Jacobs Challenging today. Reinventing tomorrow.

Resiliency Prioritization within the Distribution System

What's next???

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Resiliency Refresh

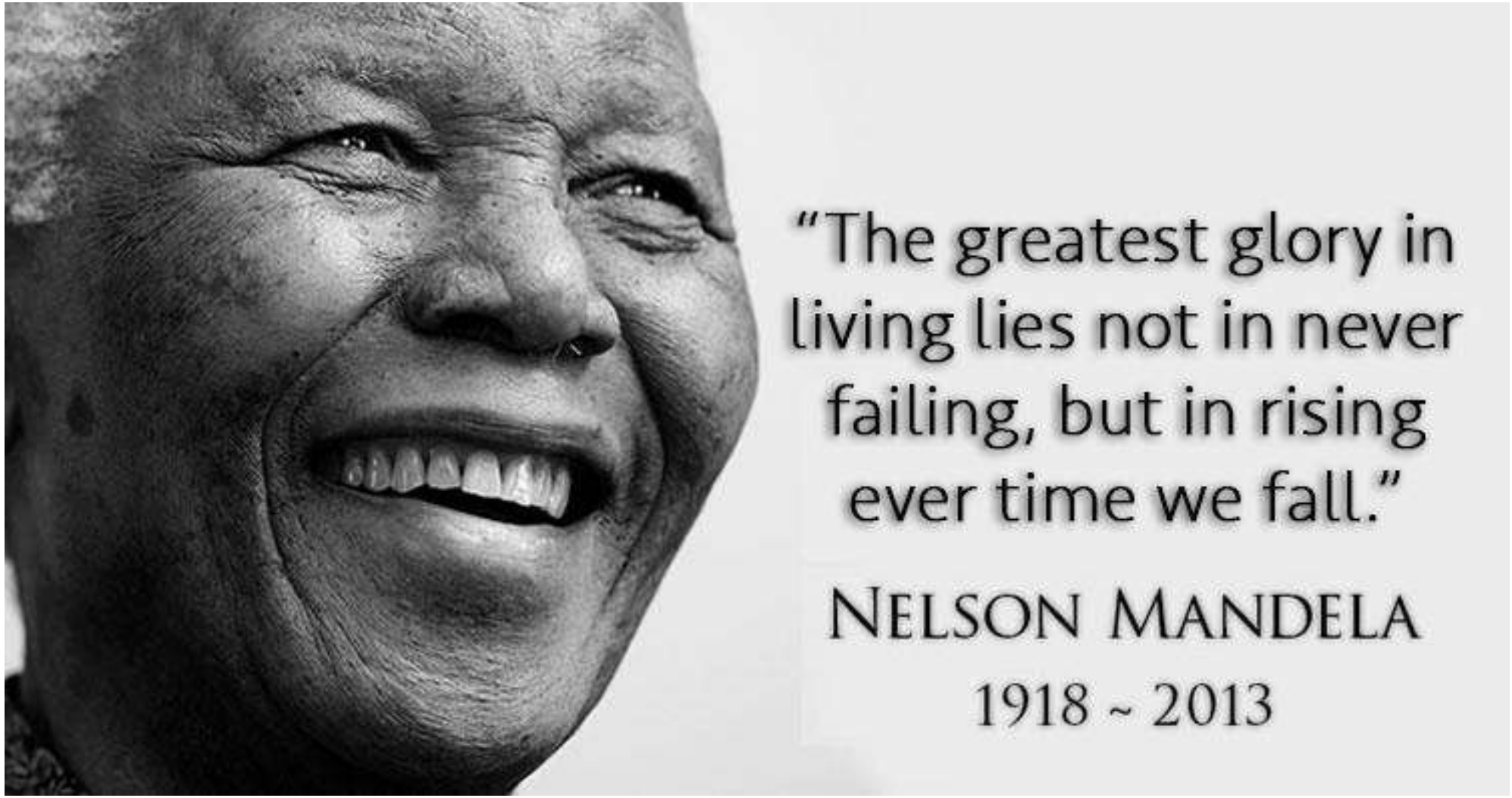
- Definition
- Where we came from
- The future

