All-Hazards Risk and Resilience Assessment for Wastewater Utilities

NJWEA 2022 Annual Conference

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May 9, 2022

CDM Smith

Agenda

- Introduction
- Methodology
- Risk and Resilience Project Framework
- Fauquier County Water & Sewer Authority Example
- Conclusion
- Q&A

www.epa.gov/waterresilience

Introduction

Risk and Resilience

ars TECHNICA BIZ & IT TECH SCIENCE POLICY CARS GAMING & CULTURE FORUMS

POISONING THE WELL —

Feds say man broke into public water system and shut down safety processes

Indictment underscores the potential for remote intrusions to have fatal consequences.

DAN GOODIN - 4/1/2021, 4:07 PM

CYBERSECURITY & INFRASTRUCTURE SECURITY AGENCY

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National Cyber Awareness System > Alerts > Compromise of U.S. Water Treatment Facility

Alert (AA21-042A)

More Alerts

Compromise of U.S. Water Treatment Facility

Original release date: February 11, 2021 | Last revised: February 12, 2021

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Summary

at a U.S. drinking water
, a caustic chemical, as part of
efore the SCADA system's
cted and continued to operate
tdated operating system. Early
o the system, although this
SS), and the Federal Bureau of

Fort Frances crews attempt to pump water out of the White Pine Lift Station, which stopped working during the weekend's storm. The exact problem hasn't been identified, as crews have been unable to access the pump to find out why it stopped working. (Craig Miller/Provided)

America's Water Infrastructure Act (AWIA)

- Signed: October 23, 2018 and amends the Safe Drinking Water Act (SDWA)
- New requirements:
  1. Risk and Resilience Assessment
  2. Emergency Response Plan
- Community water systems serving over 3,300 people (directly or indirectly)
- Update/certify **both** documents every five years

Risk and Resilience Assessment

Population served ≥100,000	Population served 50,000-99,999	Population served 3,301-49,999
March 31, 2020	December 31, 2020	June 30, 2021

Emergency Response Plan

No later than six months after certifying the Risk and Resilience Assessment (June 30, 2020)

Purpose of All Hazards Risk and Resilience Assessments

Evaluate

- The risk and resilience of community water systems to natural hazards and malicious acts.

Prepare

- Utilities to respond to natural hazards and malicious acts.

Protect

- The public from natural hazards and malicious acts that may occur at community water **& wastewater systems.**

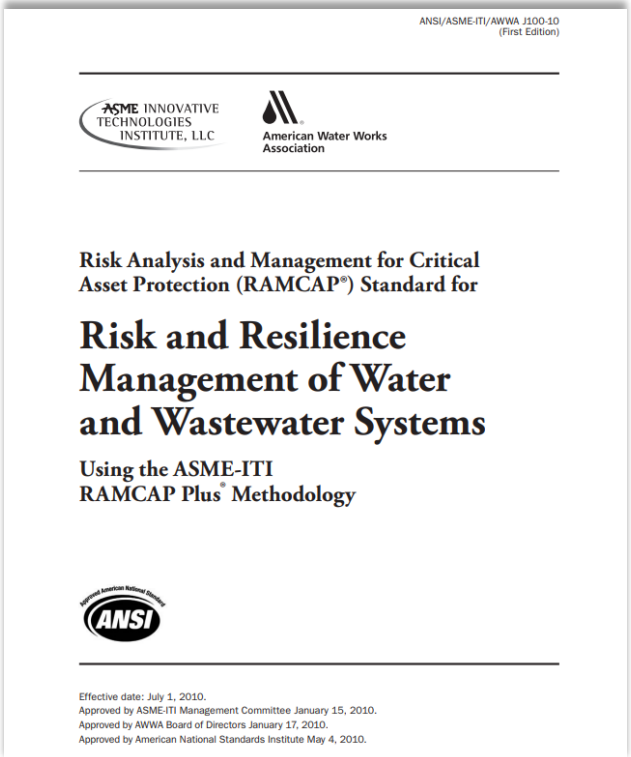
Methodology

Risk & Resilience Assessment Methodology

Risk Analysis and Management for Critical Asset Protection

1. Asset Characterization
2. Threat Characterization
3. Consequence Analysis
4. Vulnerability Analysis
5. Threat Analysis (Likelihood)
6. Risk Analysis (R=C×V×T)
7. Risk Management (B:C)

Result: Quantified Risk Scores



Risk & Resilience Assessment Methodology

**Risk ($) =** Threat Likelihood (%) x Consequence ($) x Vulnerability (%)

Threat Likelihood (%)

- How likely a given threat is to occur in a given year; a percentage value ranging from nearly zero (very unlikely to occur) to one (almost certain to occur).

Consequence ($)

- The worst reasonable consequence to an asset, assuming a threat does occur; a dollar value.
- For most threats*: Consequence = Cost of Temporary Measure/ Equipment + Cost from Fatalities + Cost from Injuries + Repair/Replacement*

Vulnerability (%)

