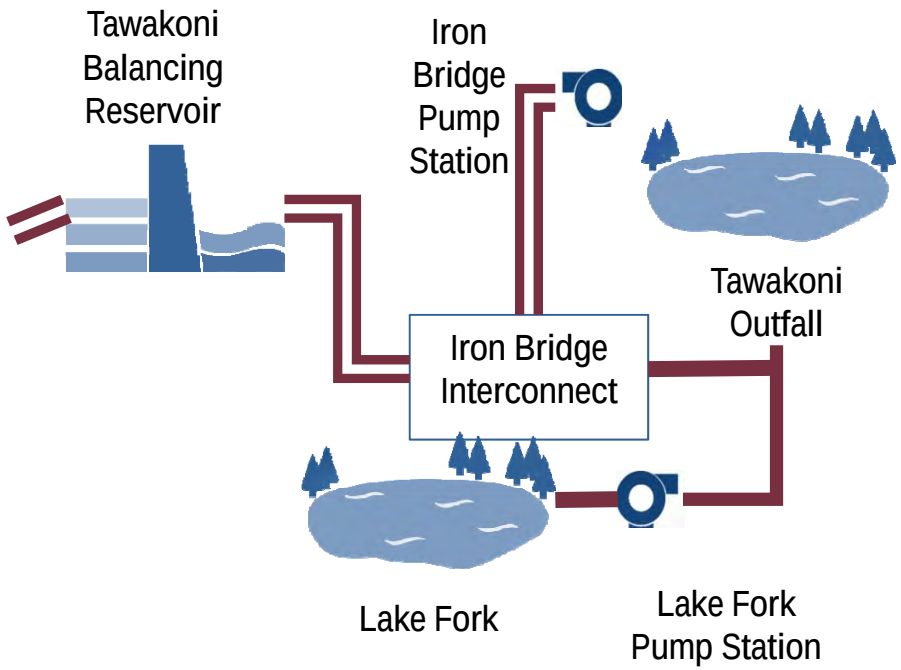
An added benefit is the assistance with new DWU initiatives

Enterprise Work-order & Asset Management System (EWAMS)

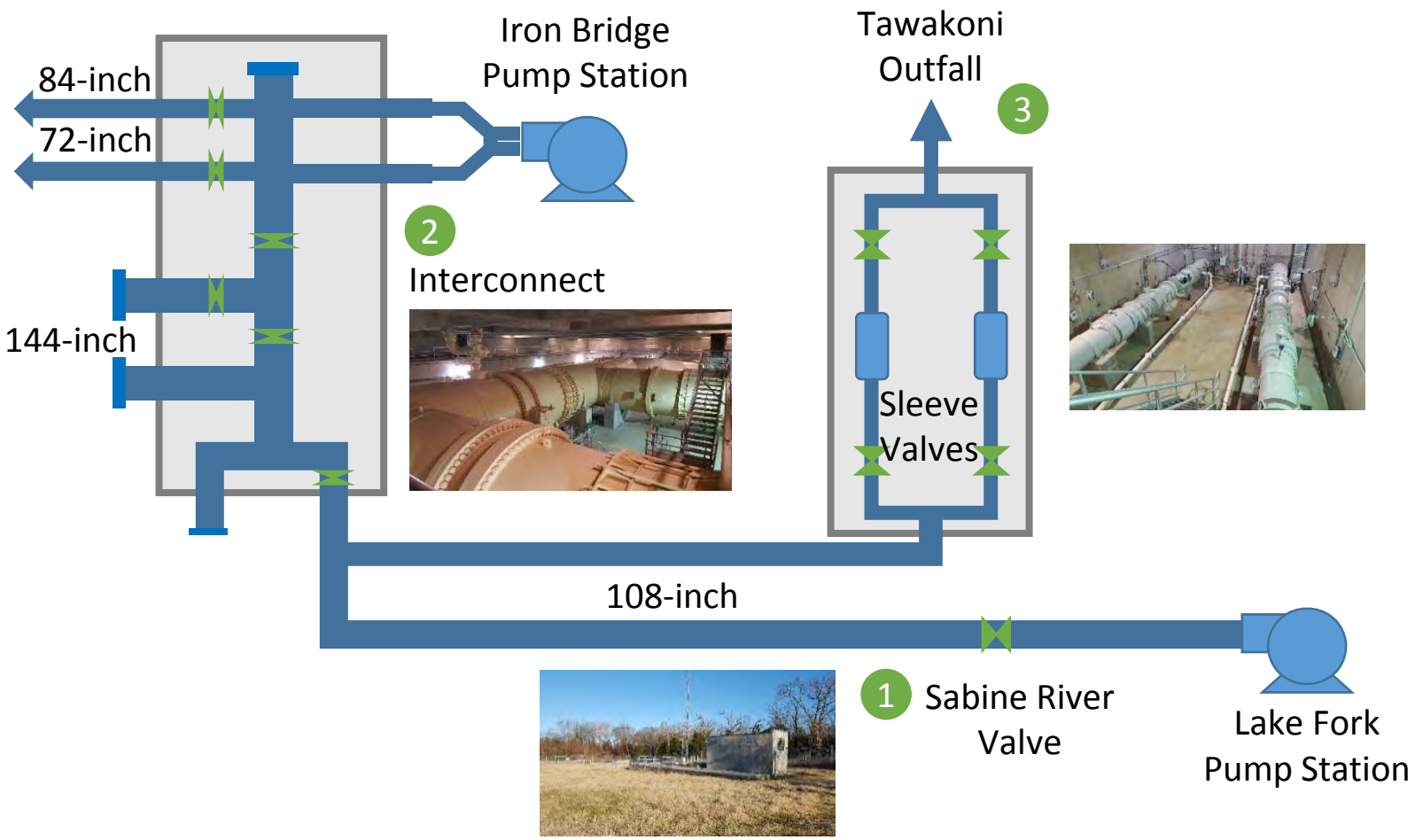
- Maximo Computerized Maintenance Management System Implementation
- Uniform Asset Identification
- Standardized Scoring (1 to 5) for Consequence and Liklihood of Failure