Resiliency in a Distributed System

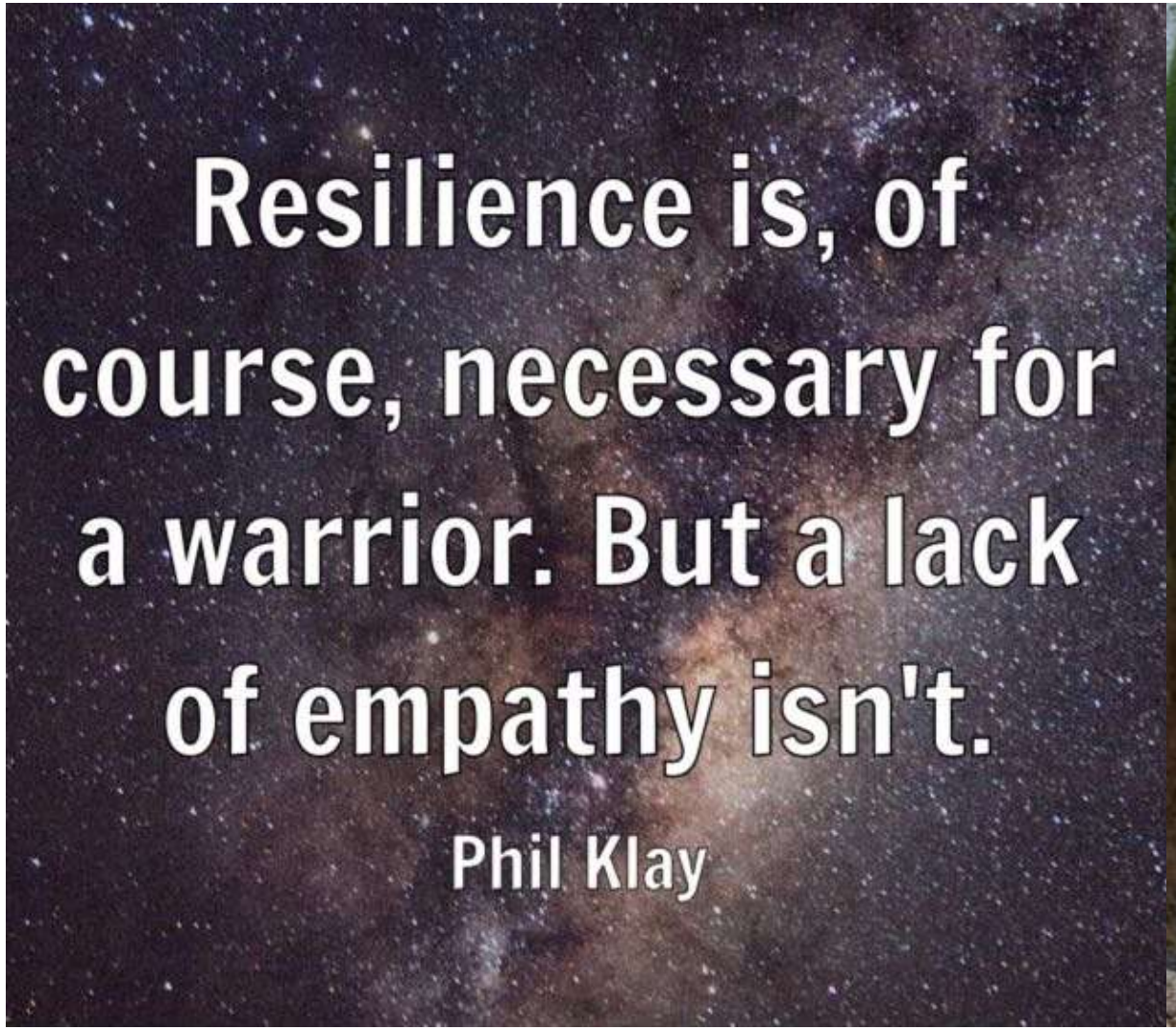
- Distribution
- Storage
- Pumping Systems

Resiliency Refresh

Let's Define It



Let's Define It



Let's Define It

"An ability to recover from or adjust easily to adversity or change."

