



# **Resilience Planning and Adaptation Training for Water and Wastewater Utilities**

## **Introduction to CREAT**

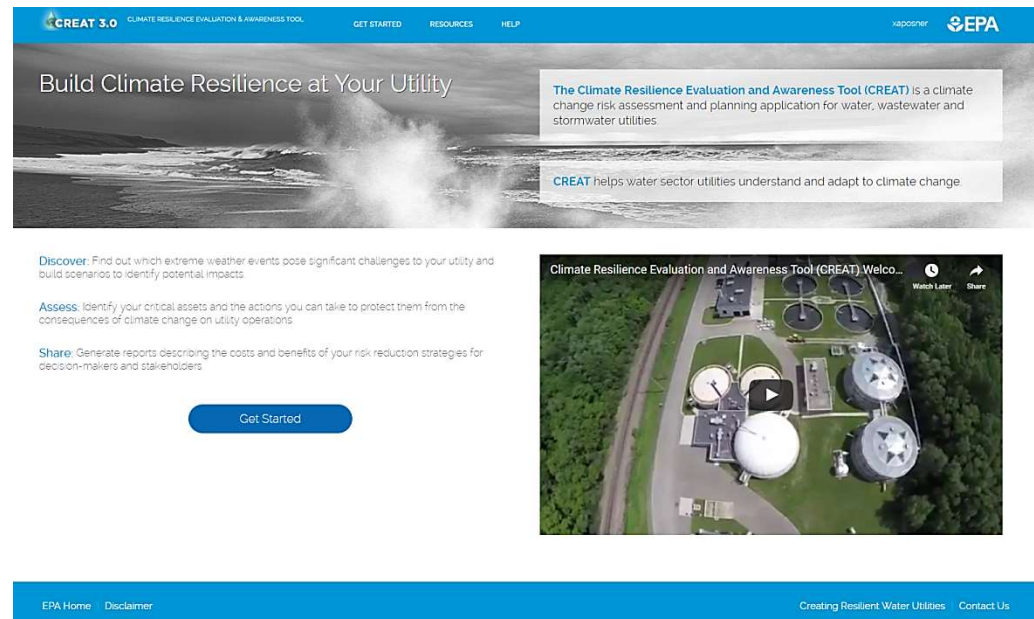
**Alfredo Lagos, GDIT**

**Mary Jo Kricorian, GDIT**

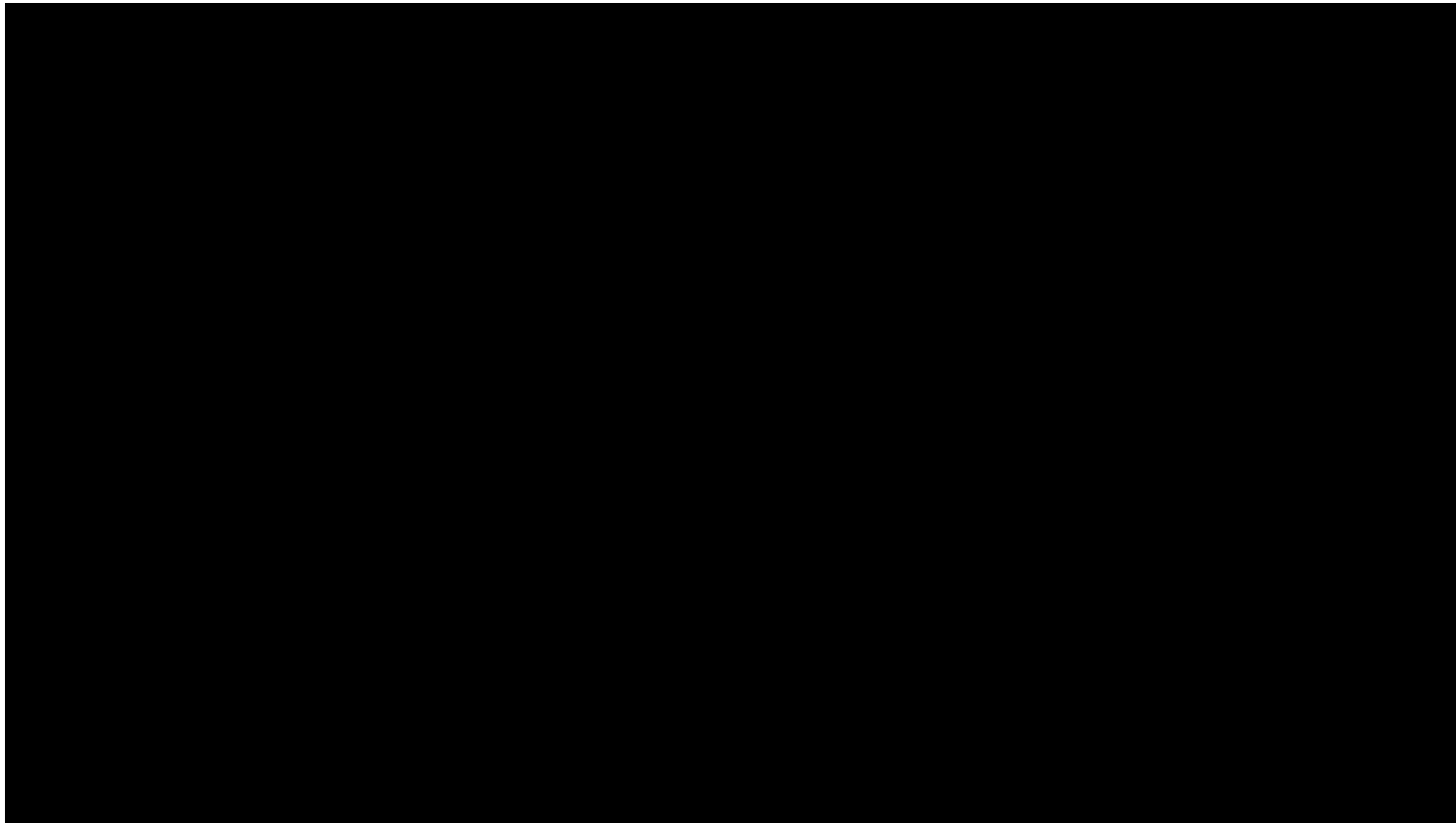
**Marc Pritchard, Moorhead Public Service**

# CREAT Overview

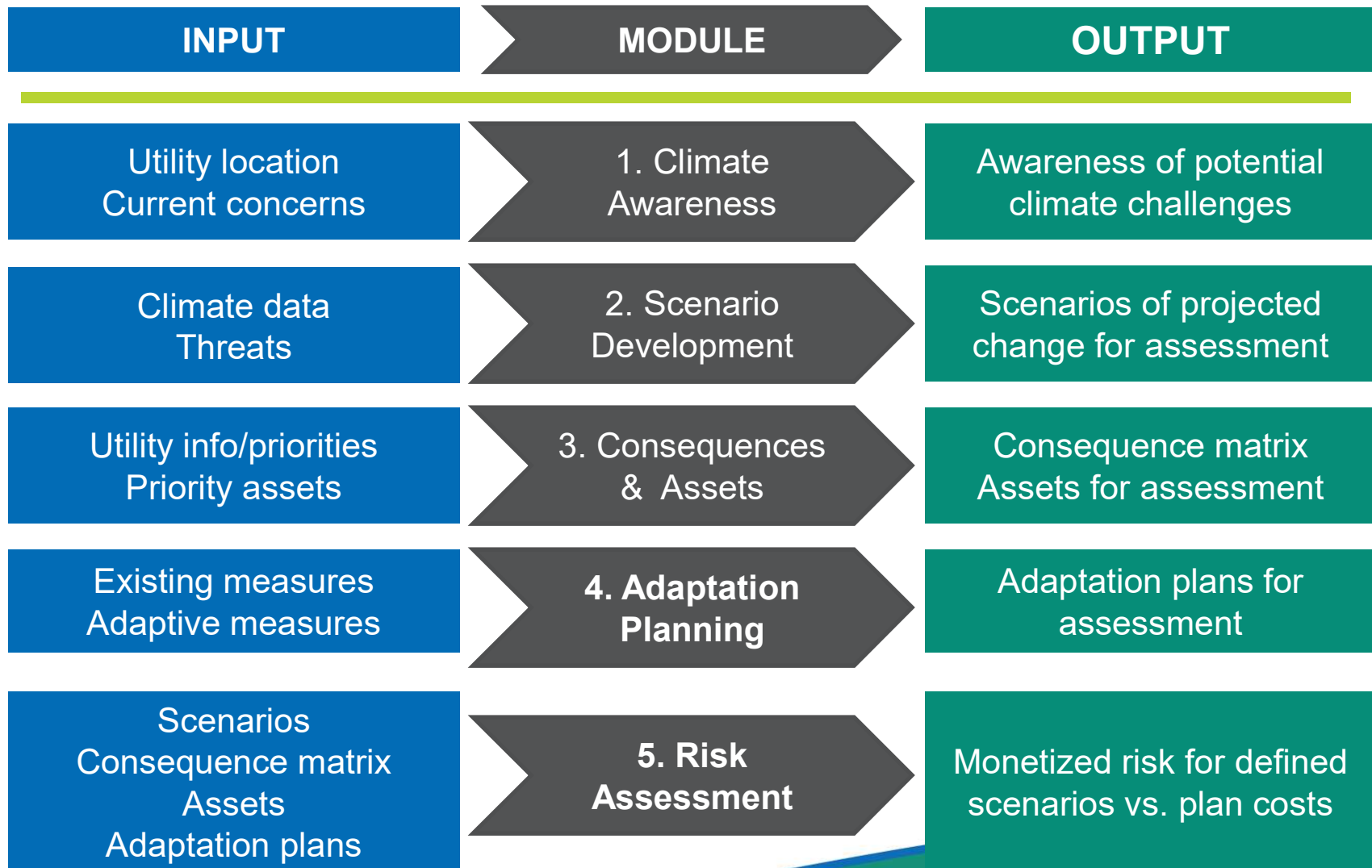
- Easy to use
- Decision support tool
- Step by step process
- Up to date climate data
- Streamlined analysis option



# CREAT Welcome Video

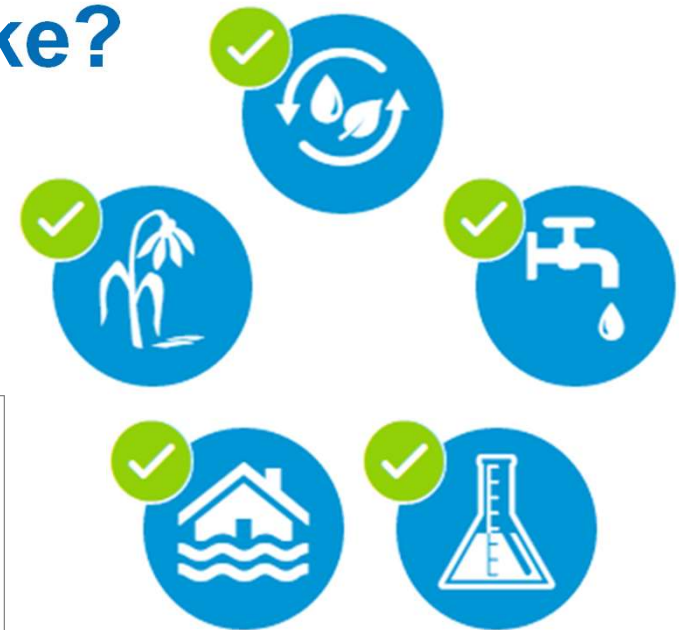
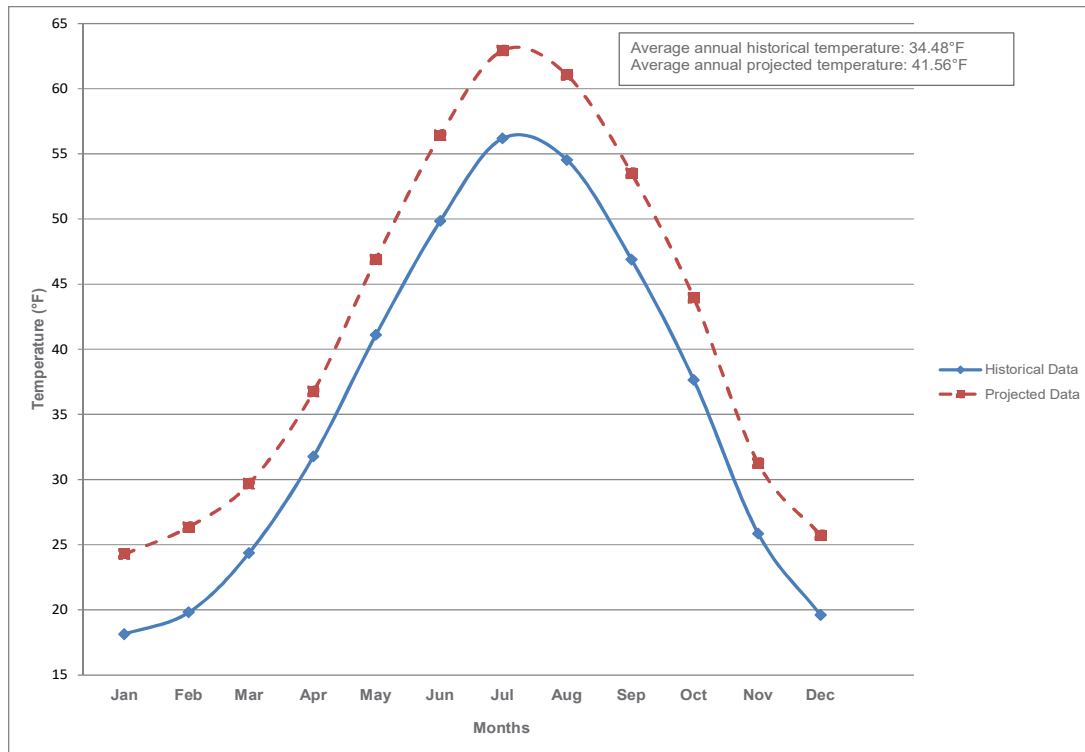


# CREAT process overview



# What will the future look like?

- Identify threats and learn how they might change over time



- Projected climate data to help guide this thought exercise

# What can I do to protect critical infrastructure and utility operations?

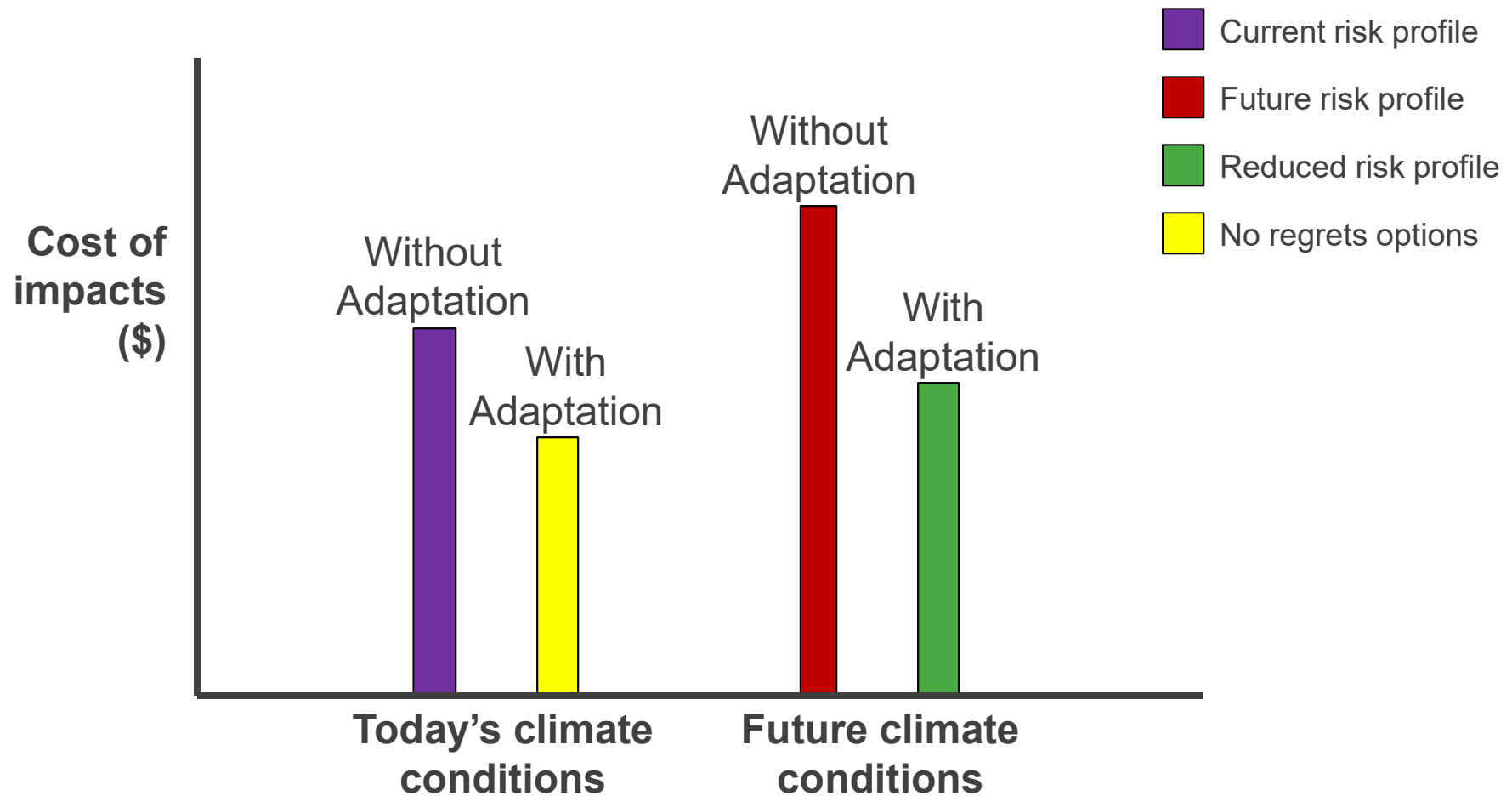
- Learn about potential consequences to business revenue, equipment damage and changes in water quality and quantity
- Identify adaptation strategies for additional resilience

