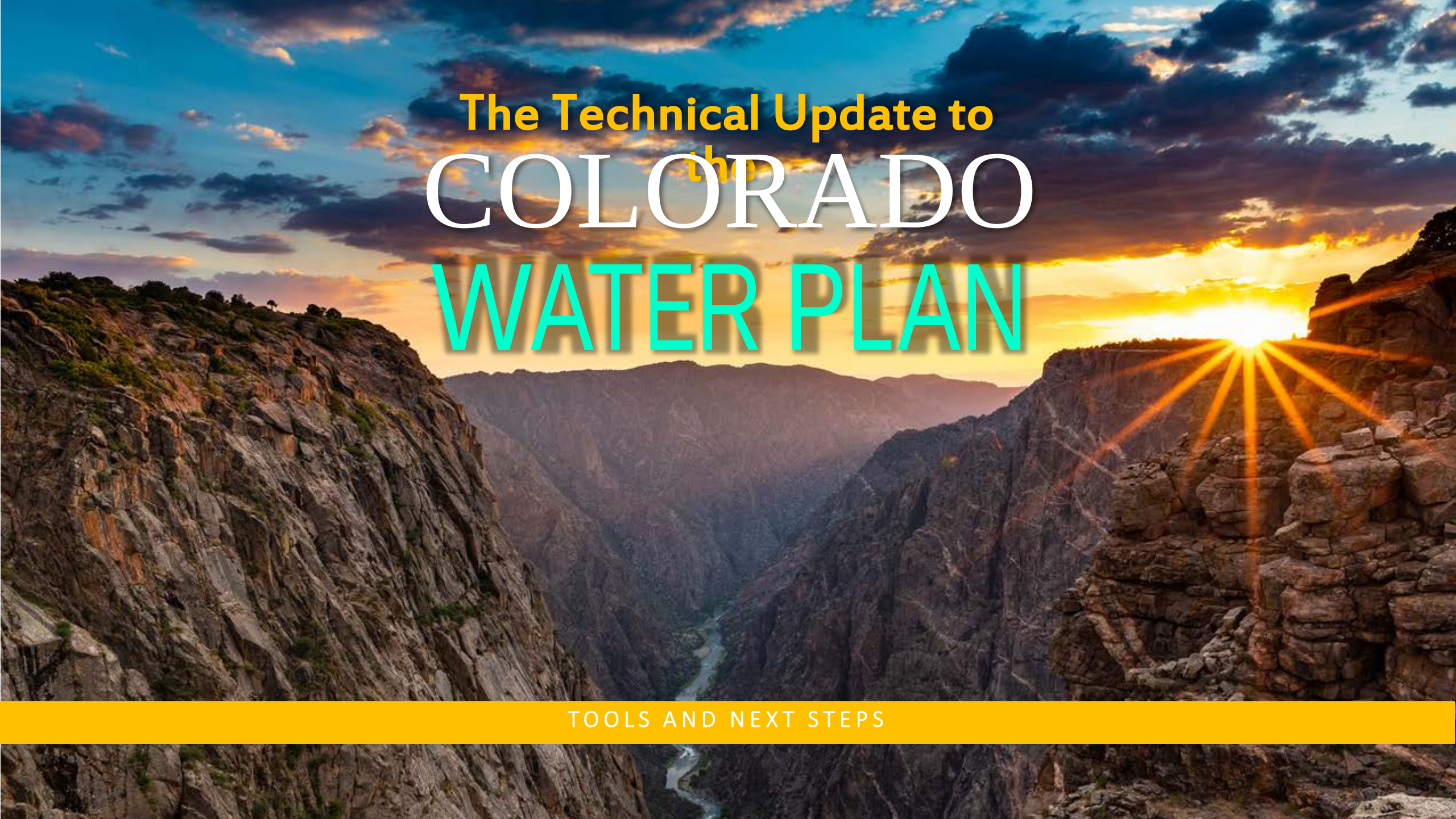

The Technical Update to the
COLORADO
WATER PLAN
TOOLS AND NEXT STEPS

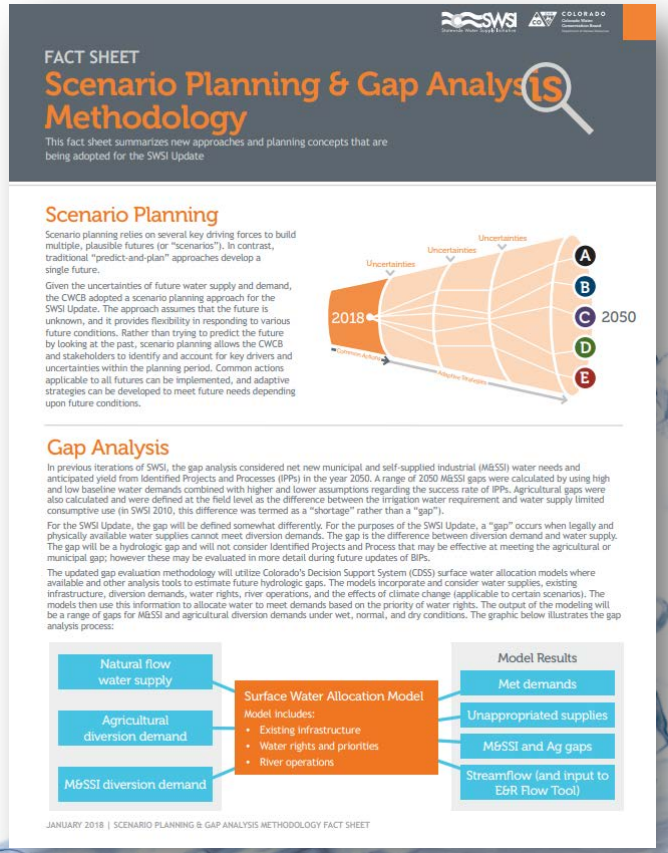
PRESENTATION

AGENDA

- Background / Process/ Methodology
- Case Studies/ Economic Impacts of Shortages/ Public Values/ Storage Opportunities/ Water Reuse/ ATM's
- Flow Tool
- Project Cost Estimating Tool
- Next Steps

TECHNICAL UPDATE
METHODOLOGY

- New Water Plan-based approach
- First update since the Water Plan
- First update to incorporate climate
- First update to use the hydrologic modeling



FACT SHEET

Scenario Planning & Gap Analysis Methodology

This fact sheet summarizes new approaches and planning concepts that are being adopted for the SWSI Update

Scenario Planning

Scenario planning relies on several key driving forces to build multiple, plausible futures (or "scenarios"). In contrast, traditional "predict-and-plan" approaches develop a single future.

Given the uncertainties of future water supply and demand, the CWCB adopted a scenario planning approach for the SWSI Update. The approach assumes that the future is unknown, and it provides flexibility in responding to various future conditions. Rather than trying to predict the future by looking at the past, scenario planning allows the CWCB and stakeholders to identify and account for key drivers and uncertainties within the planning period. Common actions applicable to all futures can be implemented, and adaptive strategies can be developed to meet future needs depending upon future conditions.

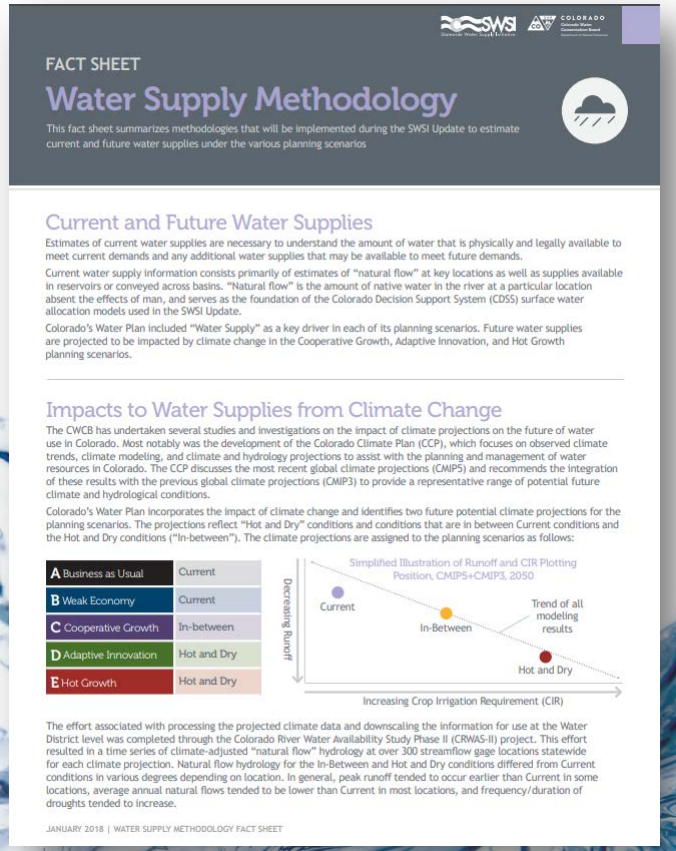
Gap Analysis

In previous iterations of SWSI, the gap analysis considered net new municipal and self-supplied industrial (M&SSI) water needs and anticipated yield from Identified Projects and Processes (IPPs) in the year 2050. A range of 2050 M&SSI gaps were calculated by using high and low baseline water demands combined with higher and lower assumptions regarding the success rate of IPPs. Agricultural gaps were also calculated and were defined at the field level as the difference between the irrigation water requirement and water supply limited consumptive use (in SWSI 2010, this difference was termed as a "shortage" rather than a "gap").

For the SWSI Update, the gap will be defined somewhat differently. For the purposes of the SWSI Update, a "gap" occurs when legally and physically available water supplies cannot meet diversion demands. The gap is the difference between diversion demand and water supply. The gap will be a hydrologic gap and will not consider Identified Projects and Process that may be effective at meeting the agricultural or municipal gap; however these may be evaluated in more detail during future updates of BIPs.

The updated gap evaluation methodology will utilize Colorado's Decision Support System (CDSS) surface water allocation models where available and other analysis tools to estimate future hydrologic gaps. The models incorporate and consider water supplies, existing infrastructure, diversion demands, water rights, river operations, and the effects of climate change (applicable to certain scenarios). The models then use this information to allocate water to meet demands based on the priority of water rights. The output of the modeling will be a range of gaps for M&SSI and agricultural diversion demands under wet, normal, and dry conditions. The graphic below illustrates the gap analysis process:

JANUARY 2018 | SCENARIO PLANNING & GAP ANALYSIS METHODOLOGY FACT SHEET



FACT SHEET

Water Supply Methodology

This fact sheet summarizes methodologies that will be implemented during the SWSI Update to estimate current and future water supplies under the various planning scenarios

Current and Future Water Supplies

Estimates of current water supplies are necessary to understand the amount of water that is physically and legally available to meet current demands and any additional water supplies that may be available to meet future demands.

