City of Fort Collins Utilities
Climate Change Adaptation Planning

Technical Memo

February 2012

Prepared by:

MWH Global, Inc.
370 Interlocken Boulevard
Suite 200
Broomfield, Colorado 80021

This page left blank intentionally for printing purposes.

Table of Contents

Contents

1.0 Executive Summary

Shifting weather patterns have long been integrated into utility design and management processes. More recently, utilities across the United States have begun planning around dramatic and long term shifts in climate patterns. These planning efforts have been variably driven by responses to recent severe climate events, advances in climate models, improvements in our understanding of pre-recorded-history weather patterns, shifts in demographics, and changing assumptions about our future climate scenarios.

The City of Fort Collins Utilities (FCU) initiated this Climate Change Adaptation Study to examine possible future impacts of shifts in weather patterns. The purpose of the study is to understand the climate shifts which may occur, brainstorm impacts of those changes, and design a framework to incorporate climate adaptation into FCU's ongoing asset management planning. This approach is taken in recognition of the fact that climate science is likely to improve dramatically in the future, and the resulting knowledge around and response to expected weather shifts will evolve.

This memo presents the results of a research and brainstorming effort to understand the impacts of anticipated changes in climate conditions on FCU. The brainstorming effort was conducted by a number of FCU staff and was organized around specific functional areas within FCU.

Key Issues

Throughout the process several overarching key issues and recommendations were identified for FCU and are included below.

- **Existing water rights** may be central to significant challenges in operations and in the ability to service customers. To overcome these challenges diversification of water supply and storage should be pursued.
- **Increased storage requirements** may be necessary to meet future customer demands, regardless of and additional to the water diversification strategies which are pursued. Given the long lead time required it is advisable to begin assessment of options now.
- **Management of public expectations** will be critical to adaptation efforts, including outreach to the community, and outreach and coordination with other Cities and Utilities.
- **Momentum should be maintained**. There may be challenges in keeping momentum around integrated and effective climate adaptation planning at FCU as other near-term priorities arise. However given the severity of potential impacts, consistent long-term planning efforts should be maintained. Specifically, this should include a policy of integrated planning, with scheduled dates, defined metrics, and accountable parties responsible for quarterly/annual reporting on progress.

- **Funding resources** will be needed to ensure adaptation planning continues even at a low level, but this might be leveraged through joint planning across functional areas as well as through Federal, State and other grants or sources of funding.

Key Issues by Functional Area

Major areas of concern related to potential shifts in climate were also identified specifically for each functional area. These items and associated recommendations to address those concerns which were developed during the brainstorming sessions are listed below.

WATER Concerns

- **Insufficient yields from water rights** due to drier and warmer climate
- **An increase in water pollutants** such as high total organic carbon and other high nutrient levels due to drier and warmer climate and more severe events

  Recommendations to address these impacts include:
  - Evaluate options to diversify the water supply system
  - Build reliability/safety factors into projects
  - In some areas additional funding may be required

WASTEWATER Concerns

- **Flooding** from earlier spring melt and extreme precipitation events
- **Altered receiving water quality** due to increased summer temperatures

Recommendations to address impacts **specific to flooding** events include:
  - Improvements to gates at MWRF to allow more diversion to DWRF, rather than adding effluent pumps
  - For flooding events appropriate funding would be needed to fix poor condition areas in the collection systems

STORMWATER Concerns

- **Damages to Conveyance Systems** due to extreme precipitation events and warmer & wetter summers & winters

  Recommendations to address these impacts **specific to flooding** events, and include:
  - Outreach to manage Public expectations about flood events and results (frequency, inconvenience, etc)
  - Educate population on impacts and costs

Light & Power Concerns

- The ability to **Meet Power Demand** due to increased loads during and after extreme events.

  Recommendations to address this include increased funding.

Recommended Next Steps:

- **Integrated Climate Planning** – to establish a mechanism to incorporate future climate shifts into regular, ongoing planning activities. Such an approach provides a mechanism for collaboration and communication, enabling optimal operational risk-mitigation, leveraging of efficiencies, and higher return on investment for FCU.
  - **Functional Area Planning** - Integrated planning should begin immediately at the functional area level to ensure each group addresses the identified implications highlighted above and, in greater detail, in Section 5. Specific actions should be assigned to FCU groups and/or departments. Each group should identify the possible options for addressing implications of anticipated climate changes over the next two years.
  - **Measureable Approach** - This approach should involve a consistent and measurable level of activities according to the "plan, do, check, act" cycle with assigned accountability and appropriate metrics.
  - **Knowledge Renewal** – Utilities should plan to hold quarterly or bi-annual reviews of the state of climate knowledge as relates to near- and long-term projections and planning to meet City needs. In addition, Utilities should plan to remain active with climate groups in the local area, such as the Joint Front Range Vulnerability Assessment team, as well as nationally and, in a focused manner, internationally. In this manner Utilities can seek best practices through relevant case studies.
  - **City-Wide Coordination -** In order to maximize collaboration and positive impact, these planning efforts should be coordinated with the City of Fort Collins sustainability team and other City Departments.

2.0 Introduction

Although climate science has improved dramatically in recent years, our knowledge about future climate shifts in any region of the world still has significant variability and uncertainty. The Front Range region in Colorado is expected to experience an increase in extreme events, including high precipitation events and droughts events, as well as overall warmer temperatures. These scenarios may affect the City of Fort Collins Utilities (FCU), posing new challenges to the operations, infrastructure, business continuity and service to the community.

Utilities across the United States are taking steps to prepare for potential future climate variations. Given the uncertainty of current climate models, it is essential to develop a planning process designed to incorporate future improvements in climate science while still enabling decisions based on today's data and within existing planning timelines.

The City of Fort Collins Utilities initiated this Climate Adaptation Planning Project to help identify, understand and plan for impacts associated with existing and future climate conditions. The project consists of the following three components:

- **Data Analysis and Risk Planning** – to review current climate science and identify potential impacts for FCU;
- **Decision Framework Development -** to enable adequate incorporation of climate considerations into operational and capital decisions.
- **Adaptation Integration Planning** – to establish a mechanism to incorporate climate adaptation into regular, ongoing planning activities.

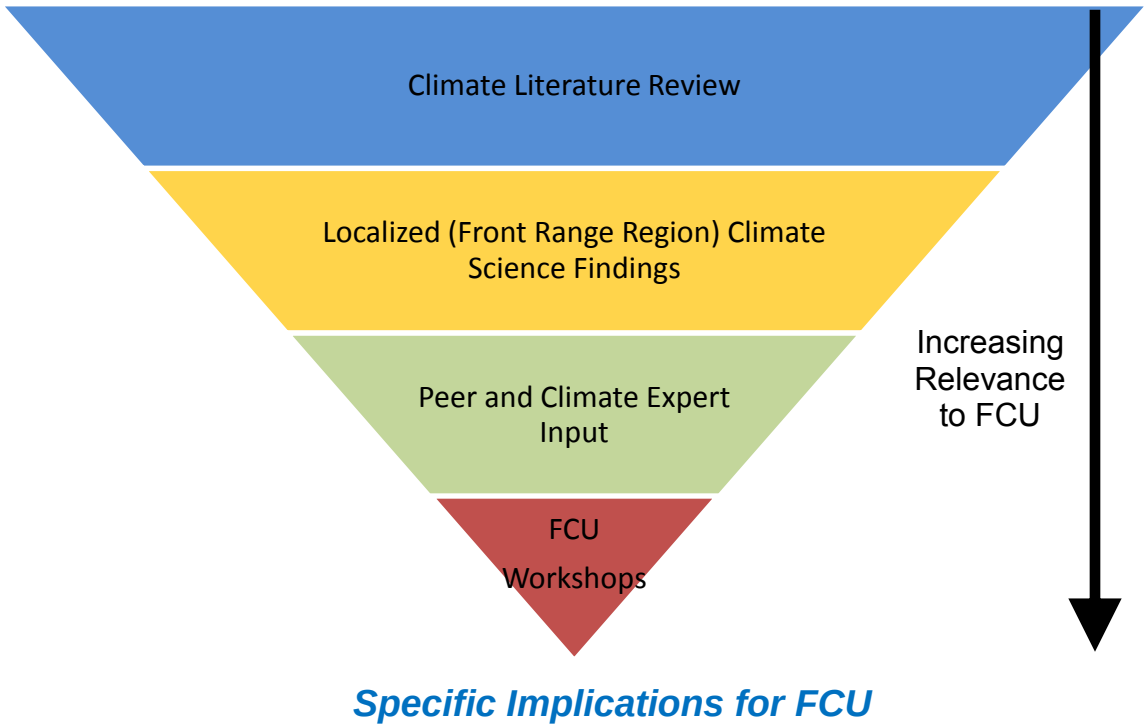
This memo presents key findings from the Data Analysis and Risk Planning Phase of work. The work associated with this activity includes:

- **Literature review** of the latest climate science research, with emphasis on the Front Range Region.
- **Consolidation of anticipated climate impacts, based on scientific data,** related to localized temperature, precipitation and stream flow variation that may affect FCU's assets and operations.
- **Incorporation of inputs from climate experts** and peer organizations to validate the literature review and identify items pertinent to FCU.
- **Workshops with key staff from FCU** to identify potential climate impacts, implications for FCU, and preliminary adaptation strategies for addressing associated issues.

Beginning with climate science and information obtained during the literature review, the **Data Analysis and Risk Planning** Phase of work provides a rigorous process for filtering available climate information into key findings for FCU. The end result is a set of high priority implications which will become important decision tools for resource and investment planning.

It is important to point out that the process, as shown in the figure below, is conducted such that each step can be revisited and refined as new observations or data points become available.