## CREAT Adaptive Measures Library (Step 1 of 2)

Choose an adaptive measure from the CREAT provided library. Choose an adaptive measure from the CREAT-provided library below, then click "Next" to refine your selection.

| CONSTRUCT <span>[-]</span>                     |                                       |
|--|---------------------------------------|
| ALTERNATE WASTEWATER / STORMWATER CAPABILITIES | <a href="#">SELECT</a> <span>+</span> |
| BACK-UP POWER                                  | <a href="#">SELECT</a> <span>+</span> |
| FACILITY LOCATION                              | <a href="#">SELECT</a> <span>+</span> |
| HYDROLOGIC BARRIER                             | <a href="#">SELECT</a> <span>+</span> |
| INCREASED CAPACITY - WASTEWATER / STORMWATER   | <a href="#">SELECT</a> <span>+</span> |
| LEVEE  | <a href="#">SELECT</a> <span>+</span> |
| LOW-HEAD DAM                                   | <a href="#">SELECT</a> <span>+</span> |

# CREAT in a Bar Graph (Simplified)



# CREAT in a Bar Graph (Real-world Result)





# How do I decide which measures to implement?

Cost to adapt

Cost of impacts

\$\$

<

\$\$\$\$\$



\$\$\$\$\$

>

\$\$\$



\$\$\$

=

\$\$\$

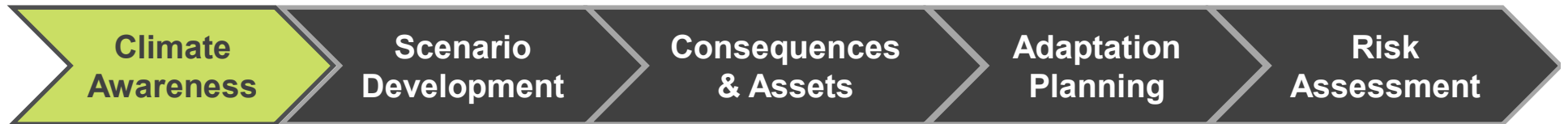


# Are these strategies beneficial to implement?

- **Consider the likelihood that the threats will occur**
  - Are your adaptation strategies still cost effective?
  - Are some of your strategies “No regrets” strategies?
- **Identify external impacts of implementation**
  - Will my energy costs go up?
  - What funding sources are available?
  - How can I minimize the costs to my customers?
  - Do the water conservation strategies impact other sectors?

# Module 1: Climate Awareness

**GOAL:** Increase awareness of climate impacts for your utility's location to help inform future assessment inputs and decisions



This module provides basic information about climate impacts and allows you to enter general information about your utility

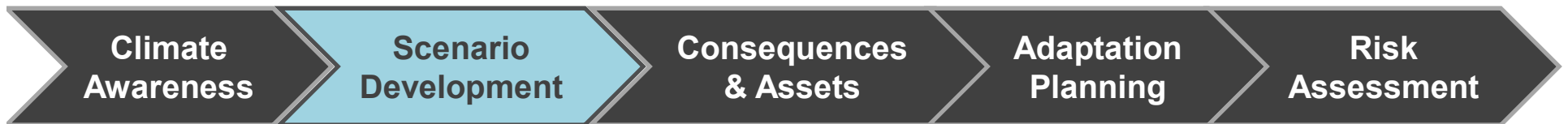
# Module 1: Climate Awareness

- Show Module 1 in CREAT
  - Utility information
  - Current concerns

The screenshot displays the CREAT 3.0 interface for the Climate Awareness Module. The top navigation bar includes the CREAT 3.0 logo, the text 'CLIMATE RESILIENCE EVALUATION & AWARENESS TOOL', and links for 'GET STARTED', 'RESOURCES', and 'HELP'. The EPA logo and the user 'xalagos' are also visible. A left sidebar contains a menu with 'Climate Awareness' selected, and sub-items: 'Utility Information' (active), 'Utility Location', 'Climate Change Basics', 'Current Concerns', and 'Awareness Summary'. Below this are 'Scenario Development', 'Consequences & Assets', 'Adaptation Planning', and 'Risk Assessment'. The main content area is titled 'CREAT Demo' and 'Climate Awareness Module'. The current page is 'Utility Information', with a sub-header 'Enter your utility's information below. CREAT uses this information to provide climate and economic data to support your assessment.' The form fields are: 'UTILITY NAME' (text input), 'OWNERSHIP' (radio buttons for PUBLIC and PRIVATE), 'ADDRESS' (text input), 'FINANCIAL CONDITION' (radio buttons for ADEQUATE, GOOD, and STRONG), 'CITY' (text input), 'POPULATION SERVED' (text input with value 0), 'STATE' (dropdown menu), 'SYSTEM TYPE' (dropdown menu), 'ZIP' (text input), and 'MILLIONS OF GALLONS PER DAY (MGD)' (text input with value 0 and an MGD label). At the bottom are 'Back' and 'Continue >' buttons. A vertical 'Feedback' button is on the right edge.

# Module 2: Scenario Development

**GOAL:** Develop scenarios of potential future climate conditions for assessing impacts through time



What have we done so far?

- Reviewed climate impacts
- Identified our current concerns

This module prompts you to think critically about the challenges your utility may face under future climate conditions and allows you to build scenarios to use in your assessments

# What is a scenario?

- In CREAT, scenarios are projected changes in climate with respect to average conditions, extreme events, and sea level rise
- Scenarios can represent potential climate conditions based on historical records, climate models or other data.



## Baseline Scenario

- Historical climate conditions for a given location
- Use this scenario to compare current threats with how they could change in the future

# What could the future be like?

**Projected Scenarios** – Define projected scenarios to consider a range of potential conditions



How would threats change if the future was hotter and drier?

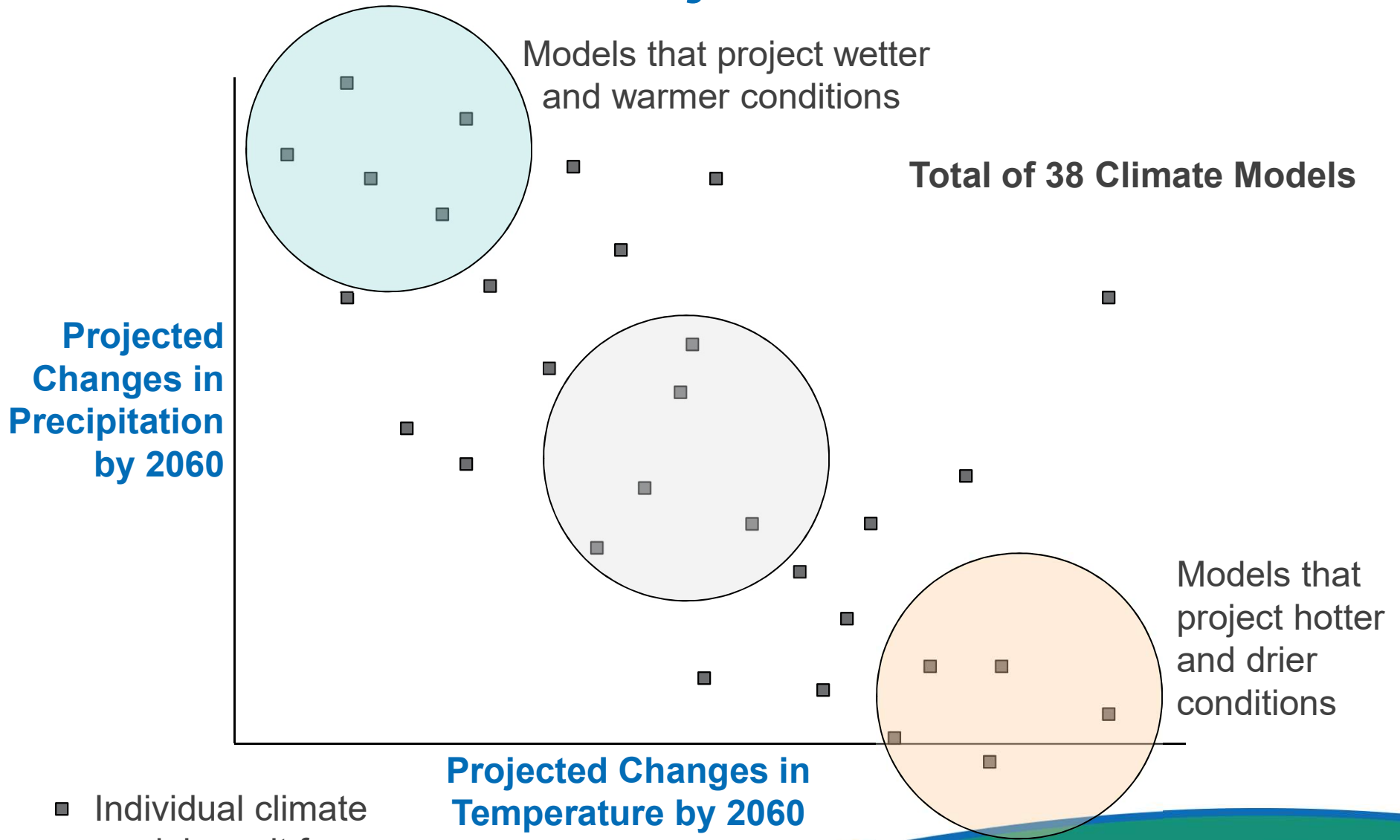


Or if the future was warmer and wetter than it is now?



What would moderate changes look like?

# CREAT-Provided Projected Scenarios





# Module 2: Scenario Development

- Show Module 2 in CREAT
  - Review historical and projected climate data
  - Build scenarios of future conditions
  - Identify and define threats

The screenshot displays the CREAT 3.0 user interface. The top navigation bar includes the CREAT 3.0 logo, the text 'CLIMATE RESILIENCE EVALUATION & AWARENESS TOOL', and links for 'GET STARTED', 'RESOURCES', and 'HELP'. On the right side of the header, it shows 'xalagos' and the EPA logo. A left-hand sidebar contains a navigation menu with categories: 'Climate Awareness', 'Scenario Development' (selected), 'Consequences & Assets', 'Adaptation Planning', and 'Risk Assessment'. Under 'Scenario Development', the sub-menu items are: 'Scenario Primer' (active), 'Threat Identification', 'Baseline Scenario', 'Time Period', 'Projected Scenarios', 'Threat Definition', and 'Scenario Summary'. The main content area is titled 'Scenario Primer' and contains three paragraphs of introductory text. The first paragraph explains the goal of identifying threats. The second paragraph describes the use of historical climate data to create a baseline scenario. The third paragraph discusses potential future climate conditions. Below the text is a video player showing a construction site with a large truck and workers. At the bottom of the main content area, there are 'Back' and 'Continue >' buttons. A vertical 'Feedback' button is located on the right edge of the interface.

CREAT 3.0 CLIMATE RESILIENCE EVALUATION & AWARENESS TOOL GET STARTED RESOURCES HELP xalagos EPA

Climate Awareness

Scenario Development

- Scenario Primer
- Threat Identification
- Baseline Scenario
- Time Period
- Projected Scenarios
- Threat Definition
- Scenario Summary

Consequences & Assets

Adaptation Planning

Risk Assessment

CREAT Demo Scenario Development Module

## Scenario Primer

To get started on your climate change risk assessment, you will identify and define climate **threats** you want to consider for this analysis based on the current concerns identified in the Climate Awareness module. Watch the video located on the right-hand side of this screen for an overview of the Scenario Development module.

In this module, you will review historical climate conditions provided by CREAT for your location, such as temperature, precipitation and storm events, which will help you to understand how these conditions drive your threats of concern. This historical climate data is used to build a **Baseline Scenario** for comparison with scenarios of future climate conditions.

There are a number of potential future climate conditions you could plan for based on changes in temperature, precipitation and storm events, which might exacerbate your current threats or present new threats. The projections in CREAT represent potential future climate conditions that range from hotter and drier to wetter and stormier.

You will want to review the CREAT data and consider how your threats will change in response to these future climate conditions. With the addition of sea level rise values for coastal facilities, CREAT delivers the ability to define identified threats as scenarios for assessment.

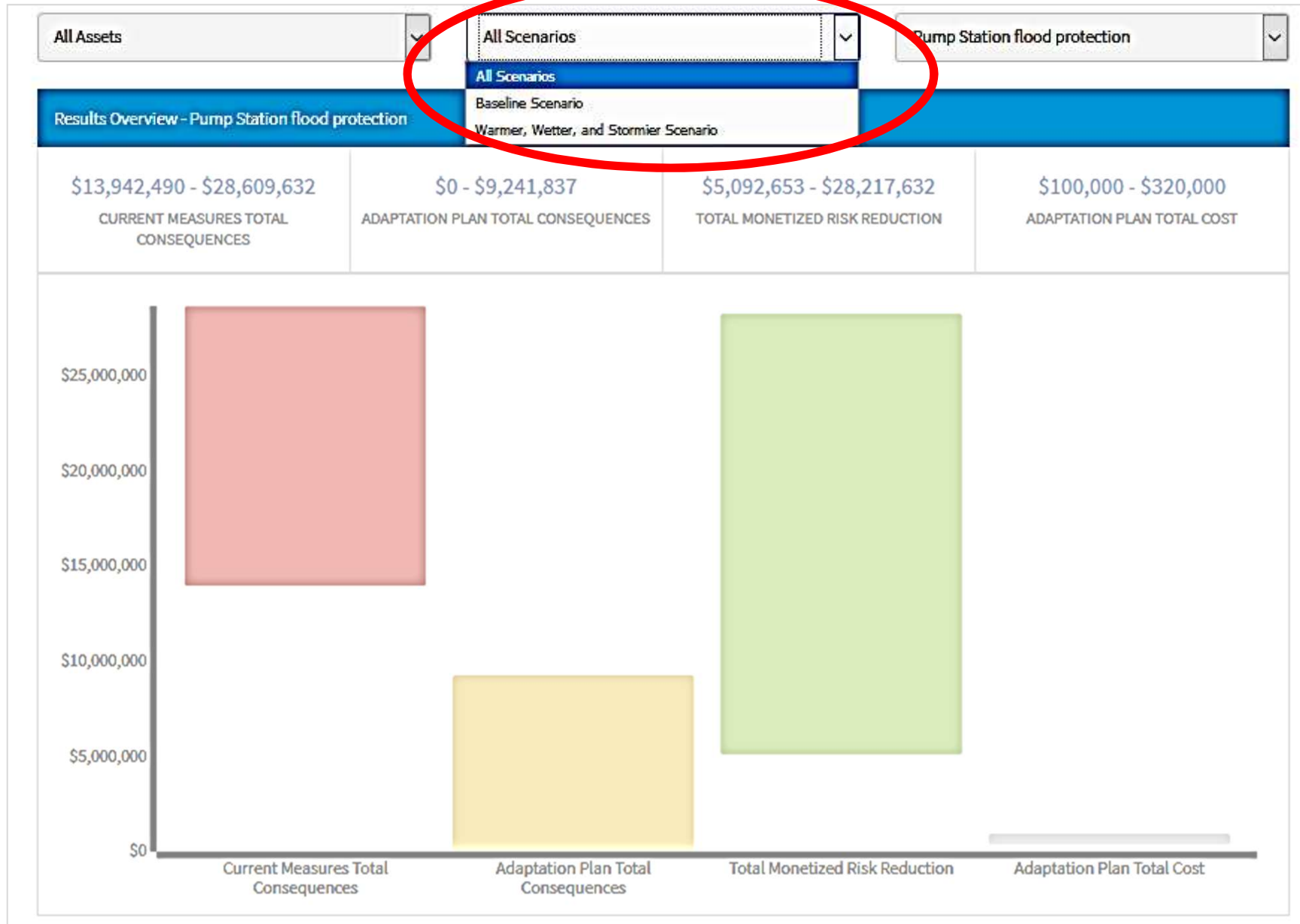
When this module is complete, you will have developed projected scenarios that represent changes in threats for your assessment. Understanding how climate may change in the future will help you to identify adaptation options and improve your resilience to climate change impacts.

Climate Resilience Evaluation and Awareness T...