Current water supply information consists primarily of estimates of "natural flow" at key locations as well as supplies available in reservoirs or conveyed across basins. "Natural flow" is the amount of native water in the river at a particular location absent the effects of man, and serves as the foundation of the Colorado Decision Support System (CDSS) surface water allocation models used in the SWSI Update.

Colorado's Water Plan included "Water Supply" as a key driver in each of its planning scenarios. Future water supplies are projected to be impacted by climate change in the Cooperative Growth, Adaptive Innovation, and Hot Growth planning scenarios.

Impacts to Water Supplies from Climate Change

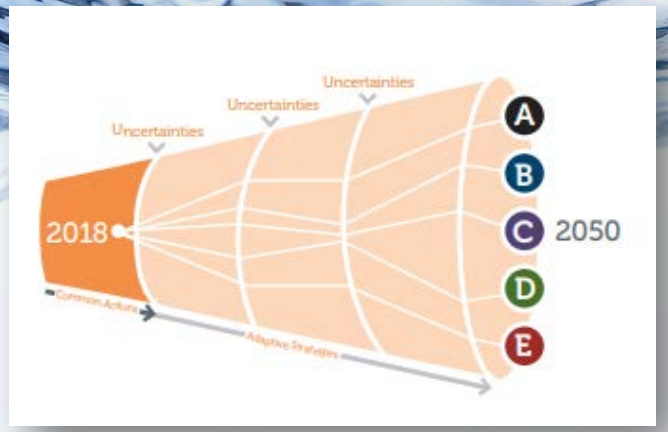
The CWCB has undertaken several studies and investigations on the impact of climate projections on the future of water use in Colorado. Most notably was the development of the Colorado Climate Plan (CCP), which focuses on observed climate trends, climate modeling, and climate and hydrology projections to assist with the planning and management of water resources in Colorado. The CCP discusses the most recent global climate projections (CMIP5) and recommends the integration of these results with the previous global climate projections (CMIP3) to provide a representative range of potential future climate and hydrological conditions.

Colorado's Water Plan incorporates the impact of climate change and identifies two future potential climate projections for the planning scenarios. The projections reflect "Hot and Dry" conditions and conditions that are in between Current conditions and the Hot and Dry conditions ("In-between"). The climate projections are assigned to the planning scenarios as follows:

A Business as Usual	Current
B Weak Economy	Current
C Cooperative Growth	In-between
D Adaptive Innovation	Hot and Dry
E Hot Growth	Hot and Dry

The effort associated with processing the projected climate data and downscaling the information for use at the Water District level was completed through the Colorado River Water Availability Study Phase II (CRWAS-II) project. This effort resulted in a time series of climate-adjusted "natural flow" hydrology at over 300 streamflow gage locations statewide for each climate projection. Natural flow hydrology for the In-Between and Hot and Dry conditions differed from Current conditions in various degrees depending on location. In general, peak runoff tended to occur earlier than Current in some locations, average annual natural flows tended to be lower than Current in most locations, and frequency/duration of droughts tended to increase.

JANUARY 2018 | WATER SUPPLY METHODOLOGY FACT SHEET



Brown AND Caldwell

Presentation by

Matt Lindburg - Principal

www.brownandcaldwell.com

OVERARCHING

GOALS

Technical Update update goals:

- A consistent statewide framework for examining future water supply and demand scenarios.

- Tools and data for roundtables to update their basin plans (e.g. identify local solutions).

- Meet other Water Plan timing goals and actions (e.g. Chapter 6 Actions)
  - Monitor Drivers
  - Promote the use of scenario planning and adaptive strategies
  - Support the Colorado Decision Support System

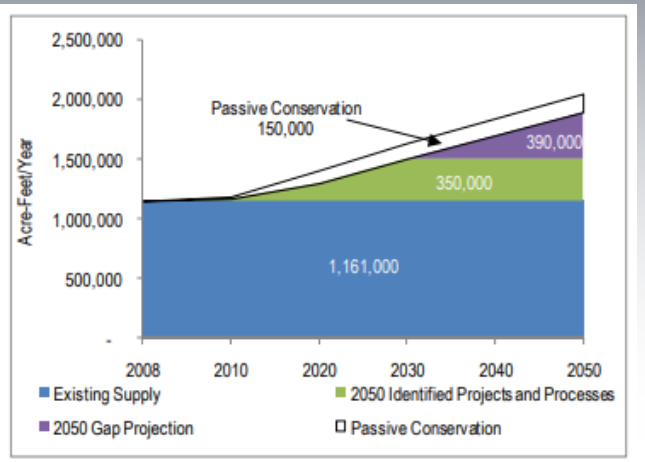
STAKEHOLDER-DRIVEN METHODOLOGIES

2050 Demand Projections

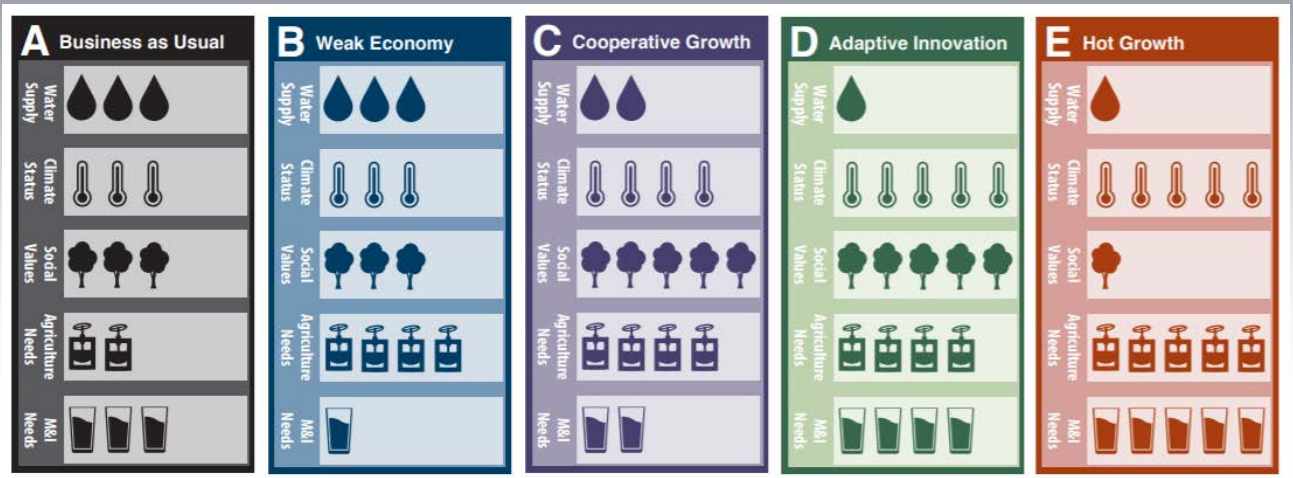
- IPPs

_____

= 2050 M&I Gap

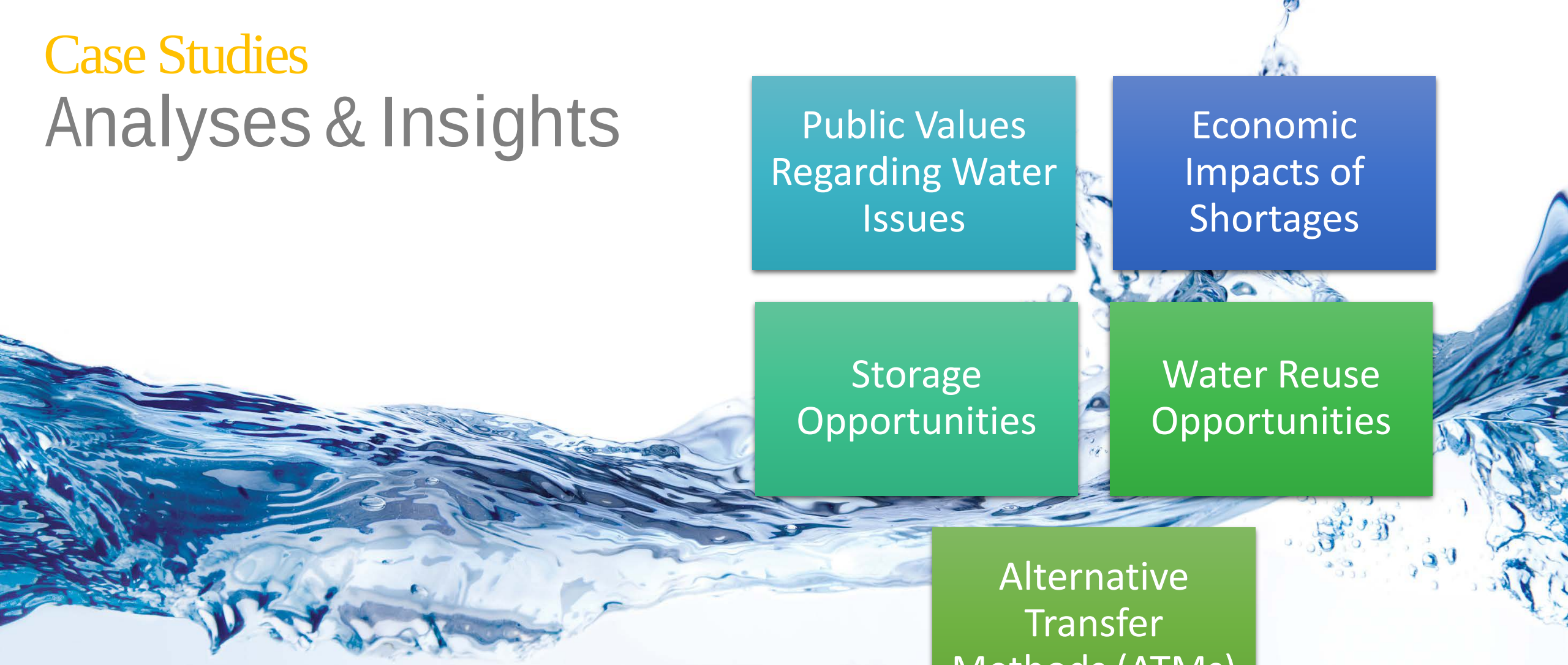


- **Hydrologic Modeling**
- **Municipal Modeling**
- **Agricultural Modeling**
- **Environmental Modeling**
- **Scenario Planning Across Major Drivers**