Figure 2.1. Data Analysis Process



3.0 Climate Information Review

Literature Review

To develop an understanding of the state of climate science, a review of published and available literature was conducted. The review resulted in the collection of nearly 25 pertinent documents which have been organized into an electronic reference library for FCU. The library is designed to be a living repository which can be easily accessed and updated as additional relevant climate information is uncovered. Periodic (semi-annual or annual) literature reviews should be conducted to identify peer reviewed content and other new findings for inclusion in library and for use in planning.

The objective of the review was to identify and assess information relating to:

- The state of climate science, particularly for the Front Range Region;
- The link between potential climate changes and impacts on resources, infrastructure, community and business; and
- Adaptation planning efforts and relevant best practices of other utilities.

The recently completed Joint Front Range Climate Change Vulnerability (JFRCCV) Study provides specialized climate science information particularly relevant to FCU. This document is an especially pertinent resource for this task and the overall project. The full list of documents is included in the References Section of this document, and a summary of the research is presented in the Appendix.

Key Observations

All Global Climate Models (GCMs) indicate an overall warming. In fact, the starting point of any GCM is an assumption that warming will occur. This inevitably leads to projections of temperature increases which may or may not prove to be true.

Colorado's Front Range is one of the most complex regions in the world for climate model predictions. This is due to the steep mountains, micro climates, and northern and southern weather influences. The result is an even greater level of uncertainty than faced by other regions.

For example, while some GCMs indicate an increase in precipitation, others indicate a decrease for the Front Range. This leaves planners in an uncertain scenario with the pressing question "which do we plan for?"

Similarly, Regional Climate Model (RCM) results are available, which interpolate results to a more detailed level. RCMs depend on GCM output and thus incorporate associated data weaknesses. At this point in time, the resolution of GCMs may still be too coarse for derivation of RCMs and for downscaling to be an accurate prediction tool.

The Front Range region has a documented history of extreme climate events. This includes, most alarmingly, extreme droughts and extreme floods. Utilities should have robust systems in place to prepare for such events in the future.

A further discussion of the specific models studied and what those models indicate for the Front Range is included in Appendix 1.

4.0 Planning Approach

A key objective of climate adaptation planning is reduced risk. Since climate information is constantly evolving, the planning process has to be dynamic and constantly refined in order to enable continued improvement and optimal results.

Selecting a Scenario Approach

Based on the literature review and input from climate experts and peer Utility organizations, it was concluded that a multiple scenario approach would be used. The reality is that the future is unknown and projected future climate change scenarios will likely be inaccurate to some degree. It is not feasible to assign probabilities. Therefore, rather than planning for any one scenario, planning should incorporate a broad representation of possible future changes.

The following figure illustrates the value of a scenario approach. A focused, near term strategy can be developed which incorporates considerations for numerous potential outcomes (represented by the letters A-E in the figure) in the longer term.

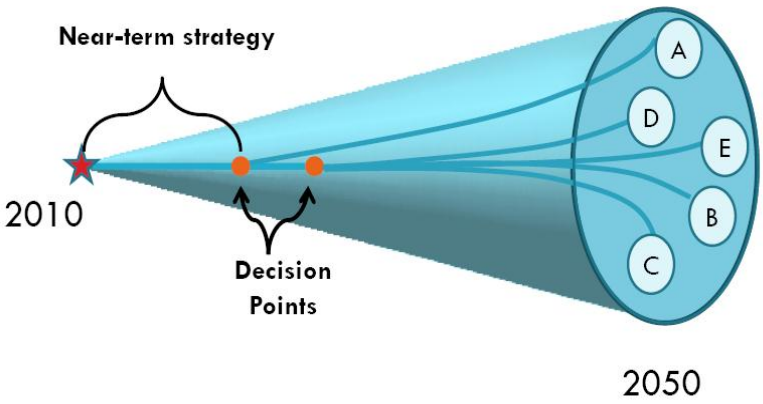


Figure 4.1 Scenario Planning, Source: Denver Water

As new information and data is uncovered, decision points will mark the opportunity for refined and revised planning and the ability to focus future operational measures appropriately.

To implement this approach for FCU, five scenarios were selected, as described below. The scenarios represent the extreme possible climate conditions predicted by current models. **By using these scenarios, FCU will be preparing for the worst predicted disruptions to service, cost of service, infrastructure, and the environment.**

The five selected scenarios include:

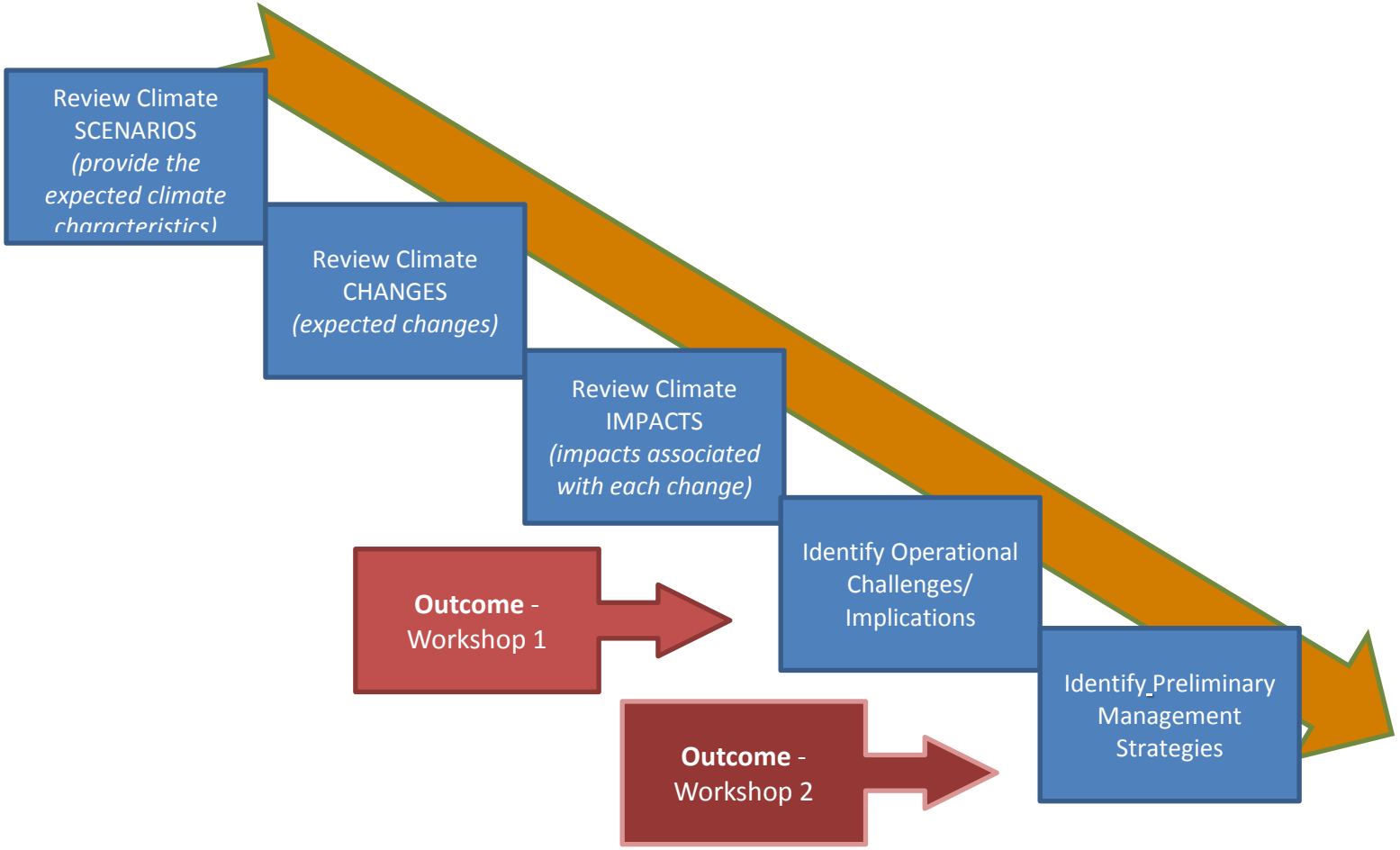
- Warm & Wet
- Hot & Dry
- Median
- Extreme Precipitation
- Extreme Drought

All five scenarios are described in detail in Appendix 1. The first three represent a subset of three of the five forecasts presented in the JFRCCV Study for the year 2040. The subset was selected due to its representation of the variation of temperature, precipitation, stream flow and shift in peak run-off which is relevant to the Front Range Region and FCU.

The remaining two scenarios, Extreme Precipitation and Extreme Drought were selected from a subset of climatic phenomena predicted to occur regardless of the eventual climate shift.

With the scenarios selected, a series of steps were taken to enable the translation of existing climate data and information into relevant impacts and associated implications for FCU. Once identified, the implications are the basis on which adaptation planning occurs. The following graphic outlines the overall scenario approach, which is also described in the below text.

Figure 4.2 Scenario-based Approach



Conducting the Scenario-Based Planning

Each of the five climate scenarios was used to generate a list of specific impacts to FCU.

Each impact was, in turn, translated into implications for the operation of FCU's infrastructure. This was accomplished through two half-day workshops including key personnel from FCU, technical experts, representatives from peer utilities and MWH.

Once the implications were identified, they were analyzed specifically for several key functional areas including: Water, Wastewater, Stormwater, Light & Power, and FCU Organizational-Wide. Experts from each functional area indicated the most relevant implications for their area and prioritized the selected implications based on a set of key criteria, including: cost of no action, environmental impact, customer impact, and operational disruption.

Finally, preliminary adaptation strategies were prepared for each of the top implications. The results of these exercises are shown in Section 5.

Each step of the process is well-documented, transparent, easily replicable and editable; enabling FCU to use and refine the same process as future improvements in climate science occur, and knowledge around local climate impacts improves.

This page left blank intentionally for printing purposes.