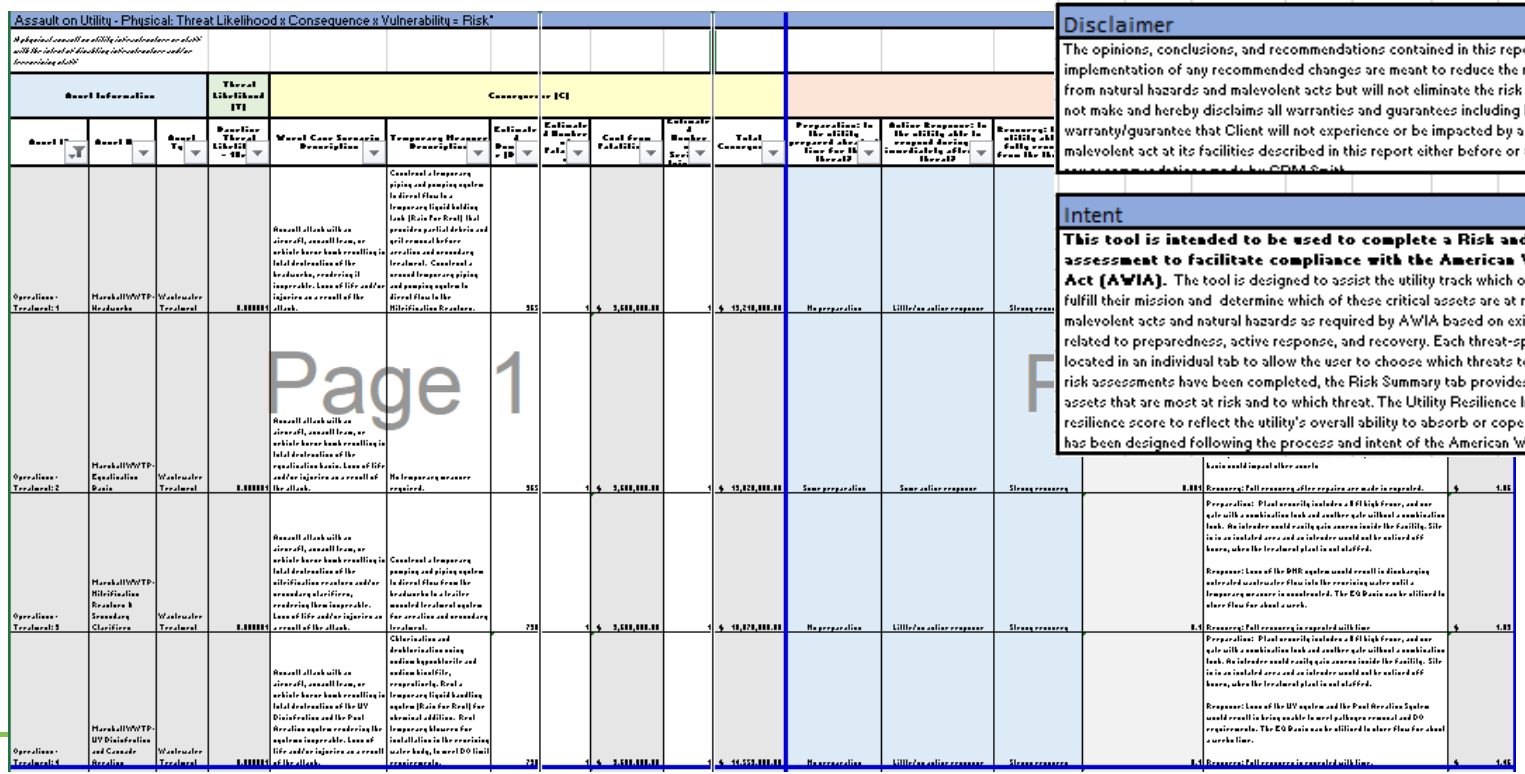
- An assessment of the utility's preparedness ahead of time for the threat, whether it will be able to respond during or immediately after the threat, and if the utility would be able to fully recover from the threat; a percentage value ranging from 0.001 (least vulnerable) to 1 (most vulnerable).
- For most threats*: Vulnerability = Preparedness x Active Response x Recovery*

- Values from EPA, FEMA or AWWA guidance.

- Values will be determined based on: workshop input, data collected, site visits, engineering judgement, best practices

Risk & Resilience Assessment Methodology

- CDM Smith's Risk and Resilience RRA Tool



Risk and Resilience Assessment (RRA) Tool

to facilitate compliance with

America's Water Infrastructure Act (AWIA)

Disclaimer

The opinions, conclusions, and recommendations contained in this report and Client's implementation of any recommended changes are meant to reduce the risk to the Client's facilities from natural hazards and malevolent acts but will not eliminate the risk entirely. CDM Smith does not make and hereby disclaims all warranties and guarantees including but not limited to any warranty/guarantee that Client will not experience or be impacted by a natural hazard or malevolent act at its facilities described in this report either before or after the implementation of

Intent

This tool is intended to be used to complete a Risk and Resilience assessment to facilitate compliance with the American Water Infrastructure Act (AWIA). The tool is designed to assist the utility track which of their assets are critical to fulfill their mission and determine which of these critical assets are at risk to threats posed by malevolent acts and natural hazards as required by AWIA based on existing measures in place related to preparedness, active response, and recovery. Each threat-specific risk assessment is located in an individual tab to allow the user to choose which threats to assess. Once all relevant risk assessments have been completed, the Risk Summary tab provides an overview of the critical assets that are most at risk and to which threat. The Utility Resilience Index includes a utility-wide resilience score to reflect the utility's overall ability to absorb or cope with an incident. The tool has been designed following the process and intent of the American Water Works Association