Case Studies

Analyses & Insights



Presentation by
Brendan Hedel, Water Resources Engineer
www.jacobs.com

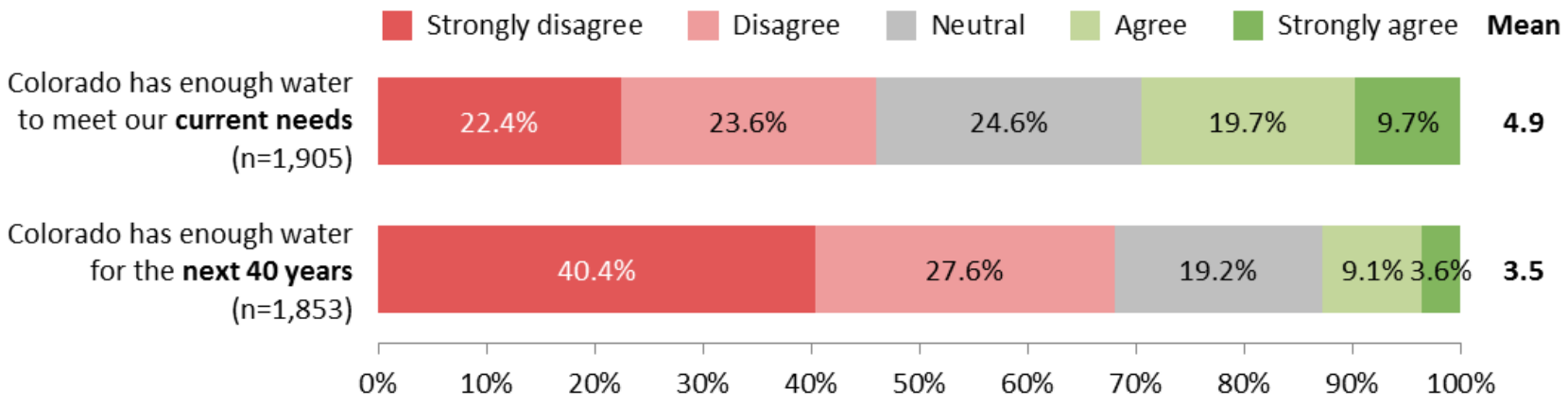
Public Values Regarding Water Issues in Colorado

Question

- Can we better understand public values related to water supply challenges in Colorado?

Analysis

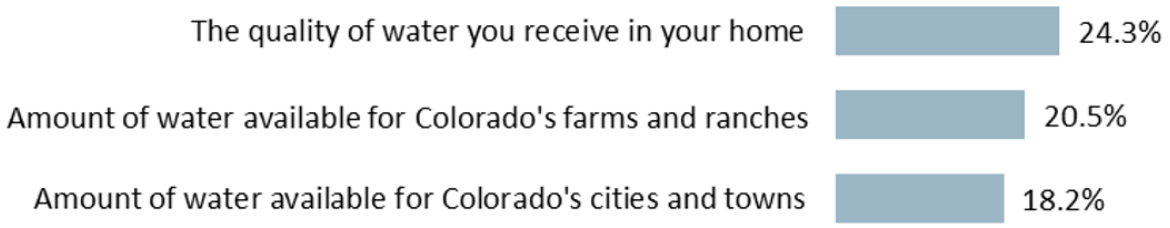
- Update to 2013 CWCB survey of public water issue awareness



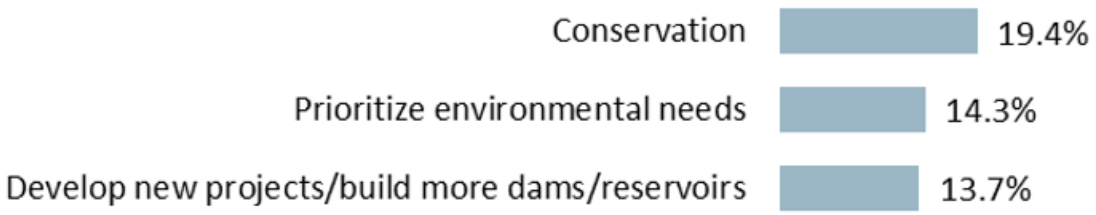
Public Values Regarding Water Issues in Colorado

Key Insights

Top Three Public Concerns



Top Three Public Solutions



Willingness to Pay

Economic Impacts of Shortages

Question

- What are potential economic impacts of failing to solve future supply/demand gaps in Colorado?

Analysis

- Estimate future annual revenues not realized and associated reductions in jobs for future gaps

Economic Impacts of Failing to Solve Future Projected Supply/Demand Gaps

Key Insights

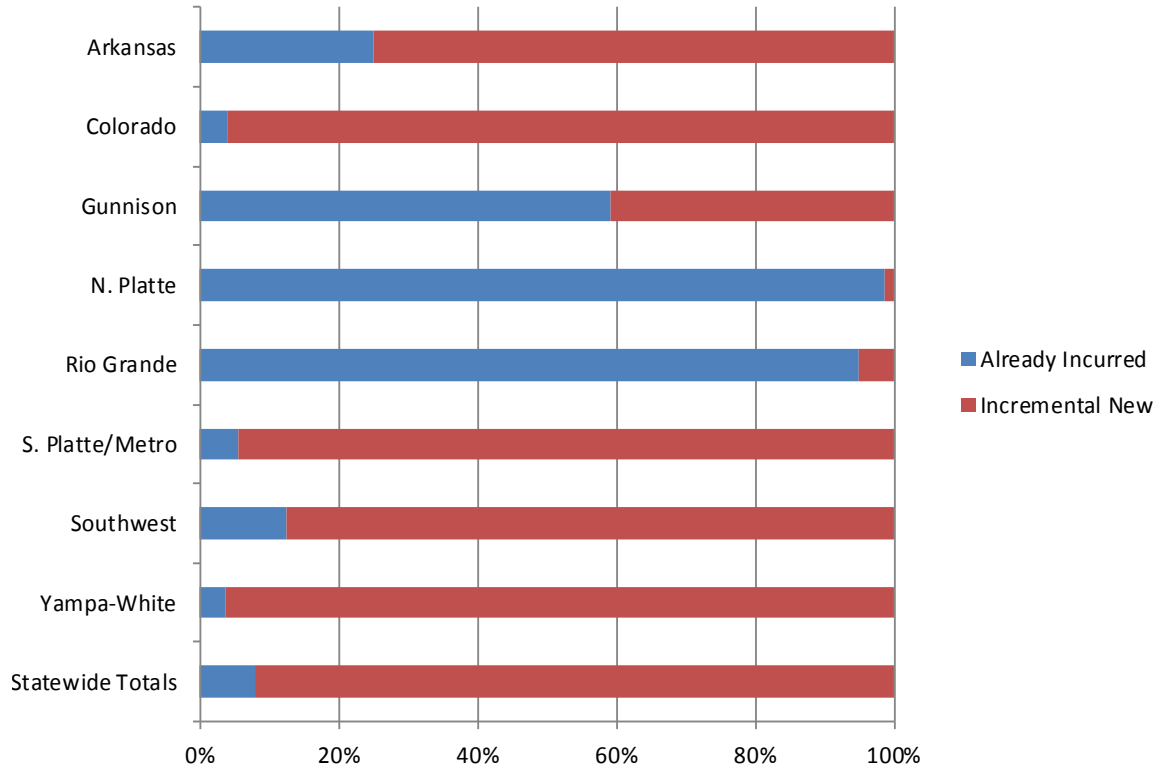
Existing Shortages Impacts

- $3 billion annual revenue not realized
- 28,000 fewer jobs

Failing to Solve 2050 Shortages

- $53 - $90 billion in annual revenue not realized
- 335,000 – 587,000 fewer jobs
- $3 - $6 billion annual state and local tax revenues not realized

Proportions of projected 2050 economic impacts already incurred due to gaps in available agricultural water supply



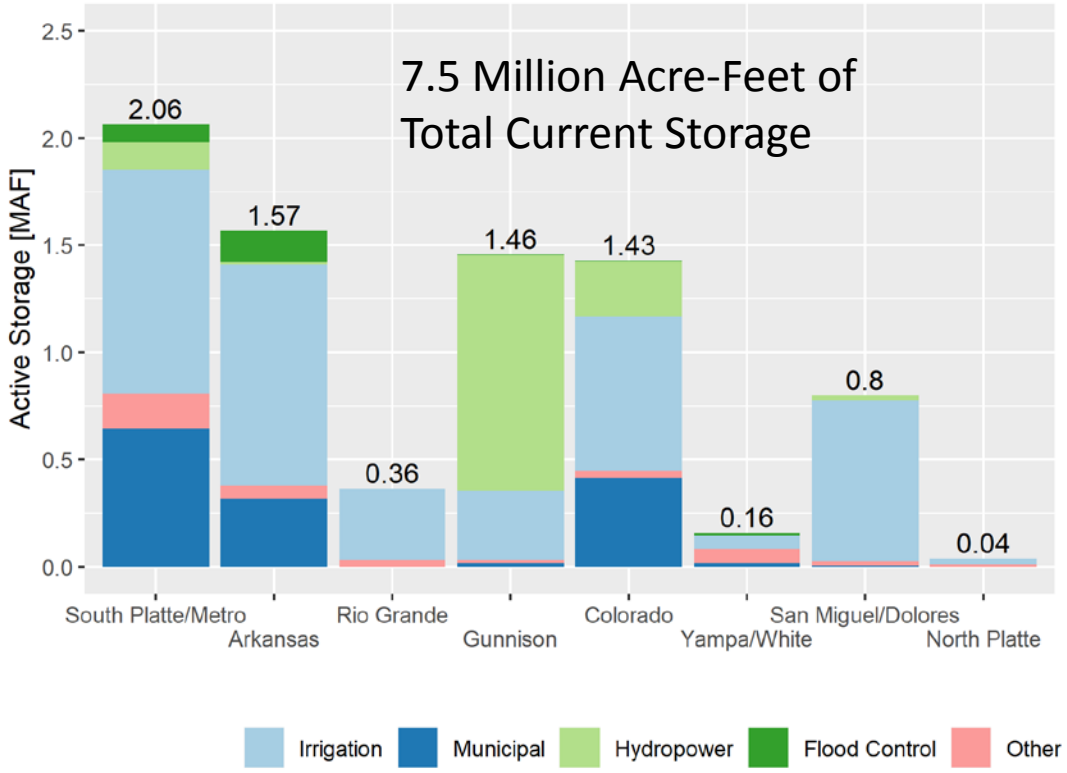
Storage Opportunities

Question

- What opportunities exist for developing future storage and increasing existing storage?