Merriam-Webster

"Capacity to ***withstand*** or recover ***quickly*** from adverse conditions for the purpose of ***maintaining*** essential functions and to provide critical life support."

Dan Shafar

Why Resiliency

Capacity to Withstand

- Continued ability to provide service
- No cost from damage
- No attributable economic loss
- No gap in public service

Recover Quickly

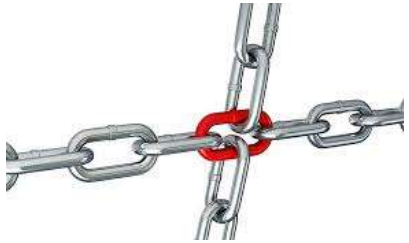
- Minimize cost from damage
- Reduce economic loss
- Manageable gap in public service

Resiliency resists threats

- Aging infrastructure
- Retiring workforce
- Procurement disruptions
- Weather events
- Natural disasters
- Human caused disruptions
- Regulatory requirements
- Customer behavior

Where to invest first

- Single points of failure
- Sources of typical disruptions
- Sources of supply
- Treatment works
- Primary transmission
- Utility management & training
- Operations & procedures



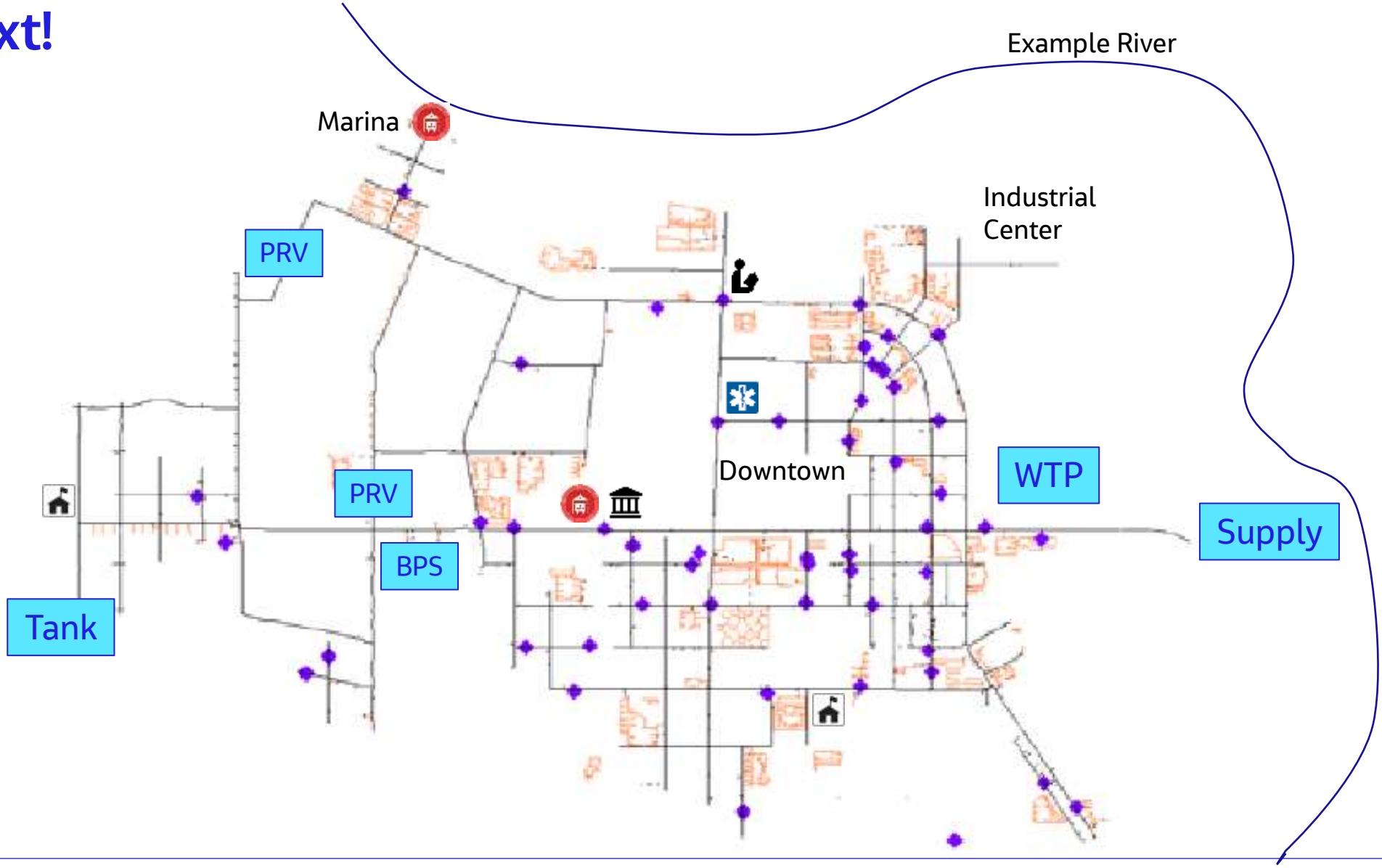



Water System Resiliency (to date)

- Wells & intakes
  - Ground improvement, condition assessment, retrofit & replacements
- Dams & reservoirs
  - Ground improvement, condition assessment, breach analysis, structural assessments
- Treatment works
  - Asset criticality, redundancy
- Primary transmission
  - Resilient piping, alignment selection
- Asset security
  - Fencing, locks, monitoring
- Backup power
  - Generators, solar, battery

Resiliency in a Distribution System

What's next!