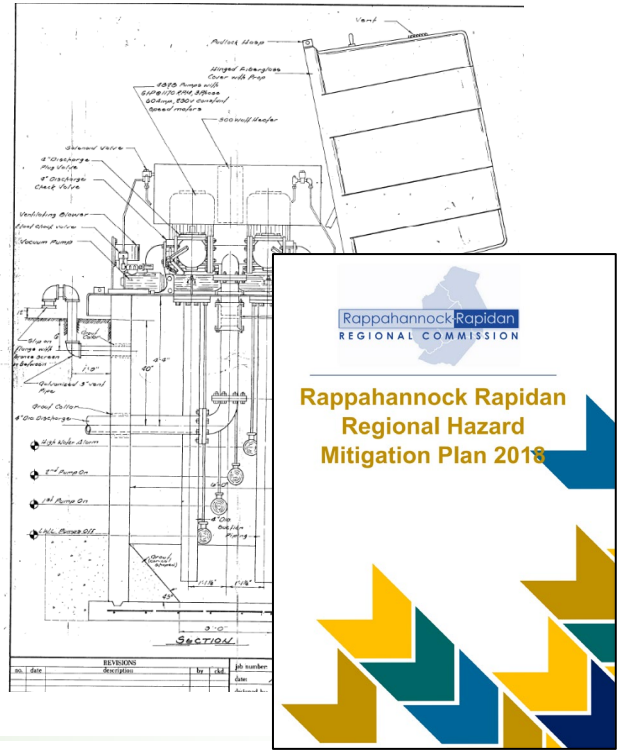
Risk & Resilience Assessment Project Framework

Risk and Resilience Project Framework

Data Gathering and Review

Data Collection & Review

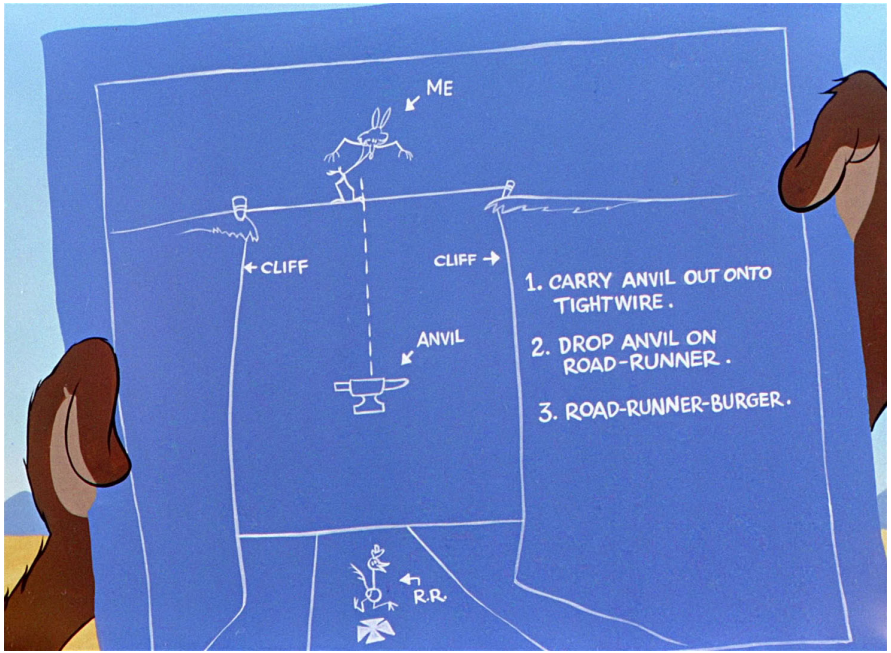
- GIS/asset management program for water system assets
- Locations and facility descriptions of water system assets
- Near-term capital projects
- As-built drawings of critical facilities
- Past events (e.g., after-action reports)
- Local hazard mitigation plans
- Previously prepared vulnerability or risk assessments
- Previously prepared Business Continuity and/ or Emergency Response Plans (ERP) and associated annexes.



Threats: Malevolent Acts*

Threat Asset Pairing

- Assault on Utility - Physical
- Theft or Diversion – Physical
- Contamination
- Sabotage – Physical
- Cyber Attack
  - Business Enterprise Systems
  - Process Control Systems



 *EPA Baseline Information on Malevolent Acts of Community Water Systems (2019): https://www.epa.gov/waterresilience

Threats: Natural Hazards*

Threat Asset Pairing

- Drought
- Earthquake
- Extreme temperatures (heat and cold)
- Flooding
- Pandemic
- Wind related hazards
- Wildfires

*2018 Rappahannock-Rapidan Hazard Mitigation Plan: www.madisonco.virginia.gov
2018 Commonwealth of Virginia Hazard Mitigation Plan: https://www.cakex.org/sites/default/files/documents/COV-SHMP-3-2018-Public.pdf

Asset Types

Threat Asset Pairing

- Operations-Treatment
  - Wastewater treatment plants and related assets (shop areas, plant buildings, etc.)
  - Power supply
- Operations-Collection
  - Collection piping
  - Lift stations
- Operations Personnel
- Finance and Accounting
  - Billing, payroll, third-party suppliers
  - Personnel
- Information Technology
  - SCADA
  - Enterprise Servers & laptops/ workstations

Example of a Threat-Asset Pair

Threat Asset Pairing

- **Asset:** Bat Computer

(which includes the SCADA system for the Bat Cave!)