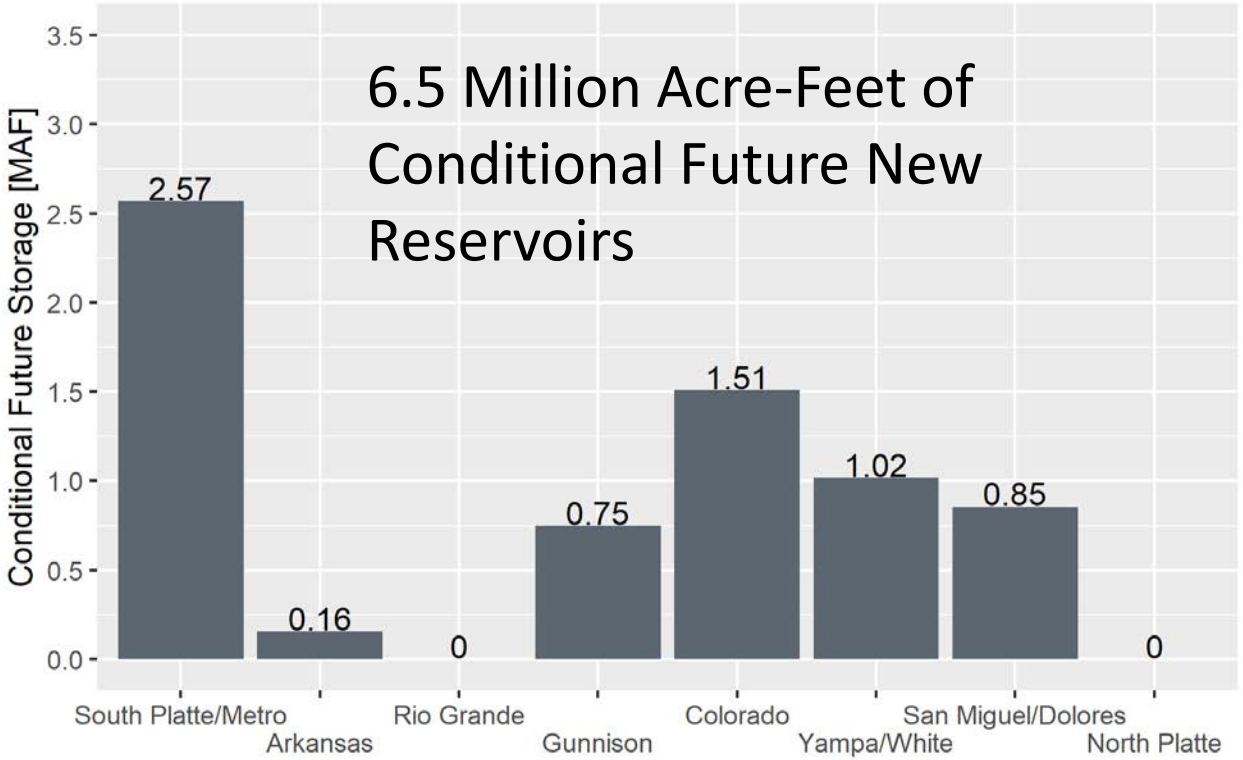
Analysis

- Queried the State's water rights database to identify:
  1. Current statewide storage
  2. Future conditional storage



Storage Opportunities

Key Insights



Other Storage Opportunities

- Reallocation of flood storage
- Removal of sediment from reservoirs
- Rehabilitation of fill restricted dams
- Dam enlargements
- Aquifer storage and recovery

Water Reuse

Question

- What are key considerations for developing future reuse projects?

Analysis

- Compared benefits and challenges of the following types of reuse:

Reuse via Exchange
Indirect Potable Reuse
Direct Potable Reuse

Non-Potable Reuse

Graywater Reuse

Water Reuse

Key Insights

- All forms of reuse can reduce the need for new supplies
- Some types of reuse can be more effective than others
- Reuse can result in a reduction in downstream flow that requires close coordination with downstream users

Alternative Transfer Methods (ATMs)

Question

- How might traditional barriers to ATMs be overcome and to what scale would they be needed to make a large impact?

Analysis

- Compared benefits and challenges of the following types of ATMs:

Ag. To Municipal

Ag. To Environmental

Ag. To Compact Compliance

Alternative Transfer Methods (ATMs)

Key Insights

Key Methods for Overcoming Barriers

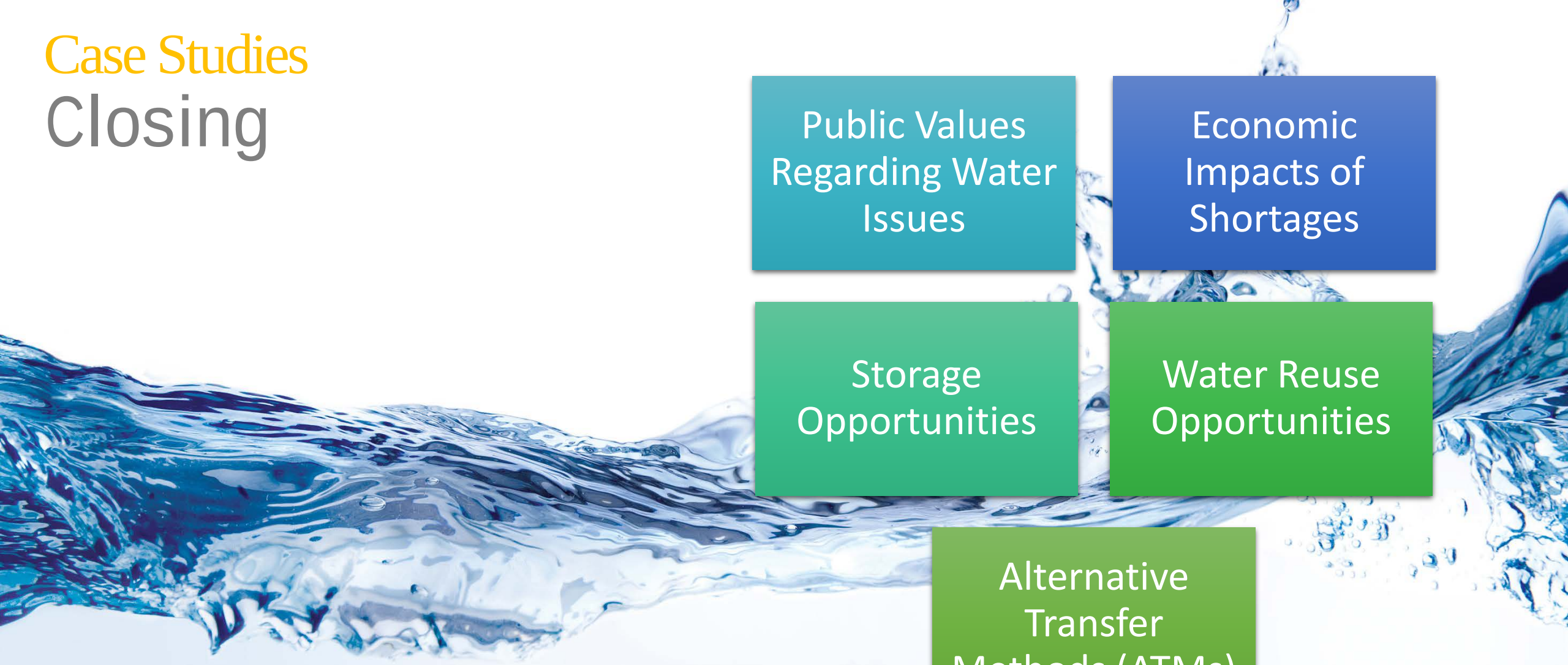
- New legal abilities to transfer water
- Ability to protect HCU
- Innovative ATM operations, e.g. split-season fallowing
- Recognition that there is no “one size fits all” approach for ATMs

Land Required for Large-Scale ATM

To meet 25% of a hypothetical South Platte Basin municipal gap of 100,000 acre-feet:

- 15% of South Platte Basin irrigated acres (825,000 acres) may need to be enrolled in large-scale ATM program
- Significant infrastructure components potentially required

