
0.0 Executive Summary

0.1 Introduction

Genivar and TetrES Consultants Inc. conducted a Water Resources Infrastructure Assessment Pilot Study to assess potential vulnerabilities within Portage la Prairie's critical water infrastructure in response to climate change. Portage la Prairie's critical water infrastructure was considered to include the city's Drinking Water Treatment Plant as well as its water supply intake and distribution facilities.

Climate Change is a phenomenon with potential to create changes in both the severity and frequency of extreme weather events. These severe events can reduce the effectiveness of a system by reducing its capability and/or its service life. While extreme weather events are considered in engineering designs through use of historical climate data and other weather data, climate change is expected to create vulnerabilities in engineered systems when these systems are forced to perform in environments outside the normal ranges they were designed to function in. Mounting evidence suggests that climate has changed, and will continue to change, creating situations where typical climate design ranges used in engineering the design for a given location are no longer representative for that given location.

When an engineered facility is subjected to an environment where the weather conditions vary beyond the normal historical weather ranges, then the facility is expected to react with reduced or limited performance, efficiency and service life as it struggles to operate in a harsher environment than it was designed for. In many cases, the design can accommodate these changes in operating environment, however in other cases, vulnerabilities can occur which require review, prioritization, and if severe enough, mitigation and/or adaptive operating strategies to compensate for the vulnerability

A procedure for assessing engineering designs for vulnerabilities to climate change effects has been developed and promoted by Engineers Canada, formerly the Canadian Council of Professional Engineers. Engineers Canada established the Public Infrastructure Engineering Vulnerability Committee (PIEVC) in order to oversee the planning and execution of a national engineering assessment of the vulnerability of Canadian Public Infrastructure to changing climatic conditions. The PIEVC has concluded that potential water resources infrastructure failure can have common impacts and that there are examples of water resources vulnerability across Canada. Consequently, PIEVC has identified water resources infrastructure vulnerability as a priority area to be reviewed as part of the first National Engineering Assessment.

The facility selected by PIEVC for this Pilot Study is the water resource infrastructure of the City of Portage la Prairie located in the Province of Manitoba (Figure 1), including the water works system and drinking water treatment plant. The Portage la Prairie Water Treatment Plant will serve as a Pilot for assessing the applicability of the Protocol as developed by PIEVC.



Figure 1: Location of Portage la Prairie

0.2 Assessment Approach

The assessment's end product is to identify vulnerabilities that could result in impacts to drinking water treatment and distribution systems that would render them incapable or severely limited in their ability to meet defined performance goals and levels of service to its customers and essential services. Most water utilities have pre-defined Performance Goals and Acceptable Levels of Service which include the following considerations:

- Life Safety: preserving the life and safety of a plant's personnel while providing sufficient quantities of safe, clean water to the public
- Fire Suppression: ensuring local fire fighting teams have access to sufficient potable water to fight fires
- Public Health Needs: hospital have a continuous need for potable water, emergency shelters have an immediate need for potable water, and personal hygiene/waste disposal requirements have a continuous need for potable water.

- **Local Industry:** Communities can often have industries that rely on large, continuous supply of potable water for their processes and/or process safety. If water supplies are disrupted, these industries may suffer production shutdowns or more severely, potential emergency conditions due to a process that cannot be conducted safely in the absence of potable water.

Any response or breakdown in a water infrastructure component that prevents the overall system from performing up to these minimum levels of performance constitutes vulnerability in a water system. Once the vulnerabilities have been identified, they can be prioritized in order of severity and a set of recommended actions can be assembled for review and action by City managers.

The Protocol applied in this assessment is simply a procedure developed to organize and review both climate and water infrastructure data for the purpose of determining “how sensitive” a given water facility could be in response to much more extreme and frequent weather events than those typically experienced in a location prior to the influence of Climate Change. In order to assess Climate Change Effects, a number of climate elements and Potential Change Factors were considered in the assessment:

Table 1: Climate Effects and Potential Change Factors

Climate Elements	Potential Change Factors
Temperature	<ul style="list-style-type: none"> • Rate of change • Mean values • Extremes <ul style="list-style-type: none"> – High summer – Low winter
Precipitation as Rain	<ul style="list-style-type: none"> • Frequency (One-Day, Short Duration Less than 24 hours, Multi-Day) • Total annual/seasonal precipitation and rain • Intensity of rain events (One-Day, Short Duration Less than 24 hours) • Proportion of annual and seasonal precipitation as rainfall • Drought conditions
Precipitation as Snow	<ul style="list-style-type: none"> • Frequency • Total annual/seasonal precipitation and snow • Magnitude of snow events • Frequency and intensity of rapid snow melt events • Rain on snow events
Wind Speed	<ul style="list-style-type: none"> • Mean values (one hour mean winds) <ul style="list-style-type: none"> – Monthly

