Have We Mitigated Known Cross-Sector Interdependencies?

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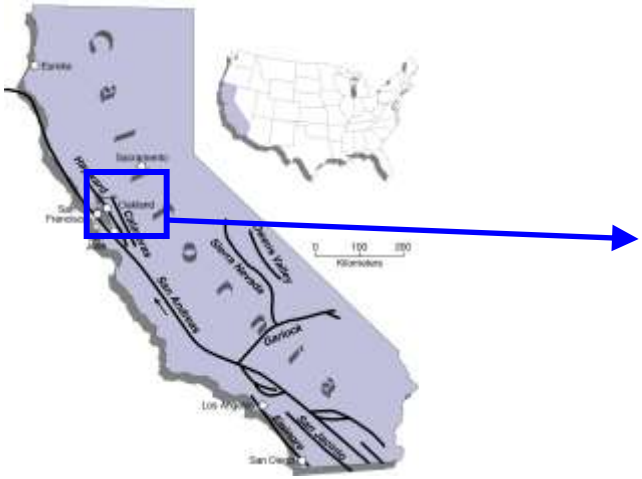
East Bay Municipal Utility District
Oakland CA

Outline

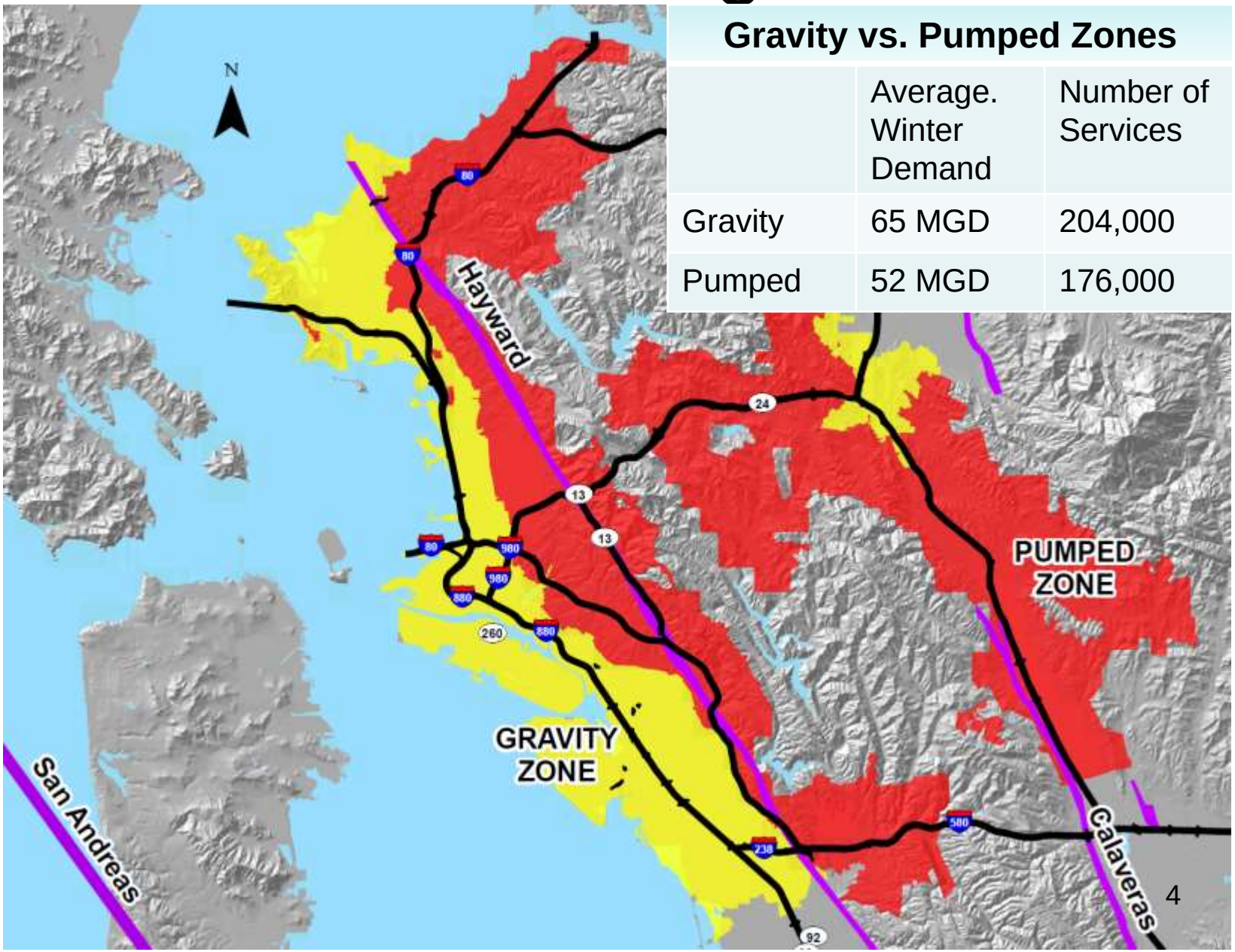
- About East Bay Municipal Utility District (EBMUD)
- Overview of Cross-sector Interdependencies
- Discussion of Selected Interdependencies
  - Assessment of “Common Knowledge”
  - Survey of Actual Practice
  - Gap Between Knowledge and Practice
- Possible Reasons for Gaps
- Conclusions