Case Studies
Closing



Presentation by
Brendan Hedel, Water Resources Engineer
www.jacobs.com

NEW TOOLS FOR WATER PLANNING

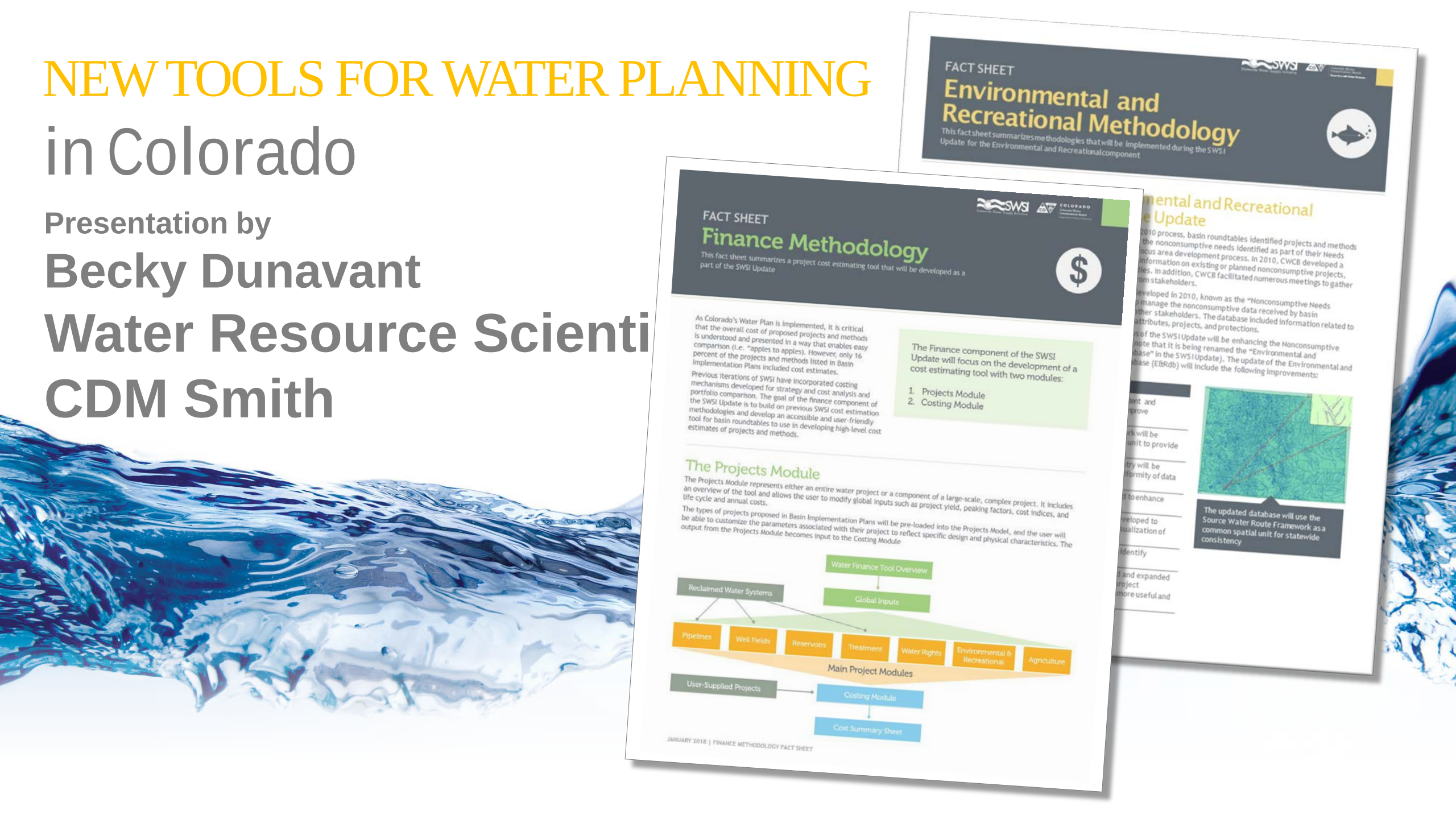
in Colorado

Presentation by

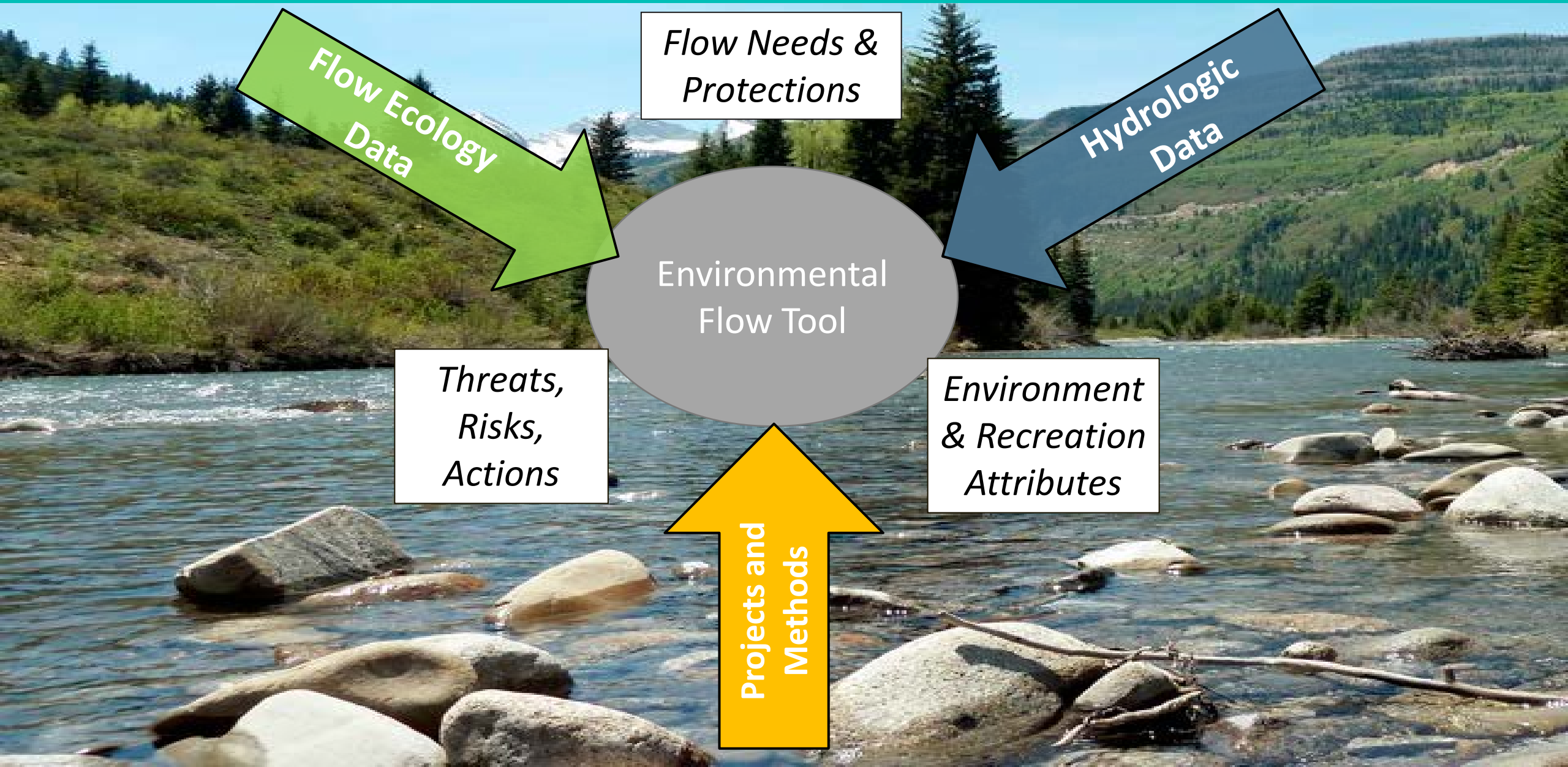
Becky Dunavant

Water Resource Scienti

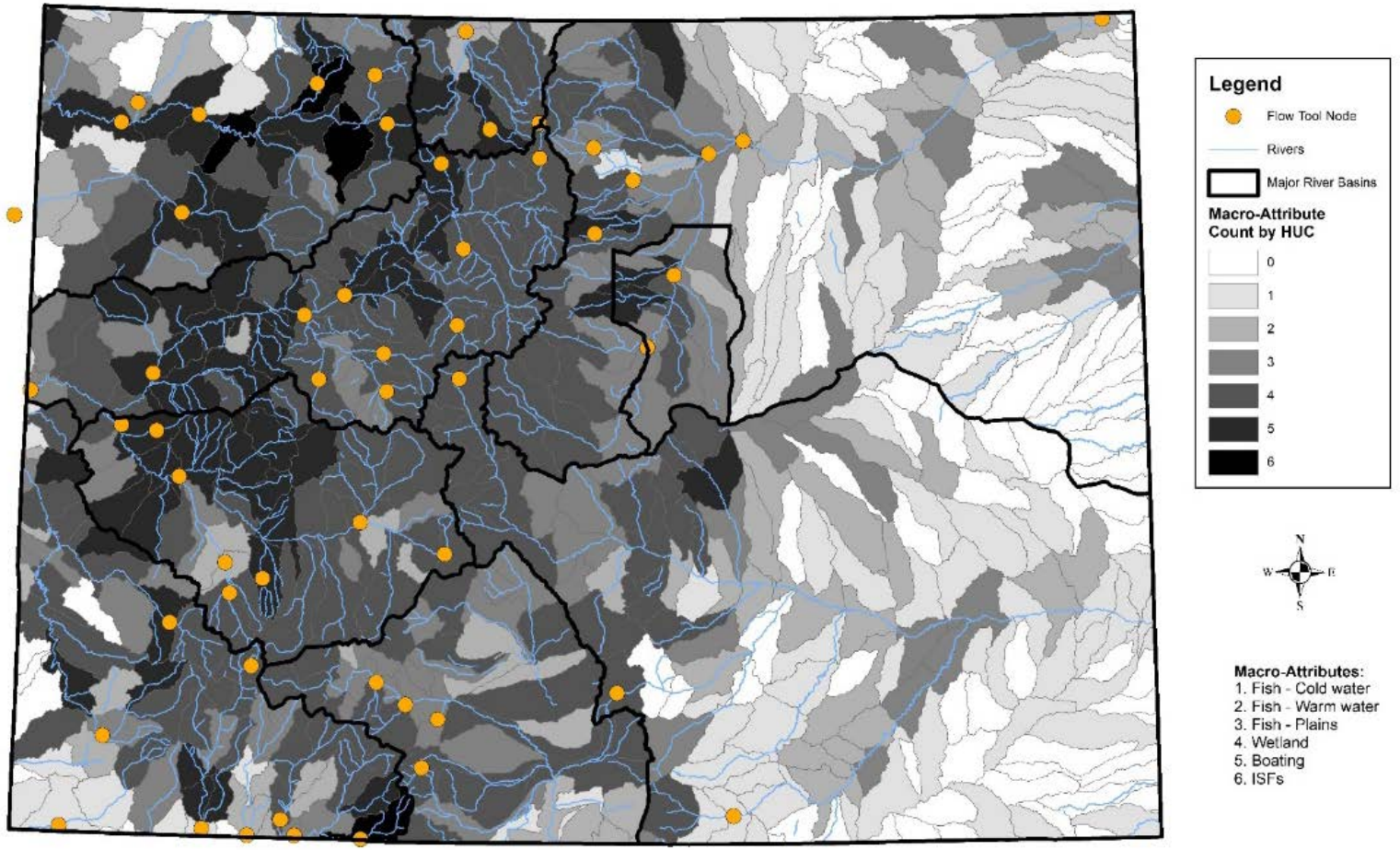
CDM Smith



Environmental Flow Tool



Environmental Flow Tool



MACRO-ATTRIBUTE CATEGORIES

Coldwater Fish	Warmwater Fish	Plains Fish	Wetlands	Boating	Instream Flows

Environmental Flow Tool

Colorado Environmental Flow Tool

Calculation Details

Basin Name:	Node Name:
Colorado	09057500 (Blue River bl Grn Mtn Reserv

Calculation Period

Start Year: 1975 End Year: 2013

Available Simulation Period = 1975 - 2013

Flow Data Sets

Historical:
- A.) Naturalized Flow
- B.) Baseline Flow

Future:
- C.) Business as Usual
- D.) Weak Economy
- E.) Cooperative Growth
- F.) Adaptive Innovation
- G.) Hot Growth
- H.) Naturalized: Hot/Dry
- I.) Naturalized: Inbetween