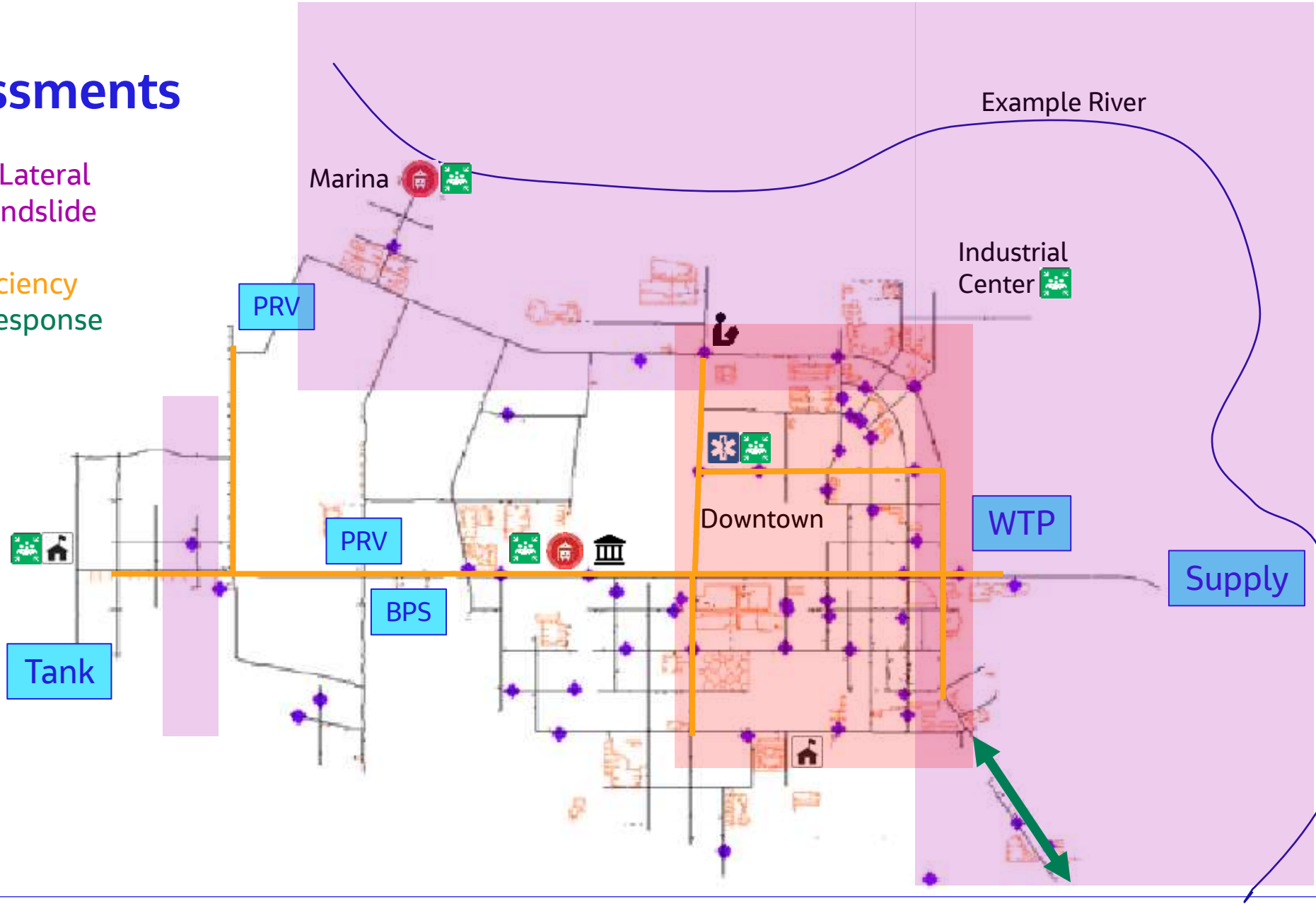


Distribution System

- Understand System
  - Risk assessments
  - Asset inventory
  - Condition assessments
  - Critical facility identification
  - Emergency response coordination

Risk Assessments

- Liquefaction, Lateral Spreading, Landslide
- System Age
- Capacity Deficiency
- Emergency Response

