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Background

This report summarizes the potential for reducing consequences that Montague WPCF may experience due to current and projected climate conditions. These consequences are the foundation of the risk that climate conditions may pose to those assets defined as vulnerable by the assessor.

System type	Wastewater Only
Volume treated (Million Gallons per Day)	0.85
Population served	2,297

The focus of this report is the Wastewater Treatment Facility improvements, defined as the following: Ensure ability of WWTF to operate under high-flow/extreme events. In each case, where consequences were assessed, the potential gains of implementing this plan were determined in comparison to current resilience to these same conditions. The ability to protect assets today is described in the Current Measures plan, where those practices and infrastructure protections that currently exist provide some level of consequence reduction in the face of assessed threats.

For each asset, a guided risk assessment was conducted based on the occurrence of multiple scenarios of the same threat; please see Attachment A. For example, the possible consequences to a pump station due to flooding could be assessed across several scenarios of historical or projected changes in precipitation. The time period over which to consider both threats and the ability to implement plans is a critical component of this assessment. The time period selected for this analysis was from 2022 to 2047, which aligns with the 2035 projected climate and sea level data provided in CREAT.

The types of consequences considered by the assessor in the risk assessment summarized in this report were selected based on the types of losses anticipated for those threats and assets being considered; please see Attachment B. For each type of economic consequence, a monetary scale was selected to define levels of consequence to use during risk assessment.

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This report was generated based on the assessment conducted by Mary Jo Kricorian (MaryJo.Kricorian@gdit.com).

Utility Information

This assessment covers a specific list of Montague WPCF assets and climate-related threats. These assets may include both physical infrastructure and natural resources. The results in this report only consider losses associated with these assets and threats; the scope of conditions can be expanded by revising the assessment in CREAT.

Assets	Service Demand and Use
Wastewater Treatment Facility - Treatment facility is located along the banks of Connecticut River and west of downtown Turners Falls. Facility has two levels; water enters at lower grade and must be pumped to upper portion of facility. Screw pumps are at end of useful life, and are vulnerable to failure if subject to extremely high flows. Pump failure could cause overflow of untreated wastewater from the facility into the Connecticut River and backflow into collection system, potentially impacting many buildings/connections.	✓
Pump stations - Eight pump stations located throughout town, located in residential or industrial park areas, and four grinder pumps (separate from stations, located in Lake Pleasant community). Majority of the pump stations receive/transmit both sewer and stormwater flows. Six of the stations are from 1960s era with original pumps, and are vulnerable to failure during extreme precipitation/flows. Failure could result in localized flooding as well as backups in collection system.	✓

Adaptation Planning

Utility assets can be protected by adaptive measures that effectively reduce the consequences if a threat were to occur. Both current measures, those already in place, and the potential plan described below, can afford some level of protection. Examples of measures include new infrastructure and changes in operation or practices.

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Measures already in place represent the current resilience of a utility to projected changes in climate, even if these measures were implemented for reasons unrelated to climate change. The Wastewater Treatment Facility improvements plan provides some risk reduction that can be compared with the cost of implementing these adaptive measures. For a comparison of how the selected plan compares to all plans included in this assessment, please see Attachment C.

Current Measures	Relevant Threats
Current Measures – Existing adaptive measures.	Service Demand and Use
Adaptive Measures	Total Cost
Storage tanks - Installation of a storage tank in collection system and at treatment facility to handle heavy flows and mitigate CSO discharges.	\$6,000,000
Pump station upgrades - Two stations closest to the Connecticut River were elevated and upgraded with new pumps, wet wells, generators, etc. to enable them to better handle high-flow events and avoid discharge of untreated wastewater to river, and minimize likelihood of flooding from river.	\$2,000,000
Portable pump - Portable diesel-driven pump can provide backup pumping in event of WWTF pump failure. The pump is not large enough to handle excessive flows expected during high-flow event, so some overflow or backflow of untreated wastewater could still occur.	\$100,000
Inflow and Infiltration Study - Conduct inspections of structures throughout your system that may be compromised due to climate-related changes in event frequency, duration or magnitude. Inspections should be part of any assessment of failure risk under projected climate conditions. Study will look at major sources of I&I and develop priorities for addressing.	\$260,000
Total Plan Cost	\$8,360,000