Back Continue >

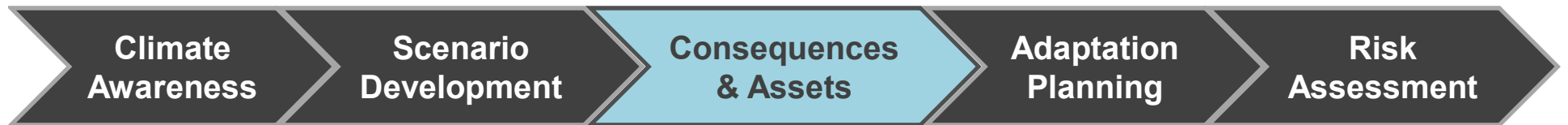
Feedback

# Building our Risk Assessment – add scenarios



# Module 3: Consequences & Assets

**GOAL:** Review CREAT's scorecard for use during your risk assessment and catalog assets and their value to the utility



So far we have identified:

- Impacts from future climate conditions
- Current utility concerns
- Threat of concern
- Scenarios that outline current and future climate conditions
- How the threat might change over time

This module gives you the opportunity to consider the different types of consequences that may result from your threats and to identify priority assets for your assessment

# Module 3: Consequences & Assets

- Show Module 3 in CREAT
  - Review economic and public health consequences
  - Select critical assets

The screenshot displays the CREAT 3.0 web application interface. The top navigation bar includes the logo 'CREAT 3.0 CLIMATE RESILIENCE EVALUATION & AWARENESS TOOL', navigation links 'GET STARTED', 'RESOURCES', and 'HELP', and the EPA logo. A left sidebar menu lists navigation options: 'Climate Awareness', 'Scenario Development', 'Consequences & Assets' (selected), 'Adaptation Planning', and 'Risk Assessment'. Under 'Consequences & Assets', sub-items include 'Consequences Primer' (selected), 'Economic Consequences Matrix', 'Public Health Consequences', 'Asset Definition', and 'Consequences Summary'. The main content area is titled 'CREAT Demo Consequences Primer' and contains three paragraphs of text. A video player on the right shows a worker in a blue shirt and safety gear working on a large pipe. Below the text are 'Back' and 'Continue >' buttons. A 'Feedback' button is visible on the right edge of the content area.

CREAT 3.0 CLIMATE RESILIENCE EVALUATION & AWARENESS TOOL GET STARTED RESOURCES HELP xalagos EPA

Climate Awareness  
Scenario Development  
Consequences & Assets  
Consequences Primer  
Economic Consequences Matrix  
Public Health Consequences  
Asset Definition  
Consequences Summary  
Adaptation Planning  
Risk Assessment

CREAT Demo  
Consequences Primer

At this point you have identified the types of threats that may impact your utility and selected data that defines scenarios of threats based on different changes in climate conditions at your location. Next, you need to determine which types of consequences you might expect if these threats were to occur. Watch the video located on the right-hand side of this screen for an overview of the Consequences & Assets module.

CREAT provides monetary values as a basis for calculating consequences. For each consequence category, definitions and proposed ranges for monetized consequences are provided for comparing the monetized risk of a threat impacting an asset with the cost of taking action to mitigate the impacts.

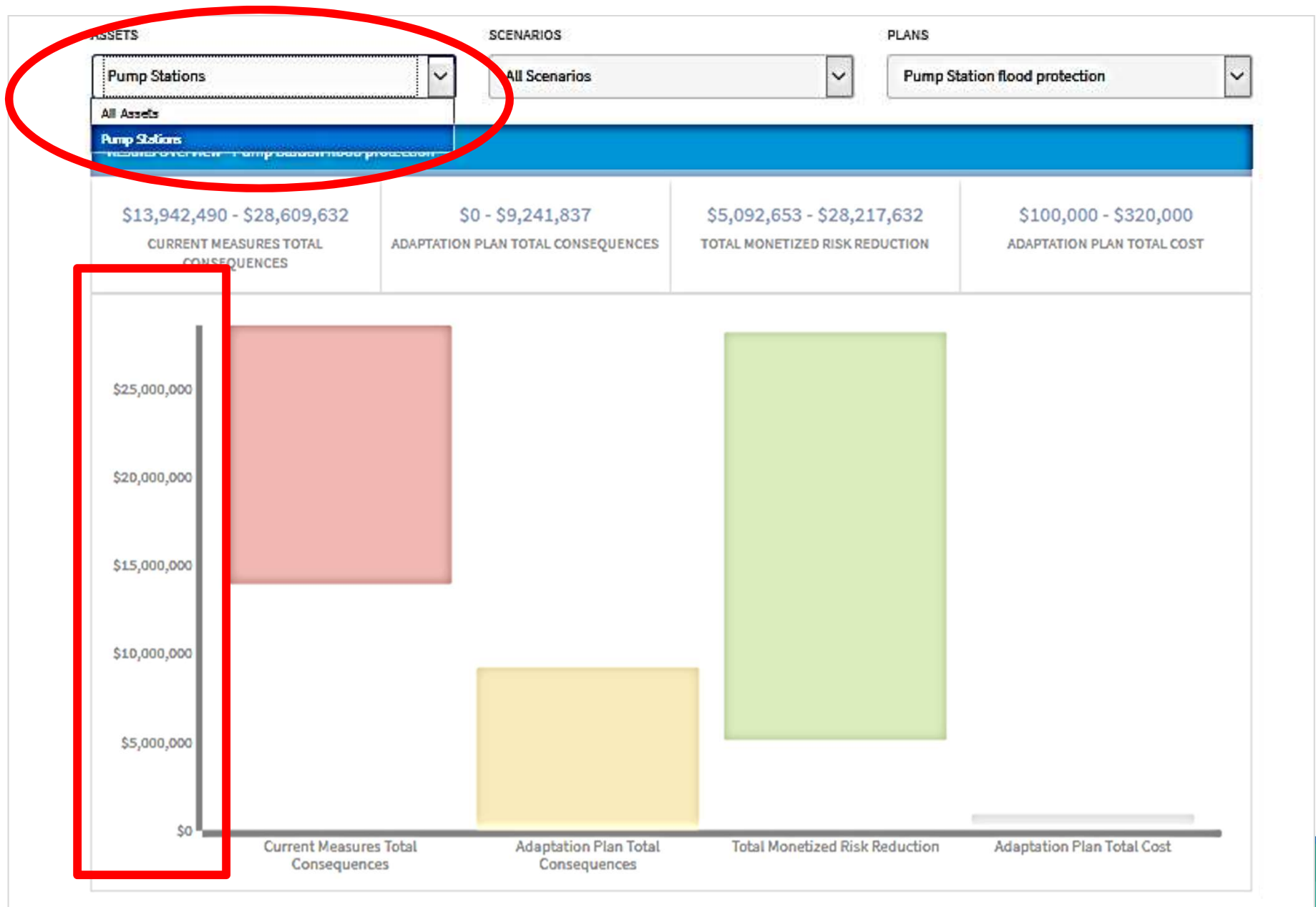
If you have difficulty assigning costs to any of these categories, you can opt out of monetizing them for consideration at a later time.

After reviewing potential economic and public health consequences, you will then define specific assets or groups of assets to focus on for your assessment. This exercise is not meant to identify all utility assets but instead allows you to identify the assets that are critical to operations and are at risk from your identified threats.

Climate Resilience Evaluation and Awareness To...  
Feedback

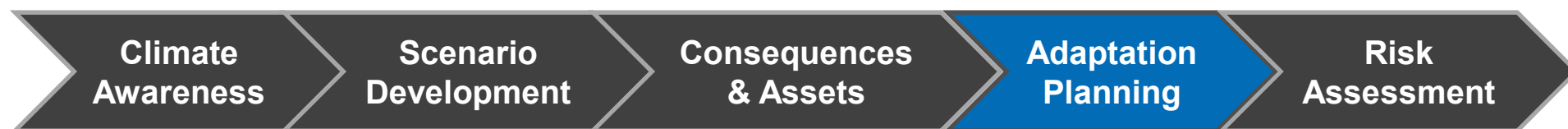
Back Continue >

# Building our Risk Assessment – *add monetized consequences and assets*



# Module 4: Adaptation Planning

**GOAL:** Document existing and potential adaptation strategies for protecting assets



So far, we have identified:

- Our threat
- How that threat could change through time
- The types of consequences if the threat were to occur
- Which assets are most at risk to the threat

This module allows you to document anything you are currently doing or would consider doing to increase resilience to threats and to organize these options into plans

# How do utilities typically design adaptation plans?

- **Some examples of how utilities approach this challenge:**
  - Develop a ‘no-regrets’ plan
  - Develop plans based on available funding or that complement other utility priorities
  - Develop plans to be implemented over time
  - Develop different plans based on certain trigger events or thresholds



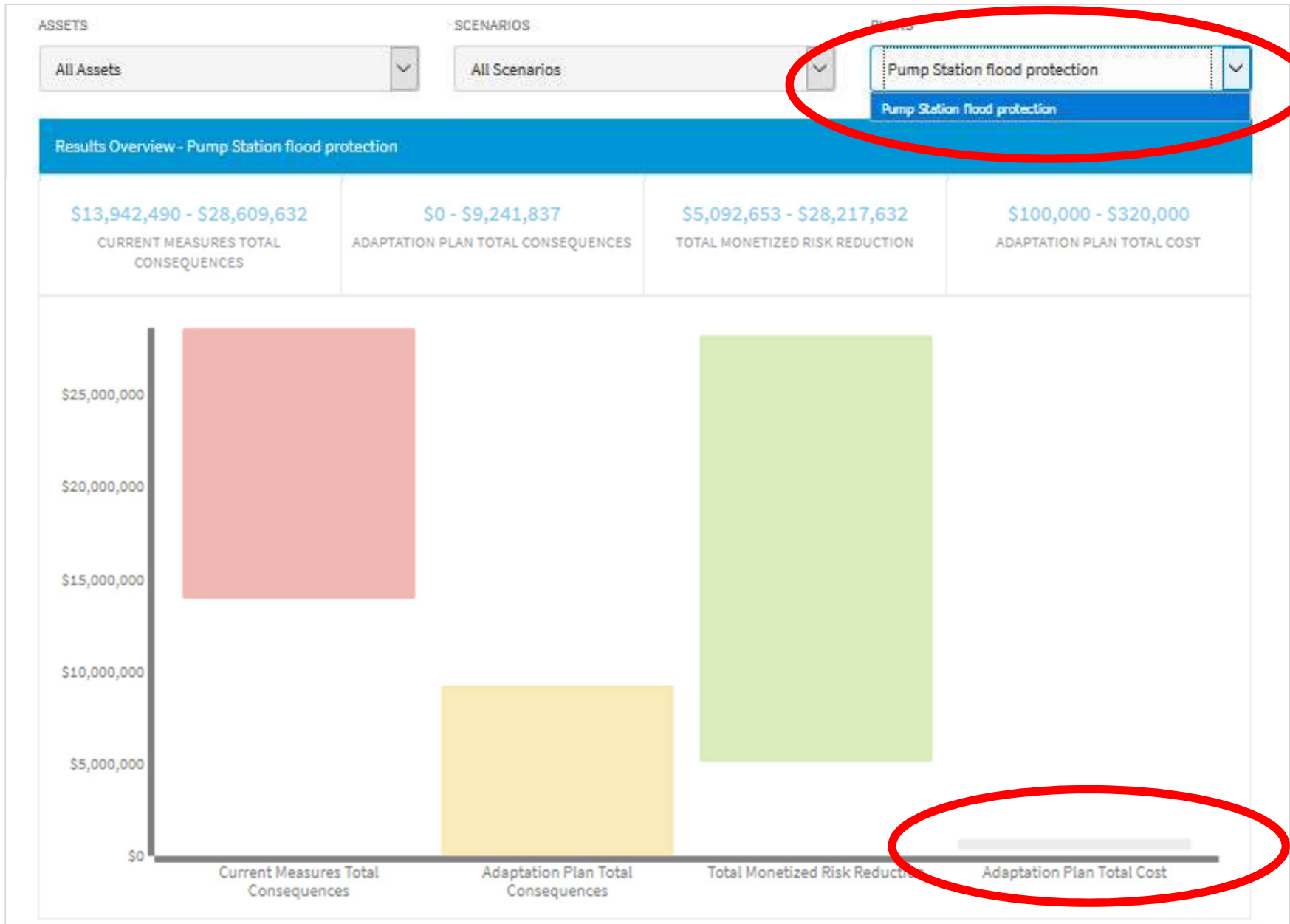
# Module 4: Adaptation Planning

- **Show Module 4 in CREAT**
  - Identify existing and potential adaptive measures that increase resilience

The screenshot displays the CREAT 3.0 web application interface. The header includes the logo 'CREAT 3.0 CLIMATE RESILIENCE EVALUATION & AWARENESS TOOL', navigation links 'GET STARTED', 'RESOURCES', and 'HELP', and the user 'xalagos' with the EPA logo. The left sidebar contains a menu with categories: 'Climate Awareness', 'Scenario Development', 'Consequences & Assets', 'Adaptation Planning' (expanded), and 'Risk Assessment'. Under 'Adaptation Planning', the sub-items are 'Adaptation Primer' (selected), 'Existing Adaptive Measures', 'Potential Adaptive Measures', 'Adaptation Plans', and 'Adaptation Summary'. The main content area is titled 'CREAT Demo Adaptation Planning Primer' and includes an introduction: 'In this module, you will consider how different actions called adaptive measures can mitigate the consequences of a threat occurring to a given asset. You will be asked to identify and define specific actions to develop an inventory of options to help you build resilience to climate change through the adaptation planning process. First, you will identify existing adaptive measures your utility has already put into practice or built. These existing measures will help you understand your current resilience to various threats and how you can build upon these measures to increase your capabilities. Next, you will choose potential adaptive measures and group these into adaptation plans that will help you assess how you can reduce the risk of future climate change to your utility.' Below the text are 'Back' and 'Continue >' buttons. A 'Feedback' button is visible on the right edge of the content area.

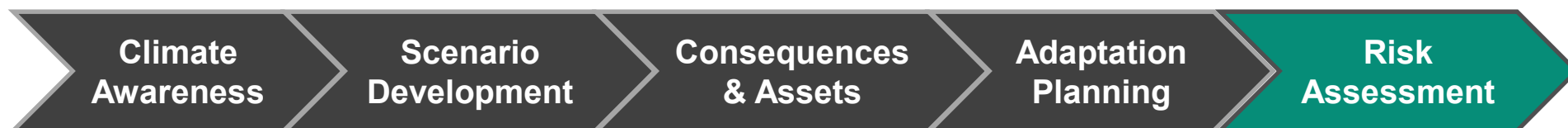


# Building our Risk Assessment – *add adaptation plans*



# Module 5: Risk Assessment

**GOAL:** Assess the capabilities and benefits of plans across your defined scenarios



So far, we have identified:

- Our threat
- How that threat can change through time
- The types of consequences if the threat were to occur
- Which assets are at risk to the threat
- Current and new strategies to protect these assets from the threat
- Plans of adaptation strategies that we could implement

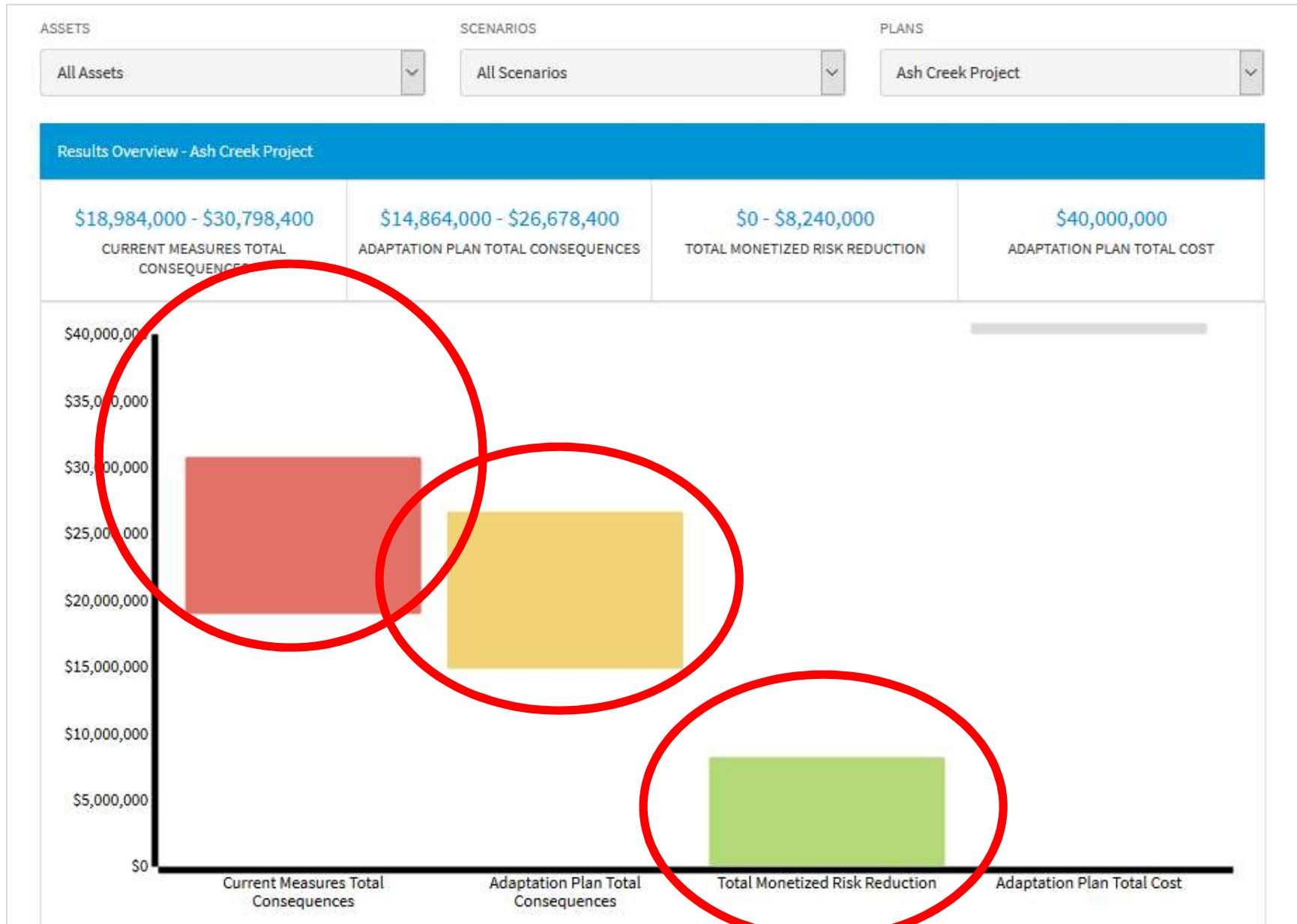
This module guides you through the risk assessment process and provides monetized risk and plan costs as outputs

