Effects of Climate Change on Water Utility Planning Criteria and Design Standards [Project #4154]

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OBJECTIVES:
This project is intended to be a first step in better preparing water utilities in the planning and design of facilities that are more resilient to climate change. It examines the current state of knowledge, assesses the vulnerabilities of existing planning criteria and design standards, and seeks to identify remaining knowledge gaps.

BACKGROUND:
Planning criteria are an ensemble of measures, models, and methods used by utilities to plan for adequate supply to meet future demand. Examples of planning criteria are planning horizons, projected demands, desired supply reliability, and firm yield. Design standards consist of generally accepted uniform procedures, sizing, dimensions, materials, or parts that directly affect the design of a water system facility. Storage sizing, pump stations, pipelines, plant equipment selection, and material design and installation are examples of design standards.

Current planning criteria and design standards are typically based on climate patterns of the past. A large body of evidence shows that the climate variability of the future will not be consistent with that of the past. Changes in the global hydrological cycle can lead to a range of impacts that could be of concern for water utilities. If not addressed, the planning criteria and design standards being applied today may be inadequate to handle such changes.

APPROACH:
- Assessed what is known about the potential implications of climate change to water utilities in the Western United States through a review of current literature and studies.
- Examined the anticipated climate change impacts currently being contemplated by surveying utilities and documented the current planning criteria that are being used.
- Evaluated how existing planning criteria and design standards may be modified to incorporate the anticipated impacts of climate change (including criteria used for water supply reliability, water demand projections, and sizing of facilities, as well as American Water Works Association [AWWA] Design Standards).
- Performed case studies for the participating west coast water utilities (Contra Costa Water District, Los Angeles Department of Water and Power, San Diego County Water Authority, and Seattle Public Utilities). In addition, a case study evaluating the

effects of climate change on water utility planning criteria and design standards in Australia was also examined.
- Presented preliminary findings of the research to the participating utilities and project members at a utility workshop and obtained feedback. These comments were incorporated in the research and the project report.
- Developed a framework for evaluating climate change impacts on water utility facility planning and design to enable other water utilities across North America to assess the vulnerability of their existing and future facilities.

RESULTS/CONCLUSIONS:

Findings of the literature review underscore that key climate change impacts to water resources may include impacts to water supply and water quality. Climate change impacts to water resources are interrelated to each other in a complex manner and can potentially affect utility infrastructure and operations. Use of existing planning criteria and design standards was determined through a survey of 24 diverse utilities located in the Western U.S. and varying in size, customer profile, and source(s) of supply. Most utilities had performed a climate change vulnerability assessment but were concerned with the reliance on historical data and the level of uncertainty remaining after the analysis. More than half of the surveyed utilities had done a recent assessment of their existing water supply planning criteria that may be susceptible to the impacts of climate change and were highly concerned with climate change impacts related to reduced runoff, changes in snowmelt, and temperature extremes. More than half of the utilities were concerned with poor water quality that may impact design criteria associated with water treatment facilities but had not conducted an assessment of design standards that may be susceptible to the impacts of climate change.

Although review of AWWA Design Standards and Manuals of Water Supply Practices indicated that all AWWA Standards and many of the AWWA Manuals could be impacted in some way by the effects of climate change, fundamental changes to these documents would not be necessary. In order to consider the impacts of future climate change in current planning criteria, utilities should consider water demand forecasting, hydrological modeling, and evaluation of water sources.

In addition to planning criteria, water utilities should consider the effects of climate change on the primary design elements rather than on design standards. The primary design elements of importance for water utilities are design components (source collection, raw water storage, conveyance, treatment, treated water storage, pump stations, pipelines, and distribution), planning decisions (water supply reliability, water sources, demand patterns, and demand forecasts), and design basis selection (infrastructure-related elements, treatment process selection, and redundancy).

