



Climate Change Hazards Summary Report for Facility Investment Planning

Chickasaw National Recreation Area January 2021

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Introduction

Parks are required to complete a PARK Project Narrative Template for each proposed Great American Outdoors Act Facility Investment Plan (GFIP) project for Legacy Restoration Funding in fiscal years 2023-2025. Information provided in this report is intended to help parks consider climate change related hazards when addressing Question 16 of the narrative template.

Specifically: What risks or hazards (current and projected, e.g. effects of climate change) are likely to affect this project? If applicable, what adaptation strategies and/or resiliency measures have been identified for scenarios that pose high risks to project assets?

Step 1: Review summary information for known or potential hazards identified for Chickasaw National Recreation Area

- Review the list of potential hazards below and decide whether or not they apply to your specific GFIP project. NPS Climate Change Response Program (CCRP) staff attempted to identify potential hazards for the park; however, park staff and project planners have more information about hazards that are likely to be applicable to a specific project.
- The hazards below were selected from a longer list included in Appendix 1, which also indicates CCRP's 'best professional judgement' about the relevance of the hazard for this park. Note both lists serve as a "coarse filter" screening tool to help identify potential climate-related hazards for facility and asset planning.

Hotter average days and more very hot days

Climate change is already driving observable increases in average and extreme temperatures, and this trend is projected to continue, with record setting years becoming more common in the future (U.S. Global Change Research Program et al. 2017). The annual average temperature in the United States is expected to increase by 2.3 to 11°F by the end of the century depending on greenhouse gas emissions, relative to 1986-2015 (U.S. Global Change Research Program et al. 2018). Extreme temperatures can increase weathering of structures, threaten park staff and visitor safety, and increase stresses for HVAC systems. Demand for complex air conditioning systems can add stress to building envelopes and often requires significant alterations to a structure if not reduced through design solutions.

Since the beginning of the 20th century, temperatures in Oklahoma have risen less than 1°F. Temperatures in the past decade have been higher than in the previous 40 years and have approached the levels seen during the 1950s and the 1930s Dust Bowl era (Frankson et al. 2017).

Average temperatures are projected to warm by 1.6 to 4.9 °F, under the low and high emissions scenarios, by the end of the 21st century (Gonzalez et al. 2018). Under a lower emissions pathway, average annual temperatures are projected to most likely exceed historical record levels by the middle of the 21st century. If large increases in temperature occur, future heat waves are likely to be more

intense while cold waves are projected to become less intense (Frankson et al. 2017). By 2100, Oklahoma is likely to have three to four times as many days above 100°F as it has today (EPA 2016).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Increased drought frequency, intensity, magnitude, and duration

Rising air temperatures and changing precipitation patterns are exacerbating drought risk in many parts of the United States (Wehner et al. 2017). Changing drought conditions (frequency, severity, duration) can challenge a variety of infrastructure and operations (Department of Homeland Security 2015) in the NPS (e.g., water supply and wastewater systems), impair water quality (Mosley 2015), affect soil heaves and shrinkages (Fernandes et al. 2015), and will enhance other related risks such as wildfire (Halofsky et al. 2020).

While temperatures are projected to get hotter, changes in precipitation are uncertain. Even if summer precipitation remains the same, higher temperatures will increase evaporation rates and decrease soil moisture. Thus, the intensity of future droughts, a natural part of Oklahoma’s climate, is projected to increase. Increased drought intensity, along with decreased summer precipitation, will also increase the risk of severe wildfires (Frankson et al. 2017).

With increased drought, river flows are expected to decrease, leading to problems for recreation and public water and lower the water level in lakes and reservoirs, which may limit swimming, fishing, and other recreational activities (EPA 2016).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Increased wildfire frequency, intensity, magnitude, and duration

Wildfire is a natural part of many forest, woodland, and grassland ecosystems. Excessive fire, however, can damage ecosystems, kill people, and damage infrastructure. Climate change is intensifying the heat that drives wildfire (Jolly et al. 2015) and altering the distribution and density of vegetation that comprises the fuel for wildfires (Gonzalez et al. 2010). These effects combine with the unnatural buildup of coarse woody debris and understory trees from decades of suppression of all fires, even natural ones (Agee and Skinner 2005). The effects of climate change on wildfire vary across landscapes. For areas where projected climate change increases fire risk, buildings, cultural landscapes, or other infrastructure located under or near tree canopies or dense grasslands are vulnerable to burning and destruction.