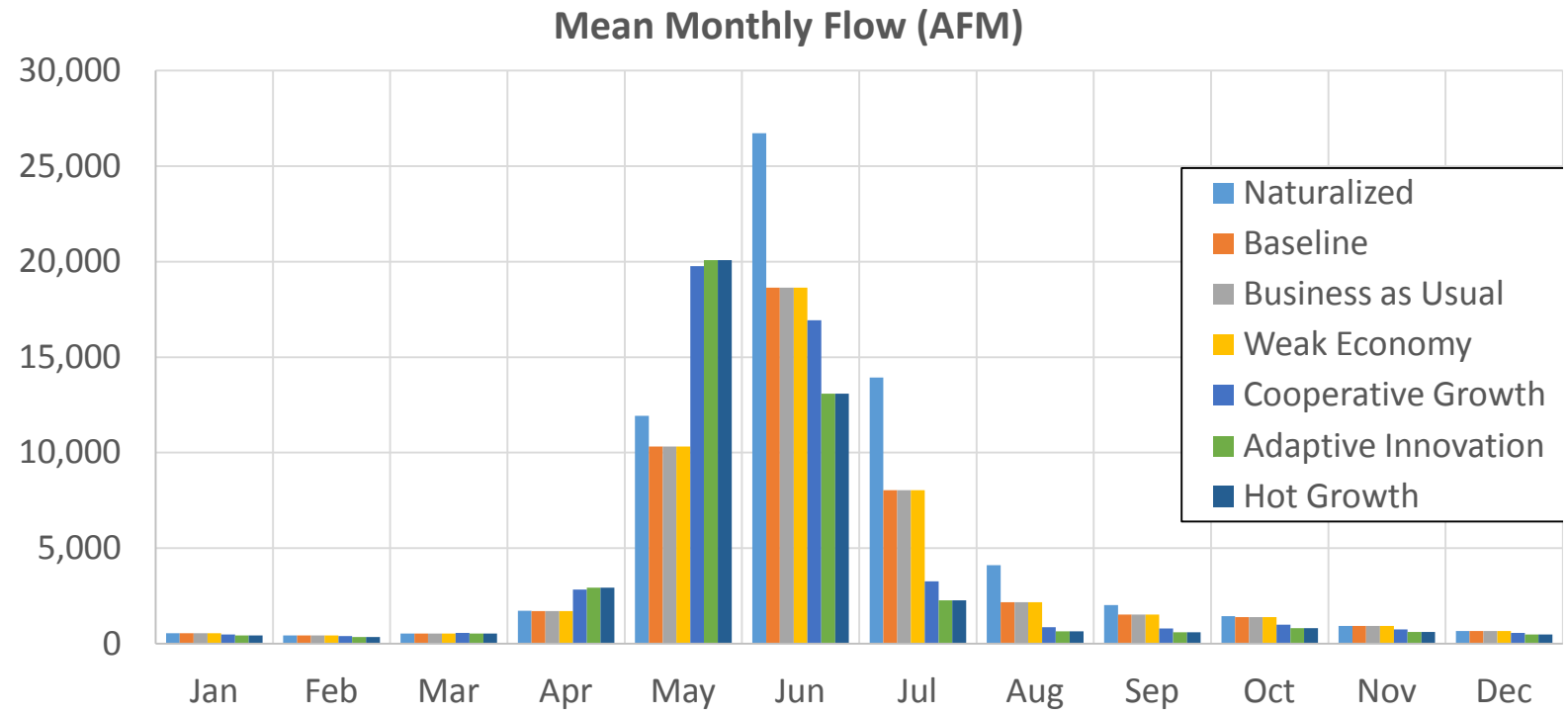
Outputting
- ***monthly timeseries plot***
- ***annual timeseries plot***
- ***3 year rolling avg. plot***
- ***10 year rolling avg.***
- ***monthly avg. plot***
- ***flow percentiles plot***
- ***hydrologic classification table***
- ***regulatory low flow table***
- ***environmental flow metric table***

(•) color coding only
( ) metric values

Description of Future Scenarios

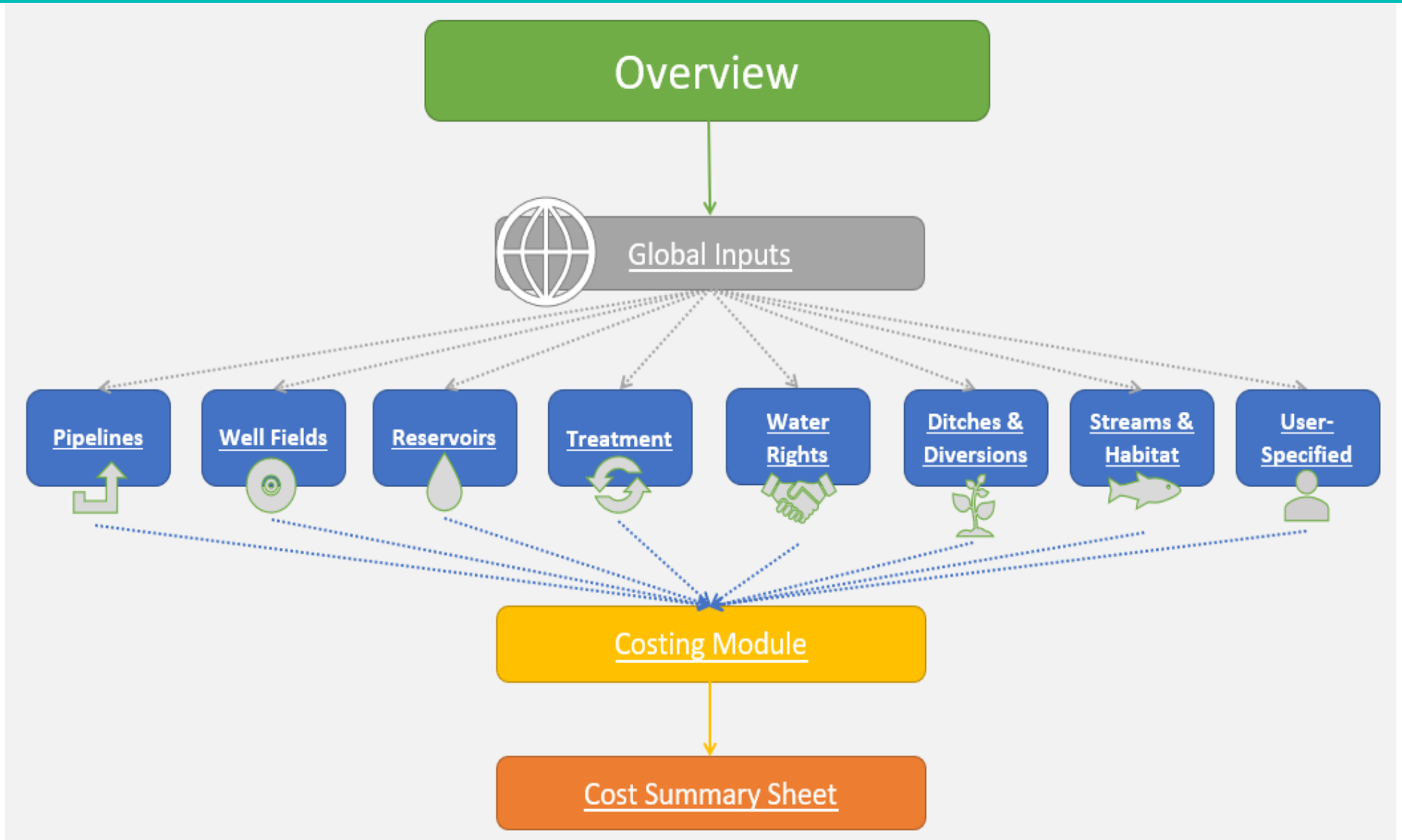
Note: Default reference flows for environmental flow metrics = naturalized flow data set. If baseline data set is preferred as reference then run calculations without naturalized but with baseline data set.

Calculate | Close



Flow Metric	*Naturalized*	*Gaged*	*Baseline*	*Scenario 1: Business as Usual*	*Scenario 2: Weak Economy*	*Scenario 3: Cooperative Growth*	*Scenario 4: Adaptive Innovation*	*Scenario 5: Hot Growth*
Cold Water Fish Baseflow Fraction: Aug, Sep								
Change in Plains Fish Baseflow Fraction: Jul, Aug								
Change in Peak Flow, for Wetland Plants								
Change in Max Sucker Biomass								
Change in Peak Flow, for Warmwater Fish								
Change in Average Annual Flow								
Change in Average Winter Flow								
Change in Average Late Summer Flow								

Colorado Water Project Cost Estimating Tool – Overview



Colorado Water Project Cost Estimating Tool – Global Inputs

CWCB Colorado Water Project Cost Estimating Tool

Input Key

0	User Input
0	Informational Data*
0	Default Value, Adjustable by User
0	Calculated Values, Not to be Adjusted

Reset All Module Inputs

*This tool provides a means of collecting cost data for various projects throughout the state of Colorado. Some information may not currently factor into costing of a project, but is useful for understanding the components of the project. User to please provide as much information as possible regarding their proposed project.

Project Information

Project Name:	
Project ID:	
Project Need Addressed (check all that apply):	☐ Municipal and Industrial ☐ Agricultural ☐ Environmental & Recreation ☐ Other:
Basin:	
Location:	
Cost Estimator:	
Checked By:	
Calculation Date:	6/19/2019

Modules Utilized

☐ Pipelines	☐ Well Fields	☐ Reservoirs	☐ Treatment	☐ Water Rights	☐ Streams & Habitats	☐ Ditches and Diversions

Project Start (MONTH-YY)		
Project Completion (MONTH-YY)		
Construction Period	-	years
Base Construction Cost Time Period	2017	
Project Construction Start Time Period	2017	
Estimated Project Useful Life	50	years
Annual-Average Water Supply Yield		ac-ft/yr

Reset General User Inputs

Restore General Input Default Values

Project Development Costs

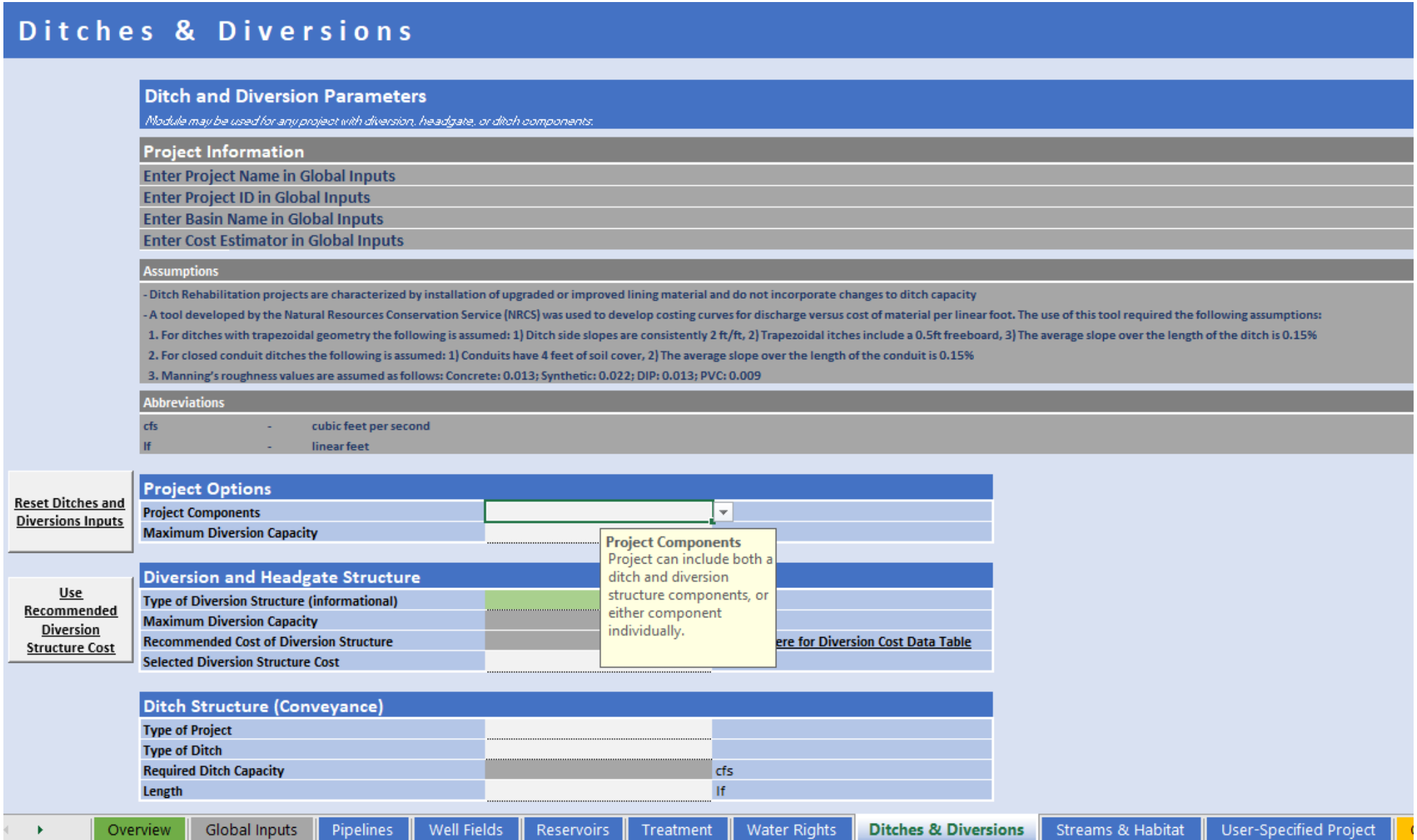
Engineering Services	20.0%	% of Capital Costs
Surveying	1.0%	% of Capital Costs
Legal Service	10.0%	% of Capital Costs
Financing and Bond Assistance	1.0%	% of Capital Costs
Environmental and Cultural Studies	1.0%	% of Capital Costs
Required Land Acquisition		acres
Land Acquisition Cost		$ per acre
Permitting	1.0%	% of Capital Costs
Interest During Construction	4.0%	