# Module 5: Risk Assessment

- Show Module 5 in CREAT
  - Assess consequences for asset-threat pair
  - Review results

The screenshot displays the CREAT 3.0 interface. The top navigation bar includes the CREAT 3.0 logo, the text 'CLIMATE RESILIENCE EVALUATION & AWARENESS TOOL', and links for 'GET STARTED', 'RESOURCES', and 'HELP'. On the right side of the header, the user 'xalagos' and the EPA logo are visible. A left-hand sidebar contains a menu with the following items: 'Climate Awareness', 'Scenario Development', 'Consequences & Assets', 'Adaptation Planning', and 'Risk Assessment' (which is expanded to show sub-items: 'Risk Primer', 'Asset/Threat Pairs', 'Risk Results', 'Likelihood Sensitivity', and 'Plan Comparison'). The main content area is titled 'CREAT Demo Risk Primer' and includes a 'Risk Assessment Module' toggle. The text explains that in this module, users assess risk for each asset/threat pair across all defined scenarios. It states that CREAT provides estimated monetized risk results based on the assessment of consequences using categories defined in the Consequences & Assets module. The goal is to implement measures that lower risk, and users can return to the Adaptation Planning module to build new plans. It also mentions that users can evaluate the likelihood of a scenario occurring to inform adaptation planning decisions. A video player is embedded on the right, showing a man crouching by a stream with the text 'How resilient are we already?'. Below the video are 'Back' and 'Continue >' buttons. A vertical 'Feedback' button is located on the far right edge of the interface.

# Building our Risk Assessment – *risk results*



# CREAT Analysis Recap

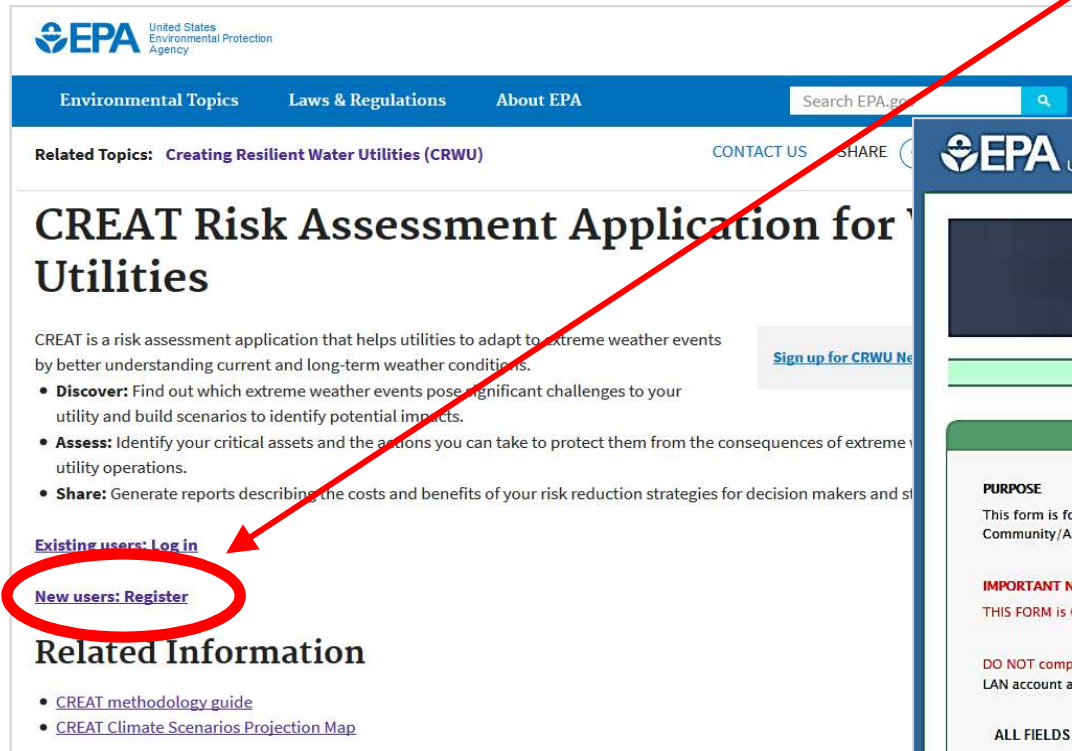
Using CREAT, our risk assessment identifies:

|                 |   |
|-----------------|---|
| <b>Module 1</b> | Our climate threat  |
| <b>Module 2</b> | How that threat can change over time  |
| <b>Module 3</b> | Types of consequences if the threat were to occur                               |
|                 | Which assets were at risk to the threat   |
| <b>Module 4</b> | Existing and potential strategies to protect the asset                          |
|                 | Plans of adaptation strategies to provide further protection                    |
| <b>Module 5</b> | Benefits of implementing adaptation plans compared to the cost of doing nothing |
|                 | How likelihood can inform adaptation decision making                            |
|                 | External benefits of plan implementation  |

# How to sign up to use CREAT

1. Go to <https://creat.epa.gov>

2. Click 'New Users: Register' and complete form



**EPA** United States Environmental Protection Agency

Environmental Topics    Laws & Regulations    About EPA    Search EPA.gov

Related Topics: [Creating Resilient Water Utilities \(CRWU\)](#)    CONTACT US    SHARE

## CREAT Risk Assessment Application for Utilities

CREAT is a risk assessment application that helps utilities to adapt to extreme weather events by better understanding current and long-term weather conditions. [Sign up for CRWU News](#)

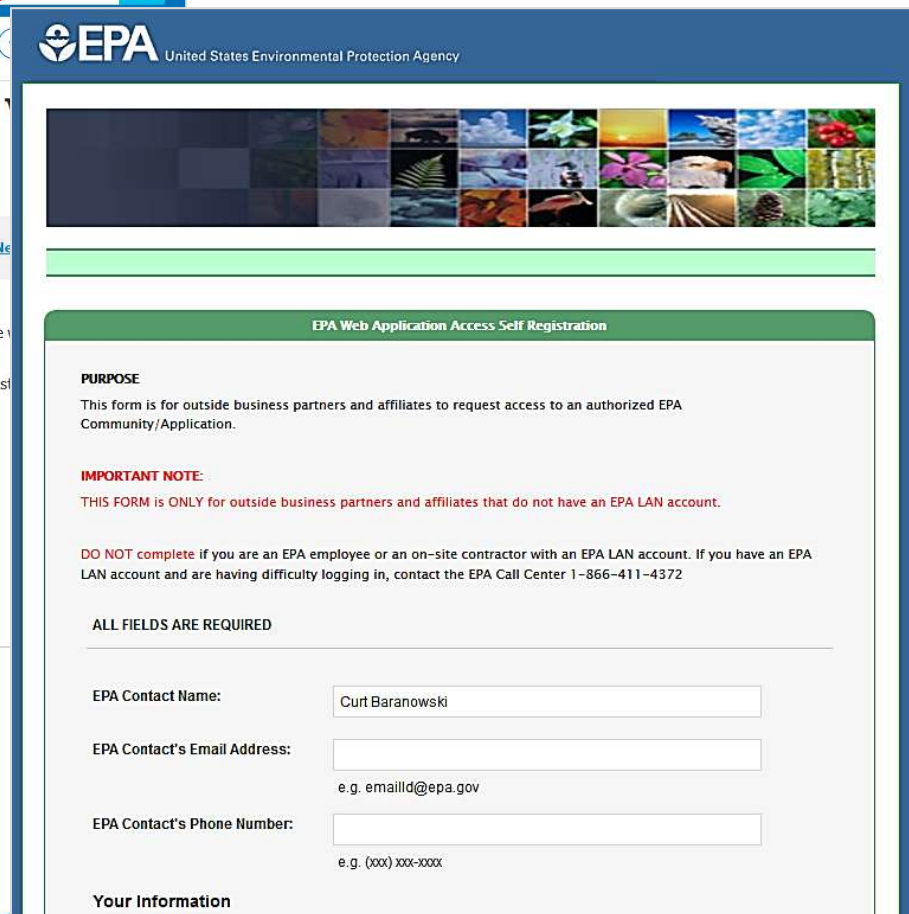
- **Discover:** Find out which extreme weather events pose significant challenges to your utility and build scenarios to identify potential impacts.
- **Assess:** Identify your critical assets and the actions you can take to protect them from the consequences of extreme weather events on utility operations.
- **Share:** Generate reports describing the costs and benefits of your risk reduction strategies for decision makers and stakeholders.

Existing users: [Log in](#)

**New users: [Register](#)**

### Related Information

- [CREAT methodology guide](#)
- [CREAT Climate Scenarios Projection Map](#)



**EPA** United States Environmental Protection Agency

### EPA Web Application Access Self Registration

**PURPOSE**  
This form is for outside business partners and affiliates to request access to an authorized EPA Community/Application.

**IMPORTANT NOTE:**  
THIS FORM is ONLY for outside business partners and affiliates that do not have an EPA LAN account.

DO NOT complete if you are an EPA employee or an on-site contractor with an EPA LAN account. If you have an EPA LAN account and are having difficulty logging in, contact the EPA Call Center 1-866-411-4372

ALL FIELDS ARE REQUIRED

EPA Contact Name:

EPA Contact's Email Address:   
e.g. emailId@epa.gov

EPA Contact's Phone Number:   
e.g. (xxx) xxx-xxxx

Your Information

## What do we do now that we have completed our CREAT assessment?

- Communicate our results to decision-makers
- Identify additional information to refine our assessment
- Secure funding for adaptation implementation
- Share our findings with partners, customers and other stakeholders
- Add our adaptation case study to CRWU's [Adaptation Case Study and Information Exchange](#) map



# Resilience Planning and Adaptation Training for Water and Wastewater Utilities

**Questions?**





**Resilience Planning and Adaptation Training  
for Water and Wastewater Utilities**

**Moorhead Public Service  
CREAT Assessment**

**Marc Pritchard, Moorhead Public Service**



# MPS' EPA CREAT Module Exercise

Marc Pritchard  
*Water Plant Supervisor*

---

JULY 18, 2019

# Overview

---

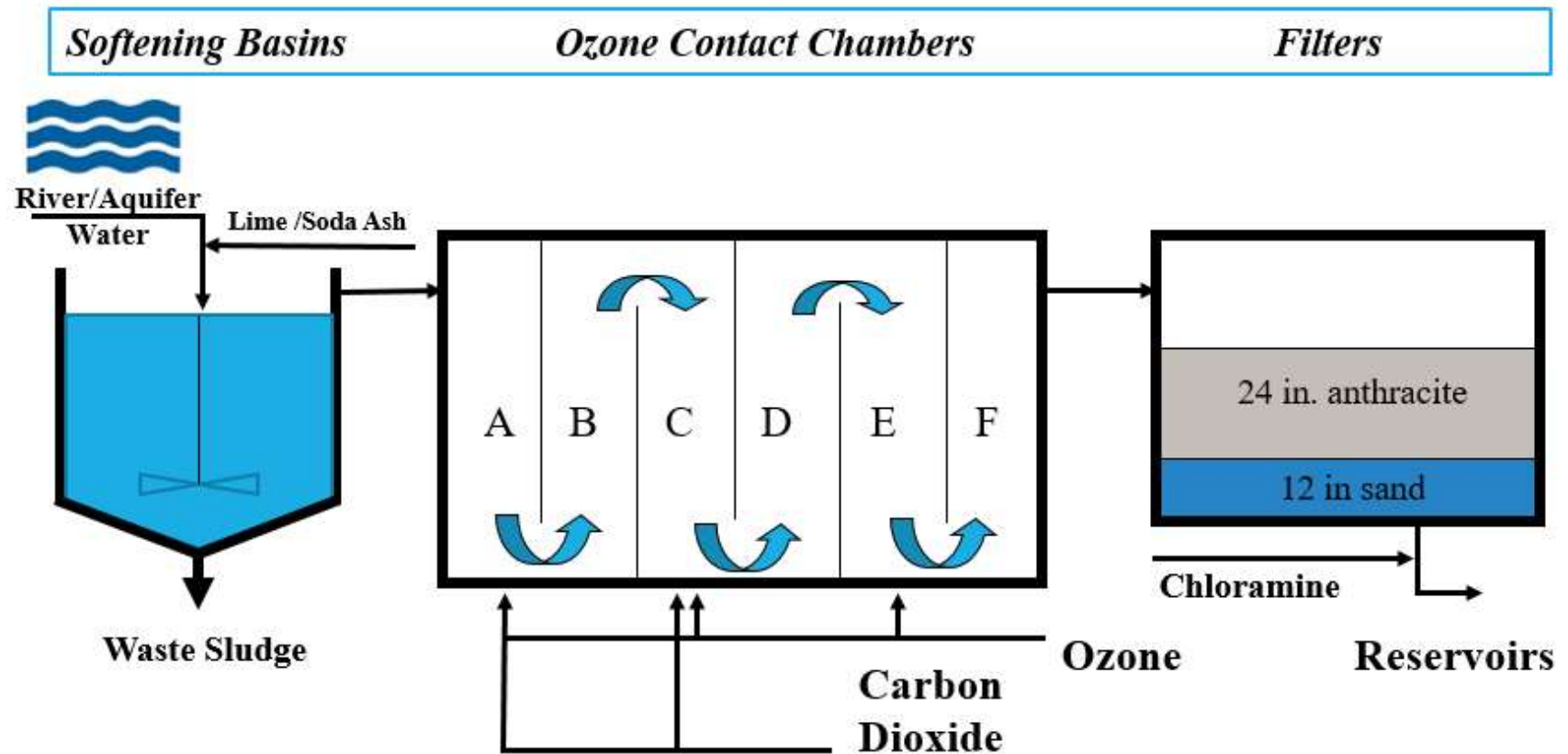
- CREAT Modules ✓
- Moorhead Public Service Water Supply
- Long-Term Water Supply (Drought) Planning
- Drought Supply Options
  - Buffalo Aquifer Expansion
- MPS CREAT Module Experience
  - Climate Awareness
  - Scenario Development
  - Consequences & Assets
  - Adaptation Planning
  - Risk Assessment

# Moorhead Public Service

---

- Moorhead Water Treatment Plant
  - Municipal utility - Public
  - Built in 1994
  - Population served: ~48,000
  - Design capacity: 10 MGD
  - Average 4.52 MGD (2018)
  
- Source water
  - ~80% - Red River of the North
  - ~20% - Moorhead and Buffalo Aquifers
  - Large variation in water quality
  
- Treatment process
  - Lime-softening, ozone disinfection, dual-media filtration, chloramination

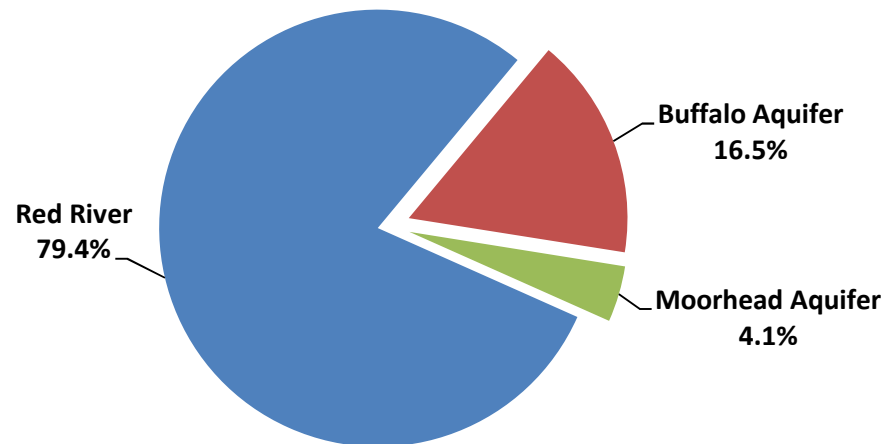
# Moorhead Public Service



# MPS Water Supply

---

- Surface Water – Red River
  - Primary Source
- Groundwater – Buffalo Aquifer and Moorhead Aquifer
  - Supplemental Source