Higher temperatures and drought are likely to increase the severity, frequency, and extent of wildfires, which could harm property, livelihoods, and human health. On average, more than 1 percent of the land

in Oklahoma has burned each decade since 1984 (EPA 2016). CHIC is the boundary of eastern deciduous forests transitioning into western prairie grasslands located in the “cross-timbers” ecosystem. Change in fire probability in the cross timbers ecosystem ranged from 5% to 37% (baseline 1900-1929) from mid-to end-of century. By the end of century, fire probability may begin to decrease due to lack of fuel (Stambaugh et al. 2018).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Altered precipitation patterns and changing humidity

Changing precipitation patterns have been observed in many regions of the United States as result of climate change and changes are expected to continue. Depending on the region in the United States, increases or decreases in precipitation have been experienced (U.S. Global Change Research Program et al. 2018). Changing precipitation and humidity conditions can result in local flooding, encourage mold growth, wood decay, increase fire risk, and intensify drought conditions, depending on the pattern of change.

Projections of overall annual precipitation are uncertain. Although summer precipitation is projected to decrease slightly across the state, the decreases are smaller than natural variations (Frankson et al. 2017). Within the Great Plains, annual precipitation by mid-century may decrease slightly (0% to -3%), while seasonally, an increase is projected for winter (+6 to +9%) and a decrease in summer (-10% to -20%), compared with 1971-2000 values (Kunkel et al. 2013).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Increased extreme precipitation

Increased frequency and intensity of extreme precipitation events has been attributed to climate change within some regions of the United States and such increases are projected to continue over the next century (U.S. Global Change Research Program et al. 2018). Furthermore, the intensity of extreme precipitation events increase with increasing temperatures (Easterling et al. 2017). Extreme precipitation events present a variety of threats to infrastructure and operations including flooding of sites, sewage backup, accelerated decay of masonry, overcoming drainage systems, road wash out, cracks in building infrastructure, erosion of adobe, destabilization of buildings and pipes, erosion of supporting ground around structures, among many other effects.

The frequency of extreme precipitation events (more than 2 inches of precipitation) has increased, with the past three decades seeing the highest number of events in the historical record (Frankson et al. 2017).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Riverine flood/Flash Flood

Extreme precipitation events and the risk of flooding are expected to regionally intensify with a changing climate (Dethier et al. 2020, Tabari 2020). Floods threaten infrastructure and operations through a variety of mechanisms, including inundation of structures, enhanced erosional forces, road wash out, structural collapse from force of floodwaters, sewage backup, and damage to utilities, generators, and electrical systems. Post-flooding effects include increased rot, fungal/insect attack, mold and mildew, and physical deterioration of wood, brick and stone building materials.

Although summer droughts are likely to become more severe, floods may also intensify. During the last 50 years, the amount of rain falling during the wettest four days of the year has increased about 15 percent in the Great Plains. Over the next several decades, the amount of rainfall during the wettest days of the year is likely to continue to increase, which would increase flooding (EPA 2016).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Tornadoes

With continued climate change, the potential for severe thunderstorms that provide conditions for tornadoes may increase substantially (Abell et al. 2007, Diffenbaugh et al. 2013, Gensini and Mote 2015). Tornadoes can result in catastrophic damage to infrastructure from high winds, and associated debris, hail, and flash flooding.

Scientists do not yet know how the frequency and severity of tornadoes will change in Oklahoma. Rising concentrations of greenhouse gases tend to increase humidity, and thus atmospheric instability, which would encourage tornadoes. But wind shear is likely to decrease, which would discourage tornadoes. Research is ongoing to learn whether tornadoes will be more or less frequent in the future within Oklahoma. Because Oklahoma experiences about 60 tornadoes a year, such research is critical to understand future conditions (EPA 2016).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Pest infestation

Increased temperatures and CO₂, changes in precipitation, and disturbance due to extreme climate events can increase the survival, spread, growth, and establishment of pests (Intergovernmental Panel on Climate Change et al. 2014). Rooting and burrowing mammals and termites have the potential to cause direct damage to power, water, transportation, and building facilities (Vissicelli 2018). Facilities may be impacted indirectly through other mechanisms exacerbated by climate change such as forest insect pest invasions or fluctuating ground water levels leading to increased tree mortality, hazard trees, and treefall.