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Potential Plan	Relevant Threats
Wastewater Treatment Facility improvements – Ensure ability of WWTF to operate under high-flow/extreme events	Service Demand and Use
Adaptive Measures	Total Cost
Pump replacement at Wastewater Treatment Facility - Replacement of two screw pumps at WWTF to ensure able to continue operation even in a high-flow event. Funds have been appropriated for this purchase as of August 2022.	\$89,400
New Emergency Generator at Wastewater Treatment Facility - New emergency generator to replace 1979 generator at WWTF. This would enable full operation of pumps even during power outage. Would require upgrade of transfer switches. Funding has been appropriated as of August 2022.	\$8,700
Total Plan Cost	\$98,100

Risk Assessment Results

Below is a summary of the results obtained from risk assessments for each scenario. These results indicate the change in monetized risk attributable to the implementation of Wastewater Treatment Facility improvements relative to the resilience already provided by Current Measures. Total risk, as shown in the tables below, is the sum of assessments made for asset-threat pairs, assigned based on the determination that an asset is imperiled by the assigned threat.

Baseline Scenario

	Current Measures	Selected Plan
Economic Consequences	\$18,700 - \$109,531	\$0 - \$81,481

Wetter and Stormier – Warmer and Wetter temp and average precipitation.

	Current Measures	Selected Plan
Economic Consequences	\$145,250 - \$336,350	\$47,481 - \$152,715

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Moderate Future – Moderate future average temps and precip, not as stormy future.

	Current Measures	Selected Plan
Economic Consequences	\$47,481 - \$152,715	\$0 - \$81,481

The overall risk reduction performance of this plan, compared to other plans in this assessment, is listed below by scenario. The plan described in this report is at the top with any other plans considered in this CREAT analysis listed below.

Monetized Risk Reduction				
Plan	Total Cost	Baseline Scenario	Wetter and Stormier	Moderate Future
Wastewater Treatment Facility improvements	\$98,100	\$0 - \$46,750	\$0 - \$281,403	\$0 - \$118,715
Natural flow improvements	\$14,000 - \$56,000	\$0 - \$46,750	\$0 - \$281,403	\$0 - \$59,538

Next Steps

This report documents the risk reduction possible from implementing the Wastewater Treatment Facility improvements adaptation plan at Montague WPCF. These results are a useful input into the decision making process, either as metrics supporting the decision to implement or defer taking action or as a documentation of additional data and information needed to make an informed decision.

If results indicate that more information is needed, please consider the following approaches for re-visiting the analysis to refine or improve results:

- Investigate costs of adaptation options to reduce uncertainty in plan costs;
- Review consequence level definitions to narrow ranges based on utility- or region-specific economic factors;
- Expand the number of assets assessed to better characterize risk posed to the system; and
- Collect additional data on the influence of climate on threats being assessed to ensure definitions are well-informed and detailed enough to compare with thresholds for asset damage or loss.

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Once CREAT results meet the expectations of decision makers and partners, consider a strategy for integrating risk reduction results into overall planning in a way that ensures climate adaptation can be combined with other priorities to support holistic prioritization and selection of plans. This strategy will be a powerful tool for using risk assessment frameworks, like CREAT, as new threats present themselves and as an increasing number of assets may be vulnerable to these threats.

Beyond the CREAT risk assessment process, there are opportunities to learn from other water utilities through the exchange of information and experience. Sharing the results of your assessment and planning activities with others could benefit similar utilities that may be facing similar challenges. One way to share your progress and lessons learned is to contribute your story to the [Case Study and Information Exchange Map](#). This map contains stories from utilities across the Nation, each contributed to help other water sector utilities with their own adaptation planning processes and decision-making.

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Attachment A – Scenario Data

At a minimum, each assessment will consider a single 'Baseline' scenario, often based on historical climate data provided in CREAT for the utility location. This data is from daily observations of temperature, precipitation, streamflow data, and coastal data from selected reporting stations (see CREAT Methodology Guide for more details on sources and methods). The following reporting stations were used for Montague WPCF.

Data Type	Station/Site/ Cell ID	Station Name	Latitude	Longitude
Temperature	1626		42.7506	-72.7500
Hot Days Station	USC00198580	TURNERS FALLS	42.6167	-72.5500
Precipitation	1626		42.7506	-72.7500
Intense Precipitation Station	USC00198580	TURNERS FALLS	42.6167	-72.5500
Streamflow Gage	01170500		42.5802	-72.5745
Streamflow Projection Point	1001371		42.5715	-72.6026
Tide Gauge			0.0000	0.0000

If additional scenarios are listed below, these conditions are also defined based on the same measurements; however, the basis for these scenarios are possible changes in climate, based on climate model data in CREAT or other information or previously determined critical thresholds. The following measurements and data were selected to define the scenarios in this assessment:

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Scenarios	Threats
Baseline Scenario	Service Demand and Use
Wetter and Stormier – Warmer and Wetter temp and average precipitation.	Service Demand and Use
Moderate Future – Moderate future average temps and precip, not as stormy future.	Service Demand and Use

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Measurement	Baseline	Wetter and Stormier	Moderate Future
Annual Average Temperature (Fahrenheit)	43.62	--	--
January Average Temperature (Fahrenheit)	19.37	--	--
February Average Temperature (Fahrenheit)	20.81	--	--
March Average Temperature (Fahrenheit)	30.16	--	--
April Average Temperature (Fahrenheit)	41.84	--	--
May Average Temperature (Fahrenheit)	53.41	--	--
June Average Temperature (Fahrenheit)	62.13	--	--
July Average Temperature (Fahrenheit)	66.72	--	--
August Average Temperature (Fahrenheit)	64.80	--	--
September Average Temperature (Fahrenheit)	57.17	--	--
October Average Temperature (Fahrenheit)	46.79	--	--
November Average Temperature (Fahrenheit)	36.06	--	--
December Average Temperature (Fahrenheit)	24.13	--	--
Annual Degree Change in temperature (Fahrenheit)	--	2.39	2.75
January Degree Change in temperature (Fahrenheit)	--	2.64	3.09
February Degree Change in temperature (Fahrenheit)	--	2.45	2.51
March Degree Change in temperature (Fahrenheit)	--	1.70	1.97
April Degree Change in temperature (Fahrenheit)	--	1.97	2.28

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May Degree Change in temperature (Fahrenheit)	--	2.17	2.26
June Degree Change in temperature (Fahrenheit)	--	2.39	2.69
July Degree Change in temperature (Fahrenheit)	--	2.62	3.18
August Degree Change in temperature (Fahrenheit)	--	2.80	3.63
September Degree Change in temperature (Fahrenheit)	--	2.66	3.29
October Degree Change in temperature (Fahrenheit)	--	2.57	2.96
November Degree Change in temperature (Fahrenheit)	--	2.18	2.40
December Degree Change in temperature (Fahrenheit)	--	2.59	2.81
Annual Number of hot days over 90 °F (Days)	9	20	23
Annual Number of hot days over 95 °F (Days)	2	5	7
Annual Number of hot days over 100 °F (Days)	0	1	1
Annual Total Precipitation (Inches)	50.39	--	--
January Total Precipitation (Inches)	4.03	--	--
February Total Precipitation (Inches)	3.33	--	--
March Total Precipitation (Inches)	4.19	--	--
April Total Precipitation (Inches)	4.25	--	--
May Total Precipitation (Inches)	4.57	--	--
June Total Precipitation (Inches)	4.38	--	--

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July Total Precipitation (Inches)	4.18	--	--
August Total Precipitation (Inches)	4.50	--	--
September Total Precipitation (Inches)	3.98	--	--
October Total Precipitation (Inches)	4.30	--	--
November Total Precipitation (Inches)	4.58	--	--
December Total Precipitation (Inches)	4.10	--	--
Annual % Change in precipitation (%)	--	4.97	3.54
January % Change in precipitation (%)	--	6.89	6.79
February % Change in precipitation (%)	--	5.89	6.46
March % Change in precipitation (%)	--	5.24	6.20
April % Change in precipitation (%)	--	9.27	7.57
May % Change in precipitation (%)	--	5.90	6.72
June % Change in precipitation (%)	--	0.27	0.35
July % Change in precipitation (%)	--	3.22	-1.26
August % Change in precipitation (%)	--	6.30	1.52
September % Change in precipitation (%)	--	3.36	-3.72
October % Change in precipitation (%)	--	4.21	1.30
November % Change in precipitation (%)	--	2.88	2.09

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December % Change in precipitation (%)	--	6.04	8.38
100-year storm event (Inches/24hr)	5.88	--	--
100-year storm event (Inches/72hr)	8.40	--	--
5-year storm event (Inches/24hr)	3.16	--	--
15-year storm event (Inches/24hr)	4.08	--	--
5-year storm event (Inches/72hr)	3.93	--	--
15-year storm event (Inches/72hr)	5.28	--	--
5-year storm event (%)	--	8.69	1.09
15-year storm event (%)	--	8.98	0.81
100-year storm event (%)	--	9.71	2.07

* Baseline relative sea-level rise (SLR) is typically a rate based on vertical land movement (VLM), if available

Attachment B – Consequence Definitions

CREAT provides the user the ability to assess economic consequences across specific categories often used by water utilities to gauge the value of assets. The default names for these categories are:

- Utility Business Impacts,
- Utility/Equipment Damage,
- Source/Receiving Water Impacts, and
- Environmental Impacts.