- **Threat:** Cyber Attack on
on Control Systems

Threat-Asset Pairs

Threat Asset Pairing

List of Typical Assets

- Wastewater Treatment Plants
- Pump & Lift Stations
- Power Supply (Incl. Back Up Power)
- Collection & Conveyance
- Administrative Buildings & Maintenance Facilities
- SCADA
- IT & Communication Systems
- Personnel

Natural Hazards

- Pandemic
- Drought
- Extreme temperatures (Heat & Cold)
- Flooding
- Wind events
- Wildfires
- Earthquakes

Malevolent Acts (recommended by EPA)

- Assault on Utility
- Contamination
- Cyber Attack
  - Business Enterprise Systems
  - Process Control Systems
- Sabotage
- Theft or Diversion

Develop Threat-Asset Pairs Matrix

Critical Wastewater Assets

Malevolent Acts

Natural Hazards

Threat Asset Pairing

Critical Assets		Reference Threats						Reference Threats				
		Malevolent Threats (Based on EPA Threat Categories)						Natural Hazards*				
Asset ID	Asset Name	Assault on Utility - Physical	Contamination of Wastewater	Cyber Attack on Business Enterprise Systems	Cyber Attack on Process Control Systems	Sabotage - Physical	Theft/Diversion	Drought	Earthquake	Extreme Temperature	Flooding and Heavy Rainfall	Major Storms
Operations - Treatment: 1	Marshall WWTP- Headworks	Yes	Yes	N/A	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Operations - Treatment: 2	Marshall WWTP- Equalization Basin	Yes	Yes	N/A	N/A	Yes	N/A	N/A	Yes	Yes	Yes	Yes
Operations - Treatment: 3	Marshall WWTP- Nitrification Reactors & Secondary Clarifiers	Yes	Yes	N/A	N/A	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Operations - Treatment: 4	Marshall WWTP- UV Disinfection and Cascade Aeration	Yes	N/A	N/A	Yes	Yes	N/A	N/A	Yes	Yes	Yes	Yes
Operations - Treatment: 5	Marshall WWTP- Chemicals & Chemical Feed Systems	Yes	N/A	N/A	N/A	Yes	Yes	N/A	Yes	Yes	N/A	Yes
Operations - Treatment: 6	Marshall WWTP-Outfall & Effluent Pipeline	N/A	N/A	N/A	N/A	No	N/A	N/A	Yes	Yes	N/A	N/A
Operations - Treatment: 7	Marshall WWTP-Solids Handling	Yes	N/A	N/A	Yes	Yes	N/A	N/A	Yes	Yes	Yes	Yes
Operations - Treatment: 8	Marshall WWTP- Back Up Power	No	N/A	N/A	N/A	Yes	N/A	N/A	Yes	Yes	N/A	Yes
Operations - Treatment: 9	Vint Hill WWTP- Influent PS (New Baltimore PS #2)	Yes	Yes	N/A	N/A	Yes	N/A	N/A	Yes	Yes	N/A	Yes
Operations - Treatment: 10	Vint Hill WWTP- Headworks	Yes	Yes	N/A	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Operations - Treatment: 11	Vint Hill WWTP- Sequencing Batch Reactors & Post Equalization	Yes	Yes	N/A	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Operations - Treatment: 12	Vint Hill WWTP-Filtration and Aeration	Yes	N/A	N/A	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Operations - Treatment: 13	Vint Hill WWTP- UV Disinfection	Yes	N/A	N/A	N/A	Yes	N/A	N/A	Yes	Yes	Yes	Yes
Operations - Treatment: 14	Vint Hill WWTP- Chemicals & Chemical Feed Systems	Yes	N/A	N/A	N/A	Yes	Yes	N/A	Yes	Yes	N/A	Yes
Operations - Treatment: 15	Vint Hill WWTP- Sludge Stabilization & Dewatering	Yes	N/A	N/A	Yes	Yes	N/A	N/A	Yes	Yes	Yes	Yes
Operations - Treatment: 16	Vint Hill WWTP- Outfall, Effluent Pipe	N/A	N/A	N/A	N/A	Yes	N/A	N/A	Yes	Yes	N/A	N/A
Operations - Treatment: 17	Vint Hill WWTP- Back Up Power	No	N/A	N/A	N/A	Yes	N/A	N/A	Yes	Yes	N/A	Yes
Operations - Treatment: 18	Remington WWTP- Preliminary Treatment & Septage Receiving	Yes	Yes	N/A	N/A	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Operations - Treatment: 19	Remington WWTP- Aeration Tanks (Schrieber Tanks) & Secondary Clarifiers	Yes	Yes	N/A	N/A	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Operations - Treatment: 20	Remington WWTP Post Aeration	Yes	N/A	N/A	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes
Operations - Treatment: 21	Remington WWTP- Disinfection & Effluent Monitoring	Yes	N/A	N/A	Yes	Yes	N/A	N/A	Yes	Yes	Yes	Yes
Operations - Treatment: 22	Remington WWTP- Chemicals & Chemical Feed Systems	Yes	N/A	N/A	N/A	[illegible]	Yes	N/A	Yes	Yes	N/A	Yes
Operations - Treatment: 23	Remington WWTP- Outfall & Effluent Pipe	N/A	N/A	N/A	N/A	[illegible]	N/A	N/A	Yes	Yes	N/A	N/A
Operations - Treatment: 24	Remington WWTP- Solids Handling Systems	Yes	N/A	N/A	Yes	[illegible]	N/A	N/A	Yes	Yes	Yes	Yes
Operations - Treatment: 25	Remington WWTP- Back Up Power	No	N/A	N/A	N/A	[illegible]	N/A	N/A	Yes	Yes	N/A	Yes

For every critical asset, identify which threats have a potential High-Consequence: Yes, No, TBD

Purpose of the Risk and Resilience Workshop

Stakeholder Engagement Workshops

Collaborate

- To provide input to the risk and resilience assessments while creating useful documentation for participants

Validate

- The vulnerabilities and consequences from threats to critical assets to inform the Risk and Resilience Assessment