Percent of water supplied to MHD by source (2006-2015)

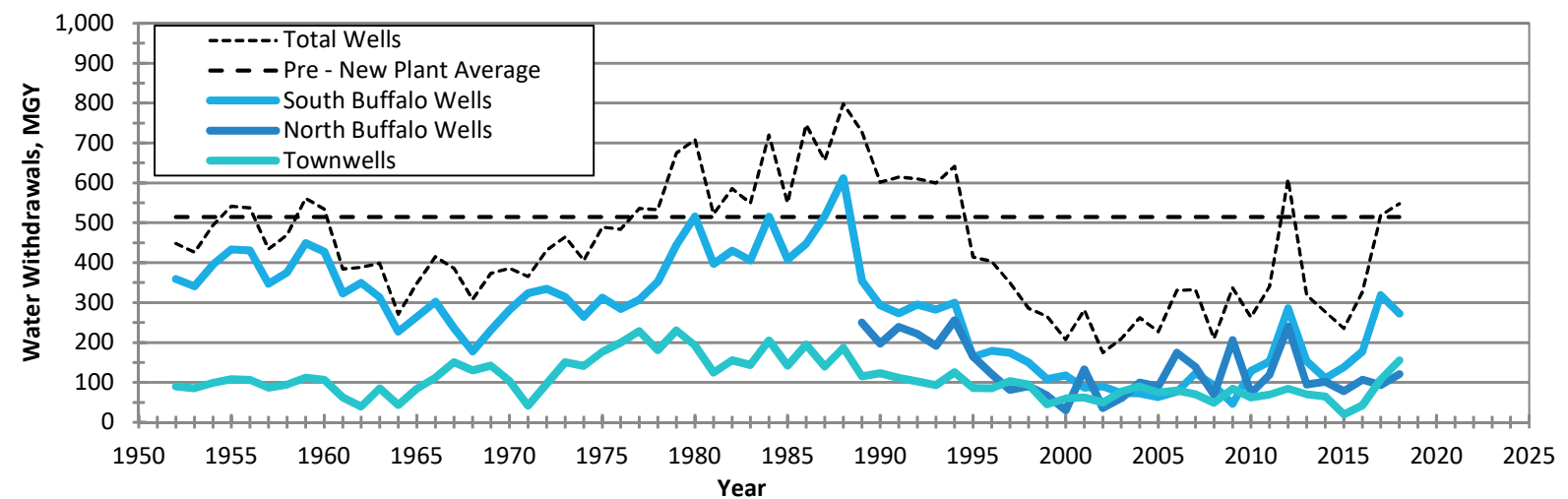
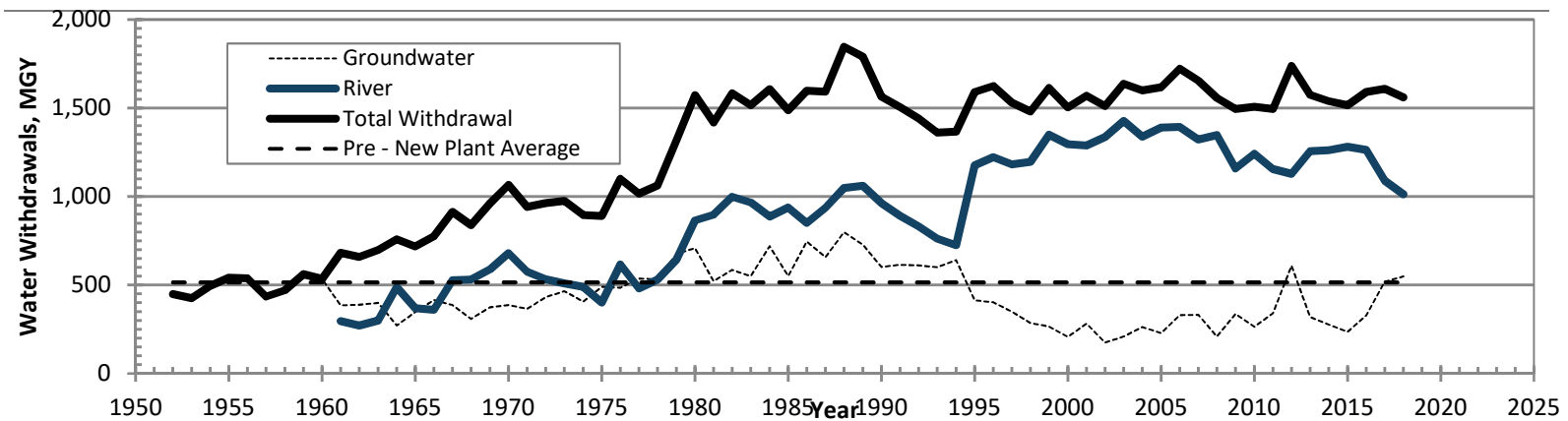
# MPS Water Supply

---

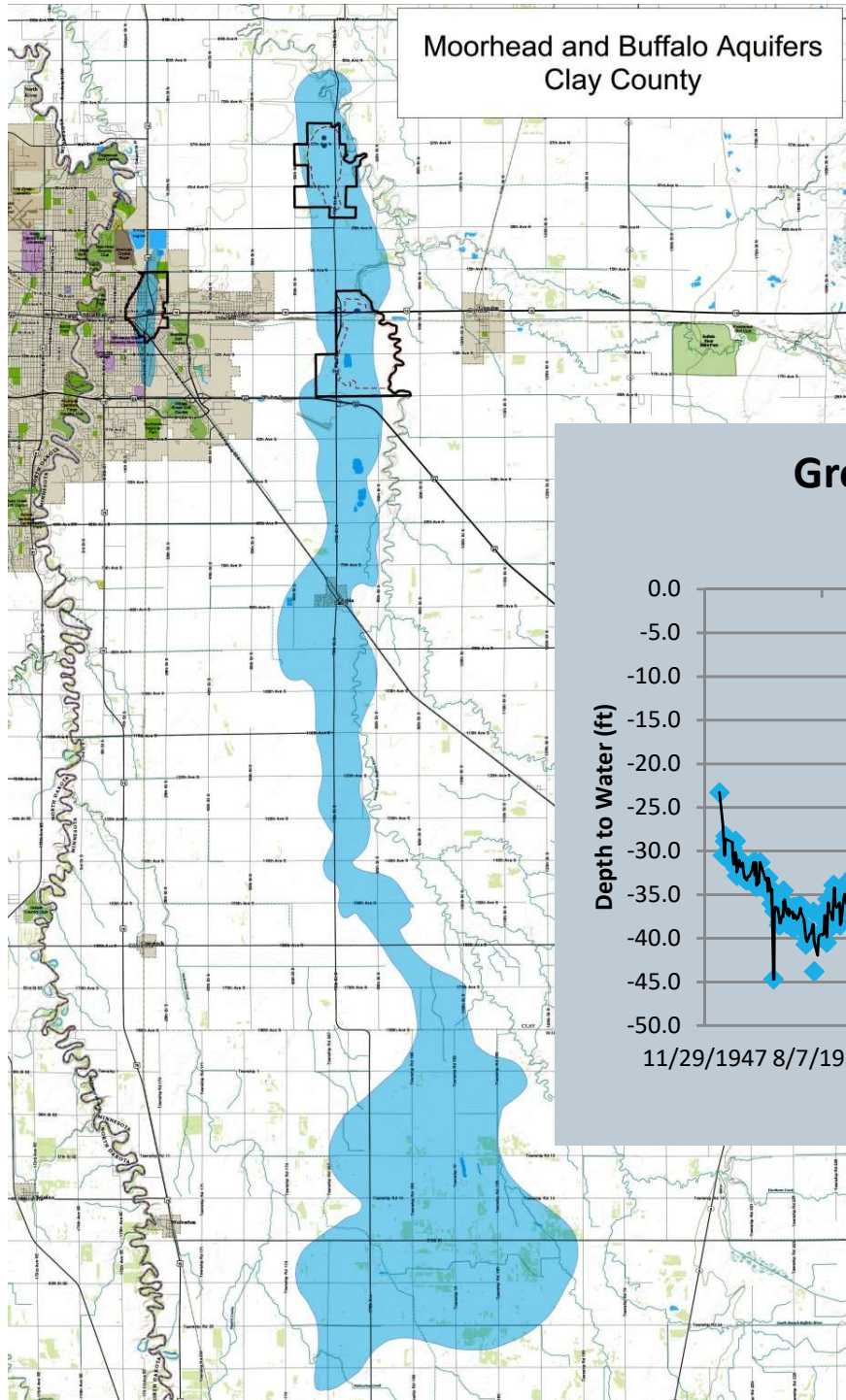
Maintain regular use of all 3 raw water sources for:

- **Drought and water shortage preparedness**
- Redundancy for Water Quality Variations
- Manage Treatment Operations
- Minimize chemical use and associated costs
- Control taste and odor events

# MPS Water Supply

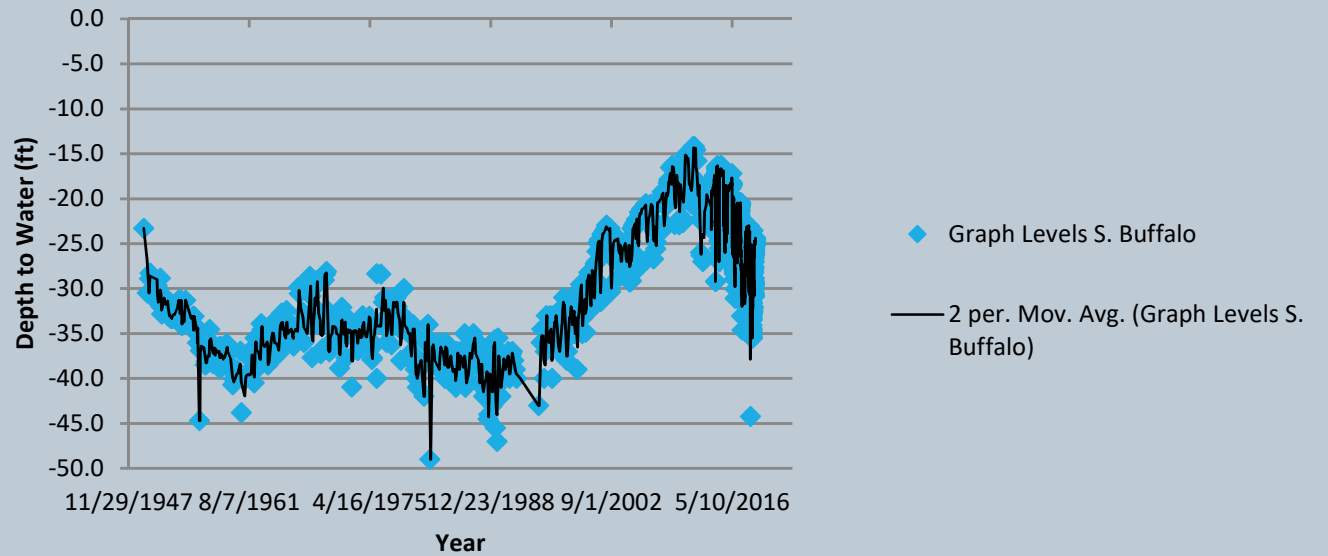




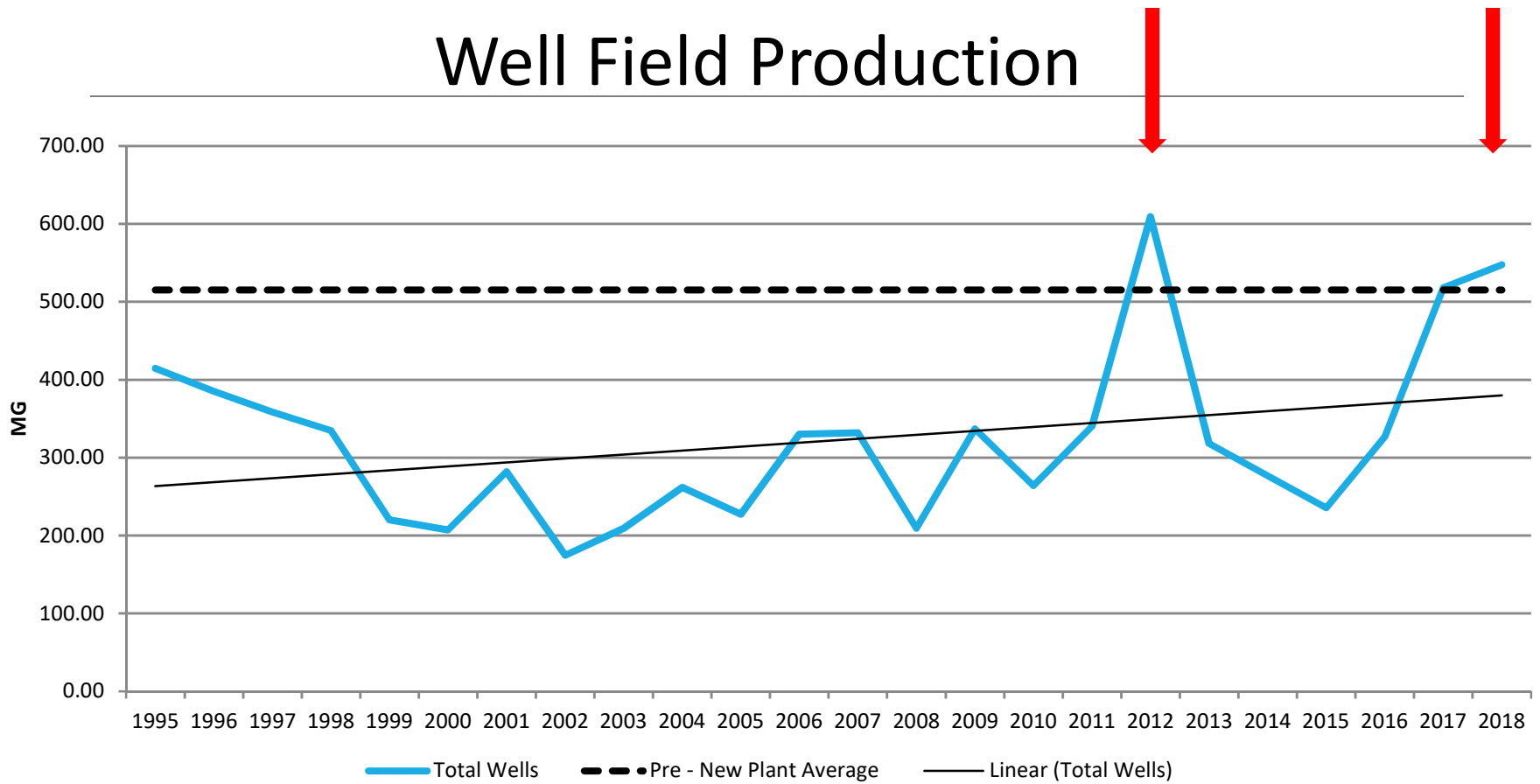


# Sustainable Utilization of the Buffalo Aquifer

## Ground Water Level in Buffalo Aquifer Near Moorhead



# Well Field Production



# MPS Raw Water Summary

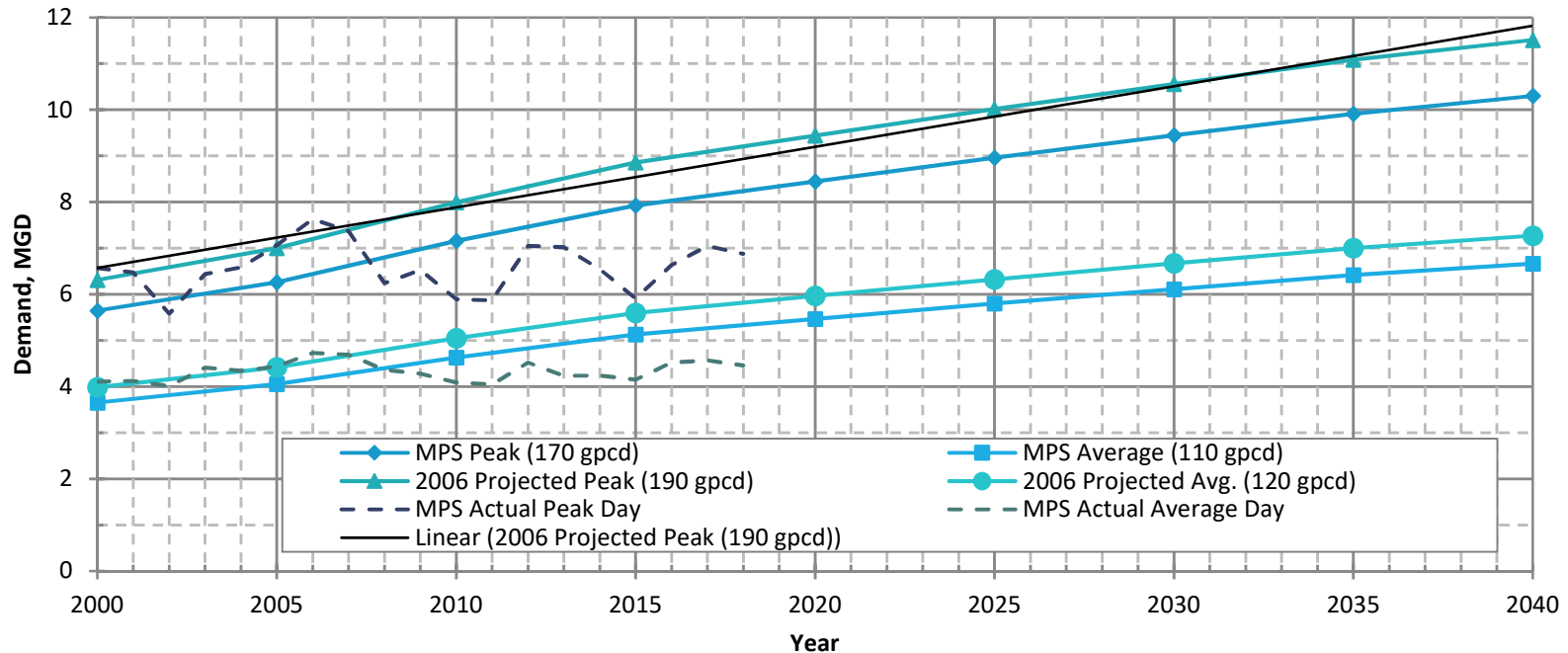
---

- Total Capacity = 12.78 MGD
- Firm Capacity = 10.53 MGD
  - (largest pump out of service)
  - Current Well Capacity of 5.5 MGD
- MN DNR has permitted 25.6 MGDe for Moorhead
  - Buffalo Aquifer wells and Red River could be expanded to provide additional water from existing sources
  - MPS is determining where additional water supply will be provided