Based on the results of the literature review, utility survey, and a review of current planning criteria and design standards, recommendations were made to help manage the impacts of climate change. These recommendations relate to design components (Table 4.1 in report) and planning decisions and design basis selection (Appendix D). Further, adaptation strategies and measures for each design component (source, raw water storage

and conveyance, treatment, treated water storage pump stations, and pipelines and distribution) were identified for each main category of impacts (changes in yield, water quality, and demand).

This research also featured four case studies of participating utilities. Information gathered during the case studies helped identify adaptation strategies employed by utilities to allow planning and designs to be adaptable to an uncertain future climate. Each of the four utilities is at a different stage in the consideration of climate change impacts on their water supplies. In general, water quality impacts have not been fully considered at this point.

A case study on the Australian experience was also presented as a point of comparison to better understand adaptation strategies considered by another country. Australia faces significant biophysical climate risks while exhibiting the economic resources and technical expertise that are critical determinants of adaptive capacity. Water utilities across Southern and Eastern Australia have embarked on major programs to improve water supply reliability that typically revolve around three major themes: understanding the climate change risks, demand management, and supply augmentation. Most of their adaptation efforts focus on their planning criteria to secure an adequate supply. The adaptation strategies employed by Australia include diversification of water sources (e.g., desalination, recycling, reuse), increase in storage capacity, addition of flexibility in operations, modification of operations to meet peak demand, maximization of the use of fit-for-purpose water sources, and implementation of intensive demand management programs.

A framework for climate change evaluation adapted from the Australian/New Zealand Standard (AS/NZS) 4360 is presented that is applicable to a wide range of utilities. The framework is intended to assist utility managers, planners, and engineers with the assessment of climate change impacts on their utility, identify changes to design elements, and consider adaptation strategies and measures.

APPLICATIONS/RECOMMENDATIONS:
The project team developed the following recommendations through this research:

- Incorporate operational and supply flexibility into their water systems. Some of the strategies that can allow engineered systems to be more adaptable in an uncertain future include
  - Implement infrastructure modifications through project phasing to maximize flexibility as events unfold. Infrastructure implementation may not be time flexible but infrastructure sizing and below-ground infrastructure should include project phasing as these are more difficult to modify in the long run.
  - Balance infrastructure and operational investment to maximize incremental benefits using “knee in the curve” approach (cost inflection points).
  - Design for “safe failure” instead of endeavoring to be “fail safe”.
- Implement robust, “no regrets” strategies such as system redundancy, diversified water sources, conservation/demand management, and recycled water use. “No

regrets" strategies make good business sense and create other benefits or efficiencies for the utility.

- Incorporate uncertainties of climate change into water utility planning by using decision support planning methods.
- Improve documentation of utility standards to establish better understanding of how climate influences designs so that if new information arises, adaptation strategies may be implemented accordingly.
- Customize climate change adaptation strategies to their specific climate projections and design practices.
- Reevaluate response strategies and means of incorporating climate change into planning and design as new information becomes available. This may drive utilities to select different materials, equipment, treatment, and operating strategies.
- Consider the utility's role in climate change mitigation through improved energy efficiency of new and existing facilities as well as use of renewable energy sources (e.g., wind, solar, hydroelectric).
- Consider climate change impacts to design elements related to water quality treatment capabilities and process selection.
- Consider the tradeoffs observed between improved water quality through the use of advanced treatment technologies and the energy and environmental impacts associated with these technologies.
- Continuously monitor climate change related impacts. Updated information should be used in making future decisions.
- Stay abreast of current water quality and treatment regulations and the impacts these may pose on current and future utility operations in the context of climate change.
- Be involved with cutting-edge research on climate modeling and downscaling to keep up with new developments.
- Develop clear communication pathways and streamline communications to educate stakeholders and decision makers and mitigate concerns.
- Develop and strengthen collaboration between utilities. Climate change is a regional, national, and global issue that requires cooperation amongst utilities.

MULTIMEDIA:

The report appendices are included on a CD-ROM packaged with the printed report. They are also available with the PDF version of the report on the WaterRF Website.

RESEARCH PARTNERS:

- Contra Costa Water District
- Los Angeles Department of Water & Power
- Seattle Public Utilities
- San Diego County Water Authority