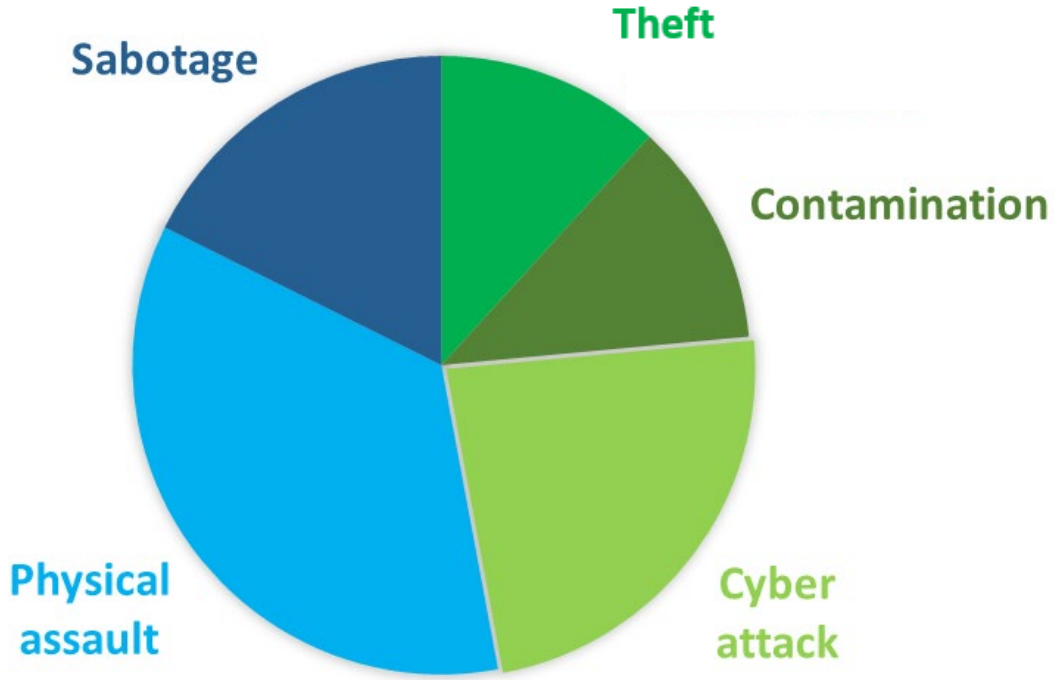
Engage

- To reveal opportunities for resilience for each participant in their day to day responsibilities.

"The biggest difficulty in this exercise will be prioritizing limited resources to all of the areas of risk."

Which malevolent acts or natural hazards are you most concerned about?

Stakeholder Engagement Workshops



"Attack on our treatment facility, we are in a remote area"

"Physical damage or harm to people and property"

"Security of facilities has been ignored for years, unless there is a forced project."

Stakeholder Engagement Workshops

Stakeholder Engagement Workshops

Put your Leadership Hat on and think into the future…

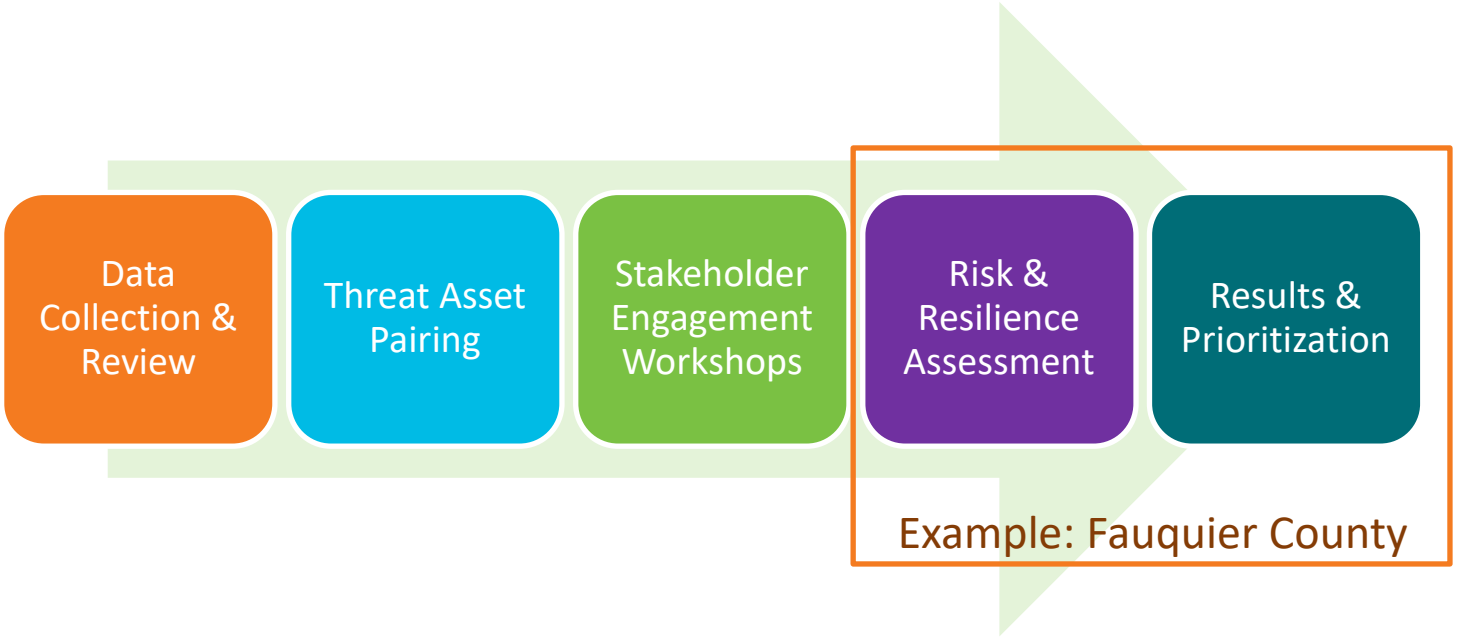
- What critical assets are ***most*** vulnerable in your opinion?
- Why and how are they vulnerable?
- Based on these vulnerabilities, what are the possible “worst reasonable case” consequences that could occur?