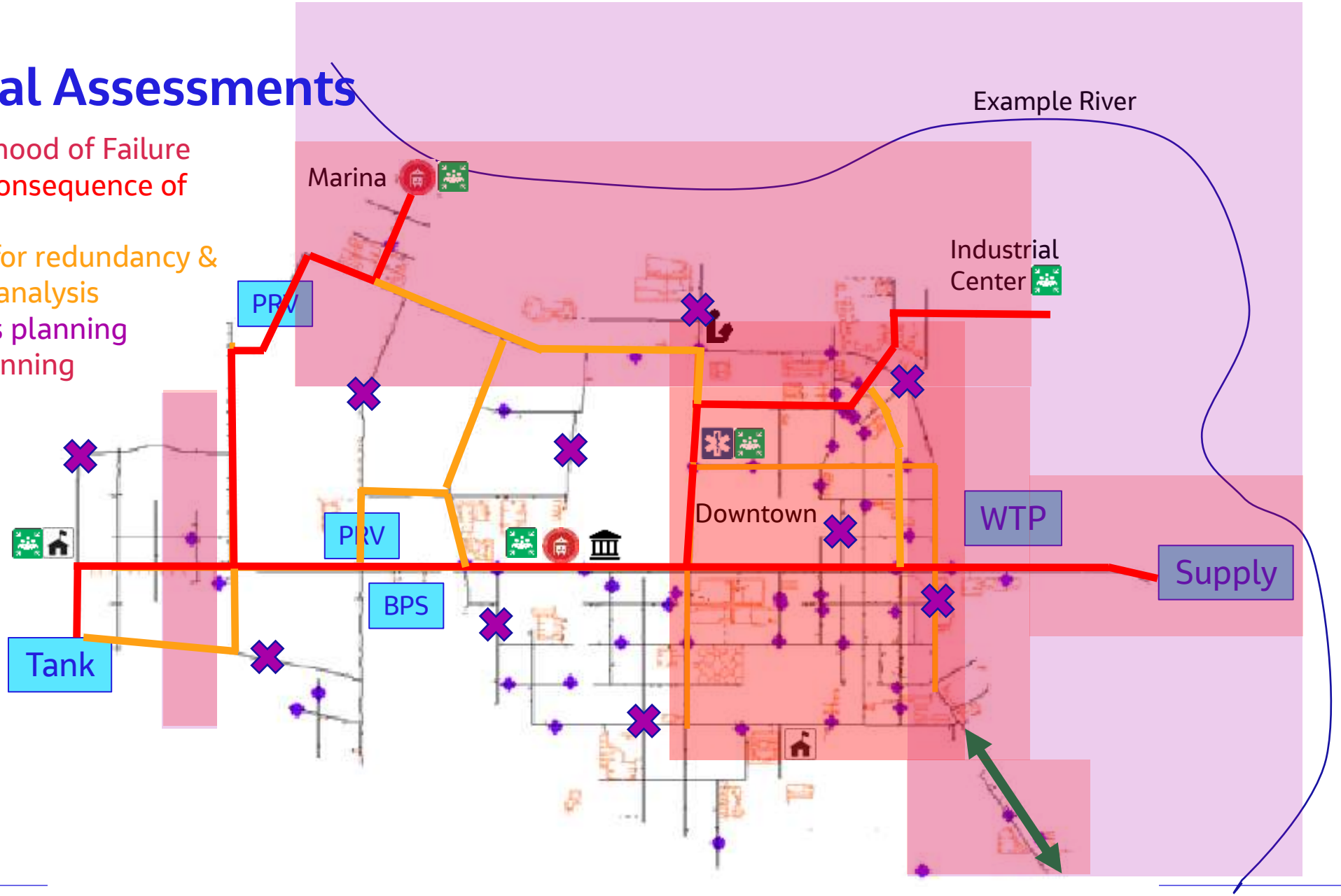


Distribution System

- Analytical Assessments
  - Assess likelihood of failure
  - Assess consequence of failure
  - Line break & hydraulic modeling
  - Monetize for triple bottom line
  - Develop operations plan
  - Inform capital plan