Each category is assessed on a scale with four levels, each with a range of monetized loss that quantifies the impact of a threat to each vulnerable asset. For Montague WPCF, the default values for these monetary losses were provided based on population served, ownership, system type and capacity (see CREAT Methodology Guide for details on data sources and methods).

Economic Consequences

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Consequence Category	Low	Medium	High	Very High
Utility Business Impacts – Operating revenue loss evaluated in terms of the magnitude and recurrence of service interruptions. Consequences range from long-term loss of expected operating revenue to minimal potential for any loss.	Minimal potential for loss of revenue or operating income \$0 - \$34,000	Minor and short-term reductions in expected revenue \$34,000 - \$68,850	Seasonal or episodic compromise of expected revenue or operating income \$68,850 - \$102,850	Long-term or significant loss of expected revenue or operating income > \$102,850
Utility Equipment Damage – Costs of replacing the service equivalent provided by a utility or piece of equipment evaluated in terms of the magnitude of damage and financial impacts. Consequences range from complete loss of the asset to minimal damage to the equipment.	Minimal damage to equipment \$0 - \$18,700	Minor damage to equipment \$18,700 - \$46,750	Significant damage to equipment \$46,750 - \$112,200	Complete loss of asset > \$112,200
Environmental Impacts – Evaluated in terms of environmental damage or loss, aside from water resources, and compliance with environmental regulations. Consequences range from significant environmental damage to minimal impact or damage.	No impact or environmental damage \$0 - \$4,961.52	Short-term damage, compliance can be quickly restored \$4,961.52 - \$12,426.77	Persistent environmental damage \$12,426.77 - \$29,815.06	Significant environmental damage > \$29,815.06
Source/Receiving Water Impacts – Degradation or loss of source or receiving water quality or quantity evaluated in terms of recurrence. Consequences range from long-term compromise to no more than minimal changes to water quality or quantity.	No more than minimal changes to water quality \$0 - \$23,819.89	Temporary impact on source water quality or quantity \$23,819.89 - \$59,538.24	Seasonal or episodic compromise of source water quality or quantity \$59,538.24 - \$142,873.4	Long-term compromise of source water quality or quantity > \$142,873.4

Attachment C – Plan Comparison

As part of deciding which plan provides the most benefit for the investment, the comparison of costs to risk reduction in this report is only one factor. Based on entries by the assessor, the table below summarizes the other factors that may be important in selecting a plan to implement. The plan described in this report is at the top with any other plans considered in this CREAT analysis listed below.

Plan	Total Cost	Energy Impacts	Socio-economic Impacts	Community Public Health Impact
Wastewater Treatment Facility improvements	\$98,100	BENEFICIAL	BENEFICIAL	BENEFICIAL
Natural flow improvements	\$14,000 - \$56,000	BENEFICIAL	BENEFICIAL	BENEFICIAL

Attachment D – Likelihood Sensitivity

For each scenario, there may be a range of likelihood where the cost of implementing Wastewater Treatment Facility improvements is comparable to the monetized risk reduction attainable after the potential adaptive measures have been implemented. To explore the influence that scenario likelihood would have on the comparison of costs to benefit, CREAT provides the ranges of likelihood where the intersections of cost and risk reduction represent “break even” points for utilities to consider in their planning. The following table lists the comparison of plan cost to risk reduction for each scenario.

Scenario	Wait and See	Consider Implementing Plan	Implement Plan
Baseline Scenario	0.00% - 100.00%	--	--
Wetter and Stormier	0.00% - 34.86%	34.86% - 100.00%	--
Moderate Future	0.00% - 82.63%	82.63% - 100.00%	--

The definitions for the possible conclusions following comparison of cost with risk reduction are defined as follows:

- Wait and See** - The range of implementation costs of the selected plan exceed the entire range of possible risk reduction for the threats in the selected scenario. Based on the current assessment, there would be a negative return on investment. It is possible that, based on additional experience and improved data, a later assessment may reduce this range of likelihood and support implementation;
- Consider Implementing Plan** - The range of implementation costs for the selected plan overlap with the range of possible risk reduction for the threats in the selected scenario. Based on the current assessment, there would be an uncertain return on investment. Consider additional benefits from implementing this plan or return to conduct another assessment to support your decision regarding implementation of this plan; and
- Implement Plan** - The entire range of implementation costs of this selected plan is below the entire range of possible risk reduction for the threats in the selected scenario. Based on the current assessment, there would be a positive return on investment. The monetized risk reduction alone provides adequate benefit to support your decision regarding implementation of this plan.