5.0 Findings

The highest priority climate impacts, and their associated implications, were individually addressed by each of the selected FCU functional areas. These are summarized and discussed in detail below.

FCU Water Key Issue: Extreme Drought

- **Insufficient yields from water rights** were of concern because they might lead to:
  - A need for more storage capacity to mitigate low seasonal water levels
  - Customer water use restrictions
  - Landscape impacts
- **An increase in water pollutants** such as high total organic carbon and other high nutrient levels, which might lead to:
  - Drinking water quality issues
  - Difficulty meeting regulatory requirements

Recommendations to address these impacts, based on the FCU functional group brainstorming, include:

- Evaluate options to diversify the water supply system
- Build reliability/safety factors into projects
- In some areas additional funding may be required

Table 5.1. Results of FCU Water Planning

Functional Area: Water Climate Change	Impact	Implication(s)	Current Status	Goals and Steps for Adaptation	Other Considerations/Resources Needed
Extreme Drought	Yields from water rights may be significantly reduced/insufficient	-- Insufficient storage capacity -- Restrictions -- Landscape Impacts	-- Currently short of storage capacity process is slow and expensive -- Project is going through permitting process -- Reservoir storage is controversial -- Level of water conservation and quality of life	-- Build additional storage capacity -- Continue to pursue current project -- Seek support and approval -- Continue to look at alternatives -- Need cooperation with others -- Get permit, design, build	**-- Additional funding may be needed** **-- Need diverse water supply system** **-- Need to build reliability/safety factor into projects**
Extreme Drought	Runoff following droughts will increase TOC and nutrients	-- Water quality issues -- Difficulty meeting regulatory requirements -- Increased nutrient loading	-- Use blending to address high TOC -- Have monitoring programs -- Continuing increasing trend in TOC in reservoir - making it more difficult to reduce concentrations in raw water creating a potential increased reliance on chemical usage -- Meet regulatory requirements for removal -- Study origin and character of TOC	-- Add treatment processes to make removal more efficient -- Different supply for high TOC periods for blending -- Dual supply to customers to reduce amount of finished water needed to meet consumptive demand -- Address non-point and point source of nutrients (ag runoff, septic leaks, etc) through partnership with landowners, ranchers, etc. -- Economic impact of decreased water quality --> Businesses depend on increased water quality	**-- Additional funding**

FCU Wastewater Key Issue: Flooding and Altered Receiving Water

- **Early Spring Melt & Runoff and other Extreme Flooding Events** were of concern for possible flooding issues and impacts on the collection systems
- **Increased Summer Temperatures** were of a concern because of the potential for altered receiving water quality issues

Recommendations to address these impacts, based on the FCU functional group brainstorming, were **specific to flooding** events, and include:

- Improvements to gates at MWRF to allow more diversion to DWRF, rather than adding effluent pumps
- For flooding events appropriate funding would be needed to fix poor condition areas in the collection systems

Table 5.2. Results of FCU Wastewater Planning

Functional Area: Wastewater Climate Change	Impact	Implication(s)	Current Status	Goals and Steps for Adaptation	Other Considerations/Resources Needed
Warmer and Wetter Winters	Early Spring Melt and Runoff	-- Flooding	-- Both plants are protected from 100 year waters. -- Key problem is effluent discharge. -- MWRF discharge protected to a 50-year event -- DWRF at current 100-yr event -- Can currently divert flow from MWRF to DWRF	-- Determine "New" event storms -- Determine improvements requirement to raise effluent elevation -- See if structures are still protected -- Possible need for improvements to effluent discharge pumping or diversion at MWRF if 100-year event becomes greater -- Improvements to emergency power/backup	**-- Improvements to gates at MWRF to allow more diversion to DWRF may make more sense than adding effluent pumps**
Hotter/Drier Summers	Increased Temperatures	-- Altered biology/chemistry of receiving water	-- Currently meeting all NPDES permit limits -- Plans for proposed new limits are in place (no funding for SPT) -- Master plan for even higher limits is in place	-- Maintain watch on state/EPA issuances -- Budget preparation is recommended if higher limits are required	**-- Less flows and less dilution would cause general challenge to meeting required limits**
Extreme Precipitation Events	Extreme Flooding	-- Flooding in collection system	Currently in investigative phase of I/I study	Fix identified inflow issues	**-- Need appropriate funding to fix poor condition areas**

FCU Stormwater Key Issue: Higher Peak Discharge Levels

- Both individual **Extreme Precipitation Events and Warmer & Wetter Summers & Winter** could:
  - Increase the damage to the storm water management facilities and conveyance systems
  - Require additional management and repairs of relevant infrastructure
  - Potentially require an increase in the quality of the stormwater infrastructure

Recommendations to address these impacts, based on the FCU functional group brainstorming, were **specific to flooding** events, and include:

- Outreach to manage Public expectations about flood events and results (frequency, inconvenience, etc)
- Educate population on impacts and costs

Table 5.3. Results of FCU Stormwater Planning

Functional Area: Stormwater					
Climate Change	**Impact**	**Implication(s)**	**Current Status**	**Goals and Steps for Adaptation**	**Other Considerations/Resources Needed**
Extreme Precipitation	Higher/More frequent Peak Discharges	-- Increased risk of damage to stormwater management facilities and convergence systems -- Need for management and repair of infrastructure	-- Expectation that infrastructure is designed to withstand damage -- Concerned about perception - that people will wonder "why it wasn't done right the first time" -- Concerned about having sufficient level of staffing	-- Identify approach to model more extreme events -- Increase maintenance budgets through increased reserve for replacement/repair of projects (rate increases) -- Develop strategies for damage avoidance - PDM grants - actively pursue - Property buy-outs -- Modify land use regulations -- Change design criteria to accommodate potential future higher flows - upsize pipes and channels - dam design to be enlarged - policy change -- Rate impacts for retro fit projects -- Understand how to quantify change in design flows (% of current criteria)	**-- Outreach to manage Public expectations about flood events and results (frequency, inconvenience, etc)** **-- Educate population on impacts and costs**
Warmer/Wetter	Higher/More frequent Peak Discharges	--Potential need to increase stormwater infrastructure quality	-- Designed to standards based on historical conditions that are changing -- Public is not getting the level of protection they expect and paid for	-- Quantifying the change and when it occurs -- PR & outreach to public about change -- Increasing stormwater capacity in town -- Cost of retrofit and stormwater fee -- Master plan for future potential changes - acquire additional land now for a current detention pond or bump pile size for storm drain project or allow for spilling of outlet works capacity	

FCU Light & Power Key Issue: Requirements for Additional Energy and Capacity

The main concern in this area is that although FCU has plenty of generating assets, other owners of generation such as PRPA and the City will need to add additional capacity in order to meet projected demand. Their doing so will impact the stability of FCU's grid and ability to continue to meet power demands.

Table 5.4. Results of FCU Light & Power Planning

Functional Area: Light & Power					
Climate Change	**Impact**	**Implication(s)**	**Current Status**	**Goals and Steps for Adaptation**	**Other Considerations/Resources Needed**
All	Increases requirement for energy and capacity	-- Inadequate electrical supply could have a significant impact and require additional resources	-- City is capacity rich but PRPA, the City and the region will have to add additional generation resources to meet demand	-- Long range planning and more sophisticated forecasting -- Development of cleaner generation resources -- Maximize demand response, energy efficiency and conservation -- Add energy storage opportunities and distributed generation development to the portfolio	**-- Funding**

FCU Utilities-Wide brainstorming group Key Issue: Extreme Events of any sort

The particular concern was around **impacts on the community** in regard to supply and the economy, and **stresses upon the Utility infrastructure and business continuity**.

Table 5.5. Results of FCU Utilities-Wide Planning

Climate Change	Implication(s)	Current Status	Goals and Steps for Adaptation	Other Considerations/Resources Needed
Extreme Drought	-- Increased demand -- Dramatically reduced supply -- Community-wide impacts to economy -- Population loss -- Revenue loss	-- Blocked pricing irrigation -- Draught response plan -- Water conservation -- Seeking more storage -- Senior water rights	-- More conservation -- More storage -- Increased awareness/education/communication -- Regional collaboration -- Irrigation (outdoor landscaping changes?) -- Revised water rights -- Improved financial strategy	**-- Storage** **-- Water quality improvements** **-- More regulation** **-- Financing** **-- Regional collaboration - especially for water rights** **-- Water-Energy Nexus**
Extreme Precipitation	-- Impact to City infrastructure, treatment infrastructure and plant facilities -- Issues for business continuity	-- Have emergency planning but need more -- Reviewing flood plain and master plans -- Some regional collaboration occurring -- Interoperation	-- More emergency planning -- More preparation and closer attention to infrastructure -- More communication and awareness (community/customers) -- Budgetary planning -- Land acquisition for larger detention	**-- More regional collaboration** **-- Increased resiliency for shorter response/reaction time**

Highest Priority Implications by Functional Area - Color Key		
Water	Light & Power	Stormwater
Wastewater	FCU Organization Wide	High priority for two or more Functional Areas