Lake Fork Pump Station

Eastern Facility



Eastern Facilities: Sabine River Valve, Tawakoni Outfall, Interconnect



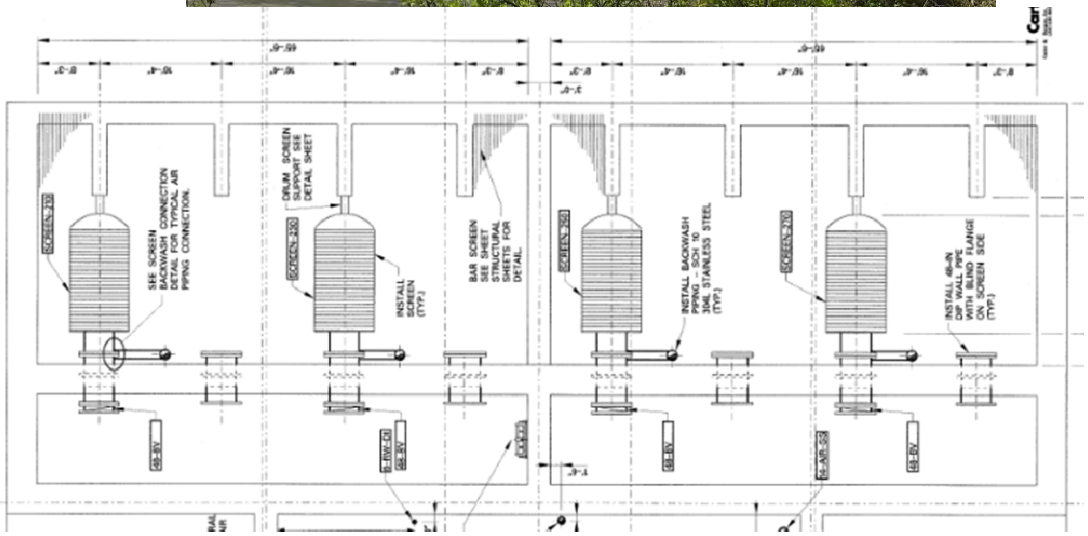
The Lake Ray Hubbard Intake

Eastern Facilities: Forney Pump Station

Why this approach example; Bachman Intake

Public access / Public blocking / Heavy debris / Manual debris removal / Back flooding / Assets in floodplain / Zebra Mussels / Limited roadways / Elevated chemicals / 60+ years old

Why this approach example; Lake Fork Intake



Restricted Access / Onsite Operations / Low debris / Automated debris removal from screen / Debris buildup in forebay / Low chance for Zebra Mussels / No chemicals / 12 yrs old