# Moorhead Water Demand projections

MPS' peak demand is projected to surpass the current firm capacity in approximately 2040

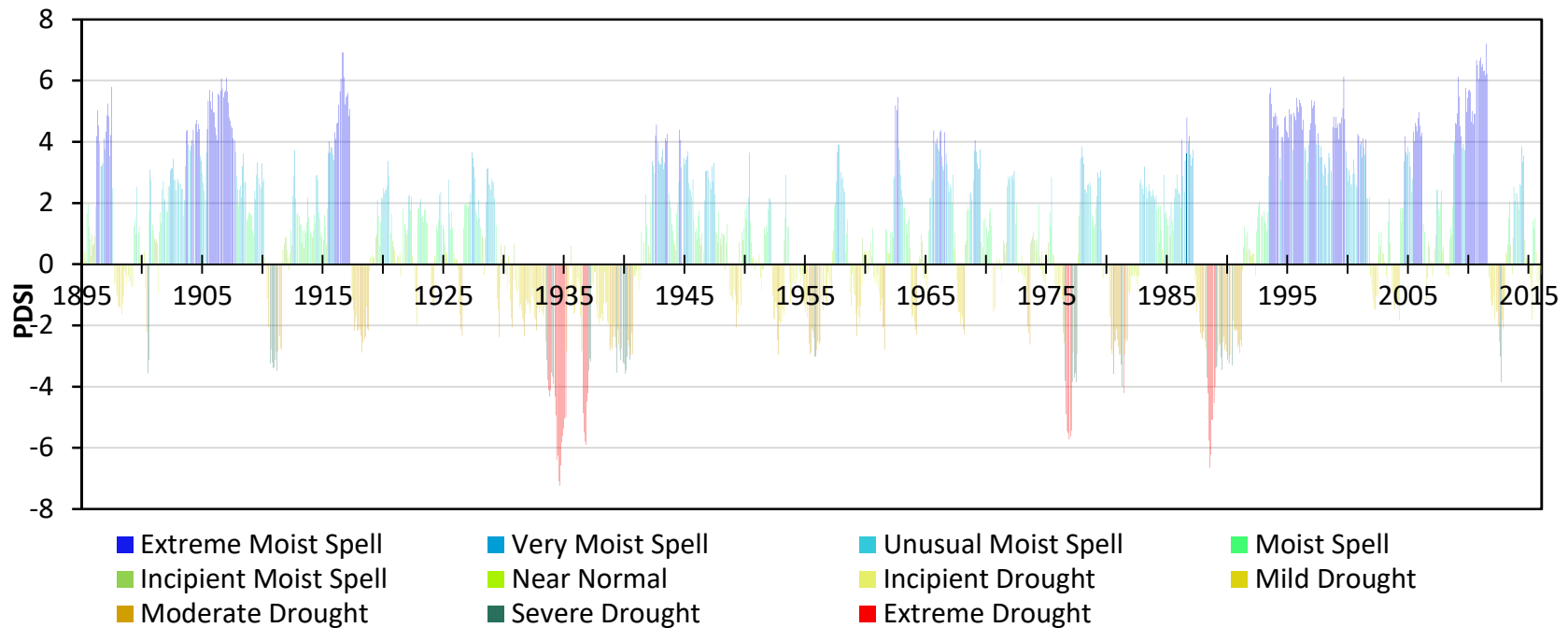
### Future Water Demands for Moorhead



# Defining Climate Threats

Lower surface water (Red River) levels driving need for increased groundwater use from Buffalo Aquifer

Lower groundwater recharge (Buffalo Aquifer)



# Defining Climate Threats

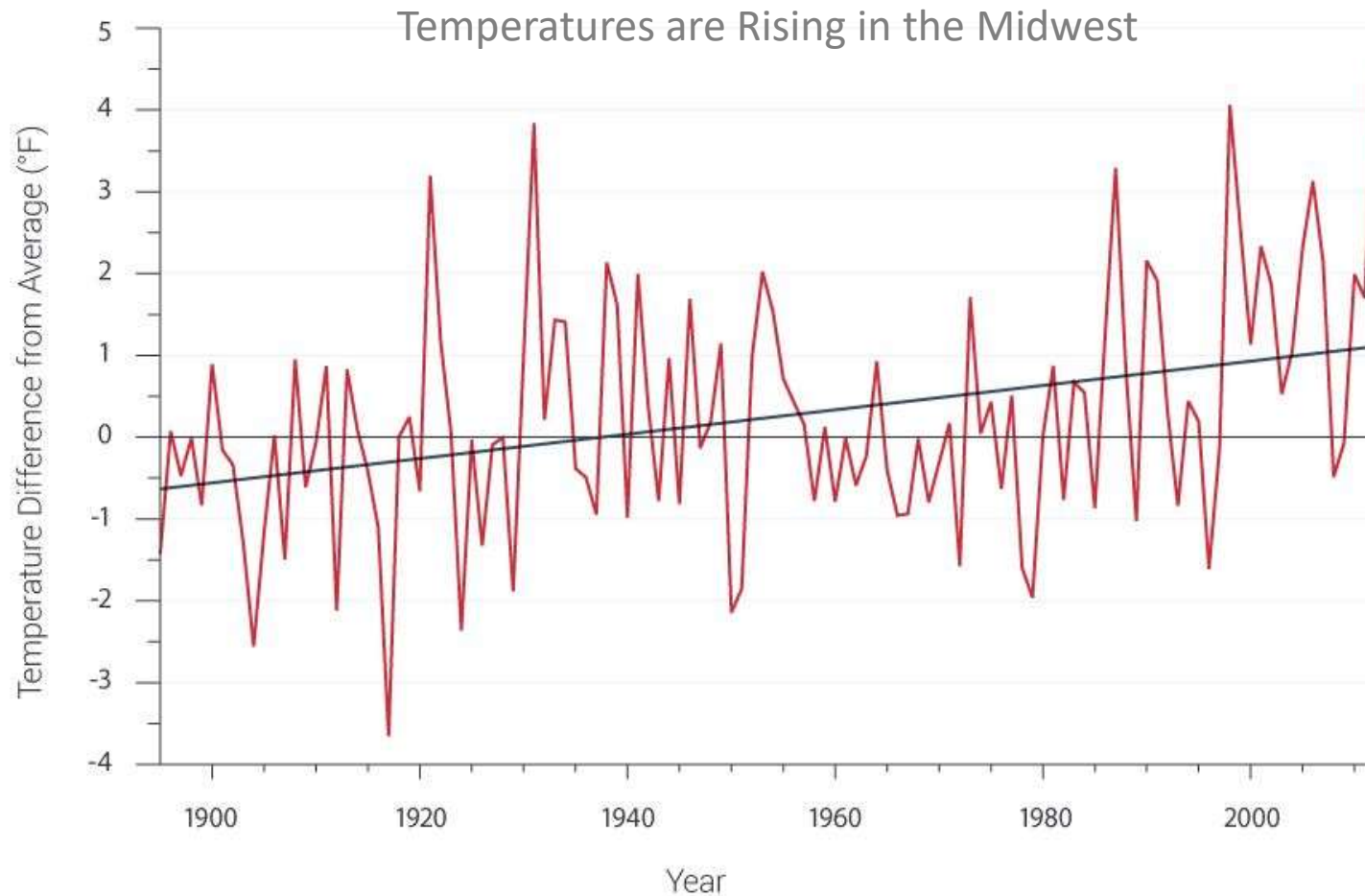


Figure 18.1: Annual average temperatures (red line) across the Midwest show a trend towards increasing temperature. The trend (heavy black line) calculated over the period 1895-2012 is equal to an increase of 1.5°F. (Figure source: updated from Kunkel et al. 2013).

# Public Health Issues

---

- Drought
  - Reduced soil moisture, groundwater, lakes, rivers, wetlands and stream flows
  - Potential concentration of pollutants
  - Decreased water supply for drinking water and agriculture
  - Fire
  
- Increased Water Temperature
  - Fish populations
  - Mercury biomagnification in predatory fish
  - Harmful Algal Blooms (HABs)
  - Invasive species
  - Increased vector born diseases (West Nile Virus, etc.)





# Extreme Heat Records

---

## ■ Boom or Bust Water Cycle

### ■ 2011

#### ■ 5 extreme heat advisories in MN

- June 6-7
- June 30-July 1
- July 16-20
- July 23
- August 1

#### ■ July 19, 2011

- State Record Heat Index of 130 degrees F set in Moorhead, MN
- 88 degree dew point with 93 degree f air temp

#### ■ Extreme heat events Increasingly driven by high dew point, not high temperature – MN Weather Almanac

- More evaporation occurs – warm air is less dense, so there is more room for water vapor
- Water holding capacity of air increases 7% per degree C – part of the reason for higher statistical likelihood of higher intense storms with more precipitation overall, but less source water recharge
- Humidity – function of temp and water vapor in atmosphere → affects skin's ability to evaporate moisture (sweat) to cool the body

# Extreme Heat Events (drought)

**HEAT INDEX (HI):** A measure of how hot it really feels when relative humidity is factored in with the actual air temperature.

NOAA's National Weather Service Heat Index  
Temperature (°F)

|     | 80 | 82 | 84  | 86  | 88  | 90  | 92  | 94  | 96  | 98  | 100 | 102 | 104 | 106 | 108 | 110 |
|-----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 40  | 80 | 81 | 83  | 85  | 88  | 91  | 94  | 97  | 101 | 105 | 109 | 114 | 119 | 124 | 130 | 136 |
| 45  | 80 | 82 | 84  | 87  | 89  | 93  | 96  | 100 | 104 | 109 | 114 | 119 | 124 | 130 | 137 |     |
| 50  | 81 | 83 | 85  | 88  | 91  | 95  | 99  | 103 | 108 | 113 | 118 | 124 | 131 | 137 |     |     |
| 55  | 81 | 84 | 86  | 89  | 93  | 97  | 101 | 106 | 112 | 117 | 124 | 130 | 137 |     |     |     |
| 60  | 82 | 84 | 88  | 91  | 95  | 100 | 105 | 110 | 116 | 123 | 129 | 137 |     |     |     |     |
| 65  | 82 | 85 | 89  | 93  | 98  | 103 | 108 | 114 | 121 | 128 | 136 |     |     |     |     |     |
| 70  | 83 | 86 | 90  | 95  | 100 | 105 | 112 | 119 | 126 | 134 |     |     |     |     |     |     |
| 75  | 84 | 88 | 92  | 97  | 103 | 109 | 116 | 124 | 132 |     |     |     |     |     |     |     |
| 80  | 84 | 89 | 94  | 100 | 106 | 113 | 121 | 129 |     |     |     |     |     |     |     |     |
| 85  | 85 | 90 | 96  | 102 | 110 | 117 | 125 | 135 |     |     |     |     |     |     |     |     |
| 90  | 86 | 91 | 98  | 105 | 113 | 122 | 131 |     |     |     |     |     |     |     |     |     |
| 95  | 86 | 93 | 100 | 108 | 117 | 127 |     |     |     |     |     |     |     |     |     |     |
| 100 | 87 | 95 | 103 | 112 | 121 | 132 |     |     |     |     |     |     |     |     |     |     |



Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution
  Extreme Caution
  Danger
  Extreme Danger

37



These storms started out producing large hail and a few funnel clouds, then transitioned to bow echoes and 60 to 70 mph winds. These strong winds hit the Fargo-Moorhead area as well as the Fergus Falls, Minnesota area.



# A Resilient Utility

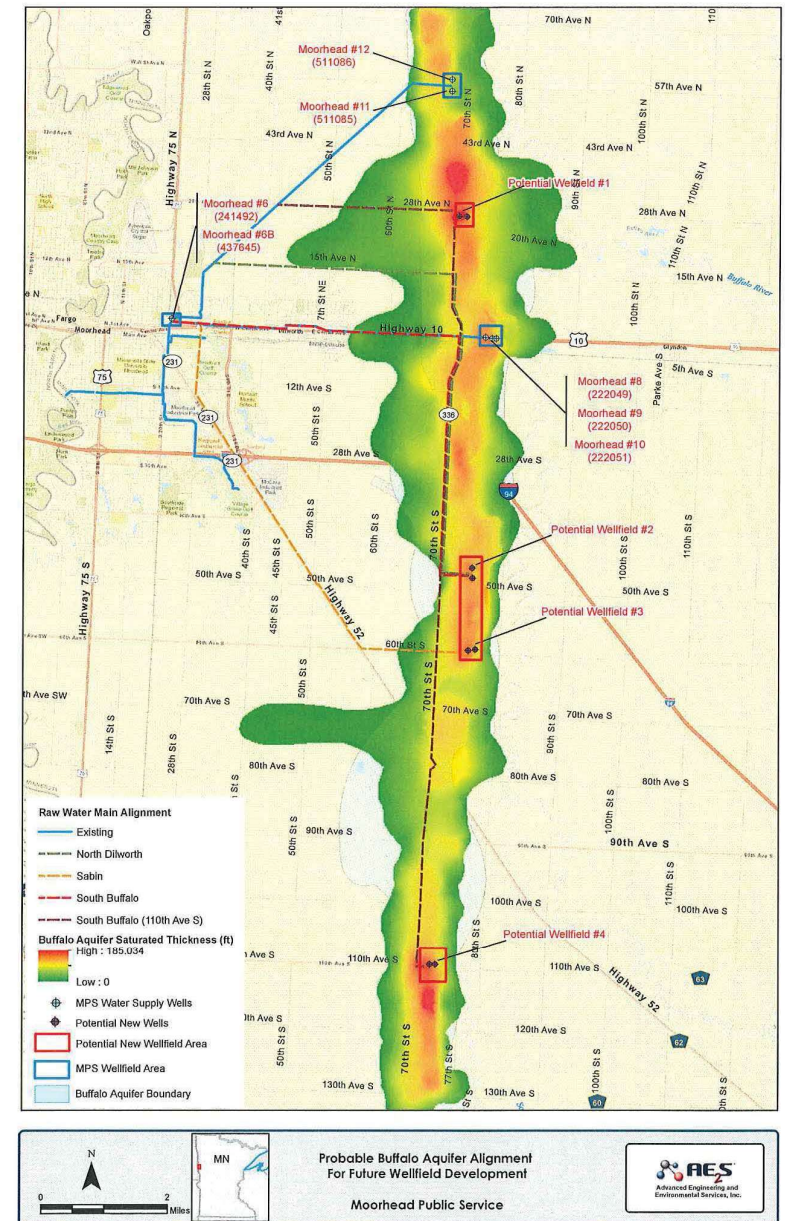
---

- To prepare for potential drought conditions and the corresponding climate impacts, MPS initiated the development of a Buffalo Aquifer Management Plan to develop drought management strategies and evaluate the feasibility of a **Buffalo Aquifer Expansion Project** for the sustainable usage of the aquifer during a drought.
- The operational strategy used at the current WTP has helped MPS reserve groundwater supplies for extended drought conditions in the Red River Valley and periods of contaminated water quality conditions on the Red River.