Table 5.6. Outcomes of the Workshop Implications Planning

Expected Climate Changes	Climate Impacts		Challenges/Implications		Water	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Wastewater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Stormwater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Light and Power	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Fort Collins Utilities Wide	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Policy
	Impacts	Impacts (level 2)	Implications	Implications (level 2)																										
Warmer and Wetter Winters	Decreased winter snowpack and Increased rainfall	Increased base flow during winter months	Undesirable releases from reservoirs		✕																									
		Shift in ecosystem flora/fauna	System damage due to overgrowth (e.g. pipelines/canals etc)																											
			Increased maintenance needs due to degradation in water quality		✕										L															
			Increased sedimentation in runoff and reservoirs from Vegetation die-off												L															
			Implications for revegetation and restorations efforts: selecting plant species that better tolerate new conditions	Ranch Vegetation: too wet to spread (?)						✕	L	M	L	M	L										✕					
		Insufficient storage for some events during spring	Undesirable releases from reservoirs																											
			Need for additional storage capacity to control flows and retain water resource	For L&P could mean additional pumping demand	✕	L	H	H	L											✕	M	L	M	M	✕					
	Increased temperatures	Fewer cold weather days	Less cold weather operating challenges in wastewater plants & biosolids handling																						✕					
			Less cold weather operating challenges in collection and distribution systems																						✕					
			Potentially lower overall power requirements for electrical heating																	✕	L	L	L	L						
			Shift in winter peak load (heating) to summer peak load (cooling)	Higher available biogas						✔	Positive	Positive	L	L	L					✕	L	L	L	L						
			Ecological alterations, i.e.: beetle kill		✕	M	H	L	M																✕					
	Later freeze & earlier thaw		Less cold weather stress on conveyance systems																											
	Earlier spring melt & runoff	Higher spring peak flow	Run off pattern shift produces insufficient resources from stream flows during warm months		✕																				✕					
			Current water rights may cause misalignment between supply and demand timing.		✕	M	L	L	L																✕					
			'One-fill rule' - Inability to accumulate / store run-off		✕																				✕					
			Insufficient storage capacity given the size of the city of Ft. Collins		✕																				✕					
		Broader window for power production	More hydro generation during a broader window																	✔	L	L	L	L						
		Rain on snow	Faster run-off	Augmented frequency and magnitude of flash floods											H			X	X											

Expected Climate Changes	Climate Impacts		Challenges/Implications		Water	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Wastewater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Stormwater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Light and Power	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Fort Collins Utilities Wide	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Policy
	Impacts	Impacts (level 2)	Implications	Implications (level 2)																										
Warmer and Wetter Summers	Increased in spring/summer stream flow	Susceptibility to flooding	Insufficient infrastructure capacity							✕					L										✕					
		Increased sedimentation	Higher maintenance needs												M															
		Reservoir capacity may be affected	Change in reservoir release needs																						✕					
		Higher/more frequent peak discharges	Potential need to increase stormwater infrastructure capacity	Change in design parameters may be needed											H			X	X						✕					
			Changes in operation requirements may be necessary												L															
	Increase in summer precipitation	Lower outdoor water use	Decrease in user demand																						✕					
		Ecological alterations	Increase in plagues and diseases, i.e.: mosquitoes and West Nile virus	Increased storage pond maintenance											L										✕					
			Increased riparian vegetation	Changes in drainage patterns, resistance to erosion, susceptibility to overflow											Positive										✕					
			Decreased risk of wildfires												Positive										✕					
			Changes in biosolids concentrations	Difficulty achieving required biosolid dryness for land application						✕	L	M	L	M																	
		Increase surface run-off and soil saturation	Increase in Inflow and Infiltration (I&I)	Increased volume and costs entering treatment systems						✕	M	L	L	M																	

Table 5.6. Outcomes of the Workshop Implications Planning (Continued)

Highest Priority Implications by Functional Area - Color Key		
Water	Light & Power	Stormwater
Wastewater	FCU Organization Wide	High priority for two or more Functional Areas

Expected Climate Changes	Climate Impacts		Challenges/Implications		Water	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Wastewater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Stormwater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Light and Power	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Fort Collins Utilities Wide	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Policy
	Impacts	Impacts (level 2)	Implications	Implications (level 2)																										
Hot and Drier Summers	Decrease in surface water resources	Insufficient water supply to meet demand	Needing additional water supply	Increase requirement for capital reserves for securing water options, planning and project capital	✕	H	H	H	L																✕					Medium/High
			Inadequate conservation and drought management																						✕					
			Water rights may need to be shifted or renegotiated	Increased litigation around water rights	✕	M	L	L	L																✕					
			Economic repercussions: prioritizing industrial vs. residential water use																						✕					
		Lower base flows and reservoir levels in late summer	Changes in receiving water quality due to low flows																						✕					
		Reduced service reliability	Increase in PR expenses																						✕					
			Changes in source water quality due to low flows		✕	M	M	M-H	L																					
	Increased forest fires	Increased sediment load in runoff	Increased dredging needed for reservoirs		✕										L										✕					
		Degraded water quality	Increased needs for additional treatment		✕	H	M	M	L																✕					
	Less rainfall during growing season	Increased damage to collection and conveyance system pipes due to increased depth of growth of tree roots	Increased maintenance needs for system pipes																						✕					
		Increased outdoor / irrigation water use	More water supply needed to meet demand		✕																				✕					
			Impacts on ranchland	Biosolids reuse						✕	L	M	L	M											✕					
	Longer growing season / Shift in	Increase agricultural water demand	More water supply needed to meet demand																						✕					
	Increased temperatures	Altered biology and chemistry of wastewater treatment and collection systems	Increased odor and corrosion in wastewater collection systems																						✕					
			Altered energy and chemical requirements at treatment facilities																						✕					
		Altered biology and chemistry of receiving waters	More stringent treatment requirements to meet regulations	EPA / State lowering Nitrogen limits						✕	M	H	H	M											✕					
		Heat-island effects and landscaping																		✕	L	L	L	L						
		Stress on vegetation																												
		Air quality issues	Ground-level ozone, dust, create health issues																						✕					
		Demographic / Economic shifts (migration to mountains)																												
		Increase in water demand and competition/disputes over water			✕	M	H	H	L																					
		Increased overall energy consumption	Increased power procurement needed	Minor facilities HVAC issues						✕	M	L	L	M						✕	H	L	H	H	✕					
		Increased cooling water demand in power generation	Increased silica deposition																	✕	M	L	L	M	✕					
		Altered biology and chemistry of source waters	More stringent treatment requirements to meet regulations		✕	H	M	M	L																					
		Increased peak power demand																		✕	H	L	H	H						
	Infrequent Storms	"First Flush" pollutant loading	Increased maintenance and BMP design criteria												M															

Highest Priority Implications by Functional Area - Color Key		
Water	Light & Power	Stormwater
Wastewater	FCU Organization Wide	High priority for two or more Functional Areas

Table 5.6. Outcomes of the Workshop Implications Planning (Continued)

Expected Climate Changes	Climate Impacts		Challenges/Implications		Water	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Wastewater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Stormwater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Light and Power	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Fort Collins Utilities Wide	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Policy
	Impacts	Impacts (level 2)	Implications	Implications (level 2)																										
Extreme Precipitation Events	**Severe/Extreme Flooding Events**	**Higher/more frequent peak discharges**	Increased risk of flood damage to FCU infrastructure	Increased risk of direct flood damage to treatment plant, pumping and conveyance, outfall, and biosolids facilities						X	H	H	L	H	M															
				Potential flood damage and increased maintenance needs due to sediment deposition in stormwater detention facilities											M															
				Increased risk of direct flood damage to stormwater management facilities and water conveyance infrastructure											H	X			X											
				Management and repair of infrastructure and plants						X	M	H	M	H	H				X											
			Increased risk of flood damage to public infrastructure	Potential damage to streets, roads, bridges											M															
			Increased private property damage	Potential for increased insurance premium and third party liability											L															
			Increased risk of untreated sewage overflows during conveyance due to high flows exceeding existing capacity							X	H	H	H	H	L															
			Increased risk of untreated sewage overflows via treatment plant by-passes due to high flows exceeding existing capacities												L															
			Infiltration and Inflow issues							X	M	L	M	M																
			Potential need to increase stormwater infrastructure capacity	Change in design parameters may be needed											H	X			X											
			Increased debris in stormwater system	Increased expenses in debris management											M															
		Increased channel erosion	Increased requirements for channel maintenance												M															
			Potential for property damage												L															
			Threat to water conveyance lines		X	H	M	M	M																					
		Increased turbidity and sedimentation in receiving waters	Increase in maintenance requirements																											
	Increased watershed erosion (especially in combination with drier climate)	**Sediment deposition in water infrastructure**	Need for reservoir dredging and clean up of stormwater infrastructure												M															
	More frequent/severe extreme weather events		Infrastructure damage due to wind, hail, debris, fallen trees, etc.												L															

Expected Climate Changes	Climate Impacts		Challenges/Implications		Water	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Wastewater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Stormwater	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Light and Power	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Fort Collins Utilities Wide	Cost of No Action	Environmental Impact	Customer Impact	Operational Disruption	Policy
	Impacts	Impacts (level 2)	Implications	Implications (level 2)																										
Extreme Drought Events	**Intense heat waves/dry spells**	**Water conservation efforts reduce inflow to wastewater treatment plants**	Damage to pipe infrastructure																											
			Odor, corrosion, water quality issues							X	M	L	M	M																
			Changes in receiving water quality							X	M	M	L	L																
		Low base flows in late summer	Insufficient water supply to meet demand		X	L	L	M	L																					
		Increased need for cooling/air-conditioning	Increased power consumption																	X	See Hot&Dry Scenario									
		Risks of fire	Increased sedimentation in runoff	Increased separation needs at plants	X	H	M	M	M						L															
			Air quality issues																											
		Reduced yield from storage due to higher evapotranspiration rates	Insufficient water supply to meet demand		X	L	L	L	L																					
		Loss of landscaping	Need to adjust landscaping to xeriscaping												L															
			Permanent shifts in landscaping	Reduced outdoor water needs																										
			Change in plant design for detention and water quality ponds												M															
			Ranchland grasses	Biosolids resuse						X	M	M	L	M																
		Reduced life of distribution equipment																		X	L	L	M	M						
	Altered water biology and chemistry		Increased treatment needs	Water quality complaints, operational response to address issues																										
		Accelerated eutrophication of reservoirs	Reduced water quality	Higher water treatment requirements						X	M	H	M	L																
			Decrease is water storage capacity																											
	Accumulation of dead vegetation in the watershed	**Runoff from rains following droughts will have high total organic carbon (TOC)**	Water quality issues	Insufficient treatment capacity to deal with elevated TOC	X	H	M	H	M																					
			MS4 (?) Maintenance needs												M															
	Interplay between agricultural and urban water use changes																													
	River runoff is reduced over a multi-year period	**Yields from water rights may be significantly reduced**	Water supply shortages to City customers	Customer restrictions, landscape impacts																										
				Less revenue from customer water sales																										
			Less rental water available to local farmers	Less rental revenue for Utility																										
			Insufficient storage capacity given the City's size	Customer restrictions, landscape impacts	X	H	H	H	M																					
		Reduced water available for cooling																		X	L	L	L	L						
		Reduced hydroelectric production																		X	L	L	L	L						

This page left blank intentionally for printing purposes.

