Report

Associated Engineering

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

City of Calgary Water Supply Infrastructure

Climate Change Vulnerability Risk Assessment

May 2011

Executive Summary 2

1 INTRODUCTION

Climate is changing, and infrastructure will need to withstand new weather conditions. Engineers are responsible for designing long lasting, safe and reliable infrastructure. Traditionally infrastructure design codes, standards and practices have been based upon historical climate data, and engineers have relied on this information to provide for long-lasting infrastructure. Changing climatic conditions that differ from historical conditions may reduce the lifespan of infrastructure and increase risks to public health and safety. Engineers must consider the uncertainties caused by changing climate in the future development of design codes and operational practices, and impacts to existing infrastructure.

The City of Calgary, in cooperation with Engineer's Canada, embarked on a project to assess the potential vulnerability of its water supply infrastructure to climate change. This vulnerability assessment was conducted in partnership with Engineer's Canada (the business name for the Canadian Council of Professional Engineers), who has established the Public Infrastructure Engineering Vulnerability Committee (PIEVC) to oversee a national engineering assessment of the vulnerability of Canadian public infrastructure to changing climatic conditions.

PIEVC has developed a Protocol, based on standard risk assessment methodologies, to guide climate change vulnerability assessments. The Protocol provides a step by step process to gather information and data, which are subsequently used to understand relevant climate effects and their predicted interactions with infrastructure.

The scope of the vulnerability risk assessment addresses the entire water supply infrastructure within the City of Calgary boundaries that is owned and operated by The City, including the current design, construction, operation and management of the infrastructure. In addition to the infrastructure within the city boundaries, the scope of work also includes the watersheds in terms of impacts on both the quality and quantity of water available at the intakes, as the source for the supply of the drinking water system. Within the watersheds, infrastructure, not owned or operated by The City, forms critical components to the water supply system, and are addressed in terms of their impact to the raw water source. Components of the water supply infrastructure supporting the regional system, although critical components to the regional supply systems, are not directly addressed in this study.

Water system upgrades are currently being conducted to gain sufficient capacity to meet the requirements of projected population growth up to at least 2021. The study addresses the potential impacts of future climate change for the years 2020 and 2050.

2 INFRASTRUCTURE

Calgary has two sources of drinking water: the Elbow River and Bow River. Source water is supplied to the drinking water treatment plants by three intakes. Two intakes and associated pump stations on the Bow River serve the Bearspaw Water Treatment Plant. The third intake located in The City's Glenmore Reservoir and Dam serve the Glenmore raw water pump station and treatment plant.

Following treatment, the potable water flows to high lift pumps. The pumps push water through transmission mains, which transport large volumes of water to strategically located storage reservoirs and pump stations. The City has developed 4,678 km of water pipe infrastructure in Calgary. Some of the transmission mains constructed in the early 1900s are still in use today.

3 CLIMATE CHANGE

The entire globe has experienced a changing climate over the past century. In estimating the vulnerability of existing infrastructure to anticipated climate change, the PIEVC protocol requires information on various climatic elements. Estimates of these climatic elements facilitate estimations of the exposure the infrastructure will face under future climate change, and highlights which element or climatic condition will have the greatest impact on its vulnerability. A climate review was undertaken to provide baseline parameters and how some of these are predicted to change in the future.

Baseline parameters were obtained from several Environment Canada weather stations within the watershed study area and the City of Calgary. The Climate Normals or averages are used to summarize or describe the average climatic conditions of a particular location.

Several climate models are available for projecting future changes in climate conditions. The Intergovernmental Panel on Climate Change (IPCC) has indicated that the warming is unlike anything experienced in the past 1300 years, and that if no action is taken to reduce GHG emissions, the extreme result istemperatures over the entire globe are expected to increase between 1.1ºC and 6.4ºC over the period 1990 - 2100 (IPCC, 2007).

This study used the most recently available information from a group of Global Climate Models (GCMs), to develop average climate change projections. Some of the expected climate changes for the Calgary area and Bow and Elbow Basins include:

- Increased temperatures
- Decreased snowpack
- Earlier melt and earlier onset of spring freshet
- Shorter, warmer winters
- Extended drought conditions
- Changes in precipitation type
- Decreased rain in the summer

- Increased rain in the fall, winter and spring
- Increasing frequency of extreme weather events.