# CREAT Experience

- Series of computer modules designed to compare risks to costs of adaptive measures
- Can evaluate specified threats a utility can face to operational resiliency
- MPS' modules centered around the **Buffalo Aquifer Expansion Project** as outlined in the **Buffalo Aquifer Management Plan**
- Focused on source waters and pumping and conveyance systems in CREAT



# Climate Issues by Region

CREAT 3.0 CLIMATE RESILIENCE EVALUATION & AWARENESS TOOL

GET STARTED RESOURCES HELP


xmpritch EPA

- Climate Awareness
  - Utility Information
  - Utility Location
  - Climate Change Basics
  - Current Concerns
  - Awareness Summary
- Scenario Development
- Consequences & Assets
- Adaptation Planning
- Risk Assessment

Moorhead\_1553010949358

## Climate Change Basics

Click on any region in the map below to learn about climate change impacts in that area. You can also review national or coastal climate impacts and learn about how climate change is expected to impact a specific sector by clicking on the Topic Links.



Map labels: Northwest, Coasts, Southwest, Alaska, Islands, Great Plains, Midwest, Northeast, Southeast.

Climate Awareness Module

### Topic Links

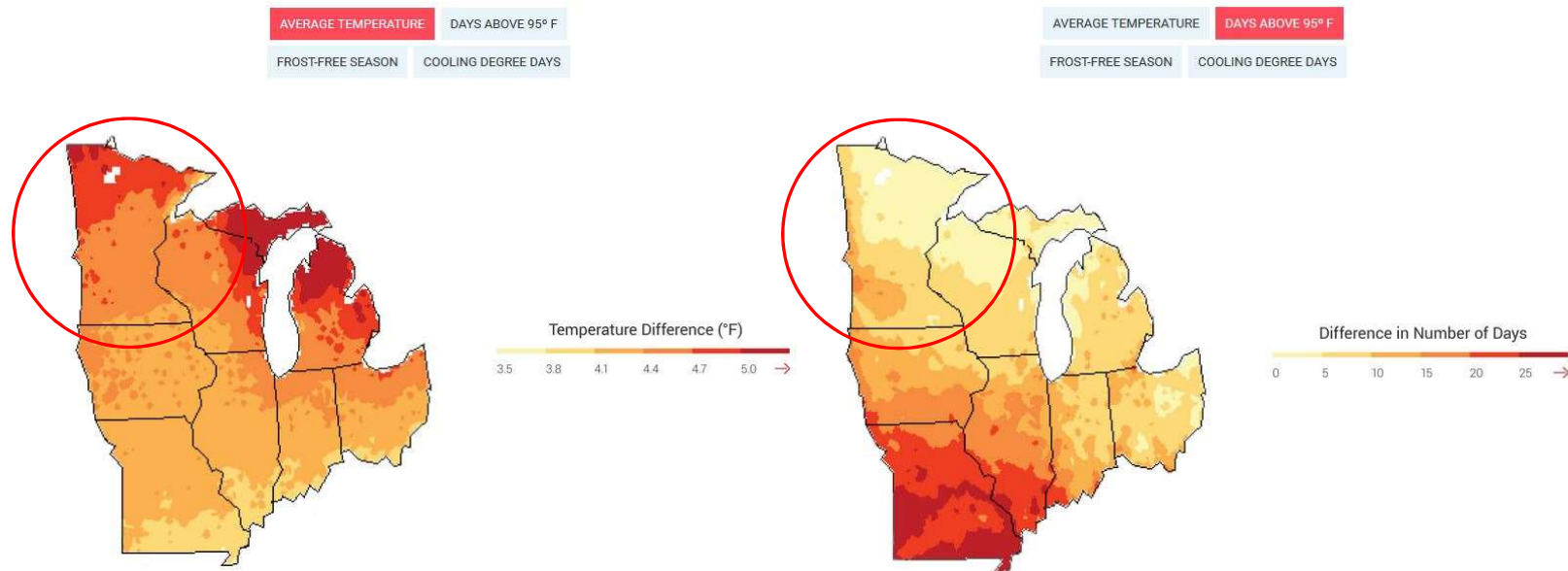
Note: Map and Topic Links open in a new window or tab in your web browser.

- National
- Sea Level Rise
- Agriculture
- Human Health
- Coasts
- Water
- Transportation
- Rural Communities
- Extreme Weather
- Energy
- Forest
- Ecosystems

Back Continue >

# Climate Issues by Region

## Projected Climate Changes

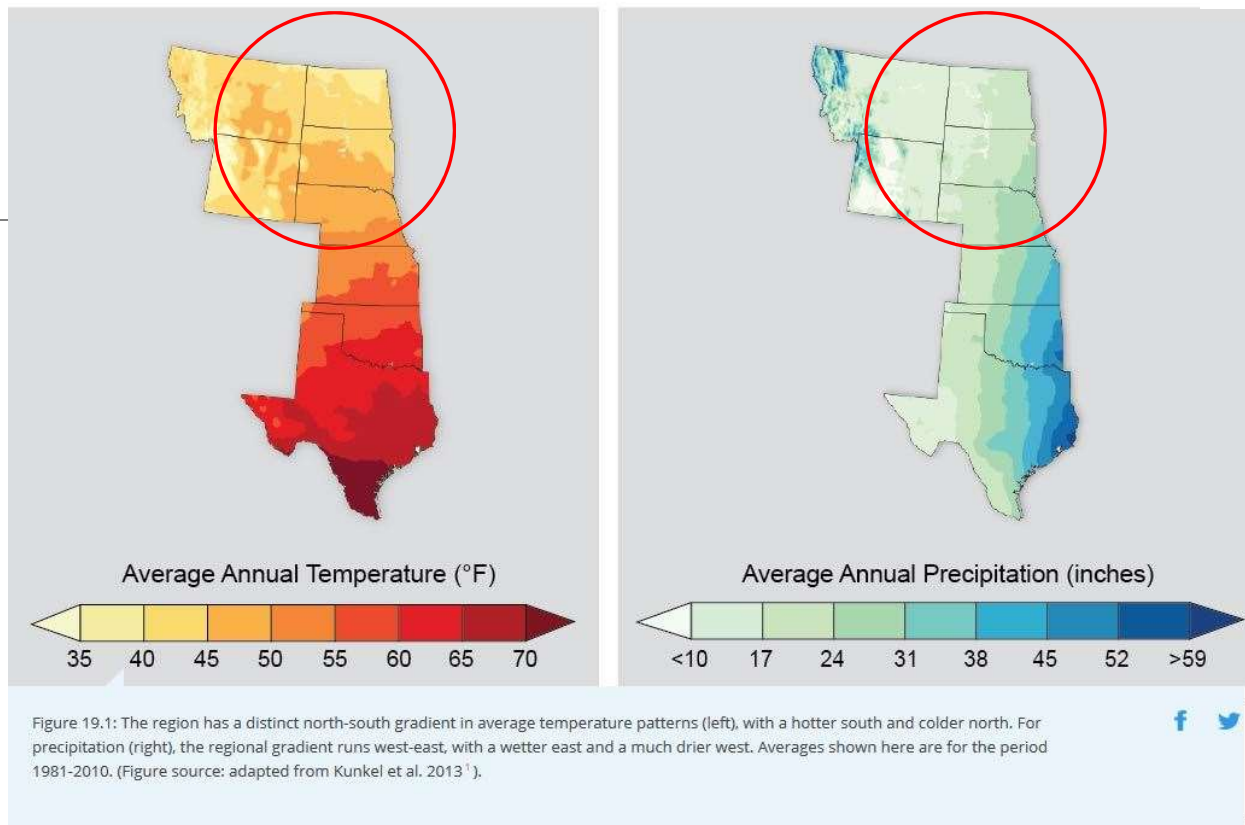


- Generally, annual precipitation increased during the past century (by up to 20% in some locations), with much of the increase driven by intensification of the heaviest rainfalls (Pryor et al. 2009). This tendency towards more intense precipitation events is projected to continue in the future (Schoof et al. 2010). **Precipitation is projected to increase in winter, spring and fall, but decrease in the summer, and the average number of days each year without precipitation is expected to increase.**
- Heat waves are anticipated to be more frequent, more severe and longer in duration

Figure 18.2: Projected increase in annual average temperatures by mid-century (2041-2070) as compared to the 1971-2000 period tell only part of the climate change story. Maps also show annual projected increases in the number of the hottest days (days over 95°F), longer frost-free seasons, and an increase in cooling degree days, defined as the number of degrees that a day's average temperature is above 65°F, which generally leads to an increase in energy use for air conditioning. Projections are from global climate models that assume emissions of heat-trapping gases continue to rise (A2 scenario). (Figure source: NOAA NCDC / CICS-NC).



## Temperature and Precipitation Distribution in the Great Plains



- Projections of increasing temperatures, faster evaporation rates and more sustained droughts brought on by climate change will only add **more stress to overtaxed water sources**.
- Projected **increases in precipitation are unlikely to be sufficient to offset decreasing soil moisture** and water availability in the Great Plains, due to rising temperatures and aquifer depletion.
- **More frequent extreme events, such as heat waves, droughts, snow and heavy rainfall are projected to occur.**
- North Dakota's increase in annual temperature over the past 130 years is the fastest in the contiguous U.S. and is mainly driven by warming winters.

# Scenario Development

---

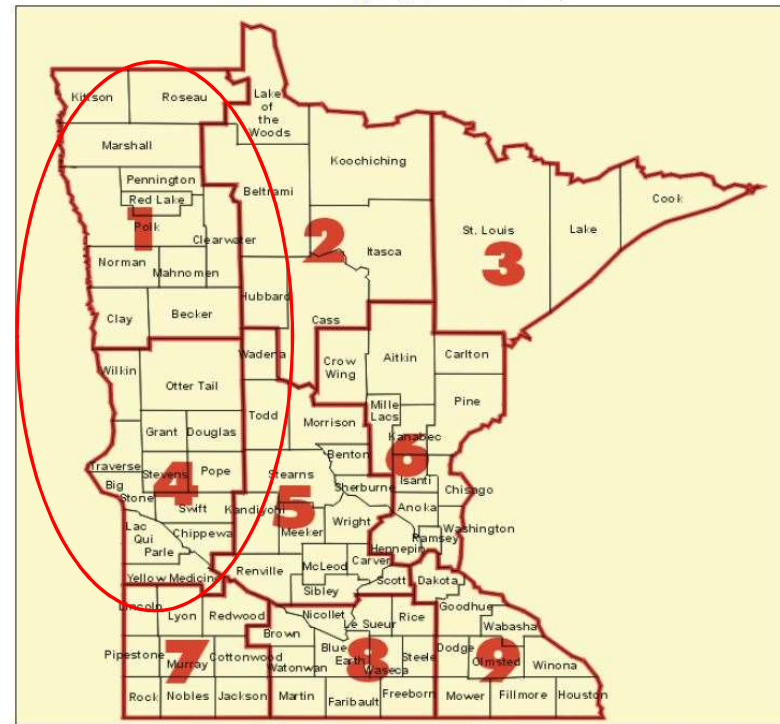
- Goal is to identify and define climate **threats** you want to consider based on the current concerns identified in the Climate Awareness module
- Review historical climate conditions provided by CREAT for your location, such as temperature, precipitation and storm events (stock data)
- Stock data helps you to understand how these conditions drive selected threats. This historical climate data is used to build a **Baseline Scenario** for comparison with scenarios of future climate conditions.
- MPS used customized location – specific data from Buffalo AMP for drought scenario development
  - CREAT (PRISM data from 1981-2010) vs MPS Drought Model data
  - Used CREAT default values for the 100-year intense precipitation event and annual number of hot days for analysis

# Scenario Development: Buffalo AMP Data Regions

North Dakota (Regions 6 and 9):



Minnesota (Regions 1 and 4):



South Dakota (Region 3):



# Scenarios Identified

---

## ■ **Baseline Scenario**

- **Reduced groundwater recharge of the Buffalo Aquifer and streamflow for the Red River and Buffalo River.**
- Decreased surface water supplies and groundwater recharge
- MPS compared their climate records with the default CREAT data (PRISM data from 1981-2010)
  - Custom data used for Baseline Scenario
  - Default CREAT values used for the intense precipitation event and a range of metrics for annual number of hot days.

## ■ **Hotter & Drier Scenario**

- **Reduced groundwater recharge for the Buffalo Aquifer and reduced streamflow for the Red River and Buffalo River.**
- Decreases in summer-month precipitation will decrease surface water supplies and groundwater recharge. Related potential factors include:
  - increased reliance on groundwater to meet demand;
  - increased demand due to increasing temperatures;
  - increased strain on groundwater resources due to increased agriculture increases; and
- decreased ability to meet peak demand due to insufficient groundwater pumping capacity.

- Note: Both scenarios baseline and hot & dry required monthly temperature, precipitation, 100-year intense precipitation events (inches in 24 hrs), number of hot days above 90, 95, & 100 (annually, degrees F)

# Scenario: Custom Baseline (2019-2060)

## Baseline Scenario



CREAT TIP



The Baseline Scenario is composed of historical climate variables based on observations from near your location, like average temperature, total precipitation and extreme events. These climate conditions define the threats you may be experiencing today and will continue to face even with minimal climate change. Understanding your baseline climate conditions will help you consider how projected future changes in these conditions might alter your threats and ultimately place your assets and water resources at risk.

## Baseline Scenario

Review the **Baseline Scenario** for your location below. Click "Edit Scenario" to update the values seen in the table or add additional measurements for consideration. If you do not wish to change the data, click "Continue."

If you do not see the Number of Hot Days in the table below, the default or currently selected climate station does not have this data available. To add this data, edit the Baseline Scenario and either change the Climate Station or add the data based on your records or other data sources under Other Conditions. To review stations that have Hot Days data, visit the [CREAT Projection Map](#).



Baseline Scenario

| Baseline Scenario: Historical Data |       |            |        | <a href="#">VIEW SCENARIO</a> |
|------------------------------------|-------|------------|--------|-------------------------------|
| MEASUREMENT                        | VALUE | UNITS      | SOURCE |                               |
| Average Annual Temperature         | 40.63 | Fahrenheit | Custom |                               |
| Average January Temperature        | 7.03  | Fahrenheit | Custom |                               |
| Average February Temperature       | 11.65 | Fahrenheit | Custom |                               |

# Scenario: Hotter & Drier (2019-2060)

Moorhead\_1553010949358

Scenario Development Module

## Projected Scenarios



### Hotter & Drier

Click "Add Scenario" to build a new scenario. You should include at least one scenario, in addition to the Baseline Scenario, to continue your assessment.

As you develop scenarios, consider the projection data provided in CREAT as a basis for your threat definitions. **Each value shown as a projection in the table below is based on an average of those climate model results that represent each of the possible climate futures provided.** These projections are provided to illustrate the future range of potential changes in climate; no single scenario is more likely to occur than any other.

+ Add Scenario



Baseline Scenario



Hotter & Drier

| Hotter & Drier (2060):<br>Hotter And Drier Future Conditions |       |            |        | <a href="#">VIEW SCENARIO</a> |
|--|-------|------------|--------|-------------------------------|
| MEASUREMENT  | VALUE | UNITS      | SOURCE |                               |
| Annual Change In Temperature                                 | 7.43  | Fahrenheit | CREAT  |                               |
| January Change In Temperature                                | 9.07  | Fahrenheit | CREAT  |                               |
| February Change In Temperature                               | 8.93  | Fahrenheit | CREAT  |                               |
| March Change In Temperature                                  | 6.88  | Fahrenheit | CREAT  |                               |
| April Change In Temperature                                  | 6.03  | Fahrenheit | CREAT  |                               |



# Scenario Development - Selections



Water Supply Management



Water Quality Management



Natural Disasters

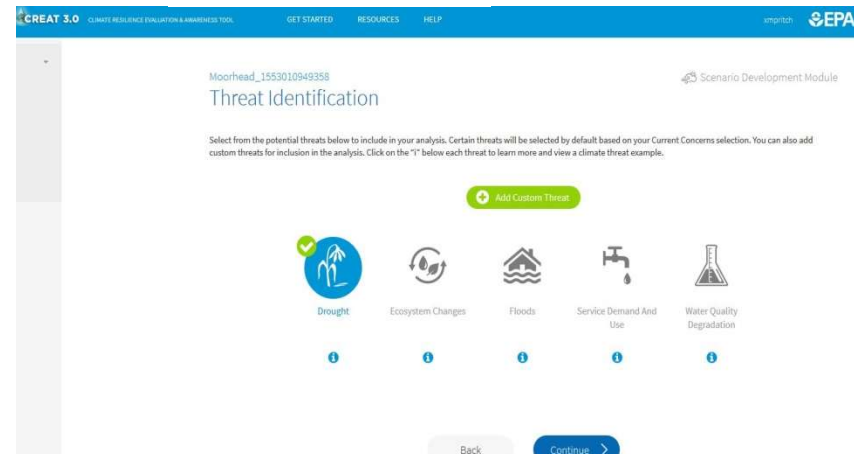
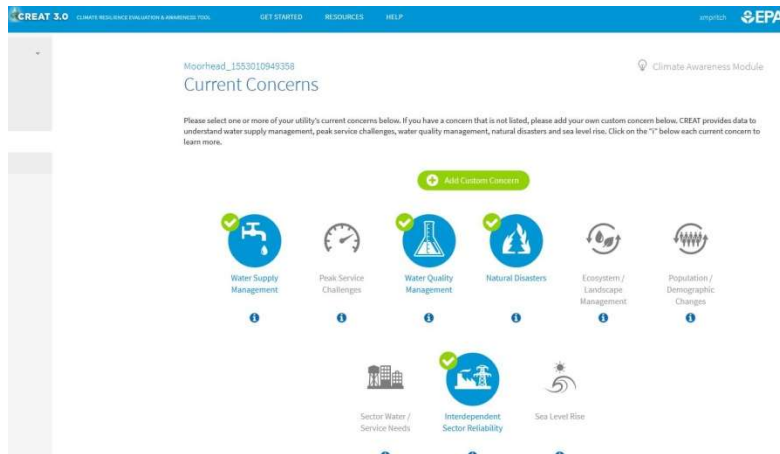