Climate Elements	Potential Change Factors
	<ul style="list-style-type: none"> – Seasonal – Annual • Extremes/gusts • Thunderstorm winds • Changes in hurricane and/or tornado event frequency/intensity
Ice	<ul style="list-style-type: none"> • River or lake ice build up
Hail	<ul style="list-style-type: none"> • Frequency of events • Magnitude of events
Frost	<ul style="list-style-type: none"> • Freeze thaw cycles • Change in frost season
Ice Accretion	<ul style="list-style-type: none"> • Change in frequency/intensity of ice storm events • Ice build up on infrastructure elements
Other	<ul style="list-style-type: none"> • Degree days • Albedo • Streamflow on the Assiniboine River – Extremes

0.2.5 Assessment Findings and Recommendations

The Protocol proposed for use by PIEVC was applied to the Portage la Prairie Water Infrastructure and specifics pertaining to the mechanics of the assessment are provided in the main report. Genivar/TetrES' assessment has yielded recommendations that fall into four major categories:

1. **Remedial action is required to upgrade the infrastructure** – vulnerabilities falling into this category represent critical issues that, if allowed to remain unmitigated, could result in unacceptable consequences in the form of unacceptable interruption of water supply/service and/or danger to life, health and property;
2. **Management action is required to account for changes in the infrastructure capacity** – vulnerabilities that create reduced capacity in infrastructure such that it may fail to meet the minimum intended needs of the community it serves;
3. **No further action is required** – vulnerabilities that are negligible in nature and have no measurable impact on system performance; and/or
4. **Additional data and study are required:** There are gaps in data availability or data quality that require further work.

Climate may cause a number of different forms of vulnerability within a community's water infrastructure. Application PIEVC's Vulnerability Assessment Protocol resulted in identification of infrastructure components with potential for an undesired effect which

could prevent a water system from meeting the minimum performance needs and levels of service required to maintain essential services and major industry in the community. In general, these vulnerabilities have potential to result in negative effects associated with a facility's:

- Structural integrity,
- Serviceability,
- Functionality,
- Operations and maintenance,
- Emergency response risks,
- Insurance considerations,
- Policies and procedures,
- Economics,
- Public health and safety, and
- Environmental effects.

A summary of these identified Performance Response categories and the infrastructure components with potential sensitivities in these categories are summarized in the following section.

0.2.6 Identification of the Vulnerabilities of the Infrastructure Components

For the main infrastructure components of the Portage la Prairie water resources infrastructure, the following vulnerabilities related to changing climate conditions are noted:

0.2.6.1 Administration/ Operations

City Personnel

Vulnerabilities of the City personnel related to floods, ice jams, ice build-up and ice storms were noted. Based on the existing capacity of the City personnel to adapt to these events, no additional vulnerability exists and therefore no further action by the City is recommended.

Vulnerabilities of the City personnel related to intense winds and tornados were also noted and management action is recommended. The City should review their emergency preparedness requirements for intense wind and tornado events to ensure that proper plans are in place for personnel related to the operation of the infrastructure.

Facilities/ Equipment

Vulnerabilities of the water treatment plant facilities and equipment related to high temperature, floods, ice jams, ice build-up and ice storms, intense winds and tornados were noted.

For high temperature climate variables, no action is recommended. High temperature changes resulted in slight system vulnerability in the extended climate change projection to 2080. This timeframe is well beyond the expected service life of the existing facilities and equipment it is expected that the future system will adapt to these changes. The climate projections associated with 20 and 40-year projections did not yield infrastructure responses sufficient to cause system vulnerabilities.

For floods, ice jams and ice build-up, management action is recommended. The City should review the level of flood protection related to each facility and prepare an action plan in the case of flooding. In the case where infrastructure is highly vulnerable, remedial flood protection work works should be completed.

For ice storms, remedial action is recommended. The City should review their emergency preparedness requirements to ensure that proper plans are in place related to the operation of the infrastructure. In addition the City should review installing full standby power or back-up facilities at the water treatment plant to reduce power vulnerability generally associated with ice storm events.

