



Climate Change Hazards Summary Report for Facility Investment Planning

Valley Forge National Historical Park March 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 Valley Forge National Historical Park

- 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.

Warming temperatures and increasing hot days

Extreme temperatures can increase weathering of structures, threaten park staff and visitor safety, and increase stresses for HVAC systems. If not addressed through building design or more efficient temperature control systems, the increased demand for complex air conditioning systems can add stress to building envelopes and can require significant alterations to a structure.

From 1895-2010 or 1950-2010 there was no significant changes in average annual temperatures at VAFO at the park scale (Gonzalez et al. 2018). However, for the Pennsylvania Southeastern Piedmont Climate Division (where VAFO is located), average annual temperature has been increasing at the highly significant rate of 6.7 °F per century from 1980 through 2020 (NOAA NCEI), and both the mean annual temperature and temperature of the hottest month in recent decades was "extremely hot" (top 5th percentile in the 1900-2012 period; Monahan and Fisichelli 2014). Under a high greenhouse gas emissions scenario, climate models project additional temperature increases of about 5.7 °F by mid-century and about 9.2 °F by 2100. The temperature increase could be kept to about 4.3 °F by mid-century and 5.2 °F by 2100 under a scenario of reduced emissions (Northwest Climate Science Center, MACA downscaled climate projections). The length of the freeze-free period is projected to increase by as much as 6 weeks by 2100 (Dupigny-Giroux et al. 2018).

VAFO is in a region of the US that has not yet experienced an increase in extremely hot days (Dupigny-Giroux et al. 2018). However, climate models very consistently project large increases in temperatures associated with both extreme cold and hot periods. For five-day events that occur once in 10 years (10% probability of occurrence annually), the average temperature of extreme cold events could increase by nearly 16 °F by mid-century from a near-present (1976-2005) baseline. For extreme hot events, temperatures could increase by almost 13 °F by mid-century (Dupigny-Giroux et al. 2018). These large increases in extreme temperatures pose challenges to designing appropriate HVAC systems for very rapidly changing conditions.

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Altered precipitation patterns, increased extreme precipitation, and changing humidity

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. Extreme precipitation events present a variety of threats to infrastructure and operations including flooding of sites, sewage backup, accelerated decay of masonry, overwhelmed drainage systems, road wash out, cracks in building infrastructure, destabilization of buildings and pipes, erosion of supporting ground around structures, among many other effects. Flooding often has indirect effects associated with the loss of power, water, access or other facilities needed to maintain park resources and operations.

Total annual precipitation at VAFO has been highly variable over the past century, but there has been no statistically significant trend to more or less total precipitation (Gonzalez et al. 2018; Easterling et al. 2017). However, VAFO is in the NE region of the US that has experienced the greatest increase in extreme precipitation events (Fig. 7.4 in Easterling et al. 2017; Huang et al. 2017). The increase in extreme precipitation is a result of human-caused climate change (Kirchmeier-Young and Zhang 2020). Depending on how extreme precipitation is measured (as a one-day total, largest 2-day total in a 5-yr period, etc.), the increase in events has been between 27% and an astonishing 92%. Climate models anticipate a continuation of this trend with increased frequency and severity of extreme precipitation into the future (Easterling et al. 2017, Lopez-Cantu et al. 2020). In recent decades, VAFO has experienced an extremely high frequency (greatest 5th percentile) in the number of cloudy days and number of wet days (Monahan and Fisichelli 2014). Increasingly humid conditions, particularly associated with warming temperatures, can enhance rates of rot (by mold, fungi, bacteria, etc.), require (additional) dehumidification in buildings, and increase proliferation of pests.

Climate models mostly forecast increased precipitation for VAFO, with an overall modest increase in annual precipitation of 5-15% by the end of the century (Gonzalez et al. 2018), with increased precipitation primarily in winter (Shortle et al. 2015). Forecasts of increased precipitation, with a greater amount of the precipitation falling in heavy and extreme events, clearly points to a need for adequate building gutters, drainage ditches, water detention structures, bridges, underground utilities,

and other systems that are resilient to flooding, saturated soils, and increased surface waters. And, potentially, backup systems that accommodate outages of power and other utilities.