Interdependent Sector Reliability



Drought

Threat Selected



- Able to select utility concerns and specific threats for Risk Assessment in the Module
- Used customized location – specific data in place of baseline historical data provided by CREAT
  - Purpose was to more closely align efforts with completed MPS Drought Model

# Scenario Summary

---

## ■ Hotter & Drier

- Decreases in summer-month precipitation will decrease surface water supplies and groundwater recharge, especially impacting utilities that rely on groundwater supplies.
- Related potential factors include:
  - increased reliance on groundwater to meet demand;
  - increased demand due to increasing temperatures;
  - increased strain on groundwater resources due to increased agriculture increases; and
  - decreased ability to meet peak demand due to insufficient groundwater pumping capacity.



| Climate Station: MOORHEAD<br>Custom Baseline Scenario |       |             |        | Climate Station: MOORHEAD<br>Hotter & Drier |        |            |       |
|---|-------|-------------|--------|---|--------|------------|-------|
| Ave Annual Temp                                       | 40.63 | Fahrenheit  | Custom | Annual Change in temp                       | 7.43   | Fahrenheit | CREAT |
| Ave May Temp  | 54.8  | Fahrenheit  | Custom | May Change in temp                          | 5.93   | Fahrenheit | CREAT |
| Ave June Temp   | 64.48 | Fahrenheit  | Custom | June Change in temp                         | 6.58   | Fahrenheit | CREAT |
| Ave July Temp   | 69.99 | Fahrenheit  | Custom | July Change in temp                         | 8.14   | Fahrenheit | CREAT |
| Ave August Temp                                       | 67.76 | Fahrenheit  | Custom | August Change in temp                       | 7.64   | Fahrenheit | CREAT |
| Ave September Temp                                    | 57.73 | Fahrenheit  | Custom | September Change in temp                    | 7.22   | Fahrenheit | CREAT |
| Total Annual Precipitation                            | 21.21 | Inches      | Custom | Annual Change in precip                     | 1.56   | %          | CREAT |
| Total May Precip                                      | 2.68  | Inches      | Custom | May Change in precip                        | 4.49   | %          | CREAT |
| Total June Precip                                     | 3.74  | Inches      | Custom | June Change in precip                       | -8.13  | %          | CREAT |
| Total July Precip                                     | 3.06  | Inches      | Custom | July Change in precip                       | -17.41 | %          | CREAT |
| Total August Precip                                   | 2.7   | Inches      | Custom | August Change in precip                     | -15.82 | %          | CREAT |
| Total September Precip                                | 2.16  | Inches      | Custom | September Change in precip                  | -0.81  | %          | CREAT |
| 100-year Intense Precipitation Event                  | 7.23  | Inches/24hr | CREAT  | Change in 100-year Intense Precipitation    | 25.75  | %          | CREAT |
| Annual Number of hot days over 90 °F                  | 7.4   | Days        | CREAT  | Annual Number of hot days over 90 °F        | 43.73  | Days       | CREAT |
| Annual Number of hot days over 95 °F                  | 0.93  | Days        | CREAT  | Annual Number of hot days over 95 °F        | 16.47  | Days       | CREAT |
| Annual Number of hot days over 100 °F                 | 0     | Days        | CREAT  | Annual Number of hot days over 100 °F       | 3.87   | Days       | CREAT |

# Consequences and Assets

---

- Identified the types of threats that may impact MPS and selected data that defines scenarios of threats based on different changes in climate conditions at your location. Next, you need to determine which types of consequences you might expect if these threats were to occur.
- Utility Business Impacts
- Utility Equipment Damage
- Environmental Impacts
- Source/Receiving Water Impacts

## Economic Consequence Matrix for Moorhead Public Service

| Levels           | Utility Business Impacts  | Utility Equipment Damage  | Environmental Impacts  | Source/Receiving Water 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. | 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. | 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. | 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. |
| <b>Very High</b> | Long-term or significant loss of expected revenue or operating income   | Complete loss of raw water pumps and transmission mains   | Significant environmental damage   | Long-term compromise of source water quality or quantity  |
|                  | > \$1,246,500   | > \$120,000   | > \$173,880  | > \$1,181,280   |
| <b>High</b>      | Seasonal or episodic compromise of expected revenue or operating income   | Significant wear to raw water pumps and transmission mains  | Persistent environmental damage  | Seasonal or episodic compromise of source water quality or quantity   |
|                  | \$832,500 - \$1,246,500   | \$80,000 - \$120,000  | \$72,680 - \$173,880   | \$492,200 - \$1,181,280   |
| <b>Medium</b>    | Minor and short-term reductions in expected revenue   | Minor wear to raw water pumps and transmission mains  | Short-term damage, compliance can be quickly restored  | Temporary impact on source water quality or quantity  |
|                  | \$414,000 - \$832,500   | \$40,000 - \$80,000   | \$28,980 - \$72,680  | \$196,880 - \$492,200   |
| <b>Low</b>       | Minimal potential for loss of revenue or operating income   | Minimal wear to raw water pumps and transmission mains  | No impact or environmental damage  | No more than minimal changes to water quality   |
|                  | \$0 - \$414,000   | \$0 - \$40,000  | \$0 - \$28,980   | \$0 - \$196,880   |

Note: values based on water sector survey data and calculated using the utility type, population served, total daily flow, public vs private ownership, and financial condition, with input and adjustment by MPS

## Public Health Consequences

Do you wish to consider public health consequences for this analysis file?

Yes No

CREAT provides defaults for the Value of Statistical Life (VSL) and the Value of Statistical Injury (VSI) to analyze public health impacts. You can customize these values, if desired.

**Value of statistical life:**

\$7,900,000

VSL is the value attributed to each fatality assessed due to the occurrence of a threat to a particular asset. A default value of \$7,900,000 is provided based on [Guidelines for Preparing Economic Analyses](#).

**Value of statistical injury:**

\$79,000

VSI is the value attributed to each injury assessed due to the occurrence of a threat to a particular asset. A default value of \$79,000 is provided based on [Guidelines for Preparing Economic Analyses](#).

Back

Continue >

# Asset Definition

---

- Prioritize those assets that are particularly vulnerable to the threats you have defined. Think about your assets and how you might group them together based on their thresholds for specific impacts.
  - Surface Water – Red River of the North
  - Ground Water – **Buffalo Aquifer**
  - Pumps and Conveyance Systems for Transport and Treatment

# Adaptive Measures

---

## Existing

- Multiple Well Fields along Buffalo Aquifer
- Identified Drought Management Stages corresponding to Water Supply Plan Action Levels
- New River Pump Station (2013)
- Limited storage of Surface Water
- Full Maintenance and Rehabilitation of All Well Houses Complete in 2018

## Potential

- Increase Buffalo Aquifer Capacity (Included in Assessment)
- Replace existing raw groundwater transmission mains
- Regular inspection and annual statistical analysis of individual well production and performance (specific capacity)
- Concerted Public Outreach Efforts



| PLAN NAME                   | RELEVANT THREATS | TOTAL COST                  |
|-----------------------------|------------------|-----------------------------|
| Current Measures            | Drought          | \$3,600,000                 |
| Increase capacity & storage | Drought          | \$22,760,000 - \$22,790,000 |

Table D-1. Existing Adaptive Measures at MPS

| EXISTING ADAPTIVE MEASURE        | DESCRIPTION  | TOTAL COST  |
|----------------------------------|--|-------------|
| <b>Buffalo Aquifer</b>           | The Buffalo Aquifer was developed to augment and supplement water supply when water availability decreased from the Red River. Currently, there are 2 separate well fields (North Buffalo and South Buffalo).  | \$0         |
| <b>Demand Management</b>         | MPS has documented Drought Stages and corresponding drought management actions.  | \$0         |
| <b>Lime Sludge Storage Ponds</b> | Currently 3-5 weeks of supply are stored in the ponds, considering a raw water pumping rate of 290 gpm; storage capacity decreases as lime sludge volumes increase. There are 12 storage ponds.  | \$0         |
| <b>New Intake Construction</b>   | A new intake and complete river pumping station were constructed 2012-2013; they are resilient to a 500-year flood level (~45 ft). The intake has been relocated from the river bank to the channel at the center of the river. This will allow water to be withdrawn even under low flow conditions seen during drought. MPS used FEMA funds (pre-disaster mitigation funds) for the project. | \$3,600,000 |

| PLAN NAME                   | RELEVANT THREATS | TOTAL COST                  |
|-----------------------------|------------------|-----------------------------|
| Current Measures            | Drought          | \$3,600,000                 |
| Increase capacity & storage | Drought          | \$22,760,000 - \$22,790,000 |

Table D-2. Potential Adaptive Measures at MPS

| POTENTIAL ADAPTIVE MEASURE  | DESCRIPTION  | ESTIMATED COST        |
|---|--|-----------------------|
| Improve Buffalo Aquifer Capacity – Construct Potential Wellfield #2 | Buffalo Aquifer developed to augment and supplement water supply when availability decreased from the Red River.<br>2 Separate wellfields (North and South)<br><br>Construct Potential Wellfield #2<br>Total cost = \$20,400,000<br>Annualized Cost (not including Annual O&M) = \$1,108,600   | \$1,108,600           |
| Annual O&M of New Well Field on Southern Buffalo Aquifer            | Once constructed, annual Operation and Maintenance costs for the Southern Buffalo Aquifer (New Well Field #2) are estimated.   | \$30,000 - \$40,000   |
| Improvement of Lime Sludge Storage Ponds – Add De-Watering Facility | Construct de-watering facility \$6.4-6.8 million (total cost). Could then move water directly from the river to the ponds; increases total capacity to store water. Based on cost/benefit calculated, MPS opted to construct the facility rather than pay for dredging, de-watering, and disposal costs every three years (around \$1.2 million per pond each time). | \$410,000 - \$440,000 |



# Risk Assessment Results

Figure 2a. Monetized Risk Reduction for the Increase Capacity Adaptation Plan Under a Hotter and Drier Future Conditions Scenario

## Red River of the North



# Risk Assessment Results

Figure 2b. Monetized Risk Reduction for the Increase Capacity Adaptation Plan Under a Hotter and Drier Future Conditions Scenario

## Buffalo Aquifer



# Likelihood Sensitivity



Figure 3. Likelihood Range for Analysis of Adaptation Plan Cost Effectiveness: Hotter and Drier Future Conditions Scenario

# The Value of Redundant Supply

---

Safeguard Public Health

Improve Flexibility and Reliability

Risk Reduction

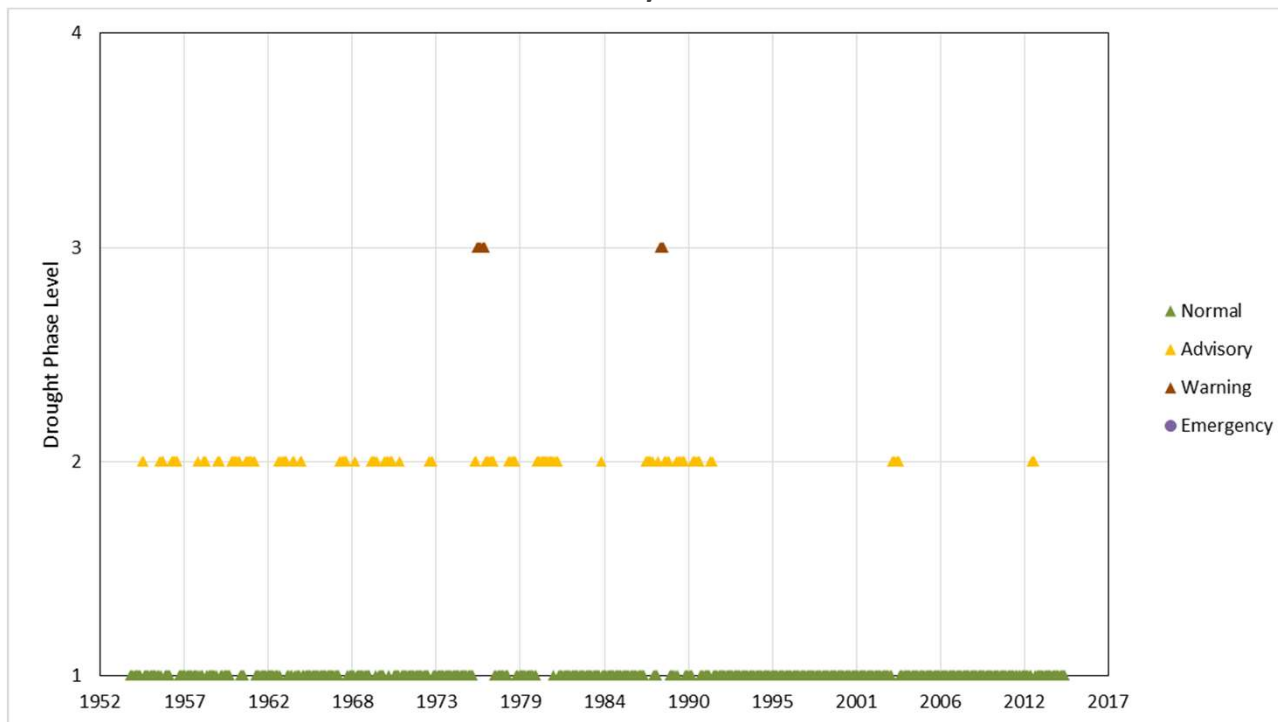
Seamless transfer to redundant systems without service disruptions

Reduce stress on Buffalo Aquifer during heavy withdrawal

How to quantify in CREAT?

# Future Work

- Incorporate climate projections data from CREAT into MPS' Drought Model
- Quantify the value of redundancy of supply in subsequent CREAT Modules
- Adaptation of module data for flood analysis



# Questions? Please contact me at:

---

Marc Pritchard

MPS Water Plant Supervisor

[mpritchard@mpstutility.com](mailto:mpritchard@mpstutility.com)

218-477-8072

701-367-6588

[www.mpsutility.com](http://www.mpsutility.com)

# Contact Us

**crwuhelp@epa.gov**

## **CURT BARANOWSKI**

Baranowski.Curt@epa.gov

## **STEVE FRIES**

Fries.Steve@epa.gov

## **MARC PRITCHARD**

MPritchard@mpsutility.com

## **ALFREDO LAGOS**

Alfredo.Lagos@gdit.com

## **MARY JO KRICORIAN**

MaryJo.Kricorian@gdit.com

Visit us on the web at:

**[www.epa.gov/crwu](http://www.epa.gov/crwu)**

Join our mailing list:

**[crwu\\_contacts@lists.epa.gov](mailto:crwu_contacts@lists.epa.gov)**

# References

---

Stream Flows: <http://waterdata.usgs.gov/nwis/rt>

Reservoir Levels: <http://www.mvp-wc.usace.army.mil/>

U.S. Palmer Drought Severity Index: <http://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/>

Standard Precipitation Index: <http://drought.unl.edu/MonitoringTools/ClimateDivisionSPI.aspx>

American Water Works Association (AWWA), *Drought Preparedness and Responses – Manual of Water Supply Practice M60*, 2011.

City of Fargo, *Drought and Water Service Management Plan*, 2015.

City of Grand Forks, *Drought Management and Demand Reduction Plan*, July 2007.

HDR, *Red River Basin Immediate Drought Responses Process*, February 2009.

Leggette, Brashears & Graham, Inc., *Groundwater Flow Modeling to Assess the Long-Term Sustainability of the Buffalo Aquifer as a Groundwater Source*, 2015.

Moorhead Public Service, *Water Emergency and Conservation Plan*, 2006.

Moorhead Public Service, *Water Supply Plan*, 2016.

Moorhead Public Service, *Wellhead Protection Plan*, 2012.

Moorhead Public Service, *Buffalo Aquifer Management Plan*, 2016.

Ronald J. Wolf, Hydrology of the Buffalo Aquifer, Clay and Wilkin Counties, West-Central Minnesota, February, 1981.

Ulteig and McKibben Demographics Research, *Demographic Forecast Study for the FM Metropolitan Area*, December 2012.

U.S. Geological Survey Water—Resource 81—4, *Hydrology of the Buffalo Aquifer, Clay and Wilkin County, West—Central Minnesota*, 1981.

EPA CREAT 3.0: <https://creat.epa.gov/creat/analysis/climate-awareness/climate-change#top>

MDH Webinar : [https://www.youtube.com/watch?v=ui\\_AZxq9BG8&list=PLnv1INVkxmvgeSWcbXwIwJarnAqx5Gaw&index=6](https://www.youtube.com/watch?v=ui_AZxq9BG8&list=PLnv1INVkxmvgeSWcbXwIwJarnAqx5Gaw&index=6)