About EBMUD

- EBMUD provides water to 1.3M people
- Service area is over 86K hectares (212K ac)
- Significant seismic hazard
- Also exposed to other hazards including:
  - Flood
  - Power outage
  - Acts of malice
  - Pandemic

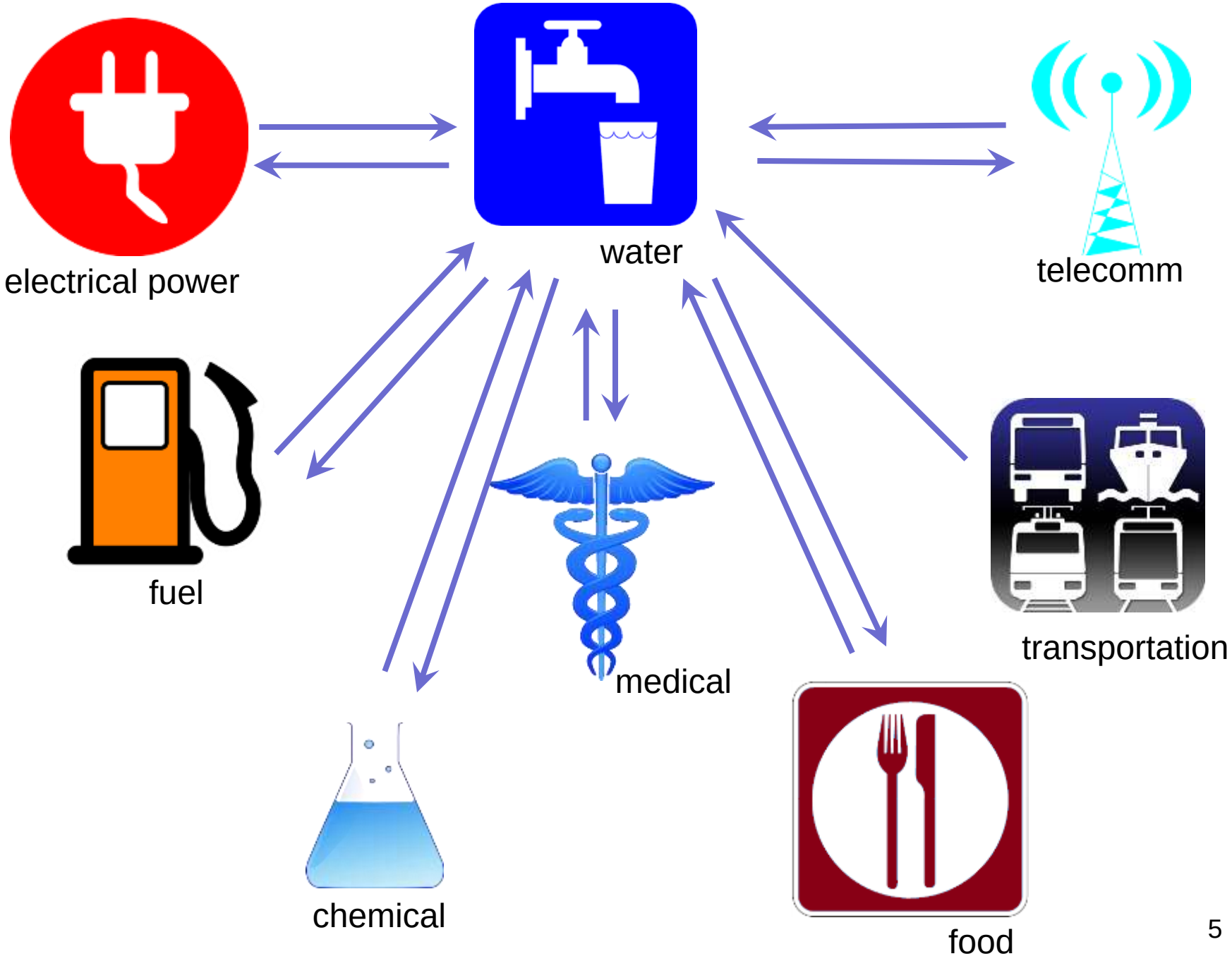


EBMUD – Background

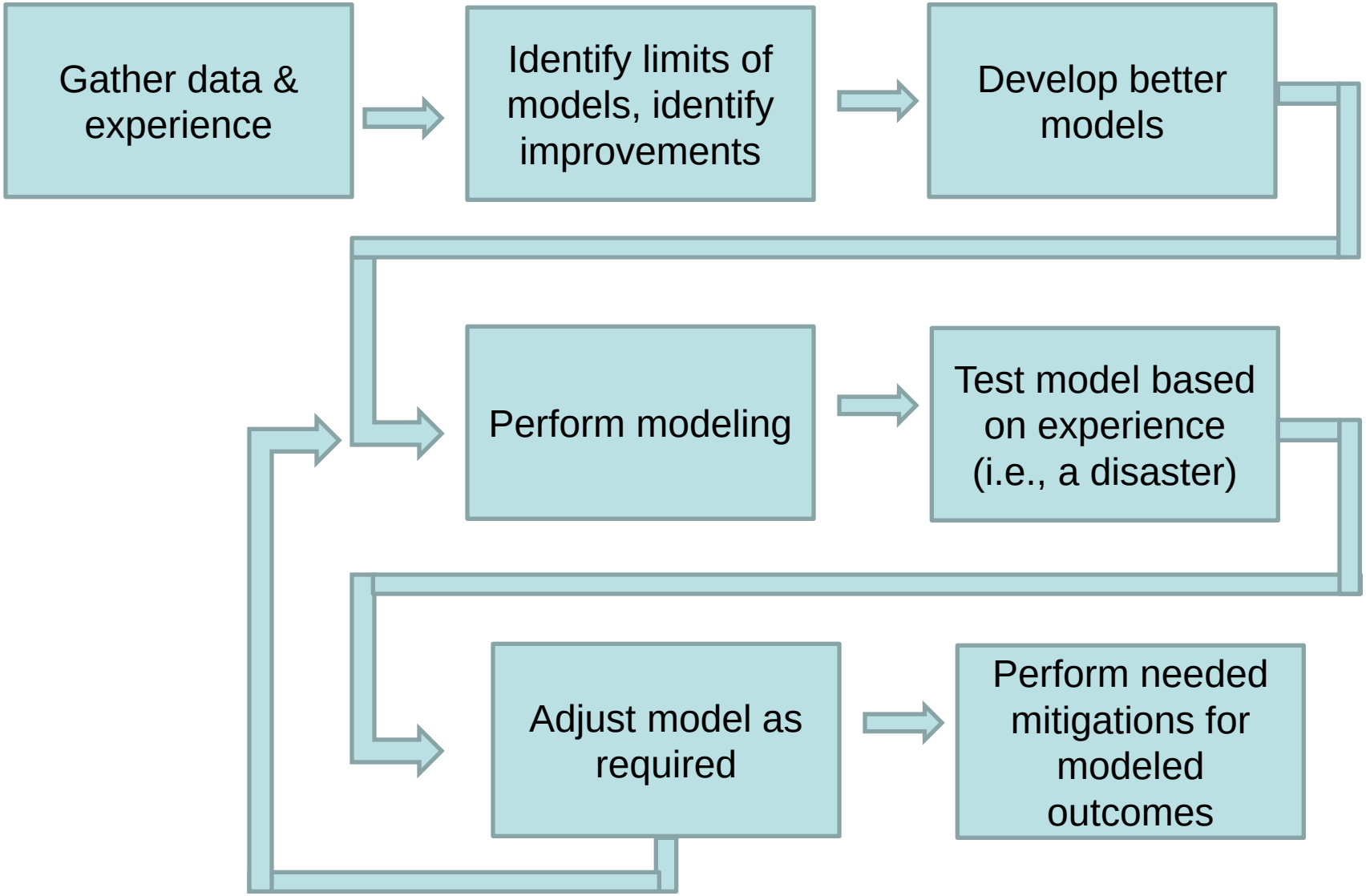


Gravity vs. Pumped Zones

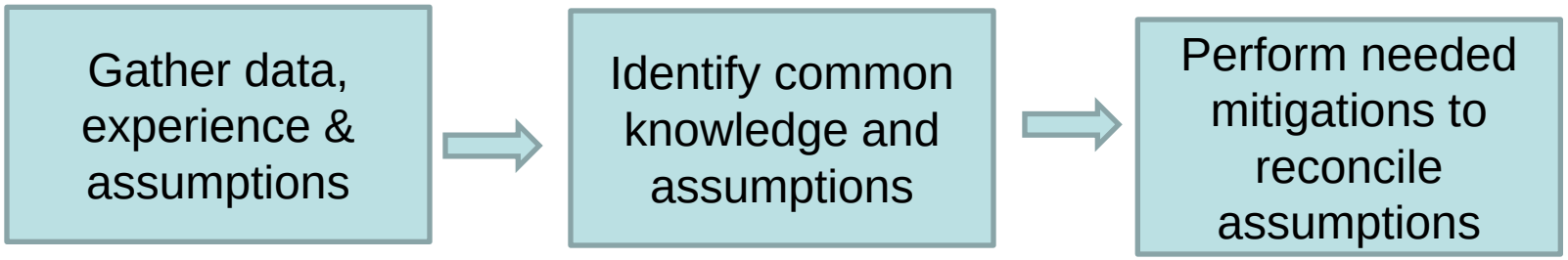
	Average. Winter Demand	Number of Services
Gravity	65 MGD	204,000
Pumped	52 MGD	176,000


electrical power
water
telecomm
fuel
medical
transportation
chemical
food

Possible Approach to Addressing Cross-sector Interdependencies



A Simpler Approach



“Common Knowledge” vs. Modeling Example

Situation: we want to drive solo across the desert

Modeling Approach

- We need data on
  - Anticipated road conditions
  - Fuel station locations
  - Tire performance statistics
  - Desired level of reliability
- Then we build a model
- And hope it’s right

Common Knowledge Approach

Carry a spare tire

Example “Common Knowledge”