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), and affect soil heaves and shrinkages (Fernandes et al. 2015).

The Northeast U.S. is a wet region that historically experiences damaging droughts, despite simultaneous increasing precipitation (Dupigny-Giroux et al. 2018). Climate models clearly forecast that increased temperatures and precipitation variability will likely lead to more frequent short, but intense drought conditions (Krakauer et al. 2019, Pendergrass et al. 2020). These "flash droughts" are characterized by short, intense sudden onset droughts and rapid intensification of conditions with severe impacts (Pendergrass et al. 2020). In 2016, the Northeast experienced an abnormally warm, dry summer, preceded by low winter snowfall causing a flash drought that challenged water resource managers throughout the region (Sweet et al. 2017).

Park staff assessment – relevant to GFIP Project:

☐ Yes

☐ No

Increased wildfire frequency, intensity, magnitude, and duration

While overall wildfire risk is likely low at VAFO, climate change increases fire risk to buildings, cultural landscapes, or other infrastructure located under or near tree canopies or dense grasslands that may be vulnerable to burning and destruction.

Fire suppression in eastern U.S. forests has created moister and shadier conditions and less flammable fuel beds that favor moist tree species and disfavor dry fire-adapted species (Nowacki and Abrams 2008). Under continued climate change, increased precipitation would tend to keep wildfire ignition low in the mid-Atlantic area (Clark et al. 2014), but droughts – including flash droughts – could increase fire danger. In addition, widespread tree mortality due to e.g. emerald ash borer can result in open canopies and drying that rapidly increases fire hazard.

Park staff assessment – relevant to GFIP Project:

☐ Yes

☐ No

Riverine flood/Flash flood

Extreme precipitation during the later part of the 20th century and the early 21st century has been greater in the northeastern U.S. than other portions of the country and these will drive increased flooding (summarized above). Dethier et al. (2020) found annual high-flow frequency increased in the northeastern U.S. in the past two decades (2007-2016) as compared to 1950-1969, consistent with other reports of increasing flooding in the northeast (Collins 2009, Hodgkins et al. 2017). Flood trends within the region show high spatial variability depending on catchment conditions and what generates flooding. In many cases, climate is just one factor leading to flooding (Peterson et al. 2013), with urbanization and other land cover changes exerting a strong influence (Yang et al. 2015). Given this variability, it is important to understand the local patterns and drivers of flooding when planning infrastructure. In some cases, it is inadequate to assume that design flood values will remain stationary in the future as climate changes (Siddique et al. 2020, Van Dusen et al. 2020). As a result, local studies to characterize changes in extreme flows or increases in current safety factors may be necessary to account for climate change in infrastructure design (Siddique et al. 2020, Van Dusen et al. 2020).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

Hurricanes and tornadoes

North Atlantic hurricane intensity and rainfall rates are projected to increase under continued climate change, although projections of the total number of North Atlantic hurricanes under climate change vary (IPCC 2013, USGCRP 2017). Under a low greenhouse gas emissions scenario, the maximum intensity during the course of individual North Atlantic hurricanes could increase 4% and rainfall rates could increase 15% to 20% by 2100 (Knutson et al. 2015). The number of days in spring in the eastern U.S. with severe thunderstorms that could produce tornadoes could increase 40% from 2000 to 2100 under the highest greenhouse gas emissions scenario (Diffenbaugh et al. 2013). Moreover, tornado power, a function of wind speed, tornado path area, and air density, has increased $5\% \pm 1\%$ per year from 1994 to 2016 (Elsner et al. 2019).