erview | Global Inputs | Pipelines | Well Fields | Reservoirs | Treatment | Water Rights | Ditches & Diversions | Streams & Habitat | User-Specified Project | Costing Module | Cost Summary

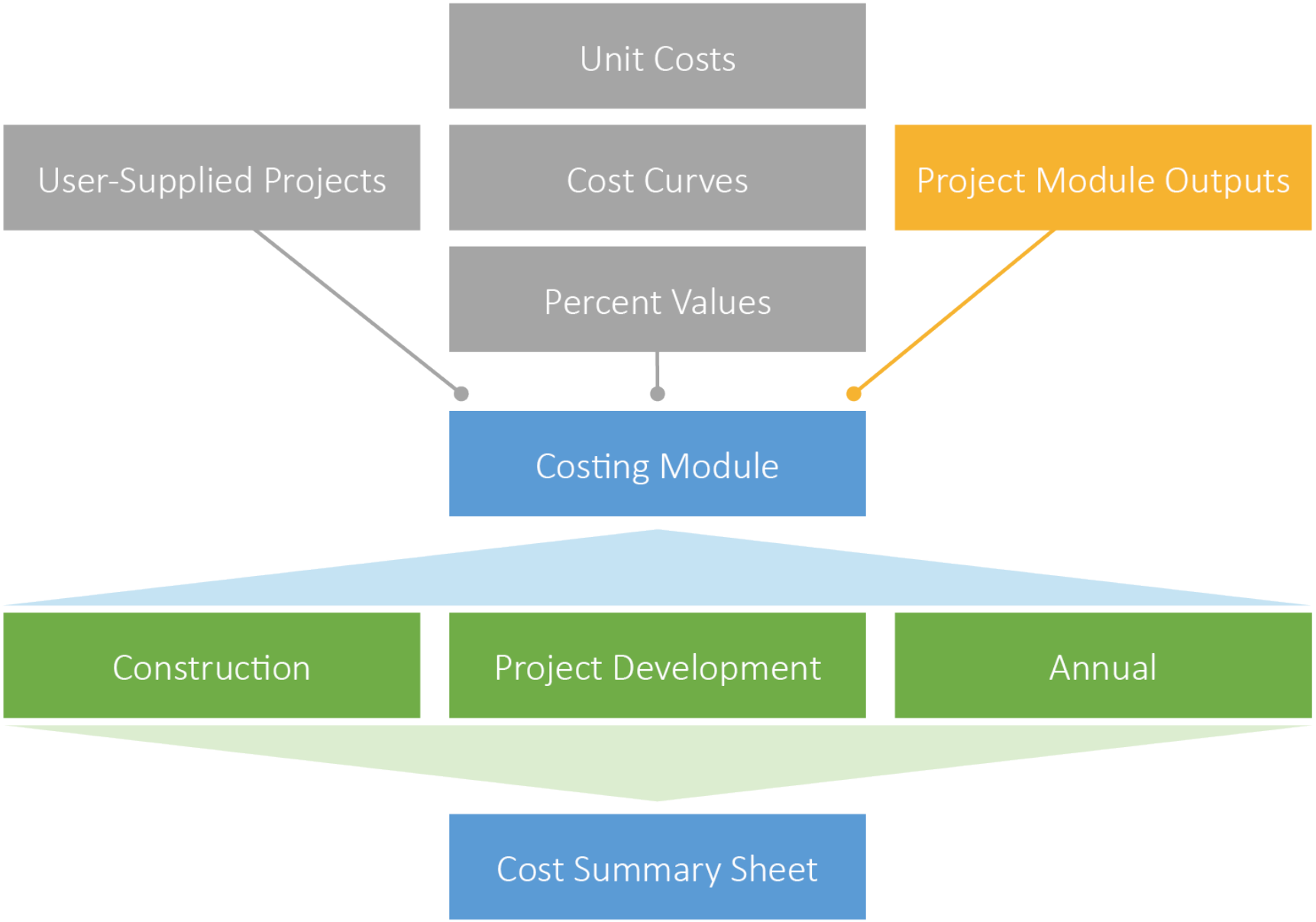
Colorado Water Project Cost Estimating Tool – Project Modules

Project Module	Types	Components	General User Inputs
Pipelines	Raw, Treated	Pipelines, Pump Stations, Storage	Project Yield and Peaking Factor, Pipeline Profile Components, Pipe Size and Length, Pump Type
Well Fields	Public Supply, Aquifer Storage and Recovery, Injection, Irrigation Wells	Wells, Booster Pumps, Pipe Network	Water Table Characteristics, Project Yield and Peaking Factor, Transmission Pipeline Profile Components, Number of Wells and Average Production, Well Depth and Capacity, Transmission Pipe Size and Length, Booster Pump Capacity
Reservoirs	New Reservoir, Reservoir Expansion, Reservoir Rehabilitation	Reservoir, Reservoir Rehab, Hydropower Production	Project Type, New Storage Volume, Reservoir Rehab Project Description, Cost of Rehabilitation, Height of Falling Water, Discharge through Hydropower Station
Treatment	Various Treatment Types	Treatment	Average Day Demand and Peaking Factor, Treatment Type
Water Rights	Instream Flow Requirements, Recreational In-Channel Diversion, Water Supply	Cost	Total Capital Cost of Water Right Purchase
Ditches and Diversion	New Ditch, Ditch Rehabilitation	Diversion Structure, Headgate Structure, Ditch	Type of Diversion Structure, Type of Headgate Structure, Maximum Diversion Discharge/Ditch Capacity, Type of Ditch, Ditch Length
Streams and Habitat	Stream Restoration, Conservation, Habitat Restoration/Species Protection, Acid Mine Drainage Water Treatment	Land Acquisition, Channel Improvements, Channel Structures, Channel Realignment	Stream Width Range, Length of Restoration, Level of Restoration
User-Specified Project	Project Types not represented by other modules	User-specified	Project Description, Total Capital Costs, Total Operations & Maintenance Costs

Colorado Water Project Cost Estimating Tool – Project Modules (example)



Colorado Water Project Cost Estimating Tool – Costing Module



Colorado Water Project Cost Estimating Tool – Cost Summary Sheet

Enter Project Name in Global Inputs
Enter Project ID in Global Inputs
Enter Basin Name in Global Inputs

Cost Analysis Computed by

6/19/2019

Create Cost Summary | Reset Cost Summary

Capital Construction Costs

Total Pipelines Project Cost	*$0*
Total Well Field Project Cost	*$0*
Total Treatment Capital Project Cost	*$0*
Total Ditches & Diversions Project Cost	*$0*
Total Streams and Habitat Project Cost	*$0*
Total User-Specified Capital Project Cost	*$0*
Total Additional Project Costs	*$0*
Construction Project Costs Subtotal (Non-Reservoir)	***$0***
Total Reservoir Project Cost	*$0*
Construction Reservoir Project Cost Subtotal	***$0***

Project Development Costs

Land Acquisition	*$0*
Total Water Rights Project Cost	*$0*

Non-Reservoir Project Development Costs

Engineering Services	*$0*
Surveying	*$0*
Legal Service	*$0*
Financing and Bond Assistance	*$0*
Environmental and Cultural Studies	*$0*
Permitting	*$0*
Interest During Construction	*$0*
Power Connection Costs - Pump Stations	*$0*
Project Development Costs Subtotal (Non-Reservoir)	***$0***
Total Project Cost (Non-Reservoir)	***$0***