For intense winds and tornados, management action is recommended. The City should review their emergency preparedness requirements for intense wind and tornado events to ensure that proper plans are in place for the operation and protection of the infrastructure.

0.2.6.2 Source Water

Shellmouth Dam/ Reservoir

The vulnerability of the Shellmouth Dam/ Reservoir to drought was assumed by engineering judgment to be very high. Data was not available to confirm this assumption. Additional study is required to assess the vulnerability of this infrastructure due to this climate variable.

Assiniboine River System

The vulnerability of the Assiniboine River system to drought was assumed by engineering judgment to be very high. Data was not available to confirm this assumption. Additional study is required to assess the vulnerability of this infrastructure due to this climate variable.

Vulnerabilities of the Assiniboine River System related to floods, ice jams and ice build-up were noted and management action is recommended. The City should work with the Province of Manitoba to review flood related vulnerabilities for the Assiniboine River at Portage la Prairie to further assess the impacts to the water resources infrastructure.

Control Dam Structure

Vulnerabilities of the control dam structure related to floods, ice jams and ice build-up were noted and management action is recommended. The City should review the level of flood protection related to the dam and prepare an action plan in the case of flooding. In the case where infrastructure is highly vulnerable, remedial works should be completed. In the case of ice jamming (blinding off the intake), the City should prepare an action plan to remedy the blockage.

Intake Well/ Pumps

Vulnerabilities of the intake well and pumps at the dam related to floods, ice jams, ice build-up, intense rain and drought were noted.

For floods, ice jams, ice build-up and intense rain, management action is recommended. The City should review the level of flood protection related to the intake well and prepare an action plan in the case of flooding. In the case where infrastructure is highly vulnerable, remedial works should be completed. In the case of ice jamming (blinding off the intake), the City should prepare an action plan to remedy the blockage.

For drought, additional study is required. The vulnerability of the Intake well to drought was assumed by engineering judgment to be very high. Data was not available to confirm this assumption. The City should also review drought related issues with the Province of Manitoba to establish water rights priorities in the event of drought on the Assiniboine River. The City should also request that the Province further study the Assiniboine River watershed for climate change effects.

0.2.6.3 Treatment

Pretreatment (Actiflo)

Vulnerabilities of the pretreatment facilities and equipment related to high temperature, floods, ice jams, ice build-up and drought were noted.

For high temperature climate variables, no action is recommended. Using professional judgment due to insufficient data, it is not expected that greater vulnerability exists due to future changes of high temperatures and related effect on water quality. It is assumed that the range of water quality changes under these events will not exceed current seasonal spikes and water quality variables. Based on this assumption, the infrastructure has existing capability.

For floods, ice jams and ice build-up, no action is recommended. Using professional judgment due to insufficient data, it is not expected that greater vulnerability exists due to future changes of floods, ice jams and ice build-up and related effect on water quality. It is

assumed that the range of water quality changes under these events will not exceed current seasonal variations. Based on this assumption, the infrastructure has existing capability.

For drought, additional study is required. The vulnerability of the pretreatment system to drought was assumed by engineering judgment to be very high. Data was not available to confirm this assumption. The City should review drought related issues with the Province of Manitoba to establish water rights priorities in the event of drought on the Assiniboine River. The City should also request that the Province further study the Assiniboine River watershed for climate change effects.

Softening/ Clarification

Vulnerabilities of the Softening/ Clarification equipment related to high temperature and drought were noted.

For high temperature climate variables, no action is recommended. Using professional judgment due to insufficient data, it is not expected that greater vulnerability exists due to future changes of high temperatures and related effect on water quality. It is assumed that the range of water quality changes under these events will not exceed current seasonal spikes and water quality variables. Based on this assumption, the infrastructure has existing capability.

For drought, additional study is required. The vulnerability of the softening/ clarification system to drought was assumed by engineering judgment to be very high. Data was not available to confirm this assumption. The City should review drought related issues with the Province of Manitoba to establish water rights priorities in the event of drought on the Assiniboine River. The City should also request that the Province further study the Assiniboine River watershed for climate change effects.

Storage

Vulnerability of the treated water storage related to drought was noted and additional study is required. The vulnerability of treated water storage for drought was assumed by engineering judgment to be very high. Data was not available to confirm this assumption. The City should review drought related issues with the Province of Manitoba to establish water rights priorities in the event of drought on the Assiniboine River. The City should also request that the Province further study the Assiniboine River watershed for climate change effects.