6.0 Summary and Next Steps

Summary

The **Data Analysis and Risk Planning** Phase of FCU's Climate Adaptation Project provides FCU with the foundation and approach needed to reduce exposure to impacts of climate and associated risks. The outcome of the task includes a transparent and repeatable methodology for translating a vast amount of climate information into actionable planning strategies. The approach outlines a step-by-step process including input from FCU peers, climate experts and FCU functional area experts, which ensures a thorough, but pertinent look at expected climate conditions in the Front Range Region.

It is important to remember that like any risk-oriented planning activity, climate adaptation planning should be done in an iterative fashion. New information, climate science findings, peer best practices or operational conditions may provide an opportunity to improve or drive the need to update previously developed plans. Creation of 'decision points' and regular examination of the expected climate conditions and associated impacts should be conducted to ensure identification of new or previously missed implications.

This Data Analysis and Risk Planning Phase includes development of a spreadsheet analysis framework which houses the selected climate scenarios, expected impacts, implications for FCU and preliminary functional area strategy considerations. The spreadsheet currently provides a central storage point of information for FCU as well as a framework for revisiting and updating this information.

While a key output of this project is a set of high priority implications pertinent to FCU and resulting planning strategies, another was the identification of organizational procedures, best practices, constraints or other elements which may influence FCU's ability to effectively conduct climate adaptation planning. During the workshop implication planning activity several key, overarching comments emerged around opportunities to overcome potential hurdles to both the development of adaptation strategies and to the implementation of specific actions within existing operational planning procedures. A list of these overarching concerns and recommendations is included in the table below. As the climate adaptation planning continues, these elements should be revisited and explored to ensure that they are effectively understood and proactively addressed.

Table 6.1. Issues and Recommendations

Issue	Recommended Action	Description
Management of Public Expectations	Collaboration	Coordination with other utilities and local governments enables broader outreach and capacity to communicate effectively.
	Communication	Education and outreach around climate event impacts, rate changes and resulting public inconveniences will help to manage public expectations.
Insufficient Funding	Collaboration	Coordination of planning activity between internal functional areas may identify synergies which will enable increased return for FCU's financial and time investments Coordination with other utilities and local governments may provide opportunities for increased access to grants and other funding incentives.
Existing Water Rights May Provide Significant Challenges to Operations and Ability to Service	Collaboration	Coordination with other utilities and local governments will be required to develop suitable solutions.
	Integration	Local policy may need to be influenced to enable required changes.
Storage Requirements	Collaboration	Coordination with other utilities and local governments will be required to develop suitable solutions.
	Integration	Local policy may need to be influenced to enable required changes.
Challenge Keeping Momentum Around Integrated and Effective Climate Adaptation Planning at FCU	Collaboration	Proactive coordination of planning activity between internal functional areas will increase accountability and may identify synergies which will enable increased return for FCU's financial and time investments
	Integration	An internal policy defining planning approach will help provide structure, transparency and continuity to the process.
	Communication	Internal communication about the planning process as well as regular report-outs by functional area will improve accountability and sustainability of the process

Next Steps

This memo highlights the key findings of the Data Analysis and Risk Planning Phase of the FCU Climate Adaptation Planning Project. Next steps for the project include:

- **Decision Framework Development -** to enable the functional areas of FCU to adequately incorporate climate considerations into operational and capital decisions. This will be accomplished through the identification and weighting of a set of key criteria and incorporation of the criteria into the FCU decision tool of choice; and
- **Integrated Climate Planning** – to establish a mechanism to incorporate future climate shifts into regular, ongoing planning activities. Such an approach provides a mechanism for collaboration and communication, enabling optimal operational risk-mitigation, leveraging of efficiencies, and higher return on investment for FCU.

  This should begin at the functional area level to ensure each group is able to begin to address the identified implications immediately. Eventually, however, an integrated, FCU-wide planning approach is recommended.

  This approach should involve a consistent "plan, do, check, act" cycle with assigned accountability and appropriate metrics.

  These planning efforts should be coordinated with the City of Fort Collins sustainability planning and other City departments.

As described in the Summary Section of this memo, it is recommended that FCU place a priority on communication, collaboration and integration, both internally and externally with other utility and local governmental organizations as they move ahead with climate adaptation planning. The ability to leverage parallel efforts and manage expectations will reduce constraints and provide added momentum to implementation of strategies. In addition, FCU should look for opportunities to integrate climate considerations into existing policies and procedures, or develop new policies will help to maintain a structure for effective and sustainable adaptation action.

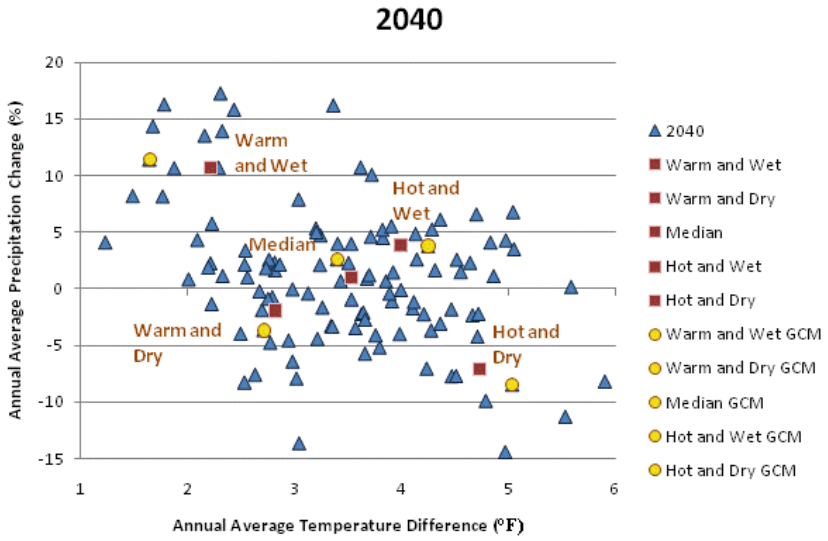
This page left blank intentionally for printing purposes

7.0 Appendix 1: Overview of Climate Science and Scenario Selection

This project relies predominately on two sources for projected climate scenarios in studying the impacts on FCU's infrastructure and operations: the hydrologic and climate models of the JFRCCV Study and the projected impacts described in WERF's technical report titled Implications of Climate Change for Adaptation by Wastewater and Stormwater Agencies.

The Warm & Wet, Hot & Dry and Median scenarios extracted from the JFRCCV Study constitute the output of climate model simulations and their effects on the hydrologic systems for the study region (i.e. the headwaters of all major Colorado river basins). The JFRCCV Study looked at the output of 112 General Climate Models (GCMs), each the result of an individual climate model run (using 16 different models) with different initial conditions and GHG emission scenarios based on IPCC's Special Report on Emission Scenarios (2000).

While all GCMs point towards overall warming, trends in precipitation for the Front Range Region are less clear. Some models indicate a net reduction while others point towards a net increase in precipitation, as shown in the figure below. Based on the relative differences among the model outputs, a subset was labeled to help provide clarity to the results. The subset includes: Warm & Wet, Warm & Dry, Hot & Wet, Hot & Dry and Median.



Annual Temperature and Precipitation Changes in the year 2040 for 112 individual GCMs compared to 1950-1999 annual averages. Red squares represent qualitative scenarios; yellow circles are the selected GCM runs. (Source: JFRCCV Study)

In order to provide regionally-focused output data, the GCM output was downscaled. Downscaled data is the result of taking low-resolution information from GCMs and using local physical models and statistical tools to correct and increase the data resolution. The downscaled climate data was used to signal the effects of temperature and precipitation changes on surface water resources. The JFRCCV Study relied on two hydrologic models, the Sacramento and the WEAP, to simulate stream flows. In spite of slight differences between the two model's outputs, similar trends are reflected across the five different selected scenarios.

The resulting series of timelines with information on temperature, precipitation and stream flows help to help paint a picture of the potential climate and water resources in the Front Range Region in 2040. A perspective on this information facilitates the identification of associated impacts and implications for FCU. For example, with increased temperatures, snowpack melts faster and earlier and peak stream flows take place earlier in the year; a trend very pertinent to FCU given the impacts on storage capacity, water rights and timing of water demand for agriculture.