- Every water customer should plan for at least 3 days without water; 7-14 days is more appropriate for some customers
- Every power customer, including water companies, should plan for power outages of at least 3 days

Advantages of Using Common Knowledge

- Available right now
- Free
- Reasonable, even if not provably correct
- Robust
  - Insensitive to details of scenario
  - Insensitive to model error
  - Anchored to reality

Common Knowledge Gathered by Examining:

- Regulations
- Codes and standards
- Expert belief
- Stated goals, e.g. “We strive to maintain a 30-day supply of chemicals”
- Actions, e.g. “We always keep at least two days worth of fuel on hand”

Knowledge Assessed for These Dependencies

- Water sector dependency on:
  - Energy (fuel, power)
  - Transportation
  - Telecommunications
  - Food (including drinking water)
  - Chemicals
  - Medical
- Medical sector dependency on:
  - Water
  - Energy

Example Findings: Power Dependency

Regulations, Codes and Standards

GUIDANCE MANUAL
FOR
COMPLIANCE WITH THE
FILTRATION AND DISINFECTION REQUIREMENTS

3.2.4 Disinfection System Redundancy

Another requirement for unfiltered water supply systems is disinfection facility redundancy. A system providing disinfection as the only treatment is required to assure that the water delivered to the distribution system is continuously disinfected. The SWTR requires either redundant disinfection equipment with auxiliary power and automatic start-up and alarm; or an automatic shutoff of delivery of water to the distribution system when the disinfectant residual level drops below 0.2 mg/L. In order to fulfill the requirement of providing redundant

Federal requirements not quantitative

American Water Works Association

Home > About Us > Policy Statements > Policy Statement

Electric Power Reliability for Public Water Supply and Wastewater Utilities

AWWA believes that every water and wastewater utility should set uninterrupted service as an operating goal and include potential service interruptions in its risk assessment and resiliency plan.

Avoiding extended interruptions in water service is essential for protecting public health, fire safety, local economies, and the environment.