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Invasive species

Increased temperatures and CO₂, changes in precipitation, and disturbance due to extreme climate events can increase the survival, spread, growth, and establishment of invasive species (Intergovernmental Panel on Climate Change et al. 2014). Weeds and aquatic mussels have the potential to cause direct damage to power, water, transportation, and building facilities (Vissicelli 2018). Non-native species that may not currently impact facilities may become harmful due to changes in local climates (National Research Council 2002, Intergovernmental Panel on Climate Change et al. 2014).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

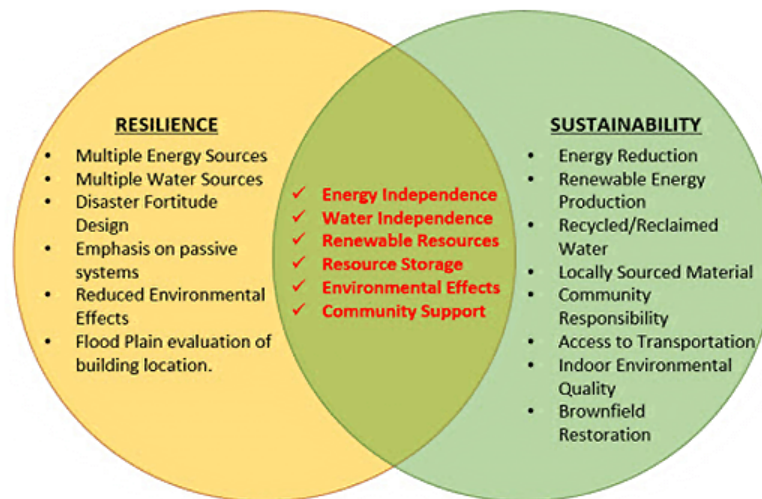
Step 2: Consider adaptation and resiliency strategies

- Review definitions of resiliency and adaptation strategies.
- Identify adaptation strategies that will help park resources respond to the hazards identified in Step 1.

Question 16 requires a screening for climate hazards followed by a review of adaptation and resiliency strategies that would be put in place to respond to these hazards. For the purposes of this report and investment planning, resilience is a property of a system or asset and generally refers to the ability of the system or asset to maintain its intended purpose following a temporary disturbance.

Adaptation strategies, in the context of built infrastructure, refers to the intentional management decision to identify, prepare for, and respond to observed or expected sustained changes in hazards, including climate change, to adjust to a sustained change in conditions.

It is important to note that resilient park operations can be supported through the use of green infrastructure such as sustainable landscaping, as well as sustainable energy, water, and building envelope solutions. The figure below illustrates this relationship.



Lists of adaptation strategies for different types of infrastructure projects in response to different hazards can be found here: [Incorporating Climate Change Adaptation in Infrastructure Planning and Design](#) (see Chapter 4, Tables 25-34). If used, these adaptation strategies will need to be modified for proposed park projects.

Buildings and assets within national parks may include cultural resources (e.g., historic and pre-historic buildings and structures). The adaptation and resiliency options for cultural resources often overlap with those defined for facilities; however, NPS has detailed specific strategies when dealing with cultural resources and climate change in national parks. ([Cultural Resources Climate Change Strategy](#)). “Climate

change poses an especially acute problem for managing cultural resources because they are unique and irreplaceable — once lost, they are lost forever.” ([NPS Policy Memorandum 14-02](#)).

Step 3: Develop an answer to Question 16 for your specific project and location, as well as strategies to address each hazard

Question 16: What risks or hazards (current and projected, e.g. effects of climate change) are likely to affect this project? If applicable, what adaptation strategies and/or resiliency measures have been identified for scenarios that pose high risks to project assets?

Several climate change hazards have been identified that may affect this project, including hotter average days, more extreme heat days, increased tornado impacts, altered precipitation patterns, and increased extreme precipitation. Adaptation and resiliency strategies for the expected hazards are described below:

- Hotter average days and more extreme heat days will increase demand and requirements for appropriately sized air conditioning systems.
- Changes in building design or building systems may allow maintenance of appropriate temperatures and humidity without increasing energy use (which would increase greenhouse gas emissions and exacerbate climate change). Energy conservation and renewable energy systems can prevent any increase in fossil fuel energy use.
- Extreme heat and humidity can stress the building envelope and will require significant humidity control alterations for structures.
- With continued climate change, the potential for severe thunderstorms that provide conditions for tornadoes may increase substantially. Consider wind resistant fortification of the structures. Addressing hazardous trees and retrofitting roof structures to be more wind resistant may also be required.
- Hotter and drier conditions will likely lead to an increase in wildfires. It will be important to maintain or increase the park’s prescribed fire program and design any structures susceptible to wildfire damage with fire-resistant materials.
- Winter and spring precipitation is projected to increasingly fall in the form of very heavy precipitation events, which can increase flooding and runoff. Road construction may require larger culverts to accommodate heavy runoff. Buildings, infrastructure, and roads in existing flood zones may need additional mitigation.
- The potential for increased invasive species should be mitigated. Measures include mitigation during construction (e.g., using weed-free gravel and cleaning construction equipment) and increased weed treatment post construction.