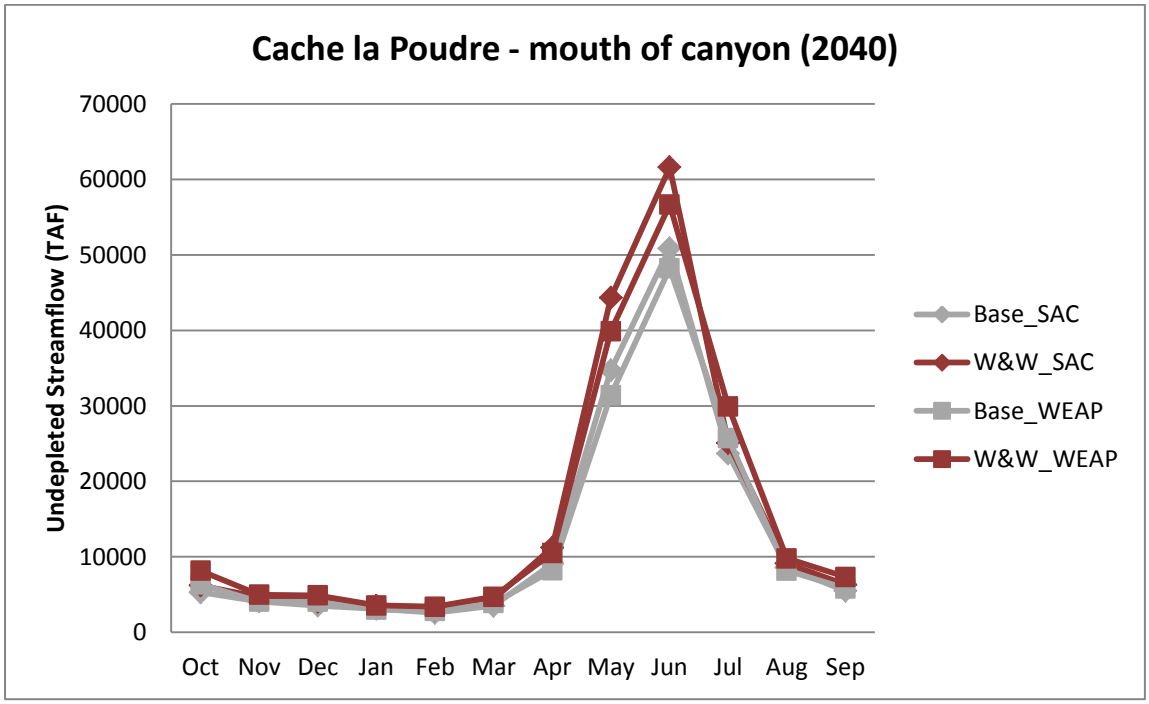
In order to focus on the scenarios representing the greatest potential impact to FCU's assets, infrastructure and business operations, a subset of two of the five climate scenarios were considered: Hot & Dry and Warm & Wet. These were chosen because they represent the opposite ends of the five scenarios presented in the JFRCCV Study and capture the widest range of possible climate variations. For example, an early analysis proved that the effects of the Warm & Dry scenario were similar to those of the Hot & Dry but less extreme and intense. Since planning for the latter would cover the risks implied by the former, only the more extreme was selected. The Median scenario was maintained as a reference point.

Only the stream flow data for the Colorado River near Granby and the Cache la Poudre River at Mouth of Canyon were considered, as they reflect the effects on surface water resources for the two basins relevant to FCU. Furthermore, only data for 2040 was deemed useful given the extent of FCU's planning horizons.

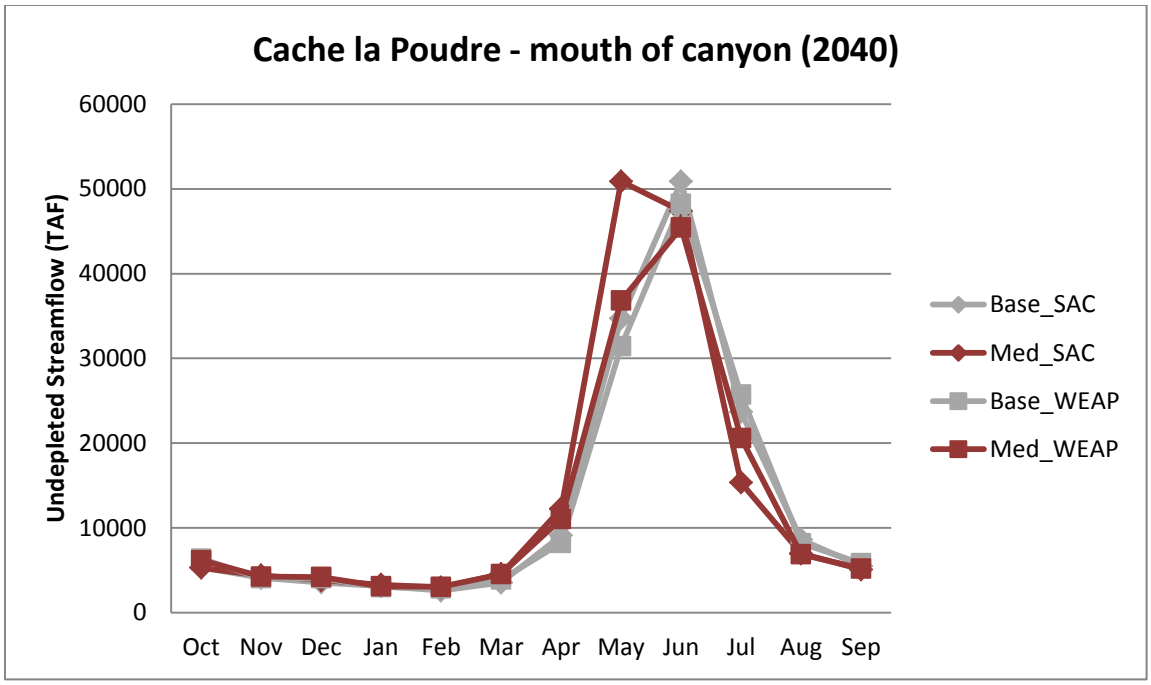
The following table and charts were used during Workshop 1 and represent a concise summary on the outcomes of the JFRCCV Study relevant to this Project.

Summary parameters of the JFRCCV Study climate and hydrologic models used in this Project

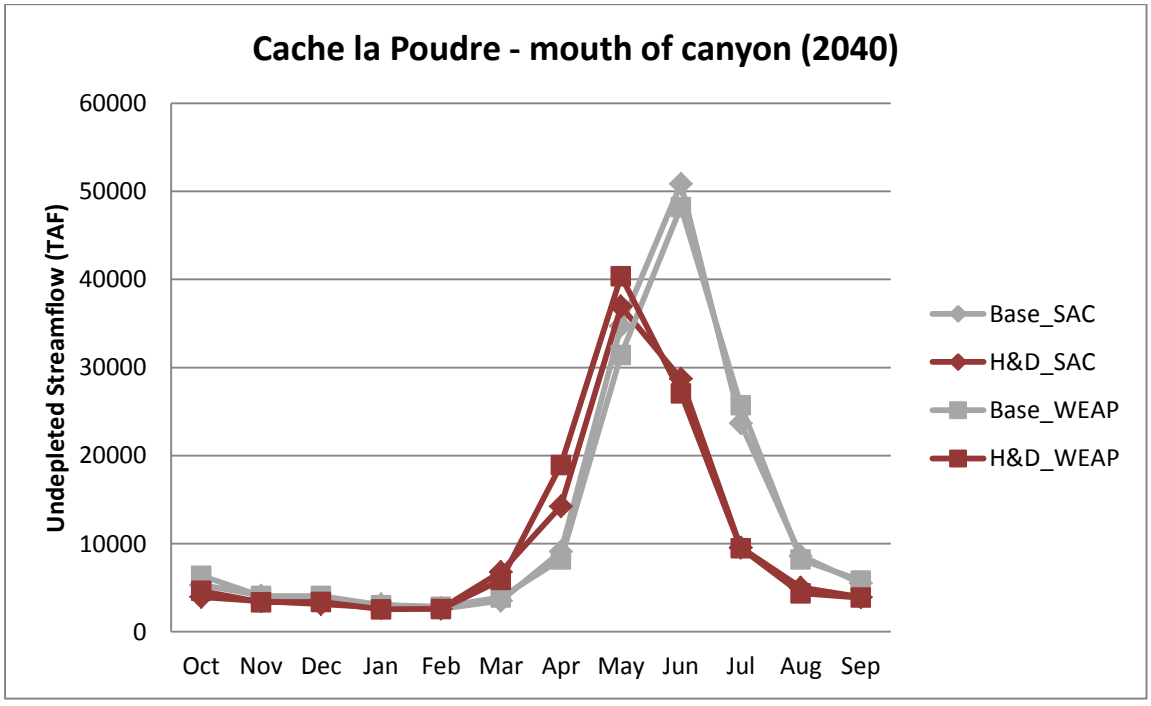
				% Annual Change in Stream Volumes			
				Colorado at Granby		Cache la Poudre at mouth of canyon	
	Scenario	Annual Temp. Increase (°F)	Annual Prec. Change (%)	WEAP	Sacramento	WEAP	Sacramento
2040	Warm & Wet	1.64	11.43	13%	16%	20%	23%
	Median	3.40	2.60	9%	7%	7%	16%
	Hot & Dry	5.04	-8.51	-10%	-21%	-14%	-18%