Building standard guidance is based on base flood elevations of 2-3 ft above FEMA flood zones of 100-year (1%-annual chance) storms, depending on the building criticality. For existing buildings that are not above base flood elevation, adaptation measures to reduce flood impacts should be considered. Hurricanes also threaten structures via damage from wind, wind-blown rain and debris; their large temperature swings stress buildings through sudden thermal expansion and can crack pipes.

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 (IPCC 2014). Rooting and burrowing mammals and termites have the potential to cause direct damage to power, water, transportation, and building facilities (Vissichelli 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.

Where pests and invasive species may be anticipated due to climate change (or other factors), building and landscaping projects can be designed to prevent pest invasions (Geiger and Cox 2012; and Geiger and Baefsky 2020, respectively). VAFO is in a region that will likely be subject to colonization by additional species of termites, which may require enhanced protection of buildings and other wooden structures (Buczowski and Bertelsmeier 2017). When facilities are not designed to deter pests and impacts due to invasions, facilities managers may increase their reliance of pesticides, which will result in increased potential of exposure of people to pesticides, in both indoor and outdoor environments (IOM 2011).

The Pennsylvania Climate Impacts Assessment provides detailed discussions of climate-sensitive forest pests that may pose increasing or new challenges, including current pests such as gypsy moth, emerald ash borer, and other that may be associated with climate-driven changes in the distribution of tree species (chapter 5 in Shortle et al. 2015).

When and where invasions and infestations may occur is difficult to predict because multiple factors such as landscape change, habitat disturbance, and human-facilitated vectors interact with climate change to limit or accelerate the range-expansion of invasive species and pests. Consult with your regional NPS pest and invasive species management coordinators to identify current and potential invasive and pest infestation threats, as well as management strategies, including contracting BMPs to prevent invasions and spread of invasive/pest species, early detection/rapid response, mitigation, and eradication tactics to help design, construct, and manage your facilities and managed landscapes to minimize the impacts of invasive species and pests.

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 (IPCC 2014). Weeds and aquatic mussels have the potential to cause direct damage to power, water, transportation, and building facilities (Vissichelli 2018). Non-native species that may not currently impact facilities may become harmful due to changes in local climates (NRC 2002, IPCC 2014). Poison ivy, for example, thrives with increased CO₂ levels and may become even more invasive than in the past (Mohan et al. 2006).

Park staff assessment – relevant to GFIP Project:

- ☐ Yes
- ☐ No

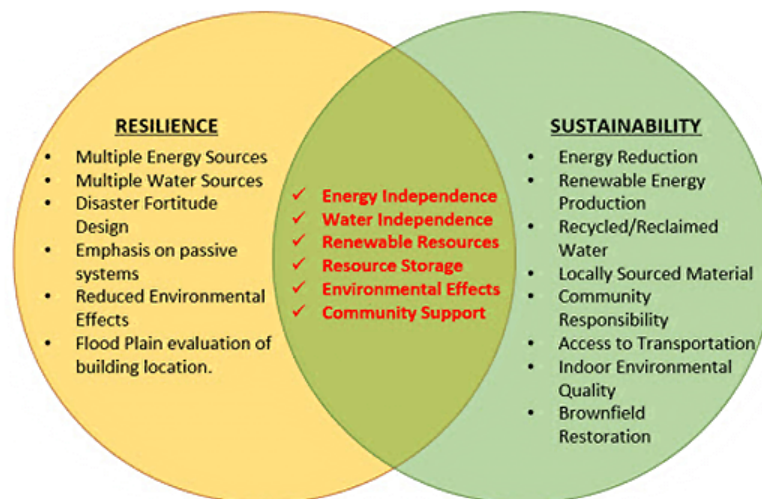
Step 2: Consider adaptation and resiliency strategies

- 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

- Example responses to Question 16 are provided below. THESE ARE GENERIC EXAMPLES FROM OTHER PARKS. You can view other examples here: [Example responses to Q16 on hazards Organized by Park](#).
- You will need to develop park specific answers based on the hazards identified in Step 1 and the adaptation strategies identified in Step 2 for your park and project. The park response should be as project-specific as possible.
- The NPS Climate Change Response Program (CCRP) and Sustainable Operations and Maintenance Branch (SOMB) are available to help evaluate climate change hazards and resiliency strategies for your specific projects. Requests should be sent to the NPS [GFIP Hazards and Risk Assistance email account](#); a member of the team will reply with support.