Stakeholder Engagement Workshops

Stakeholder Engagement Workshops

- Document how past events challenged the system?
- Capture and document Institutional Knowledge
- Consider “What if” impacts beyond recent experience to fully understand the impact of specific threats on utility business functions

Risk and Resilience Project Framework



Case Study: Fauquier County

Utility Overview

- Fauquier County Water and Sanitation Authority
- 4,600 service connections
- 96 miles of sanitary sewer mains
- Fifteen (15) sanitary sewer lift stations
- Three (3) main systems
  - Marshall
  - Remington
  - Vint Hill

Risk & Resilience Assessment

Assets

Risk & Resilience Assessment

- Operations-Treatment
  - 3 wastewater treatment plants and related assets (shop areas, plant buildings, etc.)
  - Power supply
- Operations-Collection
  - Collection piping
  - 15 Lift stations
- Operations Personnel
- Finance and Accounting
  - Billing, payroll, third-party suppliers
  - Personnel
- Information Technology
  - SCADA
  - Enterprise Servers & laptops/ workstations

Threats

Risk & Resilience Assessment

Malevolent Acts:

- Assault on Utility - Physical
- Contamination
- Theft or Diversion – Physical
- Cyber Attack
  - Business Enterprise Systems
  - Process Control Systems
- Sabotage – Physical

Natural Hazards:

- Drought
- Earthquake
- Extreme temperatures (heat and cold)
- Flooding
- Pandemic
- Wind related hazards

Threat Asset Pairs

Response Team Asset Grouping	Total Assets	Top / High Criticality Assets
Operations - Treatment	38	35
Operations – Conveyance	21	21
Finance and Accounting	6	5
Information Technology	14	13
	79 Total	**74 Evaluated**

- **Total of**
  - **74 Critical Assets Evaluated**
  - **421 “Threat Asset Pairs” Evaluated**

Example Calculation – Sabotage on Wastewater Lift Station

Threat Likelihood

- Threat likelihood is 0.05

- EPA Guidance

Consequence ($)

- The **worst-case scenario** is intentional sabotage or damage of pump controls or other pump equipment. Perpetrated by insider or outsider.
- Temporary measure: FCWSA temporary bypass pump can be installed while pump is rehabilitated.

- 60 days of downtime
- $0 cost of temporary measure
- $110,000 repair/ replacement costs

Example Calculation – Sabotage on Wastewater Lift Station

Threat Likelihood (%)

- Threat likelihood is 0.05

- 5% Likelihood

Consequence ($)

- The **worst-case scenario** is intentional sabotage or damage of pump controls or other pump equipment. Perpetrated by insider or outsider.
- Temporary measure: FCWSA temporary bypass pump can be installed while pump is rehabilitated.

- 60 days of downtime
- $0 cost of temporary measure
- $110,000 repair/ replacement costs

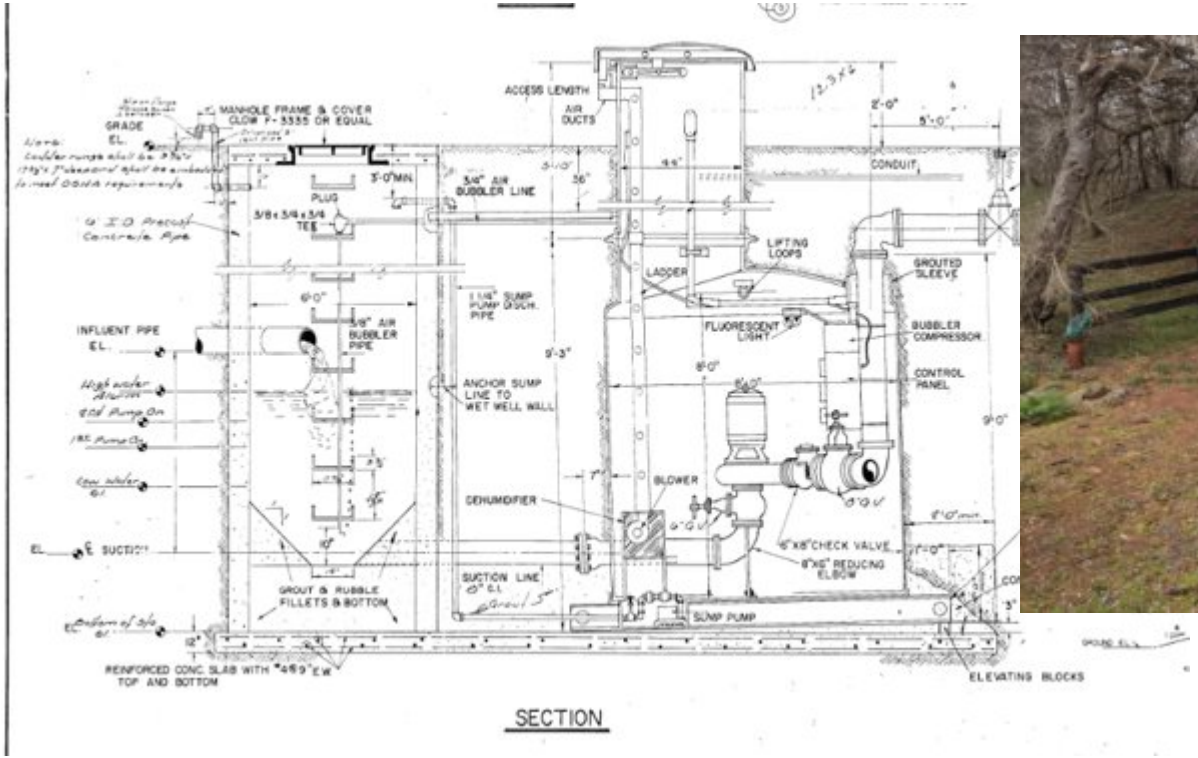
Vulnerability (%)