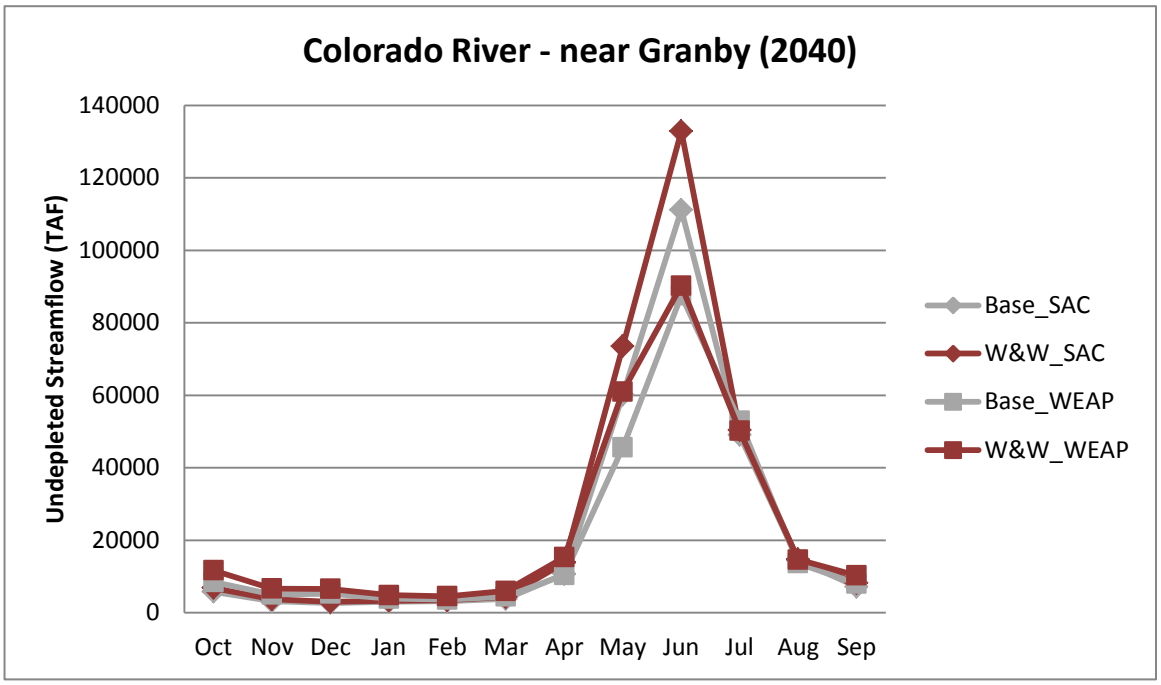
Simulated Stream Flows for the Warm & Wet Scenario – Cache la Poudre



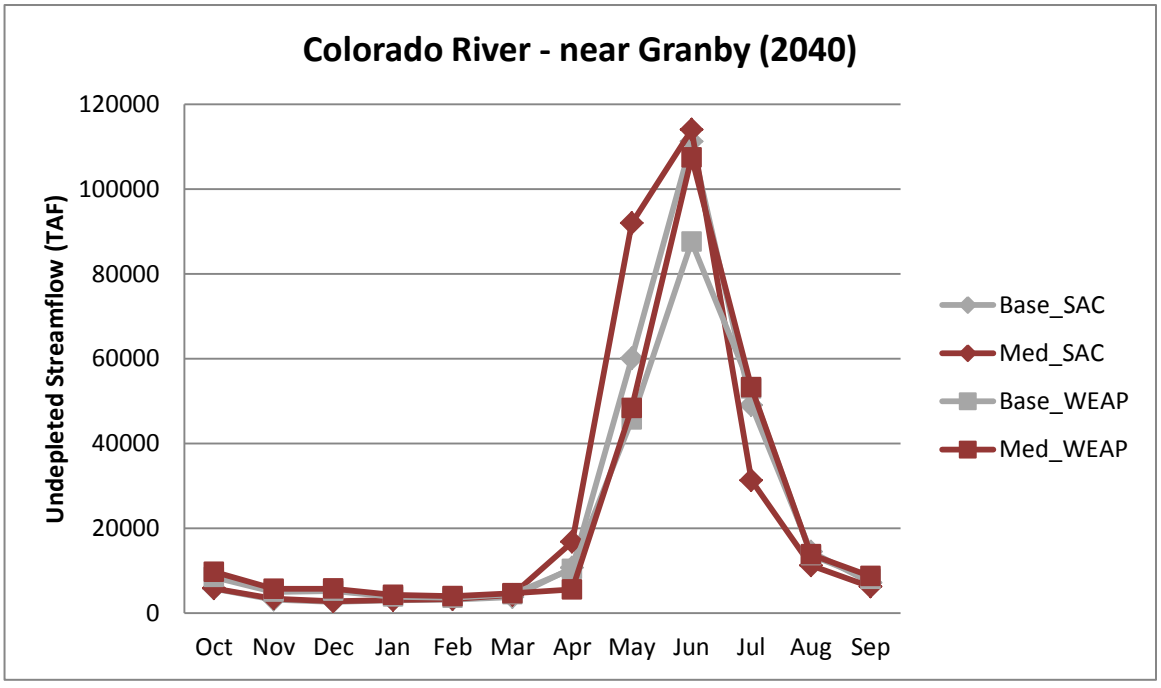
Simulated Stream Flows for the Median Scenario – Cache la Poudre



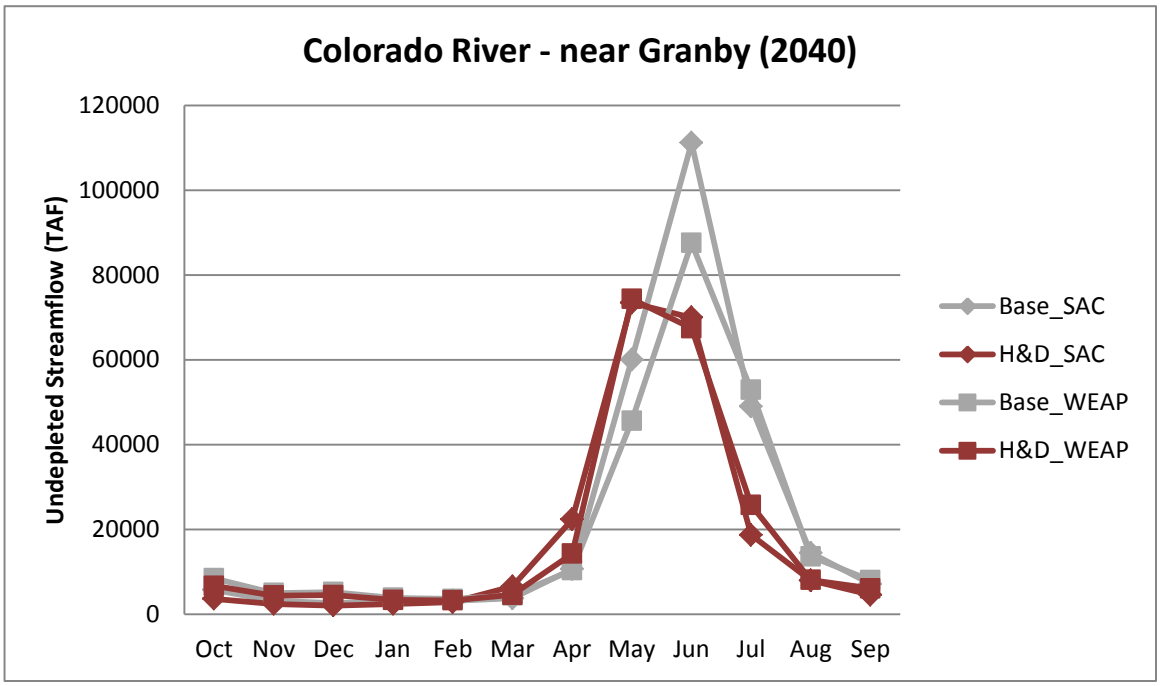
Simulated Stream Flows for the Hot & Dry Scenario – Cache la Poudre



Simulated Stream Flows for the Warm & Wet Scenario – Colorado River



Simulated Stream Flows for the Median Scenario – Colorado River



Simulated Stream Flows for the Hot & Dry Scenario – Colorado River

An intrinsic limitation of the climate simulations as used in the JFRCCV Study is their inability to predict significant weather events. Even if a model predicts an increase in precipitation, it says nothing as to how that precipitation is going to present itself. For example, it may occur as regular light drizzles or as sporadic storms with intense precipitation episodes.

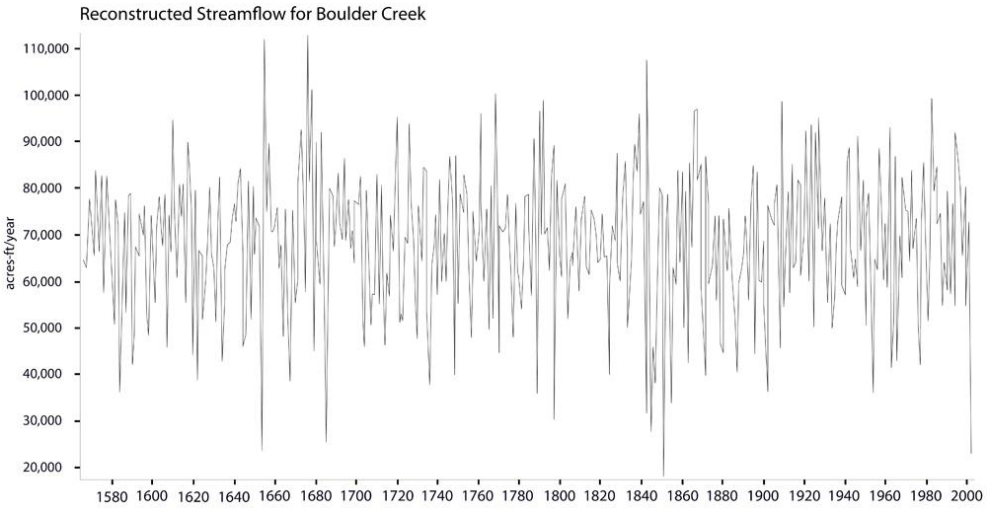
The scientific community agrees that, as a consequence of a warming climate, "[i]t is very likely that hot extremes, heat waves and heavy precipitation events will become more frequent." [AR4 Synthesis, pg. 46], while "increased extreme drought is likely" [ICCAWSA-WERF, pg 27] to take place.

These, as well as a number of other projected climate characteristics, are widely agreed upon within the scientific community and summarized in the paper Implications of Climate Change for Adaptation by Wastewater and Stormwater Agencies. The complete list includes:

- Sea Level Rise
- Glacier Melt
- Extreme Precipitation
- Extreme Drought
- Warmer & Shorter Winters
- Warmer & Drier Summers

For the purposes of this project, only the two extreme events were added as additional scenarios: Extreme Precipitation Events (increase in frequency, intensity and duration of precipitation events) and Extreme Droughts (prolonged and more sever dry spells). The extent at which these phenomena will take place, both in frequency and intensity, is not represented by current global or regional climate models. Hence it is not possible at this point to assign weather parameters as done to the previous scenarios.