4 CONCLUSIONS

In general the City of Calgary is fortunate to have robust treatment processes, in addition to two raw water sources and redundancy within the distribution system. Operation and management plans are in place to reduce both the probability and severity of some negative climate-infrastructure interactions occurring.

The climate changes identified as having a negative impact to infrastructure will be seen as gradual changes, and ongoing monitoring can identify trending of changes and be incorporated into long-range plans. The vulnerabilities judged as the highest priorities are those associated with extreme events such as flooding, drought, and compounding events.

4.1 Source Water

As climate change occurs, it is anticipated that the watersheds may change as well, in terms of the quantity of water available, when it is available and the quality of water. Changes in temperature and precipitation may both impact the water quality, and level of contaminants from forest fires, algae, increased runoff, etc., in the raw water source to the drinking water facilities. Continued monitoring and studies to address the potential for change are recommended. Maintaining networks within the scientific community to learn from the experiences of others with new and emerging issues will help to mitigate potential impacts in the future.

The City of Calgary's raw water intake system is fairly adaptable to the impacts of future climate changes, with two sources of raw water and three intakes. The redundancy provides some flexibility in shifting production from one source or intake to another in the event one becomes compromised. However, supply is still limited in terms of water quantity by water withdrawal licences and priorities of withdrawal rights.

The Glenmore Reservoir has limited storage capacity, and limited ability to mitigate potentials for flooding. The reservoir was not designed as a flood control structure, and The City currently has Flood Emergency Responses Plans in place to react in the event of flooding and mitigate flooding effects. However, as future climate projections predict a potential for increased storm events and increases in the maximum instantaneous flows for the Elbow River, The City should give some consideration to the functionality of the reservoir. During drought conditions The City has water conservation measures in place to reduce demands on the system.

4.2 Treatment Facilities

Recent and planned upgrades to the treatment facilities provide for robust systems, with adaptive capacities to withstand many of the potential impacts of climate change. Increased precipitation and storm events leading to a potential for decrease in water quality (increased turbidity, pathogens

from runoff) are expected to be handled by the upgraded pretreatment systems. Additionally, ongoing upgrades include the provision of ultraviolet disinfection which will provide a multiple disinfection barrier against the potential for increased numbers of pathogens. However, in the event of a large forest fire, the treatment systems are likely able to handle the impacts of increased sedimentation, but increased organics, nutrients and metals may require additional treatment technologies to meet drinking water standards.

4.3 Storage and Conveyance

The City has built-in redundancy within the distribution system with the ability to cross-serve pressure zones, and move water within the system. City staff, however, have identified concerns with The City's definitions for level of service with regards to treated water storage capacities. Water conservation policies and management practices currently in place have helped reduce demand during critical periods, reducing the load on the distribution systems and downstream wastewater treatment plants. Vulnerabilities may exist with consecutive peak demand periods and the ability of the reservoirs to catch-up, once the storage volumes are depleted.

Pump stations within the distribution system have experienced increased loadings, compounded with increased temperatures, resulting in overloads to MCCs, and tripping of breakers. The facilities themselves have built-in redundancies with standby engines or generators, however increased operator/maintenance attention is required to install temporary fans during high heat periods. A review of the HVAC systems of some of the older facilities is recommended with remedial action to follow.

4.4 Supporting Systems

Though some staff have been prevented from accessing facilities in the past due to storm events, The City has reduced risk of impacts to the water supply system, due to staff being unavailable or unable to get to the facilities as a result of cross training programs in place to ensure trained staff/system operators are available at all times.

Similar to those impacts identified with the distribution pump stations, supporting facilities have also experienced increased loading of the HVAC systems during high temperature periods. As climate change models project an increase in the extreme daily temperatures and increased heat wave durations, consideration should be given to review of HVAC design codes and an assessment of existing facilities to identify remedial actions.

An increase in temperature/heat duration presents potential impacts related to HVAC systems/electrical and controls and the availability of standby generation at all facilities including the water treatment plants. GWTP has limited operational capacity while functioning on standby power. A review of standby power capacity at critical facilities is recommended.