Chemical Storage/ Hazardous Materials

Vulnerabilities of the chemical storage and hazardous materials stored at the facilities related to floods, ice jams, ice build-up, intense winds and tornados were noted.

For floods, ice jams, ice build-up, management action is recommended. The City should review the level of flood protection related to each the bulk chemical and other hazardous material and prepare an action plan in the case of flooding. In the case where infrastructure is highly vulnerable, remedial works should be completed.

For intense winds and tornados, management action is recommended. The City should review their emergency preparedness requirements for intense wind and tornado events to ensure that proper plans are in place for the operation and protection of the infrastructure.

Valves/ Pipelines at the Water Treatment Plant

Vulnerability of the valves and piping at the water treatment plant site was noted related to floods, ice jams and ice build-up and no action is recommended. Using professional judgment due to insufficient data, it is not expected that greater vulnerability exists due to future changes of these climate variables. It is assumed that the infrastructure has existing capability.

0.2.6.4 Distribution

Pumping Stations (Water Treatment Plant and McKay)

Vulnerabilities of the pumping stations at the water treatment plant site and at the McKay Reservoir related to high temperature, floods, ice jams, ice build-up, intense winds and tornados were noted.

For floods, ice jams, ice build-up, additional study is recommended. The City should review the level of flood protection related to the intake well and prepare an action plan in the case of flooding. In the case where infrastructure is highly vulnerable, remedial works should be completed. In the case of ice jamming (blinding off the intake), the City should prepare an action plan to remedy the blockage.

For high temperature climate variables, no action is recommended. High temperature changes resulted in slight system vulnerability in the extended climate change projection to 2080. This timeframe is well beyond the expected service life of the existing facilities and equipment it is expected that the future system will adapt to these changes. The climate projections associated with 20 and 40-year projections did not yield infrastructure responses sufficient to cause system vulnerabilities.

For intense winds and tornados, management action is recommended. The City should review their emergency preparedness requirements for intense wind and tornado events to ensure that proper plans are in place for the operation and protection of the infrastructure.

Pipelines/ Valves

Vulnerability of the valves and piping in the distribution system noted related to floods, ice jams and ice build-up and no action is recommended. Using professional judgment due to insufficient data, it is not expected that greater vulnerability exists due to future changes of these climate variables. It is assumed that the infrastructure has existing capability.

0.2.6.5 Electric Power

Substations/ Transformers

Vulnerabilities of the substations/ transformers supplying power to the water treatment plant and pumping stations related to high temperature, floods, ice jams, ice build-up and ice storms, intense winds and tornados were noted.

For floods, ice jams, ice build-up, additional study is recommended. Using professional judgment due to insufficient data, it is not expected that greater vulnerability exists due to future changes of floods, ice jamming and ice build-up. It is assumed that the utility infrastructure is reasonably flood proofed. Assuming this, the infrastructure has existing capability. Additional study is required to confirm this assumption.

For ice storms, remedial action is recommended. The City should review their emergency preparedness requirements on Ice Storms. In addition the City should review installing full standby power at the water treatment plant to reduce power vulnerability generally associated with ice storm events.

For intense winds and tornados, remedial action is recommended. Using professional judgment due to insufficient data, but with comments from Ouranos related to extreme wind and tornadoes, it is possible that greater vulnerability exists due to future climate changes. The City should review their emergency preparedness requirements on tornadoes as well as working with Manitoba hydro to bury as many transmission lines as possible to reduce the vulnerability.

Standby Generators

Vulnerabilities of the standby generators supplying back-up power to the water treatment plant and pumping stations related to floods, ice jams, ice build-up, high temperatures, ice storms, intense winds and tornados were noted.

For floods, ice jams, ice build-up, additional study is recommended. Using professional judgment due to insufficient data, it is not expected that greater vulnerability exists due to future changes of floods, ice jamming and ice build-up. It is assumed that the utility infrastructure is reasonably flood proofed. Assuming this, the infrastructure has existing capability. Additional study is required to confirm this assumption.

For high temperature climate variables, no action is recommended. High temperature changes resulted in slight system vulnerability in the extended climate change projection to 2080. This timeframe is well beyond the expected service life of the existing facilities and equipment it is expected that the future system will adapt to these changes. The climate projections associated with 20 and 40-year projections did not yield infrastructure responses sufficient to cause system vulnerabilities.