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?

Example from Minute Man National Historic Park: Restoring historic structures

Several climate change hazards may affect building-related projects at MIMA, including hotter average days, more extreme heat days, increased hurricane impacts from wind and flooding, 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 higher capacity air conditioning systems unless accommodated through modified building designs or other systems.
- Extreme heat and humidity can stress the building envelope and will require significant humidity control alterations for structures.

- Changes in building design or post-flooding dehumidification systems, in coordination with the NPS Historic Architecture, Conservation and Engineering Center or Historic Preservation Training Center, to avoid any increase in energy use.
- Hurricane force wind and wind-blown rain as well as damage from wind-blown debris or treefall will require wind resistant fortification of the structure. Addressing hazardous trees and retrofitting roof structures to be more wind resistant may also be required.
- Flooding from increased hurricane events, increased extreme precipitation, or in conjunction with altered precipitation patterns may require modifications to building infrastructure location and landscape drainage systems.
- Post-flooding effects may include increased rot, mold and mildew, and physical deterioration of wood, brick and stone building materials. Adaptation actions will include identifying appropriate dehumidification and air handling systems and coordinating with the NPS Historic Architecture, Conservation and Engineering Center or Historic Preservation Training Center regarding alternatives and maintenance for historic structures.

Example from San Francisco Maritime National Historic Park: pier repair, historic building restoration, road repair, or water system project

Several climate change hazards may affect a (pier repair, historic building restoration, road repair, or water system) project at San Francisco Maritime National Historical Park, including sea level rise, storm surge, more frequent storms, San Francisco Bay flooding, increased street stormwater runoff, hotter temperatures, and increased insect pests. Possible adaptation and resiliency strategies include:

- Adoption of sea-level rise adaptation measures developed by Golden Gate National Recreation Area in a plan for Crissy Field ([CMG Landscape Architecture 2016](#)) that covers an area up to the western boundary of San Francisco Maritime National Historical Park.
- Natural shoreline features along Aquatic Park Beach to handle some inundation from sea level rise.
- Vegetated catch basins for urban street stormwater runoff.
- Drainage systems and culverts that could handle greater water flows.
- Relocation of any infrastructure from an area where a hazard cannot be avoided.
- Water conservation measures to reduce water use during droughts.
- Strengthening structures to prevent damage from extreme storms or treefall.
- Changes in building design or post-flooding dehumidification systems, coordinating with the NPS Historic Architecture, Conservation and Engineering Center or Historic Preservation Training Center and avoiding any increase in energy use, which would increase greenhouse gas emissions and exacerbate climate change.
- Changes in building design or building systems to maintain appropriate temperatures and humidity without increasing energy use, which would increase greenhouse gas emissions and exacerbate climate change. Energy conservation and renewable energy systems to prevent any increase in fossil fuel energy use.
- Early detection and removal of termites or other pests or hazards.

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 **Valley Forge National Historical Park** 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 Judgment' 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 • State climate summary	• 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 State climate summary	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