Step 4: Seek additional assistance if desired

- Additional resources for answering question 16 and related questions can be found in:
 - Appendix 1 below, which includes a full hazards checklist, providing additional links for supporting information related to each hazard.
 - Appendix 2 below, which provides a map to visualize how climate is changing for the park.
 - The [GFIP Guidance and Logistics](#) folder under the [Resources to Assess Risks and Hazards tab](#) includes:
 - An Excel workbook labeled [T75 Parks GFIP NRSS Supporting Materials](#) that provides links to information for natural resources to be considered during project design and construction.
 - A [FAQs – Assessing Risks and Hazards](#) document that provides detailed guidance for answering Question 16.
 - A [Natural Hazard Assessment Webinar](#) recording that provides key information, definitions, and guidance for understanding natural hazards and related resources.
- The NPS Climate Change Response Program (CCRP) and Sustainable Operations and Maintenance Branch (SOMB) are also available for assistance in evaluation of climate change hazards and resiliency strategies as they relate to specific projects. Questions can be sent to the NPS [GFIP Hazards and Risk Assistance email account](#) and a member of that team will reply with support.

Appendix 1: The Climate-Related Hazard Checklist

This appendix provides an initial evaluation of climate hazards for **Chickasaw National Recreation Area** according to the hazard ratings identified below. The information used to identify hazards in the checklist is mostly from regional assessments. Park and project specific information was generally not available when assessing these hazards. NPS Climate Change Response Program (CCRP) staff made an initial attempt to identify potential hazards for the park broadly (see 'Best Professional Judgement' column); however, park staff and project planners have more information about hazards that are likely to be applicable to a specific project.

Explanation of Hazard Ratings

Known hazard: Conditions that cause the hazard are well documented in the area where the park occurs. If applicable to the project site, these hazards should always be addressed in the project plan.

Potential hazard: Conditions that cause or underlie the hazard are known to occur nearby or are likely to occur based on studies with conditions similar to the park. If applicable to the project site, these hazards should be considered for inclusion in the project plan.

Not applicable: No evidence *was identified* showing this hazard is relevant to the park. Note this is a coarse filter evaluation; local knowledge of a hazard(s) should be used, when available.

Table 1. Climate-related Hazards Checklist

Potential Climate Hazard	Best Professional Judgment	Examples of risk or secondary hazard	Sources of General Non-site specific Data	Sources for Site Specific Data
Hotter average days and more very hot days	Known Hazard ☐ Potential Hazard ☒ Not Applicable ☐	• Inadequate HVAC • Road surface degradation • Lack of water due to increased water for irrigation • Increased humidity • Danger to staff	• National Climate Assessment	• National Climatic Data Center • DAYMet gridded climate data • National park historical and projected climate change

Potential Climate Hazard	Best Professional Judgment	Examples of risk or secondary hazard	Sources of General Non-site specific Data	Sources for Site Specific Data
Increased drought frequency, intensity, magnitude, and duration	Known Hazard ☐ Potential Hazard ☒ Not Applicable ☐	• Limited water supply for cooling, landscaping, structural fire suppression, other equipment • Increased competition for available water and water rights conflicts • Crack/heave damage in drier soils • Increased vulnerability to wildfire (below)	• Drought Monitor • National Integrated Drought Information Center • National Climate Assessment	• Drought Monitor • National Integrated Drought Information Center
Increased wildfire frequency, intensity, magnitude, and duration	Known Hazard ☐ Potential Hazard ☒ Not Applicable ☐	• Damage to facilities and contents • Smoke damage • Air quality dangerous to staff and visitors • Increased runoff • Increased erosion • Damage to water treatment plants	• Barbero et al. 2015 International Journal of Wildland Fire	• NIFC • International Wildland-Urban Interface Code
Altered precipitation patterns and changing humidity	Known Hazard ☐ Potential Hazard ☒ Not Applicable ☐	• Local flooding • Mold growth • Wood decay • Drought • Fire • Groundwater change	• National Climate Assessment	• National Climatic Data Center • DAYMet gridded climate data • National Park historical and projected climate change