To provide uninterrupted service, water and wastewater systems require an acceptable level of electric power reliability. Every utility is unique with respect to its vulnerability to electric supply disruption and must undertake a critical assessment of the issue based on local conditions. For some utilities even a single small electric service outage can have significant consequences. Redundancy of supply or backup generating capacity tends to reduce risk.

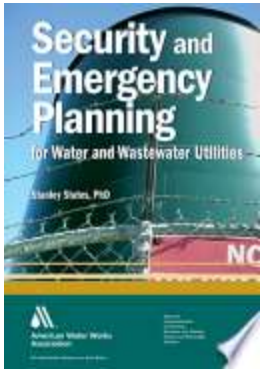
Every public water supply and wastewater utility should assess the likelihood and consequences of a supply disruption, identify critical vulnerabilities, and consider alternative power or supply redundancy to mitigate service disruptions lasting up to 72 hours or longer if public health, environmental, or economic impacts are severe. As part of this process, careful thought must be given to how much water service (such as minimum daily demand) can be assured, given local circumstances. In addition, every utility should have a robust emergency response plan that includes a public communications plan tailored to its needs and circumstances, for use in case of an electric supply disruption.

AWWA says at least 72 hours

10 States Standards say 8 hours ?!

Example Findings: Power Dependency

Expert Beliefs and Goals



- "Backup power for … 48 hours" per *Security and Emergency Planning* by States
- Some surveyed water utilities have no specific goal
- Of those utilities with a goal, the range is 24-72 hours

Example Findings: Power Dependency

Assumptions Revealed by Actions of dependent parties

- Hospitals in the US must plan for 96 hours without power; the plan can include evacuation or diversion
- In California, hospitals required to be operable for 72 hours without power or water (by the year 2030)

Summary of “Common Knowledge” Findings for Power

“Common knowledge” is that one should plan for:

- ***3-day outage of regional line power; longer outages in smaller areas***
- ***3-day interruption in fuel availability, longer periods of limited supply***

Summary of Common Knowledge, Various Sectors

Dependency	Common Knowledge says plan for:
Electrical power	3-day outage
Fuel	3-day outage
Telecommunications	3-day disruption
Chemicals	30-day disruption
Food supply	3-14 day interruption
Transportation	Potentially major disruption lasting for months, highly variable in space and time
Drinking water	3-14 day system-wide outage, months of impacted service

Are Infrastructure Providers Mitigating Those Known Dependencies?

Utilities and hospitals were asked about desired and actual readiness to operate without power, drinking water, food, etc.

- Often wanted to answer different questions than asked, e.g., the percent full a tank is kept, or number of gallons kept rather than number of days
- Utilities often had no specific readiness goals in various areas
- Utilities often indicated that goals and practices are fractured within a single utility
- Hospitals often did not know their baseline water usage

Utility/Hospital Survey
Power and Fuel Readiness

- Typical goals for fuel are between 24-72 hours for utilities; 96 hours for hospitals
- Hospitals generally feel confident they can meet goals
- Readiness among utilities is typically less
  - Standby generators for a only a fraction of facilities
  - “Oversized” treated-water storage a source of resilience but will tend to shrink over time based on water quality goals
  - Fuel stockpiles based on normal levels of usage; post-disaster use could be higher
  - No fuel stockpiled for employees, or other viable plan for them to get to/from work

Utility/Hospital Survey
Food and Water Readiness

- Less formal goals than for fuel, often *ad hoc* and inconsistent within an agency
- 3-day is most commonly cited goal level, on the extreme low end of “common knowledge” of 3-14 days
- Some utilities stockpile food for only a small fraction of total employees, contrary to industry finding that 41% of workforce is critical

Utility/Hospital Survey
Communications Readiness

- Utilities typically have multiple communication methods, e.g. internet, phone, radio, satellite phone
- Typically reliant on commercial or regional providers for some or all communications
- Often, a utility's many redundant communication systems are vulnerable to common-cause failure due to power outage or act of malice

Findings:
Lack of Internal Coherence

- Many responses reveal no coherent “Concept of Operations”
- For example:
  - If employees are to commute, fuel would need to be stockpiled for that purpose – but it’s not
  - If employees are instead to “camp out” at work, one would need food for more people, on a 24-hour basis, with rudimentary lodging provisions – but no utility reported lodging provisions for large #’s of employees

Findings:
Lack of Cross-Sector Alignment

Example:

- Hospital plans for 96-hour water outage often involve patient diversion
- But society will expect hospitals to be open after a major disaster

Another example:

- Common knowledge that transportation may be heavily impacted for many days
- But utilities' fuel inventories are often based on business-as-usual fuel deliveries, e.g., daily

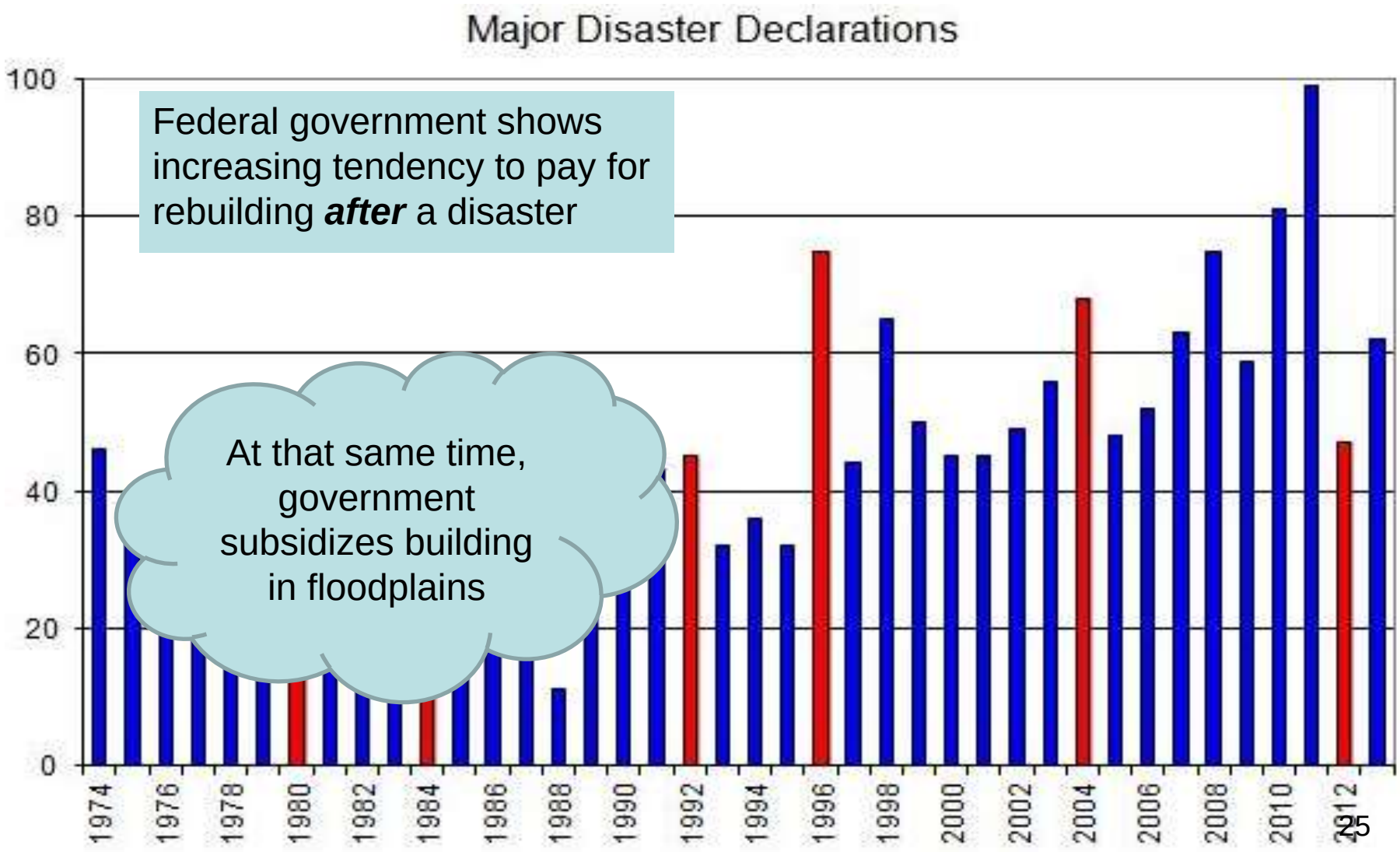
Still another example:

- Common knowledge that we're vulnerable to a regional power outage
- But many utilities rely on primary and backup commercial communication systems that are vulnerable to loss of power