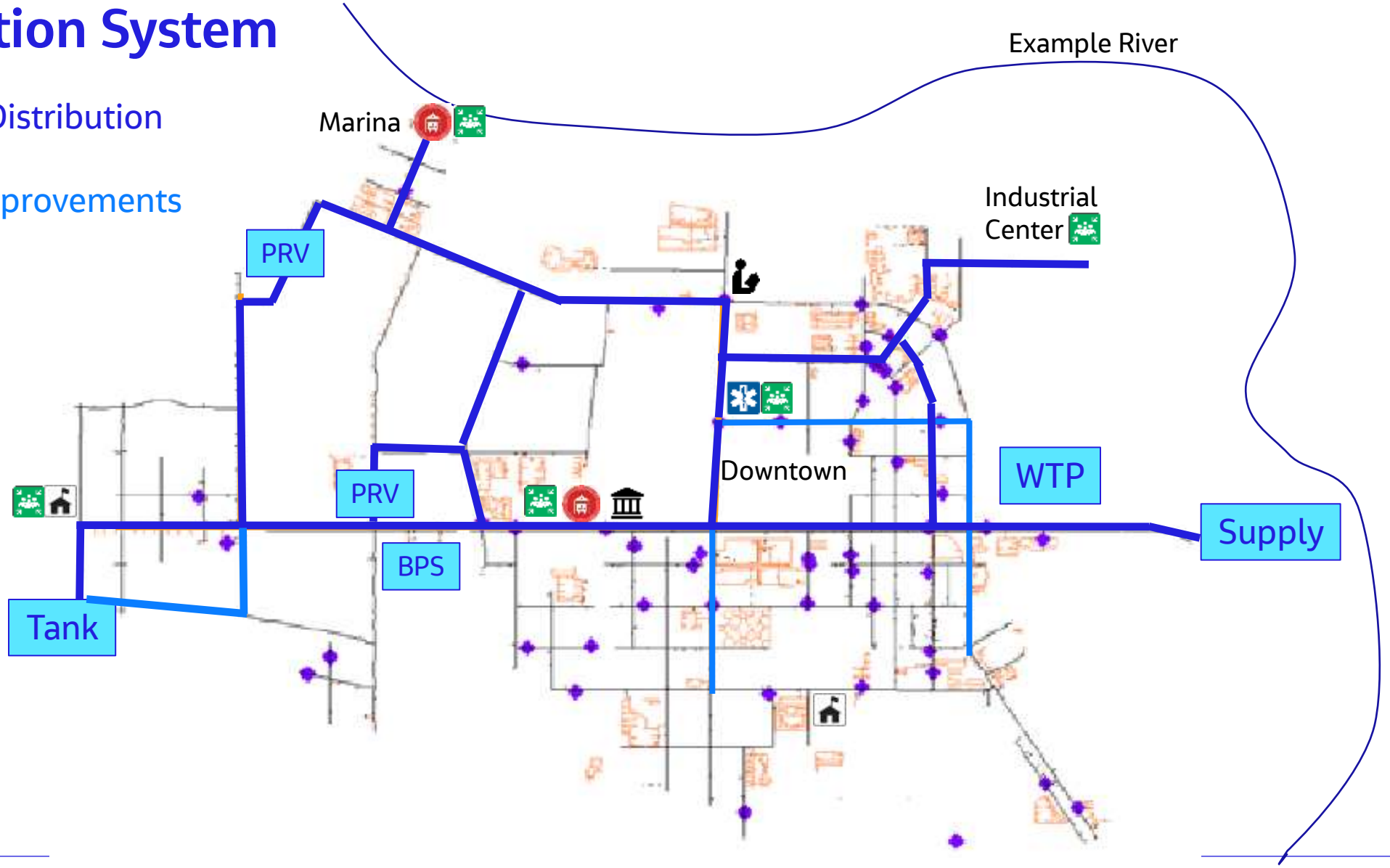
Analytical Assessments

- Map Likelihood of Failure
- Evaluate Consequence of Failure
- Modeling for redundancy & line break analysis
- Operations planning
- Capital planning