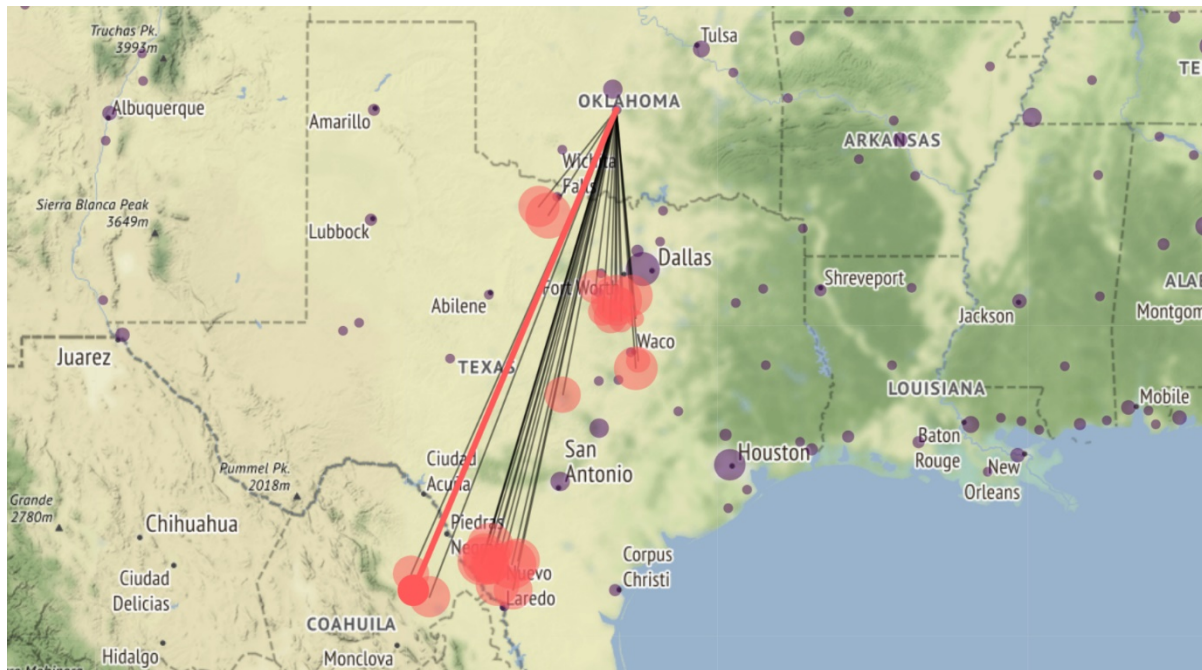
Potential Climate Hazard	Best Professional Judgment	Examples of risk or secondary hazard	Sources of General Non-site specific Data	Sources for Site Specific Data
Increased extreme precipitation	Known Hazard ☐ Potential Hazard ☒ Not Applicable ☐	• Surface erosion • Floods (see below) • Water damage to structures from driven rain • Unstable saturated soils	• National Climate Assessment	• Evaluations are mostly at regional scales
Riverine flood/flash flood	Known Hazard ☐ Potential Hazard ☒ Not Applicable ☐	• Damage or destruction of infrastructure • Stream channel migration • Stream bank erosion/extreme erosion • Safety • Water quality diminished • Damage to water source and delivery infrastructure • Changing requirements for culvert flow capacity	• FEMA Flood map service	• FEMA Map Service Center • Floodplain maps for HUD projects • Van Dusen et al. 2020 (for select parks) • May require a special flood study
Sea/lake level change and coastal storm surge	Known Hazard ☐ Potential Hazard ☐ Not Applicable ☒	• Rising sea and lake levels • Rising water – wind driven (e.g. hurricane, nor'easter) • Saltwater intrusion • Vegetation damage	• NOAA SLR viewer • NOAA - Great Lakes Environmental Research Laboratory	• IRMA – Coastal reports • NPS SLR viewer • Specific Hazard Assessment: Coastal Storm Surge with Climate Change Effects (requires VPN connection) • SLR reports • Great Lakes Dashboard Project

