Probability Analysis and Risk Management Discussion

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Purpose

1. To review an approach to determine the probability of occurrence of the design event that serves as the basis for the storage deficiency in the western portion of the District's water system, and
2. To discuss risk management issues associated with evaluating and addressing the storage deficiency.

References

- Academia
  - Professor Fahimeh Rezayat, Ph.D., California State University, Dominguez Hills
  - Professor Behrokh Khoshnevis, Ph.D., University of Southern California
  - Professor Alfredo H-S. Ang, Ph.D., University of California, Irvine
- Business Community
  - Jeffrey T. Dodds, Managing Member, Tolman and Wiker Insurance
  - Paul Fuller, CPCU, Vice President, Alteris Inc.

Design Condition

- Three simultaneous events:
    1. Commercial structure fire,
    2. Maximum day demand, and
    3. Water system malfunction or failure.

Approach for Analysis

1. Collect and compile historical data.
2. Determine the probability of each event occurring independently.
3. Estimate the probability of the three events occurring simultaneously, assuming events are truly independent.
4. Characterize the relationships between the three events.
5. Model the inter-relationships and perform "what if" simulations to determine probabilities under different conditions.
6. Select and apply a methodology for use of the probability information (i.e. confidence level, potential loss, etc.).

Overriding Considerations

1. Accepted engineering practice is to consider that the three design conditions occur concurrently, and
2. Experts and published literature caution the use of probabilistic analyses for very low frequency/high impact events (i.e. black swan events, 4^{th} quadrant risks, fat-tail distributions).

Engineering References

- Partial list of engineering references for sizing potable water distribution system storage:

1. American Water Works Association, *Principles and Practices of Water Supply Operations: Water Transmission and Distribution*, Third Edition: 2003.
2. HDR Engineering, Inc., *Handbook of Public Water Systems*, Second Edition, John Wiley & Sons, Inc, New York: 2001.
3. American Water Works Association Committee 4620 M – Education, *AWWA M8 Distribution Manual: A Training Course in Water Distribution*, Journal AWWA, p. 907, July 1961.
4. Brock, Dan A., *Determination of Optimum Storage in Distribution System Design*, Journal AWWA, p. 1027, August 1963.
5. Fee, John R., *Planning Distribution Storage in Nonhilly Areas*, Journal AWWA, p. 714, June 1960.
6. Culp, Russell L., EPA Technical Guidelines for Public Water Systems, Chapter VI, "Storage", NTIS, PB-255-217, U.S. Department of Commerce, Springfield, VA, June 1976, p. 195.
7. California Code of Regulations, Title 22, Division 4, Chapter 16 – California Waterworks Standards, Article 2, §64554.
8. Turneaure, Frederick E., *Cyclopedia of Civil Engineering*, Volume VII, American Technical Society, Chicago: 1909.

Risk Management Perspective

- Letter provided by Tolman and Wiker, Broker, and Alteris Insurance Services, Underwriter.
  - Parts of the Three Springs area is considered a brush hazard area by ISO, translating to higher likelihood of brush fire.
  - Brush fires bring high probability of both property damage and bodily injury.
  - Insurance carriers consider it prudent to have a high-level of water supply redundancy.
  - Insurance industry expects that risk for a utility adhere to a fundamental set of operating and supply standards.
  - Lack of frequency can make it difficult for very large claims to be accurately predicted, yet the likelihood exists in fire prone areas.

Conclusions

- The probability of the design event could be estimated; however, the accuracy of predicting the likelihood of low frequency/high impact events is poor.
- Experts caution the use of probability models to predict low frequency/high impact events.
- A probabilistic analysis should <u>not</u> be considered as an alternative to following accepted engineering practice.