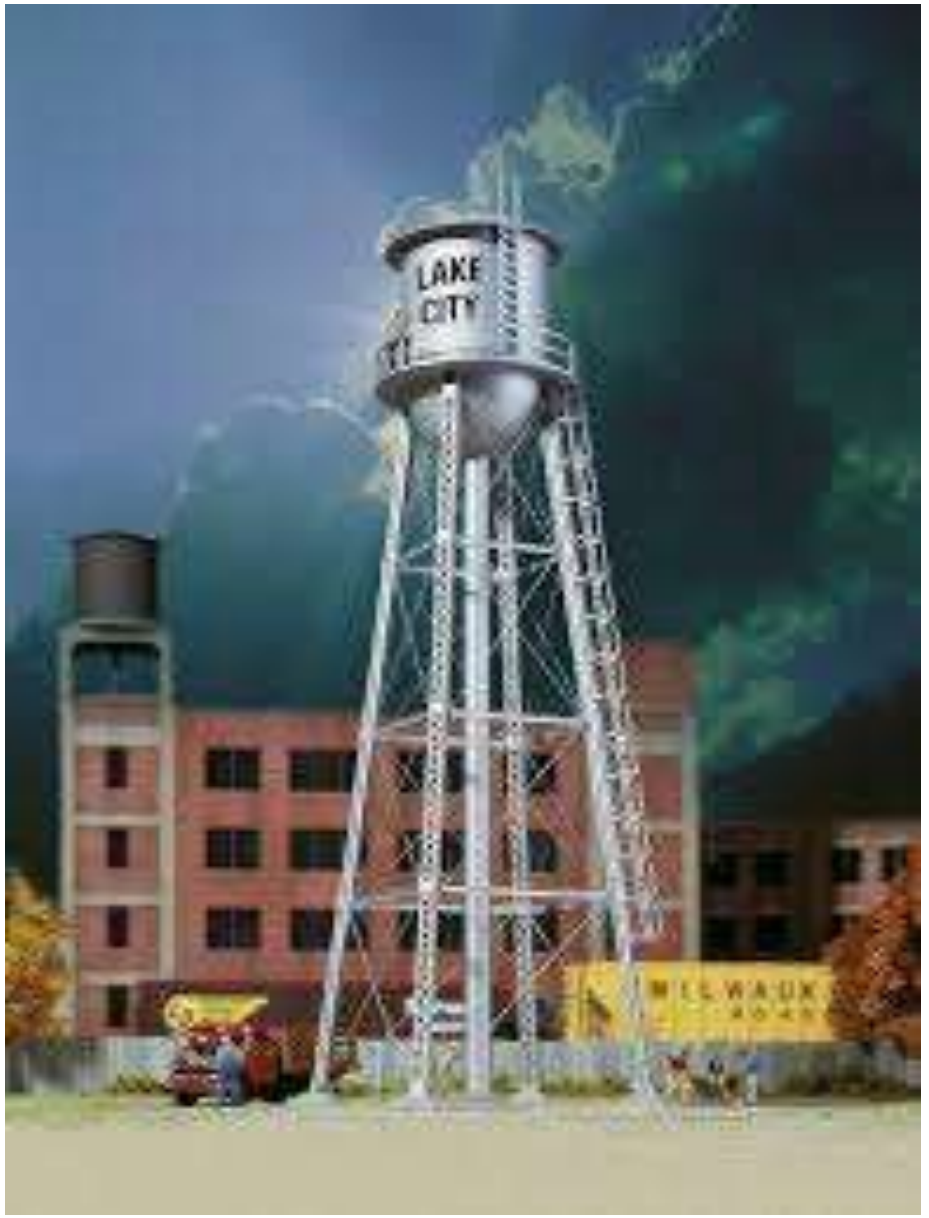
Distribution System

- Resilient Distribution System
- Capital Improvements



Storage

- How much storage is in the system?
- Can you keep water in the reservoirs & tanks?
- Is storage protected from vandalism / access?
- Structural systems up to current code?



Storage

- Consider how much water is needed for critical functions?
  - Fire fighting
  - Hospital usage
  - Community consumption

- Control valves
  - Protect storage volume vs. fire fighting needs
  - Backup power & remote control

Storage

- System Security & Operations
  - Site access control
  - Tamper proof vault/valve access
  - Can you provide means to provide public access to Potable in emergency?

- Structural updates
  - Seismic
  - Climate change
  - Condition assessment

Pumping Systems

- Supply to pumping intakes
- Resiliency of piping configurations
- Emergency Power
- Spare Parts
- Instrumentation & Control Redundancy

Pumping Systems

- Supply to pumping intakes
  - Is the intake/well resilient?
  - Can you direct feed pump truck?

- Resiliency of piping configurations
  - Is the suction side of piping resilient?
  - Options in header piping and flow directions
  - Flexibility in bends

Pumping Systems

- Emergency Power
  - Multiple sources of power
  - Protected tamper proof fuel storage

- Spare Parts
  - Supply chain disruptions
  - Availability to standardize spares
  - Proximity of the spares

Pumping Systems

- Instrumentation & Control Redundancy
  - Multiple sources of communication
  - Backup power for controls & communication
  - Triggers for emergency protocol
    - Seismic
    - Weather
    - Fire fighting

Summary

- Distribution System resiliency needed to supply water to essential facilities
  - Broad benefits to improving resiliency
  - Need to approach systematically
  - Opportunities may overlap

- *Capacity to withstand* must address not just survivability but serviceability.

- *Quick recovery* will not be possible in all locations; utilities must assess and prioritize. In some cases relocation may be preferred.

- Don't focus only on the biggest assets – our job is to *maintain essential service* to critical users.

Questions?

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