- *Vulnerability = Preparedness x Active Response x Recovery*
- Preparedness: This site is not secured with a fence; lift station is not housed in a building; an intruder would have full access to every control panel; locks on the wet well hatches and control panel; site is equipped with an alarm system; two pumps are required to handle the average flow.
- Active Response: Use temporary bypass pump until pump station operation can resume; generator is at the site with sufficient fuel for a week; FCWSA has contracts with electricians, septage haulers, generator vendors and SCADA contractor.
- Recovery: Total recovery is anticipated.

- Little preparation
- Strong response
- Strong recovery

Risk Score: $55

Example Calculation – Sabotage on Wastewater Lift Station

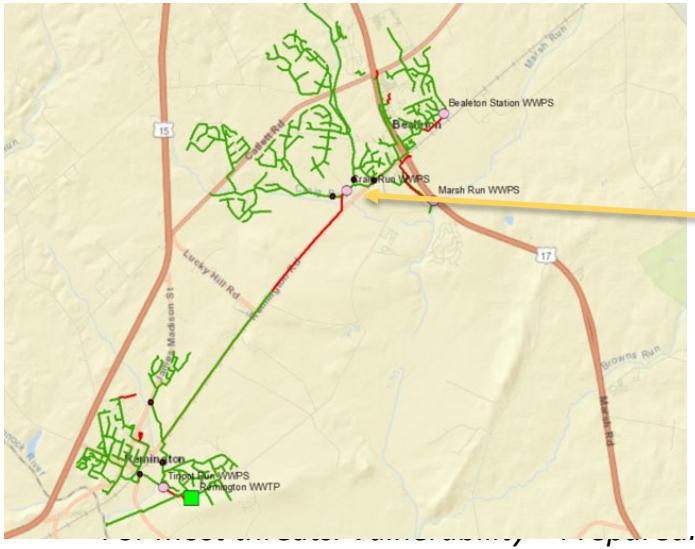


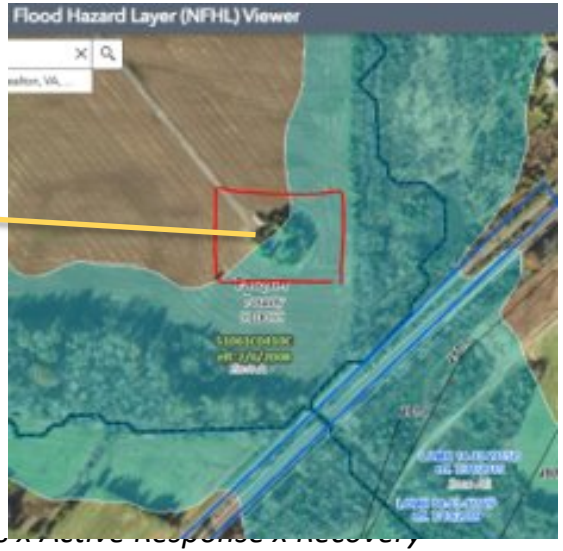
Example Calculation – Flood Risk at Lift Station

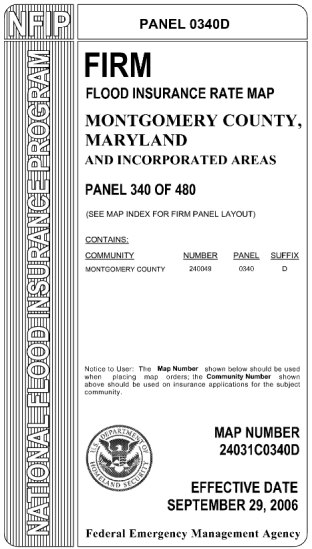
Threat Likelihood (%)

- Lift Station is in the 100-year FEMA floodplain

- 1.0% Likelihood







Example Calculation – Flood Risk at Lift Station

Threat Likelihood (%)

- Lift Station is in the 100-year FEMA floodplain

- 1.0% Likelihood

Consequence ($)

- Damage to above ground equipment, in particular pump motors and electrical equipment

- 7 Days downtime,
- $0 cost of temporary measure
- $220,000 repair/ replacement costs

Example Calculation – Flood Risk at Lift Station

Threat Likelihood (%)

- Lift Station is in the 100-year FEMA floodplain

- 1.0% Likelihood

Consequence ($)

- Damage to above ground equipment, in particular pump motors and electrical equipment

- 7 Days downtime,
- $0 cost of temporary measure
- $220,000 repair/ replacement costs