Reservoir Project Development Costs

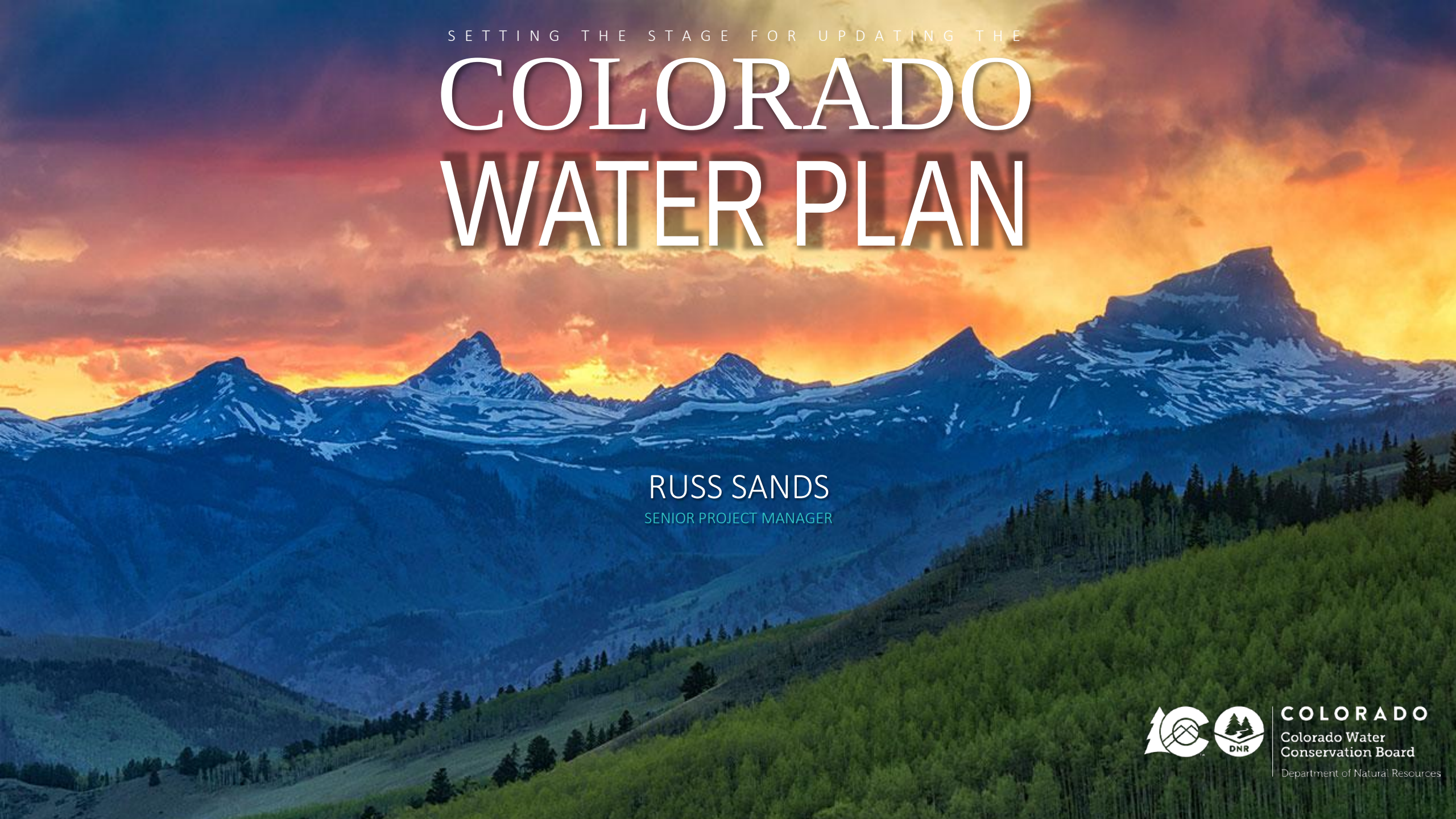
Colorado Water Project Cost Estimating Tool – Intended Use

Limitations

- Does not replace developed and/or detailed cost estimates

Provides

- Basins a tool to estimate/report planning-level costs for proposed projects
- Basins a tool for financial reporting of project cost estimates during BIP development
- CWCB like-for-like comparisons of proposed projects across the state



SETTING THE STAGE FOR UPDATING THE

COLORADO WATER PLAN

RUSS SANDS

SENIOR PROJECT MANAGER

COLORADO

Colorado Water Conservation Board

Department of Natural Resources

TECHNICAL WEBINARS

- February 19 — SWSI Methodologies Overview and Population Data
- March 19 — Municipal and Industrial Data & Methodologies
- April 23 — Agricultural Data & Methodologies
- May 21 — Environmental Data & Methodologies
- June 25 — SWSI Tools & Next Steps

SIGN-UP FOR WEBINARS

WEBINARS

UPDATING THE WATER PLAN

A ANALYSIS + TECHNICAL UPDATE PHASE

B BASIN PLAN UPDATE PHASE

C COMPREHENSIVE UPDATE PHASE

THE COLORADO WATER PLAN

A B C

TABLE 11-1 CYCLICAL PLANNING PROCESS PROPOSED BY THE CWCB

Product	Year Initiated
Basin Implementation Plans	2013
Colorado's Water Plan	2013
Statewide Water Supply Initiative	2016
Basin Implementation Plans	2018
Colorado's Water Plan	2020
Statewide Water Supply Initiative	2022

ACTIONS

1. The CWCB will work with other state agencies, the basin roundtables, and the people of Colorado to update Colorado's Water Plan, beginning no later than 2020.
2. The CWCB will develop guidelines for Basin Roundtable WSRA grants to help facilitate the implementation of the BIPs.

CLARIFY THE MESSAGE

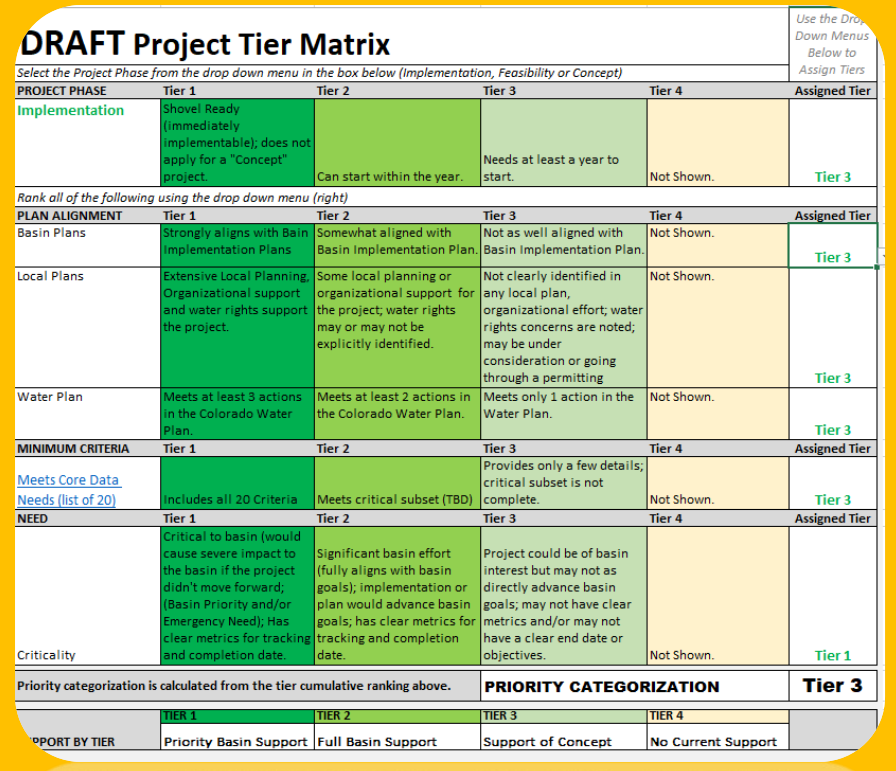
- Rebrand; make it clear how various plans are connected
- Help people understand where you're going and why
- Can't just be "because" – show the Value Add!

BETTER NUMBERS SUPPORT BASIN FUNDING

1. UPDATE PROJECT LISTS

2. UTILIZE COSTING TOOL

3. IDENTIFY HOW PROJECT LISTS MIGHT BE TIERED



DRAFT Project Tier Matrix

Use the Drop Down Menus Below to Assign Tiers

Select the Project Phase from the drop down menu in the box below (Implementation, Feasibility or Concept)

PROJECT PHASE	Tier 1	Tier 2	Tier 3	Tier 4	Assigned Tier
Implementation	Shovel Ready (immediately implementable); does not apply for a "Concept" project.	Can start within the year.	Needs at least a year to start.	Not Shown.	Tier 3

Rank all of the following using the drop down menu (right)

PLAN ALIGNMENT	Tier 1	Tier 2	Tier 3	Tier 4	Assigned Tier
Basin Plans	Strongly aligns with Bain Implementation Plans	Somewhat aligned with Basin Implementation Plan.	Not as well aligned with Basin Implementation Plan.	Not Shown.	Tier 3
Local Plans	Extensive Local Planning, Organizational support and water rights support the project.	Some local planning or organizational support for the project; water rights may or may not be explicitly identified.	Not clearly identified in any local plan, organizational effort; water rights concerns are noted; may be under consideration or going through a permitting	Not Shown.	Tier 3
Water Plan	Meets at least 3 actions in the Colorado Water Plan.	Meets at least 2 actions in the Colorado Water Plan.	Meets only 1 action in the Water Plan.	Not Shown.	Tier 3

MINIMUM CRITERIA	Tier 1	Tier 2	Tier 3	Tier 4	Assigned Tier
Meets Core Data Needs (list of 20)	Includes all 20 Criteria	Meets critical subset (TBD)	Provides only a few details; critical subset is not complete.	Not Shown.	Tier 3

NEED	Tier 1	Tier 2	Tier 3	Tier 4	Assigned Tier
Criticality	Critical to basin (would cause severe impact to the basin if the project didn't move forward; (Basin Priority and/or Emergency Need); Has clear metrics for tracking and completion date.	Significant basin effort (fully aligns with basin goals); implementation or plan would advance basin goals; has clear metrics for tracking and completion date.	Project could be of basin interest but may not as directly advance basin goals; may not have clear metrics and/or may not have a clear end date or objectives.	Not Shown.	Tier 1

Priority categorization is calculated from the tier cumulative ranking above.	PRIORITY CATEGORIZATION	Tier 3

	TIER 1	TIER 2	TIER 3	TIER 4
PPORT BY TIER	Priority Basin Support	Full Basin Support	Support of Concept	No Current Support

GRASS ROOTS EFFORTS HAVE TO KEEP GROWING

1. HAVE BRT GOALS CHANGED? (50% TURNOVER)

2. EVALUATE LOCAL GAPS AND OPPORTUNITIES?

3. INTEGRATE NEW BASIN PLANNING EFFORTS (e.g. SMPs)

LIVING PLANS ONLY
LIVE IF THEY GET UPDATED

1. WHAT NEEDS TO BE UPDATED IN THE WATER PLAN?

2. HOW ARE WE TRACKING PROGRESS?

3. WHAT ACTIONS ARE COMPLETED OR NEED TO BE ADDED?

"Chapter 11 confirms that the plan is a living document that will require updates on an ongoing basis."

- Colorado Water Plan

HOW WE'RE PLANNING TO GET THERE.

YEAR 1
Procurement & Project Lists

YEAR 2
Document Updates

2019 SEPT — 2020 SEPT — 2021 SEPT

C-9

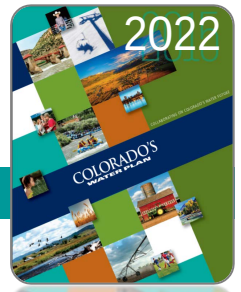
HIRE CONTRACTORS
SEPT '19 – JAN '20

UPDATE IPPS
FEB '20 – AUG '20

ANALYZE + UPDATE BIP DOCUMENT
SEPT '20 – SEPT '21

C-9

WATER PLAN
NOV '20 – NOV '22



SUMMIT

AGENDA

SEPTEMBER 25 + 26 2019

QUESTIONS?

Brown AND Caldwell

JACOBS

CDM Smith

COLORADO
Department of
Natural Resources