For ice storms, additional study is required. Additional study is required to determine the frequency of ice storms and the need for standby power during these extreme events.

For intense winds and tornados, remedial action is recommended. Using professional judgment due to insufficient data, but with comments from Ouranos related to extreme wind and tornadoes, it is possible that greater vulnerability exists due to future climate changes. The City should review their emergency preparedness requirements on tornadoes as well as working with Manitoba hydro to bury as many transmission lines as possible to reduce the vulnerability and determine the extent back-up power requirements.

Transmission Lines

Vulnerabilities of power transmission lines related to ice storms was noted and remedial action is recommended. The City should review their emergency preparedness requirements on Ice Storms. In addition the City should review installing full standby power at the water treatment plant to reduce power vulnerability generally associated with ice storm events.

0.2.6.6 Transportation

Service Vehicles

Vulnerabilities of City service vehicles related to ice storms, hail and intense wind and tornados was noted.

For ice storms, additional study is required to determine the frequency of ice storms and its effects on service vehicles.

For hail, no further action is recommended. Climate change projections were not available related to this climate variable. Although additional data specific to hail is required, the vulnerability of service vehicles based on a hail event is low.

For intense winds and tornados, management action is recommended. The City should review their emergency preparedness requirements for intense wind and tornado events to ensure that proper plans are in place for the operation and protection of the infrastructure.

Maintenance Facilities

Vulnerabilities of City service vehicles related to ice storms, intense wind and tornados was noted.

For ice storms, additional study is required to determine the frequency of ice storms and its effects on maintenance facilities.

For intense winds and tornados, management action is recommended. The City should review their emergency preparedness requirements for intense wind and tornado events to ensure that proper plans are in place for the operation and protection of the infrastructure.

Supplies

Vulnerabilities of supplies related to related to ice storms, intense winds and tornados were noted.

For ice storms, additional study is required to determine the frequency of ice storms and its effects on supplies.

For intense winds and tornados, remedial action is recommended. Using professional judgment due to insufficient data, but with comments from Ouranos related to extreme wind and tornadoes, it is possible that greater vulnerability exists due to future climate changes. The City should review their emergency preparedness requirements on tornadoes. Back-up/ alternate sources of supplies should be considered.

Roadway Infrastructure

Vulnerabilities of the roadway infrastructure related to floods, ice jams, ice build-up, intense winds and tornados were noted.

For floods, ice jams, ice build-up, additional study is recommended. Using professional judgment due to insufficient data, it is not expected that greater vulnerability exists due to future changes of floods, ice jamming and ice build-up. It is assumed that the utility infrastructure is reasonably protected from flooding. Assuming this, the infrastructure has existing capability. Additional study is required to confirm this assumption.

For intense winds and tornados, remedial action is recommended. Using professional judgment due to insufficient data, but with comments from Ouranos related to extreme wind and tornadoes, it is possible that greater vulnerability exists due to future climate changes. The City should review their emergency preparedness requirements on tornadoes. Alternate means of access to critical infrastructure should be reviewed.

0.2.6.7 Communications

Telephone

Vulnerabilities of the telephone network to ice storms, hail and intense wind and tornados were noted.

For ice storms, additional study is required. Additional study is required to determine the frequency of ice storms and its effect on telephone services.

For hail, no further action is recommended. Climate change projections were not available related to this climate variable. Although additional data specific to hail is required, the vulnerability of the telephone network to a hail event is low.

For intense winds and tornados, remedial action is recommended. Using professional judgment due to insufficient data, but with comments from Ouranos related to extreme wind and tornadoes, it is possible that greater vulnerability exists due to future climate changes. The City should review their emergency preparedness requirements on tornadoes. The City should also consider burying telephone lines to the greatest extent possible or having back-up wireless communication.

Telemetry

Vulnerabilities of the City's telemetry network to ice storms, hail and intense wind and tornados were noted.

For ice storms, additional study is required. Additional study is required to determine the frequency of ice storms and its effect on telephone services.

For hail, no further action is recommended. Climate change projections were not available related to this climate variable. Although additional data specific to hail is required, the vulnerability of the telemetry equipment due to a hail event is low.

For intense winds and tornados, remedial action is recommended. Using professional judgment due to insufficient data, but with comments from Ouranos related to extreme wind and tornadoes, it is possible that greater vulnerability exists due to future climate changes. The City should review their emergency preparedness requirements on tornadoes. The City should also consider burying communication lines to the greatest extent possible or having back-up wireless communication.