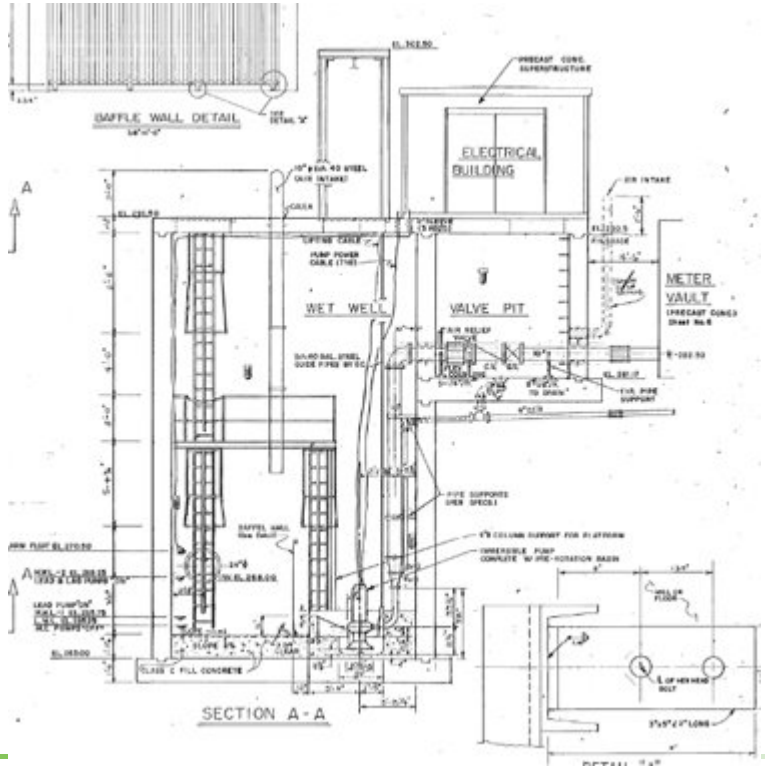
Vulnerability (%)

- *Vulnerability = Preparedness x Active Response x Recovery*
- Preparedness: Electrical equipment is in electrical building and elevated; back-up generator is on site; no additional flood protection measures on site.
- Active Response: If damaged use temporary bypass pump until pump station operation can resume; generator is at the site with sufficient fuel for a week; FCWSA has contracts with electricians, septage haulers, generator vendors
- Recovery: Total recovery is anticipated.

- Moderate Preparation
- Strong Response
- Strong Recovery

Risk Score: $110

Example Calculation – Flood Risk at Lift Station



FCWSA Lessons Learnt

- Natural Hazards typically higher risks due to higher likelihoods compared to malevolent acts
- Assets most at risks are:
  - Personnel
  - Biological treatment of WWTPs
  - Electrical & control equipment
  - Higher criticality lift stations
  - Vint Hill WWTP (batch reactors & post equalization)
- Factors contributing to higher level of preparation & response
  - Cross-training of staff
  - Ability to manually run plants & bypass pump stations
  - Spare parts, back-up power, emergency contracts & temporary pumps

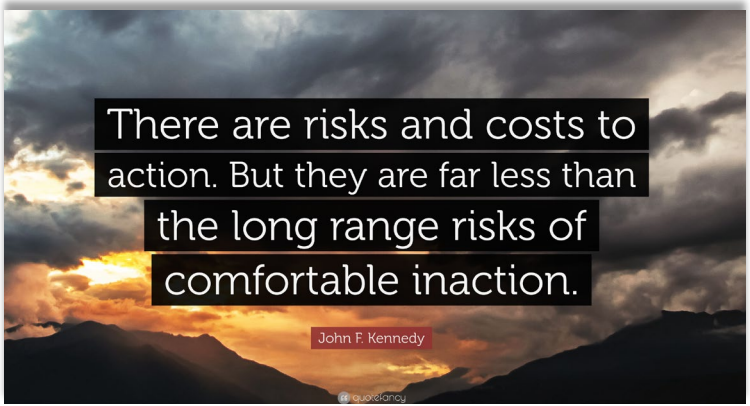
Vint Hill WWTP

Conclusion

Conclusion

A comprehensive risk assessment can...

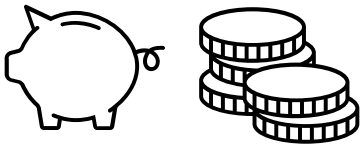
- Help utilities to identify vulnerabilities and prioritize actions
- Identify risks that are easily reduced or eliminated
- Clarify what is known and unknown about critical assets



Conclusion

A comprehensive risk assessment can...

- Provide an objective basis for decisions on controlling risks
- Provide opportunities for staff engagement and awareness raising
- Provide basis for funding opportunities, for example
  - FEMA funding
  - Bipartisan Infrastructure Bill



Market Analysis › Article

Infrastructure Bill: $46 Billion Proposed for Resilience Efforts

Published: November 24, 2021

SLED Market Analysis | Administration Transition | USDA | Architecture Engineering and Construction | BUREAU OF RECLAMATION *(INTERIOR)* | Environment & Conservation Services | FEMA | FS | Grants | Infrastructure | DOI | Justice/Public Safety & Homeland Security | NOAA | Natural Resources/Environment | Policy and Legislation

The Infrastructure Investment and Jobs Act H.R. 3684 will invest in issues from climate change to extreme weather events to cybersecurity, with a common goal of proactively increasing resilience before disasters occur.

The $1.2 trillion infrastructure bill, known as the Infrastructure Investment and Jobs Act, narrowly passed the Senate in August and has now been passed by the House. A high-level breakdown of the bill's spending can be found **here**. Out of the $1.2 trillion, only $566 billion represents new spending. Included in that new spending is $46 billion for infrastructure resilience efforts, including climate change, extreme weather events, and cyber-attacks. For climate issues specifically, flood mitigation, drought, wildfire management, and pre-disaster mitigation all received attention. According to a White House **fact sheet** on the bill, this legislation would represent the "largest investment in the resilience of physical and natural systems in American history."

"Makes the largest investment in clean drinking water and waste water infrastructure in American history…"

Questions?

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