Potential Climate Hazard	Best Professional Judgment	Examples of risk or secondary hazard	Sources of General Non-site specific Data	Sources for Site Specific Data
Hurricanes and tornados	Known Hazard ☐ Potential Hazard ☒ Not Applicable ☐	• Building destruction • Flying debris • Storm surge • Tree fall (see other categories for associated intense rainfall and floods)		• Wind speed data – from local codes • International Building Code • FEMA Map Service Center
Pest infestation	Known Hazard ☐ Potential Hazard ☒ Not Applicable ☐	• Historic/facility fabric loss • Vegetation loss • Disease vectors may increase • Termites and other woodboring pests expanding range with warming and increased humidity	• USFS Forest Health Program	• Integrated Pest Management • Fisichelli et al. forest pests • USFS maps
Invasive species	Known Hazard ☐ Potential Hazard ☒ Not Applicable ☐	• Aquatic mussels – water intakes clogged • Vegetation (kudzu, vines) – damage buildings, kill trees, obstruct waterways	• National Invasive Species Council	• Early Detection and Distribution Mapping System (current distribution) • Early Detection and Distribution Mapping System (projected distribution)

Appendix 2. What Will the Park Climate Feel Like in 60 Years?

The map below is intended to help visualize how the present-day climate in the region of **Chickasaw National Recreation Area** is projected to change as a result of climate change (Fitzpatrick and Dunn 2019). Under a high greenhouse gas emission scenario, Norman, Oklahoma's climate in 2080 may feel

like today's climate near Sabinas, Mexico. The typical summer in Sabinas, Mexico is 9.1°F (5.0°C) warmer and 40.7% drier than summer in Norman, Oklahoma. The red line shows the average of the 27 climate models; the black lines show the 27 individual projections assuming continued high emissions, providing a sense of the plausible range of future climates. The size of the red circles give a sense of how good of a match that location is, with smaller circles indicating better matches; all circles (red or purple) denote cities used in the analysis. The analysis is based on twelve climate metrics, including minimum and maximum temperature and precipitation by season (spring, summer, fall, winter). More details are available in the reference cited above and the website <https://fitzlab.shinyapps.io/cityapp/>.



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Disclaimer

Report Purpose and Scope:

Parks identified for Legacy Restoration Funding in fiscal years 2023-2025 are required to develop a Great American Outdoors Act Facility Investment Plan (GFIP). The intended use of this series of park-specific reports is to help parks address Question 16 of the narrative template: *What risks or hazards (current and projected, e.g. effects of climate change) are likely to affect this project? If applicable, what adaptation strategies and/or resiliency measures have been identified for scenarios that pose high risks to project assets?*

Each report compiled and summarized published information on a suite of climate change hazards. Each report included an analysis of each hazard, for which the report author assigned a 'hazard rating' as follows:

Known hazard: Conditions that cause the hazard are well documented in the area where the park occurs. If applicable to the project site, these hazards should always be addressed in the project plan.

Potential hazard: Conditions that cause or underlie the hazard are known to occur nearby or are likely to occur based on studies with conditions similar to the park. If applicable to the project site, these hazards should be considered for inclusion in the project plan.

Not applicable: No evidence was identified showing this hazard is relevant to the park. Note this is a coarse filter evaluation; local knowledge of a hazard(s) should be used, when available.

As articulated within the report (in an appendix of the hazard ratings) those ratings constitute the author's 'best professional judgement' about the relevance of the hazard for that park based on the reviewed literature (cited in the narrative text for the hazard & provided in the report bibliography).

The intended use of each report is to inform decisions for facility investment planning related to (i) potential hazards that a suggested facility investment concept would need to appropriately consider and avoid or mitigate and (ii) identifying facilities possibly at greater relative vulnerability due to the identified hazards. The level of information quality in the report was calibrated to those purposes, i.e. to inform development of questions for a facility investment scoping process to further explore.

Peer Review Process:

Each report was based on a template, which heavily relied on boilerplate text for the non-park specific elements. The boilerplate text underwent multiple rounds of informal peer review by assorted CCRP staff, including members of the Climate Science and Adaptation Team, the Communications Team, the Regional Climate Change Liaisons, and the Climate Change Liaison to Facilities and Planning. Each report was peer-reviewed by a member of CCRP to check interpretation, consistency in hazard ratings, improve narrative coherence, and flag priority additions/modifications. In situations where revisions were required, the peer reviewer then re-reviewed the final revised report to assure adequate resolution of the identified issues.