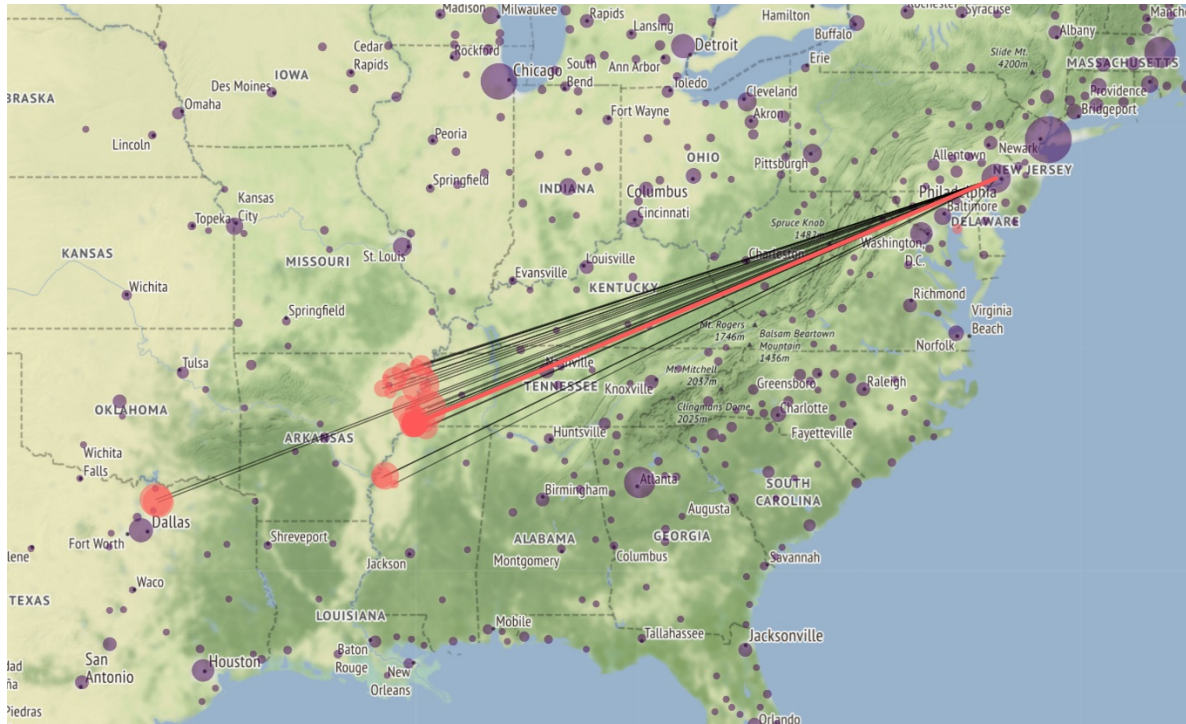
Potential Climate Hazard	Best Professional Judgment	Examples of risk or secondary hazard	Sources of General Non-site specific Data	Sources for Site Specific Data
Altered precipitation patterns, increased extreme precipitation, and changing humidity	Known Hazard ☒ Potential Hazard ☐ Not Applicable ☐	• Local flooding • Mold growth • Wood decay • Drought • Fire • Groundwater change • Surface erosion • Floods (see below) • Water damage to structures from driven rain • Unstable saturated soils	• National Climate Assessment • State climate summary	• National Climatic Data Center • DAYMet gridded climate data • National Park historical and projected climate change • 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

Potential Climate Hazard	Best Professional Judgment	Examples of risk or secondary hazard	Sources of General Non-site specific Data	Sources for Site Specific Data
Sea 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
Lake and reservoir level change	Known Hazard ☐ Potential Hazard ☐ Not Applicable ☒			
Hurricanes and tornadoes	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

Potential Climate Hazard	Best Professional Judgment	Examples of risk or secondary hazard	Sources of General Non-site specific Data	Sources for Site Specific Data
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 Advisory System	• NPS Pest and Invasive Species Management Contacts • 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	• NPS Pest and Invasive Species Management Contacts • 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 **Valley Forge National Historical Park** is projected to change as a result of climate change (Fitzpatrick and Dunn 2019). Under a high greenhouse gas emission scenario, Philadelphia, Pennsylvania's climate in 2080 may feel like today's climate near New South Memphis, Tennessee. The typical summer in New South Memphis, Tennessee is 6.5°F (3.6°C) warmer and 16.1% drier than summer in Philadelphia, Pennsylvania. 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 a red circle gives 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.