The best alternative is to consider historic events exacerbated by a warmer climate. The work done by the JFRCCV Study team included the reconstruction of historic flows from 100 years of gauge records. Another effort from the City of Boulder, working with local consultants AMEC and the University of Arizona, used tree ring data to extend the record to the year 1566. The output of this study is represented in the chart below. Both these efforts will be useful for FCU in predicting the extent and severity that floods by heavy rainfall and drought periods will have in its service area.



Variability in stream flow reconstructed from tree-ring data for Boulder Creek near Orodell, CO. Provided by Connie Woodhouse, University of Arizona. (Source: “Will Boulder’s Water Supply Stand Up to Climate Change?” available at http://www.climatewatch.noaa.gov/)

Warmer & Shorter Winters and Warmer & Drier Summers are already considered in the previously selected scenarios. Sea level rise and Glacier Melt do not directly pose significant implications for FCU due to geographical location. It should be noted, however, that sea level rise may impact FCU indirectly through population shift and the migration of people inland from the coasts.

The complete list of selected scenarios for FCU planning includes:

- Warm & Wet;
- Hot & Dry;
- Median;
- Extreme Precipitation; and
- Extreme Drought.

8.0 Appendix 2: References

1.0 Alexander, P., Brekke, L.; Davis, G. et al (2011). *SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water, Report to Congress, 2011.* U.S. Department of the Interior Bureau of Reclamation. 226pp.

2.0 Averyt K., Cody K., Gordon E., Klein R., Lukas J., Smith J., Travis W., Udall B., Vogel J. (2011). *Climate Preparedness Project, Final Report*. Prepared by Western Water Assessment for the State of Colorado. 114 pp.

3.0 Barsugli, J., Anderson, C., Smith, J., Vogel, J. (2009). *Options for Improving Climate Modeling to Assist Water Utility Planning for Climate Change*. Prepared for the Water Utility Climate Alliance. 146 pp.

4.0 Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., (2008). *Climate Change and Water*. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp.

5.0 Bernstein, L., Bosch, P., Canziani, O. et al (2007). *Climate Change 2007: Synthesis Report.* Intergovernmental Panel on Climate Change, Fourth Assessment Report. 52pp.

6.0 Christensen, N., Wood, A., Voisin, N. et al. (2004). *Effects of Climate Change on the Hydrology and Water Resources of the Colorado River Basin*. Climatic Change, vol 62, pp. 337 - 363.

7.0 Hoerling, M, Webb RS, Ray AJ, Doesken N, Bradley U, Barsugli JJ, Averyt KB, Wolter K (2008). C*limate Change in Colorado, A Synthesis to Support Water Resources Management and Adaptation*. A report by the Western Water Assessment for the Colorado Water Conservation Board. 58pp.

8.0 Karl, T., Melillo, J., and Peterson, T. (eds.) (2009). *Global Climate Change Impacts in the United States*. Cambridge University Press. 196 pp.

9.0 Kennedy, C. (June 2011). *Will Boulder's Water Supply Stand Up to Climate Change?* ClimateWatch Magazine. Retrieved from http://www.climatewatch.noaa.gov/article/2011/39522/7

10.0 Means, E. Laugier, M., Daw, J., Kaatz, L. and Waage, M. (2010). *Decision Support Planning Methods: Incorporating Climate Change Uncertainties into Water Planning*. Prepared for the Water Utility Climate Alliance. 113 pp.

11.0 Smith, J., Strzepek, K., Rozaklis, L., Ellinghouse, C., Hallett, K. (2009). *The Potential Consequences of Climate Change for Boulder Colorado's Water Supplies*. Prepared for NOAA by Stratus Consulting. 83 pp.

12.0 Woodbury, M., Yates, D., Baldo, M., and Kaatz, L. (2012). *Joint Front Range Climate Change Vulnerability Study*. Sponsored and published by Water Research Foundation.

9.0. Appendix 3: List of Abbreviations

DWRF	Drake Water Reclamation Facility.
FCU	Fort Collins Utilities.
GCM	General Circulation Model or Global Climate Model. It refers to computer models based on mathematical equations that replicate our understanding of how Earth's climate works. They are used to reconstruct past phenomena and project future climate conditions.
I/I	Infiltration and Inflow. I/I refers to the dilution of sewage by water entering the sewage stream through these two processes and results in decreased efficiencies in the treatment process.
IPCC	Intergovernmental Panel on Climate Change. The IPCC is a scientific intergovernmental body of the United Nations responsible for reviewing and assessing all scientific, technical and socio-economic information produced worldwide in order to improve our understanding of climate change.
JFRCCVS, JFRCCV Study	Joint Front Range Climate Change Vulnerability Study.
MWRF	Mulberry Water Reclamation Facility.
NPDES	National Pollutant Discharge Eliminator System. The U.S. Environmental Protection Agency's (EPA) NPDES is a "permit program [that] controls water pollution by regulating point sources that discharge pollutants into waters of the United States." (from EPA's NPDES website, http://cfpub.epa.gov/npdes/)
PR	Public Relations.
PRPA	Platte River Power Authority.

RCM	Regional Climate Model. It refers to a small-scale climate model that reflects the interaction of large-scale climate patterns with regional topography and other weather-determining factors in order to replicate and predict local climate conditions. The output resolution of RCMs is more detailed in comparison to that of GCMs.
TOC	Total Organic Carbon. It is a measure of the amount of carbon bound in organic compounds and is used as a non-specific indicator of water quality.
WEAP	Water Evaluation And Planning. WEAP is a user-friendly computer system developed and administered by the Stockholm Environmental Institute that helps in water resources planning. It includes a hydraulic model that can be calibrated to represent a specific river basin.
WERF	Water Environment Research Foundation.

10.0 Appendix 4: Agenda and Attendees at Workshop 1

MEETING AGENDA

City of Fort Collins Utilities

Climate Change Adaptation Planning

Workshop 1

Monday, July 11, 2011 9:00AM – 1:00 PM

Community Room

215 N. Mason (NW corner of Laporte Avenue and Mason)

Fort Collins, CO

Purpose:

To identify implications for FCU based on risks associated with climate changes expected in the Front Range region.

Agenda:

09.00	Welcome and Introductions	Simon Heart, MWH
09.10	FCU Objectives and Overall Project Background	Katy Bigner, FCU
09.20	Workshop Overview and Objectives	Jamie Loucks, MWH
09.30	Climate Science and Progress in the Front Range	David Yates, NCAR

		Mark Woodbury, Riverside Technologies
10.00	Climate Planning Case Study	Laurna Kaatz, Denver Water
10.30	Break	
10.45	Potential Front Range Climate Risks and Implications for FCU – Interactive Session	Jamie Loucks, MWH
12.30	Working Lunch	
12.50	Wrap-up and Next Steps	Simon Heart, MWH
01.00	Adjourn	

Participants:

Fort Collins Utilities Department
Katy Bigner, Environmental Project Coordinator John Stokes , Director, Natural Resources Department Lucinda Smith , Senior Environmental Planner (Air Quality and Climate) Brian Janonis, Utilities Executive Director Joe Frank, Advance Planning Director Dennis Bode, Water Resources Manager Bruce Hendee, Assistant to the City Manager Kevin Gertig, Water Resources and Treatment Operations Manager
Denver Water
Laurna Kaatz
MWH
Simon Heart, Project Manager Chip Paulson, Client Service Manager Jamie Loucks, Technical Lead Luis Matheus, Project Engineer Lisa Fardal, Project Engineer
Riverside Technologies
Mark Woodbury
NCAR
David Yates

11. Appendix 5: Agenda and Attendees at Workshop 2

MEETING AGENDA

City of Fort Collins Utilities

Climate Change Adaptation Planning

Workshop 2

Thursday, September 1, 2011 8:30AM – 12:00 PM

Primrose Studio - 43 Michaud Lane

Fort Collins, CO

Purpose:

Previously as part of this project, a rigorous review of current climate science and information on climate change impacts in the Colorado Front Range was completed and assessed through an interactive workshop. The workshop resulted in a documented list of expected climate changes and associated impacts for Fort Collins Utilities. This list of identified impacts is the foundation for the development of a decision framework and action planning to reduce risk associated with climate change.

The purpose of Workshop 2 is to take the next step in the process by exploring these impacts in detail and identifying:

1) Associated implications for Fort Collins Utilities that may need addressing ;
2) An approach to prioritize action toward these implications; and
3) Preliminary steps that can be taken to address the implications.

Agenda:

08.30	Welcome and Introductions	Simon Heart, MWH
08.40	Workshop Objectives	Jamie Loucks, MWH
08.45	Review of Climate Change Impacts	Jamie Loucks, MWH
08.55	Identification of Implications:	All

	How will expected climate change impacts affect FCU?	
09.50	Break	
10.00	Characterization of Implications: Which issues should be addressed first?	All
11.00	Preliminary Strategy Discussion: What steps should be taken to reduce or eliminate negative impacts associated with climate change?	All
11.50	Wrap-up and Next Steps	Simon Heart, MWH
12.00	Adjourn	

Participants:

Fort Collins Utilities Department
Katy Bigner John Stokes Bruce Hendee Kevin Gertig Lisa Voytko John Phelan Ken Sampley Chris Parton Patty Bigner Jill Oropeza Jon Haukaas Link Mueller Dennis Bode Steve Catanach Cliff Hoelscher
MWH
Simon Heart, Project Manager (Outgoing) Chris Puccio, Project Manager Chip Paulson, Client Service Manager Jamie Loucks, Technical Lead Luis Matheus, Project Engineer

;