Possible Reasons for the Gaps

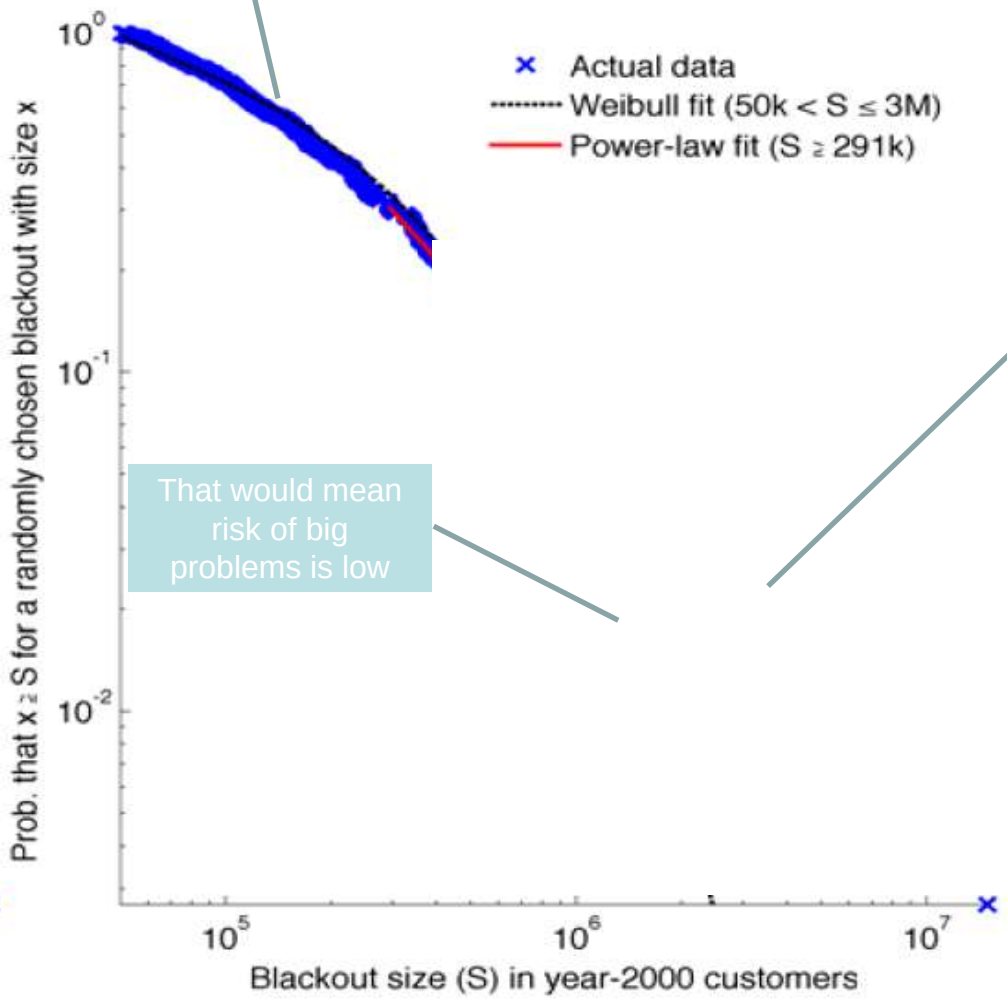
- Information not 100% consistent
- Information too compartmentalized
- Information not universally believed (the unfamiliar seems unlikely)
- Lack of incentive or wrong incentive
- Cognitive bias
- Inability to perceive slow increases in one’s own vulnerability

Example of Wrong Incentives



Cognitive Bias Hinders Awareness of Risk

Most data could fit Gaussian or Weibull curve



That would mean risk of big problems is low

But complex systems tightly connected systems can have power-law distributions; risk of big problems is not so low

Graph from http://www.uvm.edu/~phines/publications/2009/hines_2009_blackouts.pdf

Slow Change in Risk Difficult to Perceive

http://www.ferc.gov/industries/electric/indus-act/reliability/cybersecurity/ferc_meta-r-319.pdf

Summary

- Cascading failures of infrastructure are very difficult to model or predict
- However there exists generally agreed upon “common knowledge” about prudent planning assumptions
- This common knowledge is not consistently and uniformly accounted for in response planning or in actual practice
- Enhancing consistent application of “common knowledge” would likely enhance post-disaster infrastructure performance

Thank You

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Teddy the Yorkshire terrier applies common knowledge to his stockpile of water